भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
BUREAU OF INDIAN STANDARDS
(Ministry of Consumer Affairs, Food & Public Distribution, Govt. of India)

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व्यापक परिचालन मसौदा

हमारा संदर्भ: सीईडी 46 /टी-28 **08 मार्च 2025**

तकनीकी समिति: भारत की राष्ट्रीय भवन निर्माण विषय समिति, सीईडी 46

प्राप्तकर्ता :

1. सिविल अभियांत्रिकी विभाग परिषद, सीईडीसी के सभी सदस्य
2. राष्ट्रीय भवन निर्माण संहिता विषय समिति, सीईडी 46 के सभी सदस्य
3. सीईडी 46 की उपसीमितयों और अन्य कार्यदल के सभी सदस्य
4. रुचि रखने वाले अन्य निकाय।

महोदय/महोदया,

निम्नलिखित मानक का मसौदा संलग्न हैं:

प्रलेख संख्या	शीर्षक
सीईडी 46 (26829) WC	**भारत की राष्ट्रीय भवन निर्माण संहिता भाग 12 परिसम्पत्ति तथा सुविधा प्रबंधन** [SP7(भाग 12) का चौथा पुनरीक्षण] (आई सी एस नंबर: 01.120: 91.040.01)

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियाँ यह बताते हुए भेजे कि यह मसौदा प्रकाशित हो तो इस पर अमल करने में आपको व्यवसाय अथवा कारोबार में क्या कठिनाइयां आ सकती हैं।

सम्मतियाँ भेजने की अंतिम तिथि: 07 अप्रैल 2025

सम्मति यदि कोई हो तो कृपया अधोहस्ताक्षरी को ई-मेल द्वारा ced46@bis.gov.in पर या उपरलिखित पते पर, संलग्न फोर्मेट में भेजें। सम्मतियाँ बीआईएस ई-गवर्नेंस पोर्टल, www.manakonline.in के माध्यम से ऑनलाइन भी भेजी जा सकती हैं।

यदि कोई सम्मति प्राप्त नहीं होती है अथवा सम्मति में केवल भाषा संबंधी त्रुटि हुई तो उपरोक्त प्रलेख को यथावत अंतिम रूप दे दिया जाएगा। यदि सम्मति तकनीकी प्रकृति की हुई तो विषय समिति के अध्यक्ष के परामर्श से अथवा उनकी इच्छा पर आगे की कार्यवाही के लिए विषय समिति को भेजे जाने के बाद प्रलेख को अंतिम रूप दे दिया जाएगा।

यह प्रलेख भारतीय मानक ब्यूरो की वैबसाइट www.bis.gov.in पर भी उपलब्ध हैं।
धन्यवाद।

भवदीय

ह/-
(द्वैपायन भद्र)
वैज्ञानिक 'ई' एवं प्रमुख (सिविल अभियांत्रिकी विभाग)

सलंग्न: उपरिलिखि

भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
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WIDE CIRCULATION DRAFT

Our Reference: CED 46/T-28 **08 March 2025**

National Building Code of India Sectional Committee, CED 46

ADDRESSED TO:

1. All Members of Civil Engineering Division Council, CEDC
2. All Members of the National Building Code Sectional Committee, CED 46
3. All Members of Subcommittees, Panels and Working Groups under CED 46
4. All others interested

Dear Sir/Madam,

Please find enclosed the following draft:

Doc No.	Title
CED 46 (26829) WC	**National Building Code of India Part 12 Asset and Facility Management** [Fourth Revision of SP 7 (Part 12)] (ICS No. 01.120: 91.040.01)

Kindly examine the attached draft and forward your views stating any difficulties which you are likely to experience in your business or profession, if this is finally adopted as National Standard.

Last Date for comments: 07 April 2025

Comments if any, may please be made in the enclosed format and emailed at ced46@bis.gov.in or sent at the above address. Additionally, comments may be sent online through the BIS e-governance portal, www.manakonline.in.

In case no comments are received or comments received are of editorial nature, kindly permit us to presume your approval for the above document as finalized. However, in case comments, technical in nature are received, then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website www.bis.gov.in.

Thanking you,

Yours faithfully,

Sd/-
(Dwaipayan Bhadra)
Scientist 'E' / Director and Head
(Civil Engineering Department)

Encl: As above

FORMAT FOR SENDING COMMENTS ON THE DOCUMENT

[Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/ table/figure, etc, be stated on a fresh row. Information/comments should include reasons for comments, technical references and suggestions for modified wordings of the clause. **Comments through e-mail to ced12@bis.gov.in shall be appreciated**.

Doc. No.: CED 46 (26829) WC **BIS Letter Ref**: CED 46/T-28

Title: National Building Code of India Part 12 Asset and Facility Management [Fourth Revision of SP 7 (Part 12)] (ICS No.01.120:91.040.01)

Last date of comments: **07 April 2025**

Name of the Commentator/ Organization: _____

Clause/ Para/ Table/ Figure No. commented	Comments/Modified Wordings	Justification of Proposed Change

NOTE- Kindly insert more rows as necessary for each clause/table, etc

BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

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Draft Indian Standard

National Building Code of India

Part 12 Asset and Facility Management

[Fourth Revision of SP 7 (Part 12)]

(ICS No. 01.120: 91.040.01)

National Building Code Sectional Committee, CED 46	**Last Date for Comments: 07 April 2025**

C O N T E N T S

National Building Code Sectional Committee, CED 46

FOREWORD

There has been significant growth in the requirement of building maintenance in view of an increased output of the construction industry in terms of buildings and built environment. This has been primarily due to large scale new construction taking place all across the country. While there is a need for proper maintenance of the existing building assets, there is a growing awareness of the need to manage the condition of the nation's building stock more efficiently. Paralleling these developments has been the increased application of new technology, permitting more efficient use of data and resources. Notwithstanding this, it is still the case that much maintenance activities take place in a context that do not create a fully integrated approach to managing asset/facility performance and, thus, the full potential of many assets/facilities is never wholly realized. The likely adverse impact on safety and business continuity due to lack of a well planned maintenance strategy is also not fully appreciated as yet.

Poor detailed design affects building performance and hence impacts maintenance cost and consequent effect is well known. There is need to look into this aspect and explore design-maintenance relationship. Many of the problems encountered in buildings stem from the development phase, where a failure to establish user requirements in sufficient detail results in the poor performance of the completed building. At the hand-over stage also there may be serious shortcomings, and more careful consideration need to be given to providing the client with a proper building model to facilitate the effective management of the property. None of these crucial developments can take place without a major shift in client attitudes, and professions working with the built environment.

Considering all the above, the National Building Code Sectional Committee decided to incorporate this new Part to NBC, namely, Part 12, to give a comprehensive approach to asset and facility management for adoption by all concerned. This part was introduced in the year 2016.

The 2016 version of this part covered provisions relating to the management of building assets and associated services, addressing issues related to the maintenance of all types of facilities and fixed assets, such as buildings and building services. In addition to these provisions, critical activities and critical assets that facility managers needed to focus on were also identified. The responsibilities of occupants for maintaining facilities, such as structures, equipment, and exterior property, were also covered.

While outlining a process approach to maintenance management at the strategic and tactical levels with links to operational activities, the 2016 version made owners and occupants aware of the importance of initiating timely actions to formulate strategies and policies for maintenance management. Measures to help organizations and individuals assist those responsible for ensuring that assets and facilities continued to

perform as intended, retaining their asset value at minimal cost, were also included. Additionally, the 2016 version emphasized the importance of improving the capabilities of facility managers to ensure the effective use of funds spent on maintaining assets.

In this revision significant enhancements to improve the management and maintenance of building assets and facilities, focusing on sustainability, efficiency, and pandemic preparedness (in **17.4**) have been introduced. These updates aim to provide clear guidelines for facility managers on the calculation of common area maintenance (CAM) charges, energy management, and the adoption of innovative technologies like digital twins (in **27**). Annexes on safety in operation, monsoon preparedness and building operation insurance are included respectively in Annexes K, L and M. Other significant improvements include:

a) Guidelines on expenses towards housekeeping, energy consumption, maintenance contracts, and insurance etc, with flexible area-based or service-specific calculation methods, in **9.13.2**.

b) Encouraging the use of low-flow faucets, dual-flush toilets, and water-saving appliances to reduce water usage and improve sustainability, in **11.9**.

c) Introduction of corrosion-resistant materials like cross-linked polyethylene (PEX) and chlorinated polyvinyl chloride (CPVC) to minimize leaks and extend the lifespan of building plumbing systems, in **11.9**.

d) Protocols for enhanced ventilation, high-efficiency particulate air (HEPA) filtration, and Ultraviolet UV-C disinfection to improve air quality and reduce airborne pathogen transmission, in **17.4.1**.

e) Encouraging the use of touchless entry systems, sensor-based faucets, and automatic doors to minimize physical contact in high-traffic areas, in **17.4.1**.

f) Performance monitoring and energy efficiency for HVAC systems, with a focus on real-time data analysis and system optimization, in **12.10**.

g) Introduction to the use of digital twins for real-time monitoring and virtual representation of building systems to optimize maintenance and operational efficiency, in **27.1**.

h) Prioritizes automation and resilience planning to ensure essential building functions continue during emergencies, with a focus on business continuity, in **26**.

Following Indian Standards have been utilized while formulating this Part 12:

IS 15183	Guidelines for maintenance management of buildings:
(Part 1) : 2018	General
(Part 2) : 2018	Finance
(Part 3) : 2018	Labour

Considerable assistance has also been drawn from following International Standards while formulating this Part:

ISO 55000:2014	Asset/Facility Management — Overview, principles and terminology
ISO 55001:2014	Asset/Facility Management — Management systems — Requirements
ISO 55002:2018	Asset/Facility Management — Management systems — Guidelines for the application of ISO 55001
BS 8210:2020	Guide to Facilities Maintenance Management
BS 8536:2022	Asset/Facility Management Briefing code of practice
BS 8572:2018	Guide to Procurement of Facility-Related Services
BS 8587:2012	Guide to Facility Information Management
BSI PAS 55:2008	Publicly Available Specification for the optimal management of physical assets

Reference has also been made to following publications:

Maintenance Manual 2023, Central Public Works Department, Govt of India.

Solid Waste Management Rules, 2016, Ministry of Environment, Forest and Climate Change, Govt. of India

Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, Ministry of Environment, Forest and Climate Change, Govt. of India

All standards, whether given herein above or cross-referred to in the main text of this Part, are subject to revision. The parties to agreement based on this Part are encouraged to investigate the possibility of applying the most recent editions of the standards.

For the purpose of deciding whether a particular requirement of this Part is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:2022 `Rules for rounding off numerical values (*second revision)*'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Part of the Code.

Code Users are requested to share their inputs/comments on the draft particularly based on the changes listed above in the foreword; and specially on those highlighted in blue and text in red in this draft.

Important Explanatory Note for Users of the Code

In any Part/Section of this Code, where reference is made to **'good practice'** in relation to design, constructional procedures or other related information, and where reference is made to **"accepted standard"** in relation to material specification, testing, or other related information, the Indian Standards listed at the end of the Part/Section shall be used as a guide to the interpretation.

At the time of publication, the editions indicated in the standards were valid. All standards are subject to revision and parties to agreements based on any Part/ Section are encouraged to investigate the possibility of applying the most recent editions of the standards.

In the list of standards given at the end of a Part/Section, the number appearing within parentheses in the first column indicates the number of the reference of the standard in the Part/Section. For example:

a) Good practices [12(1)] refers to the Indian Standard(s) give at serial number (1) of the list of standards given at the end of this Part/Section, that is, IS 15183 (Part 2): 2018 'Guidelines for maintenance management of buildings: Part 2 Finance (first revision)'

DRAFT FOR COMMENTS ONLY

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Draft Indian Standard

National Building Code of India

Part 12 Asset and Facility Management

[Fourth Revision of SP 7 (Part 12)]

(ICS No. 01.120: 91.040.01)

National Building Code Sectional Committee, CED 46	**Last Date for Comments: 07 April 2025**

1 SCOPE

1.1 This Part 12 covers provisions relating to management of building assets and associated facilities and includes various aspects relating to maintenance of all types of facilities and fixed assets, such as, buildings and building services.

1.2 This Part does not cover assets other than physical assets.

1.3 Whereas all asset and facility management services in permanent or temporary buildings, including mechanical, electrical and plumbing services relating to buildings, maintenance of landscaped areas, etc, are covered in this Part, the maintenance of bulk services required for towns and cities are not covered in this Part. This Part, however, covers all operations/efforts required to ensure that the asset/facility continues to meet the requirements which were set for it during design stage.

2 TERMINOLOGY

For the purpose of this Part, the following definitions shall apply.

2.1 Access – Approach, entry, internal circulation or exit, including in cases of emergency.

2.2 Ageing – Getting old, specifically beyond the design life of the asset.

2.3 As-built Information – Expression of the design, its working detail, construction works and/or installations, functions, operations and maintenance needs of a facility in a form suitable for use in managing that facility.

2.4 Asset – A useful or valuable thing or an item of property owned by a person or organization, regarded as having value and life of more than one year, available to meet debts, commitments, or legacies and performing predetermined functions to facilitate the users.

2.5 Asset Life – Period from asset creation to end of its functional life.

2.6 Asset Register – A central database of information about asset/facility in terms of their manufacturer, vendor, make, model, specifications, date of acquisition, initial cost, maintenance costs and requirements, additions/alterations over period, accumulated depreciation and written down value.

2.7 Asset Type – Grouping of assets having common characteristics that distinguish those assets as a group or class, for example, physical assets, information assets, intangible assets, critical assets, enabling assets, linear assets, information and communications technology (ICT) assets and infrastructure assets.

2.8 Asset/Facility Management – Integration of processes within an organization to maintain and develop the agreed services which support and improve the effectiveness of its primary activities.

2.9 Benchmarking – Comparing performance, often between companies in similar sectors.

2.10 Biodegradable Waste – Any organic material that can be degraded by microorganisms into simpler stable compounds.

2.11 Briefing – Briefing is the process of communicating the objectives and needs of an owner, or prospective owner, of a facility to a designer in order to prepare a design for that facility. This process includes clarification and confirmation of the owner's intentions and documenting the consequent provisions for the facility to enable informed decision making primarily in design, but also in construction work and/or installation, testing and commissioning, handover and start-up of operations. A number of stages are envisaged for preparing and applying the brief during design and in later phases.

2.12 Buffer Zone – A zone of no development which shall be maintained around landfills, processing and disposal facilities of solid waste.

2.13 Building Fabric – Elements and components of a building other than furniture and services installations.

2.14 Building Information Model (BIM) – Shared digital representation of physical and functional characteristics of any built object (including buildings, bridges, roads, etc) which forms a reliable basis for decisions.

NOTE — A building information model may embody, for example, building geometry, spatial relationships, geographic information and the quantities and properties of building components.

2.15 Building Maintenance – Work undertaken to maintain or restore the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

2.16 Building Management System (BMS) – Computer aided control systems, including hardware and software, to collect and monitor parameters and performance

data of plant, equipment, systems and elements either at source or remotely and to enable corrective action to be initiated.

2.17 Building Manual – Guidance to assist in making the best use of the design features, services and systems of a building or other facility.

2.18 Business Continuity Management (BCM) – Holistic management process that identifies potential threats to an organization and the impacts to business operations that those threats, if realized, may cause, and which provides a framework for building organizational resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value creating activities.

2.19 Carbon Emissions – Polluting carbon substances released into the atmosphere.

2.20 Carbon Footprint – Totality of greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product.

2.21 Cleaning – Locating, identifying and properly disposing of undesirable substances from surfaces or material.

2.22 Cleaning Services – Services undertaken to ensure the cleanliness, maintenance and aesthetic upkeep of the building/property.

2.23 Competent Person – Person, suitably trained and qualified by knowledge and practical experience.

2.24 Computer Aided Facilities Management (CAFM) – Systems, applications and tools that automate functions needed to support the core business in its efficient and effective use of facilities.

2.25 Computer Aided Maintenance Management System (CMMS) – System specifically designed to enable planning, organizing, directing and controlling maintenance programmes and to collect and collate historical data on the performance of assets so that the most effective maintenance method is selected under actual performance and environmental conditions.

2.26 Condition Monitoring – Act of measuring and recording data from operating parameters, using either human senses or instrumentation, to verify plant and equipment condition and trends. It is also the act of assessing an asset to understand how it is likely to perform in future.

2.27 Confined Space – Space which may be inadequately ventilated for any reason and may result in a deficiency of oxygen, or a build-up of toxic gases, for example, closed tanks, sewers, ducts, closed and unventilated rooms, and tanks particularly where heavier than air gases or vapours may be present.

2.28 Corrective Maintenance – Maintenance carried out after fault recognition and intended to put an item into a state in which it can perform a required function.

2.29 Crime Prevention Through Environmental Design (CPTED) – A multi-disciplinary approach to crime prevention using urban design, architecture and the management of built environments. CPTED strategies aim to reduce victimization, deter offender decisions that precede criminal acts, and build a sense of community among inhabitants so they can gain territorial control of areas, reduce crime, and minimize fear of crime.

2.30 Critical Activities – Activities which have to be performed in order to deliver the key products and services which enable an organization to meet its most important and time sensitive objectives.

2.31 Critical Asset – Asset having potential to significantly impact on the achievement of the organization's objectives.

2.32 De-construction – A planned selective demolition in which salvage, re-use and recycling of the demolished structure is maximized.

2.33 Deliverable – Product or service as an outcome of a process.

2.34 Design Development – Transitional phase where the basis of the design progresses towards the production of detailed design information.

2.35 Design Life (DL) – Intended/expected service life by the designer or as stated by the designer to the client to support specification decisions.

2.36 Documented Information – Information required to be controlled and maintained by an organization and the medium on which it is contained.

2.37 Domestic Hazardous Waste – Waste contaminated with hazardous chemicals or infectious waste such as discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles, gauge and syringes, etc. generated at the household level.

2.38 Dry Waste – Waste, other than food waste, inert and including recyclable waste, non recyclable waste, combustible waste and sanitary waste.

2.39 Dump Sites – A land utilized by urban local body for unscientific disposal of solid waste without following the principles of sanitary land filling.

2.40 Durability – Ability of a building and its parts to perform its required function over a period of time and under the influence of agents.

2.41 Duress Alarms – Duress alarms are installed to protect personnel who may be placed in danger of physical assault during interactions with other persons. Duress alarms are normally placed in locations where an employee may be alone with a potentially threatening person.

2.42 End-user – Recipient of facility-related services.

NOTE — Recipients include occupants and other users of a facility.

2.43 Estimated Service Life (ESL) – Service life that a building or parts of a building should be expected to have in a set of specific in use conditions, determined from the reference service life data after taking into account any differences from the reference in-use conditions.

2.44 Exterior Property – The open space on the premises under the control of owners or operators of such premises.

2.45 External Envelope – Roof and façade including openings.

2.46 Facilities Maintenance – Work needed to maintain the performance of the building structure, fabric and components, and engineering installations.

2.47 Facility – Tangible asset that supports/serves an organization.

2.48 Facility Asset Performance – Requirements in terms of measurable outcomes for meeting organizational goals.

2.49 Hazardous Waste – It shares the properties of a hazardous material (for example ignitability, corrosivity, reactivity, or toxicity), or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Wastes may also be defined as 'hazardous' by local regulations or international conventions, based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics. Sludge from a waste treatment plant, water supply treatment.

2.50 House Keeping – The routine recurring work which is required to keep a structure in good condition so that it can be utilized at its original capacity and efficiency along with proper protection of capital investment, throughout its economic life.

2.51 Information Management – Processing and storage of information in a controlled manner.

2.52 Intrusion Detection Systems – An intrusion detection system (IDS) is a device or software application that monitors the activities for malicious activities or policy violations and produces reports to a management station. Intrusion detection and prevention systems (IDPS) are primarily focused on identifying possible incidents, logging information about them, and reporting attempts.

2.53 Life Cycle – The stages of an asset from acquisition through commissioning and operation to disposal.

2.54 Maintenance – An intervention on an asset to improve its operation or ensure its continued good operation (It is also the combination of all technical and associated administrative actions during the service life to retain a building, or its parts, in a state in which it can perform its required functions.).

2.55 Maintenance Management – Process of ensuring that the most effective and efficient maintenance programme is formulated and delivered to ensure that assets/facilities continue to perform their intended function. The organization of maintenance has to be within an agreed policy. Maintenance can be seen as a form of 'steady state' activity.

2.56 Maintenance Manual – Technical instructions intended to preserve an asset/facility in, or, restore it to a state in which it can perform a required function.

2.57 Maintenance Plan – Structured and documented set of tasks that include the activities, procedures, resources and the time scale required to carry out maintenance.

2.58 Maintenance Policy – Scope and course of action taken to achieve an organization's objectives.

2.59 Maintenance Programme – Arrangement of maintenance tasks in terms of their sequence, durations and resource requirements.

2.60 Maintenance Strategy – Statement of organizational approach to maintenance management.

2.61 Management System – Set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives.

2.62 Mantrap – A small room with two doors. The first door is locked; a person is identified and authenticated. Once the person is authenticated and access is authorized, the first door opens and allows the person into the mantrap. The person has to be authenticated again in order to open the second door and access a critical area. The mantrap area can have a weight sensing floor as an additional control to prevent literal piggybacking.

2.63 Occupants – Users who spend a significant proportion of their time in or about a facility.

2.64 Operational Plan – Organization's statement of actions intended to achieve a specific business goal(s).

2.65 Operational Strategy – Overall approach to managing production or use of a facility.

2.66 Perimeter Intrusion Detection and Assessment System (PIDAS) – A type of fencing that has sensors on the wire mesh and base of the fence. A passive cable vibration sensor sets off an alarm if an intrusion is detected.

2.67 Perimeter Security – The security measures employed at the perimeter of a built environment, to mitigate threats and offer first line of resistance to unauthorized access and identified vulnerabilities .

2.68 Physical Asset – A tangible, manmade object that has a specific function, normally within a broader system.

2.69 Planned Preventive Maintenance – Maintenance organized and carried out with forethought, control and the use of records to a plan based on the results of condition surveys.

2.70 Predicted Service Life – Service life predicted from performance recorded over time in accordance with standard laid down procedure.

2.71 Predictive Action – Action to monitor the condition of an asset and predict the need for preventive action or corrective action.

2.72 Preventive Maintenance – An intervention on an asset taken in advance of a failure to reduce the chances of failure.

2.73 Preventive Action – Action to eliminate the cause of a potential non-conformity or other undesirable potential situation (for asset/facility management).

2.74 Primary Collection – Collecting, lifting and removal of segregated solid waste from source of its generation including households, shops, offices and any other non-residential premises or from any collection points or any other location specified by the urban local body.

2.75 RASCI Chart – Responsible, accountable, supported, consulted and informed chart that is used to summarize the roles and functions performed in the procurement process and the activities within it.

2.76 Reliability Centered Maintenance (RCM) – An approach which targets intervention on assets based on the known historic performance of that or similar assets.

2.77 Repair, Renovate, Refurbish – An intervention which improves the performance and condition of an asset to upgrade or retain desired performance.

2.78 Residual Waste – Includes the waste and rejects from the solid waste processing facilities which are not suitable for recycling or further processing.

2.79 Root Cause Analysis – A thorough assessment of all of the factors influencing the occurrence of a fault or failure.

2.80 Sanitary Land Filling – The final and safe disposal of residual solid waste and inert wastes on land in a facility designed with protective measures against pollution of ground water, surface water and fugitive air dust, wind-blown litter, bad odour, fire hazard, animal menace, bird menace, pests or rodents, greenhouse gas emissions, persistent organic pollutants slope instability and erosion.

2.81 Sanitary Waste – Wastes comprising of used diapers, sanitary towels or napkins, tampons, condoms, incontinence sheets and any other similar waste.

2.82 Scope Creep – Uncontrolled changes to the agreed scope of the facility related service being provided.

2.83 Secondary Collection – Collection of solid waste deposited at secondary waste storage depots or bins for onward transportation of the waste to the processing or disposal facility.

2.84 Secondary Storage and Fire Hazard – The temporary containment of solid waste at a public place in a covered bin or container in a manner so as to prevent littering, vectors, stray animals and odour.

2.85 Service Life – Period of time after installation during which a building or its parts meets or exceed the performance requirements.

2.86 Shutdown/Outage – A period, either planned or otherwise, during which asset interventions occur.

2.87 Stabilizing – The biological decomposition of biodegradable wastes to a stable state where it generates no leachate or offensive odours and is fit for application to farm land, soil erosion control and soil remediation.

2.88 Stakeholder – Individual, organization or group with an interest in an organization, facility or project. It also applies to the person or entity with an interest in or concern about a facility.

2.89 Surveillance – Surveillance is the monitoring of the behaviour, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them. Surveillance is the visual monitoring (and may include auditory also) of the behavior, activities, or other changing information, of spaces, devices and people, properties and operations therein for the purpose of influencing, managing, directing, or protecting them. This can include observation from a distance by means of electronic equipment (such as, CCTV cameras). Surveillance is used for intelligence gathering, the prevention of crime, the protection of a process, person, group or object, or for the investigation of crime

2.90 Surveillance Devices – Surveillance device can be defined as any instrument, apparatus or equipment used either alone, or in conjunction with other equipment, which is being used to conduct surveillance.

2.91 Whole Life Costing – An understanding of the full economic impact of owning an asset, covering all stages of its life cycle.

3 GENERAL ASPECTS OF ASSET/FACILITY MANAGEMENT

3.1 Asset and its Management

The physical assets represent only one of the five broad categories of asset types that have to be managed holistically in order to achieve the organizational strategic plan. The other categories are human assets, information assets, financial assets and intangible assets (reputation, morale, intellectual property,

goodwill, etc). The scope of this Part is limited to maintenance of physical assets.

Asset management is the process by which an owner maximizes the value of a property or portfolio of properties from acquisition to disposition within the objectives defined by the owner.

Asset management utilizes strategic planning practices including investment analysis, operation analysis and the positioning of a property in the market place in accordance with market trends.

3.2 Facility and its Management

Facility is something that is built for a specific purpose and which is used by end users for predetermined purposes. Facilities management is the integration of processes within an organization to maintain and develop the agreed services which support and improve the effectiveness of its primary activities as well as enhances its ability to successfully control the building environment that houses people (employees, clients, visitors). Facilities management encompasses multi-disciplinary activities within the built environment and the management of their impact upon people and the workplace. It is also known as a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology.

3.3 Overview of Asset/Facility Management

Asset/Facility management is a multidisciplinary approach for designing, planning and managing in an integrated and coordinated way all non-core support services necessary for an effective and efficient execution of the organization's core activities. It involves systematic and coordinated process of planning, operating, maintaining, upgrading and replacing assets cost effectively with minimum risk and at the desired level of customer service at the lowest life cycle cost for the purpose of achieving its organizational strategic plan. It can be used to help assure that utility services are provided in a sustainable, cost-effective way to assist and help to improve the quality of life of people.

Asset/Facility Management is not an accounting exercise or a substitute for quality management. It is for everyone working in a organization that owns or operates assets. This includes those working in procurement, finance, personnel, service, planning, design, operations, administration, leadership, marketing and sales. It is neither a project management system nor just about maintenance.

It is devoted to the coordination of space, infrastructure, people and organization, often associated with the administration of office blocks, public arenas, schools, sporting complexes, convention centers, shopping complexes, hospitals, hotels, etc. Facilities /management practice is applicable for all class of assets, that is, retail, residential, commercial, industrial, warehousing and hospitality, etc.

If correctly implemented, facility management can deliver safe, productive, humane and cost effective environments in different spheres of people's living, commercial activities and working. This practice also enhances the skills of people within the

facilities management sector, creates career opportunities, and enables new working styles which is important in this technologically driven world. All these benefits will not only enhance the organization's image and brand name but also make the infrastructures across class of assets a safe, healthy and productive place.

Asset/facility management includes the integration of the planning and management of a wide range of services both 'hard' (for example, building fabric and building services) and 'soft' (for example, catering, cleaning, security, and mailroom), the management of an increasingly broad range of tangible assets, support services as well as people skills.

The identified core competencies of the asset/facility management are:

a) *Communication* – Communication plans and processes for both internal and external stakeholders;
b) *Emergency preparedness and business continuity* – Emergency and risk management plans and procedures;
c) *Environmental stewardship and sustainability* – Sustainable management of built and natural environments;
d) *Finance and business* – Strategic plans, budgets, financial analyses, procurement;
e) *Human factors* – Healthful and safe environment, security, facility management employee development;
f) *Leadership and strategy* – Strategic planning, organization, staff and leadership organization;
g) *Operations and maintenance* – Building operations and maintenance, occupant services;
h) *Project management* – Overseeing and management of all projects and related contracts;
j) *Quality* – Best practices, process improvements, audits and measurements;

NOTE – Management of only physical assets are covered in this Part.

The asset/facility management can be done either in-house or by engaging outside agency.

Asset management and facility management have overlapping aspects, these are therefore dealt with in this Part together and accordingly, in most cases the term 'asset/facility' has been used while in some other cases, the two terms have been used interchangeably.

3.3.1 *General Issues Relating to Asset/Facility Management*

Any asset/facility will have following stakeholders:

a) Owner,
b) Execution team,
c) End user, and
d) Maintenance or operation team (Operator).

All the four may be different entities or may be one. In any case it is essential to ensure that the best interests of all the stakeholders are served. This gets served when an asset/facility is maintained in such a manner that it performs the function or allows functions to be performed for which the facility was conceived.

The owner may be the operator of the asset/facility or another party may fulfil this role. In either case, it is important that the interests of the operator are taken into account from the outset. This interest extends to the needs of the end-users of the asset/facility. In larger organizations, an operations team, asset/facility management team or a facility manager is responsible for the asset/facility on a day-to-day basis. In smaller organizations, there may not be any equivalent provision. Nonetheless, someone has to provide expertise on operational matters and that may have to fall to a consultant engaged for this purpose. This person is necessary to provide comment and advice on the implications of design and construction proposals from an operational perspective as they are developed from planning to the procurement strategy through to the handover and close-out work stage.

The operator, operations team or facility manager, as appropriate, should be given authority by the owner to contribute information concerning the operational strategy and operational requirements, including performance outcomes and targets, operational costs and budgets, and the procurement of facility related services where appropriate. The owner may agree that such contributions are channeled through the owner's representative or they may be communicated directly to the design and construction team. In the latter case, the design and construction team should ensure that contributions are duly recorded and made available within the team. A responsible, accountable, supported, consulted and informed (RASCI) chart should be used to clarify responsibilities.

Effective asset/facility management, combining resources and activities, is vital to the success of any organization. At a corporate level, it contributes to the delivery of strategic and operational objectives. On a day-to-day level, effective facilities management provides a safe and efficient working environment, which is essential to the performance of any business – whatever its size and scope. Maintaining and developing services through the process of building maintenance, administration and contract management, maintaining communications infrastructure ensures that a facility gives value during its operational life.

Timely action and proper maintenance ensures continued serviceability during life of the asset/facility and gives better return on investment, ensures enhanced life of asset, continued safety and helps avoid risks of the asset/facility loosing value and requiring greater amount of effort and finances to bring it back to a serviceable stage. It ensures that the asset continues to meet the standards which were set during design stage.

3.3.2 *Strategy*

An organization should formulate a facilities maintenance strategy and policy that meets its current and likely future needs. The strategy and policy should be reviewed, at least annually, to ensure that it continues to be aligned to the organization's core business and primary processes. An organization should ensure that the needs of its stakeholders are identified and the impact of those needs is assessed and taken into

account when formulating the strategy and policy. A communication plan to disseminate the strategy and policy, as well as tactical and operational actions, to stakeholders should be prepared by the organization. Details of annual, or more frequent, reviews to check on the alignment between actions and the organization's facilities maintenance strategy should be included in the plan.

3.3.3 *Stakeholder Engagement*

Stakeholders should be involved in discussion about the arrangements for asset/facility management in general and facility-related services in particular in defining their needs and the level of performance that is acceptable. This task includes,

a) Involving stakeholders, as far as practicable, in identifying their needs through, for example, the use of questionnaire-based surveys and in contributing to the drafting of service specifications and service levels;
b) Identifying diversity of need such as when seeking to include people with disabilities or other individuals' specific needs;
c) Prioritizing the needs of stakeholders; and
d) Controlling stakeholder inputs and changes once service specifications and service levels have been agreed in order to avoid scope creep.

3.3.4 *Effective Communication*

Effective communication between the procurer and service providers (another stakeholder group) should be maintained to enable the implementation of an asset/facility management strategy (in terms of the broad approach to the procurement of services) which is both understood and capable of being acted upon. Clear and regular communication is required to develop relationships.

3.3.5 *Performance Evaluation*

It is imperative that the strategy for managing the asset/facility should be efficient and cost-effective in terms that are quantifiable. It may be advisable to set the following performance outcomes at the strategy work stage and monitored during each subsequent work stage up to operation and end of life, with post occupancy evaluation (POE) during a defined period of extended aftercare used as the basis for measuring operational performance:

a) *Environmental* – The asset/facility should meet performance targets such as those for energy use, CO_2 emissions, water consumption and waste reduction or others defined by the owner and operator.

b) *Social (that is, functionality and effectiveness)* – The asset/facility should be designed and constructed to meet the functional and operational requirements of the owner such as the overall concept, context, uses, access, visual form, space, internal environment, durability and adaptability, and in operation should meet the operator's and end-users' requirements of utility, usability, safety, maintainability, security, inclusiveness and comfort.

c) *Economic* – The asset/facility should meet performance targets for capital cost and operational cost, which should be considered side-by-side to enable whole-life costs to be calculated.

Outcomes and targets should be specific to the project and should be verified in each work stage.

3.3.6 *Statement of Needs*

Deliverables in the briefing process should include a statement of needs. A statement of needs embodies the owner's objectives and the extent to which they are likely to be satisfied by the facility. A functional brief is the interpretation of the statement of needs in the form of defined scope of work as a basis for design.

Internal and external stakeholders should be identified at the start of the briefing process and their interest in the facility should be assessed and documented. A stakeholder impact analysis should be undertaken to determine how, and the extent to which, stakeholder interests may impact on the facility in terms of its design, construction work and/or installation, testing and commissioning, handover and start-up of operations.

A statement of the owner's primary activities and primary processes should be prepared. This statement should provide details of how the facility is expected to contribute to the fulfillment of the owner's primary activities and should describe the processes to be carried out in or from the facility.

The space efficiency of the facility should be calculated, where applicable, and used to assess the owner's space provision over the anticipated lifetime of the facility. Allowance for growth and/or reduction in the demand for space and its phasing over the lifetime of the facility should be incorporated in the assessment of this provision.

Results of the stakeholder impact analysis used in assessing stakeholder interests in the facility should be made available to the designer if prepared by the owner or a third party. The results should show the nature, extent and relative importance of all expressed needs. Any prioritization should be made explicit. The statement should express the needs of the owner both in general terms and specifically in relation to the facility.

The statement of needs should be used to inform the provision of an operational facility. Information and data on the expected use of the facility, including technical solutions, should be prepared against criteria given in the statement of needs. The information and data should be grouped as follows:

a) Primary activities and processes to be accommodated by the facility;
b) Operational demands and support processes for users; and
c) Technical solutions, including the appraisal of options for satisfying identified needs.

This information is used, amongst other things, in planning the layout and arrangement of spaces and functions within the facility. There can be different ways of satisfying

an identified need and these have to be made clear and supported by information and data for decision-making.

3.3.7 *Importance of Asset/Facility Management System*

Systems asset/facility management are vital for organizations that are dependent on the function and performance of their physical assets in the delivery of services or products, and where the success of an organization is significantly influenced by the stewardship of its assets. Asset/facility management is important because it can help organizations to,

a) Reduce the total costs of operating their assets;
b) Reduce the capital costs of investing in the asset base;
c) Improve the operating performance of their assets (reduce failure rates, increase availability, etc) and ensure continued serviceability during life of the asset;
d) Reduce the potential health impacts of operating the assets;
e) Reduce the safety risks of operating the assets;
f) Minimize adverse environmental impact of operating the assets;
g) Maintain and improve the reputation of the organization;
h) Improve the regulatory performance of the organization;
j) Reduce legal risks associated with operating assets;
k) Gives better return on investment (important from financers point of view), enhanced life of asset, ensures continued safety; and
m) It ensures that the asset continues to meet the standards which were set during design stage – the strategy for managing the asset/facility should be efficient and cost-effective in terms that are quantifiable.

The key to good asset/facility management is that it optimizes these benefits. That means that asset/facility management takes all of the above into account and determines the best blend of activity to achieve the best balance for all of the above for the benefit of the organization. Asset/facility management is explicitly focused on helping organizations to achieve their defined objectives and to determine the optimal blend of activities based on these objectives.

4 ORGANIZATIONAL STRUCTURE OF AN ASSET AND FACILITY MANAGEMENT SYSTEM

The organizational strategic plan is the starting point for development of the asset/facility management policy, strategy, objectives and plans. Monitoring and continual improvements within the asset/facility management system is very important.

Organization setup for large facilities will be guided by the factors given below.

4.1 Scope of Work to be Carried Out

In general, asset/facility management will require carrying out necessary activities in various disciplines involved for covering all relevant aspects. For each discipline, the

number of persons required at field level and supervisory levels will depend on the quantum of assets to be managed.

4.2 Competence of Staff at Various Levels

Asset/facility management work will need personnel with adequate and relevant expertise in each of the concerned disciplines at various levels.

4.3 Organization Roles at Various Levels

The top management has to ensure that the personnel at various levels are aware of their roles and responsibilities and an information communication system is in place to see that all activities specified for asset/facility management have been duly carried out at all levels.

4.4 Facility Manager

Normally functions of facility management are entrusted to a dedicated functionary termed as facility manager. He can be assisted by various skilled and unskilled persons as per facility requirements.

4.4.1 *Functions of Facility Manager*

Facility Manager is primarily concerned with operational planning and control of the activities covered under asset/facility management. This will involve various items as given under **4.4.2** to **4.4.4.**

4.4.2 *Persons Reporting to Facility Manager*

They should be aware of their roles and responsibilities and procedures to be followed. Facility manager has to see that adequate resources are made available to them for carrying out the required activities. Where necessary, their competence is to be developed further so that they may carry out the present and future assignments successfully.

4.4.3 *Control Mechanisms*

The facility manager should put in place certain control mechanisms to ensure that:

a) There is documentation to enable verification that the activities required were duly carried out and completed as required.
b) There is documentation to enable verification that the risk management processes required were duly carried out and completed as required.
c) Efforts are made to determine emerging risks and plan changes to asset/facility management well in advance, if required.

