CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board

500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

AVL Michigan Holding Corp.
1801 East Ellsworth Road
Ann Arbor, MI 48108

has been assessed by ANAB
and meets the requirements of international standard

ISO/IEC 17025:2005

while demonstrating technical competence in the field of

TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of tests to which this accreditation applies.

L2105.01-1
Certificate Number

ANAB Approval

Certificate Valid: 10/31/2017-10/19/2019
Version No. 001 Issued: 10/31/2017

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

AVL Michigan Holding Corp.

1801 East Ellsworth Road
Ann Arbor, MI 48108
Contact: Steve Plewa Phone: 800 222 5283

TESTING

Valid to: **October 19, 2019** Certificate Number: **L2105.01-1**

Mechanical – Dynamometer Engine / Engine Component Testing, Dynamometer Engine / Emission Testing

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Temperature: (0 to 1 200) °C	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	K-Type Thermocouple Resistance Temperature Detectors
Liquid Flow: (1 to 300) L/hr	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Flow Meter
Pressure: (0 to 21) Bar	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Transducer
Torque: (0 to 3 900) Nm	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	AFA Dyno
Power: (0 to 800) Kw	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	AFA Dyno
Rotational Speed: (0 to 10 000) RPM	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	AFA Dyno
Air Flow: (10.9 to 5 400 kg/hr)	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Laminar Flow Element
Humidity: (11.3% to 75%) RH	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Vaisala
Emissions: Nox - 1-5 500 µmol/mol THC - 1-10 000 µmol/mol C1 CO - 9-100 000 µmol/mol CO2 – 5 300-160 000 µmol/mol O2 – 5 300-220 000 µmol/mol CH4 - 6-500 µmol/mol	Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Chemiluminescence Flame Ionization Detection Nondispersive IR Paramagnetic Flame Ionization Detection

Electrical – Battery Testing

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Channel A & B Voltage (8 to 900) VDC Current (-500 to 500) ADC Power (-125 to 125) kW	Customer Specific	Batteries for Propulsion System	AV 900 ABC 150
Parallel Voltage (8 to 900) VDC Current (-1 000 to 1 000) ADC Power (-250 to 250) kW	Customer Specific	Batteries for Propulsion System	AV 900 ABC 150

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2105.01-1.

CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board
500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

AVL Michigan Holding Corp.
47519 Halyard Drive
Plymouth, MI 48170

has been assessed by ANAB
and meets the requirements of international standard

ISO/IEC 17025:2005

while demonstrating technical competence in the field of

CALIBRATION AND TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of tests to which this accreditation applies.

L2105-1
Certificate Number

ANAB Approval

Certificate Valid: 10/31/2017-10/19/2019
Version No. 001 Issued: 10/31/2017

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

ANSI-ASQ National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

AVL Michigan Holding Corp.

47519 Halyard Drive
Plymouth, MI 48170
Contact: Janet Montoya Phone: 800 222 5283
Email: janet.montoya@avl.com

CALIBRATION AND TESTING

Valid to: **October 19, 2019** Certificate Number: **L2105-1**

Amount of Substance - Particulate

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Emission Analyzer Nox	(0 to 5 200) µmol/mol	1.356 % of reading	Gas Divider Certified Gas
THC	(0 to 15 000) µmol/mol		
CO	(0 to 100) mmol/mol		
CO_2	(0 to 200) mmol/mol		
O_2	(0 to 250) mmol/mol		
Smoke Meters	(0 to 10) FSN	0.384 FSN	Reflection Heads (FSN-Filter Smoke Number)

Electrical - Current

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Current Input Isolated Range	(0 to 20) mA	7 µA	Fluke 741B

Electrical - Resistance

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Measuring System RTD (PT 100) Simulation	(0 to 300) °C	0.238 °C	Fluke 741B

Electrical - Voltage

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Simulation Type K	(0 to 1 200) °C	1.3 °C	Fluke 741B
Type J	(0 to 750) °C	1.3 °C	
Analog Input	+/- 10 V	0.004 Vdc	

