



American Water Works  
Association

*Dedicated to the World's Most Important Resource™*

# AWWA Asset Management Definitions Guidebook

*Version 1.0*



American Water Works Association  
Asset Management Committee  
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Association**

*Dedicated to the World's Most Important Resource™*

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# 1. INTRODUCTION

## 1.1.INTENT

A vernacular is emerging among water utility Asset Management professionals. It includes some concepts and nuanced uses of terms that are only understood by advanced practitioners. And even advanced practitioners disagree about the use of certain words and phrases. This can lead to poor communication and inconsistencies in the water industry.

This guidebook defines terms commonly used in water utility Asset Management practice. AWWA's Asset Management Committee developed it to help improve learning, consistency, and communication in the water industry. The Committee encourages professionals throughout the industry to use the guidebook, and expects the terminology in products that the Committee sponsors (e.g., publications and presentations) to be consistent with it.

As Asset Management practice in the water industry matures, its terminology is likely to change. Thus, the Committee plans to revise this guidance periodically to reflect changes, and invites people that use the document to send the Committee comments on how it can be improved. Please email comments and suggestions to [research@awwa.org](mailto:research@awwa.org).

## 1.2. STRUCTURE

Definitions in this guidebook are grouped by common themes or families to help the reader understand and differentiate between similar terms. ***The index (page 31) includes an alphabetical listing of all terms.***

The Definition Families in this guidebook include:

| Definition Family          | Description  | Page |
|----------------------------|--|------|
| Asset & Asset Organization | The Asset and Asset Organization family of terms are commonly used when an organization is collecting and organizing their Asset information.                                  | 6    |
| Asset Life                 | The Asset Life family of terms are commonly used when an organization is describing how long their Asset is expected to last from a variety of different perspectives.         | 10   |
| Asset Management           | The Asset Management family of terms provides high level definitions associated with the development and implementation of an Asset Management Program within an organization. | 12   |

| Definition Family                    | Description  | Page |
|--------------------------------------|--|------|
| Asset Performance                    | The Asset Performance family of terms are commonly used when assessing an Asset to determine Remaining Useful Life.  | 15   |
| Asset Rehabilitation and Replacement | The Asset Rehabilitation and Replacement family of terms are commonly used when assessing Rehabilitation and Replacement options available to the Asset.   | 17   |
| Asset Valuation                      | The Asset Valuation family of terms are commonly used when assessing an Asset to determine its value to the organization.  | 18   |
| Decision Making                      | The Decision Making family of terms are commonly used when making Asset Management Strategy and investment decisions (to Repair, replace, rehabilitate).   | 19   |
| Information Management Systems       | The Information Management System family of terms is focused on the Information Management Systems that serve as Asset Management Enablers to manage Asset data and Asset information to inform decision making. | 22   |
| Levels of Service                    | The Levels of Service family of terms are commonly used when an organization wants to measure the performance of its Assets and Asset Management Program.  | 23   |
| Maintenance                          | The Maintenance family of terms are commonly used in the context of maintenance management.  | 24   |
| Risk                                 | The Risk family of terms are commonly used when assessing and evaluating Asset Risk.   | 27   |
| Water Industry Specific              | The Water Industry Specific family of terms are specifically used in the water industry when discussing the topic of Asset Management.   | 30   |

Each definition went through a discussion and vetting process with the Asset Management Definitions Subcommittee for this project. At the end of each definition, a metadata identifier (C, M, or R) typed in

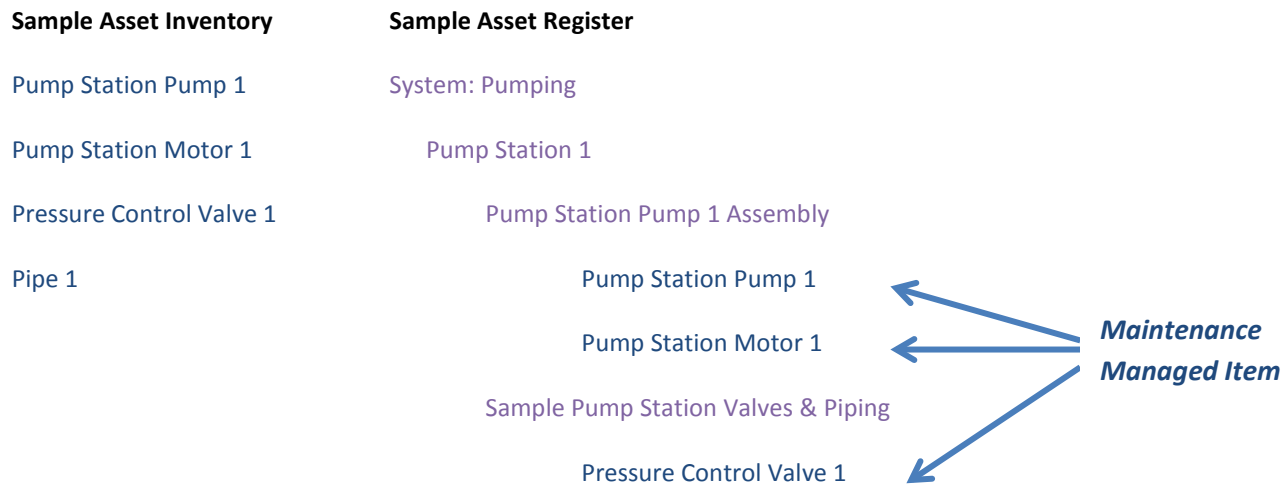
superscript indicates the level of support the definition received from the Subcommittee. The table below describes each identifier.

| <b>Metadata Identifier</b> | <b>Support from Subcommittee</b>   |
|----------------------------|--|
| C                          | Consensus on definition reached by Subcommittee  |
| M                          | Majority (but not consensus) on definition reached by Subcommittee                               |
| R                          | Majority not reached on definition, but majority voted to include definition in document anyway. |

## 2. ASSET AND ASSET ORGANIZATION TERMS

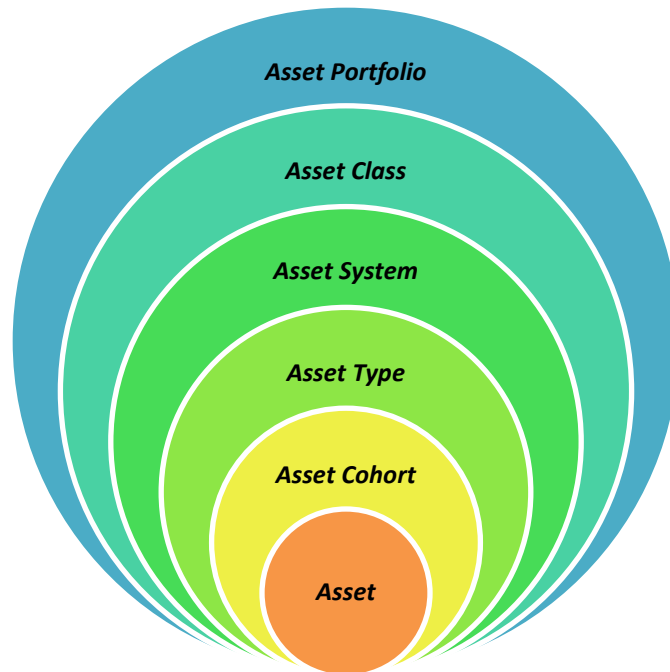
The Asset and Asset Organization family of terms are commonly used when an organization is collecting and organizing their Asset information.

