Las Vegas, Nevada

TECHNOLOGY FIELD TRIALS PROGRAM

Final Report

Power Efficiency Corporation Performance Controller

Caesar's Palace Hotel Escalator/Elevator Tests
Las Vegas

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Executive Summary

The Power Efficiency Corporation (PEC) Performance Controller is a device designed to work with an electric motor and optimize the motor voltage at partial loads to reduce magnetic losses in the motor core. This action reduces the electrical demand and energy consumption of the electric motor. This type of motor controller is most beneficial in reducing losses for motors running for long periods at low loads, usually below 30%. Other benefits, such as soft start capability and the potential for longer motor life, may influence a user's decision to install a motor controller, but do not impact electric utility operations and were not addressed in this report.

The objective of the PEC field test was to determine the level of energy efficiency improvement resulting from installation of the PEC Performance Controller on an NPC customer electric elevator motor, an electric escalator motor used for "upward" travel, and an electric escalator motor used for "downward" travel. All three motor tests were implemented under "typical" field loading conditions and are representative of a large number of motors used in elevator and escalator applications. Testing consisted of measuring electrical demand and energy consumption of each motor with and without the Performance Controller turned on, and comparing the results. The resulting data was analyzed and the results documented in this report.

Results show a significant reduction in average motor demand for the periods with the Performance Controller "On". For the 3-second interval tests, the demand reduction values are 29.52% and 32.72% for the "Up" and "Down" escalators respectively. No significant change in demand was observed with the PEC Performance Controller in operation during the 3-second interval tests for the elevator motor while the elevator passenger car was making a round trip. However, while the elevator motor is at idle, that is the elevator car is stationary, a demand reduction of 44.02% was observed. For the 15-minute interval tests, the demand reduction values are 34.07% and 36.51% for the "Up" and "Down" escalators respectively, and 21.02% for the elevator motor with the PEC Performance Controller in operation.

Projected annual energy savings are based on 24-hours/day, 365-days/year operations. For the "Up" escalator motor, the projected annual savings are 18,133 kWh. For the "Down" escalator motor, the projected annual savings are 20,148 kWh. For the elevator motor, the projected annual savings are 4,993 kWh.

Estimated annual energy and demand-charge cost savings, based on the NPC tariff rates for an LGS-X customer categorization, and resulting from implementation of the PEC Performance Controller are $1,597.60, $1,775.11, and $432.20 for the "Up" escalator, "Down" escalator, and elevator systems respectively.

The purchase prices for the PEC Performance Controller units used in this test are: $2,800 each for the escalator units and $3,850 for the elevator unit. These costs result in a simple calculated payback period of 1.75 years, 1.57 years, and 8.9 years for the "Up" escalator, "Down" escalator, and elevator systems respectively.

Other PEC Performance Controller features such as soft start capability and the resulting potential for extended motor life were not included for evaluation in this analysis, but if included, these additional benefits would tend to reduce the life-cycle costs.

1. Introduction

Nevada Power Company (NPC) authorized field-testing of the Power Efficiency Corporation (PEC) Performance Controller as part of its Energy Efficiency and Conservation group's Technology Field Trials Program. The tests were performed to measure and verify the manufacturer's motor controller performance claims and assess the energy savings and electrical demand reductions achievable in "field-use" situations with the PEC Performance Controller installed on an NPC customer electric elevator and (2) escalator motors, under "typical" loading conditions.

Technology Description

While electrical impedance, mechanical, and magnetic losses are all present during the operation of an electric motor; it is the motor's core losses that are the focus of the PEC Performance Controller. Core losses are the sum of energies expended to energize a motor's stator and rotor core. These losses can be grouped into two core-related loss categories: hysteresis and eddy current. Hysteresis losses result from energy expended in initially magnetizing the motor's core material; Eddy current losses result from energy expended in the form of heat when unavoidable currents flow within the conductive core material, motor housing, and any other conductive parts of the motor.

Because the magnitude of the core losses is proportional to the square of the source voltage applied to the motor stator, the Performance Controller attempts to minimize the voltage applied to the motor when operation and load demands require less than full line voltage (i.e. partial motor loading). When the motor load is low, the motor voltage is reduced to reduce losses. As the load increases, the Performance Controller continuously adjusts the motor voltage appropriately to meet the required load. The Performance Controller utilizes an electronically controlled thyristor system to achieve this control as well as high-low by-pass filters and output isolation transformers to reduce introduction of harmonics into the system. A motor controller of this type is most beneficial in reducing losses for motors running for long periods at low load.

Test Objectives

The objective of the PEC Performance Controller field test was to measure and verify the manufacturer's motor controller performance claims and assess the energy savings and electrical demand reductions achievable in "field-use" situations with the Performance Controller installed on three separate NPC customer electric motors: one 60 Hp electric elevator motor and two escalators each equipped with two 20Hp motors (up and down). All tests were implemented under "typical" loading conditions.

Testing consisted of measuring electrical demand and energy consumption of each motor with and without the Performance Controller in operation, under similar operating conditions for both scenarios, and comparing the results. The collected data was analyzed and the results documented in this report.

A benefit-cost calculation was made to assess the overall impact of utilizing the Performance Controller as compared to operating the facility's motors alone.

2. Site Description and Test Methodology

Test Site and Tested Devices

The field-testing was conducted by measuring electrical parameters under typical motor loading conditions for (1) electric elevator and (2) electric escalators. The escalators operate one each in the "up" direction and one in the "down' direction. Testing occurred at Caesar's Palace Hotel and Casino located at 3570 Las Vegas Boulevard Las Vegas, NV 89109.

This facility operates 24 hours per day, 7 days per week. Caesar's subcontracted with two companies to provide operation and maintenance services for the lift systems, including control components. KONE operates and maintains the electric escalator systems and Otis operates and maintains the elevator systems.

Figure 1. Test Site Map
(Caesar's Palace Hotel and Casino- Las Vegas, NV)

Figure 2. Test Load *(Elevator #15 Motor)*

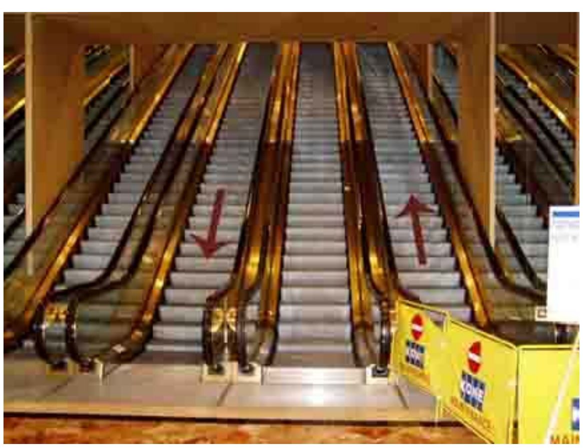

Figure 3. Test Load *("Up" and "Down" Escalator)*

The level of motor electrical efficiency improvement resulting from installation of a PEC Performance Controller was tested on three separate, three-phase electric motors, each having different functions and loading characteristics. Testing consisted of measuring the electrical energy consumption of each motor, under similar operating conditions with and without the Performance Controller's optimization function enabled. The Performance Controller device is equipped with an adjustment knob used to disable the controller's optimization function. The three machines that were tested include:

- Electric Elevator (60HP Motor)
- Electric "Up" Escalator ((2) 20HP Motors) - transports passengers upward
- Electric "Down" Escalator ((2) 20HP Motors) - transports passengers downward

The elevator operates in the 12-floor Centurion guest tower and is available to run 24 hours/day, 7 days/week. The two escalator motors typically run 24 hours/day, 7 days/week. The loading magnitude on all three motors ranges from light to heavy and is intermittent and variable, depending on passenger density and travel inside the facility. The nameplate specifications for the elevator motor used in the testing are identified in Table 1. Note that the nameplate data for both escalator motors was not obtained, due to the requirement of removing several steps to retrieve the information.

