

Report BAY-01197

## **VENDING MACHINE SERVICE CALL REDUCTION USING THE VENDINGMISER**

*Prepared for:*

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195 Bear Hill Rd.  
Waltham, MA 02451-1003

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# 1. INTRODUCTION

The VendingMiser is designed to reduce the cost of ownership of vending machines. The compressor life is extended by reduction of the total number of ON-OFF cycles and varies based on vending machine design and manufacturer. Other components, such as lights, fans, and electronics will exhibit extended life by the reduction of the number of hours of operation. The frequency of preventative maintenance can also be reduced.

# 2. SOURCES OF INFORMATION

Information shown in this report was gathered from manufacturer’s testing, published specifications, industry standards, in-house testing, interviews with service managers, currently advertised market prices and labor rates.

# 3. COMPRESSOR CYCLE RATES

Normal refrigeration cycle rate data varied widely from one source to another. Foster-Miller in-house testing shows an average of less than 2/hr for most full machines in a 90°F ambient environment. Other reports indicate this number may be 5/hr or more. This study uses a cycle rate of 3/hr as a “good industry average”. In addition, a cycle rate of 5/hr is also considered for less-than-full vending machines.

# 4. CLASSES OF VENDINGMISER INSTALLATIONS

This study considers five typical cold beverage vending machine installation locations. These encompass a wide range of VendingMiser based cost savings due to periodic and anticipated vacancies. All locations are indoors and in controlled environment conditions (schools, office buildings, shopping centers, etc.). Outdoor locations are not included, as it is difficult to predict hours of inactivity, and in general, account for a minority of the machine locations. Also not included are 3-shift factories or 24/7 locations, which are occupied around the clock (e.g. emergency waiting room areas of hospitals), as there would probably be little or no benefit realized from the VendingMiser. The installations considered in this study are:

LOCATION	HOURS OF OPERATION
<b>I. OFFICE-1 or Elementary School</b>	<b>8am – 6pm, Monday-Friday</b>
<b>II. OFFICE-2 or High School</b>	<b>7am – 7pm, Monday-Friday</b>
<b>III. STORE-1</b>	<b>7am – 10pm, Monday-Saturday</b>
<b>IV. STORE-2</b>	<b>7am – 10pm, Monday-Saturday 9am – 5pm, Sunday</b>
<b>V. 2-SHIFT FACTORY</b>	<b>16 hours per day, Monday-Saturday</b>

Table 1 shows, for each installation, the number of hours of normal operation, and the number of hours during which the VendingMiser takes control. For cycle-based life calculations, the table computes the extension factor. This is the factor by which the life is extended due to reduction in the cycle rate. The time extension rate is also shown and is due to the reduction in running time.

*Table 1. Calculation of Cycle and Time Extension Factors*

	LOCATION				
	I	II	III	IV	V
hrs/wk - normal operation	50	60	90	98	96
hrs/wk - VM	118	108	78	70	72
# of cycles @ 5/hr wo/VM	840	840	840	840	840
# of cycles @ 5/hr w/VM	309	354	489	525	516
<b>Cycle Factor @ 5/hr</b>	<b>2.72</b>	<b>2.37</b>	<b>1.72</b>	<b>1.60</b>	<b>1.63</b>
# of cycles @ 3/hr wo/VM	504	504	504	504	504
# of cycles @ 3/hr w/VM	209	234	309	329	324
<b>Cycle Factor @ 3/hr</b>	<b>2.41</b>	<b>2.15</b>	<b>1.63</b>	<b>1.53</b>	<b>1.56</b>
<b>Running Time Factor</b>	<b>2.11</b>	<b>1.93</b>	<b>1.53</b>	<b>1.45</b>	<b>1.47</b>

## 5. SERVICE CALLS

When a service call is requested there are a variety of true causes for the call, however most involve repairing or replacing the compressor “deck”. This deck is mounted on rails located at the bottom rear of the machine and includes the compressor, evaporator coils and condenser fan. Other potential “refrigeration calls” may involve the replacement of the thermostat, motherboard electronics, lights, starter and associated ballast. Although not impacted by the VendingMiser directly, leaky door seals and vandalized or missing can door flaps also generate service calls.

