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Expenditure Efficiency & Projects Authority

National Manual of Assets and Facilities Management
Volume 6 Chapter 9

Electrical Systems Maintenance Plan for Housing

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1.0 PURPOSE

The purpose of this document is to provide the Entity and/or Facilities Management Company (FMC) guidelines for the development of their Maintenance Management Plans for Electrical Systems within a House (single dwelling) or a Housing Low rise complex / facilities (Compound or apartment building).

This Plan provides examples of maintenance scheduling frequencies and advises best practice for Planned Maintenance (PM) tasks. This document is intended to:

- Impart knowledge that enables the Entities and/or FMCs a base structure from which they can develop a set of documents and procedures.
- Enable the Management, Senior Management and Engineers to have a clear understanding of the minimum maintenance requirements, along with Entity, Client, FMC, staff roles, and responsibilities.
- Identify the base analytical information that should be recorded by engineers and technicians to ensure discrepancies are pre-emptively identified and rectified through the maintenance management processes applied
- Guide the Entity and FMC service providers on how to develop the Electrical Maintenance Management Plans/Manual.
- Provide a structured flow and reliable reference points within the document that can be related back to the relevant sections.
- Give examples and guidance on how to formulate a bespoke set of documentation, developed against a What, Why, How, Who and When structure that includes the Shall, Should, Consider and Advise philosophy.

2.0 SCOPE

This chapter will cover Roles and Responsibilities, Systems, Sub-Systems, Equipment and the equipment PM scheduling requirements that shall be incorporated as a minimum into the finalized bespoke facility maintenance plan.

The Maintenance Management document (Operating Manual) has a structured flow of elements that will enable the Entity to develop the bespoke maintenance plans for the facility.

This document will address the following criteria of a maintenance management plan:

- **What** needs to be included - *formulated tasks against adopted standard*
- **Why** it should be incorporated - *standards, regulations, law, good practice, and efficiencies*
- **How** to build the document**-** *structure, process, guidance, and flow*
- **Who:** Roles and Responsibilities - *responsibilities for what elements, competence level requirements, and management inputs*
- **When:** Scheduled frequency - *required scheduled periods, PM intervals, and incorporated content. This is dependent on adopted standards, or best practice where these standards do not exist.*

Incorporated diagrams and/or flow charts are for guidance and should not be classed as all-inclusive but as elements that should be further developed as required. These should be in-line with the finalized document ensuring structured flow and reliable reference points that can be related back to relevant sections of documentation.

Entities and FMCs should be aware that the variants of facilities that the document covers might not include the equipment highlighted in this document, as a standard. Therefore, care around developing the bespoke maintenance plan is paramount.

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For a facility's bespoke document, other standards shall be considered and the most effective and/or stringent scheduling/planned maintenance elements adopted. The overarching Electrical systems High Voltage (HV), Medium Voltage (MV), Low Voltage (LV) and Extra Low Voltage (ELV) may be found in a facility environment and include other sub-system and equipment examples for maintenance plan development.

Some larger low-rise facilities / compounds may include all of the above overarching Electrical systems whereas a single villa/townhouse dwelling will not. However, inclusion of these systems into a facility's bespoke maintenance management plan should be restricted to only those found within the Entity's facilities. The finalized scheduling and task documents disseminated, as working documents shall be reviewed on a regular basis thereafter to ensure all information and process related content are updated, relevant, and correspond with the Asset List for maintainable plant and equipment within the facility.

For the purpose of the document "Housing" has been defined as a detached and or semi-detached villa/townhouse dwelling through to a low-rise (3-6 story) multi-dwelling building.
For high-rise building facilities, the Facilities Management Company (FMC) can refer to the office guidance contained within this volume chapter 9 – Offices, as a basic baseline guide on probable plant, equipment, system. As the office tenant boundaries, residential tenant boundaries and requirements including how they interact with the FMC are comparable.

Types of facilities considered within the document are as follows:

- Villa (Multi room single family dwelling)
- Town-House (Multi room single family dwelling)
- Low- Rise Housing (Buildings lower than High-Rise and up to six (6) stories with common and or public access, egress areas, communal areas, common tenant areas (pool, gym, meeting etc), common electrical utilities etc.
- Mixed-use buildings (low-rise residential / mixed-use buildings.)
- Compounds containing a variety of some and or all definitions (villa, town house and or low-rise residential / mixed-use buildings.)

For mid-rise and high-rise housing, refer to EOM-ZM0-PL-000029 Electrical Systems Maintenance Plan for Offices when referencing systems, plant and equipment.

3.0 DEFINITIONS

Term	Definition
AHJ	Authority Having Jurisdiction
AP	Authorized Person
ATS	Auto Transfer Switch
BMS	Building Management System
CB	Capacitor bank
CBS	Central Battery System
CMMS	Computer Maintenance Management System
COSHH	Control of Substances Hazardous to Health Regulations
CP	Competent Person
DB	Distribution Board
DSP	Distribution Service Provider (electrical generation entity)
ECRA	Electricity & Co-Generation Regulatory Authority
ELV	Extra Low Voltage
EMDB	Emergency Main Distribution Boards
EPDS	Emergency Power Distribution System
EPGS	Emergency Power Generation System
EPS	Emergency Power System
EPSS	Emergency Power Supply System
ELV	Extra Low Voltage is classified as below 50V

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Term	Definition
FM	Facilities Manager
FMC	Facilities Management Company (facilities maintenances)
FOC	Facilities Operating Client (client/building owner)
FOM	Facilities Operations Management (client/building owner representative)
HF	Harmonic Filter
HV	High Voltage is classified as above 13.8KV (an allowable variance of between 13.1kV to 14.5kV is applicable)
IBC	International Building Code
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronic Engineers
IET	Institute of Engineering & Technology
IFC	International Fire Code
LV	Low Voltage is classified as being above 50V and below 600V
MDB	Main Distribution Boards
ME	Maintenances Engineer
MV	Medium voltage is classified as being above 600V and below 13.8KV
MS	Method Statement
MSDS	Materials Safety Data Sheet
MVS	Medium Voltage Substation
MVSN	Medium Voltage Supply Network
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Standards Foundation
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Health Administrations
O&M	Operations and Maintenance
PM	Planned Maintenance
PPE	Personal Protective Equipment
PPC	Pool plant control panels
QPM	Quarterly Preventative Maintenance
RA	Risk Assessment
RAMS	Risk Assessment & Method Statement
RMU	Ring-Main Unit
SASO	Saudi Standards, Metrology and Quality Organization
SEC	Saudi Electrical Company
SMDB	Sub-Main Distribution Board
SOP	Standard Operating Procedure
SS	Substation
TDB	Tenant Distribution Board
TR	Transformers
UL	Underwriters Laboratories, Inc.
UPS	Uninterruptable Power Supplies
VFD	Variable Frequency Drive

