IFMA's Operations and Maintenance Course

Student Guide

IFMA™
International Facility Management Association
Empowering Facility Professionals Worldwide

Acknowledgements

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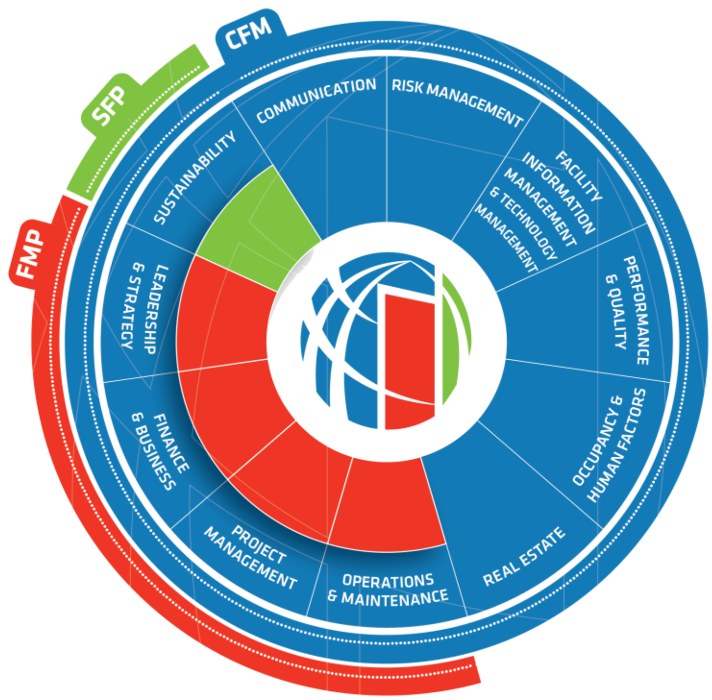
IFMA Credentials

About IFMA Credentials

After analyzing the work performed by facility managers, we have defined 11 competency areas. Our three world class FM credentials. — Facility Management Professional™ (FMP®), Sustainability Facility Professional® (SFP®), and Certified Facility Manager® (CFM®) — are based on these competencies.



1. The FMP is the foundational credential for FM professionals and industry suppliers looking to increase their depth-of-knowledge on the core FM topics deemed critical by employers.
2. The SFP is the leading credential for all facilities managers and like-minded professionals who are interested in the development of sustainable FM strategies.
3. The CFM is the premier certification for experienced FM professionals. A comprehensive exam assesses knowledge, skills, and proficiency across all FM competency areas.

Facility Management Professional (FMP) Program

IFMA's Facility Management Professional (FMP) credential is an assessment-based certificate program. This program demonstrates the fundamentals of facility management (FM). Developed from a foundation based on IFMA's global job task analysis (GJTA), the FMP Credential Program is continuously refreshed to align with current industry standards

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for FM knowledge, skills and tasks. The knowledge demanded by today's global employers is taught and tested online or in the classroom.

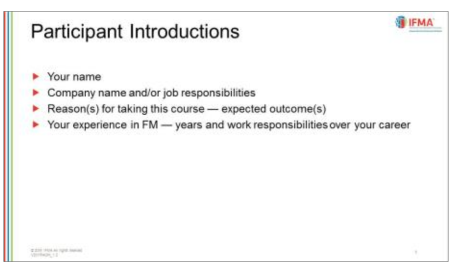
The four knowledge domains that the FMP Credential Program provides content and assessments on are:

- Operations and maintenance
- Project management
- Finance and business
- Leadership and strategy

This course focuses on operations and maintenance. To receive the FMP credential, successfully complete all four courses (via elearning or instructor-led channels) and final assessments and submit an FMP application to IFMA for approval.

Course Overview

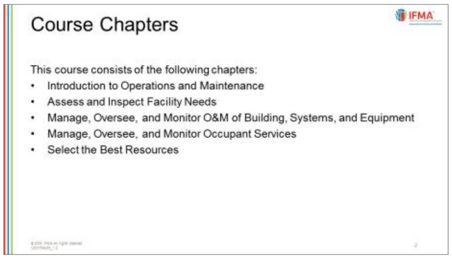
Introductory Activity



Course Audience

This course is designed for persons intending to earn their FMP credential or enhancing their FM industry professional development.

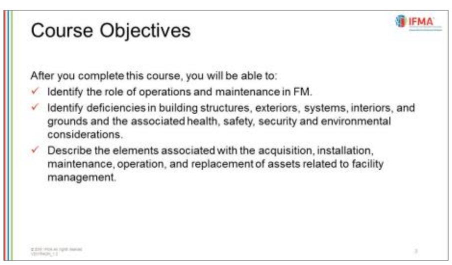
Course Chapters

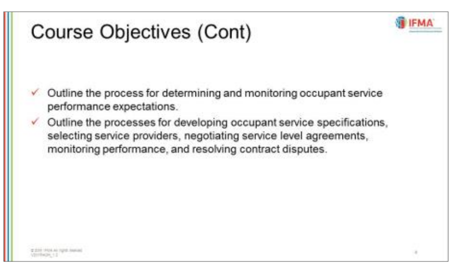


This course consists of the following chapters:

- Introduction to Operations and Maintenance
- Assess and Inspect Facility Needs
- Manage, Oversee, and Monitor O&M of Building, Systems, and Equipment
- Manage, Oversee, and Monitor Occupant Services
- Select the Best Resources

Course Objectives





After you complete this course, you will be able to:

- Identify the role of operations and maintenance in FM.
- Identify deficiencies in building structures, exteriors, systems, interiors, and grounds and the associated health, safety, security and environmental considerations.
- Describe the elements associated with the acquisition, installation, maintenance, operation, and replacement of assets related to facility management.

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Course Introduction

Facility Management (FM)

FM encompasses multiple disciplines which ensure functionality of the built environment, this profession requires a broad range of knowledge and skills.

IFMA conducts a global job task analyses (GJTA) to identify task, knowledge and skill areas that are important for competent performance by facility managers. The GJTA updates the core foundation of competency areas that contain the body of knowledge for FM and FM professionals.

Role of Facility Managers as Related to Operations and Maintenance

According to the IFMA GJTA:

> *The primary role of facility managers is to manage/oversee an operating facility. To do this, facility managers must have a working knowledge of building systems, structure, interiors and exteriors and grounds so the facility and all of its required systems function efficiently, reliably, safely, securely and in a manner consistent with existing regulations and standards.*

In addition, the various aspects of operations and maintenance (O&M) are constantly changing due to wear or deterioration, new regulations or requirements, operational modifications, occupant expectations, and many other individual but interrelated circumstances. Managing a facility means continually managing change.

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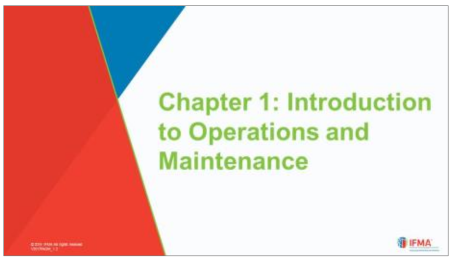
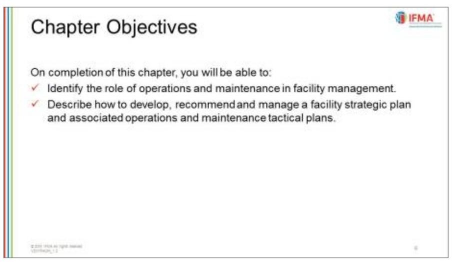
Chapter 1: Introduction to Operations and Maintenance

Chapter Introduction





On completion of this chapter, you will be able to:

- Identify the role of operations and maintenance in facility management.
- Describe how to develop, recommend and manage a facility strategic plan and associated operations and maintenance tactical plans.

The term **demand organization** is referenced throughout this document. ISO 41011 defines demand organization as an entity which has a need and the authority to incur costs to have requirements met.

The demand organization terminology is used to bring clarity to the relationship between the parties involved by focusing on the process itself. The demand organization and the FM organization to work together to clearly define needs to meet the core business strategy and to develop FM policies and practices that will enable the core business activities of the demand organization.

Lessons

- Operations and Maintenance Overview
- Begin with a Plan

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Operations and Maintenance Overview

Lesson Introduction

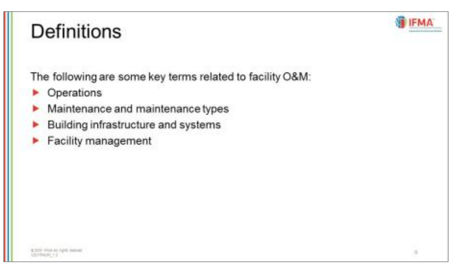
On completion of this lesson, you will be able to:

- Identify the role of operations and maintenance in facility management.

This lesson contains the following topics:

- Definitions
- Facility Manager Duties and Responsibilities

Definitions



The following are some key definitions related to facility operations and maintenance (O&M):

- Operations ensure that the facility's building infrastructure usage and management provides a satisfactory business environment that is in compliance with all laws and regulations, meets financial goals, reflects efficient utility services and costs, and protects the surrounding community and environment.

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- Maintenance ensures that all elements of building infrastructure are serviced to operate effectively, efficiently, and are reliable and safe. Periodic, predictive, preventive, and corrective activities are scheduled, conducted, and monitored regularly. Operations keep the facility functional for its intended purpose and maintenance sustains the asset's anticipated productive life.
  - The aim of Predictive Maintenance (PdM) is first to predict when equipment failure might occur, and secondly, to prevent the occurrence of the failure by performing maintenance. Monitoring for future failure allows maintenance to be planned before the failure occurs. Ideally, predictive maintenance allows the maintenance frequency to be as low as possible to prevent unplanned reactive maintenance, without incurring costs associated with doing too much preventive maintenance.
  - Preventive Maintenance (PM) is a fundamental, planned maintenance activity performed at regular predefined intervals, designed to improve equipment life and avoid any unplanned maintenance activity.
- Building infrastructure consists of building systems, building structures, interior elements including furniture, fixtures and equipment, exterior envelope, separate structures and grounds.
- Facility management (FM) is the organizational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business (ISO 41011:2017). From an operations and maintenance perspective, FM is at the center of occupant needs, business and communication processes, management, workflow and the physical infrastructure itself, as shown in *Exhibit 1-1*.

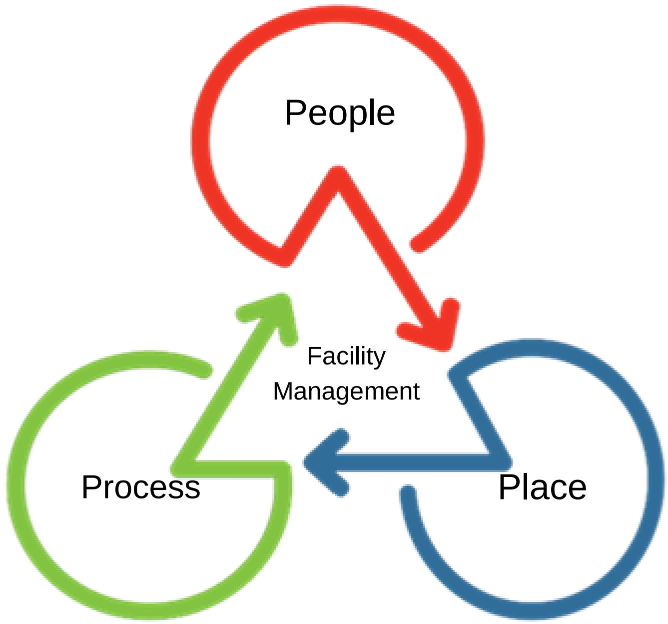
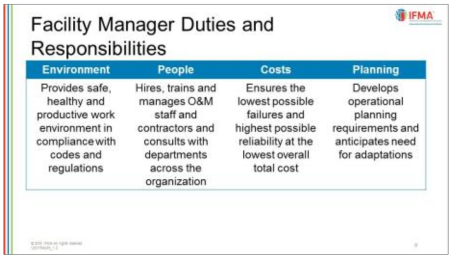


Exhibit 1-1: Interacting Responsibilities

Operations and maintenance methods vary by company and organization. For the purpose of this course, IFMA organizes O&M into hard and soft services.

- A hard service is referred to as O&M essential for the **facility's building infrastructure.**
  - For example, HVAC maintenance and building maintenance.
- A soft service is referred to as O&M for **occupant needs**.
  - For example: Cafeteria and cleaning services.

Facility Manager Duties and Responsibilities



Operations and maintenance represent a cost center. It adds directly to the cost of an organization but only indirectly to its profit. O&M produces a total expense second only to the salary or pay of occupants in a typical facility. This makes operating and managing facilities critical in the overall success of the organization.

Facility managers must know how to bring methods and procedures together to ensure the functionality, comfort, efficiency and safety of the built environment. Being directly responsible for the physical asset's condition and function, the facility manager must adapt and respond to optimize the asset's life expectancy while balancing the needs of the organization. The success of these efforts is measured with productivity and performance results.

The facility manager should be qualified to direct operations and maintenance activities within established organization policies, across the demand organization. The facility manager should be accountable for and able to demonstrate the lowest overall total cost of ownership of O&M to provide the optimum level of service that meets the needs of the organization and those who occupy the facility. To accomplish this, facility managers will need to draw from their experience and business capability to search for external resources who can provide O&M planning and organization.

Facility managers must become familiar and comfortable in their understanding of the organization and should:

- Understand the demand organization and its culture. The facility manager should know the long-term plan, or O&M operating plan, and be familiar the plan aspects such as the expectations, set goals, and what has been prepared to realize these goals.
- Know what the mission-critical issues are, what the owner and executive decision makers consider most important, such as productivity, customer satisfaction, quality, security, systems/equipment, performance, and reliability.
- Identify operational and management issues relative to financial planning, budgeting and capital projects.
- Be familiar with the status of service contracts and agreements.

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- Have knowledge of any automated management system or other computerized maintenance management system that is used for facility O&M.
- Be prepared and able to organize, track, analyze, discuss and interpret service activities for executive-level presentation to decision makers.

A facility manager is expected to operate and maintain the facility in a manner that supports the goals and mission of the demand organization. They must interpret and identify the needs of the organization and occupants/customers while balancing competing requirements.

In this way, the facility manager is able to manage the environment, people, costs and planning:

Environment	**People**
• Provide safe, healthy and productive facility environments. • Develop, implement and manage recycling and sustainability programs. • Develop, recommend and manage facility operational planning requirements, such as temperature control, lighting and equipment replacement. • Facilitate the use of automated facility management technology, such as computer-based workflow, operations and analysis functions. • Produce suitable and publicly satisfactory overall appearance and aesthetics.	• Provide efficient, cost-effective support services (contracted or internal staff) throughout the demand organization. • Hire, train, manage and assess the technical performance and occupant service performance of O&M staff. • Act as a consultant to other departments on facility-related matters. • Consider human factors as an integral component of facility operations and maintenance.
Costs	**Planning**

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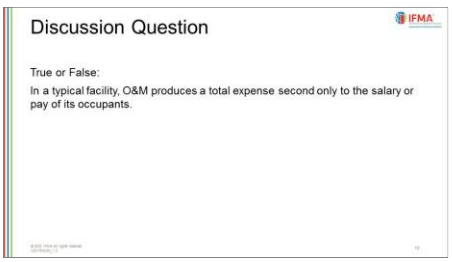
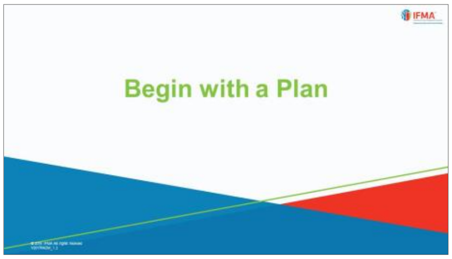
• Develop operations which successfully balance cost and performance. • Provide more efficient use of facility assets for increased occupant productivity, lower overtime expense and lower energy consumption.	• Anticipate change and plan in advance for necessary adaptations. • Comply with all relevant international, national and local codes and regulations. • Ensure appropriate fire, life safety and emergency response readiness • Participate in Business Continuity exercises and planning.



Begin with a Plan

Lesson Introduction



On completion of this lesson, you will be able to:

- Describe how to develop, recommend and manage a facility strategic plan and associated operations and maintenance tactical plans.

This lesson contains the following topics:

- Strategic Planning
- Determine Physical Assets as an Inventory
- Determine Maintenance and Repair Cycle
- Determine Maintenance Schedule
- Determine Applicable Regulations, Codes and Standards
- Determine Agreed-Upon Occupant Services and Requirements

Strategic Planning

Facility managers should have a detailed and complete management plan. Planning is essential to anticipate both long-term, or strategic, and short-term, or tactical, requirements. It forms the basis of how facility O&M is successfully applied to all assets of the building infrastructure so that occupants/customers are satisfied, and the organization’s mission is accomplished.

Strategic planning helps the facility manager to determine:

- The level of service expected and needed.
- Operations and maintenance policies, procedures, standards and best practices.
- Operational requirements.

- Maintenance program requirements in detail and specified through service level agreements.
- Operational and capital improvement projects based on total cost of ownership and life-cycle cost analysis (LCCA).
- Availability and capability of facility management organization's resources.
- Services, statements of work and tasks to contract an outside provider.
- Programs for quality control and assurance.
- Key performance indicators and balanced scorecard measurements help the facility manager to identify, prioritize and update a strategic building infrastructure long range plan.

All of these aspects are defined and discussed in greater detail throughout this course. This is a high-level introduction.

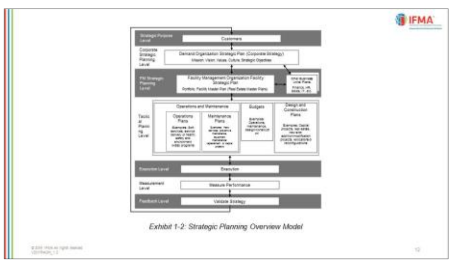


Exhibit 1-2: Strategic Planning Overview Model

Plans begin at a high strategic level and proceed to the ever-greater detail of tactics to accomplish the strategy. A **tactical plan** is a detailed set of steps needed to accomplish a goal in the strategic plan.

For O&M, levels of planning may include:

- Identifying the *strategic purpose and planning* levels, which take the requirements and expectations of occupants or customers into consideration and align them to the mission, vision, values and culture of the demand organization
- Recognizing that each *business unit*, department or external service provider of an organization may develop its own strategic plans aligned with the organization’s strategy.
- Recognizing that *tactical plans* are the steps needed to accomplish the goals of the strategic plans. Tactical plans are short-range activities covering a year or less. For FM these tactics are represented through maintenance schedules, operational activities, service delivery outcomes, equipment replacement timelines, budget development and other O&M tasks.
- Understanding that *execution, measurement, and feedback* produce a set of strategic and tactical plans as a step in the larger process.

The goal of strategic planning is to develop business-driven schemes or strategic plans and turn them into action. A **strategic plan** outlines the organization's direction; it defines broad, long-term, significant plans, methods and actions that will be put into operation.

Exhibit 1-2: Strategic Planning Overview Model demonstrates how an organization defines and aligns its mission and core values to operations and maintenance. It is an overview of the various levels above and below strategic planning and is an iterative life-cycle model meaning that the final activity, Validate Strategy, feeds back to the start of the process.

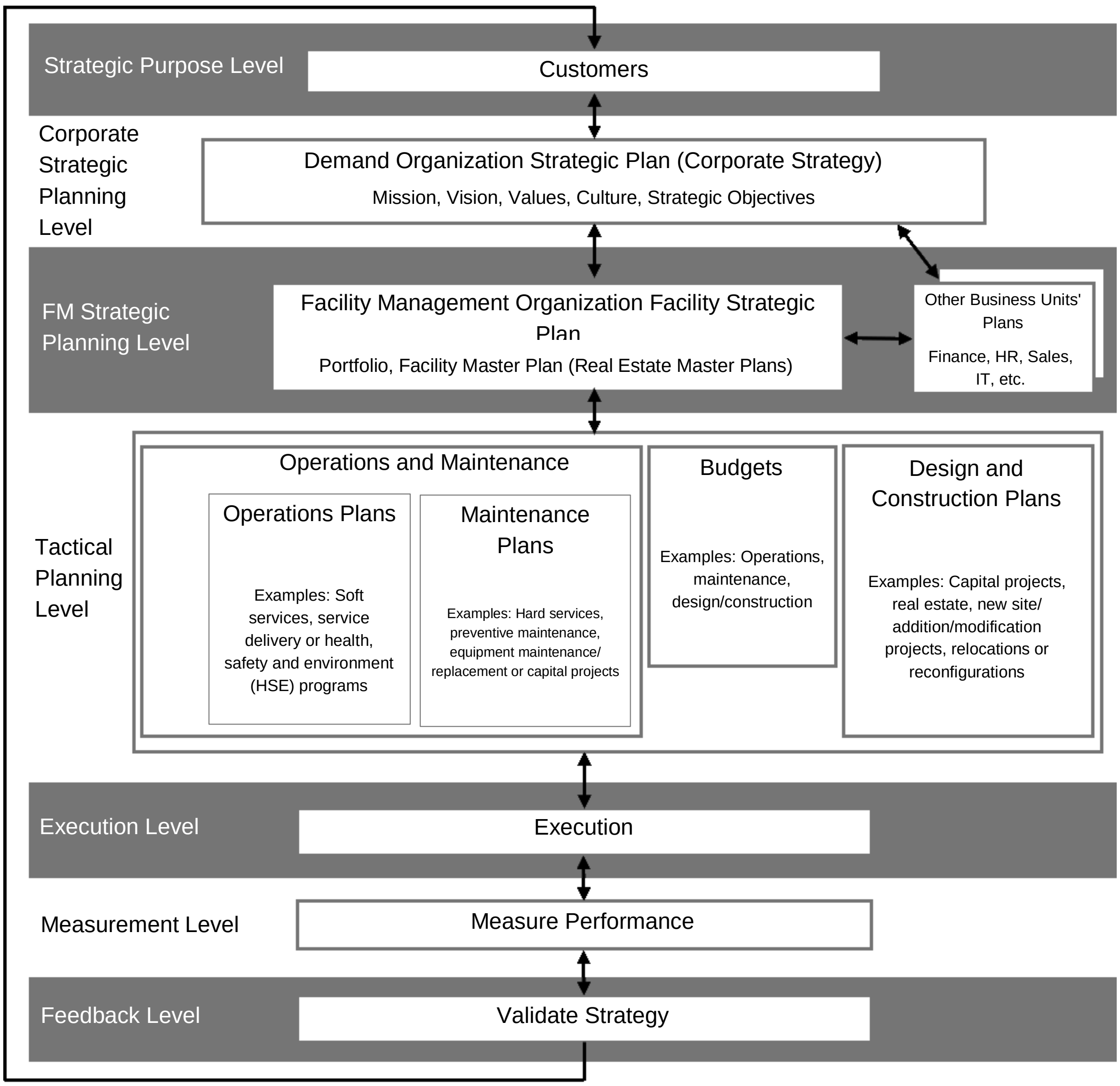
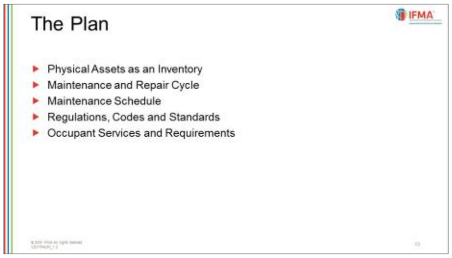


Exhibit 1-2: Strategic Planning Overview Model

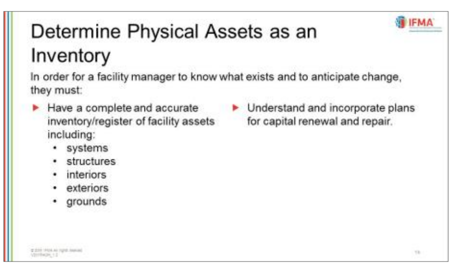


The facility manager develops an O&M approach by determining several aspects:

- Physical assets as an inventory
- Maintenance and repair cycle
- Maintenance schedule
- Applicable regulations, codes and standards
- Agreed-upon occupant services and requirements

Other aspects, such as preparing budgets, developing design and construction plans and preparing for capital renewal, are covered in the IFMA FMP Credential Program courses *Project Management* and *Finance and Business*.

Determine Physical Assets as an Inventory



To apply a facility strategic plan and the subsequent O&M plans, the facility manager must determine exactly what building infrastructure assets are contained and the long-term plans to replace capital items. A complete program of capital renewal and repair plans must be in place to manage the physical infrastructure.

A facility's physical assets are not static; they continually change due to wear, age, obsolescence, organizational change or other time-related factors. FM requires agility and adaptability and can be considered an agent for facility change management. The facility manager needs to anticipate change based on tendencies, insight and actual equipment, component or service conditions. FM requires a thorough, detailed knowledge of the present condition of the infrastructure's physical elements, equipment life expectancies and maintenance.

In order to know what exists and to anticipate its deterioration, on-going maintenance needs, and replacement, the facility manager needs a complete and accurate inventory/register of facility assets (see *Exhibit 1-3: Facility Assets Register).* To manage the ongoing change of assets, processes should be implemented to keep the inventory maintained and up to date.

If a current complete and up-to-date inventory/register is not available, the facility manager should initiate an inspection to create one by listing all assets and their corresponding components.

During the inspection, facility personnel or third-party inspectors should look for abnormalities in building systems such as:

- Poor working order
- Missing items
- Deficiencies
- Illumination problems
- Spills, evidence of leakage, gas releases, insufficient air movement
- Corrosion
- Excessive or unusual noise, vibration
- Safety or security hazards such as missing spark arrestors, open vents, trip hazards, intrusion potential (access grates or grills)
- Safety-code violations
- Environmental risks
- Incorrect components/applications

A facility inspection has other purposes beyond verifying that equipment and systems operation are occurring as intended. The facility manager may also use the inspection to:

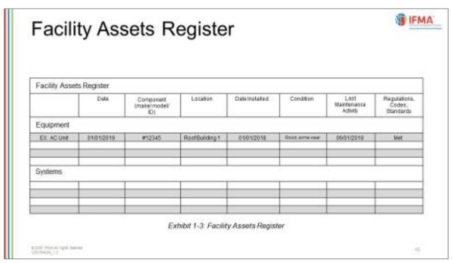
- Confirm the effectiveness of current preventive, predictive and corrective programs.
- Interact with occupants to collect their observations and feedback relative to the mission and vision of the demand organization.

Once a facility inspection is completed and the inventory/register is documented, it can also become part of a contractual arrangement through a lease or other service agreement.

The inventory/register is the basis for operations and maintenance plans that address all the physical elements contained in the building infrastructure.

The physical assets are related to other aspects of facility management that include the following:

- Security and safety, such as emergency preparedness and business continuity
- Technology, such as security, information, and building automation systems
- Environmental stewardship and sustainability
- Project management, or the ability to successfully carry out O&M activities
- Quality, or the performance to specifications
- Finance and business, the fiscal and contractual responsibility
- Leadership and strategy, the ability to lead and inspire others to work at their peak performance levels and to always see the big picture



Each of these is an IFMA core competency area comparable to O&M. For the purposes of this course, it is important to recognize that having an inventory/register of physical assets is the necessary foundation upon which all other tasks and these separate competencies are built.

Facility Assets Register							
	Date	Component (make/ model/ ID)	Location	Date Installed	Condition	Last Maintenance Activity	Regulations, Codes, Standards
Equipment							
EX: AC Unit	01/01/2019	#12345	Roof Building 1	01/01/2018	Good; some wear	06/01/2018	Met
Systems							

Exhibit 1-3: Facility Assets Register

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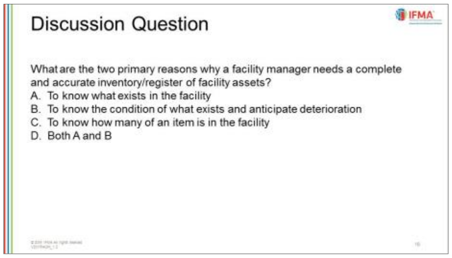
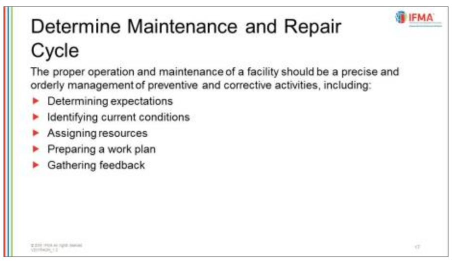


Determine Maintenance and Repair Cycle



Facilities need to be properly maintained, repaired and operated to meet occupant/visitor needs and regulatory requirements. The decisions on when to apply predictive, preventive or no scheduled maintenance are determined by, safety, overall cost, available resources, occupant satisfaction and productivity. In this way, facility maintenance may be considered a return on performance rather than just a property investment.

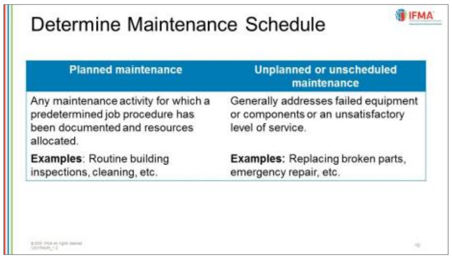
The proper operation and maintenance of a facility should be a precise and orderly management of preventive and corrective activities.

The FM manages these activities in a controlled, predetermined cycle that incorporates the range of operational aspects, such as:

- Equipment and systems operations, maintenance and repair
- Renewal, alterations and relocations, or moves
- Energy management
- Waste management and recycling
- Fire/life safety, disaster recovery, health and safety

Each of these operational areas is discussed in other topics in this course. They may all be part of a planning cycle that generally consists of determining needs and expectations, identifying current conditions and gaps, assigning resources, preparing a work plan, executing works, commissioning and gathering feedback.

Determine Maintenance Schedule



A maintenance schedule represents an O&M tactical approach that is time-related, where the activities that occur the soonest are known and the more distant activities are less known. Activities expected in the short-term have challenges and requirements that have been identified. Activities that may occur later or long-term, need planning and preparation in advance. The short-term strategy determines what to do to maintain and improve current O&M management and services. The long-term strategy considers all the variables and aspects of sustainability, quality, occupant services, provisions for equipment and capital renewal estimates. It identifies priorities, compares costs, determines services and forecasts future needs/requirements.

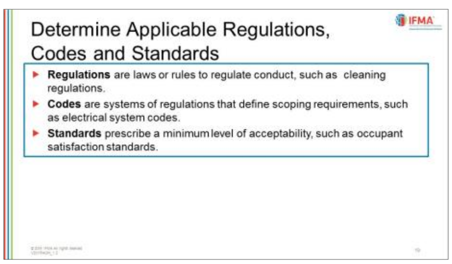
Whether the planning is short-term or long-term, it is important to include the qualitative aspects of maintenance activities such as ownership goals, staff or contractor expertise, occupant expectations and priorities. These soft elements relate to an O&M approach that recognizes and incorporates both planned and unplanned maintenance aspects.

- **Planned maintenance** — is any maintenance activity for which a predetermined job procedure has been documented and for which all labor, materials, tools and equipment required to carry out the task have been estimated and their availability assured before commencement of the task.
- **Unplanned or unscheduled maintenance** — is any maintenance work that has not been included on an approved maintenance schedule prior to its commencement. It generally addresses failed equipment or components or an unsatisfactory level of service. Level of service is discussed in later in this course.

Maintenance may be planned or unplanned. The facility manager employs preventive and predictive maintenance and repair activities to lower cost and prevent expensive breakdowns, by implementing a small proportion of unplanned, or corrective, maintenance. It is not possible to eliminate unplanned maintenance. Best practice is to find the optimum balance between preventive and corrective maintenance. This is worked on a ratio of 80 percent preventative maintenance and 20 percent corrective maintenance, to realize the optimized reliability at the lowest cost. When planning maintenance, a facility manager needs to recognize the potential impacts, determine how best to mitigate the impacts on occupants and identify where there are dependencies on others or tasks to properly schedule and plan.

With a plan in place, the facility manager can execute an orderly approach to the business of operating and maintaining building systems, structures, interiors, exteriors and grounds. Properly maintained facilities meet the expectations of occupants, the obligations of owners and the requirements of regulators. It should not matter whether facilities are owned or leased. Meeting the minimum expectations of all parties should be important to the facility manager.

Determine Applicable Regulations, Codes and Standards



Regulations, codes and standards have been established across the world. Many share common requirements internationally. These documents define minimum or required parameters for most aspects of a facility and include nearly everything for which a facility manager is responsible.

- **Regulations** — are laws or rules prescribed by an authority to regulate conduct; an official governmental regulatory act that transmits a stated purpose.
- **Codes** — are systems of regulations that define scoping requirements. Internationally and in the United States, model codes (such as those provided by International Code Council, or ICC) are adopted, amended and enforced at the local level. These codes refer to many other codes and standards that cover building, environmental, safety, barrier-free access and other requirements.
- **Standards** — state the minimum level of acceptability and incorporate the technical installation requirements of the code when/where referenced.

Building codes are performance and prescriptive requirements for building construction, operations and maintenance. They establish predictable and consistent minimum standards that are applied to the quality and durability of construction materials and building systems. Construction must meet minimum standards that determine what is practical and adequate for protecting life, safety and the welfare of the public.

Building codes can embrace all aspects of building construction, including:

- Fire and life safety issues
- Structural design
- Mechanical systems
- Electrical systems
- Plumbing systems
- Energy conservation
- Occupancy requirements
- Sustainability
- Accessibility

Building codes provide safeguards to ensure uniformity in the construction and facilities industries.

While codes provide a means to reduce risks to an acceptable level, no code can totally eliminate all potential hazards. Government agencies or authorities that have jurisdiction may interpret and enforce codes differently from country to country and at different times. Local regulators or even facility owners or executives may require exceptions that exceed nominal code requirements to make them more appropriate to the purpose or mission of the facility.

In addition, regulations, codes and standards themselves can change regularly. New references may be published each year and updated even more frequently.

Facility managers should be aware of all applicable requirements, should be current in their understanding and should include those codes, regulations and standards in all considerations of building systems, structures, interiors, exteriors and grounds.

Codes, regulations and standards change so frequently and continuously that it is not practical to list them in a document such as this. A useful, international, relatively current appendix is available through the IFMA FMP Credential Program Resource Center.

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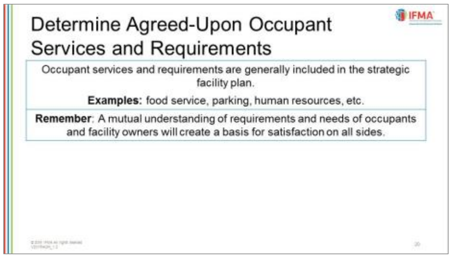
Determine Agreed-Upon Occupant Services and Requirements



To create a safe, productive and occupant-pleasing environment, the facility manager takes an active role in providing the services and requirements occupants and facility owners/decision makers need and expect. These needs and expectations form the basis for operations plans and these routine facility management activities must function within the approved funds and staff resources available.

Services and requirements need to be agreed upon by those who require them and those who provide them. A mutual understanding provides the basis for satisfaction on both sides.

Considerations about customers or, in the case of facility management, occupants, are included at the highest strategic level. Both the demand and FM organization include these considerations as part of the strategic plan.

Planning and measuring approaches such as service level agreements and performance measurements support this mutual understanding. These aspects are discussed later in this course.

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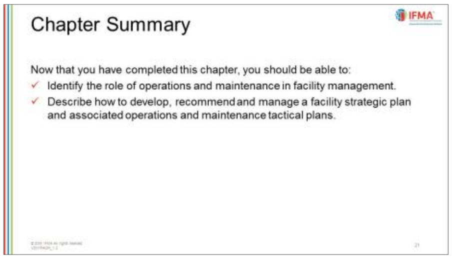

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Progress Check Questions

1. Read the following definition and select its corresponding term.

   What aspect of a facility's usage and management, CAN provide a satisfactory business environment AND comply with laws and other factors?

   a. Maintenance
   b. Building infrastructure
   c. Operations
   d. Facility management

2. What does maintenance NOT ensure?

   a. Effective and efficient operation of equipment.
   b. Integration of people, place and process.
   c. Monitoring of assets.
   d. Prevention of failures.

3. What must the operation and maintenance of the facility support?

   a. The goals and mission of the organization.
   b. Environment, people, costs and planning.
   c. The needs of occupants.
   d. All of the above.

4. What should FM be able to do to be effective?

   a. Identify operational and management issues relative to financial planning, budgeting and capital projects.
   b. Be vaguely familiar with the status of service contracts and agreements.
   c. Have knowledge of all management systems that are used for the entire organization.
   d. Be prepared and able to organize, track, analyze, discuss and interpret service activities with major customers of the organization.

5. If a complete, accurate inventory/register is NOT available, what should the facility manager do?
    a. Begin to create one as new assets are acquired and installed.
    b. Develop a plan to create one.
    c. Observe how individual assets are functioning based on work logs and condition reports.
    d. There is nothing a facility manager can do.

6. What does a maintenance and repair cycle typically include?
    a. An examination of facility assets and capital improvement expectations.
    b. An energy management review.
    c. A combination of preventive and corrective activities.
    d. A schedule of methods and resources.

7. How are maintenance activities typically divided?
    a. Operable and inoperable.
    b. Predictive and unnecessary.
    c. Strategic and tactical.
    d. Planned and unplanned.

8. What is NOT determined from strategic planning? OR What does strategic planning NOT address?
    a. Level of service that is expected.
    b. Capability of the organization's resources.
    c. Operational requirements.
    d. Maintenance program failures.

9. What best describes unplanned maintenance?
    a. Activities that were documented before commencement.
    b. Activities not included on an approved maintenance schedule.
    c. The prevention of costly breakdowns.
    d. All of the above.

10. What best defines laws or rules prescribed by an authority to regulate conduct?

    a. Codes
    b. Standards
    c. Regulations
    d. Ordinances

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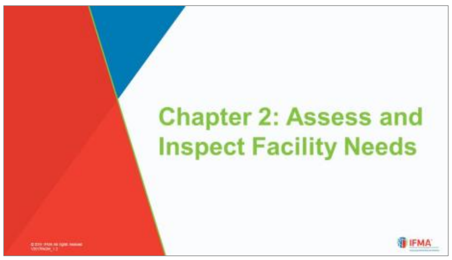
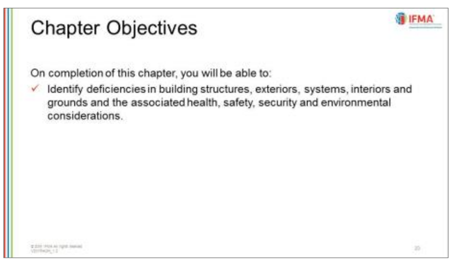
Chapter 2: Assess and Inspect Facility Needs

Chapter Introduction





On completion of this chapter, you will be able to:

- Identify deficiencies in building structures, exteriors, systems, interiors and grounds and the associated health, safety, security and environmental considerations.

It is important to note for this chapter that:

- An assessment is an evaluation of an item's nature, performance or quality.
  - Includes regulatory compliance, adherence to standards, condition and design adherence, and are done on a less frequent basis.
- An inspection is a thorough investigation conducted on specific items.
  - Includes evaluating the condition and function of components and are done on a more regular basis.

Lessons

- Assess and Inspect Condition of Building Structure
- Assess and Inspect Exterior Structures and Elements
- Assess and Inspect Condition of Building Systems
- Assess and Inspect Interior Furnishings, Fixtures and Equipment

- Assess and Inspect Grounds
- Chapter Activity

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Assess and Inspect Condition of Building Structure

Lesson Introduction

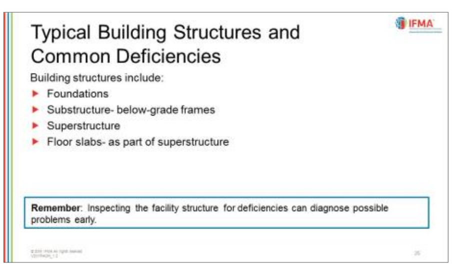
On completion of this lesson, you will be able to:

- Describe the common deficiencies in building structures and the associated health, safety, security and environmental considerations.

This lesson contains the following topics:

- Typical Building Structures and Common Deficiencies
- Health, Safety, Security and Environment Considerations

Typical Building Structures and Common Deficiencies



Building structures are the construction elements that support the building design/framework, such as walls, glazing, façade, structural components, foundation, subfloors, roof, elevator shafts and stairwells. They enable buildings to support the forces of users, such as occupants or visitors, and of nature, such as wind, rain, heat or earthquakes, and the equipment that maintains the structure's intended purpose. Elements of building structures include those listed in *Exhibit 2-1*.

Exhibit 2-1: Elements of Building Structures

Building Structures	Elements
Foundations	• Drilled piers, caissons and shafts • Driven and bored piles, such as steel, wood and precast concrete • Shallow spread and strip footings, such as simple concrete footings bearing on ground support columns, concrete foundation walls or the grade beams above them • Special foundation systems, such as structural mats, which are thick, deeply positioned slabs • Seismic footings and foundation systems
Substructure (below-grade) frames	• Structural concrete framing • Walls • Steel framing
Superstructure	• Cast-in-place concrete which is typically reinforced and post-tension • Prefabricated/precast concrete columns, beams and joists • Steel frame with trusses, beams and joists • Wood for low-rise construction • Reinforced masonry
Floor slabs (as part of superstructure)	• Slab-on-grade • Elevated or suspended structural slabs • Below-grade slab
Walls	• Most modern commercial buildings consist of drywall (gypsum-based) sheeting attached to light-gauge galvanized steel framing • Load-bearing or interior firewalls usually are constructed of reinforced concrete block • Finished drywall sheathing can be painted or covered with a decorative wall covering

Building Structures	Elements
Ceilings	• The most convenient and economical type of finished ceiling is a drop-in ceiling grid with lightweight ceiling tiles • Typical floor-to-ceiling slab heights are 10-feet (3 meters) or greater

Load-bearing walls are an important component of the building structure and may be difficult to identify just by looking at them. A blueprint of the layout of the building will clearly identity where load-bearing walls are located. Other identifiers are noting the direction of the wall. Load-bearing walls often run perpendicular to joists and parallel to the ridge of the building roof.

In some countries the foundation is considered to be the area surrounding the footings such as an earth or rock foundation or concrete footing. For the purposes of this course, foundations describe load-bearing elements at or below grade.

An inspection to observe the condition of a building structure can detect deficiencies, so that repairs can restore the structure's optimum usefulness. Structural audits may require hiring experts, who use specialized instruments, investigative tools and measurements to diagnose possible problems. The facility manager should be able to recognize when to contract professional resources such as structural engineers to use their experience for assessing structural concerns or deficiencies identified during an inspection.

An assessment of the facility structure can include other aspects such as environmental sustainability, quality, technology and safety. The list of possible causes and structural deficiencies is virtually limitless. Refer to *Exhibit 2-2* for examples of deficiencies.

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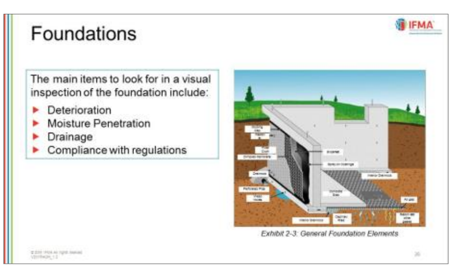
Exhibit 2-2: Examples of Building Structure Deficiencies

Examples of deficiencies to look for in a building's structure may include:

- Cracks in exterior or interior walls or lintels, or in exposed concrete at the base of the building; arching or valleys in floors or concrete
- Cracks running diagonally along mortar joints in veneers
- Differential displacement of floor slabs or joints
- Separation of corners at windows, doors or joints where walls meet; caulked joints pulling apart along the bottoms of windows and doors
- Standing water or pools collected near the facility during or after rain
- Evidence of moisture penetration such as leaking, dampness, staining, condensation or mold growth
- Nail or screw heads popping out of interior partitions
- Unusual cracks in floors; ridges in tile or below carpet that produce wear points and safety issues
- Deterioration evident as corrosion, chemical reactions, decay or insect infestation
- Doors that no longer open and or close properly, for example, doors that are difficult to close or don't remain open on their own
- Windows that no longer open smoothly

Not all cracks are undesirable; some may be useful or even designed to permit expansion or spacing. However, any crack that produces unevenness across the separation could indicate structural problems.

Foundations



Foundations are the structural components of the building frame that accept and transfer the massive load or weight of the building unit into the surrounding soils.

Foundations consist of different elements that interact to provide stability, bear loads, protect against moisture penetration and maintain integrity against potential erosion, seismic events and freeze/thaw cycles.

Foundations include items such as the following:

- Foundation walls or supports are usually of poured concrete, concrete blocks, pilings or piers.
- The footing is the enlarged concrete pad at the base of the foundation wall that transfers the weight of the structure to the soil, rock or pier.
- The footing drain tile is a pipe perforated with openings or “weep holes” to allow water to drain.
- The floor slab is a layer of concrete that forms a floor at any level of a building.
- The grade beam supports and stabilizes the exterior wall of a superstructure (for buildings without a basement) by directly bearing on the column footings or may be self-supporting as a strap footing.
- The reinforcement wire and rebar, which is reinforcing carbon steel bar contained by the concrete pour, adds strength and stability to the wall or floor.
- Gravel fill may be placed beneath a basement floor slab to permit drainage and help maintain a dry floor. Vapor barriers separate the gravel from the concrete slab-on-grade.
- Backfill is earth that is replaced and compacted around the foundation once the concrete walls have been built.
- The drainage board is a below-grade sheet, board or membrane that may insulate as well as enhance drainage.
- Filter fabric is often placed over the drain pipe or drain tile to keep fine soil or silt from accumulating and clogging drain openings.
- The waterproofing membrane is a liquid coating that cures to a flexible rubber and is applied to waterproof below-grade concrete walls.

Exhibit 2-3 illustrates some typical foundation elements.

It may not require a specialist to recognize foundation problems such as cracks (including cracks around doors and windows) or door/window openings that bind because of settling. If any inspection reveals evidence of foundation problems, the facility manager should hire a consultant or specialist contractor.

To remediate or prevent foundation deficiencies:

- Add grade soil to ensure that it slopes away from the building to drain water away from foundations and below-grade walls.
- Implement drain roof downspouts so that rainwater is directed away from building walls.
- Plant trees, vines and vegetation away from, not adjacent, to a building in order to prevent heaving or roots impacting the foundation.

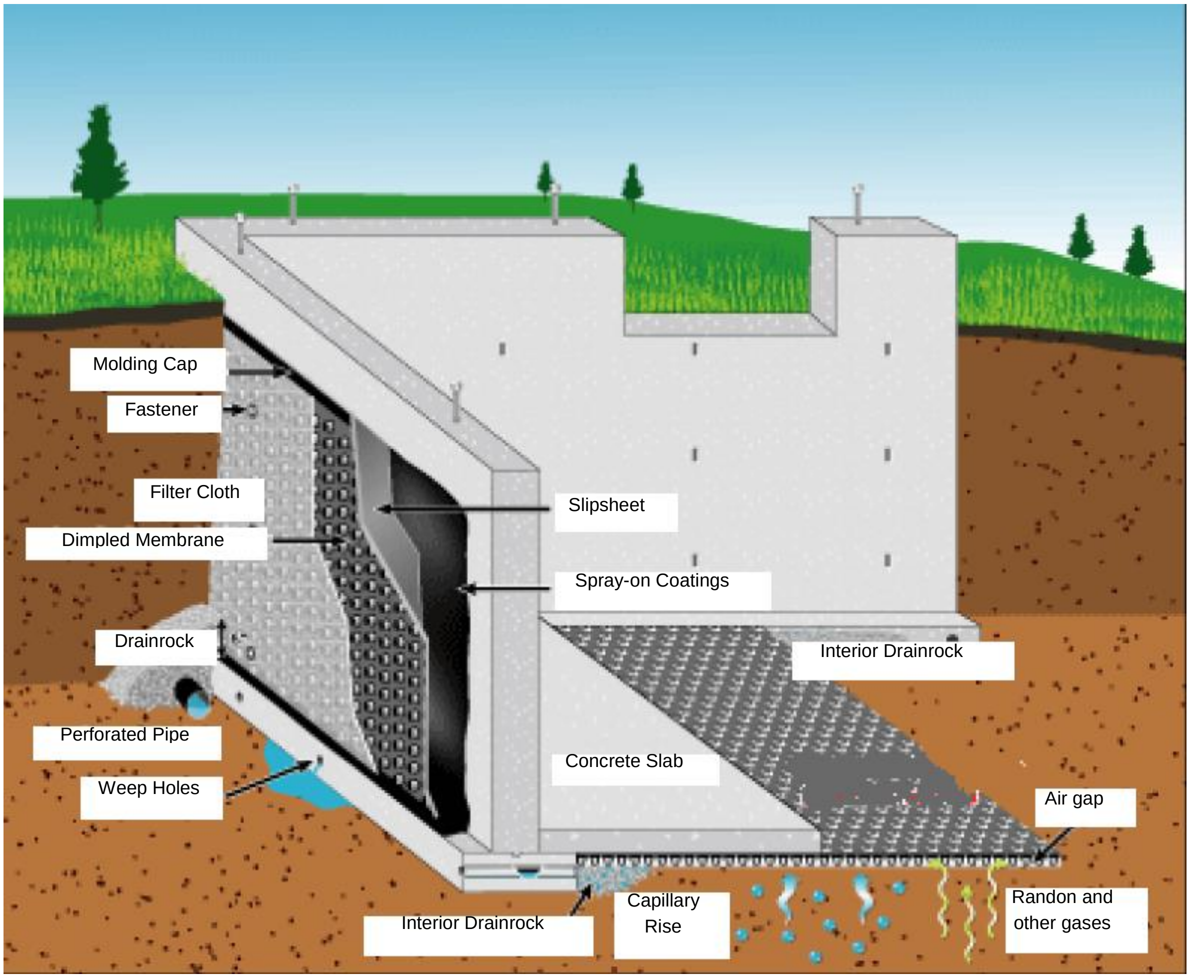


Exhibit 2-3: General Foundation Elements

All aspects of a facility's infrastructure — structures, systems, interiors, exteriors and grounds — should undergo a thorough assessment so that the facility manager:

- Is aware of the condition of everything related to the facility and can develop a comprehensive work plan that indicates when to maintain, repair or perhaps eventually replace components.
- Can identify when to schedule preventive maintenance and how to recognize and correct out-of-line conditions.
- Can maintain systems and components within operational specifications to sustain and improve efficiency.

These inspections should be part of the facility manager's comprehensive audit and should include sustainability, quality, technology, and safety aspects. Throughout this course, sample inspections are included that provide guidance for a facility manager in investigating the state of various facility components. *Exhibit 2-4* illustrates a partial sample of a foundation system inspection.

Components: footings, grade beams, walls, waterproofing, drains, rebar, insulation

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

General causes or concerns

Deterioration

[ ] Surface spalling
[ ] Corrosion, chemical reaction
[ ] Decay
[ ] Shrinkage
[ ] Settlement
[ ] Weather wear
[ ] Frost heave
[ ] Poor crawl space ventilation
[ ] Visible cracks
[ ] Uneven floors
[ ] Door operation issues
[ ] Uneven/cracked stairs

Moisture penetration

[ ] Inadequate drainage
[ ] Surface pooling
[ ] Water table changes
[ ] Condensation
[ ] Leakage
[ ] Unexpected hydraulic pressure

Drainage

[ ] Reduced soil cover
[ ] Foundation settling
[ ] Improper/inadequate surface slope
[ ] Insufficient drainage

Compliance (codes/regulations)

[ ] Local
[ ] Area
[ ] National/international standards
[ ] Required permits

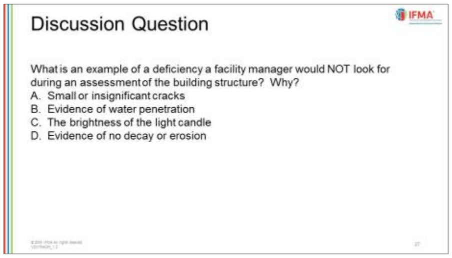
Maintenance History (date/activity)

____

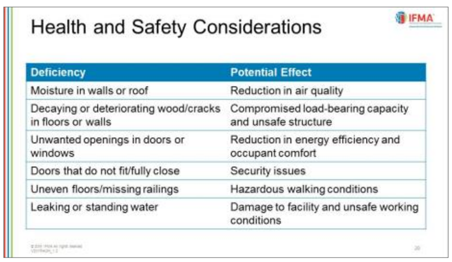
Component evaluation

Description (type, location, serial number/ID)	Condition (items that need attention/deficiency described)

Exhibit 2-4: Foundation System Assessment



Health, Safety, Security and Environmental Considerations



Deficiency	Potential Effect
Moisture in walls or roof	Reduction in air quality
Decaying or deteriorating wood/cracks in floors or walls	Compromised load-bearing capacity and unsafe structure
Unwanted openings in doors or windows	Reduction in energy efficiency and occupant comfort
Doors that do not fit/fully close	Security issues
Uneven floors/missing railings	Hazardous walking conditions
Leaking or standing water	Damage to facility and unsafe working conditions

It is important to recognize and correct deficiencies in structures because they can seriously affect the health, comfort and safety of occupants. Refer to *Exhibit 2-5* for examples.

Corrective action should be completed by qualified contractors or individuals working in accordance with all local, state and federal codes.

Exhibit 2-5: Examples of Health and Safety Deficiencies

Examples include:

- Moisture in walls or beneath roofs can promote mold, algae or other conditions that affect air quality.
- Decay or deterioration of wood or other natural building products caused by moisture, insect infestation or exposure can compromise the load-bearing capacity and make the building structure unsafe.
- Cracks in floors or walls may indicate unsafe shifts in the structure itself and perhaps unsafe design loads.
- Unwanted openings or deterioration around doors or windows can significantly reduce energy efficiency, air quality and occupant comfort.
- Doors that do not fit squarely, that bind or are misaligned may not fully close. This can produce energy leaks and reduce efficiency, as well as security issues if an opening cannot close enough to be locked.
- Uneven tread width, depth, and levelness, and uneven riser height and width, as well as loose, weak or missing railings can cause trip and fall hazards or other safety issues.
- Uneven floors, thresholds or railing heights can also cause hazardous walking conditions.
- Leaking or standing water can damage equipment, electrical systems, furnishings and finishes and not only produce unpleasant aesthetics but unsafe conditions.

Natural Disasters

Risks from natural disasters affect most buildings. The scale of a natural disaster can have a great impact on a building's structure and foundation.

Building vulnerability and unsafe conditions can be caused by:

- Seismic disruption
  - Earthquakes
  - Tsunamis
  - Volcanoes
- Storms
  - Hurricanes/typhoons/cyclones
  - Tornadoes
  - Snow and ice
  - Straight-line winds

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  - Thunderstorms
  - Dust storms
- Floods
  - Heavy Rains
  - Overflowing Rivers
  - Storm Surges and Tsunamis
  - Landslides into water reservoirs
  - Melting Snow and Ice
  - Changes in water level due to prolonged or intense rainfall or snowmelt
  - Stream erosion
  - Earthquakes
  - Volcanic activity
- Fires
  - Lightning
  - Volcanic
  - Meteor
  - Coal seam
- Lightning strikes and resulting damages, such as electrical damage and structural blowout

While there is little from an O&M perspective that can be done to reduce the potential for these hazards, the facility manager can retain experts to analyze and improve resistance to the effects of nature’s power, especially when planning capital improvements or renovations.

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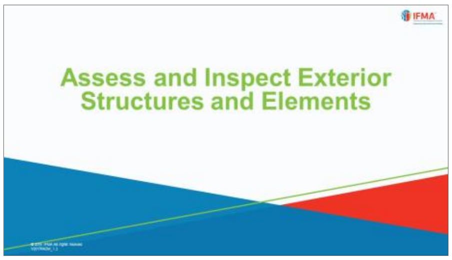
Assess and Inspect Exterior Structures and Elements

Lesson Introduction



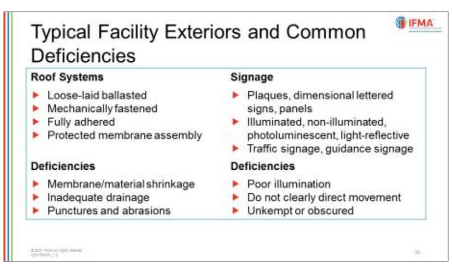
On completion of this lesson, you will be able to:

- Describe the common deficiencies in building exteriors and the associated health, safety, security and environmental considerations.