Motor Description	Elevator #15	"Up" Escalator	"Down" Escalator
Location	(Centurion Tower)	(Conference Center)	(Conference Center)
Manufacturer	Imperial	-	-
Model #	368EMDOHOH015	-	-
Serial #	574973	-	-
Rating(HP)	60	2(20)	2(20)
Rating(Volts)	230/460	480	480
Rating(Amps)	136/68	-	-
Phases	3	3	3
RPM	1750	-	-
Motor Age	5 months	8 years	8 years
PEC Controller #	PC3-46-60-32-77	PC3-46-40-22-52	PC3-46-40-22-52

Table 1. Motor Nameplate Specifications

The specifications for the PEC Performance Controllers tested are shown in Table 2.

Motor Description	Elevator #15	"Up" Escalator	"Down" Escalator
Location	(Centurion Tower)	(Conference Center)	(Conference Center)
Model#:	PC3-46-60-32-77	PC3-46-40-22-52	PC3-46-40-22-52
Volts:	460	460	460
Max. FLA:	77	52	52
Max. HP:	60	40	40

Table 2. PEC Performance Controller Specifications

Figure 4 below shows one of the PEC Performance Controller devices under test.

Figure 4. PEC Performance Controller Device

Test Procedures

During the field test, the PEC Performance Controller was installed on the branch circuit between the motor's existing controls/starter and the motor unit. As shown in Figure 5 below, the data logging instrumentation was installed between the distribution panel circuit breaker and the existing motor controls/starter.

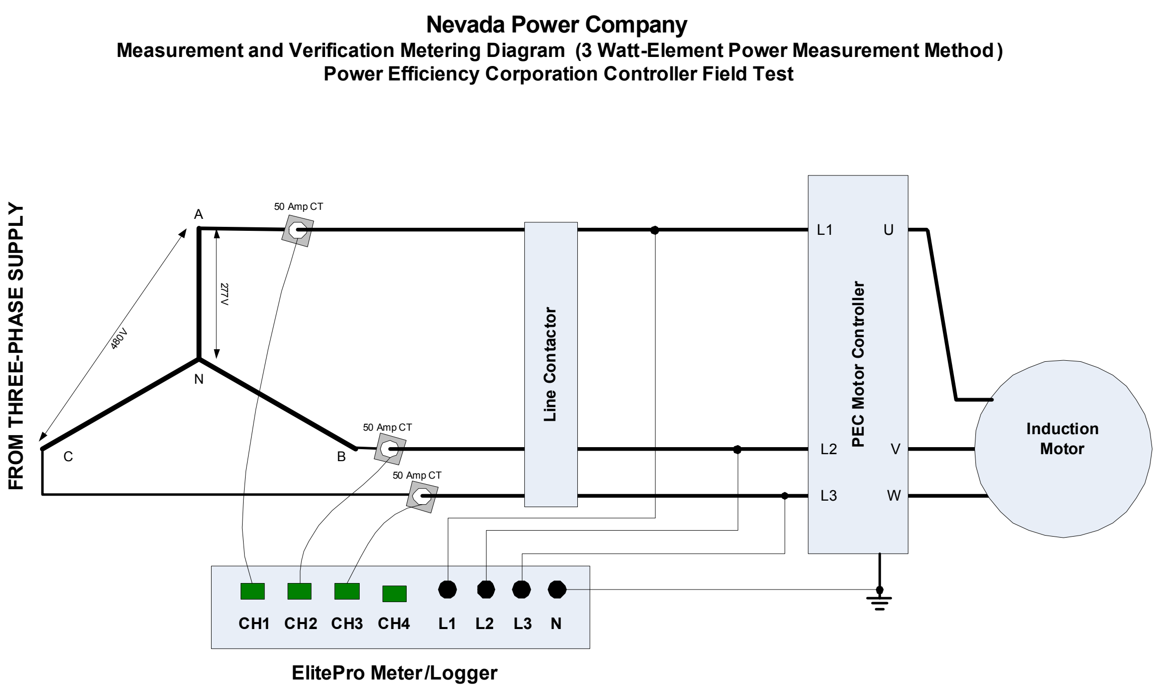

Figure 5. Instrumentation Diagram for the PEC Performance Controller and ElitePro Data Logger.

Installation of the data logging instrumentation at this location in the branch circuit provides the means to capture the electrical parameters associated with the combination of motor and motor controls/starter with/without the PEC Performance Controller enabled. Electrical savings measured at this point represent the savings that would be recorded by the utility's electric meter.
The sequence and timelines for field tests and metering measurements were as follows:

Elevator (Motor #15 - Centurion Tower)			
BASELINE			
Case #	**1**	**2**	**3**
Data Interval **Test Duration** **Motor Operation**	3 seconds 5 minutes Idle	3 seconds 5 minutes Roundtrip (no passenger load)	15 minutes 5 days Normal (variable load)
Test Conditions	Motor is operating. The Performance Controller is disabled and is not functionally present in electrical system.		
Data Parameters	Voltage, current, demand power (kW), power factor, reactive power (kVAR).		
Objective	Determine the baseline operating characteristics of the target motor		
PERFORMANCE			
Case #	**1**	**2**	**3**
Data Interval **Test Duration** **Motor Operation**	3 seconds 5 minutes Idle	3 seconds 5 minutes Roundtrip (no passenger load)	15 minutes 5 days Normal (variable load)
Test Conditions	Motor is operating. The Performance Controller is installed, enabled and operating in the motor branch circuit.		
Data Parameters	Voltage, current, demand power (kW), power factor, reactive power (kVAR).		
Objective	To establish operating characteristics of the motor circuit with the Performance Controller installed, enabled, and operating in the circuit.		

Figure 6. Elevator Test Procedure/Data Collection Schedule

"Up" and "Down" Escalators (Conference Area)			
BASELINE			
Case #	**1**	**2**	
Data Interval **Test Duration** **Motor Operation**	3 seconds 5 minutes Running (no passenger load)	15 minutes 5 days Normal (variable load)	
Test Conditions	Motor is operating. The Performance Controller is disabled and is not functionally present in electrical system.		
Data Parameters	Voltage, current, demand power (kW), power factor, reactive power (kVAR).		
Objective	Determine the baseline operating characteristics of the target motor		
PERFORMANCE			
Case #	**1**	**2**	
Data Interval **Test Duration** **Motor Operation**	3 seconds 5 minutes Running (no passenger load)	15 minutes 5 days Normal (variable load)	
Test Conditions	Motor is operating. The Performance Controller is installed, enabled and operating in the motor branch circuit.		
Data Parameters	Voltage, current, demand power (kW), power factor, reactive power (kVAR).		
Objective	To establish operating characteristics of the motor circuit with the Performance Controller installed, enabled, and operating in the circuit.		

Figure 7. "Up" and "Down" Escalator Test Procedure/Data Collection Schedule

Because the elevator and escalator systems can experience rapidly varying loading and unloading, the M&V application required the addition of a higher-resolution (3-second interval) test to more accurately determine the electrical characteristics of the Performance Controller.

Test Instrumentation

Voltage, current, and power measurements were made using a Dent Instruments Elite PRO recording poly-phase power meter. This meter is a three-phase true-rms recording power meter, 12-bit A/D, with a sampling frequency of 7.68 kHz. Clip on voltage leads were used to monitor voltage in each phase of the three-phase circuit. The current was monitored in each phase using 100A split core current transformers (CTs) from Dent Instruments. Installed instrumentation can be seen below in Figures 8 and 9 for the elevator and one of the escalator motors respectively.

