ECM ECO Monitoring
Process and environmental monitoring systems

OPUS RSE

Opus Remote Sensing technology

1 DESCRIPTION

Opus AccuScan™ RSDs remotely measure exhaust emissions from motor vehicles as they are driven past the remote sensing device on streets and highways. The emissions are measured spectroscopically by casting a narrow infrared (IR) and ultraviolet (UV) beam of light across the road and through the trailing exhaust of passing motor vehicles. A mirror then reflects the IR/UV light back to a series of detectors that measure the amount of transmitted light at characteristic wavelengths absorbed by the pollutants of interest.

By subtracting any pre-vehicle background absorption from the amount of IR/UV light absorbed by the various tailpipe pollutants, the system can determine the pollutant levels in the vehicle's exhaust. As the emissions are measured, the video camera captures a digital image of the license plate and the speed/acceleration sensors record the speed and acceleration of the vehicle. The emissions, weather conditions, slope, speed and acceleration data as well as the license plate image are merged within less than a second to complete a measurement record which is then stored in a computer database for future analysis and reporting.

The RSD can measure the emissions of vehicles circulating under real driving conditions. Since it takes only a second to capture a measurement, these devices can capture large quantities of vehicle emissions data in a short period of time. Also, since it is a non-intrusive technique, the RSD audits the circulating vehicles without interfering with the traffic flow, therefore it can audit an entire fleet in a short period and with no impact on daily operations.

AccuScan™ RSDs have measured **hundreds of millions of vehicles worldwide**, far more than any other technology.

2 COMPONENTS

RSDs are comprised of three main systems, all of which can be placed safely off the traveled roadway:

1. Emissions Analyzers.
2. License Plate Cameras.
3. Speed and Acceleration Measurement Systems.

Together the three gather the minimum required information to evaluate the emissions health of a vehicle.

A typical mobile installation of the various RSD components is shown below (Figure 2-1).

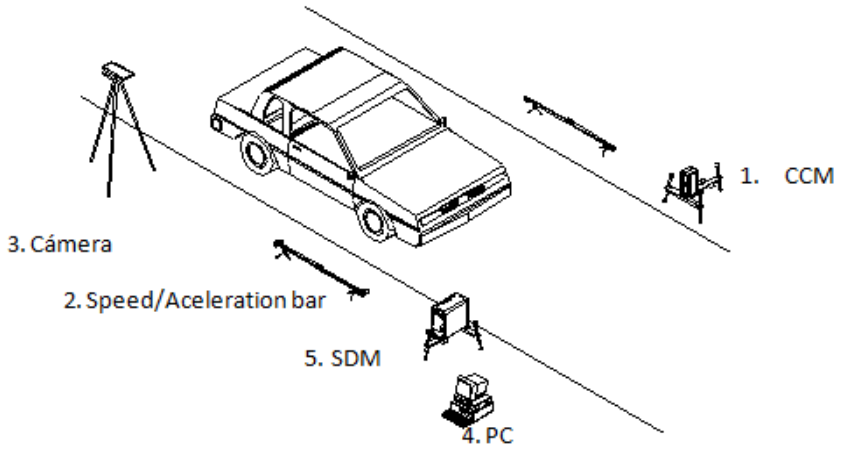

Figure 2-1 Basic scheme of Opus RSD components

The main components of Opus RSD5000 system are described below:

Gas Analyzer / Source Detector Module (SDM)

The RSD has an enclosed Source Detector Module. Using Sapphire windows, the SDM is sealed against the environment to better protect the optics and electronics inside. These windows are impervious to scratching and are easily cleaned. Along with an enclosed SDM, the RSD can have an automated gas calibration cell that eliminates the need for using gas calibration bottles and will calibrate during normal traffic movement.

The Corner Cube Mirror (CCM)

The Corner Cube Mirror (CCM) is a simple reflector of the Source light beams. It returns the beams back to the Detector side of the SDM. The CCM consists of three stationary mirrors positioned at a 90° angle with respect to one another, like the corner of a room (**Chyba! Nenašiel sa žiaden zdroj odkazov.**).

Speed/Acceleration System (Detector/Emitter Bars)

This system provides valuable information to the operator about the driving conditions of the vehicles at the time of the measurement. Poor test sites can be immediately identified by test results showing too many cars undergoing hard accelerations or decelerations. The Emitter and Detector Bars of the S/A system along with other parts of the RSD work in tandem to help the operator determine if a test site is favorable to capturing accurate emission readings.