This lesson contains the following topics:

- Typical Building Systems and Common Deficiencies
- Health, Safety, Security and Environment Considerations

Typical Facility Exteriors and Common Deficiencies



Facility exteriors include the building envelope as well as structures separate from the main building.

“Building envelope” is a common term for the system that keeps the weather and noise out and the heat and cooling in. The building envelope generally includes elements such as facades, curtain walls, exterior walls, windows, skylights and roofs.

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Curtain walls and the exterior insulation finish system (EIFS) are facades that enclose the building. They are attached to the building's skeletal structure as a means to provide architectural design as well as a barrier to exterior elements. As a veneer or outer covering, curtain walls may be made of aluminum, glass, stone, metal, concrete, brick, stucco or other materials. They span multiple floors and are designed to accommodate thermal expansion and building sway. They may also provide thermal efficiency to more cost-effectively heat, cool or illuminate the building.

Types of curtain walls include:

- Barrier systems are intended to act as a physical barrier to moisture penetration
- Cavity wall systems are expected to take in some moisture and then direct that moisture back to the exterior of the structure with flexible flashings and weep systems

Separate or independent facility exterior structures can include:

- Outbuildings, sheds, guard houses
- Fitness, exercise and recreation courts, pools, rinks, fields
- Animal shelters
- Vaults, greenhouses, conservatories
- Band shells, pavilions, outdoor dining facilities that are not part of the main facility

These exterior structures may also require attention to sustainability, technology, security and safety, as would the main facility infrastructure. Exterior buildings also require its own, separate inspection from that of the main building.

The appearance of exterior structures imparts an image to the public and occupants. The overall aesthetics of materials and finishes, the condition of surfaces, cleanliness, and features provide an obvious impression of the entire infrastructure. Lighting, signage, layout and general maintenance all imply to visitors what importance and value the owners and the facility manager place on the building, its occupants and their purpose.

A facility that is not occupied by the owner may not have as stringent appearance requirements. Tenants may be held to accept specific minimum standards, or they may negotiate for different standards as part of a lease agreement. A facility's appearance influences perceptions on its quality and even its capabilities.

Some common deficiencies to look for among exterior elements and structures in general include:

- Deteriorating foundation, wall, roof/roof elements, and other surface conditions such as cracks, peeling, rotting, moisture or condensation
- Spills, stains, improperly stored materials or items

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- Ill-fitting, misshaped or otherwise out-of-alignment windows, doors, building corners or rooflines
- Poor joints, anchoring, ventilation, lighting
- Insufficient size, capacity, access or egress
- Deteriorating exterior sealants and mortar joints

Exterior structures require much the same O&M and facility management as primary building structures to the extent that these supplemental structures are heated, cooled, supplied with water, enclosed and occupied.

Two facets of exterior structures that deserve some further attention are roof systems and signage.

Roof Systems

Roof systems are of particular concern to facility managers because they must maintain a weatherproof membrane and withstand the range of potential weather conditions. A roof that is not properly designed, constructed and maintained will likely affect the life cycle and safety of the structure or require expensive remediation or early replacement.

Roofs are generally either pitched, which have a steep slope, or low slope, which appear to be flat. Pitched roofs may consist of shingles, slate tiles, thatch or standing-seam metal panels. Most commercial structures have primarily low-slope roofs with waterproofing membranes.

There are many different types of low-slope roofing constructions and materials. Some of the more common types of roofs are shown in *Exhibit-2-6*.

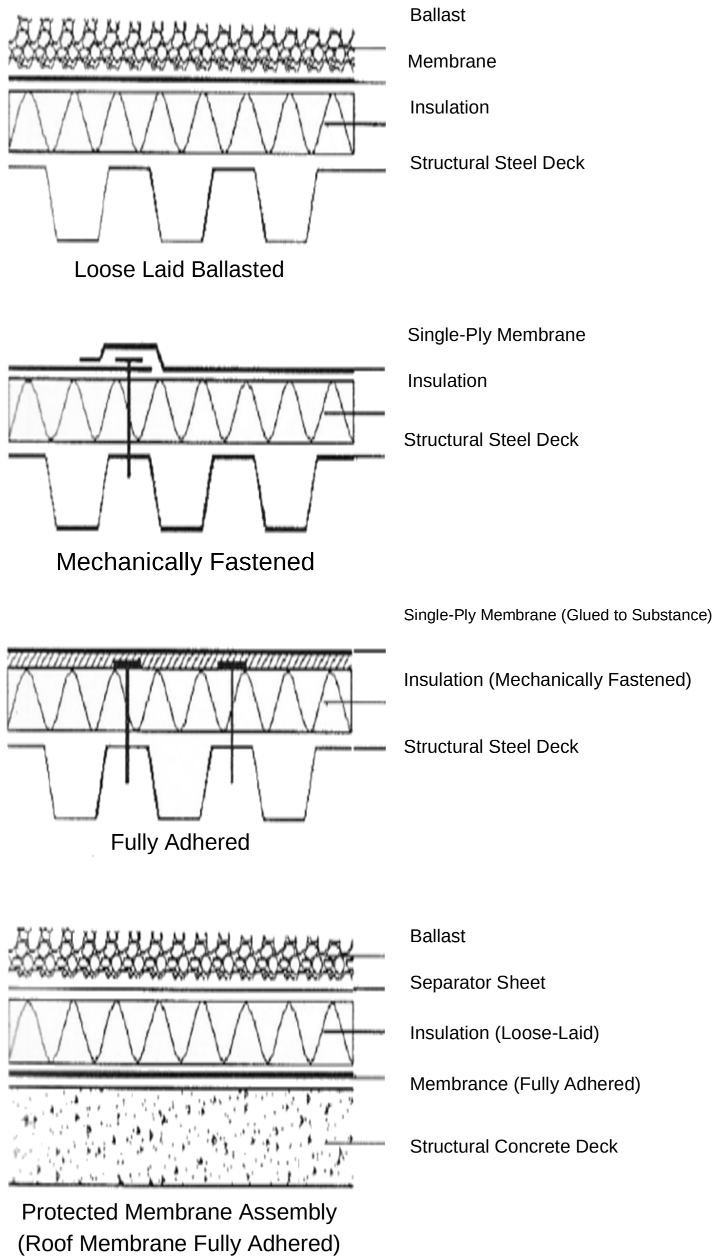

Exhibit 2-6: Common Roof Constructions

- **Loose-laid ballasted roofs** — consist of a membrane weighted down by a layer of small round stones, gravel, paving slabs or even soil and plantings as used in green roof systems.

- **Mechanically fastened roofs** — use a single-ply membrane affixed to the roof deck using screws, nails or adhesive and mechanically welded or otherwise fabricated to produce an impervious layer.
- **Fully adhered roofs** — use a membrane that is bonded to the roof deck to form a single sheet.
- **Protected membrane assembly roofs** — adhere the membrane fully to the roof deck beneath an insulation layer, separate sheet and ballast on the surface, putting the waterproof layer beneath the insulation rather than on the surface, so that some manufacturers refer to them as upside-down roofs.
- **Bituminous roofs** — (see *Exhibit 2-7*) use materials such as felts, small minerals and fillers such as limestone or sand as built-up layers to produce a waterproof surface. Modified bitumen membranes may also be used to build bituminous roofs using factory-fabricated layers.
- **Single-ply roof systems** — contain thermoset membranes commonly made of rubber polymers. Common thermoset membranes include ethylene propylene diene monomer (EPDM), chlorosulfonated polyethylene (CSPE) and Hypolon. These membranes require adhesives to form a watertight seal where the membrane overlaps.
    - Thermoplastic membranes may also be used on single-ply roofs. A common thermoplastic is polyvinyl chloride (PVC) that is made to be flexible and in which seams are welded using heat or chemicals. Other thermoplastics include chlorinated polyethylene (CPE) and thermoplastic olefin (TPO).

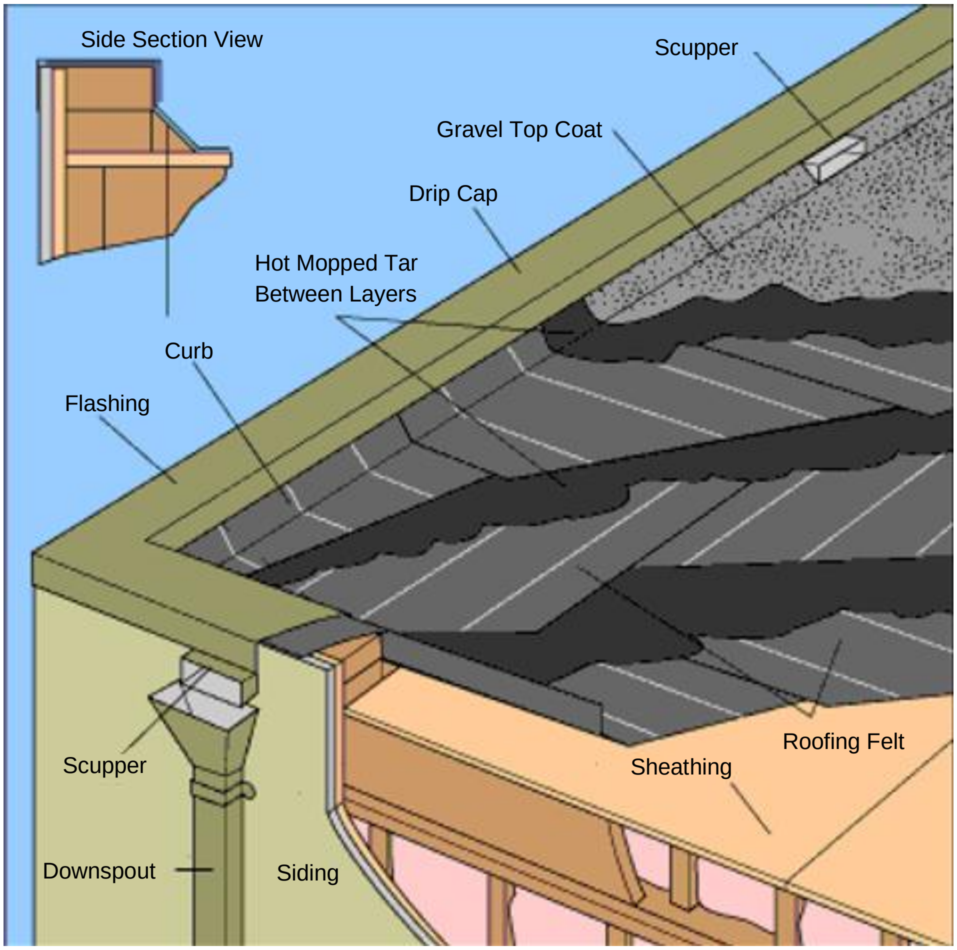

Exhibit 2-7 Bituminous Roofing

As technology and building structures become more advanced and environmentally efficient, facility managers should pay close attention to the introduction of "green roofing." Green roofing is a flat, or slightly sloped waterproof roof, with a layer of vegetation. This type of roofing is becoming more popular with sustainable initiatives.

The average life span of most roof systems constructed in the past several decades is between 10 and 20 years; this can be extended with proper design, construction and maintenance. There are many different types of roofing, all roofs need maintenance to simply withstand the abuse of normal aging. This is because undetected small problems can become large and expensive dilemmas that can compromise the building structure and interior and even the facility's mission. Roof systems are warranted for many years, but a thorough preventive maintenance inspection should be performed annually. Thermographic imaging can be used in this inspection to detect insulation deterioration or temperature variations that could indicate a breach in the roof membrane.

Some common deficiencies to look for in single-ply roofs are:

- Blisters, ridges, curling, wrinkles, holes, tears, punctures, cuts, abrasions or cracking in roof membranes
- Loss of protective surfacing or adhesion to deck surfaces
- Surface degradation because of weather exposure or defects
- Membrane shrinkage
- Evidence of oil or chemical damage
- Inadequate slope or drainage causing pooling water
- Abrasions caused by loose debris, foot traffic and equipment

Flashing sheets, or additional purpose-installed layers of material, and built-up roofing and are molded around required roof openings to maintain a waterproof seal at these vulnerable points.

Some common deficiencies to look for in flashings are:

- Inadequate allowance for movement
- Movement of roof drains or vent pipes
- Poor attachment
- Material shrinkage
- Poor adhesion or coverage protections (shrinkage)
- Punctures, abrasions or flashing height that is not sufficient to maintain integrity

Signage

Signage is a significant exterior aspect for facility management. The variety and regulatory requirements alone make the placement, design, maintenance and use of signage complex as well as important.

Signage may include:

- Plaques, dimensional lettered signs, panels
- Illuminated, nonilluminated, photoluminescent, light-absorbing and light-emitting, light-reflective
- Traffic signage, guidance signage

Assessing the quality, positioning and professional presentation of signs is particularly relevant to assisting individuals find their way around a facility.

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Signage and identification of exterior structures enhance a facility’s image when:

- Buildings and entries are clearly visible to passing traffic and pedestrians.
- Buildings are clearly identified from all directions with clear, visible, professional and well-constructed signs.
- Signs clearly direct traffic.
- Signs are properly sized, clearly lettered and at proper heights for compliance and easy reading.
- Signs are well maintained.
- Signs for exits, entrances, emergency and directional purposes are lighted or otherwise distinguishable in darkness.

Signs are important elements relating to exterior structures as well as grounds, as illustrated in *Exhibit 2-8*.

Exhibit 2-8: Exterior Signage

Exhibit 2-9 is an example of what could be included in an assessment of signage on exterior structures.

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

Components: identification, directional and traffic signs; nameplates, posts/poles, marks and notices, pavement graphics

General causes or concerns

Visibility
- [ ] Unobscured by vegetation
- [ ] Not seen from all directions
- [ ] Not visible to all passing traffic
- [ ] Low reflectance levels
- [ ] Not apparent at night
- [ ] Properly Oriented

Clarity/legibility
- [ ] Proper letter size
- [ ] Poor placement
- [ ] Poor positioning

Maintenance
- [ ] Deteriorated paint
- [ ] Defacement
- [ ] Corrosion/rust
- [ ] Discoloration

Quality
- [ ] Poor general condition
- [ ] Poor overall appearance
- [ ] Not professionally made
- [ ] Temporary appearance
- [ ] Wear or fading
- [ ] Elements missing
- [ ] Damage

Safety
- [ ] Unlcear direction
- [ ] May confuse traffic

Does not meet image
- [ ] Aesthetic minimum
- [ ] Occupant expectations
- [ ] Owner expectations
- [ ] Neighborhood expectations

Compliance (codes/regulations)
- [ ] Local
- [ ] Area
- [ ] National/international standards
- [ ] Required permits

Maintenance History (date/activity)

____
____
____
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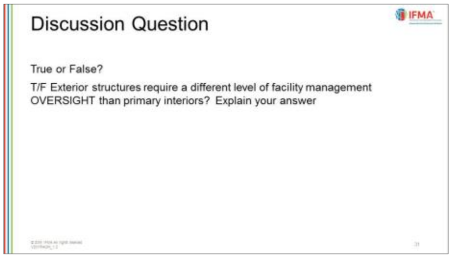
Component evaluation

Description (type, location, serial number/ID)	Condition (items that need attention/deficiency described)

Exhibit 2-9: Signage Assessment



Health, Safety, Security and Environmental Considerations

Relative to exteriors and among many other risks, safety concerns include the risk of falls, the risk of falling objects and storm preparedness.

Risk of Falls

There is an ever-present risk of falls when working near the edge of an unprotected roof area or when maintaining facades or stairs. The facility manager must recognize and be informed about aspects related to fall protection.

This includes knowing about:

- Activities and situations that may require added alertness and fall protection.
- Proper use of ladders, platforms, scaffolds and other elevation-raising devices.
- Proper use and maintenance of safety belts, harnesses, lanyards and other fall-arrest systems and personal protective equipment.
- Applicable safety codes and regulations.

Risk of Falling Objects

Facade ordinances exist in some major cities to protect the public and surrounding property from the risk of falling objects that might occur because of poorly maintained or improperly repaired exteriors. These codes or regulations establish baseline cycles of inspection, maintenance and repair.

The facility manager must be aware of applicable facade ordinances and support their application.

Storm Preparedness

One safety issue that deserves specific attention relative to exterior structures is storm preparedness. Exterior structures are often not enclosed or constructed with the same loadbearing or weather-shielding elements as an occupant facility.

The facility manager plans for natural threats by providing routine inspection of exterior structures for storm readiness such as:

- Shutters, tie-downs
- Landscape runoff
- Storm water basins
- Containment features
- Outdoor equipment and corresponding anchoring
- Removing, storing and capping roof vents
- Inspecting roof drains and reinforcing roofing systems
- Securing and protecting windows and doors
- Removing or securing potential projectiles such as:
    - Trash cans
    - Loose signs
    - Construction materials
    - Ladders
    - Chairs

Facility managers must be observant of structure condition, equipment, and potential hazards in order to identify storm-related risks.

Assess and Inspect Condition of Building Systems

Lesson Introduction

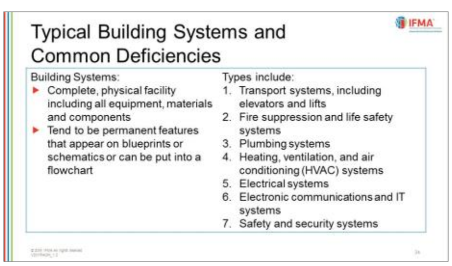
On completion of this lesson, you will be able to:

- Describe the common deficiencies in building systems and the associated health, safety, security and environmental considerations.

This lesson contains the following topics:

- Typical Building Systems and Common Deficiencies
- Health, Safety, Security and Environment Considerations

Typical Building Systems and Common Deficiencies



The term "building systems" refers to the complete, physical facility including all equipment, materials and components. It can refer to the organized combination of related parts that actively provide important functions for the facility.

Under that definition, building systems have the following characteristics:

- They are in place; that is, once installed they tend to be permanent features of the facility.

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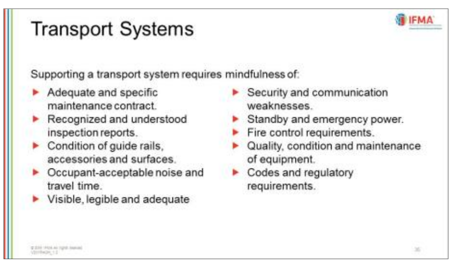
- They appear on blueprints or schematics or can be flowcharted.

There are several specific, permanent building systems that provide critical operating features. We will go into further detail on:

- Transport systems, including elevators and lifts
- Fire suppression and life safety systems
- Plumbing systems
- Heating, ventilation and air conditioning (HVAC) systems
- Electrical systems
- Electronic communications and information technology systems
- Safety and security systems

Transport Systems



Transport systems include conveyance for people, mail, trash and waste, food, freight and hazardous materials. Transport, or conveyance systems, include elevators/lifts, escalators and moving walks and are used to transport people, mail, trash, food, freight and hazardous materials. Permanent stairs are generally not included, as they are part of the building interior or exterior structure.

Transport systems are typically installed when a building is constructed. They can be complicated, involving sophisticated mechanical, electrical and electronic technology.

Elevators are generally of two types:

- Traction, or electric elevators, use geared or gearless mechanisms for vertical movement. They permit virtually limitless rise for tall buildings and high-rise speeds but can be of high cost.
- Hydraulic, or oil elevators, can be of several types and offer a lower initial cost but relatively high renovation costs and lower rise speeds than traction elevators. They are generally limited to heights of six stories or fewer.

Due to security, evacuation and confinement issues, elevators and enclosed escalators may require two-way communications, redundancy and protective features.

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Two of the more frequently occurring liability issues produced by elevators are:

- Trip hazards caused when a cab does not stop level with the building floor
- Knocking people down when improper kinetic energy settings cause doors to run into people as they enter or exit a cab

Legislative changes may require modifications to elevators/lifts not only to support users but also to protect the health and safety of service personnel.

The facility manager can support a transport system that is operating to occupants' satisfaction by being mindful of:

- An adequate and specific maintenance contract.
- Recognized and understood inspection schedules and reports.
- Condition of guide rails, accessories and surfaces.
- Satisfactory, or occupant-acceptable operational noise, floor-to-floor travel times, and door opening/closing duration for traffic accommodation.
- Visible, legible and adequate signage.
- Security and communication weaknesses, such as alarm bells and phone operation.
- Standby and emergency power and the operational norms around equipment responses in the event of power disruption.
- Fire control requirements.
- Quality, condition and maintenance of equipment.
- Codes and regulatory requirements.
- Entrapments

Renovations are expensive and disruptive yet may be needed every 20 to 25 years or as elevators end their efficient life span. Older buildings modernize elevators to compete with newer buildings and to meet changing occupant expectations.

Elevators, escalators and moving walks are complex systems. Their maintenance is generally best in the hands of professional contractors who are expert in operations, regulatory and code requirements, safety and security features. Complete, regular, periodic checks and maintenance by a licensed contractor are the facility manager's most reasonable O&M options.

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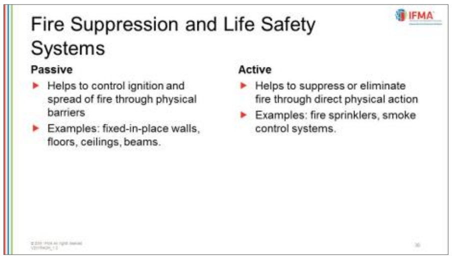
Fire Suppression and Life Safety Systems



Fire life safety or fire alarm and suppression functions ensure that the facility is a safe, secure place to work and is in compliance with applicable laws and regulations. Life safety refers to government regulations and building code requirements for a building relative to seismic, fire, risk and accessibility standards.

Alarms monitor fire and smoke alerts and provide the means to alert or notify occupants. Safety systems also include safe, planned exits or egress from buildings, including pathways, emergency lighting, communication and other support. Codes mandate minimum protections.

Basic fire protection principles divide fire protection into passive and active systems.

- **Passive fire protection measures** — help control the ignition, growth and spread of fire by using fire-resistive materials or providing physical barriers to the movement of flames or smoke. Passive systems are generally fixed-in-place walls, floors, ceilings, beams, columns and shaft enclosures that are built to a prescribed fire resistance rating. Control of egress or exit paths may also be a part of the passive system.
- **Active fire protection measures** — take direct physical action to suppress or eliminate a fire and control migration of smoke. These include fire sprinkler and smoke control systems that receive signals, alert occupants and start fire control actions. Fire extinguishers are considered part of an active fire protection system.

There are many different types of suppression systems:

- Wet pipe systems maintain water constantly within the system to discharge immediately onto the fire when a sprinkler is activated.
- Dry pipe systems use pipes filled with pressurized air or nitrogen instead of water to hold a remote dry pipe valve closed and prevent water from entering the pipe until fire causes one or more sprinklers to operate.
- Pre-action systems are similar to dry pipe systems in that water is not contained within the pipes. However, in this type of system, water is withheld by an electrically operated valve and controlled by independent flame, heat or smoke detection.
- Deluge systems, as the name implies, provide high-velocity suppression in high-hazard areas. They are similar to pre-action systems except that sprinkler heads are open, and the pipe is not pressurized so that, upon smoke or heat detection, water discharges through the sprinkler heads.
- Chemical/gaseous systems use inert gases and liquid or dry chemical agents rather than water to extinguish a fire. A typical fire extinguisher is a form of chemical fire suppression. There are also gaseous or chemical fire suppression products such as heptafluoropropane (FM200®) or Energen systems that are introduced into the room or space to displace oxygen in a fire zone and thus remove or reduce the fire condition.
- Low oxygen or hypoxic environments are created where fire or smoke can threaten irreplaceable assets yet fire suppression using water or chemicals could also create substantial damage. Oxygen content is reduced enough to suppress or prevent fire yet remains high enough for normal human activity.

Fire suppression systems should be regularly and rigorously inspected, tested, maintained and documented. International and national codes determine the requirements.

Maintenance, inspection and testing of alarm and suppression systems is complex, as demonstrated by the complex systems in *Exhibit 2-10*. As such, this oversight is generally contracted to competent life safety service providers.

Exhibit 2-10: Examples of Fire Suppression Elements in a System

Fire Pump

Fire System

Exhibit 2-11 provides an example of an assessment for fire protection deficiencies.

Facility, system and location identification ____________________

Inspector name and date of assessment ____________________

Components: HVAC exhaust, smoke/fire detectors, alerts (sounders), controllers, sprinklers, pipes, standpipe hoses, extinguishers

General causes or concerns

Condition
- [ ] Hose/pipe integrity
- [ ] False alarms/trouble alarms
- [ ] Alarms not heard
- [ ] Potential freezing
- [ ] Water in dry pipe systems
- [ ] Inadequate flow (water pressure)
- [ ] Signs of leakage
- [ ] Valves in open position
- [ ] System is functional

Inspection
- [ ] Improper, inadequate or incomplete tests
- [ ] Inexperienced inspectors
- [ ] Poor or inconsistent documentation
- [ ] No dry system inspection

Maintenance
- [ ] Dirty smoke detectors
- [ ] Obstructed or damaged sprinkler heads
- [ ] Incorrect installation
- [ ] Control valves/ dampers closed or inoperable
- [ ] Sensors correspond to system
- [ ] Extinguishers (correct number, regular inspection)
- [ ] Air compressor or jockey pump failure
- [ ] Accidental discharge
- [ ] Motors, fans
- [ ] Lights/signs operational

Compliance (codes/regulations)
- [ ] Local
- [ ] Area
- [ ] National/international standards
- [ ] Required permits
- [ ] Up to current code

Maintenance History (date/activity)

____
____
____
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____
____

Component evaluation Description (type, location, serial number/ID)	Condition (items that need attention/deficiency described)

Exhibit 2-11: Active Fire System Assessment

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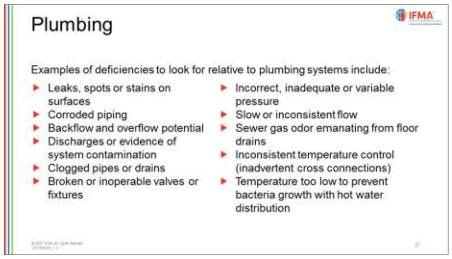
Plumbing Systems



Plumbing systems distribute water or other liquids and gases and collect waste.

Plumbing systems are used in buildings to:

- Provide potable/drinkable water
- Provide chilled and hot water for cleaning
- Provide water to operate HVAC equipment
- Deliver water, chemicals or gases for fire suppression systems
- Remove wastewater
- Remove gray/rainwater and groundwater

Components in a typical plumbing system include:

- Distribution system piping to transport liquids/gases
- Pumps to provide the means to move liquids/gases
- Control components such as electronic or mechanical switches and gauges
- Piping, drains, control valves and traps to control the flow of liquids
- Sanitary and other plumbing fixtures (toilets, urinals and bidets) as a means to deliver liquids
- Water heaters to increase water temperature
- Filters and traps to remove impurities liquids/gases
- Vents and controls to maintain and regulate pressure and ensure proper flows
- Backflow preventers, or check valves, to prevent water/waste cross-contamination

Exhibit 2-12 and 2-13 illustrate a typical building plumbing system. The heavy lines indicate supply lines and flow direction.

Plumbing systems are a long-term investment, most of which is out of sight in walls, ceilings and floors. They need to be durable and reliable for the anticipated life of the building. This means that they are designed to not become outdated or require replacement while major components are still serviceable.

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In addition, disruptions or leaks can cause major damage to other building systems, interiors and exteriors or endanger the health of occupants. This makes durable design especially important.

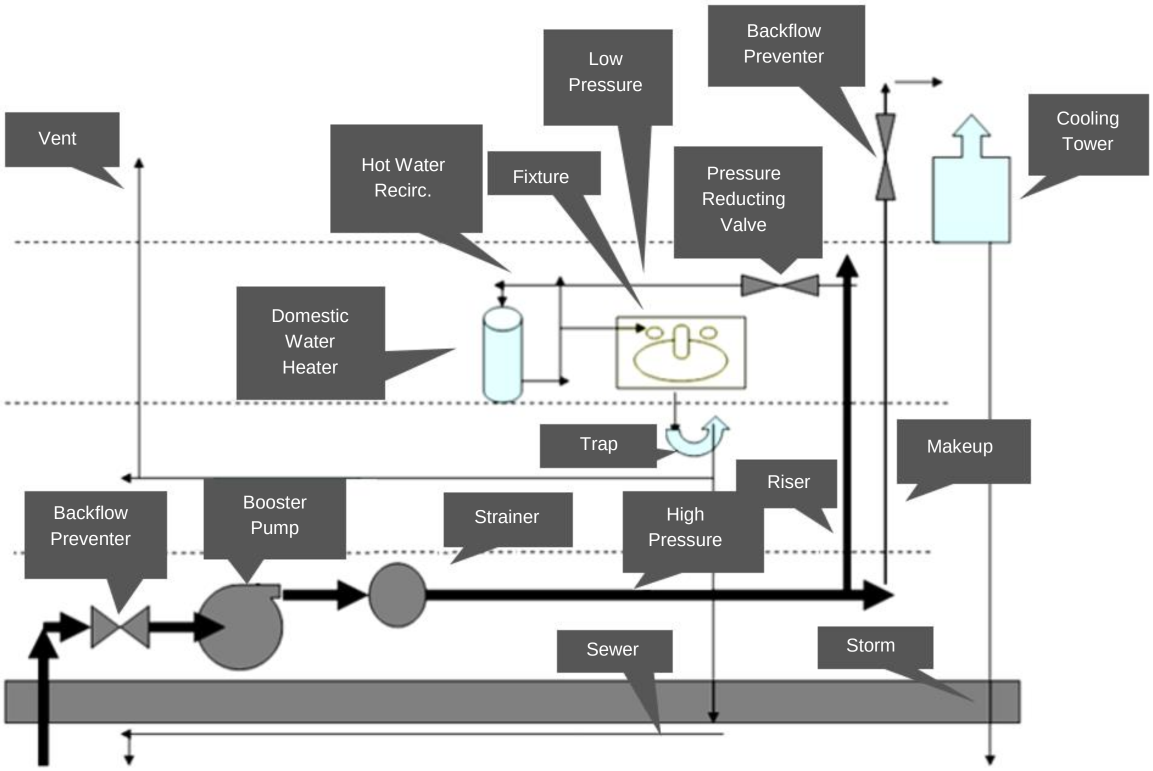


Exhibit 2-12: Plumbing (Distribution) System

Exhibit 2-13: Plumbing System

Examples of deficiencies to look for relative to plumbing systems include:

- Leaks, spots or stains on surfaces
- Corroded piping
- Backflow and overflow potential
- Discharges or evidence of system contamination
- Clogged pipes or drains
- Broken or inoperable valves or fixtures
- Incorrect, inadequate or variable pressure
- Slow or inconsistent flow
- Sewer gas odor emanating from floor drains
- Inconsistent temperature control (inadvertent cross connections)
- Temperature too low to prevent bacteria growth with hot water distribution

Exhibit 2-14 is an example of some of the elements contained in a water plumbing systems audit. A similar assessment would be required to assess a plumbing system that manages other liquids or gases for heating, cooling or other purposes.

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

Components: pipes, fittings, pumps, valves, vents, filters, insulation, fixtures

General causes or concerns

Water System

[ ] Supply adequacy/pressure
[ ] Quality (taste, mineral contamination)
[ ] Safe hot temperature setting
[ ] Operable main cutoff valve
[ ] Pump condition
[ ] Insulation

Waste/sanitary system

[ ] Drain/backflow protection
[ ] Floor drains
[ ] Clean-out access
[ ] Disposal (gradient, recycling, purification, etc.)

Pipes

[ ] Chemical resistance
[ ] Visible corrosion
[ ] Metal condition
[ ] Galvanic corrosion (incompatible metals)
[ ] Safety (no lead)
[ ] Pipe hanger supports/clamps
[ ] Leaks

Fixtures

[ ] Types
[ ] Condition
[ ] Aesthetic appeal
[ ] Joints, seals
[ ]

Compliance (codes/regualtions)

[ ] Local
[ ] Area
[ ] National/international standards
[ ] Required permits
[ ] Barrier-free access

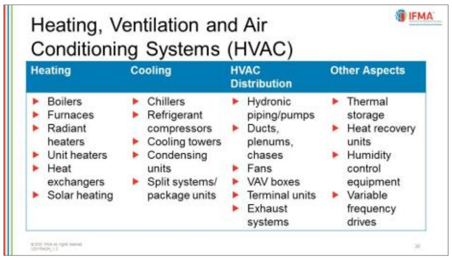
Maintenance History (date/activity)

____
____
____
____
____

Component evaluation Description (type, location, serial number/ID)	Condition (items that need attention/deficiency described)

Exhibit 2-14: Water Plumbing System Assessment

Heating, Ventilation and Air Conditioning Systems (HVAC)



Heating, ventilation and air conditioning (HVAC) mechanical systems within a building control and maintain temperature, humidity and air quality. Depending upon the type of system and the geographical location, they may include equipment for steam and hot water generation, chilled fluids, indoor/outdoor air exchange, air circulation and heating/cooling distribution. They contain control components such as electronic or mechanical switches, valves, dampers, diffusers and gauges that are managed by a computerized building operations and reporting system.

The elements of HVAC systems are summarized in *Exhibit 2-15*.

Exhibit 2-15: HVAC System Elements

Element	Description
Heating	• Oil, gas or electric boilers that heat water or generate steam for distribution • Furnaces that burn fuel to heat water or air for distribution • Radiant heaters that deliver heat that is absorbed by objects rather than using forced air to transfer heat • Unit heaters that may be a room-sized device or central heating system that circulates warm air or steam through finned tubes over, which may include a fan, forces air to provide warmth • Heat exchangers that passively transfer heat from one material to another in two chambers separated by a single wall or partition • Solar heating, which uses sunlight to collect, store and generate warmth

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Element	Description
Cooling	• Chillers that include compressor, evaporator, condenser, reservoir, thermal expansion valve and other components as a system to create cooling • Refrigerant compressors that turn low-pressure gases into high-pressure and high-temperature gases as a way to create a cooling effect • Cooling towers that spray or drop cooling water to release heat to the air through evaporation • Condensing units that condense refrigerant vapor into a liquid and discharge the resultant heat to the environment • Split systems, which consist of a single system that has components in two locations such as an outside compressor and an indoor furnace/air-handling unit • Package units or all-in-one systems in which all components are located in one cabinet
HVAC distribution	• Hydronic piping and pumps that deliver steam, hot water and chilled water to radiators, fan coil units and convectors and deliver the returning water to the primary generation unit • Ducts, plenums and chases that route or otherwise enclose spaces to distribute warm or cool air • Fans that drive or force warm and cool air through a distribution system • Variable air volume (VAV) boxes that control the volume and distribution of supply air into a specific zone • Terminal units, such as air-handling units to condition and circulate air, fan coil units to heat or cool and direct air and other such devices • Exhaust systems or devices such as vents or fans to control odors or otherwise expel air, fumes or particles • Air handling unit (AHU), which regulates and circulates air

Element	Description
Other HVAC-related aspects	• Thermal storage that uses technologies, reservoirs or other repositories to maintain a temperature higher/warmer or lower/cooler than the ambient environment • Heat recovery units that use heat produced in a process to enhance efficiency or in another way • Humidity control equipment that regulates the degree of saturation or quantity of water vapor in the air • Variable frequency drives, also known as variable speed drives, that control the rotational speed of an electric motor • Automated building management systems or building management and control systems that manage the complex interactions of systems and the building environment for human comfort and operating efficiency

Central plant designs combine any or all HVAC capabilities into one place as a more efficient way to generate interior thermal conditions for one or more buildings. Rather than producing steam, hot water, heat and cooling within individual buildings or in separate places within a building, as a decentralized system would do, the central plant provides for these needs from its own dedicated place.

Examples of deficiencies to look for relative to HVAC systems include:

- Inadequate heating or cooling within a building or area of a building
- Uneven air supply causing uneven temperatures and/or drafts
- Odors
- Humidity and air quality problems
- Lack of fresh outside air or excessive carbon monoxide
- Leaking return ducts in crawl spaces, poor thermal management and possible introduction of contaminants
- Unsafe electrical wiring or damaged/deteriorated equipment, such as burners, heat exchanger, components
- Carbon monoxide and other toxic gases drawn through air intake
- Refrigerant leaks

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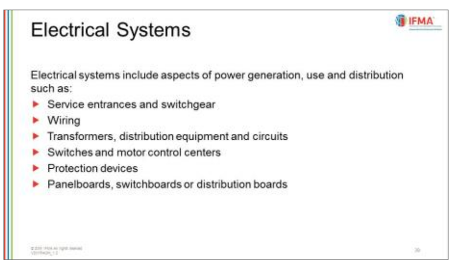
- Excessive noise from fan units or air handlers
- Deterioration of the insulation system, which leads to loss of energy

Lack of proper maintenance is the chief cause of HVAC deficiencies. Without proper routine maintenance, HVAC systems can develop problems that reduce equipment life and efficiency and occupant comfort such as:

- Excessive component vibrations and poor fan alignment
- Insufficient air movement to reach all spaces
- Drafts in areas being cooled
- Excessive noise, evidence of leaking, deterioration and corrosion

Facility managers should be active and knowledgeable about environmentally friendly replacement substances, equipment alternatives and sustainable resources.

Electrical Systems



Electrical systems include, but are not limited to, aspects of power generation, transmission, distribution and use such as:

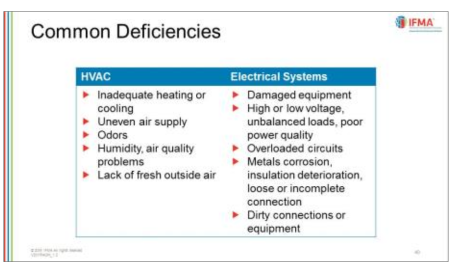
- Service entrances and switchgear
- Wiring, which includes conductors, conduit, wireways, floor raceways
- Transformers, distribution equipment and feeder circuits
- Switches, such as disconnect, switch, fuse, on/off and motor control centers
- Motors and motor circuits
- Protection devices, such as circuit breakers, fuses, proper grounding applications, ground fault interrupters, earth leakage circuit breakers and ground fault circuit interrupters
- Panelboards, switchboards or distribution boards, which organize and control feeder and branch circuits
- Electrical controls and instrumentation

- Power-generating and storage equipment, for example, generators, solar panels, power filters and conditioners, battery storage and transfer switches that divert, change or manage electrical loads
- Power factor correction capabilities
- Communications and security systems
- Lighting
- Emergency and standby power sources
- Uninterruptible Power System (UPS)

Electrical systems are critical to facility operation because they provide energy for heating, cooling, lighting and equipment operation. Preventive maintenance is important because the total cost of an unscheduled shutdown due to failure can be much higher than the cost of scheduled equipment repair or replacement.

Electrical failure that interrupts communications can dramatically reduce productivity. Failure that compromises security systems puts occupants at unnecessary risk. The facility manager should be aware of the inventory of different types of electrical equipment, the characteristics and use, as well as safety aspects, regulations and codes.

Diagnosing problems or even assessing the condition of electrical systems can be complex and may pose a danger to inspectors and system users. It is important to assign a trained and qualified person to perform any survey of a facility's electrical systems.



Examples of deficiencies to look for relative to electrical systems include:

- Damaged equipment
- High or low voltage, unbalanced loads, poor power quality
- Overloaded circuits
- Metal corrosion, insulation deterioration, loose or incomplete connection
- Dirty connections and equipment
- Water or moisture problems
- Improper component replacement
- Improper grounding

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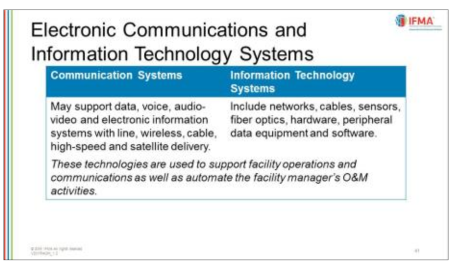
- Inadequate clearance and ventilation

Improvements in electrical systems and advances in electrical devices have produced gains in sustainability, energy conservation and energy use.

Some representative enhancements include:

- Power factor correction units that filter electrical current to increase active power and reduce reactive power. The improved power factor can reduce energy bills and enhance the capacity of an electrical system.
- Converting older fluorescent and incandescent lighting to light-emitting diode (LED) lighting, compact fluorescent light (CFL) products, EE/ED series fluorescent lights and other high efficiency technologies.
- Variable speed drives and other electrical control devices to conserve energy use.
- Energy management systems in computer-aided tools that automatically control and monitor the heating, ventilating and lighting needs of a building or group of buildings. This energy tool may also be included as part of a complete building management system; this is discussed later in this course.

Electronic Communications and Information Technology Systems



As an overall definition, communication is the process of creating and sending messages with the goal to influence the opinions, actions and decisions of the intended audience. The process includes selecting the appropriate media to best reach the intended audience.

Systems used for communications and information technology (IT) can range from simple arrangements of devices to complex installations that are critical to the mission and require sophisticated operations and maintenance. Current technology is vast and complex, but a few examples include work order systems, life safety systems and other automated systems.

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From an operational perspective, communication plays a role in several ways:

- Fire life safety requires prepared, clear, practiced and deliverable communication even when there is no electrical power, systems are down and evacuations must occur from pre-arranged plans.
- New systems, materials or equipment should integrate with existing operations so that the functionality of the entire facility is optimized. This is supported when communications with contractors, staff and independent parties are consistent, informed or redundant.
- Operations are enhanced when the facility manager prepares messages, incorporates feedback and resolves questions in ways that satisfy everyone involved in operations, including staff, contractors, regulators, occupants, visitors, neighborhoods and communities.

Communications systems may operate to support data, voice, audio-video and electronic information systems with services that could include line, wireless, cable, high-speed and satellite delivery. A facility may devote entire rooms to communications and data-gathering equipment, requiring special consultant services for operations and maintenance.

Exhibit 2-16: Examples of Information Technology

Information technology systems include:

- Networks
- Cables
- Sensors
- Fiber optics
- Peripheral data equipment
- Hardware
- Software

These items may be centralized or have elements distributed, which support facility operations, communications and automate the facility manager's O&M activities. They are used to create, manipulate, store data and generate reports related to facility maintenance. The electronics and fiber optics control energy consumption, temperature, humidity, lighting and the operation of buildings and grounds.

These operational aspects may be found in a facility's information technology area rather than as part of facility operations. Facility managers must understand, incorporate and utilize technology to support facility operations. Technology can provide critical tools and capabilities to help the facility manager effectively direct and oversee day-to-day

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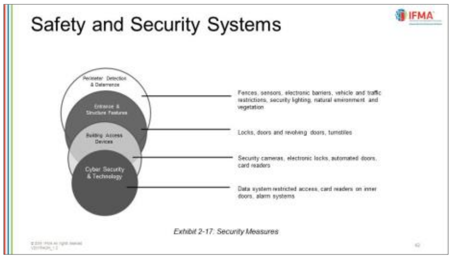
infrastructure operations and integrate new systems, materials and equipment, to optimize the functionality of the entire facility.

Safety and Security Systems



A broad definition of security in the sense of safety, is the freedom from danger, doubt or fear. At this level, a facility manager is expected to operate a facility prepared for threats that include, but are not limited to, the potential for natural disasters, terrorism, hazardous materials, medical emergencies, power failure, elevator and escalator incidents, civil disorder, workplace violence and cyber threats. Security systems help protect against these events, both external, internal and technology based.

From a security standpoint, technology may be applied to prepare for and protect against cyber-terrorism techniques. These illegal activities disrupt or damage computer-based information systems to cause fear, injury or economic loss. Less harmful invasions known as "spam" can inhibit productivity. Though a facility manager has limited control over these threats, there are policies and procedures that the facility manager can put in place to mitigate risk, such as incorporating security measures into technology and being vigilant of applications that are within control. FM should be prepared and take the necessary steps to manage threats so that occupants and visitors can work and reside in the facility safely and with confidence.

Systems and approaches for avoiding threats are varied and can be complex, depending upon the nature of the facility, the value of its purpose and the perceived threat of its loss.

The facility manager considers several ranks or rings of security that begin at the outer perimeter of the grounds, at entrance points and within buildings. The following exhibit shows the layers and components of security.

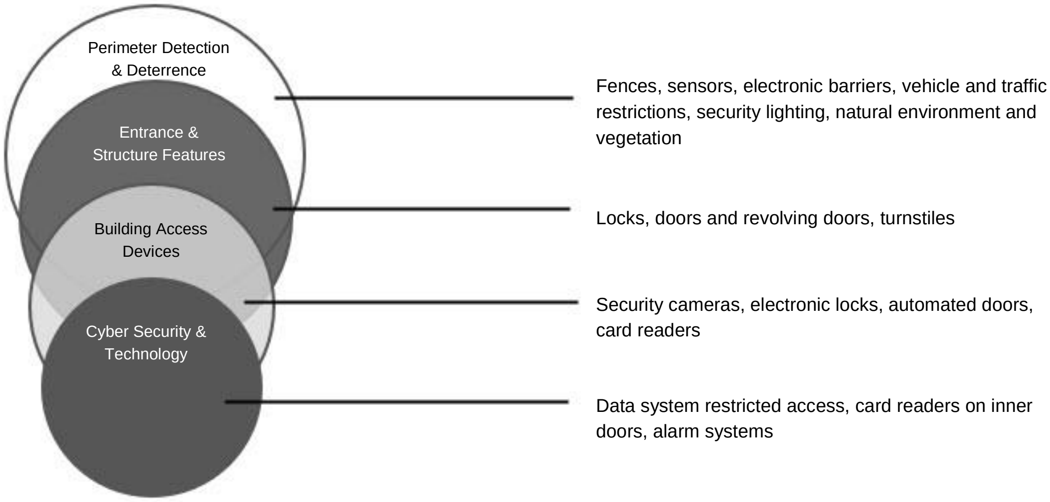


Exhibit 2-17: Security Measures

Security may include a standoff zone, the area between the facility and the threat that can extend outward from the facility a few meters/yards to a hundred or more meters/yards. Surveillance and confirmation activities, such as remote visual identification, intercom communication, screening deliveries at entrances, and authorized-only access help the facility manager provide security that gives occupants confidence.

In any case, the facility manager develops a security approach that considers many aspects beyond the technical elements of systems themselves.

These overarching aspects include:

- Organizational policy and owner expectations
- Budgetary and operational limits
- Interactions and relationships with emergency responders
- Emergency management provisions and crisis management
- First response practices
- Emergency drills and tests
- Recovery and backup preparations

The facility manager may assess the current state of security, safety and sustainability in a facility using a grid such as that shown in *Exhibit 2-18*.

The assessment is categorized by urgency of each item, the importance and the utility (functionality) of the item.

The facility manager can:

- Evaluate the urgency, importance and utility of each safety and security aspect.
- Determine the level of significance (low/medium/high) relative to urgency, importance and utility.
- Select the most significant priorities with the highest urgency.
- Prepare a plan to improve safety and security that resolves the highest priorities first.

For example: the fire alert system is of high urgency, high importance and high utility. From this assessment, the facility manager can create a plan to improve the safety and security based on the fire system's high priority.

Exhibit 2-18: Safety and Security Priority Matrix

Safety/Security Aspects	Urgency			Importance			Utility		
	L	M	H	L	M	H	L	M	H
Fire Life Safety									
Fire alert									
Noxious gas alert									
Fire suppression									
Smoke/gas exhaust									
Trip/fall hazards									
Standards									
Known requirement									
Code compliance									
Owner expectation									
Security									
Access control									
Preparedness									

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Safety/Security	Urgency			Importance			Utility		
Technology									
Communication									
Environmental Health									
Energy efficiency									
Sustainability									
Waste/use costs									

Safety Overview

Facility managers must be cognizant of occupant safety regulations. This can include government regulations, local, state and federal laws, and international standards. Codes and standards play a key role in facility management and, in turn, promote the health and safety of building occupants.

The Occupational Safety and Health Administration (OSHA) enforces standards on safe and healthy working conditions which govern facilities in the United States. Around the globe, similar organizations have set laws and regulations to ensure a safe workplace, including EU-OSHA, International Code Council and the International Organization for Standardization (ISO).

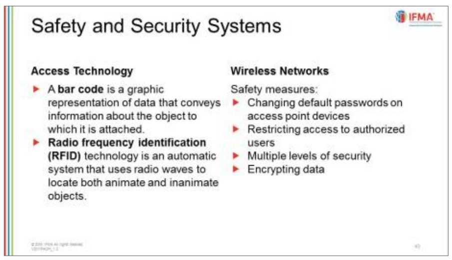
Facility managers should be well aware of compliance obligations related to, for example, building codes and signage, fire detection and suppression systems and indoor air quality. Facility managers need to understand how these laws and regulations affect their facilities' layout and operation. For example, some laws may specify the maximum distance between workstations and exterior windows.

FM must also be aware of and comply with national and local laws and regulations and with the requirements of individual employment contracts and agreements with workers councils or labor unions.

Other compliance demands can include anti-discrimination measures, training and accommodation requirements and complex worker health and safety requirements. Most countries, as well as regional and municipal governments, have numerous laws that regulate the health and safety of working conditions and that shape the employment relationship.

Facility managers may be responsible for monitoring and documenting facility conditions, for example, control of hazardous materials, testing of fire suppression systems, and for logging and reporting workplace injuries. There are also issues of organizational liability for harm suffered by occupants while in the facility, with substantial civil and possibly criminal penalties.

Safety Technology



By putting more integrated knowledge about every aspect of a building at a facility manager’s fingertips, emerging technologies can help facilities support goals. These goals set standards related to productivity, safety, security, and sustainability, and achieve compliance with codes and regulations. For example, facility managers can achieve data security by being aware of and in compliance with data privacy laws.

Data privacy can include:

- General Data Protection Regulation (GDPR)
- Cybersecurity
- Specified access credentials

Along with data safety, technology can be used to ensure a facility is safe and secure. Facility managers should have an understanding of the safety and security needs of the facility in order to implement safety features for the facility perimeter, building entrance and access, which includes both technological and physical assets.

Facility managers can use technology alongside physical security assets as an enabling tool to create a safe and secure facility. By implementing access monitoring, cameras, sensors, and other systems, FM can utilize technology to satisfy occupant needs, as well as keep the facility safe and running efficiently.

Access safety is an extremely important piece of security technology that allows specified occupants to enter the facility, which equates to better monitoring, reporting, and safety of the facility. Permissions and accessibility to systems, areas, rooms, and buildings can be determined and modified in order to maintain or change access restrictions for occupants. In order to decide what type of access security technology is right for the facility, FM

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should consider criteria, such as how many employees are in the facility, how many access locations there are and what the right level of technology is for the facility.

Two examples of access safety technology are Bar Codes and Radio Frequency Identification (RFID).

- A **bar code** is a graphic representation of data that conveys information about the object to which it is attached. The representation or symbol can be read by an optical scanner. This information is then transmitted to a computer, which accesses the associated data files and delivers this information to the user.
  - Bar codes on identification cards control access to secure areas of the facility.
  - Systems allow tracking of access to support investigations in the event of losses.
  - Bar codes on windshields can admit vehicles to authorized parking areas.
- **Radio frequency identification (RFID)** technology is an automatic system that uses radio waves to locate both animate and inanimate objects. RFID is used in electronic locking systems.
  - In some facilities, where security needs are high and occupants are not guaranteed conventional privacy rights, RFID badges can be used to track an occupant's movements in real time.

With evolving technology and increased safety regulations, it is important for facility managers to know and understand the expectations of the facility occupants within the limits and needs of the organization. Security expectations may vary depending on company culture. While worker safety laws may require monitoring, documenting and reporting of workplace conditions, it is important for facility managers to implement security that is robust enough to ensure proper monitoring without being more intrusive than necessary.

Wireless Network Security

With growing importance and a shift toward cloud-based data, technology is becoming an ever-present part of the workplace, namely, wireless internet access.

Wireless networks, referred to often by the term Wi-Fi™, can offer high-speed connections over the Internet in many locations. Keeping the workplace connected and supported with wireless internet access is extremely important to keep organizations running efficiently.

However, these internet transmissions are subject to intrusions, theft and tampering. Facility managers must work with their IT functions to ensure that their organizations' data is protected, that appropriate automatic protections are in place and that occupants are trained about safe computer and smart device use.

Security of wireless communication is a primary concern for organizations. The U.S. Department of Homeland Security recommends several steps to securing wireless networks:

- Changing default passwords on access point devices
- Restricting access to authorized users. Multiple wireless networks with different levels of security can be created to accommodate visitors.
- Encrypting data
- Installing not only a network firewall but a host-based firewall on wireless devices

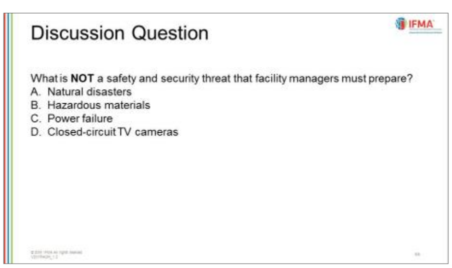
Training Employees on Safety

Creating a safe and secure workplace must be an integrated process because it aims at changing behavior that is probably deeply ingrained and may be motivated by complex factors.

The process of creating a culture of safety and security begins with enlisting support from the organization's leaders and gaining greater awareness of the range of risks to occupant safety and security that a facility is likely to confront. Then, facility managers can set goals and develop appropriate strategies and involve management and occupants actively in their implementation. Finally, the facility manager must measure the effectiveness of these strategies, reinforcing or revising them as needed.

Some key safety areas a facility manager should train on are:

- How to identify security threats
- Understand safety codes and regulations
- Be aware of restricted areas/access
- Understand signage



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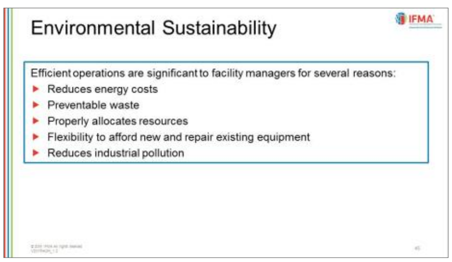
Health, Safety, Security and Environmental Considerations

There are many concerns about health and safety relative to building systems. Among them are three primary ones that reflect different aspects of building systems:

- Environmental sustainability
- Workplace safety
- Workplace risk assessment

Environmental Sustainability



Sustainable processes and activities ensure that the creation and use of the built environment does not harm the natural environment.

Sustainability is supported by policies and practices designed to:

- Reduce the consumption of energy through energy-saving devices and systems.
- Reduce waste production by employing more efficient processes including consumption reduction and recycling programs.
- Preserve water through water management programs that include waste, drinking and storm water.
- Protect wetlands and wildlife.
- Protect the natural environment through the use of biodegradable chemicals and materials to clean and preserve surfaces.

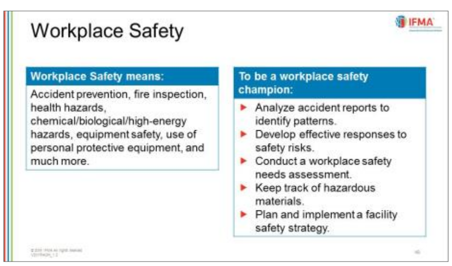
By implementing sustainability-focused policies and practices, facility managers and their demand organizations have an opportunity to support the environment while saving unnecessary operating costs by using energy more efficiently. In this way energy management, or energy conservation, is a measure of both sustainability and facility efficiency.

Efficient operations are significant to facility managers for several reasons:

- The high costs associated with energy use increase overall operating expenses, reducing the effectiveness of the facility.
- Any preventable waste adversely affects the facility manager's operating budget by either reducing opportunities for upgrades or limiting choices.
- Misuse or wasteful use of depleting resources adds to both the unit cost of those resources and to higher future energy expenses.
- Overly restricted budgets, possibly caused by excessive energy or materials use, may reduce the facility manager's ability to acquire new materials, systems or equipment that have better long-term advantages.
- Industrial pollution is a primary consideration in the public today, and wasteful use of resources — especially carbon-based energies — is scrutinized for code compliance that ranges from local agencies to international treaties.