The full listing of *Assets* is called an *Asset Inventory*. An *Asset Register* typically contains a list of the *Assets* at the *Maintenance Managed Item* level. *Assets* in a register are commonly organized using an *Asset Hierarchy*. The *Maintenance Managed Item* level can be at the *Asset* level or the *Asset Component* level or possibly even at the *Asset System Level*.



**Figure 1: Asset Inventory & Asset Register Example**

Each *Asset* has its own unique set of *Asset Attributes*. Based on these attributes, *Assets* may be grouped using various methods to allow for simpler planning, analysis, monitoring and reporting. They may be classified as either *Horizontal Assets* or *Vertical Assets*. They may be grouped by their *Asset System*, their *Asset Type*, or other similar characteristics. *Assets* within the same *Asset Management Program* or *Framework* may be grouped by *Asset Portfolio*. Typically, *Asset Management Plans* are developed per *Asset Class*. *Asset Types* usually have the same maintenance and renewal strategies, plans and schedule intervals. *Asset Types* may be further broken down into *Asset Cohorts* in cases where maintenance and renewal strategies are not the same at the *Asset Type* level.



**Figure 2: Asset Groupings**

## **ASSET**

Plant, equipment, buildings, property, pipelines, infrastructure and other items that have potential or actual value to the organization. Utility assets are the items that contribute to the production and delivery of the utilities' service to the community or group of customers. While the main focus for *Asset Management* in the utility industry is around physical assets, assets can also be intangible, such as leases, brands, digital assets, use rights, licences, intellectual property rights, reputation or agreements (PAS 55, 2008) (ISO 55001, 2014) (modified).<sup>M</sup>

## **ASSET ATTRIBUTE**

A quality or feature that is a characteristic of an *Asset*, e.g., make, model, serial number, rated capacity, age, length, diameter, material, etc. (IAM Asset Management - an anatomy, 2015)(modified).<sup>c</sup>

## **ASSET CLASS**

A logical grouping of *Assets* from one or more *Asset Types* that fulfill a similar high-level function and tend to have a common overall *Asset Management Strategy*. e.g. water mains, pump stations, buildings, fleet.<sup>c</sup>

## **ASSET COHORT**

A group of *Assets* within one *Asset Type* having similar characteristics, such as *Useful Life* (e.g. cast iron spun pipe, pre-1940 cast iron cast pipe, gate valve, ball valve, pipe of different ANSI values or manufacturer). *Assets* of the same cohort typically have the same maintenance and renewal plans, even with respect to timing of those activities.<sup>R</sup>

## **ASSET COMPONENT**

A part of an Asset that contributes to the overall function of the Asset having specific attributes such as, different life expectancy, maintenance regimes, *Probability of Failure* or *Criticality* (SIMPLE)(Modified).<sup>C</sup>

## **ASSET HIERARCHY**

A tiered structure to allow for organized management of Assets and asset data. An Asset Hierarchy typically uses a parent-child relationship. The *Asset Hierarchy* can be based on asset function or process in which the asset is deployed; *Asset Type*; asset location; or a combination of these. Grouping by facility is commonly done near the parent level. The lowest child level is typically at the *Maintenance Managed Item* level (IIMM, 2015) (Modified).<sup>C</sup>

## **ASSET INVENTORY**

A complete list of all physical Assets for which an organization is responsible.<sup>C</sup>

## **ASSET PORTFOLIO**

A grouping of Assets and facilities for which an organization is responsible that is within the same *Asset Management System* or program scope. These are typically grouped by major business lines where management authority and funding sources may be separated, e.g. Water Distribution versus Wastewater Collection (ISO 55001, 2014)(Modified).<sup>C</sup>

## **ASSET REGISTER**

A record of asset information, typically held in a spreadsheet, database or software system, including *Asset Attribute* data (IIMM, 2015)(Modified). Assets may be presented in hierarchy format in the register and are at the *Maintenance Managed Item* level of detail. This is typically not as comprehensive a list as the *Asset Inventory*, but contains greater detail on the Assets listed.<sup>C</sup>

## **ASSET SYSTEM**

A group of Assets that work together to deliver a required business function or purpose (PAS 55, 2008)(Modified) e.g. Chlorine Injection System, Water Storage System.<sup>C</sup>

## **ASSET TYPE**

A group of Assets with similar function or use. This is typically at a more detailed level than *Asset Class*. e.g. *Asset Class* = Pump Station, *Asset Type* = AC Motor. *Asset Class* = Distribution Water Mains, *Asset Type* = cast iron pipe. Assets of the same type typically have similar maintenance and renewal plans.<sup>C</sup>

## **HORIZONTAL ASSET**

Assets which may be configured or networked for the purpose of moving materials or services from one place to another. Also known as linear asset or frequently referred to as below ground asset due to the location of most *Horizontal Assets* below ground. In the context of the water industry, this includes pipeline assets for water distribution, collection and transmission.<sup>M</sup>

## **INFRASTRUCTURE**

A collection of Assets on which the continuation and growth of a community depends, such as power, roads, wastewater and water plants, and transportation and communication systems (AWWA Water Dictionary, 2010) (modified).<sup>C</sup>

