



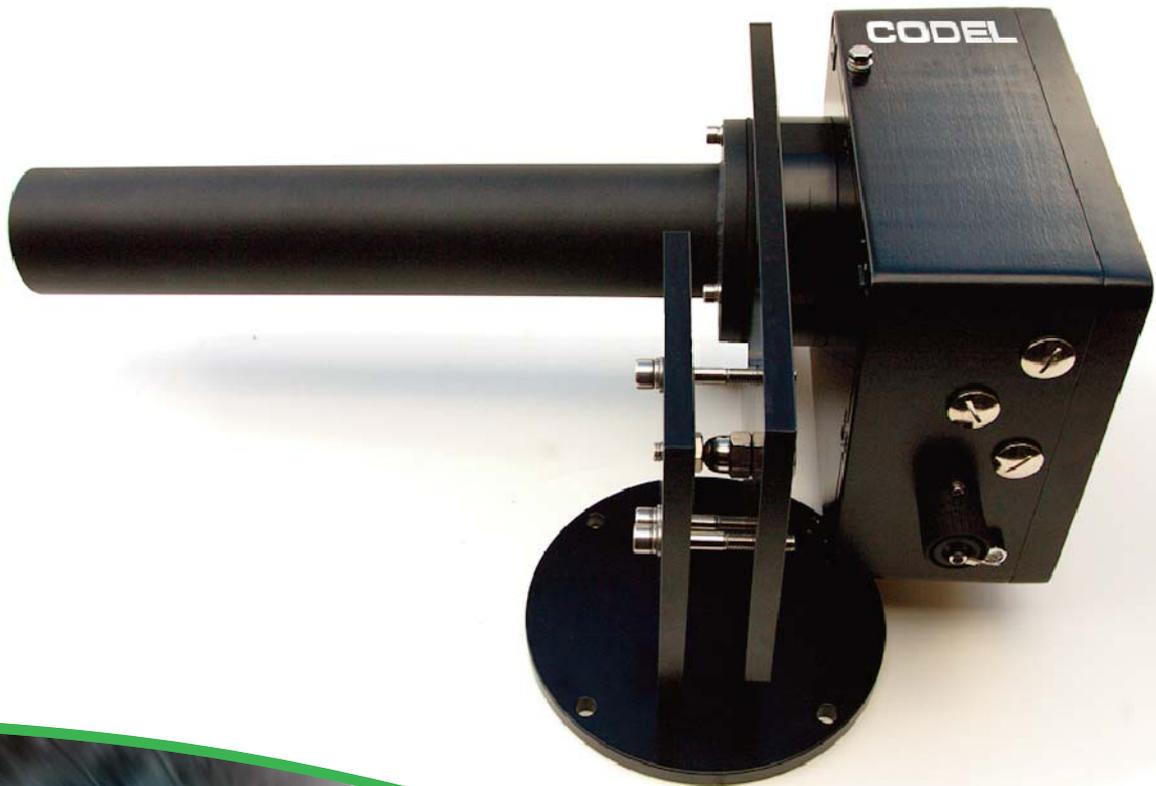
## Tunnel Atmosphere Monitoring

TunnelCraft 3 - Air Quality Monitor

CO, NO & Visibility

### Low-cost Precision Tunnel Sensors

- Multi-channel measurement technology to measure CO, NO & Visibility in one compact sensor
- Designed to withstand the harshest of tunnel environments
- High resolution measurement of visibility, precision of 1 ppm for CO & 2 ppm for NO
- Routine maintenance limited to annual cleaning of optical surfaces



## TunnelCraft 3 - Air Quality Monitor

The TunnelCraft 3 Air Quality Monitor (AQM) is CODEL's industry proven tunnel atmosphere sensor.

Three decades of development, knowledge and practical experience have been utilised to produce this advanced-technology tunnel sensor which gives complete flexibility in the choice of measurement options whilst delivering superb accuracy and reliability at a very competitive price.

The Air Quality Monitor (AQM) enables the measurements of CO, NO, and visibility to be combined into a single compact sensor, consisting of a transceiver that projects visible and infrared beams to a reflector mounted 3m away. The reflected light is received by the transceiver and the specific absorption is measured to determine the visibility coefficient, carbon monoxide and nitric oxide concentrations within the path of the beams.

Using only one moving component within the sensor and a fully automated zero calibration function, the AQM is designed to be maintenance free limiting service visits to annual cleaning of optical surfaces.