High energy costs, particularly for fossil fuels, have caused facility designers and builders to specify better insulated, tighter with less air leakage, more energy-efficient buildings with sealed windows, mechanical ventilation and controlled air exchange. This provides greater control over energy use and loss. It also increases the facility manager's responsibility to maintain adequate ventilation, more closely monitor filtration and exchange systems and rigorously maintain mechanical system cleanliness so that pollutants are minimized.

Workplace Safety



Workplace safety crosses too many areas and issues to fully address in this course. It involves accident prevention, fire inspection, health hazards, chemical/biological/high-energy hazards, equipment safety, use of personal protective equipment (PPE) such as hardhats, eyewear, ear protection, fire-resistant clothing, air quality monitors, gloves and tie-offs for above-ground duties and much more.

Some statistics on electrical safety in the workplace show how critical this subject is. In the United States alone, the National Safety Council reports 1,000 electrocution deaths and 30,000 nonfatal shock accidents each year. The current that flows when a common 75 watt, 120v lamp lights, if passed through the chest, is enough to kill an individual.

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The facility manager must strive to embed safety into the culture by incorporating proper understanding, techniques, equipment and resources into O&M activities as well as facility use in general.

For the entire physical infrastructure, it is important to check protocols against local, regional, national and international requirements.

This is particularly significant relative to:

- Hazardous materials and spill
- Solid, liquid, gas or hazardous agent releases
- Proper availability of resources
- Use, inspection, storage and replacement of personal protective equipment
- Emergency response, support, equipment, scene management and cleanup

The facility manager should also extend safety issues beyond compliance. He or she should promote a culture of safety that supports the mission of the facility, improves productivity, reduces injuries and their costs, considers the environment and helps direct how operations and maintenance activities are conducted.

This responsibility includes an incident management approach that has both leading or pre-emptive and lagging or follow-up behaviors so that all personnel, staff, contractors and occupants are aware of and can practice a safe working approach.

The facility manager is a champion of workplace safety through actions, assessments and activities that demonstrate its importance. In addition, the facility manager must:

- Work with human resources to analyze accident reports and claims for workers' compensation to identify patterns of problems and key sources of risk.
- Collaborate with the demand organization's safety officers or department to develop effective responses to safety risks.
- Arrange for an insurer or consultant to conduct a workplace safety needs assessment. Insurers may also be able to provide online tools to assess risk.
- Conduct safety walk-through tours of the facility.
- Observe occupants and facility technicians at work.
- Compile a list of all hazardous materials used in the facility and their storage locations.
- Plan and implement a facility safety strategy.

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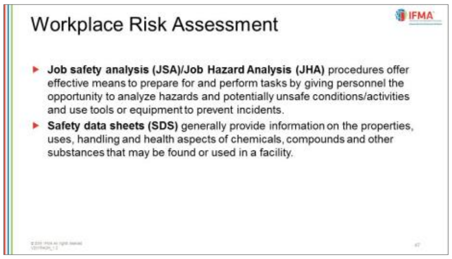
Workplace Risk Assessment



Most accidents and incidents in a facility are the result of unsafe acts or conditions. Unsafe acts generally occur because of behaviors by an individual or group. Behavior is difficult to change because it can involve personal habits and attitudes. Yet facility managers actively assess risks and strive to reduce them in the workplace. Two examples of risk-reducing approaches are job safety analysis/job hazard analysis and safety data sheets.

Job safety analysis (JSA) or Job Hazard Analysis (JHA) procedures offer effective means to prepare for and perform tasks by giving personnel the opportunity to analyze hazards and potentially unsafe conditions/activities and use tools or equipment to prevent incidents.

This can include:

- Approaches and requirements to working in confined spaces
- Lockout/tagout for energy or electrical systems
- Hot work processes where welding, brazing or soldering occurs and where flammable material is present
- Handling hazardous materials such as asbestos coating material, lead, mold, radioactive materials and chemicals

A JSA may also be known as a job hazard assessment/analysis (JHA), safe operating procedure or safe work method statement (SWMS). All are designed to explain what's required to complete a job or activity safely, with minimum risk to the individual, others nearby, the property and the environment.

In general, JSAs provide details on an activity while SWMSs provide detail on a task.

Safety data sheets (SDS) generally provide information on the properties, uses, handling and health aspects of chemicals, compounds and other substances that may be found or used in a facility. Countries and suppliers have different protocols and requirements for proper material handling. These protocols may be known under different names or descriptive terms such as material safety data sheets (MSDS), chemicals hazard information and packaging (CHIP), and risk and safety statements.

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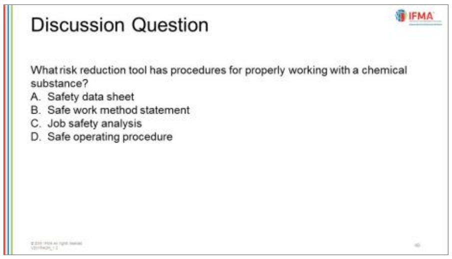
SDS forms are widely used and universally available to provide the procedures for properly working with a chemical substance.

Facility management policies and procedures help influence how people maintain safety in a facility. The facility manager provides the practices, procedures, oversight and diligence to promote and support a safe facility and working environment.



Assess and Inspect Interior Furnishings, Fixtures and Equipment

Lesson Introduction

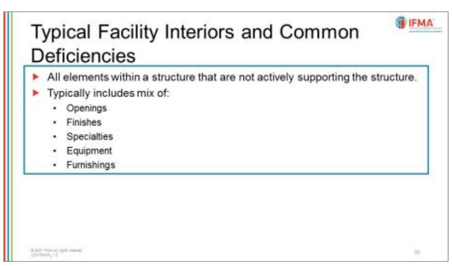
On completion of this lesson, you will be able to:

- Describe the common deficiencies in building interiors and the associated health, safety, security and environmental considerations.

This lesson contains the following topics:

- Typical Facility Interiors and Common Deficiencies
- Health, Safety, Security and Environment Considerations

Typical Facility Interiors and Common Deficiencies



Facility interiors generally include all elements within a structure that are not actively supporting the structure. A typical interior is a complex mix of different yet integrated materials, openings, and furnishings, fixtures and equipment (FF&E).

Exhibit 2-19 lists some typical elements of facility interiors.

Exhibit 2-19: Interior Elements

Interior Element	May Include...
Openings	• Operations and maintenance portals and access openings • Doors and frames of various materials and specialties • Entrances and storefronts • Windows, roof windows and skylights • Glazing • Louvers and vents
Finishes	• Plaster, gypsum board and cement plastering • Tile • Ceiling types, such as acoustical, specialty, textured • Flooring, such as laminate, masonry, wood, resilient and carpeting • Wall coverings, carpeting, facings, acoustic treatments • Painting and coatings
Specialties	• Information elements, like visual display surfaces such as chalkboards and markerboards • Display cases, directories and signage • Compartments, cubicles, partitions, screens and service walls • Wall and door protection • Toilet, bath and laundry accessories • Fireplaces and stoves • Safety and emergency cabinets • Lockers, mailboxes and storage shelving
Equipment	• Service equipment for vehicle, parking, loading dock and pedestrian support • Security, detention and other commercial equipment • Maintenance equipment storage • Hospitality, office and soft services equipment • Library, laboratory and other scientific equipment • Entertainment, athletic, recreational and health-care equipment

Interior Element	May Include...
	• Waste/recycling collection and disposal equipment
Furnishings	• Casework • Countertops • Window treatments • Accessories, lamps, bed, bath and waste receptacles • Rugs and mats • Furniture and multiple seating assemblies • Art, plants and other internal elements

There is great variety within interiors because there are so many different materials, finishes, functional purposes, fixtures and security and safety requirements. Among all these options, the facility manager attends to aesthetic and decorative as well as functional O&M concerns. In addition, the facility manager oversees soft/occupant services, such as custodial, that may influence the condition or quality of a facility's interior.

The scope is so broad that it is good practice to perform assessments and monitor results as part of scheduled maintenance. *Exhibit 2-20* shows a sampling of deficiencies that may occur in interiors that could compromise functionality, safety, security or health.

Exhibit 2-20: Deficiencies in Interior Elements

Interior Component	Deficiencies
Interior walls, windows and doors	• Cracks, rips, tears, peeling, flaking • Joint openings, poor seals or poor fit, such as doors, windows and access panels • Worn or poor physical condition, deterioration • Water stains, discoloration, other evidence of moisture • Malfunctioning or missing hardware • Abuse, vandalism, security breaches, such as incorrect latching • Interior doors without appropriate fire-rated door classifications
Ceiling systems	• Settling or sagging • Poor alignment • Stains, discoloration, evidence of moisture

Interior Component	Deficiencies
	• Missing panels or elements • Cracks, surface deterioration, poor adhesion • Poor acoustic quality, such as high noise levels and distracting traffic noise
Floors and floor coverings	• Carpet wear, color fading, age, stains, odor from carpet or carpet pad, holes, tears, poor seam conditions • Continuous topping such as concrete/terrazzo cracks, porosity, such as void spaces in a material, poor joints or seals • Resilient floor broken or loose elements, shrinkage, cupping, cuts, holes, porosity, fading • Wood shrinkage, warping, wear, unevenness, decay, poor finish • Masonry, such as brick and stone, cracks, stains, porosity, poor joints or seals, deterioration, discoloration • Trip hazards, such as unsecured electrical cords or cables or items on the floor, uneven or slippery floors

Many aspects of a building's interior functioning are closely regulated, especially regarding health and safety. Code compliance is critical both for occupant satisfaction and to maintain the building in good standing with regulatory authorities and agencies.

A comprehensive facilities assessment inspection is likely to be an opportune time to systematically identify any functional weaknesses that might hinder free access and movement. Any such barriers may also violate local, national or international requirements. From a business perspective, barriers to mobility might also reduce or inhibit productivity.

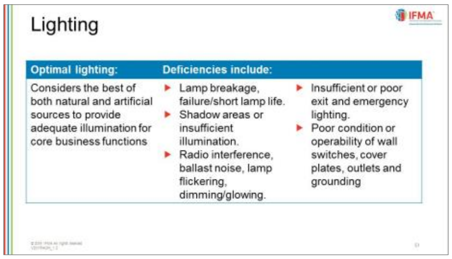
The usefulness of any space depends on reliable heating, cooling, electrical systems, water supply and waste removal.

In addition, space usefulness depends upon:

- How the space is allocated
- How configurations support workflow
- How management goals are realized
- How current arrangements permit growth and change

These strategic and managerial factors affect the ultimate value and effectiveness of O&M. The facility manager recognizes and makes business decisions that support these non-mechanical aspects of building interiors.

Lighting



This topic takes a closer look at another element of facility interiors, namely, lighting systems.

A well-integrated indoor lighting system considers the best of both natural and artificial sources to provide adequate illumination for core business functions. It should create a suitable and pleasant visual environment that enables occupants to function visually with efficiency and comfort at a minimum of electrical consumption.

The following concepts are important in the design of lighting systems:

- Reflectance is the amount of light a surface reflects relative to the total amount of light upon the surface
- Glare is the lighting or brightness reflected from a surface
- Contrast is the balance of light and surrounding dark areas
- The color of light relates to the hue that specific artificial lighting produces (usually green, blue, pink and brown)
- Lumens measure the projection of light to an area
- Brightness or luminance refers to the perception or measurement of the level of intensity in a particular direction
- Ambient light refers to the available light in an environment or room
- Task light is a controllable light for a local, well-defined activity

Effective lighting depends on what lighting levels and light quality the space requires, on ceiling height, and on the reflectance value of the ceiling, walls and floors.

Over time, light output from fixtures can drop below initial designed values because:

- Lamps themselves deteriorate with use and age.
- Dust and dirt can collect on lamps, lenses and reflecting surfaces in the room.

- The reflecting and transmitting materials of some lamps gradually change chemically in the presence of air and light.

Good lighting design integrates illumination to support tasks, enhance the architectural image, provide emergency lighting and reinforce security at night. Lights in unoccupied areas should be able to be dimmed or turned off. Daylight openings should be adjustable using blinds, shutters and reflectors.

Deficiencies in lighting systems can include:

- Lamp breakage, failure or short lamp life
- Shadow areas or insufficient illumination
- Radio interference, ballast noise (buzzing, humming or other sounds), lamp flickering, dimming or glowing
- Insufficient or poor exit and emergency lighting
- Poor condition or operability of wall switches, cover plates, outlets and grounding (grounded wiring).

Lighting fixtures and reflective surfaces require regular cleaning to preserve efficiency. An area ventilated with forced and filtered air generally stays cleaner than a naturally ventilated space.

Lighting maintenance is now generally accepted on a replace-lamps-as-needed basis rather than replacing entire zones regardless of whether lamps are burned out. An exception to this policy is lamps that are difficult to reach, require lifts or special equipment, or are in limited access areas such as manufacturing lines, hospital operating rooms and building lobbies. In these instances, facility managers generally have lamps replaced on a set schedule.

Exhibit 2-21 is an example of some of the elements contained in a lighting systems assessment.

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Components: fixtures, visible motor controls, switches, cover plates, grounds, lighting protection, accessible wiring

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

General causes or concerns

Lighting levels

- [ ] Excessive, insufficient
- [ ] Balanced, adequate
- [ ] Controllable
- [ ] Aesthetically pleasing

Energy use

- [ ] Controllable lighting
- [ ] Sufficient wattage
- [ ] Systematic conservation (turn off lights, month-over-month/year-over-year energy use comparison

Deterioration

- [ ] Ballast noise
- [ ] Flickering/glowing
- [ ] Dimming
- [ ] Water/moisture

Maintenance

- [ ] Dust/Dirt
- [ ] Improper installation
- [ ] Broken/failed lamps
- [ ] Loose wiring/ connections
- [ ] Custodial supervision
- [ ] Fixture condition

Lamps

- [ ] Energy-efficient
- [ ] Unexpectedly short life
- [ ] Lens condition

Safety

- [ ] Proper grounding
- [ ] Blown fuses/circuits
- [ ] Overloaded circuits/motors
- [ ] Proper wattage for circuits
- [ ] Dimming
- [ ] Water/moisture

Compliance (codes/regulations)

- [ ] Local requirements
- [ ] Area requirements
- [ ] National/international standards
- [ ] Required permits

Maintenance History (date/activity)

____
____
____
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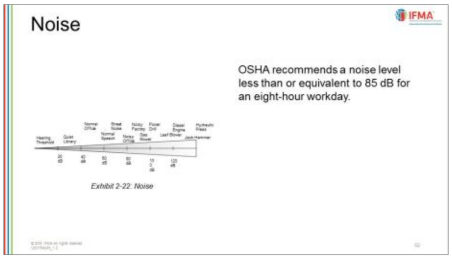
Component evaluation Description (type, location, serial number/ID)	Condition (items that needs attention/deficiency described)

Exhibit 2-21: Interior Lighting Assessment

Noise



Noise can be considered unwanted sound that can harm health and impair productivity. Sound is measured in decibels. *Exhibit 2-22* identifies common noise levels.

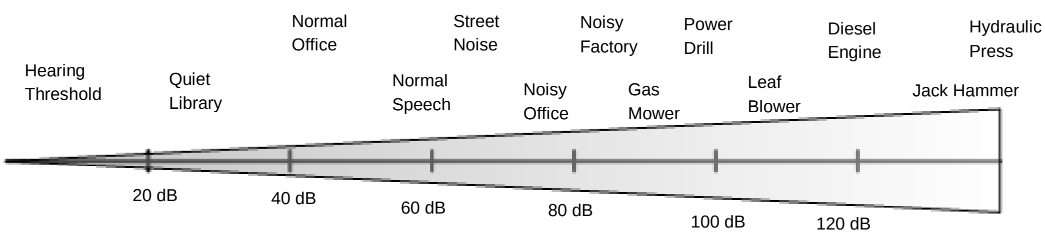


Exhibit 2-22: Noise

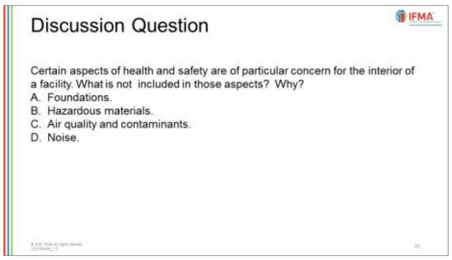
In many countries, acceptable noise levels in different types of workplaces are defined through regulation, such as the Control of Noise at Work Regulations (2005) in the U.K. Facility-generated noise may also be regulated as a form of environmental pollution. Again, facility managers must be aware of these legal requirements.

The effects of too much noise have been well studied, but with the increased use of open workplace designs and quieter ventilation systems and office equipment, facility occupants are becoming more aware of the effects of too little noise. Too little ambient noise can challenge speech privacy, as conversations can be easily overheard. A survey of over 65,000 office workers on four continents found that more than half were dissatisfied with the level of speech privacy that their workplaces provided. The lack of background noise can also increase distractions. A study by the Institute of Occupational Health in Finland found that overheard conversations could cause a 5 to 10 percent decline in the performance of cognitive tasks by unintended listeners.

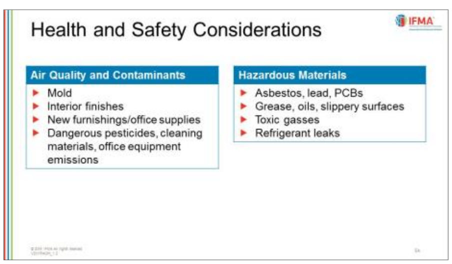
In the same sense, it is undesirable to have too much noise. A noisy environment can cause lack of focus, increased stress and lessen occupant satisfaction.

Depending on the needs and uses of a workspace, the optimal noise level may vary. For instance, a call center will have a higher average acceptable volume than that of an attorney office. In order to reduce the risk of hearing loss, OSHA recommends a noise level less than or equivalent to 85 dB for an eight-hour workday.

A facility manager must be aware of the needs of the occupants and make corrections to support or suppress noise levels, whether that is creating a more open layout or installing sound absorbent surfaces.



Health, Safety, Security and Environmental Considerations



Facility managers are expected to maintain a safe interior environment. Protecting occupants from unsafe interior conditions includes fire life safety and minimization of hazards. The facility manager must always be alert for conditions that might cause injury, incapacitation or discomfort. Storm preparation is also necessary so that the resources and responses are in place to maintain an open, operating and safe facility during routine storm conditions.

The facility manager is also wise to review manufacturer safety data sheets and to be familiar with government-mandated information concerning health and safety. It is especially important that the facility manager be familiar with health and safety compliance, including relevant codes, standards and regulations.

There are aesthetic as well as economic reasons for keeping a facility safe and functional.

The facility manager strives to maintain a safe working environment so that occupants and visitors are satisfied with their surroundings and the building provides optimal conditions for productive use. Furthermore, any negative event that endangers life and property could cause an asset to be damaged or lost. This produces a financial penalty that multiplies the cost of any injury or productivity loss.

Health and safety aspects of particular concern regarding interiors include air quality and contaminants, hazardous materials and indoor environmental quality.

Air Quality and Contaminants

Acceptable indoor air quality or, more broadly, indoor environmental quality, can be compromised if a building has been constructed so that air quality cannot be controlled, and the amount of fresh air and humidity is limited.

Biological contaminants such as mold or fungi can grow wherever four essentials are present:

- Viable mold spores
- Acceptable temperature range
- Consistent moisture source
- Nutrient source, such as paint, paper, wood products, adhesives, plastics and fabrics

Mold is an invasive and common problem in structures, especially in high humidity environments. Unfortunately, it may be hidden, occurring inside walls and ceilings or anywhere moisture collects and cannot be readily observed, such as HVAC ducting system or air distribution system.

Signs to look for that might indicate mold infestation include:

- Peeling or blistering paint
- Rot or other damage around windows, doors and air conditioning units that permits water penetration
- Cracks, breaks or undesired openings in exterior walls and around windows or doors
- Roof damage that permits water penetration

- Water pooling in basement window wells
- Joints, sills and jambs where different claddings meet that could permit water penetration
- Cracks or damage to basement walls or foundations that may indicate water intrusion

Indoor air quality can be affected by a number of factors in addition to mold, including facility furnishings. Paints, glues and coatings can emit volatile organic compounds (VOCs), which can irritate mucous membranes, impair memory and cognitive processes and cause headaches and, in extreme cases, liver damage. Pollutants can be produced from interior finishes, new furnishings, office supplies, detergents, pesticides, cleaning materials, even emissions from office equipment. New furniture and carpeting are especially problematic off-gassing sources. A facility manager must be aware of all facility furnishings and monitor VOCs to ensure a safe and healthy workplace.

For example, new carpeting may emit gases that contain VOCs that reduce indoor air quality. To avoid poor air quality, it is recommended to purchase low or no VOC carpeting.

Hazardous Materials

Any solid, liquid, gas or infectious agent that can chemically or physically affect life, health or the environment is a concern for the facility manager and should be carefully managed within buildings. A spill that would be unsafe outside of a facility can easily produce a toxic condition inside the structure.

The facility manager must be alert for unsafe conditions such as:

- The presence of hazardous materials, their storage, location and handling that may be part of the facility's purpose.
- The presence of environmental hazards or pollution from materials such as asbestos, lead, polychlorinated biphenyls (PCBs), gasoline, diesel and other chemicals as well as the visible and invisible fumes they may create.
- Grease, oils or slippery surfaces that could not only affect air quality but also cause slips or falls.

Additional concerns include:

- Carbon dioxide or other toxic gasses from idling vehicles or faulty heating units, which could also be drawn into equipment and air supply systems.
- Refrigerant leaks at condenser or evaporator coils in HVAC units.
- Leaking return ducts in crawl spaces that compromise heating/cooling efficiency or air quality.

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- Unclean and unfiltered air handlers that send pollutants and dirt into interior spaces to make cleaning difficult and more expensive.
- Unsafe electrical wiring.
- Poor, inadequate, imbalanced or unreliable fresh air exchange.
- Poor or non-draining condensation pans.
- Use of ill-fitting primary pre- and final air handler filters.

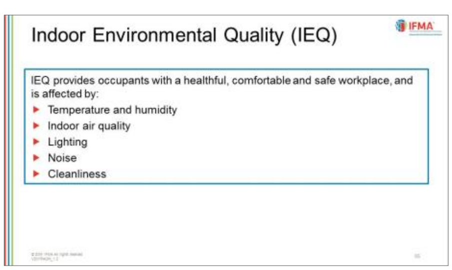
Monitors and detectors should be installed and periodically maintained to alert occupants to unhealthy emissions, such as carbon monoxide, fuel vapors and other dangerous conditions.

Relative to hazardous spills or leaks, the facility manager should have a plan, such as an emergency procedures manual, to manage situations that can appropriately respond with:

- Types of possible releases and their danger levels.
- Safety data sheets and labeling information.
- First-line defense equipment, such as first aid, fire extinguisher, hydrants and hose and containment supplies.
- Evacuation, communication and transportation management protocols.
- Trained, or emergency personnel with personal protective equipment and material for support and cleanup.
- Prepared and documented information relating the most stringent or specific (local, regional, national and international) requirements for response, materials management, replacement and review.

Dangerous and hazardous materials are subject to strict environmental codes and regulations around the world. The facility manager must be aware of these restrictions and watchful for these materials within and near the facility.

Indoor Environmental Quality (IEQ)



The term indoor environmental quality (IEQ) refers to the strategies and systems used to provide occupants with a healthful, comfortable and safe workplace. IEQ is a consideration in most sustainable building certification or ratings systems (LEED, for example). Improved

IEQ correlates with lower rates of respiratory infections and headaches. It supports higher rates of productivity and concentration needed for complex tasks.

Workplace environmental quality is influenced by culture, local practices, work equipment or process requirements, and, in some countries, by laws and building codes. For example, expectations of cleanliness may vary by culture and industry. It is FM's responsibility to ensure that all of these influences and requirements are reflected in the facility strategy for creating IEQ.

Part of IEQ is maintaining the quality of facility air. The facility air quality refers to the levels of pollutants present in the air of the facility: high levels of carbon dioxide, carbon monoxide, ozone and other gases; volatile organic compounds; bacteria, viruses and mold spores; odors; dust and toxic substances, including asbestos.

Overall IEQ is affected by:

- Temperature and humidity
- Indoor air quality
- Lighting
- Noise
- Cleanliness

Exhibit 2-23 shows the elements of an IEQ assessment.

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

Components: fixtures,thermostats, cleaning items, noise control

General causes or concerns

Condition

[ ] Comfortable temperature
[ ] Supports occupant comfort
[ ] Clean
[ ] Monitor temperature and humidity

Lighting

[ ] Controllable lighting
[ ] Functioning lamps/lights
[ ] Systematic

Noise

[ ] Excess mechanical noise
[ ] Insufficient white noise
[ ] Monitor noise levels

Maintenance

[ ] Vent intakes are monitored
[ ] Failed thermostat
[ ] Broken/failed lamps
[ ] Loose wiring/ connections
[ ] Cleanliness condition
[ ] Visual inspection of deficiencies

Cleanliness

[ ] Vents are clean
[ ] Signs of mold
[ ] Regular cleaning

Compliance (codes/regulations)

[ ] Local
[ ] Area
[ ] National/international standards
[ ] Required permits

Maintenance History (date/activity)

____
____
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____

Component evaluation Description (type, location, serial number/ID)	Condition (items that needs attention/deficiency described)

Exhibit 2-23: Indoor Environmental Quality

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Assess and Inspect Grounds

Lesson Introduction

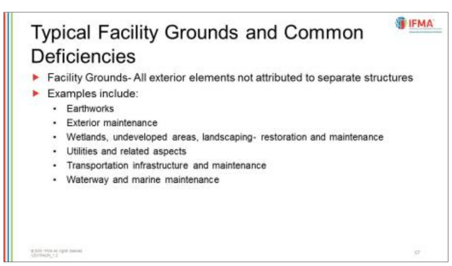
On completion of this lesson, you will be able to:

- Describe the common deficiencies in building grounds and the associated health, safety, security and environmental considerations.

This lesson contains the following topics:

- Typical Facility Grounds and Common Deficiencies
- Health, Safety, Security and Environment Considerations

Typical Facility Grounds and Common Deficiencies



Facility grounds include all exterior elements not attributed to separate structures. Examples are listed in *Exhibit 2-24*.

Exhibit 2-24 illustrates an example of grounds and surfaces.

Type of Facility Grounds	Examples
Earthworks	• Maintenance through site clearing, earth moving, underpinning, retaining walls, berms, dikes, terraces

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Type of Facility Grounds	Examples
	• Soil treatment, rodent and termite control, stabilization • Slope protection, grading • Grouting, expansion joints, maintaining foundations • Tunnels and mining
Exterior Maintenance	• Pavement cleaning, rehabilitation, repair • Level changes, bases, ballasts, paving, aggregate surfaces • Curbs, gutters, wheel stops and parking bumpers • Markings, traffic calming, yield/stop signs, pedestrian crossing signs • Fences, gates, walls, bridges • Streetscape furniture, such as light poles, flag poles, railings, seating areas, reinforced trash receptacles • Security fences and site access gates, aesthetic illumination and lighting for way-finding • Sculpture, statues, art, fountains, water features, planter boxes • Steps, stairs, ramps, docks
Wetlands, undeveloped areas	• Planting, seeding • Water, including ponds, reservoirs, cisterns and storm basins • Irrigation equipment and water runoff systems, culverts, trenches
Utilities and related aspects	• Water, wells, storage, distribution, fire hydrants • Sanitary sewer, storm drainage, piping, mains and tanks • Manholes, sewer covers, gratings, drain covers, electrical covers • Fuel distribution, such as natural gas and liquid fuel • Steam energy • Site utilities, systems and infrastructure, such as power transformers, energized equipment, gas lines, power lines, water lines, electrical grounding

Type of Facility Grounds	Examples
	• Communications utilities, such as towers, distribution and wireless
Transportation infrastructure and maintenance	• Roadways, railways, guideways, airports, bridges • Parking lots and structures • Signaling and control equipment • Fare collection equipment • Vehicle ID systems
Waterway and marine maintenance	• Waterway preservation, cleaning, deepening, or dredging • Signaling and control equipment • Shoreline protection, artificial reefs, levees, banks, scour protection, dams
Landscaping	• Terrace decks, retaining walls • Plant strips, beds and features • Turf, shrub and tree maintenance • Integrated pest management with ecological use of insecticides/pesticides

Exhibit 2-25: Grounds

A facility's setting is a particularly important and challenging aspect of O&M, because the grounds:

- Represent a significant long-term financial obligation.
- Provide an immediate impression that reflects on the building owner and occupants.
- Require continuous, labor-intensive maintenance year-round, including turf mowing, tree pruning, hedge/brush trimming, flower care, fertilization, edging, aeration, irrigation, disease and insect control, sweeping and surface cleaning as well as litter, leaf and snow removal.

The smoothly transitioning, visually attractive entrance to a building or complex provides an immediate, positive first impression. This not only influences the surrounding community but also affects occupants and visitors.

Facilities generally reflect the organizational image. Outward tangible appearances communicate a lot about the organization and its culture. For this reason, it is important for facility managers to maintain and improve the outer appearance of the facility.

Successfully maintained grounds provide:

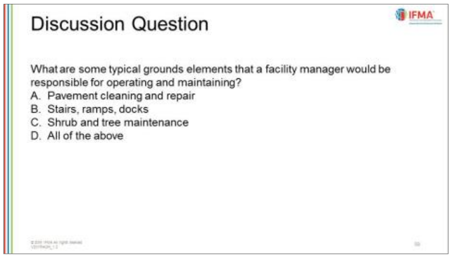
- Safe, smooth pedestrian paths and vehicle pavements

- Adequate parking areas and structures
- Integrated pest management
- Barrier-free access for individuals with limited mobility
- Well-drained sites free of standing water
- Adequate snow and ice removal
- Clean grounds free of leaves and debris
- Adequate irrigation and xeriscaping (use of native vegetation)
- Intuitive, easily understood travel direction day and night
- Security and emotional comfort day and night
- Shade in summer
- Shelter from wind, rain and inclement weather
- Seating areas
- Noise reduction
- Visual screening
- Habitat for wildlife

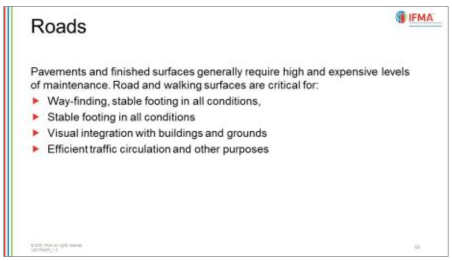
Integrated property management is an approach to landscape design and maintenance that may be linked to life-cycle costing. This method helps recognize what resource-conserving options support a lasting and healthy landscape at a lower total cost of ownership.

Maintaining grounds is a challenge to preserve existing features and incrementally enhance the exterior environment.

Facility managers may use staff or contractors for grounds O&M. Many select contractors to maintain grounds because these activities are not usually significant to the core purpose of the facility or connected to the functions of the occupants. These services may also be contracted because they are seasonal. The level of care and aesthetics given to grounds is usually dictated by the budget provided and the general impression the owners or the organization desires to maintain.



Roads



Pavements and finished surfaces generally require high and expensive levels of maintenance. Road and walking surfaces are critical for way-finding, stable footing in all conditions, visual integration with buildings and grounds, efficient traffic circulation and other purposes.

Exterior paved surfaces can be subject to heavy use as well as the extremes of temperature and weather. Yet they should continually meet aesthetic, directional, safety and security expectations and should be regularly assessed and substandard conditions corrected.

Exhibit 2-26 is an example of some of the elements that could be contained in an assessment of roadways and paved surfaces.

Components: pavement, curbs, gutters, drains, aprons, wheel stops, markers, pavement graphics

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

General causes or concerns

Condition

[ ] Spalling, flaking, chipping
[ ] Cracks, holes, potholes
[ ] Uneven surfaces
[ ] Roughness or unexpected changes in surface conditions
[ ] Out-of-level, unusual slopes
[ ] Poor drainage, erosion
[ ] Deterioration

Safety

[ ] Tripping or slipping
[ ] Misaligned surfaces
[ ] Unlevel walking path
[ ] Unclear pedestrian markings
[ ] Need reflective/light-visible paint

Maintenance

[ ] Standing debris
[ ] Standing water, ice
[ ] Joints not filled, buckled
[ ] Discoloration

Fixture condition

[ ] Need painted direction arrows
[ ] Inadequate surface graphics
[ ] Need traffic calming aspects

Aesthetics

[ ] Overgrown or invasive vegetation
[ ] Faded paint/striping

Compliance (codes/regualtions)

[ ] Local
[ ] Area
[ ] National/international standards
[ ] Required permits

Maintenance History (date/activity)

____
____
____
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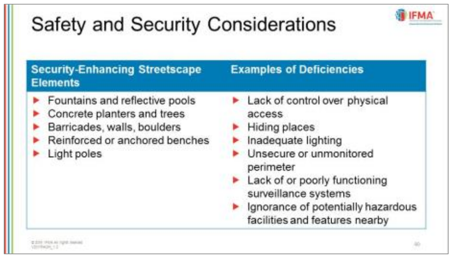
____
____

Component evaluation Description (type, location, serial number/ID)	Condition (items that needs attention/deficiency described)

Exhibit 2-26: Road Assessment

Health, Safety, Security and Environmental Considerations



Grounds are typically designed to promote a pleasant aesthetic without sacrificing pedestrian or building security. For the purposes of O&M, several security aspects relate to facility management and passive landscaping of grounds.

Streetscape elements are used to deny vehicle access and maintain standoff/security distance. These elements can include fountains, reflective pools, concrete planters, barricades, walls, reinforced or anchored benches, boulders, trees and light poles. Grounds should be assessed to determine what is being done to prevent or frustrate man-made threats and prepare against natural ones.

Examples of security concerns to look for on facility grounds include:

- Lack of control over physical access, flow patterns, passive barriers, building entry scrutiny and command, locks and locking procedures
- Hiding places such as overgrown vegetation, blind spots, blocked sight lines
- Inadequate lighting, areas in shadow
- Unsecure or unmonitored site or building perimeter
- Lack of or poorly functioning alarms and surveillance systems
- Ignorance of nearby potentially hazardous facilities, such as fuel storage and chemical labs
- Ignorance of nearby potentially hazardous natural features, such as hillsides for potential mudslides, seismic activity, water levels that could flood and trees that could fall

The facility manager would be wise to prepare a security maintenance checklist that regularly reviews security practices and corrects any weaknesses. It should include contact information for critical nearby fire, police and hospital resources as well as equipment manufacturers' operations, service and emergency shutdown procedures.

Grounds should also be maintained in order to limit unauthorized access. Facility managers should incorporate grounds elements such as fences and security checkpoints. As mentioned previously, the implementation of access security will increase the safety of a facility and ensure only authorized personnel enter.

Chapter Activity

Building Deficiencies Class Activity

Instructions:

- Inspect each image. What deficiencies or health and safety concerns can you identify?

Example 1

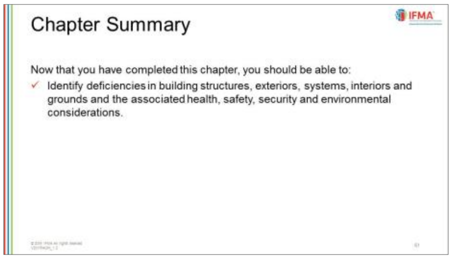
Example 2

Example 3

Example 4

Example 5

Example 6


Chapter Summary
IFMA
Now that you have completed this chapter, you should be able to:
✓ Identify deficiencies in building structures, exteriors, systems, interiors and grounds and the associated health, safety, security and environmental considerations.

Progress Check Questions

1. What is part of a building foundation structure?
    a. Drilled piers and shafts
    b. Roofs
    c. Active fire protection
    d. HVAC, plumbing and similar systems

2. What is NOT considered a common deficiency in a building structure?
    a. Vertical cracks in foundation walls
    b. Separation of corners at windows, doors or joints
    c. Poor acoustic quality
    d. Overgrown shrubs, trees or foliage next to the structure

3. What is the most important reason to recognize and correct structural deficiencies?
    a. They are unsightly and bad for morale.
    b. They can be the primary cause of poor air quality.
    c. They are inexpensive if caught early.
    d. They could seriously affect health and safety.

4. What approach is regularly used to remediate or prevent foundation deficiencies?
    a. Position trees near the building to divert rainfall effects.
    b. Grade slopes and position roof downspouts to drain water away from foundations.
    c. Provide a level grade out from foundations to support water percolation.
    d. Add shutters, awnings or other coverings to deflect rainfall.

5. What deficiencies are common among exterior elements and structures?
    a. Deteriorating foundation, wall, roof, and other surface conditions.
    b. Poor joints, anchoring, ventilation, lighting.
    c. Insufficient size, capacity, access or egress.
    d. All of the above.

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6. What is NOT an example of an information technology system?
   a. Networks
   b. Filters
   c. Sensors
   d. Software

7. What best describes passive fire protection measures?
   a. They are generally fixed-in-place walls and shaft enclosures.
   b. They require on-premises firefighting personnel.
   c. They include sprinkler and smoke control systems.
   d. They are seldom necessary or required.

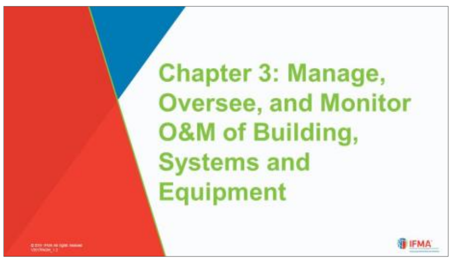
8. JSA and SDS are designed for what purpose?
   a. To reduce the risk of accidents and incidents.
   b. To catalog equipment and systems maintenance activities.
   c. To support long-range planning.
   d. To maintain manufacturer warranty requirements.

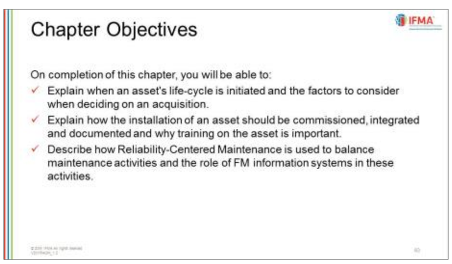
9. What can affect air quality?
   a. Furnishings.
   b. Noise.
   c. Lighting.
   d. Regulated temperatures.

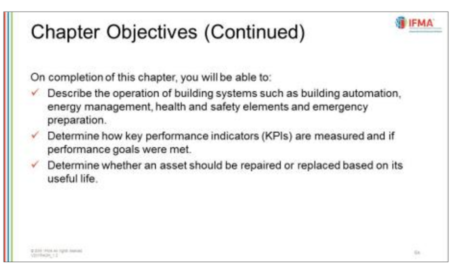
10. What is an example of a security concern that can be identified on facility grounds?
    a. Lack of control over physical access, flow patterns, passive barriers, building entry scrutiny and command, locks and locking procedures
    b. All of the above
    c. Hiding places such as overgrown vegetation, blind spots, blocked sight lines
    d. Ignorance of nearby potentially hazardous facilities, such as fuel storage and chemical labs

Chapter 3: Manage, Oversee, and Monitor O&M of Building, Systems and Equipment

Chapter Introduction







On completion of this chapter, you will be able to:

- Explain when an asset's life-cycle is initiated and the factors to consider when deciding on an acquisition.
- Explain how the installation of an asset should be commissioned, integrated and documented and why training on the asset is important.
- Describe how Reliability-Centered Maintenance is used to balance maintenance activities and the role of FM information systems in these activities.

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Lessons

- Acquire Systems, Materials and Equipment
- Install Systems, Materials and Equipment
- Maintain Systems, Materials and Equipment
- Operate Building Systems and Equipment
- Monitor Use and Performance of Facilities
- Replace Systems, Materials or Equipment

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Acquire Systems, Materials and Equipment

Lesson Introduction

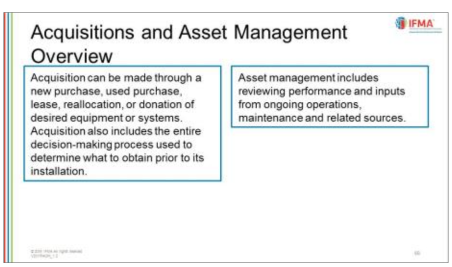
On completion of this lesson, you will be able to:

- Explain when an asset's life-cycle is initiated and the factors to consider when deciding on an acquisition.

This lesson contains the following topics:

- Acquisitions and Asset Management Overview
- The Life-Cycle Process Begins at the Acquisition
- Considerations in Deciding on an Acquisition

Acquisitions and Asset Management Overview



Operations and maintenance is required for systems/equipment and to support occupant needs. A way to differentiate these areas is to consider O&M for facility systems as **hard services**, and O&M for occupant needs as **soft services**.

Hard and soft services share several common aspects:

- Both require operations and maintenance.
- Both have similar work plan processes by which O&M is accomplished.
- Both may be performed by employed staff or hired contractors.

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This chapter focuses on operating and maintaining facility systems and equipment. Later chapters will focus on occupant services.

A facility's hard systems, such as the building structure, plumbing, electrical, HVAC, and production equipment, can easily represent a major portion of the demand organization's physical assets. It is the facility manager's responsibility to operate and maintain those assets in a manner that maximizes the asset's life-cycle and is in alignment with the organization's strategic plan and goals. That responsibility generally begins when an asset is acquired.

Acquisition can be made through a new purchase, used purchase, lease, reallocation or donation of desired equipment or systems. Acquisition also includes the entire decision-making process used to determine what to obtain prior to its installation.

Acquisitions range from broad and encompassing, such as during a renovation, to individual, such as when replacing a pump. These acquisitions occur due to changing functional needs, updates, renovations or the functional failure of equipment.

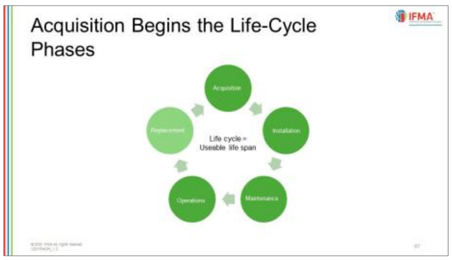
Facility managers are becoming involved in the original specification, design and construction phases of an infrastructure, including its equipment and systems. Most systems are new when a building is constructed; however, the life of the building is usually longer than the life of many of its components and systems. The facility manager should be involved in developing a long-term asset replacement and renewal plan ahead of obsolescence or failure.

New equipment or systems are acquired to improve performance rather than just as a replacement for maintenance reasons. A long-term capital renewal plan is important to fund and make these acquisitions possible.

Once an asset is acquired, it must be added to the facility inventory/register and managed accordingly. Asset management is an overall practice that includes reviewing performance and inputs from ongoing operations, maintenance and related sources. According to IDO 55000, asset management is a "coordinated activity of an organization to realize value from assets." It may begin with specification and design that is value engineered. Value engineering is a consideration used in asset management that compares cost-adding aspects with value-adding aspects as a way to assess and analyze the user's requirements for a new asset, ensuring that those requirements are met but not exceeded. Value engineering should not be viewed as a cost-cutting approach.

After the asset is installed, it is the facility manager's responsibility to achieve optimal performance and sustain that performance for the asset's useful life. To accomplish this, the facility manager reviews performance and feedback from ongoing operations, maintenance and related sources such as a Computerized Maintenance Management System (CMMS).

The Life-Cycle Process Begins at the Acquisition



An asset life-cycle is defined as the total length of time that a product, process, facility, tool, system, technology or natural resource lasts, incorporating time from acquisition up to its disposal. Useable life-span can be defined as the length of time a given asset can be expected to last given appropriate maintenance.

Acquisition initiates the life-cycle of a physical asset and installation marks the start of the usable life of an asset. The life-cycle is based on the presumption that all things go through a continuous cycle beginning with creation, moving to use and ending with replacement/disposal.

Once the asset is acquired, installed and commissioned in compliance with design specifications, it becomes part of the asset inventory/register. The asset is tracked for the remainder of its entire life as it is operated, maintained and repaired, if needed. At the end of the item's useable life or installed purpose, it is removed from service and recycled, scrapped, resold or re-purposed, thus ending its life-cycle and tracking.

Tracking an asset, once it is acquired, provides important information about O&M activities. This helps give the facility manager the means to recognize an appropriate time to refurbish or replace the asset.

It is important to track assets because:

- Assets have different life spans.
- Similar assets have similar life-cycles.

Assets Have Different Life Spans

All hard components or physical assets have a built-in useful life that is different for different components. For example, the life-cycle of a light bulb or lamp is much shorter than that of an elevator. Yet, a commercial elevator may have a useful life that is shorter than the life of the building in which it was originally placed. In this way, "useful life" refers to both functionality and performance.

A properly functioning component may at some point be no longer considered an adequately performing asset for reasons such as:

- Changing occupant expectations
- New product design
- New technology has made the current system outdated or undesirable

Similar Assets Have Similar Life-Cycles

Acquisitions not only signify the start of an asset's use but also represent due diligence, or the investigation and analysis of a potential purchase to minimize risk and possible loss. The facility manager gathers information and studies, compares and selects among similar assets to help determine what acquisition to make and when.

Some of this knowledge comes from existing assets of a similar kind that are tracked through O&M reports. These reports provide information on frequency and costs for maintaining or repairing existing material, equipment or systems, typically through the use of a (CMMS).

The facility manager tracks functionality, benefit and useful life of all physical assets. This helps determine when the total cost for continuing to keep and maintain the asset exceeds replacement or upgrade costs. At that point, a replacement asset is acquired, and the life-cycle and tracking of the replacement begins.

Considerations in Deciding on an Acquisition

Every hard component has a built-in useful life. The facility manager needs to know the life-cycle of the item to maintain it effectively, determine when to end maintenance and either repair or acquire a new item.

Several aspects are considered when deciding to acquire a new item or to continue maintenance, including:

- Life-cycle cost

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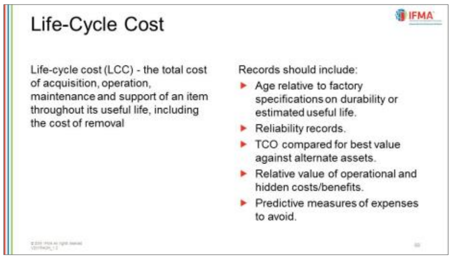
- Reliability and maintainability
- Performance and energy use
- Sustainability

Life-Cycle Cost (LCC)



Life-cycle costing (LCC) is the decision-making process of determining (in present-value terms) all costs incident to the planning, design, construction, operation and maintenance and disposition of an asset over time. This process takes into account aspects such as the total cost of acquisition and support of an item throughout its useful life, including the cost of removal and disposal. LCC is needed to plan for activities such as maintenance and preparation for future needs and funds. Life-cycle cost reflects the hard costs, or the upfront costs of an asset, including capital investment costs, operating costs, maintenance costs and the cost of disposal.

A thorough discussion of life-cycle costing can be found in the *Finance and Business* course.

For the purposes of O&M, there are several significant life-cycle cost considerations:

- Initial costs, such as acquisition, capital investment, design, construction
- Recurring costs, such as operation, maintenance and repair costs; energy and resource, or sustainability, costs; alteration, improvement and replacement costs
- Potential added value, such as:
    - Any value of deferred maintenance
    - Any realized benefits, such as improved productivity, safety, aesthetics
    - Measurable residual, salvage or resale value upon disposal

The facility manager also considers other strategic factors and space requirements when preparing to acquire systems, equipment or other significant physical assets.

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These other considerations may include:

- Owner/management policy — what aligns to the business strategy
- Goals — what the acquisition is expected to accomplish
- Allocations — how the activities and equipment are proportioned
- Growth — what potential expansions or changes may require new rounds of acquisition or replacement

The facility manager must be able to contrast and compare all factors. This analysis helps provide the most accurate and complete information to determine the best possible acquisition among qualified alternatives.

Importance of Life-Cycle Cost

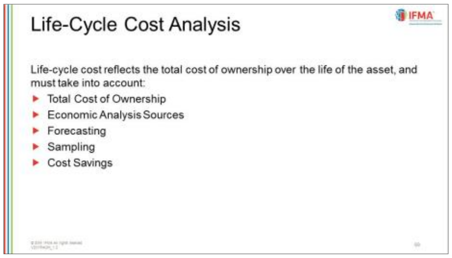
Life-cycle costing is important to the facility manager because it can indicate general guidelines for when replacement may be more suitable than repair. Properly prepared LCC information is made possible with accurate, complete work log records and maintenance reports.

These records and reports should include the following information:

- The age of the component, equipment or system compared to factory specifications on durability or estimated useful life
- Reliability records, including all service activities, results and costs, which can be projected to show a trend against manufacturer or facility manager estimates of typical costs for the asset
- Total cost of owning the asset compared to best value against alternative assets considered to fulfill the same function
- Relative value of operational and hidden costs/benefits to improve productivity, support occupant needs and promote sustainability
- Predictive measures of expenses to avoid, such as emergency or after-hours repairs, unplanned shutdown, temporary relocations, lost business or productivity as a threshold number that would support replacement or renovation over repair or maintenance of a deteriorating asset

This type of information helps the facility manager anticipate the life-cycle of an asset and the point at which replacement is prudent. This is most relevant because an estimated useful life is fairly predictable for most building systems and components.

Life-Cycle Cost Analysis



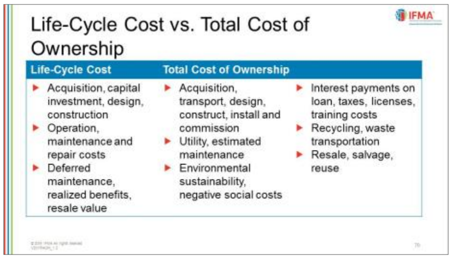
An asset's life-cycle, life-cycle phases and life-cycle cost are part of the considerations when acquiring a new asset. In this manner, life-cycle cost analysis begins in the planning/design stage and is useful in comparing options in equipment, systems, materials or components. LCC analysis can also be helpful when choosing between contractors or staff to source work. Once an asset is placed in operation, the facility manager uses life-cycle cost analysis and related factors to help determine whether to service, refurbish or replace that asset later on in its life-cycle.

To accurately identify and track life-cycle costs, the facility manager should capture all time expended and materials used to maintain assets. This helps:

- Factually support and justify repair versus replacement decisions.
- Provide input to evaluate and estimate task completion times.
- Produce more complete and accurate information on work activities to support facility management decisions.
- Allocate resources properly and justify those allocations.
- Provide data to measure against key performance indicators to assess compliance, performance and potential changes.
- Support a focused approach to a facility strategic plan for effective use of the facility as it accomplishes its mission.

While life-cycle cost estimates hard (upfront) costs, it is important to note that LCC fits into the bigger bucket known as Total Cost of Ownership. LCC also relates to other fiscal factors such as economic analysis sources, forecasting and sampling.

Total Cost of Ownership (TCO)



Total cost of ownership (TCO) is an FM strategy that accounts for the complete life-cycle (cradle-to-grave) measurement and management of a physical asset's useful life. This includes both direct costs that are related to the item or asset, as well as indirect costs shared by several grouped assets.

TCO takes into account some of the same aspects as life-cycle cost, but also includes costs that LCC does not account for. Examples include soft costs such as:

- Loan payments
- Environmental impact costs
- Insurance
- Training expenses

The life-cycle of an asset can be divided into planning, design and construction, operations and maintenance and capital renewal and renovation, and disposal. All activities except initial planning/design/construction are usually in the realm of the facility manager. They represent 60 to 80 percent of the TCO, a significant responsibility. Facility managers must understand and apply TCO to develop budgets for, determine actual costs of, and make decisions about whether to service, refurbish or replace an asset.

A model of factors related to TCO is shown in *Exhibit 3-1*.

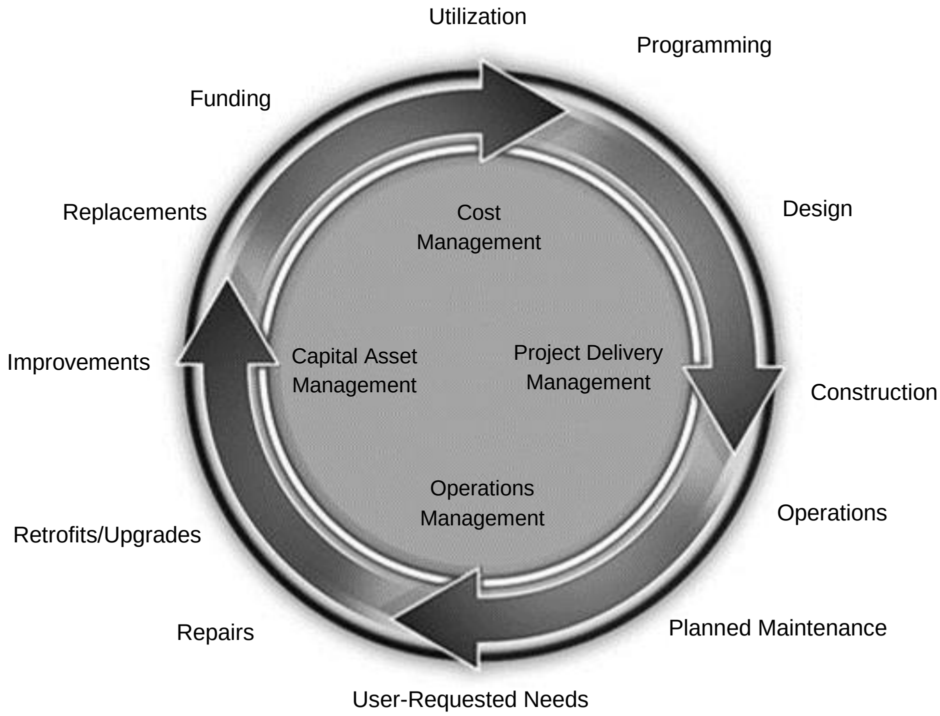


Exhibit 3-1: Asset Life-Cycle Model for Total Cost of Ownership

As a financial estimate, TCO helps the facility manager and others who have a need or requirement, calculate known and anticipated costs of an asset.

These costs may include the following:

- Initial purchase costs — this includes all initial money outlays, or capital, to acquire, transport, design, construct, install and commission the asset.
- Operating expenses — these recurring costs include utility (energy/water) use; floor space requirements; and estimated maintenance, repair and downtime costs for the useful life of the asset.
- Hidden factors — these can include environmental sustainability and negative social costs such as pollution that affect the neighborhood or society. There may also be other hidden factors that are difficult to measure, for example, the facility manager can consider competitive positioning, aesthetic improvement, community standing and similar social benefits.
- Carrying charges — any fees associated with having the asset, such as interest payments on the loan balance, taxes or licenses.

- Replacement and decommissioning costs — these costs include recycling, waste transportation and related disposition expenses.
- Residual value — any resale, salvage, reuse or other income realized when the asset is removed from service are also considered and may reduce the TCO estimate.

The facility manager should separate operational expenses from capital replacement/renewal budgets. While these are divided into separate budgets, they must be considered together when calculating the TCO. For example, the capital replacement cost for replacing a chiller may be justified because it could significantly reduce operating costs through lower utility bills.

The facility manager incorporates all factors relevant to the asset in order to analyze what that asset will cost throughout its lifetime of use. This calculation helps indicate when the continuing cost of maintaining or repairing the asset may not be justified, so that replacement or renovation is a better business alternative.

These considerations are useful for small upgrades as well as acquisitions and major renovations. The TCO analysis is needed to determine the payback period, or the length of time it will take to recoup the initial investment cost. This may indicate the value and wisdom of acquiring a specific asset in the first place. For example, if the TCO analysis indicates that the payback period exceeds the useful life of the asset, the facility manager may consider less expensive alternatives.

To compare life-cycle cost to TCO, it is important to note that LCC is used for asset comparisons within the unit decision process, while TCO helps push the final justification once a decision is proposed for the action of funding an asset.

Economic Analysis Sources

The facility manager refers to other sources to support the economic analysis.

These references may include:

- Studies presenting experience with similar components or systems
- Maintenance experience gathered from contractors, staff or other facility managers familiar with the component or system
- Published data by the equipment/system manufacturer on maintenance cycles and specifications
- Information or requirements available from local, regional or national regulatory or planning boards

Each of these resources may provide information that the facility manager can include in a complete analysis that estimates TCO for a material, component, equipment or system. All may be considered by the facility manager.