## **LINEAR ASSET**

Refer to *Horizontal Asset*.<sup>R</sup>

## **MAINTENANCE MANAGED ITEM**

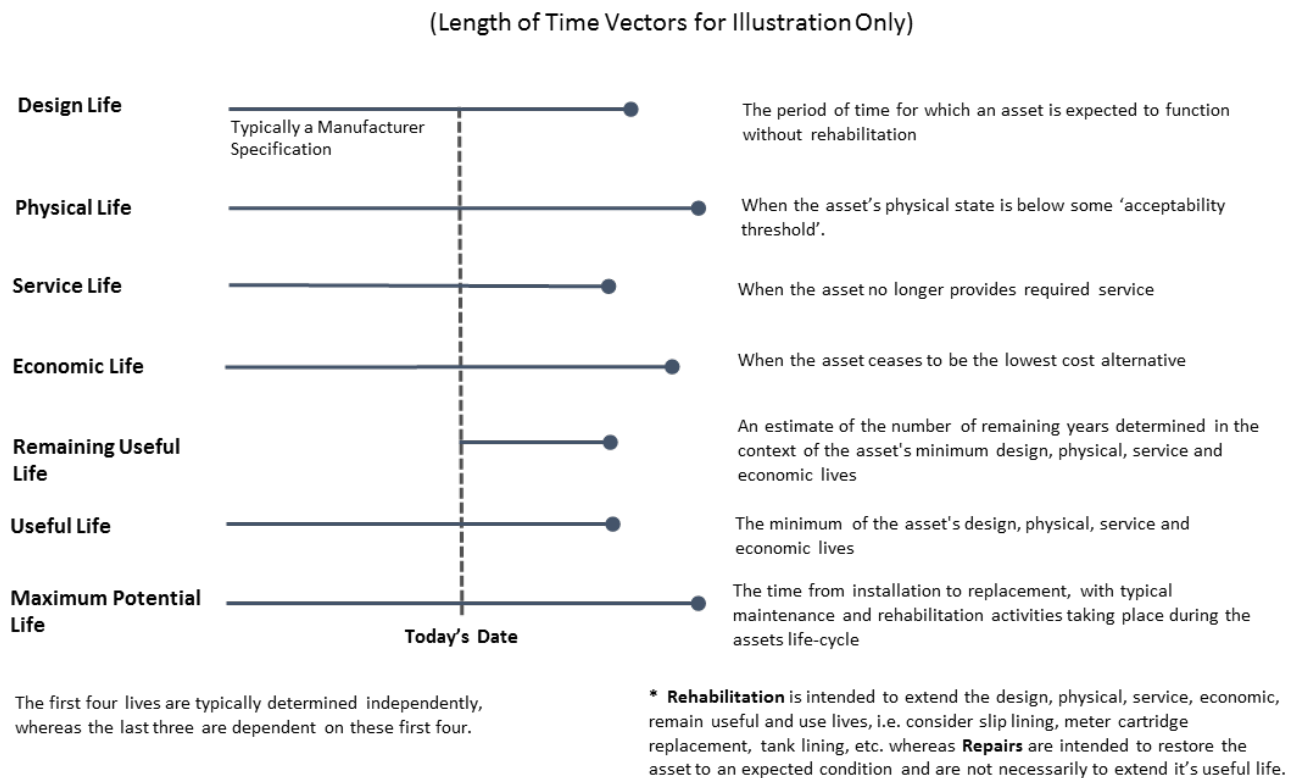
An Asset or component that exists generally at the lowest level in the *Asset Hierarchy* and for which an owner will make management decisions to *Repair*, rehabilitate, or typically replace instead of running to failure. Non-maintenance managed items that may exist in the *Asset Inventory* but not the *Asset Register* may include spare parts, small valves, and other items with low financial value that are *Run-To-Failure* without any maintenance.<sup>C</sup>

## **VERTICAL ASSET**

An Asset within a building and/or facility often comprised of multiple components, also known as an above-ground asset. In the context of the water industry, this typically refers to Assets within pump stations, treatment plants, and may include other facilities, such as storage facilities.<sup>M</sup>

### 3. ASSET LIFE TERMS

The Asset Life family of terms are commonly used when an organization is describing how long their *Asset* is expected to last from a variety of different perspectives.



**Figure 3: Asset Life**

#### **DESIGN LIFE**

The period of time for which an *Asset* is expected to function without *Rehabilitation*.<sup>C</sup>

#### **ECONOMIC LIFE**

The length of time from installation to when the *Asset* ceases to be the lowest cost alternative to satisfy a specified level of performance or service (WRF, 2016).<sup>C</sup>

#### **MAXIMUM POTENTIAL LIFE**

The length of time from installation to *Replacement*, with typical maintenance and *Rehabilitation* activities taking place during the *Asset's* life cycle.<sup>C</sup>

#### **PHYSICAL LIFE**

The length of time from installation to when the *Asset's* physical state is below some "acceptable threshold", which may be defined in terms of an unacceptable *Risk* of failure or some measure of structural condition (WRF, 2016) (modified).<sup>C</sup>

### ***REMAINING USEFUL LIFE***

The time remaining until an *Asset* ceases to provide its required use in the context of design, physical, service and economic lives.<sup>M</sup>

### ***SERVICE LIFE***

The length of time from installation to when the *Asset* no longer provides the required service. End of service life can be reached due to changes in an *Asset's* operational context (its capacity is then insufficient) or because service standards change (e.g. changes in water quality standards) (WRF, 2016).<sup>C</sup>

### ***USEFUL LIFE***

The period over which an *Asset* is expected to be available by an organization for use in the context of design, physical, service and economic lives.<sup>M</sup>

## 4. ASSET MANAGEMENT TERMS

The *Asset Management* family of terms provides high-level definitions associated with the development and implementation of an *Asset Management Program* within an organization. Typically, the need to develop an *Asset Management Program* is outlined in the *Organizational Strategic Plan* which in turn drives the development and implementation of the *Asset Management System* comprised of the *Asset Management Policy*, Strategy, Objectives, Plans and Enablers in support of the whole *Asset Life Cycle*. The *Asset Management Program* is developed relative to an Organization's *Asset Management Maturity* and often an *Asset Management Gap Analysis* is completed to help provide direction on what the priorities should be.

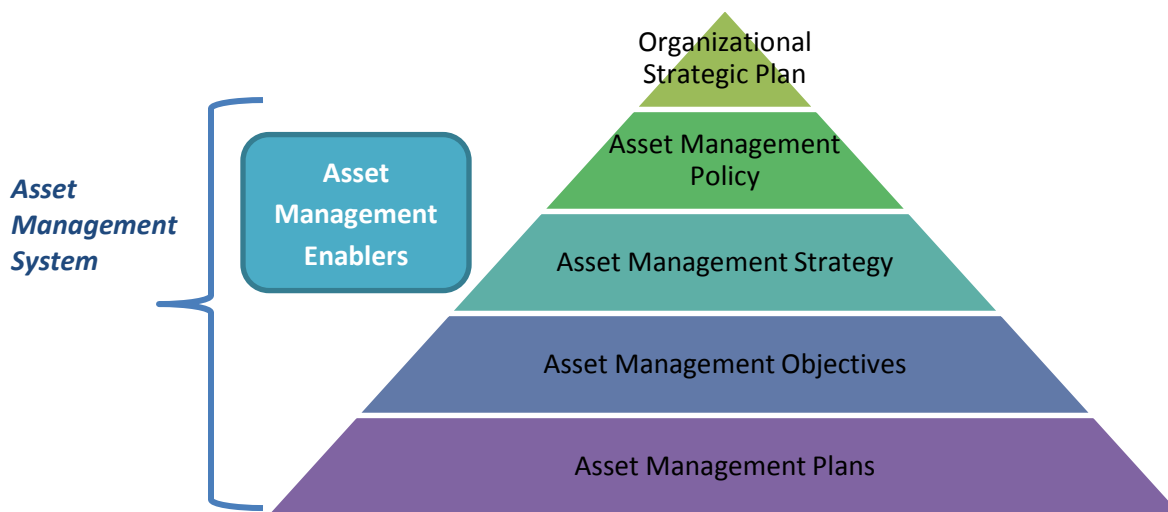


Figure 4: Asset Management

### ASSET LIFE CYCLE

Stages involved in the management of an *Asset* (ISO 55001, 2014). These stages or activities include asset planning, design, construction, commissioning, operation, maintenance, and retirement/decommissioning.<sup>C</sup>

