THE PURPOSE AND ARRANGEMENT OF THE MANUAL

The purpose of this manual is to consolidate into one document the System Design Life Tables which are presented in the Department of Energy Condition Assessment Survey Design and Inspection Standards Manuals. These manuals consist of twelve volumes that breakdown the systems normally found in a typical building or structure. By consolidating the System Design Life Tables into one volume Sites can easily find the information necessary to determine if the building or system component has reached the end of its useful life. This information can be used to determine exactly where limited funds will provide the best return. The best return on investment can either be the repair of the deficiencies found or the complete replacement of the system or component.

This manual is separated into four main sections. The first section is an introduction describing the importance of Life Cycle analysis when evaluating a building or structure. The introduction discusses the advantages of using Life Cycle data and the cost savings that can be realized over the life of the structure. In today’s climate of limited funding, dollars need to be directed to where they can realize the largest return. Failure to address Life Cycle can result in higher costs or the premature loss and deterioration of the structure.

The second section consists of the consolidated Design Life Tables from the DOE CAS Manuals. The tables are arranged in order of the twelve systems which divide the system and components found in typical structures. The items on the lists were developed based on industry standards and manufacturer data. The tables are meant as a representation of commonly found items and do not constitute the entire list of items that may be encountered. If an item is not found in the lists, select an item that is similar or closely resembles the item under consideration.

The third section consists of Life Cycle Asset Management Performance Measures under development. These measures are included for informational purposes only and are not to be interpreted as a directive or requirement. The purpose of the measures is to illlustrate how Life Cycle Asset Management can be use to meet Site requirements. The tables indicate measures that can be used to determine the impact and success in accomplishing the objectives defined. This information can be useful for determining and documenting the successful use of Life Cycle Asset Management techniques to maximize return on investments.

The fourth section consists of references used in the compilation of this manual. This section is self explanatory and is included to credit sources and allow the user to research further if necessary.

INTRODUCTION

A building is an investment made by owners in anticipation of the shelter and services it will provide to the people and the activities it will house. With proper management of this investment, returns may continue for hundreds of years, but failure to recognize the continuing costs of ownership can lead to premature loss of services and deterioration of the building and high costs for the building's users. Some materials and building systems are particularly reliable or durable and repay their higher initial costs with savings in future operation and maintenance efforts. Other materials or systems may be selected because their lower initial costs meet the limits of available construction budgets and, with proper use, are likely to deliver entirely satisfactory service. Sometimes safety, security, or aesthetic concerns warrant both higher initial and future costs. Designers and owners of buildings recognize that there are many such choices and trade-offs among initial construction costs, recurring operations and maintenance (O&M) costs, and building performance. Decisions about a building's design, construction, operation, and maintenance can in principle, be made such that the building performs well over its entire life cycle and the total costs incurred over this life cycle are minimized.

In practice, defining and controlling the life-cycle costs are difficult. The future behavior of materials and mechanical and electrical systems is uncertain, as are the future uses of the building, the environmental conditions to which it may be exposed, and the financial and economic conditions that influence relationships between present and future costs. Unexpected use of the building, unusual events such as storms or earthquakes, poor construction practices, changes of ownership, budgetary constraints, or financial conditions may alter the strategy for minimizing life-cycle cost. Finding the best course of action and assuring that it is followed are challenges that continue as long as a building is in use, challenges that life-cycle cost analysis can help decision makers to meet.

Life-cycle cost analysis is an economic evaluation tool for choosing among alternative building investments and operating strategies by comparing all of the significant differential costs of ownership over a given time period in equivalent economic terms. An effective life-cycle cost analysis depends on having a reasonable range of possible alternatives that is likely to deliver equally satisfactory service to owners and users over a given service life. For projects whose scale does not warrant explicit development of design alternatives, design criteria and guide specifications can help assure that principles of life-cycle cost analysis are reflected in specific designs.

Substantial obstacles to implementing life-cycle cost control in practice include (1) failure of designers to include life-cycle cost goals in their design criteria; (2) failure of owners or managers with short-term responsibility for a building to consider effectively the longer-term impact of their decisions on the building's O&M requirements; (3) general desire of many decision makers to minimize their initial expenditures in order to increase short term return on investment, meet budgetary restrictions, or both; and (4) lack of data and accepted industry standards for describing the maintenance effect and operational performance of building components. Managers from federal, state, and local government agencies encounter these obstacles in legislative budget procedures; procurement regulations that limit design specificity to enhance competition; and administrative separation of responsibilities for design, construction, and maintenance.

Several decades of experience with highways, and more recently bridges, suggest that improved life-cycle cost management for public buildings can be achieved through development and application of systematically structured and comprehensive life-cycle costs management of public buildings. In the near term, design criteria may be a practical tool available for controlling life-cycle costs, but over the longer term there is a broader range of actions that each agency responsible for these buildings should take:

- Formally recognize control of life-cycle cost as an essential and effective element of the agency's mission.
- Include explicit assessment of design alternative that influence life-cycle cost as an element of the scope of work and fees of agency designers.
- Assure that value engineering programs and construction contract incentives and other procurement mechanisms demonstrate savings in expected life-cycle cost rather than construction cost only.
- Direct designers to document clearly their design decisions made to control life-cycle cost and the subsequently expected operating consequences for each facility.

INTRODUCTION

- Implement cross-training and staff exchange of design and operations and maintenance management personnel to assure that life-cycle cost is controlled at all stages in the facility's service life and are applied in practice.
- Establish a life-cycle cost management system to maintain O&M data and design decisions in a form that supports operations and maintenance.
- Assign accountability for maintenance and repair at the highest levels in the agency. Responsibilities should include effective use of maintenance and repair funds and other actions required to validate prior decisions on facility life-cycle cost management decisions.

Public buildings are assets needed to serve government purposes. The public is called upon to invest in these assets and pay the costs of their upkeep. Minimizing the total costs of ownership is the most efficient use of the public's resources to obtain the services these assets provide. Overcoming the economic, technical, and political obstacles to meaningful control of the total costs of public buildings will enhance productivity and the public's return on its investment.

Agencies' managers generally recognize the need for facilities that serve efficiently the purposes of government and seek ways to overcome obstacles to effective cost management.

To the extent that facilities are built and used by the same institution, the same concerns apply in the private sector as well. Buildings are an investment in the future, and substantial expenditures of funds for design and construction are made by a building's owner in anticipation of the shelter and services the building will provide to the people and activities it will house. Structures around the world demonstrate that the returns on such investment may continue for decades.

These returns are seldom achieved without continuing effort. Owners must make expenditures for labor and material to operate and maintain a building, expenditures that continue until the building is demolished or abandoned. Structures around the world also demonstrate that failure to make these expenditures effectively can lead to premature deterioration or loss of services and damage to the facility, expose occupants to unsafe and unhealthy conditions, and impose additional costs on the building's users.

Some materials and building systems are particularly durable and repay their higher initial costs with savings in future operating and maintenance (O&M) expenditures. Other materials or systems may be selected because their lower initial costs meet the limits of available construction budgets and, with proper use, are likely to deliver satisfactory service. Some design choices raise the cost of construction, operations, or both, but also increase the service productivity or revenue received from the completed building.

Designers and owners of buildings often recognize that there are such choices and trade-offs between initial construction costs and recurring O&M costs and that decisions about a building's design, construction, operation, and maintenance can be made--in principle--so that the building performs well over a specified period of time and the total of all costs incurred over that period will be minimized.

In practice, defining the design options and operating strategies that will lead to the lowest life-cycle costs is difficult and subject to uncertainties. The behavior of materials, and mechanical and electrical systems must be forecasted, along with the likely uses of the building and the environmental conditions to which it may be exposed. Financial and economic assumptions and the period of time over which the analysis is made will influence the results. Analysts have devised a variety of ways to deal with these uncertainties.

However, a variety of factors may subvert effective action. Sometimes budget constraints impose pressures to reduce construction costs and lead in turn to design choices that raise O&M requirements. Similar pressures in the planning and design stages may underlie neglect to perform analyses and reduced effort to develop feasible alternative that would save money in the long run. Sometimes O&M efforts may not achieve results envisioned in design because of later budgetary pressures, lack of staff understanding of the designer's intent, poor information, or human error. Fires, earthquakes, violent storms, or other unusual events may damage facilities. Unanticipated use

INTRODUCTION

of the building, changes of ownership, or financial conditions may alter the strategy that would minimize life-cycle cost.

Because of these factors, facilities designers, builders, owners, and managers must continue working to control total costs of ownership throughout a facility's service life. Life-cycle cost analysis is typically used in planning and design, but other opportunities for using life-cycle cost analysis lie beyond these early states.

The most difficult obstacles to controlling total costs of ownership are those raised by administrative procedures and managerial or political decisions driven by short-term gains. Budgeting processes that divorce capital and operating expenditures make it difficult to identify and manage total costs of ownership. Their limited tenure may encourage senior managers and elected officials to value immediate results over long-run efficiencies. Competing public demands for government action may push these officials to shift resources away from facilities needs and toward those issues that attract strong constituencies. These obstacles impose cost burdens on the public and must be overcome if the greatest return on the public's assets is to be achieved.

Budgeting for the maintenance and repair of assets is an important role of facility managers within the DOE. A successful, valid budget request should be based on hard data which clearly shows the purpose for which the requested funding will be used. It should contain sufficient detail to clearly support the functional objectives and be able to withstand critical analyses.

Budgets should be based on measurable performance criteria and planned workloads. It is no longer sufficient to request last year's allocation plus an additional percentage to cover inflation or other cost growth. Budgeting must be based on an analysis of the functions to be performed, identifying the quantities of work to be performed, with details on unit prices, labor costs, transportation, materials, special contracts, and all other aspects which show how the funds will be spent.

Performance budgeting for maintenance and repairs requires a comprehensive data base including building identification numbers, function, size of facility in square feet, age of facility, ownership (owned or leased), specific project data (scope and estimated cost) for contract work, and work priority information. Budget data should be identified by Site, Area, Asset, Tenant, etc..

For that portion of the budget covering in-house operations, the budget should cover personnel staffing, grade levels, salary rates, materials, equipment and tools, transportation costs, miscellaneous minor contracts, and other such costs. Data should be provided showing the workload in terms of the number of assets, and square feet to be maintained.

Without a structured approach, budget submissions cannot be readily analyzed or reviewed, and financial allocations become a matter of negotiation based on prior year allocations.