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Forecasting

The facility manager may forecast the costs for maintaining an asset at a predetermined service level. Forecasting helps develop long-term capital budgets and gives the facility manager the means to assess operations and maintenance plans relative to life-cycle costs.

This input can be projected to a budget that reflects an understanding of:

- What is anticipated to happen among the various assets of the entire infrastructure.
- What total costs are associated with O&M across the entire infrastructure.

The level of detail and accuracy of a forecast depends upon the expertise and information available to the facility manager. The forecast may be intuitive and approximate on some aspects, use generic standards for others, and have comprehensive data on others. The final result will be as dependable as the quality and accuracy of its business and financial inputs.

Sampling

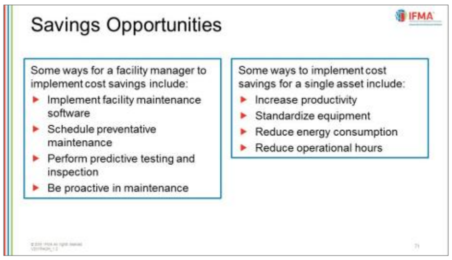
A facility manager may decide to include sampling, also known as parametrics, as a way to increase accuracy or confidence in a life-cycle costing estimate. Sampling is the practice of gathering a subset of the total data available from a process or a population. For example, the facility manager may estimate utility costs for one area by looking at specifications for energy use by all devices in that area and then applying that same measurement to similar areas in the facility. By preparing a sample cost for one area, the facility manager can more reasonably and accurately anticipate similar costs for other, similar areas.

Potential areas or aspects a facility manager might sample could include:

- Personnel costs for particular tasks
- Utilities
- Maintenance
- Breakdown emergencies or productivity losses
- Repair/alteration projects
- Furnishings and fixtures
- Grounds, such as roads, signs, traffic management

These sampled calculations can provide insights into key areas where replacing an asset might be a better alternative than keeping it, even if its operating life is not over. For example, the facility manager may look at utility costs and loss of productivity during breakdowns. This will help determine that a specific system or item of equipment should be replaced because a more energy-efficient and reliable alternative should produce an overall savings against utility, productivity, personnel and breakdown losses.

Savings Opportunities



Cost savings can be identified in the total cost of ownership and can be generated from improvement programs and benchmarking to understand best practices.

Opportunities for savings requires maintaining organizational costs within a specified budget and controlling expenditures so that they meet financial targets. The exhibits below show cost-containment opportunities in FM and through individual assets.

Exhibit 3-2: Facility Management Savings Opportunities Examples

- Implement zero-based budgeting.
- Promote efficiency programs to reduce resource units consumed in each activity.
- Work on supply chain consolidation:
  - Reduce costs of buyer administration and management through managing fewer suppliers.
  - Remove duplication of supply chain management, administration and overhead costs.
  - Leverage volume purchasing opportunities.
- Develop multi-skilled staff to reduce total resource requirements, program out slack time and so forth.
- Reduce staffing levels to meet norms, not peaks of activity, and procure temporary resources for peak activity periods.
- Subcontract services to remove margin-on-margin pricing markups and replace with transparent costing for costs of procurement and administration.
- Implement service level reviews to understand and act on opportunities to reduce service levels, activity frequencies and so forth to save materials and other resource usage.
- Implement process reviews to remove unnecessary stages in processes and so remove time or cost.
- Market test to check value for money from current service delivery structures, whether internally or externally sourced.
- Consider opportunities for activity deferral to delay expenditure to another budget period.
- Invest in planned maintenance so as to reduce reactive maintenance costs, such as planned revamping rather than reactive replacement.
- Review risk profiles and consider accepting heightened risk on some facilities or services.
- Invest in productivity improvements such as an energy-efficient plant.
- Change core business activity cycles or processes that create high facility costs such as re-planning space allocations and contributing to production planning decisions.
- Revamp property disposal through improved space usage effectiveness:
  - Sublease vacant leased space.
  - Sell vacant property.
- Sell used furnishings and equipment.
- Analyze risk sharing with vendors.
- Introduce effective chargeback practices to service users.
- Implement facility maintenance software

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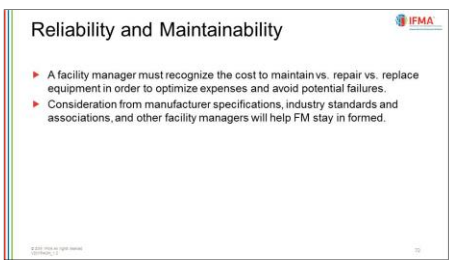
Exhibit 3-3: Individual Asset Savings Opportunities Examples

- Increase productivity
- Reduce maintenance requirements
- Reduce inventory by standardizing equipment
- Reduce energy consumption
- Efficiency gains
- Lower utility costs
- Reduce operational hours
- Implement smarter equipment with more sensor control

When implementing these initiatives, keep in mind:

- Strategies need to fit the organization.
- Actions should be quantifiable and measurable.
- Strategies should be chosen carefully to mitigate any harm to the business or people.
- It is important to be proactive and plan ahead.

Reliability and Maintainability



Cost Considerations - another aspect of the acquisition process is tracking the cost of maintaining existing systems and equipment. By doing so, the facility manager has a means to recognize more accurately when it might be time to replace rather than maintain or repair infrastructure assets.

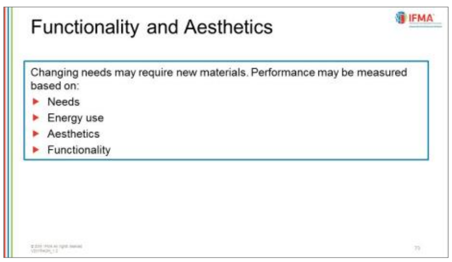
Reliability Considerations - confidence in the reliability of critical systems also plays a role in the decision to acquire an asset. For example, it may be better to replace a critical piece of production equipment before the chance it may fail becomes too great. In this way, criticality and life-cycle costing helps in making informed decisions.

Reliability Information - information can be found on the potential operational reliability and maintenance aspects of an acquisition under consideration from manufacturer specifications, industry standards benchmarks, associations and other facility managers.

Information Support Considerations - it is important to know where to go and whom to contact for objective, professional help. When considering an acquisition of materials, equipment or systems, the facility manager may need to seek advice from design, architectural and engineering services or knowledgeable contractors. Vendors can be requested to provide references who may be asked for information and insight.

Cost Expectations - all of these inputs help provide a more accurate understanding of the costs to expect for operating and maintaining an acquired component or system over its useful life. This not only permits cost comparisons among competitive potential items but also provides information on service and maintenance frequency, possible productivity benefits and other life-cycle cost expectations.

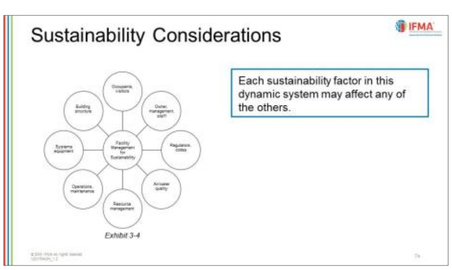
Functionality and Aesthetics



Changing needs may require that new materials, systems or equipment be acquired. A facility may add new functions, different occupants or capacity. Any of these changes could require new materials, systems or equipment. New technology such as energy-efficient lamps, equipment or other performance improvements could provide savings that merit purchasing them, even when existing lamps or equipment are still functioning.

Aesthetics, rather than functional factors, may create the need for new carpet or fresh paint. In these cases, performance is measured in perceptions and occupant satisfaction as much as productive savings. These are some of the aspects a facility manager tracks and considers as part of life-cycle costing and the total cost of ownership.

Sustainability Considerations



Both public policy and business perspectives play a role in defining and promoting sustainability. They recognize a common concern to meet short-term basic social and economic needs without undermining future resources or environmental quality. Countries and internationally recognized groups have developed or adopted codes and standards relative to environmental concerns and the sustainable use of resources. The facility manager takes direction from these types of associations and examines local cultural and commercial expectations. This provides the wide, critical view to help understand the long-term effect that a new material, piece of equipment or system has relative to sustainability.

Sustainability considerations may be assessed by ranking areas of sustainability concern as an approach for decision-making and factors of influence.

Areas of Concern for Sustainability

The following is a brief list of some of the regulated areas the facility manager considers when deciding upon an acquisition:

- Air pollution, both indoor air quality and material releases into the atmosphere
- Noise and light pollution
- Emissions, including those from newly acquired materials that may contain volatile organic compounds
- Asbestos, lead and other toxic noxious elements
- Water use, such as waste disposal, pollution and reuse
- Recycling, reduction and biodegradability (breakdown) potentials

Rankings of Sustainability

When acquiring new assets, the facility manager should favor resources that rank higher in relative sustainability.

These can be ranked as follows in order of most sustainable to least sustainable:

1. **Perpetual resources** — such as solar, wind, geothermal and tidal energy represent the most sustainable and environmentally positive option.
2. **Renewable resources** — such as timber, soil and grass represent the next most sustainable option.
    - Biodegradable plant materials, such as soy, cork and straw might be considered a more desirable material subset among renewable resources.
    - Biomass products, such as mulch, compost, plastic lumber/wood and building insulation are also preferred over less recyclable or renewable resources.

    It is important to note that renewable materials are natural, which can also make them more susceptible to rot or decay. Some products may contain added chemicals such as arsenic, asbestos or formaldehyde that could prohibit their use. The facility manager must consider all of these factors.

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3. **Recyclable resources** — such as aluminum, paper, glass or some plastics can be reprocessed and used to make new products but at added, and perhaps not financially viable, expense.
4. **Reducible resources** — including packaging or energy use, can reduce environmental impact with changes in how they are handled, maintained or originated.
5. **Nonrenewable resources** — such as coal, oil and natural gas, which cannot be reused and may not be replaced as fast as they are being used, represent the least sustainable option.

Approach to Decision-Making

The facility manager may make decisions or support others who make decisions about acquisitions to determine the most sustainable, environmentally friendly option.

These considerations could:

- Identify material categories
- Select the most sustainable options
- Gather and review technical information; seek expert input
- Assess materials and potential acquisitions for the greatest safety
- Compare costs
- Identify the best choice

Factors of Influence

Sustainability factors play a significant role not only in systems but also in service level determinations because sustainability represents both human and machine aspects, as represented in *Exhibit 3-4.*

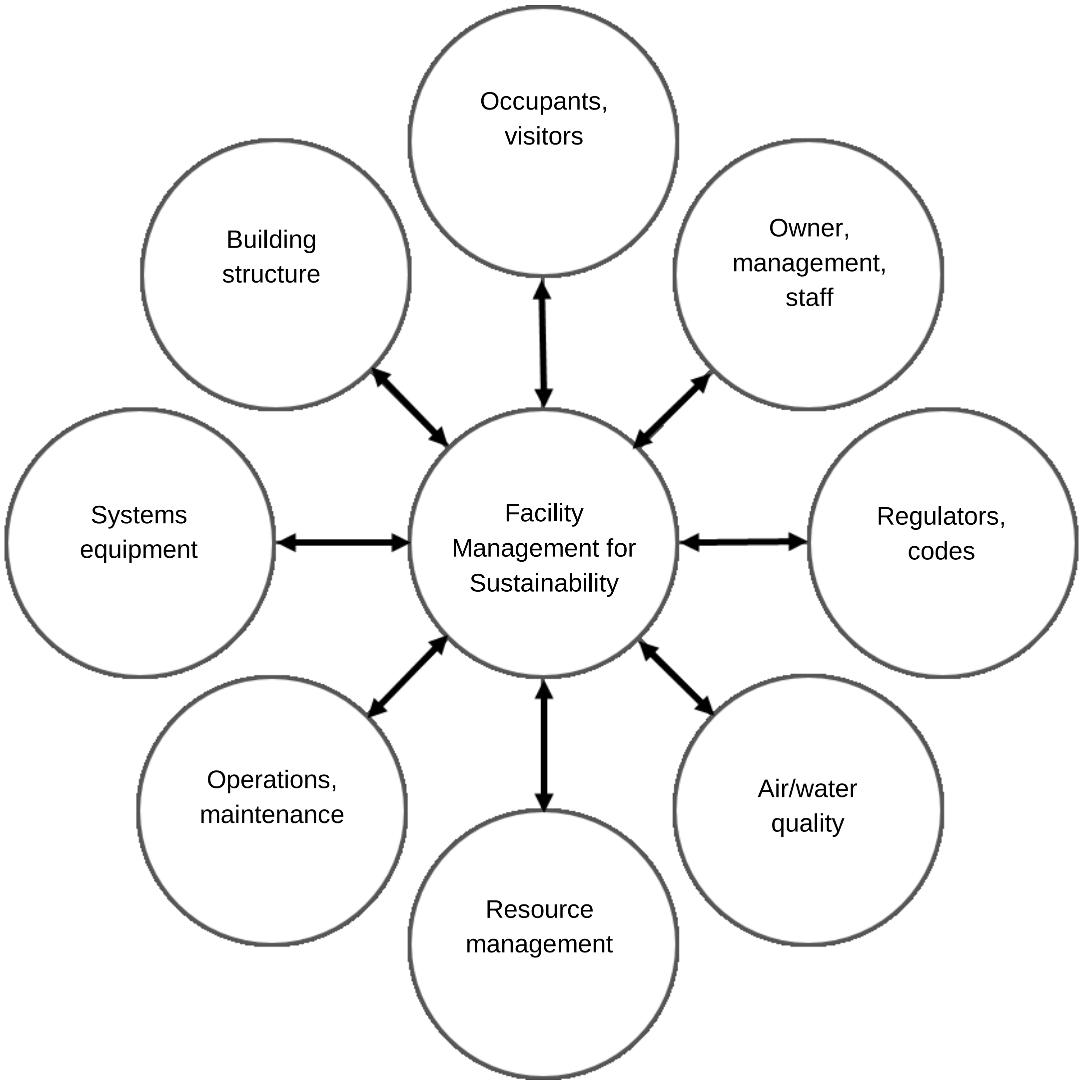


Exhibit 3-4: Sustainability Factors

Each sustainability factor may affect any of the others. All represent a dynamic system in which the facility manager recognizes these relationships in order to select assets and develop work plans that support more sustainable, energy-efficient, resource-conserving facility management.

Install Systems, Materials and Equipment

Lesson Introduction

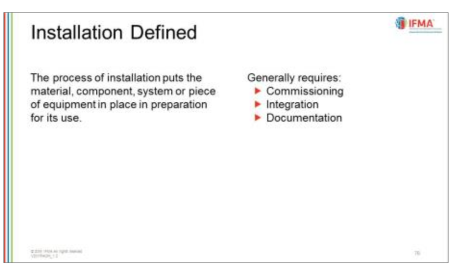
On completion of this lesson, you will be able to:

- Explain how the installation of an asset should be commissioned, integrated and documented and why training on the asset is important.

This lesson contains the following topics:

- Installation Overview
- Commissioning
- Integration
- Documentation
- Education and Training

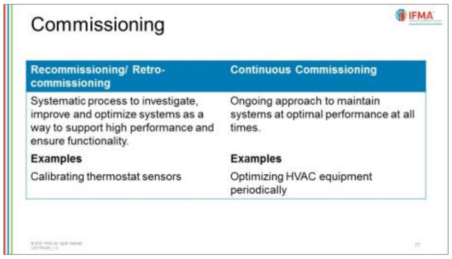
Installation Defined



Installed equipment is considered the equipment affixed to the building structure and maintained by the facility manager. The process of installation puts the material, component, system or piece of equipment in place in preparation for its use.

Installation of equipment and systems requires commissioning, integration and documentation.

Commissioning



Commissioning is the process of evaluating, verifying and documenting the performance of facility systems, subsystems, components and operations and maintenance procedures to ensure that assets function efficiently, meeting the acquisition's goals.

Commissioning may be considered the transition and should ideally occur between installation and O&M in the physical asset life-cycle.

Commissioning consists of:

- Documenting requirements, activities and decisions relative to the acquisition of equipment and its specified purpose
- Testing for functional performance
- Establishing baseline performance
- Training operators

Commissioning helps make the acquisition ready for useful operation and marks the beginning of its maintenance schedule, it does not always occur just at the initial installation. It can occur whenever equipment or systems are operated with, installed, replaced, or at a certain interval to confirm continued, efficient operation.

For example, predictive testing and inspection methods, such as vibration analysis and motor circuit analysis (MCA) help not only to ensure efficient performance but help avoid future maintenance issues, early failures or other reliability problems. Vibration analysis and MCA are discussed later in this chapter.

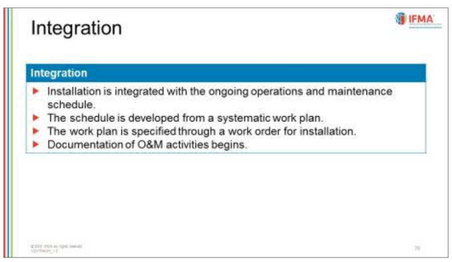
Commissioning may occur at different times and in different ways. The following are a few examples:

- **Recommissioning or retro-commissioning —** is a systematic process to investigate, improve and optimize systems as a way to support high performance and ensure functionality. This process can refer to restoring an asset to its initial performance after a period of time. Recommissioning or retro-commissioning should not be considered a substitute for major repairs. It is separate from maintenance procedures and is used to reach a higher standard in energy efficiency, occupant satisfaction or some other performance goal.

- **Continuous commissioning** — is an ongoing approach to maintain systems at optimal performance at all times. This process is applied to energy use, management and conservation in existing buildings. It may be utilized when portions of a system are replaced to produce assurances that the new equipment or parts support overall system performance and the capabilities of existing equipment or parts.

Commissioning activities may be accomplished by staff, contractors or independent third parties, depending upon the expertise or compliance regulations required. An independent party can be hired to commission complex environmental or health and safety equipment while staff or contractors may operate and maintain it after commissioning.

Integration



The facility manager oversees installation in a timely, efficient and effective manner. This means that:

- Installation is integrated with the ongoing operations and maintenance schedule.
- The schedule is developed from a systematic work plan.
- The work plan is specified through a work order for installation.
- Work is scheduled such that occupant disruption is limited.
- Documentation of O&M activities begins.

Few operations or maintenance activities within a facility should occur in isolation. Independent action may be required to manage an emergency, respond to a breakdown, or react to an unexpected event. Anticipated installation activities should be contained in the O&M routine and occur as part of the schedule.

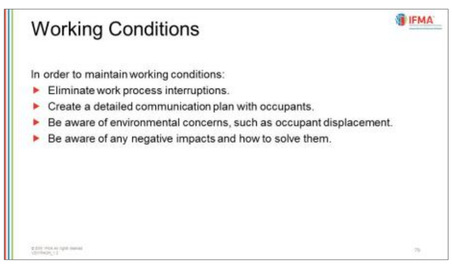
It is important to schedule installation so that it minimally disrupts operations, occupants, customers and tenants. It is important to coordinate the installation schedule with other work, including maintenance, repair, alterations and other capital projects. The facility manager must consider business continuity and have alternative options in place in case a disruption occurs. For example, coordinating activities helps ensure that a wall will not be freshly painted by a maintenance team right before it is removed by a renovation team.

New acquisitions that involve utilities, such as electricity, water, fuel and communication wiring, should be selected and installed with particular care. They become invisible once installed and are noticed only when they fail to function. Occupants are particularly sensitive to occasions when these highly critical systems malfunction.

Core systems, such as plumbing, electrical, heating and cooling can be complex and difficult to inspect once they are behind walls, floors and ceilings. Careful installation and complete documentation are important so that as a building ages and assets deteriorate, the facility manager can maintain systems for adequate safety, reliability and efficiency.

Once installation is complete, the asset becomes part of the facility manager's O&M schedule. This means that the asset is integrated into the work plans and work orders of facility management. This workflow process is discussed later in this chapter.

Working Conditions



Modification of buildings, grounds and systems should be implemented for successful business operation and to satisfy occupant needs. This may require changes or cause disruptions in the workplace. When modifications occur, it is important that the facility manager makes appropriate arrangements/accommodations for the occupants while maintaining work processes and working conditions.

To provide the best working conditions for occupants during periods of modification, facility managers should:

- Minimize work process interruptions
- Create a detailed communication plan with occupants and alignment from relevant stakeholders
- Be aware of environmental concerns
- Be aware of any possible negative impacts and how to solve them

Stakeholders include anyone who is affected by the modifications and those who can negatively or positively affect the outcome of the project. Managing stakeholders is a task that involves regular and ad hoc communications, both formal and informal, to address and resolve issues and ensure that all feel informed and recognized.

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Stakeholder management also requires straight-forward involvement. Those who are kept involved are less likely to disrupt the project and are more likely to accept the final product or service and are in a better position to understand changes or problems as they arise. Communication is key to ensure occupants are feeling supported, heard and engaged.

Communication management begins with a detailed plan for constant and clear disclosure with all occupants. The communication management plan recognizes varying needs of stakeholders as well as the requirements for the type of work to be performed. It allows flexibility for adjustments of communication methods and techniques to accommodate occupants.

When preparing to manage stakeholders, facility managers should review the communications management plan to ensure that no stakeholders are omitted and that the appropriate content and communication frequency, styles and media are used.

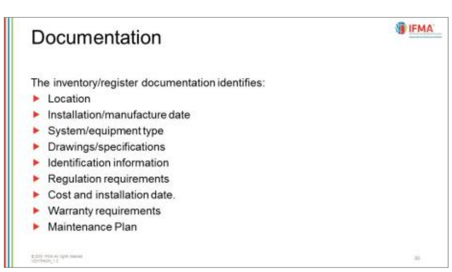
During modifications, a facility manager should be aware of environmental concerns within the organization, such as occupant displacement and maintaining working order of essential systems. Proactive planning is critical to prepare for and take into account these environmental impacts or concerns.

Organizational concerns can be influenced by:

- Organizational culture
- Administration policies
- Established communication systems
- Global, regional or local practices
- Distribution of resources

Negative impacts from modifications can include occupant discomfort, displacement and stress. A solid communication plan will help the facility manager understand pain points for occupants and how to mitigate them.

Documentation



Installation marks the start of the useable life of an item or system. Documenting the installation is important because it officially captures the start of the installed asset's use and is a convenient source when information is needed in the future. The decisions that led to the selection of the item may be supported or challenged by the recorded and cumulative results of its ongoing operations and maintenance.

Complete documentation of the installation provides the orderly, organized start that the facility manager needs for timely, complete and effective O&M.

This documentation is organized in an equipment O&M manual, which is a portion of the overall documentation that includes design, installation, and various other components of the equipment. Each documented item should be compiled in the inventory/register to be stored in a central file or conveniently near the system itself. The location is noted in the work order log so that anyone working on the installed element knows where to find its documentation.

The inventory/register documentation contains important information that:

- Designates location, such as building, floor, room, placement of item
- Indicates date installed and year of manufacture
- Describes type of equipment or system
- Specifies manufacturer, model number, serial number, inventory/register ID number
- Specifies any regulatory requirements
- Indicates intended useful life, maintenance plan and recommended intervals

A facility manager may not have a documented list of assets if, for example, a building is purchased, and the new owner is not given an inventory or if the register is incomplete or nonexistent.

In this instance, the facility manager may seek other information sources, including:

- Operations and maintenance manuals
- Drawings, plans and other available digital data
- Other files, notes or documents available through purchasing, accounting or other departments

When there is no inventory/register or if it is incomplete or determined to be inaccurate, the facility manager should perform an assessment so a record may be established.

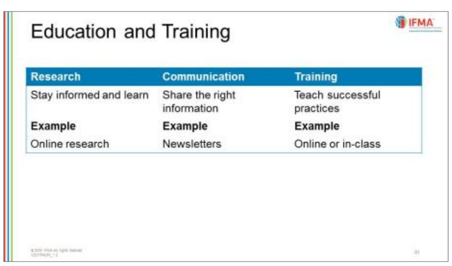
In facility management operations, the documentation, along with work requests, is incorporated into a central, automated system that tracks schedules, prioritizes, indicates work approach and personnel such as a CMMS or integrated work management system (IWMS).

The information in a CMMS/IWMS may include:

- Manufacturer specifications, parts inventory suggestions
- Warranty and service schedule requirements
- Maintenance history, planned and unplanned activities
- Maintenance attributes such as filter sizes, belt sizes, capacity, horsepower, voltage, amperage and pressures
- Cumulative costs of maintenance efforts, such as labor, downtime, lost production
- Planning for budget and personnel
- Identify critical equipment

These automated systems contain both operations and maintenance data for facility-wide management. The system tracks costs to help the facility manager make informed decisions about optimum maintenance schedules, operating results and repair/replace thresholds.

Education and Training



Education and training are at the core of understanding systems and the impact they have on the organization.

Education consists of three interrelated components:

- research
- communication
- training

Research

Facility managers can access a wide variety of information on automated systems to support training programs. When trying to educate people on technology and processes, a facility manager may want to include a larger quantity of operations-related information. One way to do this is by finding case studies that demonstrate best practices or lessons learned by other organizations. Another way to research operations and maintenance ideas and processes is by participating online in blogs and forums. Performing research online is an excellent way to stay informed on current trends and events.

When implementing a new policy or technology, include information relevant to the initiative. The latest in sustainable technology options is certainly a topic to be researched prior to purchasing. Policies and regulations pertinent to the organization's geographic location, governmental regulations or specific products are also good areas to research.

Communication

The next component of education and training is communication. Sharing the right information with the right individuals at the right time is important to raise awareness and build support for a new O&M activity. Communication must be planned, delivered and evaluated in order to be successful. The facility manager should plan communication to fit the audience; there are a number of options for communicating program policies and new procedures to those involved with the organization, both internally and externally. If the facility manager has the responsibility for any external communication, the company website can be used to communicate to those individuals, such as customers and the public. The primary communication target audience are those within the organization, such as the occupants and FM staff. The facility manager can use a number of communication tools or channels, such as corporate intranet site to communicate with this group.

A newsletter is another way to communicate both internally and externally. Two separate newsletters may be needed in order to customize the information provided to each of the audiences; what is important to one stakeholder may differ from that for another. A facility manager may want to develop a repository for information and tools he or she can use in communications.

The facility manager should also evaluate the success of communication through surveys or analyzing feedback from team members and customers. If discrepancies in communication are identified, an adjustment to the method might be required to adapt to the audience.

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Training

Expand the capacity of the staff through training, access to information and transfer of successful practices, procedures and technologies. Investing in training and systems to share successful practices helps ensure the success of the action plan by building overall organizational capacity. An informed staff leads to an increased efficiency of equipment, accurate monitoring and training, preventive and predictive maintenance and an increased success of initiatives through feelings of ownership and an understanding of synergies. Many organizations have found that informed employees are more likely to contribute ideas, operate equipment properly and follow procedures, helping to guarantee that capital investments in sustainability improvements will realize their potential.

The facility manager should understand the steps to designing, developing and delivering effective training:

- Identify the type of training, such as online, in-class, on-the-job
- Define metrics for measuring the success of the training
- Develop training materials for participants and trainers
- Schedule the appropriate amount of time to deliver training

Maintain Systems, Materials and Equipment

Lesson Introduction

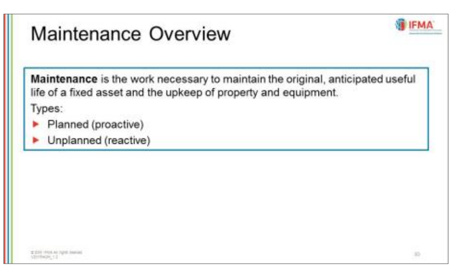
On completion of this lesson, you will be able to:

- Describe how Reliability-Centered Maintenance is used to balance maintenance activities and the role of facility management information systems in these activities.

This lesson contains the following topics:

- Maintenance Overview
- Types of Maintenance and Typical Maintenance Activities
- Balancing Maintenance Activities: Reliability-Centered Maintenance
- Maintenance Management Workflow
- Maintenance During Peak Periods

Maintenance Overview



Maintenance is the work required to ensure the original, anticipated useful life of an asset and the upkeep of property and equipment. It is the work needed to keep assets in optimum operating condition. Operational maintenance of buildings, systems and

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equipment relates to activities that keep the facility functioning as intended so that occupants are productive.

Over time, operational costs will far exceed a facility’s design and construction costs (three times more according to D. G. Cotts in *The Facility Management Handbook)*. Proper maintenance can have a significant positive affect on the total cost of ownership.

General operational maintenance costs are different from capital-funded costs:

- Capital-funded projects focus on large-expenditure repairs or replacements of systems or building components as well as remodeling or other major changes designed to, for example, anticipate property improvements or expand productivity. The funding for these activities may accumulate as reserves over several years or may be requested from a capital expenditure fund.
- Funding for O&M activities that maintain the building, manage its efficient use and support current systems and equipment is an annual budget item that is based on tracked and estimated expenses.

Part of maintaining the facility is ensuring the proper upkeep and functionality of the building infrastructure and the furniture, fixtures and equipment (FF&E). FF&E includes office furniture, seating, office equipment, common area furniture and equipment and any specialty furnishings and equipment.

The type of FF&E used in a facility can vary widely depending on the use, philosophy and budget of the organization.

It is important for facility managers to know the expected function and keep pertinent information regarding functionality of all facility elements, which can include:

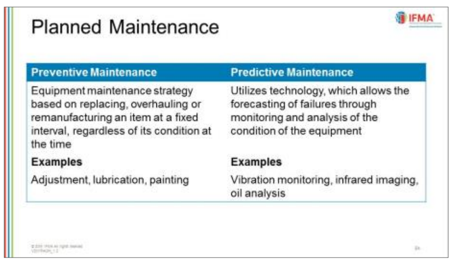
- Owner's manuals
- Operations manuals
- Design documents and drawings
- Regulations and codes
- Contact information for equipment representatives

Just as any new installation, furniture, fixtures and equipment should be documented and included on the asset inventory and maintenance and repair cycles. Systems should be put in place to document location, maintenance activity and any concerns. Facility managers must understand all FF&E function, use and needs as part of the building infrastructure.

Types of Maintenance and Typical Maintenance Activities

In terms of buildings, systems and equipment, the tasks of operational maintenance can generally be divided into two major types, planned and unplanned.

Planned Maintenance



As covered earlier in this course planned, or proactive, maintenance is any maintenance activity for which a predetermined job procedure has been documented, materials have been estimated and identified and their availability has been assured before commencement of the task. Routine building inspections and tours are part of planned maintenance as well as corrective work identified during other planned maintenance, referred to as preventive and predictive maintenance.

Preventive Maintenance

Preventive maintenance is an equipment maintenance strategy based on replacing or overhauling an item at a fixed interval, regardless of its condition at the time. This strategy includes performing adjustments, minor repairs and completing restorative activities recommended by the manufacturer to ensure the asset life-cycle is achieved. Preventive maintenance brings value to occupants because it is likely to increase the function, dependability and capability of building operations.

Typical preventive maintenance activities include the following:

- Periodic or occasional inspection — is any task undertaken to determine the condition of equipment and/or the tools, labor, materials and equipment required to repair an item. Special technologies or equipment may be used to aid in the inspection.
- Adjustment — refers to any activity performed on materials, equipment, systems, and so on, to adjust, recalibrate, adapt or otherwise change the circumstances of that asset to match a standard or meet a requirement. As new assets are added to a facility, changes may be needed to either meet predetermined specifications,

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perform more effectively within the infrastructure or adapt to conditions caused by other changes to the system.

- Lubrication — means to make smooth or slippery in order to reduce friction and prevent damage by abrasion. Lubrication can also dissipate heat caused by the friction of moving parts making contact.

  For maintenance purposes, lubrication may involve a lubricating oil analysis, usually part of predictive maintenance, as defined below. This analysis is performed on in-service machines to monitor emerging conditions, confirm problems identified through other means, such as vibration, and troubleshoot known problems.

- Cleaning (noncustodial) — can improve operational productivity. Dirty conditions can cause:
  - Dust buildup accumulated on surfaces affecting occupants
  - Air, oil and steam condensation on filters
  - Grease accumulation on machinery
  - Improper care of FF&E
  - Dirty atmospheric conditions
  - Bind equipment
  - May inhibit how the facility efficiently conducts its mission

  Noncustodial or maintenance cleaning can be established on daily, weekly and monthly schedules. The facility manager must initiate and monitor the cleaning of surfaces, metals, fabrics, systems and components with the same diligence as other O&M activities.

  - Noncustodial cleaning may involve:
    - → Steam cleaning or sandblasting, as well as traditional rag and brush methods
    - → Housekeeping around and inside HVAC, electrical and plumbing equipment such as cleaning vents, filters, hoods, fittings, lines
    - → Checklists and work orders clearly describing what, when and how to clean specific assets
  - Periodic maintenance cleaning serves to preserve and improve the facility's appearance and promote pride of ownership. These activities promote greater respect for and attention to traditional concepts of housekeeping functions.

- Painting — the act of coating any surface with any liquid for a utilitarian purpose. Maintenance tasks may include applying coatings to protect against corrosion, weathering or deterioration; to promote visibility or durability; or to provide color and aesthetics as when painting furnishings, moldings and walls.

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- Replacement — of parts is the replacing an item of permanent investment or plant equipment. It is the exchange or substitution of one fixed asset for another having the capacity to perform the same function. The need for replacement may arise from obsolescence, wear and tear, or destruction. Replacement, as distinguished from repair, involves a complete, identifiable item.
- Minor repairs **—** are generally ascribed to maintenance activities that do not exceed one or two workdays per task and do not noticeably prolong service life or add to value. Generally routine tasks.
- Major repairs — are those that exceed two workdays or cannot be performed by staff. They may prolong service life but not increase the value of equipment/systems.

Predictive Maintenance

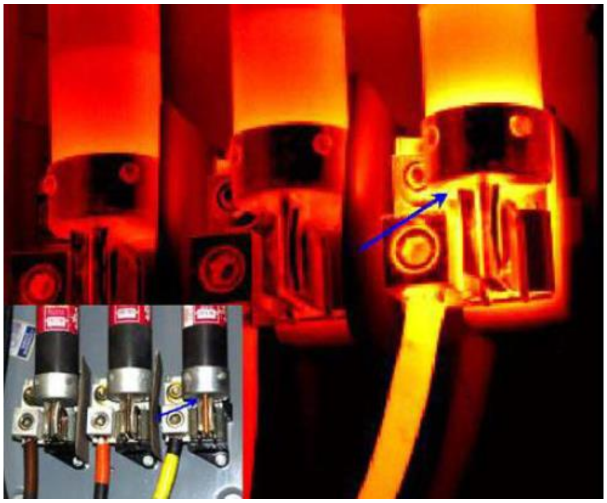
Predictive maintenance (PdM) is planned maintenance that uses technology to forecast failures through monitoring and analyzing the condition of the equipment. The analysis is conducted through a form of trending of a parameter, such as vibration, temperature or flow. PdM is also known as condition monitoring, condition-based maintenance or predictive testing and inspection.

Predictive maintenance anticipates the need for repairs by identifying faults as early as possible. It allows equipment to be repaired at times that do not interfere with production schedules.

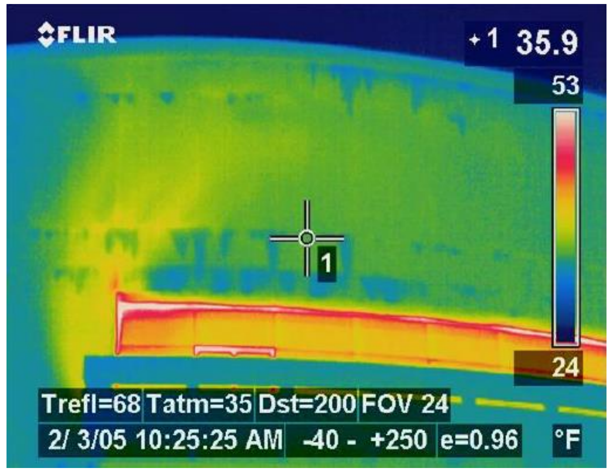
The following list of predictive maintenance technologies or instruments demonstrates the range and purposes of PdM.

- **Vibration monitoring and analysis** — is used to establish a scientific and objective measurement of the running condition of machinery.
- **Infrared (IR) imaging/thermography** — is a thermal (temperature or heat) analysis tool that has become widely used for preventive maintenance on mechanical and electrical systems. See *Exhibit 3-5.*

Exhibit 3-5: Infrared (IR) Imaging/Thermography



Electrical System Infrared Imaging



Thermal Imaging on Equipment

- **Oil analysis** — is the routine assessment of lubricant properties and suspended contaminants to monitor and report timely, meaningful and accurate information on the condition of the lubricant and the machine.
- **Airborne ultrasonics** — use equipment that senses high frequency sounds produced by air or gas leaks, electrical emissions and mechanical operations.
- **Motor circuit analysis (MCA) —** is a sophisticated testing and analysis technique to determine the condition of and detect hidden irregularities in a motor power circuit before catastrophic motor failure can occur.
- **Laser shaft alignment** — is a technology that is used to determine the collinear condition or alignment of pump and motor shafts.
- **Laser sheave alignment** — is the process for magnetically mounting a tool against the inside of a sheave or pulley that measures against the face of the opposite sheave to maintain proper belt alignment.
- **Tong tests —** use a current clamp or probe that fastens around an electrical conductor to measure the electrical current in the conductor without requiring the conductor to be disconnected.

Facility managers refer to and use reliability data available from outside resources. See the *IFMA FMP Credential Program Online Resource Center* for lists of some of the many national and international associations and agencies that supply reliability data.

Predictive maintenance can provide several advantages, including:

- Less equipment downtime, catastrophic failure or additional damage
- Fewer emergencies

- Better control over maintenance schedule
- Advanced notice to prepare personnel, materials and equipment
- A cost-effective maintenance approach
- Reduction in unplanned shutdowns

PdM activities may be applied as part of the initial phases of facility construction or repair, such as during design, procurement, installation and operational aspects. This could include applying techniques such as root cause and failure analysis, age exploration, and precision alignment and balancing during the life cycle of the facility. These aspects are discussed later in this topic.

An illustration of what might be included in a basic preventive maintenance template is shown in *Exhibit 3-6*.

Equipment/asset ID: Air compressor

Facility location: ____________

Routing: ____________

Job #: ____________

Department #: ____________

Account #: ____________

Maintenance | Next

Frequency: Days: Semiannual ____________

(units) Meter ____________ ____________

Run time ____________

Fixed [ ] Floating [ ]

Work group/trade (list)

HVAC shop

Special tools (list)

1. Standard tools—basic
2. Belts
3. Lubricants
4. Fin comb
5. Vacuum cleaner
6. Test gauge

Parts (list)

Job description

1. Perform normal checks and operation.
2. Change compressor crankcase oil.
3. Clean air intake filter.
4. Check air dryer.
5. Check condensate drains.
6. Inspect air tank for proper operation.
7. Inspect belt alignment and condition.
8. Check accuracy of gauges with calibrated test gauge.
9. On two-stage compressor, check intermediate pressure.
10. Test relief valves; replace if leaking.

Complete preventive maintenance checklist.

Work results/uncovered issues

Remarks/special instructions

1. Review manufacturer's instructions
2. Coordinate motor preventive maintenance on an annual basis. See Guide M-3.
3. Tank should be inspected and tested by qualified inspector.
4. Secure the electrical service.

Work performed by ____________

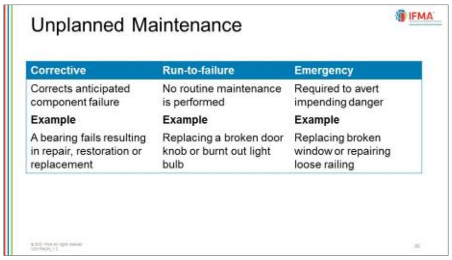
Work checked by ____________

Work authorized by ____________

Exhibit 3-6: Basic Preventive Maintenance Template

Preventive maintenance is based on time-scheduled activities, while predictive maintenance is based on the condition of the equipment. By measuring planned maintenance, the facility manager can monitor the amount of work being accomplished as a way to anticipate and prevent failures. This helps the facility manager identify defects that could lead to failure. To maximize the benefits of avoiding failure, some facility managers promote a high level of planned maintenance work balanced against total cost of ownership; this is discussed in more detail in this topic.

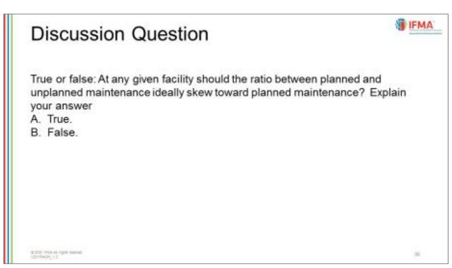
Unplanned Maintenance



Unplanned, reactive, or unscheduled, maintenance refers to any maintenance work that was not on an approved maintenance schedule before it began.

There are three subcategories of unplanned maintenance: corrective, run-to-failure and emergency:

- Corrective maintenance — is any activity that is required to correct an unanticipated component failure that has occurred or is in the process of occurring. For example, a machine breakdown because of bearing failure. This activity may consist of repair, restoration or replacement of components.
- Run-to-failure — a strategy in which no routine maintenance tasks are performed on the equipment. The only maintenance performed on the equipment is corrective maintenance, and then, only after the equipment has suffered a failure. This is described as a nonscheduled maintenance strategy. An example would be replacing a small quarter-horsepower pump when it fails in a noncritical system. The cost to maintain the pump would be more than the cost to replace it. Other examples of items that run to failure are doorknobs and relamping.
- Emergency maintenance — Emergency maintenance is any activity that requires immediate repair because of impending danger or disruption to the occupants, their business processes, the building or a building system.



Typical Maintenance Activities

Exhibit 3-7 illustrates where different maintenance activities, planned and unplanned, may occur.

Exhibit 3-7: Typical Maintenance Activities

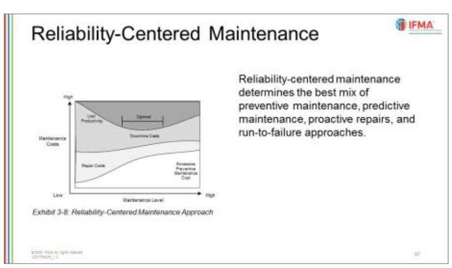
Planned Maintenance		Unplanned Maintenance	
Preventative	**Predictive**	**Corrective**	**Emergency**
• Inspect • Adjust • Lubricate • Clean traps • Paint • Check for noise, odors, vibration • Tighten connections	• Vibration analysis • Ultrasonic • MCA • IR thermography • Laser alignment • Oil analysis	• Hot/cold call • Lights out • Broken fixture • Clogged toilet • Spill/stain • Damaged furniture • Broken lock • Vandalism	• Leak/flood • Power outage • Gas leak • Safety/hazard issue • Chemical spill

Prioritization of all the options relative to operational maintenance is generally determined by the criticality of the system or equipment.

Deferred Maintenance

Deferred maintenance is used to delay repairs and maintenance on assets because of changing needs, budget limitations or lack of funding. Delaying maintenance can increase future costs and capital expenditures. Despite its consequences, deferred maintenance is a common practice in many facilities.

Balancing Maintenance Activities: Reliability-Centered Maintenance



An organization should have more planned maintenance activities than unplanned. In production or manufacturing facilities with large equipment and complex processes, plant engineers recognize that the breakdown of a piece of equipment can be costly, not only in

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terms of labor hours lost and repair expenses, but in the revenue lost because goods are not produced. Preventive and predictive procedures are critical to avoiding such breakdowns.

It is not possible for a facility manager to strive for 100 percent planned maintenance. Labor hours spent in operational maintenance generate an opposing cost, and there is a point of diminishing returns between the cost of total preventive maintenance to produce ideal operating conditions and low cost from minimum maintenance that increases the potential for expensive breakdowns. Unplanned maintenance is not necessarily the result of improperly conducted or inadequately planned activities. The facility and its management are dynamic. The operational status of materials, equipment, systems and even the building itself can change without warning.

The facility manager needs to balance planned and unplanned maintenance.

The ratio between the two may vary depending upon the mission, age, requirements and resources of the facility/owners. The ideal balance occurs by finding the optimal timing and method of maintenance so that planned maintenance costs are at their lowest while keeping the potential or realized equipment downtime also at its lowest. This relationship optimizes maintenance by comparing it to the cost to replace or restore losses due to equipment failure. It may be referred to as a reliability-centered maintenance (RCM) approach and is illustrated in *Exhibit 3-8*. Note that the exhibit does not apply to organizations with data centers and a high level of cleanliness.

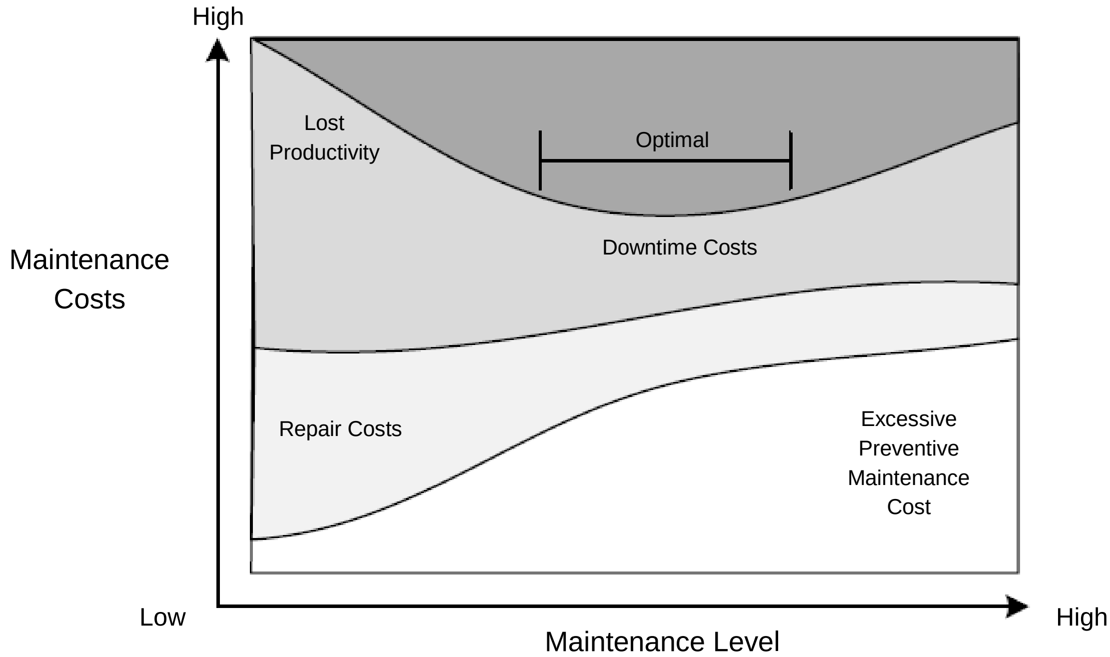


Exhibit 3-8: Reliability-Centered Maintenance Approach

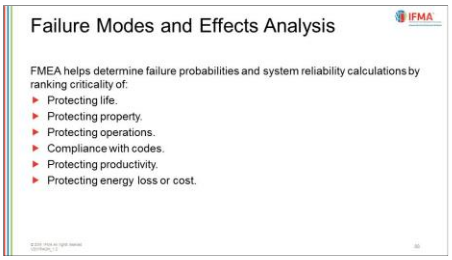
Reliability-centered maintenance determines the best mix of preventive maintenance, predictive maintenance, proactive repairs and run-to-failure approaches. These different maintenance and repair options are integrated and employed in combination to produce the greatest probability that a machine or component functions as intended over its design life cycle balanced against the proper level of maintenance.

The overall goal is to provide for the stated function of the facility with the required reliability and availability at the lowest cost. Maintenance decisions are based on requirements supported by sound technical and economic justification.

Many paths or processes can lead to that final RCM goal, since the consequences of failure can vary significantly based on the nature of the facility or industry. For example, RCM analysis is rigorously applied by the aircraft and nuclear industries, where functional failures can potentially produce large losses or catastrophic environmental impact. Facility managers in less critical industries or missions may employ a streamlined or more intuitive RCM process because the high analysis cost of the more rigorous approach does not supply equally high results in system reliability savings. The streamlined approach is based on the same principles but may not recognize or analyze all possible failure modes.

The facility manager may apply a number of analysis tools to maximize reliability and performance at the lowest total cost. These tools can include failure modes and effect analysis, root cause analysis, and age exploration.

Failure Modes and Effects Analysis



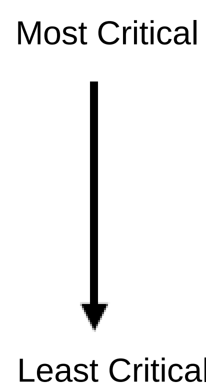
Reliability-centered maintenance may include a detailed failure modes and effects analysis (FMEA) to help determine failure probabilities and system reliability calculations. This analysis helps the facility manager determine what maintenance approach and tasks to use in addressing each identified potential failure and its consequences.

The facility manager screens and evaluates work relative to how critical it is to occupants and the facility. Physics of failure (PoF) and criticality are examples of approaches used to support FMEA.

PoF is an approach to incorporate reliability into product design using materials, structures and technology that support reliability assessments.

Criticality can be ranked as values most critical to least critical to the facility mission and strategic plan, such as:

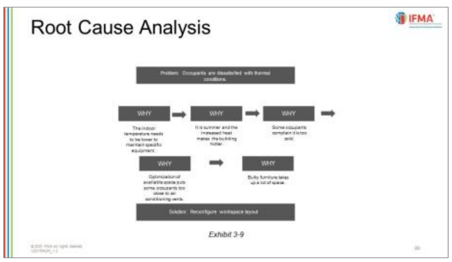
- Protecting life
- Protecting the environment
- Protecting property
- Protecting operations
- Compliance with codes
- Protecting company reputation
- Protecting productivity
- Protecting energy loss or cost



Other rankings of criticality or importance may include:

- Monetary value, such as budget and financial policies that determine which job may be assigned for maintenance first.
- Work complexity, for example, if work is complicated enough to require training, advanced preparation, or new inventory order.
- Occupant satisfaction, where social penalties may occur such as lower morale, poor aesthetics, or increased turnover.

Root Cause Analysis



Root cause analysis (RCA) is the process to discover the systemic cause of system results by finding the underlying or root cause of the problem. Some problems should not be fixed, but instead, the system or equipment should be replaced. A root cause analysis can help determine this.

When CA is used to identify what might cause a problem, it is a *leading* indicator for deciding what maintenance to perform. When RCA is used to identify what caused a problem, it is a *following* indicator to determine why a system, component or process failed.

Generally, RCA applies five questions, or the five “whys," as a technique to reach beyond symptoms to determine the root cause of a problem. *Exhibit 3-9* gives an example of how the five "whys" is used.

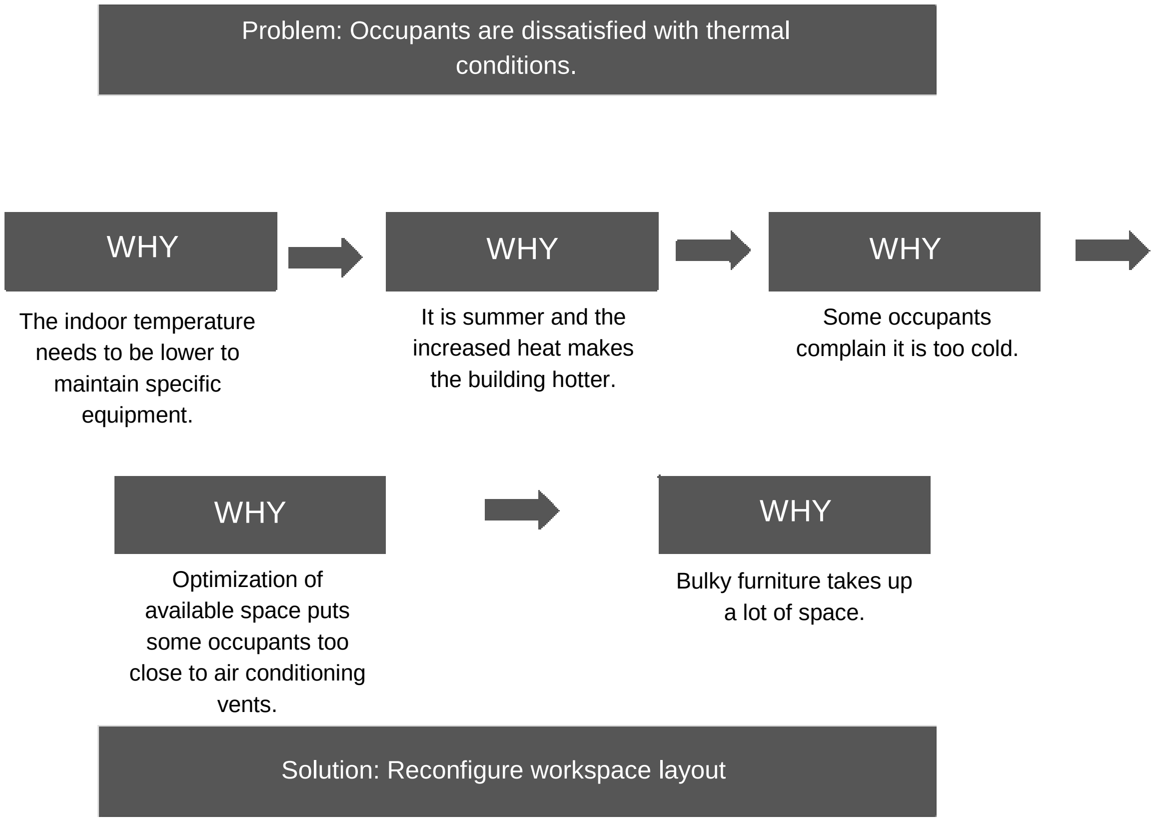
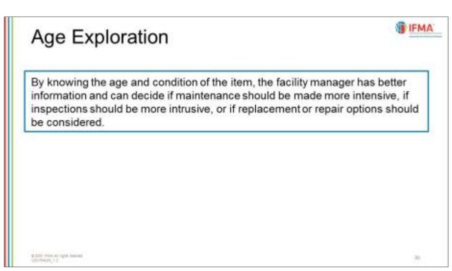


Exhibit 3-9: Five Why's

The questions ask why the customer/occupant was dissatisfied in order to reach the basic cause of the problem. The question loops back several times by continuing to ask "why" until there is agreement on what the problem is and how it happened.

Facility managers can use root cause analysis to help understand why systems failed historically and what effects those failures had on the operation or mission of the facility. A root cause analysis is not intended to find fault or blame but to recognize the true cause of equipment and system failures.

Age Exploration

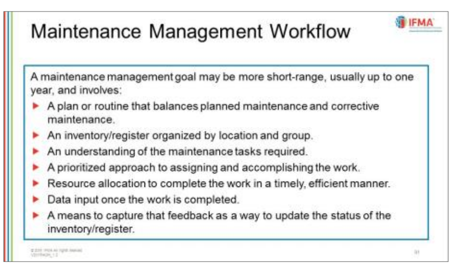


Age exploration, or reliability analysis, uses historical data to improve reliability, productivity or reduce the cost of maintaining an item. It is similar to FMEA and RCA in that the goal is to understand the condition of the component, equipment or system and the potential/probability of failure. By knowing the age and condition of the item, the facility manager has better information and can decide if maintenance should be made more intensive, if inspections should be more intrusive, or if replacement or repair options should be considered.

Systems, components and machines will deteriorate, break or fail to a level that does not perform to expected standards. It is unlikely that any maintenance program can prevent all failures. RCA can help provide historical maintenance knowledge, FMEA can help provide proactive maintenance knowledge, and RCM can help the facility manager achieve a balanced maintenance approach to support the productivity and efficiency expectations of the business owner based on lowest total overall cost.

The facility manager should be able to quantitatively justify the balance that is struck between planned maintenance and anticipated breakdowns. Most facility managers would agree that there is a place for demand or corrective maintenance as well as run-to-failure options in a complete maintenance approach.

Maintenance Management Workflow



Maintaining a facility's assets requires exceptional information input, organization and control. In general, it involves:

- A plan or routine that balances planned maintenance and corrective maintenance.
- An inventory/register organized by location and group.
- An understanding of the maintenance tasks required.
- A prioritized approach to assigning and accomplishing the work.
- Resource allocation to complete the work in a timely, efficient manner.
- Data input once the work is completed.