### ASSET MANAGEMENT

The coordinated set of activities within an organization to realize the overall value from all *Assets* through stronger governance and accountability. More specifically in the water industry it is the combination of management, financial, economic, engineering and other practices applied to all *Assets* (*Infrastructure*, people, processes, and systems) with the objective of providing the required *Level of Service* at an acceptable level of *Risk* at an optimal *Life Cycle Cost*.<sup>M</sup>

### ASSET MANAGEMENT ENABLERS

Supportive processes, systems, and activities that will facilitate the successful implementation of an *Asset Management Program*, and that are a key component of an *Asset Management System*.<sup>C</sup>

## **ASSET MANAGEMENT GAP ANALYSIS**

A formal methodology to identify and document all the differences between an organizations' current capabilities and practices and the future desirable *Asset Management* capabilities, structure and practices. Typically, the gaps identified through this analysis enables an organization to prioritize its needs for *Asset Management* implementation and would be incorporated in the *Asset Management Strategy* and/or *Asset Management Program*. Also referred to as Asset Management Needs Analysis.)<sup>M</sup>

## **ASSET MANAGEMENT MATURITY**

The extent to which the capabilities, performance, and ongoing assurance of an organization have been established and implemented for meeting the current and future needs of its stakeholders. *Asset Management Maturity* ranges from Aware (e.g. corporate awareness of the benefits of *Asset Management*) to Advanced (e.g. *Asset Management Policy* and strategy is fully integrated in the organization's business processes).<sup>C</sup>

## **ASSET MANAGEMENT OBJECTIVES**

Outlined in the *Asset Management Strategy*, they relate to the desired performance (efficiency and effectiveness) of the organizational *Asset Management Program* as well as to the desired performance of the organization's *Levels of Service*. These *Asset Management Objectives* must be consistent with organizational objectives and all *Asset Management Policies* and must be periodically monitored and reviewed.<sup>M</sup>

## **ASSET MANAGEMENT PLAN**

A written representation of the intended approach for the management of *Infrastructure Assets* over their life cycle based on the organization's understanding of service level requirements. A key purpose of *Asset Management Plans* is to drive longer term thinking and planning and ensure the organization is operating in a financially sustainable manner.

An *Asset Management Plan* typically includes *Levels of Service*, current performance, future demand, *Risk Management*, life cycle management plans (e.g. maintenance plan, *Rehabilitation and Replacement Plan*), and financial forecasts.<sup>C</sup>

## **ASSET MANAGEMENT POLICY**

A formal document for organizational leadership (Board of Directors, Executive Management) to signal their commitment and priorities for an *Asset Management Program* and provides clear direction as to the appropriate focus and the anticipated levels of *Asset Management* practice and engagement.<sup>C</sup>

## **ASSET MANAGEMENT PROGRAM**

A formalized, systematic set of practices to implement the *Asset Management Plan* within the organization, with a focus on developing *Asset Management* capabilities within the organization. The Program typically includes the cohesive development, implementation, and integration of people, processes and information systems.<sup>C</sup>

## **ASSET MANAGEMENT STRATEGY**

A long-term optimized approach to management of the Assets, derived from, and consistent with, the *Organizational Strategic Plan* and the *Asset Management Policy*. The strategy converts the *Organizational Strategic Plan* and *Asset Management Policy* into a high-level, long-term asset management action plan and/or *Asset Management Program* with well-defined and measurable *Asset Management Objectives* and *Key Performance Indicators* (KPIs).<sup>M</sup>

## **ASSET MANAGEMENT SYSTEM**

A framework of policies, processes, procedures, organizational structure, resources and information systems used by an organization to establish and achieve its *Asset Management Policy, Strategy and Objectives*. Note, in this context, a "system" refers to all framework elements within an organization and not any single information technology system.<sup>M</sup>

## **INFRASTRUCTURE ASSET MANAGEMENT**

*Asset Management* with a focus on physical *Infrastructure Assets*. It is the continual assessment of the condition and usefulness, projected life expectancy, *Criticality*, and operations and maintenance history, with a long-range plan for financing *Asset Rehabilitation* or *Replacement* (R&R). Results from these assessments prioritize *Infrastructure Assets* and are typically incorporated into the organization's annual capital improvement planning and operational budget processes.<sup>R</sup>

## **ORGANIZATIONAL STRATEGIC PLAN**

A formal document to communicate the organizational vision, mission, goals, objectives, *Levels of Service*, and the strategic actions necessary to achieve those goals. Typically, the business need/s or driver/s for an *Asset Management Program* would be stated within the *Organizational Strategic Plan*.

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## 5. ASSET PERFORMANCE TERMS

The *Asset Performance* family of terms are commonly used when assessing an *Asset* to determine *Remaining Useful Life*. *Asset Condition* and *Performance* is determined via *Condition Assessments*, *Failure Code* tracking and *Performance Monitoring*. This information in turn is used to determine the *Condition Grade* & *Performance Grade*. The condition &/or performance information, along with *Asset Utilization*, the *Deterioration Curve* and *Deterioration Rate* are then able to be used to estimate the *Remaining Useful Life*.

