O&M Manuals

PROGRAMMED MAINTENANCE DIRECTIVE

Programmed Maintenance Instructions Mechanical & Electrical Systems

Regulatory Requirement

Regulation 40 requires that every workplace, and the equipment, devices and systems to which this regulation applies, is maintained in an efficient state, in efficient working order, and in good repair.

This includes building fixed services, such as electrical and mechanical systems installed to support the safe operation of the building.

Scope of Building Fixed Services

Building fixed services include
- Electrical distribution systems (LV panels, distribution boards, cabling)
- Lighting and emergency lighting systems
- Fire detection and alarm systems
- HVAC systems (heating, ventilation, air conditioning)
- Domestic water services and drainage systems
- BMS (Building Management Systems) and controls
- Security and access control systems

Key Principles

Planned Preventative Maintenance (PPM
- A structured maintenance regime shall be implemented to ensure ongoing system reliability and compliance.

Efficient Operation
- Systems operate as intended, in accordance with design parameters and commissioning set points.

Timely Repairs
- Faults, defects, or deterioration shall be identified and rectified without delay.

Record Keeping
- Maintenance activities, inspections, and repairs shall be recorded and retained.

Competent Persons
- Maintenance and servicing shall be carried out by suitably qualified and competent personnel.

The O&M Manual supports compliance with Regulation 40 by providing:
- System descriptions and operational guidance
- Maintenance schedules and procedures
- Manufacturer's instructions
- Testing and inspection requirements
- Fault finding guidance
- Spare parts and lifecycle information

This O&M Manual contains information and strategies designed to guide operational participants in the normal use and maintenance of this project's equipment and facilities actions and responses to anything that may arise during the life of the equipment.

For this reason, this O&M manual should be treated as a live document, remaining flexible to accommodate changes and further developments that will inevitably occur as the building and buildings services mature

Authorised persons

The persons carrying out practical maintenance or servicing must possess the correct level of competence as required to perform such tasks together with a working knowledge of the systems installed.

There has to be a complete understanding of each item of plant, including risk assessments, frequency of maintenance, recording processes and safety measures required.

If an item of equipment is within the warranty of guarantee period, it is essential that all processes are in total accordance with specific manufacturers maintenance requirements, if in doubt, a consultation with the installers and manufacturers is advisable beforehand.

Observational and Planned Maintenance procedures

GREEN	Observational checks carried out by occupants
BLUE	Practical maintenance carried out by authorised in house persons or specialist contractors
RED	Practical maintenance carried out by authorised specialist contractors only

A Guideline for Occupants

This information provides simple day-to-day observational checks of the electrical and mechanical building services included in this project. With a vigilant approach, potential problems can be identified quickly and before they turn into more serious issues.

Carried out by The Occupant

The occupant can perform these procedures by the normal daily operations of the systems; they are simple observational routines that will not require any technical knowledge in order to carry them out.

Basic Daily Observations Electrical and Mechanical Services

LOOK	Look for any change in the appearance of installed equipment or their surroundings note signs of thermal damage or water leakage as well as poor structural conditions, obvious missing components, faceplates, covers or fixings, or exposed wiring or dripping fluids
LISTEN	Listen for the changes in the usual sounds that the services or appliances make, are they running louder or quieter than usual, spluttering with intermediate loss of services, humming noises, rattling sounds often suggest loose components
SMELL	Unfamiliar odours and smells indicate electrically powered equipment has become overheated or in need of cleaning due to a build-up of dust or dirt. Odours from mechanical systems smells due to the accumulation of leaks that create pools of stagnant water or fluids.
FEEL	Feel abnormal vibration from appliances during starting up or shutting down process or continual operating conditions, water hammering suggests loose pipework or termination connections or centrifugal motors have become unaligned and need resetting.
INFORM	Inform the building service team resident on site in such an occurrence, and determine if the systems are safe to continue to use

These rudimental daily observations are as important as the regulated maintenance and services programmes carried out periodically to ensure the wellbeing of the buildings and occupants.

Early discovery can prevent problems manifesting into major emergency situations.

Important Daily Observations Checking List

1. Wear and tear in evidence
2. Deterioration in performance levels
3. Missing items such as screws and covers
4. Broken equipment or parts
5. Overheating and its signs of thermal damage
6. Properly secured doors and covers on electrical enclosures
7. Obstructions to switch gear
8. Loose fixings
9. Proper labelling

Things that Occupier could look out for:

Electrical Services

1. Loose or missing specialist alarm components
2. Luminaires are securely mounted and do not get hot when in use
3. Lighting PIR not operational
4. Wiring cables that have become exposed
5. Missing or damaged wired accessory faceplates
6. Broken or damaged switches
7. Missing fuses in fixed wired spur units
8. Noticeable reduction in lighting level from luminaires
9. Plug tops become hot when in use
10. The surface of wired accessories become hot when in use
11. Malfunctions of Call and Alarm Systems
12. Consumer Units trip continuously
13. Burning smells
14. Electrical power surges
15. Electrical shocks from appliances or metallic surfaces

Mechanical Services

1. Deteriorations in water pressure
2. Overall quality of water
3. Water is cloudy or has particles of dirt
4. Water hammers
5. Drain blockages or back flow issues
6. Exposed water pipes other than those deigned to be exposed
7. Rapid build ups of lime scale
8. Soil pipe odours
9. Freezing pipework
10. Leaking pipework
11. Smells from extract fans

Associated Structural issues

1. Plaster cracking around wall or ceiling mounted appliances or controls
2. Water seepage from other apartments
3. Signs of damp patches
4. Damage where pipework or cabling enters the building
5. Water damage to floors
6. Electrical spikes or shocks from walls or structures
7. Ceiling or wall mounted appliances are loose or not securely fixed to structures
8. Disruption to structure caused by animals, birds, rodents etc.

First Year Operation and Maintenance Requirements

WARNING
The maintenance of equipment or replacement of spare parts, servicing or cleaning is never undertaken while equipment is still live and connected to a main supply of any kind.

Ensure all electrical, pressure systems, gas, or mains water supplies are dead and locked off and remain so before and during any work is being carried out or Maintenance and Repair teams

It is typical contractual practice to require manufacturers and installers, as a form of warranty of their work, to be formerly responsible for any equipment, component or operational defects, that may arise or become apparent within the agreed liability period.

This liability period usually operates for a year after the final hand over of the dwelling; in some cases, this liability period is shorter or sometimes longer. Each contract will have a unique contractual agreement and therefore confirmation should be sought from manufacturers and installers for each aspect.

It is stressed that the contractual or warranty responsibilities for defects in the liability period after formal completion have nothing to do with, and do not include responsibilities from routine maintenance.

It should be further noted, that the need for maintenance attention does not lessen because the installation is new. Indeed, it may be argued that the need for maintenance attention during the running in period is greater than under normal circumstances.

Reporting

A reporting system is required so that occupiers can report any observed and potential problems to relevant parties such as Facilities Management

Useful Time Frames

Vital services that have battery backup facilities should have batteries renewed at least annually, or directly after a long period of use due to a fault condition. Often, appliances will 'beep' to signal that batteries are coming to the end of their life, and the occupants should have spare batteries for such an occurrence.

Maintenance & Operational Guidelines key Strategies

Efficiency	To make sure that the installation and equipment continues to operate efficiently
Prevention	To prevent the dangers that could arise in the event of a failure
Failures	To prevent the cost associated with system failures
Pollution	To minimise the environmental pollution which can occur if the by-products of maintenance are not disposed of correctly

Annual Maintenance Summary

All equipment installed will have the same principles of routine and regular maintenance procedures, which should be carried out and recorded as a standard requirement

A list of routine and regular maintenance applicable for each section of equipment includes

Basics

1.	Equipment being used for the purpose designed and intended
2.	Competently trained operatives only using the equipment
3.	Equipment working as intended
4.	Area around the equipment is adequate and not cluttered
5.	Equipment is generally clean, dust and dirt free, no burning smells, no vibrations
6.	Equipment is sound without exposed working or current carrying parts
7.	Adequate assistance available in the case of an equipment malfunction
8.	Any equipment malfunctions or poor operations are reported immediately
9.	Equipment not used until problems correctly repaired or replaced

Regular and routine procedures

1. Competently trained operatives only carrying out maintenance procedures
2. All equipment is isolated before maintenance work starts
3. Where required, adequate Access Equipment and methods are used
4. Correct tools and calibrated testing equipment employed
5. Required maintenance records are available and up to date
6. Repairs or replacement requests from previous maintenance attended to
7. Previously carried out Risk Assessments are understood and compliant
8. Previously on-going recorded problems have been rectified
9. Associated areas have been notified of maintenance work being carried out
10. Previously fitted spares or new parts are performing to the required standards
11. Equipment is not adversely affecting other adjacent equipment
12. All guards and protective devices where required are in place and working
13. All switching and isolating procedures work correctly and immediately on request
14. Correct environment protection, ie free from water, steam, ingress potential
15. All new parts and spares are in accordance with the equipment
16. Modifications to equipment do not overload the equipment and render it unsafe
17. Specialist equipment is maintained by Specialist Contractors or Engineers
18. Equipment is maintained at regular intervals as recommended by manufacturer
19. All commissioning records are up to date
20. Adequate supplies of essential spare parts are readily available
21. Faulty equipment remains isolated and un-used until repaired and tested