STANDARD SYSTEM DESIGN LIFE TABLES

GENERAL

Life expectancy of any given item is a function of numerous factors. The Standard (nominal) Design Life of a given System Assembly/Component is defined as the projected service life measured from the date of installation to the date of replacement. The task of the Facility/Asset Manager is to balance this Design Life with the expected Service Life, that is, the point at which the item no longer serves its purpose and must be replaced. Manufacturers frequently have data which indicates a range of years of service that might be expected from their products. This data is usually based on historical trends observed over time for identical or similar items. In addition to manufacturers' data, there are publications which address life expectancy of facility components based on a variety of data from numerous companies or organizations that routinely maintain such data. In general, this data has great validity as a base line to use in projecting replacement needs for budgeting purposes based on Design Life.

As a reference in this guide, tables of commonly accepted design life data with replacement parameters for Work Breakdown Structures (WBS) are provided. Judgment must be applied to the numbers presented to adjust for specific system operation and maintenance standards. The location and environment of the system/component and its relationship with other system/components will also affect replacement life and should be taken into account when considering the subject. The numbers listed are based on industry standards where possible and if no standards are available a best guess estimate based on past experiencehas been used. Design life is an estimated number only and will vary based on maintenance frequency and system use.

Table A on the next page illustrates key column headings. The remaining tables are listed by volume and indicate standard design life and replacement quantities of standard system assembly/components.

Table One (Volume 0.01 - Foundations & Footings)
Table Two (Volume 0.02 - Substructure)
Table Three (Volume 0.03 - Superstructure)
Table Four (Volume 0.04 - Exterior Closure)
Table Five (Volume 0.05 - Roofing)
Table Six (Volume 0.06 - Interior Finishes and Construction)
Table Seven (Volume 0.07 - Conveying Systems)
Table Eight (Volume 0.08 - Mechanical)
Table Nine (Volume 0.09 - Electrical)
Table Ten (Volume 0.10 - Production/Lab/Other Equipment **[Future]**)
Table Eleven (Volume 0.11 - Specialty Systems)
Table Twelve (Volume 0.12 - Site Work)
Table Thirteen (Volume 0.13 - Other Structures and Facilities)

TABLE A

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced

STANDARD SYSTEM DESIGN LIFE TABLES

Note 1:	Used to document the replacement life* of significant WBS System Assembly/Components.	
Note 2:		Used to estimate percent of WBS System Assembly/ Component cost replaced at the year specified (measured from installation date to end date specified by the replacement life period*).

TABLE ONE

ITEM DESCRIPTION	**Replacement Life, Years***	**Percent Replaced**
0.01 FOUNDATIONS & FOOTINGS		

STANDARD SYSTEM DESIGN LIFE TABLES

Raft concrete slab foundation	200	100
Concrete grade beams	200	100
Cast-in-place concrete footings	200	100
Cast-in-place concrete foundation walls	150	100
Precast concrete foundation walls	150	100
Masonry foundation walls	100	100
Concrete block foundation walls	100	100
Stone foundation walls	50	100
Wood pile foundations, treated	100	100
Wood pile foundations, untreated	30	100
Precast concrete piles, square	150	100
Prestressed concrete piles	150	100
Cast-in-place concrete piles	150	100
Steel pipe piles, concrete-filled	100	100
Steel pipe piles, nonfilled	100	100
Steel "H" piles	100	100
Wood with cast-in-place concrete composite piles	75	100
Wood with precast concrete composite piles	75	100
Foundation dampproofing	50	100
Foundation waterproofing	50	100
Excavation/backfill	50	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE TWO

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.02 SUBSTRUCTURE		

*Note: The term Replacement Life is synonymous with Design Life.

STANDARD SYSTEM DESIGN LIFE TABLES

SLABS-ON-GRADE		
Standard 4" slab on grade floor	50	100
Standard 5" slab on grade floor	50	100
Structural 4" slab on grade floor	50	100
Structural 5" slab on grade floor	50	100
Concrete steps on grade	60	100
COLUMNS		
Wood columns, treated	50	100
Wood columns, untreated	30	100
Precast concrete columns	75	100
Prestressed concrete columns	75	100
Cast-in-place concrete columns	75	100
Steel pipe columns, concrete-filled	75	100
Steel pipe columns, nonfilled	75	100
Steel "H" columns	75	100

TABLE THREE

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.03 SUPERSTRUCTURE		
STRUCTURAL FRAME		

STANDARD SYSTEM DESIGN LIFE TABLES

Steel structural frame (includes columns, beams, girders, trusses, spandrels, bracing, and fireproofing)	75	100
Reinforced concrete structural frame (includes columns, beams, and miscellaneous frame elements)	75	100
Precast concrete structural frame (includes columns, beams, and miscellaneous frame elements)	75	100
Wood structural frame (includes posts, girts, plates, studs, girders, and built-up beams)	50	100
Metal joist structural frame (includes metal joists and accessories)	75	100
INTERIOR STRUCTURAL WALLS Interior concrete block load-bearing walls	60	100
Interior brick load-bearing walls	75	100
Interior concrete load-bearing walls	75	100
Interior wood load-bearing walls	50	100
FLOOR SLABS & DECKS Reinforced concrete floor slabs (includes slab and beams)	50	100
Post-tensioned concrete floor slabs	50	100
Precast prestressed concrete floor slabs (may include planks, concrete, tees, floor channels, and structural concrete topping)	50	100
Noncellular open metal decking with structural concrete topping	50	100
Cellular metal decking with structural concrete topping	50	100
FLOOR SLABS & DECKS Structural wood framing (includes sheathing, joists, beams, etc.)	40	100
Corrugated metal deck with light weight concrete topping	50	100
Corrugated metal deck only	30	100
Precast concrete (hollow core) roof slab	50	100
Poured-in-place gypsum concrete over formboards	40	100
STAIRS Metal-edged gypsum plank	40	100
Cement fiber planks	40	100
Precast concrete	50	100
Steel pan type, filled with concrete	40	100
Steel tread and riser	40	100
Prefabricated steel form filled with concrete	50	100
Steelframe, precast concrete treads, and risers	40	100

TABLE FOUR

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.04 EXTERIOR CLOSURE		
Masonry veneer: 4" brick and 4" block, insulation and vapor barrier	75	100
Precast concrete veneer insulation and vapor barrier	75	100

STANDARD SYSTEM DESIGN LIFE TABLES

Stucco on metal studs: insulation and vapor barrier	35	100
Stone veneer, block backup insulation, and vapor barrier	75	100
Aluminum panel: insulation and vapor barrier	50	100
Metal panel: insulation and vapor barrier	40	100
Cast-in-place 8" concrete wall: insulation and vapor barrier	200	100
Concrete block (standard) 8" wall insulation and vapor barrier	150	100
Split-face concrete block 8" wall: insulation and vapor barrier	150	100
Plywood siding, texture 1-11 with wood studs: insulation and vapor barrier	30	100
Cedar siding, rough-sawn with wood studs: insulation and vapor barrier	40	100
Redwood siding, board, and batten: insulation and vapor barrier	40	100
Screen louvers, galvanized steel	15	100
Screen louvers, copper	25	100
Storm proof louvers, galvanized steel	15	100
Storm proof louvers, copper	25	100
Air grills, galvanized steel	15	100
Glass screen and metal frame	15	25
Preformed metal screen and metal frame	15	25
Fabric screen and metal frame	15	25
Cast-in-place concrete	75	100
Precast concrete	75	100
Brick masonry	75	100
Concrete unit masonry	60	100
Stone	75	100
Wood	30	100
Metal panels	40	100
Glass panels	40	100
Exterior gypsum board including metal hangers	12	100
Cement asbestos including metal hangers	16	100
Metal panels including metal hangers	40	100
Fixed glazing, frame, hardware	40	100
Operable glazing, frame, hardware	35	100
Single glazing, fixed frame, hardware	40	100
Double glazing, fixed frame, hardware	40	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE FOUR

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.04 EXTERIOR CLOSURE (Continued)		
Reflective single glazing, fixed frame, hardware	40	100
Tinted single glazing, fixed frame, hardware	40	100
Aluminum spandrel panel	50	100
Stainless steel panel	50	100
Porcelain enamel panel	50	100
Weathering steel panel	50	100
Opaque colored-glass panel	40	100
Ceramic tile facing or panel	50	100
Stone facing or panel	75	100
Hollow metal door, frame, hardware	40	100
Solid-core wood door	40	100
Overhead metal service door, frame, hardware	30	100
Rolling metal service door, frame, hardware	30	100
Telescoping metal service door, frame, hardware	25	100
Revolving door, frame, hardware	25	100
Automatic sliding door, mechanism, frame, hardware (2 horsepower)	15	50
Aluminum panel, framing, insulation	50	100
Hollow metal panel, framing	40	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE FIVE

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.05 ROOFING		
Asphalt & gravel built-up membrane roofing, 4 ply- 15# felt	20	100
Prepared roll roofing, 15# felt	12	100
SINGLE-PLY/IRMAS		
Inverted insulated roof membrane	20	100
Butyl rubber sheet roofing, self-flashing	20	100
Neoprene sheet roofing	30	100
Hypalon sheet roofing	30	100
METAL ROOF SYSTEM		
Copper roofing: flat, standing, or batten seam	50	100
Galvanized steel sheet metal	30	100
COATED FOAM MEMBRANE	15	100
SHINGLES	20	100
Asphalt, fiberglass, and wood	30	100
Slate/Cement	50	100
TILES - Metal, clay, and concrete	40	100
PARAPETS, MASONRY, CONCRETE, METAL, WOOD	See System .04 for appropriate replacement life of the material used	
ROOF DRAINAGE SYSTEMS		
Gutters and downspouts	20	100
Scuppers, drains	20	100
ROOF SPECIALTIES		
Roof hatches, painted steel	24	100
Roof hatches, galvanized	40	100
Roof hatches, stainless	40	100
Relief vents	40	100
SKYLIGHTS	40	100
Skylights, single and double glazed	40	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE SIX

