Car Park Ventilation System

Based on

Monitoring of

Carbon Monoxide(CO)/

Temperature/

Carbon Dioxide(CO2)

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A. FAQ

1. Why CO monitoring and control system?

Mainly for energy conservation and/or energy saving.

Potential energy saving depends on the car park usage, control strategy, control setting and types of vehicles/engines (majority) entering/ leaving the car park.

2. What is the coverage of the sensor?

There are several guidelines for determining the coverage of sensors.

2.1 Guidelines within continental Europe recommend one detector for 400m2 or 20m x 20m grid.

2.2 Members of Cal OSHA requires one sensor per 5,000 square feet of garage area.

2.3 Australian Standard 1668.2-1991 has a formula to calculate the sensors in the carpark as below item 3.

Considerations:

a. Maximum distance of any corner in the car park to the nearest sensor shall be less than 25m.
b. First 12m from fresh air opening are considered as natural ventilation (NV) zone.
c. Sensors are grouped according to the zones by the exhaust fans.

3. How to determine number of sensing points required?

The number of sensing points is calculated using the guidelines of AS1668.2 with the considerations given above.

N = A /1000 x SQRT (L/W)

$$N = A / 1000 \times \sqrt{L/W}$$

Where N : no. of sensing points
A : Area of car park in sq meters
L : Length of car park in meters
W : Width of car park in meters
SQRT : square root

4. Where to place the sensor?

Sensor shall be installed at 0.9m ~ 1.8m above floor level (AS1668.2). However, for practical reason (in order to avoid vandalism), the sensors can be installed just above 1.8m.

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5. What type of mounting : duct mounted or wall mounted?

	Advantage	Disadvantage
In Duct Measurement	• More economical as less sensors required • Straight forward control as one sensor controls one or two fans serving the same area	• May not provide adequate control if exhaust/ supply fans serve a large area • Measurement is an average reading that does not take care of the worst case situation • Requires minimum air flow in the duct for the measurement
Space Measurement	• More representative of space condition thus more accurate control can be achieved. • Provision for complete switch-off of the fans (if allowed) when CO concentration is very low.	• Higher cost up-front since more sensors required • More complicated in controls as the number of sensing points increases.

6. Product country of origin?

CO/CO2 combinational sensors – Singapore/Sweden
CO sensor/controller – Singapore

7. What are the minimum requirements of a typical CO sensor?

Sensor shall have:

a. Minimum measuring range : 0 ~ 50 ppm or 0 ~ 100 ppm
b. Accuracy : +/- 10% or less

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8. What are the different types of control strategy?

A. **ON/OFF control**

The pairs of exhaust & supply fans can be controlled with the following control set-points:

1st stage : Fans switched ON when CO is above 9ppm (CP13-1999, residential)
Fans switched OFF again when CO drops below 6ppm

2nd stage: Fans switched ON when CO is above 25ppm (CP13-1999, residential)
Fans switched OFF again when CO drops below 20ppm

If only single stage fans available, the fans shall be controlled at 25ppm.

In cases where more than one sensor is used to control a fan, the worst case of the sensors' reading shall be used for control purpose.

B. Variable Frequency Drive (VFD)/ Variable Speed Drive (VSD) Control

a. Control ventilation at minimum ventilation rate, say 20Hz, when CO measurement is below 20ppm.
b. Ventilation rate shall increase proportionally when CO level increase beyond 20ppm and reach the maximum when CO level is above 50ppm.
c. Periodic higher ventilation shall be built-in to the VFD system from the BMS.

Provisions :

a. Timer override - The car park ventilation may include timer over ride for periodic peak car park usage, for instance, morning and evening rush hours.
b. Manual override - The car park should also include manual override.
c. Temperature override – in case of high temperature, the ventilation may be activated so as to create "wind" effect and improve the comfort.

Note : Control of 1st or 2nd stage fans are only applicable in Normal Mode (NM) operation.

9. What is the payback period?

Payback period varies from 9 to 24 months. Typical payback period is around 12 months.

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10. **How to calculate energy saving?**

Energy saving and simple payback:

Item	Unit	Quantity
Total Fan Wattage	KW	A
Operating hours (daily)	Hour	B
Nominal energy usage per day	KWH	A x B
Monthly energy usage	KWH	30 AB
Energy rate	$	0.2568 (low tension rate)
Monthly energy usage in $ & cents	$	0.2568 x 30 x A x B
Potential energy saving	%	
Monthly saving from CO system	$	
Capital Investment for CO system	$	
Simple payback	Year	

11. What is the warranty period?

One year limited warranty against faulty parts & manufacturing defects.

