



AEROSPACE RECOMMENDED PRACTICE

ARP4418™**REV. B**Issued 1995-08
Revised 2018-11

Superseding ARP4418A

(R) Procedure for Sampling and Measurement of Aircraft Propulsion Engine and APU
Generated Contaminants in Bleed Air

RATIONALE

This document is the required Five-Year Review and revision document. The descriptions of sampling and measurement techniques for a subset of bleed air contaminant marker compounds have been expanded and updated.

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1. SCOPE

This ARP outlines recommended practices to quantify the concentrations of a subset of bleed air contaminant marker compounds on an aircraft propulsion engine or APU prior to delivery and installation on civil and military aircraft. Testing is specified during steady state (non-transient) operation only, in a ground level test bed. Included are recommended test setup, test procedures, techniques for sampling ambient air and bleed air, and one or more specific analytical methodologies for each of the suggested bleed air contaminant marker compounds at quantification levels, given practical constraints.

1.1 Purpose

To provide test procedures to quantify bleed air contaminant concentrations in the air supplied by aircraft propulsion engines and APUs in a ground level test bed.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

2.1.1.1 AIR7521 Measurement Data and Reference Values for Compounds Potentially Found in Aircraft Engine Bleed Air

2.1.1.2 ARP1256D Procedure for the Continuous Sampling and Measurement of Gaseous Emissions from Aircraft Turbine Engines

2.1.2 USEPA Publications

2.1.2.1 USEPA Ambient Monitoring Technology Information Center, contains procedures including EPA TO-11A, TO-13A, TO-15A, EPA test methods. Available at <http://www.epa.gov/ttn/amtic>.

2.1.3 Other Publications

2.1.3.1 Armbruster, DA. & Pry, T. Limit of Blank, Limit of Detection and Limit of Quantitation. Clinical Biochem Rev. 2008 Aug. 29(Suppl1): S49-S52.

2.1.3.2 ISO 16000-6:2011/. Indoor air-Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling of Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID. Available at <https://www.iso.org/standard/52213.html>.

2.1.3.3 ISO 16000-3:2011/. Indoor air-Part3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air-Active sampling method. Available at <https://webstore.ansi.org/RecordDetail.aspx?sku=ISO%2016000-3:2011&source=google&adgroup=iso&gclid=Cj0KEQjw0lvIBRDF0Yzq4qGE4lwBEiQATMQIMdLsq5RcZi0737dvy5KWCoVbdz3nM-PlfTVBc8u2aZsaApUo8P8HAQ>.

2.2 Definitions

AERODYNAMIC DIAMETER: The diameter of an equivalent sphere of unit density (1 g/cm^3) with the same settling velocity as the particle in question.

BLEED AIR: Compressed air that is taken from the aircraft engine or APU compressor stage, which is upstream of the combustion chamber, or on a shaft driven by a turbine engine. Bleed air provides pressurized air to the aircraft pneumatic system for applications such as ventilation, anti-ice, fuel tank inerting, and water tank pressurization.

BLEED AIR CONTAMINANTS: Engine-generated chemical substances in gaseous, semi-volatile, or particulate matter, potentially present in the bleed air.

ELECTRICAL MOBILITY DIAMETER: The diameter of an equivalent sphere with the same electrical mobility as the particle in question; also referred to as mobility diameter.

LIMIT OF BLANK (LOB): The highest apparent analyte concentration expected to be found when replicates of a blank sample containing no analyte are tested. $\text{LOB} = \text{mean}_{\text{blank}} + 1.645 \times (\text{SD}_{\text{blank}})$.

LIMIT OF DETECTION (LOD): The lowest analyte concentration likely to be reliably distinguished from the LOB and at which detection is feasible. LOD is determined by utilizing both the measured LOB and test replicates of a sample known to contain a low concentration of analyte. $\text{LOD} = \text{LOB} + 1.645 \times (\text{SD}_{\text{low concentration sample}})$. [2.1.3.1] LOD should exclude all sources of spurious readings. Laboratories may use other definitions for LOD.

LIMIT OF QUANTIFICATION (LOQ): LOQ is the analyte concentration sufficient to produce analytical signals that meet predetermined targets for bias, imprecision, and total error. $\text{LOQ} > \text{LOD}$

MARKER COMPOUND: A bleed air analyte that is believed to be indicative of the presence of a type of contaminant of interest, such as oil or exhaust.

PARTS PER MILLION BY VOLUME (ppmV): The unit volume concentration of a gas per million unit volume of the gas mixture of which it is a part.

PM2.5: Particles with an aerodynamic diameter smaller than $2.5 \text{ }\mu\text{m}$, represented by mass per unit volume.

PM10: Particles with an aerodynamic diameter smaller than $10 \text{ }\mu\text{m}$, represented by mass per unit volume.

STEADY STATE CONDITION: Condition during single engine power setting characterized by stable temperature and bleed pressure.

TRANSIENT OPERATING CONDITION: Condition other than steady state engine power setting characterized by unstable temperature and/or changing bleed pressure.

ULTRAFINE PARTICLES: Particles with electrical mobility diameters smaller than 100 nm .

2.3 Acronyms

AIR - Aerospace Information Report (SAE)

APU - Auxiliary Power Unit

ARP - Aerospace Recommended Practice (SAE)

CAS - Chemical Abstract Services

CO - Carbon Monoxide

CO₂ - Carbon Dioxide

DNPH - 2, 4-dinitrophenylhydrazine

ECS - Environmental Control System

EPA - Environmental Protection Agency

FID - Flame Ionization Detector

GC/MS - Gas Chromatography/Mass Spectrometry

HP - High Pressure

HPLC - High Performance Liquid Chromatography

ISO - International Standard Organization

LOB - Limit of Blank

LOD - Limit of Detection

LOQ - Limit of Quantification

LP - Low Pressure

NASA - US National Aeronautics and Space Administration

NDIR - Non Dispersive Infrared

NIOSH – US National Institute for Occupational Safety and Health

OSHA - US Occupational Safety and Health Administration

PTFE - Polytetrafluoroethylene

SD - Standard Deviation

UFP - Ultrafine Particles

2.4 Units

2.4.1 Physical Quantities

atm = 1 atmosphere pressure = 101.325 kPa

g = gram

Hz = Hertz (1 per second)

K = Kelvin

m = meter

Pa = pascal

s = second

slpm = standard liter per minute