- A means to capture that feedback as a way to update the status of the inventory/register.

The facility manager uses the directional goals established by the facility strategic plan and the inventory/register to produce a short-range O&M approach, usually up to one year, for maintenance management.

The approach may be different, depending on the mission of the organization, the priorities of the ownership, the state of the facility's equipment/systems, and the facility manager's methods.

All types of maintenance may follow the same general approach. The difference usually occurs at the point when work is requested.

- Requests for planned maintenance come automatically based on predefined schedules set for preventive and predictive maintenance.
- Requests for unplanned maintenance can come as telephone calls, faxes or e-mail messages into a work control or work management center.
- Corrective maintenance is added to the schedule based on the criticality, demand and priority of that unplanned maintenance.

A typical maintenance management workflow process consists of the activities shown in *Exhibit 3-10*.

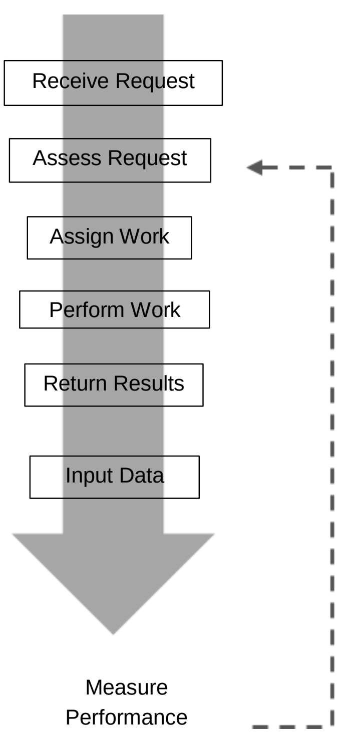
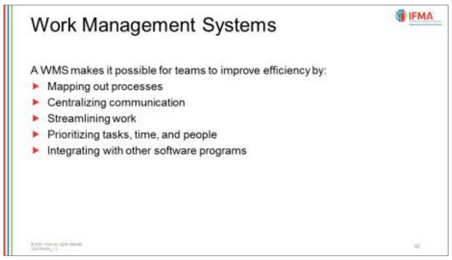


Exhibit 3-10: Typical Workflow Process

Work Management Systems



A facility manager's goal is to not only manage resources wisely but to also support all entities, which can be optimized through a work management system (WMS).

Gartner IT Glossary defines a work management system as "*a set of software products and services that apply workflow structure to the movement of information as well as to the interaction of business processes and human worker processes that generate the information*."

A work management system is software that allows organizations to improve internal processes in order to achieve success.

This tool makes it possible for teams to improve efficiency by:

- Mapping out processes
- Centralizing communication
- Streamlining work
- Prioritizing tasks, time and people
- Integrating with other software programs

A facility manager can use a work management system to set tasks and communicate with the right people to optimize maintenance. A WMS can identify areas of growth in production and business processes, define and deploy resources at the right time and ensure it goes to the right place in order to optimize labor, materials and other efficiencies. The facility manager can monitor life-cycles of equipment, make informed decisions about occupancy planning and optimize space and equipment. A WMS allows the management and development of metrics to create meaningful and robust reporting, which keeps FM and stakeholders informed.

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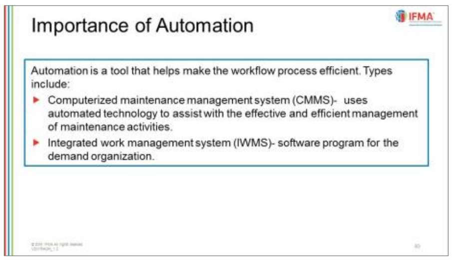
Facility managers that employ work management systems experience success through reduced redundancy, more efficient task deployment and calculated distribution of resources and processes.

Importance of Automation



Automation is a tool that makes the workflow process more efficient. This automated relationship is noted by the dotted line in *Exhibit 3-10* that connects and encapsulates the steps from when a request is assessed until performance of the work is measured. This forms a continuous loop that becomes the basis for continuous improvement in managing a facility.

Work requests or inputs are gathered to establish all the maintenance work that needs to be done, this information is collected in a facility management information system. This is an information technology tool that includes the hardware and software needed to store, manage, distribute and use information that is critical to an organization's mission, such as coordinating operations and maintenance.

FM information technology:, for example, CMMS/IWMS:

- Provides a tool to support the facility's business and maintenance work processes.
- Provides consistent and accurate data and information so that the facility manager can make sound decisions regarding the building and its systems and equipment.
- Provides a tool to measure performance.

A computerized maintenance management system (CMMS) uses automated technology to assist with the effective and efficient management of maintenance activities. It includes elements such as equipment and inventory management, computerized work orders and applications for scheduling planned maintenance tasks as well as numerous other features. A computer-aided facility management (CAFM) system may incorporate the functionality of CMMS and add special or geographic information system (GIS) applications. GIS provides a way to reference or map assets and processes relative to location.

With an integrated work management system (IWMS), a facility manager may have access to software programs for the demand organization. As enterprise-encompassing tools, IWMS can support a comprehensive, controllable approach across the entire infrastructure, its assets and their functionality.

It can provide ever-increasing and broadening functionality, which may include features for:

- Project management
- Capital planning
- Sustainability
- Fleet management
- Environmental health and safety
- Security
- Disaster preparedness
- Mission-critical equipment/systems
- Foundation for business continuity planning

There are several different application approaches for CMMS-type systems, such as the following:

- Client-server-based systems have individual PCs with a facility management program installed.
- Online approaches use an Internet-based wide area network to communicate and preserve facility maintenance records.
- Vendor-hosted approaches use an application service provider or software as a service. The software is installed at the vendor's hosting facility, and the facility has a monthly or annual license agreement that permits connection via the Internet to a secure server.

The cost and complexity of applications can vary greatly. Software license costs represent only a fraction of the total costs to implement a CMMS/IWMS.

Facility maintenance software applications may experience high failure rates. This suggests that many technology implementations fail to meet the needs of their users.

Facility management technologies may fail for any of several reasons, including the following:

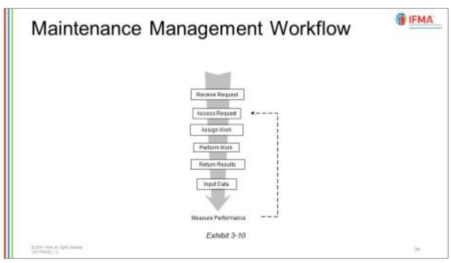
- Users, such as owners, executives, facility managers and systems personnel, do not have or recognize a strategic technology plan so they do not clearly express what is expected of a system before it is installed, configured and implemented.
- Data standards are not established, and data entry and maintenance are inconsistent, leading to unreliable results and performance measures.

- Inadequate training worsens the situation and can lead to data being incomplete, inaccurate or both, and neither the facility manager nor executing personnel know how to use and respond to the system effectively.
- Incorrect or insufficient data was input during implementation.
- Information is not continually updated.

The facility manager uses a manual process to schedule and review operational maintenance activities required if there is no computer-based system to help determine and organize O&M schedules or requests.

Whether the requests and work performance data are automated or manually generated, the facility manager’s ability to efficiently and effectively maintain building, systems and equipment is only as good as the quality of the record system and the inputs provided.

Typical Workflow Process



This section will take a closer look at each of the steps in the typical workflow process, as shown in *Exhibit 3-10*.

Receive Request

Requests are collected from authorized sources to determine all maintenance or repair work potentially needed across the entire infrastructure. A work request is the primary method by which user departments request a maintenance task. These work requests may be part of regular, scheduled maintenance, or they may come from occupants or others making requests through a work management center (WMC) or help desk. They may be made by e-mail, telephone, meeting or direct entry into a CMMS. The work request is converted to a work order (WO) after it has been authorized for action.

Service orders and service requests represent smaller, service-oriented requests for maintenance that need immediate attention. They are measured by the cost and time of the work so that, at some threshold for either, the request is more closely considered and estimated.

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Routine maintenance for the building, equipment and systems is also included through work requests that will be turned into work orders. Manufacturer warranty requirements and recommendations determine the schedule and frequency of planned maintenance. Routine planned maintenance requests, rather than unplanned maintenance requests, should reflect the majority of requests when a facility is managed by a reliability-centered maintenance philosophy.

Assess Request

Supervisors or other authorized personnel identify, prioritize and otherwise sort the work requested. The approach to all maintenance and operations activities, or work plan, is managed through the work management center (WMC). The WMC is a place or activity where all scheduled and unplanned work is screened and evaluated so that work assignments and activities can be communicated to individuals or teams and trades with specific tasks, expectations of time required to complete the job, and date/time for doing the job.

The WMC may be the exclusive domain of a facility manager or may involve the coordination of many individuals responsible for work reception, preventive maintenance, estimating/planning/budgeting, materials, customer service and work assignment. Regardless, the WMC is usually the central point that collects and reviews requests for maintenance or repair. At the WMC all work is estimated, planned, coordinated, scheduled, executed, measured and tracked. In a larger operation, an individual, or WMC staff, enters request data into the CMMS/IWMS and routes work orders to a supervisor for review and assignment.

WMC/help desk staff may coordinate different types of work coming from many different sources.

The receipt, assignment, communication and monitoring may include:

- Coordination and sequencing of activities by individuals and different skills to specific projects.
- Projects, alterations and renovation work directed by the facility strategic plan and the tactical O&M plan.
- Support for operations such as moves, custodial activities, security and other requests.
- Planned maintenance including preventive and predictive maintenance, routine building inspections and watches.
- Special or planned events such as reimbursable services, activities coordinated among multiple trades or shops, planned outages and others.

- Previously unscheduled corrective and emergency maintenance activities approved to be done.
- Corrective or demand work that moves to a higher priority.
- Anticipated requests from a backlog that recognizes all work available to be done, including job interruptions.
- Backlog work that has been approved and for which parts are either listed or bought and everything is ready.

Work schedules may also reflect priority handling or special considerations such as the following shown in *Exhibit 3-11*.

Exhibit 3-11: Work Schedule Considerations

Consideration	Ask
Safety	Is occupant or visitor health, well-being or security significantly affected positively or negatively?
Worker safety	Are proper work safety procedures in place and being used based on the nature of the maintenance activity?

	For example:
	• Lockout/tagout
	• Label and keep equipment from accidentally:
	  - Operating
	  - Working in a confined space
	  - Handling hazardous materials
	• Wearing appropriate personal protective equipment such as:
	  - Hardhat
	  - Gloves
	  - Eye protection
	  - Footwear

Regulations	Are there potential local code violations or concerns relative to national or international standards?
Customer deadline	Does the occupant require a completion time that is critical to their business purpose, operational productivity or other important need to satisfy?
Energy efficiency	Is there a significant cost benefit in the earliest possible completion?

Consideration	Ask
Environmental impact	Are there pollution, depletion, toxicity or quality factors that would be considerably reduced by the earliest possible completion?
Performance improvement	Is there a significant productivity or commercial benefit in the earliest possible completion?
Durability	Does the operational maintenance add reliability or stability benefits in the earliest possible completion?
Economy of work motion	Is there related or nearby work that could be combined with this maintenance activity to reduce costs?
Aesthetics	Is there added occupant comfort, competitive advantage or other nonspecific benefit to be gained by the earliest possible completion?

Help desks/WMCs may be responsible for monitoring building automation systems, fire and life safety system alarms and perhaps security monitoring systems. When this is the case, help desk personnel communicate with FM leaders, including the facility manager, to ensure that the necessary information is going into the CMMS/IWMS to generate meaningful and accurate performance measures.

These performance measures could include:

- Staff productivity
- Preventive maintenance versus corrective maintenance
- Work order aging, or how long it has been since the WO was prepared
- Turnaround time, or how quickly the WO was completed
- Emergency response time, or how quickly responses occurred
- Preventive maintenance completion rates, or how efficiently it was performed

Performance measurements and approaches are discussed later in this course.

The information accumulated by the CMMS/IWMS helps to produce a work plan. The work plan proceeds to individual work orders that divide the work plan into detailed tasks.

Assign Work

Once a work request is received and assessed, it is assigned to an individual or team usually through a work order, or its equivalent such as a job ticket.

The WO is the prime document for planned and unplanned operational maintenance.

It may include information such as:

- Description and type of work required
- Work location
- Customer and contact information
- Work group or service organization assigned to complete the work
- Repair codes
- Task priority
- Job procedures to be followed
- Parts, materials, tools and equipment required to complete the job
- Labor hours, costs and materials consumed in completing the task
- Key information on failure causes
- Work performed
- Prior work performed
- Other details or notes specific to the task and assignments

In some facilities, this information is entered at the work management center, and a WO is prepared, or the request is reviewed by a supervisor before the actual WO is prepared. Supervisory-level personnel may review work requests to identify type of work, urgency, skills required, available personnel and other aspects that promote efficiency. In this way the facility manager can determine whether to prepare a WO, place the request on hold or dismiss it.

Work orders can range from simple to complex, depending upon what is required and to what level the work is planned. Typical WOs for maintenance for equipment or systems may require many different tasks and components and may include a list of the trades or skills involved, the job steps for each and their equipment and material requirements. Work orders do not anticipate or allow for delays, unforeseen events or unusual circumstances.

There are two general types of work orders:

- A **standing work order** is left open either indefinitely or for a predetermined period of time for the purpose of collecting labor hours and/or supplies/materials costs for which it has been decided that individual work orders should not be raised. Examples would include standing work orders raised to collect time spent at safety meetings or in general housekeeping activities.
- A **standing operating order** represents predictable, routine services that can be planned in advance and occur on a regular basis. These may include inspections and established preventive maintenance. Some facility managers include non-core services such as custodial, waste collection, food services and grounds maintenance

as standing operating orders that are automatically included as work reception inputs.

The facility manager uses standing operating orders by:

- Applying them to short-term, repetitive jobs.
- Assigning them to specific jobs that occur frequently.
- Grouping them to reduce random preparation and travel by service people.
- Providing specific instructions or procedures to promote the fastest quality work.

Standing operating orders can reduce individual work orders and paperwork. Using standard, preprinted descriptions supports the maintenance activity yet reduces redundant planning, writing and paperwork.

Automated systems, such as CMMS can create standard work orders or standing operating orders to support personnel doing short duration, less than one hour, maintenance or repair activities. These quick projects can account for a measurable portion of the total O&M labor hours. Efficiency is important in doing the task and in shortening the interval between activities or locations of activities.

Perform Work

Work activities signal the actual execution of maintenance work accomplished by staff or contractors. Personnel execute planned and unplanned maintenance work based on the decisions of the work plan and the directions of the WO.

The work plan and the work order that represents it may include any of several considerations, such as:

- Work to accomplish.
- Any advanced preparation, such as materials, tools, equipment, or special skills personnel or individual training needed.
- Dependencies among tasks, such as coordinating staff or contractors with different skills or responsibilities so that tasks are efficiently accomplished without unnecessary delay or waiting time.
- Tasks and task sequence in the correct order.
- Coordination and productivity considerations, such as priorities, relationship with nearby O&M activities, and economic use of time and motion.
- Estimated start and end dates, or work duration.

When jobs are more complicated or involve several different workers or skills, the facility manager, assisted by the CMMS, must carefully consider how schedules interact. This can reduce conflicts and promote more coordinated activities.

Managing activities at one job site may require coordinating several visits by different maintenance personnel at different times. The sequence of work may prioritize which trades or individuals appear, when they appear, and what they must accomplish for the project to continue in an orderly, efficient manner.

By being aware of potential conflicts among projects, for example, if an individual or crew is needed in two places of equally high priority at the same time, the facility manager may determine alternate project service dates or times or involve more service personnel. The facility manager uses this knowledge to assess the conflict and make a decision.

An integrated workflow schedule can help the facility manager assign work crews across projects more efficiently.

For example, efficiencies may be lost or gained because activities may:

- Occur near to each other and may be done at the same time or in quick succession.
- Require the same tools, parts or skills and may benefit by using the same personnel.
- Be redundant because others are performing the same, similar, or partial work at a different time.
- Be unnecessary because a different, overarching activity negates its purpose, for example, lubricating a machine scheduled to be removed the next day.

Work productivity can be adversely affected in O&M because so many aspects need to be recognized and coordinated.

Productivity rates can fall when:

- Parts, materials or tools are not available
- Work groups are not synchronized
- Emergencies produce conflicts
- Customers or occupants delay access
- Poor work descriptions cause confusion

The facility manager must strive to keep activities efficient, orderly, in the right sequence, on time, within guidelines and fully reported.

Return Results

Once the requested work is complete, or at some other designated point, the results of the work are communicated, and any additional needs or unanticipated requirements are noted. Staff/contractors return the WO with complete detail on the work performed. This may be transmitted to a supervisor or to the work management center/help desk.

Regarding work activities, the facility manager, or a designate, may also:

- Check and inspect the maintenance work.
- Close completed work orders and perform cost accounting.
- Update activities with reports.
- Solicit feedback from occupants, owners and maintenance personnel to be included as inputs in the ongoing, cyclic management of the maintenance workflow.

Input Data

The work results are collected and organized to regularly update the status of maintenance and the condition of the facility and its equipment and systems. Data from the WO is entered into a facility information management system, such as the CMMS/IWMS, or equivalent. This data may include work class, repair codes, equipment and time. Once the data is entered, the WO is completed and closed. If additional or follow-up work is needed, an additional WO is usually created and becomes part of the ongoing work plan.

Work inputs are transferred to a central database to provide the facility manager with current and ongoing information relative to:

- The facility as a logical grouping of equipment and systems.
- Requirements, condition and parts needs of each operating asset, such as materials, components and equipment across building structure, systems, interiors, exteriors and grounds.
- Maintenance procedures, special instructions and skill requirements for specific projects.
- Sequence and frequency of maintenance procedures relative to all assets scheduled for maintenance.
- History of prior maintenance, results and out-of-ordinary circumstances.

Measure Performance

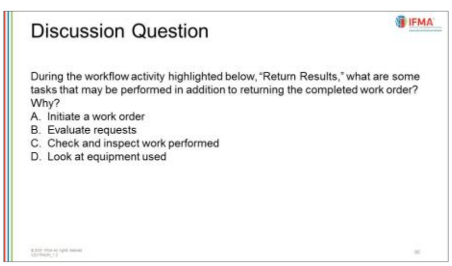
As data is accumulated, the facility manager uses some means, usually automated information technology such as CMMS/IWMS, to compare overall results against predetermined performance expectations. Some best practices relative to a maintenance management policy can establish how the CMMS helps in preparing a work plan. The quality of inputs from work orders determines the accuracy of information the facility manager uses to support efficient, effective operational maintenance.

When maintenance management is part of CMMS-type automation, the facility manager can benefit from computerization that brings together all business aspects of O&M. This supports not only the execution of maintenance schedules but also the business administration of O&M.

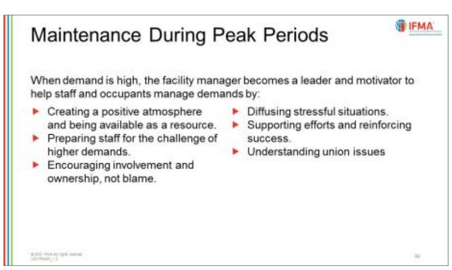
The CMMS can deliver a reasonable work plan when the facility manager considers and applies rules such as the following:

- Productivity and results are highest when staff/contractors know what to do, when to do it, how to do it and who (what individual or team) is expected to do it.
- System input and use is more than document management and is a means to inform, direct and implement maintenance activities.
- Relationships and service quality are core requirements whether using staff or contractors.
- Measurement determines control; in general terms what is measured is performed.
- All assets and their condition are known, inventoried, recorded and updated with each service visit in a dynamic, responsive system.
- Authorized personnel at all levels have access to the information needed to do their jobs.
- System access and use ensures privacy, security and integrity.

Facility management requires many other abilities that influence this basic maintenance management approach. These include planning, estimating, budgeting, materials control, payments, contracts, quality measurements, reports and customer service as well as other skills and practices that the facility manager needs in order to deliver competent management. These skills are discussed in other IFMA courses.



Maintenance During Peak Periods



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Managing a facility can be especially stressful during peaks when resources may be strained. This is a time when the facility manager becomes a leader and motivator to help staff and occupants manage demands.

The *Leadership and Strategy* course is a good resource to use in learning more about leading personnel.

Some examples include the following:

- Be present as a facility manager by creating a positive atmosphere and being available to answer questions and resolve conflicts.
- Prepare staff, contractors and occupants for the challenge of higher demands; recognize the heightened emotional state.
- Encourage involvement and ownership so that the focus is on efficiently handling tasks and solving problems and not finding blame or becoming distracted by complaints.
- Help dampen stressful situations and upset individuals. Encourage staff as well as occupants to express their anxiety and frustration; encourage patience.
- Support efforts made to respond, reinforce success with rewards, recognition and acknowledgement. Share success and emphasize challenges undertaken rather than deadlines missed.
- If facility technical staff are union members, the facility manager should fully understand and address the related issues, concerns and work rules.
- Develop and sustain a regular communication process to keep occupants/management informed.

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Operate Building Systems and Equipment

Lesson Introduction

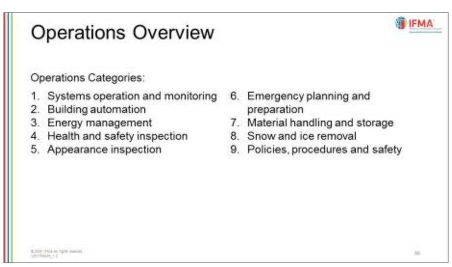
On completion of this lesson, you will be able to:

- Describe the operation of building systems such as building automation, energy management, health and safety elements and emergency preparation.

This lesson contains the following topics:

- Operations Overview
- Systems Operation and Monitoring
- Inspections
- Emergency Planning and Preparation
- Additional Planning Considerations

Operations Overview



Operations involves ensuring that the facility's infrastructure and how it is used and managed:

- Provides a satisfactory work environment
- Is in compliance with laws and regulations
- Meets financial performance goals

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- Protects the surrounding community and environment

Guidelines for how systems operations are used and maintained can vary depending upon the facility, its purpose, its level of specialization, its age, the owners' mission and other characteristics. The infrastructure should provide appropriate and reliable temperature control, lighting, equipment and all the other operating aspects required for effective and efficient building systems, structures, interiors, exteriors, grounds and occupant comfort. As technologies and products change and as facilities age, the facility manager must be diligent in maintaining a level of service that supports occupant safety and comfort and energy efficiency.

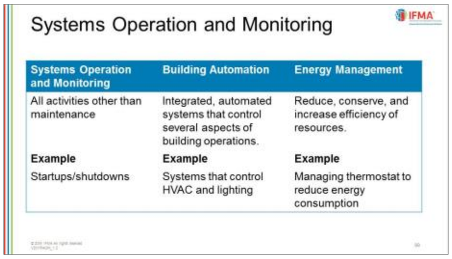
Energy efficiency, environmental sustainability and air and water quality are all significant to facility management because they directly relate to issues that concern the facility's productivity, efficiency, safety and code compliance. Facility managers must not just be aware of these issues but must also be prepared to deal with them as part of their management responsibilities. Energy efficiency, environmental sustainability and air and water quality are business issues that affect operational planning and the mission of the facility.

Maintaining the operations of systems and equipment may cover several categories, including the following nine:

1. Systems operation and monitoring
2. Building automation
3. Energy management
4. Health and safety inspection
5. Appearance inspection
6. Emergency planning and preparation
7. Material handling and storage
8. Snow and ice removal
9. Policies, procedures and safety

This lesson briefly summarizes each.

Systems Operation and Monitoring



Routine, ongoing systems operations and the monitoring of those operations are significant aspects of facility management. Operations that may be continuously monitored include water treatment, cooling systems, heating systems and ventilation systems.

The operation of systems and equipment can be considered as all activities other than maintenance. These activities can include:

- Startups and shutdowns, such as starting up boilers in cool weather to warm a building before occupants arrive.
- Monitoring and adjusting, such as adjusting thermostats or dampers based on reference measurements and reading pressure and temperature gauges.

Activities such as these are common routines for managing a facility and may or may not be automated.

Building Automation

Building automation systems (BAS), also known as building management systems (BMS), are integrated, automated systems that control several aspects of building operations such as HVAC, lighting, energy, elevators, fire suppression and security. This integrated automation technology uses monitors and computers in a distributed control arrangement to automatically regulate facility systems. Ideally, BAS/BMS technology helps produce what is often called an intelligent or smart building that self-regulates so that the facility operates at peak efficiency, with the greatest cost savings, lowest greenhouse emissions and optimal energy use. In this way, BAS/BMS can be a significant method to produce effective energy management.

Integrated automation technology from a systems standpoint refers to many different equipment and maintenance elements, including:

- Network equipment, conductors, cables and pathways.
- Maintenance schedules and commissioning.
- Devices, gateways, networks, control units and software.

- Terminal devices relative to facility equipment, conveying equipment, fire suppression, plumbing, HVAC, electrical systems, communications, safety and security and the control sequences for these devices.

While integrated automation may be most common in large buildings, it is coming into wider use because a high-performing BAS/BMS can help provide:

- Comfort and productivity for occupants.
- Greater control over energy consumption and targeted goals.
- Early detection of equipment mechanical problems or other conditions.
- Greater reliability and durability of facility equipment.
- More efficient use of maintenance personnel.

Automation in energy usage is an example of emerging technology to optimize building functions and create more efficient operation. For example, rooms can be equipped with sensors that detect occupancy, light meters can measure natural lighting which then adjust artificial lighting and sensors on window coverings can measure temperature and adjust blinds accordingly.

Energy usage can be managed and improved with the use of technology such as smart meters which store and transmit energy data. This data can then be used for:

- Forecasting
- Identification of opportunities for energy improvement investment
- Testing of strategic energy tactics
- Advanced diagnostics
- Verifying service agreements with energy service contractor
- Commissioning new equipment and systems
- Compliance

Building components are becoming more automated. Smart office spaces are equipped with voice, video and data connectivity for meetings, projectors and room control systems. Wireless local area networks (Wi-Fi) is incorporated throughout facilities to improve connectivity and mobile abilities.

Building operations are becoming dynamic with the increased need for operations to function automatically and remotely. BAS monitoring and control systems are moving to remote automation, which can set controls on systems, regulate temperatures and set alarm systems from a remote location.

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Energy Management

Energy management is an operational aspect that spans the entire facility infrastructure, such as systems, structures, interiors, exteriors and grounds. Facility managers are usually mandated to reduce waste, increase efficiency, conserve use and meet quality requirements. Energy is used to heat, cool, provide light and run equipment, it is vital to supply and expensive if not used effectively and efficiently.

As the cost, sustainability and significance of energy use continues to become more important, facility managers must be alert to methods and opportunities that support better use of resources and reliable delivery.

A process for managing energy could include the following elements:

- Control demand — some widely recognized behaviors help control demand such as turning off lights when leaving a room, closing drapes and shades to retain heat in cold seasons and block sunshine in summer. Others involve integrated automation in the form of an energy management system (EMS) to monitor, control and optimize the performance of electrical generation, transmission equipment and related utilities.
- Develop a baseline — the facility manager uses invoices, meter readings and all available methods to measure and track energy consumption for each utility, such as electricity, liquid/gas fuel, water and communications. The use of these energy resources may be further divided by location, building, type of use, age of the system or other factors. The energy manager or facility manager tracks use and uses business returns, life-cycle costing and other measurements to determine where efficiencies may be created through better maintenance, replacement with more efficient alternatives, improved conservation or others in a combination that delivers the lowest total overall cost.
- Determine a hierarchy of energy management measures — the facility manager is always alert for approaches that support savings or sustainability or provide other means to reduce cost and resource use. This may include developing and ranking a complete list of possibilities relative to their cost, criticality, capacity to pay for their use, value in occupant satisfaction and other factors.
- Consider energy management opportunities — design, repair, upgrade and renovation decisions should be considered relative to energy conservation. As new technologies and more energy-saving systems and alternatives become available, the facility manager must be aware of these potential solutions and apply sound business principles to select among them.

For energy conservation alone, there are many aspects to consider that go beyond maintaining room temperature for human comfort. Effective operations and maintenance demand the continuous delivery of energy, dependable heating/cooling equipment operation, humidity control and consistent maintenance.

The facility manager can provide policies and procedures to support energy conservation such as:

- Provisions for using outside air and energy-saving equipment such as fans during moderate weather.
- Installing ventilation systems that are the most efficient possible in terms of their configuration and design.
- Using and maintaining air filters that remove particles to levels that comply with best practices, air quality codes and occupant needs.
- Instituting and monitoring a program that encourages turning off lights when and where possible and purchasing energy-conserving lamps in bulk quantities.

The facility manager can develop and apply best practices across the entire infrastructure to monitor use and performance.

Ways to reduce energy consumption could include the following:

- Record and track all energy bills, check bills and readings for accuracy, identify energy use by zones to more accurately measure and compare areas, equipment mix and systems.
- Schedule and perform predictive and preventive maintenance to optimize equipment efficiency as well as support higher reliability and better occupant satisfaction, avoid major breakdowns and their productivity and repair costs.
- Plan non-emergency repairs and renovations to integrate with routine maintenance schedules, minimize disrupting occupant activities and most effectively use resources, such as personnel, tools and materials, to produce the maximum work result.
- Consider decreasing energy usage in unoccupied space by adjusting temperatures, turning lights off and other non-essential equipment.

The facility manager supports energy management solutions that produce greater energy efficiency in order to realize cost savings, maintain facility productivity and occupant comfort and support environmental sustainability.

Exhibit 3-12 is a partial example to demonstrate some considerations when reviewing a facility's resource use. Assessments such as this could be helpful for different facility O&M aspects such as resource conservation which includes electrical, fuel, water and chemical, indoor air quality, waste management, grounds and soil, renovation and recycling, protecting plant and animal habitat and conservation engineering practices to save energy and resources costs.

Components: fixtures, visible motor controls, switches, cover plates, grounds, lighting protection, accessible wiring

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

General causes or concerns

Water system

[ ] Leaks, losses
[ ] Appropriate temperature of running water
[ ] Inadequate electrical pump maintenance
[ ] Appropriate pipe insulation
[ ] Waste not managed, properly disposed or recycled

HVAC systems

[ ] Adequate CO2 levels in buildings
[ ] Dust buildup on electric heating coils
[ ] Clean filters and equipment operating within normal parameters
[ ] Radiators impaired by closely-set furnishings
[ ] Fresh air and door openings not supporting efficiency

Interior

[ ] Electrical items (computers, photocopiers, room lights) off when not in use
[ ] Thermostat set for temperature/humidity comfort
[ ] Energy-saving bulbs are used and lighting is adequate
[ ] Exit signs and emergency lighting working properly
[ ] Photoelectric cells not used to automatically turn off lights in vacant spaces such as storerooms, restrooms
[ ] Safety/alarm system functioning properly
[ ] Emergency pathways are clear

Compliance (codes/regulations)

[ ] Local
[ ] Area
[ ] National/international standards
[ ] Required permits
[ ] Barrier-free access

Fixtures and devices

[ ] Energy conserving
[ ] Maintained for lowest energy use
[ ] Energy-efficient motors, tools, compressors
[ ] Security lights reviewed for savings

Component evaluation

Description (type, location, serial number/ID)

____
____
____
____
____
____
____

Condition (items that need attention/deficiency described)

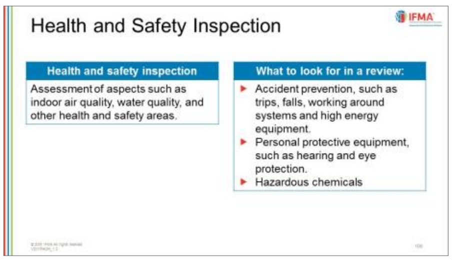
____
____
____
____
____
____
____

Exhibit 3-12: Resource Conservation Assessment

Inspections

A few important types of inspections include health and safety inspections and appearance inspections.

Health and Safety Inspection



Part of a facility manager's operational responsibility is to oversee regular inspections for the health and safety of the facility and its occupants. This includes indoor air quality and all the general factors relative to health and safety, which were discussed previously when assessing and inspecting the condition of the building structure, exteriors, systems, interiors and grounds.

In general, health and safety inspections of to the building and its systems and equipment may review:

- Accident prevention, such as trips, falls, working around systems and high energy equipment.
- Personal protective equipment, such as hearing and eye protection.
- Hazardous chemicals.

Air quality, water quality, recycling and related forms of resource management and compliance with regulations are the facility manager's responsibility. If a facility or system is shut down or operates unreliably because of a loss of power, poor management of service, unhealthy air quality or other issue, the economic cost can be significant. To prevent liabilities and penalties, facility management must ensure corrections are made to existing health and safety problems.

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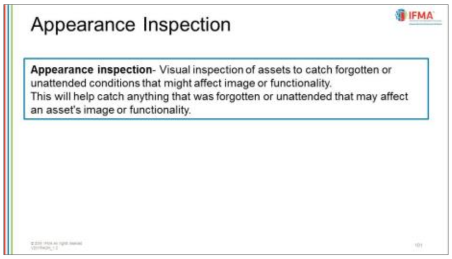
Appearance Inspection



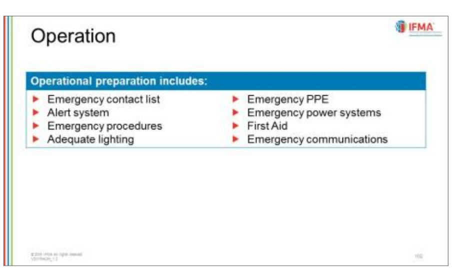
As part of maintenance routines and as general rules for staff performing O&M activities, the facility manager may inspect or assess appearance of assets. This includes items such as wall coverings, painting or flooring, cleanliness of restrooms and general appearance and condition of equipment doors, hinges and hardware. It may be anything that is visible to the observer. These inspections may be formal or informal, separate or part of scheduled maintenance.

The purpose of appearance inspections is to catch forgotten or unattended conditions that affect the image or functionality of an asset. Upon identifying issues affecting condition or image of an asset, a facility manager must make the appropriate adjustments to fix and ensure the issue will not occur again in the future. This can range from repairing the asset, to full replacement if needed.

Emergency Planning and Preparation

Emergency preparedness is a state of readiness designed to respond to potential unscheduled events and natural disasters that can affect building occupants, disrupt business operations and potentially impair the physical facility. The facility manager makes preparations for all types of threats whether caused by humans, such as terrorism, workplace violence, medical crises, the environment, such as hazardous spills, or nature, such as storms or power failures, through operation, escalation and publication.

Operation



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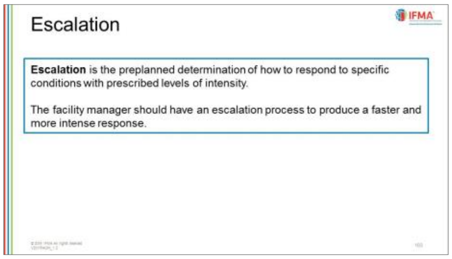
Operational preparation brings all aspects of the infrastructure — systems, structure, interiors, exteriors and grounds — into a complete plan that assigns responsibilities and develops templates for activities before, during and after an emergency.

The facility manager may prepare for a safe response to operations by having a plan that includes:

- Emergency contact list of area responders and support agencies, capabilities and typical response times.
- Security procedures, including building and elevator keys, responses.
- Alert and communication systems such as public address, stairwell intercom, and other emergency warning systems, also called emergency warning information systems.
- Emergency procedures developed and published for operating mechanical, electrical and utility equipment affected by storms.
- Debris and snow removal, deicing, water/flood management.
- Readiness of vehicles, structures and equipment for operation in storms, excessive cold or heavy snow (winterization), excessive heat, unusual crowd conditions.
- Procedures and checklists of required information, communication protocols, recovery and safety elements.
- Emergency communications backups such as battery-operated radios and two-way transmitter/receiver, or walkie-talkie.
- Pathway lighting.
- Emergency equipment and personal protective equipment, locations and assignments.
- Information prepared and conveniently placed describing weather-related or environmental possibilities, such as heavy rain, winds, snow, cold or heat, and potential effects, such as mudslides, flooding, entrapment, exposure.
- Emergency and standby power systems.
- Communication from the work management center.
- Operations checklists relative to emergency actions for heating, cooling, traffic flow from pedestrian and vehicle, air-handling and harmful gas exhaust.
- Emergency directions for occupants or visitors based on building locations, storm situations and evacuation plans.
- In-place procedures for structures in the event that evacuation is incomplete or delayed.
- Emergency electrical, heating/cooling, water and injury response capabilities.
- Emergency equipment cache such as first aid, portable lights/generators, sandbags, tarpaulins, shovels, axes, lumber/plywood and nails, water, ready-to-eat food, infant supplies, clothing, bedding, sanitation supplies.

Escalation



From an emergency operations standpoint, escalation is the preplanned determination of how to respond to specific conditions with prescribed levels of intensity. An emergency can escalate from an incident with possible loss, to a disruption of normal function, to a dangerous situation, to a crisis in which an unsustainable condition requires an immediate, urgent response. The intensity of a response should be appropriate to the intensity of the emergency.

In the case of most emergencies, especially those of greater intensity, response generally proceeds through stages such as:

- Alert
- First response for safety
- Operational security
- Public welfare, such as occupants and visitors
- Recovery

The facility manager prepares for these stages with an escalation process in which greater emergencies produce a faster and more intense response.

This preparation would likely include:

- Prescribed indicators that trigger response levels. For example, a fire in a wastebasket would not require the same response intensity as a fire near fuel storage.
- Roles and responsibilities assigned to individuals who are trained in their requirements.
- Rules of engagement that provide responsible individuals with clear communication relative to threat level.
- Response approach and activities relative to the nature of the emergency. For example, the response would be different when detecting a harmful gas release than an approaching hurricane.

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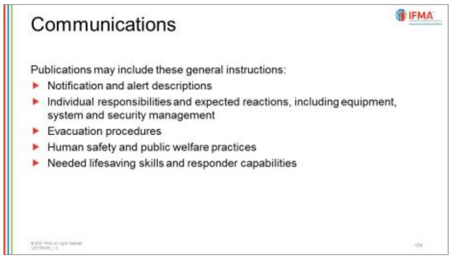
Communications



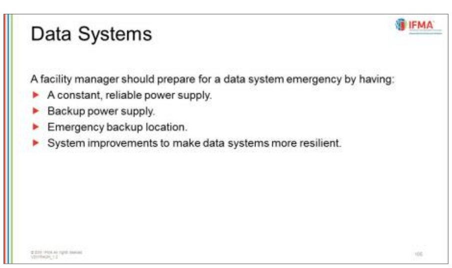
The facility manager not only prepares for emergencies but organizes and publishes those preparations so that others in the organization are competent in their roles. This requires including other personnel active in the facility such as administrators, managers, business overseers, floor supervisors and contract workers or staff who are on site such as custodial, food service, waste management and other services.

Publications may include these general instructions:

- Notification and alert descriptions
- Individual responsibilities and expected reactions, including equipment, system and security management
- Evacuation procedures
- Human safety and public welfare practices
- Needed lifesaving skills and responder capabilities

Publishing emergency plans not only helps the facility manager prepare for contingencies but also involves the demand organization in carrying out a controlled, safe and efficient response.

Data Systems



Data systems and centers are used to house technology and provide uninterrupted data availability to a facility. As a facility manager, it is vital to be prepared in emergency planning involving data systems.

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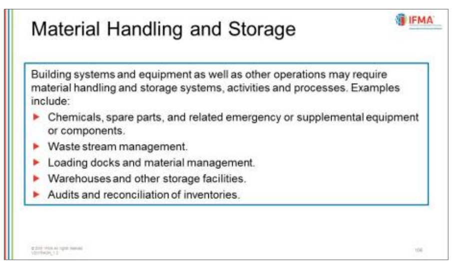
Emergency planning can begin with a meeting between FM and IT. FM and IT can collaborate on the design of data centers to ensure that all needs are identified and addressed.

This can include:

- An uninterrupted power source and backup power supply
- An emergency backup facility in a specified location
- Improvements to data center resiliency
- Data backup policies

Additional Planning Procedures

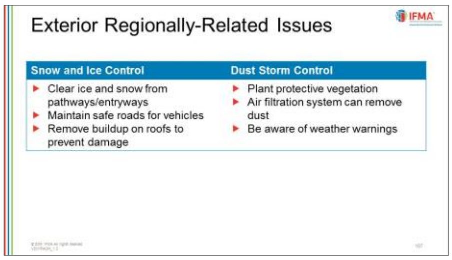
Material Handling and Storage



Building systems, equipment and other operations may require material handling and storage systems, activities and processes. Some examples of these include:

- Cleaning liquids/chemicals and safety data sheets
- Spare parts and maintenance equipment
- Related emergency or supplemental equipment or components
- Waste stream management
- Loading docks and material management
- Warehouses and other storage facilities
    - For example, diesel and oil storage for generators.
- Audits and reconciliation of inventories

Exterior Regionally-Related Issues



In order to properly prepare for weather-related issues, exterior precautions must to be in place. The facility manager should have a plan to ensure exterior equipment and materials are safe and secure from weather-related damage. Among many weather-related threats, a few examples of conditions to practice exterior precaution for are snow and ice, flooding and dust storms.

In cold weather, facility managers oversee the prompt removal of snow and ice to:

- Provide ready access to the facility for continued productivity and the convenience of occupants and visitors.
- Maintain safe passageways for vehicles and pedestrians free of slippery surfaces.
- Remove potentially damaging buildup of snow and ice on roofs, overhangs and awnings.

Sand and dust storms can be a potential hazard to health and facilities. Facility managers should be prepared to make adjustments and implement protective measures.

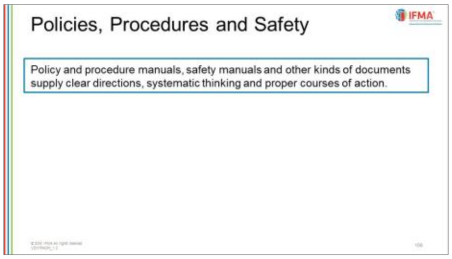
A facility manager should take dust storm precautions such as:

- Plant vegetation and trees to control soil erosion and block wind.
- Ensure air filtration system is in good condition to control dust levels.
- Monitor and understand weather warnings in order to be prepared.
- Organize additional cleaning to remove fine dust/sand from floors.

Another major issue for many organizations may be flooding, which can be caused by heavy rainfall or severe storms such as hurricanes. To prepare for flooding, the facility manager should:

- Be aware if the facility is built in a designated flood zone.
- Ensure the facility has proper roof gutters to collect and remove water buildup.
- Ensure parking lots, sidewalks and grounds direct water flow to underground drainage or collection areas.
- Maintain the roof and exterior of the building to prevent leaks and interior water damage.

Policies, Procedures and Safety



Facility managers help create, produce and continually update standards and expectations for maintaining the infrastructure as well as occupant services. This information is documented, communicated and made available to staff and contractors in a tenant/occupant services manual or similar document that is prepared for and provided to facility occupants.

Policy and procedure manuals, safety manuals and other kinds of documents supply clear directions, systematic thinking and proper courses of action. They exist not only to support proper, efficient O&M but also to represent the foundation from which performance expectations and tasks can be determined and measured.

Monitor Use and Performance of Facilities

Lesson Introduction

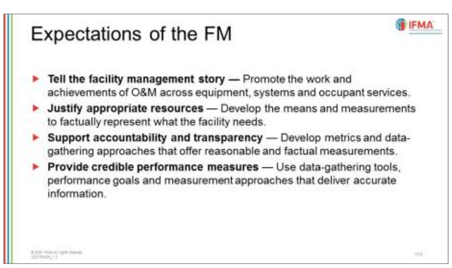
On completion of this lesson, you will be able to:

- Determine how key performance indicators (KPIs) are measured and if performance goals were met.

This lesson contains the following topics:

- Expectations of the FM to Monitor Facilities
- Respond to the Plan
- Determine Performance Measurements
- Consolidate in a Balanced Scorecard
- Compare to Work Log Results
- Recommend Future Asset Purchases

Expectations of the Facility Manager to Monitor Facilities



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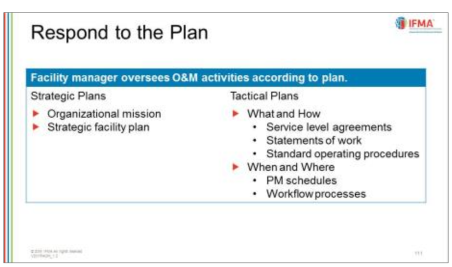
Facility managers recognize that the performance of virtually any facility would most likely benefit from improvement. This places several expectations on the facility manager:

- **Tell the facility management story** — promote the work and achievements of O&M across equipment, systems and occupant services. Be prepared with information — results, needs, ideas and accomplishments — so that executives and occupants alike are aware of what facility management is doing and how it supports the strategic objective of the organization.
- **Justify appropriate resources** — develop the means and measurements to factually represent what the facility needs, including staff and contracted resources, capital and maintenance budgets and the plans for managing everything wisely.
- **Support accountability and transparency** — develop metrics and data-gathering approaches that offer reasonable and factual measurements so that executives and other stakeholders understand how facility management is proceeding and how it is doing.
- **Provide credible performance measures** — use data-gathering tools, performance goals and measurement approaches that deliver accurate information that decision makers understand with confidence and that sustain the facility mission.

Facility managers must be aware of the need to measure, justify and clearly communicate what is being accomplished. It is important to promote FM, what it is doing and what's needed so that this activity is integrated with and enhances the purpose of the facility.

Respond to the Plan



The facility manager is responsible for overseeing the O&M of the facility and its systems and the proper execution of occupant services. Service level agreements (SLAs), statements of work (SOWs) and standard operating procedures (SOPs) describe what and how it is done; maintenance schedules and workflow processes describe when and where it is done.

The facility manager oversees the execution of these activities to support the mission of the organization, its facility strategic plan and the O&M approach that is developed from it. In this way, the emphasis of O&M is on outcome, not merely on activity.

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As first introduced earlier in this course, the activities that occur with O&M, as well as paralleling tactical planning areas such as budgeting and design/construction, are driven by the business strategy for the facility and the demand organization to the benefit of customers.

Exhibit 1-2 (previously shown in Chapter 1) outlines the approach a facility manager may take to turn the organization's strategy into a sound facilities plan and an O&M program with measured results.

The facility manager takes direction from the facility strategic plan and interprets its goals into the specific activities, assignments and outcomes that generate the work of O&M for building systems and occupant services.

Whether the workflow process represents planned or unplanned maintenance or occupant services, the approach can be generally the same. This was described in this chapter in *Exhibit-3-10: Typical Workflow Process*.

The facility manager measures actual performance against realistic, quantitative goals. These goals may be described as performance requirements, and performance requirements may be summarized into a few, mission-critical ones called key performance indicators (KPIs).

By defining outcomes to achieve specific goals, the facility manager has the means to develop appropriate work plans, oversee their accomplishment and compare actual results to desired performance. This is the basis for facility management that can provide building owners and executives with useful information on how well O&M outcomes are supporting strategic business goals.

The strategy of the facility plan determines tactics and the delivery of the workflow process executes that plan.

This capability is built around knowing:

- What to measure, called the performance indicators.
- How they compare, called the benchmarks that represent a point of reference.
- How to bring it together, called a balanced scorecard.
- How to track and record it using recorded results.

By applying these techniques, the facility manager has an accurate and meaningful presentation that justifies what activities were undertaken, what work plan decisions were made and how facility operations supported the building’s purpose and its occupants. It is not only the basis for how things have been accomplished but is an organized approach for continuous improvement.

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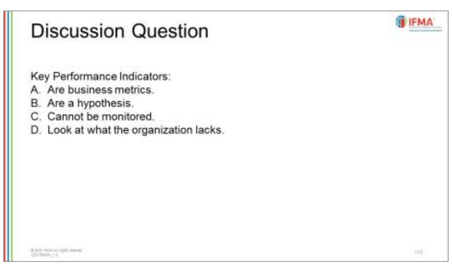
Determine Performance Measurements

In determining what performance to measure, the facility manager considers the facility strategic plan. For example, if it is a production facility, a performance measurement could be minimal anticipated downtime. If it is a hospital or apartments, a performance measurement could be customer satisfaction.

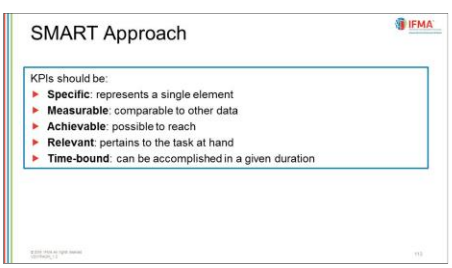
Specific performance indicators or outcomes can be determined to monitor the results of virtually any activity, task or outcome that is considered important to the purpose of a facility. They measure performance relative to the SLA (covered in the next chapter), SOW, or other written requirements developed in the workflow process.

Key performance indicators are business metrics that demonstrate how effectively a company is achieving crucial business objectives. They are identified so that O&M activities can be measured against expected results. KPIs usually summarize or collect lower-level performance measurements into representative data to evaluate success of reaching benchmarks.

The facility manager compares actual results to KPIs to evaluate how successful a maintenance activity in the SLA or SOW has been accomplished relative to KPI expectations. KPIs may be generally described using the SMART approach, varied types, and quantitative and qualitative measures, which are discussed in the next sections.



SMART Approach



The SMART approach is a way to develop feasible key performance indicators, or any performance outcomes, that represent a critical facility management goal. SMART is an acronym that represents a test of feasibility with a KPI that is:

- **Specific** — and clear to avoid misinterpretation. The KPI or performance measurement should represent a single element of the performance outcome and be written so that any stakeholder with a basic understanding of the facility's purpose can understand it.
- **Measurable** — to be compared to other data. The KPI should define how to measure whether it is achieved; this is usually a quantitative measurement that represents a specific, understood outcome.
- **Achievable** — or attainable, with a reasonable expectation to be reached under the conditions expected. This means that the goal can be met using the skills, assets and capabilities of the intended staff/contractor and work plan. It also assumes that requirements do not conflict with each other.
- **Realistic** — in that it fits within the organization's current capabilities, pertains to the task at hand and is cost-effective. It must be feasible and agreed upon by the responsible parties, or those who do the work as well as those who oversee the work.
- **Time-bound** — in that it should be accomplished within the given duration and is appropriate compared to other priorities or capabilities of O&M and the facility mission. Accurately estimated deadlines promote efficiency and provide a foundation for reporting and control.

There are many ways to develop key performance indicators and thus develop or determine best practices.

More common stages for developing a KPI may include the following:

- Identify potential goal area.
- Determine what to measure, such as hours, activities, work completed, planned versus unplanned maintenance.
- Set performance expectation based on known standards or historic results.
- Collect information/data on current activity.
- Compare findings against expectation to determine performance gap and use as a benchmark.
- Set improvement goals based on corrections or work approach changes.
- Monitor progress.

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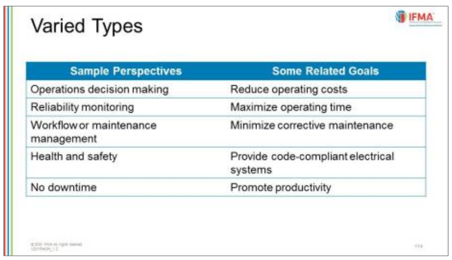
SMART goals are further discussed in the *Project Management* course.

Varied Types



KPIs can be as varied as facilities and facility managers themselves. There are likely hundreds of potential metrics relative to facility management. The goal is to select the right mix of metrics to develop as key performance indicators that set goals, measure outcomes and support the organization in realizing its overall operational goals.

They may be developed to enhance facility management from different perspectives, such as:

- Operations decision making with a goal of reducing operating costs and risks and maximizing output.
- Reliability monitoring to maximize operating time and preserve asset integrity.
- Workflow or maintenance management to minimize corrective maintenance or restore asset condition.
- Health and safety to reliably provide expected and code-compliant electrical systems; air, water and waste management quality; security and emergency preparedness; and a safe working environment free from hazardous conditions.
- No downtime, such as for a data center or productivity on a manufacturing line.

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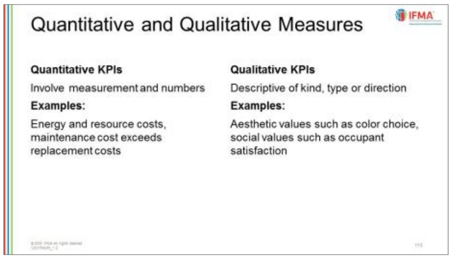
Quantitative and Qualitative Measures



KPIs are measurable, some may apply qualitative factors that are descriptive of kind, type or direction as opposed to size, magnitude or degree. Others will apply quantitative factors involving measurements and numbers. In both instances, KPIs should reflect standards that are understood, communicated and agreed upon by the facility manager, executive management, staff, contractors, interested occupants and any other relevant parties.

KPIs for operations and maintenance include any or all of these quantitative and qualitative aspects:

- Quantitatively measured energy and resource costs to help determine if a more energy-saving alternative will pay for itself in long-term savings
- Quantitatively reviewed cost cycles that identify when the cost of maintaining an asset becomes more than the life-cycle cost of replacing it
    - This measure can be drawn as an item from the cost of operation, which provides the total costs associated with the daily operation of a facility. It includes all maintenance and repair costs, both fixed and variable, administrative costs, such as clerical, timekeeping, general supervision, labor costs, custodial, housekeeping and other cleaning costs, utility costs and indirect costs, such as all costs associated with roadways and grounds.
- Qualitative general wear expectations in which the useful life stated by the asset manufacturer may be affordably extended to produce a longer service life
- Qualitative requirements that reflect cultural values and organizational strengths, weaknesses, opportunities and threats
- Qualitative aesthetic values that refer to design considerations such as materials quality, color choices or maintenance frequency
- Qualitative expectations relative to social values such as occupant satisfaction, community reputation and competitive standing

What Success Looks Like

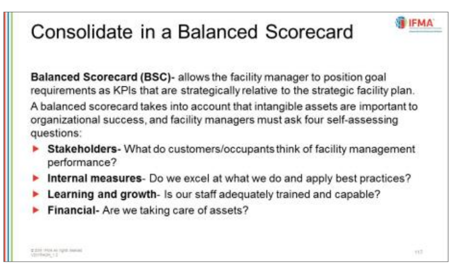
In order to understand what a successful KPI looks like, a facility manager must establish the desired outcome. Comparing actual results of what has been accomplished versus what was planned to be accomplished can provide insight to what is going well and what needs improvement. This can be looking at metrics such as revenue, employment statistics, occupant satisfaction, customer service ratings and organizational efficiency.

In order to achieve success. FM must be in alignment with goals and KPIs.

The alignment of success can create cooperation and agreement on topics such as:

- Policies and standards
- Acceptable O&M activities
- Building appearance
- Thermal comfort and building environment

Consolidate in a Balanced Scorecard



A key performance and measurement approach applied to facilities, as well as processes and the workplace, is known as the balanced scorecard (BSC). A BSC helps the facility manager implement practices that align with the demand organization's mission and strategy. The balanced scorecard approach was first developed in the early 1990s to measure, compare and balance financial performance against employee, business process and customer perspectives. This relationship is illustrated in *Exhibit 3-13*.