Fully configurable analogue and alarm outputs are generated direct inside the sensor alleviating the requirement for expensive processing monitoring stations. In addition there is a choice of either RS232 or RS485 outputs which can be utilised to deliver MODBUS protocol to a SCADA system located in the tunnel control centre.

The AQM is available with a choice of a visibility only measurement; dual CO & visibility; and combined CO, NO & visibility measurements to suit varying tunnel specifications.

Over the last 15 years CODEL tunnel sensors have been supplied to more than 400 road and rail tunnels throughout the world. Our impressive reference list includes Eurotunnel France, Mont Blanc Tunnel France, Dartford Tunnel UK, Lane Cove Tunnel Australia, Snow Mountain Tunnel Taiwan and the SMART Tunnel in Malaysia, plus many others throughout China, Italy, Switzerland and South Korea placing CODEL as a world leader in tunnel atmosphere monitoring.

CODEL's tunnel sensor range is further extended by additional sensors for the measurement of NO<sub>2</sub> and tunnel airflow.

Please see additional product data sheets:-

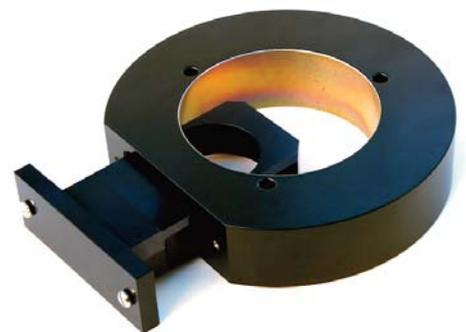
- TunnelCraft 3 Air Flow Monitor  
For the measurement of wind speed and direction
- TunnelCraft 3 NO<sub>2</sub> Monitor  
For the measurement of nitrogen dioxide



TunnelCraft 3 Sensor Unit



TunnelCraft 3 Reflector

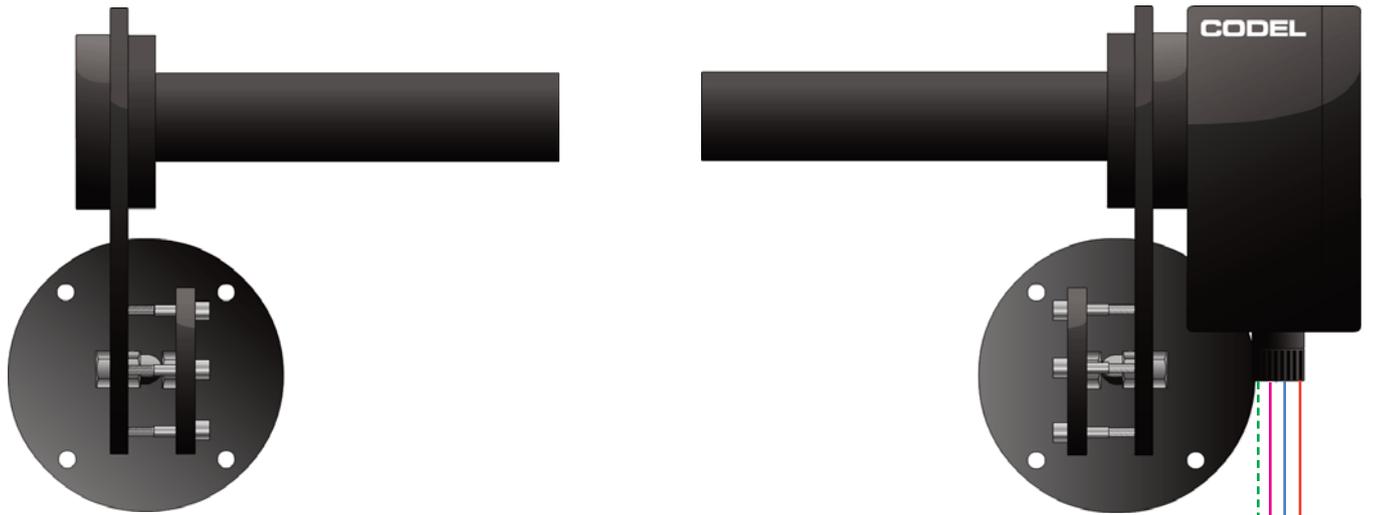


Check Cell & Holder (Optional)



12V Power Supply Unit (PSU)

# TunnelCraft 3 - Air Quality Monitor - System Arrangement



mA Outputs

Relay Outputs



Mains power in

12V Power Supply (PSU) (Optional)

## Temporary commissioning equipment



RS232/485 Communications Unit\*



CODEL TunnelCraft 3 Software\*

\*RS232/485 Communications Unit and TunnelCraft 3 Software are required for commissioning and maintenance use.