Specific details of actual equipment installed are featured in Equipment Installed Section and pertinent to each system in particular. These are general guidelines to offer information regarding preparation and monitoring

Identification of Residual Maintenance Risks

Discipline	Hazard	Risk	Control Measures
Cleaning of lamps or fittings including emergency lighting luminaires	Person or materials failing from heights	Medium	Use of scaffold tower, cordon off area below, use a non-alcohol-based cleaning solution on a non-abrasive cloth.
Test & inspection of fixed power wiring	Risk of electrocution	Medium	Isolate power to circuits being worked on, test circuit is dead before performing acts of work
Test & inspection & tightness check of the distribution system	Risk of electrocution	Medium	Isolate power to circuits being worked on, test circuit is dead before performing acts of work
Test & inspection of the fire alarm equipment and wiring	Damage to the fire alarm panel or accessories	High	Where possible, employ a specialist in this field.
Replacement of lamps or fittings including emergency lighting luminaires	Person or materials failing from heights, risk of electrocution	Medium	Use of scaffold tower, cordon off area below isolate power to circuit before performing nay acts of work.
Replacement of louvres on lighting fittings in general	Person or materials failing from heights, risk of electrocution	Medium	Use scaffold tower cordon off area below.
Testing & inspection of the fixed lighting wiring including emergency lighting luminaires	Risk of electrocution	Medium	Isolate power to circuits being worked on, test circuit is dead before performing acts of work
Cleaning of socket and spur units	Risk of electrocution	Low	Use a non-alcohol-based cleaning agent and a non-abrasive clot.
Replacement of sockets. Spurs and light switches	Risk of electrocution	Medium	Isolate power to circuits being worked on, test circuit is dead before performing acts of work.
Isolation of distribution boards	Risk of electrocution	Medium	Before removing the cover off the distribution board check isolator handle is switched off. Test distribution board is dead before performing acts of work.
Relocation of isolators	Risk of electrocution	Medium	Isolate power to circuits being worked on, test circuit is dead before performing acts of work
Cleaning or replacing components connected to the fire alarm system	Risk of damage to fire panel and accessories	High	Where possible, employ a specialist in this field.

List of Consumables for Mechanical Plant

1.	Light oil for lubrication
2.	Inhibitors for heat emitters and radiators
3.	Recommended Fan Blades
4.	Refrigerant replacements
5.	Filters, rubber seals, washable cores
6.	Gate Valves
7.	Complete replacement motors for essential services
8.	Replacement Essential pump
9.	Water chlorination - registered users only
10.	Storage Tank cleaning agents – registered users only
11.	Replacement thermostats
12.	TRV/Lock Shield valves as appropriate
13.	Light oil for lubrication of moving mechanical parts

List of Consumables for Electrical Plant

1.	Cell and button batteries
2.	Standard batteries
3.	Spare lamps – suggested 4x each type
4.	Utility use lamps
5.	Cables
6.	Plug tops and specialist connection interfaces
7.	Spare MCB's/RCBO's
8.	Standard fixings and wall mountings
9.	Terminal sprays
10.	Phase PVC tapes
11.	Collection of rated fuse links
12.	Identification labels

Life expectancies

Life expectancies of equipment and plant could vary due to their extended use or periods of dormant activities, but with regular servicing and maintenance procedures, it could be expected that mechanical plant should provide an expected active life span of 15 years before complete overhauls or wholesale changes could be required.

With electrical plant items, items such as lamps and light sources and fuses may have a much shorter life expectancy and will require regular replacements to form part of the overall strategy.

WARNING!

It is important to understand that remotely controlled systems could become re-energised without warning. BEFORE starting any maintenance or servicing works, ENSURE that where installed, backup generators and like systems are ISOLATED and "LOCKED OFF' and cannot automatically return mains power to any system at any level including a standby operation.

Also ensure that other site operatives cannot reconnect any mains supplies without the maintenance team's knowledge. The maintenance and servicing of Lock Off Devices are also a vital aspect of this process.

The Importance of Maintenance

Maintenance is essential to ensure that buildings and other built assets present a good appearance and operate at optimum efficiency. Apart from decay and degradation of the building itself, inadequate maintenance will reduce performance, affect health and threaten the safety of occupants and those in the vicinity.

Depending on its design, quality of materials and workmanship, function and location, buildings deteriorate at different rates and require different levels of attention. No building will be maintenance free but the quality of the design and workmanship can minimise the level required. Maintenance can assist with:

1.	Prevent the process of decay and degradation
2.	Maintain structural stability and safety
3.	Prevent unnecessary damage from the weather or general usage
4.	Determine the causes of defects and so help prevent re-occurrence
5.	Ensure continued compliance with statutory requirements
6.	Prevent the process of decay and degradation

Maintenance Management items covered

1. Basic Operations
2. Introductions to the Objectives of Maintenance
3. Building Services Designers
4. First Year Operation and Maintenance Requirements
5. Maintenance Techniques and Applications
6. Types of Maintenance
7. Establishing a Maintenance Policy
8. Choice of Maintenance Strategy
9. Spare Parts Policy
10. Maintenance Contracts
11. Maintenance Strategy and Inspection Frequencies
12. The Design Stage
13. The Operational Stage
14. Plant Maintenance Frequencies
15. Statutory Documentation for all buildings
16. Statutory documentation for buildings where applicable
17. Energy Efficiency and Maintenance
18. Gaining an Overview using Audits
19. Legislation and Codes of Practice
20. Energy Efficient Brief
21. Metering
22. Lighting
23. Heating and Hot Water
24. Electrical Power
25. Controls
26. Refrigeration Systems
27. Energy Policy
28. Checking Energy Consumption
29. Controls for Building Services
30. Purpose of Controls
31. Periodic Re-commissioning
32. Control Components Influences
33. Routine Controls Maintenance Checks
34. Building Management Systems – BMS
35. Commissioning and Testing
36. Documentation

Before Maintenance Starts

1. Competently trained operatives only carrying out maintenance procedures
2. All equipment is isolated before maintenance work starts
3. Specialist Maintenance carried out by nominated Specialist Contractors
4. Ensure that no backup systems are likely to return equipment to mains power
5. Use test equipment to ensure equipment is dead
6. Where required, adequate access equipment is used and by authorized persons
7. Correct tools and calibrated testing equipment used
8. All new parts and spares are in accordance with the equipment
9. Maintenance records from previous serving available, read and understood
10. Repairs or replacement parts that failed last service have been rectified
11. Previously reported malfunctions have been rectified
12. Associated areas have been notified of maintenance work being carried out
13. Is the maintenance process a job for more than one person?
14. Update record logbook when maintenance completed

Objectives of Maintenance

Maintenance is becoming more analytical and numerically based, as well as dealing with failure probabilities, management of resources, and determining systems operating at minimum risk and optimum performance. Even greater emphasis is given to the consumption of energy required in operating plant and how this energy is monitored, controlled and economically used without compromising overall system performance levels.

Building services engineers provide the environmental conditions that assist business premises function at an optimum level while providing comfortable conditions for occupants and visitors to achieve the highest performance potential.

The engineering services that provide these conditions need to be properly operated and maintained throughout the lifespan of the building's services, many of which could extend to thirty years. This will ensure that they continue to perform efficiently and viably.

This guide is intended for the benefit of those involved in the operation and maintenance of engineering services. The intention is to identify current good practices and address those topics of a particular interest and significance at all levels of services, operations and maintenance.

Building Services Designers

Client's requirements with respect to the operation and maintenance of engineering services may differ but the primary interest in almost every case will be to accomplish trouble free procedures of the business premises.

There will also be an expectation that such operations are within the scope of staff that are trained and competent and will not require an abundance of expensive and additional specialists. Similarly, clients will not expect the maintenance demands to interfere unduly on their usage of the premises.

The environmental impact of a building and its engineering services is another area where the client's attitude may vary significantly. The attitude of some may be simply to stay the right side of the law. Others will be more committed to a formal environmental policy, which could further include third part assessments and certifications.

Whatever the attitude, the situation is clearly brought into focus when a complete plant or department becomes un-operable due to a failure or the onset of the end of life of particular components within the plant, which in turn will shut down a system.

At one end of the scale, a client may view running costs as being marginal when assessed against costs of maintenance staff wages and simply accept operating and maintenance expenditure as a necessity.

At the other end a client may challenge even the smallest of costs in order to keep these under continued review and to seek cost-effective means of improving efficiency and reducing expenditure.

Maintenance Techniques and Applications

The engineering plant and equipment used in buildings serves a variety of purposes. They provide the environmental conditions, which make occupants comfortable, for example.

1. Heating
2. Ventilation
3. Air Conditioning
4. Lighting
5. Small power electrical services
6. Communication Facilities
7. Telephones
8. Staff Location Systems
9. Data Transmissions
10. Normal and Emergency Standby power Systems
11. Electrical Distribution Systems
12. Basic necessities such as water systems

Once such services are installed in the building, they require continuing attention to ensure that they operate correctly and economically and that they are available for use when required.

Justification of maintenance

1. Compliance with the law, in particular health and safety requirements
2. Compliance with the terms of occupation or lease agreements
3. Protect the value of the property as an investment
4. Maximise plant utilization and minimise non-availability of the services
5. Provide a service to the building occupants
6. Ensure a safe, healthy environment for the building occupants
7. Ensure energy is used efficiently

Maintenance can comprise more than the controls of activities associated with each item of equipment, these can be addressed broadly under the heading of technical and control.

