INTEC CONTROLS

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Ventilation Controls in High Performance Parking Garages

Green Garage Certification Picks Up Where LEED Leaves Off

Rev 1.0

In addition to complying with local building and safety codes, parking garage owners and operators now have a means to demonstrate their commitment to environmental sustainability.

About

GREEN PARKING COUNCIL
AN AFFILIATE OF THE INTERNATIONAL PARKING INSTITUTE

Who is the GPC?

Parking is about the spaces between people in motion. The Green Parking Council collaborates and innovates in this space – this parking space – to strengthen people and planet.

The Green Parking Council (GPC) emerged from leaders in and around the parking industry motivated by a vision of parking as part of the solution. GPC is a national 501(c) (3) organization providing leadership and oversight for the green conversion of parking facilities to sustainable, environmentally responsible assets. It is an affiliate of the International Parking Institute, the largest and leading trade association representing parking professionals and the parking industry worldwide.

GPC is dedicated to expanding green parking practices through developing certification and credentialing programs, open- source standards, professional leadership and general education.

GPC works at the intersection of parking, green building, clean technology, renewable energy, smart grid infrastructure, urban planning and sustainable mobility. By challenging us to collaborate and create open-source, sustainable best practices, GPC encourages exceptional industry transformation.

The GPC has developed many tools to accomplish this mission, one of which is the Certified Green Garage.

What is Green Garage Certification?

Green Garage Certification integrates 48 discrete technologies, programs and management practices into a transformational lever moving the parking industry to sustainability. Developed, tested and endorsed by building owners & managers, parking operators and manufacturers, like an industry-specific LEED, it defines the standard for parking sustainability and the goal for parking owners and operators.

For more information on the GPC and Green Garage Certification, visit the GPC on the web at www.greenparkingcouncil.org.

INTEC Controls (a brand of Relevant Solutions) is a proud Launch Partner of the Green Parking Council with representatives serving on the Certification and Sustainable Technologies committees.

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Green Garage Certification Standard

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A special thanks to Joshua Zaccarine and Tessa Lowe at Axis2Design for their wonderful design work here and on our website – and for their extraordinary patience with us! And overwhelming gratitude to Dan Ciarcia of Two Willows Consulting for making sure we got over the finish line.

Printed by Toledo Ticket Company, a Green Parking Council Launch Partner, on FSC-certified paper using Xerox digital presses. (For more information on printing sustainably at Xerox, see www.xerox.bz/ln94kac and www.xerox.bz/1jaueYR)

First Printing, June 2014

ISBN 978-0-9904328-0-7

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Version 1.0 - June, 2014

An affiliate of the International Parking Institute

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Green Garage Certification is both a road map and an assessment tool for High Performance Garages in the 21st century.

Over 200 parking leaders, sustainability experts and technologists contributed to the forty-eight elements of Green Garage Certification. The program was beta-tested at fifty-one sites across the U.S. and Canada.

Introduction

Welcome to Green Garage Certification, the transformational tool recognizing and inspiring high-performance, sustainable parking facility design, technology and management. In a time of growing desire for more livable communities alongside a rising concern about our planet, Green Garage Certification is both a road map and an assessment tool for 21st century parking.

This emerging approach integrates evolving technologies, multimodal mobility, connected cars, smart parking, and intelligent transportation innovations. A century after the emergence of the Model T, parking facility owners, developers, planners, architects, tenants, operators, policy makers and others are moving from a narrow "where do we put the cars?" towards an integrated vision of enabling more varied and sustainable means of mobility.

Green Parking Certification is a voluntary, consensus-driven standard developed by passionate, volunteer experts organized by the not-for-profit Green Parking Council with generous support from the International Parking Institute. Emerging from forward-looking leaders in the real estate, parking, automotive and technology industries, Green Parking Certification pursues the triple bottom line of parking, planet and profit. It recognizes that for sustainable parking to be a sustainable business model, it has to offer the flexibility to work in commercial, public, university, airport, hospital, entertainment, retail, public and other parking markets.

