# Garage DCV System Case Study: Opera Plaza, S.F.

***Adapting To Older, Non-inverter Duty Motors Not An Impediment – Actually Extends Garage Mechanical System's Operational Life***

### *The Property*

Constructed in 1982 and offering a wide choice of residences, businesses and shops, Opera Plaza houses 450 residential units, more than 80,000 square feet of office and retail space and a subterranean garage providing 600 parking spaces.

Opera Plaza, San Francisco

*"The NES retrofit markedly improved our garage system operations while delivering impressive energy savings."*

Kacey Callinan, GM, Opera Plaza Management

### *The Savings Opportunity / Challenge*

The retrofit of Opera Plaza's garage presented Nagle Energy Solutions (NES) a unique opportunity: To retrofit a 32-year-old ventilation system consisting entirely of two-speed garage fan motors that property management ran for years on a 24/7 basis at their "low" speeds, having bypassed an inoperable ACME carbon monoxide (CO) sensor system installed at the time of building construction.

The challenge was to demonstrate whether our innovative, CO sensor-based, demand-control ventilation (DCV) system could further reduce the baseline of energy consumed by a ventilation system already running its motors at low speed(s) and to remedy operational inefficiencies related to the old, dilapidated CO system.

Additionally, the two-speed motors in the Opera Plaza garage are non-inverter-duty motors, meaning they are less compliant with Variable Frequency Drive (VFD) technology than single-speed, inverter-duty motors. The NES DCV system and ventilation strategy incorporates the use of VFDs.

### *Baseline Energy Measurements & Findings*

The garage at Opera Plaza is two-level, below-grade structure measuring a combined 187,000 square feet. It is ventilated by:

- ✓ One (1), 25-HP, two-speed exhaust motor;
- ✓ One (1), 20-HP two-speed exhaust motor;
- ✓ Two (2), 10-HP, two-speed exhaust motors; and
- ✓ Two (2), 7.5-HP two-speed exhaust motors.

The operating hours for each fan motor amounted to 168 hours per week or 8,760 hour annually. To establish an accurate baseline of energy consumption, NES measured each garage fan motor's true power (kW) consumption, as well as the voltage and current (amperage) output and the actual power factor (PF) and motor load of each motor.

Our measurements showed that, with the motors running 24/7 at their low speeds, their combined, annual energy draw totaled 118,081 kilowatt hours (kWh), with a peak kW demand equaling 13.48 kW. At a utility rate of $0.21/kWh, that meant Opera Plaza management spent nearly $24,800 to ventilate its garage.

### *Ventilation Prerequisites & Project Design*

VFDs are designed to sync with fan motors operating at 100% of capacity, i.e., their "high" speed. This required us to also measure the power (kW) consumption of the motors at their high speeds and then calculate the obtainable energy savings based on the difference between the energy consumed by the fan motors running in conjunction with VFDs at their high speeds (post installation) and the energy consumed by fan motors at their low speeds (pre retrofit).

To enable the non-inverter duty motors to work in conjunction with VFD technology and thereby minimize the risk of motor failure, NES installed "dV/dt" filters in conjunction with each VFD we installed.

On average, dV/dt filter technology reduces the risk of non-inverter-duty motor failure by approximately 80%, according to technical advisors for Danfoss, which manufactures the VFDs that NES installs.

Lastly, on-site inspection of the garages' electrical system confirmed it was possible to reduce the total number of VFDs from six (6) – or one (1) VFD per motor – to four (4) by pairing each 10-HP motor with a 7.5-HP motor on a 20-HP VFD, thus enabling us to significantly reduce the retrofit bill of material (BOM).

### *The Results*

NES retrofitted the Opera Plaza garage ventilation system in late 2013 / early 2014, switching the respective garage exhaust motors to run at high speed to better "sync" with the respective VFDs.

The energy savings achieved are noteworthy. Post-installation data logging – measuring kW consumption, voltage and current (amperage) output and PF at intervals of one (1) per minute, 24 hours per day for 10 days – showed our garage DCV system will reduce the garage fan motors' combined kWh consumption by 100,953 kWh a year – an 85.5% savings. Peak kW demand has been reduced by 11.52 kW, which also equates to an 85.5% savings.

| Energy Use | Pre Installation | Post Installation | Savings | % Savings |
|---|---|---|---|---|
| Total kWh | 118,081 | 17,128 | 100,953 | 85.5% |
| Total Cost @ $0.21/kWh | $ 24,797 | $ 3,597 | $ 21,200 | 85.5% |
| Total kW Demand | 13.48 | 1.96 | 11.52 | 85.5% |

Moving forward, Opera Plaza Management's cost to ventilate its garage will drop from $2,066 to $300 per month or $10 per day, thus providing a minimum cash inflow of roughly $241,900 throughout the 15-year lifespan of our system.

Our measurement and verification methodologies were accepted and approved by the inspecting engineer for the regional utility, Pacific Gas & Electric, resulting in a rebate amounting to $8,436.

### *Convergence with Stricter Standards*

Often overlooked by property owners/managers is the considerable cost to ventilate enclosed parking garages. At the same time, a growing number of states and municipalities are adopting stricter energy efficiency and operational standards for CO sensor systems.

These revised standards no longer permit the deployment of CO sensor systems that switch on garage fans only when elevated CO levels require it, which is commonly referred to as an "on/off" or "start/stop" ventilation strategy. Plus, an industry trick of the trade – simply shutting off garage fans to avoid energy costs/fees – is expressly prohibited in an increasing number of cities and states. The International Mechanical Code has adopted similar standards, as well.

Our sensor-based garage DCV system benefits property owners by providing a cost-effective means to minimize garage ventilation costs while adhering to the new, stricter standards.

### *Our Solution*

NES has developed, manufactures and installs an innovative, digital "variable flow" garage DCV system. It utilizes a smart-control logic to detect and measure vehicle fumes and modulates fan motor speeds to prevent CO levels from exceeding 10 parts per million (ppm) for extended periods of time. The result is to enable property owners to continuously ventilate their garages in an energy efficient manner while ensuring the health and safety of building occupants and visitors.

### *About Nagle Energy Solutions (NES)*

Nagle Energy Solutions, LLC (www.nagle-energy.com) is a manufacturer, distributor and installer of an innovative demand-control ventilation (DCV) system for commercial garages that reduces energy consumption by an average of 93% – with quantifiable savings as high as 97% achieved. Our sales and service capabilities extend nationally and internationally.

NES digital controllers and peripherals are scalable and conform to several building management system (BMS) and energy management system (EMS) communication platforms, as well as monitor / report on energy consumption/savings.

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