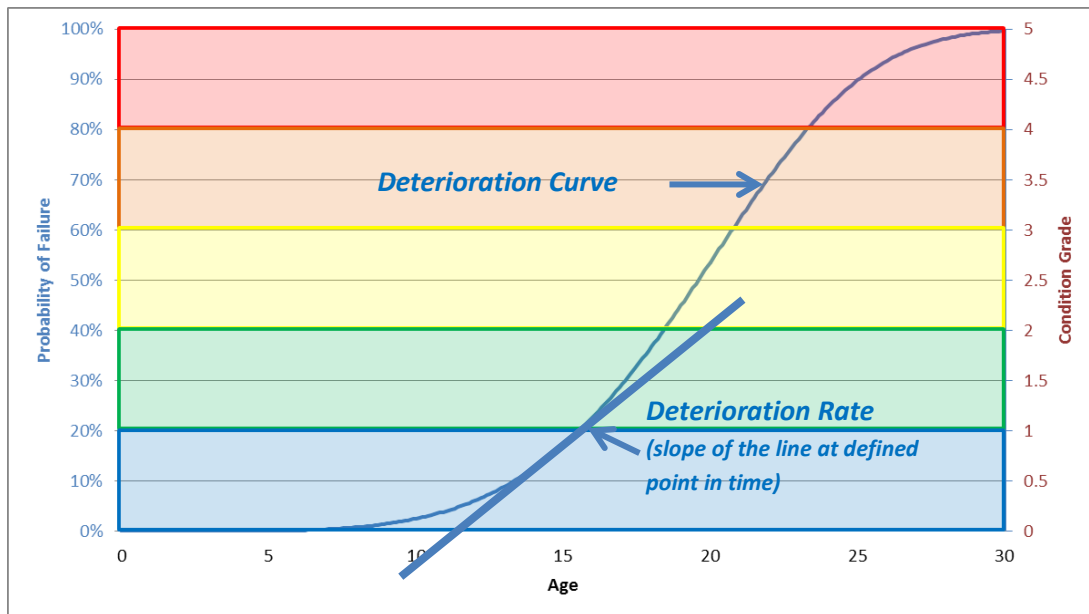


Figure 5: Deterioration Curve Example

### ASSET CONDITION

The physical state of the *Asset* (IIMM, 2015). Condition is a key parameter in determining *Remaining Useful Life*, and can be used to predict how long it will be before an *Asset* requires *Repair*, *Rehabilitation* or *Replacement*.<sup>c</sup>

### ASSET PERFORMANCE

A measure of the extent to which an *Asset* is fulfilling its intended function.<sup>c</sup>

### ASSET UTILIZATION

The capacity of the *Asset* utilized to meet service level requirements.<sup>c</sup>

### CONDITION ASSESSMENT

A technical assessment of an *Asset* followed by the interpretation of the resultant data to determine its current and/or future physical condition, performance, *Probability of Failure*, and/or *Remaining Useful Life* (IIMM, 2015) (SIMPLE)(modified). The assessment can be based on a desktop analysis, physical observation/inspection, interviews, and/or through the use of instrumentation.<sup>m</sup>

### **CONDITION CURVE**

A graphical representation of *Asset Condition* over time where the y-axis represents dependent variables such as *Condition Grades*, condition ratings, *Probability of Failure*, etc. and the x-axis represents independent variables such as time, cycles, or frequencies which influence condition and may be converted to time. The general aim of the curve is to support decision-making regarding the timing of assessment, inspection and *Renewal* intervention.<sup>M</sup>

### **CONDITION GRADE**

A measure of the physical integrity of an *Asset* (IIMM, 2015).<sup>C</sup>

### **DETERIORATION CURVE**

The path by which an *Asset* deteriorates and passes through different stages of its life and the associated *Probability of Failure* throughout the life. Also commonly referred to as Decay Curve, Degradation Curve, *Condition Curve* or Performance Curve.<sup>M</sup>

### **DETERIORATION RATE**

The rate at which an *Asset* approaches failure (end of life) (IIMM, 2015). Also commonly referred to as Decay or Degradation Rate.<sup>C</sup>

### **FAILURE CODES**

A list of logical alphanumeric abbreviations or cross-referenced numeric values representing a list of common descriptions of the root cause(s) of failure.<sup>C</sup>

### **PERFORMANCE GRADE**

A measure of *Asset Performance* in the context of service levels.<sup>C</sup>

### **PERFORMANCE MONITORING**

Continuous or periodic quantitative and qualitative assessments of the actual performance compared with specific objectives, targets or standards (IIMM, 2015).<sup>C</sup>

## 6. ASSET REHABILITATION AND REPLACEMENT TERMS

The *Asset Rehabilitation* and *Replacement* family of terms are commonly used when assessing *Rehabilitation* and *Replacement* options available to the *Asset*. *Replacement* and *Rehabilitation* Planning is performed to determine when a *Capital Expenditure* may be required. Depending on the *Asset*, there may be different combinations of *Replacement* and *Rehabilitation* available to the *Asset*; from *Rehabilitation* to *Restoration*, to full *Renewal* and *Replacement*.

### **CAPITAL EXPENDITURE (CAPEX)**

Expenditure used to create new *Assets* or to increase the capacity of existing *Assets* beyond their original design capacity or service potential. CAPEX increases the value of *Asset* stock (IIMM, 2015).<sup>c</sup>

### **REHABILITATION**

Works to rebuild or replace parts or components of an *Asset*, to restore it to a required functional condition and extend its life, which may incorporate some modification. Generally involves repairing the *Asset* to deliver its original *Level of Service* without resorting to significant upgrading or *Renewal*, using available techniques and standards (IIMM, 2015).<sup>c</sup>

### **RENEWAL**

The *Replacement* of an existing *Asset* with a new *Asset* of equivalent capacity or performance capability (IIMM, 2015) (SIMPLE)(Modified).<sup>c</sup>

### **REPLACEMENT**

The complete *Replacement* of an existing *Asset* that has reached the end of its *Useful Life*.<sup>c</sup>

### **REPLACEMENT & REHABILITATION PLANNING**

Using available data on *Asset* age, condition, performance, *Reliability* and expected life to forecast when the *Asset* will require *Replacement* or *Rehabilitation*.<sup>c</sup>

### **RESTORATION**

Maintaining a majority of the existing *Asset*, while transforming its appearance and functionality to "as new", and in some instances, "better than as new" (SIMPLE)(modified).<sup>c</sup>

## 7. ASSET VALUATION TERMS

The *Asset Valuation* family of terms are commonly used when assessing an *Asset* to determine its value to the organization.

### **ASSET VALUATION**

A process for determining the value of an *Asset*. There are primarily three approaches to valuing an *Asset*; the cost approach, market approach and income approach. The approach used will depend on the purpose for which the valuation is required.

The Market Approach is used when there is an active and known used market in which comparable sales can be measured and quantified (this is often used for land and buildings, as well as vehicles).

The Income Approach is determined by measuring an *Asset's* income generating capability, usually by calculating the *Net Present Value* or using a discounted cash flow method.