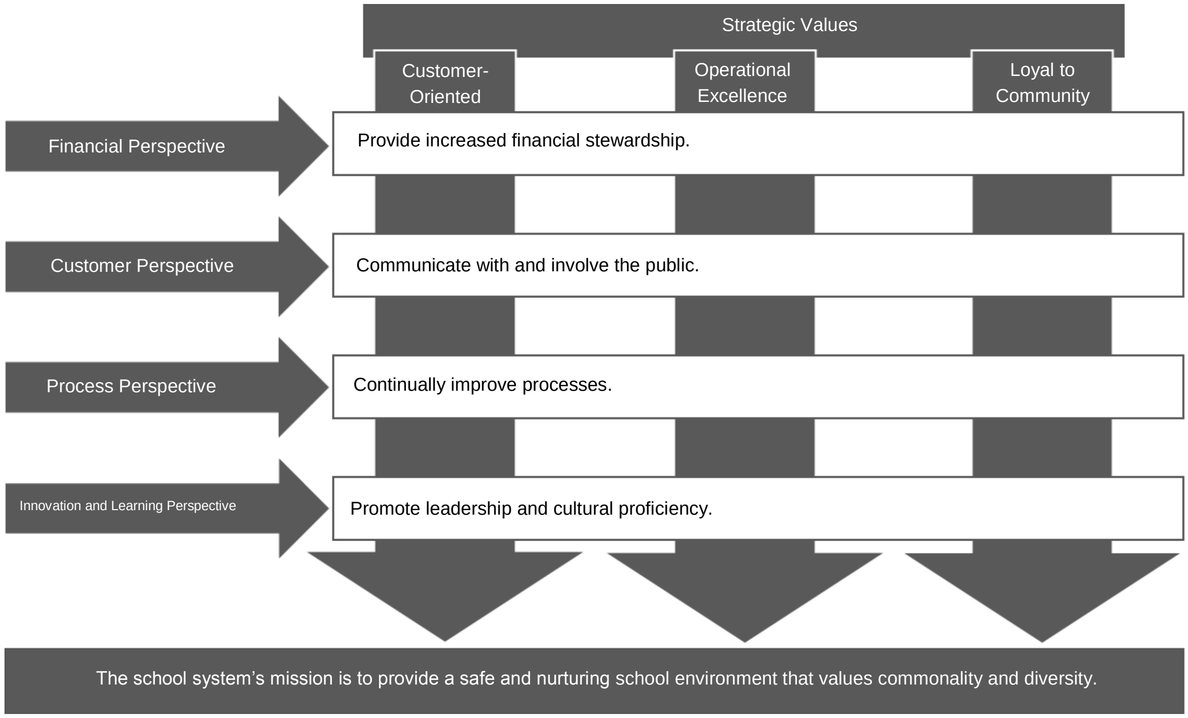


Exhibit 3-13: Example of Balanced Scorecard Strategic Objectives for a School System

By viewing the organization from these perspectives, the facility manager has the means to review results against expectations or performance indicators. It helps the facility manager organize and present O&M results, requests and objectives in a way that communicates with upper management and facility owners.

Performance measurements summarized as KPIs allow the facility manager to set measurable goals, based on the facility strategic plan. The balanced scorecard allows the facility manager to position goal requirements as KPIs that are strategically relative to the facility strategic plan.

The demand organization — facility management executives and finance — can be viewed through the balanced scorecard perspective to develop metrics, collect data, and analyze options that transform strategic planning into measurable results determined from viable alternatives. In this way the balanced scorecard supports facility management in a business as well as operational manner.

The facility manager uses the balanced scorecard method and related metrics to assess how well goals are being achieved and to optimize the performance of the entire infrastructure. This helps the facility manager operate the facility with greater confidence and smarter business sense.

A balanced scorecard is based on the premise that intangible assets such as employees, information technology and image are important to an organization's success.

To accomplish this, the balanced scorecard views the organization from four perspectives that facility managers turn into self-assessing questions:

- **Stakeholders** — measures reflect the satisfaction of customers or occupants. Ask: What do customers/occupants think of FM performance?
- **Internal —** measures reflect performance of key business processes. Ask: Do we excel at what we do and apply best practices?
- **Learning and growth** — measures reflect on the organization's learning curve or capabilities and position. Ask: Is our staff adequately trained and capable?
- **Financial** — measures reflect fiscal performance. Ask: Are we taking care of assets?

With these four perspectives, the BSC helps compare short- and long-term objectives, outcomes desired and the performance aspects that drive those outcomes as objective/subjective measures.

In an ideal planning cycle, the BSC is derived from the demand organization's strategic plan, the more specific facility strategic plan and the work plan process written into SLAs. In this way, the entire approach to managing the facility is aligned with and directed to the facility mission. The results of the work log tell the facility manager how well O&M activities are achieving KPIs to meet BSC goals. The relationships are illustrated in *Exhibit 3-14*.

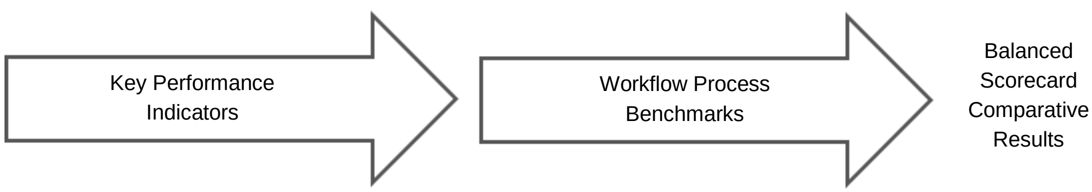


Exhibit 3-14: Performance Relationships

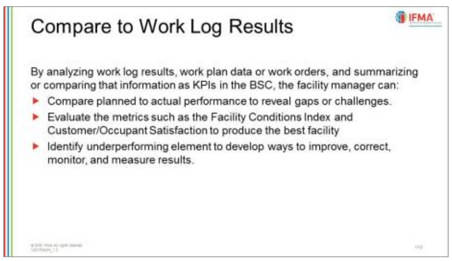
Exhibit 3-15 shows examples of how KPIs vary by organization and are specific to each company.

Exhibit 3-15: KPI Example

Organization	KPIs	Measurement
Food Service	• Average revenue per guest • Percentage of sales per item	Percentage increase/decrease in revenue from previous year
Construction Industry	• Number of accidents	Satisfaction level and safety

Organization	KPIs	Measurement
	• Percentage of change orders	increase/decrease
Manufacturing Industry	• Labor as percentage of cost • Reduction in defect rates	Cost reduction and efficiency rating increase/decrease

Compare to Work Log Results



The facility manager incorporates several aspects to relate work log results, or workflow process benchmarks, to the BSC.

These aspects may be summarized as follows:

- The approach begins with knowledge of the facility strategic plan.
- That plan identifies measurable goals for facility management.
- Metrics assess the O&M of assets relative to, for example, TCO and most favorable LCC.
- These metrics provide measurable goals that are defined as key performance indicators and included in the BSC.

The tracked results of the work plan log may be compiled within the CMMS to provide current, accurate, complete information on all accomplished O&M and related activities.

By analyzing work log results, such as work plan data or work orders, and summarizing or comparing that information as KPIs in the BSC, the facility manager can:

- Compare planned to actual performance.
- Evaluate the metrics.
- Identify underperforming elements.

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Compare Planned to Actual Performance

A current and complete inventory/register should contain measurable cost and performance information taken from work logs and operations, maintenance and repair inputs.

With this information, the facility manager updates total cost of ownership information to:

- Determine history and trends based on actual experience, manufacturer specifications and expected useful life.
- Compare planned performance to actual performance to reveal gaps or challenges.
- Review alternative systems and components as a possible baseline for future replacements or renovation.

By having the means to predict the total cost of ownership for an asset and measure that prediction against actual performance, the facility manager can make decisions to improve productivity and minimize costs.

Evaluate the Metrics

Facility managers produce and use several potential metrics to produce a world-class facilities organization, as shown in the exhibit.

Exhibit 3-16: Metrics

Metric	Explanation
Facility condition index (FCI)	This assessment objectively benchmarks current and projected building condition, often using inputs and outputs from a CMMS. An FCI also helps the facility manager supply information to owners/decision makers about renewal costs compared to building replacement value.
Planned maintenance to corrective maintenance	This KPI indicates how adequately current preventive maintenance (PM) is sustaining systems and equipment relative to the cost of unplanned corrective activities and repairs.
Preventive maintenance completion and percentage of re-work	These rates indicate how efficiently work is being accomplished according to schedule and right the first time.
Work order aging and response time	These measures indicate how quickly a problem is addressed and resolved. They may help the facility manager recognize the capabilities of current staff or contractors relative to

Metric	Explanation
	workload.
Customer/occupant satisfaction	This KPI approach is useful for providing clear and factual metrics relative to how well O&M is serving occupant needs.
Custodial level of service	Any occupant service or maintenance program such as custodial, groundskeeping, information technology or even security that has specified service level requirements may be compared against actual performance to determine gaps and weaknesses.
System reliability, unscheduled downtime and productivity	These KPIs help a facility manager recognize how complete and adequate PM is and its effect on operations.
Top ten work orders by type	This KPI identifies the most commonly occurring problems or activities in order to find ways to improve on performance.
Mean time between failures (MTBF)	This KPI estimates average time between anticipated failures as a system operates and may incorporate the time required for repair and downtime, or unplanned maintenance, if a failure occurs. This helps a facility manager build O&M schedules that maintain the highest productivity at the lowest PM cost.
Percentage root cause analysis	Root cause analysis (RCA) is not only a method for determining why things fail or problems occur but can also be used as a summary to indicate if analyses are useful to stop problems from recurring. Generally, the greater application of RCA produces better results.

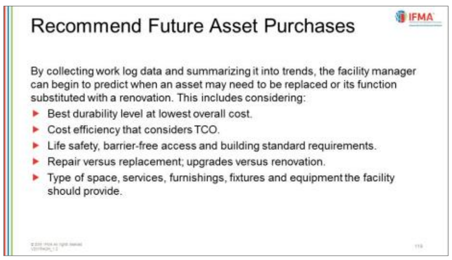
The KPIs a facility manager establishes should reflect the facility strategic plan and the recognized mission of the demand organization. They can relate to O&M for building systems and equipment as well as quality of occupant services. In this way, the intentions of the owner/decision-maker stipulated in the SFP are supported by the O&M work plan.

Identify Underperforming Elements

By measuring and comparing actual performance to planned performance, the facility manager is alerted to assets that are not meeting expectations. These are called variances, and they measure or indicate the difference between expected outcomes and actual results. Underperformance may be occurring due to inadequate or incorrect maintenance schedule, work time estimates or work difficulty that is different from expectations, causing higher labor, materials or other maintenance costs.

The facility manager recognizes assets that are not performing as expected and develops ways to set improvement goals, develop corrective action, monitor the approach and continue to measure results.

Recommend Future Asset Purchases



Technologies, processes, compliance regulations and standards are always changing, in many countries, building codes are updated and published in a new edition every year.

The facility manager stays current on all aspects of FM. This becomes relevant when considering adding new equipment, systems or materials or replacing those that are nearing the end of their useful life.

By collecting work log data and summarizing it into trends, the facility manager can begin to predict when an asset may need to be replaced or its function substituted with a renovation.

By staying current and researching new alternatives for an asset, an estimate for the overall TCO for that asset can be developed and supported by life-cycle cost analysis and by balanced scorecard measurements of KPIs.

The facility manager analyzes material, equipment and systems to determine the most cost-efficient choices. In some instances, it is more beneficial to perform a complete replacement of an asset, while in other cases, it is more cost effective to make repairs to an existing asset. This information can be integrated into the strategic planning process.

Relative to performance measurements, these considerations can include the following:

- Best durability level at lowest overall cost. Flexibility may be considered along with durability so that, for example, a series of 50-ton chillers may be a better alternative than a 300-ton chiller.
- Cost efficiency that considers total cost of ownership when comparing and selecting lighting, boilers, roofs, windows, control systems, flooring and fixtures

- When renovations or capital improvements are being planned, the facility manager supports a team approach represented by the range of individuals who own, manage, occupy and support the facility. Together they can reach decisions with the widest acceptance at the least cost that considers important criteria such as:
  - Life safety, barrier-free access and building standard requirements.
  - Repair versus replacement; upgrades versus renovation.
  - Type of space, services, furnishings, fixtures and equipment the facility should provide.

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Replace Systems, Materials or Equipment

Lesson Introduction

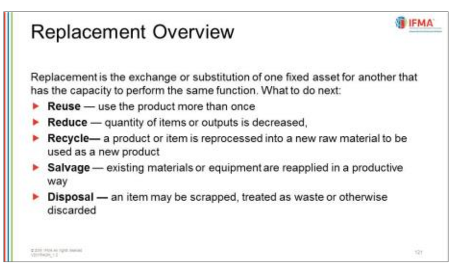
On completion of this lesson, you will be able to:

- Determine whether an asset should be repaired or replaced based on its useful life.

This lesson contains the following topics:

- Replacement Overview
- Recognizing an Asset's Useful Life
- Conditions for Replacement
- Managing Disposal

Replacement Overview



Replacement is the exchange or substitution of one asset for another that has the capacity to perform the same function. The replacement arises from obsolescence, wear and tear, functional failure or destruction of the item being replaced. Replacement involves a complete identifiable item. In the sense of operational maintenance, the replacement of a component, piece of equipment or system does not merely mean to remove and discard it. For the facility manager, replacement signifies the end of the asset's intended operational use and a plan for what to do with it next.

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Well-planned replacement represents a systematic approach to sustainability. It consists of several elements or actions:

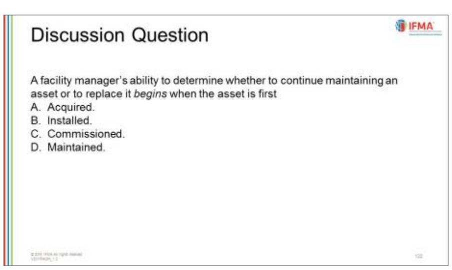
- **Reuse** — uses the product more than once such as using maintenance rags rather than paper towels
- **Reduce** — the quantity of items or outputs is decreased, such as by using less packaging material or other disposables, energy resources or single-use products
- **Recycle** — a product or item is reprocessed into a new raw material to be used as a new product
- **Salvage** — existing materials or equipment are repurposed in a productive way for another purpose without being recycled or otherwise reprocessed
- **Disposal**— an item may be scrapped, treated as waste or otherwise discarded

Preventive maintenance is meant to replace items at regular intervals, regardless of condition, in order to prevent failures. Replacing working-condition assets can reduce the risk of breakdowns and other issues but may result in unnecessary expenses. A facility manager must be aware of the preventive maintenance plan and when the cost of replacement may exceed the cost-benefit analysis.

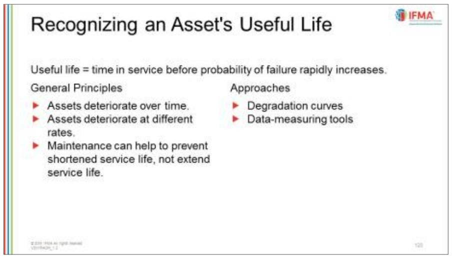
In order for replacement to be cost-effective, it must meet certain criteria:

- A hidden failure was prevented, and replacement reduced the risk of multiple failures.
- A safety or environmental failure was prevented.
- The cost of replacement is less than the cost of not replacing.

A facility manager must monitor and keep accurate record of this information in order to reach maximum efficiency, and determine whether to reuse, reduce, recycle, salvage or dispose of the asset.



Recognizing an Asset's Useful Life



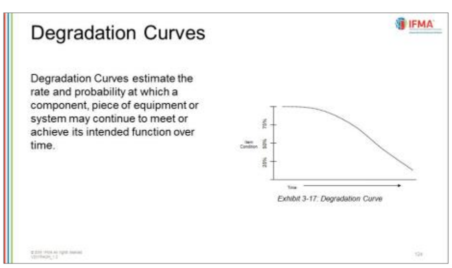
Useful life refers to the expected time that a component can be left in service before it will start to experience a rapidly increasing probability of failure.

There is no standard rule to predict useful life across all the different materials, components, equipment or systems that may be found in a facility. Some general principles for all of these assets can be suggested:

- All assets deteriorate over time.
- Assets deteriorate at different rates, for example, a lamp fails before the electrical system wiring fails.
- Routine or preventive maintenance may not extend service life beyond expectations, but it can avoid rapid deterioration that may shorten life compared to expectations.

Useful approaches to determine an asset's useful life are degradation curves and data-measuring tools, and a useful tool to determine the life of the building is the facility condition assessment.

Degradation Curves



The facility manager may acquire and use or even develop degradation curves, which estimate the rate and probability at which a component, piece of equipment or system may continue to meet or achieve its intended function over time. Degradation curves may be developed for virtually any known element, including structures, roofs, roadways, planned maintenance and so forth. Estimates generally relate to asset functionality or condition measured over time and assume proper planned maintenance. Equipment manufacturers

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may also provide statistics and even warranties on typical useful operating life for their products. *Exhibit 3-17* illustrates a generic degradation curve.

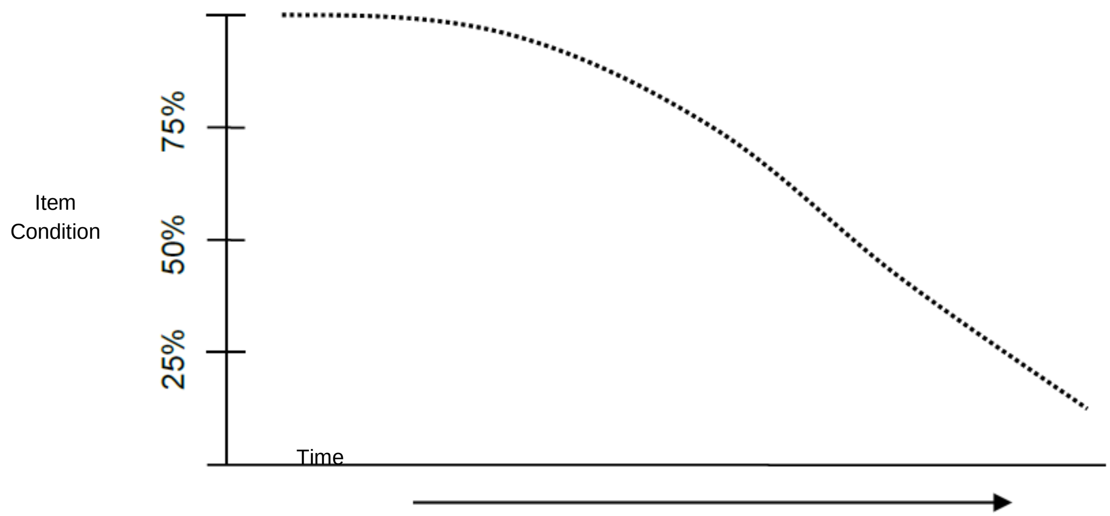


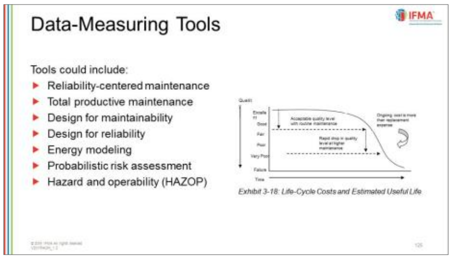
Exhibit 3-17: Degradation Curve

An actual curve would indicate expected product condition or capability across a course of time such as years. Depending upon the purpose of the asset, the information might estimate its value, functionality, reliability, maintenance cost, efficiency or other factors over time. The overall condition of an asset recognizes the nature of the failure or decay, where the asset currently is on the curve and an estimate of the remaining useful life.

For example, a sample review of the condition of carpeting or paint may reveal that it should be replaced or repainted because of aesthetic rather than functional reasons. A parametric sampling, as discussed previously, of one building or a few floors could represent the measurement of several buildings and become part of a degradation curve estimate as well as a forecasting approach.

Forecasting may incorporate degradation curves as part of the information to project future performance based on historical data and measures of current conditions. Forecasting will help determine expected deterioration time and when an asset may reach a new condition level.

Data-Measuring Tools



A range of possible measuring and data-gathering tools are also available to the facility manager. Several have already been mentioned to measure total cost of ownership and life-cycle costs.

These tools include the following:

- **Reliability-centered maintenance** — is an ongoing process that determines the mix of reactive, preventive and predictive maintenance practices to provide the required reliability at the minimum cost. It can use diagnostic tools and measurements to assess when a component is near failure and should be replaced. The purpose is to eliminate more costly unscheduled maintenance and minimize preventive maintenance.
- **Total productive maintenance (TPM)** — is an approach that emphasizes having the equipment operator be responsible for and knowledgeable about the equipment's performance and maintaining that performance. The integrity of production and quality systems are maintained and improved through the machines, equipment, processes and employees that add business value to the organization.
- **Design for maintainability** — is a quality effort in which the product is designed with greater maintenance ease built in, for example, by making grease fittings prominent and accessible on the front of a machine.
- **Design for reliability** — is a quality effort in which the dependability of the product is produced by design rather than through inspection.
- **Energy modeling** — compares specific materials, systems and equipment relative to their expected annual energy cost, lifetime performance and any efficiencies that might enhance them.
- **Probabilistic risk assessment** — is a top-down approach used to apportion risk to individual areas of plant and equipment and possibly to individual assets so as to achieve an overall target level of risk for a plant, site or organization. These levels of risk are then used in risk-based techniques, such as reliability-centered maintenance.

- **Hazard and operability (HAZOP)** — studies help develop appropriate equipment maintenance strategies that identify required equipment modifications. A HAZOP study is generally done by experienced teams who examine engineering and process standards to uncover potential operational hazards or malfunctions and how they might affect the facility and surrounding area.

Whether acquiring or tracking assets by using approaches such as these, the facility manager can strike a balance for the lowest risk, the lowest cost and the highest benefit for a given asset.

Exhibit 3-18 illustrates that, with maintenance, an asset should provide excellent or good service to service level standards for a predictable period. The exhibit is shown for illustration purposes and does not represent an actual asset or relationship to any group of assets. What it shows is that, at some point, the cost of maintaining the asset at a required level of quality exceeds the value the asset provides when compared to a replacement.

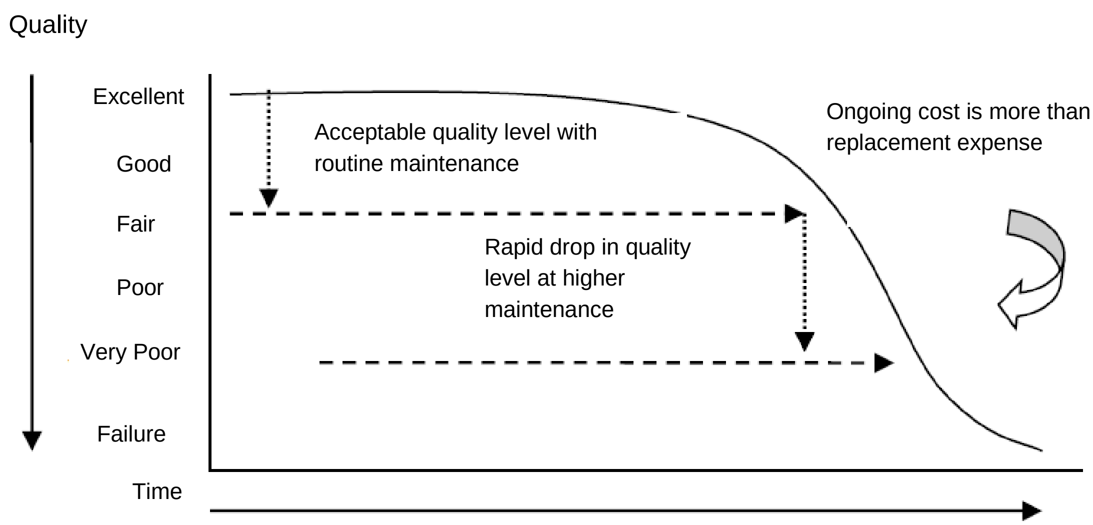


Exhibit 3-18: Life-Cycle Costs and Estimated Useful Life

The point at which natural deterioration makes continued maintenance impractical can be recognized as a trend in maintenance costs and reliability concerns reported in work order logs. If the facility manager waits too long to make appropriate repairs or replacement, the cost to bring the component or system back to serviceable condition may be much more than the cost of making the repair or replacement.

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Facility Condition Assessment

A Facility Condition Assessment (FCA) is an evaluation that objectively benchmarks current and projected building condition, often using inputs and outputs from a CMMS, and helps the facility manager supply information to owners/decision makers about renewal costs compared to building replacement value. The facility condition index (FCI) is a number that represents building condition. FCI is calculated by dividing the outstanding maintenance costs by the actual replacement value of the building.

Building condition is often defined in terms of FCI as follows:

- **Good** — 0 to 5 percent FCI
- **Fair** — 5 to 10 percent FCI
- **Poor** — 10 to 30 percent FCI
- **Critical** — greater than 30 percent FCI

The purpose of the FCI is to provide a means for objective comparison of facility or building condition as well as allowing senior decision-makers to understand building renewal funding needs and comparisons.

An FCA is used to determine an asset's estimated useful life. FM must take into account elements such as maintenance requirements and costs, installation date, designed life, and how it is maintained.

Another part of recognizing a facility's useful life is considering elements such as environment, age, and materials used. For example, a facility built in a warm, temperate climate will potentially have a longer useful life compared to that of a building that is exposed to harsher conditions.

The FCA chart below depicts the metrics of ongoing FM operations in buildings ranging from showcase, the ideal, to reactive, the worst.

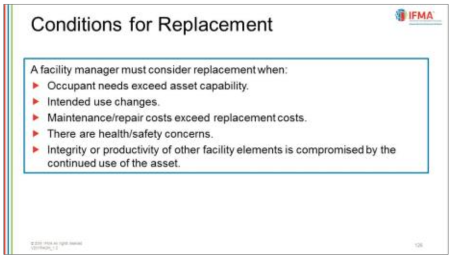
Exhibit 3-19: Facility Condition Assessment

Level/ Description	1/Showpiece Facility	2/ Comprehensive Stewardship	3/Managed Care	4/Reactive Management
Customer Service and Response Time	Able to respond to virtually any type of service, immediate response.	Response to most service needs, including non-maintenance activities, is typically in a week	Services available only by reducing maintenance, with response times of one	Services available only by reducing maintenance, with response times of one year or less.

Level/ Description	1/Showpiece Facility	2/ Comprehensive Stewardship	3/Managed Care	4/Reactive Management
		or less.	month or less.	
Customer Satisfaction	Proud of facilities, have a high level of trust for the facilities organization.	Satisfied with facilities related services, usually complimentary of facilities staff.	Accustomed to basic level of facilities care. Generally able to perform mission duties. Lack of pride in physical environment.	Generally critical of cost, responsiveness, and quality of facilities services.
Response Time / Satisfaction vs. Corrective Maintenance	100%	75-100%	50-75%	25-50%
Maintenance Mix	All recommended preventive maintenance (PM) is scheduled and performed on time. Emergencies, for example storms or power outages, are very infrequent and are handled efficiently.	A well-developed PM program: most required PM is done at a frequency slightly less than per defined schedule. Occasional emergencies caused by pump failures, cooling system failures, etc.	Reactive maintenance predominates due to system failing to perform, especially during harsh seasonal peaks. The high number of emergencies causes reports to upper administration.	Worn-out systems require staff to be scheduled to react to systems that are performing poorly or not at all. PM work possible consists of simple tasks and is done inconsistency.
Aesthetics, Interior	Like-new finishes.	Clean/crisp finishes.	Average finishes.	Dingy finishes.
Aesthetics, Exterior	Windows, doors, trim, exterior walls are like new.	Watertight, good appearance of exterior cleaners.	Minor leaks and blemishes, average exterior	Somewhat drafty and leaky, rough-looking exterior, extra painting

Level/ Description	1/Showpiece Facility	2/ Comprehensive Stewardship	3/Managed Care	4/Reactive Management
			appearance.	necessary.
Aesthetics, Lighting	Bright and clean, attractive lighting.	Bright and clean, attractive lighting.	Small percentage of lights out, generally well-lit and clean.	Numerous lights out, some missing diffusers, secondary areas dark.
Service Efficiency	Maintenance activities appear highly organized and focused. Service and maintenance calls are responded to immediately.	Maintenance activities appear organized with direction. Service and maintenance calls are responded to in a timely manner.	Maintenance activities appear to be somewhat organized but remain people-dependent. Service and maintenance calls are variable and sporadic, without apparent cause.	Maintenance activities appear somewhat chaotic and are people dependent. Service and maintenance calls are typically not responded to in a timely manner.
Building Systems' Reliability	Breakdown maintenance is rare and limited to vandalism and abuse repairs.	Breakdown maintenance is limited to system components short of mean time between failures (MTBF).	Building and systems components periodically or often fail.	Many systems are unreliable. Constant need for repair. Backing of repair needs exceeds resources.
Facility Maintenance Operating budget as % of CRV	>4.0	3.5-4.0	3.0-3.5	2.5-3.0
Average FCI	<0.5	0.05-0.15	0.15-0.29	0.30-0.49

Conditions for Replacement



At some point in the life cycle of any component, system or piece of equipment, the facility manager needs to determine whether to continue to maintain that item, replace it or upgrade it as an entirely new installation. The ability to make that determination can begin when the original item is acquired. As part of the life-cycle cost analysis, the facility manager takes into account the estimated useful life of the item and recognizes the potential schedule for replacement.

In general terms, an asset is considered no longer useful for its original purpose when the:

- Wants or needs of occupants and users exceed the capability of the asset to provide for that need.
- Conditions of its installation or intended use change.
- Cost of ongoing maintenance and repair exceeds the cost of replacement.
- Integrity or productivity of other facility elements is compromised by the continued use of the asset.
- Operating potential of a new replacement asset justifies replacing the current asset. For example, new products or technologies produce measurably more effective results, environmental sustainability or occupant satisfaction.

By comparing alternative items, the facility manager may consider:

- Lifetime energy and resource costs.
- Lifetime operations, maintenance and repair costs.
- Replacement costs.
- Residual value.
- Scrap, disposal or handling expenses, for example, fees to manage hazardous elements.
- Health and safety considerations, such as hazardous materials, chemicals and preservatives in the asset’s construction, toxicity at disposal, compliance codes, environmental impact and waste management.

Other business considerations also contribute to determining when to replace an asset, such as:

- Whether to repair versus replace depending upon the estimated costs and anticipated benefits between those choices.
- Annual cost of ownership versus cost to maintain as a long-term life-cycle cost analysis.
- Energy use as an expense for operating utilities with less efficiency or outdated technology.
- Sustainability in which materials, equipment or systems are initially chosen because their creation has minimal long-term effect on the environment. Decisions made when acquiring an asset in the first place also generate better options for the asset's eventual replacement.
- Reliability relative to the need for maintenance, frequency and time that maintenance requires, potential costs of downtime caused by breakdowns and so forth.
- Performance measured in productivity as well as durability of the equipment or system in operation.
- Image or aesthetics in which an outdated but operational system or machine no longer projects the impression ownership desires.

While there are no standard rules for determining this transition, a general threshold may be that when the annual cost of maintaining an asset exceeds the estimated annual cost of ownership based on life-cycle costing, the facility manager should consider replacement.

More information on planning approaches can be found in the *Finance and Business* course.

Managing Disposal

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Facility managers administer, organize, publicize and monitor sophisticated materials management programs to identify, collect and dispose of assets at the end for their useful life. This includes not only parts, components and materials but also the supplies, chemicals and waste products that are produced by them. In this interpretation, there are two aspects regarding disposal: asset disposal and waste product disposal.

Asset Disposal

When it is time to decommission and/or remove an asset from service, the facility manager considers several options:

- Resale to another party
- Reuse in another fashion. For example, salvaging renovation lumber for use in a second application or more directly somewhere else in the organization
- Recycling items such as paper, plastics, metals, glass and packaging
- Donation

Some facilities offer warehouse or drop-off areas where replaced items are gathered for occupants and visitors to purchase at vastly reduced prices or even at no cost as a benefit of being an occupant. These resales can be an opportunity to dispose of replaced or damaged items in a more popular, useful and environmentally supportive way.

Equipment, furniture, building materials and system components may have some residual value instead of being thrown away as trash.

Typical examples of recycling or reselling items could include:

- Computer parts and equipment
- Copper plumbing, conduit, tubing
- Electronics
- Used furniture and fixtures
- Kitchen equipment and other specialty items

The goal of replacement is to obtain the best overall value at the end of the component’s life cycle through a business return, environmental savings, further adaptability or other accepted measures. It does not necessarily mean achieving the highest monetary return but instead producing the greatest total return.

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Waste Product Disposal

Programs that support removing the byproducts of a work environment include these key aspects:

- Convenient collection points near users and clearly labeled
- Regular collection and appropriate disposal
- Services and/or approaches for sorting and efficient management
- Regularly solicited feedback on service levels and occupant satisfaction
- Accounting practices to measure and compare costs, savings, returns and sustainability results

Environmentally appropriate waste management programs recognize, define handling guidelines and properly dispose of anything the facility may use or create, such as:

- Hazardous waste, such as solids, liquids and gas.
- Industrial waste, such as chemicals, paints, preservatives, grease, lead, mercury, such as fluorescent bulbs, refrigerants such as chlorofluorocarbons (CFCs) or asbestos-containing materials (ACMs).
- Construction debris, such as brick, concrete, wood, steel and gypsum.
- Furnishings, such as materials, textiles, fixtures, batteries, tritium exit lights, which contain radioactive material.
- Equipment waste, such as electronics, metals, plastics, and packaging.
- Biodegradable waste, such as vegetation, food, composting, and water management.
- Wastewater, such as drainage and plumbing discharge.

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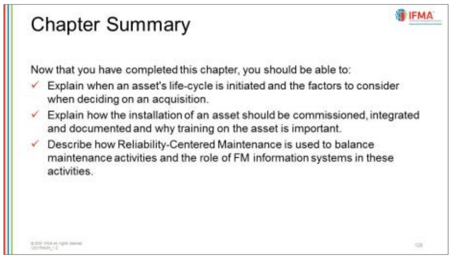

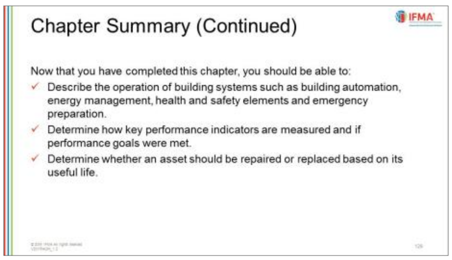

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Progress Check Questions

1. What best describes the life-cycle of a typical physical asset?
    a. The entire useful life of that asset.
    b. It is unknown until the asset fails.
    c. It should not be considered when determining cost of ownership.
    d. It is between 10 and 15 years.

2. Which type of resources are the most sustainable on the hierarchy of sustainability?
    a. Perpetual
    b. Renewable
    c. Reducible
    d. Natural

3. What can be said about the installation phase of an asset's life cycle?
    a. It may require commissioning.
    b. It marks the start of that asset's useful life.
    c. It should be completely documented.
    d. All of the above.

4. What best describes the process of commissioning?
    a. Paying incentives to contractors for superior work
    b. Evaluating and documenting performance prior to operation
    c. Providing rewards to staff such as special privileges
    d. Running equipment to failure before replacement

5. What are vibration monitoring, airborne ultrasonics, and laser shaft alignment examples of?
    a. Air quality concerns.
    b. Equipment failure.
    c. PdM analysis tools.
    d. Root cause analysis requirements.

6. What are periodic inspections, adjustments, and lubrication, examples of?
   a. Unscheduled maintenance requirements.
   b. Poor maintenance requirements.
   c. Mission-critical predictive maintenance.
   d. Preventive maintenance activities.

7. What aspects of building operations do building automation systems control?
   a. HVAC and lighting
   b. Grounds keeping
   c. Parking and parking meters
   d. Custodial

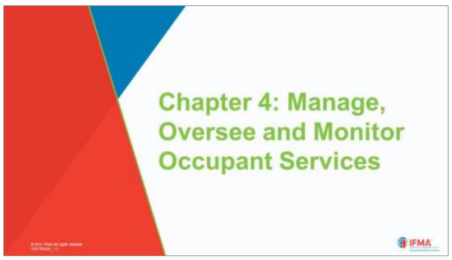
8. What is NOT included in an emergency response plan?
   a. Contact list of area responders.
   b. Dim pathway lighting
   c. Emergency equipment locations.
   d. Alert and communication systems.

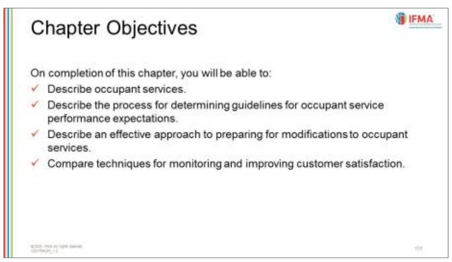
9. KPIs include what type of aspect(s)?
   a. Quantitative and qualitative.
   b. Only quantitative.
   c. Only qualitative.
   d. None of the above.

10. What is the approach used to estimate the rate and probability at which a component, piece of equipment, or system may continue to meet or achieve its intended function over time known as?
    a. Facility condition index
    b. Degradation curve
    c. Reliability-centered maintenance
    d. Energy modeling

Chapter 4: Manage, Oversee and Monitor Occupant Services

Chapter Introduction





On completion of this chapter, you will be able to:

- Describe occupant services.
- Describe the process for determining guidelines for occupant service performance expectations.
- Describe an effective approach to preparing for modifications to occupant services.
- Compare techniques for monitoring and improving customer satisfaction.

Lessons

- Recognize Required Occupant Services
- Develop Usage and Service Level Guidelines
- Prepare and Execute Modifications to Occupant Services
- Monitor Occupant Satisfaction

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Recognize Required Occupant Services

Lesson Introduction

On completion of this lesson, you will be able to:

- Describe occupant services.

This lesson contains the following topics:

- Occupant Services Overview
- Examples of Occupant Services

Occupant Services Overview

The term "occupant services" refers to anything that facility occupants or visitors might need beyond the operational maintenance of the hard assets of the building and its systems. These occupant, or soft, services are the critical activities through which the facility manager directly affects the users of the building. When competently performed, these activities are invisible to occupants, yet, the occupant services themselves are highly visible and present the image of the organization to the rest of the world.

Occupant services should align with the organization's business strategy. These services are the main interface with the organization's own customers; their quality and consistency imply the facility manager's competence and value. Any failure in service to occupants is immediately apparent and detracts from the organization's mission and image.

Examples of Occupant Services

Occupant services may occur facility-wide, such as waste removal, custodial cleaning or be applied to specific areas, such as information security or childcare. Potential occupant services for a facility can include those listed in *Exhibit 4-1*. Occupant services extends far beyond heating, cooling, water and power. This partial list serves to demonstrate the variety of services facility management may be expected to provide.

To manage/oversee these services, the facility manager needs to identify what services facility owners, occupants or guests may require. In addition, the facility manager must determine what staff or contracted party should supply them.

Exhibit 4-1: Potential Occupant Services

- Custodial, such as light cleaning, vacuuming, dusting, trash removal, restroom refreshment
- Cleaning and refurbishing, such as window washing, floors, fixture replacement
- Waste management, such as collection, recycling, incineration, hazardous materials, shredding, secure destruction
- Food service, such as coffee, ready-to-eat, cafeteria, dining rooms, banquet
- Parking, such as pickup, delivery, vehicle security
- Fleet, such as vehicle cleaning, maintenance, acquisition, lease, resale
- Travel, such as reservations, itinerary, transportation
- Concierge, such as facility help desk, greeting, directing, support for individuals
- Security services, such as personnel, watch, and response separate from the systems themselves
- Emergency preparedness, such as fire, medical, disaster, terrorism training, practice drills, triage
- Safety, such as providing a safe and effective work environment
- Copying, printing, document management
- Records management, such as media, files, security, disaster recovery
- Childcare, such as facility, nursery, preschool, before- and after-school support
- Health, such as nurse services, benefits administration, counseling, fitness
- Landscaping, such as grounds maintenance, planting, design and so forth

• Collections or curator, such as art, sculpture, display management, security • Mail, such as pickup, distribution, packaging and shipping, fees, tracking, insurance, messenger • Shipping and receiving, such as pickup, packaging, transport, routing, tracking, insurance • Managing relocations or moves and changes (MAC), which can include packing, shipping, unpacking, sorting and setup • Information technology, such as maintenance, disposal, information management such as e-mail and server support, information security	• Communication, such as line telephones, cellular phones, fax, wire and wireless communication separate from network systems themselves • Conference centers to hold meetings • Help desks, such as directory services and technology assistance

Exhibit 4-1: Occupant Services

Develop Usage and Service Level Guidelines

Lesson Introduction

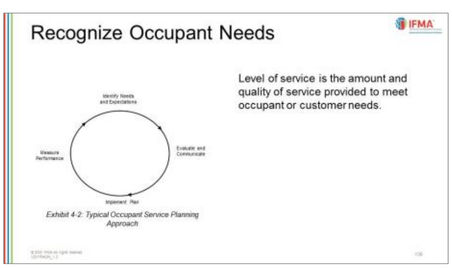
On completion of this lesson, you will be able to:

- Describe the process for determining guidelines for occupant service performance expectations.

This lesson contains the following topics:

- Recognize Occupant Needs
- Workplace Design and Space
- Occupant Services Workflow Process
- Guidelines Support the Workflow Process
- Custodial Cleaning Example

Recognize Occupant Needs



Planning relative to occupant services produces facilities that occupants find comfortable, safe and effective. While a facility manager may not be responsible for deciding which occupant services are provided, it is important they understand how the services are determined. Thus, the facility manager evaluates current conditions to ensure that the desired level of service is provided.

Relative to occupant services in facilities, level of service refers to the amount and quality of service provided to meet occupant or customer needs without hindering the mission or profitability of the facility. Level of service can vary widely based on budget, expectations and other aspects.

Along with level of service is the mix of services in a facility. The selection of services is usually based on the facility's functions, economic conditions, the organization’s culture and other factors. By recognizing how services are determined, the facility manager has a better understanding of what level of service to provide and how to determine if the service is sufficient.

To determine guidelines for occupant service performance expectations, the facility manager will likely:

- Identify needs and expectations
- Evaluate and communicate
- Implement plan
- Measure performance

Exhibit 4-2 illustrates these aspects of occupant service planning and operations.

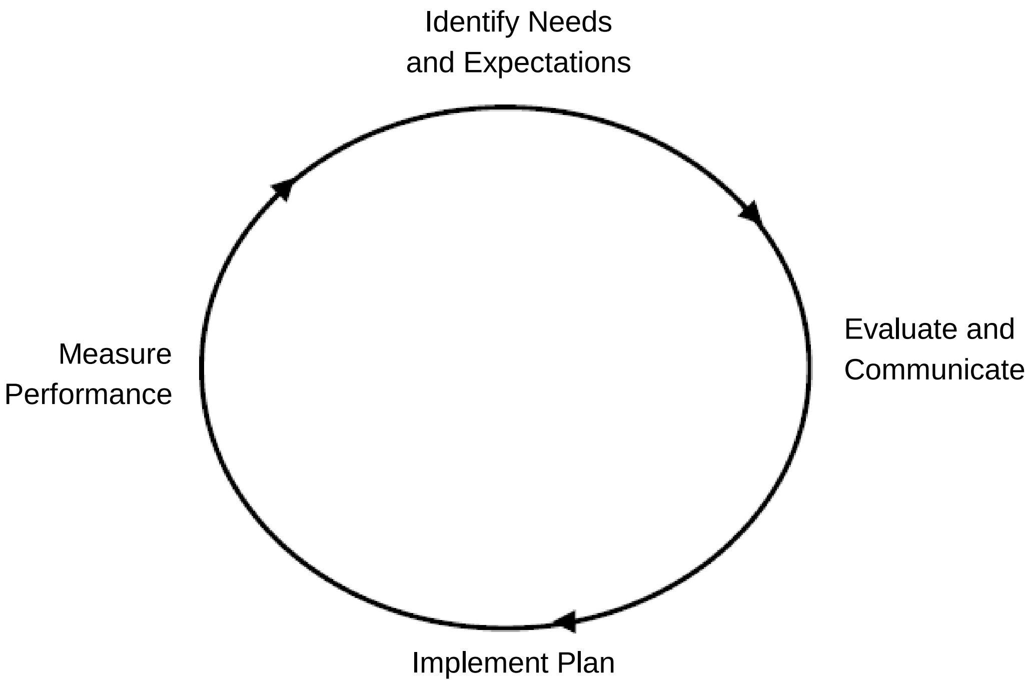
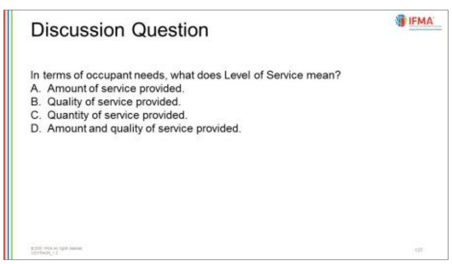
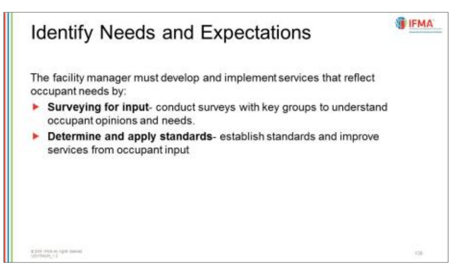


Exhibit 4-2: Typical Occupant Service Planning Approach



Identify Needs and Expectations



The facility manager needs an accurate understanding of occupant services to be able to supply the right services in the right amount. This will ensure that occupants are satisfied, and the mission of the facility is not compromised. Independent of whether there is relevant and current data about what occupants expect the facility manager must assess how well services are being provided.

Occupants can provide an invested and relevant viewpoint on the state of the facility. They are the core contributors to the facility mission, and their satisfaction represents the basic capability of the facility to sustain its mission. This makes their satisfaction with their environment significant to the overall purpose and success of the facility.

The facility manager must listen to occupant opinions about facility services. By soliciting feedback from occupants and attending to what they say, the facility manager learns about problems in the early stages and does not wait for complaints to accumulate.

As a source of information on the quality, reliability, efficiency and effectiveness of the facility, occupants' opinions can expose gaps in expectations, needs and the current level of service. A rapid, responsive approach helps ensure that service quality meets occupant expectations.

The facility manager must develop and implement services and policies that reflect occupant needs, requirements and expectations while supporting management objectives. To determine those expectations, the facility manager can begin by surveying groups and determining and proposing acceptable standards.

Survey for Input

Several different groups might be surveyed to develop an understanding of service needs. For example, the facility manager might canvass:

- **Occupants** — by directly talking to some or all, preparing and conducting a survey, and/or sampling key occupants and visitors.
- **Owners and executives** — by survey or interview to determine how services are meeting or not meeting the current vision or strategic facilities plan.
- **Visitors or guests** — with simple response forms, brief on-site interviews and/or follow-up satisfaction surveys to learn their opinions on the variety, mix and quality of services.

In addition, facility managers must continue to conduct surveys to stay current on occupant opinion. Feedback from occupants on service needs and expectations can be reviewed over time to detect trends or potential adjustments. This information can help the facility manager predict new needs or the impact changes may have on existing building systems, structures, interiors, exteriors and grounds.

This is possible only if the facility manager:

- Consistently gathers information and opinions
- Compares information to prior inputs

- Looks for gaps and opportunities

Determine and Apply Standards

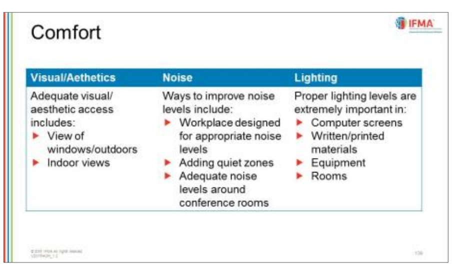
Input from contractors, staff, occupants, visitors, owners and executive management can provide the full range of important data. The facility manager uses this information to establish standards for the level of service, aesthetic quality, facility efficiency and other operational requirements. From this input, the facility manager can develop descriptions of services that clarify what current services exist, what they provide and inquire into what they might or should provide.

These standards become the basis for measuring results and are a way to identify trends that might suggest the need for change. This understanding of needs can be formalized into an occupant service plan discussed later in this topic.

Human Needs

As part of recognizing needs and achieving organizational goals, occupants require the necessary physical comfort and cleanliness. For example, occupants require comfortable temperature and humidity, adequate lighting, fresh air, work satisfaction, and a clean and maintained working environment.

Comfort



The starting point in developing strategies to achieve a healthy workplace is understanding the concept of comfort, which applies to both physical needs and the emotional needs associated with work environment.

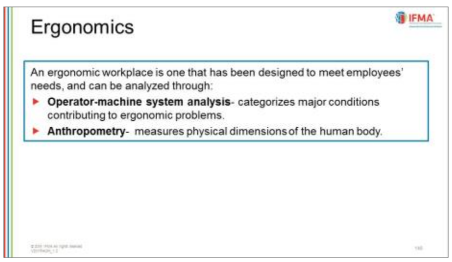
From an occupant's perspective, a physiologically comfortable facility is one in which:

- Temperature ranges are appropriate for the type of work and the culture, and there is adequate ventilation and control of humidity.
    - Studies have shown that performance declines measurably when temperatures deviate significantly, either up or down. Temperature preferences vary by

individual, but it is important ensure the majority of occupants are comfortable.

- Noise levels are controlled and support working conditions.
- Lighting levels are appropriate to the type of activity in an area.
  - There is no glare, which can be simply defined as unwanted brightness, either direct or indirect.
- There is an adequate and appropriate level of cleanliness.

Ergonomics



An important factor of comfort is ergonomics, or the scientific study of human work, where work is any activity that has purposes or effort. An ergonomic workplace is one that has been designed to meet employees' needs. If needs are not met, ergonomic design is poor, or poor work habits exist, the result can be musculoskeletal disorders (MSDs). MSDs are injuries involving bones, muscles, joints and tendons.

Operator-machine system analysis is used to categorize major conditions contributing to ergonomic problems. This analysis examines factors such as:

- People
- Equipment and machinery
- Workplace layout
- Environment

Anthropometry is used to measure the physical dimensions of the human body in order to improve the human fit within the workplace. These measurements help designers determine furniture or workplace layout and can therefore impact and eliminate ergonomic issues.

A facility manager must ensure the workplace meets ergonomic standards. Managing practices, worksite analysis and control methods are critical in reducing ergonomic-related injuries and illnesses. In order to ensure an ergonomic workplace, the facility manager should make sure occupants are properly trained on how to use ergonomic workstations, chairs, monitor arms, keyboard trays and other amenities. Proper training will help incorrect adjustments in the workspace that do not fit occupant's bodies.

Visual/Aesthetics

Views provide both physical relief and a cognitive rest. They may be required by law, depending on jurisdiction. Eye strain can be reduced if occupants change their visual focal point at intervals — looking up from computer displays or desktops to more distant images.

Ideally, and possibly legally under some workplace regulations, all occupants should have some access to windows and outdoor views. However, views can be interior as well, such as atriums or glass-walled hallways. Visual interest can be created even in small areas by using different colors and textures. FM should be aware of whether views are accessible to a majority of occupants or only a few.

Noise

Noise can become both a distraction and an annoyance in a work environment. Noise thresholds and standards based on the type of work environment and the needs of occupants.

The following are risks of a noisy environment:

- Absenteeism
- Reduction in productivity
- Stress
- Turnover
- Worker dissatisfaction

A facility manager should ensure proper training and understanding of appropriate noise levels throughout the organization. Though preferred noise levels are subjective to each individual, it is important to regulate and set standards for optimal noise control.

A way to control noise is to take into account acoustic properties when designing a workspace. For example, FM can implement sound-masking elements such as sound absorbing ceiling, wall and flooring materials. A practically designed workspace provides open areas to move about and has a flow of soft noise as well as areas of noise reduction for speech privacy and concentration.

Based on the needs of the organization, facility managers should ensure there are areas that provide the optimal working noise conditions. This can include conference rooms or quiet zones for areas that require collaboration and concentration. Training on noise control may include proper etiquette for conversations in an open office environment, not using speaker phones for conference calls, providing occupants with personal headsets and moving away from quiet areas to more collaborative spaces.

Lighting

Lighting can be defined as the application of light in an environment. A workplace must be equipped with adequate lighting, but the way lighting is used can affect productivity and health for workers.

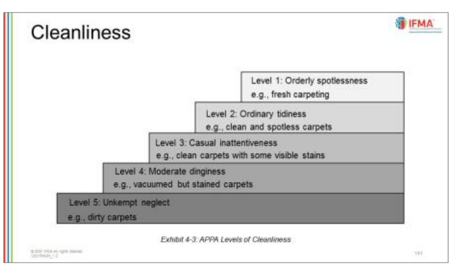
Productivity can be affected by lighting of:

- Computer screens
- Written/printed materials
- Equipment
- Rooms

Several studies have shown that light levels can impact overall productivity and health. Brighter light has been noted to improve speed of performance, while overexposure to bright light can cause health issues such as eye strain and headaches.

A facility manager should understand the needs and improvements in lighting for occupants in every area of the facility. For example, FM must understand and provide a balance of ambient and artificial light, establish an acceptable color and intensity of light and provide task/desk surface lighting. The facility manager can work with an electrical engineer or other subject matter expert to ensure that standards are established and met based on the type of facility and needs of occupants.

Cleanliness



Part of meeting occupant needs is providing a clean workplace. Cleanliness refers to the absence of dirt and dust and the maintenance of interior elements and furnishings.

Although cleanliness expectations are subjective and contextual, APPA is an organization for educational facilities that has created standards by which an organization can measure its cleanliness. These levels are shown in *Exhibit 4-3*. The guidelines are detailed, comparing certain facility elements at each level. The exhibit provides examples related to carpeting, but the guidelines also cover walls, lighting fixtures, restrooms and trash collection.

These guidelines can be useful in helping FM develop its own standards for self-assessment. They are also recognized by the U.S. Green Building Council and are used in the LEED building certification system.

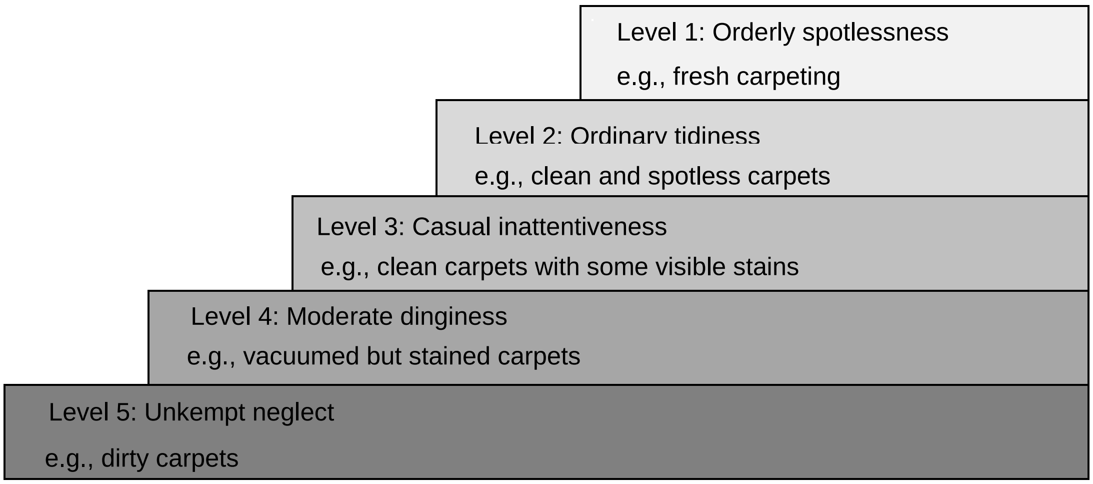
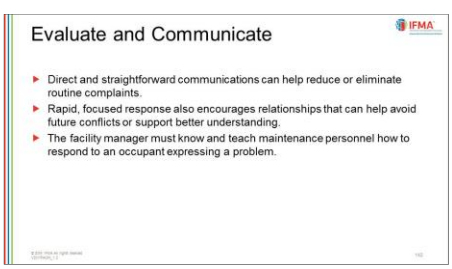


Exhibit 4-3: APPA Levels of Cleanliness

The cleanliness of a facility is an economic issue for property owners, but for occupants it is a matter of health, productivity and motivation. Clean facilities have less dust and mold, and surfaces are disinfected more regularly. Orderly, well-maintained workspaces offer fewer visual distractions and can impact an occupant’s need for esteem and fulfills aesthetic needs. Facility managers must be aware that a clean and well-maintained workplace can improve worker efficiency and boost morale.

Evaluate and Communicate



The delivery of occupant services relates to both the assignment and the performance of occupant services operations and maintenance. Scheduling and performance are mentioned here because they are described more fully later in this chapter as the services

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workflow process. However, evaluation and communication also relate to how inputs and complaints are handled.

Initial interviews and surveys provide a preliminary level of input that helps FM evaluate the wants and needs of occupants. The organization can then craft a plan based on analyzing what was learned from the occupants, and what financially feasible. It is wise to respond directly and quickly to any expressed dissatisfaction; the facility manager's request for information may also cause the responding individual to expect further action and feedback.