Over 200 parking leaders, sustainability experts and technologists contributed to the forty-eight elements of Green Garage Certification. The program was beta-tested at fifty-one sites across the U.S. and Canada. External reviewers from the U.S. Green Building Council, Harvard University, the Urban Land Institute, the Massachusetts Institute of Technology, Project for Public Spaces, TIAA-CREF, Ramboll, Alta Planning and Design and others provided valuable feedback. This document is testimony to the GPC motto "No one is a smart as everyone."

Green Garage Certification is designed to serve existing and new parking structures in all markets. It evaluates parking structure performance in three categories, addressing how we manage our facilities, the programs we offer and the technology and structures we employ. The individual elements contained in the following pages of this Standard span the range of approaches identified to date:

This document, Green Garage Certification Standards, defines the performance measures and documentation requirements to reach Bronze, Silver, or Gold Certification status.

Management	Programs	Technology and Structures Design
Parking Price	Placemaking	Idle Reduction Payment Systems
Shared Parking	Access to Mass Transit	Fire Suppression
TMO/TMA	Wayfinding Systems - External	No or Low VOC Coatings, Paints, Sealants
Recycling	Wayfinding Systems - Internal	Tire Inflation Station
Sustainable Purchasing Programs	Traffic Flow Plan	EV Charging Stations
Proactive Operational Maintenance	Carshare Program	HVAC Systems - Occupied Spaces
Cleaning Procedures - Occupied Spaces	Rideshare Program	Ventilation Systems - Parking Decks
Cleaning Procedures - Parking Decks	Fuel Efficient Vehicle Program	Lighting Controls
Building Systems Commissioning	Alternative Fuel Vehicles	Energy Efficient Lighting System
Construction Waste Management	Alternative Fuel Fleet	Stormwater Management
Regional Materials	Bicycle Parking	Rainwater Harvesting
Regional Labor	Bicycle Sharing	Greywater Reuse
Reused, Repurposed or Recycled Materials	Marketing/Educational Program	Indoor Water Efficiency
Third Party Sustainability Certification		Water Efficient Landscaping
Credentialed Management		Roofing Systems
Life Cycle Analysis		Renewable Energy Generation
		Design for Durability
		Energy Resiliency-Storage

In addition, an innovation category allows for recognition for emerging approaches to green parking.

Facilities seeking Green Garage Certification will be evaluated based on their achievement towards these Standards. Performance is recognized with points, with minimum levels of achievement required in all three categories. Based on overall level of performance, parking structures eligible for certification will be recognized with Bronze, Silver, and Gold Certification. This document, Green Garage Certification Standards, defines the performance measures and documentation requirements. Application procedures, fees, program requirements and certification levels are available in the Green Garage Certification Program Guide, a free and regularly updated tool available at www.greenparkingcouncil.org/ProgramGuide.

We know that developing the theory and practice of green parking alone won't save the world. But if every industry makes such an effort, together we will make great strides towards an economy that meets the needs of the present and safeguards the planet on which we and future generation depend. Thank you for celebrating the best attributes of sustainable parking structures and helping us all build and operate parking in ways respectful of our planet.

On behalf of the board, partners and volunteers of the Green Parking Council.

Paul Wessel, Executive Director
Green Parking Council, an Affiliate of the International Parking Institute
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Demand controlled ventilation yields benefits to the sustainability "triple bottom line" – people, planet and profit. People enjoy an environment with safe levels of toxic carbon monoxide gas, greenhouse emissions are lower due to lower energy consumption in the garage, and garage operating costs are lower with the significant reduction in fan run time.

MEASURE 7

Ventilation System – Parking Decks

Objective:

Utilize energy efficient ventilation systems to reduce energy consumption in enclosed parking structures while maintaining or exceeding existing garage air quality standards.

Description:

Vehicles with internal combustion engines (ICE) produce emissions that are harmful to human health and must be mitigated with either natural or mechanical ventilation.

Ventilation systems use a significant amount of energy to operate large fans that provide a fresh air supply to the garage. Many other facilities or structures with traditional ventilation systems run ventilation fans at full power for 24 hours per day. This is highly inefficient as the fan motors are often operating when there is no need for ventilation or when the ventilation is not needed at full capacity.