## TunnelCraft Software

- Easy installation and set-up
- Will operate on any Windows based operating system
- User friendly Alignment Mode to aid initial set-up and optical alignment
- Allows sensor's configuration settings to be adjusted
- Fault diagnostic logging for sensor troubleshooting

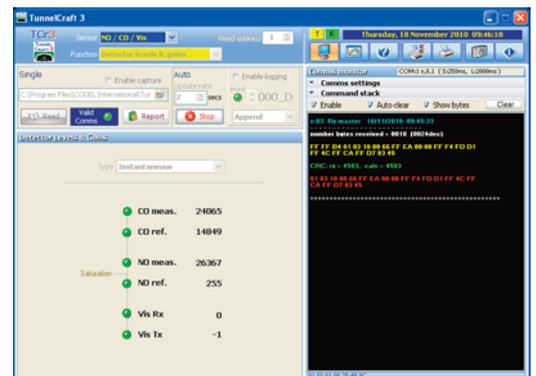
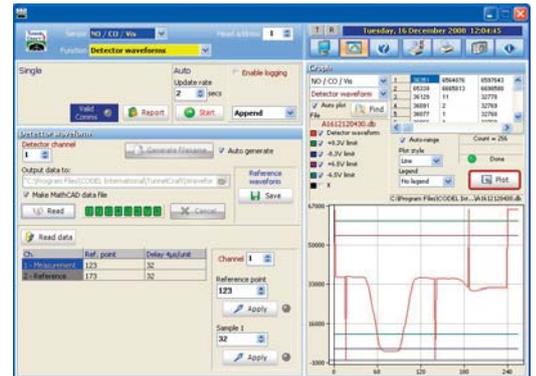
TunnelCraft 3 Software is supplied with all CODEL Tunnel Sensor's as standard for the purpose of commissioning and maintenance of the sensors. With simple installation and set-up routine to any Windows based laptop PC, the program takes only minutes to load and configure and comes with a comprehensive on-board help feature.

The software enables the sensor's complete data and control functions to be accessed via a PC using either an RS232 or optional RS485 communications box, also supplied with the sensor.

A built-in alignment feature aids the initial set-up and commissioning routine by giving a display of the detector signals to the engineer to ensure that optical alignment is maximised and the sensor operates to its optimal performance

Zero calibrations and span checking (using a CODEL sealed Check Cell or Flow Through Check Cell) can be initiated via the software after commissioning or a maintenance period. Should it be necessary to alter the initial factory-set current and relay output configuration then this can also be carried out with ease.

For maintenance the software includes short-term logging and trending of diagnostic data for fault analysis.



## Communication Interfaces



RS232 Unit



RS485 Unit

# A comparison of CODEL Sensors and alternative manufacturer's

## Key Design Parameters

Open path optical absorption technology used by CODEL has proved to be very accurate and reliable. For maximum performance however certain key design parameters need to be optimised.

### Path length

There is often a misconception that measurements over a longer path length will produce a more accurate reading because more gas is being measured. If the optical beam was highly focused, like a laser beam, for example, then this would be the case. However such a beam would be extremely sensitive to alignment resulting in a very unreliable measurement.

As a result, open path measurement systems use an optical arrangement in which a broader beam of energy is used to desensitise the impact of optical misalignment. The result of this is that the energy received by the sensing element reduces with the square of the path length, thereby reducing the signal/noise ratio of the measurement as path length is increased.

We thus have two conflicting elements that determine the overall accuracy of an open path measurement system. Basic measurement sensitivity increases with path length, while signal/noise ratio reduces with the square of the path length. Increasing the path length to achieve higher sensitivity will simply result in a noisier signal, with the noise increasing faster than the measurement sensitivity.

The compromise solution to this dilemma is to select the shortest path length consistent with achieving the required measurement sensitivity. Increasing the path length beyond this point brings no added value, only a noisier signal, and increased difficulties with alignment stability.

CODEL measure CO, NO and visibility over a path length of 3 metres using a folded beam arrangement, giving a total path length of 6 metres. This enables the accuracy requirements for all three channels to be comfortably satisfied. Sensors from other manufacturers require longer path lengths (typically 10metres) to achieve their specified accuracy. We view that as a disadvantage due to increased measurement noise and optical alignment sensitivity.