Table 1 Definitions

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4.0 REFERENCES

This document contains reference examples intended to guide the Entity and/or FMC on best industry practices and incorporates the following international standards and regulations in conjunction with the Kingdom of Saudi Arabia's established codes and decrees:

- ASTM F496-14a: American Society for Testing and Materials, In-Service Care of Insulating Gloves and Sleeves
- ASTM F696-06: American Society for Testing and Materials, Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens, electrical protective gloves-rubber
- BS 1363: British Standards Institution (BSI) plugs and sockets
- BS 697: British Standards Institution (BSI) Specification for Rubber Gloves for Electrical Purposes
- BS 7671:2018 Institute of Engineering Technology (IET)
- EN 20471: European Standard, certification for high visibility work wear.
- EN 341: European Standard, requirements, test methods, marking & information, descenders
- EN 354: European Standard, lanyards for fall arrest
- EN 358: European Standard, Belts and lanyards
- EN 361: European Standard, marking, manufacturer information, and packaging specifications for full body harnesses
- EN 365: European Standard, Safety harnesses, Safety devices, Restraint systems
- EN 795: European Standard, Personal fall protection equipment - anchor devices
- EN 813: European Standard, Personal fall protection equipment. Sit harnesses
- HSG 85 - Electricity at Work Safe Working Practices
- HSR 25 (Guidance) Memorandum of guidance on the Electricity at Work Regulations:1989
- IEC 61482-2, International Electro technical Commission, Protective Clothing against Arc Hazards
- IET Guide to Electrical Installations in Medical Locations:2017
- ISO 11612: International Organization for Standardization, protective clothing made from flexible materials, which are designed to protect the wearer's body
- National Project Management Organization White Book - installation/construction
- NFPA 1 Fire Code
- NFPA 4 Standard for Integrated Fire Protection and Life Safety System Testing
- NFPA12A Standard on Halon 1301 Fire Extinguishing Systems
- NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
- NFPA 70 National Electrical Code
- NFPA 70A National Electrical Code, Requirements for One- and Two-Family Dwellings
- NFPA 70B Recommended Practice for Electrical Equipment Maintenance
- NFPA 70E Standard for Electrical Safety in the Workplace
- NFPA 72 National Fire Alarm and Signaling Code
- NFPA 73 Standard for Electrical Inspections for Existing Dwellings
- NFPA 78 Guide on Electrical Inspections
- NFPA 110 Standard for Emergency and Standby Power Systems
- NFPA 111 Standard on Stored Electrical Energy Emergency and Standby Power Systems
- NFPA 110 Chapter 8 and Emergency Power Supply System (EPSS)
- NFPA 110 Chapter 5 and 8 Emergency Power System (EPS)
- NFPA 720 Standard for the Installation of Carbon Monoxide(CO) Detection and Warning Equipment
- NFPA 791 Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation
- NFPA 853 Standard for the Installation of Stationary Fuel Cell Power Systems
- NFPA 1078 Standard for Electrical Inspector Professional Qualifications
- OSHA 1910-137: Occupational Safety and Health Administration, Electrical Protective Equipment.
- SASO Standard 1148 Plugs and socket-outlets for household and similar
- SASO Standard 2203 Plugs and Sockets

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- SASO Standard IEC 60669-2-1, 2.2 & 2.3 switches for household and similar fixed electrical installations
- SASO Standard IEC60838-1/2007 Lamp Holders
- Saudi Building Codes
- Saudi Electrical Company (SEC)-Electrical Standard
- Saudi Standards, Metrology and Quality Organization
- SFG20
- The Electricity at Work Regulations Act 1989
- The Electricity Safety, Quality and Continuity Regulations Act:2002
- URN 02/144 (Guidance) - Electricity Safety, Quality and Continuity Regulations Act 2002

Note: These standards shall be selectively applied based on the evaluation of individual requirements. Where the standards stipulated conditions conflict, the most stringent shall govern, unless otherwise noted herein. When there is any conflict with the Saudi Building Code (SBC), only the Saudi Building Code will be applied.

5.0 RESPONSIBILITIES

Role	Description
Chief Executive of Entity (Facilities Operating Client or FOC)	Chief Executive of the Entity having overall management of the facility
Electrical Safety Group	Committee appointed by and representing the Facilities Operating Client. The requirement for this committee is not mandated other than under the HTMs' for Healthcare, but should be considered as "best practice"
Facilities Operations Management (FOM)	Discipline Certified Managers and Engineers appointed by FOC to oversee any appointed Facilities Management Company (FMC) activities
Designated Responsible Person	The Responsible Person is employed directly by the Entity and is the "Duty Holder" of the engineering systems and the staff who operate those systems; and is overall responsible and accountable for their design, installation, operations, and maintenance and ensuring control of those systems. The Responsible Person has a legal responsibility (within the UK) for ensuring that the Entity has complied with the relevant legal regulations / decree pertaining to those engineering systems and the staff involved. The Responsible Person shall ensure that the systems are kept up to date with the latest relevant legal regulations / decree's. The responsible Person should not be the Authorizing Engineer
Facilities Management Company (FMC)	The facilities management company is an appointed client representative who, in collaboration with the client, controls the operational engineering departments; and who is responsible and accountable for the AP's and CP's as well as the site engineering systems, their design, installation, operations, and maintenance and ensuring control of those systems are in line with the Client SOP for the maintenance activities.
Designated Authorizing Person	The Designated Authorizing Person, AP, is appointed by the Responsible Person (normally under the recommendation of the operating client), to take responsibility for the effective management of the safety guidance. The AE should possess the necessary degree of independence from local management to act where necessary and alert the chief executive in the event that local management does not take action to avoid harm.