4.4.4 *Management of any Change*

During operational phase, there may be changes due to supply chain constraints in respect of materials or labour, or there may be competing demands on resources.

New assets may also have to be managed. There may be a change in processes and so on. Efforts have to be made to foresee the changes and take timely action to avoid any disruption in asset/facility management processes.

4.5 Outsourcing

Certain items under the facility manager may have been outsourced. Facility Manager has to supervise those items with effective monitoring in order to ensure that the concerned agencies are discharging their responsibilities properly and performance is as planned, which should be supported by necessary documentation. The control of risks which cannot be transferred to outside agencies should be maintained with the facility manager.

5 METHODOLOGY

During the planning of the asset/facility management system, the resources required for the activities planned should be determined. These resources may be grouped broadly in the following two categories:

a) In-house; and
b) Outsourced.

The costs of activities required for asset/facility management should also be incurred under above two categories.

5.1 In-house Activities

Following aspects should be kept in view while planning the activities required for asset/facility management as in-house activities:

a) Cost to be incurred on salary and establishment expenses of regular staff will be more or less fixed depending upon the number of staff in various categories and the infrastructure required for them by way of office accommodation, tools and plants, equipment, etc. This expenditure will not vary much unless the number of staff or the quantum of equipment is varied depending on the work load.

b) Generally, the quantum of works to be carried out is decided keeping in view, in addition to technical requirement, the availability of funds. Cost incurred on works will depend on the actual quantum of work carried out and is, therefore, variable.

5.2 Outsourced Activities

The procurer should determine the extent to which, if any, facility-related services are to be provided from within the organization and those services that are to be outsourced. Where both occur, account should be taken of the need to integrate the two sources of service delivery and the resources and costs that may be involved in managing such an arrangement. Consideration should be given to the interfaces

between separate services, including any obtained from within the organization, so that end-users experience seamless service delivery.

5.2.1 *Precautions to be Taken During Outsourcing*

The advantage of managing activities with in-house resources is that the organization has direct control over the operations. However, when activities are outsourced, such direct control is not automatic. The organization shall assess the associated risks and shall ensure that outsourced processes and activities are controlled. There has to be a clear demarcation between the activities that have to be outsourced and the activities to be managed by the organization in-house. Arrangements have to be made for sharing the knowledge and information between the organization and the agencies with whom contract has been entered into for providing certain activities. Therefore, in case of outsourcing of certain activities, the organization shall lay down responsibilities and authorities within the organization for controlling such outsourced activities including monitoring of their performance.

5.3 Processes to be Adopted

Adequate staff having necessary training in carrying out various operations for ensuring required levels of cleanliness, serviceability, hygienic conditions, safety and security of occupants under guidance of facility manager should be deployed. The facility management team should draw up plans for achieving the desired standards. It should also keep track of best practices developed elsewhere and is exposed to latest developments in this field.

6 RESOURCES REQUIREMENT FOR ASSET/FACILITY MANAGEMENT

6.1 Resource Assessment

A facility, and the individual assets that it comprises, should be maintained to deliver the most effective outcomes in terms of minimal cost and risk. Assets should be classified into risk categories, for example, small, medium, severe and critical, according to their potential impact on the core business of the organization in the event of failure in performance. The condition of assets should be determined and a decision made as to the most effective option for their maintenance.

The organization shall determine and provide the resources needed for the establishment, operation, and further improvement of the asset/facility management system; meeting the asset/facility management objectives and implementation of the activities specified in asset/facility management system. Information technology will help in making better use of resources, reduce risk of failure of essential services, and make available information for better future planning.

6.2 Resource Plan

A maintenance resource plan should be prepared for assets operating under normal (operating) conditions. This plan should be modified, where necessary, to reflect operating conditions within the facility that fall outside specified design requirements and/or tolerances. The plan should be capable of aligning with changes in demand

for, or modes of, service delivery. For an existing facility, a condition assessment of the assets should be undertaken before preparing the maintenance resource plan, wherever practicable. The cost of implementing the plan should be estimated and adequate provision made within budgets. Once implemented, the plan should be monitored for effectiveness and performance, with adjustments made where appropriate to ensure that the requirements set out are met.

6.3 Need Assessment

An organization should align its service needs, including service dependency, utilization, location, capacity and functionality, and maintenance planning with the required level of facility asset performance. Where a new facility is being procured, an organization should ensure that adequate provision is made during the design and construction phases to incorporate these requirements. Maintenance should be planned to take account of the maintenance cycle of each element/sub-element and inspections should be made at regular intervals (as determined by the properties of each element/sub-element and its anticipated service life). An organization's production and operational requirements should be integrated into the maintenance plan. Annual programmes of maintenance should take into account subsequent years' programmes so that additional costs or abortive works are minimized. Decisions to replace or repair components should be taken after due consideration of whole-life costs.

6.4 Adequacy of Resources

6.4.1 The resources available may be compared with the resources required. In case of shortfall in availability as compared to requirement, the shortfall may be met by one or more of the following options:

a) Augmenting in-house resources;
b) Augmenting outsourced resources; and
c) When resources cannot be augmented, say, due to non-availability of requisite funds, postponing the requirements which are not so urgent.

6.4.2 Following factors affect the choice of the category of resource required for various activities:

a) *Competence of staff* — It is to be seen whether the requisite competence is available with the staff available in-house, or it is necessary to arrange the same by outsourcing. Where required, the competency needs should be met by provision of training to the available persons, or hiring or contracting of competent persons. The following shall be taken care of,

    1) The organization shall determine the required level of competence of persons doing work under its control that affects its asset performance, asset/facility management performance and asset/facility management system performance.
    2) The organization shall ensure that the persons engaged on its works are competent on the basis of appropriate education, training or experience.

3) Where required, action should be taken to see that the concerned persons acquire the requisite competence by further training, etc.
4) Adequate documented information shall be kept as evidence of competence of concerned persons.
5) The organization shall periodically review current and future competency needs.
6) Staff is aware of their job requirement and expected deliverables.

b) Persons doing work under the organization's control, who can have an impact on the achievements of the asset/facility management objectives, shall be aware of:

1) the asset/facility management policy;
2) their contribution to the effectiveness of the asset/facility management system, including the benefits of improved asset/facility management performance.
3) their work activities, the associated risks and opportunities and how they relate to each other.
4) the implications of not conforming to the asset/facility management system requirements.

c) *Tools, plant and machinery* — Certain maintenance operations may require tools, plants and machinery, which may or may not be available in-house. In case of non-availability in-house, it has to be decided whether the same should be procured or the work outsourced.

7 PROCUREMENT OF ASSET/FACILITY RELATED SERVICES

7.1 Roles, Responsibilities and Accountabilities

One of the functions of asset/facility management is to determine which procurement option, or combination of options, for the delivery of maintenance-related services best fits the core business and primary processes of an organization. It is important for organizations to understand the full maintenance requirements and the capability and capacity required to deliver these services.

Procurement of facility-related services should be regarded as a distinct function within the procurer's organization and, as such, should be covered by a designated role. Formal systems, processes and procedures should be assessed to determine whether or not arrangements covering facility related services have been included and, if so, how these may apply.

The procurer should determine where responsibilities and accountabilities rest with respect to defined roles in the procurement of facility-related services. Where tasks to be performed fall outside existing roles, the organization should consider designating additional personnel for this purpose. The need for expert advice from external sources to supplement any lack of internal skills and competence should be ascertained. Where found necessary, additional roles should be defined and incorporated alongside those existing. The procurer should identify all roles that are connected with the function of procuring facility-related services and ascertain their

nature and the relationship between them. Where the procurer is unable to fulfil required roles, the appointment of a managing agent (or other consultant) should be considered.

7.2 Planning for Procurement

A plan of the procurement process should be prepared to identify the stages involved and activities within them. The plan should take the form of a schedule in which stages, planned activities and their resources, decision points and milestones are shown against a time-scale.

Planning for procurement is a project in its own right. Resources include finance, budgets, human resources, consumables, equipment and IT. Milestones cover commencement dates, completions and deadlines. Approvals and other key decisions are better considered as activities having durations and not as milestones since they are rarely, if ever, instantaneous events. The plan should complement existing processes and procedures, and align with the requirements of corporate governance. The procurement plan should identify:

a) Stages and decision points in the procurement process;
b) Criteria for decision-making;
c) Activities within stages and their sequence;
d) Sources of information and data to be used in activities;
e) Individuals and external organizations to be involved in activities and their roles;
f) Other stakeholders who may be involved;
g) Resources needed to support the activities; and
h) Deliverables at each stage and the form they should take.

The plan should incorporate the tendering process and procedures to be adopted.

7.3 Pre-qualification

A request for proposal (RFP) or a pre-qualification quotation (PQQ) should be prepared by the procurer and reflect, as a minimum, the following:

a) Legal form and ownership of the service provider;
b) Areas of specialization, competences and technical skills;
c) Proposed approach to service delivery (that is, method of work);
d) Extent of subcontracting;
e) Relevant track-record (based on evidence of similar contracts);
f) Financial capacity and dependency;
g) Organizational organogram;
h) Health, safety, security and sustainability policies, procedures and practices;
j) Commitment to provisions on access, inclusion and equality;
k) CSR policy and initiatives;
m) Alignment with the procurer’s business process and systems; and
n) Basis for assessing overall suitability (including criteria, scoring and any weightages to be applied).
p) Training infrastructure

The RFP/PQQ may be undertaken in two parts: firstly, through a preliminary evaluation which is used to determine and filter out any service providers that are clearly unsuitable; and, secondly, through a detailed evaluation aimed at objectively assessing the ability of prospective service providers. Any preliminary evaluation should enable the procurer to quickly establish the suitability of service providers, enabling them to focus attention on those best qualified to deliver the service.

NOTE — Standard procedures for call of tenders may be as well established by respective organizations, for example, ones under two/three envelope system.

The procurer should determine the number of service providers that it wishes to invite to submit an RFP/PQQ. A maximum and minimum number should be set. The procurer should determine if, at the end of the RFI stage, it lacks information to specify all of its facility-related services and required levels of performance. In such a case, it should make arrangements to gather that information before proceeding to a request for proposal (RFP).

7.4 Financial Appraisal

All prospective service providers, irrespective of specialization or size, should be treated fairly and with equal diligence during the financial appraisal process. As a minimum consideration, the following should be undertaken:

a) Inspection of the financial accounts for the past three years of trading (in the absence of audited statements, other information that demonstrates the service provider's financial standing should be sought); and
b) Assessment of the service provider's ability and capacity to deliver the service at the current estimated contract value.

Where the procurer considers that its knowledge of the market is underdeveloped, it should investigate the availability of prospective service providers and the extent to which they may cover the identified scope of facility related services. The procurer should engage in direct enquiries with service providers and/or the trade associations or other bodies that represent them. Market testing should represent a genuine attempt to engage existing and prospective service providers in discussion about approaches to service delivery.

The procurer should consider the benefits of seeking indicative cost estimates to guide decision-making.

7.5 Centralized *Versus* De-centralized Management of Service Contracts

Where the procurer has both centralized and de-centralized management with respect to procurement, it should state its position and policy in regard to services that may be procured locally and those that may only be procured centrally and *vice-versa*. Note should be taken of the arrangements for day-to-day management of service contracts and authorities for contract awards, approval of payments and significant changes in the scope of contracts or their value. Where there is a requirement for pre-qualification for the purpose of inclusion in a list of tenderers, policy in this regard should be made clear both centrally and locally.

7.6 Geographical Location and Limits

By examining needs in regard to the provision of facility-related services, in particular attributes of service, the procurer should be able to achieve a clear understanding of what is important in service delivery. The procurer should consider the extent to which the local market is able to offer the planned services and the geographical limits that are acceptable when considering the suitability of a prospective service provider.

7.7 Single/Multiple Service Contracts

The procurer should explore the combinations of services that can be delivered by prospective service providers with regard to the defined scope and the relationships and interfaces between the services. Account should be taken of the ability of service providers based on evidence of performance and/or reference sites.

7.8 Local, Regional and National Service Providers

The procurer should determine the extent to which the market locally, regionally or nationally has the capacity to satisfy needs. Account should be taken of the specialization, number and size of service providers able to offer the planned services. Informal enquiries directed to prospective service providers may reveal the extent to which they are in a position to undertake new work, although care should be exercised when making judgments as to their capacity to do so.

7.9 Award of Works and Monitoring

The work shall normally be awarded to lowest responsible bidder whose bids are found to be responsive and is capable of delivery. Proper monitoring system shall be put in place to ensure quality work, as per work schedules and within budget estimates.

8 CLASSIFICATION OF ASSET/FACILITY MANAGEMENT

8.1 Typically asset/facility management can be classified into two areas of ‘hard’ and ‘soft’ services. The scope is extremely varied and services are likely to include hard services and soft services as given under **8.1.1** and **8.1.2**, respectively.

8.1.1 *Hard Services*

Hard services basically include building fabric maintenance, building services maintenance, such as plumbing, heating, ventilation and air conditioning (HVAC), electrical installations, lifts and escalators, etc.

MEP equipment provide essential service and make the building/facility safe and workable it is most essential that all the systems installed in any building/facility are maintained in good running/operating condition. Shortcoming in maintenance can lead to disruption of essential service and lead to impacting adversely the working within the facility therefore downtime should be minimized. All these services have to be carried out as per the type and usage of the facility.

For large or sensitive installations/facilities, it will be desirable to co-opt the facility management team at planning and design stage and utilize their inputs during the lay-out/design of building fabric and services, which can ultimately lead to easier and better functioning. Selection of materials, system, which have proved to be easier to maintain should be considered while making selection at project execution stage.

Some of these hard services, as follows are covered in this Part:

a) Building fabric maintenance (including addition/alteration and refurbishment) (*see* **10**);
b) Building services maintenance:
    1) Plumbing and drainage (*see* **11**);
    2) Air Conditioning, heating and mechanical ventilation (HVAC) services (*see* **12**);
    3) Electrical installations (*see* **13**);
    4) Lifts and escalators (*see* **14**); and
    5) Fire fighting-detection and suppression (*see* **15**); and
c) Roads and pathways (*see* **16**).

8.1.2 *Soft Services*

Soft services, such as housekeeping, pest control, waste management, security, valet services, office support services, etc, are as essential a part of asset/facility management as maintaining hard services.

All these soft services have to be carried out as per the type, usage of the facility and may vary considerably. For instance, services and service standards for a hotel, hospital or shopping malls/complexes may be quite different from those required for a standalone residence. A considered call on this has to be taken by the owner and the standards required to be achieved have to be communicated to the facility management team.

Some of these soft services, as follows, are covered in this Part:

a) Environment, health and safety (*see* **17**)
b) Landscaping and horticulture waste management (*see* **18**)
c) Housekeeping (*see* **19**);
d) Pest control (*see* **20**);
e) Security management (*see* **21**); and
f) Solid waste management (*see* **22**).

8.2 Asset/facility management in respect of common areas in a building and built environment should also take care of the provisions of **9.13**.

8.3 Various services, whether hard or soft, require understanding of different aspects, methodologies and management of maintenance, which have been detailed in **9**.

9 BUILDING MAINTENANCE – METHODS AND MANAGEMENT

9.1 General

Any building (including its services) when built has certain objectives and during its total economic life, it has to be maintained in proper condition to meet those objectives. Maintenance is a continuous process requiring a close watch and taking immediate remedial action. It is interwoven with good quality of housekeeping. It is largely governed by the quality of original construction. The owners, engineers, constructors, occupants and the maintenance agency are all deeply involved in this process and share a responsibility. Situation in which all these agencies merge into one is ideal and most satisfactory. There are two processes envisaged, that is, the work carried out in anticipation of failure and the work carried out after failure. The former is usually referred to as preventive maintenance and the latter as corrective maintenance. The prime objective of maintenance is to maintain the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

Maintaining a building is expensive; it costs many times more to run a building over its lifetime than to build it, yet maintenance is often not accorded the priority it warrants. A poorly maintained building will be a drain on resources and will impair building use, whereas a well maintained building will function smoothly and represent an appreciating asset to its owners. A professional approach is therefore required to building maintenance.

Though the building may be designed to be very durable it needs maintenance to keep it in good condition. Whereas construction stage lasts for a short period, maintenance continues for comparatively very large period during the useful life of building. Inadequate or improper maintenance adversely affects the environment in which people work, thus affecting the overall output. In the post construction stage the day to day maintenance or upkeep of the building shall certainly delay the decay of the building structure. Maintenance management of building is the art of preserving over a long period what has been constructed

9.1.1 The objective of maintenance is,

a) To preserve building and services, machinery in good operating condition;
b) To restore it back to its original standards; and
c) To improve the facilities depending upon the development that is taking place in building and services engineering.

9.1.2 Maintenance in general term can also be identified in the following broad categories:

a) *Cleaning and servicing* – This is largely of preventive type, such as checking the efficacy of rain water gutters and servicing the mechanical and electrical installations. This covers the house keeping also.

b) *Rectification and repairs* – This is also called periodical maintenance work undertaken by, say, annual contracts and including external replastering, internal finishing, etc.

c) *Replacements* – This covers major repair or restoration such as reproofing or re-building defective building parts.

9.2 Maintenance Methods

An organization should determine which method or combination of methods best satisfies its operational needs in maintenance in accordance with its facilities maintenance strategy and policy. Each method should be assessed in terms of the extent to which it satisfies (or does not satisfy) the criteria defined as part of the facilities maintenance strategy. When taking into account asset criticality and monitoring capacity within the facility, the benefit of combining methods should be evaluated.

There are a number of methods of maintenance; these can be grouped into two broad categories (*see also* Fig. 1):

a) Planned maintenance, which includes planned preventive maintenance and shutdown maintenance. Preventive maintenance further includes condition-based maintenance, reliability centred maintenance (RCM) and total productive maintenance (TPM); and

b) Unplanned maintenance, which includes corrective maintenance, breakdown maintenance and emergency maintenance.

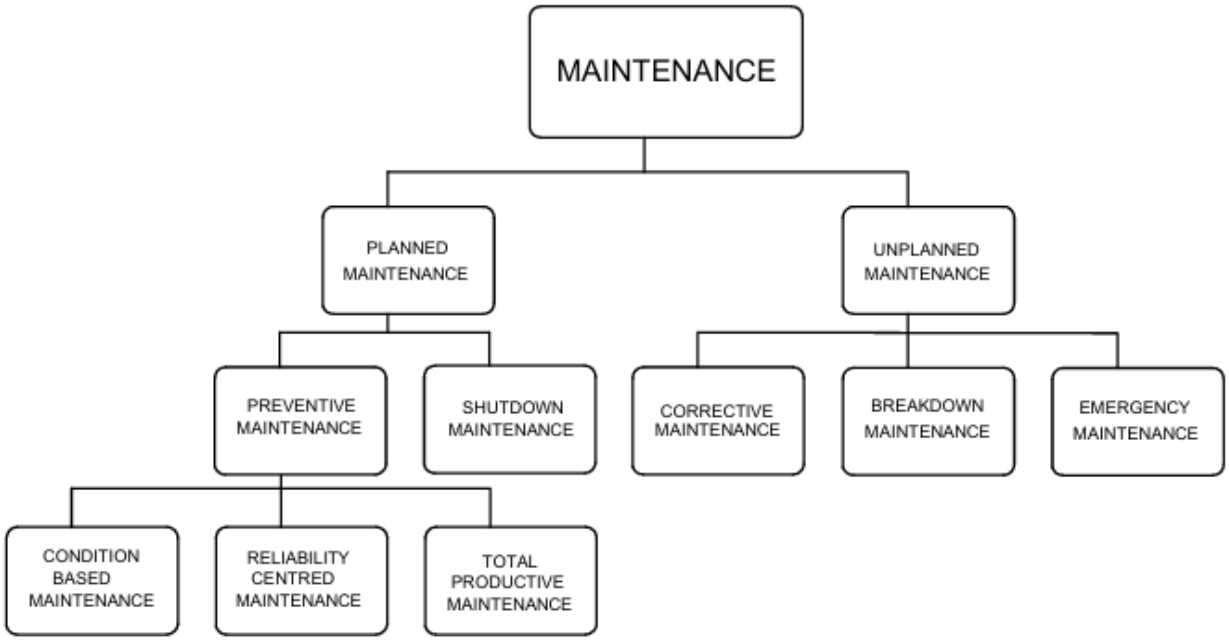


FIG. 1 MAINTENANCE METHODS

9.2.1 *Planned Maintenance*

9.2.1.1 *Planned preventive maintenance or scheduled maintenance*

This method allows maintenance activities to be organized and carried out with forethought, control and records to a predetermined plan, based on the results of condition surveys. This method aims to avoid or to mitigate the 'consequences of failure' and to minimize maintenance-induced failures and their associated costs. It is based on the criticality of failure to the organization and is also known as scheduled maintenance.

Planned preventive maintenance is further classified into following categories:

a) *Condition-based maintenance* — This method of maintenance is based on the results of condition monitoring of building, plant, equipment, systems and elements to avoid loss of function or failure. Condition-based maintenance is performed by selecting and monitoring a parameter which, for example, indicates plant condition. Data are collected and analysed and required maintenance is determined from the findings. This work can be carried out continuously, periodically or on demand in real time and is often used for remotely monitoring plant condition.

b) *Reliability centred maintenance* — Reliability centred maintenance is a systems-based method used to determine maintenance tasks needed to ensure that a facility asset or system continues to function in order to fulfil its purpose as designed in its present operating condition. The method can involve the implementation of asset condition monitoring, based on the advance provision of an asset register.

c) *Total productive maintenance* — Total productive maintenance is a systematic approach to improving maintenance effectiveness, which operates at the tactical level and normally builds on the successful implementation of strategic methods. The method also involves the implementation of asset condition monitoring, based on the advance provision of an asset register.

9.2.1.2 *Planned shutdown maintenance*

This method is normally used for continuous process production and manufacturing facilities, where a detailed plan is produced for all assets for work to be carried out during a total shutdown.

9.2.2 *Unplanned Maintenance*

9.2.2.1 *Corrective maintenance*

Maintenance initiated as a result of the observed or measured condition of plant, equipment, systems, elements, before or after a functional failure, can be used to resolve the problem and ensure correct functional performance. This work can be planned or unplanned.

9.2.2.2 *Breakdown maintenance*

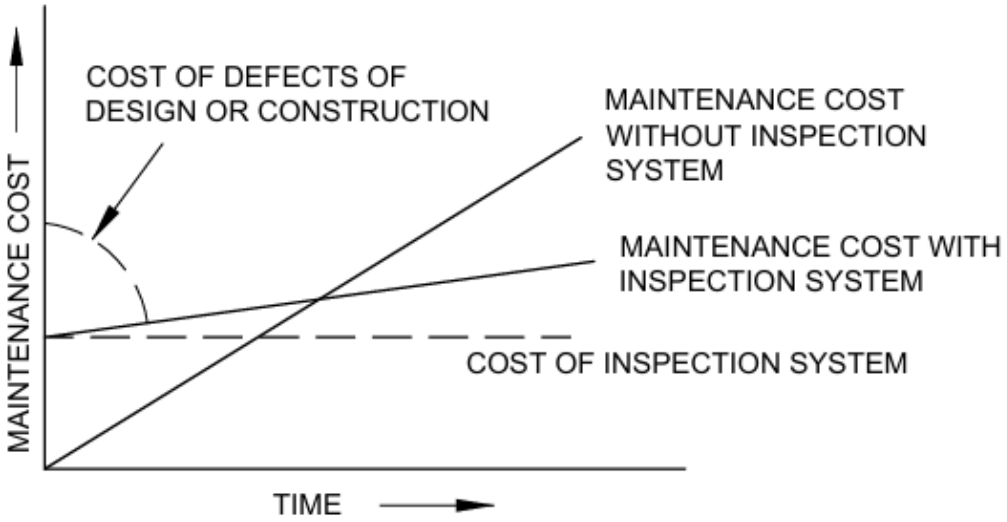
Breakdown maintenance relates to the task of restoring an asset so that it can fulfill its original function after failure. This method may result in high replacement costs over the lifetime of the asset, but has a low initial maintenance resource requirement. It is sometimes used for simple facilities that have few operatives and no critical environments to support.

9.2.2.3 *Emergency maintenance*

This maintenance method results from a sudden, unforeseen occurrence requiring immediate corrective work to be carried out to restore to function and to avoid potentially serious consequences.

9.3 Cost Effectiveness

The facility manager has to work out the cost effectiveness of the method adopted taking into account the resources availability, criticalness of services and cost trade off to determine the frequency and level of maintenance to be ensured. Impact of various factors on costs involved and degree of maintenance services achieved is shown in Figs. 2 to 4.



NOTES

1 IN GENERAL MAINTENANCE CLASSIFICATION MAY BE AS:
  a) MAJOR REPAIR OR RESTORATION
  b) PERIODIC MAINTENANCE
  c) ROUTINE OR DAY-TO-DAY MAINTENANCE

2 A SYSTEM WHICH IS BASED ON PLANNED INSPECTIONS AND MAINTENANCE WILL HAVE HIGHER OVERHEAD COSTS THAN THE ONE THAT IS NOT, BUT THE PLANNED LEAD TO LOWER MAINTENANCE EXPENDITURE.

FIG. 2 COST RELATIONSHIP BETWEEN
PLANNED AND UNPLANNED SYSTEM

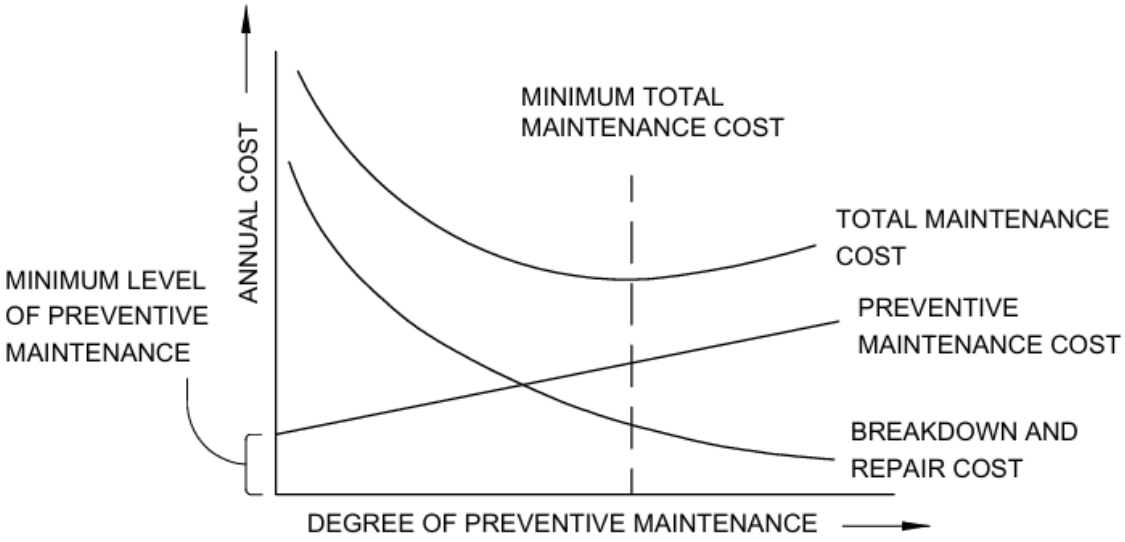


FIG. 3 TRADE-OFF BETWEEN REPAIRS AND
PREVENTIVE MAINTENANCE

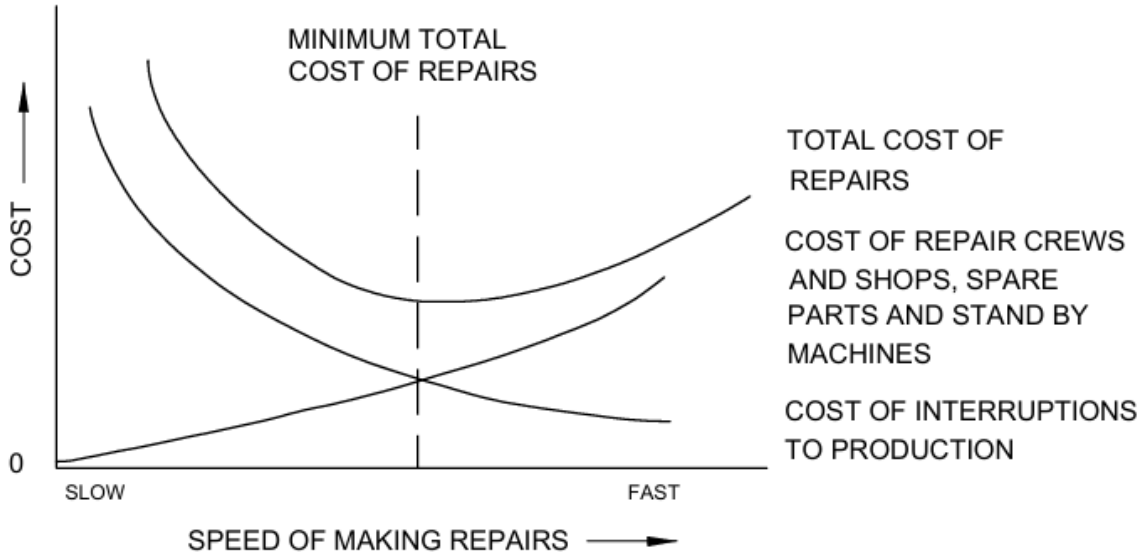


Fig. 4 SPEED OF MAKING REPAIRS

9.4 Aspects Influencing Building Maintenance

9.4.1 Maintenance of the buildings is influenced by the following factors:

a) *Technical factors* – These include age of building, nature of design, material specifications, past standard of maintenance and cost of postponing maintenance.

b) *Policy* – A maintenance policy ensures that value for money expended is obtained in addition to protecting both the asset value and the resource value of the buildings concerned and owners.

A maintenance policy should be developed to support the preparation of operational plans in accordance with the maintenance strategy. The policy should outline the scope and course(s) of action that should be taken to achieve an organization's goals. The maintenance policy should embody the principle of best value for money to protect both the asset value and the resource value of the facility. The policy should cover,

1) the organization's anticipated future requirements for the facility, taking into account the facility's physical performance and functional suitability, for example:
   i) The use of the facility, that is, anticipating likely upgrades and the effect on the life cycles of existing materials, components and engineering installations;
   ii) A change of use for the facility and the effect of any conversion work on the life cycles of existing materials, components and engineering installations; and
   iii) The anticipated date of conversion, renovation or refurbishment work.
2) Any cycles of maintenance determined in accordance with (a);
3) The method of maintenance, taking account of cycles of maintenance together with the requirements of the organization with respect to the use of the facility and any special requirements to which this may give rise;
4) Holding spare parts and other items to replace those that are beyond repair or which have exceeded their useful life; and
5) The means for reporting on performance achieved.

c) *Financial and economic factors* — The planning and control of finance is an important aspect of maintenance management not only for the control of maintenance but also to demonstrate that the owners are getting value for money and that the maintenance proposals justify the funds requested.

Financial considerations start with the development of maintenance programmes and the preparation of budget proposals. They also include the preparation of the detailed maintenance programme following the allocation of budget funds. These will involve decisions regarding optimum repair reaction time and the choice of the most appropriate method of execution (directly employed).

d) *User* – the maintenance requirements of buildings and their various parts are directly related to the type and intensity of use they receive and the people who use these facilities especially those with disabilities, elderly and children in particular.

9.4.2 *Other Factors Affecting Maintenance*

9.4.2.1 *Health and safety*

9.4.2.1.1 *General*

The management of occupational health and safety has to be viewed as an integral component of facilities maintenance management and not as a separate function or as an add-on.

An organization should assess risks and other hazards at all stages in a facility's life cycle. Identified risks should be monitored and, wherever possible, their potential impacts should be mitigated. An organization should implement a formal system of risk management, including establishing and maintaining a risk register. Periodic reassessment of risks should be undertaken to update the risk register and associated risk mitigation.

9.4.2.1.2 *Initial review*

An initial review should be undertaken to provide information on the appropriateness, efficiency and effectiveness of existing health and safety management systems. Where no formal, or a minimal, health and safety management system exists (such as when an organization is newly established or when carrying out new activities) the initial review should be used as a base from which to develop a new system.

9.4.2.1.3 *Risk control and corrective actions*

An organization should implement risk control, as an integral part of its risk management, to ensure that control measures remain in place and that they remain efficient and effective. The risk management system should allow, as a minimum, for the following:

a) Identification of health and safety hazards arising from maintenance and other work determined by workplace inspections, behavioural observations, tours, and formal and informal discussions with the workforce;
b) Identification of people who may be at risk from maintenance, for example, maintenance personnel, occupants, visitors, passers-by, trespassers, persons with disabilities, elderly people and children;
c) Evaluation of the risks to which individuals and/or an organization may be exposed;
d) Devising ways to eliminate, reduce and/or control risks, for example guarding and fencing, method statements, safe systems of work, permit-to-work, training and supervision;
e) Monitoring and recording the effectiveness of risk control measures and systems, for example inspections, observations, safety tours and checklists;
f) Taking coordinated corrective action;
g) Providing feedback to the workforce and other stakeholders;
h) Training, together with health and safety checks, of operatives; and
j) Auditing and reviewing the system and, therefore, health and safety performance.

9.4.2.2 *Environmental factors*

9.4.2.2.1 *External*

An organization should assess the extent to which external environmental factors can influence the condition of the structure, fabric, engineering installations, fixtures and external finishes, and take such factors into account when drawing up maintenance plans. This should also include control of moisture. Swimming pool structures are vulnerable to the effects of chlorine used in water.

9.4.2.2.2 *Internal*

Humidity, temperature and pollution are factors that can adversely affect the condition of the structure, fabric, engineering installations, fixtures and internal finishes. The effects of intermittent heating and condensation can be particular problems.

An organization should assess the extent to which internal environmental factors, as well as the level of maintenance, influences the condition of the structure, fabric, engineering installations, fixtures and internal finishes. These factors should be taken into account when maintenance plans are drawn up. Factors that have a damaging effect on physical conditions, for example control of moisture, static electricity, as well as any unintended consequences for maintenance personnel, occupants and other users of the facility, should also be taken into account.

9.4.2.2.3 *Materials and components*

When drawing up maintenance programmes and plans, including inspection schedules, the likely maintenance cycle of each element/sub-element (in accordance with the known quality of the materials and components employed and their manufacturers' recommendations where available) should be incorporated. The following need special attention:

a) Potentially hazardous materials and components such as:

    1) Those containing asbestos;
    2) Lead, which may be present in some paint or be used for pipes carrying potable water;
    3) Materials that are either highly combustible or give off large quantities of smoke and fumes when involved in an established fire or in confined spaces (for example electrical risers); and
    4) Areas that should operate under a permit-to-work system.

b) Types or methods of construction that, under certain circumstances, may become dangerous.

c) Finishes and decorations, including their protection and treatment, where required.

9.5 Influence of Design

9.5.1 The physical characteristics, the life span and the aesthetic qualities of any building depend on the considerations given at the design stage. All buildings, however well designed and conscientiously built, will require repair and renewal as they get older. For better performance of the building envelope the following ways help to minimize troubles at later stage.

a) Due attention be paid to maintenance requirements of the facility from the planning stage. The agency which is likely to be entrusted with the work of subsequent maintenance and upkeep of the facility should be involved from the design stage itself. Their inputs will be very valuable in ensuring economical maintenance during the lifetime of the facility. This aspect needs greater attention as the defects that are built in at planning stage are difficult to be addressed at subsequent stages.
b) Detail and choose materials during construction so that the job of maintenance is less onerous.
c) Specifications adopted should be practical and based on local practices. Durability considerations and maintenance of various areas should be kept in view.
d) In addition, initial costs and life, type of finish achieved and fire and life safety requirements should be built in at the time of design.
e) Detailing of components should be done to ensure that they are conducive to effective operation and maintenance
f) Accessibility for maintenance purposes of areas and services requiring maintenance is taken care of. It is necessary that service personnel are able to reach the service easily, safely, have adequate working space, safe working conditions and adequate lighting provisions. Cleaning of façade and replacement of glass panes needs to be kept in view while finalizing exteriors.
g) In addition to designing a building for structural adequacy, consideration should also be given to environmental factors such as moisture, natural weathering, corrosion and chemical action, user wear and tear, pollution, flooding, subsidence, earthquake, cyclones etc.
h) Design phase should cover such items as the owner's anticipated future requirement for the building taking account of the building's physical performance and its functional suitability. This may lead to decisions regarding,
    1) a change of use for the building and the effect of any conversion work on the life cycles of existing components or engineering services; and
    2) availability of replacements.
j) The present use of the building anticipating any likely upgrading and their effect on the life cycles of existing components or engineering services.

9.5.2 During construction stage it should be ensured that suitable construction techniques are adopted, adequate quality control measures are taken, special attention is paid to services and testing of lines, effective supervision throughout and sound remedying of defects is ensured.

Need of good workmanship needs no emphasis. Proper detailing of elements and various fittings and fixtures will ensure good workmanship and quality work which in

turn will not only give longer life to the facility but will ensure their long term functional service.

9.5.3 A list of common causes for maintenance problems is given in Annex A for guidance. However, no such list is likely to be entirely comprehensive.

9.6 Maintenance Planning

9.6.1 *General*

Maintenance plans should be driven by and support the intended outcomes stated in the facilities maintenance policy and strategy and should be fully aligned with them. Maintenance plans should be prepared in consultation with stakeholders, taking account of the following as a minimum:

a) Organization's requirements for production and operational demands and constraints;
b) Organization's financial circumstances and/or taxation position; and
c) Feedback data on maintenance outcomes, including associated costs. Multi-year programmes of maintenance should be put in place where appropriate, that is, for long-term planning, finance or other expediency. Programmes should state a review date for assessing progress and performance.

When formulating maintenance plans, alternate maintenance methods should be evaluated. The links between the selected maintenance method(s), maintenance performance, facility asset performance and service delivery should be established through metrics, such as, key performance indicators (KPIs), based on a practical and effective maintenance process.

9.6.2 *Assessment of Maintenance Planning*

An organization should assess the benefits of maintenance planning, basing the assessment on the following:

a) Contribution to the organization's goals;
b) Satisfaction of stakeholder interests;
c) Effectiveness of the facility in supporting the organization's operational plans;
d) Availability and reliability of the facility at minimal cost;
e) Capital and tax planning;
f) Asset/facility management strategy;
g) Protection of the value of facility assets;
h) Provision of data on facility asset performance;
j) Provision of data for maintenance benchmarking;
k) Provision of data for continual process improvement;
m) Provision of data on environmental performance;
n) Basis for service life planning;
p) Contribution to energy management;
q) Contribution to business continuity management;
r) Basis for service level agreements;
s) Transparency and sound governance in financial reporting;

t) Identified security risks;
u) Awareness environmental sustainability;
v) Improvement of outsourcing and collaboration agreements;
w) Contribution to the facilities management strategy;
y) Contribution to total quality management; and
z) Contribution to procurement and supply chain management.