Technical Elements includes:

1. Determining what plant needs to be maintained
2. How often and at what level
3. Identifying problems and diagnosing causes
4. Monitoring effects
5. Preparing and analysing records
6. Technical information
7. Initiating procedures to cope with situations before they arise
8. Techniques are achieving the desired results

Control Elements include:

1. Providing the required technical services at minimum expense
2. Management of labour and spare parts
3. Monitoring where the work is required
4. Organising transport
5. Setting priorities
6. Co-coordinating systems
7. Setting budgets
8. Identifying higher maintenance costs
9. Collection of information to form a basis for decision making

Types of Maintenance

1. Planned Maintenance
2. Un Planned Maintenance

Planned Maintenance is organised, controlled and follows a recognisable and quantifiable procedures which can take several forms, such as;

1. After Fault Maintenance
2. Corrective Maintenance
3. Immediate or Deferred Maintenance
4. Before Fault Maintenance
5. Preventative Maintenance
6. Condition Based Maintenance
7. Scheduled and Continuous Maintenance
8. Scheduled by Programmes
9. Predetermined Maintenance
10. Opportunity Maintenance

With Unplanned Maintenance there is no organised arrangements to follow and everything is carried out as a reaction to a situation, such as:

1. We will fix it if it does wrong
2. When equipment fails to produce optimum and required output
3. An emergency situation has occurred due to poor state of the equipment
4. Operative has had an accident
5. Run to failure process

It is fair to say that in truth, most maintenance programmes have a degree of both planned and unplanned structures about them.

Working on 'Dead Systems'

It is a vital importance to make sure that the systems in question really is "Dead" and that it remains so for the whole of the time during which the work is continued. The pre-cautions to be taken before commencing work, must include-

1. Open all circuit breakers and isolating switches, remove fuses and so on. 2. Post "Warning 'Signs at all places to prohibit reclosing the electrical supply 3. Ensure signs are understood in the event of different languages etc.
4. The circuits concerned must be proved "Dead' by the use of a voltage testing device which itself is tested before use
5. Take other step to ensure that the supply will not be inadvertently reconnected. To this end, one or more of the following can be adopted 6. All fuses are removed, together with other current limiting devices 7. All switches and isolators opened must ne locked off with approved locking methods 8. Removal of plugs from portable appliances
9. Some circuits are controlled by time switches and are 'Dead' during the 'Off' period. Om no account must the workers rely on the integrity of the switch
10. If exposed live conductors are present in the working area, they must be clearly identified by Warning Notices, which are clear to all workers

Live Working in exceptional circumstances

The Electricity at Work Regulations make it very clear that working on a live electrical system must take place unless

1. It is unreasonable in the circumstances for it to be 'Dead'
2. It is reasonable in the circumstances for live working to take place
3. Suitable precautions are taken to prevent injury, including the provision of special protective equipment

Live working, including testing and fault findings should only be attempted when there is no other way of carrying out the work. The method is routinely used in many circumstances, notably when working on high voltage or low voltage systems. It is usual in such cases for those carrying out the work to be especially competent and practised.

Testing, maintenance and fault finding on electrical systems often cannot be carried out if the supply is disconnected, for example, the measurement of earth faults loop impedance includes the supply system, which must remain connected. In such cases, not only must the tester take great care, but must ensure that al instrumentation and connecting leads used at=re of the correct type for safe working

Establishing a Maintenance Policy

The maintenance policy of each installation is unique, but many variables are likely to apply generally and often, such as:

1. The implications of failure
2. This plant likely to fail
3. The probability of failure
4. Standby facilities available
5. Technical expertise available
6. This expertise is organised
7. Spares available on site
8. How quickly can spare be sourced if not kept on site
9. Are spare parts unique to the equipment
10. Are spare commercially available from a number of sources
11. The standard of maintenance required
12. What documentation will be required
13. How will compliance be demonstrated
14. The financial resources are available

Choice of Maintenance Strategy

In the early years, maintenance could be covered under liability periods or manufacturers warranties, and such, the installation will be kept as close to its original condition, but as wear becomes pronounced the needs of the occupants change, and technology improves, there is likely to be an increasing demand for extensive replacement and refurbishments.

Simple yes or no choices will exist here and consideration made, such as:

1.	Is the maintenance essential – Yes/No
2.	Is there a Safety Risk – Yes/No
3.	Is it cheaper to maintain than replace – Yes/No
4.	Are standby facilities available
5.	Would standby facilities be feasible and viable
6.	Are maintenance resources available on site

Whichever approach is adopted it should take account of anticipated future requirements of a building and its services.

Maintenance Contracts

For specialist services it may well be simpler and more cost effective to employ the services of a Maintenance Contractor. Usually these are already skilled in the specific areas required, more over they could have a direct affiliation with a manufacturer or agent responsible for the equipment in question.

Such a contract could be formed using these basic steps:

1.	An intention to create a legal partnership
2.	An offer made to the occupier by the installers
3.	Considerations for cost reduction

In addition, the following must prevail:

1.	Possibility of performance
2.	Contractual capacity
3.	Genuineness of consent

When selecting and employing Maintenance Contractors, ensure that all due diligence has taken place, to be confident that all aspects of the maintenance procedure is covered. Specialist systems could include:

1.	Specialist Alarms
2.	BMS Systems
3.	Fire Alarm and Emergency Lighting
4.	Luminaires located at high levels
5.	Seasonal controls of equipment
6.	Periodic Testing
7.	Health and Safety issues
8.	Operator Training
9.	Chemical cleaning requirements
10.	Control Systems
11.	Inhibitors, chlorination and legionella processes
12.	Removal of toxic materials or redundant equipment.
13.	Re lamping

Maintenance Strategy and Inspection Frequencies

The maintenance and inspection frequency for building services needs to be addressed at two stages, they are:

1 The Design Stage

Designers will have evaluated the suitability of equipment and the maintenance requirements of different design options. Designers will also consider using equipment that has minimum or no required maintenance requirements, and as such 'Design Out" the need for maintenance, and how support systems can be built into installations to facilitate efficient and cost-effective operations and maintenance. Key issues include:

1.	Positioning and sizing of plant rooms
2.	Plant reliability
3.	Requirements for specialist knowledge
4.	Requirements for specialist labour
5.	Spare's requirements and their availability
6.	After sales support
7.	Standardisation of plant and components
8.	Built in systems for monitoring
9.	Designing out maintenance
10.	Ease of maintenance

2 The Operational Stage

Apart from statutory requirements, for example, the frequency and nature of competent person examinations and their maintenance task capabilities, frequencies need to be selected to suit the needs of the particular item of plant.

The performance of building services is important to the operation of an organisation, and senior management retains the responsibility for setting the policy for wider issues of operation and maintenance of building services that will affect the organisations objectives, this will involve decisions on the following:

1.	The level of risk the organisation is willing to tolerate
2.	Methods of resourcing maintenance
3.	Budgets
4.	Benchmarks

A strategy must be able to establish the level of operation and maintenance that needs to be carried out to match expectations of the organisation and key criteria needs to be considered, such as:

1.	Compliance with the regulations and authority bodies
2.	Meeting the health and safety needs of the building users
3.	Ensuring the function, reliability of plant and equipment
4.	Optimising the utilisation of resources
5.	Satisfying the key objectives of the organisation
6.	Safeguarding assets

Plant Maintenance Frequencies

The purpose of regular maintenance of plant, equipment and services is to sustain their operating efficiency and to prolong economic life. This servicing will incur labour costs and will require the provision of materials such as consumables, for example, lubricants and replacement components.

The life cycle cost for serviced plant will therefore comprise its initial capital costs, replacement costs and its service costs over its complete life.

1.	Statutory requirements for example as recognised by Health and Safety
2.	Manufacturer's recommendations
3.	Standard Frequencies

Statutory documentation for all buildings

Statutory documentation as essential for all buildings

1.	Fire Risk Assessment
2.	Records of Fire Detection
3.	Checks on Fire Protection Systems
4.	Risk Assessments in relation to the Management of Health and Safety
5.	Legionella Risk Assessments
6.	COSHH
7.	O&M Manuals
8.	Record Drawings
9.	Emergency Lighting System Test Records
10.	Electrical Earthing
11.	Portable Appliance Testing
12.	Waste Disposal – Environmental Protection Act
13.	Gas Safety

Statutory documentation for specific services

Statutory documentation as essential for all buildings where applicable

1.	Records of Sprinkler Systems
2.	Lift Inspection
3.	Lifting Equipment
4.	Pressure Systems
5.	Smoke Extract Systems
6.	Records of maintenance and servicing of equipment containing refrigerants
7.	Asbestos Register

Energy Efficiency and Maintenance

All organisations use energy in some way in their operation regime and improving energy efficiency can offer a ready means of making cost reductions.

The key to energy efficient management of an existing building is to:

1.	Gain a sound understanding of how the building is meant to work
2.	Set out a clear energy management policy
3.	Organisational structures
4.	Highlight and encourage occupants to use the building correctly
5.	Set energy targets
6.	Monitor performance levels
7.	Set controls to adapt to seasonal changes

Gaining an Overview using Audits

To establish how the building is intended to be used and how it relates to overall performance, the following need to be established through a auditing process.