The Cost Approach is typically used where there is no active market for an *Asset*. It reflects the cost to replace the *Asset*, less adjustments for *Depreciation*.<sup>c</sup>

### **DEPRECIATED REPLACEMENT COST**

The current *Replacement Cost* of an *Asset* less accumulated *Depreciation* to reflect the remaining service potential of the *Asset*, taking into account the condition and service consumption.<sup>c</sup>

### **DEPRECIATION**

The systematic allocation of the depreciable amount of an *Asset* over its *Useful Life* (IIMM, 2015) (modified).<sup>c</sup>

### **LIFE CYCLE COST**

A methodology that provides an estimate of the total capital, operating and maintenance costs of an *Asset* over its operating life. Relevant costs include planning, design, acquisition, installation, maintenance, *Rehabilitation*, financing, retirement/ decommissioning/ disposal and any other costs directly attributable to operating or using an *Asset*.<sup>c</sup>

### **MARKET VALUE**

The estimated amount at which an *Asset* would be exchanged on the date of valuation, between a willing buyer and a willing seller, in an arm's length transaction and when the parties have each acted knowledgeably, prudently and without compulsion (IIMM, 2015)(modified).<sup>c</sup>

### **REPLACEMENT COST**

The current cost of replacing an existing *Asset* with a new modern equivalent *Asset* that provides the same or similar Level of Service potential.<sup>c</sup>

## 8. DECISION MAKING TERMS

The Decision Making family of terms are commonly used when making *Asset Management Strategy* and investment decisions (to *Repair*, replace, rehabilitate). Many factors weigh into the decision making process and a variety of analytical tools are available to support making these decisions. Some focus primarily on the costs, others incorporate additional factors, such as required *Levels of Service*, and other societal or environmental considerations.

### **BENEFIT COST ANALYSIS**

A systematic approach to estimating the *Life Cycle Costs* and benefits of an alternative (or set of alternatives) to determine if an investment is justified and, if so, the value it will provide. Also known as cost benefit analysis (CBA).<sup>c</sup>

### **BUSINESS CASE ANALYSIS**

An evaluation of the objectives of an investment proposal and an analysis for each project alternative. It includes review of the value for money, scope, costs and benefits, *Risks*, and schedule. The *Business Case Analysis* provides enough information such that an investment option can be chosen, based on an objective appraisal of the relative strengths and weaknesses of alternatives to meet a stated business objective, often captured in a comprehensive *Life Cycle Cost Analysis*.<sup>c</sup>

### **COST BENEFIT ANALYSIS**

Reference *Benefit Cost Analysis* for definition.<sup>c</sup>

### **DISCOUNT RATE**

A rate used to relate and compare future and present money values, taking *Inflation* and the cost of debt (interest) rates into consideration.<sup>c</sup>

### **INFLATION**

The rate of increase applied to costs incurred at a future time to reflect the relative purchasing power of money relative to a particular time, usually the present (IIMM, 2006).<sup>c</sup>

### **INTERNAL RATE OF RETURN (IRR)**

The *Discount Rate* at which the *Net Present Value* of all the cash flows (both positive and negative) from a project or investment equal zero. *Internal Rate of Return* is used to evaluate the attractiveness of a project or investment.<sup>c</sup>

### **LIFE CYCLE COST ANALYSIS**

An engineering economic analysis method for assessing the total cost of ownership for an alternative (or set of alternatives), including all *Life Cycle Costs* and benefits.<sup>c</sup>

### **MONETIZATION**

The process of assigning a financial value to a benefit or impact in order to create a common denominator for criteria-based comparative analysis.<sup>c</sup>

## **MULTI-CRITERIA ANALYSIS**

A technique to compare alternative project solutions using a variety of criteria. Each alternative is given a relative score for each criterion being evaluated as opposed to assigning a financial value. In some cases, criteria are assigned a relative weighting factor, and the sum of weighted scores for each alternative are used to help choose a solution. <sup>c</sup>

## **NET PRESENT VALUE**

The difference between the benefits and costs expressed in monetary terms in today's dollars. To convert future cash flows into today's dollars, the time value of money needs to be taken into account. This is done through the use of a *Discount Rate*. NPV is a key component in *Benefit Cost Analysis*. <sup>c</sup>

## **OPTIMIZED DECISION MAKING**

A method of identifying the best value compromise between a set of competing objectives or influences. Optimizing involves adjusting inputs with constraints in order to maximize/minimize an objective function. This usually represents the lowest combined business impact of costs, *Risks* and performance losses, or the maximization of net value, over the Life cycle. <sup>c</sup>

## **SENSITIVITY ANALYSIS**

A method of determining how the results of an alternative analysis respond to incremental changes in the value assigned to one or more project variables, about which there may be uncertainty. <sup>c</sup>

## **SUSTAINABILITY**

In the context of *Asset Management*, *Sustainability* refers to the designing, building, operating and funding of *Infrastructure Assets* in ways that do not diminish the social, economic and ecological processes required to maintain human equity, diversity, and the functionality of natural systems. The integration of *Asset Management* and *Sustainability* is possible due to the overlap of core concepts inherent in both frameworks. *Sustainability's* focus is on life cycle (planning, design, construction, operation, maintenance, *Repair* and *Replacement*, disposal) where a *Triple Bottom Line Analysis* can be performed. <sup>c</sup>

## **TRIPLE BOTTOM LINE ANALYSIS**

A method of assigning financial values to financial, social, and environmental factors that do not have an assigned *Market Value*, such as service interruptions to customers, noise, pollution, traffic delays, community aesthetics, consumer confidence, and public health and safety *Risks*. <sup>c</sup>

## ***WILLINGNESS TO PAY***

A measurement of the rate payers' *Willingness to Pay* for a change in the *Level of Service* or specific product. The *Willingness to Pay* assessment methodology is normally conducted through a series of surveys and applying some process of optimization. *Willingness to Pay* is distinguished from ability to pay in that willingness reflects a value judgement on the part of a person, whereas ability to pay reflects a person's capability to use financial resources to compensate another party for a specific level of service or product. Results of a *Willingness to Pay* assessment can be used to assess benefits as part of the *Benefit Cost Analysis*.<sup>c</sup>

## 9. INFORMATION MANAGEMENT SYSTEM TERMS

The *Information Management System* family of terms is focused on the *Information Management Systems* that serve as *Asset Management Enablers* to manage asset data and asset information to inform decision making.