9.6.3 *Maintenance Planning Process*

While taking up maintenance planning, following should be kept in consideration:

a) Facility assets required to support the core business and the delivery of services should be defined;
b) Required level of facility asset performance, including performance indicators, should be agreed;
c) Condition and sufficiency of facility assets for their intended purpose should be audited;
d) Scope of the maintenance required should be identified through gap analysis;
e) An appropriate maintenance method from those available should be selected;
f) Resources required for the chosen maintenance method should be assessed;
g) Maintenance plans and budgets should be prepared to cover the required scope of services over the short, medium and long term;
h) A tactical plan for delivery of maintenance should be formulated;
j) Resources to deliver the scope of maintenance should be provided;
k) Maintenance plans and programmes of work are implementable;
m) Performance monitoring, review and control of maintenance plans and programmes of work should be carried out.

Information and data gathered from this process should be used to re-inform the organization's need for, and use of, facility assets during this and any future iterations, of this process.

9.6.4 *Financial Management*

Maintenance budgeting is directed to keeping building in appropriate condition by the most economic means and each aspect of maintenance policy bears on cost. In maintenance budgeting, there are two prime elements relating to what to budget for and how to assess its cost.

Financial control is an important aspect of maintenance management; this ensures that maintenance proposals justify the funds requested and that organizations obtain best value for money.

A maintenance strategy, and its associated maintenance programme(s), should include estimates of the cost of known work and provision for work that may be required but where the extent is unknown. These estimates should be used as the basis for preparing budgets for maintenance in line with an organization's overall financial planning and management accounting requirements. Budgets should include, but are not limited to, repair/replace decisions, the optimization of planned

preventive maintenance, surveying/inspection costs and whole-life costs. Budget proposals should be presented in a way that identifies,

a) The impact on capital value;
b) The costs and benefits that accrue from the funds required;
c) The risks and associated costs of not carrying out maintenance programmes in accordance with the maintenance strategy; and
d) The costs and benefits of repair against refurbishment and against replacement and the basis of calculation, for example, net present value (npv).

In the case of outsourced contracts, the contract sums and the costs associated with the management of the contracts, should be prepared. An audit should be carried out in each financial year to ascertain the extent to which best value for money has been obtained from the funds expended in the previous year on maintenance and to determine if any changes are needed to improve value for money.

It will be a good practice to carry out during the following financial year, a technical audit to ascertain the extent to which value for money was obtained from the funds expended in the previous year and what improvements in management may be made to improve cost benefits.

Guidelines relating to estimation of expenditures for maintenance as in **9.11.2** may be used.

For details *see* good practice [12(1)].

9.7 Maintenance Work Programmes

The programming of maintenance work can affect an owner or his activities. Following aspects need consideration:

a) Maintenance work should be carried out at such times as are likely to minimize any adverse effect on output or function.

b) Programme should be planned to obviate as far as possible any abortive work. This may arise, if upgrading or conversion work is carried out after maintenance work has been completed or if work such as rewiring is carried out after redecoration.

c) Any delay in rectifying a defect should be kept to a minimum only if such delay is likely to affect output or function. The cost of maintenance increases with shortening response times.

d) Maintenance work, completed or being carried out should comply with all statutory and other legal requirements.

9.7.1 *Maintenance Guides*

An owner responsible for a large number of buildings may have established procedures for maintenance. When an owner is responsible for the maintenance of only one building or a small number of buildings, the preparation of a guide tailored to suit each particular building, can offer significant advantages. Such a guide should take into account the following:

a) Type of construction and residual life of the building, and
b) Environment and intensity of use.

The guide may form part of a wider manual covering operational matters.

9.7.2 *Feed Back*

9.7.2.1 Feedback is normally regarded as an important procedure of providing information about the behaviour of materials and detailing for the benefit of the architect/engineer designing new buildings, which will result in lessening maintenance costs. It is an equally valuable source of information for the persons responsible for maintenance. Every maintenance organization should develop a sample way of communicating its know-how, firstly for benefit of others in the organization and secondly for the benefit of the building industry as a whole. There should be frank and recorded dialogue on an on-going basis between those who occupy and care for buildings and those who design and construct them.

9.7.2.2 Feedback should aim at the following:

a) User satisfaction, particularly from diversity of users, such as, women, elders and persons with disabilities;
b) Continuous improvement; and
c) Participation by all.

9.7.2.3 *Source of information*

The information on feedback can be obtained from the following:

a) Occupants,
b) Inspections,
c) Records, and
d) Discussions.

9.8 Means of Effecting Maintenance

9.8.1 Responsibility

Some maintenance work will be carried out by the occupier of a building or by the occupier's representative. In the case of leasehold or similar occupation not all maintenance may be the responsibility of occupier. Responsibility of common areas, as need to be clearly defined (*see* **9.13**).

9.8.2 The owner/occupant is primarily responsible for ensuring meeting minimum requirements of maintenance and upkeep as specified in **9.12**. Maintenance work sub-divided into major repair, restoration, periodical and routine or day-to-day operations may be undertaken by one of the following:

a) Directly employed labour,
b) Contractors, and
c) Specialist contractors under service agreement or otherwise.

9.8.3 The merits of each category for typical maintenance work shall be considered because optimum use of resources appropriate to tasks in a given situation is an important element of policy.

9.8.4 The success of contracting out depends on the nature of the services, conditions in which contracting is undertaken (the tendering process), how the contract is formulated and subsequent monitoring of service quality. The important consideration in the decision to contract out is whether a contractor can ensure a socially desirable quantity and quality of service provision at, a reasonable cost to the consumers.

9.9 Access for Maintenance

9.9.1 *General*

All maintenance activities including any preliminary survey and inspection work require safe access and in some situations this will have to be specially designed. Maintenance policy, and maintenance costs, will be much influenced by ready or difficult access to the building fabric and to building services. Special precautions and access provisions may also need to be taken for roof work or for entry into confined spaces such as ducts or voids.

9.9.2 *Access Facilities*

Permanent accessibility measures should be provided at the design stage only for all the areas for safe and proper maintenance. It is a matter on which those experienced in the case of the building can make an important contribution at design stage in the interest of acceptable maintenance costs.

A wide variety of temporary access equipment may appropriately be provided for maintenance work, ranging from ladders to scaffoldings or powered lift platforms.

Wherever possible, it is better to provide permanent access facilities, such as fixed barriers, ladders, and stairways. When such permanent access facilities are provided necessary arrangement may be included in maintenance plans for their regular inspection, maintenance and testing.

All personnel employed for carrying out maintenance should be provided with the necessary protective clothing and equipment and instructed in its use.

When physical access is not possible in situations such as wall cavities, drains, etc, inspections may be made with the aid of closed circuit television or optical devices such as endoscopes.

9.9.3 *Access to Confined Spaces*

Following should be ensured for facilitating maintenance in confined spaces:

a) *Ventilation* – Special precautions need to be taken when entering a confined space. Such confined spaces should be adequately ventilated, particularly before being entered, to ensure that they are free from harmful concentrations of gases, vapours other airborne substances and that the air is not deficient in oxygen.

b) *Lighting* – Good lighting is necessary in order that maintenance work can be carried out satisfactorily. This is particularly important in confined spaces. When the normal lighting is inadequate it should be supplemented by temporary installations. These should provide general and spot illumination as appropriate.

9.10 Performance Management

9.10.1 *General*

Performance management involves monitoring, controlling and improving the efficiency and effectiveness of maintenance management and applies to both internal and outsourced arrangements. Various models, methods and tools are available to assist in the measurement of performance and in indicating where improvement is required; examples include, but are not limited to, value management.

Performance management can be used as a means to foster efficient and effective working relationships between the parties of a contract or agreement relating to maintenance and/or its management, with the aim of achieving continual improvement in performance. It is not intended to be used as the basis for penalizing contractors or service providers, but instead to encourage better performance. Requirements for performance management should be formulated as part of the maintenance strategy and policy and communicated to all affected stakeholders.

An organization should establish a performance management system based upon service level agreements. Where a quality management system exists, the relationship between that and the performance management system should be made clear. In such cases, information and data should be capable of being entered once into either system and should be accessible from both.

9.10.2 *Quality Control*

Quality of construction has to be ensured during planning stage and construction stage of the facility as already emphasized by making suitable provisions for use of durable materials, proper specifications, adequate detailing with emphasis on works required to be done after construction for maintenance and upkeep. All maintenance should

ideally be inspected while it is being undertaken and immediately after completion to ensure that it complies with requirements. Records and accounts rendered for maintenance work carried out should be checked for completeness and accuracy.

9.10.3 *Inspections*

Maintenance is intended to ensure that the facility remains fit for purpose in terms of satisfying organizational goals. This requirement is met, in part, through an effective inspection regime and forward-looking maintenance reporting.

9.10.3.1 The facility should be inspected to determine the quality of the internal environment and the condition and performance of the structure, fabric, engineering installations, fixtures and finishes. Inspection intervals should take into account the properties and anticipated service life of elements/sub-elements.

Regular inspections are actual part of the procedures for the maintenance of buildings. They are needed for a variety of purposes and each purpose requires a different approach if it is to be handled with maximum economy and efficiency. A more detailed inspection covering all parts of a building is needed to determine what work should be included in cyclic and planned maintenance programme.

Inspections should be carried out carefully as unrecorded dangers may exist. If any area or task is suspected of being hazardous, suitable precautions should be taken.

9.10.3.2 *Frequency of inspection*

Inspection should be carried out at the following frequencies:

a) *Routine* – Continuous regular observations should be undertaken by the building user as part of the occupancy of building. Feedback resulting from this type of observation should be encouraged. Consultation with occupants and other users of the facility to determine the existence of any maintenance matters that may require action and, where such work has been undertaken, measurement of users' satisfaction with the outcomes.

b) *General* – Visual inspections of main elements should be made annually under the supervision of suitably qualified personnel at appropriate times. That informs an organization's budgets for maintenance programmes and other maintenance.

c) *Detailed* – The frequency of full inspection of the building fabric by suitably qualified personnel should not normally exceed a 5 year period. An inspection should be carried out by using a checklist made up of facility elements/sub-elements and arranged in way that supports safe working

9.10.3.3 *Inspection schedule*

The preparation of a specific schedule should be encouraged. Once prepared, it can be used for subsequent inspections.

9.10.3.4 *Inspection of engineering services*

Engineering services generally have a shorter life expectancy than building fabric and because of their dynamic function should be subjected to more frequent inspections and maintenance.

Inspection of services should be carried out for three purposes as follows:

a) To check, if maintenance work is required,
b) To check, if maintenance work is being adequately carried out, and
c) For safety reasons to comply with statutory requirements and if required, with recommendations of other relevant organizations.

The frequency of inspections for purpose (a) will depend upon types of plant and system manufacturer's recommendations and subjective judgment. Frequencies for purpose (b) should be carried out on an annual basis.

9.10.3.5 *Method of Inspection*

The limited life of building services means it is important to record their residual life so that their replacement can be budgeted for, and inspection methods should be arranged accordingly.

A checklist of items of plant to be inspected should be considered. Detailed procedure of how inspections should be carried out are necessary because a simple visual inspection is unlikely to show whether plant operating correctly and efficiently.

Inspections frequently necessitate the use of appropriate instruments by competent persons. An example of this is the inspections carried out to check compliance with statutory requirements.

When instruments are used it is important that adequate training is provided in the use of the instruments and the interpretation of the results.

9.10.3.6 Records of all inspections should be kept. Inspection report for buildings may be prepared in the format as given in Annex B.

9.10.3.7 *Reporting*

A maintenance report should be prepared. Information gained from inspections should be collated into two groups:

a) The degree of urgency needed to carry out repairs; and
b) A comparison of maintenance plans, including work of a planned preventive nature.

Attention should be paid to the requirements defined in the maintenance policy. Each item should be carefully assessed when postponing apparently non-urgent work so that it does not result in a major defect or failure over the longer term. The anticipated life of the facility, or any element of it, should be taken into account.

Anticipated failures and defects expected to lead to failure should be highlighted in reports. The resulting information should be arranged in three categories: those matters requiring immediate attention, those that can be placed into a maintenance programme and those which can be postponed but which should continue to be monitored and reviewed.

The maintenance report should address all maintenance requirements not covered by planned preventive maintenance for a period of five to ten years. Where contracts run over longer periods, maintenance plans may extend beyond this limit. The following points should be included, as a minimum, in the maintenance report:

1) Location;
2) Name of element (for example, roof);
3) Name of sub-element (for example, roof covering – tiling);
4) Existing condition (for example, excellent, satisfactory, adequate, poor or unsafe);
5) Prioritization of the element (for example, the redecoration of a customer-facing reception area will have a higher ranking than a storage room);
6) Anticipated phasing of maintenance; and
7) Cost of maintenance.

9.11 Standard Norms for Maintenance Management

9.11.1 *Labour Management*

9.11.1.1 Since the types of assets and facilities, requirements and levels of maintenance vary widely from asset to asset, the same may be established between the parties concerned depending on the type of the asset and the complexities involved. Typical indicative norms for employment of workmen for day-to-day maintenance of buildings is given at Annex C.

9.11.1.2 Multidisciplinary skill among the workers should be encouraged.

Multidisciplinary training programmes should be organized for the workmen to impart them knowledge of various skills. After suitable tests, they should be entrusted with multidisciplinary responsibilities. This approach of multidisciplinary skill will help in improving the quality of maintenance and shall also result in speedy attendance of maintenance complaints requiring attention of two/three disciplines at a time. For details see good practice [12(2)].

9.11.1.3 Organizations should ensure that suitable expertise is available for maintenance and its management at all levels within the organization. Where this expertise is not available in an organization, external resources should be employed instead. Persons responsible for managing the maintenance of facilities, including engineering installations, should possess appropriate management ability and technical competence.

9.11.2 *Recommendatory Expenditures for Maintenance*

A major part of expenditure on asset/facility management is incurred on maintenance, which is determined as follows:

a) Maintenance for day-to-day services,
b) Annual repairs, and
c) Special repairs.

Plinth area maintenance rates, that is annual financial yardstick established for building maintenance on plinth area basis for civil, electrical/mechanical works may be taken as per existing provisions in works departments at central or state level or any other prevalent rates. Special considerations may be taken into account for hilly areas, coastal areas or other areas with severe aggressive climate.

These rates may be multiplied by approved city and year maintenance cost index factor to set the present values for particular city for particular time period. Weightages for various components may be determined based on the usage and applied to work out cost index factors for maintenance works.

NOTE — Typical weightages for building maintenance works may be:

a)	Aggregate	3.50
b)	Cement	9.00
c)	Lime	15.00
d)	Paint	25.00
e)	Sand	4.00
f)	Timber	9.00
g)	Unskilled labour	23.50
h)	Skilled labour	11.00
	Total	100.00

However, the wages shall be governed by *Minimum Wages Act* along with the statutory provisions like PF, ESI, Bonus, etc, and other prevalent mandatory regulations of the respective States/Union Territories.

9.12 Responsibility of Occupants for Maintenance of Facilities

The provisions of **9.12.1** to **9.12.5** shall govern the responsibilities of occupants for maintenance of facilities, such as, structures, equipment and exterior property.

9.12.1 *Responsibility*

The owner of the premises shall maintain the structures and exterior property in compliance with requirements given in **9.12.2** to **9.12.5**, except as otherwise provided for in this Code. Occupants of a building/premises/dwelling unit are responsible for keeping in a clean, sanitary and safe condition, that part of the building/premises/dwelling unit which they occupy and control.

9.12.2 *Exterior Property Areas*

The owner/occupant shall maintain the following:

a) *Vacant structures and land* – Vacant structures and premises thereof or vacant land shall be maintained in a clean, safe, secure and sanitary condition so as not to cause a blighting problem or adversely affect the public health or safety.

b) *Sanitation* – Exterior property and premises shall be maintained in a clean, safe and sanitary condition. The occupant shall keep that part of the exterior property that such occupant occupies or controls in a clean and sanitary condition.

c) *Sidewalks and driveways* – Sidewalks, walkways, stairs, driveways, parking spaces and similar areas shall be kept in a proper state of repair, and maintained free from hazardous conditions.

d) *Weeds* – Premises and exterior property shall be maintained free from weeds or plant growth in excess of height specified by Authority. Noxious weeds shall be prohibited.

   Upon failure of the owner or agent having charge of a property to cut and destroy weeds after service of a notice of violation, any duly authorized employee of the Authority or contractor hired by the Authority may be authorized to enter upon the property in violation and cut and destroy the weeds growing thereon, and the costs of such removal shall be paid by the Owner or agent responsible for the property.

e) *Exhaust vents* – Pipes, ducts, conductors, fans or blowers shall not discharge gases, steam, vapor, hot air, grease, smoke, odors or other gaseous or particulate wastes directly upon abutting or adjacent public or private property or that of another *tenant.*

f) *Accessory structures* – All Accessory structures, including *detached* garages, fences and walls, shall be maintained structurally sound and in good repair.

g) *Motor vehicles* – Except as provided for in other regulations, inoperative or unlicensed motor vehicles shall not be parked, kept or stored on any premises, and vehicles shall not at any time be in a state of major disassembly, disrepair, or in the process of being stripped or dismantled. Painting of vehicles is prohibited unless conducted inside an approved spray booth.

h) *Defacement of property* – A person shall not willfully or wantonly damage, mutilate or deface any exterior surface of any structure or building on any private or public property by placing thereon any marking, carving or graffiti. It shall be the responsibility of the owner to restore said surface to an approved state of maintenance and repair.

9.12.3 *Exterior ~~and Interior~~ Structure*

The exterior of a structure shall be maintained in good repair, structurally sound and sanitary so as not to pose a threat to the public health, safety or welfare. Following measures shall be taken:

a) *Protective treatment* — Exterior surfaces, including but not limited to, doors, door and window frames, cornices, porches, trim, balconies, decks and fences, shall be maintained in good condition. Exterior wood surfaces, other than decay-resistant woods, shall be protected from the elements and decay by painting or other protective covering or treatment. Peeling, flaking and chipped paint shall be eliminated and surfaces repainted. Siding and masonry joints, as well as those between the building envelope and the perimeter of windows, doors and skylights, shall be maintained weather resistant and water tight. Metal surfaces subject to rust or corrosion, shall be coated to inhibit such rust and corrosion, and surfaces with rust and corrosion shall be stabilized and coated to inhibit future rust and corrosion. Oxidation stains shall be removed from exterior surfaces. Surfaces designed for stabilization by oxidation are exempt from this requirement.

b) *Premises identification* – Buildings shall have approved address numbers placed in a position to be plainly legible and visible from the street or road fronting the property. These numbers shall contrast with their background. Address numbers shall be Arabic numerals or alphabet letters. Numbers shall be not less than 102 mm in height with a minimum stroke width of as 12.7 mm.

c) *Decorative features* – Cornices, belt courses, corbels, terra cotta trim, wall facings and similar decorative features shall be maintained in good repair with proper anchorage and in a safe condition.

d) *Overhang extensions* – Overhang extensions including, but not limited to, canopies, marquees, signs, metal awnings, fire escapes, standpipes and exhaust ducts shall be maintained in good repair and be properly anchored so as to be kept in a sound condition. Where required, all exposed surfaces of metal or wood shall be protected from the elements and against decay or rust by periodic application of weather-coating materials, such as paint or similar surface treatment.

e) *Stairways, decks, porches and balconies* – Every exterior stairway, deck, porch and balcony, and all appurtenances attached thereto, shall be maintained structurally sound, in good repair, with proper anchorage and capable of supporting the imposed loads.

f) *Insect screens* – Every door, window and other outside opening required for ventilation of habitable rooms, food preparation areas, food service areas or any areas where products to be included or utilized in food for human consumption are processed, manufactured, packaged or stored shall be supplied with approved tightly fitting screens of minimum 16 mesh per 25 mm, and every screen door used for insect control shall have a self-closing device in good working condition.

g) *Window, skylight and door frames* – Every window skylight and door frame shall be kept in sound condition, good repair and weather tight.

i) Glazing – Glazing materials shall be maintained free from cracks and holes.

ii) Openable windows – Every window, other than a fixed window, shall be easily openable and capable of being held in position by window hardware.

h) *Structural members* – All structural members shall be maintained free from deterioration, and shall be capable of safely supporting the imposed dead and live loads.

j) *Roofs and drainage* – The roof and flashing shall be sound, tight and not have defects that admit rain. Roof drainage shall be adequate to prevent dampness or deterioration in the walls or interior portion of the structure. Roof drains, gutters and downspouts shall be maintained in good repair and free from obstructions. Roof water shall not be discharged in a manner that creates a public nuisance.

9.12.4 *Interior Stucture*

The interior of a structure and equipment therein shall be maintained in good repair, structurally sound and in a sanitary condition. Occupants shall keep that part of the structure that they occupy or control in a clean and sanitary condition. Every owner of a structure containing a rooming house, housekeeping units, a hotel, a dormitory, two or more dwelling units or two or more nonresidential occupancies, shall maintain, in a clean and sanitary condition, the shared or public areas of the structure and exterior property.

a) *Potentially unsafe conditions* – The following conditions shall be considered to be potentially unsafe:

i) Structural members have deterioration or distress that appears to reduce their load-carrying capacity.
ii) The anchorage of the floor or roof to walls or columns, and of walls and columns to foundations has deterioration or distress that appears to reduce its load-carrying capacity.
iii) Structures or components thereof have deterioration or distress that appears to reduce their load-carrying capacity.
iv) Stairs, landings, balconies and all similar walking surfaces, including guards and handrails, are not structurally sound, not properly anchored or are anchored with connections not capable of supporting all nominal loads and resisting all load effects.
v) Foundation systems that are not firmly supported by footings are not plumb and free from open cracks and breaks, are not properly anchored or are not capable of supporting all nominal loads and resisting all load effects.

NOTE – Exceptions are provided for:
1) Where substantiated otherwise by an approved method.
2) Demolition of unsafe conditions shall be permitted where approved by the code official.

b) *Structural members* — Structural members shall be maintained structurally sound, and be capable of supporting the imposed loads.

c) *Interior surfaces* — Interior surfaces, including windows and doors, shall be maintained in good, clean and sanitary condition. Peeling, chipping, flaking or abraded paint shall be repaired, removed or covered. Cracked or loose plaster, decayed wood and other defective surface conditions shall be corrected.

d) *Handrails and guards* — Every handrail and guard shall be firmly fastened and capable of supporting normally imposed loads and shall be maintained in good condition.

e) *Stairs and walking surfaces* — Every stair, ramp, landing, balcony, porch, deck or other walking surface shall be maintained in sound condition and good repair.

f) *Interior doors* — Every interior door shall fit reasonably well within its frame and shall be capable of being opened and closed by being properly and securely attached to jambs, headers or tracks as intended by the manufacturer of the attachment hardware.

9.12.5 *Rubbish and Garbage*

9.12.5.1 *Accumulation of rubbish or garbage*

Exterior property and premises, and the interior of every structure, shall be free from any accumulation of rubbish or garbage.

9.12.5.2 *Disposal of rubbish and garbage*

Every occupant of a structure shall dispose of all rubbish and garbage in a clean and sanitary manner by placing such rubbish, garbage in an approved rubbish/garbage disposal facility or approved containers.

a) *Refrigerators* — Refrigerators and similar equipment not in operation shall not be discarded, abandoned or stored on premises without first removing the doors.

b) *Containers* — The operator of every establishment producing garbage shall provide, and at all times cause to be utilized, approved leakproof containers provided with close-fitting covers for the storage of such materials until removed from the premises for disposal.

9.12.6 *Pest Elimination*

9.12.6.1 *Infestation*

Structures shall be kept free from insect and rodent infestation. Structures in which insects or rodents are found shall be promptly exterminated by approved processes that will not be injurious to human health. After pest elimination, proper precautions shall be taken to prevent re-infestation.

9.12.6.2 The responsibility of pest elimination in several cases of occupancy shall be as below:

a) *Single owner* – The owner of any structure shall be responsible for pest elimination within the structure prior to renting or leasing the structure and the occupant of a one-family dwelling or of a single-tenant non-residential structure shall be responsible for pest elimination on the premises.

b) *Multiple occupancy* – The owner of a structure containing two or more dwelling units, a multiple occupancy, a rooming house or a non-residential structure shall be responsible for pest elimination in the public or shared areas of the structure and exterior property.

c) *Occupant* – The occupant of any structure shall be responsible for the continued rodent and pest-free condition of the structure.

Where the infestations are caused by defects in the structure, the owner shall be responsible for pest elimination.

9.12.7 *Swimming Pools, Spas and Hot Tubs*

9.12.7.1 *Swimming Pools* — Swimming pools shall be maintained in a clean and sanitary condition, and in good repair.

9.12.7.2 *Enclosures* — Private swimming pools, hot tubs and spas, containing water more than 600 mm in depth shall be completely surrounded by a fence or barrier not less than 1200 mm in height above the finished ground level measured on the side of the barrier away from the pool. Gates and doors in such barriers shall be self-closing and self-latching. Where the self-latching device is less than 1400 mm above the bottom of the gate, the release mechanism shall be located on the pool side of the gate. Self-closing and self- latching gates shall be maintained such that the gate will positively close and latch when released from an open position of 150 mm from the gatepost. An existing pool enclosure shall not be removed, replaced or changed in a manner that reduces its effectiveness as a safety barrier.

NOTE – Exceptions are provided for:
1) Spas or hot tubs equipped with a lockable safety cover.
2) Private swimming pools equipped with a power safety cover that complies with and is in working condition using the control switch.

9.12.8 *Component Serviceability*

The components of a structure and equipment therein shall be maintained in good repair, structurally sound and in a sanitary condition.

9.12.8.1 *Potentially Unsafe Conditions*

Where any of the following conditions cause the component or system to be beyond its limit state, the component or system shall be considered to be unsafe:

a) Soils that have been subjected to any of the following conditions:
   i) Collapse of footing or foundation system.
   ii) Damage to footing, foundation, concrete or other structural element due to soil expansion
   iii) Adverse effects to the design strength of footing, foundation, concrete or other structural element due to a chemical reaction from the soil.
   iv) Inadequate soil as determined by a geotechnical investigation.
   v) Where the allowable bearing capacity of the soil is in doubt.
   vi) Adverse effects to the footing, foundation, concrete or other structural element due to the ground water table.

b) Concrete that has been subjected to any of the following conditions:
   i) Deterioration.
   ii) Ultimate deformation.
   iii) Fractures.
   iv) Fissures.
   v) Spalling.
   vi) Exposed reinforcement.
   vii) Detached, dislodged or failing connections.

c) Aluminum that has been subjected to any of the following conditions:
   i) Deterioration.
   ii) Corrosion.
   iii) Elastic deformation.
   iv) Ultimate deformation.
   v) Stress or strain cracks.
   vi) Joint fatigue.
   vii) Detached, dislodged or failing connections.

d) Masonry that has been subjected to any of the following conditions:
   i) Deterioration.
   ii) Ultimate deformation.
   iii) Fractures in masonry or mortar joints.
   iv) Fissures in masonry or mortar joints.
   v) Spalling.
   vi) Exposed reinforcement.
   vii) Detached, dislodged or failing connections.

e) Steel that has been subjected to any of the following conditions:
   i) Deterioration.

ii) Elastic deformation.
iii) Ultimate deformation.
iv) Metal fatigue.
v) Detached, dislodged or failing connections.

f) Wood that has been subjected to any of the following conditions:
i) Ultimate deformation.
ii) Deterioration.
iii) Damage from insects, rodents and other vermin.
iv) Fire damage beyond charring.
v) Significant splits and checks.
vi) Horizontal shear cracks.
vii) Vertical shear cracks.
viii) Inadequate support.
ix) Detached, dislodged or failing connections.
x) Excessive cutting and notching.

NOTE – Exceptions are provided for:
1) Where substantiated otherwise by an approved method.
2) Demolition of unsafe conditions shall be permitted where approved by the code official.

9.13 Common Area Maintenance

Maintenance of common areas in any building, group of buildings, should be responsibility of all those who share and use the common areas.

9.13.1 *Common Areas and Equipment*

The common area of a building or project includes all space contained in building premises that are not exclusive to any specific occupant(s) and which benefits, or is intended to benefit, all users/occupiers of the building, in common and without distinction.

Common area of a multiple building campus/project is proportionately loaded on to the individual segments within the overall campus. Common area of such campuses will include driveways, ramps, walkways, pavements, corridors, entrances, vestibules, stairways, atriums, refuge area, terraces (with or without common rights of access) landscapes, common toilets, loading and unloading docks, dedicated property management office, parking areas, external peripheries, façade and elevation elements and utility areas such as DG room, plant room, etc.

Common equipment will include all types of pumps for water supply, firefighting, etc; lifts and escalators; firefighting system; HVAC plant and equipment; E&M equipment like electric panels, DG sets, transformers, lightning protection system, earthing system, etc.

9.13.2 *Maintenance of Common Areas*

One way to arrange for funds to carry out this function is to levy a common area maintenance (CAM) charge on all the users. The value of CAM to be charged can be

decided by the owner or it can be collectively decided by the users. Normally, CAM is charged on pro-rate basis, that is, on the ratio of area in actual occupation of each user vis-a-vis the total area.

While calculating CAM charges, it is standard practice to include various expenses incurred in providing common facilities and services. These may include, but are not limited to:

a) Housekeeping services for common areas such as lobbies, corridors, and shared amenities.
b) Energy consumption of lighting, HVAC systems, and other equipment serving the common areas.
c) Annual maintenance contracts (AMC) for equipment and systems installed in the common areas, including repairs and servicing of lifts, security systems, and fire safety equipment, E&M equipment like electric panels, DG sets, transformers, lightning protection system, earthing system, etc.
d) Property management services covering administrative and operational costs.
e) Regulatory and statutory compliance costs, such as ensuring adherence to safety codes, fire regulations, and environmental laws.
f) Building and equipment insurance to cover risks such as fire, theft, or natural disasters.
g) Sinking fund contributions set aside for future capital expenses or major repairs.
h) Expenditure on maintaining common areas, including landscaping, facade cleaning, and general upkeep.

In determining the CAM charge, it is important to consider whether specific weightage should be applied to particular components. For example, energy consumption or high-cost maintenance contracts may require greater allocation, for example, energy consumption or high-cost maintenance contracts may require greater allocation. To ensure fairness, the following factors can be considered when calculating CAM charges:

1) *Cost apportionment* – Expenses such as energy, maintenance, and insurance can be divided based on the actual use or benefit to each user.

2) *Area-based calculation* – CAM charges can be proportionally distributed based on the floor area occupied by each user, with adjustments for any exclusive services or amenities used by specific occupants.

3) *Service-specific charges* – Some expenses, such as those related to premium services (for example, enhanced security, concierge), may be apportioned differently or added separately.

9.14 Maintenance from Accessibility Consideration

All maintenance and refurbishment in public buildings and built environment shall take into account improving accessibility for persons with disabilities and care taken that accessible design features are properly maintained during maintenance activities (*see* **B-25** of Part 3 'Development Control Rules and General Building Requirements' of this Code). Periodic access audits shall be carried out at least once in three years to

ensure that the requisite accessible features as per Part 3 'Development Control Rules and General Building Requirements' of this Code are provided in the building and its built environment and maintained in good condition on an ongoing basis.

10 BUILDING FABRIC MAINTENANCE

10.1 This constitutes maintenance of elements and components of a building other than furniture and services installations.

10.2 Prevention of Cracks, Repairs, Retrofitting and Seismic Strengthening of Buildings

Cracks in buildings are of common occurrence. A building component develops cracks whenever stress in the component exceeds its strength. Stress in a building component can be caused by externally applied forces, such as dead, imposed, wind or seismic loads, or foundation settlement or it can be induced internally due to thermal movements, moisture, chemical action, etc. The buildings affected by earthquake may suffer both non-structural and structural damages. Nonstructural repairs may cover the damages to civil and electrical items including the services in the building. Repairs to non-structural components need to be taken up after the structural repairs are carried out. Care should be taken about the connection details of architectural components to the main structural components to ensure their stability. The main purpose of the seismic strengthening is to upgrade the seismic resistance of a damaged building while repairing so that it becomes safer under future earthquake occurrences.

10.2.1 Prevention of cracks, repair work, seismic strengthening and retrofitting of an existing building shall be done in accordance with Part 7 'Construction Management, Practices and Safety' of the Code.

10.3 While demolishing a damaged building or existing unsafe building, safety precautions as given in Part 7 'Construction Management, Practices and Safety' of the Code shall be observed.

11 MAINTENANCE OF PLUMBING AND DRAINAGE SYSTEMS

11.1 General

Plumbing fixtures shall be properly installed and maintained in working order, and shall be kept free from obstructions, leaks and defects and be capable of performing the function for which such plumbing fixtures are designed. Plumbing fixtures shall be maintained in a safe, sanitary and functional condition. Where it is found that a plumbing system in a structure constitutes a hazard to the occupants or the structure by reason of inadequate service, inadequate venting, cross connection, back-siphonage, improper installation, *deterioration* or damage or for similar reasons, the same should be attended to immediately.

11.2 Plumbing System

Plumbing system is a system installed in a building for the distribution and use of potable water and the removal of waterborne wastes. It covers the system that operates toilets, sinks, showers, bathtubs, etc, as also laundry facilities in buildings for washer, utility sinks, and drains that may be installed.

11.3 Drainage System

Water outputs in a building include,

a) storm water,
b) grey water,
c) black water, runoff, and
d) evaporation and leaks.

These are discussed in **11.3.1** to **11.3.4**.

11.3.1 *Storm Water*

Storm water should be reclaimed to a great extent though properly designed rainwater harvesting. Excess storm water needs to be drained off through properly designed drainage system. Outlet for it shall be identified and checked for its carrying capacity and final disposal so as to avoid inundation and unhygienic conditions.

11.3.2 *Grey Water*

It is the waste water collected from indoor sources, other than toilets, such as showers and hand basins, washing machines and requires treatment such as screening, oil and grease removal (if kitchen wastewater is also included in the source), filtration and disinfection. Grey water comprises 50-80 percent of residential wastewater. If grey water is filtered properly, reusing it for irrigation and further conveyance is safe from a health perspective.

11.3.3 *Black Water*

It is the discharge from the toilet and contains significant nutrient concentrations. The microbial contamination associated with black water demands it to be treated to a very high level, especially with respect to disinfection.

11.3.4 *Evaporation and Leaks*

Evaporation can account for a significant water loss in building systems that rely on evaporative cooling towers. Leaks can also account for a significant quantity of water use if they are not detected and corrected in a timely manner. In taking a strategic approach to improving water performance, all inputs, uses, and outputs should be considered.

11.4 Plumbing and drainage system shall be designed in accordance with Part 9 'Plumbing Services', Section 1 'Water Supply' and Section 2 'Drainage and Sanitation'

of the Code. Good practices as given in these Sections of the Code attempt to minimize risk by specifying technical standards of design, materials and workmanship.

11.5 Only licensed plumbers with specified qualifications should be permitted to carry out work of plumbing and installations. Such works shall be inspected by competent person to check their adequacy and functionality. For guidelines for registration of plumbers including the minimum standards for qualifications for the grant of licences, reference may be made to good practice [12(3)].

No person should be permitted to construct, install, extend or materially alter any plumbing system without making formal application to, and receiving formal approval from, the concerned authority. Except where the authority shall agree in writing to other dispositions, only a licensed plumber shall be authorized to be responsible for the construction, repair, alteration or removal of pipes, valves, drains or other appurtenances of any drinking-water supply or drainage system (including storm drainage discharging into a public sewer or watercourse) in any building or on any land. Only a licensed plumber may make a connection to a public water main or to a public sewer, and he shall be responsible for giving notice to the water and sewerage authorities of the intention of making such connection for satisfying any requirements of those bodies.

11.6 Restoration and Recycling of Waste Water

All wastewater can potentially be recycled within a building system. Wastewater exiting the building under grey water or black water should be recycled in various possible ways.

11.7 Rain Water Harvesting

It is essential to provide rain water harvesting or storage systems to capture the runoff from the roof surfaces. For details, reference shall be made in Part 9 'Plumbing Services', Section 2 'Drainage and Sanitation' of the Code.

11.8 Common Problems

The maintenance of water supply and sanitary system in buildings requires thorough knowledge about the design, specifications and the materials used within the building and for external connections. If the defects are not attended timely, these may result in unhygienic conditions and ultimate structural failures too. Availability of as-built drawings for services is of great help in taking up repair and restoration works.

The faults in these services occur due to defective system and misuse. The common problems in water supply and sanitary system are as follows:

a) Leakage in internal pipes;
b) Blocked drains and leaking joints;
c) Damaged floor drains;
d) Overflowing cisterns;
e) Blocked waste pipes;
f) Defective or improperly fixed fittings;

g) Inadequate pressure;
h) Maintenance of appliances;
j) Noise in plumbing system;
k) Odour in piping system;
m) Seepage through floor joints of wet areas;
n) Heading up of water on terraces; and
p) Damaged or cracked appliances.

Early detection of leakage seepage is possible with use of thermal cameras which are available and can detect the early signs of leakages, etc, and can actually photograph the same showing location and its intensity.

As steady drip which comes out drop by drop can waste as much as 9 000 litre of water every three months, use of good fittings and urgent attendance to leakages/drippings can hardly be overemphasized.