A further disadvantage of a long optical path length is that when measuring gases, the sensitivity of measurement decreases with the amount of gas measured, because of saturation effects of the gas infra-red spectrum. It is thus not possible to maintain accuracy over a wide measurement range when using a long path length. For example at a 10 metre path length (20 metre folded beam) the measurement uncertainty over the range 150 to 300ppm CO will be more than twice that over the range 0 to 150ppm. The CODEL sensor can maintain its accuracy over the full operating range of 0 to 300ppm.

### Choice of infrared detector

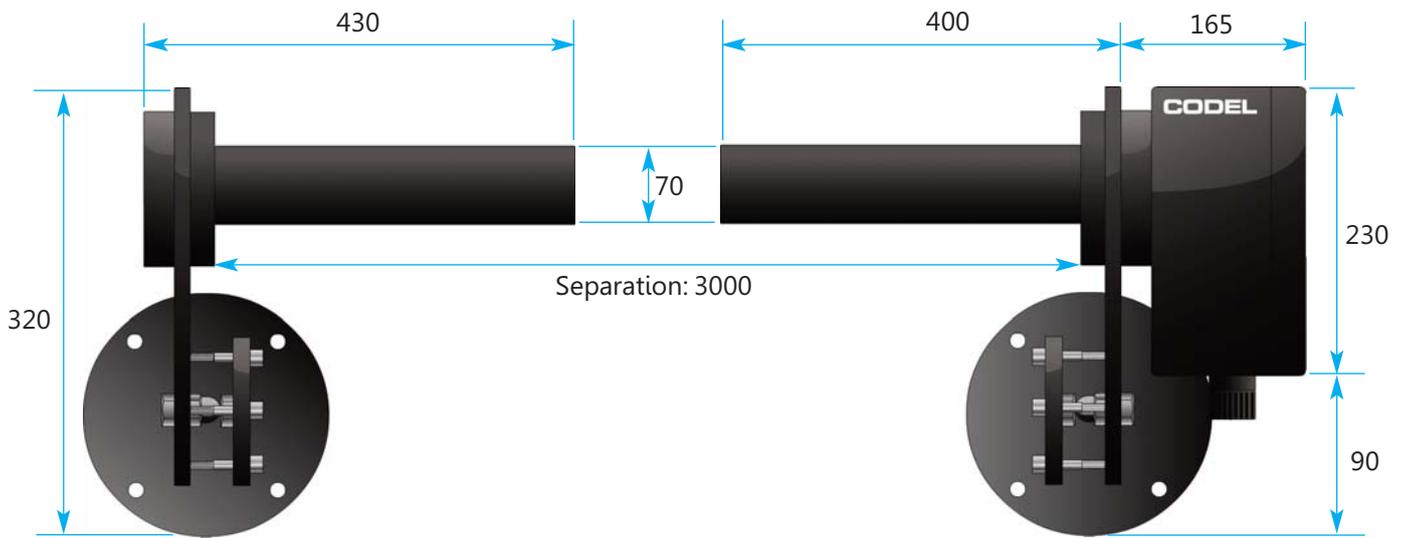
To avoid the problems of operating a long pathlength in order to achieve the required sensitivity CODEL utilise a very high quality thermo-electrically cooled lead selenide detector. This enables an accuracy for CO measurement of 1ppm to be maintained over a 3 metre folded beam path for the range 0-300ppm. Contrast this with other manufacturers sensors, utilising less sophisticated and cheaper pyroelectric detectors, having an accuracy specification of only 5ppm over a 10 metre path for the range 0-150ppm and 12ppm for the range 150-300ppm.

Intelligent design and value engineering of the total system achieve the cost effectiveness of the CODEL solution. No compromises on component quality are tolerated.

### Measurement of NO

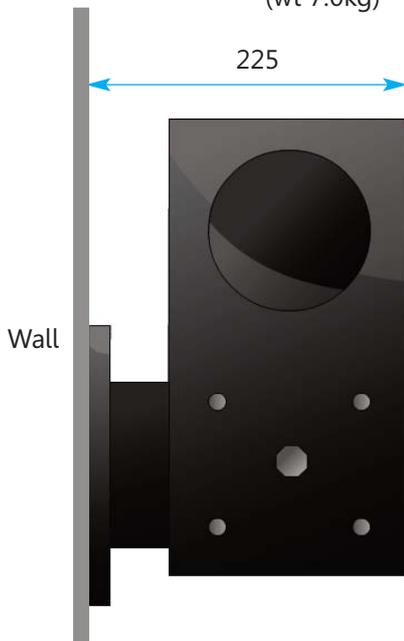
Use of the lead selenide detector also enables CODEL to integrate a measurement channel for NO into the tunnel sensor, a result not possible with pyroelectric detectors. The CODEL sensors are unique in their ability to provide three key measurements, CO, NO and visibility in one compact sensor.

