

# **Vending Machine Reliability Testing And Effect on Profitability**

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Reliability test results based on independent laboratory testing  
conducted by:



# Executive Summary

This report presents the financial impact of the differences in reliability of the OTIS 400, the Dixie-Narco BevMax 2 (DN 5800) and the Vendo Vue-40 machines. An independent testing agency tested two machines of each model for approximately 70,000 vends and recorded the failures which occurred. Based on the test results and the cost estimates, it can be concluded that over a 10 year vending machine useful life, the OTIS 400 will be more profitable than the BevMax 2 by providing at least \$3,516 of incremental sales revenue from reduced machine downtime and by saving at least \$2,050 in operating expenses from reduced service calls. Over the same period, the OTIS 400 will be more profitable than the Vue-40 by providing at least \$2,610 of incremental sales revenue and by saving at least \$1,522 in operating expenses.

## Study Purpose

The study was conducted to determine the following:

- The reliability of the leading beverage vending machines as demonstrated by Intertek (ETL) independent testing
- The effect that vending reliability can have on profitability

## Background

The leading soft drink vending machine manufacturers have recently offered new vending machines for sale in the vending market. The primary change in these new vending machines is the “vending

mechanism” or “delivery system.” The stated benefits of these new models are improved vend reliability and greater diversity in the type of packages that can be vended. As the soft drink bottlers develop new packages and offer consumers more non-traditional beverages through the vending channel, they require a vending machine that is designed to dispense these packages in a reliable manner. Poor vend reliability can cost the operator lost sales, expensive service costs and ultimately a poor consumer experience that the consumer may associate with the brand.

## Methodology

Intertek (ETL), a testing agency located in Cortland, NY, performed the reliability test. Intertek (ETL) is the world’s leading product and commodity testing organization with roots dating back to 1896 with Thomas Edison’s Electrical Testing Laboratories (ETL). The company provides product safety testing and certification, performance testing and quality management systems from over 400 offices and 250 laboratories worldwide.

Three models of vending machines were tested: OTIS 400, Dixie-Narco BevMax 2 (DN 5800), and Vendo Vue-40. It should be noted that all vending machines were shipped to the testing agency directly from the distributor or the OEM.

Two new machines of each model were obtained and each machine was vended approximately 36,000 times for a total of 72,000 vends for each model, using a mix of 70% 20 oz. plastic bottles and 30% 12 oz. aluminum cans. Since this was a test of delivery system reliability, the machines were set up in free vending mode so that the

## Summary of Vend Test Procedures

- (2) OTIS 400 units, (2) Dixie-Narco BevMax 2 units, and (2) Vendo Vue-40 units.
- Vended seven (7) loads of 20 oz. plastic bottles and three (3) loads of 12 oz. aluminum cans until 36,000 products were vended from each machine.
- Randomly selected and vended products.
- Plastic bottles were replaced after 15 vends and cans were replaced after 10 vends.
- Operator wrote down pertinent and detailed information when the machine failed to perform satisfactorily and the consequence of such a malfunction.

coin changer and bill acceptor were not used. 72,000 vends were selected to represent the average number of vends a typical machine would be required to perform during its life. 72,000 vends represents 300 case drops per year over 10 years of service. The vends were randomly selected until the vending machine was fully vended. In order to eliminate any bias from worn or damaged packages, any package that appeared damaged was eliminated from the test. In addition, plastic bottles were replaced after 15 vends and cans were replaced after 10 vends. Intertek (ETL) recorded all errors, failures and malfunctions that were observed during the tests.

## Classification of Errors and Malfunctions

**Absolute Failure:** is an occurrence that requires a service call to correct or that renders the machine inoperable until the next regularly scheduled routeman visit. Examples are a broken part, product falling and jamming the mechanism, or the general delivery mechanism getting jammed.

**Related Failure:** is an Absolute Failure that occurred repeatedly due to the inability of the Intertek service personnel to repair the initial instance of the Absolute Failure.

**Error:** is an inconvenience to the consumer. Examples are a machine requiring multiple attempts to retrieve a product, the consumer having to make a second selection or where a jammed cell requires the consumer to make another selection.

## Test Results OTIS 400

The first OTIS 400 machine performed without failure for all the 36,000 vends. After 3,100 vends in the second machine, the black plastic component that is used to push the product forward in one cell failed. The remaining 39 cells in that machine remained operational. The mechanism was repaired on site by Intertek (ETL) personnel and the machine finished the test without any additional pusher issues. This failure was not seen again on any of the other 79 pushers in the two test machines. At approximately 33,000 vends, a pulley came loose and the testing was stopped. Thus, it can be concluded that the first machine had no Absolute Failures. The second machine had 2 Absolute Failures, both of which required human intervention. In total, there were 2 Absolute Failures out of 69,000 vends. No Related Failure or Errors were observed.