11.9 Precautionary Measures

a) *Avoid chemical drain-clearing products* – Clogged drains are the most common home plumbing problem. Chemical products used to clear clogged drains, may harm the drainage system. They can actually erode cast-iron drain pipes, and because they typically don't remove the entire clog, the problem is likely to recur, resulting in their repeated use. Drain should therefore be cleaned by removing chunk of hair and grease by using flexible drain cleaning devices (snake).

b) *Prevent future clogging* – Clogs aren't just nuisances. Backed-up water puts added pressure on wastepipes, stressing them and shortening their lifespan. Therefore, avoid plug-ups by watching what goes down the drains. Keep food scraps out of kitchen drains, hair out of bathroom drains, and anything but sewage and toilet paper out of toilets.

c) Install screens over drains in showers and tubs, and pull out hair every few weeks to prevent build-ups. Scrape food into the trash before doing dishes, even if there is a disposal and never put liquid grease down the drain; pour it into a sealable container to put in the garbage after it cools.

d) *Reduce the pressure* – High water pressure stresses pipes, and increases the likelihood of a leak. It drastically reduces the life of plumbing system. It makes pipe joints, faucets, and appliance valves work harder.

e) *Soften the water* – If the water has a high mineral content, known as hard water; it can shorten plumbing's lifespan. A white build up on showerheads and faucets is a tell-tale sign of hard water. To effectively deal with hard water install a water softener.

f) *Keep sewer lines or septic tank clear* – Snake main sewage cleanout every few years to remove messy sewage backups. Always detect and fix problems quickly. Even small leaks can make pipes corrode more quickly, and cause significant water damage. Water test and/or smoke tests on the drainage of the

plumbing system should be carried out before accepting the system and allowing final finishing works.

g) *Water-Efficient Appliances* – Buildings should integrate water-efficient appliances such as low-flow faucets, dual-flush toilets, and water-saving showerheads. These reduce water consumption and lessen the strain on drainage systems. Use of water-efficient appliances can be in accordance with accepted standards [12(4)].

h) *Pipe Material Selection* – When replacing or installing new piping, consider using corrosion-resistant materials such as cross-linked polyethylene (PEX) or chlorinated polyvinyl chloride (CPVC) instead of traditional metal pipes. These materials are durable, reduce the risk of leaks, and are less affected by chemical drain cleaners.

j) *Green Roofs and Permeable Surfaces* – To reduce the load on drainage systems, buildings should incorporate green roofs or permeable paving. These features help manage rainwater runoff naturally by allowing water to be absorbed into the soil or vegetation, reducing strain on drainage systems during heavy rainfall.

k) *Water Quality Monitoring* – Ensure that the water supply is periodically tested for contaminants like lead, chlorine, and bacterial content, especially when using older systems or when integrating rainwater and greywater reuse systems.

11.10 Maintenance of Plumbing and Drainage Systems

11.10.1 *General*

Proper maintenance ensures that all fittings and fixtures are kept in acceptable working condition so that their utility is not sacrificed.

Even little leaks in plumbing can lead to big problems. It is therefore necessary to be alert to signs of impending plumbing failures, such as, leaking faucets, damp cabinets, leaking toilets or dripping refrigerators; all signal problems that need prompt attention. Problems should be repaired early. A leaking faucet isn't just annoying; the moisture it releases puts wear on sink fixtures and can encourage the growth of mold and mildew. A licensed plumber should be called to get repairs done in a professional manner.

Design of various areas has to be such that all appliances and areas needing frequent maintenance are easily approachable and adequate working space is available to maintenance personnel.

Shaft shall be of adequate size to allow workmen to carry out their functions properly. Working platforms and easy access to the shafts and working platforms should be ensured. Specific provisions are required to be made for maintaining services in multistoried buildings.

Checking of roofs, drains, traps on regular basis should be carried out as part of preventive maintenance to ensure that they are clean and functional. Users and cleaning personnel have to be educated not to throw solid waste into WC's, traps and drainage system.

It is good practice to lay-down a periodical drill for doing some of the maintenance works required to be done on regular basis such as white washing, painting, drain de-silting, roads re-carpeting, cleaning of traps, manholes, cleaning of tanks, etc. A small inventory of items which are often required should be kept in store for immediate use.

For effective maintenance it is necessary that the buildings are inspected on regular basis and corrective measures taken as per the outcome of inspection. Special attention is required to be paid to inspection of storm water drainage works, roofs before monsoon. This can help in preventing problem from getting worse.

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Special attention is to be paid to inspection of storm water drainage works, roofs before monsoon.

All fittings and fixtures should be checked regularly. For monitoring on an annual and bi-annual basis, a check list will be helpful for checking plumbing problems or potential plumbing problems.

11.10.2 *Maintenance of Plumbing Systems*

11.10.2.1 All water mains communication pipes, service pipes and pipes used for distribution of water for domestic purposes shall be thoroughly and efficiently disinfected before being taken into use and also after every major repair. The method of disinfection shall be subject to the approval of the Authority. The pipes shall also be periodically cleaned at intervals, depending upon the quality of water, communication pipes and the storage cisterns shall be thoroughly cleaned at least once every year in order to remove any suspended impurities that may have settled in the pipes or the tanks.

11.10.2.2 Storage tanks shall be regularly inspected and shall be cleaned out periodically, if necessary. Tanks showing signs of corrosion shall be emptied, thoroughly wire brushed to remove loose material (but not scraped), cleaned and coated with suitable anti-corrosive material not liable to impart taste or odour or otherwise contaminate the water. Before cleaning the cistern, the outlets shall be plugged to prevent debris from entering the pipes. Tanks shall be examined for metal wastage and water tightness after cleaning.

11.10.2.3 Record drawings showing pipe layout and valve positions shall be kept up to date and inspection undertaken to ensure that any maintenance work has not introduced cross-connections or any other undesirable feature. Any addition or alterations to the systems shall be duly recorded from time to time.

11.10.2.4 Any temporary attachment fixed to a tap or outlet shall never be left in such a position that back-siphonage of polluted water may occur into the supply system.

11.10.2.5 All valves shall periodically be operated to maintain free movement of the working parts.

11.10.2.6 All taps and ball valves shall be watertight, glands shall be made good, washers shall be replaced and the mechanism of spring operated taps and ball valves shall be repaired, where required.

11.10.2.7 All overflow pipes shall be examined and kept free from obstructions.

11.10.2.8 The electrical installation shall be checked for earth continuity and any defects or deficiencies corrected in the case of hot water supply installations.

11.10.3 *Maintenance of Drainage Systems*

11.10.3.1 *General*

Domestic drainage system shall be inspected at regular intervals. The system shall be thoroughly cleaned out at the same time and any defects discovered shall be made good.

11.10.3.2 *Cleaning of drainage system*

a) Sewer maintenance crews, when entering a deep manhole or sewer where dangerous gas or oxygen deficiencies may be present, shall take safety precautions required and follow the following procedures:

    1) Allow no smoking or open flames and guard against sparks.
    2) Erect warning signs.
    3) Use only safety gas-proof, electric lighting equipment.
    4) Test the atmosphere for noxious gases and oxygen deficiencies (presence of hydrogen sulphide is detected using lead acetate paper and that of oxygen by safety lamps).
    5) If the atmosphere is normal, workmen may enter with a safety belt attached and with two men available at the top. For extended jobs, the gas tests shall be repeated at frequent intervals, depending on circumstances.
    6) If oxygen deficiency or noxious gas is found, the structure shall be ventilated with pure air by keeping open at least one manhole cover each on upstream and downstream side for quick exit of toxic gases or by artificial means. The gas tests shall be repeated and the atmosphere cleared before entering. Adequate ventilation shall be maintained during this work and the tests repeated frequently.
    7) If the gas or oxygen deficiency is present and it is not practicable to ventilate adequately before workers enter, a hose mask shall be worn and extreme care taken to avoid all sources of ignition. Workers shall be taught how to use the hose equipment. In these cases, they shall

always use permissible safety lights (not ordinary flash lights), rubber boots or non-sparking shoes and non-sparking tools;

8) Workmen descending a manhole shaft to inspect or clean sewers shall try each ladder step or rung carefully before putting the full weight on it to guard against insecure fastening due to corrosion of the rung at the manhole wall. When work is going on in deep sewers, at least two men shall be available for lifting workers from the manhole in the event of serious injury; and
9) Portable air blowers, for ventilating manhole, are recommended for all tank, pit or manhole work where there is a question as to the presence of noxious gas, vapours or oxygen deficiency. The motors for these shall be of weather proof and flame-proof types; compression ignition diesel type (without sparking plug) may be used. When used, these shall be placed not less than 2 m away from the opening and on the leeward side protected from wind, so that they will not serve as a source of ignition for any inflammable gas which may be present. Provision should be made for ventilation and it should be of the forced type which can be provided by a blower located at ground level with suitable flexible ducting to displace out air from the manhole.

b) The following operations shall be carried out during periodical cleaning of a drainage system:

1) The covers of inspection chambers and manholes shall be removed and the side benching and channels scrubbed;
2) The interceptive trap, if fitted, shall be adequately cleaned and flushed with clean water. Care shall be taken to see that the stopper in the rodding arm is securely replaced;
3) All lengths of main and branch drains shall be rodded by means of drain rods and a suitable rubber or leather plunger. After rodding, the drains shall be thoroughly flushed with clean water. Any obstruction found shall be removed with suitable drain cleaning tools and the system thereafter shall be flushed with clean water;
4) All subsoil drains shall be periodically examined for obstruction at the open joints due to the roots of plants or other growths;
5) The covers of access plates to all gullies shall be removed and the traps plunged and flushed out thoroughly with clean water. Care shall be taken not to flush the gully deposit into the system;
6) Any defects revealed as a result of inspection or test shall be made good;
7) The covers or inspection chambers and gullies shall be replaced, bedding them in suitable grease or other materials; and
8) Painting of ladders/rings in deep manholes and external painting of manhole covers shall be done with approved paints.

11.10.3.3 *Operation and maintenance of sewage treatment plant (STP)*

a) *Operational checks for STP* – More and more campuses are now being served by STPs for treatment of waste water and reusing it for various purposes. Maintenance of STPs and their operation is an essential activity for proper functioning of facilities where such plants are provided.

The methods of checking operational aspects of the STPs are given in Annex D.

b) *Operation and maintenance considerations*

1) Typically, in small plants, the filter press may be sized for a single batch operation per day. In large plants, three batches per day, one per shift, is the norm.
2) Fresh sludge (not more than a day old), kept fully aerated and mixed (agitated).
3) Dewaters easily in the filter press. Hence, sludge shall not be stored in the holding tank for longer durations.
4) The desired quantity of polymer needs to be added 15 min to 30 min before the dewatering operation. Filter press operation is carried out over 3 h to 4 h, or when filtration ceases.
5) After every dewatering operation, the filter clothes shall be thoroughly cleaned, so that clogging in the pores of the woven polypropylene filter fabric is avoided. Periodic cleaning of filter cloth with hypo solution will also prolong the life of cloth.
6) When the filtration process becomes excessively slow, it is time to replace the filter cloth with a fresh set.
7) Normal maintenance as prescribed by the manufacturer may be practiced for the high pressure helical screw pump. Care shall be taken not to damage the rubber stator of the screw pump by dry running of the pump. It is generally preferable to locate the pumps such that positive suction is enabled.

c) *Miscellaneous considerations*

1) Genset backup power to run the entire STP in case the mains electricity line fails.
2) Adequate illumination in STP if in a room, or basement.
3) Totally covered, underground STPs are neither operator-friendly, nor maintenance-friendly.
4) Adequate exhaust and ventilation system to be provided for operator comfort, health and hygiene.
5) Without proper exhaust/ ventilation in enclosed spaces, carbon dioxide accumulates, gets converted to carbonic acid and corrodes metallic parts in the STP. Carbonic acid also depresses *p*H of the wastewater, thus affecting treatment performance.
6) Provide safe and comfortable access to all units in STP for monitoring, operation, and maintenance.
7) Prepare and maintain a standard operating procedure for the STP and train all operators to follow those procedures.
8) Prepare and maintain an operating log book for all activities in the STP.
9) Prepare and maintain a mechanical checklist for routine preventive maintenance.

10) Prepare and maintain a history sheet for each critical equipment in the STP.
11) Prepare and maintain a chemicals/consumables stock register.
12) Periodically check and validate all log books, checklists, etc.
13) Provide a water meter at the outlet of each type of water treatment system for respective uses to monitor average daily throughput of the STP.
14) *Ventilation system* – Required air changes should be provided to ensure good ventilation. The air change is calculated based on the open/vacant head space of the underground/ basement room. There shall be a fresh air fan (forced draft) and an exhaust fan (induced draft), with two separate ducting systems.
15) If the induced draft fan is designed for a slightly higher capacity than the fresh air fan, then the room will always be under a slight negative pressure, and gases will not escape the room as fugitive emissions.

d) *Abnormal conditions*

1) *Excess flow to STP* – At times due to malfunction of the flushing systems in the toilets, excessive inflow to the STP may be encountered. Similar is the situation during heavy rainfall. This upsets normal operation by flooding the collection tank; submerging the pumps and causing excessive flow to aeration tank. The remedies and recommended operational procedures for these situations are as follows:

2) *Remedy*

i) Make all toilets' flushing systems fail proof.
ii) Raise manhole levels and make covers water tight in the conveyance system.
iii) Replace existing lift pumps by submersible pumps.

3) *Operation*

i) Keep collection tank near empty at all times in order to accommodate sudden excessive inflows.
ii) If level continues to rise to near pump level, start both pumps.
iii) If level continues to rise, switch off both pumps and activate standby external portable pump to save the duty pumps.

4) *MLSS washout due to excess flow* – Consequent to high inflow conditions due to reasons cited in 1 above, mixed liquor suspended solids (MLSS) washout from the system may occur. In order to quickly put the system back to normal, it is recommended that controlled transfer of MLSS from the digester tank (to a maximum extent of 50ml/l of MLSS per day) to the aeration tank be done so that the design level of MLSS is reached within 4-5 days of washout. For this purpose, the aerobic digester tank should be operated at near full conditions.

5) *p*H *variations in inflow* — Although *p*H variations in domestic sewage are not a cause for concern, it is possible that due to accidental spillage/ excessive usage of cleaning chemicals in the toilets may result in *p*H variations.

11.11 Attention to Wet Areas

In case of wet areas, planning for good maintenance has to be done even before execution. Bathroom, kitchen, water closet and to a lesser extent *Verandah*, balconies and sunshades may be termed as wet areas of a buildings which are more vulnerable to water due to their functional requirements. These wet areas are one of the main source of leakage and dampness in a building which leads to unhygienic conditions affecting badly the health and comfort of the inhabitants and seriously deteriorating the stability of the building. The causes of dampness and leakage may be due to defective design, sub-standard material, improper execution and incorrect usage by the occupant. For provisions on methods to be employed in a building under construction for preventing dampness and leakage arising out of the wet areas, reference shall be made to the good practice [12(5)].

Problem of leakage and dampness in building already in use require different considered approach in the analysis of the cause and remedial measures.

11.12 Selection, installation and maintenance of sanitary appliances shall be done in accordance with good practice [12(6)].

12 MAINTENANCE OF HEATING, VENTILATION AND AIR CONDITIONING (HVAC) SYSTEMS

12.1 The aspects of operation and maintenance of HVAC services and guidelines on good operating practices, maintenance requirement, its frequency, etc, in order to improve the performance of the equipment, reduce failure risk, increase life and effective use of the equipment, and save on energy consumption are covered hereunder. HVAC services include,

a) individual units;
b) plants and pumps;
c) ducts, grills and other air conveyance systems;
d) smoke extraction system; and
e) fire dampers.

For effective management of the asset, component wise operation and maintenance protocol need to be observed. It is necessary to understand basic operating logic that can be implemented manually, or through a building management system.

12.2 Selection of Equipment/Systems

Selection of equipment/systems should be made after careful consideration keeping in view the specific requirements of the facility and after duly computing the heat loads and other relevant factors. At the stage of handing over of the HVAC system by the

vendor, the facility manager shall check the system running with internal loads, and also check that uniform temperature, within allowable tolerances, is being maintained throughout the air conditioned area.

12.3 The HVAC vendor shall handover the system with complete air and water balancing, along with a commissioning report. There are various types of HVAC systems available and these are selected, depending upon the intended use and economic viability. Whichever be the system installed, the same has to be maintained properly to obtain optimum output.

12.4 Guidelines on maintaining of equipment issued by the manufacturer shall be followed and regular servicing shall be got done through trained/accredited service providers to ensure proper results.

12.5 Operation of the system should be done by first switching on the indoor unit fan, and then the condensing unit. Normally most modern packaged and ductable split units have an inbuilt sequencing and only an on/off switch needs to be operated. In order to save energy consumption and to prevent discomfort to occupants, it is advisable to set the temperature in accordance with Part 8 'Building Services', Section 3 'Air Conditioning, Heating and Mechanical Ventilation' of the Code. It is advisable to switch on the HVAC units a little before facility/office starts working to lower the indoor temperature for achieving comfort levels.

12.6 Regular cleaning of filters is the most important maintenance aspect for HVAC systems. A schedule for air filter cleaning shall be established and followed and a log should be maintained for same. Frequency of cleaning of filters should be determined keeping in view the usage, location and recommendation of the manufacturers.

12.7 Cleaning the condenser coil for air conditioning (AC) units and checking all operating pressures to ensure that there are no gas leaks and that the system is working properly should be got done through skilled technicians at regular intervals to ensure proper working of all systems.

12.8 Maintaining and operating of central HVAC plant should be done as per guidelines of the manufacturers and suppliers as it has a number of components. The components of a central air conditioning system include, chillers, pumps, air handling units, chilled water pipe systems, control valves, electrical systems, ducts, cooling towers and water softening systems. All these components are important and shall be maintained properly and as per protocol prescribed by the manufacturer/design consultant.

12.8.1 *Operation of Central AC Plants*

12.8.1.1 It is important to follow laid down sequence either manually, or through BMS – first, switch on the air handling units (AHUs), followed by chilled water pumps, followed by cooling tower fan, followed by condenser water pumps, followed by chiller. Following measures shall be adopted:

a) The chilled water temperature shall be set as per design set point. However, the set point can be increased in winter or during night operation by 1°C to 3°C, to

save energy. This set point change may be done when loads are less, during winter/night, especially in non-monsoon months as per the advice of the HVAC system designer. Room thermostats for common areas may be set at universal comfort condition of 24°C, and individual area thermostats at temperature between 24°C and 25.5°C, depending upon individual comfort.

b) All AHU should be maintained properly to ensure that there is no loss of energy because of clogged filters. The basic maintenance protocol is similar (in terms of filter cleaning) as a ductable split. In addition, a regular maintenance visit by HVAC vendor is recommended, to check strainer, pressure drops, etc.

c) All pumps shall be checked regularly to look for leakages, current consumption, temperature and operating pressure, etc.

d) Cooling tower sump water should be checked monthly and laboratory analysis of the water shall be carried out to ensure that the total dissolved solid (TDS) level is below 500 ppm (or as per chiller supplier's recommendation). Blow down or bleed off from the sump, with continuous replenishment of soft water, to maintain TDS levels is recommended. Where possible, the bleed off from sump of cooling tower may be led to water softening plant for treatment and recirculation.

e) Cleaning of air-conveyance system such as ducting, grills, diffusers, is important to ensure that desired level of hygiene is maintained. This is most important in hospitals and public places.

12.8.1.2 The most important aspect is to continuously monitor the plant. It is advisable that this monitoring be done through a BMS and continuously seek refinement of the programmed logic, till the user is satisfied. A BMS does not substitute a scheduled maintenance operation but it helps to check and document sensor readings making it perform better and improve the life of the system. Readings through this system can be evaluated every quarter, to obtain annually a calibration of components like flow meters and gauges. The BMS can also provide measurement and verification of plant capacity and efficiency. It is also recommended to do a quarterly random check of few sample reports, and compare with physical readings. In addition, the BMS shall be interlinked with all safety and alarms, such as fire and access control. The BMS shall maintain a log of basic parameters like operating hours of each major component of HVAC plant, with records of in/out temperatures, and operating pressures. These logs shall be scrutinized at least once in a month by the operations team, to check for anomalies if any, in order to detect adverse operating conditions, and prevent failures.

12.9 Periodicity/Frequency of Servicing

Depending upon the type of facility, type and specification of equipment installed, usage and other operational and financial constraints, the optimum frequency of carrying out servicing should be determined. A regular record of all maintenance and service operations shall be maintained and periodically reviewed.

Daily logs of operation with timings, and readings of important parameters should be maintained. It should be ensured that logs are always up to date in real time. Back log being filled later shall be prohibited.

12.10 Energy Management and Performance Monitoring of HVAC Systems

An Energy Management System (EMS) should be integrated with HVAC systems to provide real-time data on energy consumption and performance metrics. The EMS can continuously monitor energy usage, detect inefficiencies, and optimize system operations to reduce energy waste. Additionally, it enables the automation of alerts for abnormal conditions such as excessive energy consumption or equipment malfunctions, allowing for timely intervention and maintenance. The EMS should also be configured with simple yet effective monitoring tools and alert mechanisms. These tools can generate automated reports and performance trends, providing facility managers with insights into HVAC performance and areas for improvement. The alert system can notify operators when predefined thresholds are exceeded, ensuring prompt action to maintain efficiency. By integrating EMS with HVAC systems, facilities can effectively monitor energy consumption, optimize performance, and respond quickly to potential issues, ultimately reducing energy use and improving overall system efficiency.

12.11 In addition to above, the requirements for operation and maintenance of HVAC systems as laid down in Part 8 'Building Services', Section 3 'Air conditioning, Heating and Mechanical Ventilation' of the Code shall also be complied with.

13 MAINTENANCE OF ELECTRICAL INSTALLATIONS

13.1 Electrical installations in building have to be installed and constantly maintained in proper working condition to ensure efficient use of electricity including safety from fire and shock. Electrical system maintenance is very important as it also helps in ensuring smooth operation of all plants and equipment. The coverage is limited to maintenance of internal electrical installations starting from receiving of electric supply within premises. It covers HV panels, HV switches, transformers, LV panels, floor panels, earthing, internal electrical distribution systems, light fixtures/switches/MCBs, lighting arrestors, street lighting systems, facade lighting and transformers.

13.2 Planning of Electrical Maintenance Work

The authorized person shall have complete knowledge of the electrical appliances to be worked upon, to ensure safety. Repetitive nature of jobs require lesser pre-planning, whereas infrequent nature of jobs may need careful planning.

Planned routine maintenance will facilitate continued safe and acceptable operation of an electrical system with a minimum risk of breakdown and consequent interruption of supply. As far as the electrical equipment/installations are concerned, for the interval between the maintenance required, recommendation of the manufacturer should be followed. The manufacturer should be requested to specify minimum maintenance frequency under specified conditions. These intervals greatly upon the design of the equipment, the duty that it is called onto perform and the environment in which it is situated. At least annual health check up of all E&M equipment shall be carried out. Following two types of maintenance are envisaged:

a) *Routine maintenance* – Routine maintenance of the electrical equipment goes along with the regular inspections of the other equipment. Inspections shall reveal the undue damage and excessive wear to the various components. Examination of the equipment shall reveal need for conditioning of the contact system, lubrication and adjustment of the other relevant mechanisms.

b) *Post fault maintenance* – When there is a breakdown in the system and certain parts are identified for the replacement and then the maintenance/repair of the defective part away from the operating environment is covered under post fault maintenance.

13.3 Uninterrupted and hazard free functioning of the electrical installations are the basic requirements of maintenance. The equipment should be restored to correct working conditions. Special attention should be paid to the items and settings that may have been disturbed during the operational phase. Loose and extraneous equipment or wiring give rise to potential safety hazards. All covers and locking arrangements should be properly checked and secured to achieve original degree of protection.

13.3.1 Following maintenance procedures shall be adopted:

a) All transformers shall be provided with a linked switch with fuse or circuit breaker of adequate capacity. These should be checked annually to ensure the safety of the transformers. Where oil type transformers are used, timely de-hydration of oil and topping up shall be done to ensure proper functioning. Condition based monitoring Sensor based online transformer monitoring solution should be used for critical transformer fleet

b) Regular servicing of all circuit breakers shall be ensured so that they function properly and provide desired safety.

c) The supply of energy of each motor or a group of motors or other equipment/apparatus meant for operating one particular machine should be controlled by a suitable linked switch, or a circuit breaker, or an emergency tripping device suitable for isolation with manual reset of requisite capacity, placed in such a position as to be adjacent to the motor or a group of motors; or other apparatus readily accessible to and easily operated by the person in charge and so connected in the circuit that by its means all supply of energy can be cut off from the motor or group of motors or apparatus from any regulating switch, resistance of other device associated therewith. It should be ensured that at time of working on these equipment, this switch remains in off position to ensure safety of workers.

d) All insulating materials should be chosen with special regard to the circumstances of its proposed use ensuring that their mechanical strength is sufficient for its purpose and so far as is practicable of such a character or so protected as to maintain adequately its insulating property under all working conditions in respect of temperature and moisture.

e) Adequate precautions shall be taken to ensure that no live parts are so exposed as to cause danger.

f) Where energy is being supplied, transformed, converted or used, the consumer, supplier or the owner of the concerned installation should be responsible for the continuous observance of the provisions in respect of his installations.

g) List of authorized person should be displayed on HV, LV, lift machine room because of likelihood of lots of hazards in these areas. Proper signage shall be displayed to discourage unauthorized personnel in these areas.

h) Lock out and tag out (LOTO) processes:

1) Inform all affected employees that more than one group/person is doing servicing /maintenance on same equipment/ location.
2) Have person in charge for each group for locked out and tag out to perform the servicing or maintenance.
3) Authorized employee has to identify the type and magnitude of the energy and inform all concerned.
4) Person in-charge has to fill the declaration form owning his overall responsibility to place lock out/tag out.
5) The person in-charge has to impart the necessary information to each person of the various sources of hazardous energy and the method of isolation.
6) Equipment is to be disconnected from the energy source.
7) Each person in-charge has to provide his/her lock, on behalf of the group and tag out.
8) Key of the lock shall be kept with the person executing the job.

13.3.2 *Maintenance of UPS/Inverter*

Following maintenance procedures shall be adopted:

a) UPS/Inverter for emergency lighting system backup shall be checked at regular intervals
b) Life safety systems; emergency lighting and fire alarm systems that are required to be provided with an emergency power supply from batteries shall be checked by switching off power supply to see their operations. A log book for backup time shall be maintained.

13.3.3 *Maintenance of Energy Storage Systems (ESS)*

Energy storage systems (ESS), including storage batteries, are used for various functions such as UPS/Inverters, DG sets, lift Automatic Rescue Devices (ARD), and other critical applications. To ensure safe operation and maintenance of ESS, the following measures shall be implemented:

13.3.3.1 *Ventilation and safety in ESS rooms*:

a) Two flameproof exhaust fans shall be installed in the ESS room. One fan shall operate during normal conditions, while the other shall activate in case of fire indication or via a timer to exhaust harmful gases (released during charging) or smoke (in case of fire).
b) All light fixtures and fittings in the ESS room shall be flameproof.
c) *Battery and system replacement* – Lift ARD batteries and other critical system batteries within the ESS shall be replaced as per OEM recommendations to ensure reliable performance and avoid failures.
d) *Gas detection and monitoring* – Appropriate gas detectors may be installed in ESS rooms to detect and warn about the buildup of harmful gases. These gas detectors shall be regularly monitored, tested, and maintained to ensure proper functioning.

13.3.3.2 *Standard operating procedures for maintenance of dry cell battery*

a) Check the batteries as per the schedule and make record.
b) Clean the battery terminal on regular basis.
c) Avoid charging of batteries on boost mode. Float mode of charging is best way to increase the life of the battery.
d) Check the charger for auto cut after charging. Overcharging is very harmful for the batteries.
e) Check for deposition of any sulphate on battery terminal, if found, clean with hot water and apply petroleum jelly.
f) Avoid high temperature in battery room.
g) For the performance of the batteries, voltage shall be checked on each battery terminal after determination of individual battery terminal.
h) Replace the battery, if voltage is found to be less than the specified voltage.

13.3.3.3 *Standard operating procedures for maintenance of lead acid battery*

a) Do the routine checks of lead acid batteries.
b) Check the distilled water level in the batteries. Never overfill the water.
c) Always keep the chargers in auto charge mode. Avoid boost charging.
d) Never add new electrolyte in the batteries.
e) Never add raw water to the batteries, it may contain minerals that can contaminate the electrolyte.
f) Check for the sulphation.
g) Check all the cells with the help of cell tester.
h) Check the gravity of the batteries on regular basis.
j) Battery terminals to be checked and tightened.
k) Maintain the cross ventilation in battery room.

13.3.3.4 *Standard Operating Procedures for Maintenance of Including Li-ion Batteries*

a) Always wear safety glasses when handling Li-ion batteries.
b) Remove jewelry (for example, rings, watches) to avoid accidental contact with battery terminals.
c) Handle batteries carefully to prevent short-circuiting or physical damage.

d) Store batteries in their original containers or securely in a well-ventilated, dry area.
e) Avoid elevated temperatures, as heat degrades Li-ion batteries.
f) Keep depleted batteries separate from fresh ones and away from combustible materials.
g) Use chargers recommended by the manufacturer to avoid overcharging or overheating.
h) Do not subject batteries to unanticipated charging or forced discharging currents.
i) Regularly check for physical damage, swelling, or leaks.
j) Inspect for and address potential hazards, such as electrolyte leaks or corrosion.
k) Ensure all connections and terminals are clean and tight.
l) In case of overheating or fire, use an ABC extinguisher for Li-ion batteries.
m) Avoid stacking objects on batteries to prevent deformation or internal short circuits.
n) Install fire detectors and maintain Class ABC fire extinguishers in storage and operational areas.
o) Cover battery terminals with non-conductive tape to prevent short circuits during disposal.
p) Dispose of batteries in designated areas following hazardous waste guidelines.

13.3.4 *Earth Pits and Earthing Installations*

Earth pit should not be located near pavements, roads and near the building and minimum distance from the wall to the pit should not be less 1.5 m. Earth wires running along various sub-circuit shall terminate at the main distribution panel. Resistance of earthing pits shall be checked at least once in a year. Earthing pit record shall be maintained.

13.3.5 *DG Set and its Auxiliary Operation*

DG sets should be maintained and operated only by trained technicians. Adequate stock of diesel should be maintained to ensure that the DG sets are able to provide backup power for duration of mains failure. If more than one DG set is installed then where possible DG sets should be synchronized to ensure that optimum power output is received. It should be ensured that DG sets are not operated beyond their designated power rating and also not below desired power rating. In this regard recommendation of DG set manufacturers shall be followed.

Regular checks shall be got carried out from authorized technicians/service providers. Adequate safety precautions shall be taken while operating the DG sets. All exhaust systems shall be checked at regular intervals to ensure that DG exhaust does not get blocked or is allowed to pollute sensitive areas.

13.3.6 *Emergency Lighting*

13.3.6.1 Just like fire extinguishers, smoke alarms and other life safety equipment, emergency lighting fixture is required in commercial, industrial and institutional

buildings for times when emergency situations arise, so that people are able to find their way out of a building. These are often referred to as egress lighting.

Modern emergency lighting is installed in virtually every commercial and high occupancy residential building. The lights consist of one or more parabolic aluminized reflector (PAR 36) sealed beams or wedge base lamps. All units have a reflector to focus and intensify the light they produce. This can either be in the form of a plastic cover over the fixture, or a reflector placed behind the light source. Most individual light sources can be rotated and aimed for where light is needed most in an emergency, such as towards fire exits. Advance feature fixtures usually have a test button which temporarily overrides the unit, and causes it to switch on the lights and operate from battery power even if the main power is still on. Modern systems are operated with relatively low voltage, usually from 6V to 12 V. This reduces both the size of the batteries required as also the load on the circuit to which the emergency light is wired. Batteries are commonly made of lead-calcium/maintenance free and can last for 10 years or more on continuous charge. Fire safety aspects may require a minimum of 90 min on battery power during a power outage along the path of egress.

To indicate that a power outage has occurred, some models of emergency lights can only be shut off manually after they have been activated, even if the main building power has come back on. The system will stay lit until the reset button on the side of the unit is pressed. As there are strict requirements to provide required lighting along the path of egress, emergency lighting should be selected carefully to ensure compliance thereof as per this Code.

An emergency lighting installation may be either a central standby source such as a bank of lead acid batteries and control gear/chargers supplying slave fittings throughout the building, or may be constructed using self-contained emergency fittings which incorporate the lamp, battery, charger and control equipment. Self-contained emergency lighting fittings may operate in ‘maintained’ mode (Illuminated all the time or controlled by a switch) or ‘non-maintained’ mode (Illuminated only when the normal supply fails).

Another popular method are battery backup ballasts that are installed within or adjacent to existing lighting fixtures. Upon sensing power loss, the ballasts switch into emergency mode turning the existing lighting into emergency lighting without the need of wiring separate circuits or external wall mounts.

For remote mounted emergency lighting, wiring from the central power source to emergency luminaries should be kept segregated from other wiring, and constructed in fire resistant cabling and wiring systems. Minimum illumination levels in escape routes and open areas should be kept as per the requirements of this Code. When non-maintained fittings are used, they shall be supplied from the same final circuit as the main lighting circuit in the area.

Emergency lighting fixtures/exit lights can use non-electrical photo luminescent lighting technology with advantage to save energy.

Smoke injures or kills more people than heat from the fire, hence the electrical emergency lighting should be designed and properly marked to effectively help people find the exits or installed near floor level for ease of evacuations in smoke.

13.3.6.2 *Procedures for maintenance of emergency lighting fixtures*

The testing intervals for the system shall be determined based on the type of usage. More frequent testing shall be done in case of buildings where large public gathering takes place. In any case, this should not exceed six months. However, units that are not operational between the test intervals should be checked out and repaired on an ongoing basis.

a) *Half yearly procedures*

1) Replace any faulty lamps prior to the test procedure. When replacing a faulty lamp it may also be required to replace the lamp starter also.
2) Operate the fitting from their battery supply by turning off their normal lighting power supply. This is generally done by turning off the electrical switchboard circuit that is controlling the exit and emergency lighting (*see* Note 1).
3) The light shall remain illuminated for at least 90 min.
4) Replace any faulty lamps or fittings (*see also* Note 2).
5) Turn on the normal lighting power supply and check that the battery charger indicator light on the fitting functions correctly.
6) Record details of the test and correct operation of the system. Record the replacement of faulty lamps and the replacement of fittings.

NOTES

1 On some older installations this may also affect general lighting, as the exit lights may be wired on the same electrical circuit. In these cases coordination with building occupants is required to ensure occupant safety during testing.

2 Depending upon the nature of the fault at fixture, fittings can be repaired or replaced as considered expedient and economical.

b) *Yearly procedures*

1) Carry out the half yearly procedures.
2) Clean down all light emitting and reflecting surfaces.
3) Record details of the test, cleaning and correct operation of the system.
4) Record the replacement of faulty lamps and the replacement of any fittings.

In addition to the above, a regular program of inspection should be implemented by the building tenants to check that all maintained exit and emergency lights are operating as required.

The emergency lighting system should include adequate facilities for testing and recording the system condition. Appropriate testing should be carried out to ensure towards maintaining compliance of the system. These need to be appropriate for the specific site and should be considered as part of the system design. The tests include function test and discharge test.

13.3.7 In addition to above, the procedures for maintenance of electrical equipment to ensure their smooth functioning as given in Annex E as also provisions of Part 8 'Building Services', Section 2 'Electrical and Allied Installations' of the Code shall also be complied with.

14 OPERATIONS AND MAINTENANCE OF LIFTS AND ESCALATORS

The essential requirements for the operation and maintenance and also inspection of lifts and escalators to ensure their safe and satisfactory performance are covered hereunder. Generally, lifts designed for passenger usage should not be used for movement of goods, etc.

14.1 Acceptance

The purchaser should accept the lift installation only on completion of testing and commissioning with all necessary standards and documents, for example third party insurance cover of passengers and belongings, license from the regional lift inspectorate along with lifts handing over certificate, etc.

It shall be ensured that two numbers of door open keys, operation manual, auto attendant keys and machine room keys are handed over to the owner.

14.2 Guarantee and Servicing

To ensure the continuance of satisfactory and safe operation, the purchaser (or building occupier) should arrange for the completed lift to receive regular servicing by competent persons at such intervals as the type of equipment and intensity of operation demands. Beyond free maintenance period, a comprehensive maintenance contract with the lift/escalator manufacturer is desirable and need to be entered into.

The maintenance contract shall be all inclusive including cost of manpower/supervisor/engineer as required, regular servicing, intermediate service calls, repairs and replacement of worn parts. If the owner decides to exclude provision of some major parts from the scope of maintenance contract, such exclusions should be clearly mentioned in the contract. However, this list should be bare minimum so that lift installation is not out of commission for delay in procurement of parts.

The building owner should ensure that the equipment is properly used, and that unauthorized persons are not permitted to enter the lift shaft, pit or machine rooms. Particular attention should be paid to ensure that lifts are not overloaded or misused specially when they are used in connection with furniture and equipment removals, and internal redecoration and other similar activities, which may be undertaken within the building.

14.3 Statutory Examinations

Lifts in certain premises (residential and commercial) are required by statutory regulations to be examined at intervals, as specified by the state Lift Acts, by a competent person, who is required to report on a prescribed form. Such reports should

normally be kept in a register. Statutory examinations are not a substitute for servicing; the provision of statutory examinations and reports may be specially included in a service contract or may be arranged separately.

14.4 Service Contract (Annual Maintenance Contract)

Generally, this is a document which is made in interest of lift purchaser and manufacturer within agreed terms and conditions by both parties. This document has the contact details of both parties with escalation matrix for all the related communications. Service contract period depends on purchaser and manufacturer's mutual decision. Generally, service contracts are made for 12 months.

There are two types of service contracts, namely,

a) *Comprehensive contract* – This covers all the man, material and machine required for meeting the best performance of the lift or its connected equipment. Normally car enclosures, door panes, false ceilings, car gates, lights with fixtures, hand rails, mirrors, starters, chokes, floor coverings and carpets, others architectural features, hoistway enclosures, landing gates, door frames, external wiring, fans and batteries, etc, are not included. However, all terms and conditions, inclusions and exclusions shall be fully clarified and documented. Manufactures normally do not cover damages caused by mishandling and acts of God (such as natural disaster, riot, blackout, brownout, flood, fires and earthquakes). Service level agreement (SLA) for rectification of deficiencies shall also be amply documented.

b) *Non-comprehensive contract* – A non-comprehensive contract does not have the provisions to cover the parts of lifts; in such cases manufacturer provides the parts on chargeable basis as per industry norms, wherever required. In this type of contract, manufacturer has to provide the services for attending call backs and preventive maintenance and rescue operation in case of man entrapments.

14.4.1 *Manufacturer's Responsibilities*

Manufacturer is liable to fulfill all the requirements of the purchaser with reference to lifts as given in **14.4.1.1** and **14.4.1.2**.

14.4.1.1 *Deployment of manpower*

The lift maintenance contractor shall deploy adequate quantum of skilled technicians/supervisor/engineer with proper PPE (Personal Protective Equipment) to attend to servicing/maintenance/repairs/rescue operation as required.

When the lift number is substantial or lift service is critical like hospitals, the maintenance contract may provide for manning the lift control room by a skilled and trained staff to attend to emergency calls from the lifts and to attend to emergency rescue operation, or any emergency situation.