1.	Occupancy Levels including Cleaners and night workers
2.	Any different uses of particular areas within the building
3.	Gross and treated floor area
4.	Landlord and tenant agreements
5.	Key items of plant, what they supply and the areas they serve
6.	The means of heating and cooling
7.	Means of ventilation, and how it is controlled
8.	Types of lighting, areas served and how it is controlled
9.	How the building is managed

Tangible benefits from energy efficiency range from the individual to the national level to include:

1.	Improved design and operation of the building
2.	Better working environments
3.	Life cost savings
4.	CO2 emissions.

Legislation and Codes of Practice

The Building Regulations impose requirements aimed at improving energy efficiency in domestic and non-domestic buildings.

1.	Energy efficient and properly commissioned building
2.	Operators with sufficient information to operate systems efficiently
3.	Controls and constraints on the energy used to run systems

This requirement will include:

1.	Limiting heat loss and gains
2.	Providing space heating and hot water systems
3.	Providing lighting systems
4.	Limiting exposure to solar overheating
5.	Minimising the use of mechanical ventilation
6.	Providing sufficient information on operating systems efficiently

Energy Efficient Brief

An existing or new building should have an Energy Efficient Brief. This is required to be more complex than is appropriate for the type and size of the building. It should incorporate:

1.	The occupier's intentions, requirements and investigation criteria
2.	Energy targets
3.	Environmental targets
4.	Life cycle costs
5.	Specific operational equipment

Metering

Metering is a key part of the feedback mechanisms that are essential to monitor the status and operation of a building and allows the building manager to determine whether energy consumption is greater than expected or required.

Good metering is fundamental and an essential part of the energy management. Improved sub metering and benchmarking of end uses help building operators to understand and manage their buildings better, consequently resulting in energy savings.

Reasonable provisions of sub metering would be to improve additional meters so that consumptions can be directly measured or estimated, for example:

1.	Electricity, gas, oil and LPG
2.	Energy consumed by plant
3.	Heating or cooling systems

Lighting

Building Regulations Approved Document L2 states that lighting systems should be efficient and make effective use of daylight where appropriate. Requirements include:

1.	Minimum efficacies of lamps
2.	Energy efficient light sources, for example the use of LED's
3.	Efficiency of lighting controls
4.	Maximum power consumptions of control gear

Starting with the simplest and most economic options, every effort must be made to ensure the best use of daylight. This may require action to minimise solar gain and to ensure glare does not cause a nuisance to occupants.

Automatic dimming control of luminaires near to windows can be used as part of the daylight regime.

1.	Lighting switching should be arranged to match usage of accommodation
2.	Individual switching for cellular layouts
3.	Switching arrangements ideally coincide with departmental boundaries

Maintenance routines will improve lighting efficiency by a regular programme of cleaning lighting diffusers and by replacing luminaires as they become less efficient with age. There may also be advantages in replacing older type tubular fluorescent lamps with modern improved efficiency units including LED with an equivalent lighting output.

Heating and Hot Water

Periodic boiler efficiency tests and checks on boiler cycling ensuring that the system air venting is good.

Distribution temperatures checks to highlight insulation deficiencies and monitoring of control set points all have a contribution to efficiency.

The calibration of the set points for frost and condensation protection should be checked routinely to ensure that actuation temperatures are kept as low as practicable. As most buildings have a high thermal capacity and take a long time to cool, the actuation setting for condensation protection systems could be experimentally reduced so that the true need is established.

Temperatures of hot water systems need to be kept at appropriate levels to minimise legionella risk but there is usually some scope for timing the operating hours.

Variable speed pumping could be considered wherever the heating load profile shows this to be worthwhile.

Electrical Power

Large or small electrical power loads form a significant part of the total energy use in buildings.

Office equipment can typically account for more than 20% of the energy used in an office, lighting can be up to 25%. In larger offices, significant energy is consumed by the power systems supplying IT equipment. Careful design and selection can result in energy savings.

Transformers found on larger sites that usually take supplies at 3.3kV or 11kV will typically use about 1% which although is small, can again be significant and selection of the most efficient is important.

Uninterruptable power supplies will provide clean power to critical IT equipment. They have fixed losses, which become a larger proportion of output as the load falls, as such reducing their efficiency.

Computer room air conditioning is often uneconomical, using as much energy as the computer equipment although current best practice installations use some 65% of the computer power.

In air-conditioned offices, it can take 50% more energy to remove heat produced by the installed equipment itself. Oversized plant will lower operating efficiency. Catering equipment such as hot water, boilers, kettles, refrigerators and vending machines can contribute significantly to heat gain.

Considerable electrical power is used by electric motors and their rating should be appropriate to the essential duty. The use of variable speed drives ought to be considered wherever feasible and cost effective.

To put this into perspective, a fan or pump drive motor operating at half speed reduces power consumption by more than 85%.

Controls

Control systems can be complex. As well as trying to ensure that a control system is completing its function effectively, facilities managers need to ask whether they fully comprehend the system and verify if it is manageable. Controls need to be managed and maintained efficiently and economically.

Where this is not possible the need for a change is indicated. Perhaps the control system could be simplified or possibly the facilities manager and maintenance team be given better training.

The calibration of control sensors is a critical factor in ensuring that a control system function properly. In some instances, recalibration of controls is a demanding requirement consuming a significant proportion of the systems costs. The replacement of sensors with better quality components can reduce or even eliminate the problem of set-point drift as well as improving energy efficiency.

Routine maintenance checks are important on time switches and optimisers controls to ensure that the settings are as intended and appropriate to the operational regime.

For centralised system controls, access should be constrained to authorised personnel with the appropriate training and expertise. Even these operatives could be further instructed to modify control settings in accordance with proposals that have properly discussed and agreed.

Refrigeration Systems

It is important that only trained personnel with appropriate expertise carry out the operations and maintenance of refrigeration systems.

Skill and proficiency are essential for effective monitoring of a refrigeration unit system including charge levels, compressor cycling and pressures and temperatures throughout the refrigeration system circuits.

Water treatment needs to be applied and maintained to keep heat exchange surfaces clean and to maximise efficiency. This applies particularly to units with evaporative cooling where water treatment is crucial to control algae and microbial and bacterial activity this includes legionella.

Energy Policy

Adopting an appropriate and realistic energy policy delivers increased and sustainable performance and provides a clear sense of direction. Any new policy could review current practices and provide a good starting point to the energy campaign.

An energy policy will:

1.	Establish clear management commitments to energy efficiency
2.	Improve the overall approach to energy management
3.	Help to keep the main objectives in full view
4.	Maximise the use of resources both in time and money
5.	Provide goals against which to monitor
6.	Provide a clear direction for the energy team

Checking Energy Consumption

Energy consumption can be estimated using installed loads, estimated hours run and simple diversity factors

Controls for Building Services

Controls and control systems are an essential part of buildings and management of the internal environment. Control irregularities are also a significant cause of excessive energy consumption. These may be the result of inappropriate controls concept, poor design of the control system, poor equipment selection incorrect commissioning or inadequate maintenance

While maintenance may not be responsible for a particular fault in a control system, it can identify and rectify problems originating from earlier work, including improvements to the control system design.

Purpose of Controls

The fundamental purpose of building engineering services controls whether automatic or manual is to regulate the performance of systems to meet operational and environmental requirements, in accordance with the design intent. In most instances the designer takes account of energy efficiency in selecting control sequences and set point constraints.

Controls are needed to ensure safe operations and to achieve the required output from the building services systems and as such they act to achieve and then maintain a specific condition, for example, lighting or temperature controls.

Controls of the building services play a key role in meeting the requirements of Building Regulations Part L, which requires that buildings be operated in an energy efficient manner.

Three main functions of building controls are:

1.	To switch equipment on and off
2.	To adjust the output of equipment to maintain the required operating conditions
3.	To provide monitoring and metering functions

Mechanical maintenance of manual controls and automatic control actuators is necessary to ensure that these operate smoothly over their complete range. It is also important to check the set points and calibration of the control sensors to ensure satisfactory operation of the control system. In addition, the performance of the system should be monitored.

Periodic Re-commissioning

With some systems, monitoring may show a progressive deterioration of performance to a degree where re-commissioning becomes necessary.

Control Component Influences

Design provisions can aid the maintenance undertaking. For example, the provisions of high-quality sensors can reduce the tendency for set point drifting, and as such the need for regular calibration or even replacement. Intelligent controls can be arranged for self-monitoring; this can be a valuable asset in maintenance, provided that not too much faith is placed in this facility.

Routine Controls Maintenance Checks

Ideally the necessary routine checks of the control systems should be identified at the design stage and it would be prudent to seek guidance from the controls specialist. The installation engineer should identify and highlight those controls that are most critical to the effective performance of the design.

The range and frequency of routine checks of controls will depend on the actual installation and information gathered from the installers and manufacturers will be of benefit.

Typical controls checks could include:

1. The effective functioning of all safety devices of primary importance
2. Sensor set point calibration, typically on a rolling programme basis
3. Actuator functionality through the full operational range with more frequent checks on devices critical to the normal functioning of the organisation.

Details of routine checks should be recorded in the systems logbook in sufficient depth to permit the identification of re-occurring problems.

Building Management Systems – 'BMS'

A Building Management System is a control system, which performs the control and monitoring functions for some or all of the building plant and systems.

It is a network system with one or more operator stations delivering the user interface. For most applications the sensors and actuators are interconnected into outstations, which gather information, act to provide the form of control and transmit information to the operator terminal.