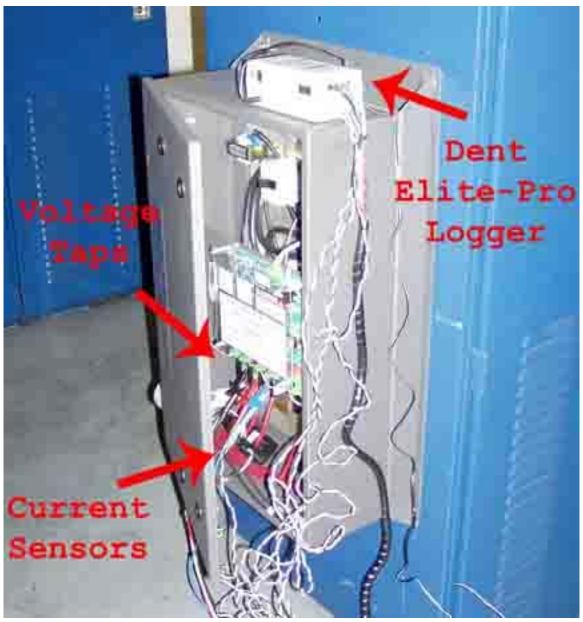

Figure 8. Instrumentation Installation
(Elevator Motor Control Cabinet)

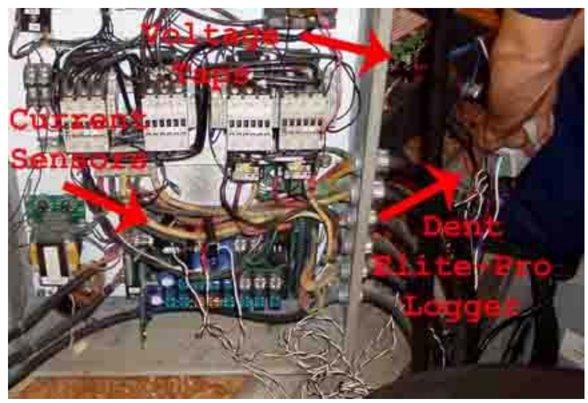

Figure 9. Instrumentation Installation
(Typical Escalator Motor Control Cabinet)

Installation and removal of data logging instrumentation was performed by subcontractors per Paragon instructions and wiring diagrams. Data management was performed exclusively by Paragon.

Test Conditions

The PEC Performance Controller test was conducted on site from 3/31/06 to 4/12/06. Baseline and Performance data was collected @ 3-second intervals for 5 minute durations on 3/31/06 between 11AM and 2PM for the elevator and both escalator motor loads. Baseline 15-minute interval data collection occurred from 3/31/06 to 4/5/06 for all three test loads and Performance 15-minute interval data collection occurred from 4/5/06 to 4/12/06 for all three test loads.

3. Discussion of Analysis and Results

The data collected from the field test was summarized and analyzed to determine the level of benefits obtained from operation of the PEC Performance Controller with the elevator motor and two sets of escalator motors. The benefits of primary interest to Nevada Power Company were the impacts on electrical demand, kW, and electrical energy savings, kWh. Other potential benefits to a user of the PEC Performance Controller, such as soft start capability and decreased motor operating temperature/increased motor life, are not addressed in this report. Potential benefits from soft starting may influence a user's decision to install a motor controller, but they do not impact electric utility operations. Only 4 motor starts are occurred during all Baseline and Performance data collection periods, 2 each during the 5-day, 15-minute Baseline testing periods for both the "Up" and "Down" escalators. At the above data collection rate and duration, soft start effects are negligible.

Impact on Demand Reduction, kW

The reduction of motor losses and corresponding improvement in efficiency should result in reduced electrical demand for the same level of motor output.

3-Second Data Collection Interval Tests

Figure 10 shows the electrical demand of the "Up" escalator motors during the 3-second interval testing period. The PEC Performance Controller is "On" and "Off" as indicated in the chart. Equivalent and comparable loading conditions were observed between the two test cases. Initial inrush current aside, demand variations during the "Off" period range from 14% to 21% of full load (30kW), and for the "On" period the range is from 12% to 19%.

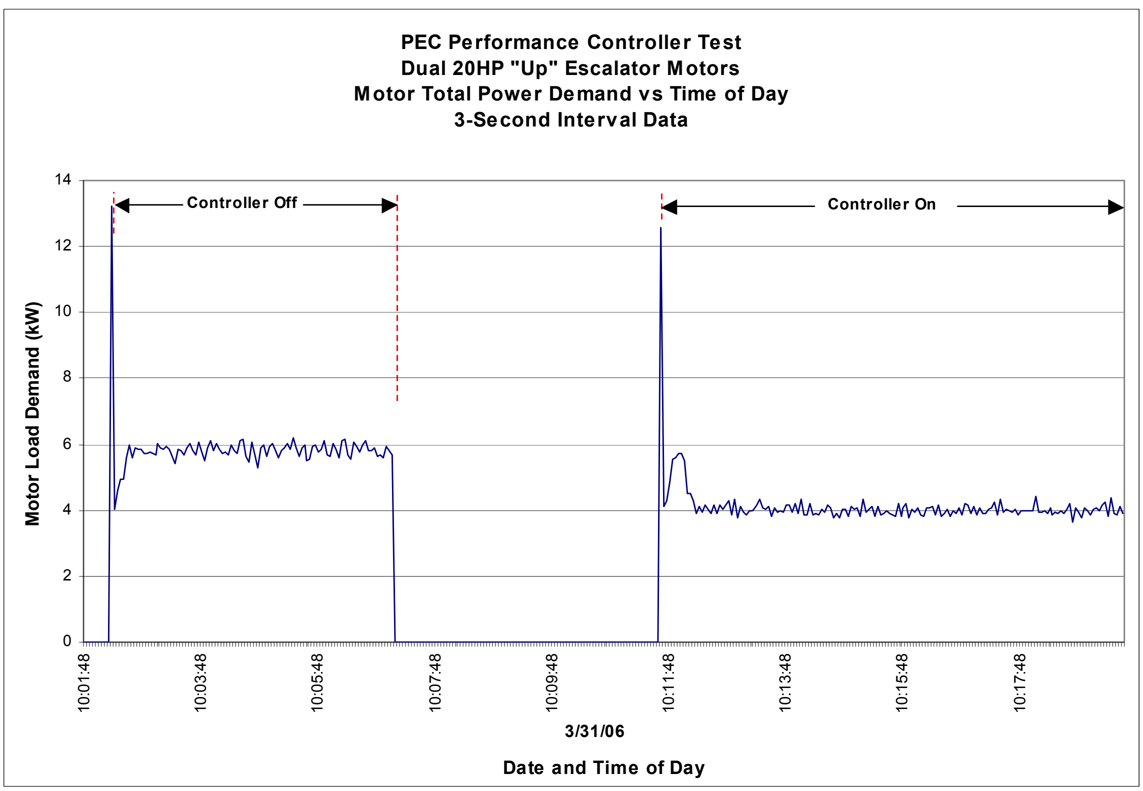

Figure 10. "Up" Escalator Motors' Power vs. Time; 3-Second Data Collection Intervals

Figure 11 shows the electrical demand of the "Down" escalator motors during the 3-second interval testing period. Similarly, the PEC Performance Controller is "On" and "Off" as indicated in the chart. Equivalent and comparable loading conditions were observed between the two test cases. Initial inrush current aside, demand variations during the "Off" period range from 18% to 25% of full load (30kW), and for the "On" period the range is from 13% to 23%.