The lift manufacturer shall train few earmarked personnel like security staff pertaining to safe method of rescuing trapped persons.

14.4.1.2 *Statutory approvals and compliances*

Lift manufacturer will provide all the required liaison to obtain the lifts license form the competent authority, lift insurance. Annual equipment safety certificates should also be obtained from competent authority as may be required.

14.5 Equipment's Operations

Operation of some important lifts equipment that shall be kept functional and needs to be monitored is described below:

a) *Emergency alarm operation* — This is a general bell and situated inside the shaft at ground floor in conception with car operating panel (COP). It shall be ensured that this is in working condition at all the times and shall be pressed in an emergency situation.

b) *Intercom/Press to talk operation* — This is also an important and necessary equipment and shall generally be located in lift car and parallels connected to lift lobby/control room and machine room. Intercom shall be hung on car panel or located on COP with a symbol to make easier identification for users.

c) *Emergency lights* — There shall be a provision of emergency lighting in cab to ensure proper illumination in it in case of main supply failures or emergency.

d) *Door open and door close (DO and DC) operation* — A door open button shall be available in the COP towards the car gate to reverse the closing motion and hold the door. Door closing button shall also be provided in COP next to DO button. DC shall operate when user wish to close the door before its normal dwell time.

e) *Auto attendant mode operation* — There shall be a key operated switch in the COP and shall be operated by the attendant to take lift in manual control.

f) *Automatic rescue device (ARD) operation* — This shall be provided in accordance with Part 8 'Building Services', Section 5 'Lifts, Escalators and Moving Walks : 5A Lifts' of the Code. In the event of power interruption, ARD which is powered by an internal battery shall operate within 15 - 20 s, enabling the arrival of lift to the nearest floor at slow speed and open the doors to let the passengers evacuate. Condition of the ARD batteries shall also be checked regularly as per manufacturer guidelines and entry of the same shall be made in ARD's battery log card. ARD batteries should be replaced if their condition is found unsatisfactory. Poor condition of batteries adversely impacts the functioning of ARD and compromises on safety of the lift.

g) *Over speed governor (OSG) operation* — OSG is a safety device which is engaged with lift car or counter weight. It is an automatic device which brings

the lift car or counter weight to rest by operating the safety gear in the event of the speed in a descending direction exceeding a predetermined limit.

h) *Door safety (Sensor) operation* — This is a very important safety function located at the front edge or back edge of car door. This is known by different names, such as, as door sensor, door screen, etc. Door sensor shall protect full height of the door, covering at least 1 600 mm of car door height from bottom. Selection of the type of sensor to be supplied should be such that even slightest encumbrance will ensure that the doors do not close.

j) *Fireman lift operation* — It is a mandatory requirement and shall be implemented in all the lifts, individual or in group, with minimum of 1 or 2 h (Or as may be prescribed by competent authority) fire rating. Two way (ON/OFF) fire switch shall be common to all in case of group of lifts, and individual fire switch for single lift, to evacuate the lift at ground floor, protected in a box with glass in front with suitable level indication that it is a fireman switch. When the switch is on, all the landing calls for all the floors shall become inoperative and the lift shall be on car control only after reaching at parking floor which is generally at ground, and shall park at with open door condition. Fireman lift should work only when the door close button is pressed continuously. In this exercise all the landings and car calls will not respond and remain inoperative.

NOTE — Fire lifts shall be clearly identified with word ‘FIRE LIFT’ at all the landing floors.

Maintenance and routine check of fire lift shall be carried out as per the schedule given below:

Frequency	*Requirement*
Weekly check	Operating the fire switch by building maintenance staff that should check that the lift returns to the parking floor with its door open.
Monthly check	Simulate failure of the primary power supply. Building maintenance staff should operate the fire switch and observe its operation by entering few calls.
Half yearly check	Inspection and testing of the operation sequence of the lift should be made.
Annual check	A full operation test of the lift should be performed at least once in a year. A record of this test should be retained and maintained.

k) *Lift full load operation* — In case of lift full load, all the landing call shall be inoperative and only car calls made from inside the cab shall be active to satisfactorily serve the users. This full load setting should match with the full load setting agreed for the lift.

14.6 Preventive Maintenance

Modular based preventive maintenance method shall be implemented to ensure safety, availability of lifts. Maintenance modules are categorized into modules and the effectiveness is monitored through site audits. For keeping proper records, manufacturer should generate the reports and log cards. Manufacturer shall provide a schedule of plan preventive maintenance (PPM) to the user. Preventive maintenance profile should be as per the prescribed format, a typical example of which is given in Annex F.

14.7 Checks

14.7.1 *Checks for Lifts*

a) *Daily checks* – Lifts and connected parts should be checked by user on daily basis as per the typical check list given in **G-1**.

b) *Monthly checks* – Lifts and connected parts should be got checked by user on monthly basis as per the typical check list given in **G-2**.

14.7.2 *Checks for Escalators*

a) *Daily checks* – Escalators and connected parts should be checked by user on daily basis as per the typical check list given in **G-3**.

b) *Monthly checks* – Escalators and connected parts should be got checked by user on monthly basis as per the typical check list given in **G-4**.

14.8 Call Backs

Every call back or complaint related to lift should be reported by user to manufacturer on 24 x 7 basis. Manufacturers normally provide a toll free number to the users with 24 x 7 serviceability and an acknowledgement number is issued to the user.

14.9 Man Entrapments Rescue Operation

Lift rescue operation is an important function and responsibility of the lift technician/ manufacturer engineer/trained person to ensure safe and smooth lift rides. Following measures are taken in such eventualities:

a) *Automatic rescue device* (*ARD*) – In the event of intermittent power, the lift should automatically restart once supply is restored or ARD shall start working within 15 s to 20 s. When there is power shut down, the lift moves to nearest floor to let the passengers out provided there is no fault in the system. Passengers get trapped only when there is any electro-mechanical fault in lift.

b) *Rescue operation procedure*

1) As soon as the call is received from lift car about the trap (by intercom or by hooter noise), facility management team shall call the call centre of the

service provider/lift agency and register call while simultaneously informing rescue team of service provider available in the building.

2) The passengers shall be informed (using Intercom) that they are going to be rescued soon, so nobody should get panicked and nobody should try to open the car door.

3) Communication shall be continuous with the passengers in the lift to avoid the panic situation while entrapment.

4) Respective lift machine room shall be reached immediately and the level of lift shall be checked from the rope marking with reference to floor level marking; also, the shaft light of the respective lift should be switched on;
   i) One should also try to reset the lift by switching off the main incomer panel and switch it on again after 10 s.
   ii) If there will be any fault which may get resolved after reset then lift will operate and come to the level and the doors will open to let the passengers out from lift.

5) If lift is found to be at level and or near level as per the rope level marking;
   i) Main supply should be cut off from main incomer panel of that particular lift and ARD shall also be switched off.
   ii) The floor where the lift car has landed shall be reached; then the landing doors should be opened manually by hand (not by inserting de-locking key); lift doors will open smoothly if the lift is on level and the passengers may be taken out and rescued.

6) If lift is out of level as per rope level marking, services team shall not try to rescue by any means. They shall follow up with service provider and wait until the arrival of lift agency's rescue team for rescue operation. Communication shall be continuous with the passengers in the lift to avoid the panic situation while entrapment. It will be better to reach the floor and knock the door during communication to ensure presence.

7) If lift agency/service provider does not reach within 10 min, building manager and service provider shall be informed for further action.

8) After the successful rescue operation, the lift shall be shut down 'Lift Under Service' signage shall be put in front of the landings. The service agency shall then be informed for their investigation and corrective actions. Lift should not be operational until it get fully checked and confirmed by lift agency for its safe working.

14.10 In addition to above, the requirements of ARD, fire lift and other lift equipment and also procedures for maintenance of lifts and escalators as given in Part 8 'Building Services', Section 5 'Lifts, Escalators and Moving Walks' of the Code shall also be complied with.

15 MAINTENANCE OF FIRE FIGHTING SYSTEMS

15.1 Maintenance of fire detection and suppression systems in any facility is a very important task for the facility manager. All owners shall arrange to deploy adequate number of trained people to man the systems and also ensure adequate budgetary support to enable proper maintenance and upkeep of the systems.

15.2 Besides properly maintaining all systems such as fire detectors, sprinklers, first aid fire equipment's, yard hydrants, fire tanks, fire pumps, etc, it is imperative that all fire exits and staircases are kept free from any form of obstruction to allow easy egress of occupants in case of any fire incident.

15.3 At time of commissioning of any facility proper testing of all fire detection and suppression systems shall be done in accordance with relevant Indian standards and proper record of same shall be maintained. Wherever lift lobbies, staircases, lift wells or any other such location has been designed to remain under pressure from firefighting point of view it is imperative that necessary pressure fans, etc, are kept properly maintained so that there is no failure in this regard. Security guards/lift operators shall be guided to ensure that, wherever doors have been provided to maintain differential pressures are closed to ensure proper functioning.

15.4 Similarly smoke extraction fans, fire dampers in HVAC systems shall be periodically (at least a fortnightly check is desirable) run and tested to ensure that they function properly in case of any emergency.

15.5 The facility manager shall hold regular mock firefighting drills so that people are made aware of the systems installed, the location of nearest exits, etc.

15.6 Maintenance of fire extinguishers shall be carried out in accordance with the good practice [12(7)]. Periodic inspection, testing and refilling shall be got done from competent and trained persons as per provisions given in the above mentioned good practice and as per recommendations of the manufacturers. Proper records of this activity shall be maintained. All fire detection systems shall be strictly maintained in accordance with the good practice [12(8)]. Facility manager shall ensure that during any fit out or refurbishment, no detector is subjected to any interior decoration treatment such as painting, alteration of exterior cover to conform to the environment.

15.7 A log book should be maintained for recording details, including causes of all the alarms (genuine, test or false), faults service tests and routine inspections, servicing/repairs, etc, as and when done. Period of disconnection/non-operation should also be shown.

15.8 Checks shall be made every day to ascertain that the fire panel indicates normal operation and if not, then any fault indicated should be recorded in a log book and corrective action taken and record of that should also be maintained. It shall be ensured that any fault warning recorded the previous day has received attention. The control panel shall be manned regularly so that in case of any incident, immediate action can be initiated.

15.9 Success of any firefighting system will depend upon timely and proper functioning

of the fire pumps. Regular maintenance of these pumps shall be done in accordance with the good practice [12(9)]. Checking of jockey pumps shall be a daily exercise. Adequate stock of diesel shall be maintained in a safe location to ensure that pumps can be operated for design duration.

15.10 Other fire installations such as external fire hydrants, hose reels, etc, shall be checked periodically and shall be maintained. External fire hydrants shall be inspected, checked and maintained in accordance with the good practice [12(10)]. Internal fire hydrants and hose reels on premises shall be maintained in accordance with the good practice [12(11)]**.** Automatic sprinkler system shall be maintained in accordance with the good practice [12(12)].

15.11 Fire Water Reservoirs/Tank

It shall be ensured that fire water tank reservoirs are always full and free from any foreign materials. The water level shall be recorded weekly. Reservoirs shall be cleaned at least once in a year or more frequently depending upon quality of water and sludge formation shall be prevented.

Records of inspection, testing and maintenance operations and reports of hydraulic pressure tests of extinguishers and other equipment shall be maintained as per history sheet.

15.12 All maintenance operations shall be carried out as a well-planned exercise to ensure that the facility is not subjected to unnecessary risk.

a) *In case of planned shut down*:

1) Authorities shall be kept informed before shutting of the installation for any reason, whatsoever.
2) A though assessment of the risk shall be undertaken before a part or total shut down to ensure that there is no incident of fire during shut down.
3) The heads of all the departments, tenants, RWAs shall be notified in writing that the installation shall remain inoperative and they shall exercise abundant caution during the period.

b) *In case of unplanned shut down* – When the installation is rendered inoperative as a matter of urgency or by accident, the measures stated above for planned shutdown shall be implemented with least possible delay.

15.13 Fire Drills

Carrying out regular and periodic fire drills, at intervals as may be prescribed, is essential to ensure preparedness of personnel and testing of equipment to ensure that all systems function smoothly in case of any exigency.

15.14 All assets used for firefighting and fire prevention can be equipped with sensors. These sensors shall be capable of monitoring the health of the equipment. Sensors should log the status and send to the central database at monitoring station or BMS, where provided.

15.15 Staircases, fire exits, refuge areas, passages, open surroundings inside or outside the premises should be kept clear of goods.

16 ROADS AND PATHWAYS MAINTENANCE AND UPKEEP

16.1 General

Like other facilities, great care in planning and construction stage is very important for roads/pavements/paths for their subsequent maintenance and upkeep. It is to be ensured that the roads are well planned and foot paths/pavements provided are at a standard height (usually 150 mm) above the road surface so that they do not cause obstruction to the vehicles and are easily manoeuvrable. All services required at the time of construction including those anticipated in future should be taken care of in the planning stage itself and adequate provisions shall be made for them from the very beginning. This will ensure that the roads are not required to be dug/cut time and again for laying of such services and also the laying of services will be efficient and economical once these are thought of and incorporated well in advance.

16.2 External Services

Special attention needs to be paid to the drainage of the area as storm water drains, more often than not, remain unplanned in the early stages of any project and the areas get inundated during rains causing inconvenience to the users. Proper survey and outlets for the rain water shall be ensured while taking up the work of the residential or commercial complexes. Need for rainwater harvesting systems has already been explained and emphasized (*see* **11.6**). These provisions have to be taken into account while designing roads/pavements and paths. All external services should be planned and coordinated before execution. Care has to be taken to ensure that the sewer lines do not run above water lines and also do not cross potable water lines as far as possible.

16.2.1 *Ease of Movement*

While laying out foot paths/walk ways and cycle tracks traffic studies shall be carried out, junctions and crossings shall be well planned. It should be ensured that foot paths/walkways are easily approachable and are user-friendly especially to elderly people and persons with physical disabilities. A simple test for the same can be to make a person walk with a trolley and he should be able to move around without having to lift the trolley at any point.

Action at design stage should be taken to develop a safe and effective network of cycle paths. Footpaths and cycle paths are provided to assist the community with walking and cycling activities. Walking and cycling need to be encouraged as modes of transport as they,

a) Enhance fitness, health and general life enjoyment;
b) Reduce traffic congestion;
c) Reduce greenhouse gas emissions; and
d) Reduce public expenditure on new roads and car parking facilities.

Damage to paths mainly arise from aging infrastructure, vehicle overrun or through tree roots lifting the paths.

16.3 Maintenance Requirements

Materials used for footpaths and walkways need not be very costly but should be of good quality and durable so that the maintenance needs remain minimal. Attention needs to be paid to regular cleaning of drains and walkways for which the time schedule can be drawn up depending upon the usage and expectations.

All roads present maintenance problems in varying degrees depending upon the specifications and standard of execution at construction, change in traffic intensity/ pattern, climatic conditions natural calamities. In the case of concrete roads, the repairs to the roads are more or less as those applied to any other concrete works.

Road layouts indicating location of culverts, cross drainage and other underground services shall be prepared and kept available with the facility manager and exhibited in office. Different types of roads like gravel, bituminous, or concrete roads should be indicated along with length of the each stretch. A register of roads indicating total length of different types of roads shall be maintained. Similarly, a register of drains/culverts and cross drainage works shall also be maintained indicating type, length/span, etc.

16.4 Inspections

The minimum frequency of inspections of road conditions shall be specified. Permanent surface evaluation based on surface condition like cracking, patching, riding quality, road roughness and skid resistance will form the basis for taking periodic maintenance decisions. The data collected as a result of inspection should be recorded methodically. The condition of road assets, including community paths and pedestrian areas should be regularly inspected, with focus on areas with high pedestrian usage. Priority for inspections should be given to intensively used areas.

During inspections following observations should be carefully noted:

a) Carriageway and crust conditions;
b) Berms - gullies and erosion;
c) Road side drains;
d) Road protection works - retaining walls pitching on slope's, weep holes;
e) Safety aspects:
    1) Cuts on roads,
    2) Over hanging branches of trees shall be above 4.5 m,
    3) Vertical clearance from power lines, and
    4) Berms should not be lower than 25 mm from carriageway;
f) Maintenance of the bituminous road surfaces:
    1) Surface defects on account of defective quantities of bitumen;
    2) Cracks - longitudinal, edge and hairline cracks; and
    3) Bleeding on account of binder moving upwards and collecting on the surface.

Maintenance of walkways, roads and paths should specifically ensure proper maintenance of accessibility features provided, to facilitate movement of people with disabilities.

16.5 Routine Road Maintenance

Following shall be attended to as part of routine maintenance activity:

a) Periodic inspections should be carried out;
b) All patch repairs and rectification of undulations shall be attended well in time;
c) Shoulders and the side drains to be kept in camber/cleaned;
d) Proper signage to be provided;
e) Soil erosion to be avoided; and
f) Vegetative cover should be established on cut/fill slopes.

16.5.1 *Permanent Maintenance Management System* (*PMMS*)

Permanent maintenance management system is used for managing or directing and controlling maintenance resources in a scientific manner for optimum benefits for major road system. Matching of resources time materials and labour equipment, funds, design and timely decision-making is an integral part of PMMS. The required data of assets to be maintained should be collected and made available to the facility manager who will be able to identify requirements of funds, labour, materials and equipment for maintenance works based on the methodology to be adopted.

16.6 Environmental Concerns

Environmental concerns are also to be looked into to reduce the vehicle operating costs and levels of emission from road traffic. Urban roads have unique features which need to be accounted for in the maintenance norms so as to ensure that the maintenance is carried out in right perspective. These features include traffic signals, pedestrian walkways, cycle tracks, street furniture, footpath, service lanes, streetlights, etc. Even removal of dead animals becomes a part of maintenance. These roads are subjected to continuous flow of traffic thereby giving only very limited working hours for maintenance purposes hence high level of mechanization is required. Proper monitoring of the maintenance works needs no emphasis. While carrying out design work for the roads and pavements it shall be ensured that there are no deficiencies left in the crust thickness.

17 HEALTH AND SAFETY REQUIREMENTS

17.1 Personal Protective Equipment (PPE)

17.1.1 Many hazards exist in work environment which cause thousands of injuries and health problems every year. Working at a site involving constructional work/maintenance work can pose a serious/fatal threat to the personnel involved if appropriate PPE’s are not used. PPEs are protection gears used by individuals to reduce the consequence of specific risks in the work place, for example, safety helmet, safety shoes, gloves, etc.

All the PPE shall be suitable for the industry need and comply with the requirements of relevant Indian Standards. There shall be zero tolerance and no compromise on the safety at all the times. All PPE shall be maintained in optimum condition to ensure longer sustainability and durability and stored properly in easily accessible locations

17.1.2 PPE being the basic requirement, shall be supplied to all the employees, labour, contractors vendors and suppliers to protect themselves as well as others. Respective units as field and factory shall incorporate specialized PPE for operation in their respective operational control procedures.

17.1.3 *Responsibility*

Each one in the premises involved in work environment shall be equally responsible to ensure use of the PPE as per HSE Manual and safety code. The need and importance of safety measures shall be explained to each worker on day-to-day activities at work place.

17.1.4 *General Requirements*

a) Use PPE properly according to the nature of work.
b) Awareness of the correct way to use PPE. This may be done by training, reading and discussion on the usage of manual of specialized PPE.
c) Regular checking, cleaning and maintenance of PPE. PPE shall be maintained in good shape and condition to ensure that the purpose is served.
d) Information to be given to supervisor regarding need to repair and replace PPE.

Each establishment shall prepare and notify safety requirements and guidelines for use of PPE. Non-adherence to the guidelines so prepared should be treated as an offence. If any personnel are noticed for non-compliance, it shall be reported to line manager or work manager for appropriate disciplinary action. This shall be a general practice to impart refresher training to all the employees meeting their other training needs as tool box talk before starting any task.

17.1.5 *Use of PPE for Specific Areas*

a) *Maintenance of electrical installations* — All personnel are required to observe the following procedures for PPE use:

    1) PPE use is mandatory when contact with exposed electrical sources is likely. Only use PPE that is designed for the work being performed. Inspect and test all PPE prior to use.
    2) Use a protective outer cover (for example, leather), if the work being performed may possibly damage the PPE's insulation.
    3) Wear non-conductive headgear, if there is danger of electrical burns or shock from contact with exposed, energized equipment. Wear eye and/or face protection, where there is danger of flying objects, flashes or electrical arcs produced by an electrical explosion.

b) *Maintenance of E&M services* — All workers employed in maintaining MEP equipment shall be supplied with proper PPE and should be trained to use them properly. Working on machines and plants without proper PPE should be strictly discouraged. Some of the PPE usage which shall be ensured are:

1) Use of insulated gloves for electrical maintenance;
2) Use of safety shoes for all kinds of maintenance;
3) Use of safety helmets if it is a construction site;
4) Suitable 'Wet area' displays to be provided at the time of wet service;
5) Disconnect main power supply while attending to any service requirement on the respective equipment;
6) Always check with line tester that supply is disconnected;
7) Use safety belt and harness if working on building vertical faces;
8) Ensure limit switch, fan guard and marine light inside AHUs;
9) Ensure adequate lighting at all times during service;
10) Use only competent and trained service agencies/personnel;
11) Ask service provider's service representative to display identity card before commencing service, to prevent sabotage/industrial espionage; and
12) Use genuine/reliable spares.

c) *Personal Protective Equipment (PPE) for Firefighting* — All personnel involved in firefighting operations shall wear appropriate PPE specifically designed to provide protection against fire, heat, smoke, and hazardous environments, PPE shall comply with recognized safety standards and be inspected regularly for wear, damage, or contamination. The components of Firefighting PPE are below:

1) Flame-retardant suits shall be worn to protect the body from high temperatures and direct flames.
2) Fire-resistant helmets with visors or face shields shall be used to protect against heat, falling debris, and impacts.
3) Self-Contained Breathing Apparatus (SCBA) shall be used to provide breathable air in environments with smoke, toxic gases, or oxygen deficiency.
4) Heat-resistant gloves shall be worn to protect hands from burns, cuts, and abrasions.
5) Fire-resistant safety boots with anti-slip soles shall be worn to provide protection against heat and hazardous ground conditions.
6) Goggles or integrated face shields should be used to guard against heat, sparks, and debris.
7) Firefighters exposed to high noise levels, such as during explosions or equipment operation, shall use appropriate hearing protection.
8) Firefighting PPE shall be inspected before and after each use for any damage or contamination.
9) Damaged PPE shall be removed from service immediately and replaced or repaired as per safety protocols.
10) All firefighting personnel shall receive training on the proper use, inspection, and maintenance of PPE.
11) Compliance with PPE requirements shall be strictly enforced during all firefighting operations.

17.2 Maintenance Tools

17.2.1 A list of recommended tools should be maintained. Out of the list, tools relevant to the specific maintenance activity may be used. All tools and other equipment which are used shall be stored properly and be easily accessible. Wherever tools are to be used for working on hazardous areas, they shall be procured from reputed manufacturers to ensure safety of the workers.

17.2.2 *Portable Electrical Tools*

a) Portable electrical tools (especially metal body) should be connected through 30 mA earth leakage circuit breaker (ELCB) only to avoid any injury due to any leakage current.
b) Portable electrical tools should be double insulated because with regular use, the portable tools insulation gets weak and during the work technician may get injured due to electrical shock.
c) Portable electrical equipment shall be regularly examined, tested and maintained to ensure that the equipment and its leads are in good order.
d) Register shall be maintained for inspection, recording the testing dates and results of the equipment.
e) All portable appliances shall be provided with three core cable and three pin plug. The third pin of the plug shall invariably be earthen.
f) It shall be ensured that the metal part of the equipment shall be effectively earthed.
g) All connections to portable equipment or machines from the panel/distribution board/extension board shall be taken using three core double insulated PVC flexible copper wires in one length. No joints shall be allowed in this flexible wire. In case single length of wire is not sufficient for a particular location then the supply can be tapped by providing another extension board comprising of switch and socket.
h) Flexible cables for portable lamps, tools and apparatus shall be regularly examined, tested periodically and maintained to ensure safety.

17.3 Good Practices

Besides ensuring use of appropriate PPE, tools and trained manpower, there are some other aspects which each facility management team should follow. These aspects include the following:

a) Always ensure that the service provider checks the operation logs, to verify whether plants were operating as they should be.
b) Always ensure that the vendor prepares a service report and duly signs it.
c) Always ensure that service report is signed by an authorized person representing the owner.
d) Always ensure that all components of the plant are maintained as per protocol.
e) Always ensure that there is a physical meeting between operator and service provider, at the time of each quarterly service.

f) Never allow unauthorized personnel to enter plant rooms, sub-stations or other installations where machinery or other equipment are installed.
g) Do not allow wearing of loose clothes by operators and technicians as it can be a potential hazard.
h) Maintain all plant rooms, sub-stations, electrical panel rooms, etc, neat and clean. Remove all unwanted materials from these areas as it may hinder operations in times of emergency.
j) Senior supervisors, facility managers shall review maintenance operations and records regularly to ensure that proper schedules are being followed and that servicing, etc, of equipment is being done on time.
k) Constant emphasis shall be given on safety aspects.
m) Regular onsite training will help maintenance personnel to improve their performance
n) All maintenance manuals, documents related to equipment, service records shall be kept in a convenient place to allow quick and easy access.
p) Wherever a special service request is received, a follow up on the same shall be done after action has been taken to resolve it. This will help in generating confidence of end users in the facility management team and will also ensure that the personnel tasked with resolving the request perform properly.
q) Some operations are required to be carried out on a 24 x 7 basis. In all such places, proper provision for a rest room shall be provided.
r) Many installations may need deployment of large work force for maintenance and operations. In all such places it will be desirable to provide a proper rest room for the workers or an area for the purpose may be designated so that they can be approached quickly, whenever a need arises.

17.4 Pandemic Safety Measures in Buildings

In light of recent global health crises, it is critical to incorporate specific health and safety protocols in building management to ensure the well-being of occupants. These measures focus on minimizing the spread of infectious diseases within built environments.

17.4.1 *Ventilation and Air Quality*

In order to ensure optimal indoor air quality and minimize the risk of airborne contaminants, the following measures shall be implemented:

a) Enhanced Ventilation

1) *Increase airflow* – Buildings shall be equipped with mechanical ventilation systems capable of increasing fresh air intake and minimizing recirculated air, especially in high-occupancy areas. For buildings with natural ventilation, windows and doors should be opened periodically to promote airflow.

2) *HEPA filtration* – Heating, ventilation, and air-conditioning (HVAC) systems shall be upgraded with high-efficiency particulate air (HEPA) filters capable of capturing airborne pathogens, including viruses.

3) *UV-C disinfection* – Installation of UV-C light technology within air ducts can provide an additional layer of pathogen inactivation.

b) *Zoning and Airflow Control* – Design and retrofit air-conditioning and ventilation systems to create separate zones that limit air mixing between different parts of the building, especially in areas like healthcare facilities, office spaces, and waiting areas. This helps to contain any potential airborne contaminants.

c) *Humidification* – Maintain indoor relative humidity levels between 40 percent to 60 percent to help reduce the survival of airborne viruses, as dry air can promote the spread of pathogens.

17.4.2 Contactless Systems and Sanitation

To reduce the risk of contamination and enhance sanitation, the following contactless systems and hygiene practices shall be implemented:

a) *Touchless entry and operation* – Automatic doors, touchless elevators, and sensor-activated faucets shall be installed to minimize the need for physical contact with shared surfaces. High-traffic areas should be equipped with contactless access control systems such as facial recognition or card-based entry to reduce the spread of germs.

b) *Hand hygiene stations* – Hand sanitizer dispensers with alcohol-based solutions (minimum 60 percent alcohol content) should be installed at all entry points, elevator lobbies, and common areas to encourage hand hygiene. Hand-washing stations should be easily accessible, with signage promoting proper hand hygiene techniques.

17.4.3 Social Distancing and Space Management

To maintain safe social distancing and effectively manage space, the following measures shall be adopted

a) *Occupancy limits* – Maximum occupancy for communal spaces, including meeting rooms, lobbies, and elevators, shall be reduced to maintain social distancing guidelines (1 to 2 meters apart). These limits shall be clearly indicated through signage.

b) *Workspace layout* – Reconfiguration of seating arrangements in office spaces and public waiting areas should be done to ensure appropriate distancing. Considerations should include staggered seating, partitions, or plexiglass barriers in areas where distancing is not feasible.

c) *Scheduling and staggering occupancy* – Implement staggered working hours or alternating schedules for building occupants to reduce the overall density at

any given time, particularly in high-use areas like cafeterias, conference rooms, and lobbies.

17.5.4 *Cleaning and Disinfection Protocols*

To ensure a hygienic environment and reduce the risk of infection, the following cleaning and disinfection protocols shall be implemented:

a) *Routine cleaning* – Frequently touched surfaces such as door handles, elevator buttons, and handrails shall be disinfected multiple times daily using EPA-approved disinfectants proven to be effective against viruses.

b) *Deep cleaning* – In the event of a known infection within the building, deep cleaning protocols involving thorough disinfection of all surfaces, HVAC systems, and equipment should be initiated promptly to prevent further transmission.

17.5.5 *Health Screening and Monitoring*

To protect occupant health and promptly identify potential health risks, the following screening and monitoring practices shall be implemented:

a) *Temperature screening* – Thermal cameras or infrared thermometers shall be deployed at entry points to monitor the temperature of occupants, with designated protocols for isolating those displaying symptoms of illness.

b) *Occupant health tracking* – Buildings may implement voluntary health monitoring apps or systems that allow occupants to self-report symptoms, exposure, or positive test results for infectious diseases. This information can be used to trigger appropriate cleaning protocols and occupancy restrictions in affected areas.

17.4.6 *Emergency Preparedness*

To ensure readiness for health emergencies, the following emergency preparedness measures shall be established

a) *Pandemic response plan* – A pandemic-specific emergency preparedness plan shall be in place, covering response protocols, communication plans, isolation zones, and evacuation procedures in case of an outbreak within the building. Training for facility management teams on infectious disease control and usage of personal protective equipment (PPE) should be conducted regularly.

b) *Isolation zones* – Buildings, particularly commercial and healthcare facilities, shall have designated isolation areas for individuals who begin exhibiting symptoms while on-site, allowing for safe containment until medical assistance is available.

17.4.7 *Communication and Signage*

To effectively communicate health and safety protocols, the following communication and signage measures shall be implemented:

a) *Health and safety messaging* – Clear and visible signage should be placed throughout the building, promoting hygiene practices, social distancing guidelines, mask usage, and symptom awareness. Digital communication boards or mobile app alerts can be used to disseminate updated health guidelines or protocols.

b) *Occupant education* – Regular updates on health and safety measures should be provided to building occupants, including instructions on how to use contactless systems, report health concerns, and maintain proper hygiene practices.

18 MAINTENANCE OF LANDSCAPING AND HORTICULTURE WORKS

18.1 General

Landscape maintenance specifications and management plan is the key to aesthetic environment, natural surveillance/security and pleasant surroundings. Well maintained and manicured green areas not only enhance the value of the asset but also provide relief to the users. The objective is to provide regular time defined services as per the landscape maintenance specifications laid down for the property. This covers hardscape as well as softscape, which are explained below:

a) Hardscape are primarily the design elements that are solid and remain unchanged as the years go by, examples are rocks, walkways, retaining walls, paver patios, outdoor kitchens, water features, fountains, decks, podiums, driveways, etc.
b) Softscape are elements that are fluid and change with time. It is the living animated part of a landscape, comprising of elements such as soil, plants, shrubs, trees, flowers, vegetables, vines, turf, etc.

Maintenance of hardscape and softscape should be ensured as planned. Maintenance of walkways, roads and paths should specifically ensure proper maintenance of accessibility features provided, to facilitate movement of people with disabilities.

18.2 Maintenance of Plants

The fundamental principle of maintenance of in-door and out-door plants means using the right plant and the right place in the property. Indigenous plants, or others well adapted to local conditions, should be used wherever possible. Plant growth rate, size at maturity, life span, brittleness and requirements of light, water and soil *p*H are important factors in selecting plants, along with their colour, texture, fragrance and seasonal characteristics. Matching plant requirements with site realities and correctly placing appropriate plants helps avoid expensive and time consuming problems.

Plants should be maintained in foliage, height etc to maintain the original design intent including sightlines, surveillance, access control and territoriality as relevant

In case of indoor plants, it is necessary to choose the right location with good light and away from heat, vent, air conditioner. In case of a location with abundant sunlight, in-door plants should be placed in east west facing windows, whereas in case of locations with less sunlight, they should be placed in a north facing window. It is essential to give right amount of water as both too much water and not enough water can be the primary reason for a plants death. Plants should be given plenty of moisture depending on its type. In-door plants should be kept free of pest and dust. Over-time in-door plants become sickly and poor looking as a result of dust build up and insect pest infestation. They shall be cleaned with a rag and organic insecticide soap every few months. Unhealthy growth should be removed. In case of out-door plants/trees, it shall be ensured that they are getting enough sunlight. They should be watered on regular basis. Insects, snags and snails should be killed with organic insecticides. Care of planted area shall be done in accordance with **18.5.1**.

18.3 Regular, weekly maintenance services, as outlined in the landscape maintenance specifications, should be provided and weekly and monthly checklists should be maintained. All landscape areas, including irrigation systems, should be examined on a weekly basis, looking for problems or potential problems so that timely action can be taken. This is essential as the plants once damaged can only be replaced which will require extra financial burden.

18.4 Following documents needs to be maintained in suitable formats for effective monitoring:

a) Landscape maintenance plan;
b) Weekly and monthly monitoring checklists;
c) Attendance register for the garden maintenance team;
d) Records to be maintained for gardening consumables purchased in a month;
e) Weekly checks on the gardening tools and tackles; and
f) AMC for mechanized equipment.

18.5 Methodology and Processes to be Adopted

18.5.1 *Care of Planted Area*

a) *Trees* — Trees shall be maintained in a healthy, vigorous growing condition, free from disease and large concentrations of pests. Pruning of trees should be done only in appropriate months. Timely action, to remove dead, diseased, broken, dangerous, or crossing branches, to be undertaken as part of the regular maintenance to encourage a high-branching structure. All non-structural branches between the ground and a point half the tree's total height should be removed (for very tall trees branches higher than 6 m above the ground should not be removed). Trees planted for screening purposes, such as those at rear perimeters of many sites shall not be pruned except as needed to remove dead, diseased, broken, dangerous, or crossing branches. The cutting blades on pruning shears, clippers, blades, saws, etc, shall be sterilized after pruning each tree to minimize the possibility of spreading disease.

A vertical clearance of 2.90 m is required above all parking spaces. A vertical clearance of 2.0 m is required above all walkways. Trim trees to remove all limbs within these areas.

b) *Shrubs and vines* — Shrubs and vines shall be pruned weekly or as needed to keep them in healthy, vigorous condition, free from disease and large concentrations of pests. Works to be carried out under guidance of a competent professional. Shrubs should be allowed three months to rejuvenate prior to pruning or replacing.

c) *Groundcover* — Groundcover shall be maintained in a healthy, vigorous growing condition. Groundcover shall be planted at 200 mm spacing from the building to encourage quick coverage. Prior to planting replacement groundcover, the soil shall be tilled to a depth of 150 mm to prepare it for the new plants. The groundcover should be kept trimmed back from sidewalks, curbs, and paved areas on a weekly basis. Vertical edges should not be created when pruning groundcover. The edges should be cut at an angle for a more natural appearance and healthier plants.

d) *Weed control* — Weeds in planted areas, sidewalks, curbs, gutters, or pavement shall be removed or killed weekly as the weeds emerge.

e) *Mulch and/or rock layer* — Soil mulch and/or rock layer shall be cared for, as needed to create and maintain an even and uniform appearance over the visible soil surface of each planter area. Replacement rock shall be of the same size and colour as existing decorative rock on site. In the event no rock is existing, the decorative rock used shall have a maximum diameter of 20 mm and a minimum diameter of 10 mm.

f) *Fertilizer* — When applying granular fertilizers to drip-irrigated areas, the fertilizer shall be washed in by hand or rainfall before turning on the drip system. Running the drip system immediately after application will push the fertilizer away from the emitters, resulting in a high concentration of fertilizer at the edge of the wetted zone. This highly-concentrated fertilizer can kill or damage plants. It is recommended that granular fertilizers be applied to drip-irrigated areas only in early spring, just prior to a moderate rainfall.

g) *Lawns* — Lawns shall be kept in a healthy, vigorous condition, free of disease and pests. Lawn height shall not exceed 130 mm at any time, preferred is 3 inches. Lawns should be mowed, edged and trimmed weekly or as required to maintain an even, well-groomed appearance. Visible lawn clippings should be removed and disposed off-site in a legal manner. It is encouraged to use mulching mowers which cut clippings into small pieces that sift down into the lawn. Weeds shall be controlled in lawn areas as described in (d).

18.5.2 *Irrigation — Water Application and Scheduling*

18.5.2.1 Hand watering should be done, as needed to supplement natural rainfall and maintain plantings in a healthy, stress-free condition, to ensure that plants receive

adequate water regardless of weather conditions. Irrigation shall be done by the use of the permanent irrigation systems. Hand watering should also be done, as needed to supplement the permanent irrigation systems.

Watering times shall be adjusted each week. Plantings shall not be over-watered. Multiple-start times and short run times should be used to prevent run-off. Drip systems should be left on for sufficient time to allow for saturation of the root zone. Shorter runs with drip irrigation do not provide sufficient water penetration for healthy root development. Multiple-start times with drip systems should be avoided, if possible. Run-off should not be allowed from any irrigation.

18.5.2.2 *Irrigation system scheduled maintenance*

Irrigation system scheduled maintenance shall include the following:

a) Each valve zone shall be observed for signs of damage on a weekly basis during the irrigation season.

b) The irrigation system should be maintained, including cleaning of filter screens yearly or more often as needed, and flushing pipes, as part of regular maintenance.

c) Drip irrigation systems need periodic flushing to remove sediment and shall be performed as per the required frequency. Drip systems shall be flushed at least once a year. Ends of drip lines should be opened and run for at least 15 min at full flow to flush. It may be necessary to install flush outlets in order to flush the drip system.

d) For safety, sprinklers shall not be installed on risers above the ground level, even if the risers are flexible. Spring-operated, pop-up style, sprinkler heads should always be used. Sprinkler heads are available with pop-up heights up to 300 mm above ground level. If the existing sprinklers are mounted on above-ground risers, the replacements shall be pop-up type sprinklers.

e) The entire irrigation system should be inspected weekly for items such as dry spots and missing or malfunctioning irrigation components. It shall be checked for leaking valves, water running across sidewalks, water standing in puddles, or any other condition which hampers the correct operation of the system or the public safety. The team shall carefully observe plant materials for signs of wilting, indicating a lack of water.