## Overall Dimensions - TunnelCraft 3



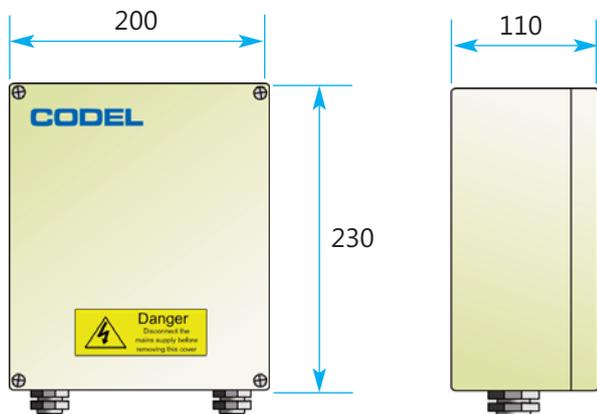
**TunnelCraft III Mirror  
Assembly**  
(wt 7.0kg)

**TunnelCraft III Sensor  
Head**  
(wt 8.5kg)

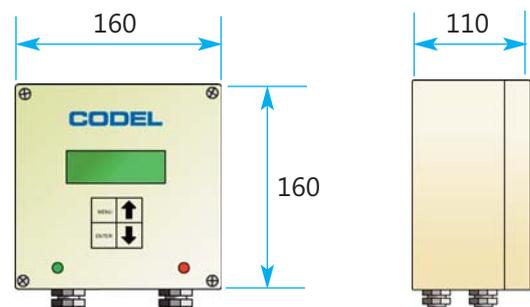


Note: All dimensions are in mm

## Overall Dimensions - Power Supply Unit & Tunnel Display Unit (Optional)



**Power Supply Unit  
(PSU) (wt 4kg)**



**Tunnel Display Unit  
(TDU) (wt 2kg)**

Note: All dimensions are in mm

# TunnelCraft 3 Air Quality Monitor - Technical Specification

## Sensor Unit

Gas Species Options	Single or multi-gas measurements available: CO, NO & Visibility		
Measuring units	ppm for CO & NO, m <sup>-1</sup> or m for visibility		
Path Length	3 meter (6m folded beam)		
Calibration	Automatic zero calibration - manual span check by sealed check cell		
Measurement	Carbon Monoxide (CO)	Nitric Oxide (NO)	Visibility
Measurement Technique	Infrared Gas Cell Correlation	Infrared Gas Cell Correlation	Transmittivity using LED
Measurement range (typical*)	CO 0 - 300ppm	NO 0 - 30ppm	0 - 0.015 m <sup>-1</sup>
Accuracy	CO +/- 1ppm	NO +/- 2ppm	Vis +/- 0.0002 m <sup>-1</sup>
Resolution	CO +/- 1ppm	NO +/- 1ppm	Vis +/- 0.0001 m <sup>-1</sup>
Ambient Temperature	-20°C to +50°C		
Power supply	12V DC, 20 VA from separate power supply		
Construction	Corrosion resistant epoxy coated aluminium housing sealed to IP67		

\*Other measurement ranges available on request

## Compliances

EMC	EN61326-1:2006 & EN50270:2006 directive compliant
Low Voltage	73/23/EEC directive compliant

## Communications & Outputs

Analogue outputs	3 x 4-20mA current outputs as standard, isolated, 500Ω load max, fully configurable through TunnelCraft software.
Relay Outputs	3 x volt-free SPCO contacts, 50V, 1A max, configurable as alarm contacts
Communications Port	For local connection to laptop PC using RS232 or optional RS485 interface unit

## Services

Power	12V DC @1.5A
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## Optional Items

Power Supply	110/220VAC, 50Hz +/- 10%, 60w at 12V
Check Cell Holder	For manual span check using sealed check cell
Sealed Check Cell	CO & Visibility span check optical cell
Flow Through Check Cell	NO span check using bottled audit gases
Tunnel Display Unit	For local display of sensors outputs
Serial Data	RS485 Modbus Protocol

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## Distributor