A full understanding of the Building Management System is generally confined to the manufacturer and it is not uncommon for a thorough understanding to be limited to the specialist responsible for constructing the system software.

The effectiveness of a Building Management System depends directly and fundamentally on the software, which it comprises. It is not unusual for manufacturers to be cautious in disclosing details of their systems and software, the reasons stated for this generally concern commercial sensitivity.

The manufacturers or a system house therefore generally undertake maintenance.

Commissioning and Testing

The commissioning and testing functions are legal requirements and categorised as follows:

1. Commissioning – is the advancement of an installation from static completion to working order according to specified requirements
2. Testing – is the measurement and recording of system parameters to assess specification compliance

Commissioning of buildings and their engineering services is important to their safe and energy efficient operation. This key stage in the construction process enables the installed systems to be operated according to the design intent.

When coupled with good maintenance practice, commissioning and periodic re-commissioning assists to provide the building occupants with a safe, good quality, comfortable internal environment using heat and electrical energy, whether generated on site or obtained from public networks.

The main factors influenced by the commissioning of the building services are:

1. Plant operation within the specified design parameters, including internal and external conditions
2. Maintenance of internal design parameters within defined tolerances at all load conditions
3. Minimising energy consumption
4. Future maintenance requirements

Good commissioning of building services requires specialist skills and knowledge. It also requires an early input in the life of a project, when key decisions relating to the construction process are taken.

Documentation

Comprehensive documentation to support commissioning and testing activities is of paramount importance. Such records will show that statutory requirements have been met both mechanically and electrically, allowing the building to be certified as safe for occupation.

Of much greater importance in the longer term, the commissioning documentation should provide a record that the commissioned systems operate in accordance with the design intent.

It is further essential that the completed documentation is kept safe and made readily available to everyone involved with the operation and maintenance of the building and its services.

This documentation will form a permanent record and reference manual to which interested parties can refer when checking the ongoing performance of the building services.

It is essential that any changes, modifications or investigations carried out are undertaken in a controlled and logical manner and that an audit trail is kept with the original commissioning and testing records.

At practical completion, the following commissioning information should be available:

1.	Main Plant Performance Results
2.	Air and Water Flow Regulations
3.	Specialist Plant Commissioning and Test Records
4.	Pipework and Ductwork Pressure Test Certification
5.	Fire Alarm Test Certificate
6.	Security/CCTV Certificates
7.	Sprinkler/Dry Riser Testing and Insurance Certifications
8.	Check Sheets recording System Interfaces
9.	BMS Commissioning and Testing Certification

Risk Assessment

- A risk assessment must be carried out, a Safe System of Work identified and the form completed and signed prior to commencing work. Control measures must be taken if dictated by the result of the risk assessment. Due regard must also be given to the Residual Hazards identified in the appropriate section of the Health & Safety File.

Isolate Supplies

- Before commencing maintenance work on any items of plant ensure that the associated supplies have been isolated and locked off and that all control and ancillary circuits have been made dead.

Manufacturers Literature

- These general maintenance guidance notes are supplemented by particular manufacturers recommendations: Refer to the companion manufacturers literature documents.

B&ES

- These general maintenance guidance notes follow the standards/frequencies recommended by the Building & Engineering Services Association Standard Maintenance Specification for Building Services SFG 20.

Health & Safety

- All work must be carried out in accordance with the Health and Safety at Work Act 1974, Health & Safety Electricity at Work Regulations 1989 (encompassing BS7671 2008 17th Edition IET Wiring Regulations and Amendments and Associated Guidance Notes) and associated legislation and HSE Guidance Publications.

Daily/Weekly Tasks

- Routine Daily/Weekly inspections and tasks must form part of the maintenance routine and actions arising must be dealt with.

Spares

- For details of Spares Recommendations refer to the manufacturers recommendations where provided.

Specialist Equipment

- It is recommended that a Maintenance Contract is placed for any specialist equipment.

Competent Person

The following term has been defined in BS8210:2012. A Competent Person having sufficient professional or technical training, knowledge and experience them to:

- To carry out allotted duties at the level of responsibility laid down
- To understand fully any potential hazards when carrying out those duties.

Useful Time Frames

Vital services that have battery backup facilities should have batteries renewed at least annually, or directly after a long period of use due to a fault condition. Often, appliances will 'beep' to signal that batteries are coming to the end of their life, and the occupants should have spare batteries for such an occurrence.

Checklist of Energy related Maintenance Issues

A switch it off policy requires no capital expenditure but requires the cooperation of all the staff, particularly maintenance staff who are responsible for a large part of the good housekeeping.

Details
1. Adjust controls to match heating, cooling and lighting use to occupancy periods and to ensure service levels meet the need of occupants, for example, avoid overheating, overcooling and excessive lighting levels
2. Establish responsibility for control settings, review and adjustments
3. Arrange partitioning and layout to make best use of natural lighting and building services
4. Concentrate out of hours occupancy in as few areas or buildings as possible and run plant in these areas only
5. Switch off non-essential office equipment when not in use
6. Close windows and doors when the building is unoccupied during the heating season
7. Ensure automatic door closers function properly
8. Discourage supplementary electrical space heating appliance except for out of hours use when, otherwise central systems would have to be operated
9. Switch off miscellaneous extract fans when the building is unoccupied unless continuing operation is essential
10. Use window shading devices during summer to minimise air conditioning loads. Close blinds etc. during the heating seasons and when dark outside to minimise radiation losses
11. Reduce heat generation from internal sources during the cooling seasons, ie lighting, machines, cooking equipment
12. Ensure catering equipment is only on when necessary, particularly kitchen ovens, hot plates and dish washers, but also local water urns, vending machines etc
13. Instigate a purchasing policy that considers energy consumption when buying new equipment
14. Ensure that security staff and cleaners practice a switch it off policy

Building Fabric

Maintenance of the building fabric is essential to avoid excessive air infiltration and to minimise heat losses

Details
1. Re hang mis-aligned doors and windows
2. Replace weather stripping and sealants around windows and doors if damaged
3. Keep curtains and blinds clean and in good working conditions
4. Ensure that openable windows can be properly closed and latched with a good seal
5. Replace broken or cracked glazing
6. Replace or upgrade damaged or missing insulation

Controls

Regular checking and maintenance of controls to ensure correct setting and operation is fundamental to energy efficiency, check to ensure that

Details	
1.	Controls are correctly commissioned and are set at the desired levels, also ensure that calibration of sensors and controls has not drifted
2.	The building environment is regarded as comfortable and that changes in building use have not occurred to warrant alterations in the controls
3.	Zone controls meet the needs of the occupants and there are no occurrences of overheating, over cooling or annoyance due to automatic light switching
4.	Plant operating times are optimised and time switches and optimisers operate in accordance with the intended settings and provide appropriate flexibility in relation to occupancy patterns
5.	Weather compensators and optimisers have been fine-tuned over a long period in order to find the best settings
6.	Occupants understand the use of local controls for example, that room thermostats and TRV should be left alone once set rather than used as on/off switches
7.	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
8.	Central plant is modulating and sequencing to match the load while ensuring that controls are stable, not causing excessive cycling, unnecessary or standby by plant should remain off particularly during periods of low demand
9.	Simultaneous heating and cooling do not occur except where maximum control is essential
10.	A current record of the control settings is displayed near to the controls to assist in returning them to optimum settings if they have been tampered with

Ventilation Systems

Good maintenance of ventilation and air conditioning plant cab 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.

Details	
1.	Correct operations of window ventilation fittings and furniture
2.	Cleanliness of all equipment components, particularly, heat transfer surfaces, fan blades and interior fan casings
3.	Motor drives, where necessary, replace worn bearing and ensure correct drive alignments. Correct tensioning of belts is critical
4.	Operation of volume control devices such as speed controls, VAV boxes, dampers etc. ensure that damper blades and linkages for proper operation and tight shut off for accurate control
5.	Pressure drops, ensure that they are in accordance with the manufacturers data for example, heating and cooling coils, filters, casing interiors etc. clean outlets and inlet grilles regularly
6.	Ductwork insulation, repair or replace where necessary
7.	Absence of air short circuiting, absence of leaks in ducts as this increases heating and cooling load as well as fan consumption
8.	Lubrication of fan, fan motors and bearings
9.	Regularly vent air from heat exchangers, particularly fan coil units, where they become noisy or output is reduced
10.	Ensure correct operation of unitary air conditioning equipment, for example, 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 the units

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;

Details	
1.	Refrigerant is free of moisture by regularly inspecting moisture liquid indicators, clean filters and re-charge refrigerant when necessary
2.	Refrigerant charge is correct as low charge reduces heat transfers
3.	Expansion valves are correctly set
4.	Insulation on suction and liquid lines is in good order
5.	Chilled water temperatures are increased when humidity or load conditions permit
6.	Condenser water temperatures and flow rated are kept to a minimum
7.	Compressor operating pressure and temperatures are correct, particularly suction pressure and oil pressure, investigate any changes that occur
8.	Compressor is not cycling excessively as this may indicate inefficient operations
9.	Compressor noise level is not abnormal, excessive noise or vibration may indicate drive needs attention
10.	Compressor joints and shaft seals are not leaking
11.	Chiller performance is monitored regularly by recording water inlet and outlet temperatures and flow rates or water side pressure drop, to ensure cleanliness of water side heat transfer surfaces, investigate any variations from the normal operations
12.	Refrigerant pressures, air flow rates and temperatures are set correctly to keep air cooled condenser performance high
13.	Heat rejection equipment, for example cooling towers, performance is monitored by recording ambient wet bulb temperatures and flow rates

Lighting

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 doors is particularly important, other checks would ensure that;

Details	
1.	Efficient lamps, light sources and ballasts are used when replacement is carried out
2.	Internal surfaces are decorated with light colours to obtain benefit from natural and electric lighting
3.	Surfaces are kept clean
4.	The operation of controls is effective and they are suitable for space occupancy and use
5.	Lights are switched off when not needed

The reduction in light output due to luminaires and rooms becoming dirty can be very significant. In addition, the light output from most lamps and light sources decrease as they age. The illuminance from a lighting installation, therefore, decreases with time and the lack of maintenance will affect energy consumption and the productivity of occupants. The following measures can be taken.