Parking structures can improve air quality, increase health and safety[1], reduce greenhouse gas emissions and reduce operating expenses by upgrading ventilation systems to energy-efficient, controlled technology. Several technologies can optimize ventilation efficiency and may be implemented independently or in combination for a more robust system.

- Variable Air Flow Systems
- Demand Controlled Ventilation (DCV)
- Schedule and Occupancy Controls

[1] *Spengler, J.D. and Chen, Q. 2000. "Indoor air quality factors in designing a healthy building," Annual Review of Energy and the Environment, 25, 567-600.*

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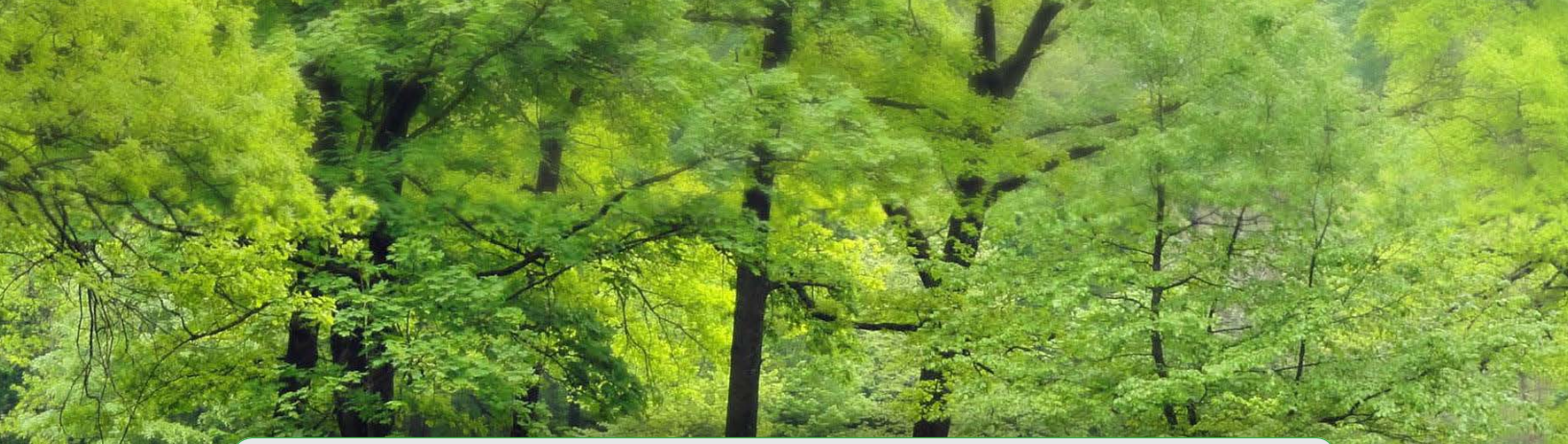

Variable air flow systems provide a higher level of efficiency because they can adjust the air flow and by extension, the amount of energy consumed. Schemes for varying the flow rate include:

- Variable Frequency Drives (VFD) consist of motors that can operate at various voltage levels to produce a range of fan frequencies. This enables the ventilation system to operate at an optimal air flow rate and ensure safe air quality without wasting energy.

- Fan walls also provide a facility with a variable rate of air flow in order to maintain air quality at an optimal energy rate. A fan wall consists of several fans residing together, with each fan individually controlled. When the flow rate needs to be adjusted, individual fans can be turned on or off as needed.

An additional benefit of these variable system designs is the soft start capability that keeps energy demand charges low and reduces the energy needed to maintain air quality.

Efficient ventilation systems require controls to activate (or increase) and deactivate (or decrease) the fan motors. Multiple technologies for controlling these motors include:

- Demand Controlled Ventilation (DCV). The most reliable and efficient control system is managed by a series of air quality sensors in the facility. These sensors typically detect the presence of high levels of carbon monoxide (CO), nitrogen dioxide (NO_2) and sometimes other gases such as Volatile Organic Compounds (VOC). The ventilation system is only activated when high levels of these gases are detected. Local building, mechanical and/or fire code dictate, which gases must be monitored and controlled (carbon monoxide, nitrogen dioxide, and/or hydrogen) as well as the gas concentration levels which trigger increased ventilation or audible/visual annunciation. The garage operator is responsible for complying with all applicable codes. DCV system reduce energy use by up to 90 percent compared to baseline system that runs the ventilation system constantly.[2] As with any type of sensor based system, DCV systems utilize either "On/Off" motors, where motors are always fully on or fully off, or "VFD" motors, where the fan motors can run over a wide range of frequencies.