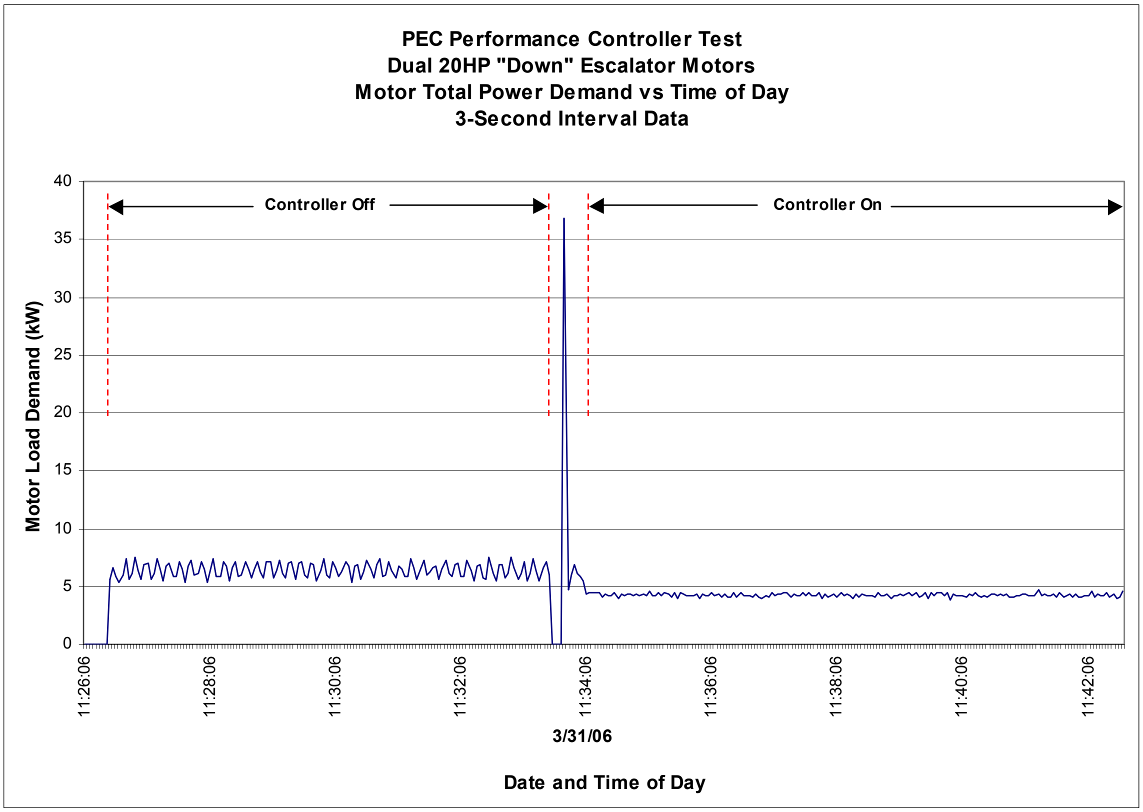

Figure 11. "Down" Escalator Motors' Power vs. Time; 3-Second Data Collection Intervals

For the elevator motor, a more complicated set of tests was performed. The Performance Controller operational status and elevator motor loading are shown for each test case in Table 3.

3-second Interval Data Collection on Elevator				
Case	**Controller**	**Motor Loading**	**Time Start**	**Time End**
1	Off	Idle	1:32	1:45
2	Off	Round-trip	1:47	1:48
4	On	Idle	1:54	1:58
5	On	Round-trip	2:02	2:04
2	Off	Round-trip	2:05	2:07
*Case 3 is the 15-minute interval data collection.				

Table 3. Elevator Motor Testing Intervals and Loading Conditions

Equivalent and comparable loading conditions were observed for all elevator test cases. The sole loading for all cases is the same: the empty elevator and associated counter weight system. The electrical demand observed for the elevator motor during each of these test periods is shown in Figure 12. The PEC Performance Controller is "On" and "Off" with the motor loading status as indicated in the chart.

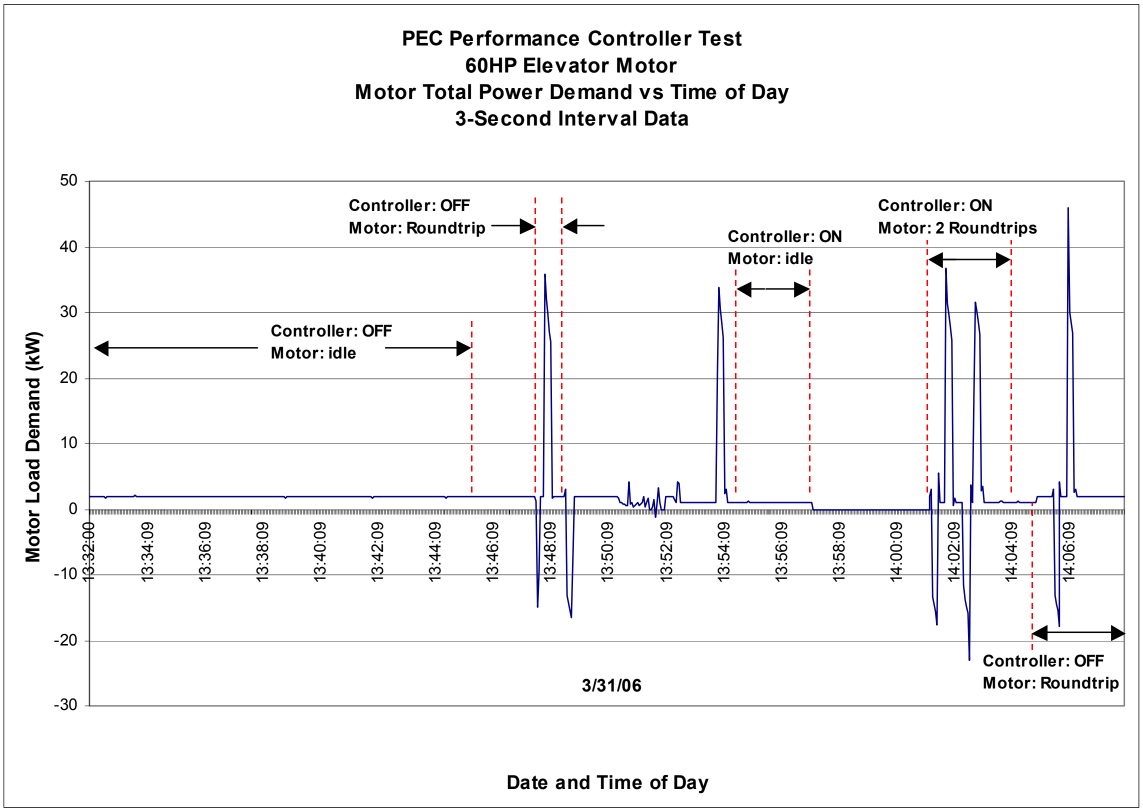

Figure 12. Elevator Motor Power vs. Time; 3-Second Data Collection Intervals

The periods of negative motor demand (power generation) recorded once during each elevator passenger car round-trip are the result of the difference in elevator passenger car and counter mass weight. Because the elevator motor is physically located at the bottom of the elevator car range-of-travel and because the counter mass weighs 1600lbs more than the empty elevator car, when the elevator motor is "raising" the empty elevator car it is actually acting as an electromechanical break for the dropping counter mass. Therefore, at the start of each empty elevator car round-trip (which initiates at the ground floor = elevator motor floor), the elevator motor demand is plotted as a negative ("generational") demand.

<u>3-Second Data Collection Summary</u>

A summary of the test results recorded for all three systems ("Up" Escalator, "Down" Escalator, and Elevator) is given in Table 4 below. In both escalator 3-second interval tests, and in the elevator motor "Idle" 3-second interval test case, a significant decrease in motor demand can be seen for the periods with the Performance Controller "On". Average improvements in demand reduction are 29.52%, 32.72%, and 44.02% respectively under no-load conditions.