Details	
1.	Clean uplighters more frequently as they are particularly prone to a rapid build-up of dust
2.	Use proper cleaning materials and techniques to reduce losses caused by chemical action or scratching of optics and electrostatic dust accumulation. Glass and acrylic diffusers generally have the longest useful life, whereas polystyrene tends to discolour with age and reduce the light output from a luminaire
3.	Plan group replacement of discharge lamps in all but the smallest installation. This is more sensible than only replacing individual lamps when they fail as it prevents efficiency and illuminance falling too low

Heating and Hot Water Systems

Heating and hot water systems require regular maintenance in order to ensure efficient operation, such as;

Details
1. Check boiler operating pressures, temperatures, fuel consumption and investigate any variations from normal operations
2. Check flue gas analysis, adjust burners to achieve most flue gas temperatures, CO2, O2 and. Excess air settings
3. Check cleanliness of water and fire side heat transfers surfaces. Ensure that water treatment levels are maintained and the system is free from sludge and scale
4. Ensure that boilers are not cycling excessively, indicating inefficient operation
5. Check the boiler and primary pipework insulation
6. On oil fired boilers, check the condition of nozzles or cups of burners, cleanliness of oil line strainers and the correct operation of the oil heaters
7. On gas fired boilers, check wear and cleanliness of oil strainers and correct operation of oil burners
8. On gas fired boilers, check wear and cleanliness of burners, burner gas pressure, operation of gas boosters, operation of governors and controls
9. On electric boilers and immersion heaters, check cleanliness and freedom from corrosion of elements and electrodes, wear and alignment and spacing of elements and electrodes, absence of loose connections
10. To avoid waste on steam boilers, meter feed water, steam output, blowdown and percentage condensate return
11. Repair steam leaks without delay
12. Ensure cleanliness of heat transfer surfaces, filters and air paths through convectors, induction units, fan coil units etc.
13. Ensure that frost protection systems are not set too high causing unnecessary operation of the heating system
14. Check that pump drives are in good condition, tighten belts and pulleys, replace worn bearings and ensure correct drive alignment. Correct tensioning of belts is critical. Ensure pump noise or vibrations is not abnormal, indicating incorrect operation
15. Check correct hot water storage temperatures are maintained but only for the periods necessary
16. Ensure that spray taps and percussion taps operate correctly
17. Check the control settings and wash any air filters on electric heating systems. The unitary nature of electric heating enables an individual heater to be replaced, if needed, without affecting the integrity of the heating systems as a whole

Motors and Drives

Correct maintenance of motors helps to keep operational efficiencies high

Details
1. Lubricate motor bearings in accordance with the manufacturer's instructions since inadequate lubrication results in excessive friction and torque, leading to overheating and power losses
2. Check motor shaft to load alignments to reduce running losses, bearing wear, noise and vibration, where necessary tighten belts and pulleys
3. Clean motor fans inlets and frame surfaces so that generated heat can be removed efficiently. An increase in the motor stator winding temperature of 1ºC can result in up to 0.5% increase in the losses as well as shortening the life of the motor insulation. Ensure good ventilation to prevent over heating
4. Replace worn brushes, belts, sheaves, bearings and gears as necessary
5. Check loading on large motors compared with rating and consider replacements
6. 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
7. Check the power factor at varying loads is within acceptable limits, consider power factor correction where necessary
8. Check electrical connections and contacts for corrosion and arcing and attend to lose 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 impeding failure
9. Use motor circuit analysis to measure the absolute and relative resistance, inductance and capacitance of the motor circuits and windings

Plant Replacement Strategies

In the event of plant being replaced, there are several aspects requiring consideration such as:

- Available budgets
- Minor or major upgrades of existing or re-instating formerly redundant plant
- Replacing like for like to ensure continuous performance
- How and when plant is replaced
- Practicalities of replacements, time scales, mains power continued capacity
- Establishing what is the end of life, poor performance or no longer functional
- Standards of maintenance have become expensive, new plant sourcing proves more economical
- Servicing companies are scarce or close
- The cost of repair is higher than a full replacement
- The onset of plant becoming obsolete and out dated
- Wear and tear complications
- Manufacturers are no longer available for support
- Change of use of the plant
- Re-location of companies to larger or smaller sites
- The scope of the existing plant is limited

Reducing Maintenance Requirements

Mass production of components in a solid state reduces the need for maintenance or stocking additional spare parts to ensure safe and efficient operations.

This process also ensures that such equipment operates to the highest performance levels, as it is set up the same way every time.

It's a simple case of replacing a piece of equipment with a like-for-like replacement rather than disassembling and rebuilding malfunctioning items or those that have exhausted their life expectancies.

Low-maintenance sealed units

There are no moving parts on these equipment items, and as such, they are maintenance-free.

All parts of these assemblies are sealed units, and there are no specific maintenance requirements other than ensuring the equipment works adequately; the performance is judged in this manner.

In the event of equipment failure, replace items with like-for-like equipment.

Spare parts/Consumables

These modern manufacturing methods will render items previously considered spare parts as consumables rather than highly technical pieces of equipment requiring expert knowledge to install and get working.

Consumables will be stocked by wholesalers, merchants, and such suppliers.

Sealed units are replaced like for like using the model/part numbers as ordering references detailed in the section “Plant Inventory” included elsewhere in this O&M manual.

Consumables are replaced as they regularly wear out or get used up.

They are the components of an end product that uses consumables to support daily safe and efficient operations.

The advantages of manufactured sealed units

- Solid state therefore, no moving parts
- Do not require additional lubrication
- Warranties are retained from the manufacturers as no remedial work is required.
- Life expectancies can be higher
- Digital mass manufacturing keeps end costs lower
- All items are the same standard and compliant with host systems
- Tested before leaving factories
- Working parts cannot be accessed
- Replacement is cheaper than repairing
- Items manufactured overseas are available in the UK

Preventative Maintenance – Mechanical & Electrical Systems

Preventive maintenance is a proactive strategy for keeping equipment and facilities running smoothly by performing routine maintenance tasks to prevent unexpected failures.

Reduce costs	Avoid the high costs and disruptions of unplanned breakdowns
Increase efficiency	Maximize efficiency over time
Extend lifespan of equipment	Catch problems early and delay the need for costly replacements
Compliance	Ensure equipment is operating in line with safety and environmental sustainability standards

Preventive maintenance involves a variety of approaches for monitoring and scheduling inspections, servicing, and repairs.

Regulations	Preventive maintenance
Correct operation	Equipment is used only for the purpose it has been designed and installed for and not retro fitted to perform un authorised or other duties
Over subscription	Operates within the tolerances expected of the equipment
Breakdowns	In the event of a breakdown or trip out, only authorised methods of repair are undertaken, under no circumstances should malfunctioning equipment be forced to operate by using un authorised or generic object to override the breakdown protection faculties
User training	Only trained operatives are allowed to use equipment having the knowledge of understanding correct operations its use its mis-use and tolerance
Observational maintenance	The daily use of observational maintenance noticing and recording noticeable changes in the appearance, sound, smell, feel of the equipment's operation when switching on and switching off and prolonged ongoing duty
Programmed maintenance	Programmed maintenance schedules are put into place using installers and manufactures methods of approved methods only
Correct spare parts	Only authorised spare parts or accepted generic spare parts are used, no retro fit methods are acceptable
Regular cleaning	General cleaning of the equipment and surrounding are carried out at specific regular intervals
Equipment repairs	Only authorised personnel or service contract engineer's conduit repairs of replacements
Like for like sealed units	Sealed units are replaced like for like, not over superscripted or improvised
Lubrication	Moving part require lubrication using authorised lubrication methods
Correct level of mains power	Main power is optimum but not over the limit limits required to operate equipment
Monitoring meters	Will monitor highlight abnormal operating conditions providing intelligence to performance levels and protentional faults and possible breakdowns
Environmental	Equipment is installed and used in environments suitable to the protection of the equipment installed
Calibration	Where required, calibration is carried out at specific and programmed intervals
Software and hardware updates	Updated and the end of life or updated software or hardware is required
Operating hours	Monitor continues hours of continual operation are within the tolerance set by the manufactures
When not in use	Shut down completely when not in use, likely standby monitors are placed elsewhere
Like for like sealed units	Sealed units are replaced like for like, not over superscripted or improvised
Back-up generators	When equipment trips out of shuts down due to a malfunction, a backup generator in the system will attempt to re-power the faulty equipment and likely cause damage to the equipment and generator systems
Faulty light sources	When a light source fail, often the host luminaire will attempt to relight the failed light source on a continuous basis, as such the host luminaire will attract more wear and tear than normal and decrease efficiency or shorten life expectancies greatly

Complex and Specialist Equipment

Serial numbers and corresponding spare parts

A unique identification number is securely attached to sealed units by means of a printed label or etched directly into more intricate equipment.