## BevMax 2

The first BevMax 2 machine had 36,116 vends and the second 36,114 vends<sup>1</sup>. Both BevMax 2 machines experienced numerous Absolute Failures, Related Failures, and Errors during the test process which were of the following types:

1. *Product delivery door related.* Examples are failures of the door to open or close. (2 Absolute Failures and 1,808 Related Failures were recorded)
2. *Product delivery related.* Examples are the product not coming off the shelf, the product falling to the bottom of the machine, the failure to sense the first product in the delivery port and various types of delivery cup malfunctions. (25 Absolute Failures, 67 Errors, and 48 Related Failures were recorded)

## Vue-40

The first Vue-40 unit broke after 20,039 vends and could not be repaired without a service call. The product delivery cup damaged parts on the delivery assembly and the unit became inoperable. The second unit completed 36,115 vends. The Vue-40 machines experienced numerous Absolute Failures, Related Failures, and Errors during the test process which were of the following types:

1. *Product delivery door related.* Examples are the door mechanism coming apart and door opens/closes with no product and displays “Machine Servicing Required.” (5 Absolute Failures were recorded)
2. *Product delivery related.* Examples are the delivery mechanism getting

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<sup>1</sup> Total number of vends differ due to the inability to vend complete product loads because of problems.

stuck, bottle tipping over, product cannot be grabbed, and product jam on shelf (10 Absolute Failures, 171 Errors, and 17 Related Failures were recorded)

## Comparative Evaluation

The reliability of these machines was analyzed using well established statistical tools. Assuming that a vending machine has the same likelihood of failure on any given vend as any other vend, we can use the test results to compute the mean trials or vends between failures (MVBF). Table 1 summarizes the test results for the three competing models. As can be seen from Table 1, the average number of vends between Absolute Failures is 34,500 for the OTIS 400, 2,675 for the BevMax 2 and 3,744 for the Vue-40.

**These test results show that the OTIS 400 is a more reliable machine than either the BevMax 2 or the Vue-40. Therefore, these machines will be significantly more costly to operate than the OTIS 400.**

Using the same results, we can compute another statistic that sheds light on the predictability of failure. Using a recognized statistical model that converts specific test results into a predictive approach, we can say with a 90% confidence level that a randomly selected OTIS 400 machine would function without a failure for 12,970 vends. Similarly, a randomly selected BevMax 2 would fail in approximately 2,066 vends and the Vue-40 would fail in approximately 2,637 vends at the same level of confidence<sup>2</sup>.

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<sup>2</sup> This is computed based on an exponential life distribution model which can be found at <http://www.itl.nist.gov/div898/handbook/apr/section3/apr311.htm>

**Table 1: Comparison of the machine failures by type**

	OTIS 400		BevMax 2		Vue-40	
	Absolute Failures	Errors	Absolute Failures	Errors	Absolute Failures	Errors
Product delivery door	0	0	2	0	5	0
Delivery mechanism	2	0	22	67	10	171
Total	2	0	27	67	15	171
<b>Absolute Failure rate: 1 in</b>	<b>34,500</b>		<b>2,675</b>		<b>3,744</b>	
<b>MVBF</b>	<b>12,970</b>		<b>2,066</b>		<b>2,637</b>	
<b>Error rate: 1 in</b>		<b>&gt;69,000</b>		<b>1,078</b>		<b>328</b>
<b>MVBE</b>		<b>29,966</b>		<b>917</b>		<b>297</b>

## Financial Impact of Reliability

When a vending machine experiences an Absolute Failure, the owner incurs two measurable types of costs. The first is the out of pocket expense in servicing the machine to make it operable and the second is the opportunity cost or the lost revenue due to the downtime when consumers are turned away because the machine is not working. The first one can be estimated by considering the cost to service the machine for a typical Absolute Failure and the second can be estimated by taking the product of the expected number of vends and the vend price while the unit is out of service. Table 2 highlights this analysis.

**Using the data in Table 2 and considering only the costs from the lower reliability of the vending system, the BevMax 2 would experience additional lost revenue of \$3,516 and cost \$2,050 more to operate over the 10 year life span compared to the OTIS 400 machine. The Vendo Vue-40 would experience additional lost revenue of \$2,610 and cost \$1,522 more to operate over the 10 year life span compared to the OTIS 400 machine.**

In addition to the two measurable financial impacts, when vending machines are used by consumers, these failures can lead to irritation, unhappiness, complaints and loss of patronage. Such a negative experience can damage the consumer's confidence in vending, and even worse, create a negative reaction to the branded product that failed to vend.