Video Camera for License Plate Capture

This high-speed and high-resolution video camera captures a digitized picture of the rear of the vehicle. It does this at the same instant the speed/acceleration values of a vehicle are calculated as the car passes through the exit beam of the S/A detector bar. Camera is software-controlled from the console. The software allows for control of pan, tilt and zoom, and light control offset that automatically compensates for the lighting conditions throughout the day.

System Control Unit

The System Control Unit (SCU) utilizes Windows based XP, an Intel P4-3.0GHz or greater processor, a built-in 802.11g WiFi communication to the remote GUI Laptop and a built-in GPS module. The SCU gathers and integrates the emission readings, speed and acceleration values and video picture of the license plate. It also archives all information including the digitized vehicle license plate picture for future reference. The SCU also mediates electronic connections between the computer, monitor, CPU and other modules. The SCU provides the connection for all the peripherals to the computer and serves as a central power supply for the system.

Weather Station

The Weather Station monitors external temperature and barometric pressure. The station includes an external temperature sensor. The console includes a power adapter with battery backup, backlit display for easy viewing, and a serial interface to a computer.

3 ON-ROAD SETUP AND OPERATION

For convenience and fast semi-unattended deployment, OPUS has packaged all the components into **two rapidly-deployed green boxes** (see Figure 3-1) and one disguised orange traffic barrel:

Component	Length	Width	Height
SDM/CCM Green Box	0.92 meters	0.61 meters	0.46 meters
CCM Green Box	0.61 meters	0.31 meters	0.31 meters

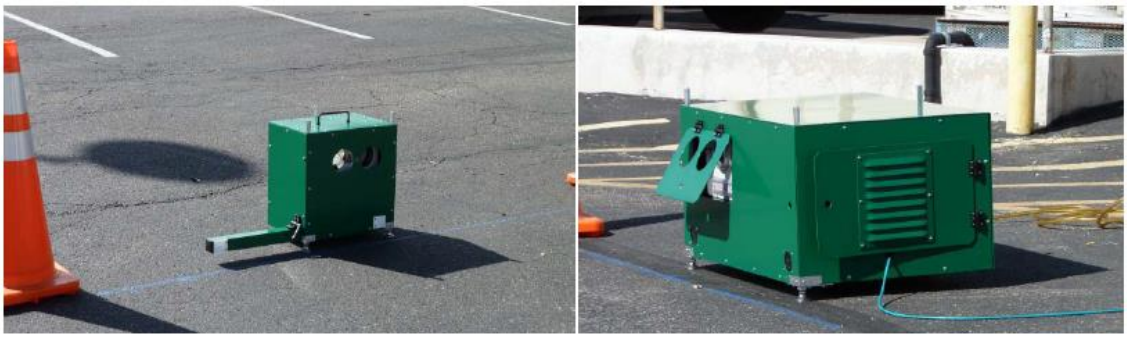

Figure 3-1 Unattended Deployment

A typical on-road deployment is show in Figure 3-2.

