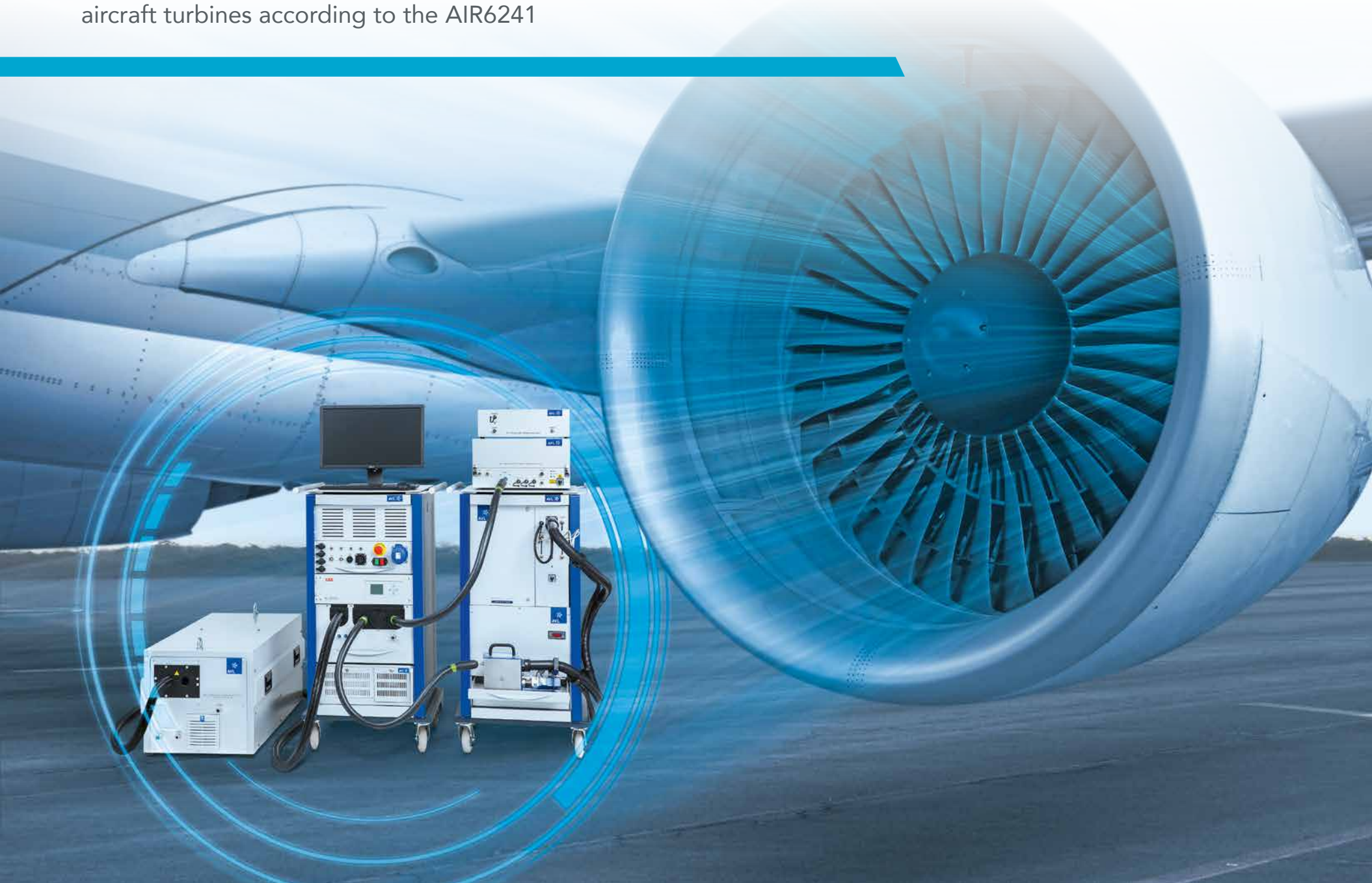
AVL Particle Measurement System Aviation

Measurement of non-volatile Particulate Matter mass and number emissions from aircraft turbines according to the AIR6241