Direct and straightforward communications can help reduce or eliminate routine complaints. Rapid, focused response also encourages relationships that can help avoid future conflicts or support better understanding.

The facility manager must know and teach maintenance personnel how to evaluate and respond to an occupant expressing a problem. A complaint may signal the first time a weakness in service is occurring. For example, an occupant might mention a noise coming from a vent which might mean a component has failed in the air conditioning system. This information provides early recognition that can prompt a timely solution before problems escalate or dissatisfaction increases. In addition to reactive communication to identified problems, a proactive approach can reduce complaints. This can be done by communicating the service level agreement (SLA) to all stakeholders to establish the expectations and minimize dissatisfaction.

Communication not only occurs between occupants and the facility manager but from the facility manager to others responsible for the facility, including owners and executives. The facility manager can use inputs and evaluations to promote and defend the budget for occupant services and earn approval from management based on clearly defined and mutually understood expectations. A well-constructed plan with measurable objectives also gives the facility manager a sound presentation to executive management.

Implement Plan

An occupant services plan should formalize service satisfaction requirements so that expectations are clear. This helps to make the delivery of occupant services measurable, consistent and of recognized quality just as with O&M services that sustain the building, systems and equipment.

There are many implementation aspects, including:

- Service requirements are documented and agreed upon
- Response criteria are perceived as effective and in the occupants' interests
- Service complaints and feedback are responded to efficiently and in a timely manner as perceived by occupants
- Dissatisfaction expressed by one or more occupants is quickly addressed, respectfully answered and managed to avoid escalation
- Planned moves, changes or other facility disruptions are identified, communicated and executed to minimize interruptions to occupant activities
- Service requests are reviewed, prioritized and executed with the same care and completeness as other O&M work orders
- Other technical and quality factors are included to maintain satisfactory results relative to recognized performances. These can include:
    - Total quality management (TQM) or a similar approach that systematically and consistently examines and integrates all organizational functions, such as operations, finance, engineering and training to add value to occupants, visitors and facility personnel by solving problems early or even before they start, if possible
    - Indoor air quality, in which the air inside buildings is satisfactory relative to pollution from dust, mites, mold spores, radon, carbon dioxide, or noxious gases and chemicals from materials and appliances
    - Fire life safety, in which construction, protection and occupancy features are in place to minimize danger to life from fire, including smoke, fumes or panic
    - Others as directed by ownership and/or the facility manager

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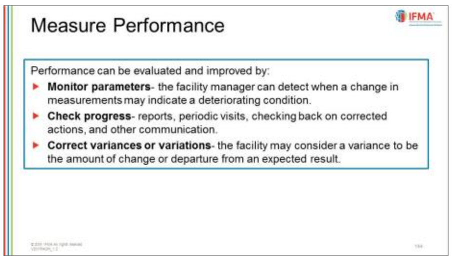
The value of developing a process to determine and deliver occupant services extends beyond the occupant service flow itself. By determining occupant needs and measuring expectations, the facility manager accrues valuable information concerning the facility itself and how to better manage it.

Measure Performance



Facility managers monitor O&M infrastructure activities to promote continuous improvement, they also monitor occupant satisfaction to detect deteriorating or unsatisfactory service activities as early as possible. This helps corrective action to be the least invasive, expensive and challenging. By combining and comparing all inputs on services, the facility manager can develop an accurate accounting of how well existing services are performing, what new services might be helpful and what level of value or priority each may have.

Performance can be evaluated and improved by monitoring parameters, checking progress and correcting variances.

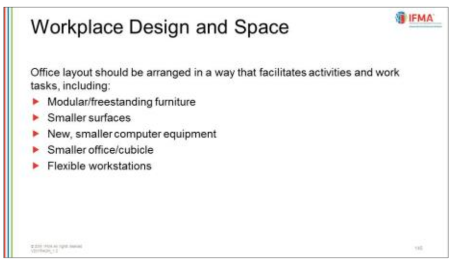
- **Monitor parameters** — By monitoring operational results, including occupant satisfaction, service levels relative to expectations and other indicators, the facility manager can detect when a change in measurements may indicate a deteriorating condition.
- **Check progress** — Reports, periodic visits, checking back on corrected actions and other communication can help the facility manager not only maintain improved conditions but also develop insight for future space or service needs. Regular, consistent communication with occupants is important to facility management.
  - For example, by understanding owner/management policy and gathering ongoing opinions from occupants, the facility manager may discover the need to expand or change custodial services. Concerns may come to the facility manager’s attention early, giving time to most appropriately respond to quality issues or add new custodial services for a more complete program.
- **Correct variances or variations** — “Variance” can have a technical, mathematical definition, in which it indicates the distribution and relative values of data points around a mean or average value. For the purposes of assessing occupant services,

the facility may consider a variance to be the amount of change or departure from an expected result. This implies that the difference is measurable, and the change is recognized through some pre-established standard.

For facility occupant services, the service level agreement can set the standard. It is assigned, measured, executed and monitored through the work plan and work logs that should account for how all worker time is spent.

The facility manager uses these inputs along with life-cycle cost analysis and specific performance indicators to determine how well occupant services goals are achieved.

Workplace Design and Space



Workplace design and space reflects the culture and business of an organization. Improper usage of space can reduce productivity and impact health. A facility manager must understand occupant work and personal needs in order to support productivity.

Office layout should be arranged in a way that facilitates activities and work tasks.

The facility manager must understand what is expected in a workspace in order to fulfil the mission of the organization and the needs of occupants. The workspace should reflect the company culture, business needs and occupant needs in order to fully support their work. In an ever-changing business environment, the facility manager must make appropriate changes in the workspace to manage these requirements.

For workplace furniture, facility managers can make a sound business case for investing in new, modular, freestanding furniture. Pieces can fit together without space-wasting gaps, and smaller surfaces can easily accommodate newer computer equipment. Office or cubicle size can be decreased and still leave some room for casual meetings or storing personal items.

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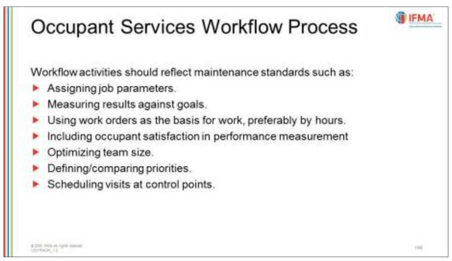
Flexible workstations are becoming more popular and beneficial. These stations provide a seated desk or can be adjusted to a standing desk. This allows workers to sit and stand, as needed, and can support a more ergonomic, productive and efficient work environment.

Direct communication is key in order to understand and address issues or concerns about workspace from occupants. Facility managers should have a direct and clear line of communication with occupants, so that when a problem arises, the facility manager can address the feedback in a direct and timely manner and share it with decision-makers to ensure change is approved and followed through.

Occupant Services Workflow Process



Delivering satisfactory services to occupants generally follows a work plan with steps similar to the approach for O&M for hard systems and equipment as described earlier in this course. Both work plan approaches are summarized in *Exhibit 4-4* to demonstrate that a typical workflow process parallels building, systems and equipment O&M.

Exhibit 4-4: Operations and Maintenance Workflow Process

Occupant Services (Soft)	Building and Equipment (Hard)
• Assess occupant needs • Schedule services • Assign tasks • Perform work • Return results • Input data • Measure performance	• Assess/devise inventory/register • Schedule maintenance (preventive maintenance, help desk request) • Assess and assign work • Perform work • Return results • Input data • Measure performance

A workflow process such as this provides the basis for effective, efficient delivery of occupant services. The facility manager monitors workflow to be aware of how the work is going.

Whether occupant services are contracted or performed by staff, the facility manager needs to know:

- Where work is occurring
- How the projects are tasked
- What priorities or exceptions exist

Knowing these aspects will ensure all FM activities in the facility are coordinated and checked for efficient use of personnel, scheduling conflicts, redundancies and prioritization. In this way, the facility manager can:

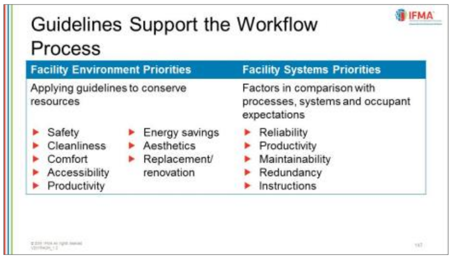
- Maintain order
- Stay abreast of all tasks going on in the facility
- Exercise control without being invasive
- Be available to handle exceptions as they arise

All workflow activities should reflect maintenance management standards such as the following:

- Productivity is enhanced when each individual is assigned definite job parameters and is competent in accomplishing the assignment.
- Measurement should precede control so that what is mutually understood is the basis for how results are measured against goals.
- The work order should be the basis for all facility maintenance, operation, alteration and renovation activities.
- Wherever possible, work orders should describe trades, tools, materials and tasks, preferably by hours.
- Occupant satisfaction should be considered a key measurement for successful facility operations and management.
- Team size is considered optimal when the fewest people can provide the desired speed and quality of results in a safe way within the required time.
- Priorities should be both defined and compared so that work planning provides the most simple, reliable and manageable activity possible.
- Visits or other oversight should be scheduled at control points that occur frequently enough to detect problems yet not so frequent that the work itself is unnecessarily interrupted or delayed.
- Specifications that measure outcomes are the best work appraisal and offer the most neutral, reasonable and acceptable approach to successful work oversight.

With these principles underlying the approach to service level standards, the facility manager has both the tools and the discussion points to competently oversee the work as it is performed and accomplished. The basis for these principles should arise from facts, not opinions, determined by quantitative information.

Guidelines Support the Workflow Process



The workflow process provides a way to merge, prioritize and coordinate O&M activities to help the facility manager know where, when and how to maintain physical assets and serve occupant needs. The work plan determines work execution across all maintainable assets for the entire infrastructure in support of occupant services. These guidelines can generally be described from two main aspects: Facility Environment and Facility Systems.

Facility Environment Priorities

The facility manager may determine how to measure for quality by applying guidelines such as the following shown in *Exhibit 4-5*.

Exhibit 4-5: Guidelines to Measure for Quality

Guideline	Description
Safety	Safety can be regulated by outside agencies and/or by an in-house safety department that establish a minimum level of compliance. The facility manager must be aware of the requirements and restrictions made by local jurisdictions and must be diligent in meeting those minimums. The facility manager, owner or occupants may require a level of safety higher than the minimums require. For example, because of terrorism or the threat that a nearby dike or hillside might collapse in bad weather, the facility manager may schedule emergency exit drills several times a year even though the local standard may not require such frequency.
Cleanliness	The cleanliness of a facility is measured by more than the absence of dust or trash. As an environmental aspect, cleanliness relates to

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Guideline	Description
	the condition of filters, vents, traps and other maintenance aspects that are significant to the efficiency and air quality of the workspace. Cleanliness may also represent custodial requirements that support the needs of the facility, its operation and its reputation. Cleanliness can become a serious issue when, for example, poor cleaning maintenance results in such high levels of disease-carrying bacteria that occupants become sick or debilitated; then cleanliness is a productivity and safety issue.
Comfort	Reliable room temperature and water and electricity supply, useful furnishings and fixtures and adequate space for working are all environmental comforts that may become a serious issue if occupants voice dissatisfaction or facility efficiency is compromised.
Accessibility	Barrier-free access is generally regulated by code requirements. However, beyond required minimums the need for accessibility in the facility can reflect positive, productive workflow so that work areas are not overly cramped, aisles and hallways are convenient, and storage and service areas are easy to reach and use.
Productivity	Interior design and the reliability of utilities and systems are all considered by the facility manager. Decisions about these relative to the working environment will depend upon what productivity factors the owner, facility manager and occupants consider significant and should be included in the work plan.
Energy savings	A facility mission determines the concern and attention given to reduce energy use or develop structures, systems and methods that meet strict requirements. Some facilities may put high priority on producing the highest possible sustainability through environmentally suitable construction. This interest could make the energy-saving environmental factor a top priority and thus change the priorities of other factors in relation to it.
Aesthetics	Use of color, light, design, quality materials and many other aspects may be an important consideration for a facility. If aesthetics is a priority, it may also mean that factors such as comfort, cleanliness and safety would also take on higher significance in the relationships among factors.

Guideline	Description
Replacement/renovation	A facility manager whose organization is undergoing physical changes because of obsolescence, deterioration, new occupants, new mission or changed productivity and comfort priorities may decide renovation is a high priority. This decision can affect other relationships to the building environment such as raising the priority of energy savings, aesthetics or comfort.

The facility manager is tasked to conserve resources and provide a quality environment at the lowest or most reasonable cost. To do this requires the insight gained by relating all of the factors discussed in the exhibit above, and then devising an O&M work plan that helps the facility manager execute, monitor, assess and make changes when necessary to meet performance expectations.

Facility managers don't have the luxury of an unlimited budget and the ability to place all environmental considerations at the highest, critical level. The facility manager may use relational tools to plan work activities that support the relationships deemed most important and those which ensure legislative or regulatory compliance, without sacrificing those deemed less important.

Facility Systems Priorities

When devising the work plan, the facility manager also considers factors in comparison with processes, systems and occupant expectations. This adds another layer of information and capability. The facility manager uses these comparisons to decide how to detect and correct inadequacies in systems within the total infrastructure in ways that best support the facility mission.

There are several different kinds of systems considerations that are all possible approaches to work plan development.

The facility manager must review and compare these factors to determine the best mix to reflect in the work plan:

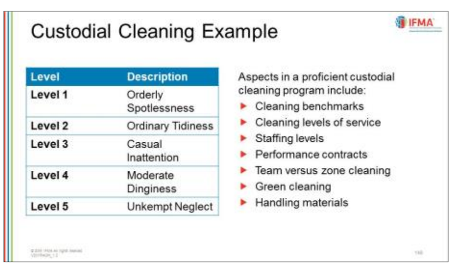
- **Reliability** — Equipment and systems that support occupant work should be reliable. The facility manager may prioritize different assets for reliability to most productively support the mission.
- **Productivity** — The productivity of the facility can be a highly significant factor based on how systems influence the environment. For example, an electrical service outage caused by a frozen bearing that overloads a circuit may have been prevented, but instead a production line is shut down, resulting in lost productivity.

- **Maintainability** — Access to service points, availability of tools and checklists, and a precise schedule of maintenance all play a role in how well systems are functioning.
- **Redundancy** — Backup capability or the ability to operate or compensate during failures may be a high priority if the facility environment has a life-critical mission or if productivity is important and downtime is costly.
- **Instructions** — Clear, measurable and complete maintenance instructions are important to keep systems operating at maximum effectiveness. The inventory/register of all infrastructure assets should be current and specific if the work plan itself is to be efficient and effective.

These systems considerations are part of what the facility manager considers, prioritizes and relates to environmental factors. They may be applied to virtually any O&M responsibility, whether it is repairs, parts replacement, routine service or other activities.

For example, custodial cleaning is a prevalent occupant service that is an expensive and ongoing challenge. In addition, cleaning or custodial services typically produce high injury rates relative to other occupant services, which aggravates the issue. A facility manager may be overly concerned about costs and which cleaner to use, yet only marginally consider performance requirements and if they are being met. This represents poor prioritization. The following discussion expands on custodial services as an example.

Custodial Cleaning Example



The facility manager must determine and specify what "clean" means within the organization. The facility manager must develop and incorporate cleaning functions as diligently as other O&M tasks. This will help produce an environment that encourages productivity, is safe, satisfies occupants, meets building regulations and derives as much value as possible from the facility as the organization accomplishes its mission.

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This requires considering a broad range of aspects in a proficient custodial cleaning program, including the following:

- **Cleaning benchmarks** — The facility manager establishes a clear understanding of what is required so that personnel know when the work is properly executed. It involves developing benchmark expectations that are specific and measurable.
- **Cleaning levels of service** — The level of service defines expectations or benchmarks that represent minimum requirements relative to response, availability, performance or other attributes of service, such as occupant satisfaction or communication. These conditions allow everyone, including contractors, staff, occupants, and others, to understand what service is necessary and how it will be measured.
    - For example, APPA has established custodial levels of cleanliness (*Exhibit 4-6*) that define five levels of what is clean as a way to assess facility appearance. These guidelines are also adopted by some industry associations.
- **Staffing levels** — The APPA Custodial Staffing Guidelines are an example of a benchmark resource that the facility manager can apply to help decide how many custodial personnel with what types of skills are needed. These criteria may be based on the facility's mission, occupant mix, size, level of service expectations and other associated characteristics. A desired cleanliness level is selected and then then the staff size is determined by the square footage of cleanable space.
- **Performance contracts** — Developed within a service level agreement or as a separate set of requirements, contracts hold personnel accountable to specific levels of service, cleanliness, hygiene or other conditions. These contracts may include rewards, penalties and other incentives based on performance. A neutral or third party may be used to audit performance so that both the facility manager and the service provider are treated equally in the assessment.
- **Team versus zone cleaning** — The facility manager can play a role in determining whether custodial work is accomplished by a team or by an individual working a zone.
    - When cleaning as a team, each individual is assigned one task, such as light duty dusting/spot cleaning, vacuuming or restrooms, and that is their responsibility for the facility, the floor or the area. Team cleaning provides a systematic approach in which individuals are proficient at their assigned task and the work is expeditious.
    - Zone cleaning is essentially the reverse of team cleaning. In zone cleaning, one person performs all the required tasks in a specified cleaning area. Zone cleaning gives the individual a sense of ownership and pride in the quality of their area.
- **Green cleaning** — Green cleaning refers to the practice of using cleaning methods, products and ingredients that mitigate health risks and preserve the environment. A

green cleaning approach avoids using chemically reactive and toxic cleaning products or those that emit volatile organic compounds. Green cleaning also refers to cleaning products themselves that are manufactured, packaged and distributed in more sustainable and environmentally supportive ways.

  - Green cleaning should not be confused with green washing, a term that is meant to criticize misrepresenting a product as having green benefits. For example, green washing would refer to a product or approach presented as a way to reduce using resources but misrepresented in order to justify cutting costs or eliminating steps.

- **Handling materials** — A broad aspect of a typical custodial service includes how to safely handle cleaning products, how to handle hazardous materials and how to manage waste. This is a major topic that is too extensive for this O&M discussion; however, these are important considerations for the facility manager.

  - Custodial personnel should be well trained on how to recognize and handle hazardous materials and properly dispose of waste. In most areas there are strict standards for managing, recycling and disposing all materials.

Exhibit 4-6: APPA Levels of Appearance

Level	Description
Level 1	Orderly Spotlessness • Floors and base molding shine and/or are bright and clean; colors are fresh. There is no buildup in corners or along walls. • All vertical and horizontal surfaces have a freshly cleaned or polished appearances and have no accumulation of dust, dirt, marks, streaks, smudges or fingerprints. Lights all work and fixtures are clean. • Washroom and shower fixtures and tile gleam and are odor-free. Supplies are adequate. • Trash containers and pencil sharpeners hold only daily waste, are clean and odor-free.
Level 2	Ordinary Tidiness • Floors and base molding shine and/or are bright and clean. There is no buildup in corners or along walls, but there can be up to two days' worth of dust, dirt, stains or streaks. • All vertical and horizontal surfaces are clean, but marks, dust, smudges and fingerprints are noticeable upon close observation. Lights all work and fixtures are clean. • Washroom and shower fixtures and tile gleam and are odor-

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Level	Description
	free. Supplies are adequate. • Trash containers and pencil sharpeners hold only daily waste, are clean and odor-free.
Level 3	Casual Inattention • Floors are swept or vacuumed clean, but upon close observation there can be stains. A buildup of dirt and/or floor finish in corners and along walls can be seen. • There are dull spots and/or matted carpet in walking lanes. There are streaks or splashes on base molding. • All vertical and horizontal surfaces have obvious dust, dirt, marks, smudges and fingerprints. Lamps all work and fixtures are clean. • Trash containers and pencil sharpeners hold only daily waste, are clean and odor-free.
Level 4	Moderate Dinginess • Floors are swept or vacuumed clean but are dull, dingy, and stained. There is a noticeable buildup or dirt and/or floor finish in corners and along walls. • There is a dull path and/or obviously matted carpet in the walking lanes. Base molding is dull and dingy with streaks or splashes. • All vertical and horizontal surfaces have conspicuous dust, dirt, marks, smudges, and fingerprints. Lamp fixtures are dirty and some lamps, up to 5% are burned out. • Trash containers and pencil sharpeners have old trash and shavings. They are stained and marked. Trash containers smell sour.

Level	Description
Level 5	Unkempt Neglect • Floors and carpets are dull, dirty, scuffed and/or matted. There is a conspicuous buildup of old dirt and/or floor finish in corners and along walls. Base molding is dirty, stained and streaked. Gum, stains, dirt, dust balls and trash are visible. • All vertical and horizontal surfaces have major accumulations of dust, dirt, smudges and fingerprints, all of which will be difficult to remove. Lack of attention is obvious. • Light fixtures are dirty with dust balls and flies, many lamps (more than 5%) are burned out. • Trash containers and pencil sharpeners overflow. They are stained and marked. Trash containers smell sour.

In order to meet the cleaning needs of a facility, sufficient custodial staff must be available, including in-house custodians and contracted custodial services.

- Contracted custodial services involve hiring a third party to perform the needed facility custodial work, which can be on a temporary or scheduled basis. The following are types of custodial contracts:
  - Prescriptive contracts- outline exact cleaning specifications, including how to clean and the expected outcome.
  - Performance contracts- describe the end result of cleaning and gives the contractor flexibility to determine how to achieve the result.
- In-house custodians are employees of the organization whose job description includes performing custodial services and maintaining cleaning tasks in the facility.

It is thought to be more effective and cost efficient to outsource custodial work with more contractors than in-house custodians. This may result in a greater number of contracted workers than in-house custodians.

Staffing levels are dependent on the cleanable square-footage of the space, number of occupants, and budget. APPA uses a self-analysis chart to help identify the variables that impact custodial operations and determine the staffing required to properly clean the facility.

Exhibit 4-7 is an example of a typical cleanliness assessment. Note that this may change based on the needs and culture of an organization.

Facility, system and location identification ______________________

Inspector name and date of assessment ______________________

Components: floors, washrooms, waste containers, furniture and fixtures

General causes or concerns

Floors

[ ] Shine/clean
[ ] Carpet is free of dirt/ stains
[ ] No dirt buildup
[ ] Clear and clean walkways

Washrooms

[ ] Working fixtures
[ ] Clean tile
[ ] Odor-free

Waste Containers

[ ] Clean
[ ] Odor-free
[ ] Only holds daily waste

Furniture/Fixtures

[ ] No visible dust or dirt
[ ] Clean windows
[ ] Functioning lights
[ ] No clutter or objects obstructing use
[ ] No stains or marks
[ ] No smudges or fingerprints

General

[ ] Items stored properly
[ ] Clean workspaces
[ ] Organization and overall cleanliness

Compliance (codes/regulations)

[ ] Local
[ ] Area
[ ] National/international standards

[ ] Required permits

Maintenance History (date/activity)

____
____
____
____
____
____
____
____
____
____
____
____

Component evaluation Description (type, location, serial number/ID)	Condition (items that needs attention/deficiency described)

Exhibit 4-7: Cleanliness Assessment

Prepare and Execute Modifications to Occupant Services

Lesson Introduction

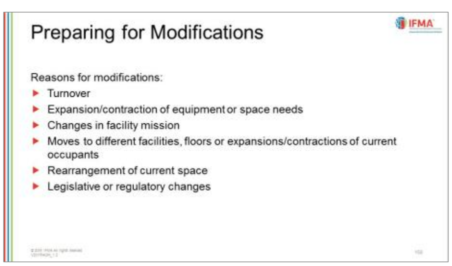
On completion of this lesson, you will be able to:

- Describe an effective approach to preparing for modifications to occupant services.

This lesson contains the following topics:

- Preparing for Modifications
- Approach
- Alterations
- Move Management

Preparing for Modifications



As discussed previously in this course, modifications should be implemented for successful business operation. It is important to note the significance of modification pertaining to occupant needs.

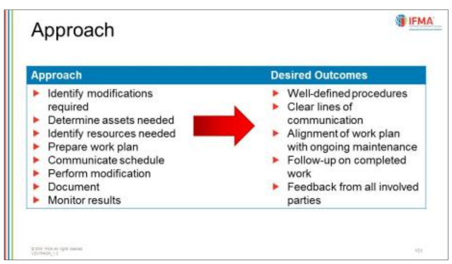
Facilities may need to be modified for occupant-related reasons such as:

- Turnover of occupants, which refers to the movement and relocation of occupants within an organization.

- Expansion or contraction of facility equipment or space needs.
- Changes in facility mission involving a reordering of priorities, systems, spaces, personnel.
- Moves to different facilities, floors or expansions/contractions of current occupants.
- Newly defined needs because of rearrangement of current facility spaces, travel paths, communications.
- Legislative or regulatory changes that require changes in facility systems, layout, service arrangements.
- Mergers or acquisitions

The facility manager uses the information gathered from periodic conversations with occupants, surveys and interviews to maintain an ongoing understanding of what occupants want, need and expect. This feedback helps the facility manager establish relationships with occupants as a means to communicate anticipated modifications that may arise if there are changes in management plans or a facility's mission.

Approach



To prepare for modifications to occupant services, the facility manager may use an approach similar to the way in which routine O&M activities are prepared for, scheduled and performed.

The approach applies key aspects that allow the facility manager to do the following listed in *Exhibit 4-8*.

Exhibit 4-8: Key Aspects

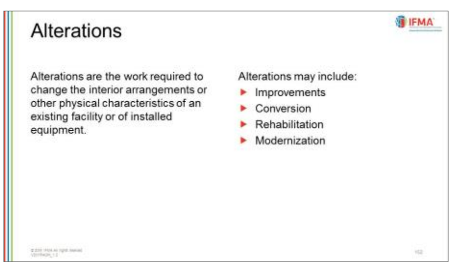
Identify modifications required	By assessing feedback from occupants, owner/management and staff to determine: • What the modifications are • Any special requirements, such as occupant schedule, critical activities or other factors

	• What is vital to the facility mission and cannot be compromised
Determine assets needed	• Equipment • Systems and components • Materials • Tools and trades • Special expertise, such as structural engineering, architectural drawings or equipment schematics
Identify resources needed	• Team sizes • Numbers • Skills • Specialties or trades
Prepare the work plan	• Assign work to specific individuals/teams • Clearly defined tasks • Sequenced so that the right skills and personnel are accomplishing work in the right order
Communicate the schedule	• All service providers, staff and contract • All occupants affected by the modification • Provide feedback systems for input and questions before, during and after the modification
Perform the modification	• Within assigned specifications and mindful of other O&M schedules • Avoid delays, interruptions or unnecessary conflicts and costs
Document	• All assets • Specifications • Manufacturer warranties • Service schedules • History of the request/project • As part of the total infrastructure inventory/register
Monitor results	• Routine • Ongoing occupant feedback • Continuous improvement

With routine occupant service modifications and systems/equipment modifications, the facility manager is focused on providing responsive, high-quality results. This includes capabilities and competence in areas such as:

- Well-defined procedures, specifications and organizational structure.
- Clear lines of communication to occupants, staff and contractors.
- A centralized, organized work management center that communicates a work plan that aligns skills, tools, materials and equipment with the modification schedule and with ongoing operations, maintenance and alterations activities.
- Follow-up on the completed work to ensure that it is checked, inspected, accounted against budget, analyzed and measured.
- Feedback from all involved parties, such as occupants, staff, contractor or owner, to:
    - Determine the success of the modification.
    - Uncover gaps.
    - Resolve disputes.
    - Maintain quality management principles for continuous improvement.

Alterations



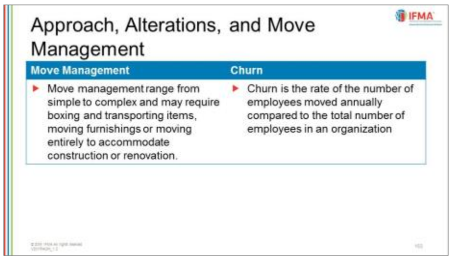
Alterations refer to the work required to change the interior arrangements or other physical characteristics of an existing facility or of installed equipment. This ensures that the asset or characteristic may be more effectively utilized for its current needs or adapted to a changed use as a result of a programmatic requirement.

Alterations may include:

- Improvements
- Conversion
- Rehabilitation
- Modernization

Alterations may occur continually in many facilities because of moves, upgrades, aesthetic improvements and mission changes. Funds for alterations are generally kept separate from those for maintenance so that budgets are discrete and accountable.

Move Management



Alterations are sometimes included within a larger concept known as move management. This concept determines that alterations may not be required, yet facilities undergo changes because occupants move, leave or work areas change or grow.

Move management is addressed in more detail in the *Project Management* course.

This concept is measured as churn. Churn is a term widely used in facility management to describe the rate of movement and relocation of occupants within an organization within a specified period. It is defined as the ratio of the number of employees moved annually compared to the total number of employees in an organization.

Churn rates greater than 50 percent generally indicate rapid growth and/or significant change. Rates this high may notably affect the facility manager's operating and project budgets as well as require excessive time to oversee activity and manage resources.

Churn projects generally cost less than capital projects; the department requesting churn may fund the venture, or it may come from an allocated organization churn fund.

Moves can range from simple to complex and may require boxing and transporting items, moving furnishings or moving entirely to accommodate construction or renovation.

Monitor Occupant Satisfaction

Lesson Introduction

On completion of this lesson, you will be able to:

- Compare techniques for monitoring and improving customer satisfaction.

This lesson contains the following topics:

- Occupant Satisfaction Described
- Workplace Design and Space
- Service Quotient Defined
- Satisfaction Improvement

Occupant Satisfaction Described

Occupant satisfaction is important because it indicates customer approval, which is critical to the success of any business. Serving customers/occupants well is a vital step toward success and a facility’s ability to fulfill its mission.

The comfort, confidence and productivity of occupants is at the core of a facility’s purpose. The delivery of excellent occupant services should be seamless and invisible.

Quality occupant service is motivated and determined by several considerations, including the following:

- Occupants/customers determine what defines quality, not the facility manager or owner.
- There should be continuous improvement, not simply sustaining the current status.
- The facility manager and owner/executive management need to be willing to measure occupant satisfaction.
- The facility manager, maintenance staff and contractors should be willing to be measured through occupant surveys and other feedback.
- The facility manager should use a total quality management approach to determine, measure, monitor and improve occupant satisfaction.
- Staff and contractors should be held accountable to meet the expectations of both the facility manager and the occupants.
- Staff and contractors are aware of, understand and are knowledgeable about how to communicate with occupants, how to respond to them and how to include feedback in work plans or surveys.

IFMA researchers have often summarized the main complaints facility managers hear from occupants. Over the years the types of complaints remain similar and vary only in their ranking among the top ten. A general summary of typical occupant complaints is shown in *Exhibit 4-9*.

Exhibit 4-9: Typical Top Complaints to Facility Managers

- It is too cold; it is too hot.
- Custodial service is poor.
- Not enough conference rooms; not enough space for me.
- Poor indoor air quality.
- No privacy in my workspace.
- Inadequate parking.
- Computer problems.
- Too noisy; high noise level.

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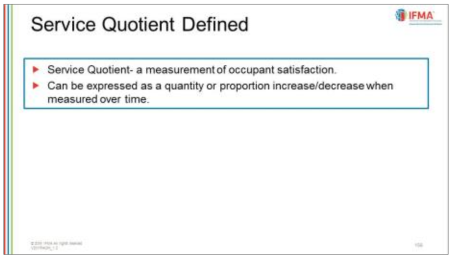
Service Quotient Defined

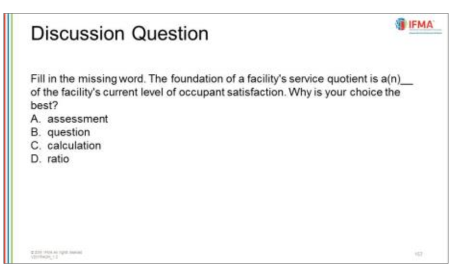


A measurement of occupant satisfaction may also be called a service quotient, or a customer service index. In facility management, a service quotient is a measurement of how satisfied occupants are with their service at a given point in time. A service quotient describes the level of occupant satisfaction, which can be expressed as a quantity or proportion increase or decrease when measured over time.

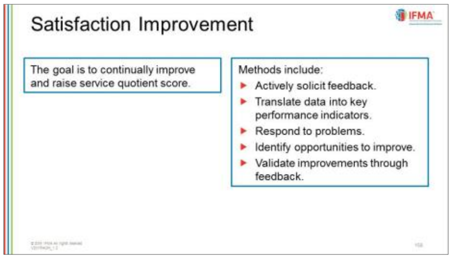
The foundation of that measurement starts by assessing the facility's current level of occupant satisfaction. Just as an inventory/register of all assets is needed to competently manage operations and maintenance, an accounting of occupant opinion is needed as a starting point to know how that facility's services are perceived.

If a facility manager has never requested or summarized the status of occupant feedback, then the first satisfaction survey provides the basis to compare against future measurements. This starting point provides the baseline so that any change in performance can be recognized.

A service quotient is distinct and original to the facility and its occupants. The initial survey sets the base. Ongoing surveys reveal improvements and weaknesses. The goal is continuous improvement; the facility manager uses inputs to help refine the work plan and approach to continually improve occupant satisfaction.

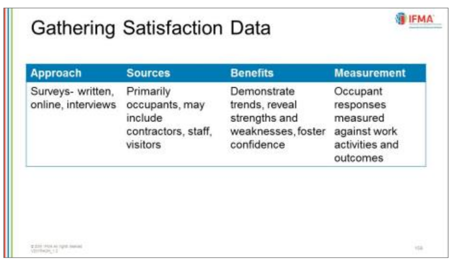


Satisfaction Improvement



Two important aspects of improving satisfaction are gathering satisfaction data and understanding the role of the facility manager in that improvement.

Gathering Satisfaction Data



Occupant satisfaction data may be gathered informally through conversations or solicited suggestions as well as more formally though surveys and work plan analyses. Thorough, complete and periodic requests for feedback are generally excellent approaches that give the facility manager a better understanding of where and how to respond through operations and maintenance.

Occupant surveys can be understood generally through approach, sources, benefits and measurements.

Approach

Occupant satisfaction should be reviewed regularly. Standard-setting bodies suggest that occupants be surveyed at least annually. The goal is to achieve a rating of 6 or higher on a 10-point rating system

The survey approach can be robust or simple depending on what the facility manager and executive management decide.

Typically, written or interview surveys include ratings based on a range of questions that include:

- Did we do what you wanted done?

- Did we do it in a timely manner acceptable to you?
- How well did we do without disrupting your work?
- How well did we clean up and conduct ourselves?
- Did we check to see if you were satisfied?

The survey should be designed so that the facility manager can understand what occupants want and need.

Communications with occupants should demonstrate that they are valued, heard and responded to. Survey inputs are two-directional: occupants are asked for their feedback and that feedback is returned to occupants as actions, communications and responses that indicate improvements are being made.

The facility manager uses the results of occupant surveys to train and develop staff and contractors to support the highest satisfaction levels possible. It is important that maintenance personnel be informed and engaged in a service commitment.

Major areas that the facility manager may stress relative to occupant services include the following:

- Establish policies and procedures that support occupant needs.
- Train personnel in communication skills.
- Develop cross-trade qualifications to improve service delivery as well as effectiveness.
- Develop competence in systems that include electrical, electronic, HVAC equipment and piping as well as minor carpentry.
- Support operations and maintenance activities by:
  - Efficiently supplying the necessary tools, parts, materials and equipment
  - Minimally disruptive work scheduling
  - Budgeting sufficiently to permit quality levels of service response

Sources

In addition to feedback from occupants, the facility manager may use other sources to develop a more comprehensive picture of occupant requirements and the facility's ability to respond to those requirements.

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These sources may include:

- O&M operational data summarized from work logs and summary reports.
- Input from contractors performing work within the facility.
- Input from other service providers, such as local telephone services, utilities providers, hired experts and others.
- Input from O&M staff and other department employees regarding their challenges, concerns and feedback from occupants.
- Visitors and guests who can offer their first impressions of the facility and its operation.

Benefits

Occupant surveys offer several benefits:

- Performed regularly, they demonstrate trends and reveal strengths and weaknesses.
- They provide direct input on the state of operations and maintenance as perceived by users for the most direct understanding of occupant needs and wishes.
- They indicate to occupants the desire and goal of responsive and satisfactory facility management attention and action.
- When survey outcomes produce O&M response, occupants gain confidence in service providers as well as services rendered, fostering a higher sense of professionalism and interest. Good service is a competitive advantage created by excellent operations and maintenance.
- Signs of occupant dissatisfaction can be identified and corrected early before they become a concern to senior management.
- Underperforming systems, spaces and service providers can be identified so that corrective actions can be taken.

Measurement

Some might consider occupant satisfaction to be a collection of opinions, the facility manager uses this feedback to measure occupant responses against work activities and outcomes. The facility manager can track key performance indicators to compare trends against the service quotient.

The facility manager can set standards on routine work based on occupant input and service level expectations. FM can then monitor the work through site visits, work logs and staff/contractor feedback.

Routine work can include:

- Predictive and preventive maintenance

- Service requests
- Custodial
- Waste management
- Cafeteria

Key performance indicators for O&M can be developed to assess gaps or weaknesses by measuring:

- Planned activities, such as tasks and projects, compared to unplanned. This can help indicate the proficiency of maintenance planning and perhaps even the reliability of specific current assets.
- Proportion of completed work orders, such as number scheduled versus number finished. This can help indicate work planning, accuracy of scheduling and work expectations and readiness of contractors or staff.
- Total work completed at a given time compared to estimated time for that work, by trade, by contractor, by area. This can help indicate work readiness, worker training, scheduling efficiency and other work performance factors.
- Planned preventive maintenance hours compared to total expended hours. This can help indicate maintenance planning and work product, accuracy of service level expectations, and perhaps reliability or service costs on specific assets.
- Estimated costs compared to actual costs to determine proportion over and under budget related to type of work or area of facility or occupant type. This can help indicate areas of inefficiency, inaccurate estimate and repeat visits.
- Contractor service and preventive maintenance proficiency by comparing service or work orders by trade, occupant area or period-over-period, or historic, averages relative to:
    - Work orders scheduled versus completed and number outstanding.
    - Cost per service order compared to industry standards or historic averages.
    - Occupant satisfaction service quotient for a particular service or maintenance routine.
- Occupant satisfaction in general to update feedback, develop trends by comparing to historic service quotients, recognize increase/decrease in occupant responses to surveys and discover changes in perceptions of community and competitive standing.

The facility manager may decide to allow occupants to remain anonymous, which would encourage more candid responses. However, it can be helpful to know what specific projects or work activities an occupant may be responding to as a way to compare inputs against the work plan.

This can reveal other levels of detail such as:

- Correlations to service providers working on specific activities and trends among individuals or teams.
- Responses or dissatisfaction correlated to specific work activities or challenging work plans.
- Correlations among work plans, worker competencies, occupant areas and/or service levels.

The Role of the Facility Manager in Satisfaction Improvement

The facility manager's goal relative to occupant satisfaction is to continually improve and raise the service quotient score. To do this, the facility manager:

- Provides the mechanisms and engagement that encourage early feedback on problems.
- Learns what occupants expect through surveys and active solicitations of opinion from all sources.
- Understands what occupants depend on, are aware of how they use infrastructure.
- Develops this understanding into key performance indicators.
- Identifies critical interfaces with occupants, such as through maintenance staff and at moments of service interruption.
- Knows how to precisely define what is wrong in order to understand what to improve.
- Understands how to respond to problems in ways that support occupant expectations, enhance relationships and demonstrate appreciation of occupant needs.
- Identifies exchanges or procedures that are not working because of ignorance, poor communication, lack of response and lost feedback.
- Observes performances through performance measures and ongoing feedback.
- Identifies opportunities to improve efficiency and effectiveness.
- Implements and manages/oversees changes.
- Validates improvements through occupant feedback and process results.

This cycle is the basis for continued improvement for higher occupant satisfaction reflected in an ever-improving service quotient.

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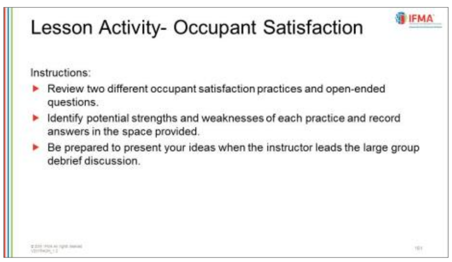
Chapter Activity

Occupant Satisfaction Activity

Instructions



1. Review two different occupant satisfaction practices and open-ended questions.
2. Identify potential strengths and weaknesses of each practice and record answers in the space provided.
3. Be prepared to present your ideas when the instructor leads the large group debrief discussion.

Practices

Shane and Bart are working together to formalize their organization's occupant satisfaction process. To date, Shane has informally canvassed management and employees about their satisfaction with FM services, relying mostly on conversations. Consider the following two possibilities.

Example 1 — Expectations Measures Using a Customer Comment Card

Leading Edge Customer Comment Card			
In the following areas, how did the facility management service you received compare with your expectations? Check each box that applies.			
FM Service *	**Exceeded**	**Met Expectations**	**Below Expectations**

	expectations		
Parking			
Custodial			
Landscaping			
Waste management			
Copying and printing			
Mail			
Work management center			
Emergency preparedness			
Break room service			

** Note that the list of services shown here is not intended to be all-inclusive but should be considered as examples of possible Leading Edge entries.*

In the table below, list the strengths and weaknesses of the customer comment card.

Leading Edge Customer Comment Card	
Strengths	**Weaknesses**

Example 2 — Expectations Measures Using Expanded Scales in a Survey

<table>
<tr><th colspan="11">Leading Edge Facility Management Customer Survey</th></tr>
<tr><td colspan="6">Service:</td><td colspan="5">Date of Service:</td></tr>
<tr><td colspan="11">How often do you use this service?</td></tr>
<tr><td>Daily</td><td colspan="2">Weekly</td><td colspan="3">Monthly</td><td colspan="2">Annually</td><td colspan="3">Never</td></tr>
<tr><td colspan="11">What is your overall level of satisfaction with this service?</td></tr>
<tr><td>Excellent</td><td colspan="2">Very good</td><td colspan="3">Met expectations</td><td colspan="2">Dissatisfied</td><td colspan="3">Strongly dissatisfied</td></tr>
<tr><td colspan="11">I would use this service again.</td></tr>
<tr><td>Strongly agree</td><td colspan="2">Moderately agree</td><td colspan="3">Neither agree nor disagree</td><td colspan="2">Moderately disagree</td><td colspan="3">Strongly disagree</td></tr>
<tr><td colspan="11">I would recommend this service to others.</td></tr>
<tr><td>Strongly agree</td><td colspan="2">Moderately agree</td><td colspan="3">Neither agree nor disagree</td><td colspan="2">Moderately disagree</td><td colspan="3">Strongly disagree</td></tr>
<tr><td colspan="11">Circle the number that best represents your feelings. Note that the first set of numbers relates to your expectations about the importance of the service and the second to how FM performed.</td></tr>
<tr><td></td><td colspan="5">Degree of importance, where:
1 = Unimportant
5 = Very important</td><td colspan="5">Degree of FM performance, where:
1 = Does not occur
5 = Always occurs</td></tr>
<tr><td>1. FM employees are professional.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>2. FM employees are courteous.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>3. Answers to questions are accurate.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>4. FM employees understand my needs.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>5. Service is prompt.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>6. Safety is</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
</table>

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emphasized.		
7. The service is up to date.	1 2 3 4 5	1 2 3 4 5

** Note that the list of questions shown here for ratings is not intended to be all-inclusive but should be considered as examples of possible entries.*

In the table below, list the strengths and weaknesses of the customer survey.

Leading Edge FM Customer Survey	
Strengths	**Weaknesses**

Open-ended Questions

- Open-ended questions are unstructured questions that allow customers to respond in their own words; they may mention any issue they choose.
- Close-ended questions, which were used in the comment card and the survey, pre-list the most anticipated responses and attempt to provide a frame of reference.

Shane and Bart are discussing whether or not to add a few open-ended questions to either the customer comment card and/or the survey. They have come up with the following as possibilities:

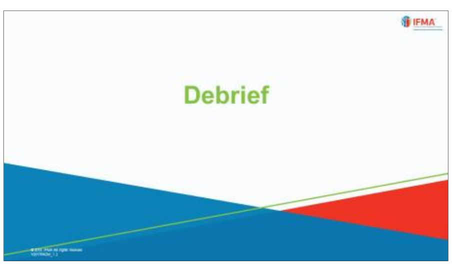
1. Please list three things FM needs to improve the most.

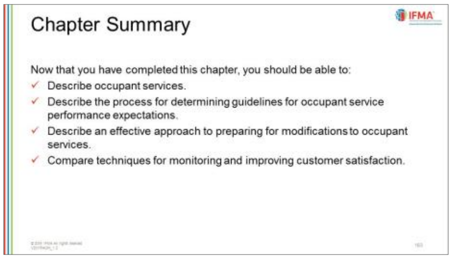
2. What was your most positive FM experience?
3. What was your most negative FM experience?
4. Is there anything else you want to tell us about FM services?

In the table below, list the strengths and weaknesses of open-ended questions

Leading Edge FM Open-Ended Questions	
Strengths	**Weaknesses**
1. 2. 3. 4.	1. 2. 3. 4.
Based on the weaknesses identified, how would you re-write these questions to make them stronger?	
1. 2. 3. 4.	

Debrief




Chapter Summary
IFMA
Now that you have completed this chapter, you should be able to:
✓ Describe occupant services.
✓ Describe the process for determining guidelines for occupant service performance expectations.
✓ Describe an effective approach to preparing for modifications to occupant services.
✓ Compare techniques for monitoring and improving customer satisfaction.

Progress Check Questions

1. What is NOT typically considered an example of a soft occupant service?
   a. Custodial cleaning, window washing, waste management
   b. Food service, records management, human resources
   c. Parking, shipping and receiving, security
   d. Inspection, testing, commissioning

2. What else does a typical occupant service planning approach include besides the identified needs and how to evaluate, communicate, and implement the plan?
   a. How to measures performance.
   b. What to assign staff rather than contractors.
   c. The processing of all occupant service requests first.
   d. All the statements are correct.

3. What should the facility manager consider when determining the right mix of occupant services?
   a. The opinions of occupants and owners.
   b. Only lowest-cost and highly competitive contractors.
   c. Low-bid requests for services.
   d. What can be performed by staff versus contract.

4. What best describes the relationship between the workflow process for occupant services and the workflow process for building systems and equipment?
   a. They are completely different
   b. They are exactly the same
   c. They are similar in approach
   d. Occupant services is considered less important

5. Why should a facility manager conserve resources and provide a quality environment?
   a. To achieve maximum sustainability.
   b. To always exceed minimum standards.
   c. To achieve the lowest possible cost.
   d. To minimize the use of outside contractors.

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6. What does zone cleaning refer to?
   a. A systematic approach by a team to an area.
   b. Deferred maintenance-based priorities rather than schedules.
   c. The comparison of one team's or individual's work against another.
   d. Cleaning of an entire area by one person.

7. Occupant turnover, changes in facility mission and even legislative changes would most likely stimulate which of these facility management activities?
   a. Modifications to occupant services
   b. Elimination of O&M budgets
   c. Replacing contract workers with staff
   d. Complete revision of performance contracts, SLAs or similar

8. What do you call the movement and relocation of occupants within an organization?
   a. Downsizing.
   b. Turnover or churn.
   c. Workflow process.
   d. Productivity management.

9. What is meant by green washing?
   a. An inappropriate practice of misrepresenting green benefits of a product.
   b. An open work order that is not done when scheduled.
   c. Environmentally supportive cleaning.
   d. Use of low-phosphate cleaning products.

10. What is NOT considered when determining quality occupant service?
    a. Occupants' definition of quality.
    b. Holding staff and contractors accountable for expectations.
    c. Measuring occupant satisfaction.
    d. NOT expecting staff and contractors to communicate with occupants.

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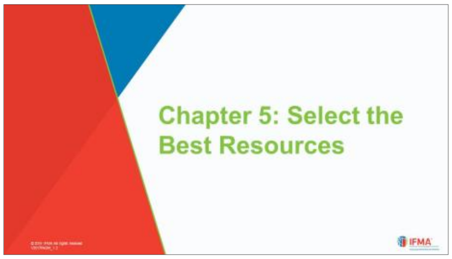
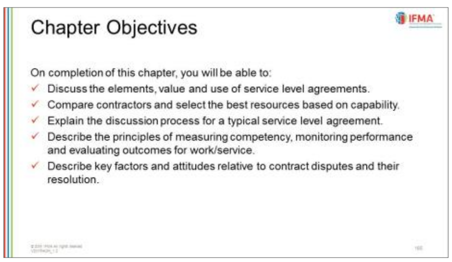
Chapter 5: Select the Best Resources

Chapter Introduction





On completion of this chapter, you will be able to:

- Discuss the elements, value and use of service level agreements.
- Compare contractors and select the best resources based on capability.
- Explain the discussion process for a typical service level agreement.
- Describe the principles of measuring competency, monitoring performance and evaluating outcomes for work/service.
- Describe key factors and attitudes relative to contract disputes and their resolution.

Lessons

- Develop Maintenance and Occupant Service Specifications
- Select Competent Service Providers (Staff or Contract)
- Discuss and Agree on Service Level
- Monitor Work/Service Performance
- Resolve Contract Disputes

Develop Maintenance and Occupant Service Specifications

Lesson Introduction

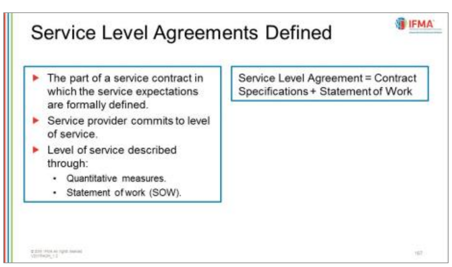
On completion of this lesson, you will be able to:

- Discuss the elements, value and use of service level agreements.

This lesson contains the following topics:

- Service Level Agreements Defined
- Service Level Agreement Specifics
- Value of Service Level Agreements
- Service Level Agreement Benefits

Service Level Agreements Defined



A facility manager is usually responsible for managing/overseeing all facility O&M. This includes the services provided to occupants or tenants as well as the operations and maintenance of building equipment and systems. This remains true whether services are performed by staff or outsourced contractors. How effectively and efficiently the facility manager does this is not only a measure of competency but may also determine how competitive, attractive and efficient the facility is for its occupants and the mission. This makes it critical to execute services properly.

Service specifications and expectations should be detailed and defined. They can be prepared for both maintenance and occupant services tasks and used with both contractors and staff.

A service level agreement (SLA) is the part of an overall contract in which the service expectations are formally defined.

SLAs are terms negotiated and agreed on between a facility representative, such as the facility manager, and a service provider. The service provider can be external or an internal to the FM organization. Services include:

- Operations and maintenance
- Custodial
- Food service
- Waste management

Before an SLA is agreed upon, the facility manager or another designated individual prepares a request for proposal (RFP), which is an official statement to vendors about the business activity in works, supply or service required. The contractor's response to the RFP begins dialogue.

RFP is covered in more detail in the *Finance and Business* course.

In the SLA, the service provider commits to an agreed-upon level of service. That level of service is usually described in quantitative measures that detail how the provider will support service through availability, serviceability, performance, operation, response, and resolution time or other attributes. The level of service may also be described in the contract by a listing of specific tasks the supplier is to perform.

The relationship may be represented in this way:
Service level agreement = Defined expectations + Time

A basic SLA usually contains the following elements:

- Identify how tasks are to be delivered:
  - **Prescriptive specifications** — outline exact task specifications, including how to complete the task and the expected outcome.
  - **Performance specifications** — describe the end result of a task and its respective time frame for completion and gives the contractor flexibility to determine how to achieve the result.
- Level of service that defines expected minimums indicating acceptable performance
- Measurements or metrics, relative to key performance indicators (KPIs), that compare results to mutually agreed-upon goals
- Oversight measures that describe how performance to level of service is reviewed
- Incentives for achieving goals beyond minimums. There may also be special aspects such as performance contracting in which future savings from more efficient systems or service delivery become part of the terms of the contract or are leveraged into the cost of the contract
- Work schedules that define when and at what frequency work tasks will occur
- Standard operating procedures (SOPs) that specify how tasks will be accomplished, such as general work and safety rules

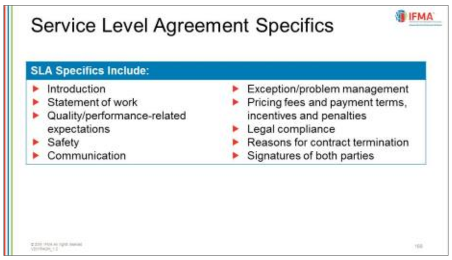
An SLA is designed to help the facility manager and the service provider or internal customer recognize what level of service quality and timelines are required and is to be delivered. An SLA's usefulness lies in how completely and accurately the level of service is described. Both the provider and the facility manager understand and agree upon what the minimum level of service is.

An SLA and the performance indicators that measure it are vital for high-quality occupant services. Whether an SLA is devised for staff or contractors, the expected and defined service levels need to be clear, realistic and mutually understood and agreed upon. When the contract is specific and clear, the facility manager's duty to oversee service providers is likely to be less stressful and be recognized as mutually reasoned, not arbitrary.

The contract essentially defines and documents the relationship between the facility manager and the service provider. As service activities are conducted, the SLA may determine the quality and tone of how the facility manager and providers, whether staff or contractors, relate to and experience each other.

Depending on the industry and country of operation, there are several ways to develop maintenance and occupant service specifications. The way IFMA defines these terms and specifications is for the purposes of this course.

Service Level Agreement Specifics



An SLA generally includes the items listed and described in *Exhibit 5-1*.

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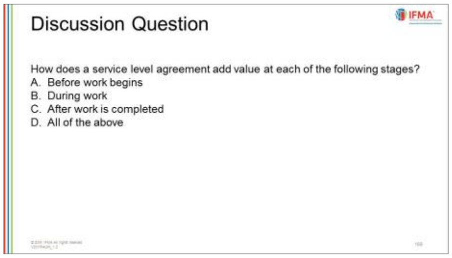
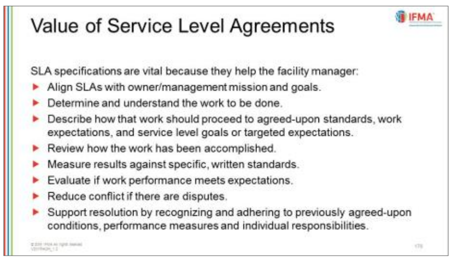
Exhibit 5-1: SLA Elements

Element	Description
Timing	• Start date • End date • Contract duration • Response time
Quality and performance-related expectations	• Supervision • Tracking, including methods by which service providers record complications or extra work • Monitoring performance measures and performance • Reporting
Safety	• Laws, codes and regulations • Personal protective equipment • Incident reporting
Communication	• Meetings • Procedures for revising the SLA • Reporting and frequency
Exception, or problem, management	• Problem definition • Escalation guidelines • Approach to disputes and dispute resolution
Pricing or compensation	• Incentives • Penalties
Signatures	• Both parties sign • Signatures confirm agreement to the SLA

The *Finance and Business* and *Leadership and Strategy* courses provide insight into contract preparation and relationship management.



Value of Service Level Agreements



Regardless of the manner or detail to which SLA specifications are determined, they are vital because they help the facility manager:

- Align SLAs with owner/management mission and goals.
- Determine and understand the agreed upon work to be done.
- Describe how that work should proceed to agreed-upon standards, work expectations and service level goals or targeted expectations.
- Review how the work has been accomplished.
- Measure results against specific, written standards.
- Evaluate if work performance meets expectations.
- Reduce conflict if there are disputes.
- Support resolution by recognizing and adhering to previously agreed-upon conditions, performance measures and individual responsibilities.