- Scheduling and occupancy control. Some control systems can activate/deactivate the ventilation system based on detected or predictable human or environmental behavior. These systems are less effective than DCV air quality control because they do not measure the actual air quality and therefore may operate the fan motors more often or less often than necessary. Systems include:

    - Scheduling uses mechanical timers to activate the motors during operating hours and deactivate them during closing hours. Disabling ventilation in the non-operating hours can save a substantial amount of energy, but keeps the system running at full speed during the garage operating hours, which many include significant periods of time when it is not needed.

[2] *"Codes and Standards Enhancement Initiative (case), Garage Exhaust", 2013 California Building Energy Efficiency Standards, California Utilities Statewide Codes and Standards Team, September 2011, pages 6-15.*

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INTEC Controls offers demand controlled ventilation solutions for any size garage utilizing our DGC-Series digital gas controllers, MGC-Series analog gas controllers and SPC3-Series single point gas controllers and their associated toxic- and combustible-gas sensors.

- Motion detectors and occupancy sensors can be utilized to turn ventilation on when an occupant is detected in the space, saving significant energy over scheduling by turning off ventilation during periods of garage inactivity. However, the correlation between occupancy and emissions isn't always consistent, since an electric vehicle or pedestrian would activate the ventilation system without any emissions.

The best strategy for maximizing energy efficiency and air quality is to implement demand controlled ventilation (DCV) in conjunction with VFD driven fans.

Recommended Best Practices:

1. Commissioning, re-commissioning, or continuous commissioning activities should be performed every twelve (12) months. Sensors have a limited operating lifetime and this process will verify that all sensors are operational and invoking the ventilation system only when it is needed. This will also ensure that all ventilation systems, including fans and filters, are cleaned, calibrated and operating as designed.

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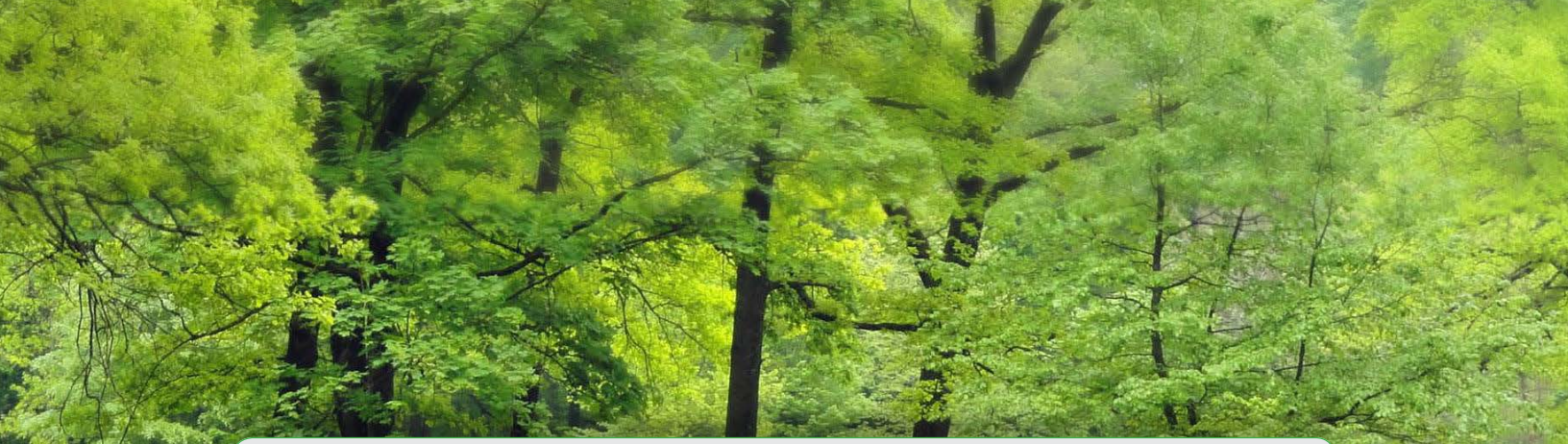