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	The Authorizing Engineer is also responsible for ensuring the relevant governing body is kept up to date and that the Authorizing Engineer is informed by the Ministry of Health of any known anomalies that may pose a safety risk to the facility or staff and patients.
Tenant Liaison Office	Person responsible for information flow between FMC and Tenants
HV Qualified Person	A FOC Approved Persons. Certified HV specialist service provider/operative who is qualified, competent and experienced. Has the necessary site knowledge to formulate the necessary client SOP documentation. Oversees the FMC's activities on behalf of the FOC
MV Qualified Person	A FOC Approved Persons. Certified MV specialist service provider/operative who is qualified, competent and experienced. Has the necessary site knowledge to formulate the necessary client SOP documentation. Oversees the FMC's activities on behalf of the FOC
LV Qualified Person	A FOC Approved Persons. Certified LV specialist service provider/operative who is qualified, competent and experienced. Has the necessary site knowledge to formulate the necessary client SOP documentation. Oversees the FMC's activities on behalf of the FOC
Competent Person (CP)	A skilled, knowledgeable, competent, and experienced individual with the necessary training who has been appointed by an Authorized Person (or by an authorizing body within the Entity). The CP can execute the required actions within a permit-to-work and/or any other directional document as assigned.

Table 2 Responsibilities

Figure 2 below highlights the responsibilities and process flow for the formulation of maintenance plans and activities. The diagram highlights the organization's responsibilities in the formulation of a maintenance strategy that will assist the Entity in achieving corporate goals and in enhancing the facility operations to incur the following benefits:

- Reducing breakdowns of plant and equipment through robust maintenance process
- Early identification of faults or degraded equipment to allow for contingency planning
- Efficient utilization of manpower to undertake maintenance activities, rather than reactive or corrective tasks
- Planning of spare parts and consumables to be available for maintenance activities
- Reduction in warehouse stock and obsolescence
- More accurate reporting to senior management and stakeholders, especially if used in conjunction with CMMS systems
- Better utilization of utilities (power, water etc.) through the efficient use of plant

It should also be a consideration that there may exist a requirement for maintenance staff to be inspected for security. Within Housing facilities there is likely to be a high prevalence of interaction with children and vulnerable adults. Therefore, Entities should consider this requirement when setting up maintenance contracts or site based teams.

Further detail on the formulation of strategic plans can be found within the National Manual of Assets and Facilities Management Volume 6, Chapter 4 – Financial Planning.

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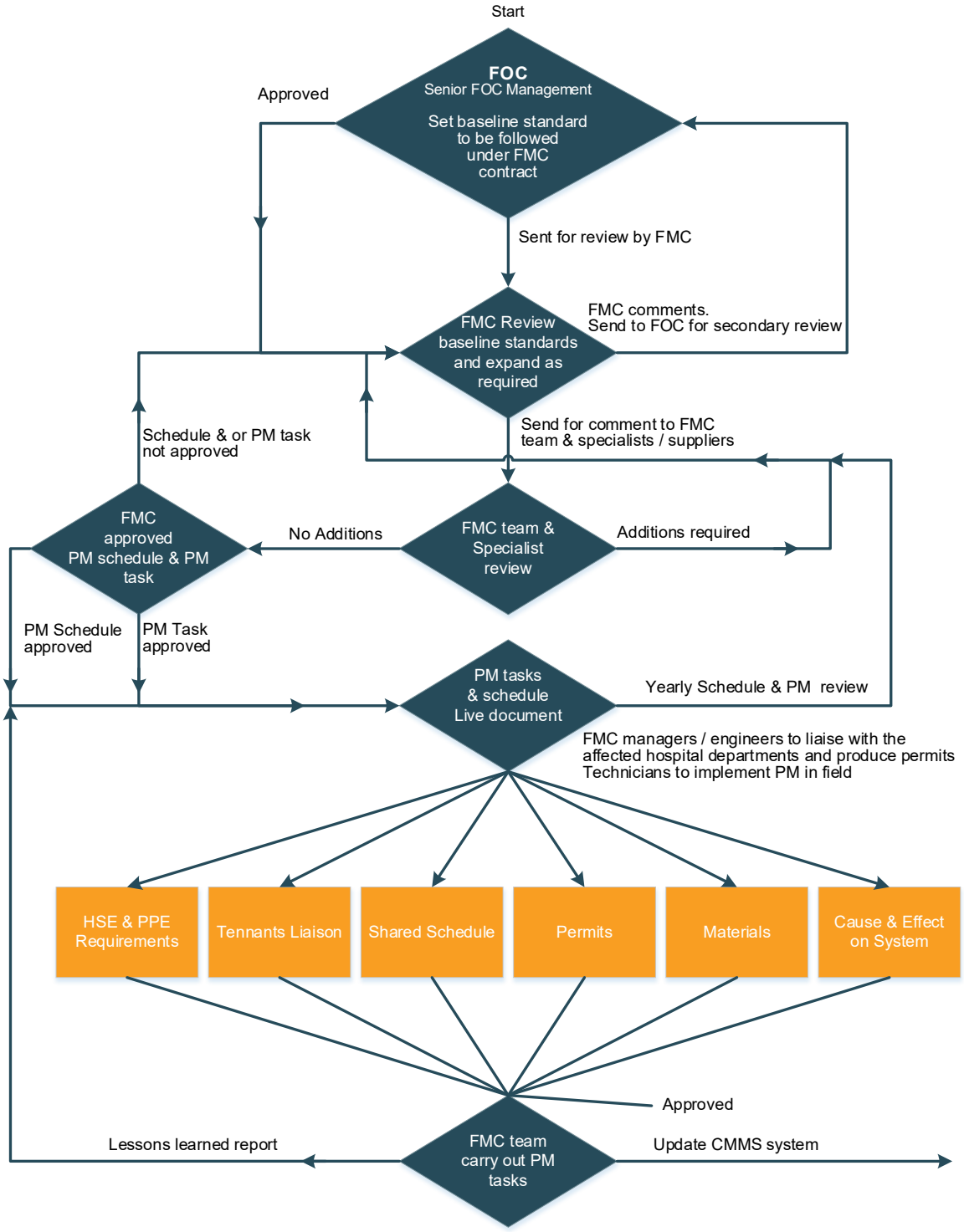

Figure 1: Roles & Responsibilities for Schedules & PM task implementation

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6.0 PROCESS

6.1 Systems Overview

The facility's electrical hierarchical/parent systems including good practice and specialist maintenance requirements are defined as follows:

6.1.1 High Voltage

HV refers to voltages exceeding 13.8 kV (allowable variance of MV 13.1kV – 14.5kV) that do not normally reside within the FMC's scope. However, it is considered good practice to have an established communication protocol in place that forms part of the facilities emergency action plan.