For the serviced components listed below, an average labor rate of \$35 is assumed, although actual labor rates vary considerably (based on union and non-union bottlers and franchisees) ranging from \$17 to \$60 per hour. The average MTBF values are approximate.

The total cost of replacement includes travel time to the machine (average = 0.75 hr), and the time to make the repair at the assumed labor rate, in addition to the cost of the part.

For the compressor, the life extension and savings were calculated for a machine cycling at 3/hr and separately for a machine cycling at 5/hr. The difference between these in actual dollars saved per year is small as shown in Table 2.

Overall, the key factors affecting maintenance savings are the price of the compressor and the labor rates then, secondarily, the other smaller cost components. Tables 2 to 8 below show cost elements. The prices are averages, and an average labor rate of \$35/hr is assumed.

**Table 2. Compressor Savings**

<b>COMPRESSOR</b>					
MTBF of compressor (yr.)	6 <sup>1</sup>				
Average life of compressor (cycles) @ 3/hr	158,000				
Average cost to replace compressor failure, including new compressor, refrigerant, etc.	\$150				
Average travel time to machine (hr)	0.75 <sup>2</sup>				
Average time to repair failed compressor (hr)	0.5 <sup>3</sup>				
Average cost to replace compressor	\$193.75				
Average per year cost of compressor	\$32.29				
	<b>LOCATION</b>				
<b>OPERATION WITH VENDINGMISER</b>	<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average Life of Compressor w/VM (yr.) @ 5/hr	16.31	14.24	10.31	9.60	9.77
Per Year Compressor Cost w/VM (5/hr)	\$11.85	\$13.57	\$18.75	\$20.13	\$19.78
Per Year Compressor Savings w/VM (5/hr)	\$20.44	\$18.72	\$13.54	\$12.16	\$12.51
Average Life of Compressor w/VM (yr.) @ 3/hr	14.47	12.92	9.79	9.19	9.33
Per Year Compressor Cost w/VM (3/hr)	\$13.39	\$15.00	\$19.79	\$21.08	\$20.77
Per Year Compressor Savings w/VM (3/hr)	\$18.90	\$17.29	\$12.50	\$11.21	\$11.52

<sup>1</sup> Major compressor manufacturers do not publish MTBF figures for their products, as it is high dependent on applications and environmental conditions. The figure of 6 yr. was established from interviews with local vending machine servicemen.

<sup>2</sup> Interviews with local vending machine servicemen.

<sup>3</sup> Service manager, major Las Vegas bottler.

**Table 3. Evaporator Fan Savings**

<b>EVAPORATOR FAN</b>		<b>LOCATION</b>				
<b>OPERATION WITH VENDINGMISER</b>		<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average MTBF (years)	6 <sup>4</sup>					
Average cost to replace failure	\$25					
Average travel time to machine	0.75					
Average time to repair failed evaporator fan	0.5					
Average cost to replace evaporator fan	\$68.75					
Average per year cost of evaporator fan	\$11.46					
Average Life of Evaporator Fan w/VM (yrs)		12.68	11.59	9.21	8.73	8.84
Per Year Evaporator Fan Cost w/VM		\$5.42	\$5.93	\$7.47	\$7.88	\$7.78
Per Year Evaporator Fan Savings w/VM		\$6.04	\$5.52	\$3.99	\$3.58	\$3.68

