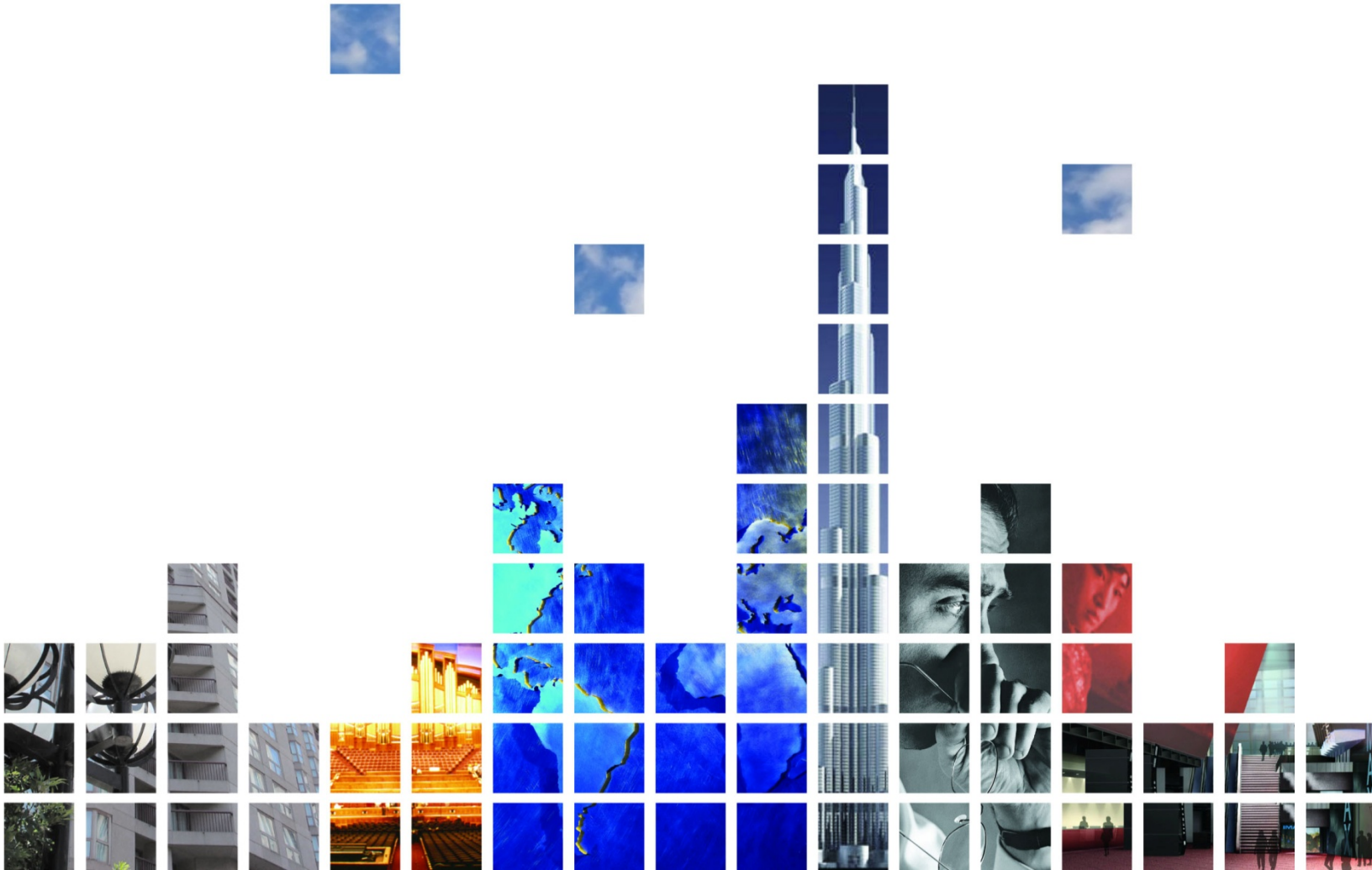
ROLF JENSEN & ASSOCIATES, INC.
FIRE PROTECTION CONSULTANTS

LIFE CYCLE COST ANALYSIS OF ELECTRONIC MONITORING OF PORTABLE FIRE EXTINGUISHERS



ROLF JENSEN & ASSOCIATES, INC.
FIRE PROTECTION CONSULTANTS

600 West Fulton Street
Suite 500
Chicago, IL 60661 USA
www.rjainc.com
+1 312-879-7200
Fax: +1 312-879-7210

LIFE CYCLE COST ANALYSIS OF ELECTRONIC MONITORING OF PORTABLE FIRE EXTINGUISHERS

Prepared for:

Fire Equipment Manufacturers' Association
Cleveland, Ohio

January 23, 2013

RJA Project No. C58655

BACKGROUND

First developed in the early 19th century, portable fire extinguishers have long played an important role in fire safety strategy. When fires are 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*. Where electronic monitoring of fire extinguishers is connected to the building fire alarm system, NFPA 72, *National Fire Alarm and Signaling Code,* also contains relevant requirements.