2. Any new design or retrofit to an existing garage ventilation system must be based on the codes and standards of the appropriate local jurisdiction. For example, in California Title 24-2013 Sec. 120.6(c), the regulations require a minimum ventilation rate of 0.15 CFM/sq-ft (cubic feet per minute per square foot of surface area in the garage) in enclosed parking garages where the total design exhaust rate is greater than or equal to 10,000 CFM and no more than 20% of the vehicle expected to be stored have non-gasoline combustion engines. Note that the code requirement of constant ventilation flow rates cannot be achievable with on-and-off control unless there are multiple independently controlled fans in a zone. California regulations of this type are often adopted nationally.

3. For best performance and reliability, sensors should be rated with at least +/- 5% accuracy, drift not to exceed 5% per year, and calibration to be required no more than once per year.

4. Electrochemical and infrared are far superior gas sensing technologies than solid state sensors. These sensor types provide a highly effective combination of measurement accuracy, length of operating life and minimal energy consumption.[2]

5. The rate at which these sensors age is highly dependent on the amount of CO gas exposure. To keep the demand control ventilation system operating efficiently, follow the sensor manufacturer's recommended maintenance schedule.

6. Temperature sensors should be incorporated to adjust the ventilation level and maintain a comfortable and safe level for occupants. This is particularly important in facilities in warm climates.

7. Permanent electrical metering and monitoring systems should be incorporated to provide trending gas sensor information. This will aid in the garage's ongoing use and occupancy pattern analysis and can be used to optimize control strategies while providing timely notification of sensor and motor failures.

8. The quality of sensor required depends on the type of sensors selected, spacing required between sensors, number of zones, structure layout and requirements of local building codes. Qualified ventilation engineers can determine the optimum system configuration and ensure the system is installed to meet building codes and manufacturer's specifications.

UL 2075 Performance Tested

9. Since the detection of CO has a life safety aspect, it is more important to select sensors that are robust and highly reliable. UL 2075 defines the minimum requirements for quality, reliability, and accuracy of gas and vapor detectors over a wide range of environment conditions. Green Parking Council recommends selecting sensors that have been certified to the UL 2075 (commercial grade) performance standard for gas and vapor detectors, or those that meet similarly stringent requirements.

[2] *"Codes and Standards Enhancement Initiative (case), Garage Exhaust", 2013 California Building Energy Efficiency Standards, California Utilities Statewide Codes and Standards Team, September 2011, pages 19.*

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Although code requirements for a particular garage are governed by the Authority Having Jurisdiction (AHJ), several codes and standards are emerging to drive best practices.

Summary and Analysis by INTEC Controls

International Mechanical Code: IMC2015. The International Mechanical Code is updated by the International Code Council every three years. Many regional and local codes are derived from the ICC standards. Although there is often a lag between the most current ICC code and the code that is in effect under any given Authority Having Jurisdiction (AHJ), each successive revision to the IMC is commonly accepted to be representative of best practice at the time of its release. Local codes should always be consulted before designing or modifying ventilation systems and controls.

Released in the summer of 2014, Section 404.1 of IMC2015 specifies that if the ventilation system in an enclosed parking garage does not run continuously, the automatic control of the fans shall be based on carbon monoxide and nitrogen dioxide sensors deployed in accordance with the manufacturer's recommendations. This allows for variation in application practices by each supplier (such as area of coverage and mounting height) but eliminates the option of less effective solutions in earlier IMC releases (such as the use of motion sensors).