This serial number is unique to that piece of equipment, and spare parts are recognised using this serial number.

During servicing or maintenance, the servicing engineer records this unique identification number and uses it as a reference to ensure that parts or replacements are specific to that unit.

Complex and specialised equipment maintenance

Is serviced, maintained or modified by a specialist nominated contractor only and one who is totally conversant with the equipment being worked on.

A recommended specialist contractor will be responsible for;

MATTERS	SPECIALITY
Inspecting	Regularly inspect equipment to identify potential safety hazards
Training	Ensures that operators are suitably trained to ensure equipment is operated safely and efficiently
Operational	Ensure equipment is working to optimum levels of efficiency and performance
Maintenance	Maintenance is conducted by a specialist trained by or employed by the original equipment manufactures
Troubleshooting	Troubleshoot issues and perform repairs to minimise malfunctions, assistance in the event of malfunctions or breakdowns
Maintenance records	Maintain and update records of servicing, maintenance and correct spare part administration
Servicing	Ensure that equipment properly serviced and calibrated within the programmed schedules and manufacturers specific requirements
Spare parts	Spare parts are administered correctly using authorised spare parts and fitted correctly in line with manufacturers requirements
Coordinating schedules	Collaborate with other departments to coordinate maintenance schedules
Implementing programmes	Implement preventive maintenance programmes to inspect, repair, and maintain systems and components of the specific equipment
Health and safety	in accordance with occupant's health and safety requirements and the obligations held by the specialist whilst on site

Set up a Serviced Maintenance Contract

A maintenance contract is a legal agreement between a service provider and a client that outlines the maintenance of equipment, systems, or assets.

The contract defines the responsibilities of each party, including the schedule, tasks, and frequency of maintenance services.

Cleaning as part of Preventative Maintenance

Under no circumstance

The maintenance, replacement of spare parts, servicing or cleaning is never undertaken while equipment is still live and connected to a main supply of any kind.

Ensure all electrical, gas, pressure systems, gas, or mains water supplies are dead and locked off and remain so before and during any work is being carried out

Mains services can only be returned once the work is completed, appliances or items of plant are safe to use, there upon re-testing and when required, re-commissioning has taken place and recorded with certification documents.

Cleaning – As part of preventative maintenance

Keeping electrical, mechanical and public health equipment clean is an important part of any preventive maintenance program, but using the wrong cleaning methods could be costly.

Asbestos Exposure

Asbestos is a toxic substance subject to government regulations.

Special considerations are taken when cleaning aged equipment containing asbestos, especially when using compressed air methods. Knowledge of government regulations is required in handling asbestos and other such materials.

Initial Considerations

Determine the cleaning method by observing the type of contamination to be removed and the time allowed until the equipment needs to be returned to service.

Sufficient dry time is required when using liquid solvents or water to clean electrical equipment. Insulation should be tested 6 to determine whether it has been properly reconditioned before re-energizing equipment.

Methods of cleaning

Never attempt to clean equipment that is still connected to its mains supply while its energised, that includes electrical, gas or water mains supplies

Observe all safe work practices and lockout/tag out procedures prior to cleaning.

Personnel must be properly qualified before cleaning any plant or equipment.

Rags and Brushes

Wiping off dirt with a clean, dry, lint-free cloth or soft brush is usually satisfactory if the apparatus is small, the surfaces to be cleaned are accessible, and only dry dirt is to be removed.

Don't use waste rags, because lint will adhere to the insulation, acting as a further dirt-collecting agent causing tracking.

Cloth rags should be clean and free of oil, grease, and metallic deposits.

Use care to avoid damage to delicate parts. Rags can easily catch on edges other and sharp objects, damaging small plastic or moving parts.

Liquid Solvents and Water

Accumulated dirt, oil, or grease might require a solvent to be removed.

A rag barely moistened but never completely wet with a non-flammable solvent can be used for wiping.

Solvents used for cleaning should be selected carefully to ensure compatibility with materials being cleaned.

Accumulated dirt, oil or grease might require liquid solvents or other alternative methods to be removed.

Do not use any liquid cleaners, including spray cleaners, unless specified by the equipment manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of insulation surfaces.

Allow sufficient time for drying after cleaning equipment with a liquid solvent or water!

Observe all material data sheets prior to using chemical cleaners, wear the required personal protective equipment such as goggles, gloves, aprons, and respirators when working with potentially hazardous solvents.

Vacuum Cleaning

Loose dust, dirt, and particles can be removed using a vacuum-type cleaner with non-metallic attachments and hoses. Blowing equipment out with compressed air is likely to spread contamination and damage insulation.

Equipment enclosures and substation room filters are cleaned at regular intervals and replaced if they are damaged or clogged. Loose hardware and debris is removed from the enclosures.

New or unusual wear or loss of parts occurring after the cleaning can be detected during subsequent maintenance

Sweeping and Moping

If the sweeping of a substation room or plant room is required, use a sweeping compound to limit the amount of dirt and dust becoming airborne. When mopping, keep the mop bucket as far as practical from the switchgear to prevent damage from spillage.

Compressed Air Methods for Cleaning Electrical Equipment

Important - Recommended carried out by specialist contractors

Where dirt cannot be removed by wiping or vacuuming, compressed air blowing might be necessary.

CAUTION:

Cleaning with compressed air creates a hazard to personnel and causes equipment to fail or malfunction.

If compressed air is used, protection should be provided against injury to workers' faces and eyes from flying debris and to their lungs from dust inhalation.

Use care when working with compressed air to avoid contaminants from become airborne, which can contaminate insulation surfaces, cause injury to personnel, or affect the mechanical operation of nearby equipment.

Compressed air will be dry and directed in a manner to avoid further blockage of ventilation ducts and recesses in insulations.

Protection is needed against contamination of other nearby equipment if the insulation is cleaned in place with compressed air.

Removed the apparatus to a suitable location for cleaning, or other exposed equipment is covered before cleaning starts to keep the debris out.

The safest procedures using compressed air is to instigate this process off site where ever possible using a specialist contractor skilled in this operation.

Building a cleaning programme

Electrical, mechanical and public health systems are generally complex and expensive assets that need to be effectively cleaned as part of a maintenance regime ensuring they operate at optimum performance over their serviceable life.

It is common to find that there has been significant effort applied to managing mechanical assets, with less focus on electrical and public health systems.

There are many reasons as to why this is the case, but the reality is that the way asset management programs are developed to accommodate all systems with equal importance.

Cleaning programmes

1.	Set aside "Down days" and "Shutdowns from normal production to ensure regular cleaning schedules
2.	Document tasks to include all services to ensure importance is given to all
3.	Refrain from "Knee Jerk" situations or reacting to a one-off event
4.	Ensure that all cleaning materials and equipment are kept on site rather than risk delays from suppliers without stocks available
5.	Cleaning materials and equipment are maintained and stored in a manner to keep them safe and in good condition for usage
6.	A forward programme is set in advance to ensure all areas are covered in line with requirements
7.	Be aware of the cost of enforced down time caused by failure to clean equipment as part of a preventative maintenance programme

Practical issues

1.	Always examine processes used to define they are the best and most cost-effective solutions, is there a better way
2.	All cleaning equipment is in working order and operators are trained if complex procedures are employed
3.	Solvents or cleaning liquids are within use by date
4.	Less critical equipment is identified and critical equipment is well accounted for
5.	Environmental and health and safety aspects are compliant
6.	All cleaning records are retained detailing what was carried out, the methods and equipment used
7.	Highlight problem areas where wear and tear is most prevalent on an ongoing basis
8.	Report any damage that may be caused during cleaning
9.	Cleaning processes are included in the maintenance programme carried out schedules as part of the overall maintenance programme
10.	All operatives are well aware of the potential risks related to COSHH and precautions are taken

Seasonal Building Shutdowns

Shutdown, decommissioning, and mothballing of premises.

Many emergencies can arise at a time when a building is closed overnight, on a weekend shutdown, annual holiday closures, or the premise is closed for some time may be due to a change of occupier.

The danger signs of potential problems can usually be spotted and rectified when people are around regularly. However, many emergencies manifest when the building is unoccupied for some time.

As part of the routine operational procedures, it is also essential to have a checklist for safely closing down a building for a while. Below is a suggested plan of action that will offer some guidance and provide adequate monitoring systems

Isolation of Systems

Ensure that where practicable, all safely disconnected systems are isolated, switched off, or closed down, including non-essential systems or electrical appliances unplugged, standby systems switched off, and generally securely shut down.

List of Essential Equipment

A simple, easy to understand list of essential and non-essential services so that a procedure list is available for maintenance or facility managers to follow at times of a pending building closure period

Lighting & Lighting Circuits

Many buildings will have lighting systems linked to custom-built lighting control systems. These will automatically control luminaries using motion, presence or absence detection devices, time lag programmes, or dawn to dusk light sensors, controlled by a central switch panel or electronic devices.

A quick trip around each area switching off those luminaries not controlled in such a manner.

