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## **STUDY ON THE LIFE CYCLE COST OF PORTABLE FIRE EXTINGUISHERS**

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## **BACKGROUND**

First developed in the early 19th century, portable fire extinguishers have long played an important role in fire safety strategy. When detected early by building occupants, portable extinguishers can be used to extinguish a fire before any significant damage occurs, often eliminating the need for fire department suppression activities. As a required feature in many buildings, portable extinguishers are subject to regular inspection and maintenance by the model fire codes, International Fire Code (IFC) and NFPA 1, and by the primary technical standard, NFPA 10, *Standard for Portable Fire Extinguishers*. Since proposals to the model codes that would mandate portable extinguishers in certain occupancies are required to consider the economic impact of such mandates, this life cycle cost analysis quantifies the impact for any size facility.

## **LIFE CYCLE COST ANALYSIS**

Life Cycle Cost (LCC) analysis is a widely accepted methodology for comparing alternative investments or purchases to determine the most cost-effective option under a specific set of assumptions. There is a consensus standard in the US published by ASTM International that details the methodology for such an analysis, *Standard Practice for Measuring Life Cycle Costs of Buildings and Building Systems, ASTM E0917-05*.

LCC techniques are used to collect all associated costs, either single costs at a point in the system life or recurring costs over the system life, and move them to a single point in time utilizing an assumed discount (interest) rate. The discount rate selected represents the interest rate that could be realized if the money spent on the system was invested. LCC permits valid comparisons of cost over a specific period, even if the life of the alternative systems vary, since replacement costs and even cost of removal and disposal (including any salvage value) can be included.

## **PORTABLE EXTINGUISHER REQUIREMENTS**

NFPA 10, *Standard for Portable Fire Extinguishers*, is the base document for the requirements for portable fire extinguishers and is either adopted by reference or extracted to the fire codes (NFPA 1 and the IFC), building codes (NFPA 5000, NFPA 101, and the IBC), and to specialty documents for specific occupancies, such as boats and RVs. Portable extinguishers are required in a long list of occupancies, primarily divided among those containing Class A hazards and those with Class B hazards. Sufficient Class A- or B-rated extinguishers are to be provided so that the maximum travel distance from any point to an extinguisher is 75 feet for Class A, or 30 to 50 feet from the hazard (depending on rating) for Class B. Class D and K hazards are handled as special cases with extinguishers located near the hazards.

## **INSPECTION AND MAINTENANCE**

Portable extinguishers are required to be visually inspected at 30-day intervals and maintained at intervals of 1 year with an examination of internal parts at 1 year (unpressurized), 3 years (AFFF and FFFP) or 5/6 years (stored pressure) where such maintenance generally involves disassembly for examination of internal parts, recharging, and replacement of some parts. Pressurized extinguishers require hydrostatic pressure testing at 5 or 12 year intervals depending on agent.

### **MONTHLY INSPECTIONS**

Every extinguisher must be inspected every 30 days to determine that:

1. The extinguisher is present;
2. Access and visibility is not obstructed; and,
3. Pressure is within a specified range.

While maintenance (annual or longer) must be performed by certified personnel [NFPA 10, Sec. 7.1.2], monthly inspections can be performed by anyone. Often these are performed by staff of the facility as an additional duty but, in any case, the recordkeeping requirements must be followed to demonstrate compliance to various authorities.

### **DATA AND ASSUMPTIONS**

Annual extinguisher maintenance required by NFPA 10 is usually performed by an extinguisher technician under a separate contract. RJA obtained (via online search) public details of fire extinguisher contract awards by municipalities that included prices for new extinguishers and for performance of required inspections and maintenance on portable extinguishers located in municipal facilities ranging from a small town to an entire state. Quoted prices, which often included a per-building service charge and a per-extinguisher charge, covered a range reflecting the size of areas needing services and the number of extinguishers present in any building.

Because the cost data includes ranges for some costs, the economic analysis was performed as a bracketing, present value comparison. Further, since such cost analyses require an assumed service life for the equipment, it was assumed that the life of an extinguisher is 24 years, having been hydrostatically tested once (at 12 years) and then replaced at Year 24, just before a second hydrostatic test is due. For an assumed 24 year service life, there will be one hydrostatic test at Year 12 and three disassembly and recharge services at Years 6, 12, and 18 because any service due at the end of life would not be performed.

The salvage value at the end of the service life is assumed to be zero since the initial cost of each component is low. Also, disposal costs of the units and equipment are assumed to be zero.

Another assumption is the discount (interest) rate. This is set at the estimated (annual) rate of return that could be realized on alternative investment of the funds to be used for the purchase being evaluated. A rate of inflation may be included in the discount rate but does not have to be. A discount rate that includes inflation over the service life is called the *nominal* discount rate and one that does not include inflation is called the *real* discount rate. The nominal discount rate ( $i$ ) is defined as:

$$i = (1+r)(1+l)-1$$

where  $r$  is the (annual) interest rate and  $l$  is the (annual) inflation rate.