MARKET REQUIREMENTS

Non-volatile particulate matter standard AIR6241

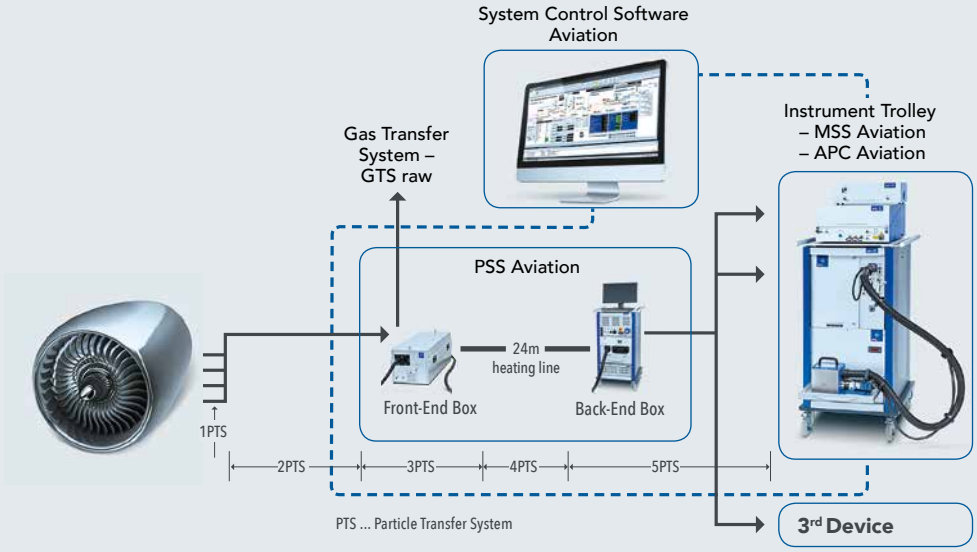
In 2016, the International Civil Aviation Organization (ICAO) will introduce a new global non-volatile Particulate Matter (nvPM) mass and number standards. These will require the manufacturers of turbojet and turbofan engines with >26.7 kN thrust to report the nvPM mass and number emission indices (EI). The AIR6241 (Aircraft Information Report) describes the instrumentation and the measurement protocol for this new standard.

In order to keep testing efforts consistent with previous requirements, the new nvPM standard facilitates the measurement of the nvPM number and mass simultaneously with the currently used Gas Transfer System (GTS). The GTS is required to measure the smoke number and gaseous emissions and is specified in Annex16 to the Convention on International Civil Aviation.

An AIR6241 compliant nvPM Measurement System shall consist of:

- Customer specific collection section comprising the sample probe and a connection line
- Transfer section
- Measurement section to determine the nvPM mass and number concentrations.

These upcoming requirements will result in additional components and complexity for turbine testing and certification. They will need a well designed and engineered system to accomplish the required measurements.



AVL APPROACH

The AVL Particle Measurement System Aviation

The AVL Particle Measurement System (PMS) Aviation is a commercially available solution to measure nvPM mass and number in compliance with the AIR6241. The PMS Aviation consists of:

- AVL Particle Sampling System Aviation (PSS Aviation)
- AVL Micro Soot Sensor Aviation (MSS-Aviation)
- AVL Particle Counter Aviation (APC-Aviation)
- AVL System Control Software Aviation (SCS Aviation)

AVL PARTICLE SAMPLING SYSTEM AVIATION

AIR6241 compliant Sampling System

The AVL Particle Sampling System Aviation (PSS Aviation) is based on the European Fixed PM Reference System design and consists of three main components:

- Front-end box
- 24 m self-regulated heating line
- Back-end box

The **front-end box** includes all required components as described for the 3PTS (Particle Transfer System) and is connected to the customer specific collection section.

The **24m self-regulated heating line** (4PTS) connects the front-end box with the back-end box. Self-regulated heating segments ensure a constant temperature of 60±15 °C over the whole 24m heating line independently from the ambient temperature, e.g. -20 °C at the engine and +25 °C near the back-end box.

The **back-end box** trolley comprises the components described in 5PTS and the make-up flow unit. It provides an interface to the measurement instruments like the APC Aviation and MSS Aviation. In addition a third device interface is available to connect e.g. a size distribution instrument. An embedded CO_2 analyzer facilitates the calculation of the mass and number EI´s.

AVL SYSTEM CONTROL SOFTWARE AVIATION

Straightforward operation due to an intuitive control

The AVL System Control Software Aviation (SCS Aviation) provides an easy and intuitive control of all system components via a single user interface. In addition to the sampling system, the nvPM instruments APC Aviation and MSS Aviation are easily integrated via a TCP/IP connection. The SCS Aviation comprises:

- Automated functions and sequences
- Limit monitoring
- All relevant data on a single screen
- Data recorders and a data browser

Analog and digital interfaces from the PSS Aviation facilitate an integration of additional components and provide an output of specific measurement and system data for an existing data acquisition system (DAS).