Include work lighting, toilet lighting, additional task lighting in service cupboards or a storeroom

Exterior Security Lighting

Ensure that all lamps are working, any controls are activated, and any light level sensors are working correctly.

Fire Alarm Systems

Fire Alarms are monitored every day, but before the shutdown, examine the system to ensure operational status, all indicators are activated, and all devices are connected.

Usually, these systems are further connected to telephone lines to report emergencies to designated telephone lines, mobile phones, or directly to the Fire & Rescue Service Providers.

Emergency Lighting Systems

When emergency services attend to a situation, the use of emergency lighting is vital to light access or escape routes, ensure that lamps and batteries are in good working order at all times, but in particular, at a time of a more extended than usual shut down period.

Computer Systems

Shut down computer monitors and peripheral hardware items situated on desktops.

In most cases, data remains on remote servers or mainframes, so switching off the individual desktop screens, is done without losing data.

Heating Systems

During the winter months, such as over a Christmas shut down, ensure those heating items are suitably controlled, frost protection or heating essential areas to prevent burst pipes or water systems.

After a period of shut down, a building can take a long time to reach the required temperature levels.

Security Alarms & Systems

Like Fire Alarm Systems, these services are used and set daily. Ensure that all detection devices and control panels remain activated, with all suitable telephone line connections in place before all shutdowns.

CCTV Operations

Check the integrity of all surveillance cameras and recording devices to ensure they are activated, and vision paths are not obstructed.

Fire Doors

The usual process is to make sure all doors remain closed, including fire doors, designed to act as an extended life door in the event of a fire. Fire doors are labelled for ease of identification.

Fire doors are heavy, and magnetic devices keep the door open in areas such as corridors or walkways. Once the main panel has raised the alarm, the door release devices automatically allow the door to close, operating a door closing device fitted to the top of the door.

Ensure that if Fire Doors are typically left open during the period when the building is unoccupied, that these closing devices are in operation

Access Doors

Similarly, to Fire Doors, ensure that all Security Doors are activated as required, and any closing or opening devices are working to an acceptable level. Keep extra keys or control devices held in easily accessible places, maybe off-site.

Door Entry Systems

Check that all Door Entry Systems are in operation before the building shut down and that all control panels and mechanisms are activated.

Essential Services

It can be freezers, refrigerators, alarm circuits, security systems, or such equipment that needs to remain switched on or at least on standby during the shutdown period.

Generator Back-Up Systems

Many vital services will switch to a backup generator if the primary functions are interrupted. Ensure that all interlinks and trigger devices retain the correct settings. Also, bear in mind that these generator backup systems, in turn, will need to be able to be shut down as restoring power to supported services may also re-introduce the emergencies when power is restored to the building.

Important Design Issues

There could be a temptation to knock off the main switch or isolate the main's electricity from the building, either by one designated knock-off switch or individual isolation. Vital services may also be switched off and lost during this process.

Consult with the electrical installation engineer for systems to be introduced where essential and non-essential circuits are segregated so important services are left connected, but non-essential isolated through a mains knock-off switch.

Telephone Lines

Operating systems such as monitored fire, security, computer interfaces, and access equipment, send awareness signals to facility managers or maintenance teams using programmed telephone or text messages to designated numbers directly upon triggered fault conditions.

Ensure that they remain operational.

Avoid Accidents and Emergencies

Accidents and emergencies will happen from time to time. That is a fact of life; however, problems are avoided beforehand if preparation and systems are in place.

Be aware of the risk situation and put suitable procedures into place, always bearing in mind that every person using the building knows techniques and understands what part everyone has in their application.

On-Occupation or Systems Shutdown

A building has been unoccupied but duly commissioned and caretaker maintenance provided, allowing water systems to circulate and air plant to be turned over at regular intervals, services continue to operate efficiently. Air and water flow volume flow rates should remain in balance.

Comparing random air and water rates or fan/pump power consumptions with the original commissioning data can check this.

Likewise, electrical systems maintained and tested for the operation could also be functional. In all cases, re-commissioning will be vital and documentation to that effect made available if a building is unoccupied for a considerable time.

It is essential that any prospective tenant or building user also carries out a health and safety risk assessment for the re-commissioned premises before the mechanical and electrical services are inspected and re-

commissioned.

Decommissioning and Mothballing

Decommissioning and mothballing are two distinctly different processes, and the precise requirements for the building are established before detailing a plan of action. Each building is assessed individually.

Decommissioning

Decommissioning is the systematic process of isolating, draining down water systems, and purging all mechanical and electrical plant and equipment, including specialist plant and equipment and services such as lifts, escalators, medical gases, fumes cupboards.

Decommissioning is carried out through a planned sequence of events supported by method statements and permit to work procedures as appropriate.

The decommissioning is carried out to demolish the building or carry out a large-scale refurbishment. Alternatively, its purpose may be to render the building eligible to be zero-rated by the local authority.

However, there are other considerations and implications considered, such as:

- Interrelationships of the building services with neighbouring systems
- The integrity of the fire, security, and safety systems
- Provision of temporary lighting and emergency lighting on staircases and walkways
- Possible retention of an in-service lift
- Likely need to maintain in running order essential plant and equipment.

Mothballing

Mothballing is the preparation of the building services to provide only essential environmental requirements in an unoccupied building, including frost protection, fire, security, and safety features to maintain the safety and integrity of the building.

Mothballing enables the building occupiers to:

- Benefit from local authority not occupied property rates
- Minimise running costs
- Save energy
- Maintain the building in a state of readiness to promptly meet a change in circumstances.

Spare Parts Policy

Most equipment purchased during the completion of this project will be factory made sealed units rather than a series of component parts in an assembled formation to create the overall piece of equipment.

This reduces the need for spare parts on site storage as factory made sealed units are simply replaced like for like rather than in a multi component form.

The daily use of consumable times is somewhat different as these play a different role in the life of the equipment installation and the buildings requirements.

In the event that more complex systems are employed, and require specific spare parts, this information, where available is stored in the file "Manufactures Supporting Documents" within the "Manufactures Literature Library" file attached to this O&M manual.

The Risks of purchasing spares 'On-Line'

- Ensure that any online retailer unfamiliar to you is reputable by researching them. Establish a physical address and telephone contact. The best way to find a reputable retailer or distributor is by means of a recommendation from a trusted source.

Other commercial issues should also be a concern, security of payments and quality and validity of spare parts being supplied. On-line purchased supplies can originate from several generic sources; part numbers and screen display images may not reflect the equipment being offered.

Also establish a returns or redemption of funds beforehand.

Avoid auction sites, a cheap price may be attractive but the previous duty and history of equipment cannot be guaranteed, and their usage will infringe terms and conditions laid down by manufacturers or specialist contractors by using non-defined equipment, which can cause damage to equipment and expensive machinery.

Spare parts stockholdings

Recommendations included are based on the manufacturer's information, where available. The information is intended to provide guidance and not a definite schedule of all spares that will be required.

• The stock of spares is based upon a policy decision.
• The stock of spares is dependent upon the degree of in-house maintenance that is undertaken.

Selecting the correct balance

Identify the consumables necessary for the day-to day and week-to week maintenance. • These include such as lamps & fuses etc. all of these are necessary and only usage will tell the rate of consumption and need for replacements
Identify the equipment causing the most disruption and down time. • Obtain from the equipment manufacturers, a list of spares, particularly the items that they consider as not 'Off the Shelf' items. • Establish a purchasing policy allowing the accessibility to critical spares
Check when buying spares of any kind if there is a limited shelf life • Consider purchases accordingly, selecting approved supply chains and frequency of purchasing • Establish "Shelf life' considerations and date stamping
Purchase direct from the supplier or manufacturer if a propriety item • investigate alternative sources of supply within the scope of the equipment specification

Spare Parts are rendered by

In House operatives	Trained and authorised in house operatives having the knowledge, experience to render spare parts to the given system
Specialist Contractor	Carried out by Specialist Contractors only
Serviced Contract	Spares replaced as part of an ongoing Service Contract carried out by specialist contractors
Programmed regimes	Spares supplied as part of a programmed maintenance regime

Spare Parts Status

Critical	Critical spares are held on site to cover break downs to critical systems
Stock hold	Levels of stock held for critical items
Lead time	Optimum lead time for spares available from suppliers
Sealed units	All parts of these assemblies are installed as a sealed unit, and there are no specific maintenance requirements other than ensuring the equipment works adequately. Therefore, complete items need to be stocked rather than individual parts. In the event of equipment failure, replace items with like for like equipment.
Service - servicing /maintenance items	Supplied during servicing or maintenance and supplied by the service engineers directly
Serial numbers – usually on larger plant or stand-alone systems	Serial numbers are unique to that piece of equipment. All parts and spares are recognised using this serial number. During servicing or maintenance, and as required, the servicing engineer will note and record this serial number and use it as a reference to ensure parts are specific to that unit. If service items are available from other sources, the manufacturers will offer guidance to the correct equipment permissible.

Spare Parts Installations;

1.	No spares are administered to systems that are connected to live mains supplies
2.	All spare as pre-made sealed sections and replaced like for like
3.	Only those spare parts designed for the equipment's functions are used
4.	No retro-fit methods are used which are un-safe and create risks to people of property
5.	Redundant items are disposed of in a proper manner
6.	Correct tools and methodology acceptable only
7.	Where necessary, all PPE is issued and used
8.	Accidents or incidents are reported immediately to the appropriate channels