12. **How many models of CO sensor does Telasia Symtonic have?**

2 models :

DCO-S3	sensor/controller for stand-alone application
CO-T1	sensor/transmitter; to work with other controllers

13. Other Considerations

In addition to CO controlled system, temperature and timer control should also be considered in controlling the car park environment.

14. What type of connection cable is suitable?

For analog signal (connection to AN1 & AN2), use a shielded twisted pair controlled cable.
For voltage-free relay contacts (connection to 1CM,1NO or 2CM, 2NO), use 1mm wires
Typically, to control 1 fan, 4 wires are used, and to control 2 fans, 6 wires are used.

15. What is the power consumption?

Less than 3 watts.
This is a 24V device so need to have step down transformer or DC power source (CO-T1)

Special Notes:

1. In case of fire, the Fire Mode (FM) ventilation shall override CO system.
2. In premises where diesel engines out number petrol engines, CO_2 sensors can be considered in place of CO sensors.

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B. Testing & Commissioning Procedures and Operating & Maintenance for Carbon Monoxide (CO) Monitoring & Ventilation Control System

Introduction

The testing & commissioning (T&C) of carbon monoxide monitoring and ventilation control system can be separated into two parts, namely:

1. Sensor/detector verification

The sensor/detector verification is to ensure that the CO measurement or monitoring is within reasonable tolerance range and accuracy. This would allow the control system to perform ventilation based on the CO level in the enclosed car park.

2. System functional tests

The system functional test checks the system functional procedures based on the reading from the CO sensor/detector(s), that is, if the ventilation comes ON at pre-determined CO level.

Sensor/Detector verification

The sensor verification can be done by injecting known gas concentration into the (CO) sensor and to verify the reading accordingly [note 1]. Typically a gas concentration (near 100ppm CO gas, balance in air) would be required. This is to elevate the CO reading and to re-calibrate the sensor if necessary [note 3].

***Note 1:** sensor operation per manufacturer's recommendation, DCO-S3 requires minimum 24 hours of continuous operation prior to T&C.*

***Note 2:** fresh-air can be used in place of purified air, this can be re-confirmed with portable CO instruments.*

***Note 3:** Re-calibration procedure per manufacturer's recommendation.*

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System Functional Test

The system functional test will ensure that the CO ventilation control system responses according to the CO concentration in the car park. The approach is to inject CO gas into the sensor. If the sole objective is to test the ON/OFF of the ventilation system, one could choose:

1. CO coming from the improper burning, such as the cigarette smoke, or
2. CO from a gas cylinder

1. By injecting cigarette smoke into the sensor, the sensor should respond with increasing CO reading. Once the CO reading is above the set-point (and the delay time), the relay should operate and the ventilation system should operate according to the design. [Please see DCO-S3 relay operation in page 5 that follows.]

2. Instead of cigarette smoke, the testing can be replaced with CO gas cylinder with known CO concentration. This may be done together with sensor verification [note 4].

Note 4: ***The control of CO concentration at the sensor head can be difficult with CO gas; since CO gas cylinder comes with single concentration. In order to ease the system tests, the gas flow should be controlled such that CO reading could rise slowly and the triggering point could be determined (consult Telasia Symtonic). After the system tests with sensor simulation, the sensor can be checked or re-calibrated with known CO concentration to ensure proper response of the sensor and system.***

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C. DCO-S3 Sensor Calibration/Re-calibration

The following equipment and gas mixtures are required for a full calibration of the DCO-S3 carbon monoxide sensor.

1. Gas bottle with single or dual stages regulators
   a. 90 ppm CO, balance in air, tolerance ±5%, certified value ± 2%
2. Gas flow meters (0 ~ 50cc per minute)
3. Tygon or PVC tubes for connections
4. Calibration cap for adaptation to the CO sensor head.

The calibration setup is shown in Figure 1.