If the HV equipment is or becomes the responsibility of the FMC, they shall engage a registered and certified HV company for all aspects of transformer PM maintenance and scheduling (specialist supplier required). Good practice also dictates that the FMC consider directly employing a HV Qualified Person to oversee all actions on behalf of the FMC or Operating Client. The HV Qualified Person will add a competence level to the Maintenance and Scheduling Process that is independent from the specialist supplier and therefore impartial to the contractor's financial goals.

6.1.2 Medium Voltage

MV is classified as being above 600V and below 13.8kV and will normally be delivered to a facility via a 33kV to 13.8kV transformer. These medium voltage transformers (allowable variance of between 13.1kV to 14.5kV) are often incorporated into the FMC scope. However, it should be noted that depending on the adopted regulations and/or standards, the maintenance tasks and any switching tasks on the MV systems may be required to be carried out only by a registered and certified MV company and/or approved persons.

Good practice also dictates that the FMC consider directly employing a qualified MV Qualified Person to oversee action on behalf of the FMC and/or Operating Client. The MV Qualified Person will add a competence level to the Maintenance and Scheduling Process that is independent from the specialist supplier and therefore impartial to the contractor's financial goals. This role may be fulfilled by a HV/MV certified Engineer.

Routine and Emergency switching operations to MV equipment should only be undertaken by competent persons who have the experience and knowledge of the dangers associated with the equipment.

6.1.3 Low Voltage

LV refers to voltages between 50V and 600V and will normally be delivered at the facility via a 13.8Kv to 400V transformer. These transformers (allowable variance of between 360V to 410V) are often incorporated into the appointed FMC's scope. However, it should be noted that, depending on the adopted regulations and/or standards, the maintenance tasks and any switching tasks on the LV system may require registered and/or certified APs or CPs, and the FMC should consider formal certified training to LV Qualified Status of staff for these tasks.

6.1.4 Extra Low Voltage

ELV is classified as below 50V and will normally be delivered via an internal equipment transformer connected to a single phase LV system input, such as a fire detection system, Building Management System (BMS), or within dedicated control systems with standby and/or constant 50V AC or DC outputs.

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Many of these systems require specialist knowledge and the FMC should consider Manufacturer/Supplier maintenance procedure and LV Qualified training to better enable the responsible maintenance staff to operate and monitor these systems.

Refer to **Attachment 2 Maintenance Skill Level Requirements Matrix** for further guidance.

6.2 Electrical System Components

6.2.1 Electrical Subsystems

Segregate into Escape, Public, common, tenant, back of house staff, plant areas etc.

Back of House & Plant Areas

- Central battery System
- Emergency Power Distribution System (EPDS)
- Emergency Power Generation System (EPGS)
- Extra Low Voltage systems
- Fire Suppression Main control and plant Systems
- Low Voltage Supply transformers and main panels
- Medium Voltage Supply transformers and main panels

Back of House Command Office Areas

- Fire Detection and Suppression System main control panels
- Lighting System main control panels
- Public Address Systems main control panels

Public & Common Areas

- Fire Detection and Suppression System (common to all areas)
- Lighting Systems (common to all areas)
- Public Address Systems (common to all areas)

Tenant Areas

- LV distribution

6.2.2 Equipment Used in Electrical Systems

Electrical equipment used within electrical systems include, but are not limited to:
Segregate into Escape, Public, common, tenant, back of house staff, plant areas etc.

Back of House & Plant Areas

- Auto Transfer Switch (ATS)
- Capacitor Bank (CB)
- Emergency lighting
- Emergency Main Distribution Boards (EMDB)
- Emergency Power Distribution system (EPDS) Panel
- Generator Set
- Harmonic Filter (HF)
- Main Distribution Boards (MDB)
- Medium Voltage Supply Network (MVSN) Distribution Panel
- Pool plant control panels (PPC)
- Ring-Main Unit (RMU)
- Transformers (TR)

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- Variable Frequency Drive (VFD)

Public & Common Areas

- Distribution Board (DB)
- Emergency lighting
- Lighting Pillar panels
- Sub-Main Distribution Board (SMDB)
- Uninterruptable Power Supplies (UPS)

Tenant Areas

- Tenant Distribution Board (TDB)
- Tenant lighting outlets
- Tenant power outlets

6.3 Equipment Maintenance Frequencies and Requirements

The frequency of Equipment maintenance varies on the area and use of the equipment. All equipment maintenance should be conducted on either a daily, weekly, monthly, quarterly, annual, biannual, and Quinquennial frequency. Outlined below are examples of the different frequencies and PM tasks, which can apply to the different areas. :

Example 1. Public and Common Areas

Low- Rise Housing, Mixed-use buildings and Compounds containing a variety of some and or all definitions.

- Daily
- Weekly
- Monthly
- Quarterly
- Annual
- Biennial
- Quinquennial

Example 2.

Frequencies and PM tasks for Tenant only buildings such as Villa, Town House defined as

- Reactive call from tenant
- Annual
- Biennial
- Quinquennial

The set frequencies and PM tasks for equipment and electrical systems installed within “Example 2” in some cases are common to “Example 1”. However, the equipment and electrical systems will not be scheduled with the same frequency. This is due to tenant boundary access protocols’.

A standalone maintenance frequency and task plan may be required. This should be incorporated into the main maintenance plan scheduling, noting that they rely more on reactive than preventative maintenance.