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced

STANDARD SYSTEM DESIGN LIFE TABLES

0.06 INTERIOR FINISHES & CONSTRUCTION		
Brick partitions, exposed	100	100
Concrete block partitions lightweight, exposed	100	100
Structural clay facing tile partitions, exposed	75	100
Drywall partitions, metal or wood studs	25	100
Lath and plaster partitions, metal or wood studs	35	100
Glazed partitions, bank-height metal or wood framing	30	100
Baked enamel steel partitions, demountable, full or bank height	25	100
Vinyl-covered steel partitions, demountable. full or bank height	25	100
Gypsum plain-finish partitions, movable, full or bank height	20	100
Gypsum prefinished painted partitions, movable, full or bank height	20	100
Gypsum vinyl-covered partitions movable, full or bank height	20	100
Gypsum plastic-laminated partitions, movable, full or bank	20	100
Vinyl lined steel folding partitions, manual	20	100
Vinyl clad steel folding partitions, manual	25	100
Aluminum-faced folding partitions, manual	20	100
Enameled-steel folding partitions, manual	25	100
Hardwood veneer folding partitions, manual	25	100
Plastic-laminated folding partitions, manual	25	100
Metal baked-enamel toilet partition: frame, door, and hardware	25	100
Laminated-plastic toilet partition: frame, door, and hardware	25	100
Stainless steel toilet partition: frame, door, and hardware	35	100
Porcelain enamel toilet partition: frame, door, and hardware	25	100
Painted plywood toilet partition: frame, door, and hardware	20	100
Marble toilet partition: frame, door, and hardware	75	100
BALUSTRADES		
Steel railing and handrail, pipe or bar	30	100
Aluminum railing and handrail	40	100
Stainless steel railing and handrail	50	100
Bronze railing and handrail	50	100
Wood railing and handrail	25	100
SCREENS Wood screen	25	100
Concrete block	40	100
Hollow metal door and frame, hardware	30	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE SIX

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.06 INTERIOR FINISHES & CONSTRUCTION (Continued)		
Hollow-core wood door with metal frame, hardware	20	100
Solid-core wood door with metal frame, hardware	30	100
Hollow core wood door with wood frame, hardware	20	100
Solid-core wood door with wood frame, hardware	30	100
Special (security) metal door	40	100
Plastic laminate wood door	25	100
Interior paint on masonry	10	100
Interior paint on plaster	7	100
Interior paint on drywall	7	100
Wall paper, light to medium weight	10	100
Vinyl, light to medium weight	12	100
Ceramic tile, glazed with organic adhesive	25	100
Ceramic mosaics, unglazed with organic adhesive	25	100
Stone veneer	75	100
Wood veneer, stain, or varnish	40	100
Oak parquet and block flooring, solid	35	100
Maple gym flooring	35	100
Resilient asphalt tile, 1/8 inch thick	15	100
Resilient vinyl tile, 1/8 inch thick	20	100
Vinyl asbestos tile, 1/8 inch thick	18	100
Carpeting, standard acrylic or nylon	12	100
Ceramic tile, glazed with trim, organic	25	100
Ceramic mosaics, unglazed with organic adhesive	25	100
Quarry tile with 3/4 inch portland cement bed	30	100
Terrazzo, 2 1/2 - 3 inches thick	50	100
Brick, unglazed pavers	35	100
Raised access floor--plastic laminate 30 x 30 inch panels	25	100
Raised access floor--carpeted 24 x 24 inch panels	10	20
Raised access floor--carpeted 30 x 30 inch panels	10	20
Acoustical tile, concealed zee splines	10	100
Acoustical tile, exposed 2x4 foot grid with hangers	10	100
Acoustical tile, mineral fiber, 12x12 inches	12	100
Acoustical tile, mineral fiber lay-in panels with painted face, 24 x 24 inches	15	100
Acoustical tile, exposed 2 x 2 foot grid with hangers	10	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE SEVEN

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.07 CONVEYING SYSTEM		
Passenger elevators - high speed, automatic (25 hp; 75% efficiency)	20	100
Passenger elevators - hydraulic (25 hp; 75% efficiency)	20	100
Freight elevators - hydraulic (35 hp; 75% efficiency)	20	100
Single-width (32") escalator (7½ hp; 75% efficiency)	15	100
Moving walk (4' 0" wide) (4 hp; 75% efficiency)	5	25

STANDARD SYSTEM DESIGN LIFE TABLES

Hand-operated dumbwaiter, 1000 lb	20	100
Electric-operated dumbwaiter, 5000 lb (5 hp; 75% efficiency)	20	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL		
0.08.01 Plumbing		
PIPE & PIPE FITTINGS		
Black steel pipe, schedule 40, 1/2-8"	30	20
Copper, type K, including fittings and supports. 1/2-2"	35	30
Copper, type L, including fittings and supports, 3/8-3"	35	30
VALVES		
Bronze gate valves, 3/8-1"	15	50

STANDARD SYSTEM DESIGN LIFE TABLES

Iron body. bronze mounted gate valves, 6"	15	50
Brass tee and lever handle type, 1/2-3/4"	15	100
Hose gate drain valves, bronze 2"	15	100
SHOCK ABSORBERS Shock absorbers, 3/4 x 4" long	25	100
WATER METERS Disk-type water meters, 3/4-2" diameter	25	100
INSULATION Piping insulation, 1/2-2 1/2"	15	75
CIRCULATING PUMPS (IN-LINE) Iron body circulation pump, 1/12 hp	15	50
Iron body circulating pump, 1/8 hp	15	50
Iron body circulating pump, 1/2 hp	15	50
DOMESTIC HOT WATER GENERATORS Gas-fired hot water generator, commercial, cement lined, 70% efficient, 500 - gal/h recovery rate	20	100
Gas-fired hot water generator, commercial, cement lined, 75% efficient, 100 - gal/h recovery rate	20	100
Electric-heated hot water generator, residential, glass lined, 100% efficient, 8-120 gal/h recovery rate	15	100
PIPE & PIPE FITTINGS Cast iron soil pipe, extra heavy (bell), 2-6"	40	100
Cast iron soil pipe, no hub, 1 1/2-2"	40	100
FLOOR DRAINS Cast iron flat round-top floor drains, 3-5" outlet	40	100
Cast iron flat square-top floor drains, 3-5"outlet	40	100
Rough brass top funnel-type floor drains, 3-4" outlet	40	100
Cast iron top floor drain with bucket, 3-6" outlet	40	100
AREA DRAINS Cast iron area drains, grate, 3" throat	40	100
TRENCH DRAINS Trench drain, light duty, 2-4" outlet - 2' 0" overall	25	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL		
0.08.01 Plumbing (Continued)		
WATER CLOSETS		
Floor-mounted water closets, washdown, and siphon jet types	35	100
Wall-mounted water closets, washdown, and siphon jet types	35	100
URINALS		
Pedestal-type urinals, washdown, and siphon jet types	35	100
Wall-hung urinals, washdown, blowout, and siphon jet types	35	100
Floor-mounted urinals, washdown, and women's type	35	100
LAVATORIES		
Vitreous china, wall-hung lavatory, 20 x 18"	35	100
Iron enamel, wall-hung lavatory, 20 x 18"	40	100
Enameled steel, wall-hung lavatory, 20 x 18"	35	100
BATHTUBS		
Cast iron enamel bathtub, 5' 0" recessed	40	100
Enameled steel bathtub, 5' 0" recessed	35	100
SHOWERS		
Terrazzo shower receptor, 32 x 48"	50	100
Enameled steel shower receptor 32 x 48"	35	100
Plastic shower receptor, 32 x 48"	20	100
Aluminum and glass shower, commercial grade	25	100
WASH SINKS		
Iron enamel, highback, single sink, 24 x 48"	35	100
Enameled steel, highback, single sink, 24 x 48"	35	100
Stainless steel, highback, single sink	40	100
Plastic, highback, single sink	15	100
DRINKING FOUNTAINS		
Stainless steel electric drinking fountain	20	100
PIPE & FITTINGS (up to 3")		
Gas and oil	20	40
VALVES & COCKS (up to 3")		
Gas and oil	20	50
PIPING SPECIALTIES & ACCESSORIES (up to 3")		
Gas and oil	20	50
METERS (up to 3")		
Gas	30	25
Oil	20	50
TANKS		
Oil storage	20	100
PUMPS (up to 3")		
Oil	15	50