UL 2075. As carbon monoxide monitoring has become widely required in residential and academic environments, there became a need for independent laboratory certification to ensure that substandard or ineffective sensors were not being installed. The result is UL standard 2075 which defines specific tests that must be passed and differentiates between residential-grade and commercial-grade products. The testing must be performed by Underwriter's Laboratory themselves or a certified NRTL (Nationally Recognized Testing Laboratory). Initial testing qualifies a product to be brought to market with the UL marking and periodic random sampling of production units for on-going compliance is required to maintain the certification. This high safety standard ensures that substandard products are not inadvertently specified or installed which could result in substantial liability for the specifying engineer or facility owner/operator.

It is important to distinguish between devices that merely contain a UL2075 certified sensing element and a complete carbon monoxide transmitter (sensor element and associated measurement and transmission electronics) that is UL2075 certified.

EN 50545-1. In August of 2014, the international community began requiring compliance with EN 50545-1 titled "Electrical apparatus for the detection and measurement of toxic and combustible gases in car parks and tunnels." Taking the science of toxic gas detection and the important energy saving benefits that it affords as both beneficial and field-proven, this standard addresses the importance of certifying minimum system functionality – including gas monitoring fan control - and sufficiently robust internal system architecture - including hardware and software fault detection, fault tolerance, fault recovery, and fault notification. Drawing on international standards that apply to many types of safety systems that utilize embedded software, EN 50545-1 requires compliance with Safety Integrity Level 1 (SIL1 - which ensures less than one failure per 10 years of operation) as defined by EN 61508-3.

Although not yet required in the North American market, this international standard further ensures that substandard products are not used in what the international community now considers a life-safety application.

Maximizing energy efficiency with uncompromised human safety requires periodic system maintenance.

Summary and Analysis by INTEC Controls

California Title 24 – "Building Efficiency Standard". Section 120.6(c) of the 2013 Edition of the California Title 24 Building Efficiency Standard specifies "Mandatory Requirements for Enclosed Parking Garages" and applies to garages that are approximately 13,000 square feet or larger. Those requirements include implementation of variable speed fans with defined continuous minimum air flow and demand response air flow rates, specific conditions that constitute system faults which must force air flow to their maximum, conditions that require fault notifications, and the maximum coverage area for each gas sensor.

While supporting the objective of reducing ventilation-related energy consumption, this Standard ensures that neither system failure nor lack of periodic maintenance will result in hazardous conditions for garage employees or guests.

Maximum certification points are earned by deploying reliable carbon monoxide and nitrogen dioxide sensors in a variable air flow system and by maintaining the system according to the manufacturer's recommendations in order to ensure effective and efficient operation over time.

System Lifecycle Considerations. The measurement of concentration levels of toxic and combustible gases in commercial and industrial environments is field-proven technology. Periodically, engineering breakthroughs yield step-change improvements in performance, cost and/or size. Currently, the widely accepted "best practice" gas sensing technology for garage applications is electrochemical sensing elements. These devices contain a special gel that reacts with molecules of the target gas such as carbon monoxide or nitrogen dioxide. Each reaction slightly depletes the sensor's sensitivity. Consequently, periodic maintenance must be performed at which time test gas with a known concentration (e.g. 200 parts per million) is presented to the sensor and the sensor's output is adjusted to meet the original device specifications. The rate at which the gel is depleted and therefore the rate at which the transmitter becomes less accurate, is dependent on how much gas the sensor is exposed to. Most electrochemical transmitter manufacturer's recommend calibration every 12 to 18 months.

Older generation gas transmitters utilize solid state or semiconductor sensor elements. This technology presented three primary shortcomings that were overcome with electrochemical elements.: 1) they have higher "cross gas sensitivity" meaning that their measurements are significantly affected by the presence of other non-toxic gases in the atmosphere, 2) their readings are affected by changes in temperature and humidity and 3) the measurement process requires heating the elements which dramatically increases the energy consumption of the detection system.

When performing the sensor calibration, it is highly recommended that each ventilation zone be checked to ensure that the test gas on a particular sensor causes proper ramp-up and ramp-down of the fan speed.

Specific documentation is required including equipment lists, manufacturer's specifications and maintenance recommendations, and proof of recent inspection and calibration.

Refer to the Green Parking Council website to obtain a copy of the complete Green Garage Certification Standard www.greenparkingcouncil.org.