6.3.1 Daily

These should be carried out as a PM task controlled via the Computer Maintenance Management System (CMMS) or as a “monitoring” function only. However, this will be very dependent on the adopted operating standards and the facilities operating client’s SOP. Daily assessments and monitoring are key for any Entity to ensure that services and plants are available for the designed function. Ideally, a check should be

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undertaken at the start of the working day and periodically throughout the shift or working cycle. Simple log sheets can be used to record parameters and demonstrate that areas and equipment have been assessed and monitored.

The systems, areas, and equipment that should be monitored on a daily basis within a schools & university facility and as good practice are:

- LV Main Distribution Boards (MDB's)
- Emergency lighting
- Fire-related equipment (fire pump plant / controls, Novec / FM200 gas suppression plant / controls)
- Other critical system monitoring control panels.

This is not a fully comprehensive list and should be tailored to the facility, depending on the installed equipment being maintained.

Findings should always be recorded into the maintenance log system either as a hard copy or via a software-based system.

6.3.2 Weekly

Weekly PM activities are controlled via the CMMS, or as a "monitoring" function only. Findings should, however, be recorded into the maintenance log to assist with the historical data for the facility. This allows for senior management to make fact-based decisions upon the strategy for planned maintenance and financial decisions.

Consistent with good practices, systems, areas, and equipment should be monitored on a weekly basis and as an addition to the daily tasks within a schools & university facility:

- MV/LV emergency generation plant/controls
  - See NFPA 110, Chapter 8 and EPSS for scheduling guidance
- MV/LV EPS (emergency power system)
  - See NFPA 110, Chapter 5 and 8 EPS for scheduling guidance
- Lighting and distribution networks
- Life Safety Systems for Fire detection and suppression (further information is contained within Volume 6 Chapter 12)
- UPS and CBS battery systems
- Other critical system monitoring control panels

Findings should always be recorded into the maintenance log system either as a hard copy or via a software-based system. It should also be noted that, compliant with NFPA standards, some PM weekly tasks should be included as specific PMs within the CMMS.

6.3.3 Monthly

All systems should be monitored on a quarterly basis within multi dwelling apartment complexes' and compounds' this is considered a good practice. If any of the PM tasks require tenant area access this should be arranged well in advance of the access requirement. In addition, Tenants must be informed of any possible electrical downtimes.

Monthly maintenance tasks are generally classed as "intrusive maintenance" and may involve partial system shutdowns. Therefore, they should be included as part of the maintenance plan in the CMMS, within a paper or software based system. However, the roles and responsibilities, required competencies, site-specific SOPs, and cause-and-effect and risk management activities, need to be taken into consideration when formulating these PM tasks. In particular, stakeholder engagement should be part of the process so that the users and persons affected may be consulted or informed prior to the activity.

Mandatory compliance with regulatory and adopted standards shall, along with NFPA, SASO references, be taken into consideration. This should comprise part of a Criticality Assessment undertaken at the

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inception of the maintenance plan to identify those items of the plant that have a significant effect upon operations or compliance with statutory requirements. The Original Equipment Manufacturer (OEM) Service Manuals shall be included within the PM task procedures to ensure that equipment is correctly serviced reducing potential outages and giving increased reliability during the equipment's lifecycle. Further guidance for maintenance tasks can be found within the References section of this chapter.

When formulating the schedule and/or PM task in line with these considerations, it should be noted that seasonal variances will need to be considered and incorporated (Refer to EOM-ZO0-PR-000006 Seasonal Planning Procedure).

The Maintenance Management Team should be aware of and liaise with discipline managers to ensure that multiple shutdowns for specific plant and/or equipment are minimalized. The co-ordination of PM tasks, engineering staff resource sharing, and work permits will enable the FMC to obtain staff efficiencies and cause as minimal as possible disruption to the Housing facility and Tenants.

It is also the FMC's responsibility to track/log, update records, review, and ensure that licensing, certification, staff competencies, training, and PM compliance to standards and regulations are continually reviewed and updated with the latest editions and versions. This is a required action that should be scheduled into the maintenance plan and entered into the CMMS as an action point.

Within a maintenance environment and particularly within a Housing complex / facility where high levels of safety are required for tenants and visitors the equipment and tools required for maintenance should be tested for compliance with calibration requirements. Personal Protective Equipment (PPE), must be in good condition and any deficiencies or damaged items must be replaced. Maintained in a "fit for use" condition and or replaced if they have an expiry date.

Other specialist PPE for example Electrical Arc flash suit, MV rated gloves, fall arrest PPE devises must have an in-date calibration and/or third party certification certificate before being used.

The below list of possible standards to refer to is for example only and would require expansion during the maintenance plan commentary.

- Refer to BS 697, OSHA 1910-137, ASTM F496-14a, F696-06 for Electrical insulated gloves standards
- Refer to IEC 61482-2, ISO 11612 for Arc flash and heat resistive clothing standards
- Refer to EN 20471, 813, 795, 341, 354, 358, 365 and 361 standards for Work Positioning Devices, restrain belts, descender devices.

It is good practice to include within the Risk and Method Statements these checks to ensure that they are recorded and that formal inspections are carried out. Additionally, recording this within the CMMS allows for historical data to be tracked and consumable or perishable stock to be ordered and delivered in a timely manner, thereby preventing the delay of activities. These tasks should be scheduled one to two weeks prior to the validity end date, or longer for longer lead items, to enable continuity and efficiency of use.

When structuring the maintenance plan, it should be noted, that the NFPA standards provides a good PM tool and in some cases, gives relevant examples, including compliant scheduling guide tables.

As an example, for the Emergency Power System, (EPS), a tabulated baseline requirement table with daily, weekly monitoring, and monthly, biannual, annual, biennial, Quinquennial PM tasks that shall be carried out are available within the NFPA guidance.

It is the PM tasks and scheduling owner's responsibility to ensure that all standard/regulatory and/or compliance activities are covered for the facility's assets and recorded in the facility's database.

Refer to **Attachment 3 Electrical System PM Type Inclusion Check Matrix template** for guidance.