18.5.3 *General Cleaning*

While it is essential to maintain all hardscape and softscapes properly it is also essential to ensure general cleaning up of these areas. Cleaning up and litter removal from, all walks, curbs, and gutters, on weekly basis should suffice. However, frequency may be determined depending upon the usage of the facility. In no case shall trash, litter, or leaves be blown or swept onto the property of others. All trash, litter, leaves, etc, shall be collected, hauled away, and disposed of legally. Under no

circumstances shall dry leaves be burned. Wherever possible, composting of horticulture waste should be resorted to.

18.5.4 *Chemicals, Pesticides and Herbicides*

All chemicals shall be used in accordance with label directions and the manufacturer's recommended dosage and handling methods and handled in accordance with all applicable regulations. Nothing in this clause shall be construed to be the advice of, or to substitute for the advice of, a pest control adviser whose advice should be sought for use of registered chemicals.

Pesticides shall not be applied within one hour of the start of operating hours for businesses at the site. In the event that it is not possible to complete the application by 1 h prior to business hours (that is, 24 h operations), applications shall be made at times when customer presence is minimal. Areas to be treated shall be blocked off and warning signs posted.

18.5.5 In addition to above, the maintenance requirements as given in Part 10 'Landscape Development, Signs and Outdoor Display Structures', Section 1 'Landscape Planning, Design and Development' of the Code shall also be complied with.

18.5.6 *Reports*

The weekly landscape maintenance checklist shall be complete in respect of all applicable items on the checklist. It shall be submitted to authorized representative each week for review. The monthly landscape maintenance checklist needs to be prepared for month on month requirements as per the season during the year. A typical checklist for landscape areas is given at Annex H.

19 HOUSE KEEPING

19.1 It is an established fact that a ‘clean’ facility enhances the appeal, productivity of occupants and the value of the facility. Janitorial service standards cover basic features of operations required to be carried out to keep the facility clean. Housekeeping or janitorial services will include, where required, ensuring desired levels of hygiene.

19.2 Methodology and Processes to be Adopted

19.2.1 Adequate staff, having necessary training in carrying out cleaning operations for ensuring required levels of cleanliness, under guidance of trained janitorial supervisor should be deployed. Having trained teams for carrying out these operations will result in better standards being achieved with lesser manpower. The facility management team should draw up plans for achieving the desired standards without disturbing the use and operation of the facility. Assessment of manpower required needs to be carefully assessed keeping in view all relevant factors.

19.2.2 While carrying out housekeeping activities following aspects should be kept into consideration:

a) All local laws and regulations are abided by, and
b) Required protocols of cleaning for all areas of the building and cleaning schedules for all areas of the building are implemented.

19.2.3 *Tools and Technology*

Cleaning chemicals to be used should have a *p*H value of (1percent sol.) : 9.5 -11.0 and it is desirable to use only green seal certified chemicals, certified by an appropriate authority, and manufactured by reputed manufacturers. This is essential to prevent damage to assets and ensure that no harmful impact is caused to facility/users.

Chemicals used should be safe and should display appropriate hazard warnings and material safety data. Storage of the cleaning chemicals should be done properly to ensure that no untoward incident occurs and misuse can be prevented.

Mechanical equipment like, dry vacuum cleaners, dustette, back-pack vacuum, upright vacuum, pile lifter, wet and dry vacuum cleaner, large tank type vacuum cleaners, carpet shampooing machine/steam extraction machine, high pressure washers, scrubbing/polishing machine, etc, may be deployed as required. Selection of cleaning equipment may be made based on:

a) Floor finish - vitrified, carpeted, mosaic, marble, granite, etc;
b) Total area required to be cleaned;
c) Cleaning standards/frequency required to be achieved;
d) Time at which cleaning activity is to be carried out and time duration available to complete the process;
e) Periodicity of the activities, that is, daily, weekly, etc; and
f) Areas/building component required to be cleaned, for example, glass facades, aluminum composite panel (ACP) sheets, atrium, etc.

Periodicity of the activities can be classified into: daily, weekly, monthly or annually.

19.2.4 *Periodic Tasks*

The activities to be carried out at intervals mentioned above shall be enumerated and the facility management team shall be aware of the same and should carry out these activities at specified intervals.

19.3 Documentation Required to be Maintained for Effective Monitoring

Like other services, proper documentation of housekeeping services shall be maintained to ensure proper execution, review and control. Following details may be maintained:

a) Supervisors check-list;
b) Deployment sheet;
c) Attendance register;
d) Week-end check-list;
e) Incident tracker;

f) Chemical consumption record; and
g) Machinery running and maintenance report.

19.4 Evaluation and Recommended Frequencies

As housekeeping is a function which shall be carried out strictly as per desired schedule, it is desirable that service level agreement (SLA) shall be reviewed and findings documented.

Recommended frequency of evaluation should be once every month.

19.4.1 *Measurements and Recording of Non-conformance*

Non-conformance can be measured through e-mail/telephonic/written/verbal report received from the employees/end users. Number of times the default has occurred in a month shall also be recorded. Any escalation on the help-desk/help-line will be categorized as non-conformance except for request. Any incident/default will be measured as a single unit.

19.4.2 Non-conformance to SLA may be classified as:

a) *High* — Any event which compromises with business continuity, life threatening incident, loss of reputation, major financial loss.
Non-conformance recording – Default twice in a month equals to one non-conformance.

b) *Medium* — Default observed in the adhering to bench-marked cleaning standards defined for the property.
Non-conformance recording – Default thrice in a month equals to one non-conformance.

c) *Low* — Any event causing minor annoyance.
Non-conformance recording – Default four times in a month equals to one non-conformance.

NOTE — The above being recommendatory, appropriate measures should be taken by the facility management team based on the type of usage of facility.

19.4.3 It is desirable that the facility management team sets benchmarks for measuring performance and non-compliance. It is recommended that a score of 95 percent or above may be accepted as having complied with the SLA and a score of 50 percent or below may be taken as to indicate failure of the housekeeping team.

19.4.4 A typical template for measurement and recording of conformance or otherwise with respect to housekeeping in given at Annex J.

19.5 Training and Skilling

Cleaning supervisor/cleaning personnel (janitor/chamber-maid) should have required skills and attitude and eye for detailing. Regular onsite training should be carried out.

This will help in improving delivery of services by the personnel. During training, housekeeping staff should be sensitized on needs of persons with disabilities, elderly and frail people and children in particular.

Housekeeping staff should also participate in, and also be trained to participate in all safety and disaster related activities.

20 PEST AND RODENTS CONTROL

20.1 Overview

A clean environment and prevention is the starting point of pest control. Keeping harmful pests at bay results in preventing loss and ensures a healthy and safe environment for the users. Pest control is the process of eliminating or minimizing a wide range of undesirable pest and insects. A watchful eye and alertness to detect tell-tale signs of pests helps to take adequate timely action. Certain kind of pests can be a great health risk and can cause safety issues for any premises. Engaging a professional service partner to manage the pest control brings about desired results.

Integrated pest control management is a holistic approach encompassing prevention, monitoring and control techniques with larger goal of suppressing pests by application of least toxic measures. Preparation of an integrated pest management plan can be very useful and following guidelines may be considered in its preparation:

a) Preventive measures should be explored;
b) Alternative methods of control to be evaluated;
c) Timely action for effectiveness and safety;
d) Most effective method to be adopted that has cost benefit and least environment effect; and
e) Adequate monitoring and documentation.

NOTE — It is recommended that control measures be adopted only when the problem occurs.

20.2 Methodology and Processes to be Adopted

20.2.1 *Tools and Technology*

Various tools and equipment employed in pest control are hand operated sprays, foot operated sprays, gum pads, gel guns/syringes, fogging machines, etc. These may be used/deployed as required.

20.2.2 *General Management*

20.2.2.1 *Prevention techniques*

An important step, as it eliminates the pests by disturbing its environment, can be through physical barriers or elimination of source, as described below:

a) *Elimination of ingress points*:

1) Allow food and beverage at designated areas only.
2) Keep areas dry, eliminate stagnant water.
3) Carpeted areas to be vacuumed frequently.
4) Precautions for food preparation and serving areas with due attention to storage, cleaning and waste disposal practices.

b) *Monitoring techniques* — Good monitoring is a cost effective aspect of integrated pest management, forming the basis for control techniques. Regular, systematic inspection of the facility is essential to be effective. It may include the following:

1) *Tell-tale signs* — Sighting of pests, damage, droppings, tracks and traces.
2) *Thresholds* — Mere presence need not trigger control action but sizeable presence warrant actions.
3) *Traps* — Very effective method of monitoring and helps reduce usage of chemicals and pesticides.
4) *Data to be recorded systematically* — Helps to detect pest problems and compare outbreaks season to season. Records should be maintained to capture dates, temperature, location of infestation and control action taken.

c) *Control techniques* — Use of control techniques to be on the basis of proven efficacy, low environmental impact, operational feasibility and cost effectiveness. Control methods by use of chemicals is most effective while cultural, mechanical, physical, biological methods contribute greatly towards prevention. Special control techniques may also be employed based on case specific requirements. Best practices for this aspect include the following:

1) Training of personnel;
2) Usage of personal protective equipment (PPE);
3) Usage of green chemicals; and
4) Usage of low toxicity chemicals.

Periodicity of activities can be daily, bi-weekly, weekly, fortnightly and monthly.

20.2.2.2 Documents like integrated pest management plan, pest monitoring checklists in appropriate formats should be maintained for effective monitoring.

20.2.2.3 Evaluation and recommended frequencies can be laid down by each establishment depending upon location, use and infestation of pests.

21 SECURITY SERVICES FOR BUILDING OCCUPANTS AND ASSETS/FACILITIES

21.1 The primary aim of security in a building occupied by people for various purposes is to take adequate measures to prevent crimes by deterrence, detection, delay and denying opportunities and also resist, respond and recover from man-made extreme events. The security issues shall be addressed in using integrated design process with an understanding of the impacts and goals of other design objectives. While ensuring safety and security measures adopted, the staff deployed should take into

account needs of persons with special needs, elderly and frail people, women and children in particular.

The security in a built environment is expected to be a composite of natural means (physical measures, existing topography/context etc.), mechanical devices, organized forms (including personnel, communities) and operational practices. While cyber security is beyond the physical domain, security of cyber related devices and equipment is within its purview and critical to all intangible forms of security also. The security design and strategy in a built environment shall ensure mitigation of threats and vulnerabilities therein ensuring no inadvertent new vulnerabilities are created in design or operations.

The physical security addresses the threats, vulnerabilities, and countermeasures that can be utilized to physically protect an asset's resources and sensitive information. These assets include people, the facility in which they work, and the data, equipment, support systems, media, and supplies they utilize. These guidelines assist in the identification of physical security measures that can be applied at facilities to safeguard or protect an organization's asset, that is, people and property. Security measures required for keeping information secure are not covered herein. For details concerning physical security measure refer Part 3 'Development Control Rules and General Building Requirements' of this Code.

21.2 Threat Types

Some types of threats to be considered include the following:

a) Structural Threats
b) Common Crimes

21.2.1 *Common Crimes* – It includes following:
a) Physical attack on persons
b) Physical attacks on properties
c) Gender based/Sexual crimes
d) Social Crimes against seniors or children
e) Economic crimes from theft to Heists
f) Vandalism
g) Unauthorised access or occupation
h) Panic

21.2.2 *Structural threats* – It includes following:
a) Blasts or Explosive threats — Stationary and moving vehicle-delivered, mail bombs, package bombs.
b) Ballistic threats — Small arms, high-powered rifles, drive-by shootings, etc.
c) Weapons of mass destruction (chemical, biological, radiological and nuclear).
d) Sabotage
e) Arson, Civil unrest or riots
f) Overcrowding

21.2.3 Suitable measures at design, construction and maintenance stage need to be taken to ensure that threats as listed above and beyond are taken care of.

21.3 Methodology and Processes

21.3.1 *Threat and Risk Assessment*

A security system is generally not effective unless it is developed based on an understanding of the actual threats and risks it is designed to control. The development of a threat and risk assessment for a facility involves the following steps:

a) *Asset Identification* – Determining what to protect,
b) *Threat Assessment* – Determining what to protect against,
c) *Vulnerability Assessment* – To identify general vulnerabilities offered by the building function or purpose and specific vulnerabilities offered by the site, location, context etc.
d) *Risk Assessment* – Determining if existing or proposed security measures are satisfactory based on probability of actualization of the threats
e) *Recommendations or Security Strategy* – Identifying what should be done to mitigate the identified threats, vulnerabilities and risk levels.

21.3.2 *Site Development*

A safeguarding strategy should be defined and used to develop a security site brief (SSB).

The institution or tenant should prepare a SSB for leasing existing facilities, because custodians generally seek existing space as a first option. If it is determined that existing space is not available or is not the first option, then another SSB for constructing facilities should be prepared. Once selected through a build, buy or lease process, the site is subjected to a survey to determine site specific security-related problems. These problems may include neighbourhood vandalism, theft or violent crime. This information is considered along with the facility threat and risk assessment and allows the safeguarding strategy to be adjusted as required and adequate safeguards to be developed for the site.

21.3.3 *Security Strategy*

21.3.3.1 The security strategy should be based upon the following principles:

a) Segregation of public and private areas;
b) Segregation of high and low security level areas;
c) Access control;
d) Surveillance;
e) Alarm generation;
f) Physical security;
g) Screening of personnel and vehicles;
h) Layered security through multiple tiers;
j) Crime prevention through environmental design (CPTED); and
k) Response to potential threats and incidents.

21.3.3.2 *Key security measures*

a) *Vehicle movement plan* — There will be several options available for movement of vehicles. The final plan should be based on smooth flow of traffic that will promote uninterrupted traffic for all types of vehicles. Ideally there should be separate entry and exit points. Security demands minimum entry and exit points to ensure proper screening and checking of vehicles.
b) *Pedestrian movement plan* — Movement of pedestrian should be restricted to one entry, if possible. There should be proper arrangement for screening of pedestrians including cabin for female pedestrians.
c) *Fire engine movement plan* — Arrangement shall be made for entry, exit and movement of fire engine. Adequate turning radius shall be provided within the entire complex. Ideally there should be separate entry and exit point to ensure regular flow of fire engines if necessary.

21.3.3.3 Security managers/security personnel's responsibilities shall include among other things the following:

a) Physical security of the organization's assets;
b) Development and enforcement of security policy and procedures;
c) Crisis management;
d) Business continuity planning;
e) Executive protection within building/facility;
f) Preliminary investigation of security incidents;
g) Employee security awareness;
h) Law enforcement and governmental liaison;
j) Workplace violence prevention;
k) Security systems management;
m) Assisting in preventing and fighting any fire incident;
n) Periodic threat assessment of the building;
p) On the job training of the security staff;
q) Regular conducting of evacuation drills;
r) Maintenance and upkeep of the security gadgets; and
s) Monitoring of security situation by electronic surveillance

Security manager can be direct employee or contractor to the organization. Security managers should be assisted by security supervisors and security guards whose duties should be detailed to cover all required aspects.

1) Supervisor should ensure that all the norms related to safety are followed by all.
2) He should be aware of emergency action plan of the premises and ensure that all guards and employees are also aware of it.
3) Security supervisor shall know the locations of fire points, hydrant points, emergency exits, fire alarm break glass switches and first aid junctions, etc within the premises. At the same time, he is to take initiatives to ensure that guards and all the employees also know about the above mentioned points.

4) Supervisor shall ensure that telephone numbers of all key personnel and emergency numbers are readily available at each post for the use during emergencies.

21.3.4 *Common Service Standards*

21.3.4.1 *Patrols*

Frequency of patrols shall be agreed and timetabled and records of all patrols shall be kept.

21.3.4.2 *Controlled access during out of hours*

a) During out-of-hours shifts only specified access and egress shall be used which the security staff should control.
b) At no time shall unauthorized individuals be allowed into the premises.
c) Any person not wearing an appropriate pass at any time, including recognized staff, shall be challenged to ensure that any and every person has a valid reason for being on the premises.
d) The scanning/vetting of any items received outside core service hours, other than pre-notified scheduled deliveries, shall be controlled by security staff.
e) All security personnel shall receive adequate training for this purpose.

21.3.4.3 *Vehicle access control*

Vehicles have been a major threat to security of any asset. These can be used for bringing armed intruders, smuggling of explosives, arms and other contraband items. Measures to secure premises/complex should include the following:

a) *Vehicle ramp schemes* — Vehicle barriers, as given below should be designed and installed at all vehicle entry/exit points.

    1) *Boom barriers* — Boom barriers perform the majority of access control functions for regulating vehicular traffic into and out of control areas. The boom barrier can be operated with radio frequency identification (RFID) to enable unobstructed entry to select clients. Tags for smooth flow during peak hours may also be considered.

    2) *Retractable bollards* — Retractable bollards are generally deployed to provide vehicle management for secure areas. Road blockers rise from road level, form a solid barrier and will not allow a vehicle to gain entry or pass by crashing through.

    3) *Sliding gates* — Sliding gates may be installed to reinforce vehicle entry points and delineate the property boundary during demonstrations. Sliding gates are quick to deploy and cannot be easily bypassed by pedestrians. These or any other combination of gates shall be installed for any unforeseen eventuality to prevent entry into the complex by vehicles or pedestrians.

b) *Vehicle screening* — Any method of vehicle inspection requires regular security officer training and diligence when performing his/her search. Adequate lighting should be provided to screen the vehicle during night. The following options for vehicle screening are available, which should be considered for taking appropriate decision for providing suitable measures:

1) *Undercarriage vehicle surveillance system (UVSS)* — The UVSS provide the operator, through video cameras, with a safe and effective means to search the underside of vehicles for explosives or firearms. The systems are available in fixed or portable units. A UVSS is recommended, however the comparison of vehicle images with a default image is dependent on capability of a security guard. The system can be upgraded to a composite system to include full vehicle search. UVSS with explosive detectors may also be used.
2) *Search mirrors* — This method of screening vehicles for an improvised explosive device (IED) is common throughout the country and may be used where the UVSS is not available/feasible.
3) *Vapour and particle detectors* — Vapour detectors and particle detectors, generally known as sniffers; identify explosives by their particulate or gaseous elements. When used correctly, sniffers can assist in the detection of a range of explosive compositions. The device collects vapour samples through a vacuum as it is run over a package, then analyses them for vapours generated by certain explosives, however, vapour detectors may miss explosives with a low vapour pressure.
4) *Explosive detection trained (sniffer) dogs* — Explosive detection trained dogs (known as sniffer dogs) used in conjunction with search mirrors is another option for screening vehicles.
5) CCTV surveillance to cover the activities of the vehicle entry point is a very important requirement and should be catered in all cases.
6) Suitable means for automatic number plate reading/recording of the vehicle and for capturing image of the driver can also be provided.
7) Speed breakers can include dynamic speed bumps, rumble strips and speed humps to facilitate vehicle screening.

c) *Car parking* — A car park can be one of buildings busiest and most vulnerable areas. Parking facilities can offer criminals the opportunities to commit personal and property crime without detection. Enhanced security operations in parking areas are supported by intercom systems, emergency phones at strategic locations, duress alarms, CCTV, scream alert detectors and motion detectors in stairwells.

1) *Duress/panic alarm stations* — Duress or panic alarms can be placed at strategic locations to enhance public/tenant safety. When the emergency button is activated, the alarm will alert the operator in the control room and emit an audible alarm and/or strobe light.
2) *CCTV* — The placement of cameras shall be done to provide optimum surveillance in all directions including all entry/exit points and cover all dark corners.

3) *Security patrols* — The guard force shall conduct regular patrols of the all car-parking areas. Installing a guard tour system can enhance patrol coverage and effectiveness.
4) *Roller shutters* — Roller shutters can be installed at all vehicle entry points to secure the area when the circumstances dictate.

d) *Loading bays* — The screening of goods vehicles is difficult and can take time to complete, the size of this development, number of loading bays and expected vehicle traffic in any one day further exasperates the situation. Loading bay has limited space for turning and checking of vehicles. Surveillance measures in form of CCTV cameras should be considered to control and monitor the following:
   1) Vehicles;
   2) Personnel;
   3) Goods loading and unloading; and
   4) General area.

e) *Car lift/waiting area in basement* — Basements are vulnerable to vehicle borne explosive devices, theft of vehicles or vehicle parts, theft from vehicles parked in basement, vandalism or damage to vehicle, unauthorised access to basement, damage to car lifts/systems, placement of explosives in lift lobbies or misconduct in lift lobbies. Since the vehicular parking areas may be less populated with limited 'eyes' available, these are also prone to common crimes especially gender based, social, economic and those against persons and properties.

f) *Managing of parking bays* — Outside working hours all parking bays should be closed with roller shutters or sliding shutters secured on the inside. During working hours, the bays should be under the control of a custodian or, where the threat is high, closed with electronically operated shutters which are only opened when the incoming vehicle has been identified and, where necessary, searched.

21.3.4.4 *CCTV monitoring*

21.3.4.4.1 Security personnel shall:

a) Be fully trained and conversant in the use of the CCTV equipment on the premises.
b) All staff responsible for monitoring the CCTV shall be rotated at regular intervals to maintain alertness as defined in recognized industry guidelines.
c) Any staff overseeing CCTV monitors shall have immediate recourse to other security staff, including emergency/incident control personnel, at all times, to ensure the safe and secure functioning of the premises and their inhabitants and to facilitate the instigation of action as appropriate.
d) Guidelines for the use and storage of all CCTV footage shall be available to all staff.
e) Any recording material shall be kept in a fire-proof secure facility to allow immediate access to their contents.

f) The maintenance of all CCTV recording material shall be kept in good order to enable ready access on an as-needs basis.
g) All CCTV recording material shall be kept available for review for four weeks.
h) Log books shall be kept of any incidents requiring investigation/intervention by security staff, and shall be available at all times.

21.3.4.4.2 *CCTV control and monitoring*

a) All access areas, such as doorways, lifts and staircases (*see* **2.1**) should be covered by CCTV surveillance for both day and night monitoring in large group housing, commercial complexes, hospitals/hotels, airports and railway stations.
b) The CCTV installation shall be interfaced to the Security Management System (SMS) to provide the operator with the facility to capture and display any camera picture.
c) Where necessary, cameras shall be provided with pan and tilt control and be fitted with a motorised lens capable of a zoom range (Pan/Tilt/Zoom or PTZ cameras) appropriate to the designated task. Pre-set capability can be provided for all fully functional camera heads to allow automatic response to adjacent alarms.

All CCTV images shall be recorded. This will provide full flexibility for remote viewing of live and recorded images. The operational requirement of each camera can be stated in terms of monitor and control, detection, recognition or identification

21.3.4.5 *Screening of personnel entering facility*

Screening personnel and their belongings at entry points can help reduce the likelihood of explosive devices, weapons and other hazardous or prohibited items or materials being brought into buildings or onto sites. Similarly, searching personnel as they exit can help reduce the risk of unauthorized removal of items and information and acts as deterrent. Appropriate screening and detection equipment can offer real benefits where used in support of robust procedures and well trained and motivated staff.

21.3.4.5.1 *Standard operating procedures (SOP)*

In order to provide an excellent security service following security procedures should be adhered to across all buildings and SOPs as per the organization's requirement should be formulated to standardize the processes:

a) Access control;
b) Identification badge;
c) Administration of locks and keys;
d) Sites' opening and closing procedures;
e) Security risk, threat and violation;
f) Card access system;
g) Search procedures;
h) Managing the security control room;
j) Incident management and investigation;
k) Reporting of security incidents and losses;

m) Asset removal;
n) Transportation security; and
p) Site emergency procedures.

21.3.4.5.2 Perimeter and landscaping

Perimeter forms an important part of security environment of any complex or asset. Landscaping shall lend itself to strengthen the security instead of creating a hurdle in securing the area. Some of the measures recommended are as under:

a) Perimeter protection through a wall/fence and barriers with adequate height to deter intrusion.
b) Physical and electronic measures to cordon the complex, when desired.
c) Surveillance of perimeter including intruder detection system and quick response from security.
d) Regular patrolling by security.
e) Provision of armed guards for limited defending capability against armed intruders.
f) All plants and trees to be kept trimmed to minimise the opportunity of concealment and/or assistance for intruders to unlawfully enter facility.
g) Allocate public space to provide natural barriers to prevent easy targeting for bag snatchers.
h) All plants and trees to be kept trimmed to minimise the opportunity of concealment of improvized explosive device (IED).
j) Provision of good perimeter lighting.
k) Adequate CCTV coverage that will deter, detect and record incidents of concern to the client.

For further details on the general design of these areas are available in **30** of Part 3 'Development Control Rules and General Building Requirements' of this Code.

Perimeter landscaping including plants, trees, shrubs, ditches and berms (low earth walls used to provide blast protection) should be constructed, located and maintained to stop, deter and/or delay an intruder. Landscaping shall not provide cover for surprise attacks on persons, and shall not permit entry or a climbing aid. Landscaping shall not obstruct lines of sight, lighting, and CCTV or intrusion detection systems.

Fountains, pools, pieces of sculpture, sizeable boulders, stairs reinforced and anchored benches, concrete planters and bollards strategically placed near a building can be used to deny vehicle access to vulnerable areas and maintain a spatial separation of vehicles from a buildings structure.

21.3.4.5.3 *Service entry/exit*

These areas are vulnerable to unauthorized entry/exit, loitering in premises/landscaped area by anti-social elements and also forced entry by unauthorized vehicle. Some of the measures for securing these should be as below:

a) Install sliding gates at the service entrance.
b) Use the gates at night to restrict access.

c) Create the impression of a ‘Harden the target’.
d) Adequate lighting of building perimeter.

21.3.4.5.4 *Pedestrian entrance/exit*

Entry of pedestrians is another major threat to the asset. Strict security measures shall be implemented to secure the asset from entry of persons into the complex. Pedestrian entry points can be used for unauthorized access of anti-national or anti-social personnel, smuggling of arms, ammunition, explosives and contraband, placement of IEDs or other fire arms /explosives within premises, removal or theft of items/articles of value, commit criminal activity, unauthorised reconnaissance or surveillance of premises. Mitigation measures recommended:

a) Mandatory display of ID cards by employees.
b) All non-employees guided to pedestrian lane.
    1) All visitors to be asked to report to the reception desk.
    2) Personnel security screening checkpoint
    3) Visitor registration and issue of photo ID badge.
    4) Screening of only visitors through Hand Held Metal Detector (HHMD) and Door Frame Metal Detector (DFMD).
    5) Checking of visitor’s baggage by X-ray scanners.
    6) Random checking of employee bags.
    7) All employees to pass through flap barrier/ turnstiles placed at lift lobby and escalator base landing by using their access cards.
    8) Separate turnstile lane needed for visitors and handicapped persons.
    9) Stairwells should provide egress only from a floor; all ground level doors should be fitted with panic bars and monitored by security/installation of electronic access control lock.

21.3.4.5.5 *Mail and courier handling*

Mails can be a source for sending letter bombs. Letter can also be used for delivery of biological/chemical contaminants. Mitigation measures recommended for prevention of threats from letter bombs can be:

a) Isolation of mail delivery area, that is, mail room;
b) Screening of mail by x-ray scanner, explosive detector (*see* Note);
c) Access control and intruder detection for critical plant rooms, like, BMS, DG room, UPS room, LT Panel, water treatment plant (WTP), AHU, etc.

NOTE — Mail detection devices represent one layer of defence and will not detect every type of explosive material. Detection technologies employed should meet very specific needs. Blast containers should be provided to hold suspect mail, which can be identified and dealt with by the Bomb Detection and Disposal Squad (BDDS) of the police.

21.3.4.5.7 *Door sets*

a) Door sets should be securely fixed into a structural opening of wall construction that shall at least be equivalent strength to the door.

b) *External secure area doors* — External door sets should be sufficiently strong to resist manual attack from assailants with tools, and the locking system should be multi-point bolting with hinges protected by hinge bolts and resistance against levering. External emergency escape doors: Emergency escape doors should be sufficiently strong to resist manual attack from assailants and the locking system should be resistant against levering.

21.3.4.5.8 *Security lighting*

The following areas should be illuminated to provide enhanced security:

a) Perimeter roads;
b) Public spaces;
c) Areas immediately surrounding buildings;
d) Pedestrian walkways/routes;
e) Car parks; and
f) Utility and service support areas

21.3.4.5.9 *Blast resistant trash bins*

Blast mitigation trash receptacles enhance public safety from terrorist bombs planted inside public trash receptacles. These blast mitigation bomb receptacles are typically used at airports, train stations, sports stadiums, and malls.

21.3.4.5.10 *Baggage inspection*

X-Ray scanners have either a fan shaped or scanning x-ray beam that is transmitted through the object to be viewed. Simple X-ray machines rely on humans to serve as pattern recognition devices; in the absence of computer pattern recognition techniques they are very dependent on human factors such as training and competency of the screener.

21.3.4.5.12 *Electronic security systems*

Electronic security systems provide a control, monitoring, and detection and surveillance capability. Electronic systems are interfaced with physical barriers such as doors, gates and turnstiles. Electronic systems need to be integrated in to a security management system (SMS). The SMS will provide the necessary capabilities to monitor control and manage the security systems.

21.3.4.5.13 *Fire detection and alarm system interface*

The SMS can interface with the fire detection and alarm system. The interface will operate such that, upon the activation of the fire alarm system, the access control system (ACS) controlled door locks, which are designated to operate in a fail-safe mode and release open, shall be de-energized. ACS controlled doors to high security areas, such as computer rooms, will be designated to fail-secure in a fire alarm condition.

21.3.4.5.14 *Access control system* (*ACS*)

A fundamental element in the security strategy is to prevent unauthorised access to restricted areas and, subsequently, to control and monitor the movement of authorized persons within the buildings. This shall be implemented in a manner, which does not inhibit operations.

The system should operate as an integral sub-system of the SMS. The proposed system should utilize the latest developments in access control technology and should be based on proximity card reading technology. The system should limit the ability of individuals without authorization to pass through 'locked' doors based on the time of the day, day of the week, week of the year and the authorization levels allocated to the individual.

Proximity technology which is extremely 'user friendly' may be used with advantage. The card is not subjected to any form of mechanical wear and the life expectancy of the card is considerable.

All high security areas within the building shall be provided with an appropriate level of access control technology. Personnel traffic shall be monitored and access to individual floors and specific areas within each floor shall be strictly controlled, as appropriate, by use of the ACS.

21.3.4.5.15 *Guard room*

A guard room serves administrative purpose which cannot be carried out from the security control room (SCR), namely:

a) Security management and shift supervision;
b) Radio communications and charging; and
c) Provide a centralized point for security issues and tenant concerns.

For further details on this refer **30** of Part 3 'Development Control Rules and General Building Requirements' of this Code.

21.3.4.5.16 *Guard tour system*

The safety and operational efficiency of the security guard force is critical to the overall security strategy as is the correct and proper patrolling of all external and internal areas. The proposed system will be wireless and operate as an integral sub-system of the access control installation and all patrols details will be displayed on the SMS graphics floor plan. Guard tour radio frequency identification (RFID) tokens presented at designated readers shall be logged and time stamped such that printouts and reviews can be attained of individual guard tour route.

21.3.4.6 *Miscellaneous systems*

21.3.4.6.1 *Truck screening*

Fixed screening devices allows the user to inspect the contents of cargo containers and vehicles quickly and easily, validate manifests in minutes, and pinpoint weapons,

explosives, drugs and other security threats. While vehicles and containers remain stationary, the gantry-mounted X-ray and detectors pass over the object being inspected. A dedicated truck screening system is not recommended.

21.3.4.6.2 *Keys*

To maintain the security of the buildings and areas, the keys and cylinders to the entrance points should be obtained under a key registration system where the keys and cylinders can only be obtained from a nominated manufacturer when the order is approved by an authorised person – usually the department/security manager. Keys should be kept in secure key cabinets where authorised persons only draw them. The key cabinet and key allocation should be controlled using a key management system. The loss or suspected compromise of a security key shall be reported immediately to the Security Manager.

21.3.4.6.3 Radio communications

It is recommended that an efficient and well organised communication network should be created to pass information as and when necessary.

21.3.4.7 *Methodology*

Like other services security services can also be carried out by deploying guards by having them on regular rolls of owner/occupant or can be out sourced to specialised agencies. Detailed guidelines on roles/responsibility/qualification of personnel deployed on security details have been prescribed by Law. For all major complexes and sensitive buildings compliance to *The Private Security Agencies (Regulation) Act,* 2005 shall be ensured as per the directions of the Authority.

22 SOLID WASTE MANAGEMENT

The requirements for waste management in buildings applicable to all large/small facilities that generate, store, or handle any type/quantity of waste are covered in **22.1** to **22.4**. Waste management of townships, etc, are not covered.

22.1 Principles

Following should be the guiding principle for solid waste management:

a) Minimize waste generation;
b) Reuse and recycling of waste;
c) Waste segregation; and
d) Waste disposal.

22.2 Solid Waste Management Planning

Facilities that generate waste should categorize their waste according to composition, source, types of wastes produced, generation rates, or according to local regulatory requirements. Effective planning and implementation of waste management strategies should include,

a) Review of new waste sources during planning, siting, and design activities, including during equipment modifications and process alterations, to identify expected waste generation, pollution prevention opportunities, and necessary treatment, storage, and disposal infrastructure.
b) Collection of data and information about the process and waste streams in existing facilities, including characterization of waste streams by type, quantities, and potential use/disposition.
c) Establishment of priorities based on a risk analysis that takes into account the potential environmental, health and safety (ehs) risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally sound manner.
d) Identify opportunities for at source reduction, as well as reuse and recycling
e) Detail procedures and operational controls for onsite storage.
f) Definition of options/procedures/operational controls for treatment and final disposal.

22.2.1 *Waste Prevention Strategy*

Processes should be designed and operated to prevent, or minimize, the quantities of wastes generated and hazards associated with the wastes generated in accordance with the following strategy:

a) Substituting raw materials or inputs with less hazardous or toxic materials, or with those where processing generates lower waste volumes.
b) Applying manufacturing process that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls.
c) Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off specification, contaminated, damaged, or excess to building/equipment/plant needs.
d) Instituting procurement measures that recognize opportunities to return usable materials such as containers and which prevents the over ordering of materials.
e) Minimizing hazardous waste generation by implementing stringent waste segregation to prevent the commingling of non-hazardous and hazardous waste to be managed

22.2.2 *Recycling and Reuse*

In addition to the implementation of waste prevention strategies, the total amount of waste may be significantly reduced through the implementation of recycling plans, which should consider the following elements:

a) Evaluation of waste production processes and identification of potentially recyclable materials.
b) Identification and recycling of products that can be reintroduced into the manufacturing process or industrial activity at the site.

c) Investigation of external markets for recycling by other industrial processing operations located in the neighbourhood or region of the facility (for example waste exchange).
d) Establishing recycling objectives and formal tracking of waste generation and recycling rates.
e) Providing training and incentives to employees in order to meet above objectives.

22.2.3 *Treatment and Disposal*

If waste materials are still generated after the implementation of feasible waste prevention, reduction, reuse, recovery and recycling measures, waste materials should be treated and disposed of and all measures should be taken to avoid potential impacts to human health and the environment. Selected management approaches should be consistent with the characteristics of the waste and local regulations, and may include one or more of the following:

a) On-site or off-site biological, chemical, or physical treatment of the waste material to render it non-hazardous prior to final disposal.
b) Treatment or disposal at permitted facilities specially designed to receive the waste. Examples include: composting operations for organic non-hazardous wastes; properly designed, permitted and operated landfills or incinerators designed for the respective type of waste; or other methods known to be effective in the safe, final disposal of waste materials such as bioremediation.

22.2.4 Every solid waste generated [except industrial waste, hazardous waste, hazardous chemicals, bio medical wastes, e-waste, lead acid batteries and radio-active waste, that are covered under separate rules framed under the *Environment (Protection) Act*, 1986] shall be managed in accordance with the *Solid Waste Management Rules,* 2016.

22.3 Construction and Demolition Waste Management

Every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organization shall be managed in accordance with the *Construction and Demolition Waste Management Rules*, 2016.

22.4 Hazardous Waste Management

Hazardous wastes should always be segregated from non-hazardous wastes. If generation of hazardous waste cannot be prevented through the implementation of the general waste management practices (*see* **22.2**), its management should focus on the prevention of harm to health, safety, and the environment, according to the following additional principles:

a) Understanding potential impacts and risks associated with the management of any generated hazardous waste during its complete life cycle.
b) Ensuring that contractors handling, treating, and disposing of hazardous waste are competent enterprises, and following good industry practice for the waste being handled.

The management of hazardous and other wastes as specified in the schedules to *Hazardous and Other Wastes (Management and Transboundary Movement) Rules*, 2016 shall be done in accordance with the said rules.

22.5 Plastic Waste Management

The plastic waste generated in the premises shall be managed in accordance with the *Plastic Waste Management Rules*, 2016.

22.6 Bio-medical Waste and E-waste Management

22.6.1 All bio-medical wastes generated in the premises shall be disposed strictly in accordance with the *Bio-Medical Waste Management Rules*, 2016 as may be applicable. Utmost care should be taken to ensure that this does not get mixed with other types of waste. Disposal should be segregated and stored in closed bins, carrying appropriate markings, which should be colour coded as prescribed in the statuary rules only in designated and suitably designed and protected areas till they are removed through and to authorised waste treatment facilities

22.6.2 E-waste generated shall also be disposed of as per *E-Waste (Management) Rules*, 2016 and to authorized e-waste recycling and disposing facilities.

22.6.3 Proper documentation shall be maintained in all such cases in formats as may be prescribed by the concerned authorities.

23 BUILDING MANAGEMENT SYSTEMS (BMS)

23.1 Overview

All buildings have some form of mechanical and electrical services in order to provide the facilities necessary for maintaining a comfortable working environment. These services have to be controlled by some means to ensure, availability of facilities as designed and comfort conditions irrespective of the number of occupants or individual preferences. Basic controls take the form of manual switching, time clocks or temperature switches that provide the on and off signals for enabling pumps, fans or valves, etc. The purpose of a building management system (BMS) is to automate and take control of these operations in the most efficient way possible for the occupiers/business, within the constraints of the installed plants/installations.