AVL PM/PN INSTRUMENTATION

AVL Micro Soot Sensor Aviation

AVL Particle Counter Aviation

AVL Particle Generator Aviation

AVL MICRO SOOT SENSOR™ AVIATION

Industry Standard for nvPM mass instrument

The AVL Micro Soot Sensor Aviation (MSS-Aviation) is designed for continuous measurement of low soot concentrations in the diluted exhaust gas and is based on the photoacoustic measurement principle. The AIR6241 compliant system is sensitive to soot and able to detect concentrations down to 1 µg/m³. The nvPM mass values are displayed in real-time without the need of additional calculations.

The MSS Aviation is calibrated according to AIR6241 requirements. The calibration of the device can be checked with an absorber window, which is included with the system.

AVL PARTICLE COUNTER™ AVIATION

Industry Standard for nvPM number instrument

The AVL Particle Counter Aviation (APC Aviation) is a compact and flexible device for a reliable and accurate measurement of nvPM number concentrations. It includes a:

- **Dilution and Conditioning System:** The VPR (Volatile Particle Remover) consists of a hot Particle Number Diluter 1 (PND1), an evaporation tube with catalytic stripper and a secondary cold dilution PND2.
- **Condensation Particle Counter:** The CPC detects the number concentration with a cut-point of 10 nm.

The APC Aviation is calibrated according to the AIR6241 requirements. The temperature, pressure and flow monitoring as well as self-diagnostic features ensure an error-free performance of the device.

AVL PARTICLE GENERATOR AVIATION

Industry Standard for quality checks

To ensure an accurate operation of the devices an annual calibration at the supplier site is specified. However, to ensure best day-to-day performance and to reduce the risk of needing to repeat measurements due to overlooked equipment or interconnect issues, system validity and verification procedures on a more frequent base are recommended.

The AVL Particle Generator Aviation enables quality assurance checks of the particle measurement equipment on-site by the customer. The tool generates combustion based soot particles and includes a thermal pre-treatment (VPR) to stabilize the aerosol. With three dilution stages the particle concentrations can be easily adjusted for specific aviation applications.

BENEFITS AT A GLANCE

Particle Sampling System Aviation (PSS Aviation)

- An AIR6241 compliant industrialized solution based on the European Fixed PM Reference System design
- Ensures highest efficiency for increasing complexity of turbine testing and certification

Sampling Control Software Aviation

Ensures convenient and efficient system operation by:

- Easy selection of various defined system states with one command
- Fully automated regulation of the pressure control valve and the diluent pre-heater
- Control of all sampling system components via a single user interface including the APC Aviation and the MSS Aviation

APC Aviation

- An industry standard for the nvPM number measurement including a Volatile Particle Remover with a Catalytic Stripper and a Condensation Particle Counter (CPC)
- Excellent accuracy and repeatability in terms of dilution due to patented primary diluter
- Ensure optimal device performance with built-in self-diagnostic and monitoring features

MSS Aviation

- An industry standard for nvPM mass measurement
- Immediate output of the determined nvPM mass value on the screen
- Easy check of the calibration factor with the included absorber window
- Large measurement range: 0.001 – 50 mg/m³

Particle Sampling System Aviation	
Dimensions Front-End Box	W x H x D: 450 x 432 x 1060 mm
Protection class Front-End Box	IP54, NEMA 12+
Dimensions Back-End Box Trolley	W x H x D: 660 x 1140 x 830 mm
Weight Front-End Box	approx. 95 kg
Weight Back-End Box Trolley	approx. 120 kg
Power Supply	230 V / 32 A
Interfaces	Analog Interface Digital I/O Interface TCP/IP Interface

CO_2 Analyzer: ABB 3020	
Concentration detection range	0 – 6000 ppm
Zero drift	≤ 1 % of span per week
Sensitivity drift	≤ 1 % of measured value per week
Linearity deviation	≤ 1 % of span
Output fluctuation (noise)	≤ 0.2 % of span
Resolution	better than 0.2 % of measurement span

APC Aviation	
Measured value	Particle number concentration [#/cm3]
PNC measuring range (single count mode)	0 to 10.000 #/cm³
PNC $t_{10\text{-}90}$ rise time	≤ 4 sec
Operating temperature	5 °C to 25 °C (up to 45 °C with optional conditioning trolley)
Max. sample gas temperature	Max. 200 °C
Compressed air supply	Acc. to ISO 8573-1, Class 1, Grade E

MSS Aviation	
Measured value	Concentration of soot [mg/m³, µg/m³]
Measuring range	0.001 – 50 [mg/m³]
Display resolution	0.001 [mg/m³]
Rise time	≤ 1 sec
Operation temperature	5 °C to 43 °C
Laser class	Class 1 laser product

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