### BevMax 2 Related Failures:

The BevMax 2 machine had a large number of Related Failures because Intertek (ETL) could not repair certain failures to the delivery door and cup. The delivery door of machine #1 had its first Absolute Failure between vend 5,535 and 5,895 and the delivery door of machine #2 had its first Absolute Failure between vend 2,520 and 2,925. Machine #1 had 809 Related Failures. Machine #2 had 1,047 Related Failures. Since the failure mode was not corrected by an authorized service representative, it would be inappropriate to consider all the Related Failures as Absolute Failures. Accordingly, the Related Failures were not treated as Absolute Failures in Table 1 or Table 2. However, because both machines had the same type of failure at a

**Table 2: Comparative analysis of the financial impact of reliability**

Assumptions	
Cases per year	300
Cases per drop	10
Days between loads	12
Cost per service call	\$70
Vend price	\$1.00
Service life (years)	10

	OTIS 400	BevMax2	Vue40
Service calls per year <sup>3</sup>	0.56	3.48	2.73
Days between service calls <sup>4</sup>	658	105	134
Service cost per year <sup>5</sup>	\$39	\$244	\$191
<b>Life service cost</b>	<b>\$389</b>	<b>\$2,439</b>	<b>\$1,911</b>
Lost sales per year <sup>6</sup>	\$67	\$418	\$328
<b>Lost sales over life</b>	<b>\$666</b>	<b>\$4,182</b>	<b>\$3,276</b>

relatively early phase of the test, it is reasonable to assume that the part that gave rise to this particular Absolute Failure would also fail at a similar rate. If we extend this rate on both machines, there are an additional 16 failures.

The delivery cup presents a similar situation. Both machines started to fail at about 11,000 vends. This could have added an additional 4 failures for a total of 20 additional failures.

<sup>3</sup> Service calls per year = 300 cases per year \* 24 bottles per case ÷ MVBF

<sup>4</sup> Days between service calls = 365 days per year ÷ service calls per year

<sup>5</sup> Service cost per year = cost per service call \* service calls per year

<sup>6</sup> We assumed that failures occurred half way between loads. Therefore, if a typical load is 10 cases, the operator would have lost 5 cases in sales per service call. (Lost sales per year = 5 Cases \* 24 Bottles per case \* Vend price \* Number of service calls.)

The BevMax 2 had a number of errors or failures that seem to be inherent to the design of the machine. The delivery door failed between 2,520 and 5,895 vends. This failure prevented the delivery door from opening or closing properly. Second, the cup failed in both machines. The most significant problem in the BevMax 2 was with the vend mechanism due to a product jam. More importantly, an improper vend can cause product to drop to the bottom of the machine which can put the machine out of service.

**Based on the additional failures, considering only the cost from the lower reliability of the vending system, the BevMax 2 would experience lost revenue of \$6,825 and cost \$3,981 to operate over the 10 year life span of the machine.**

### Vue-40 Related Failures:

The Vue-40 machine had a total of 17 Related Failures recorded due to the breakage of a 20 oz. bottle inside machine #1. The bottle ruptured during the vending process. Intertek (ETL) personnel attempted to clean the machine on two separate occasions, but the machine ultimately became inoperable.

### Errors:

The OTIS 400 did not experience any Errors. The BevMax 2 had 67 errors.

Most of these errors were due to a jammed cell condition. The customer may select another product; however, the operator loses the opportunity to sell the products in that cell until the next time the machine is serviced. Also, some customers may not select another product causing the

operator to lose the sale. The Vue-40 had a very significant 171 errors. Like the BevMax 2, the errors on the Vue-40 were due to jammed cell conditions. In addition to the slant shelf, the Vue-40 uses two small flaps to hold the product on the tray. This system appeared to contribute to the large number of errors.

### **Other Observations:**

The vending manufacturers take different approaches in the method for delivering the product from the shelf. The BevMax 2 and Vue-40 use a slant shelf that relies primarily on gravity to allow the product to fall off the shelf and into the cup. In addition, the Vue-40 employs a mechanical picker that grabs the product from the shelf. The OTIS 400 positive drive system engages the back pusher plate to push the product into the cup. The gravity approach by both Dixie and Vendo likely contributed to the high number of false “sold out” Errors or vend Failures. **The test results lead to the conclusion that the direct drive mechanism used by the OTIS 400 is a more reliable vend mechanism.**

The high number of errors associated with the BevMax 2 and Vue-40 is problematic. These errors certainly lead to poor customer experience, lost sales and costly corrective actions. **In order to maintain the most conservative and objective approach, this report did not address these costs. One can easily incorporate these additional costs by assuming that a fraction of these errors would result in a service call and lost sales. For example, if we assume that just 25% of the errors require a service call, the cost to operate a BevMax 2 would jump from \$2,439 to \$3,753. The cost to operate a Vue-40 would jump from \$1,911 to \$6,199.**

The flat shelves in the OTIS 400 make the product logo or the brand name more visible to a consumer as he/she stands in front of the machine, whereas the slanted shelves in the BevMax 2 and the Vue-40 focuses the consumer’s attention on the top of the bottle or can. In addition, the Vue-40 hides the product from view until it is delivered to the consumer.

There were also a number of Failures (15) in the BevMax 2 that were caused by the product jamming in the base of the unit. The BevMax 2 design has a vertical arm that can not reach the delivery port if product falls between the port and arm.

While both machines have vandal port doors, the BevMax 2 and Vue-40 have significantly more mechanical parts and movement involved in the operation. This too may have contributed to the large number of Errors and Failures.