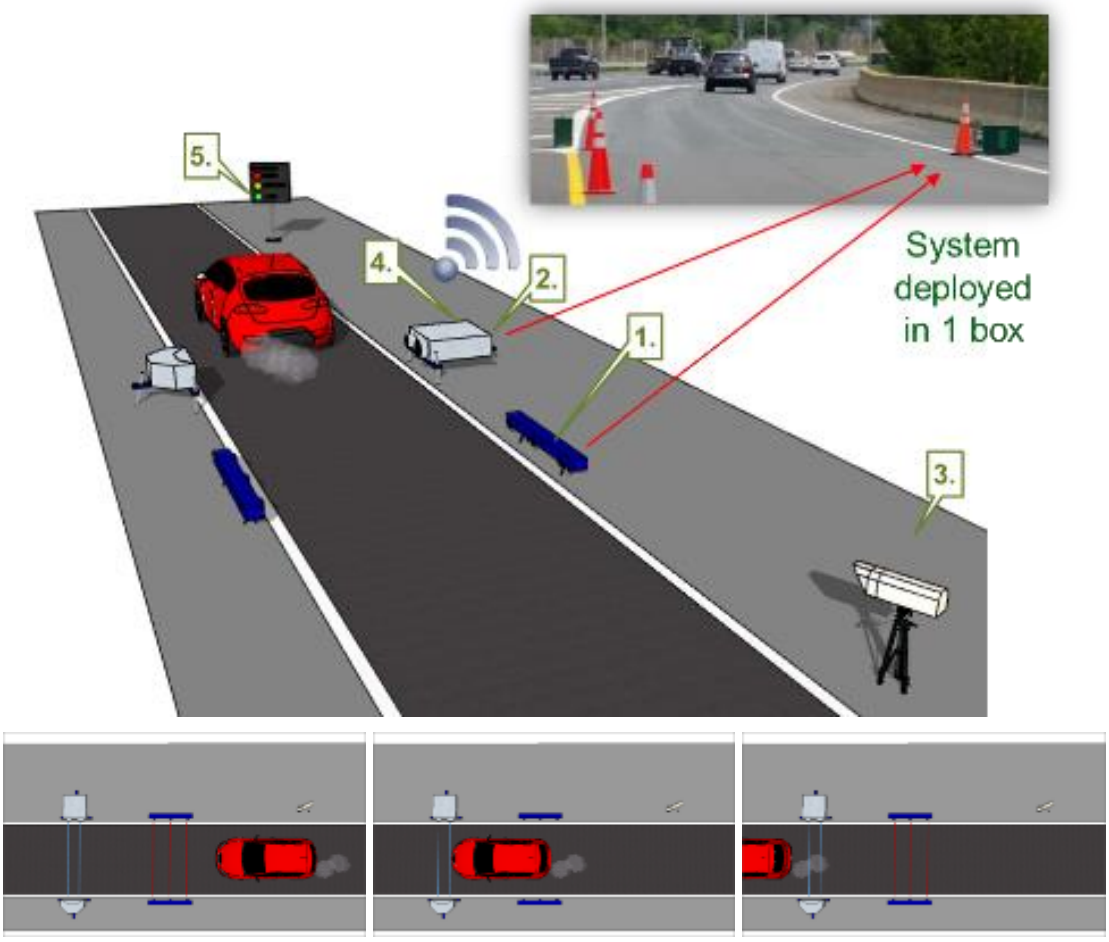

Figure 3-2 Scheme of a measurement with Opus RSD

The overall process of a measurement, referred to the numbers of Figure 3-2 is shown below:

1. The Speed and Acceleration bar records the vehicle´s speed and acceleration.
2. The SDM/CCM module measures all exhaust pollutants.
3. The digital camera takes a picture of the license plate.
4. Data are instantaneously sent to a processor unit. Emissions concentration values and other related data are stored in the computer and can also be monitored remotely by an operator stationed in a mobile unit parked safely along the roadside (see Figure 3-3).
5. It is also possible to set-up an informative LED panel to alert the driver about his/her emissions (Good, Poor, Bad).

After all that, the system is ready to analyze the next vehicle.

Overall process takes less than one second.