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL **0.08.01 Plumbing** (Continued)		
EQUIPMENT Gas compressor	15	20
Oil preheater (steam)	15	25
Preheater (electric)	10	50
INSULATION	15	75
0.08.02 Fire Protection Automatic sprinkler system, wet type, concealed piping	40	50
Simplex-type fire pumps, 20 hp, 500 gpm, 1750 rpm	20	100
Fire hose cabinets, primed steel, 1 25" hose, recessed	20	100
Siamese connection, brass, 2 1/2 x 2 1/2 x 4"	100	100
Roof manifold, brass (vertical), 2 1/2 x 2 1/2 x 4"	75	100
Dry chemical enameled steel extinguisher	15	100
0.08.03 HVAC BOILERS (steam) Packaged marine type (No. 2 oil) • 40 hp	25	100
• 50 hp	25	100
• 150 hp	25	100
• 700 hp	25	100
Packaged marine type (No. 6 oil) • 80 hp	25	100
• 250 hp	25	100
• 700 hp	25	100
Steel-fire box, base, jacket (light oil) • 25 hp	20	100
• 160 hp	20	100
• 540 hp	20	100
Steel-fire box, base, etc., packaged • 50 hp	20	100
• 170 hp	20	100
• 460 hp	20	100
Cast iron sectional w/jacket, trim, & burner (No. 6 oil) • 60 hp	20	100
• 120 hp	20	100
• 170 hp	20	100
Cast iron sectional with jacket, trim, and burner (steam and gas) • 40 hp	25	100
• 100 hp	25	100
• 170 hp	25	100
Hot water (gas)	20	100
Hot water (electric)	15	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS		
0.08.03 HVAC (Continued)		
FURNACES		
Upflow, gas-fired		
• 80,000 BTU	20	100
• 105,000 BTU	20	100
Upflow, oil-fired		
• 85,000 BTU	20	100
• 100,000 BTU	20	100
• 125,000 BTU	20	100
Upflow, electric heat		
• 77,400 BTU, 22 kW, 240V	15	100
• 120,000 BTU	20	100
• 140,000 BTU	20	100
Horizontal flow, gas-fired		
• 105,000 BTU	20	100
• 125,000 BTU	20	100
PUMPS		
Horizontal split case type		
• 3 x 2 1/2", 1 1/2 hp	20	100
• 5 x 4", 20 hp	20	100
• 10 x 8", 125 hp	20	100
End suction type		
• 1 1/2 x 1 1/4", 3/4 hp	15	100
• 3 x 2 1/2", 1 1/2 hp	15	100
• 5 x 4", 7 1/2 hp	15	100
AIR CONTROL		
Boiler fittings	20	100
Air separators		
• 56 gal/min (2" screwed)	20	100
• 300 gal/min (4" flanged)	20	100
• 2,950 gal/min (12" flanged)	20	100
Compression tank and fittings		
• 15 gal (13" diameter x 34 1/2")	20	100
• 180 gal (30" diameter x 70")	20	100
• 280 gal (36" diameter x 74")	20	100
AUXILIARY EQUIPMENT (up to 500 ph)		
Feed water treatment	15	100
Deaerators	20	100
Breeching	20	100
Flues	20	100
Draft control	15	100
HEAT EXCHANGERS		
DX	20	100
Water or steam	20	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS		
0.08.03 HVAC (Continued)		
HEAT RECOVERY		
All types	15	100
EQUIPMENT INSULATION		
All types	15	100
WATER CHILLING		
Reciprocating compressor, electric		
• 81 ton capacity	20	100
Centrifugal compressor, electric		
• 120 ton capacity	20	100
Absorption machine, steam		
• 230 ton capacity	20	100
HEAT PUMPS		
Single package, air-to-air		
• 24,000 BTU	10	100
• 48,000 BTU	15	100
• 60,000 BTU	15	100
Split system, air-to-air		
• 36,000 BTU outdoor	15	100
• 36,000 BTU indoor	15	100
COOLING TOWERS		
Packaged centrifugal blow-through		
• 200 ton capacity	15	100
Packaged axial flow		
• 200 ton capacity	15	100
Packaged draw-through		
• 150 ton capacity	15	100
Ejector type		
• 250 ton capacity	20	100
CONDENSERS		
Water-cooled condenser		
• 30 ton capacity	20	100
Air-cooled condenser		
• 100 ton capacity	20	100
Evaporative condenser		
• 10 ton capacity	20	100
PIPE & FITTINGS	20	40
DIVERTING VALVES	15	100
FREEZE PROTECTION	15	100
PUMPS		
Horizontal split case type		
• 3 x 2 1/2", 1 1/2 hp	20	100
• 5 x 4", 20 hp	20	100
• 10 x 8", 125 hp	20	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS **0.08.03 HVAC** (Continued) End suction • 1 1/2 x 1 1/4", 3/4 hp	15	100
• 3 x 2 1/2", 1 1/2 hp	15	100
• 5 x 4", 7 1/2 hp	15	100
DIRECT EXPANSION SYSTEM Refrigerant circulation system	30	100
Pipe and fittings	30	100
Accessories	25	100
INSULATION (piping and equipment)	15	75
PIPE & FITTINGS	20	40
VALVES Gate	15	50
Butterfly	15	50
Plug	15	50
OS&Y (outside screw and yoke)	15	50
PIPING SPECIALTIES & ACCESSORIES	10	50
PUMPS Horizontal split case type • 2-3" size up to 1 1/2 hp	20	100
• 4-5" size up to 20 hp	20	100
• 8-10" size up to 125 hp	20	100
End suction • 1 1/4 1 1/2" size up to 3/4 hp	15	100
• 2-3" size up to 1 1/2 hp	15	100
• 4-5" size up to 7 1/2 hp	15	100
Distribution systems • Steam	20	50
• Glycol	20	50
• Other liquid	20	50
AIR-HANDLING EQUIPMENT Single zone with mixing box HW coil, CW coil, flat filter 1750-2750 cfm	20	100
Single zone with mixing box HW coil, CW coil, manual roll filter 1750-2750 cfm	20	100
Single zone with mixing box, HW coil, CW coil, auto roll filter 1750-2750 cfm	20	100
Single zone with mixing box HW coil, DX coil, flat filter 1750-2750 cfm	20	100
Roof top unit 1750-2750 cfm	15	100
Single zone with mixing box, HW coil, DX coil, roll filter 1750-2750 cfm	20	100
Single zone with mixing box, HW coil, DX coil, auto roll filter 1750-2750 cfm	20	100
Four zone with mixing box, dampers, HW coil, CW coil, flat filter 1750-2750 cfm	20	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS **0.08.03 HVAC** (Continued) Four zone with mixing box, dampers, HW coil. CW coil, roll filter 1750-2750 cfm	20	100
Four zone with mixing box dampers, HW coil, CW coil, auto roll filter 1750-2750 cfm	20	100
Air tempering (packaged) • 24,000 BTU	15	100
Air temperature (split system) outdoor section • 24,000 BTU	15	100
• 60,000 BTU	15	100
Air tempering (split system) • 24 000 BTU	20	100
• 60,000 BTU	20	100
AIR TEMPERING (incremental) Through wall type, fixed • 11,700 BTU cool	10	100
• 13,300 BTU Heat (HW)		
Through wall type • 11,700 BTU Cool	10	100
• 15,300 BTU Heat (elect)		
Through wall type, remove chassis • 14,600 BTU	10	100
DUCTWORK Round • Low pressure	35	50
• Medium pressure	25	50
• High pressure	25	50
Rectangular • Low pressure	50	50
• Medium pressure	40	50
• High pressure	40	50
Plenums	20	100
REGISTERS & GRILLES 12 x 8"	25	100
DIFFUSERS 8" Neck	25	100
DAMPERS 8" Round	25	100
TROFFERS (Light texture type)	20	100
AIR TREATMENT EQUIPMENT	20	100
HEAT RECOVERY EQUIPMENT	15	100
ANTIVIBRATION EQUIPMENT	15	100
INSULATION Cooling (vapor barrier)	15	75
Heating	15	75

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS		
0.08.03 HVAC (Continued)		
EXHAUST FANS		
Direct drive, 1/4 hp	20	100
Belt drive, 1/2 hp and over	20	100
VENTILATORS	15	100
MAKEUP AIR UNITS	20	100
Inside/outside	15	100
BASEBOARD HEATING UNITS (hot water)		
Radiant, cast iron panel		
• 7 1/4" high	30	100
Nonferrous element		
• 4" deep x 36" long	25	100
CONVECTOR HEATING UNITS		
Baseboard panel with 9 1/18" high enclosure		
• 1" Tube	20	100
Free standing or semirecessed		
• 24" high x 36" long	25	100
INDUCTION UNIT W/CABINET		
90-510 cfm	20	100
FAN COIL UNITS W/CABINETS		
155-215 cfm	20	100
RADIATORS		
Cast iron, free standing		
• Six tube, 32" high	40	100
• Five tube, 22" high	40	100
• Three tube, 25" high	40	100
FINNED TUBE ELEMENTS		
Copper fin-tube		
• 48 fins/ft, 1 1/4" pipe	35	100
Steel Fin-Tube		
• 40 fins/ft	35	100
DUCT-MOUNTED COIL SECTIONS		
Duct-mounted coil sections, steam	20	100
Duct-mounted coil sections, hot water	20	100
Duct-mounted coil sections, electric	15	100
RADIANT HEATING UNITS		
Radiant heating units, electric	40	100
Radiant heating units, hot water	25	100
UNIT HEATERS		
Unit heaters, gas	15	100
Unit heaters, electric	15	100
Unit heaters, hot water	20	100
Unit heaters, steam	20	100
Space heater, steam/hot water	20	100
Air curtains, steam/hot water	20	100
Unit air conditioners with heating	15	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS		
0.08.03 HVAC (Continued)		
Package humidifiers	10	100
Package dehumidifiers	15	100
ROOM THERMOSTATS		
Low voltage heating	25	100
Low voltage cooling	25	100
Line voltage heating	25	100
Low voltage heating and cooling	25	100
Line voltage heating, heavy	25	100
POSITIONAL DAMPER—Motor-Actuated		
Modulating type with external return spring-transformer, inspection and 115 VAC	20	100
Modulating type with Internal return spring-transformer, 115 VAC	20	100
1" Modulating motorized valves	15	100
1 ¼" Modulating motorized valves	15	100
1 ½" Modulating motorized valves	15	100
2" Modulating motorized valves	15	100
UNIVERSAL RELAYS		
SPST, use w/low voltage controls, heat only	25	100
SPDT, use w/low voltage controls, heat or cool only	25	100
DPDT, use w/low voltage controls, heat and cool	25	100
AQUASTATS		
External bellows type, close on pressure drop, 2-50lb range	25	100
Remote bulb type, mercury tube thermostat	25	100
Make circuit on drop-line voltage	25	100
Make circuit on rise-line voltage	25	100
OTHER CONTROLS		
All parts, components, devices, tubing, wiring, and accessories necessary to control air and liquid distribution systems, components, and equipment	25	100
All parts, components, devices, tubing, wiring, and accessories necessary to monitor, record, or otherwise indicate status of any of the components of the distribution systems or equipment	25	100
All parts, components, devices, accessories, and equipment necessary to detect and repair leaks and to make adjustments, alignments, inspections, and sampling, and trial and final HVAC startup	15	100

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE EIGHT

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.08 MECHANICAL SYSTEMS **0.08.03 HVAC** (Continued) All parts, components, devices, piping or duct systems, accessories, and equipment for special cooling or heating systems, storage cells, dust and fume collectors, deodorizing system, carbon monoxide equipment, special sound attenuating equipment, air curtains, paint spray booth, and ventilation system	25	100
All parts, components, devices, piping or duct systems, accessories, and equipment	25	100
0.08.05 Special Mechanical Systems Simplex air compressor, 1 hp with 30 gal receivery	25	100
Vacuum pumps, controls, and accessories, 1 hp with 30 gal receivery	25	100
Carbon dioxide cylinders, simplex and duplex	25	100

*Note: The term Replacement Life is synonymous with Design Life.

