



June 13, 2019

CERTIFICATE OF CALIBRATION / VALIDATION of 'AUM' PHOTONIC SYSTEM

Certification of Calibration / Validation Field Trials of CASTLE Advanced Technologies and Systems (CATS) Photonic System, AUM – An indigenously designed and developed real time remote monitoring photonic system for monitoring air quality (pollution) -with standard CAAQMS stations of Karnataka State Pollution Control Board, KSPCB, Bangalore – Reg.

CATS Eco Systems Pvt Ltd - a technology start-up company and a subsidiary of CATS Global has indigenously designed and developed AUM (Air Unique-quality Monitoring) - a novel photonic system capable of remotely monitoring the various air quality parameters (including the meteorological parameters) in real time. CATS had successfully conducted calibration and validation trials of their real time remote monitoring photonic system for air quality for all the reference gases (as per Ambient Air Standards Gazette notification No.B-29016/20/90/PCI-L, Dated: 18.11.2009) at different concentrations provided by EffectTech Pvt Ltd. during November 2018 at the EffectTech Gases Pvt Ltd Laboratories in Tarapore, India - along with cross validation by standard equipment like Chemi-Luminescence Gas Analyser for $NH_3/NO/NO_x/O_3$, NDIR Gas Analyser for $CO/CO_2/CH_4$, Paramagnetic Analyser for O_2 , UV Gas Analyser for SO_2 , Gas Chromatography for $C_6H_6/C_{20}H_{12}$, and AAS/ICP for Pb, As and Ni .

This is to certify that CATS in association with Karnataka State Pollution Control Board, Bangalore has successfully conducted cross calibration and validation trials of their real time remote monitoring photonic system for air quality (all gases and environmental parameters like Temperature, Relative Humidity, Solar Radiation, Air Pressure, Wind Speed and Wind Direction as per WHO / CPCB established Ambient Air Standards) in an inter-comparison study during May 29 – 30, 2019 at the KSPCB air monitoring stations in SG Halli, Bangalore and KAVIKA, Bangalore - where continuous ambient air monitoring systems (CAAQMS) from M/S Environment SA, France and M/S Eco Tech, Australia were located.

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Central Environmental Laboratory, Karnataka State Pollution Control Board is accredited for IS/ISO 17025:2015 vide clause number 5.4 provision has been made for validation of new methods made. During the study period it was observed that photonic system is rugged with high repeatability and the following performance characteristics were noticed.

1. Selectivity and specification: Yes, of all gases/Concentrations.
2. Linearity: very high (~ 99% of full range)
3. Range: < 1ppb to 1 gm/cm³ (tonnes/m³)
4. Sensitivity: < 1µg/m³
5. Accuracy: 1ng/m³
6. Precision: 1µg/m³
7. Ruggedized system with 96% repeatability

The CATS Photonic System AUM was cross calibrated and validated satisfactorily for the following parameters during the inter comparison study between AUM the photonic system and the systems from M/S Environment SA, France and from M/S Eco Tech, Australia.

Inter Comparisons of CAAQMS (M/S Environment SA, France) with AUM System# (M/S CATS, India) @ SG HALLI Station

Parameter	M/S Environment SA, France CAAQMS	M/S CATS Eco Systems, India AUM	Variation (CAAQMS ~ AUM)
NO (µg/m ³)	2.86375	2.795175	0.068575
NO ₂ (µg/m ³)	9.25125	9.41765	0.1664
NO _x (µg/m ³)	12.075	12.04778	0.02722
SO ₂ (µg/m ³)	4.5575	4.473213	0.084287
CO (mg/m ³)	0.5325	0.530559	0.001941
PM ₁₀ (µg/m ³)	65.29	59.42359	5.86641
WS (m/s)	2.305	2.301388	0.003612
WD (deg)	161.855	160.7844	1.0706
SR (W/m ²)	709.3438	710.215	0.8712

Inter Comparisons of CAAQMS (M/S Eco Tech, Australia) with AUM System# (M/S CATS, India) @ KAVIKA Station

Parameter	Eco Tech, Australia CAAQMS	CATS Eco Systems, India AUM	difference in value (CAAQMS ~ AUM)
CO (mg/m ³)	0.51	0.491731	0.018269
O ₃ (µg/m ³)	62.28563	61.22442	1.06121
NO (µg/m ³)	6.605625	6.570994	0.034631
NO ₂ (µg/m ³)	28.5475	28.44186	0.10564
NO _x (µg/m ³)	35.15375	35.01759	0.13616
NH ₃ (µg/m ³)	19.32563	18.77049	0.55514
SO ₂ (µg/m ³)	0.9575	0.94825	0.00925
PM _{2.5} (µg/m ³)	54.25	54.9875	0.7375
PM ₁₀ (µg/m ³)	98.125	94.95375	3.17125
Benzene (µg/m ³)	0.86125	0.855938	0.005312
Toluene (µg/m ³)	2.120625	2.118	0.002625
p- Xylene (µg/m ³)	2.536875	2.553688	0.016813
o- Xylene (µg/m ³)	0.3675	0.401	0.0335
Ei- Benzene (µg/m ³)	0.404375	0.411688	0.007313
Temperature (°C)	32.81313	32.849	0.03587
RH (%)	39.58313	39.69469	0.11156
WS (m/s)	1.99625	1.968188	0.028062
WD (deg)	270.3306	275.2345	4.9039
BP (mmHg)	715.4063	715.3808	0.0255

based on average values during study period.

Ref: Technical Report on Inter Comparison of Indigenously Developed Photonic System AUM with CAAQM Systems at SG HALLI and KAVIKA Stations of KSPCB Bangalore May 29 – 30, 2019, pp. 72, submitted by CATS Eco System to CSO, KSPCB, dt. June 10, 2019.

The value additions of the AUM system are its high sampling rates of data acquisition enabling the real time remote monitoring of all ambient air parameters with a single system, high accuracy and sensitivity, portability, low power usage with no logistical requirements for setting up the system and its capability to cover a range of distances of measurement remotely from a single location.



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