**Table 4. Condenser Fan Savings**

<b>CONDENSER FAN</b>		<b>LOCATION</b>				
<b>OPERATION WITH VENDINGMISER</b>		<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average MTBF (years)	6 <sup>4</sup>					
Average cost to replace failure	\$23					
Average travel time to machine	0.75					
Average time to repair failed condenser fan	0.5					
Average cost to replace condenser fan	\$66.50					
Average per year cost of condenser fan	\$11.08					
Average Life of Condenser Fan w/VM (years)		12.68	11.59	9.21	8.73	8.84
Per Year Condenser Fan Cost w/VM		\$5.24	\$5.74	\$7.22	\$7.62	\$7.52
Per Year Condenser Fan Savings w/VM		\$5.84	\$5.34	\$3.86	\$3.46	\$3.56

<sup>4</sup> Average from manufacturers' data.

**Table 5. Thermostat Savings**

<b>THERMOSTAT (electronic)</b>		<b>LOCATION</b>				
<b>OPERATION WITH VENDINGMISER</b>		<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average MTBF (years)	8 <sup>5</sup>					
Average cost to replace failure	\$23					
Average travel time to machine	0.75					
Average time to repair failed thermostat	0.5					
Average cost to replace thermostat	\$66.75					
Average per year cost of thermostat	\$8.34					
Average Life of Thermostat w/VM (years)		16.91	15.45	12.27	11.64	11.79
Per Year Thermostat Cost w/VM		\$3.95	\$4.32	\$5.44	\$5.74	\$5.66
Per Year Thermostat Savings w/VM		\$4.40	\$4.02	\$2.91	\$2.61	\$2.68

**Table 6. Lamp Savings Using Magnetic Ballast**

<b>LIGHTS (T-12) - MAGNETIC BALLAST</b>		<b>LOCATION</b>				
<b>OPERATION W/ VENDINGMISER</b>		<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average MTBF (hrs) based on continuous usage	12000					
Average life (hrs) based on 2hrs/start	10204					
Average cost to replace failure	\$6					
Average travel time to machine	0.75					
Average time to repair failed lights	0.3					
Average cost to replace lights	\$42.75					
Average per year cost of lights	\$31.21					
Average Life of Lights w/VM (hrs)		21,563.17	19,704.28	15,655.45	14,842.18	15,037.47
Per Year Lights Cost w/VM		\$17.37	\$19.01	\$23.92	\$25.23	\$24.90
Per Year Lights Savings w/VM		\$13.84	\$12.20	\$7.29	\$5.98	\$6.30

<sup>5</sup> From interviews with local vending machine servicemen.



**Table 7. Lamp Savings Using Electronic Ballast**

<b>LIGHTS (T-8) - ELECTRONIC BALLAST</b>					
Average MTBF (hrs) based on continuous usage	12000				
Average cost to replace failure	\$6				
Average travel time to machine	0.75				
Average time to repair failed lights	0.3				
Average cost to replace lights	\$42.75				
Average per year cost of lights	\$31.21				
	<b>LOCATION</b>				
<b>OPERATION W/ VENDINGMISER</b>	<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average Life of Lights w/VM (hrs)	25,358.49	23,172.41	18,410.96	17,454.55	17,684.21
Per Year Lights Cost w/VM	\$14.77	\$16.16	\$20.34	\$21.46	\$21.18
Per Year Lights Savings w/VM	\$16.44	\$15.05	\$10.87	\$9.75	\$10.03

**Table 8. Electronic Controls Savings**

<b>ELECTRONIC CONTROLS</b>					
Average MTBF (yrs)	8				
Average cost to replace failure	\$100				
Average travel time to machine	0.75				
Average time to repair failed electronic controls	0.5				
Average cost to replace electronic controls	\$143.75				
Average per year cost of electronic controls	\$17.97				
	<b>LOCATION</b>				
<b>OPERATION WITH VENDINGMISER</b>	<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>
Average Life of Electronic Controls w/VM (years)	16.91	15.45	12.27	11.64	11.79
Per Year Electronic Controls w/VM	\$8.50	\$9.31	\$11.71	\$12.35	\$12.19
Per Year Electronic Controls Savings w/VM	\$9.47	\$8.66	\$6.26	\$5.62	\$5.78