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE NINE

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.09 ELECTRICAL		
0.09.01 Service & Distribution		
0.09.01.02 Low Voltage		
Circuit breakers, metal-clad drawout, below 600V, all sizes	20	100
Circuit breakers, fixed type, below 600V, all sizes	20	100
Disconnect switches, enclosed, all sizes	20	100
Transformers, liquid-filled, 0-750 kVA, below 600V	30	100
Transformers, dry type, 0-750 kVA, below 600V	30	100
Switchgear bus, indoor & outdoor, bare, below 600V	20	100
Bus duct, indoor and outdoor, all voltages	20	100
Cable terminations, all types of insulation, above ground and aerial, below 600V	15	100
Motor starters, contact type, below 600V	18	100
Motors, synchronous, below 600V	15	100
Motors, direct current, all sizes	15	100
Motors, induction, below 600V	15	100
0.09.01.03 Medium Voltage		
Circuit breakers, metal-clad drawout, all sizes above 600V	20	100
Circuit breakers, fixed type, all sizes, above 600V	20	100
Disconnect switches, enclosed, all sizes	20	100
Transformers, liquid-filled, 500-2499 kVA, above 600V	30	100
Transformers, dry type, 0-750 kVA, over 600V	30	100
Transformer, dry type, 500-2499 kVA, above 600V	30	100
Switchgear bus, indoor and outdoor, insulated, above 600V	20	100
Switchgear bus, indoor and outdoor, bare, above 600V	20	100
Bus duct, indoor and outdoor, all voltages	20	100
Cable, thermoplastic, above 600V	Life	N/A
Cable, thermosetting, above 600V	Life	N/A
Cable, paper-insulated, lead-covered, above 600V	Life	N/A
Cable, other, above 600V	Life	N/A
Cable joints, all types of insulation, in duct or conduit, below ground, above 600V	Life	N/A
Cable joints, thermoplastic insulation, above 600V	Life	N/A

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE NINE

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.09.02 Lighting Fluorescent interior lighting fixtures, 2 each, 40W tubes (20,000 burning hours)	20	100
Incandescent interior lighting fixtures, 1 each, 200W (1000 burning hours)	20	100
High-intensity mercury vapor lighting fixtures, 250W (24,000 burning hours)	20	100
High-intensity metal-halide (multivapor) lighting fixtures, 250W (10,000 burning hours)	20	100
High-pressure sodium vapor lighting fixtures, 250W (20,000 burning hours)	20	100
Low-pressure sodium vapor lighting fixtures, 100W (18,000 burning hours)	20	100
0.09.03 Special Systems **0.09.03.05 Emergency Power** Generators, steam-turbine-driven, 1000kW (600 psi @ 750^{o}F with 4" mercury back pressure)	25	100
Generators, gas-turbine driven, 1000kW	25	100
Generators, reciprocating diesel, 100kW	25	100
0.09.03.07 Electric Heating, Baseboards Baseboard heating units, prewired, including accessories.	20	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE ELEVEN

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.11 SPECIALTY SYSTEMS		
CANOPIES	25	100
LOADING DOCKS	20	75
TANKS	30	100
DOMES (Bulk Storage, Metal Framing)	40	100
LOUVERS & VENTS	20	100
ACCESS FLOORS	25	75
INTEGRATED CEILINGS	20	75
MEZZANINE STRUCTURES	35	100

*Note: The term Replacement Life is synonymous with Design Life.

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE TWELVE

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.12 SITEWORK		
0.12.01 Utility Distribution System		
PLUMBING		
Concrete tanks	30	100
Conveyors (belt, bucket, screw)	10	50
Manholes	40	100
Underground piping	35	100
CENTRAL HEATING		
Dust collector	10	100
Steam turbines	10	30
Stokers	10	40
Pulverizers	5	100
Scrubbers	8	100
CENTRAL COOLING		
Rotary screw chillers	25	100
Chilled water distribution system	40	100
ELECTRICAL		
Switchyards	30	100
Substations	25	100
Overhead transmission system	45	100
Underground transmission system	25	100
UTILITY SUPPORT STRUCTURES		
Steel towers & poles	45	100
Precast concrete poles	75	100
Wood poles	25	100
Tower & pole foundations	50	100
Utility service tunnels	75	100
Utility service tunnels: dampproofing/waterproofing	50	100
Concrete support pads	50	100
0.12.02 Paving Roadways/Walkways		
Curb	40	100
Walk	20	100
Roadway:		
Asphalt	15	100
Concrete	25	100
Stone (Gravel)	2	25
0.12.03 Tunnels		
ELECTRICAL:		
Service & Distribution	35	50
Lighting	20	100
MECHANICAL:		
Drainage	40	100
Ventilation	25	100
STRUCTURAL:		
Arch	50	75

TABLE TWELVE

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.12.03 Tunnels (Continued)		
Circular	75	75
Columns	75	100
Beams	75	100
Walls	75	100
Structural slabs	50	100
Joints	10	100
Foundation	100	100
FINISHES:		
Walls	60	100
Ceilings	45	100
Floors	25	100
0.12.04 Railways		
Trackwork	10	100
Signals & communications	15	100
0.12.05 Fountains & Pools	35	100
0.12.06 Security Gates & Fences	25	100
0.12.07 Landscaping	20	100
0.12.08 Bridges & Abutments		
APPROACHES:		
Pavement, asphalt	15	100
Pavement, concrete	25	100
Guide railing, concrete	25	100
DECK ELEMENTS:		
Curbs, concrete	40	100
Mono deck surface, concrete	25	100
Railings/parapets, concrete	25	100
Sidewalks/fascias, concrete	20	100
Sidewalks/fascias, steel	40	100
Wearing surface, asphalt	15	100
Wearing surface, concrete	25	100

*Note: The term Replacement Life is synonymous with Design Life.

TABLE THIRTEEN

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.13 Other Structures and Facilities		
Accelerators. Linear	35	50
Accelerators. Ring	35	50
Air Traffic Aids	15	100
Bridges (Trains)	35	100
Bridges (Vehicular)	45	100
Bridges (Walking)	75	100
Cables, Above Ground (Fire Alarm)	40	100
Cables, Above Ground (Security)	40	100
Cables, Above Ground (Voice/Data)	40	100
Cables, Under Ground (Fire Alarm)	20	100
Cables, Under Ground (Security)	20	100
Cables, Under Ground (Voice/Data)	20	100
Cables, Under Ground (Energy Management)	20	100
Catchall	35	100
Caverns (Oil)	50	100
Cooling Ponds or Reservoirs	35	100
Dams	75	25
Distribution Transformers	30	100
Docks/Wharves	35	100
Electric Generators	25	100
Electrical Cables, Primary	35	100
Electrical Cables, Secondary	40	100
Electrical Cables, Tertiary	45	100
Fencing (Security)	25	100
Helicopter Landing Pad	20	75
Igloos (Explosives)	30	100
Incinerator Plants	30	75
Large Piping (Petroleum Products)	20	40
Laterals (Reclamation)	25	75
Levees/Dikes	25	50
Lift Stations (Sewage)	25	20
Medium Piping (Petroleum Products)	25	20
Metering Stations (Natural Gas)	15	75
Other Boiler	25	100

TABLE THIRTEEN

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.13 Other Structures and Facilities		
Other Industrial, Water Wells	35	100
Other, Air Transportation Systems	25	100
Other, Chill Water Distribution System	30	40
Other, Communications Monitoring Systems	25	100
Other, Communications System Lines	25	100
Other, Communications Systems	25	100
Other, Electrical Distribution System	25	100
Other, Electrical Systems	25	100
Other, Energy Management Control Systems	25	100
Other, Energy Research Accelerators	35	50
Other, Flood Control and Navigation	25	100
Other, Gas Distribution System	15	40
Other, Heating Systems	20	75
Other, Industrial Waste/Haz Piping	15	75
Other, Monuments & Memorials	45	100
Other, Other Service Structures	50	30
Other, Paving Structures	20	75
Other, Photovoltaic Systems	20	50
Other, Plants (Industrial Waste/Hazard)	50	40
Other, Plants (Sewer)	50	30
Other, Pumping Stations	20	75
Other, Railroad Transporation Systems	15	75
Other, Reclamation and Irrigation	25	100
Other, Research and Development	35	100
Other, Security Systems	25	100
Other, Service Structures	50	30
Other, Storage	50	45
Other, Storage (Industrial Waste/Haz)	35	100
Other, Tanks (Gas)	25	100
Other, Tanks (Oil)	25	100
Other, Vehicular Transportation Systems	20	100
Other, Water Lines	30	40
Other, Water Storage	30	100
Other, Water Transportation Systems	25	100

TABLE THIRTEEN

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.13 Other Structures and Facilities		
Parking (Aircraft)	15	75
Parking (Vehicular)	25	75
Paving	20	75
Pipelines (Old RPIS 502 Entries)	40	100
Piping (Fire Protection Water)	30	20
Piping (Hazardous & Contaminated Waste)	15	75
Piping (Hazardous, Not Contaminated, Waste)	20	40
Piping (Industrial Process Gas)	20	40
Piping (Natural Gas)	20	40
Piping (Non-Potable Water)	30	40
Piping (Other Combustible Gases)	20	40
Piping (Potable Water)	30	20
Piping, Gravity (Sewage)	30	20
Piping, Gravity (Stormwater)	30	20
Piping, Pressure (Sewage)	30	20
Piping, Pressure (Stormwater)	30	20
Piping, Return (High-Temperature Water)	30	20
Piping, Return (Steam/Condensate)	30	20
Piping, Supply (High Temperature Water)	30	20
Piping, Supply (Steam)	30	20
Plants (Chill Water)	50	30
Plants (Coal-Fired)	50	40
Plants (Contaminated, Hazardous)	50	40
Plants (Evaporative Cooling)	50	30
Plants (Gas-Fired)	50	40
Plants (Hazardous Not Contaminated)	50	40
Plants (Oil-Fired)	50	40
Plants (Other Combustible Gases)	50	40
Plants (Process Gas)	50	40
Plants (Sewer, Primary Treatment)	50	30
Plants (Sewer, Secondary Treatment)	50	30
Plants (Sewer, Tertiary Treatment)	50	30
Plants (Stormwater, Primary Treatment)	50	30
Plants (Water Treatment)	50	30

TABLE THIRTEEN

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.13 Other Structures and Facilities		
Pol Services for Vehicles	50	20
Poles (Voice/Data)	45	100
Poles/Towers (Electrical Distribution)	75	100
Power Development Dams	50	25
Power Transformers	30	100
Primary Roads	15	75
Primary Tracks	10	100
Pumping Stations	25	75
Pumping Stations (Fire Protection Water)	20	75
Pumping Stations (Natural Gas)	15	75
Pumping Stations (Non-Potable Water)	20	75
Pumping Stations (Potable Water)	20	75
Pumping Stations (Reclamation)	20	75
Pumps (Petroleum Products)	15	100
Pumps (Stormwater)	25	100
Ranges, Rifle/Pistol (Security)	20	100
Return Piping (Chill Water)	30	20
Runways	20	100
Secondary Roads	20	75
Security Lights	20	100
Septic Tanks (Sewer)	35	100
Sidewalks	25	100
Storage (Open Pavement)	25	100
Storage/Diversion Dams (Reclamation)	10	100
Street Lights	20	100
Structures, Industrial, Other	50	50
Structures, Monuments & Memorials	45	100
Substations	25	100
Supply Piping (Chill Water)	30	20
Switching Stations (Voice/Data)	15	100
Tanks (Hazardous Contaminated)	25	100
Tanks (Hazardous Not Contaminated)	25	100
Tanks (Industrial/Not Hazardous)	25	100
Tanks (Oil)	25	100

TABLE THIRTEEN

STANDARD SYSTEM DESIGN LIFE TABLES

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.13 Other Structures and Facilities		
Tanks (Other Combustible Gases)	25	100
Tanks (Process Gas)	25	100
Tanks (Sewage)	25	100
Tanks (Stormwater)	30	100
Tanks, Gravity (Fire-Protection)	30	100
Tanks, Gravity (Non-Potable)	30	100
Tanks, Gravity (Potable)	30	100
Tanks, Pressure (Fire-Protection)	25	100
Tanks, Pressure (Non-Potable)	25	100
Tanks, Pressure (Potable)	25	100
Taxi Ways	20	75
Tertiary Roads	30	75
Towers (Chill Water)	45	100
Towers (Security)	45	100
Towers (Voice/Data)	45	100
Transmission Lines 230 Kv	35	100
Tunnels (Vehicular)	50	75
Tunnels (Walking)	75	75
Vaults/Bunkers (Explosives)	35	75
Vehicle Service	35	75
Vehicle Weighing Facility	15	100
Wells (Natural Gas)	100	50
Wells (Non-Potable)	35	100
Wells (Oil)	100	50
Wells (Potable Water)	35	100

*Note: The term Replacement Life is synonymous with Design Life.