The checklist shall include, but not be limited to, the systems mentioned below (NFPA references are intended only to provide guidance and not serve as an exhaustive list of standards to be applied):

- Generators and associated EPS

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    - Emergency generation and associated systems: NFPA 110, 72 & 70B
- UPS & CBS
- Stored Electrical Energy Systems Emergency lighting and Central battery systems
    - NFPA: 70, 70B 110 and 111
- Fire systems
    - Water-based fire systems: NFPA 12, 72, 20 and 25
- Lightning Protection system
    - NFPA 70 and 780
- Carbon monoxide Detection and Warning Equipment
    - NFPA 70 and 720

6.3.4 Quarterly

All systems should be monitored on a quarterly basis within multi dwelling apartment complexes' and compounds' this is considered a good practice. If any of the PM tasks require tenant area access this should be arranged well in advance of the access requirement. In addition, Tenants must be informed of any possible electrical downtimes.

Quarterly PM Task procedures may be standalone tasks or may include the Monthly PM task procedures formulated with additional requirements.

Quarterly PM related tasks usually involve extended plant downtime during maintenance activities. Maintenance tasks scheduled to take place on a monthly basis or greater will generally require additional time to complete. These activities may also require the equipment be isolated from service which may in turn require switching operations that involve the participation of more than one staff member to complete.

It is of prime importance that the following is undertaken prior to carrying out this activity:

- Tenant / Stakeholder engagement
- Consumables, Spare Parts availability
- Competent personnel to undertake the task
- Permit to Work
- Isolation facility and associated LOTO equipment
- Segregation and barriers available to prevent intrusion into the work area from tenants or public.

The above list is not exhaustive and local requirements may require further considerations. These should be included within the Maintenance Instruction guide / Task Instruction sheet.

To understand the additional requirements and how they should be scheduled alongside the Monthly PM tasks or as separate actions, a cross referencing and review exercise should be conducted by the FMC team.

(Refer to Figure 1: Roles and Responsibilities for Schedules and PM Task Implementation)

When the quarterly additions have been established, are compliant with standards and regulations, and approved as per the process, the CMMS managing party shall input this information into the system, using the current condition of equipment as an input for future maintenance planning. Where deficiencies may exist, a maintenance task may need to be created for follow-up action. Parameters for input logging need to be set and associations with other tasks must be defined.

It is important, during the further development of PM tasks and input into the adopted CMMS system, to establish what output reports the FMC and/or client/Entity will require from the information and how they could be gathered and reported. Guidance should be sought from the software developer or included manuals, where bespoke reports may be required.

NFPA standards should serve as a reliable reference guide for the plan.

6.3.5 Biannual

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Biannual PM Task procedures may be standalone tasks or may include the formulated quarterly PM tasks along with additional requirements. It must be noted that six monthly (biannual) PM tasks will often require manufacturer recommended or standard mandated equipment and/or consumable part replacements. NFPA 110 demonstrates this within the PM frequency and task tables at annex A for EPS.

Where scheduled maintenance will have a significant impact upon the operation of the facility, the scheduled periods may need to be brought forward or deferred to meet with term requirements of the facility. These changes must be agreed with any third party support where delaying maintenance activities could have financial implications on warranty or contractual comprehensive agreements. Senior management of the facility must gain the approval of the ministry to make these decisions at a local level.

Reporting for biannual activities should follow the same process for recording and reporting functions, as those outlined above for monthly maintenance activities.

6.3.6 Annual

All systems should be monitored on a quarterly basis within multi dwelling apartment complexes' and compounds' this is considered a good practice. If any of the PM tasks require tenant area access this should be arranged well in advance of the access requirement. In addition, Tenants must be informed of any possible electrical downtimes.

Annual procedures may be standalone tasks or be inclusive of the biannual procedures along with additional requirements. Some of these tasks may require prior high-level FOC management approval (depending on the cause and effect on the building operations), to ensure adequate resources are available.

The maintenance team should record all activities and retain copies of service documentation on site for future reference or compliance. Where possible the service record should be recorded within the CMMS as a signed copy upon handover by both the service technician (OEM/ Agent) and Qualified technician or onsite responsible Person.

Post maintenance testing may also be required and demonstrated to site staff on completion. The procedure for recording and witnessing those activities can be found in the National Manual of Assets and Facilities Management Volume 6 Chapter 27 – Post Maintenance Testing (PMT). The Facility Role designations/naming structure may differ from those stated within this document

6.3.7 Biennial

All systems should be monitored on a quarterly basis within multi dwelling apartment complexes' and compounds' this is considered a good practice. If any of the PM tasks require tenant area access this should be arranged well in advance of the access requirement. In addition, Tenants must be informed of any possible electrical downtimes.

Biennial procedures normally include the annual procedures and replace the annual PM task. However, they may also represent separate standalone PM tasks. This is because biennial tasks are generally more internally intrusive to the equipment and may require extended shutdown and parts replacements. The FOC and FMC must access the cause and effect on the building operations, Faculty staff and students, and schedule appropriately. An example of a biennial task is transformer maintenance requiring a full shutdown and isolation at MV and LV level. This may require standby systems to be brought into service for extended periods to allow maintenance activities to be performed. It is therefore of paramount importance that these systems be maintained prior to the biennial activity to allow maintenance to proceed without interruption.

High level FOC management and faculty department approval (depending on the cause and effect on the facility operations), should be gained well in advance to ensure adequate resources will be available, and that the departmental stakeholder engagement process has been followed.

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6.4 Quinquennial

These procedures shall normally include the Biennial procedures formulated with additional requirements. However, in some cases the Quinquennial tasks may be scheduled separately to the annual or biennial PM tasks.

The FMC must assess the cause and effect on the building operations / tenants and schedule appropriately. High level FOC management and tenant liaison office approval well in advance (depending on the cause and effect on the facility operations), should be gained to ensure adequate resources will be available, and that the tenant / stakeholder engagement process has been followed.

All subsequent scheduled maintenance planning for PM related tasks conducted from a biannual through a Quinquennial basis should comply with NFPA standards as a minimum. The FMC should then expand upon this baseline to deliver an efficient, fully compliant, and comprehensive maintenance plan to the Entity and/or FOC.