3 Second Tests		Controller OFF Demand	Controller ON Demand	% Change Demand
Up Escalator	kWave	5.77	4.07	29.52%
	kWmax	6.20	5.72	7.66%
	kWmin	4.04	3.63	10.26%
Down Escalator	kWave	6.40	4.31	32.72%
	kWmax	7.52	6.93	7.82%
	kWmin	5.34	3.85	27.94%
Elevator	kWave	3.58	3.60	-0.57%
(Roundtrip Operation)	kWmax	35.87	36.79	-2.58%
	kWmin	-15.03	-22.98	-52.87%
Elevator	kWave	1.90	1.07	44.02%
(Motor @ Idle)	kWmax	2.17	1.13	47.81%
	kWmin	1.63	0.97	40.18%

Table 4. Summary of 3-Second Test Demand (kW); Average, Max, Min, and Percent Change

15-Minute Data Collection Interval Tests

Figures 13 and 14 show the electrical demand of the "Up" escalator motors during the 15-minute interval testing Baseline and Performance periods. The PEC Performance Controller is "Off" during the Baseline test period and "On" during the Performance test period. The "Up" escalator motors are shut down for maintenance on 4/1/06 from 2:30am to 5:30am and on 4/2/06 from 2:30am to 4:30am.

In addition, it was deduced during data analysis that the ElitePro voltage lead for Channel 3 was not physically secure during the Performance data collection period. The result is that voltage values recorded for this phase are not usable and therefore the real power values for this phase are not usable in determining the total 3-phase demand. However, because the ElitePro data logger directly measures the current parameters for each phase, and the current values for all three phases are well balanced (a 1.8% variance) and within limits, the corresponding complex (kVA) and real (kW) values calculated and recorded on Channel 1 and 2 are deemed reliable as a basis for estimating an accurate Channel 3 demand value (Channel 1 and 2 kVA values have a variance of 0.3%). Relying on the markedly balanced system, Channel 3 demand (Ch3 kW) is calculated as (Ch1 kW + Ch 2 kW)/2. Cumulative system demand is calculated as (Ch1 kW + Ch2 kW + Ch3 kW). Accordingly, the maximum and minimum demand values for the Performance period are taken from this calculated, cumulative data set.

As can be seen in Figures 15 and 16, equivalent and comparable loading conditions were observed for the two test periods. Initial inrush current and shutdowns aside, demand variations during the "Off" period range from 5% to 32% of full load (30kW), and for the "On" period the range is from 9% to 21%. The 32% upper demand level reached during the controller "Off" period on 4/4/06 appears to be unique with loading usually topping out at 20% to 25% of full load.

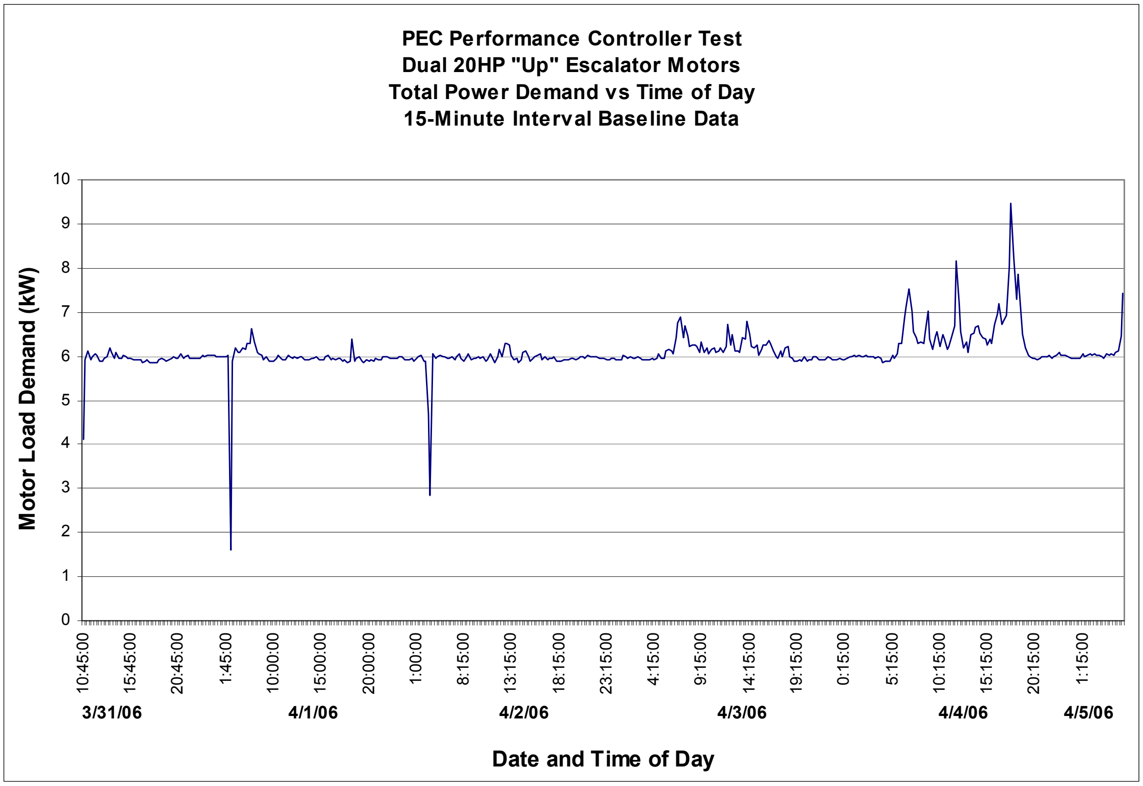

Figure 13. Baseline "Up" Escalator Motors' Power vs. Time; 15-Minute Collection Interval

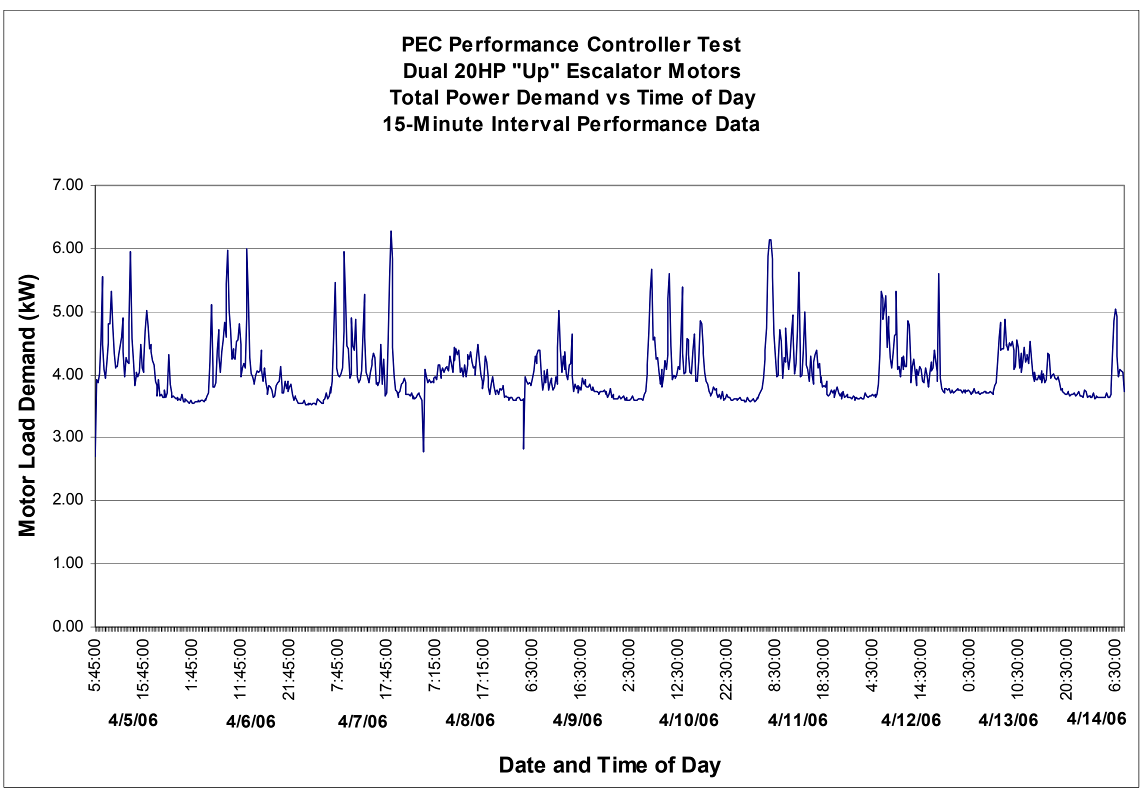

Figure 14. Performance "Up" Escalator Motors' Power vs. Time; 15-Minute Collection Interval

Figures 15 and 16 show the electrical demand of the "Down" escalator motors during the 15-minute interval testing Baseline and Performance periods. The PEC Performance Controller is "Off" during the Baseline test period and "On" during the Performance test period. The "Down" escalator motors are shut down for maintenance on 4/1/06 from 2:30am to 5:30am and on 4/2/06 from 2:30am to 4:30am. As can be seen in Figures 16 and 17, equivalent and comparable loading conditions were observed for the two test periods. Initial inrush current aside, demand variations during the "Off" period range from 7% to 23% of full load (30kW), and for the "On" period the range is from 7% to 16%.