LCAM PERFORMANCE MEASURES

LIFE CYCLE ASSET MANAGEMENT
PERFORMANCE MEASURES

Suggested performance measures for implementing the Life Cycle Asset Management (draft) DOE Order have been complied in the attached matrix and, as referenced, include existing DOE performance measures and new performance measures developed by the FM-20/Infrastructure Management & Training Program (FM/IMT) Team. The matrix and accompanying narrative on key characteristics represent a starting point for discussion of appropriate measures within a DOE/LCAM context.

The following briefly describes the methodology used to develop and interprets the matrix:

- In general, the matrix is designed to illustrate one or more performance measures for every major topic required under LCAM (except for project management to be addressed separately).
- Each major LCAM Topic (Column 1) is organized into an Objective (Column 2), Criterion (Column 3), and Measure (Column 4). Column 5 cites the LCAM Requirement to which the performance measure applies.
- Column 6, Type of Measure, is used to describe how the measure will be used; e.g., will it measure an output, a process, or an outcome of the performance objective. Of note, in practice the role of measure can change depending on the organization.
- Column 7, Level, is used to describe the organization best suited to apply the measure. Suggested levels are: 1) DOE & Site Senior Management; 2) DOE & Site Landlords; and 3) DOE & Site Program Management. The level assignment also suggests who might be interested in the results of the performance measure.
- Key characteristics, Column 8, includes a brief analysis of the main strengths and weaknesses of each measure. The attached general discussion describes these characteristics and gives examples.
- The final column, Reference, lists sources of performance measurement information. As noted, some measures are taken from DOE sites and adapted slightly to fit the matrix format. Others are industry or industry association measures. Finally, the FM/IMT Team has developed several suggested measures for consideration.

LCAM PERFORMANCE MEASURES

LIFE CYCLE ASSET MANAGEMENT
Compilation of Performance Measures

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Overall Quality	Maintain assets suitable for program needs	Percent improvement after	Percent of surveyed employees who indicate that physical working conditions are acceptable or better	6.f.2;6.f.3	Outcome	DOE and Site Senior Management ; Landlords; Programs	S-1, -3, -8, -9, -11; W-5	Industry, FM/IMT
Overall Quality	Ensures site strategy is developed with community input	Survey scores after baselining	Survey of community's participation & stakeholder involvement	6.d.1	Outcome	DOE and Site Landlords; Programs	S-1, -8, -9, W-5	FM/IMT
Overall Quality	Ensure long-term site strategy is consistent within mission needs.	Survey scores after baselining	Survey of senior executives regarding ability to meet long term missions & associated needs.	6.d.1, 6.e.1	Outcome	DOE and Site Senior Management ; Landlords; Programs	S-1, -9, -11; W-4, -5	FM/IMT
Overall Quality	Offset the impact to the community of right sizing efforts	Target net number of jobs gained	Net number of jobs created as a result of initiatives within a specified radius vs. jobs lost due to restructuring	6.d.1	Outcome	DOE and Site Senior Management ; Landlords; Programs	S-1, -9; W-5, -6	INEL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Overall Quality	Develop an integrated management approach to relate planning, operating, assessment, and improvement systems	N/A	Degree to which integrated planning, operating, assessment, and improvement elements relate to Baldridge criteria to establish a site standard	6.a, 6.c	Output	DOE and Site Senior Management ; Landlords	S-11; W-5, -8	NREL
Overall Quality & Maintenance Management	Customer satisfaction will be measured and monitored to track trends and improve satisfaction rating in maintenance	Target Survey ratings after baselining	Customer satisfaction regarding timeliness and quality of maintenance, based on surveys	6.d.3, 6.f.2, 6.f.3, 6.f.7	Outcome	DOE and Site Landlords; Programs	S-1, -3, -5; W-5	Industry, FM/IMT
Overall Quality & Maintenance Management	Maintain capital assets to ensure reliable operations in a safe & cost effective manner	Minimize personal property & programmatic equipment failure	The number of off-normal occurrences, unusual occurrences, and emergency occurrences attributed to maintenance program or work performance deficiencies will be reported & expressed as a percentage of the total number of occurrences in each category	6.f.3	Output	DOE and Site Landlords; Programs	S-1, -3; W-2, -4, -5, -7	LBL, LLNL, LANL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Overall Cost and Productivity	Manage costs of delivering assets suitable for program needs	Either target percentage or percent improvement	Annualized spending (i.e., expense & capital devoted to planning managing, building, maintaining, deactivating program and landlord facilities at a site) divided by annual program funding at the site	6.e.2; 6.e.4; 6.e.5	Outcome	DOE and Site Senior Management Landlords; Programs	S-1, -2, -3, -4, -6, -8; W-5	Industry FM/IMT
Overall Cost and Productivity	Manage costs of delivering assets suitable for program needs	Either target percentage or percent improvement	Annualized building O&M spending divided by sq. ft.	6.e.2; 6.e.4; 6.e.5	Outcome	DOE Site and Landlords; Programs	S-1, -3, -5, -6, -8, W-12	Industry FM/IMT
Overall Cost and Productivity	Reduce costs by outsourcing/privatizing as appropriate	Annual cost savings after baselining	Baseline cost less new cost for outsourced activity. Dollars saved in current year due to Privatize/Outsource (P/O) initiated up to 3 years prior	6.e.4, 6.f.2	Outcome	DOE and Site Senior Management; Landlords	S-1, -3, -9, W-2, -5, -6, -8	FM/IMT
Overall Cost and Productivity	P/O contract work & achieve a net cost savings	Based on savings as documented in make-or-buy analyses	Total dollar savings achieved for all work privatized divided by outsources within the performance period.	6.e.4, 6.f.2	Outcome	DOE and Site Senior Management; Landlords	S-3, -9; W-2, -5, -6, -8	INEL
Maintenance Management	Perform a comparison of maintenance cost as a percentage of replacement plant value	Target percentage after baselining	Maintenance cost as percentage of replacement plant value	6.f.2	Output	DOE and Site Landlords	S-3, -6, -11,; W-1, -4	Industry, FM/IMT
				LCAM	Type of		Key Characteristics	Reference

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	Requirements	Measure	Level		
Maintenance Management	Maintain capital assets to ensure reliable operations in a safe & cost-effective manner	Target percentage	Preventive maintenance spending divided by total maintenance spending	6.f.2, 6.f.3	Output	DOE and Site Landlords	S-2, -3, -4, -10; W-11	FM/IMT
Maintenance Management	Maintain capital assets to ensure reliable operations in a safe & cost effective manner	Target percentage	Corrective maintenance spending divided by total maintenance spending	6.d.3; 6.f.2; 6.f.3;6.f.7	Output	DOE and Site Landlords	S-2, -3, -4, -10; W-11	FM/IMT
Maintenance Management	Perform a comparison of maintenance cost as a percentage of total plant budget	Target percent after baselining	Maintenance cost as percentage of plant budget	6.f.2	Output	DOE and Site Landlords	S-2, -3, -4, -10, -11; W-12	FM/IMT
Maintenance Management	Conduct maintenance to ensure stewardship of federal property	Target percentage to be negotiated based on funding and other maintenance priorities	Percentage facilities for which minimum acceptable maintenance was performed during the year, where threshold level of maintenance is facility-specific (based on stewardship concerns, mission requirements, & economics) & documented in approved plan.	6.f.3	Outcome	DOE and Site Landlords	S-1, -6, -9; W-2, -3, -5	FM/IMT
Maintenance Management	Establish consistent prioritization methodology	Landlord and Program Off. buy-in of methodology	Development and approval of O&M prioritization methodology by Landlord and program office	6.f.6	Output	DOE and Site Landlords; Programs	S-1, -2, W-5	FM/IMT