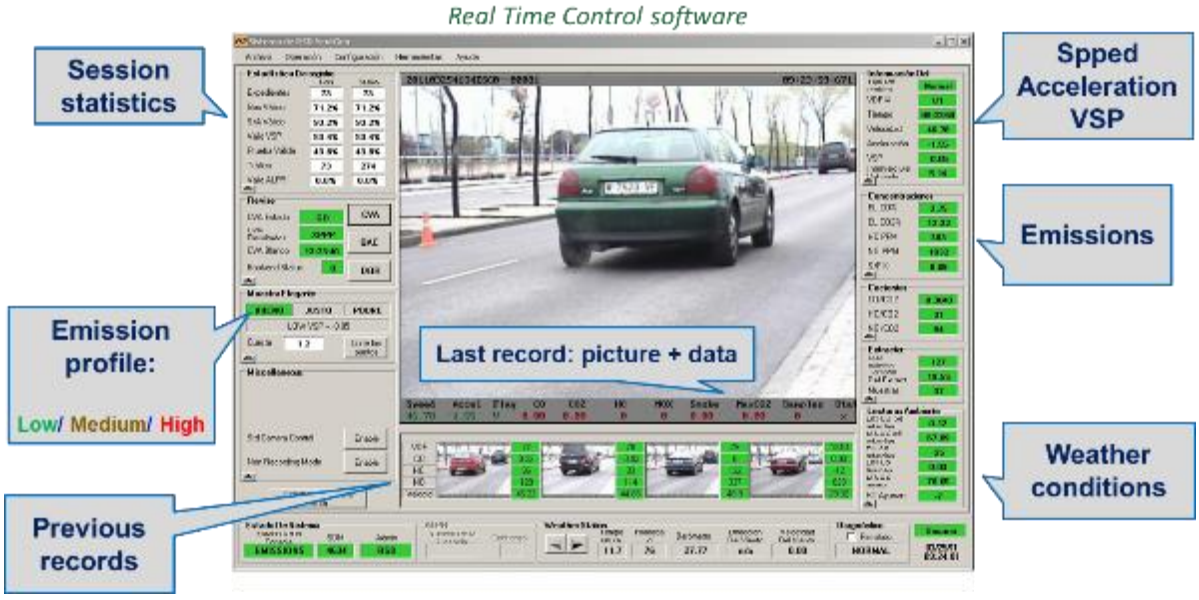

Figure 3-3 Sample of a vehicle measurement screen plot in Opus real-time monitoring software

4 FUNCTIONALITY AND PERFORMANCE

OPUS establishes the accuracy and precision of each AccuScan™ RSD unit deployed in its programs prior to its deployment. This is accomplished through a comprehensive set of pre-deployment, real-time, and post-data collection protocols which are briefly described below.

- Factory Certification: Each RSD unit is first factory certified for accuracy and precisions using several known dry-gas mixtures in accordance with the COVERS requirements.
- Client Certification: Some clients, such as the CDPHE, conduct their own acceptance test procedure (ATP) before units are deployed for use in programs.
- Field Calibration and Audit: Each unit is then calibrated, and the calibration verified prior to each data collection session.

- Periodic Audits: Each unit is then audited regularly during the course of each session to verify the system is performing within specifications and does not need re-alignment and/or re-calibration.
- Real-time Measurement Validation: As data is collected, sophisticated Accuscan™ exhaust plume validation software (developed and improved over two decades) reviews each measurement in real-time to ensure it is of adequate strength, that the exhaust plume decayed in a manner consistent with warm loaded-mode vehicle operations, and that the prevailing background levels are stable and can be accurately determined. Valid measurements that have passed the real-time filters are marked accordingly.
- Post-Collection Filters: Each session's dataset is reviewed post-collection to normalize calibration variances, eliminate cold starts, and apply VSP filters. These and other post-collection reviews have been developed over our decades of conducting studies, pilots and programs.

The Factory and Client Certifications focus on ensuring the unit is measuring within accuracy and precisions tolerances. The Field Calibration and Audits focus on ensuring the unit is optimally calibrated and effectively subtracting background levels. The **Real-Time Validation software** filters out any measurements that cannot be used with a high degree of confidence in monitoring or screening applications. The Post-Collection Filters further remove those measurements that might have been captured during operating conditions when the vehicle (by design) is unable to effectively control its emissions. Following these sequential stages of quality assessment, review, and control only the most accurate and representative measurements of the vehicle's on-road emissions are used in analysis.

Moreover, Opus RSE is worldwide the only **ISO-17025 accredited laboratory** for the unobtrusive remote measurement of real traffic emissions. This certificate is audited annually and proves that our company fulfills the requirements for testing and calibration as a laboratory. Therefore, our Remote Sensing activities are within the standards of a portable laboratory, ensuring the quality and precision of our processes and results.

Accuracy and precision of RSDs have historically been assessed using dry mixtures of exhaust gas pollutants in a controlled setting (i.e. remote parking lot or untraveled section of roadway). These known mixtures of CO, Propane for HC, NO, and CO2 in an N2 balance) are released repeatedly behind an electric vehicle or introduced directly in the optical measurement path. AccuScan™ RSDs have been evaluated in this manner since the mid-1990s when first industry performance specifications were introduced.

Apart from those certificates, our RSDs have also been audited by other entities:

- CIEMAT (Center for Energy, Environmental and Technological Research of Spain), Year 2015.
- IVL (Swedish Environmental Research Institute), Year 2016.
- JRC (European Commission's Joint Research Centre), Year 2017.
- ICCT (International Council on Clean Transportation), Year 2018.

With detailed information on solutions of your interest we are gladly available on our contact:

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