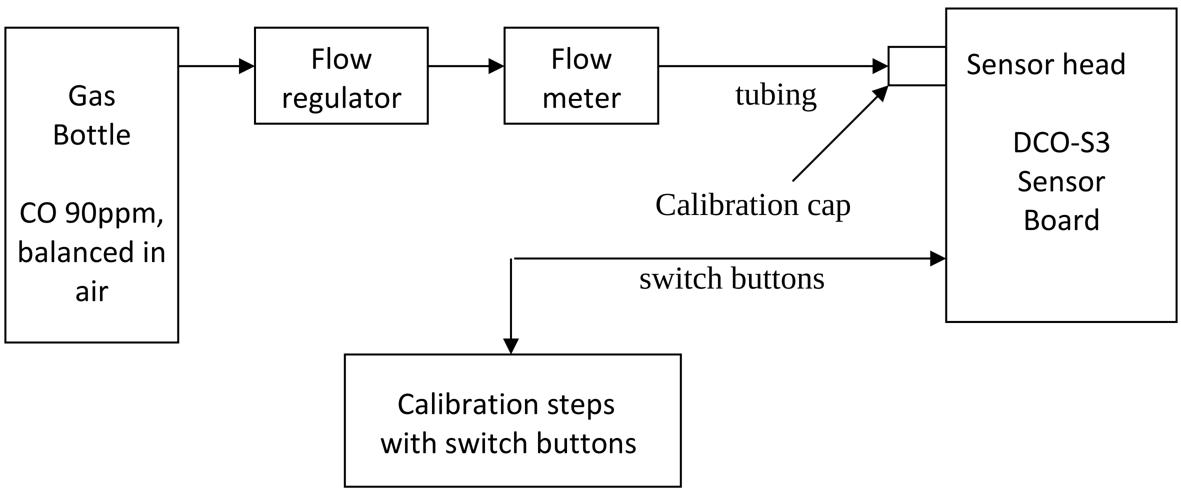

Figure 1: Calibration setup

CO calibration

1. Connect the calibration setup as shown in figure 1. Turn on the regulator of CO gas mixture (90ppm CO, balance in air) and allow the gas mixture to flow into the calibration cap. Control the outlet gauge to approximately 10psi.
2. Adjust the air flow to 50 c.c. per minute using flow meter.
3. Allow the sensor to settle for approximately 3 to 4 minutes.
4. Press "UP" switch and LC display shows "CALI", press "ENTER" to start calibration process.

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5. The next LCD shows the gas concentration used previously. Press "UP" or "DOWN" to enter the **new gas concentration used**; as written on the gas cylinder or certificate.
6. The next LCD reading shows the sensor measurement. When the reading is stabilized, press "ENTER" to complete the calibration process.
7. Turn off the regulator and remove the calibration cap from sensor head.

D. Sensor Maintenance

1. Avoid spraying water onto the CO sensor.
2. Ensure that the sensor housing to be clean, especially side vents by gently brushing the housing.
3. The sensor should be checked and verified regularly.
4. Annual re-calibration is recommended.

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E. DCO-S3 Relay Operation

- The relay status is indicated by Amber/Yellow and Red LEDs on the left hand upper corner of the circuit board (refer to instruction manual, circuit board layout).
- When the relay is triggered, the corresponding light will be lit.
  - Amber - Relay 1 (1CM & 1NO contact) is controlled by the set points in SP-1
  - Red - Relay 2 (2CM & 2NO contacts) is controlled by the set points in SP-2
- See Op-Code for details and set point changes, if required.
-

Relay 1 is triggered when

1. CO reading is higher than C1.on (default is **9ppm**) **OR**
2. Temperature reading is higher than t1.on (default is **34 deg C**)

*to **prevent erroneous triggering, an ON delay of roughly 20 seconds is built-in,***

Relay 2 is triggered when

1. CO reading is higher than C2.on (default is **25ppm**) **OR**
2. Temperature reading is higher than t2.on (default is **35 deg C**)

*to **prevent erroneous triggering, an ON delay of roughly 20 seconds is built-in,***

and to prevent frequent ON/OFF situations and to protect the fans, the relays release conditions will include the minimum ON-time. Therefore,

Relay 1 is released when

1. Minimum On-time (R1) has lapsed (On-t, default is 3 minutes) AND
2. CO reading is lower than c1.OF (default is **6ppm**) AND
3. Temperature reading is lower than t1.OF (default is **33 deg C**) AND
4. Relay 2 is OFF

Relay 2 is released when

1. Minimum On-time (R2) has lapsed (On-t, default is 3 minutes) AND
2. CO reading is lower than c2.OF (default is **20ppm**) AND
3. Temp reading is lower than t2.OF (default is **34 deg C**)

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