### **COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM (CMMS)**

A software and information system tool for planning, coordination, scheduling of maintenance activities, the labor resources to deliver them, and other essential supporting resources (IAM Asset Management - an anatomy, 2015).<sup>c</sup>

### **GEOGRAPHIC INFORMATION SYSTEM (GIS)**

An enterprise data management system designed to capture, store, manipulate, analyze, manage, and visualize geographic or spatial information.<sup>c</sup>

### **INFORMATION MANAGEMENT SYSTEM**

An enterprise system, typically administered and managed by the organizational Information Technology Department, to collect, compile, manage data and extract meaningful information on the performance of existing *Assets* (e.g. condition, performance, operations etc.) and their associated *Life Cycle Costs* and use it for effective decision making. Organizations typically have one or more *Information Management Systems* in place (e.g. *GIS*, *CMMS*, *SCADA*, Financial Information System, Customer Information System, Project Management Systems etc.). The *Information Management System* is only one element of an *Asset Management System* and the terms should not be used interchangeably.<sup>m</sup>

### **WORK MANAGEMENT SYSTEM**

The integrated processes and procedures that help an organization schedule and perform work efficiently and effectively, meet its customers and employee needs, utilize *Assets*, and evaluate performance (Arthur, 2016).<sup>R</sup>

## 10. LEVELS OF SERVICE TERMS

The *Levels of Service* family of terms are commonly used when an organization wants to measure the performance of its *Assets* and *Asset Management Program*. Typically, organizations develop several *Performance Measures* to monitor how they are performing and how their *Assets* are performing. Some of these become *Key Performance Indicators* that are regularly reported on at higher levels in the organization. Some of the measures also are utilized to inform the *Levels of Service* that are reported on to customers, governmental bodies and the surrounding community.

### **DEMAND ANALYSIS**

A predictive analysis to determine expected future service requirements and if the requirements can be provided by existing *Asset Systems* or if *Asset Systems* must be expanded or can be downsized.<sup>M</sup>

### **LEVELS OF SERVICE**

A statement of outputs or objectives that an organization or activity intends to deliver to customers and stakeholders (IIMM, 2015) (modified).<sup>C</sup>

### **PERFORMANCE MEASURE**

A qualitative or quantitative metric of actual performance against a standard or other target, often in relation to delivering *Levels of Service* (IIMM, 2015) (modified).<sup>C</sup>

### **KEY PERFORMANCE INDICATOR (KPI)**

A *Performance Measure* that is considered important to the organization (IIMM, 2015).<sup>C</sup>

## 11. MAINTENANCE TERMS

The Maintenance family of terms are commonly used in the context of maintenance management.

Maintenance Planning is what ties Maintenance to the overall organizational strategy and *Asset Management Strategy*. It uses available data on asset age, condition, performance, *Reliability* and expected life to determine and select the most appropriate maintenance strategy and further develop the proposed maintenance intervals, tasks, resources and safety requirements. The applicable maintenance strategies include: *Predictive Maintenance*, *Preventive Maintenance* and Reactive or *Run-to-Failure Maintenance*. Often *Reliability Centered Maintenance* (RCM) is used to optimize the strategies and plan selected.

Maintenance then falls into two categories, *Planned or Unplanned Maintenance*. A combination of planned *Preventive* and *Predictive* work as well as planned or unplanned corrective work forms *Backlog Maintenance*. The work can then become *Scheduled or Unscheduled*. It may be *Deferred*, left in the *Backlog* or placed on the schedule. Once the schedule is set, any corrective work or *Repairs* that occur not on the schedule is considered *Break-in Work*. The cost to complete the maintenance work is typically considered an *Operational Expenditure*.

### **BACKLOG MAINTENANCE**

Work required to avoid further *Asset* breakdown, or to restore an *Asset* back to its previous condition but is not yet on the maintenance schedule. It can include either planned or *Unplanned Maintenance*. A planned backlog allows for more efficient and effective scheduling of maintenance resources.<sup>c</sup>

### **BREAK-IN WORK**

Work performed that was not on the schedule. To monitor this, typically the schedule is locked (e.g. at the beginning of a work week) and any work that interrupts the schedule is considered *Break-in Work*.<sup>c</sup>

### **CORRECTIVE MAINTENANCE**

A maintenance task applied to rectify the failure of equipment, machine or system, restoring it to the required level of performance. *Corrective Maintenance* may be planned or unplanned, scheduled or unscheduled.<sup>c</sup>

### **DEFERRED MAINTENANCE**

In the short-term, *Deferred Maintenance* is any postponed maintenance activities due to resource availability and priority.

In the long-term, *Deferred Maintenance* is any maintenance or *Repair* needed to bring current *Assets* up to at least a minimum-acceptable physical condition level, often referred to as unfunded or unaccomplished maintenance or backlog. *Deferred Maintenance* should not cover work needed for growth, enhancements, or increases in capacity (Issues in Deferred Maintenance, 1994).<sup>c</sup>

## **OPERATIONAL EXPENDITURES (OPEX)**

Expense items incurred in the day-to-day operation of the system. They are not able to be capitalized and typically include maintenance expenditures as well as other operating expenditures such as salaries, supplies, utilities, etc. <sup>C</sup>

## **PLANNED MAINTENANCE**

Maintenance that is predetermined based on the selected maintenance strategy with maintenance tasks documented, and labour and material requirements and work and safety procedures identified. Maintenance strategies include *Predictive*, *Preventive* or *Run-to-Failure* in which case the *Corrective Maintenance* can still be planned. <sup>C</sup>

## **PREDICTIVE MAINTENANCE**

Maintenance carried out to monitor the condition of the *Asset* where attributes of the *Asset* such as temperature, vibration, and oil quality are used to predict when *Asset* failure might occur. Also known as PdM or condition monitoring. <sup>C</sup>

## **PREVENTIVE MAINTENANCE**

Maintenance conducted to maintain the operating condition of the *Asset* and slow *Asset* deterioration through cost-effective actions. *Preventive Maintenance* is performed while the equipment is still working condition, so that it does not break down unexpectedly. *Preventive Maintenance* can be further categorized by what triggers the *Preventive Maintenance*.

- Condition-Based – a maintenance activity that is performed on an *Asset* as needed and identified through *Predictive Maintenance* or through an *Asset Condition Assessment*
- Time-Based – a maintenance activity that is performed on an *Asset* on a periodic basis based on schedule or age (e.g. annual lubrication).
- Usage-Based – a maintenance activity that is performed on an *Asset* based on usage (e.g. UV bulb *Replacement* after 5,000 hours). <sup>C</sup>

## **REACTIVE MAINTENANCE**

Maintenance that occurs after an *Asset* has already failed. It often is the result of having no maintenance strategies in place, but can also occur if the *Run-to-Failure* or *Plan-to-Replace* strategy has been selected for that specific *Asset*. If *Reactive Maintenance* occurs on an *Asset* that has a *Predictive* or *Preventive Maintenance* strategy in place, it may need to be further evaluated to confirm if the maintenance plan needs modification to address the root cause of the problem. <sup>C</sup>

## **RELIABILITY CENTERED MAINTENANCE (RCM)**

A specific process used to identify the policies which must be implemented to manage the *Failure Modes* which could cause the functional failure of any physical *Asset* in a given operating context (SAE JA 1011, 2009). Initially developed by the commercial aviation industry and published by FS Nowlan and HF Heap with the US Department of Defense, it is widely used by many *Asset* intensive industries and requirements for the process are now governed by SAE JA 1011 supported with SAE JA 1012 published by the Society of Automotive Engineers.<sup>M</sup>