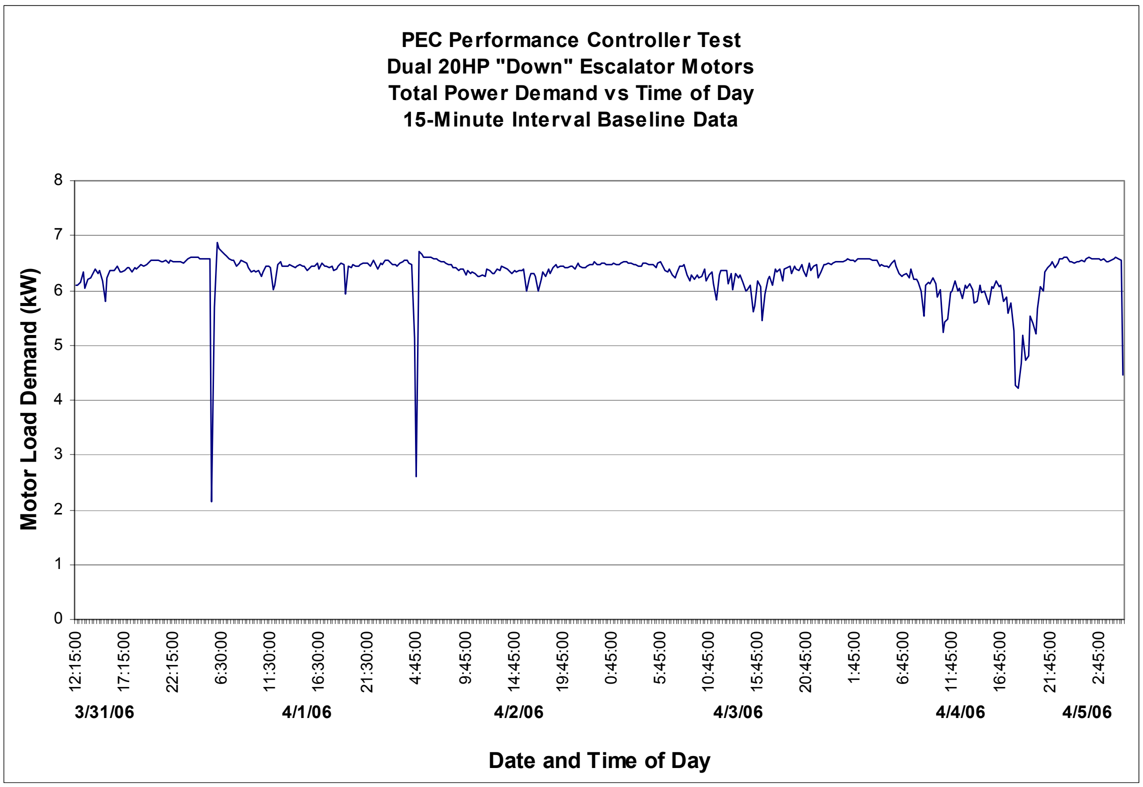

Figure 15. Baseline "Down" Escalator Motors' Power vs. Time; 15-Minute Collection Interval

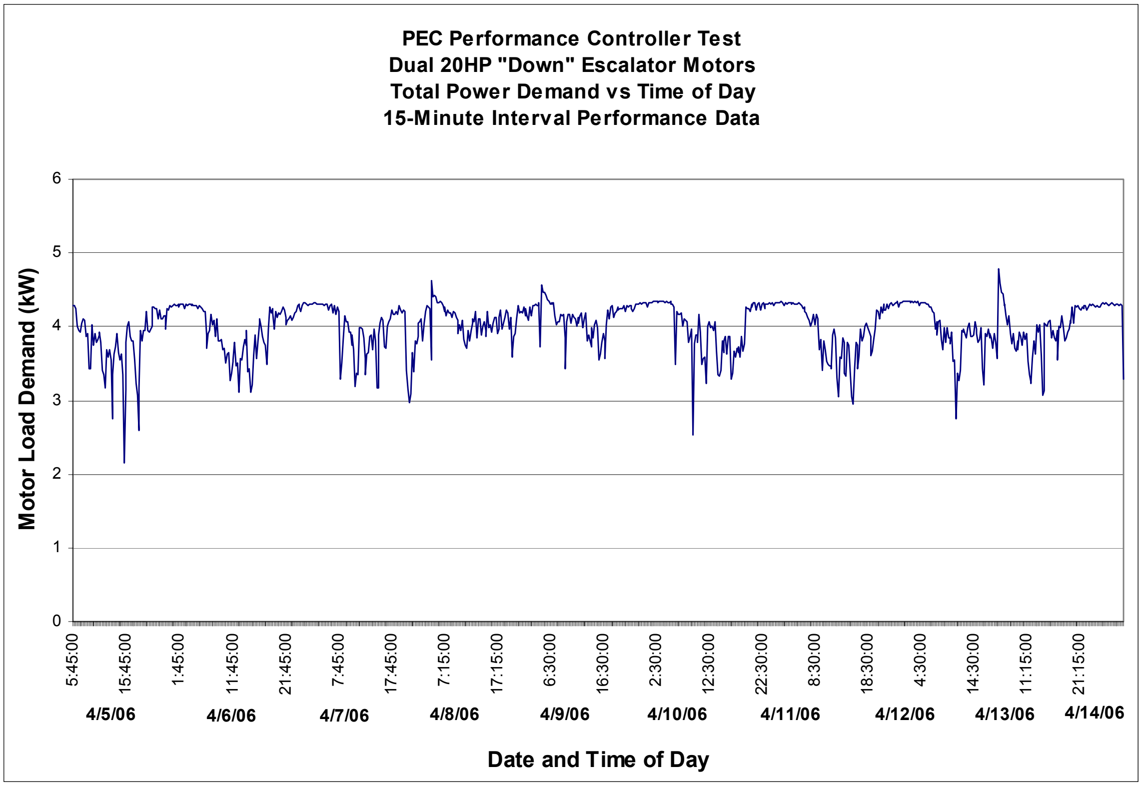

Figure 16. Performance "Down" Escalator Motors' Power vs. Time; 15-Minute Collection Interval

Figures 17 and 18 show the electrical demand of the elevator motor during the 15-minute interval testing Baseline and Performance periods. The PEC Performance Controller is "Off" during the Baseline test period and "On" during the Performance test period. Equivalent and comparable loading conditions were observed between the two test periods. As would be expected, human traffic and subsequent motor loading are observed to be exceptionally low during early AM hours. The sustained (15-minute average) elevator motor loading resulting from these empty or nearly empty passenger car round-trips is recorded as a motor demand of less than 1kW for that monitoring interval. Based on results of the 3-second interval tests (as shown in Figure 15, above), 1kW approximates the lower limit of the elevator motor demand at idle conditions. Therefore, to effectively isolate and identify possible performance improvements resulting from use of the PEC controller, periods where the 15-minute average demand is 0kW or less than 1kW are considered motor shutdown and are not included in demand averaging calculations.