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Maintenance Management	Maintain Capital assets to ensure reliable operations in a safe & cost effective manner	Maximize development of maintenance management program as defined in the contract	Number of current year's maintenance milestones accomplished divided total number of current year's milestones scheduled	6.d.3; 6.f.2; 6.f.3; 6.f.7	Process	DOE and Site Landlords	S-11; W-3, -4, -9	LBL, LLNL, LANL
Maintenance Management	Maintain capital assets to ensure reliable operations in a safe & cost-effective manner	Benchmark maintenance costs to provide a basis for evaluating maintenance program efficiency in comparison with industry performance	Benchmarking data collection: define parameters & collect site & industry data [categories: maint. cost/gross sq. ft; cost. cost/gross sq. ft; waste coll. cost/sq. ft; snow removal cost/sq. yd.; paved area maint cost/sq. yd.; ground maint. cost/acre]	6.e, 6.f.2	Output	DOE and Site Landlords	S-1, -3, -5, -6; W-12	LBL, LLNL, LANL
Maintenance Management	Maintain capital assets to ensure reliable operations in a safe & cost effective manner	Planned preventive maintenance is performed as scheduled	The number of planned preventive maintenance activities overdue by 3 months or more divided by the total number of planned maintenance activities	6.d.3; 6.f.2; 6.f.3;6.f.7	Process	DOE and Site Landlords	S-9, -11; W-1, -3, -4, -5, -12	LBL, LLNL, LANL
Maintenance Management	Maintain capital assets to ensure reliable operations in a safe & cost effective manner	Reduce the maintenance backlog over the period of the contract	Cumulative average of maintenance backlog amounts for each year of the contract period divided by baseline maintenance backlog	6.d.3; 6.f.7	Output	DOE and Site Landlords	S-3, -11; W-2, -4, -5, -6, -11	LBL, LLNL, LANL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Maintenance Management	Improved cost-effectiveness of maintenance	N/A	Maintenance service labor rate (&/hour, fully-loaded)	6.f.2	Output	DOE and Site Landlords	S-1, -4; W-5, -6	LMES
Comprehensive Planning	Conduct effective site and land use management	Target survey scores after baselining	Survey rating of program customers regarding satisfaction with siting & adequacy of facilities	6.d.1, 6.e.1	Outcome	DOE and Site Senior Management; Landlords; Programs	S-1, -9; W-5, -7	Industry, FM/IMT
Comprehensive Planning	Manage site configuration to reduce material handling and transportation costs	Target percentage or percent improvement after baselining	Material handling and intrasite transportation costs divided by total site budget	6.d.2, 6.f.3	Output	DOE and Site Landlords	S-3, -6, -11; W-2, -7, -12	FM/IMT
Comprehensive Planning	The Site Development Plan should reflect current and future needs	Facilities and land are managed consistent with the Site Development Plan	Number of items of selected data elements in the SDP that are not consistent with the Institutional Plan CAMP Report, and Surplus Facilities Inventory Assessment database	6.d.1, 6.d.2, 6.d.3, 6.d.4, 6.d.5	Process	DOE and Site Landlords	S-9, -11; W-1, -4, -5, -6	LBL, LLNL, LANL
Comprehensive Planning	Effectively manage capital funds	Improve PE and GPP costing	Percent of GPE & GPP annual budget that is costed	6.d.4, 6.e.7	Output	DOE and Site Landlords	S-2, -4, -9,; W-3	ORNL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Comprehensive Planning	Land-use planning & site conversion	Release 4,000 acres (60%) of site for general public access by the end of FY98	Establishment of agreements to facilitate transfer. Number of acres released by year	6.d.1, 6.g.3	Outcome	DOE and Site Senior Management; Landlords	S-1, -2, -3, -6; W-4	Rocky Flats
Utilities & Energy Management	Conserve energy	Percent improvement after baselining	Building energy cost divided by sq. ft. by class of facility	6.d.2; 6.f.5	Output	DOE and Site Landlords	S-2, -3, -4, -6; W-5, -11	Industry, FM/IMT
Utilities & Energy Management	Maintain a reliable utility system & conserve energy	Maintain a reliable electrical service	Customer Hour Outages: [(total # of customers hours of electrical service) less (# of customer hours of unplanned outages)] divided by total customer hours	6.d.2; 6.f.5	Outcome	DOE and Site Landlords Programs	S-1, -2, -3, -5, -6, -8; W-12	LBL, LLNL, LANL
Utilities & Energy Management	Maintain a reliable utility system & conserve energy	Manage energy usage	The reduction in building energy usage from FY85 levels in BTUs per gross sq. ft. of building expressed as a percent of FY85 energy usage	6.f.5	Output	DOE and Site Landlords	S-2, -6; W-5, -11	LBL, LLNL, LANL
Utilities & Energy Management	Maintain a reliable utility system & conserve energy by managing traditional fuel use	Manage energy usage	The reduction in gasoline & diesel fuel consumption from FY91 levels expressed as a percent of FY 91 consumption	6.d.2; 6.f.5	Output	DOE and Site Landlords	S-2, -6; W-5, -11	LBL, LLNL, LANL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Utilities & Energy Management	Maintain a reliable utility system & conserve energy	Facilities are managed consistent with the site's approved Ten-Year Energy Plan	Energy Goals: Goals accomplished in accordance with the plan/goals scheduled to be accomplished that year	6.d.2; 6.f.5	Process	DOE and Site Landlords	S-11; W-3, -4	LBL, LLNL, LANL
Capital Asset Management	Obtain reliable condition information for site assets	Negotiated based on funding and productivity	Sq. ft. of assets with current condition information divided by total sq. ft.	6.f.1	Process	DOE and Site Landlords	S-6, 9; W-4, -5	FM/IMT
Capital asset Management	Develop & implement a comprehensive responsible life cycle planning process	Target percentage (100%)	Ratio of facilities that have current condition assessment compared to a planned inspection cycle	6.f.1	Process	DOE and Site Programs	S-9, -11; W-3, -4, -5	FM/IMT
Capital Asset Management	Obtain reliable condition information for site assets	Independent condition assessment on sample assets with agreement + or - 10 percent	Independent estimate divided by site contractor estimate of dollar amount to repair or replace sample assets	6.f.1	Output	DOE and Site Landlords	S-6, -9; W-2, -8	FM/IMT

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Capital Asset Management	Provide current, accurate, and complete asset inventory	Target percentage	FIMS/REAPS: proportion of data elements determined to be current, accurate, and complete based on independent assessment. Number of data elements determined to be current, accurate, and complete divided by number of data elements sampled	6.I	Process	DOE and Site Landlords;	S-4, -5, -6; W-12	FM/IMT
Capital Asset Management	Establish consistent prioritization methodology	Landlord and Program Office buy-in of methodology	Development and approval of capital asset prioritization methodology by Landlord and program office	6.d.4	Output	DOE and Site Landlords Program	S-1, -2, W-5	FM/IMT
Capital Asset Management	Develop & implement a comprehensive responsible life cycle planning process	N/A	Ratio of action plans developed & maintained for poor & failed facilities based on a condition assessment	6.f.1	Process	DOE and Site Landlords	S-9, -11; W-2, -5	Albuquerque
Capital Asset Management	The Site will effectively manage capital assets	Real property & installed equipment capital assets will be surveyed for condition	Number of completed condition surveys divided by number of condition survey planned	6.f.1	Process	DOE and Site Landlords	S-9, -11; W-3, -4, -5	LBL, LLNL, LANL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Capital asset Management	Demonstrate technologies	Designs will incorporate cost-effective applications of energy efficiency & research energy technologies	Construction designs exceed federal baseline energy efficiency guidelines	6.e.2, 6.e.4	Process	DOE and Site Programs	S-2; W-3, -9, -13	NREL
Operations Management	Manage transportation cost	Either target percentage or percent improvement	Annualized vehicle fleet cost divided by total site budget	6.d.2; 6.f.3' 6.f.5	Output	DOE and Site Landlords	S-2, -3, -4, 5; W-2, -12	Industry FM/IMT
Operations Management	Reduce infrastructure incidents related to configuration management	Target percentage	Number of infrastructure-related incidents associated with failure of configuration management systems divided by total number of infrastructure-related reportable incidents	6.f.4	Output	DOE and Site Senior Management; Landlords	S-1, -5, -6; W-2, -7	FM/IMT
Real Property & Surplus Management	Effectively manage real property	Target percentage after baselining	Occupancy cost divided by total site budget	6.f.2	Output	DOE and Site Landlords	S-1, -4, -9; W-2, -5. -6	Industry, FM/IMT
Real Property & Surplus Management	Effectively manage real property	New & reconfigured space shall comply with GSA standard	Number of actions in compliance divided by number of total actions	6.c	Process	DOE and Site Landlords	S-2, -5; W-13	Industry FM/IMT

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Real Property & surplus Management	Effectively manage real property	Target percentage or percent improvement after baselining	Space meeting adequacy standards divided by total building space (by space type)	6.c, 6.e.5	Output	DOE and Site Landlords	S-1, -2, -4, 9; W-1	Industry, FM/IMT
Real Property & Surplus Management	Reduce O&M cost by surplusing unneeded facilities	Target percentage of O&M cost savings	Original O&M costs minus new O&M costs after facilities have been surplused	6.f.2	Output	DOE and Site Landlords	S-1, -6, -9; W-4	FM/IMT
Real Property & Surplus Management	Establishment of a methodology to determine assets surplus	Landlord and EM buy-in of methodology	Surplus facilities (actual number of facilities surplused divided by planned number of facilities based on the site comprehensive plan)	6.d, 6.j	Output	DOE and Site Landlords	S-11; W-3, -5	Albuquerque
Real Property & Surplus Management	Effective management of real property in a cost-effective manner	Surplus facilities according to plan	Surplus facilities (actual number of facilities surplused divided by planned number of facilities based on the site comprehensive plan)	6.g	Output	DOE and Site Landlords	S-11; W-3, -5	LBL, LLNL, LANL
Real Property & Surplus Management	Effectively manage real property	RPIS contains accurate and up-to date information	Number of inaccurate data elements identified during real property inventories divided by total number of data elements inventoried	6.I	Process	DOE and Site Landlords	S-4, -5, -6; W-9, -11	LBL, LLNL, LANL
Real Property & Surplus Management	Effectively manage real property	Site will optimize its total primary office space utilization	Standard: net sq. ft. per person for permanent & leased office space. Goal is GSA standard	6.e.1, 6.e.5, 6.e.6	Output	DOE and Site Landlords	S-1, -2, -4, -8; W-9	LBL, LLNL, LANL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Real Property & Surplus Management	Effectively manage real property	Substandard Building Space: The site will reduce its total substandard building space	Sq. ft. of substandard building space converted or eliminated divided by total sq. ft. of substandard buildings	6.e.5, 6.f.1, 6.g.1, 6.g.2, 6.g.3	Output	DOE and Site Landlords	S-1, -2, -4, -9; W-5 12	LBL, LLNL, LANL
Real Property & surplus Management	Effectively manage real property	Real Property Information System is reconciled with Financial Information System	Number of days for reconciliation	6.I	Process	DOE and Site Landlords	S-6, -9; W-1, -5, -12	LBL, LLNL, LANL
Financial Management	Ensures maintenance budgets are requirements-drive n	Target for dollar variances after baselining	Individual audit of selected maintenance budget elements based on industry and DOE standards and plant requirements. Total dollar of variances, where variance = budgeted maintenance elements minus industry estimate	6.f.2	Output	DOE and Site Landlords	S-9, -10; W-5, -8	FM/IMT
Financial Management	Achieve cost-effective and efficient financial management operations	Leadership in improving system wide efficiency and effectiveness	Seek opportunities (including electronic commerce) to provide proactive leadership in support of DOE initiatives for continued contractor systems improvements	6.c	Output	DOE and Site Landlords	W-1, -4, -5, -6, -9	LBL, LLNL, LANL

LCAM PERFORMANCE MEASURES

Topic	Objective	Criterion	Measure	LCAM Requirements	Type of Measure	Level	Key Characteristics	Reference
Financial Management	Achieve cost-effective and efficient financial management operations	Benchmarking reviews	Perform best practices (benchmarking) reviews and identify opportunities for improvement	6.c	Output	DOE and Site Landlords	S-9; W-4, -5, -6	LBL, LLNL, LANL
Financial Management	Ensure financial management practices are customer oriented	Implement customer service improvement program for financial services	Implement customer service improvement plan to meet customer needs	6.a	Process	DOE and Site Landlords; Programs	S-2; W-4, -5, -9	LBL, LLNL, LANL
Utilities Acquisition	Reduce delivered cost of electricity	Target average cost/KWH	Average delivered cost of electricity KWH per year compared to industry costs at similar scale	6.d.2	Output	DOE and Site Landlords	S-1, -4, -6; W-2	FM/IMT
Utilities Acquisition	Reduce delivered cost of water	Target average cost/1,000 gallons	Average cost for 1,000 gallons of water compared to industrial costs at similar scale	6.d.5	Output	DOE and Site Landlords	S-1, -4, -6; W-2	FM/IMT

LCAM PERFORMANCE MEASURES

CHARACTERISTICS OF PERFORMANCE MEASURES FOR
DOE ASSET MANAGEMENT
(SUMMARY)

Characteristics of Strong Performance Measures or Criteria
(Discussion follows this summary.)