Since inflation has been very low for some years, the real discount rate was used for this analysis. The baseline discount rate was assumed to be 5% which is the commonly used value for economic analysis

### **COST ANALYSIS SPREADSHEET**

The economic analysis is easily performed using an Excel spreadsheet. See Appendix A, Present Value Analysis, attached to this report. Costs per extinguisher were listed using the low and high costs obtained to bracket the values. Costs were further categorized as first, monthly, semi-annual, annual, maintain and recharge (6 years), and hydrostatic test (12 years) to facilitate identification of costs that had the greatest impact on the overall cost.

The assumed number of extinguishers in the facility, interest rate, and service life assumptions were based to the extent possible on actual buildings. RJA examined drawings for a dozen actual health care facilities ranging in size from 33,000 sq. ft. to 560,000 sq. ft. to determine the number of extinguishers required in each, which ranged from 15 to 420. The number of extinguishers required in each facility was then divided by the gross floor area to obtain the number of extinguishers per sq. ft. This ranged from 1500 to 2000 sq. ft. per extinguisher across all 12 facilities. NFPA 10 limits area coverage to not more than 6000 sq. ft., but other requirements make this density difficult to reach in real buildings. For this analysis, it was assumed that all extinguishers are nominal 5 pound ABC dry chemical type units rated 2-A:10-B:C, as these would be the most common in these applications.

It should be understood that in a present value analysis such as this, the discount (interest) rate only affects future payments, reducing their present cost. Thus, changing the assumed discount rate will only reduce monthly, semi-annual, annual, 6- and 12-year costs that are assumed to be made at the end of the period. (Monthly costs are paid at the end of the year in which they accrued.) First costs are not affected by the discount rate.

Monthly inspection costs consist of a per-extinguisher charge only, based on the cost of an employee spending 10 to 20 minutes per month per extinguisher at \$18/hr

salary (including benefits) performing the inspection. If these inspections are performed by an outside contractor, the cost would likely be higher, consisting of a service charge and a per-extinguisher charge.

Annual, 6- and 12-year costs include both a fixed service charge (one per visit per facility) and a per-extinguisher charge. Costs associated with the 6- and 12-year maintenance do not include costs associated with the provision of temporary replacement extinguishers since NFPA 10 does not require such replacements where maintenance is performed on-site as is the common practice of the service industry.

Charges for hydrostatic testing are applied at Year 12 but not at Year 24 since the analysis assumes that the extinguisher will be replaced at that time. Similarly, the disassembly and recharge is performed at Years 6, 12, and 18, but not at Year 24 because the extinguisher is assumed to be replaced.

## **RESULTS**

Because actual costs vary depending on many factors, including the facility size and geographic location, costs were calculated as a bracketing range, following conservative assumptions in each case. For 5 lb., 2-A:10-B:C extinguishers the first cost (procurement, installation, and all required inspection, testing, and maintenance over a 24 year life all paid at the time of purchase) ranged from just over \$700 to just over \$1400 per extinguisher.

Based on the actual health care facility extinguisher location drawings, the annual cost per square foot ranged from \$.015 to \$.04 per square foot per year. If a facility was able to maximize extinguisher coverage at 6,000 square feet per extinguisher, the annual cost per foot would range from .005 to \$.01. While unlikely that any facility can achieve the maximum permitted coverage, this calculation is provided for comparative purposes.

APPENDIX A -- PRESENT VALUE ANALYSIS					
RJA PROJECT NO. C58655-1					
Activity	Cost per Extinguisher		Service Charge per Facility Visit		Notes
	Low	High	Low	High	
Initial extinguisher purchase (5 lb., 2-A-10-B:C)	\$40	\$56	NA	NA	Plans for 12 health care facilities were reviewed to determine extinguisher quantities and sizes
Monthly inspection labor cost (10 to 20 minutes per extinguisher per month @ \$18/hr.)	\$3	\$6	\$3	\$6	Where inspection performed by owner, no service charge assessed
Annual maintenance per NFPA 10	\$3	\$6	\$50	\$100	
Disassembly and recharge per NFPA 10 @ 6, 12, 18 years, incl. cost of temporary replacements	\$10	\$12	\$50	\$100	
Hydrostatic testing @ 12 years, incl. recharge and cost of temp. repl.	\$20	\$25	\$50	\$100	Assumes extinguisher is replaced before second hydro. test
First costs	\$400	\$560			
Monthly insp. cost	\$33	\$66	Assumes "payment" at end of each year (24 periods in analysis).		
Annual NFPA 10 cost per year	\$80	\$160			
Maintain and recharge per 6 years	\$150	\$220			
Hydrostatic test per 12 years	\$150	\$230			
Total extinguishers per facility	10		Calculation amortizes service charge over 10 extinguishers per facility		
Interest rate (%)	5%				
Service life (years)	24				
First cost	(\$400)	(\$560)			
Annual costs over life	(\$6,568)	(\$13,136)			
6 year costs over life	(\$258)	(\$378)			
12 year costs over life	(\$84)	(\$128)			
<b>Total cost over life per exnguisher</b>	<b>(\$731)</b>	<b>(\$1,420)</b>			
Square feet per extinguisher	2000	1500			
Annual cost per extinguisher per sq ft	(\$0.015)	(\$0.039)			