It may be advantageous to program intrusive tasks, such as Annual and greater periodicity, where there is a change of tenant and refurbishments may be taking place prior to handover to a new occupant

Some annual, biannual and Quinquennial tasks are standalone compliance procedures such as periodic electrical tests and inspections, portable appliance testing, etc. These procedures shall be planned and scheduled separately to the normal equipment PM, and also may require dedicated engineering staff or third party resources.
Depending on the facility size, some quarterly PM tasks will normally be scheduled to take place throughout the facility area by area, against an agreed plan of action, and may be scheduled to take place weekly, monthly, quarterly, etc. (depending on the volume of assets to be tested), over a one to five-year scheduling period.

Example 1 : Maintenance activity may include the following:

- UPS quarterly PM (every three months)
    - 148 assets throughout the FMC facility
        - Two quarterly PM tasks per year per asset
            - Each UPS quarterly PM takes four (4) hours

Therefore, to accomplish just the UPS quarterly PM tasks, Quarterly Preventative Maintenance (QPM) will need to be scheduled within the maintenance plan over an extended period throughout the year. This does not allow for the weekly, monthly, biannual or yearly tasks. This is why, the maintenance plan must integrate as far as possible PM tasks, and schedule manpower accordingly for optimum efficiency enablement.

Refer to **Attachment 1** UPS yearly maintenance plan sample template for guidance.

Example 2: Tenant maintenance activity may include the following:

- Tenant area periodic electrical testing
    - Twenty-four tenant dwellings
        - Yearly PM task
            - Each periodic test takes four (4) to five (5) hours (probable evenings / weekend activity)

Therefore, only one dwelling can be completed in a working day and may require evening and or weekend scheduling of an electrical periodic testing certified team. For twenty-four dwellings, this may need to be scheduled over an extended period to accommodate tenant access. Other public, common and back of house areas will also need to be scheduled for the testing team. A separate periodic testing schedule will be required within the maintenance plan.

Refer to **Attachment 3:** “Electrical system PM Type Compliance Matrix” Each dwelling would be entered in the system column with the PM compliance recorded.

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The attachments to this document will enable the Entity, FOC and FMC to understand the fundamentals required when compiling the maintenance plan, or the baseline requirements that may already form the foundation of an existing document needing development.

Note that these documents are not intended to serve as a standard model. Rather, they have been produced merely as representative samples. Much analysis of a facility's adopted standards and asset PM requirements will need to be compiled to deliver a final maintenance plan. The attached samples will guide the FMC on how to gather and record data, enabling them to deliver a maintenance plan schedule and a compliant, comprehensive set of documents outlining lifecycle and PM related tasks.
An example maintenance activity may include the following:

7.0 ATTACHMENTS

1. EOM-ZM0-TP-000016 – UPS Yearly Maintenance Plan Template
2. EOM-ZM0-TP-000017 – Maintenance Skill Level Requirement Matrix
3. EOM-ZM0-TP-000018 – Electrical Systems PM Type Compliance Matrix Template

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Attachment 1 – EOM-ZM0-TP-000016 – UPS Yearly Maintenance Plan Example Template

UPS unit yearly maintenance plan (SAMPLE)

Document number EOM-ZM0-TP-000007 (Last revision date: 14/01/2020)

UPS yearly maintenance plate sample template
(insert "X" into cell as appropriate)

Asset No	MONTH	WEEKLY	MONTHLY	QUARTERLY	BIANNUAL	ANNUAL	expand as required
UPS 1	1						
UPS 1	2						
UPS 1	3						
UPS 1	4						
UPS 1	5						
UPS 1	6						
UPS 1	7						
UPS 1	8						
UPS 1	9						
UPS 1	10						
UPS 1	11						
UPS 1	12						
YEARLY TOTAL PM's FOR ASSET UPS 1		WEEKLY	MONTHLY	QUARTERLY	BIANNUAL	ANNUAL	XXXX ?
		0	0	0	0	0	0

TOTAL FACILITY UPS ASSETS	148

YEARLY TOTAL PM's FOR 148 No UPS ASSETS	WEEKLY	MONTHLY	QUARTERLY	BIANNUAL	ANNUAL	xxxxx ?	TOTAL UPS PM TASK's PER YEAR
	0	**0**	**0**	**0**	**0**	**0**	0

SAMPLE

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Attachment 2 – EOM-ZM0-TP-000017 – Maintenance Skill Level Requirements Matrix

NOTE:
1 – This matrix is a guide representation only and should not be replicated as a true illustration of the system competency level requirements
2 – This matrix guide is not a final and comprehensive table and requires further development in line with the facilities electrical system assets.

In-house Skill:
Level 1 – manufacturer trained & or Engineer **level 2 –** certified Discipline trained, **level 3 -** competency assessed operative, **level 4 –** assessed helper

Specialist Skill:
Level 1 Specialist – life safety licensed company and operatives, **Level 2 Specialist** – Manufacturer / manufacturer trained and certified

Type of maintenance task	Service Provision by:		Required competency level
LV Emergency power Distribution	**In-house**	**Specialist**	
Emergency power MDB's	☑	☑	**Level 1 / 2 in-house & Level**
Emergency power SMDB	☑		**Level 1 / 2 in-house**
Emergency power DB	☑		**Level 1 / 2 in-house**
Emergency power 410V equipment	☑		**Level 1 / 2 in-house**
Emergency power 230V equipment	☑		**Level 1 / 2 in-house**
LV Normal power Distribution	**In-house**	**Specialist**	
Normal power MDB's	☑		**Level 2 / 3 in-house**
Normal power SMDB	☑		**Level 2 / 3 in-house**
Normal power DB	☑		**Level 2 / 3 in-house**
Normal power 410V equipment	☑		**Level 2 / 3 in-house**
Normal power 230V equipment	☑		**Level 2 / 3 / 4 in-house**
Normal power Light fittings	☑		**Level 2 / 3 / 4 in-house**
Normal power outlets	☑		**Level 2 / 3 / 4 in-house**
Type of maintenance task	**Service provision by:**		**Required competency level**
LV Life safety equipment / plant	**In-house**	**Specialist**	
Life safety MDB	☑	☑	**Level 1 / 2 in-house & level**
Life safety SMDB	☑		**Level 1 / 2**
Life safety DB	☑		**Level 1 / 2**
Fire Panels	☑		**Level 1 / 2 n-house & level 1**
Fire pumps	☑	☑	**Level 1 / 2 in-house & level**
Central battery		☑	**Level 1 specialist**
LV Specialist equipment	**In-house**	**Specialist**	
UPS panel		☑	**Level 2 specialist**
UPS outlets	☑	☑	**Level 2 / 3 in-house & Level**
Expand columns/ rows for other	**In-house**	**Specialist**	

SAMPLE

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NOTE:
1 – This matrix is a guide representation only and should not be replicated as a true illustration of the system competency level requirements
2 – This matrix guide is not a final and comprehensive table and requires further development in line with the facilities electrical system assets.