ELECTRONIC MONITORING

Electronic monitoring continuously supervises the presence, pressure, and obstruction of extinguishers and, where connected to the building fire alarm system, produces a supervisory signal either locally or at a remote location depending on the type of fire alarm system. Where there is no fire alarm system, separate equipment can be used to monitor the extinguishers in accordance to the requirements in NFPA 10. Beginning in about 2005, the model fire codes and NFPA 10 began to recognize electronic monitoring as an alternative to the 30-day inspections required by NFPA 10.

Electronic monitoring is perceived to provide advantages over manual inspections including immediate notification of use, tampering, impairment, and elimination of the cost of manual inspections, usually performed by facility staff or on a service contract. Electronic monitoring does not impact required periodic maintenance, and involves first costs for the monitoring equipment and a fire alarm interface module for each extinguisher. Semi-annual visual inspections and an annual verification of the signal interface to the alarm system are required for the monitoring systems by NFPA 72. In addition, annual inspection and maintenance of a portion of the monitoring hardware including replacement of the batteries is required by NFPA 10.

LIFE CYCLE COST ANALYSIS

Because the decision to employ electronic monitoring of required extinguishers involves additional first costs and changes in some recurring costs, the economics is not immediately obvious. 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 of 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.

Electronic monitoring replaces only the 30-day inspections and does not affect any other periodic servicing. NFPA 10 requires inspection and maintenance of 20% of the electronic monitoring equipment each year so that every unit is addressed within 5 years [Sec. 7.3.2.5.2], but the battery in each monitoring unit must be replaced every year effectively resulting in 100% annual maintenance. Similarly, the apparent savings associated with the three-year maintenance allowance in the IFC is effectively negated because of the need for annual battery replacement.

NFPA 72 requires semi-annual visual inspection [Sec. 14.3.1.19(a)] and a test of the ability of the monitoring equipment to initiate the appropriate signal(s) at the panel (and remote monitoring station if such is provided) annually [Sec. 14.3.2.19(a)].

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.

This inspection can be performed manually or by continuous electronic monitoring [NFPA 10, Sec. 7.2.2]. The electronic monitoring is permitted to be connected to the building fire alarm system or to an independent system that provides similar functions including record keeping.

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.

ECONOMIC COMPARISON OF SYSTEM COSTS

Many buildings that require portable extinguishers also require a fire alarm system, leading to the question of whether it is less costly to utilize electronic monitoring where a fire alarm system is present than to perform the monthly inspections manually. Because electronic monitoring requires the purchase and installation of additional equipment at the start, avoids the costs of monthly inspection but adds some additional periodic testing, the answer is not obvious but is easily addressed by economic analysis techniques.

DATA AND ASSUMPTIONS

Provision of electronic monitoring requires not only the extinguisher monitoring hardware, but also an addressable interface module and system programming to initiate a supervisory signal at the panel and supervisory station, and initial testing as part of system commissioning. This would all be performed by fire alarm technicians as part of the fire alarm system installation.

As a supervisory device connected to the system, annual testing required by NFPA 72 is performed by fire alarm service personnel in conjunction with the other alarm system components on the premises that require periodic testing. Annual extinguisher maintenance required by NFPA 10 would be performed by an extinguisher technician under a separate contract and would not necessarily require coordination with the alarm technician. Annual replacement of the battery in the monitor module could be performed by either the fire alarm or extinguisher technician since both need to visit most extinguishers annually. For extinguishers not requiring annual maintenance, the fire alarm technician could replace the battery, but this responsibility needs to be clear in the service contract.

RJA contacted two national fire alarm system suppliers to determine typical costs associated with the purchase, installation, and testing of electronic extinguisher monitoring systems as part of a new fire alarm system procurement. Some of these costs were provided as a range reflecting cost differences associated with union and non-union labor regions or differences in the necessary equipment. RJA further obtained (via online) 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. Once again, quoted prices, which 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:

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

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

Since inflation has been very low for some years, the real discount rate was used for this analysis. The assumed discount rate in this analysis was 5%.

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 with and without (electronic) monitoring 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 which costs had the greatest impact on the overall cost.

The assumed number of extinguishers in the facility, interest rate, and service life assumptions are set in the gold cells. 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. For this analysis, it was assumed that all extinguishers are nominal 5 pound ABC dry chemical type units rated 2-A:40-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 (without electronic monitoring) 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. To assume that an employee performing the inspections would be paid for his/her other responsibilities and there is no “additional cost” to conduct these inspections, simply set the cost in cells B10 and D10 of the spreadsheet to $0.

Annual, 6- and 12-year costs include both a fixed service charge (one per visit per facility) and a per-extinguisher charge. The annual, per extinguisher charge by the extinguisher technician for the monitored systems includes the cost of battery replacement (a 9v alkaline battery is assumed to cost $2) in the monitoring equipment. The semi-annual inspection required by NFPA 72 is assumed to be performed by the alarm technician while doing other service work on the alarm system, so no service charge is applied, only a per extinguisher charge.