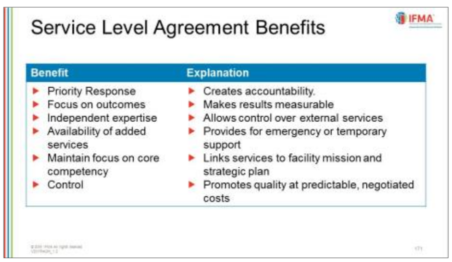
The facility manager may also require or support having some or all activities, such as tasks, schedules and results, entered into the CMMS/IWMS or other computer-aided facility management (CAFM) system so all aspects of service are available for review and control. Automated capabilities help the facility manager administer the contract from the time it is awarded to the contractors or established with staff until it is closed out or replaced by another contract.

The facility manager is responsible for administering the contract and determining that the intent, requirements, terms and conditions of the contract are met. The SLA should contain all information that the facility manager and service provider require.

A contractor submits standard operating procedures and schedules as part of the proposal. These are included to show how the statement or scope of work, level of service and other performance metrics, including KPIs, will be met.

Level of service, SOW, and KPIs help provide the standards by which the service provider and the facility manager can evaluate the conduct and outcome of the work.

Service Level Agreement Benefits



SLAs are important to the facility manager because they can produce several benefits, such as:

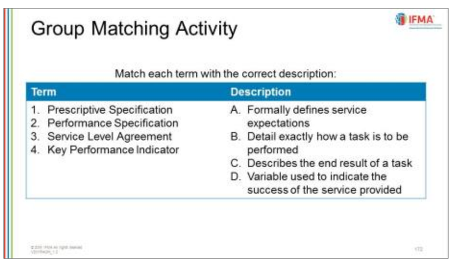
- **Priority response** — SLAs can be written so support level, service performance, response times, reliability, other measures of responsiveness and accountability can be predetermined.
- **Focus on outcomes** — performance standards can be specified so results are measurable and service providers are rewarded or sanctioned, depending upon how well they deliver.
- **Independent expertise** — for some services, such as engineering or information management, the use of a contractor may bring added technical experience or special knowledge or training that the facility may need but is beyond the training or capabilities of staff.
  - An SLA can give the facility manager control over services that may not require high-level skills but are labor-intensive, such as lawn care services.
- **Availability of added services** — an SLA can support the facility manager when outside contractors with special or extended services are needed in emergencies, at critical periods, or when temporary, added support enhances the mission.
- **Maintain focus on organizational mission** — facility managers are expected to support and enhance the core purpose of the facility and its occupants. With SLAs,

the facility manager has a written agreement on what will be done to provide services and how that supports the facility's mission and strategic plan.

- **Control** — a well-crafted SLA provides the direction, means and measures to give the facility manager control over resources and deliver quality results at negotiated costs.
  - When building systems and equipment O&M are contracted, an SLA can help the facility manager negotiate a fixed fee for planned maintenance or for labor and materials for services on request such as corrective maintenance.

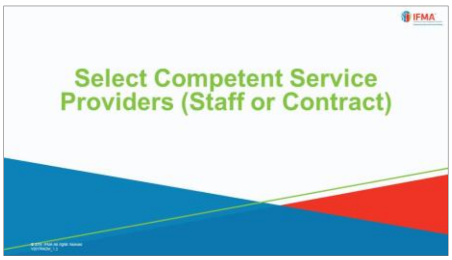
It is important to note that while an SLA has many benefits, the facility manager should also understand drawbacks. For example, if an SLA contains incorrect, insufficient, or unrealistic terms, it may cause issues in the delivery or end result.

Matching Activity



Select Competent Service Providers (Staff or Contract)

Lesson Introduction



On completion of this lesson, you will be able to:

- Compare contractors and select the best resources based on capability.

This lesson contains the following topics:

- Determining What to Contract
- Determine Contract or Staff Assignments
- Considerations for Contracting

Determining What to Contract

Contracting competent providers that are not staff is known as outsourcing, which means hiring an outside firm to supply services. Outsourcing also includes out-tasking, which means hiring an outside firm or individual to perform a specific task within a function, such as cleaning or HVAC maintenance.

Any operations and maintenance or occupant service can be performed by a competent provider. Thus, the decision to use staff or contract work is not an us-or-them consideration, but a choice based on sound reasoning.

The facility manager may use an outside contractor rather than internal staff because they offer capabilities that staff may not have. This can include:

- Specialized capabilities.
- Licenses or certifications.
- Experience performing dangerous tasks.

Outside contractors can also free staff to focus on more important tasks and provide additional support during peak times. For example, use outside contractors to perform activities that:

- Are reoccurring and adhere to a specified job plan, such as custodial cleaning or grounds maintenance.
- Require special or extensive expertise or equipment not relevant to the core mission, such as security, information technology, or landscape equipment.
- Provide extra security and cleaning during and after a special event.

On the other hand, the facility manager can determine what specific activities should be handled by staff. For example:

- Work activities that are highly important to the mission of the facility, such as the maintenance and cleaning of critical equipment.
- Work activities that require high expertise and are critical to the facility mission, such as managing occupant moves or strategic planning, based on:
    - The frequency of the activity
    - The level of special expertise needed
    - The budget available

There are no specific rules documented for making contractor/staff decisions. This is because there can be as many exceptions as there are standards. For example, the stringent requirements for security for a building might require a security service, while the requirements for guarding a manufacturing parking lot could be adequately handled with either staff or a contracted service.

The availability of contractor services or competitive candidates for a particular service may also be factors the facility manager considers. For example, if outside record-keeping services are in short supply, the facility manager may suggest developing that expertise with existing or added staff.

In addition, a facility manager may wish to hire contractors and their expertise as a way to share the risk in complex, sensitive, highly technical or otherwise higher-risk service activities. A contractor who is willing to take on responsibility suggests self-confidence; use of such a contractor can reduce risk or penalty for the facility should something not go according to plan.

In general, the facility manager considers several factors when assessing whether to contract services or manage them internally using staff. These may include:

- Relevance to the facility mission
- Level of control
- Service specialty or uniqueness
- Service response
- Productivity or oversight requirements
- Total cost of services

Relevance to Facility Mission

Facility managers generally focus staff efforts to support the primary mission of the organization. For example:

- If a facility's mission is education, then it might contract repairs or landscaping.
- If a facility's mission is to manufacture a product, it might outsource waste management or cafeteria services

The less significant the service is to the core mission of the facility and its ownership, the more likely that service may be considered for contracting.

This is because the service itself may be outside the experience or current focus of facility management. A facility manager might, for example, be immersed in staff activities that maintain hospital cleanliness and hygienic standards but contract for services to maintain a sterile research lab. This provides flexibility to the facility manager to administrate and support occupant expectations, service quality and building needs.

The business measurements and budgets documented through SLAs can also provide the facility manager with a foundation for measuring the possible cost for adding systems, structural elements and other assets to the infrastructure.

By monitoring costs compared to results, the facility manager can:

- Create and justify a business case relative to contracting or staffing.
- Develop cost analyses to determine the impact of altering or acquiring new infrastructure.
- Determine if service delivery method needs to be modified to adhere to budget constraints.

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Level of Control

Depending on the core business area and the facility manager's capabilities, the decision to use staff or contract for services may be determined based on how much control is wanted or needed.

For example, a facility manager or owners may prefer that certain critical activities be closely monitored by the facility manager through:

- Inspection
- Tightly written statements of work
- Precisely expressed levels of service
- Rigorous monitoring/evaluation of key performance indicators

A facility manager usually has more direct control and authority over staff but can still maintain a level of control over contractors through the SLA, such as instructing on day-to-day operations. In most cases, contractors report first to their supervisors. It is uncommon for a facility manager to directly intervene with contracted staff since it is the responsibility of the contracted supervisor to make sure SLA requirements are met.

Service Specialty or Uniqueness

Contract services may be the alternative choice because skills or capabilities are needed beyond the scope of staff or daily needs of occupants.

For example, contractors may be preferred for:

- Highly technical services requiring special education, unique tools or distinctive skills, such as engineering, architectural design, accounting or maintaining complex equipment.
- Labor-intensive tasks or tasks that have seasonal periods of high demand, such as lawn care, landscaping, custodial services, or moves and relocations.
- Specialty services that may be difficult to manage, irregular or seldom required, such as window washing, master carpentry or floor installation.
- Extensions of capabilities, such as waste management resources that can also handle recycling and environmental disposal as well as custodial cleaning.
- Services that are shared or represent greater economy when contracted as part of a group, such as health insurance management or security monitoring services that benefit from larger customer pools.
- Services involving expert oversight or critical health and safety management issues that exceed the facility manager's expertise or available time. For example,

contracted specialists could supply anything from vaccinations and fitness programs to marketing and customer satisfaction surveys.

Service Response

Circumstances that require an unusually rapid response or significant increase of resources may be better served through contracts. For example, few facilities have their own fire response team or on-premises paramedic unit because the continuing expense in personnel, training and equipment exceeds the potential risks of depending on the services of an outside source. When needed, the quick response and availability of a fire-rescue service also helps lower the total potential damage and thus helps the facility manager control risk better.

The facility manager may determine the need to contract services where flexibility or service response is critical.

For example, contract services may be selected to:

- Manage, maintain and upgrade information technology systems, communications devices and other specialized services.
- Sort, package and distribute products or materials through fulfillment services or moving companies.
- Dedicate availability and personal attention to occupants and visitors, such as through a help desk or lobby information service.

Productivity or Oversight Requirements

Regulatory constraints that require certifications, code compliance or licensed workers may call for services to be contracted. Strict job requirements and regulations may preclude training a staff person to perform the work to specification that could be readily accomplished by, for example, certified electricians, elevator maintenance experts or hazardous materials contractors.

Where the standard for quality or level of compliance is markedly higher than in routine operations and maintenance, the facility manager may wisely hire outside experts. For example, FM may hire outside experts to maintain on-site security, test and charge fire sprinkler systems and fire extinguishers, or to perform work in high, exposed areas or confined spaces.

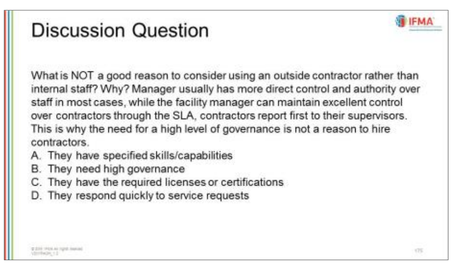
Total Cost of Service

The facility manager builds a business case to help determine whether a service should be handled by staff or contracted. A primary consideration is the balance between the controllable costs of contracting versus the estimated costs in staff hours as well as what services those potential staff hours might better serve.

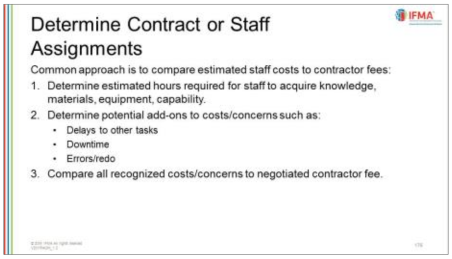
In addition, the facility manager assembles and analyzes costs that account for:

- Types of systems, activities or tasks to be done by describing the work required and performance expectations.
- Frequency of the occurrence to determine staff requirements compared to estimated cost through contracting.
- Crew size and mix to anticipate total range of capabilities, personnel and resources required.
- Total labor hours, materials, tools, equipment and other costs to maintain staff competency.

Each of these factors helps form the basis for a business case that accurately depicts what can be expected and what is required of staff and contractors. In many cases, the business case is self-evident. For example, a moving company may offer greater expertise, packing materials, transportation and labor services than a facility could provide using staff. Even with facilities that experience frequent occupant moves and relocations, a moving contractor may still be preferred based on cost, experience, risk reduction and productivity benefits.



Determine Contract or Staff Assignments



The facility manager decides when to rely on the capabilities of experts and when to use staff or contractors in operations, replacements, renovations and occupant services. Much of this depends on the facility and its use, staff, location and other factors. However, it is wise to be able to recognize when a task or activity can be accomplished in a more cost-effective manner by an outside expert and to know where to find that expertise.

A common approach is to use economic principles to determine whether to develop staff capability or buy contractor expertise. For example, it may be more cost-effective to hire someone to install a raised floor or carpeting than to assign such tasks to an in-house technician.

The process of determining whether to use staff or contractors requires a competent assessment of facts and includes the following:

- Determine the frequency and estimated hours it would take for staff to acquire the knowledge, materials, equipment and capability.
- Determine if any licenses are required.
- Determine the material handling and disposal requirements.
- Determine any aspects that may add to cost or increase concern, such as:
  - Engineering questions
  - Compliance requirements
  - Quality and time of the work
  - Acquisition costs
  - Losses or delays to other tasks
  - Downtime costs if staff cannot perform the work as quickly, completely or within minimum time constraints
  - Chance for error or unacceptable quality
  - Costs of rework

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- Compare all recognized costs, concerns, and factors against the responsibilities taken on by a contractor at a fixed or negotiated fee.

A process such as this might indicate that it is more realistic and economical for the facility manager and internal staff to create their own capability rather than seek a contractor. It may be because:

- Maintenance, operation or renovation requirement is so specialized.
- There is no available contractor.
- Incoming bids are so high that it makes better sense to accomplish the task internally.

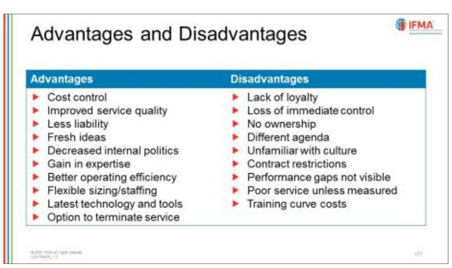
Considerations for Contracting

From an operations and maintenance standpoint, contractors and staff form an interdependent and mutually beneficial relationship. This relationship should be based on a foundation of trust, respect and consensus on performance. The facility manager must also be aware that internal staff may feel threatened by contactor support and should manage those perceptions intelligently.

The facility manager may use several factors to compare and contrast candidates as well as to determine whether staff or contracted services can provide what is best for the facility and occupants. The facility manager also considers what will receive the support of senior management.

These factors include comparing advantages and disadvantages, rating candidates, ranking candidates and determining candidate compliance.

Advantages and Disadvantages



By acknowledging possible advantages and disadvantages of contracting, the facility manager can better understand and prepare for potential issues with contractors or staff. The facility manager generally decides on whether to use contractors or staff resources based on which can achieve the highest possible quality, with the greatest efficiency, at the lowest total expense.

For example, a facility manager may favor a staff response to a critical equipment failure because, all things being equal, the contractor cannot respond as quickly as on-site personnel. The facility manager may contract for traditionally recognized staff functions because it better serves the facility's mission and thus everyone in the organization. When relationships develop based on positive criteria rather than competitive distrust, both staff and contractors recognize that they are needed and valued.

Exhibit 5-2 outlines some of the aspects a facility manager may use to make critical comparisons. These perceptions may be real or imagined. Regardless, the facility manager is aware of these potential issues, so all personnel feel respected, acknowledged, and understood.

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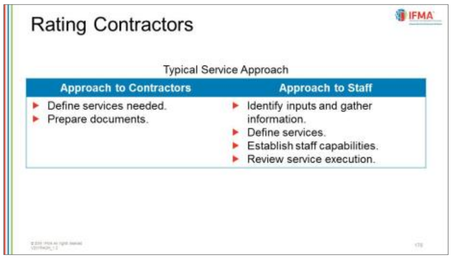
Exhibit 5-2: Potential Advantages and Potential Disadvantages of Contracting

Potential Advantages	Potential Disadvantages
• Cost control • Possible improvement in service quality • Less liability, such as insurance or legal • Fresh ideas, best practices • Less involvement in internal politics • Increased expertise • Better operating efficiency • Flexible sizing to meet each need • Latest technology and tools • Service can be terminated • Greater flexibility of staffing • In-depth specialization • Minimum on-space site needs • Negotiated, dependable cost • Fast, complete response, potentially unlimited worker availability • Accountability to SLA specifications • Contractor responsible for labor relations • Reduced staff work burden • Predictable, controllable cost • Reduced operational expenses, which extends staff capabilities without adding to staff/benefit costs • Risk Deference	• Lack of loyalty • Loss of immediate control • No ownership • Different agenda, such as money for contractor • Unfamiliar with business culture • Contract restrictions • Performance gaps not visible • Poor service unless measured • Training curve costs • Less control over personnel assigned • Turnover of personnel • Security issues • Minimum on-site empowerment • Future cost escalations • Unavailable for non-contracted response • Less flexibility in out-of-specification areas • Potential union/non-union conflict • Potential for poor staff morale • Possibly higher cost than staff • May require different supervisory skills than used for internal staffing • Poorly worded SLA/SOW may leave gaps

Rating Contractors

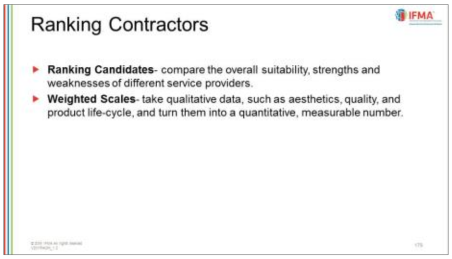


To measure the relative business effectiveness of candidates, the facility manager may look at important factors such as:

- Personnel expertise, training, work reputation and turnover.
- Safety records and business financial stability.
- Personnel supervisory quality, flexibility assigning or changing workers.
- Service reputation among other facility managers.
- Licenses and certifications, such as whether the candidate can provide inspectors for regulated inspections including:
  - Boiler certifications
  - Qualified elevator inspector certifications
  - Testing for fire alarm and suppression systems
  - Backflow preventers and fall protection
- Business experience, financial stability and pricing policy.
- Local presence for support, response, capacity to react to new conditions or requirements.
- Speed of response to service calls, support for emergency needs.
- Available tools, equipment, facilities and materials.
- Capacity to provide aligned or extensions of services.
- Communication, culture, relationships with facility managers and occupants in performance of services.

Whether the facility manager is considering staff or a contractor as the service provider, the process for determining needs should be clear and effective.

Ranking Contractors



The facility manager may consider the suitability of candidates by giving each a high, medium or low ranking based on the competency area. These ratings can be summarized in a scorecard or grid such as the one shown as *Exhibit 5-3*. This allows the facility manager to conveniently and impartially compare the overall suitability, strengths and weaknesses of different service providers.

The facility manager prepares a request for information (RFI), which is a request to gather information such as that listed in the exhibit below.

For contractor rating, scores per competency area are as follows:

- Low: 1–3
- Medium: 4–6
- High: 7–9

Exhibit 5-3: Contractor Comparison

Competency Area	Contractor A	Contractor B	Contractor C
Personnel training, expertise			
Supervisory quality, awareness			
Service reputation			
Licenses and certifications			
Business competency, stability			
Local presence, availability			
Service response, flexibility			
Tools, material, equipment support			

Competency Area	Contractor A	Contractor B	Contractor C
Capability to expand services			
Communications, relationships			
Contractor Rank (total/column)			

Weighted scales are another form of comparing service providers. Weighted scales take qualitative data, such as aesthetics, quality, and product life-cycle, and turn them into a quantitative, measurable number. These numbers are then calculated against a "weight," or percentage, representing importance. *Exhibit 5-4* shows a section of a weighted scale comparing furniture manufacturers.

To compare vendors:

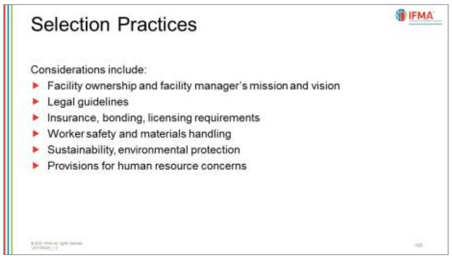
- Decide on the variables or criteria such as past performance, expertise, financial stability, and the like.
- Weight the variables or criteria in terms of how important they are to performing the work. The weights should add up to 100.
- Rate the vendors using a 5-point scale with 5 being the highest for each variable.
- Multiply the rating with the importance to come up with a score.
- Total the scores.

Exhibit 5-4: Weighted Scale Example

		Company A		**Company B**	
Factor	**Weight**	**Rating**	**Score**	**Rating**	**Score**
Proven Competence	30%	4.0	1.2	3.5	1.05
Availability	25%	3.0	.75	4.0	1
Cost/fee	25%	3.0	.75	4.0	1
Financial Stability	20%	4.0	.8	4.0	.8
	100%				
Total Score			**3.5**		**3.85**

Note: Score rated on a 1-5 scale

Selection Practices



When reviewing or selecting contractors, it is important to determine that they comply with:

- The facility's mission and vision.
- Legal guidelines such as codes, permits and accepted standards of practice.
- Insurance, bonding and licensing requirements.
- Worker safety and prescribed methods for handling hazardous or noxious materials.
- Sustainability, environmental protection and related quality concerns.
- Provisions for barrier-free access, equal employment opportunity and related human resources concerns.

Another good practice when selecting among candidates is to assess the level of technology and management systems the contractor has available. If a location is remote or the contractor has limited information technology access or capabilities, the skill level of personnel may still be the more significant factor. However, considerations on how a contractor can support data exchanges with the facility manager's system can be useful for decision-making and should be considered in the selection process.

The facility manager may use all of these factors, along with price, to compare competitive contractors, and estimated staff costs, as a way to arrive at the most competent candidate.

In the contract preparation, bidding and selection process, the facility manager:

- Assesses candidates using specific and measurable criteria that fully and accurately compare their qualifications.
- Uses service level agreement information, known best practices, service response requirements, key performance indicators, and other measurable qualities to arrive at the best candidate and make the selection based on concrete and justifiable factors.
- Carefully documents the selection process. Today's business and legal environment has made it important that the facility manager prepare and retain all documentation to be able to demonstrate the basis for selection and its justification if requested or needed at some later time.

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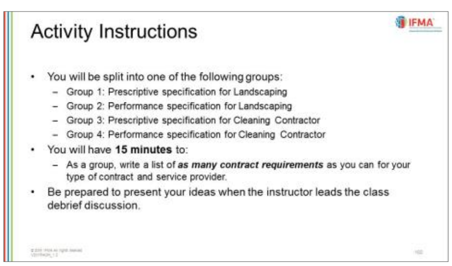
To select or compare contractors or staff, the facility manager typically applies the performance criteria defined in the SLA, or similar service contract. Once candidates are selected, the facility manager can also use these performance criteria to monitor activities and hold service personnel accountable for their work.

A complete discussion of contracts, contracting and competent approaches useful to the facility manager is contained in the *Finance and Business* course.

Lesson Activity

SLA Group Activity



Instructions

- You will be split into one of the following groups:
  - Group 1: Prescriptive specification for Landscaping
  - Group 2: Performance specification for Landscaping
  - Group 3: Prescriptive specification for Cleaning Contractor
  - Group 4: Performance specification for Cleaning Contractor

- You will have **15 minutes** to:
  - As a group, write a list of ***as many contract requirements*** as you can for your type of contract and service provider.
- Be prepared to present your ideas when the instructor leads the class debrief discussion.

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Discuss and Agree on Service Level

Lesson Introduction

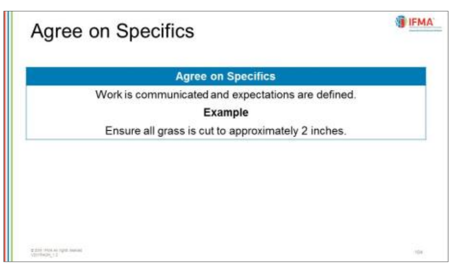
On completion of this lesson, you will be able to:

- Explain the discussion process for a typical service level agreement.

This lesson contains the following topics:

- Agree on Specifications
- Common Discussion Characteristics
- Negotiated Terms

Agree on Specifications



The facility manager communicates all work through a work order whether for maintenance, repairs, upgrades, ongoing or delayed work, activities involving occupant services or emergencies. The expected results should be clearly described and defined in the WO. Outcomes should be specific and measurable.

As mentioned previously, service contractors and the facility manager begin discussion at the request for proposal. Once a proposal is submitted by the contractor, terms can be negotiated between the parties in order to come to a mutual agreement of expectations.

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The desired results should reflect realistic and agreed-upon standards that all parties understand as the same. Agreements should not be left to individual judgment but should instead reflect mutual understanding.

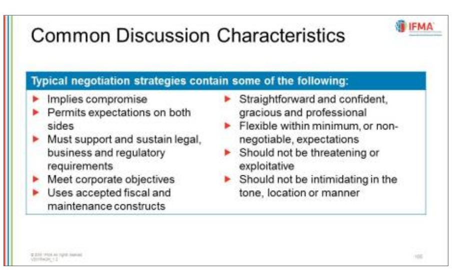
For example, some specifics relative to custodial services could include specifications such as:

- Wipe surfaces until dust and smudges are not visible, polish all unpainted metal surfaces within six feet of the floor; use accepted safety precautions to clean in the same manner all other visible metal surfaces.
- Replace fluorescent lamps semiannually and ballasts upon failure; clean light diffusers annually so no residue, dirt or other foreign items are present.
- Vacuum all hallway carpeting edge-to-edge before 7:00 a.m. to avoid interfering with regular occupant arrival.
- Inspect for and correct unsightly conditions such as dirt in corners, mop splashes on base boards or floor wax applied over dirt spots.

The contractor or staff assigned to the work should be involved in developing the standards expected of the work. This helps make everyone aware of the expectations and encourages agreement before work begins and is an excellent starting point if inconsistencies or misunderstandings occur.

Engineering specifications are precise and complete, expectations written for occupant services and the people who provide them should be unambiguous and thorough. By involving workers in the development of specifications, the facility manager makes use of their experience to help make the expected work approach realistic, understood, concrete and in everyone's best interest. When details are precise, the worker knows what is expected and can feel confident about doing the task right the first time.

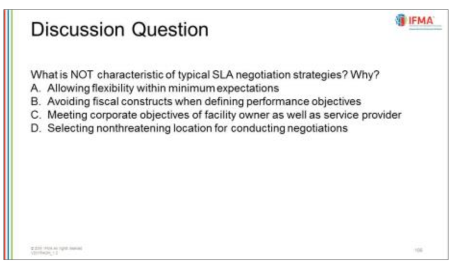
Common Discussion Characteristics



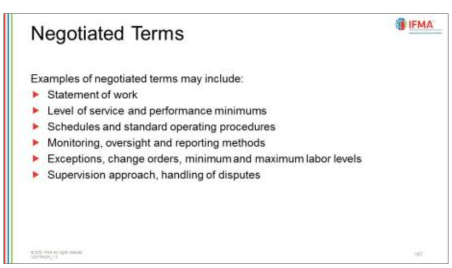
Typical negotiation strategies contain some common characteristics. Negotiation:

- Brings compromise between parties.

- Permits expectations on both sides so, once an agreement is made, both feel they have made concessions and have cooperated to achieve the outcome.
- Must support and sustain legal, business and regulatory requirements.
- Should meet the organization's corporate objectives as well as the service providers.
- Uses accepted fiscal and maintenance constructs to clearly define performance criteria measures through:
    - Return on investment, which measures how efficiently management is employing financial resources invested in the firm.
    - Hourly task time or historic data.
    - Standard books that reflect typical work times by task.
    - Other similar means.
- Should be straightforward and confident, gracious and professional.
- Should be flexible within minimum, or non-negotiable, expectations.
- Should not be threatening or exploitative.
- Should not be intimidating in the tone, location or manner in which it is conducted.



Negotiated Terms



Anything can be negotiated, depending on the requirements of the facility, its manager and the capabilities of the contractor.

Examples of negotiated terms may include:

- Statement of work

- Level of service and performance minimums
- Contract cost
- Schedules and standard operating procedures
- Monitoring, oversight and reporting methods
- Exceptions, change orders, minimum and maximum labor levels
- Supervision approach, handling of disputes

A process for discussing terms in a public-sector contract is likely to be prescribed by law, regulation or approved administrative procedures. A process for contract negotiations in the private sector can be as unique as the individuals and organizations engaged.

Relative to negotiations themselves, two significant areas requiring diligence are factors in service level agreements and documenting determinations.

Factors in Service Level Agreements

Work planning includes prioritization, coordination and flow requirements. The work plan is central to the negotiation because it specifies the expectations, approach and limits concerning the O&M service to be done. The service specification should quantify the minimal acceptable service standard that fulfills the facility mission, meets statutory requirements and accomplishes the performance outcome.

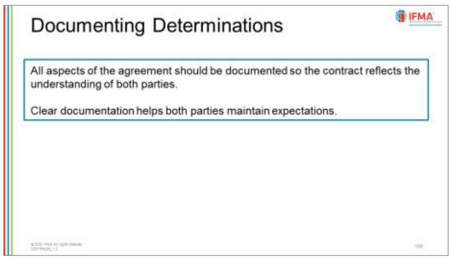
Service specifications, as part of service level agreements themselves, are tools the facility manager can use to negotiate many aspects, including:

- Scope of work and control over change
- Acceptable quality performance level
- Service level minimums and maximums, or when work is done
- What constitutes work beyond specification or agreed-upon response
- Value or pricing of services provided; fee changes for added or reduced services
- Consequences of failure to meet service level requirements such as fines, fees, loss of incentives, contract reduction, termination

- Rights and obligations of both awarding and service-providing parties

The facility manager regards service specifications not as fixed statements of requirements but as foundation descriptions for continuous improvement.

Documenting Determinations



All aspects of the agreement should be documented so the contract reflects the understanding of both parties. Documentation ensures service activities are recorded and O&M work proceeds.

A clear, precise statement of expectations represents the agreed-upon core of service requirements and thus the understanding between both parties. The negotiated, documented agreement is the basis for the relationship between the facility manager and the contractor and the source for measuring performance and outcomes.

Methods and incentives to influence continuous improvement and inhibit inferior work help both parties maintain contract expectations with less conflict, misunderstanding or communication challenges.

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Monitor Work/Service Performance

Lesson Introduction

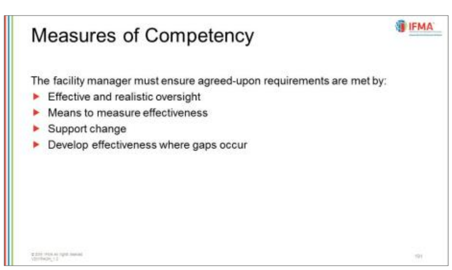
On completion of this lesson, you will be able to:

- Describe the principles of measuring competency, monitoring performance and evaluating outcomes for work/service.

This lesson consists of the following topics:

- Measures of Competency
- Monitor to Manage
- Monitor Through SLAs
- Agree on Performance Specifications
- Value of Incentives
- Evaluate Using Best Practices
- Communicate Through Feedback

Measures of Competency



The facility manager judges performance by comparing actual results with agreed-upon requirements as stated in the contract. By specifying performance criteria in SLAs, the facility manager uses them to measure work performance in a way that is impartial, less stressful and more professional.

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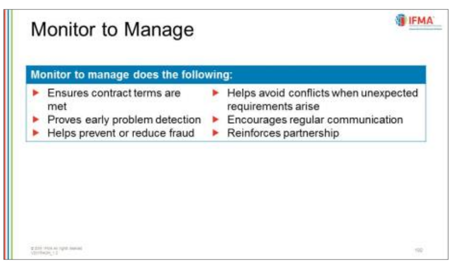
The facility manager needs to have an effective and realistic oversight plan that clearly shows whether contractors and staff are meeting agreed-upon requirements. This ability is critical so the facility manager can review performance expectations in an accurate and timely manner.

The source for analyzing effectiveness should be the SLA with its statement of work, level of service requirements, and KPIs that set goals.

With a complete, quantitative, agreed-upon set of performance requirements and activities, the facility manager has the means to not only measure effectiveness, but also support change to develop effectiveness where gaps occur.

Monitor to Manage



"What is measured gets done." This statement implies that O&M activities and the conduct of occupant services are inspected and monitored.

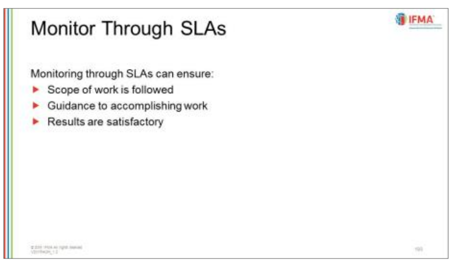
Monitoring work to determine that requirements are met is necessary and useful to the facility manager for several reasons:

- Comprehensive monitoring provides information about whether contract terms are met or not.
- Regular, ongoing inspections alert the facility manager early to eroding conditions, unmet expectations, potential misunderstandings or other service delivery issues before small exceptions become large challenges.
- Routine monitoring, and the contractor knowing that inspections will regularly occur, is one way to prevent or reduce fraud as well as ensure maintenance work is being properly completed as per the contact SLA.

- Inspections alert the facility manager to changing conditions or possible service delivery problems and support the relationship, avoiding conflicts when misunderstandings or unexpected requirements arise.
- Diligent and thorough inspections encourage regular communication between the facility manager and the service provider.
- Ongoing monitoring signifies that the facility manager is serious about the maintenance work and verifies what the service provider is accomplishing; it reinforces the partnership.

Inspection should not imply adhering blindly to work specifications or micro-managing to find fault. Contract work inspection is a practical and realistic means to keep all parties informed and in agreement about what is being done compared to what is expected. It is a useful way to maintain communications after the contract is negotiated and signed.

Monitor Through SLAs



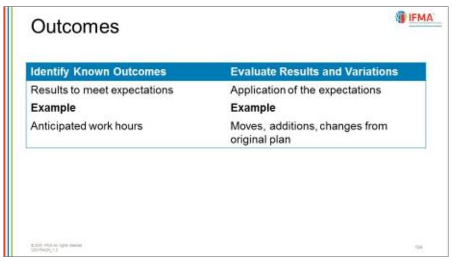
The SLA is the facility manager's reference point for monitoring the delivery of services. Properly written SLAs clearly describe the scope of work, defining the agreement among parties about what is to be done, when and to what extent. This makes an SLA a useful tool the facility manager can follow to monitor work and identify discrepancies.

Service level agreements, or similar documents that identify and clearly describe the work to do and how results are measured, can be useful whether the work is performed by internal staff or contracted services. SLA-type documents may be developed with staff as provided to human resources or administration by the facility manager.

A comprehensive review for administering and maintaining contracts is found in the *Finance and Business* course.

The facility manager must recognize the importance of having satisfied occupants and must strive to make O&M comply not only with physical, functional expectations, but also across a range of other aspects. Occupant opinions may take what began as a functional specification and expand it to include aesthetic and social impacts. This can make it a more encompassing idea of the results they expect to be achieved.

Outcomes



Work quality or performance should be measured by clearly defined standards. Vague references can lead to different interpretations and misunderstanding. When work order expectations, SLAs and other documents are clear, precise and quantitative, the work is more likely to meet expectations without controversy. Performance measures not only indicate the goals to be achieved but also show both the service provider and the facility manager whether or not performance is achieved.

A few general principles relative to outcomes are:

- Identify known outcomes
- Evaluate results

Identify Known Outcomes

When the approach to the work is clear, the results are also likely to meet expectations. The outcomes are different for sanitizing a hospital operating room than they are for cleaning an office hallway. However, both should have written descriptions that accurately state what should be done and what to achieve.

The facility manager strives to identify known outcomes or expectations, budgets or reasoned estimates of specifics so work plans are practical and agreed among all parties.

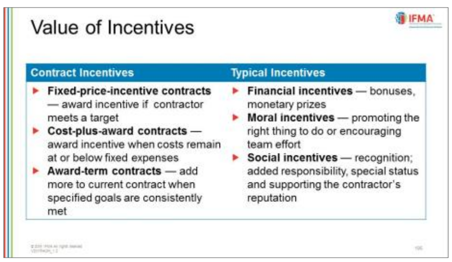
Work plans can include, for example, estimates of:

- Staff size, mix of trades
- Anticipated work hours

- Travel and setup time
- Work duration
- Work tasks, including checklists
- Skills, tools, equipment and preparation needed, including special training or personal protective equipment

The more complete, specific and mutual the work plan is, the more efficient and expected will be its outcome.

Value of Incentives



Incentives are useful tools to reward and direct work output and results. They may be used to avoid a strike or encourage a specific activity. They may also help resolve disputes and avoid the potential cost of litigation or disruption of operations. However, the use of incentives must never be perceived as a payoff, corruption or give the appearance of bribery or inappropriate influence. The facility manager must ensure that incentives are used in a fair and trusted manner by understanding the needs of the organization and reward work results.

An incentive can be financial or nonfinancial to influence a particular action, behavior or result. Typical incentives include:

- Financial incentives such as rewards, bonuses, monetary prizes and contract extensions.
- Moral incentives such as promoting the right thing to do or encouraging team effort.
- Social incentives through recognition such as personal letters, awards, added responsibility, special status and supporting the contractor’s reputation.

Contracts can be reward-based and may offer incentives for meeting work requirements, exceeding goals or simply consistently meeting specifications. Different types of incentive-based contracts include the following:

- **Fixed-price-incentive contracts** — provide added payment or other incentives if the contractor meets or stays beneath a targeted cost yet delivers quality or performance at or above the targeted minimum.
- **Cost-plus-award contracts** — hold the contractor to an agreement on maximum expenses and rewards with a bonus when costs remain at or below those fixed expenses.
- **Award-term contracts** — award contractors who consistently meet specified goals by extending or adding more years or expanding tasks to the current contract.

Incentives and rewards may be made spontaneously to recognize positive activity in the moment or announced in advance to emphasize work toward a specified goal. Incentives can also be used to deter unwanted action, behavior or results. For example, a bonus may be lost because of below-standard quality, a missed deadline, or other specified goal not being met.

When incentives are included in the scope of work for contractors or staff, the facility manager uses precisely understood and measurable specifications to determine work performance. These performance measures should be carefully prepared so whether incentives are awarded or withheld, the affected personnel recognize that the decision was correct according to the agreed-upon specifications.

Evaluate Using Best Practices

Best practices are techniques or approaches that consistently provide the desired results across an industry or within an organization.

In facility management some general best practices are developed to produce the following:

- **Occupant satisfaction** – How do occupants perceive their environment and the quality of services and infrastructure?

- **Financial best value** – How do budgets compare to costs, and what is the trend relative to costs versus benefits?
- **Emphasis on facility core mission** – How competently is O&M supporting the facility's core mission and satisfying occupants?
- **Efficient and effective operation** – How is the facility doing in terms of delivering to the purpose intended and to the expectations of the owner/executive management?

Best practices in facility management help the facility manager monitor O&M work so it continues to meet specified expectations. These best practices may be developed as performance management measures that provide evaluations the facility manager can use.

Examples of best practices derived as performance measures or benchmarks include:

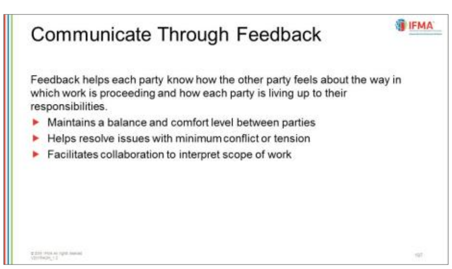
- Year-to-year comparisons and quarterly reports that show relative progress over time or against earlier times.
- Comparing activities such as priorities met compared to priorities set, appropriate assignment and use of skill sets, actual hours compared to estimated hours, compliance with codes and regulations.
- Performance management measurements that support performing the activity with the minimum wasted effort and the maximum relative value.

Both efficiency and effectiveness are necessary for adequate performance measurement. Taken together, efficient and effective performance evaluations help the facility manager measure, monitor and discuss a contractor's or staff person's work. More examples are shown in *Exhibit 5-5*.

Exhibit 5-5: Efficiency/Effectiveness Measures

Efficiency-Based Performance	Effectiveness-Based Performance
• Work time and total time per work order • Percentage of total work completed within a given time and compared to previous periods • Standard hours divided by actual hours, not counting delays • Total maintenance cost as a percentage of replacement cost • Number of work orders completed as scheduled or within a given time compared to previous periods • Number of checklists and work aids compared to previous periods • Hours or percentage of time spent in preparation, travel or setup compared to previous periods • Crew sizes and percentage of lower to upper skill mix compared to previous periods • Funding of maintenance as a proportion of the entire infrastructure budget compared period to period or to average • Percentage of contractors working from service level agreements	• Level of customer satisfaction as a percentage • Change in percentage of deferred maintenance or number/hours of delays • Percentage or number of change orders compared against previous periods • Change in percentage of preventive maintenance versus corrective maintenance • Percentage of work plan executed compared to assigned • Percentage of predictive maintenance work orders compared to preventive maintenance as a proportion of all work orders • Percentage of equipment failures or run time to failure against previous periods • Percentage of callbacks or returning to maintenance job because of incomplete or incorrect work • Percentage of occupant complaints or accolades compared to previous periods • Quality, sustainability and conservation programs and performance compared to previous periods

Communicate Through Feedback



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Communication provides feedback. Feedback helps each party know how the other party feels about the way in which work is proceeding and how each party is living up to their responsibilities. Frequent communication helps maintain a balance and comfort level between parties so issues can be raised and resolved with minimum conflict or tension.

Once a service provider, contractor or staff is selected, the facility manager clearly communicates what has been established as successful performance. The objective is to publish and follow agreed-upon criteria so the facility manager and the service provider concur on what maintenance or service is to be done, what the intended outcome will be or how it will be done, and how that performance will be measured. These criteria hold whether the work is operational, asset maintenance or supplying occupant services such as custodial cleaning, food services or mail distribution.

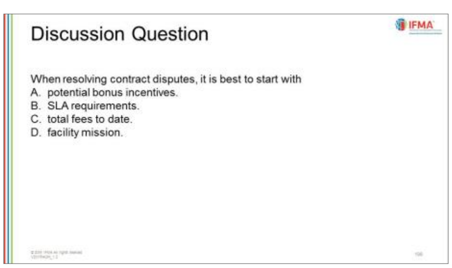
This clarity can be particularly important when working with contractors who are responsible for maintaining an asset. It is easier for contractors to maintain new equipment and have the facility owner pay for replacement. Facility managers trust their contractors yet retain the ability to independently and objectively verify their recommendations and agree on any capital expenditure plan.

When repair and replacement decisions must be made, contention can occur between the facility manager/owner and the service provider. Questions must be resolved regarding:

- Who pays for replacing the asset?
- When does it need to be replaced?
- Why does it need to be replaced- was it the end of its useful life or was it improperly maintained?

The facility manager communicates regularly to keep contactors and staff alert to the performance requirements that are already agreed upon. These discussions should seldom contain surprises because they start with the stipulations of the work agreement.

They may come under dispute about what one side or the other sees as exceptions to the agreed-upon contract principles. However, with a well-defined and mutual SLA and scope of work agreement, the discussion can be about interpretation rather than blame.



Resolve Contract Disputes

Lesson Introduction

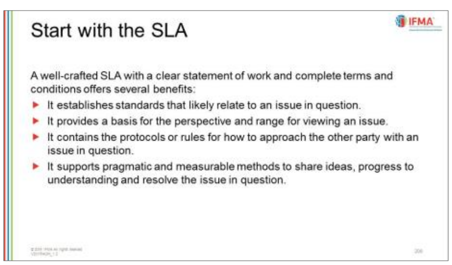
On completion of this lesson, you will be able to:

- Describe key factors and attitudes relative to contract disputes and their resolution.

This lesson consists of the following topics:

- Start with the SLA
- Managing the Relationship

Start with the SLA



Organization should have contractors and staff who are satisfied with their work environment, focused on outcomes and concentrating on tasks. This is how building maintenance and occupant service work gets done, occupants are served and the facility operates for maximum results. Contract disputes do not serve any of those issues, and the facility manager must determine ways to avoid and resolve contract disputes.

The most effective way to resolve contract disputes is to have the means to address them in the first place. The facility manager must focus on specifics to support the relationship and encourage discussion. A concrete and mutually agreed upon SLA gives both the supplier and the facility manager the basis for discussing a conflict.

Complete, accurate, measurable and specific work descriptions make it far easier to recognize, discuss and resolve disputes.

A well-crafted SLA with a clear statement of work and complete terms and conditions offers several benefits:

- It establishes standards that likely relate to an issue in question.
- It provides a basis for the perspective and range for viewing an issue.
- It contains the protocols or rules for how to approach the other party with an issue in question.
- It supports pragmatic and measurable methods to share ideas, progress to understanding and resolve the issue in question.

The quantitative requirements of the SLA are an excellent starting point because they provide a basis that both parties are familiar with, understand and agree on.

Those measures may come to be disputed for any number of reasons, such as:

- Objectives or expectations are considered to be too high or too low.
- Conditions have changed, making performance objectives unachievable or unrealistic.
- New conditions relative to expectations have changed the capability to achieve or measure original goals.
- Either party identifies a gap that changes requirements and their outcome.

The facility manager must regularly and at least annually review results to validate assumptions, check against the facility strategic plan, and be confident that work descriptions and outcomes reflect current, mutually agreed-upon parameters.

The value of existing measures remains important, even if their validity has changed. The original standards can still be the initial basis for reviewing what has changed, how to approach it and how both parties can support a resolution. This can more easily happen when the dispute or new expectations are clearly described so differences of opinion can be clearly understood, and compromises can be devised.

A positive result can be more readily achieved when:

- A previously agreed-upon process is already in place and respectfully followed by all parties for resolving disputes.
- The issue in question is documented and that documentation is shared among all parties.
- The atmosphere surrounding discussions remains cordial and focused on specifics.

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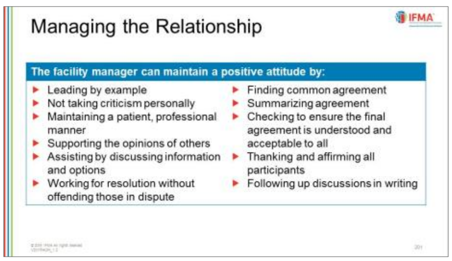
An SLA cannot anticipate every possible contract dispute and thus avoid all conflict. However, the facility manager can use a well-drafted service level agreement to begin the conversation positively and to develop a mutually satisfying result. Even if no basis can be found in the SLA, the discussion can still be treated as a negotiation between parties to find an equitable solution in the same way that the initial contract was negotiated.

Managing the Relationship



It is important to properly manage the relationship throughout the course of the contract between the facility manager and service provider. A properly managed relationship maintains communication and understanding. There is the possibility of disagreement during the relationship. This can cause dispute between the parties and must be dealt with in a healthy and positive manner.

To maintain dialog during disputes, the facility manager must maintain a positive attitude, actively listen, and have patience. This approach concentrates on finding the solution by analyzing the problem, not the party involved.

The facility manager demonstrates this attitude in many ways, including:

- Leading by example.
- Not taking criticism personally.
- Maintaining a patient, professional manner with a positive tone.
- Supporting the opinions of others by listening fully without interrupting.
- Maintaining patience throughout the discussion.
- Assisting by discussing information and options while managing expectations.
- Working for resolution without offending those in dispute.
- Finding common agreement in an atmosphere of accord.
- Summarizing agreement as discussions proceed.
- Checking with everyone concerned to ensure that the final agreement is understood and acceptable to all.

- Thanking and affirming all participants.
- Following up or documenting discussions in writing.

Facility managers must concentrate on understanding the nature of the relationship and working with the service provider. The contract itself should clearly reflect what is expected of the service provider and how those expectations are measured. Without clearly stated measurements, discussions may be less productive and more adversarial.

Respect, flexibility, willingness to listen and an unbiased attitude are qualities the facility manager must bring to discussions. They calm tense situations and help produce an atmosphere for productive resolution and an even stronger future relationship between the facility manager and the staff or contractor who provides the service.

The *Finance and Business* course covers alternative disputes in more detail.

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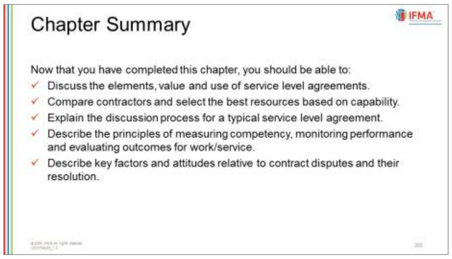
Chapter Summary
IFMA
Now that you have completed this chapter, you should be able to:
✓ Discuss the elements, value and use of service level agreements.
✓ Compare contractors and select the best resources based on capability.
✓ Explain the discussion process for a typical service level agreement.
✓ Describe the principles of measuring competency, monitoring performance and evaluating outcomes for work/service.
✓ Describe key factors and attitudes relative to contract disputes and their resolution.

Progress Check Questions

1. What is the difference between a service level agreement and a statement of work?
   a. There is no difference; they are identical.
   b. A statement of work can be part of a service level agreement.
   c. A statement of work can be negotiated; an SLA cannot.
   d. A statement of work is for staff; a service level agreement is for contractors.

2. What is typically contained in the SLA for contracting outside services?
   a. SLA's contain all information both parties require.
   b. SLA's do not stipulate how disputes will be handled.
   c. SLA's provide the facility manager with negotiating advantages.
   d. SLA's discuss incentives only in the event of disputes.

3. Who typically submits standard operating procedures?
   a. Owner/executive management.
   b. Facility manager or designate.
   c. Contractor or candidate service provider.
   d. Legal staff or administrators.

4. Why might outside contractors be hired instead of using facility staff?
   a. Staff lacks the competencies.
   b. You cannot justify using staff.
   c. The work requires competencies not relevant to the core mission.
   d. All of the above

5. What in general, is true about an activity that has high mission relevance and requires low expertise?
   a. It can probably be performed by a contracted service.
   b. It seldom requires an operations and maintenance focus.
   c. It most often requires expert services beyond the level of staff.
   d. It most likely represents a good option for staff assignments.

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6. What best describes the process of outsourcing or out-tasking?
   a. Rewarding high performers.
   b. Scheduling staff or contractors for maximum productivity.
   c. Comparing results of staff against contractors.
   d. Contracting for services, not using staff.

7. Why should a facility manager weigh the advantages and disadvantages of contracting?
   a. To better understand and prepare for potential issues with contractors or staff
   b. To foster an us-versus-them competition for greater productivity
   c. To favor staff over contractors wherever possible
   d. To better justify the use of staff over contractors

8. Which statement would NOT be considered an appropriate characteristic of negotiations?
   a. Discussion implied with compromise
   b. Meet objectives of service providers and facility owners
   c. Designed to give the facility manager an advantage
   d. Specific performance measures and non-negotiable minimums

9. What statement best defines fixed-price-incentive contracts?
   a. Provide added payment or other incentives if the contractor meets or stays beneath a targeted cost yet delivers quality or performance at or above the targeted minimum.
   b. Hold the contractor to an agreement on maximum expenses and rewards with a bonus when costs remain at or below those fixed expenses.
   c. Award contractors who consistently meet specified goals by extending or adding more years or expanding tasks to the current contract.
   d. None of the above.

10. What is an effective way to avoid contract disputes?
   a. Use incentives and rewards.
   b. Establish concrete and mutually understood SLAs.
   c. Use flexible scheduling and provide access to human resources.
   d. Maintaining a positive attitude.

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Progress Check Question Answer Key

Chapter 1: Introduction to Operations and Maintenance

Operations and Maintenance Overview

1. c
2. b
3. d
4. a

Begin with a Plan

1. b
2. c
3. d
4. d
5. b
6. c

Chapter 2: Assess and Inspect Facility Needs

Assess and Inspect Condition of Building Structure

1. a
2. c
3. d
4. b

Assess and Inspect Exterior Structures and Elements

1. d

Assess and Inspect Condition of Building Systems

1. b

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2. a
3. a

Assess and Inspect Interior Furnishings, Fixtures and Equipment

1. a

Assess and Inspect Grounds

1. b

Chapter 3: Manage, Oversee, and Monitor O&M of Building, Systems and Equipment

Acquire Systems, Materials and Equipment

1. a
2. a

Install Systems, Materials and Equipment

1. d
2. b

Maintain Systems, Materials and Equipment

1. c
2. d

Operate Building Systems and Equipment

1. a
2. b

Monitor Use and Performance of Facilities

1. a

Replace Systems, Materials or Equipment

1. b

Chapter 4: Manage, Oversee and Monitor Occupant Services

Recognize Required Occupant Services

1. d

Develop Usage and Service Level Guidelines

1. a
2. a
3. c
4. c
5. d

Prepare and Execute Modifications to Occupant Services

1. a
2. b
3. a

Monitor Occupant Satisfaction

1. d

Chapter 5: Select the Best Resources

Develop Maintenance and Occupant Service Specifications

1. b
2. a
3. c

Select Competent Service Providers (Staff or Contract)

1. d
2. d
3. d
4. a

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Discuss and Agree on Service Level

1. c

Monitor Work/Service Performance

1. a

Resolve Contract Disputes

1. b

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Appendix

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Glossary

Adjustment

Refers to any activity performed on materials, equipment, systems, and so on, to adjust, recalibrate, adapt or otherwise change the circumstances of that asset to match a standard or meet a requirement.

Balanced scorecard

A long-term strategy implementation tool developed by Kaplan and Norton that guides staff by providing measurable goals and feedback. It balances short- versus long-term goals and objective versus subjective measures. It combines different perspectives — people, customers, processes, finance — to provide a more holistic analysis.

Building infrastructure

Building infrastructure consists of building systems, building structures, interior elements (including furniture, fixtures and equipment), exterior envelope, separate structures and grounds.

Cleaning (noncustodial)

Cleaning (noncustodial) can improve operational productivity. Dust buildup; air, oil and steam condensate on filters; grease accumulation on machinery; and dirty atmospheric conditions in general can bind equipment, accumulate on surfaces and affect occupants, and in other ways inhibit how the facility efficiently conducts its mission.

Corrective maintenance

Corrective maintenance is any activity that is required to correct an unanticipated component failure that has occurred or is in the process of occurring, for example, a machine breakdown because of bearing failure. This activity may consist of repair, restoration or replacement of components.

Emergency maintenance

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Emergency maintenance is any activity that requires immediate repair because of impending danger to the occupants, their business processes, the building or a building system.

Facility Management (FM)

Facility Management is an organizational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business (ISO 41011:2017).

Forecasting

Forecasting helps the facility manager develop long-term capital budgets. It also gives the facility manager the means to assess operations and maintenance plans relative to life-cycle costs.

Lubrication

Lubrication, in its most generic meaning, means to make smooth or slippery to reduce friction and prevent damage by abrasion.

Maintenance

Maintenance ensures that all elements of infrastructure are serviced to operate efficiently, and are reliable and safe. Periodic, predictive, preventive, and corrective activities are scheduled and conducted regularly.

Major repairs

Major repairs are generally those that exceed two workdays or cannot be performed by staff.

Minor repairs

Minor repairs are generally ascribed to maintenance activities that do not exceed one or two workdays per task and do not noticeably prolong service life or add to value.

Occupant satisfaction

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Occupant satisfaction is important because it indicates customer approval, and the approval and satisfaction of customers is critical to the success of any business, public and private. Serving customers/occupants well is a vital step toward success and, ultimately, a facility's ability to fulfill its mission.

Occupant Services

Occupant Services refers to anything that facility occupants or visitors might need beyond the operational maintenance of the hard assets of the building and its systems.

Operations

Operations is about ensuring that the facility's infrastructure and how it is used and managed provides a satisfactory work environment, is in compliance with laws and regulations, meets financial performance goals, and protects the surrounding community and environment.

Operations

Operations ensure that the facility's infrastructure usage and management provides a satisfactory work environment that is in compliance with all laws and regulations, meets financial goals, reflects efficient utility services and costs, and protects the surrounding community and environment

Painting

Painting is a general term to describe the act of coating any surface with any liquid for a utilitarian purpose.

Periodic or occasional inspection

Periodic or occasional inspection is any task undertaken to determine the condition of equipment and/or the tools, labor, materials and equipment required to repair an item.

Predictive Maintenance (PdM)

Predict when equipment failure might occur, and prevent the occurrence of the failure by performing maintenance.

Preventive Maintenance (PM)

A fundamental, planned maintenance activity performed at regular predefined intervals, designed to improve equipment life and avoid any unplanned maintenance activity.

Replacement

Replacement of parts is the act of replacing an item of permanent investment or plant equipment.

Replacement

Replacement is the exchange or substitution of one fixed asset for another that has the capacity to perform the same function.

Run-to-failure

Run-to-failure is a strategy in which no routine maintenance tasks are performed on the equipment.

Service level agreement (SLA)

A service level agreement (SLA) is the part of a service contract where the service expectations are formally defined.

Service quotient

Service quotient is a measurement of how satisfied occupants are with their service at a given point in time

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