Using these criteria as a basis, elevator motor demand during the "Off" period ranges from 2% to 9% of full load (45kW), and for the "On" period the range is from 2% to 8%.

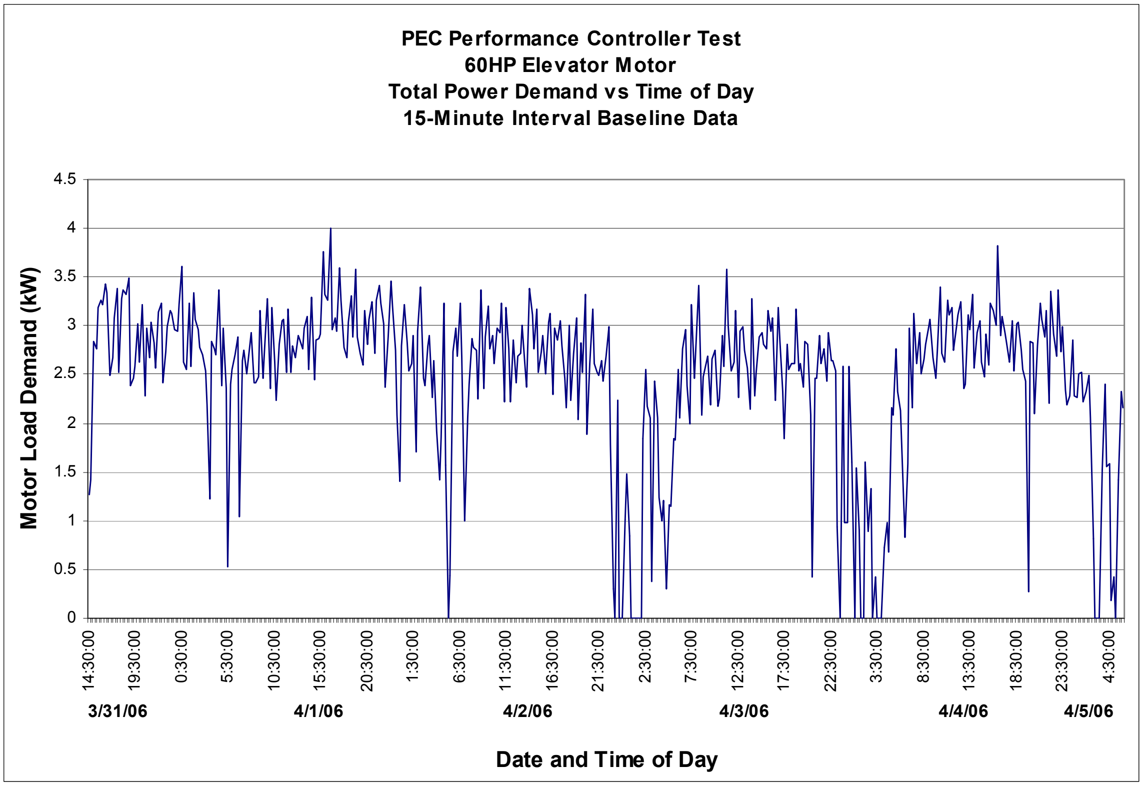

Figure 17. Baseline Elevator Motor Power vs. Time; 15-Minute Collection Interval

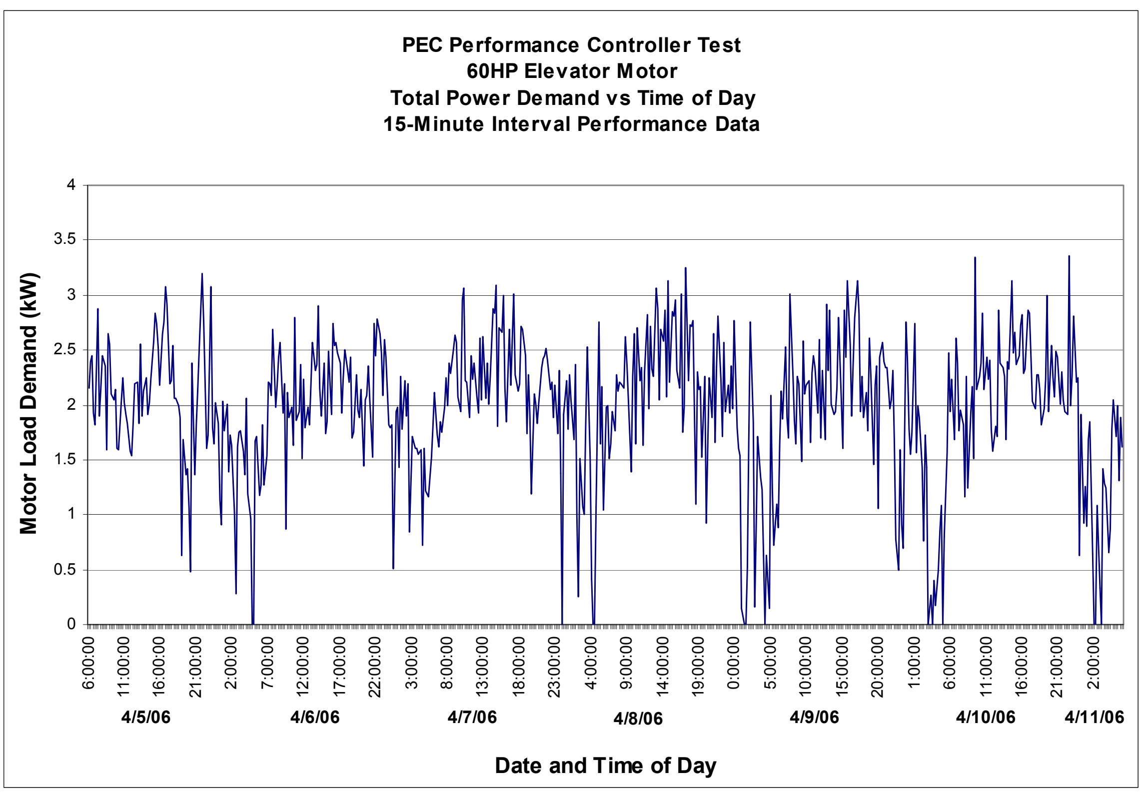

Figure 18. Performance Elevator Motor Power vs. Time; 15-Minute Collection Interval

15-min Tests		Controller OFF Demand	Controller ON Demand	Magnitude Change Demand	% Change Demand
Up Escalator	kWave*	6.08	4.01	2.07	34.07%
	kWmax	9.45	6.27	3.18	33.69%
	kWmin	1.59	2.71	-1.12	-70.77%
Down Escalator	kWave	6.30	4.00	2.30	36.51%
	kWmax	6.88	4.79	2.09	30.40%
	kWmin	2.15	2.15	0.00	-0.05%
Elevator	kWave	2.68	2.11	0.56	21.02%
	kWmax	4.00	3.36	0.64	16.03%
	kWmin	1.00	1.01	0.00	-0.40%
*Performance values calculated based on A & B phase voltages					

Table 5. Summary of 15-Minute Test Demand (kW); Average, Max, Min, and Percent Change

15-Minute Data Collection Summary

A summary of the 15-minute interval test results is given in Table 5 for all three systems ("Up" Escalator, "Down" Escalator, and Elevator). In both escalator tests, a significant reduction in average motor demand can be seen for the periods with the Performance Controller "On". The demand reduction values are 34.1% and 36.5% for the "Up" and "Down" escalators respectively. Significant improvement in the average elevator motor demand is observed for the 15-minute interval data collection periods as well. An improvement of 21.02% was achieved on the elevator with the PEC Performance Controller in operation.

Impact on Energy Consumption, kWh

It was observed and recorded that the loading on all three tested system motors ("Up" Escalator, "Down" Escalator, and Elevator) was consistent and repeatable on a daily basis for the duration of the 14-day test period. Therefore, the average 15-minute interval demand for the Baseline and Performance operating periods respectively are used to determine the estimated reduction in annual electrical energy (kWh) consumption of the motor with the PEC Performance Controller device implemented.