## 6. IMPACT OF PREVENTATIVE MAINTENANCE (PM'S)

Preventative maintenance is a powerful tool to reduce both service calls and improve customer service and positive visibility at accounts, according to the Service Manager at a major Las Vegas, Nevada bottler. They have adopted and championed an annual preventative maintenance 9-step checklist that takes 20-30 minutes to complete. This has resulted in fewer service calls primarily because lights that are getting black around the top are replaced before failure which improves the life of the starter, magnetic and electronic ballasts and has reduced the “888” display on the electronic motherboards that coincides with flickering light bulbs. Although difficult to quantify directly, by removing the lint and dust build-up on the evaporator coils the compressor works more efficiently, lasts longer and reduces service calls.

Installation of the VendingMiser should reduce the frequency of PM because the vending machines are running less often, the lights last longer, they accumulate less dust and lint and work more efficiently. Logically, given the VendingMiser’s 46% average savings or off time could reduce PM correspondingly as shown in Table 9.

*Table 9. VM Savings to PM Program*

ANNUAL SAVINGS FOR PREVENTIVE MAINTENANCE					
PM cost - labor time (hr)	0.5				
PM cost - travel time to machine	0.75				
PM cost - dedicated trip	43.75				
PM cost - w/o travel time	17.5				
Average annual PM cost	30.625				
	LOCATION				
OPERATION W/ VENDINGMISER	I	II	III	IV	V
Annual PM Savings w/VM (3/hr)	\$17.92	\$16.38	\$11.84	\$10.61	\$10.99
Annual PM Savings w/VM (5/hr)	\$19.37	\$17.70	\$12.82	\$11.48	\$11.84

## 7. LABOR RATES

In these considerations, a median labor rate of \$35/hr was assumed. This obviously varies in different locales and for different subcontractors. Actual labor rates are found to vary in the range of \$17 - \$60/hr. The following graph in Figure 1 shows the annual savings with VendingMiser over the range of labor rates. The five curves represent the five installation types being considered in this report.