The BMS is a ‘stand alone’ computer system that can calculate the pre-set requirements of the building and control the connected plant to meet those needs. Its inputs, such as temperature sensors and outputs, such as on/off signals are connected into outstations around the building. Programmes within these outstations use this information to decide the necessary level of applied control. The outstations are linked together and information can be passed from one to another. In addition a modem can also be connected to the system to allow remote access. The level of control *via* the BMS is dependent upon the information received from its sensors and the way in which its programmes tell it to respond to that information. In addition to offering a precise degree of control to its environment, it can also be made to raise alarm on

conditions that can't meet specification or warn of individual items of plant failure. Building automation is referenced as Building automation and control system (BACS) and are often referenced interchangeably as Building management system (BMS)/Building automation system (BAS) also. Frankly speaking it is very difficult to distinguish the terms BACS/BAS/BMS as they are synonymous one with other. BACS basically means monitoring and controlling facilities/utilities and associated issues related to building such as mechanical including Heating, ventilation, and air conditioning (HVAC), security, fire and other safety, lighting and communication systems so that building environment/climate is kept within range. Applied control (namely PLC) and automation would monitor system performance, and as necessary take required action to assure desired condition. A building with a BACS has lower energy and maintenance costs through energy management. Building automation monitors and controls facilities in a seamless fashion through intelligent network systems. Smart buildings use advanced and integrated building technology systems, namely building automation, life safety, telecommunications, user systems, and facility management systems. Smart building makes use of the technological advancements in building systems to achieve additional functionality that integrated systems and provides actionable information about the space within a building to allow the managing the building space in the most cost-effective manner.

Occupancy times for different areas are programmed into the BMS such that the facilities are brought on and off to meet the occupier requirements. BMS determines the plant start time based on the outside air temperature, the space temperature and the building structure.

BMS can control the following key operations:

a) HVAC systems, which include air handling units, fan coil units, chillers, pumps and boilers;
b) Lifts (it is normally used to gather information about location/movement of lifts rather than actually controlling their operation);
c) All equipment having variable frequency drives (VFD);
d) Lighting systems;
e) Water supply systems including boilers, water treatment plants, water supply pumps, etc;
f) Sewage treatment plant (STP), effluent treatment plants (ETP);
g) Medical and other gas supply system; and
h) Access control system;
j) Ventilation system;
k) Fire alarm and suppression, fire fighting systems (Sprinklers, hydrants); and
m) CCTV cameras connected to digital video recorders (DVR) or network video recorders (NVR).

Where a BMS or equivalent arrangement exists for monitoring and controlling mechanical, electrical or other engineering installations, an organization should ensure that the requirements for the maintenance of the BMS are fully incorporated into maintenance programmes. In the event of actuator failures or other faults, corrective actions should be initiated with minimal delay.

23.2 Key Components of BMS

BMS is an intelligent mix of hardware devices which works as data collecting/ warning agents and software which collates data and graphically presents same for better and simple understanding. The following are the key components of BMS:

a) *Sensors* – In BAS smart sensors are deployed to measure various parameters like temperature, humidity, CO2 level, fire sensing etc.
b) *Controllers and Control System* – There could be standalone controller or controller systems like DCS/PLC (mostly). Based on sensor data, set point and program control systems responds to produce necessary output for actuator to bring the system to the desired point as well as to optimize the system in terms of performance and energy.
c) *Actuator Devices* – Actuators carry out the commands from the control system. These could be from simple relay to complicated drive systems.
d) *Human Machine Interface (HMI) and Dashboard Interface* – These are mainly responsible for presenting data to the operating personnel to interact/interface the system. These would include engineering stations, printer, panels/dash boards.
e) *Network and Protocol* – Various facilities may be connected to form network and these could be web-based network through internet. For remote operation, big analytics, IoT and cloud computing such networking wired/wireless are necessary.
f) *Storage and Analytics* –For big systems especially when BMS is used there would be huge data generation and would be used for data analysis in arriving at optimum decision. For these, there shall be suitable storage and computing units or it shall be done through cloud computing as well.

23.3 Responsibilities Relating to BMS

23.3.1 *Responsibility of Facility Manager*

a) To operate and manage BMS systems, identify faults, and provide the required reports for the tenant, building owner and building maintenance team.
b) Adequate monitoring, zoning, scheduling so as to enable the building to operate at maximum possible energy efficiency consistent with tenant lease provisions.

23.3.2 *Occupants Responsibility*

a) Providing accurate and detailed information on equipment loads.
b) Providing a detailed schedule on occupation and equipment loads of tenanted areas.
c) Early advice on changes to usage of tenanted areas.
d) Vetting staff requests for system adjustments to ensure energy impacts are considered.

23.3.3 *Maintenance Team Responsibility*

a) Daily monitoring of the BMS for faults and exceptions relating plant and equipment.

b) Maintenance of the BMS.
c) Management of temporary or permanent adjustments to control parameters in accord with lease provisions.
d) Ensure timely BMS software and hardware upgrades.
e) Manage upgrading of BMS as required by owner and tenants to support changes in space utilization, equipment upgrades, or energy intensity improvement projects.
f) Providing timely and accurate advice and reports.

23.4 Good Practices

23.4.1 *Mechanical Services*

The software should preferably be optimized for start and stop schedules. Rather than starting to pre-condition a building at a set time, each zone may start just in time to reach minimum set condition as occupants start to arrive. For example, a hot summer's night may need an extra hour of air flow compared to a milder night. This typically means that energy requirements for heating and cooling greater will be extended, on average, by several hours per day. For example, many buildings provide full heating and cooling up to 5:30 or 6:00 pm. In well-built and insulated buildings, chillers and boilers can turn off at 4:00 pm or earlier, and still ambient conditions can remain within agreed temperature parameters for 2 h or more utilizing the heating or cooling energy within the water loops.

BMS should have the following:

a) Provision for automated seasonal temperature adjustment enabling lowering set point temperature at low temperatures and gradually raising through the seasons, giving savings.
b) Remote alarming system.
c) Secure remote access as agreed for fault response, diagnosis, and tenant emergency need.
d) Scheduling calendar so as to be able to check and adjust for daylight saving including for requirements specific to various events, which can be adjusted without programming skills. For example, shutting down unoccupied zones or temporarily varying working hours.
e) Many areas have minimal occupancy at any time or highly variable loads such as conference rooms. In such cases, it may be appropriate to provide minimal conditioned air during normal hours, and ramp up only when space is fully occupied (Ramp up can sometimes be most effectively provided by standalone units to avoid over sizing the central plant to respond to low frequency situation.).

Following safeguards should be followed:

1) Ensure sensors are correctly located. Sensors should be at the correct height, not above heat generating equipment, or hidden behind office fit-out, within supply air flow, or where external events can affect. For example, a thermostat mounted on an external wall shall be insulated from the wall cavity, or it will read cold in winter, and hot in summer. A thermostat used as a coat rack will have a delay in registering actual room temperature. A thermostat above a photo copier

may consistently read four degrees higher than actual temperature when copier is at full power to correct temperature when it is in sleep mode.

2) Frequent calibration of sensors may be required. While many modern sensors do not suffer accuracy drift over time, a base line error of up to 1° can occur. Calibration will ensure that BMS utilize a true reading at all times.

23.4.2 *Electrical Services*

Software may be programmed to ensure sensors are activated to provide required illumination controls in following ways to effect efficiency and economy:

a) Lighting is controlled in zones generally of 100 m^2 area (unless special circumstances exist) by occupancy sensors. Fire exit stairs on occupancy sensors with automatic override to full lighting during fire alarm events.
b) Car park daylight adaptation lighting to be dual dimmer controlled by photoelectric (PE) cell and occupancy sensors.
c) Car park lighting to have two stage occupancy sensor control covering normal and out of hours lighting levels.
d) Perimeter office zones to have PE cells operating dimmer controls in addition to occupancy sensors.
e) Entry lobbies to revert to occupancy sensor control outside of operating hours.
f) General security lighting to minimum level required by security cameras. With modern cameras this is very low and less than what human eye requires.
g) Responsive security lighting to be event activated with time controlled manual over ride for emergency situations.
h) Metering of equipment and zones to be integrated through BMS to required reports.
j) Lift operation to be optimized *via* intelligent lift controllers, with activity and consumption reports to BMS.

23.4.3 *Hydraulics*

a) Meters to report to BMS (number shall enable excess consumption to system or zone).
b) Temperature optimization control of boilers, by control strategy.
c) Flow meters to alarm on abnormal consumption.
d) Boiler temperature reset optimization, to match actual and predicted loads.
e) Automated shut down valves in critical areas to avoid waste and damage from major failure, with BMS over ride function.

23.4.4 *BMS Configuration Active Point Control*

a) Shall default to safe condition on failure and trigger alarm.
b) Points to be actively interrogated on status to ensure they are operating and reporting.
c) Point trending and graphing to be flexible and comprehensive.
d) Demand limiting algorithm in place and load shedding if indicated.
e) Alarms have priorities set to at least three levels, are placed in permanent file, with name of operator who responded to alarm. Archive of this information

should be permitted only to a person with highest authority level, and only when record is over one year old.

23.4.5 *Graphics and User Interface*

a) To clearly present data required to check status of system or sub-system without clutter and in logical visual presentation.
b) Navigation from a graphic page either up to a system overview or down to sub-unit or point history to be intuitive, point and click.
c) Graphics available of all systems and sub-systems.
d) Temporary trend graphics able to be set up by all users, and not require high level skills or access.
e) A full set of reports is configured to enable effective management of system and building.
f) Four level or equivalent user authorization level control: programmer, system controller, maintenance staff, tenants.
g) Simple click and point to data, graphics, and agreed control functions of each user.

23.5 Documents Required

Most of the data and reports are stored hence no documents are required except for the works which requires manual interface, for example, maintaining contacts with appropriate maintenance personnel, logs of maintenance, roaster log, etc.

24 INFORMATION MANAGEMENT

24.1 General

Records and documents relating to the maintenance of the facility should be organized, kept up-to-date and stored in a secure environment.

The following general information should be recorded:

a) *Classification* — The facility and its sub-divisions (that is, rooms and other spaces) should be assigned codes according to type or use to support the management of information and data;
b) Obligations under conditions of lease or occupancy (for example, frequency of repainting);
c) Statutory and insurance inspections;
d) Estate terrier (records of property holdings with legal status);
e) Ownership of and/or maintenance obligations of parties, separating and boundary walls;
f) Rights of way, easements and way-leaves (particularly with respect to buried utilities); and
g) Requirements and restrictions laid down by planning, building regulation control and fire authorities including, in the case of the latter, fire risk assessments.

Elements/sub-elements of the facility should be labelled or marked, as far as is practicable, so that the materials, components, systems, plant, equipment and parts

can be easily identified. Where information is limited or lacking, records should be compiled during maintenance. Alternative (or additional) surveys or investigations should be initiated to accelerate the gathering of information for record purposes; photographic records can be of assistance in this respect.

All personnel involved in the maintenance of the asset/facility should be made aware of the existence of records containing information about it. Hazardous areas should be explicitly marked on the records as well as marked in their physical location/site and should be made known to personnel, together with any system of work adopted for use in these areas.

24.2 Documentation

Good records can save owners and users/occupiers from much unnecessary expense and reduce potential hazards in exploration work, when faults arise. Records are of value only if they are kept up to date and arrangements for this should be included in any provision that may be made for records.

Records may be broadly classified as following:

a) 'As built' information, which should have been prepared before the handover of the facility, such as construction details, floor plans, perspectives and as-built drawings showing the location of engineering installations and structural details; and
b) 'As subsequently altered', which need to be kept during the operational life of the facility, such as details of defects, maintenance, alterations and redecoration work.

A record should be kept of all reported defects and the measures taken to rectify them. Details of maintenance should also be recorded and cross-referenced to the reported defect.

Periodic reviews of records should be made and where there are recurrences of the same defect, the causes should be investigated.

24.2.1 *Facility Handbook*

A facility handbook should be prepared as a compilation of records of the asset /facility, which can be stored and retrieved electronically, as well as being reproduced on paper wherever necessary. The form of the handbook should be such that content can be easily updated and future versions of it to be controlled. The handbook should include the records relating to the maintenance of the facility and the documents to support the wider needs of the organization in regard to its facilities management.

Following should be typical contents of the facility handbook:

a) A brief history of property, names and addresses of consultants and contractors.
b) Short specifications, constructional processes, components, material finishes, hidden features, special features, etc.

c) 'As built' plans and as subsequently altered with sections, elevations and other detailed drawings.
d) Foundation and structural plans/sections such as concrete reinforcement drawings.
e) Detail specification of all materials incorporated, for example, concrete mix, species and grades of timber, etc. Potentially hazardous materials and types or methods of construction that under some circumstances may become hazardous may be identified.
f) Information on house keeping and routine maintenance with details of internal and external surfaces and decorations, schedule of cleaning, inspection and maintenance.
g) Information on accessibility features of the building that makes it friendly to users with disabilities and elders.
h) Means of operating mechanical, electrical and plumbing installations.
j) Description of renovations, extensions, adaptations and repair to each elements.
k) All plant, machinery and propriety articles including manufacturers trade literature and instructions for installation, use and maintenance.
m) Methods of work used in construction such as assembly of prefabricated units.
n) All information related to fire such as,
    1) location and service arrangements of all fire alarm and call points;
    2) location and service arrangements of all extinguishers, hose reels and other fire fighting installations;
    3) location of all fire compartment walls, doors, floors and screens;
    4) location of all areas of exceptional fire hazard;
    5) fire escape routes;
    6) details of application of any fire protection treatment; and
    7) location details and description of any installation for smoke control or protection of escape routes.
p) There should be a wall chart showing at a glance the various operations which have to be undertaken. Line drawings of buildings are always useful.
q) Records of security measures should be known to authorized personnel only.
r) Where no records exist, information should be slowly built up as it becomes available during the course of maintenance work.
s) Use of computers for storing information may be preferred.

24.2.1.1 *Drawings*

The records of the facility should include as-built and as subsequently altered drawings [*see* **24.2.1** (c)] and contain, as a minimum, the following:

a) A neighborhood plan, showing the position of the facility and the site upon which it is located in relation to its surroundings;
b) The site plan, showing the facility and other structures forming the facility and external engineering installations, for example drainage runs and incoming public utilities;
c) General arrangement plans of each floor and the roof to a scale not normally greater than 1:50;
d) Elevations and sections;

e) Foundation plans and details, together with available soil investigation reports;
f) Structural plans and sections, including information relating to design parameters, such as permissible superimposed loadings on floors;
g) Structural details, such as structural steel connections and concrete reinforcement drawings and bending schedules; these are particularly important when prestressed or post-stressed forms of structure have been used;
h) Details of the construction of external wall elements and roofs, including insulation materials and vapour barriers;
j) Materials that may be injurious to health and safety;
k) Location of public health (that is, waste) systems;
m) Location of essential intake and shut-off of public utilities (water, electricity, gas and telecommunications).
n) All drawings, including those used in design and construction, should be verified against the as-built facility. Where a discrepancy is found, full details should be recorded and, wherever practicable, the affected drawing(s) should be labelled as subsequently altered.

24.2.1.2 *Specifications and schedules*

The records of the facility should include detailed specifications of,

a) All materials incorporated, for example name of facing brick, mix of concrete, species and grade of timber;
b) Materials with properties that can prove injurious to health and safety;
c) All plant and machinery, including manufacturers' trade literature, manuals and instructions for installation, operation and maintenance; and
d) Methods of work used during construction, which are unusual or a typical, such as assembly of purpose-made manufactured units.

All specifications and schedules, including those used during construction work, should be verified against the as-built facility. Where a discrepancy is found, full details should be recorded and, wherever practicable, the affected specification(s) and/or schedule(s) should be labelled as subsequently altered.

24.2.2 *Asset Register*

Asset register is an important document and shall be maintained for each asset and kept updated. Many organizations maintain this as building register for keeping records of their assets and any modifications/alterations done during life time of the asset/facility. An organization should include other information and data as may be necessary in the form of a register of its assets/facility, for example:

1) Identification number or unique reference for the asset;
2) Location of asset;
3) Initial cost;
4) Completion cost (component /unit wise if so required);
5) Make and/or model;
6) Manufacturer for machineries and equipments;

7) Vendor, if different to manufacturer;
8) Date of manufacture or year of construction for buildings;
10) Date of acquisition, installation or completion of construction;
11) Details of asset such as area statements, type of structure;
13) Whether or not the asset is subject to a permit-to-work requirement;
14) Predicted lifetime;
16) Specifications;
17) Replacement cycle;
18) Cost breakdown;
19) Servicing requirements, including type and frequency of service;
20) Other maintenance required;
21) Maintenance costs;
22) Accumulated depreciation;
23) Written-down value;
25) Source of components and spare parts, where applicable;
26) Energy consumption and, where applicable, energy efficiency rating; and
27) Identification of hazardous or other risks to people or property.

24.2.2.1 *Engineering installations*

Information describing the facility's engineering installations should be recorded. Details should include points of entry, or termination, of public utilities.

An organization should stipulate the maintenance requirements for its mechanical and electrical installations and fire protection systems; the tasks to be carried out and their frequency should be included. The following attributes of major components should be taken into account:

a) Current condition;
b) Current utilization or output;
c) Maintenance tasks to be performed;
d) Frequency of maintenance; and
e) Estimated cost of maintenance.

24.2.2.1.1 *Warranties, repairs and spare parts*

Details of warranties relating to plant, equipment, components and systems should be recorded and cross-referenced to those operational and maintenance requirements that affect them. Details of repairs should be recorded against the respective item. A list of spare parts should be kept up-to-date. Details should include the following as a minimum:

a) Description of part;
b) Identification number or unique reference for the part;
c) Original manufacturer of part;
d) Contact details of current manufacturer and/or distributor;
e) Predicted lifetime of part;
f) Operational parameters affecting lifetime of part;
g) Minimum number of parts to be held in stock (within or near to the facility);
h) Where permissible, details of any alternative part and its source;

j) Availability and minimum delivery period;
k) Warranty period;
m) Estimated cost of part;
n) Transportation and logistical considerations;
p) Details of other parts potentially affected by failure and/or replacement;
q) Specialist equipment or tools required;
r) Specific competence required; and
s) Details of special conditions or arrangements when installing.

The details given in (a) to (s) are, in effect, an inventory that should be kept up-to-date if the organization is to minimize disruption and/or loss of business continuity in the event of a breakdown or failure. An organization should determine its policy on the holding of spare parts.

24.2.2.1.2 *Documentation of mechanical records*

Documentation should record the following as installed:

a) Location, including level if buried, of all public service connections (for example, fuel gas and cold water supplies) together with the points of origin and termination, size and materials of pipes, line pressure and other relevant information;

b) Layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes as well as the results of all balancing, testing and commissioning data;

c) Location, identity, size and details of all apparatus and all control equipment served by, or associated with, each of the various services together with copies of any test certificates for such apparatus where appropriate. The information with respect to size and details may be presented in schedule form;

d) Layout, location and extent of all air ducts showing dampers and other equipment, acoustic silencers, grilles, diffusers or other terminal components. Each duct and each terminal component should be marked with its size, the air quantity flowing and other balancing data; and

e) Location and identity of each room or space housing plant, machinery or apparatus.

24.2.2.1.3 *Drawings for mechanical installations*

Drawings should record the following as installed:

a) Detailed general arrangements of boiler houses, machinery spaces, air handling plant, tank rooms and other plant or apparatus, including the location, identity, size and rating each apparatus, The information with respect to the size and rating can be presented in scheduled form;

b) Isometric or diagrammatic views of boiler houses, plant rooms, tank rooms and similar machinery, including valve identification charts. It is useful to frame and mount a copy of such drawings on the wall of the appropriate room; and
c) Comprehensive diagrams that show power wiring and control wiring and/or pneumatic or other control piping including size, type or conductor or piping used and identifying the terminal points of each.

24.2.2.1.4 *Electrical installations*

Records should be kept of the following as installed:

a) Main and sub-main cables, showing origin, route, termination, size and type of each cable. Cables providing supplies to specialist equipment, for example data centre equipment, should be identified separately;
b) Lighting conduits and final sub-circuit cables, showing origin, route, termination and size of each, together with the number and size of cables within each conduit. The drawings should indicate, for each conduit or cable, whether it is run on the surface or concealed, for example in a wall chase, in a floor screed, cast in situ or above a false ceiling. These drawings should also indicate the locations of lighting fittings, distribution boards, switches, draw-in-boxes and point boxes, and should indicate circuitry;
c) Details of secondary power sources for inclusion in a safe systems of work regime;
d) Location and purpose of each emergency lighting fitting, including an indication of the circuit to which it is connected;
e) Single and three-phase power conduits and final sub-circuit cables showing locations of power distribution boards, motors, isolators, starters, remote control units, socket outlets and other associated equipment;
f) Other miscellaneous equipment, conduits and cables;
g) Lightning conductor air terminals, conductors, earth electrodes and test clamps;
h) Location of earth tapes, earth electrodes and test points; and
j) Cables providing earth circuits for specialist equipment should be identified separately.

Records should also include, where applicable,

1) Distribution diagrams or schedules to show size, type and length (to within 1 m) of each main and sub-main cable, together with the measured earth continuity resistance of each;
2) Schedule of lighting fittings installed stating location, manufacturer and type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed;
3) Schedule of escape and emergency lighting fittings installed stating location, manufacturer, type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed. For battery systems, the position of the battery, its ampere-hour rating and battery system rated endurance, in hours, should be stated;

4) Records of smoke detectors, sprinklers and fire precautions generally, as well as security precautions;
5) Incoming supply details including the type of system, voltage, phases, frequency, rated current and short circuit level, with the details of the supply protection and time of operation as appropriate;
6) Main switchgear details which, for purpose-made equipment, should include a set of manufacturers' drawings and the site layout;
7) Transformer, capacitor and power plant details. For example in the case of transformers, the volt-ampere rating, voltages and type of cooling; and
8) Completion certificate.

All records and drawings, including those used during construction work, should be verified against the as-built facility. Where a discrepancy is found, full details should be recorded and, wherever practicable, the affected record(s) and/or drawing(s) should be labelled as subsequently altered.

24.2.3 *Operating and Maintenance Manuals*

24.2.3.1 The engineering services within buildings frequently are dynamic, involving complex systems of integrated plant items. Operation of such plant can require detailed knowledge and direction. Maintenance can also require extensive information to be available. It is, therefore, important to have suitable operating and maintenance manuals to provide the necessary guidance. These should be included as part of the contractual requirements for new installations and should ideally be prepared as reference documents for existing installations where no such information exists.

24.2.3.2 Information and data on the operation and maintenance of the facility, including measures to conserve fuel and power, should be incorporated into the O&M manual. The organization should ensure that provisions made in the facility handbook are satisfied.

Preparation of an O&M manual tailored to suit each facility can offer significant advantages in terms of providing a clear statement of intentions and required actions. Depending upon whether one is responsible for the maintenance of a number of facilities or a single facility, the maintenance manual will be designed and prepared.

An organization's procedures for undertaking maintenance should be formalized in a maintenance manual or manuals. The manual may form part of wider documentation covering operational plans and arrangements. In the event of a change of organization or maintenance advisor, an up-to-date manual and facility handbook should ensure continuity of maintenance. Copies of maintenance manuals should be held by the organization and any maintenance advisor, if appointed.

24.2.3.3 *Structure of operation and maintenance manual*

The maintenance manual should be prepared in two parts: the first part should be addressed to the organization; and the second part should be addressed to those responsible for inspecting the facility and reporting to and advising the organization.

The first part of the manual should,

a) Recommend intervals between:
   1) routine, general and detailed inspections,
   2) inspection and maintenance of each engineering installation and items of special equipment;
   3) maintenance of items which, as recommended by their manufacturers, require regular attention to preserve satisfactory performance, for example the lubrication and adjustment of moving parts in component assemblies and systems; and
   4) other periodic work as experience in use shows to be necessary, for example the clearing of gutters, downpipes or surface water gullies.
b) Draw attention to the need to ensure that a facility's provisions for means of escape in the event of fire, that is, fire resisting self-closing doors and exit hatches, are in satisfactory working order at all times, including those periods during which any maintenance is being undertaken.
c) Draw attention to critical environments, including special arrangements for gaining access for the purpose of inspections or when undertaking maintenance;
d) Specify proprietary maintenance materials, for example floor sealers and polishes likely to offer acceptable service and slip resistance.
e) Set out the names, addresses and other contact details of firms responsible for the following:
   1) inspecting, reporting and advising on the condition of the building fabric;
   2) emergency repairs to the building fabric; and
   3) servicing and emergency repairs for each engineering installation and items of special equipment.

The second part of the manual should,

a) Consist mainly of selected, concise information, abstracted from the facility handbook, and likely to be needed during inspections; this information should be ordered in the sequence in which examination is likely to be carried out.
b) Schedule those materials and components that experience shows to be prone to failure and/or to require special attention.

24.2.3.4 *Updating of O&M manual*

The maintenance manual should be reviewed annually and updated where necessary, to reflect changes in legislation as well as current circumstances and arrangements. When changes occur to facilities, or where new information becomes available, all copies of the maintenance manual should be revised accordingly, irrespective of whether it is self-standing or forms an integral part of the facility handbook.

24.3 Storage and Security of Records

24.3.1 *General*

An organization should keep records in a safe and secure location and arrange them in such a way as to enable their rapid retrieval. Records of personnel permitted to

access the records and any requirements or conditions attaching thereto should be defined.

24.3.2 *Storage*

The place for storage of records should take into account the form of the records, the media used and the conditions necessary to keep them from damage of any kind; they should also be readily accessible. Backup or duplicate records (electronic and paper-based) should be kept in a secure place in a location other than the facility to which they relate. Both sets should be kept up-to-date.

24.3.3 *Security*

Measures taken to ensure security should be recorded and a copy should be held in a secure location away from the facility to which they relate. The following records should be readily accessible to authorized personnel when required, which may be at short notice and outside normal working hours:

a) Names, home addresses and telephone numbers of key holders;
b) Details of master key system; and
c) Details of intruder alarms and other security systems.

24.4 Computerization of Information Management

An organization should review its requirements for data systems, basic information and communication technology (ICT) facilities and extended services necessary to support its maintenance management. The use of a CAFM or a CMMS as means for managing facility related maintenance information should be evaluated. The following features are likely to provide a suitable basis:

1) Budgetary and other financial controls;
2) Cost accounting;
3) Asset register;
4) Condition-based monitoring of assets;
5) Early detection of problems and rapid fault reporting;
6) Operational plans, including frequency of functions or activities performed;
7) Risk and hazard assessment;
8) Permits-to-work;
9) Personal protective equipment issued and returned;
10) Planned preventive maintenance;
11) Reactive maintenance;
12) Change management;
13) Job orders and other requisitions for goods and services;
14) Job logging, prioritization and tracking, including details of backlogs;
15) Energy use and carbon dioxide (CO_2) equivalent emitted per annum;
16) Resource consumption and productivity measures;
17) Analysis of work undertaken to identify trends;
18) Space planning and space utilization;
19) Workstation location and furniture management;

20) Performance indicators for the delivery of services;
21) End-user experiences of services delivered;
22) Audit trail of system transactions; and
23) Exception reporting for management purposes.

25 CHECK LISTS

In order that the activities of inspection/maintenance of assets may be carried out systematically in a comprehensive manner, certain check lists/proforma may be made available. While these may vary from asset to asset and organization to organization, a few examples of the activities to be covered are given below:

a) *Register of buildings* — Initial cost, cost of additions and alterations year-wise. This is required to verify periodically that all assets paid for by the organization are kept duly preserved and maintained.
b) Amount admissible per annum for carrying out maintenance operations related to civil, E&M equipment and establishments, horticulture maintenance works during a year, including,
    1) plinth area rates for maintenance works for base year; and
    2) maintenance cost index, repair cost index.
c) Maintenance norms, frequency of application of finishing items.
d) Guidelines for annual maintenance estimates for horticulture works.
e) Classification of horticulture maintenance works.
f) Inspection lists of general buildings:
    1) Civil,
    2) Electrical, and
    3) Horticulture.
g) Additional inspection lists for critical buildings:
    1) Sub station equipment, generating sets, service connection;
    2) Air conditioning plants;
    3) Electrical installations, lifts, water supply pumps, sewage pumps, filtration plants;
    4) Fire alarm, fire fighting;
    5) Public address system;
    6) CCTV, cable TV, laundry, kitchen, incinerator, etc. and
    7) Monsoon preparedness sytems;

26 DISASTER PREPAREDNESS AND RESILIENCE

Building resilience refers to the capacity to resist the disruptive impact of disasters (natural and man-made) on the assets and performance of buildings; respond to such events and recover from structural impact and disruptions, including failures in operational systems, maintenance systems, and equipment to minimise losses of lives, property, assets and functions to return to full performance at the earliest. Resilience planning shall focus on maintaining essential building functions and ensuring business continuity during emergencies or failures, even in cases where redundancy systems have been implemented. Automation of critical systems shall be prioritized to reduce human involvement and enhance the building's ability to manage operational failures efficiently with an emphasis on structurally embedded and services

integrated resilience. For further details on this refer **30** of Part 3 'Development Control Rules and General Building Requirements' of this Code. To safeguard assets, protect occupants, and sustain operations during disruptions, facility management practices shall prioritize building resilient infrastructures that are prepared for and capable of recovering from such adversities.

To enhance resilience and preparedness for operational failures and disasters, the following strategies shall be adopted-

a) *Risk assessments* – Facility managers shall conduct regular and comprehensive risk assessments to identify potential hazards and vulnerabilities, including natural disasters like earthquakes, floods, and cyclones, as well as man-made hazards such as crime and security related extreme events, cyberattacks, power outages, and supply chain disruptions. Based on these assessments, targeted mitigation strategies and contingency plans should be developed to minimize the risks to both the facility and its occupants.
b) *Emergency response plans* – Facilities should develop and maintain on-site and off-site emergency response plans in collaboration with local authorities, emergency response teams, and relevant stakeholders. These plans shall clearly outline evacuation protocols, shelter-in-place strategies, communication procedures, and medical emergency response actions. It is imperative that these plans be tailored to the unique characteristics of each facility and regularly tested and updated to ensure they remain effective.
c) *Disaster communication systems* – Robust disaster communication protocols should be integrated into both on-site and off-site plans. These should include redundant communication channels such as public address systems, emergency messaging (SMS or digital platforms), and alarm systems to provide real-time information to occupants and coordinate with off-site emergency responders. Such systems shall be tested periodically to ensure proper functionality during an emergency.
d) *Redundant systems and backup infrastructure* – Resilient facilities should incorporate redundant systems for critical infrastructure, including power, communication, and water supply. Facilities shall have backup power sources such as generators or alternative energy systems in place to ensure seamless operation in case of outages. Furthermore, backup communication channels and redundant IT systems should be available to mitigate the impact of equipment failures, network disruptions, or other emergencies. Regular testing and maintenance of these systems are essential to ensure their reliability during crises.
e) *Business continuity* – Facility managers shall implement measures to ensure the continuity of operations during and after disasters. This includes creating business continuity plans that focus on the recovery and restoration of critical systems and services, as well as strategies for maintaining essential functions and safeguarding assets during extended periods of disruption.

By integrating these principles into asset and facility management practices, buildings and facilities can be made more resilient, ensuring the safety of occupants and continuity of services in times of adversity**.**

27 DIGITAL TWIN TECHNOLOGY

A digital twin is a comprehensive digital representation of a physical building and its systems. It incorporates real-time data and historical records from sensors, IoT devices, and other monitoring systems to provide a virtual model that mimics the behaviour, performance, and condition of the building and its equipment. The purpose of the digital twin is to improve decision-making, optimize operations, streamline maintenance, and extend the lifecycle of building assets. By using digital twins, facility managers can ensure better monitoring, analysis, and control of all building components and their related systems.

Key elements included in a digital twin-

a) *Building Components* – Structural elements (for example, walls, roofs, beams), architectural features, and environmental controls.

b) *Machines and Equipment* – HVAC systems, electrical systems, plumbing, fire safety, elevators, and other mechanical systems.

c) *Detailed Information* – Model numbers, specifications, maintenance and operation schedules, part inventories, performance metrics, energy consumption, and annual maintenance contract (AMC) details.

The digital twin shall allow real-time insights into the operation of building systems, predict maintenance needs, and enable lifecycle management of all assets within the facility.

27.1 Types of Digital Twins

Digital twins can be categorized into two types for asset and facility management:

a) *Asset Twin* – The asset twin shall serve as a comprehensive digital database containing detailed information about every physical component of the building, including machines and equipment. This database shall store:

i) Specifications and technical data for all building systems (for example, HVAC, electrical, plumbing)
ii) Part inventories and replacement schedules
iii) Maintenance history, including preventive and corrective actions
iv) Contract details, including warranties and AMC terms
v) The asset twin ensures that facility managers have access to an up-to-date digital record of the building's infrastructure and equipment, enabling better management of resources, inventory, and contracts.

b) *Operational Twin* – The operational twin focuses on the real-time monitoring and performance analysis of building systems and equipment. It tracks the lifecycle of these assets, from installation to decommissioning. The operational twin shall be used to:

i) Monitor operational conditions, wear and tear, and overall performance

ii) Predict when parts or equipment need repairs or replacements, based on usage patterns and historical data
iii) Optimize the building's operational efficiency and reduce downtime through predictive maintenance
iv) Support decision-making regarding system upgrades or replacements during the asset's lifecycle

27.2 Application of Digital Twins

Digital twins shall be applied across several aspects of asset and facility management to optimize building performance, safety, and sustainability. Their applications include:

a) *Monitoring and Operations* – Digital twins shall continuously monitor the real-time status of building systems, such as HVAC, electrical, plumbing, and fire safety systems. By simulating and analyzing the real-time data, digital twins can ensure that these systems operate at peak efficiency, identifying and addressing any potential issues before they become critical.

b) *Predictive Maintenance* – Digital twins shall be used to implement predictive maintenance strategies, where data-driven insights are used to predict potential equipment failures or performance declines. Facility managers should use the twin to schedule maintenance proactively, reducing the chances of unexpected breakdowns and minimizing operational downtime. This will lead to cost savings and longer equipment life.

c) *Energy and Performance Management* – Digital twins shall track energy usage across all building systems, providing insights into where energy is being consumed and identifying opportunities for savings. They should be used to simulate various energy-saving strategies and help ensure compliance with energy efficiency standards. Digital twins also enable benchmarking of the building's performance against sustainability targets, improving overall building operations.

d) *Lifecycle Management* – Digital twins shall assist in planning for the entire lifecycle of building components, machines, and equipment. By using data from the digital twin, facility managers can plan for system upgrades, replacements, or renovations. This lifecycle management approach ensures efficient use of resources and helps reduce disruption during renovations or equipment transitions.

e) *Emergency Preparedness and Response* – In case of emergencies, digital twins shall provide real-time data and simulations to guide emergency response strategies. For example, in fire scenarios, the digital twin can show the current conditions of fire safety systems, evacuation routes, and detect faults in fire alarms or suppression systems. This aids in planning and executing quick and effective responses to protect occupants.

27.3 Data Integration and Management

To fully utilize digital twins, they shall be integrated with existing building management systems (BMS), internet of things (IoT) devices, and other relevant infrastructure. This integration ensures that data from all building systems flows seamlessly into the digital twin, providing a complete and up-to-date digital replica of the physical building. Key elements of data integration include:

a) *Sensor Data* – Digital twins shall be connected to sensors in building systems to continuously collect real-time data on performance, environmental conditions, and usage patterns.

b) *Centralized Database* – All data collected by the digital twin shall be stored in a centralized database, which can be easily accessed by facility managers. This ensures that facility management teams have real-time access to accurate information about building assets, operations, and maintenance records.

ANNEX A
(*Clause* 9.5.3)

COMMON CAUSES FOR MAINTENANCE PROBLEMS

A-1 The major causes for maintenance problems in different elements of a building are discussed in **A-1.1** to **A-1.5**.

A-1.1 Floors

a) Poor quality of construction which includes quality of construction material and workmanship.
b) Improper slopes, mainly in kitchen, bathrooms/toilets, etc.
c) Lack of rounding at junctions of walls with floors.
d) Lack of damp-proof course treatment in walls and particularly in sunken floors.
e) Poor design of building.
f) Improper waterproofing.

A-1.2 Roofs

a) Inadequate roof slopes.
b) Inferior quality of construction.
c) Cracks on roof surfaces.
d) Inadequate provision of rain water spouts.
e) Blockages in gratings/rain water pipes.
f) Worn out felts/membranes.
g) Bubbling up of tar felt and separation of joints.
h) Improper water proofing or wrong selection of water proofing technique.
i) Leakage from the openings provided on the roof.
j) Improper treatment of expansion/construction joints.
k) Non providing of *Gola* at junction of parapet and wall and roof.
m) Improper execution of *Khurra*.
n) Lack of pre-monsoon inspections

A-1.3 Plumbing

a) Inadequate slopes in soil/waste pipes.
b) Improper joints in pipes.
c) Joints in walls and floors.
d) Improper junctions of stacks.
e) Inadequate cleaning eyes at junctions.
f) Throwing of solid wastes in WC’s.
g) Lack of periodical checking and cleaning.
j) Lack of motivation/education to users for proper use.
k) Overflow from service tanks.
m) Inferior quality of fittings and fixtures.
n) Inadequate design.

A-1.4 Drainage

a) Improper surface dressing around buildings and improper upkeep of surroundings.
b) Growth of wild grass and vegetation.
c) Inadequate drainage system around the building.
d) Inadequate slope of the drains or drainage pipes.
e) Inadequate number of inspection chambers.
f) Theft of manhole covers, etc.
g) Throwing of solid waste in the open surface drains.

A-1.5 Electrical

a) Loose connections.
b) Improper earthing and earth connections.
c) Damages to wires, cables and other installations.
d) Under rated cables/wires and other installations.