S1. Measuring things we care about.

S2. Simple, but not too simple.

S3. Negotiated values are only in the criteria, not in the measures.

S4. Meaningful comparisons possible.

S5. Measured values are improved only by improved performance.

S6. Can be reviewed and validated.

S7. Multiple objectives of compound measures are mutually consistent.

S8. Measurement is possible and worth the cost.

S9. Level of detail corresponds to the intent of the measure.

S10. Can be combined consistently with other measures.

S11. Recognizes existing site conditions as the starting point.

S12. Achievable but non-trivial.

LCAM PERFORMANCE MEASURES

Characteristics of Weak Performance Measures or Criteria
(Discussion follows this summary)

W1. Measuring the wrong thing to some extent.

W2. Complicated or simplistic.

W3. Measuring relative to negotiated values.

W4. Not amenable to baselining with comparable facilities.

W5. Measured value or definition may be easily manipulated.

W6. Difficult to audit.

W7. Compound measure with potential inconsistencies.

W8. Measurement difficult or costly.

W9. Level of detail differs from the intent of the measure.

W10. Weighting of measures may not correspond to overall goals.

W11. Assumes that “more of a good thing” is always better.

W12. Assumes that “less of a bad thing” is always better.

W13. Unrealistically challenging or trivially easy.

LCAM PERFORMANCE MEASURES

CHARACTERISTICS OF PERFORMANCE MEASURES FOR
DOE ASSET MANAGEMENT
(DISCUSSION)

Real-world measures/criteria often do not perfectly fit with the objectives for management of performance. Most measures represent a compromise between feasibility, accuracy, and simplicity. Strong and weak characteristics of measures are identified below, along with examples. These examples illustrate a weakness or a strength. Being used as an example here does not mean that these measures are “recommended” or “not recommended”, since a measure which illustrates a weakness may have one or more offsetting strengths which make it a useful measure on balance.

Characteristics of Strong Performance Measures or Criteria

S1. *Measuring things we care about*. The accurately measure or indicate things we directly care about (outcomes vs. outputs), preferably as communicated in a shared vision for the organization. Example - Maintenance service rate ($/hour fully-loaded). Labor rates directly bear on the issue of performing a function cost-effectively, which is an important performance consideration.

S2. *Simple, but not too simple*. They are as simple as possible, consistent with the need for accurate measurement of performance. Example - Preventive maintenance spending divided by total maintenance spending. This is a simple ratio of two numbers which are readily measurable. The ratio provides a meaningful measure of the emphasis placed on preventive maintenance.

S3. *Negotiated values are only in the criteria, not in the measures*. They don’t imbed negotiated values or targets. Example - Building energy cost divided by square foot by class of facility. This measure is a direct measure of performance insofar as it relates to building energy consumption. The measure itself contains no reference to planned consumption or adherence to schedules (which can reflect performance in negotiation rather than building energy performance).

S4. *Meaningful comparisons possible*. They can be readily compared with 1) other, similar, measures at a site; 2) the same measure for other DOE sites; and 3) the same or similar measures for industry. Example - Average delivered cost of electricity KWH per year compared to industry costs at similar scale. When variables such as location and quality of supplied power are accounted for average cost/KWH can be compared with industry averages and other sites.

S5. *Measured values are improved only by improved performance*. Once the definition is agreed upon, the value cannot be easily manipulated except by performance-related action which forms the objective. Example - Customer satisfaction regarding timeliness and quality of maintenance, based on surveys. Perceived quality of maintenance by customers can only be increased by improved performance.

S6. *Can be reviewed and validated*. They can be quickly and reliably validated. Example - Maintenance cost as percentage of replacement plant value. Both components of this measure can be readily audited and validated in terms of approach and accuracy.

S7. *Multiple objectives of compound measures are mutually consistent*. They relate to one principal objective or a set of mutually consistent objectives. Example - Few of the measures in the table are compound and have this characteristic. An example might be dollars of savings compiled from three sources of O&M activity, where the savings are added together. If encouraging saving in all three areas contributes toward meeting consistent objectives, then this qualifies as a strength.

LCAM PERFORMANCE MEASURES

S8. *Measurement is possible and work the cost*. They are, infact, measurable, and the value of the information is worth its acquisition cost. Example - Survey of community's participation and stakeholder involvement in site strategy development. The implementation of the survey measurement is straight forward, and the value of the information seems high relative to the cost of acquiring it.

S9. *Level of detail corresponds to the intent of the measure*. They reflect a meaningful level of detail to the customer, and cover areas of interest without substantial duplication. Example - Baseline cost minus new cost for outsourced activity. This is an appropriately detailed measure to address an objective on reducing costs via outsourcing.

S10. *Can be combined consistently with other measures*. They combine with other measures consistently to reflect priorities and the corporate vision. Example - Maintenance cost as percent of plant budget. This type of measure combines readily with other cost-share measures to give a picture of overall performance.

S11. *Recognizes existing site conditions as the starting point*. They recognize current site realities as the starting point from which change must occur, rather than some idealized starting point. Example - the number of planned preventive maintenance activities overdue by 3 months or more divided by the total number of planned maintenance activities. This takes into account the current status of the facility condition at the site.

S12. *Achievable but not-trivial*. Good measures and criteria incorporate targets which are achievable but involve a stretch for the organization based on past performance. Example-Most criteria must be developed in a site-specific way, and these are not identified in the matrix (so no examples are cited).

Characteristics of Weak Performance Measures or Criteria

W1. *Measuring the wrong thing to some extent*. some performance measure don't really measure performance that we care about, or they measure aspects of performance that we don't care about *per se*. Such measures may also establish incentives which are inconsistent with our broad strategic goals and vision Example- Number of milestones accomplished as laid out in an Energy Plan, where those milestones reflect process outputs such as reports submitted to DOE, as opposed to saving energy or using it more efficiently.

W2. *Complicated* or *simplistic*. Some measures fail to reflect the tradeoff between accuracy and simplicity - either they are too hard to understand, or they don't rally measure the aspect of performance we think they do, because they over-simplify the problem. Example - The number of off-normal occurrences, unusual occurrences, and emergency occurrences attribute to the maintenance program. The attribution and counting here are complex, although the result may be worth the effort.

W3. *Measuring relative to negotiated values*. Some measure evaluate performance relative to a negotiated criterion or goal value, thereby mixing measure and criteria. This generally ensure noncomparability across measure at a site, noncomparabiltiy of the same measures at different times, an noncomparability with similar measures of other industrial sites. Building a negotiated target into a measure tends to measure performance in the skill of negotiation rather than the truce aspect of asset-management we are interested in. Example - Number of Energy Plan milestones accomplished/Number of Energy Plan milestones scheduled. this confounds the measurement of energy performance with that of negotiation performance.

W4. *Not amenable to baselining with comparable facilities*. Some measures do not lend themselves to comparable-facility baselining, even when the aspect of performance being measure is common across similar firms/facilities. Example - Percentage of inaccuracies in a RPIS database, which is as dependent on the RPIS data structure as it is on the quality of data. This would vary fro site to site, and vary even more with industry.

W5. *Measure value or definition may be easily manipulated*. Some measures can be easily manipulated through re-definition or re-assessment of terms utilized in the measure. Example - Absolute item or dollar

LCAM PERFORMANCE MEASURES

reduction in maintenance backlog. Backlog can be easily revised independent of maintenance activity due to the multiple ways to define it.

W6. *Difficult to audit*. These measures and associated criteria are difficult or impossible for DOE to independently audit. Example - Number of days for reconciliation of a discrepancy between information in RPIS vs. FIMS. Would be difficult to certify that X days were required to achieve recondition, and to define exactly what was required to achieve reconciliation.

W7. *Compound measure with potential inconsistencies*. Compound indicators can imbed inconsistent objectives or inadvertently set up incentives which are contrary to overarching goals. Example - Material handling and intrasite transportation costs divided by total site budget. Emphasis on cost may encourage improper material handling if compensating measures or controls are not imposed.

W8. *Measurement difficult or costly*. Some measures may be difficult to implement, in that the data required do not readily exist or cannot exist. Or the cost of measurement may be high or even exceed the management value of the information. Example - Independent audit of selected maintenance budget elements based on industry and DOE standards and plant requirements. This process would be expensive and difficult.

W9. *Level of detail differs from the intent of the measure*. Some measures have a level of detail which is inconsistent with the intended purpose of the measure, or which is inconsistent with the intended level of management. Example - Construction designs exceed federal baseline energy efficiency guidelines. The detail in this measure does not directly linked to the stated objective: demonstrate technologies.

W10. *Weighting of measures may not correspond to overall goals*. Measures can be weighted relative to one another in ways which do not reflect DOE priorities and management values. Example - No weightings, explicit or implicit, are provided In the matrix. Therefore, no examples are available from it.

W11. *Assumes that "more of a good thing" is better*. Some measures assume that if a little of something is desirable, than the largest amount possible is the most desirable. Example - A criterion which tries to achieve zero customer-hour outages for utilities. It is generally thought that the cost of achieving this exceeds its value for most applications.

W12. *Assumes that "less of a bad thing" is better*. Some measures assume that the sheer existence of a standing inventory of needed actions is bad. Example - Reduce maintenance backlog. Reducing a backlog to zero may introduce inefficiencies in making maintenance work assignments and staffing the management organization.

W13. *Unrealistically challenging or trivially easy*. This involves targets which are unachievable, or which are easily achievable. Either way, the criteria are not effectively encouraging improved performance. Example - Number of actions in compliance (with GSA standard for reconfigured space) divided by number of total reconfiguration actions. This may be too easy to achieve for reconfiguration actions, and this not be a good measure of relative performance in this area.

LCAM PERFORMANCE MEASURES

REFERENCES

“Life Cycle Cost Data,” Alphonse J. Dell’Isola and Stephen J. Kirk. McGraw-Hill, New York, NY

“Means Facilities Maintenance Standards,” Roger W. Liska. R.S. Means Company, Inc., Kingston, MA 1988