## **REPAIR**

Action to restore an *Asset* to its previous condition after failure or damage (IIMM, 2015). This is typically completed as a part of *Corrective Maintenance*.<sup>C</sup>

## **RUN-TO-FAILURE**

A maintenance strategy that intentionally allows an *Asset* to operate until failure before corrective action is taken based on a determination that the cost to maintain exceeds the consequences of failure. Also known as No Scheduled Maintenance and Plan-to-Replace.<sup>C</sup>

## **SCHEDULED MAINTENANCE**

*Planned or Unplanned Maintenance* that has been placed on the schedule.<sup>R</sup>

## **UNPLANNED MAINTENANCE**

Corrective work required in the short-term to restore an asset to working condition that has not been predetermined and has no resource requirements identified. Typically this is emergency work, but is also the result of a Reactive Maintenance strategy.<sup>C</sup>

## **UNSCHEDULED MAINTENANCE**

*Planned or Unplanned Maintenance* that is not yet on the schedule. Similar to *Backlog*.<sup>R</sup>

## 12. RISK TERMS

The *Risk* family of terms are commonly used when assessing and evaluating *Asset Risk*. Assessing and evaluating *Asset Risk* should occur within the context of organizational *Risk Management*, which includes the components of *Risk Assessment* and *Risk Mitigation*. *Risk* is first identified by looking at all potential impacts concerning *Assets*, including hazards due to operation of those *Assets* as well as the potential *Asset Failure Modes*. *Consequence of Failure* and *Probability of Failure* are evaluated, sometimes using structured methods, such as *Failure Modes and Effects Analysis*. *Assets* can then be assigned a *Criticality*, or a *Business Risk Exposure* score. When determining *Consequence* and *Probability of Failure*, the *Redundancy* and *Reliability* of the *Asset* and *Asset System* are taken into account. *Risk Mitigation* strategies and plans are then evaluated, prioritized (as described in the *Decision Making* family of terms) and included in the *Asset Management Plans*.

### ***BUSINESS RISK EXPOSURE (BRE)***

A measure of overall *Asset Risk* and is estimated by considering and combining the *Probability of Failure* (PoF) and the *Consequence of Failure* (CoF) of an *Asset*.<sup>M</sup>

### ***CONSEQUENCE OF FAILURE***

A measure of the direct and/or indirect costs of *Asset* failure. Direct costs are out of pocket costs to the *Asset* owner such as the cost of water loss, *Repairs*, fines, property damage, etc. Indirect costs are typically not paid directly by the *Asset* owner and may include costs of business or customer interruptions, traffic delays, public perception or reputation, and property costs not paid by the *Asset* owner, etc. Costs are also often categorized as "Triple Bottom Line" or TBL which refers to financial, environmental and societal costs.<sup>M</sup>

### ***CRITICAL ASSET***

*Assets* that are identified as having the greatest potential to impact the achievement of the organizational objectives (i.e. *Assets* with the greatest relative *Consequence of Failure*). These are *Assets* that meet defined *Criticality* measures.<sup>C</sup>

### ***CRITICALITY***

An *Asset* prioritization measure often used to determine "what" *Assets* to focus on. *Criticality* is normally based on potential *Consequences of Failure*, not *Risk*, and is used to determine higher priority *Assets* for *Risk Management* activity.<sup>M</sup>

## **FAILURE MODES**

The ways or modes in which an *Asset* may fail. *Assets* may fail through one or more of these *Failure Modes*:

- Capacity – Pressure or flow requirements exceed design capacity
- Level of Service – Service requirements exceed *Asset* capabilities
- Efficiency – The cost of maintaining and operating the *Asset* exceeds the cost of *Replacement* or other options to deliver the same capability
- Physical Mortality – The *Asset* physically stops working, fails structurally, or is otherwise nonoperational (SIMPLE)(modified).<sup>M</sup>

## **FAILURE MODES AND EFFECTS ANALYSIS (FMEA)**

A commonly used *Risk Assessment* technique in *Asset Management* that is systematic and focuses on identifying *Failure Modes* and mechanisms and the effects of the associated failures.<sup>M</sup>

## **PROBABILITY OF FAILURE**

A measure of the likelihood of an event happening at a point in time, normally expressed as a numeric frequency or as a percentage. All *Failure Modes* should be considered when determining the *Probability of Failure* (capacity, level of service, efficiency and physical mortality). The probability can be determined qualitatively or quantitatively from available data, such as *Asset* age, performance and *Condition Assessment* results, operation and maintenance history, demand forecasting, cost analysis, and experiences with that type of *Asset* in general.<sup>M</sup>

## **REDUNDANCY**

The incorporation of additional *Assets* or *Asset Systems* not necessary to meet the functional requirements, but which are available in case of *Asset* or *Asset System* failure. These need not be identical *Assets* or *Asset Systems*, but should provide the capability to meet the functional requirements.<sup>C</sup>

## **RELIABILITY**

The ability of an *Asset* or *Asset System* to consistently perform its intended function according to its specifications.<sup>C</sup>

## **RISK**

The product of the consequences of a failure event and the associated probability of occurrence. *Risk* can be expressed in qualitative or quantitative terms and in terms of a value over time (Risk cost).<sup>M</sup>

## **RISK ASSESSMENT**

The overall process of risk identification, risk analysis and risk evaluation. When assessing *Risk*, common techniques include:

- Identification: *Condition Assessment*, incident investigation, risk assessment workshops
- Analysis: deterioration modeling, root cause analysis (RCA), *Failure Mode and Effects Analysis* (FMEA),
- Evaluation (selecting Mitigations): *Reliability Centered Maintenance* (RCM), *Benefit Cost Analysis*, Multi-Criteria Decision Analysis.<sup>M</sup>

## **RISK MANAGEMENT**

Coordinated activities to manage *Risk* in the context of organizational objectives and required *Levels of Service*.<sup>C</sup>

## **RISK MITIGATION**

Activities to reduce the level of *Risk*, and may be specific to reductions in *Probability of Failure* or *Consequence of Failure*.<sup>M</sup>

## 13. WATER INDUSTRY SPECIFIC TERMS

The Water Industry Specific family of terms are specifically used in the water industry when discussing the topic of *Asset Management*.

### ***WATER MAIN BREAK***

The structural failure of the primary water main conduit or associated joint, tap, fitting or lateral resulting in a loss of service.<sup>R</sup>

### ***WATER MAIN LEAK***

The structural failure of the primary water main conduit or associated joint, tap, fitting or lateral not resulting in an immediate loss of service.<sup>R</sup>

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