Fluid Properties and Quantities - Flow

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gravimetrical Fuel Flow [1]	(0 to 150) kg/h	0.19 kg/h	Procedure CA3-CS-005
	(0 to 300) kg/h	0.19 kg/h	
Mass Fuel Flow [1]	(0.1 to 125) kg/h	0.102 % of reading	Procedure CA3-CS-070
Volume Flow	(0.3 to 30) L/hr	0.250 % of reading	PLU103B Master Meters
	(0.3 to 150) L/hr	0.289 % of reading	
	(1 to 300) L/hr	0.332 % of reading	
Mass Flow	(1 to 2 200) lb/hr	0.0094% of reading	Scale / Timer

Photometry and Radiometry – Properties of Materials

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Opacity	(0 to 100) %	1.555 % Opacity	Neutral Density Filters

Mass

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Density			
Fuel Density	(0.7 to 0.8) g/cc	0.016 % of reading	Density Transmitter
Pressure / Low Vacuum			
Pressure Measuring System Gage Pressure –Pneumatic	(-100 to 100) kPa (-100 to 250) kPa (-100 to 2000) kPa (0 to 1000) kPa (0 to 20000) kPa	0.11 kPa 0.75 kPa 2.0 kPa 1.3 kPa 5.0 kPa	Druck PM620-05G Fluke PM200-BG250K Druck PM620-13G Fluke PM200-G1M Fluke PM200-G20M
Absolute Pressure Pneumatic	0 to 200 kPa	0.26 kPa 0.19 kPa	Fluke PM200-A200K Druck PM620-07A
Differential Pressure - Pneumatic	(-35 to 35) kPa	0.14 kPa	Fluke PM200-BG35K
Torque			
Torque Transducer	(42 to 4 200) Nm	0.097 % of reading	Engine Dyno

Thermodynamic - Humidity

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity	11.3 % RH	2.08 % RH	Vaisala HMK 15 / Salts
	75 % RH	2.08 % RH	

Time and Frequency – Frequency / Period

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Input [1]	(0 to 50) kHz	0.006 kHz	Fluke 741B
Time (frequency)	(0.1 to 9 999) s	0.020 s	FT33 Time Counters

Flow

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dilution Flow Probe Flow Total Flow	(0.5 to 2.0) g/s	0.37% of point 1.48% of point 1.58% of point	Procedure CA3-CS-072

Mechanical – Dynamometer Engine / Engine Component Testing, Dynamometer Engine / Emission & Certification Testing

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Temperature: (0 to 1 200) °C	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	K-Type Thermocouple Resistance Temperature Detectors
Liquid Flow: (1 to 300) L/hr	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Flow Meter
Pressure: (0 to 21) Bar	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Transducer
Torque: (0 to 3 900) Nm	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	APA Dyno
Power: (0 to 800) Kw	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	APA Dyno
Rotational Speed: (0 to 10 000) RPM	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	APA Dyno

Mechanical – Dynamometer Engine / Engine Component Testing, Dynamometer Engine / Emission & Certification Testing

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Air Flow: (10.9 to 5 400 kg/hr)	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Laminar Flow Element
Humidity: (11.3% to 75%) RH	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Vaisala
Emissions: Nox - 1-5 500 µmol/mol THC - 1-10 000 µmol/mol C1 CO - 9-100 000 µmol/mol CO2– 5 300-160 000 µmol/mol O2 – 5 300-220 000 µmol/mol CH4 - 6-500 µmol/mol	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Chemiluminescence Flame Ionization Detection Nondispersive IR Paramagnetic Flame Ionization Detection
Diluted Exhaust Flow: (10 to 140) m^3 / min	40 CFR 86 40 CFR 1065 Customer Specific	Internal Combustion Engines (Gasoline/Diesel/NG)	Critical Flow Venturi

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 (k=2), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope
2. g/s = grams per second
3. This scope is formatted as part of a single document including Certificate of Accreditation No. L2105-1.

Vice President