The average demand (kW) reduction multiplied by the number of hours in a period determines the energy consumption (kWh) for that period. In the case of 24-hours/day, 365-days/year operations, the change in average demand, determined in this testing and shown as a percentage of the baseline in Table 5, is multiplied by 24 x 365 = 8,760 hours.

For the "Up" escalator motor, the reduction in average demand between the Baseline and Performance test periods is 2.07kW. Therefore, the projected annual energy savings would be 2.07kW x 8,760hours = 18,133 kWh.

For the "Down" escalator motor, the reduction in average demand between the Baseline and Performance test periods is 2.3kW. Therefore, the projected annual energy savings would be 2.3kW x 8,760hours = 20,148 kWh.

For the elevator motor, the reduction in average demand between the Baseline and Performance test periods is 0.57kW. Therefore, the projected annual energy savings would be 0.57kW x 8,760hours = 4,993 kWh.

Cost Effectiveness Overview

An analysis was conducted to determine the cost savings resulting from installation of the PEC Performance Controller on the three tested system motors ("Up" Escalator, "Down" Escalator, and Elevator).

For the Caesar's Palace Hotel and Casino, reductions in kWh and demand were valued based on its current Nevada Power Company Rate: Large General Service (LGS-X), Secondary, bundled service. This rate includes a Consumption Charge based on Time of Use rates for Summer On-Peak, Mid-Peak, and Off-Peak, and for non-Summer periods. The most expensive rate, Summer On-Peak is \$0.09827/kWh. A Demand Charge based on Time of Use rates for Summer On-Peak, Mid-Peak, and Off-Peak, and for non-Summer periods is in effect as well. The most expensive rate, Summer On-Peak is of \$8.77/kW. A Facilities charge of \$1.17/kW is in effect throughout the year. These rates can be found on NPC Tariff #1-B (52nd Revised) Sheet 10, dated 10/01/05 and are summarized below.

Summer Peak:	6/1 to 9/30, 1pm to 7pm daily	122 Days	6 hrs/day	732 hrs/year
Summer mid-Peak	6/1 to 9/30: 10am to 1pm; 7pm to 10pm daily	122 Days	6 hrs/day	732 hrs/year
Summer off-Peak:	6/1 to 9/30, 10pm to 10am daily	122 Days	12 hrs/day	1464 hrs/year
Other Periods:	10/1 to 5/31, all hours	243 Days	24 hrs/day	5832 hrs/year

Time of Use	Energy Use Rate/kWh	Monthly Demand Charge/kW	Monthly Facilities Charge/kW	Rate Occurrence Hours per Year
Summer Peak	\$0.09827	\$8.77000	\$1.17000	732.00
Summer mid-Peak	\$0.08431	\$0.37000	\$1.17000	732.00
Summer off-Peak	\$0.06311	\$0.00000	\$1.17000	1,464.00
Other Periods	\$0.06401	\$0.55000	\$1.17000	5,832.00

Table 6. Summary of NPC Tariffs for LGS-X Customer Category

Based on these rates, and on the average demand reduction achieved during the performance testing for each motor system, savings can be calculated as shown in the following set of tables.

Time of Use	"Up" Escalator Average Demand Reduction (kW)	Rate Occurrence Hours per Year	Annual Energy (kWh) Savings (\$)	Annual Demand (kW) Savings (\$)	Total Annual Savings (\$)
Summer Peak	2.07	732.00	\$148.90	\$246.91	\$395.81
Summer mid-Peak	2.07	732.00	\$127.75	\$38.25	\$166.00
Summer off-Peak	2.07	1,464.00	\$191.25	\$29.06	\$220.32
Other Periods	2.07	5,832.00	\$772.74	\$42.72	\$815.47
				Total Estimated Savings	**\$1,597.60**

Table 7. "Up" Escalator: Estimated Annual Savings

Time of Use	"Down" Escalator Average Demand Reduction (kW)	Rate Occurrence Hours per Year	Annual Energy (kWh) Savings (\$)	Annual Demand (kW) Savings (\$)	Total Annual Savings (\$)
Summer Peak	2.3	732.00	\$165.45	\$274.34	\$439.79
Summer mid-Peak	2.3	732.00	\$141.94	\$42.50	\$184.45
Summer off-Peak	2.3	1,464.00	\$212.50	\$32.29	\$244.80
Other Periods	2.3	5,832.00	\$858.60	\$47.47	\$906.08
				Total Estimated Savings	**\$1,775.11**

Table 8. "Down" Escalator: Estimated Annual Savings

Time of Use	Elevator Average Demand Reduction (kW)	Rate Occurrence Hours per Year	Annual Energy (kWh) Savings ($)	Annual Demand (kW) Savings ($)	Total Annual Savings ($)
Summer Peak	0.56	732.00	$40.28	$66.80	$107.08
Summer mid-Peak	0.56	732.00	$34.56	$10.35	$44.91
Summer off-Peak	0.56	1,464.00	$51.74	$7.86	$59.60
Other Periods	0.56	5,832.00	$209.05	$11.56	$220.61
				Total Estimated Savings	**$432.20**

Table 9. Elevator: Estimated Annual Savings

As can be seen in Tables 7, 8, and 9, annual energy and demand-charge cost savings resulting from implementation of the PEC Performance Controller are $1,597.60, $1,775.11, and $432.20 for the "Up" escalator, "Down" escalator, and elevator systems respectively.

The purchase prices for the PEC Performance Controller units used in this test are: $2,800 each for the escalator units and $3,850 for the elevator unit. These costs result in a simple calculated payback period of 1.75 years, 1.57 years, and 8.9 years for the "Up" escalator, "Down" escalator, and elevator systems respectively

If other PEC Performance Controller possible benefits such as the value of soft start capability for potentially longer motor life were taken into account, it would tend to reduce the life-cycle costs for this application. These potential benefits may influence a user's decision to install a motor controller, but they do not impact electric utility operations and therefore evaluation of these potential benefits is not within the scope of this test.

6. Conclusions

- For the 3-second interval tests, results show a significant reduction in average motor demand for the periods with the Performance Controller "On". The demand reduction values are 29.52% and 32.72% for the "Up" and "Down" escalators respectively. No significant change in demand was observed with the PEC Performance Controller in operation during the 3-second interval tests for the elevator motor while the elevator passenger car was making a round trip. However, while the elevator motor is at idle, that is the elevator car is stationary, a demand reduction of 44.02% was observed.

- For the 15-minute interval tests, the demand reduction values are 34.07% and 36.51% for the "Up" and "Down" escalators respectively, and 21.02% for the elevator motor with the PEC Performance Controller in operation.

- Projected annual energy savings are based on 24-hours/day, 365-days/year operations. For the "Up" escalator motor, the projected annual savings are 18,133 kWh. For the "Down" escalator motor, the projected annual savings are 20,148 kWh. For the elevator motor, the projected annual savings are 4,993 kWh.

- Estimated annual energy and demand-charge cost savings, based on the NPC tariff rates for an LGS-X (Rates in affect as of April 20, 2006) customer categorization, and resulting from implementation of the PEC Performance Controller are $1,597.60, $1,775.11, and $432.20 for the "Up" escalator, "Down" escalator, and elevator systems respectively.

- The purchase prices for the PEC Performance Controller units used in this test are: $2,800 each for the escalator units and $3,850 for the elevator unit. These costs result in a simple calculated payback period of 1.75 years, 1.57 years, and 8.9 years for the “Up” escalator, “Down” escalator, and elevator systems respectively

- Other PEC Performance Controller features such as soft start capability and the resulting potential for extended motor life were not included for evaluation in this analysis, but if included, these additional benefits would tend to reduce the life-cycle costs .

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