ANNEX B
(*Clause* 9.10.3.6)

FORMAT FOR INSPECTION REPORT

Building/Block: ……

(A) INSPECTION OF BUILDINGS (CIVIL)									
(a) House No. and Type:					(b) Location:				
(c) Date of Last Inspection:					(d) Date of Present Inspection:				
Sl No.	Item No.	Needs Repair			Needs Replacement		Priority		
		Action	Quantity	Cost	Quantity	Cost	Immediate	Annual	Routine Repairs
1.	**Walls**								
1.1	Cracks								
1.2	Repair to plaster								
1.3	Repair to brick work								
1.4	Dampness								
2.	**Floors**								
2.1	Cracks								
2.2	Settlement								
2.3	Slopes								
2.4	Skirting cracks								

2.5	Dados cracks									
3.	**Doors, Windows, Ventilators and Cupboards**									
3.1	Glass panes broken									
3.2	Panels in shutters broken									
3.3	Panels fit improperly									
3.4	Improper/missing fittings									
	3.4.1	Hinges								
	3.4.2	Handles								
	3.4.3	Tower bolts								
	3.4.4	Aldrops								
	3.4.5	Floor door stopper								
	3.4.6	Knobs								
	3.4.7	Cleats								
	3.4.8	Hooks and eyes								
	3.4.9	Curtain rods								
	3.4.10	Stays								
	3.4.11	Pelmets								
4.	**Roofs**									
4.1	Leakages/damp patches									
4.2	Water proofing treatment									

4.3	*Gola*									
4.4	*Khurra*									
4.5	Brick drip course									
4.6	Rain water pipe									
4.7	Regrading									
4.8	Top layer of tiles									
4.9	Parapet, coping									
5.	**Water Supply and Sanitary Fittings**									
5.1	Leakages in pipe joints									
5.2	Functioning of washers									
5.3	Functioning of traps in fittings									
5.4	Functioning of floor traps									
5.5	Functioning of overhead/low level cistern									
5.6	Air locking									
5.7	Leakages in pipe joints									
5.8	Condition of overhead tank									
5.9	Cleaning of overhead tank									
5.10	Fittings									
	5.10.1	Washbasin								
	5.10.2	Soap container								
	5.10.3	Mirror								

	5.10.4	Glass shelf								
	5.10.5	Towel rail								
	5.10.6	Hangers								
	5.10.7	Sinks								
	5.10.8	Taps								
	5.10.9	Pillar cocks								
	5.10.10	Showers								
	5.10.11	Cisterns								
	5.10.12	Ball valves								
	5.10.13	Seat cover								
	5.10.14	Steps								
6.	**External Services**									
6.1	Manhole covers									
6.2	Covers to gully traps									
6.3	Cleaning of manholes									
6.4	Plinth protection									
6.5	Cleaning of storm water drain									
6.6	Approach roads									
6.7	Service lanes									
7.	**Finishing**									
7.1	White washing/colour washing/distemper									
	(a)	When was it done last?								
	(b)	When is it due?								
	(c)	Existing condition.								
7.2	Painting									

	(a)	When was it done last?								
	(b)	Existing conditions								
	(c)	When is it due?								
8.	**Common Areas**									
8.1	Railing to staircase									
8.2	Staircase steps									
8.3	Staircase nosing									
8.4	Shafts									

(B) INSPECTION OF BUILDINGS (ELECTRICAL)

(a) House No. and Type :	(b) Location :
(c) Date of Last Inspection :	(d) Date of Present Inspection :

Sl No.	Item No.	Needs Repair			Needs Replacement		Priority		
		Action	Quantity	Cost	Quantity	Cost	Immediate	Annual	Routine Repairs
1.	**Switch Boards**								
1.1	Regulator								
1.2	Switches								
1.3	Fixing of tiles								
2.	**Fans**								
2.1	Canopy fixing								
2.2	Speed and noise								

3.	**Socket outlet points and connection**								
3.1	Tile								
3.2	Switch								
3.3	Outlet connection, if any								
4.	**Fittings**								
4.1	Reflector								
4.2	Louvers/Perspex cover								
4.3	Suspension rod								
5.	**Exhaust Fans**								
5.1	Speed and noise								
5.2	Louvers								
5.3	Connecting wires i/c. ceiling rose								
6.	**Call bells**								
6.1	Bell push								
6.2	Connecting wire								
6.3	Ball Buzzer								
7.	**Sub distribution boards/ BDB/Main Board**								
7.1	Switch covers								
7.2	Fuse kit kats								
7.3	Earth connection								
7.4	Fuse rating								
7.5	Inter connection								

7.6	Boards								
(C) INSPECTION OF BUILDINGS/GARDENS									
1.	**Lawn:**								
1.1	Weeding								
1.2	Patch repair								
1.3	Renovation								
1.4	Regrassing								
2.	**Hedge:**								
2.1	Gap filling								
2.2	Replacement								
3.	**Prunning and Training:**								
3.1	Naturally required pruning								
3.2	Prunning required for security purpose of building as well as occupant								
4.	**Planting Beds:**								
4.1	Needs Replacment								
4.2	Gap filling								
5.	**U/F Water Supply:**								
5.1	Matter to be reported to U/F water division after inspection								
6.	**Rockeries:**								

6.1	Gap filling of dead one								
6.2	Replacement of damaged, weak								
6.3	Replacement of stones								
6.4	Thinning, trimming								
6.5	Redesigning of paths, maintenance of paths								
7.	**Kitchen Garden:**								
7.1	Change in site								
7.2	Plan for planting of vegetables								
8.	**Road Side Plantation:**								
8.1	Gap filling Nos.								
8.2	Trimming, pruning								
8.3	Tree guards not required and to be removed/ repair/painting, etc.								
8.4	Proposal for new plantation, digging of holes, etc.								
8.5	Miscellaneous								
8.6	MOU- Detailed report (Performance and financial achievements)								

ANNEX C
(*Clause* 9.11.1.1)

TYPICAL NORMS FOR EMPLOYMENT OF WORKMEN FOR DAY TO DAY MAINTENANCE OF BUILDINGS

C-1 Building maintenance is known to be most labour intensive of the construction industry.

C-2 CIVIL WORKS

Maintenance staff is required for day-to-day maintenance of buildings. The work of carrying out annual repairs to buildings, like white/colour washing, distempering, emulsion painting, enamel paint/polish, etc, works of additions and alternations or minor works not requiring immediate execution are normally not covered in their duties and may be got done through contractors. However, spare capacity, if any, should be utilized in carrying out petty items of works.

C-2.1 Norms for Employment of Workmen

The general norms for employment of workmen for civil works in building is given in Table 1.

C-3 ELECTRICAL ENGINEERING WORKS

C-3.1 Day-to-Day Maintenance

For electrical engineering works, maintenance staff is generally employed on routine maintenance works of internal wiring. Maintenance and repair work of specialized and complicated nature are not covered. The yardsticks given in Table 1 indicate the workmen normally required for day-to-day maintenance of electrical works.

C-3.2 For electrical installations, only the electrician/wireman/assistant wireman holding the valid permit/license issued by the electrical inspectorate/state administration (of the respective state in which work is to be carried out) shall be deputed on work.

Table 1 General Norms for Employment of Workmen
(*Clauses* C-2.1 *and* C-3.1)

Sl. No.	Categories	Number	Residential Buildings	Non- Residential Buildings	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i) Civil Categories[1)]:			Plinth Area, in m^2, for Which Admissible		
a)	Mason	1	25 000	30 000	For public buildings, such as airports, hospitals, hotels, norms will depend upon the facilities and specific requirements
b)	Carpenter	1	30 000	50 000	
c)	Plumber	1	30 000	36 000	
d)	Sewerman	1	30 000	60 000	
e)	Shramik/Beldar		One beldar for each carpenter and mason. Additional as per work requirement	Twice the number of workers in category of mason and carpenter	
ii) Electrical Categories:			No. of Points for which One Person is Required		
a)	Wireman	1	3 300	3 300	
b)	Khallasi[2)]	1	6 600	6 600	For public buildings, such as airports, hospitals, hotels, norms will depend upon the facilities and specific requirements.

[1)] Number of workmen indicated is where engagement is considered desirable on regular basis for entire year. Night duty staff not included in this norm.

[2)] One khallasi for two wiremen.

NOTES

1 These norms are for government buildings where change of users is very often and permanent staff is required on account of sensitivity of users.

2 Actual requirements will depend upon type of structure, its usage and complexity/importance and level of maintenance required.

3 Requirement of other category of maintenance and operational staff will depend upon the type and usage of the facility.

ANNEX D
(*Clause* 11.10.3.3)

METHODS OF OPERATIONAL CHECKS FOR STP

D-1 CODE AND METHOD OF CHECKING

Sl No.	*Code*	*Method*	*How to Check*
(1)	(2)	(3)	(4)
i)	V	Visual	Check for presence (or absence) of the indicated feature
ii)	M	Measurement	Measure the indicated dimensions and compare against specified limits
iii)	T	Performance test	Conduct a test and compare the results against the specified limits
iv)	D	Documentation check	Check in drawings and calculations (typically for aspects that cannot checked with visual inspection or other testing methods)

D-2 BAR SCREEN CHAMBER

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Working on platform	a) Observe the operator as he collects debris b) Posture is normal during working c) Does not have to balance on platform d) Can see the whole chamber easily e) Not facing any difficulty f) Can easily reach the grill and floor g) No struggle to remove parts stuck in grill	T	If the debris-collection is not comfortable, it will stop in a few days; leading to a clogged and dysfunctional bar screen chamber
ii)	Handling of debris	a) Observe the operator as he disposes off debris b) Operator can easily use the platform (or a basket) to let the debris drip dry c) Operator can easily place the collected debris into a garbage bag	T	Disposal of debris shall be easy and hygienic

D-3 EQUALIZATION TANK

Sl No. (1)	*Check* (2)	*Acceptance Criteria* (3)	*Method* (4)	*Rationale* (5)
i)	Actual level fluctuations	Check for overflows – tell-tale coloration on side walls/freeboard	M	To determine if equalization tank size is adequate to handle peak inflows
ii)	Aeration and mixing	a) Bubbles rise across the entire surface of the aeration tank (no dead zone in any area, especially edges and corners) b) There is no odour c) There is no localized violent bubbling/ boiling	V	This is the end-result of proper diffuser selection and placement; and also correct air pressure
iii)	Maintenance of diffusers	Select a few diffusers (typically the diffuser in the most remote corner) and execute a mock repair cycle and check for the following: a) Easy to isolate from the rest of the system b) Easy to retrieve the chosen element c) Easy to dismantle the element without disturbing the other plumbing d) Easy to clean the element e) Easy to lower it back at the exact spot	T	The STP should allow easy maintenance of diffusers without significant interruption of its process

D-4 RAW SEWAGE LIFT PUMPS TANK

Sl No. (1)	*Check* (2)	*Acceptance Criteria* (3)	*Method* (4)	*Rationale* (5)
i)	Easily accessible	Simulate a repair cycle on the pump that is more difficult to access and check the following: a) Easy to isolate from the rest of the system b) Easy to dismantle c) The rest of the plumbing is not disturbed d) Easy to carry it outside its area e) Easy to place it back and assemble it	V	The STP should allow easy maintenance of pumps without significant interruption

				of its process

D-5 AERATION TANK

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Baffle wall function	a) The sewage is let into the baffle zone – No splash or overflow b) There is no bubble-free dead zone adjacent to the baffle wall on the tank	V	These signs indicate wrong dimensions of the baffle wall
ii)	Diffuser function	a) Bubbles rise uniformly across the surface b) No dead zone (especially near walls and corners) c) No large bubbles bursting through	V	To get optimum results, you may need to adjust the placement of diffusers and/or air pressure in individual diffusers
iii)	Maintenance of diffusers	Simulate a service cycle on sample diffusers (select the most remote elements) and check for the following: a) Easy to isolate from the rest of the system b) Easy to retrieve the chosen element c) Easy to dismantle the element without disturbing the other plumbing. d) Easy to clean the element e) Easy to lower it back at the exact spot	T	Maintenance of diffusers should not disrupt the STP functioning
iv)	Membrane type diffuser	Pull out and check if membranes are in good condition	V	
v)	Split aeration tank	Easy to isolate and empty each tank for repairs a) Cut off compressed air (Check safety function) b) Equal flow of sewage and recycle sludge to each compartment	V	
vi)	Biomass in Aeration tank	a) Healthy brown biomass b) Check MLSS level in aeration tank	V T	

D-6 SECONDARY CLARIFIER TANK

Sl No. (1)	*Check* (2)	*Acceptance Criteria* (3)	*Method* (4)	*Rationale* (5)
i)	Settling of sludge	a) Sludge settles without vortex b) No sludge drawn up near the weir c) No significant sludge trace in the launders d) No clumps/ balls of rising sludge	V	
ii)	Fine mesh basket at outlet	Easy to service the mesh, for which check the following: a) Easy to remove b) Easy to clean c) Easy to fit it in place	T	
iii)	Bridge	a) Bridge allows safe travel up to motor and gear box b) The safety railing has closely spaced balusters to prevent accidental fall from under the railing	T	
iv)	Maintenance of motor and gearbox	Simulate a repair cycle for the motor and gearbox a) Safe access to the motor and gearbox b) Allows safe removal of motor and gearbox c) Allows safe carrying of parts out of tank d) Allows safe re-fitting of parts e) Check rotational speed of rake	T M	If the motor and gear box cannot be made functional within 30 min, the bacteria may start dying
v)	Weir level	Check for uniform overflow of water over the entire length of the weir(s)	T	

D-7 SLUDGE RECIRCULATION PUMPS-AIRLIFT

Sl No. (1)	*Check* (2)	*Acceptance Criteria* (3)	*Method* (4)	*Rationale* (5)
i)	Air lift	Check if recirculation sludge flow is roughly between 60 -100 percent of sewage inflow	V	

D-8 SLUDGE RECIRCULATION PUMPS-ELECTRIC

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Air lift	Check if recirculation sludge flow is roughly between 60 -100 percent of sewage inflow	V	
	NOTE — Based on the STP design, select the previous table (for an airlift pump) or this table (for electric pumps used in direct-suction or buffer sump variations).			

D-9 SLUDGE RECIRCULATION SYSTEM- WITH A BUFFER SUMP

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Aeration and mixing in sludge sump	a) Bubbles rise across the entire surface (no dead zone in any area, especially edges and corners) b) There is no odour	V	This means the system does not pose a threat to the bacteria
ii)	Maintenance of pump	Simulate a repair cycle (select the pump that is more difficult to access) and check for the following: a) Easy to cut off from the rest of the system b) Easy to remove c) Easy to carry outside STP d) Easy to assemble back. e) Check if recirculation sludge flow is roughly between 60 -100 percent of sewage inflow	T	Although availability of a standby drastically reduces the risk, it should be easy (and fast) to repair a defective pump

D-10 CLARIFIED WATER TANK

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Aeration and mixing	a) Bubbles rise across the entire surface (no dead zone in any area, especially edges and corners) b) There is no odour c) No accumulation of solids in the tank	V	

D-11 FILTER FEED PUMPS

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Maintenance of pump	Simulate a repair cycle (select the pump that is more difficult to access) and check the following: a) Easy to cut off from the rest of the system b) Easy to remove c) Easy to carry outside STP d) Easy to assemble back	T	

D-12 BACKWASH PUMPS

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Maintenance of pump	Simulate a repair cycle (select the pump that is more difficult to access) and check the following: a) Easy to cut off from the rest of the system b) Easy to remove c) Easy to carry outside STP d) Easy to assemble back	T	

NOTE — This table is applicable only when the design uses a separate set of pumps for backwash (not by reversing the flow of the filter-feed pumps)

D-13 PRESSURE SAND FILTER

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Filter operation	Filter is able to handle design flow of water without excessive pressure drop	T	
ii)	Filter Backwash	Backwash filter for 5-10 min and check if initially lot of solids come out, gradually becoming clearer and finally clear water is observed	T	

D-14 ACTIVATED CARBON FILTER

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Filter operation	Get analysis reports and compare quality at inlet to filter and outlet of filter	T	
ii)	Filter Backwash	Backwash filter for 5 min and check if initially lot of solids come out, gradually becoming clearer and finally clear water is observed	T	

D-15 DISINFECTION SYSTEM

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Hypo dosing	Check residual chlorine level with test kit It shall be more than 1 ppm after 30 min of standing	T	-

D-16 SLUDGE-HANDLING SYSTEM

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Filter press operation	Run an entire sludge dewatering cycle of one batch, and check quantity (weight) of sludge cake produced	T	-

D-17 AIR BLOWERS

Sl No.	*Check*	*Acceptance Criteria*	*Method*	*Rationale*
(1)	(2)	(3)	(4)	(5)
i)	Noise	Measure the noise. Results more than 80 dB(A) indicate corrective measures are needed	T	-
ii)	Capacity	Check if air in sufficient quantity is delivered to all connected tanks simultaneously, as visual indications for each tank as described above	T	-

ANNEX E
(*Clause* 13.3.7)

GUIDELINES FOR MAINTENANCE OF ELECTRICAL EQUIPMENT

E-1 In case of electrical appliances, manufacturer's instructions for the usage and maintenance of the equipment should be strictly followed.

E-2 The detailed/working drawings of all the components of electrical installations should always be available with the maintenance unit. Following records should be available:

a) Manufacturer's name;
b) Name plate of the equipment and its salient features such as capacity, rating, etc;
c) Manufacturer's recommendations regarding availability/usage of spare parts;
d) Manufacturer's recommendations for periodical maintenance and post fault maintenance;
e) Details of the maintenance operations performed in the past; and
f) History card of equipment shall be maintained and made available when required.

E-3 Care should be taken while selecting replacement parts. The spare parts should be correct and suitable, preferably as recommended by the manufacturer concerned. During the placement of order for the supply of spare parts, nameplate particulars and serial number should be quoted.

E-4 The space where the equipment is kept should be clean and properly ventilated. Equipment should not be disturbed needlessly. Before cleaning, the equipment should be made dead. For internal cleaning a section cleaner should be used.

E-5 Covers and doors should not be left open unnecessarily during maintenance. Afterwards they should be promptly and correctly closed and locked.

E-6 Before removing the covers and connections, all covers and cable terminations should be marked to ensure correct replacements. Disturbed connections and temporary connections should be marked to facilitate reconnection. Temporary connections and markings should be removed before the installation is put to use.

E-7 Those connections which have not been disturbed should also be checked for soundness and overheating.

E-8 All insulations should be regularly checked. Solid insulations should be checked for cracks and other defects. Fibrous and organic insulations should be checked for sign of blistering, delamination and mechanical damage. For insulating oils the interval between tests should be carried out as per the recommendations of the manufacturer and keeping the adverse environmental conditions in mind or at least once in an year.

E-9 It should be ensured that the earthing connections are sound and all contact screws are tight.

E-10 During the examination of interlocks it is necessary to take precautions to prevent danger to plant or persons in the event of malfunction or inadvertent operation. A person responsible for checking and maintaining any interlock system should have thorough knowledge of the extent, nature and function of the interlock.

E-11 If the equipment is ventilated then it should be ensured that the airflow is smooth and not restricted. If filters are provided, they should be cleaned or replaced as necessary.

E-12 The standby system for tripping and closing supplies should always be kept in good order. Indicators and alarms should be maintained in time with the manufacturer's instructions.

E-13 Tools, spares and instruments should be stored near to the installation. These should be regularly checked against an inventory.

E-14 Before the start of maintenance of the circuit switches it should be ensured that all incoming and outgoing main auxiliary circuits are dead and remain so during the maintenance. Overheating of the circuit switches is the root cause for faults. Overheating may be caused by inadequate ventilation, overloading, loose connection, insufficient contact force and misalignment.

E-15 Some circuit breakers are not intended to be maintained, such as miniature circuit breakers (MCBs). Such items should not be dismantled for maintenance. These should be renewed if not found functional.

E-16 For the maintenance of fuses periodical inspection should be done for correct rating, security, overheating and correct location/orientation. Element of renewable fuses should be renewed when the deterioration is apparent. The availability and correct replacement of fuse links should be ensured.

E-17 If a fuse link of certain rating has failed and is replaced, then all fuse links of same rating apparently subjected to the fault should be destroyed and replaced by new fuse links.

E-18 In order to be reasonably sure that circuit breaker is capable of operation when required, these should be tripped and reclosed at regular intervals. Tripping should be proved manually and where possible electrically via the protective relay contacts. The leakage of oil, sign of corrosion, and any unusual smell which may indicate over-heating should be detected through inspections.

E-19 Timing devices are mostly designed for specialist maintenance. These should not be dismantled for maintenance or overhaul purposes unless specifically recommended by the manufacturers'. Actual timing periods should be verified with set values and application requirements.

E-20 In case of cable boxes and terminations, security of mounting and earthing should be examined. Exposed tails should be inspected for good conditions of insulation and freedom from moisture.

E-21 Battery cells should be inspected for shedding of active material, sedimentation and buckling of plates. Level of electrolyte should be regularly checked and the level should be corrected with distilled water.

ANNEX F
(*Clause* 14.6)

FORMAT FOR PREVENTIVE MAINTENANCE PROFILE OF LIFTS

Sl. No.		Maintenance S1					Maintenance S2					Maintenance S3				
	Components	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
	Tasks															
0	Contact customer															
1	Car interior calls, indicators, fixings	×	×		×		×	×		×		×	×		×	
2	Car lighting and diffuser	×	×		×		×	×		×		×				
3	Car door safety devices		×	×				×	×				×	×		
4	Levelling accuracy/jerk free/noise	×		×				×		×		×		×		
5	Landing operating panels, optical, acoustical fixings	×	×		×		×	×		×		×			×	
6	Controller: protection cover, lock, documentation	×	×	×	×		×	×	×	×		×			×	
7	Date check, error-log, LEDs check	×	×	×			×	×	×							
8	RAM/Trip counter/long-term tasks	×	×	×	×	×	×	×	×	×	×					
9	Manual/automatic passenger rescue device	×	×				×	×				×				
10	Alarm, communication systems two way with main power ‘ON’												×			
11	Emergency car communicate and lighting systems	×	×				×	×				×	×			
12	Connections, contactors, relays, electrical protections	×	×		×		×	×		×		×				
13	Floor level indicate, LED control	×	×				×	×				×				
14	Control booklet of maintenance visits and break downs according to local regulation	×					×					×				
15	Car relevelling/blocking/speed control devices		×					×					×			
16	Final limit switches		×					×								
17	Hoistway lightning		×		×				×				×			

18	Remote control devices for speed governor and machine brake		×					×								
19	Safety gear						×	×	×	×	×					
20	Maintenance operating device/short head room device		×					×					×			
21	Car top/maintenance platform, car blocking device	×			×		×	×		×						
22	Inspection: top of hoistway travel limit		×					×								
23	Motor: frame, fan, bearing Lubrication and level, fixings, pulleys	×			×	×	×			×	×					
24	Gear: tachometer, backlash, thrust bearing, oil level	×		×	×	×	×		×	×	×	×				
25	Machine brake: mechanical and electrical, coupling rubbers, brake contact		×	×	×	×		×	×	×	×	×				
26	Frequency converter	×			×		×					×				
27	Speed governor	×			×		×	×		×		×				
28	Car fixings	×		×												
29	Car suspension fixations and slack-rope contact	×	×		×		×			×		×				
30	Car guide shoes and lubricators/rollers	×		×	×	×	×			×	×	×				
31	Hoistway doors mechanical and electrical	×	×	×	×	×	×	×	×	×	×	×	×		×	
32	Hoistway information and connections	×		×	×		×		×	×						
33	Guide rail fixations	×		×												
34	Counter weight: guide shoes and lubricators, frame, suspension/divertor pulley fixation	×		×	×	×	×		×	×	×					
35	Counter weight: weight fixation/anti-jump/anti-twist buffer plate/compensation	×			×		×			×		×				
36	Speed governor rope	×										×				
37	Suspension ropes/STM condition and tension	×		×			×					×				
38	Door drive mechanical and electrical	×	×	×	×	×	×	×	×	×	×				×	
39	Car door safety contact		×	×	×			×	×	×			×			

40	Car door coupling to landing doors	×	×	×			×	×	×							
41	Hoistway pit safety set		×		×			×		×						
42	Hoistway/hoistway pit/oil collectors	×			×		×			×					×	
43	Speed governor rope tensioning pulley and contact		×	×	×	×		×	×	×	×	×				
44	Buffers	×	×		×	×	×					×				
45	Safety gear/buffer plate/guide shoes						×	×	×	×	×	×				
46	Suspension ropes/STM position, pulleys and retainers	×			×	×			×			×				
47	TSDs topper plate fixation and safety contact	×					×			×	×	×				
48	Compensating chain/rope and pulley	×		×	×	×		×		×		×				
49	Travelling cable and attachments	×						×				×				
50	Counterweight distance to buffer when car at top	×		×				×		×			×			
51	Load measuring device		×	×	×			×	×	×						
52	Fireman's control, special options, automatic evaluation	×	×					×					×			
53	Feedback to customer, if any	×						×				×				

NOTE — A = Visual Check, B = Function Check, C = Measurement, D = Cleaning, E = Lubrication

ANNEX G
(*Clauses* 14.7.1 *and* 14.7.2)

TYPICAL CHECKLISTS FOR MAINTENANCE OF LIFTS AND ESCALATORS

G-1 TYPICAL CHECKLIST FOR DAILY MAINTENANCE OF LIFTS

DAILY CHECKLIST FOR LIFTS:														
Site Name:									**Month:**		**Date:**			
Sl. No.	**Toner / Lift No.**	**Emergency Light and Car Light**	**Hooter / Alarm**	**Intercom**	**Door Sensor**	**All Calls and Indicat-ions**	**Floor Level**	**Any Noise Vibration**	**Music/ Floor Voice Announ-cement System**	**Car Fans/ Blowers**	**Car Sill and Landing Door Sills**	**CCTV**	**General Clearing**	**Remarks**
i)														
ii)														
iii)														
iv)														
v)														

G-2 TYPICAL CHECKLIST FOR MONTHLY MAINTENANCE OF LIFTS

MONTHLY CHECKLIST FOR LIFTS:																
Site:		**Location:**	**Lift No.:**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Sl No.	**Activity to be Carried Out**	**Status of Activity Carried Out**	**Details of the Parts Replaced, if Any**													**Remarks**
i)	All daily checks															
ii)	Check the oil level in machine gear box															
iii)	Inspection of ropes and its tension															
iv)	Lubrication of guide rails															
v)	Check bearing/ bush noise in machine room															
vi)	Door sensors/ alignment															

vii)	Check of hall/car call buttons and signal															
viii)	Governor checks															
ix)	Landing doors/car gate checks															
x)	ARD and controller checks															
xi)	Pit equipment checks															
xii)	Fireman operation															
xiii)	Hoistway equipment checks															
xiv)	Car signages and aesthetics															
	Sign. OBM:															
	Sign. Shift Engineer:															
	Sign. Facility Manager:															

G-3 Typical Checklist for Daily Maintenance of Escalators

SITE NAME:			**DAILY CHECKLIST FOR ESCALATORS:**									**Date:**	
Sl No.	**ESC No.**	**Location**	**Escalators Light (Comb Light, Handrail Light and, Traffic Light, Step Light)**	**Skirting/ Skirt Light and Skirt Brush**	**Balust-rade**	**Floor Plates Up/ Down**	**Steps**	**Auto/ Manual Sensors**	**Decking**	**Comb Plate**	**Handrail**	**Noise, if any**	**Remarks**
i)													
ii)													
iii)													
iv)													
v)													
	Sign. OEM: Sign. Shift Engineer: Sign. Building Manager:												

G-4 Typical Checklist for Monthly Maintenance of Escalators

MONTHLY CHECKLIST FOR ESCALATORS:													**Date:**		
Site:	**Locations:**	**Esc. No:**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Sl No.	**Activity to be Carried Out**	**Status of Activity Carried Out**	**Details of the Parts Replaced, if any**												**Remarks**
i)	All daily checks														
ii)	Check the oil level in machine gear box														
iii)	Chain tension checks														
iv)	Lubrication of all moving parts														
v)	Check bearing/ bush noise in machine														
vi)	Roller checks														
vii)	Floor plates sensors														

viii)	Hand rail speed monitor														
ix)	Step missing sensor														
x)	Broken steps chain monitor														
xi)	Broken hand rail monitor														
xii)	Over speed monitor														
xiii)	Skirt missing sensor														
xiv)	Anti-static brush														
xv)	Emergency switch Up/Down														
xvi)	Controller checks														
xvii)	Signages and aesthetics														
	Sign. OEM														
	Sign. Shift Engineer:														
	Sign. Building Manager:														

ANNEX H
(*Clause* 18.5.6)

TYPICAL CHECK LIST FOR LANDSCAPE AREAS

H-1 A typical checklist for landscape areas is given below:

a) Mow and edge lawns, if needed.
b) Prune back any shrubs overhanging curbs or sidewalks.
c) Prune back any groundcover overhanging curbs or sidewalks.
d) Remove litter and leaves from plants, planters, and parking lots.
e) Remove any broken or fallen branches from trees. Remove sucker growth from tree trunks.
f) Remove any weeds larger than 50 mm high or wide from planters. Weeds 50 mm and larger shall be removed, not just killed.
g) Replace bark mulch which has been knocked or washed out of planters. Smooth mulch layer, if it has been disturbed.
h) Replace decorative rock which has been knocked or washed out of planters. Smooth decorative rock surface, if it has been disturbed.
j) Check plants for signs of stress or disease. Replace any plants that meet conditions for replacement. Request authorization to replace other dead or missing plants (*see* Note 1).
k) Sweep or blow clean all walkways, curbs, and gutters.
m) Treat for any signs of disease or pest infestation.
n) Complete any items required on the monthly checklist.
p) Hand water any plants that are dry and stressed.
q) Check the irrigation system. Make emergency repairs as needed or request authorization to make major repairs (*see* Note 2).
r) Adjust the irrigation controllers for current water needs of plants.

NOTES

1 Request authorization to make replacements within one week of the damage becoming evident.
2 Request authorization for repairs within one week of the damage becoming evident.

ANNEX J
(*Clause* 19.4.4)

TYPICAL TEMPLATE FOR HOUSEKEEPING OF HOTELS

GENERAL CLEANING							
Month :							
Sl No.	**Indicative Scope of Work**	**Timelines**	**Reference Document**	**Impact**	**Incident Tracker**	**Non-Conformance**	**Total Conformance**
1	General cleaning		Supervisor checklist	Medium			
2	Supply of people related, housekeeping equipment, housekeeping chemical		Deployment sheet// attendance register	Medium			
	Daily activities to be completed with minimal disruptions during office hours						
3	Sweeping floors/wet mopping	Daily twice		Medium			
4	Washroom cleaning	Daily once		High			
5	Cleaning of dustbins	Daily twice		High			
6	Cleaning lift, cabin, floor and carpet	Daily once		High			
	Repetitive daily activities (*Consumables inventory*)						
7	Clean all unwanted materials collected from all floors to the main dustbin after security verification	As and when required	Supervisor checklist	Medium			
8	Dusting the window glass	Once	Supervisor checklist	Medium			
9	Clean the staircase and ensure the area is mopped and railings cleaned	Once and as and when required	Supervisor checklist	Medium			
	Weekly activities						
10	Wet mopping of emergency stair case of all floors	Once a week	Weekend checklist	Medium			
11	Deep cleaning of Plant Rooms			Medium			

12	Wiping of plumbing in STP, HT/LT room and pump room			Medium			
13	Cleaning of storage area			Medium			
14	Terrace area			Medium			
	Fortnightly activities						
15	Clean the cob-webs at all floors	Once a fortnight	Weekend checklist	Medium			
16	Polishing of lift cabin with relevant chemicals to maintain the shine			Medium			
17	Water cleaning of the parking area using high pressure jet			Medium			

ANNEX K
(*Foreword*)

CHECK LIST FOR SAFETY IN OPERATION
(Clause 25)

K-1 This annexure is designed to ensure safety in operational activities related to construction and building maintenance. It provides a checklist to be used by facility managers and safety officers to identify potential hazards and ensure compliance with safety standards.

Parameter	Details/Remarks	Verified (Yes/No)
1. Construction Equipment Inspection	Regular inspection of all construction equipment to ensure proper functioning.	
2. Construction Inspection Checklist	Follow a comprehensive checklist for inspecting construction activities.	
3. Electrical Inspection Checklists	Ensure that all electrical systems are regularly inspected to avoid hazards.	
4. Electrical Safety	Verify that electrical systems are properly grounded and insulated for safety.	
5. Emergency Equipment	Check if emergency equipment is readily available and in working condition.	
6. Emergency Preparedness	Ensure emergency protocols are in place and communicated to all personnel.	
7. Equipment Safety	Inspect equipment to ensure safety measures, such as guards and controls, are in place.	
8. Eye Protection Available	Verify that workers have access to eye protection gear where necessary.	
9. Fall Protection	Check that fall protection measures, such as harnesses and guardrails, are in place.	
10. Fire Extinguisher Inspection Log	Maintain a log to ensure fire extinguishers are inspected and functional.	
11. Fire Safety	Ensure that fire safety measures, including alarms and extinguishers, are in place.	
12. Foot Protection	Confirm that all workers have appropriate foot protection, such as safety shoes.	
13. Hardhats	Ensure that all personnel wear hardhats on-site to prevent head injuries.	
14. Hazard Identification Sheets	Use hazard identification sheets to document potential risks in the workplace.	
15. Hazardous Substances	Check for the safe storage and handling of hazardous substances.	
16. Head Protection	Verify that workers are equipped with appropriate head protection.	

17. Housekeeping	Ensure the workplace is free of clutter and obstacles to prevent accidents.	
18. Inspecting the Workplace	Conduct regular inspections to identify and eliminate potential hazards.	
19. Ladder and Scaffolding Safety	Ensure ladders and scaffolding are in good condition and used safely.	
20. Ladders	Verify that ladders are inspected and safe for use.	
21. Medical and First Aid	Ensure first aid kits and medical supplies are accessible and properly stocked.	
22. Personal Protective Equipment	Confirm availability and proper use of personal protective equipment (PPE).	
23. PPE Inspection	Regularly inspect personal protective equipment for damage and wear.	
24. Scaffolding	Inspect scaffolding for structural integrity and proper setup.	

ANNEX L
(*Foreword*)

CHECK LIST FOR MONSOON PREPAREDNESS
(Clause 25)

L-1 This checklist aims to assist building owners and facility managers in ensuring that their structures are adequately prepared for monsoon conditions, mitigating potential risks and ensuring safety for both the building and its occupants.

Parameter	Details/Remarks	Verified (Yes/No)
1. Adjusting Work Schedules	Ensure work schedules are adapted to account for potential weather delays and safety.	
2. Check Electrical Fittings	Inspect all electrical fittings to prevent potential short circuits and hazards during rains.	
3. Check for Cracks	Identify and repair any structural cracks that could worsen due to water ingress.	
4. Check Terrace Level Difference	Ensure there is a proper slope for water drainage to prevent water accumulation.	
5. Clean Drains Before It Rains	Clear all drainage systems to avoid blockages during heavy rainfall.	
6. Drainage	Verify that all drainage pipes and systems are functioning properly.	
7. Electrical Safety	Ensure all electrical systems are insulated and protected from water exposure.	
8. Emergency Preparedness	Have an emergency plan in place for flooding or other rain-related issues.	
9. Ensuring Structural Stability	Assess the building's structural stability to handle increased water load and weather impact.	
10. Equipment and Tool Maintenance	Ensure all equipment and tools are properly maintained to avoid damage during monsoon.	
11. Leakages	Inspect for potential leak points in roofs, walls, and windows, and address them promptly.	

12. Lightning Protection	Check if lightning protection systems are in place and functioning properly.	
13. Personal Protective Equipment	Ensure workers have appropriate protective gear for wet conditions and slippery surfaces.	
14. Preventing Electrical Hazards	Put preventive measures in place to avoid electrical hazards due to water exposure.	
15. Regular Inspections	Conduct regular inspections throughout the monsoon to identify and mitigate issues early.	
16. Roofs	Inspect roofs for structural integrity and water-proofing.	
17. Structural Integrity	Check that the building's structural elements are sound and can withstand heavy rains.	
18. Ventilation	Ensure proper ventilation to avoid dampness and mold growth during the monsoon.	
19. Waterproof Your Home	Apply waterproofing treatments to vulnerable areas, such as walls and terraces.	
20. Weather Monitoring	Monitor weather reports to anticipate and prepare for upcoming heavy rains.	
21. Windows and Doors	Check that all windows and doors are sealed properly to prevent water leakage.	
22. Worker Safety Measures	Implement safety measures for workers on-site during rainy conditions.	

ANNEX M
(*Foreword*)

CHECK LIST FOR BUILDING OPERATION INSURANCE
(Clause 25)

M-1 This checklist serves as a comprehensive guide for building owners and facility managers to ensure that all aspects of building insurance are adequately covered, specifically identifying and mitigating potential risks.

Parameter	Details/Remarks	Verified (Yes/No)
1. Coverage Scope	Ensure the insurance policy covers all intended building operations and assets.	
2. Policy Exclusions	Review and understand exclusions listed in the policy that are not covered.	
3. Workers' Compensation	Check if the policy includes compensation coverage for employees injured on duty.	
4. Commercial Liability	Confirm that commercial liability, including damage to third-party property, is included.	
5. Professional Liability	Verify that the policy covers liabilities arising from professional services provided.	
6. Directors' and Officers' Liability	Ensure coverage is provided for directors and officers in case of legal actions.	
7. Business Registration Papers	Confirm that valid business registration documents are maintained and updated.	
8. Precautionary Measures	Check if the building has precautionary measures in place to mitigate risk (for example, fire alarms, safety systems).	
9. Third-Party Liability	Ensure third-party liability coverage for accidents involving visitors or contractors.	

LIST OF STANDARDS

The following list records those standards which are acceptable as 'good practice' and 'accepted standards' in the fulfillment of the requirements of the Code. The latest version of a standard shall be adopted at the time of enforcement of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirements of the referred clauses in the Code.

In the following list, the number appearing in the first column within parentheses indicates the number of the reference in this Part.

	IS No.	*Title*
(1)	15183 (Part 2) : 2018	Guidelines for maintenance management of buildings: Part 2 Finance (*first revision*)
(2)	15183 (Part 3) : 2018	Guidelines for maintenance management of buildings: Part 3 Labour (*first revision*)
(3)	11208 : 1985	Guidelines for registration of plumbers
(4)	17650 (Part 1) : 2021	Water efficient plumbing products – Requirements: Part 1 Sanitaryware
	17650 (Part 2) : 2021	Water efficient plumbing products – Requirements: Part 1 Sanitary fittings
(5)	13182 : 2020	Waterproofing and damp-proofing of wet areas in building-Recommendations (*first revision*)
(6)	2064 : 1993	Code of practice for selection, installation and maintenance of sanitary appliances (*second revision*)
(7)	2190 : 2010	Selection, installation and maintenance of first-aid fire extinguishers — Code of practice (*fourth revision*)
(8)	2189 : 2008	Selection, installation and maintenance of automatic fire detection and alarm system — Code of practice (*fourth revision*)
(9)	15301 : 2003	Installation and maintenance of fire fighting pumps — Code of practice
(10)	13039 : 2014	External hydrant systems — Provision and maintenance — Code of practice (*first revision*)
(11)	3844 : 1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (*first revision*)

(12) 15105 : 2021 Design and installation of fixed automatic sprinkler fire extinguishing systems — Code of practice

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