### VendingMiser Savings

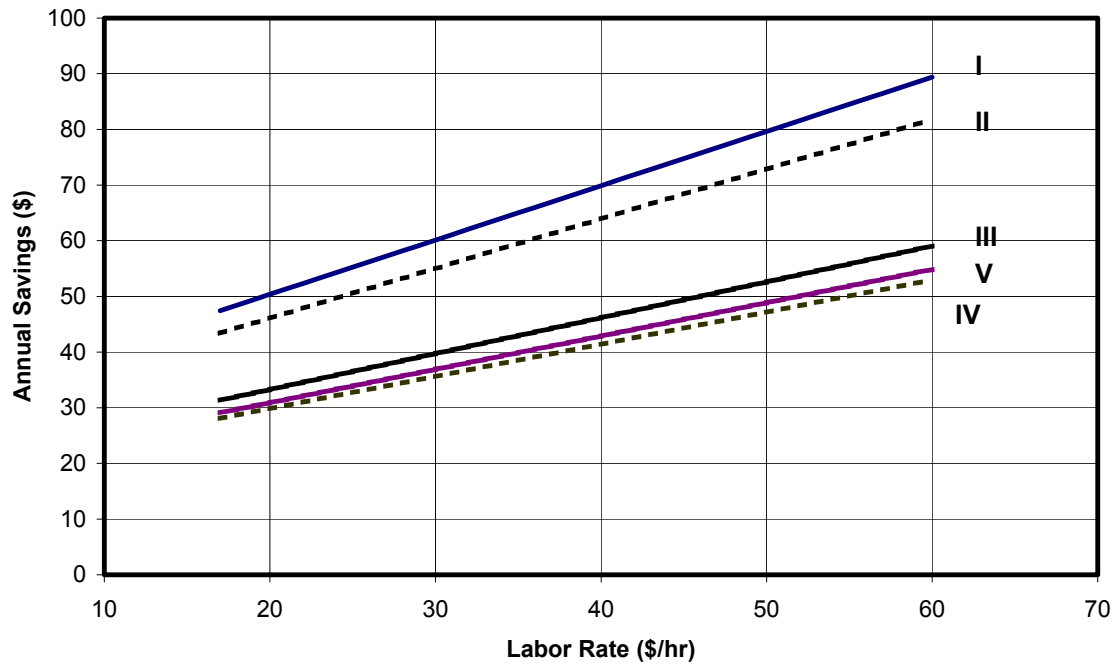


Figure 1. VendingMiser Savings

## 8. CONCLUSION

Our analysis indicates that the VendingMiser should reduce vending machine operating costs by decreasing the frequency and direct expense of component failures and thus, the number of service calls. Table 10 lists the expected total average annual savings from service call reduction in each of the installations. The results are shown for machines using electronic ballasts (new machines) and for magnetic ballasts (older machines retrofitted with VM). Separate savings numbers are listed for machines that cycle at 3/hr and at 5/hr, although, as seen in the table, the difference is small. Actual savings may fall somewhere in between.

*Table 10. Annual Savings From Reductions in Service Calls*

ANNUAL SAVINGS WITH VENDINGMISER	LOCATION				
	I	II	III	IV	V
Annual compressor savings w/VM (5/hr)	\$24.36	\$22.30	\$16.10	\$14.45	\$14.87
Annual compressor savings w/VM (3/hr)	\$22.56	\$20.65	\$14.91	\$13.38	\$13.76
Annual evaporator fan savings w/VM	\$6.04	\$5.52	\$3.99	\$3.58	\$3.68
Annual condenser fan savings w/VM	\$5.84	\$5.34	\$3.86	\$3.46	\$3.56
Annual thermostat savings w/VM	\$4.40	\$4.02	\$2.91	\$2.61	\$2.68
Annual lights savings w/VM (M-ballast)	\$13.84	\$12.20	\$7.29	\$5.98	\$6.30
Annual lights savings w/VM (E-ballast)	\$16.44	\$15.05	\$10.87	\$9.75	\$10.03
Annual electronic controls savings w/VM	\$9.47	\$8.66	\$6.26	\$5.62	\$5.78
Annual reduction in PM requirement (3/hr)	\$17.92	\$16.38	\$11.84	\$10.61	\$10.99
Annual reduction in PM requirement (5/hr)	\$19.37	\$17.70	\$12.82	\$11.48	\$11.84
<b>Total Annual Savings (3/hr &amp; M-ballast)</b>	<b>\$80.07</b>	<b>\$72.77</b>	<b>\$51.06</b>	<b>\$45.24</b>	<b>\$46.75</b>
<b>Total Annual Savings (3/hr &amp; E-ballast)</b>	<b>\$82.67</b>	<b>\$75.62</b>	<b>\$54.64</b>	<b>\$49.01</b>	<b>\$50.48</b>
<b>Total Annual Savings (5/hr &amp; M-ballast)</b>	<b>\$83.32</b>	<b>\$75.74</b>	<b>\$53.23</b>	<b>\$47.18</b>	<b>\$48.71</b>
<b>Total Annual Savings (5/hr &amp; E-ballast)</b>	<b>\$85.92</b>	<b>\$78.59</b>	<b>\$56.81</b>	<b>\$50.95</b>	<b>\$52.44</b>

As expected, installation in locations which are vacant for longer periods (as in installations 1 & 2) exhibit a higher annual savings than those in installations 4 & 5, due to the reduction in the number of cycles and the total running time.

The numbers shown in Table 10 are a significant fraction of the retail cost of the VendingMiser, and do not reflect the additional energy savings delivered by the VendingMiser.