In-house Skill:
Level 1 manufacturer trained and/or Engineer Level 2 certified discipline trained, level 3 - competency assessed operative, level 4 – assessed helper

Specialist Skill:
Level 1 Specialist – life safety licensed company and operatives, **Level 3 Specialist** – Manufacturer / manufacturer trained and certified

Type of maintenance task	Service provision by:		Required competency level
LV Emergency power Distribution	**In-house**	**Specialist Supplier**	
Emergency power MDB's			
Emergency power SMDB			
Emergency power DB			
Emergency power 410V equipment			
Emergency power 230V equipment			
LV Normal power Distribution	**In-house**	**Specialist Supplier**	
Normal power MDB's			
Normal power SMDB			
Normal power DB			
Normal power 410V equipment			
Normal power 230V equipment			
Normal power Light fittings			
Normal power outlets			
Type of maintenance task	Service provision by:		Required competency level
LV Life safety equipment / plant	**In-house**	**Specialist Supplier**	
Life safety MDB			
Life safety SMDB			
Life safety DB			
Fire Panels			
Fire pumps			
Central battery			
LV Specialist equipment	**In-house**	**Specialist Supplier**	
UPS panel			
UPS outlets			
Expand columns/ row's for other equipment as required	**In-house**	**Specialist Supplier**	

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Attachment 3 – EOM-ZM0-TP-000018 – Electrical system PM Type Compliance Matrix Example Template

NOTE:
1 – This matrix is a guide representation only and should not be treated as a true illustration of the designated system categories or inclusion elements such as compliance, standard, regulatory, manufacturer and best practice.
2 – This matrix is not a final and comprehensive table and requires further development in line with the facilities electrical system assets.

Description			System Equipment Category					Type of PM included in plan					Compliant to
System	Sub-System	Equipment	Life safety	Critical	Essential	Utility	Non-Essential	Compliance	Standard	Regulatory	Manufacturer	Best Practice	KSA / NFPA / HTM etc.
High voltage	Transformer	Cabling	X	X					X		X	X	NFPA /KSA
	Transformer	Oil	X	X					X		X	X	NFPA /KSA
	Transformer	Earthing	X	X					X		X	X	NFPA /KSA
	Transformer	Porcelain Isolators	X	X				X	X		X	X	NFPA /KSA
	Transformer Cable Containment	Cable Pit / overhead infrastructure	X	X					X			X	NFPA
	Transformer Area	Cage	X	X					X	X		X	NFPA
	Transformer Area	Earthing	X	X					X	X		X	NFPA /KSA
	Transformer Area	Fire suppression	X					X	X	X	X	X	NFPA /KSA
	Transformer Area	Fire detection	X					X	X	X	X	X	NFPA /KSA
	Transformer Area	Emergency lighting	X					X	X	X	X	X	NFPA
Medium Voltage	Transformer	Cabling	X	X	X	X	X		X	X	X	X	NFPA
	Transformer	Oil	X	X	X	X	X		X	X	X	X	NFPA
	Transformer	Earthing	X	X	X	X	X		X	X		X	NFPA
	Transformer Room	Fire suppression	X					X	X	X	X	X	NFPA /KSA
	Transformer Room	Fire detection	X					X	X	X	X	X	NFPA /KSA
	Transformer Room	Emergency lighting	X					X	X	X	X	X	NFPA /KSA
	Transformer Room	Earthing	X	X	X	X	X		X	X		X	NFPA
Low Voltage	MDB	Cabling	X	X	X	X	X		X	X	X	X	NFPA
	MDB	Earthing	X	X	X	X	X		X	X		X	NFPA
	MDB	Circuit Breakers	X	X	X	X	X		X	X	X	X	NFPA
	MDB	Bus Couplers	X	X	X	X	X		X	X	X	X	NFPA
	MDB	Control Panels	X	X	X	X	X		X	X	X	X	NFPA
	MDB Room	Fire suppression	X					X	X	X	X	X	NFPA /KSA
	MDB Room	Fire detection	X					X	X	X	X	X	NFPA /KSA
	MDB Room	Emergency lighting	X					X	X	X	X	X	NFPA /KSA
	MDB Room	Earthing	X	X	X	X	X		X	X		X	NFPA
	SMDB	Cabling	X	X	X	X	X		X	X		X	NFPA
	SMDB	Earthing	X	X	X	X	X		X	X		X	NFPA
	SMDB	Circuit Breakers	X	X	X	X	X		X	X	X	X	NFPA
	SMDB Room	Fire suppression	X					X	X	X	X	X	NFPA /KSA
	SMDB Room	Fire detection	X					X	X	X	X	X	NFPA /KSA
	SMDB Room	Emergency lighting	X					X	X	X		X	NFPA /KSA
	SMDB Room	Earthing	X	X	X	X	X		X	X	X	X	NFPA
	DB	Cabling	X	X	X	X	X		X	X		X	NFPA
	DB	Earthing	X	X	X	X	X		X	X		X	NFPA
	DB	Circuit Breakers	X	X	X	X	X		X	X	X	X	NFPA
	DB Area	Fire suppression	X					X	X	X	X	X	NFPA /KSA
	DB Area	Fire detection	X					X	X	X	X	X	NFPA /KSA
	DB Area	Emergency lighting	X					X	X	X		X	NFPA /KSA

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