Costs associated with the 6- and 12-year maintenance include costs associated with the provision of temporary replacement extinguishers required by NFPA 10 during the service. With electronic monitoring, the replacement extinguishers must be equipped with the special gage compatible with the monitoring equipment to avoid a continuous supervisory signal, increasing the cost. Where the 6- and 12-year maintenance is performed on-site, NFPA 10 does not require replacement extinguishers and the per-extinguisher charge would be the same with and without monitoring.

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.

CONCLUSION

The results of the analysis show that the present cost with electronic monitoring is significantly higher than with monthly inspections performed by an employee, ranging from about 1.5 to 1.9 times the cost for a building with an assumed 100 extinguishers. First costs with electronic monitoring are twelve to nineteen times than the non-monitored costs due to the cost of procurement and installation of the monitoring equipment. The higher first costs are not offset because of the additional inspection and testing costs required by both NFPA 10 and 72 that is incurred for the monitoring equipment.

Annual costs over system life are 1.5 to 2.5 times higher without electronic monitoring due to the cost of monthly inspections, but the cost of semi-annual inspections required by NFPA 72 for monitored systems is significant and the additional annual testing costs performed by the alarm technician adds to the LCC.

Costs associated with monthly inspections of only $3 to $6 per extinguisher when conducted by an employee have a significant effect on the economic analysis. If one assumes that monthly inspections conducted by an employee have no associated cost, then the cost of electronic monitoring is about ten times higher than with manual inspections over the life of 100 extinguishers.

***

APPENDIX A

COST ANALYSIS SPREADSHEET

APPENDIX A -- PRESENT VALUE ANALYSIS
RJA PROJECT NO. C58655

Activity	Cost per Extinguisher (low)		Cost per Extinguisher (high)		Service Charge per Facility Visit		Notes
	No Monitoring	With Monitoring	No monitoring	With Monitoring	Low	High	
Initial extinguisher purchase (5 lb., 2-A:40-B:C)	$40	$40	$56	$56			Plans for 12 health care facilities were reviewed to determine extinguisher quantities and sizes
Purchase and install extinguisher monitor	$0	$300	$0	$400			Installed by FA contractor
Purchase and install FA interface	$0	$100	$0	$500			Costs assume addressable FA system is installed and service contract in place to conduct all ITM required by NFPA 72
FA system programming	$0	$25	$0	$90	$0	$0	FA tech on site to program entire system, so no service charge included
Monthly inspection labor cost ($18/hr, 10 to 20 minutes per extinguisher per month)	$3	$0	$6	$0	$0	$0	Where inspection performed by owner, no service charge assessed
Semi-annual visual inspection per NFPA 72	$0	$10	$0	$10	$0	$0	FA tech on site to perform other semiannual tests, so no service charge included
Annual maintenance per NFPA 10	$3	$5	$6	$8	$50	$100	Includes annual battery replacement for monitor
Annual test per NFPA 72	$0	$20	$0	$20	$0	$0	No service charge since FA tech on site to perform other annual tests
Disassembly and recharge per NFPA 10 @ 6, 12, 18 years, incl cost of temp. repl.	$10	$15	$12	$18	$50	$100	Replacement extinguisher requires gauge compatible with monitor
Hydrostatic testing @12 years, incl. recharge and cost of temp. repl.	$20	$25	$25	$30	$50	$100	Assumes extinguisher is replaced before second hydro. test

First costs	$4,000	$46,500	$5,600	$104,600	
Monthly insp. Cost	$300	$0	$600	$0	Assumes "payment" at end of each year (24 periods in analysis).
Annual NFPA 10 cost per year	$350	$550	$700	$900	
Semi-annual NFPA 72 cost	$0	$1,000	$0	$1,000	Assumes payment at end of each six-month period (48 periods in analysis).
Annual NFPA 72 cost per year	$0	$2,000	$0	$2,000	
Maintain and recharge per 6 years	$1,050	$1,550	$1,300	$1,900	
Hydrostatic test per 12 years	$1,050	$1,050	$1,400	$1,300	

Variables

Total extinguishers per facility	100
Interest rate (%)	5%
Service life (years)	24

APPENDIX A -- PRESENT VALUE ANALYSIS
RJA PROJECT NO. C58655

Activity	Cost per Extinguisher (low)		Cost per Extinguisher (high)		Service Charge per Facility Visit		Notes
	No Monitoring	With Monitoring	No monitoring	With Monitoring	Low	High	
Present values (P. V.)							
First cost	($4,000)	($46,500)	($5,600)	($104,600)			
Semi-annual costs over life	$0	($27,773)	$0	($27,773)			
Annual costs over life	($54,505)	($35,187)	($109,009)	($40,016)			
6 year costs over life	($1,805)	($2,664)	($2,234)	($3,265)			
12 year costs over life	($585)	($585)	($780)	($724)			
Total P. V. cost over life	**($60,894)**	**($112,708)**	**($117,623)**	**($176,378)**			
Percent difference		85.09%		49.95%			