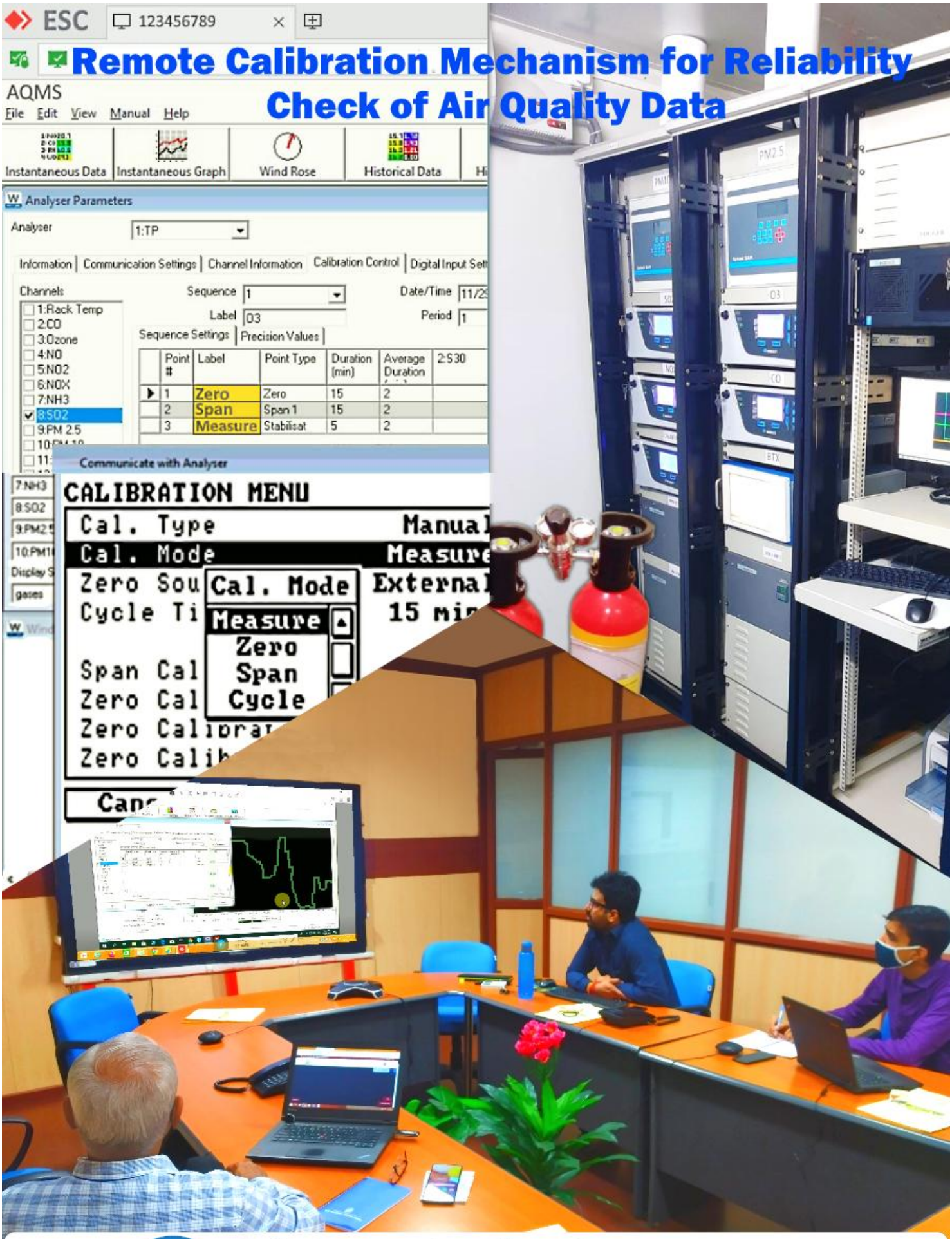
Remote Calibration Mechanism for Reliability Check of Air Quality Data



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Contents

1.0 Preamble :

The Real-time continuous monitoring has a significant role in environmental management. The availability of data on real-time basis helps in quick analysis and instant follow up action for better control on impacts on the environment. The National Environment Policy (NEP) 2006 envisaged to strengthen the testing infrastructure and network for monitoring ambient environmental quality and progressively ensure real-time and on-line availability of the monitoring data.

As intended in the NEP, the GoI instituted a mechanism of self monitoring of compliance. Under this mechanism the target industries have installed real-time monitoring systems and have established connectivity of the same with the central server at State Pollution Control Board. The real-time data is transmitted from the remote monitoring site to the central server for remote surveillance of ambient air quality, source emission quality and effluent stream quality etc.

Apart from real-time monitoring systems installed by industries the MPPCB has also established its own continuous ambient air quality monitoring systems (CAAQMS) in some districts of interest, the number of which is expanding as per need, to get a real-time picture of air quality of a particular area. This air quality data is made available on the portal for the common citizens in explicit and simple form as part of awareness.

A bulk data is generated continuously every day which help in decision support in several environmental tasks. Owing to this importance, the reliability of monitoring equipment and the generated data is of utmost importance. In order to ensure the reliability and genuineness of monitoring results a periodic performance check of CAAQMS is carried out by the **Environment Surveillance Centre (ESC)** at M.P. Pollution Control Board (MPPCB). These performance check, verification of instrument calibration, distinctly indicate the accuracy or errors in the measurement. This process ensures correct operation of system in accordance with the operating specifications by establishing quantitative relationship between actual value and the instrument response value. The Central Pollution Control Board (CPCB) has stipulated condition for online remote calibration check of the monitoring systems.

2.0 Monitoring Methodology :

The continuous ambient air quality monitoring equipment, being used for the air quality assessment, are integrated system for the measurement of particulate matters ($PM_{2.5}$ and PM_{10}) and the gaseous pollutants, viz. Nitrogen oxide (NOx), Sulphur dioxide (SO_2), Carbon monoxide (CO), Ozone (O_3) in the ambient environment. The analysers conform to USEPA automated reference / TUV/ EN or equivalent method as required by individual parameter. The method of measurement also meets the specifications of National Ambient Air Quality Standards.

Methods of measurement – The methodology for the measurement of parameters during the calibration check process was followed as per amended Schedule VII, MoEF Notification G.S.R. 826 (E) dated 16.11.2009. The data communication protocol set by the CPCB is followed for the real-time monitoring purpose.

The CAAQMS measures particulate concentration on Beta ray attenuation principle using continuous glass fibre filter tape and C-14 as Beta source. The concentration is determined in milligrams or micrograms of particulate per cubic meter of air.

The CAAQMS has the mass flow sensor, automatic flow control devices and barometric pressure sensor as well. During the study, the 'self test' feature for Particulate Matter was carried out to test the diagnostic parameters, including Filter tape and Flow control system of the PM unit. Tape strength, tape porosity, tape tension, photo interrupter, smart heater control settings, sample flow system, temperature, pressure are also part of self test. The system performs automatic checks for instrument drift due to external factors, viz. Temperature, barometric pressure, humidity etc every hour.

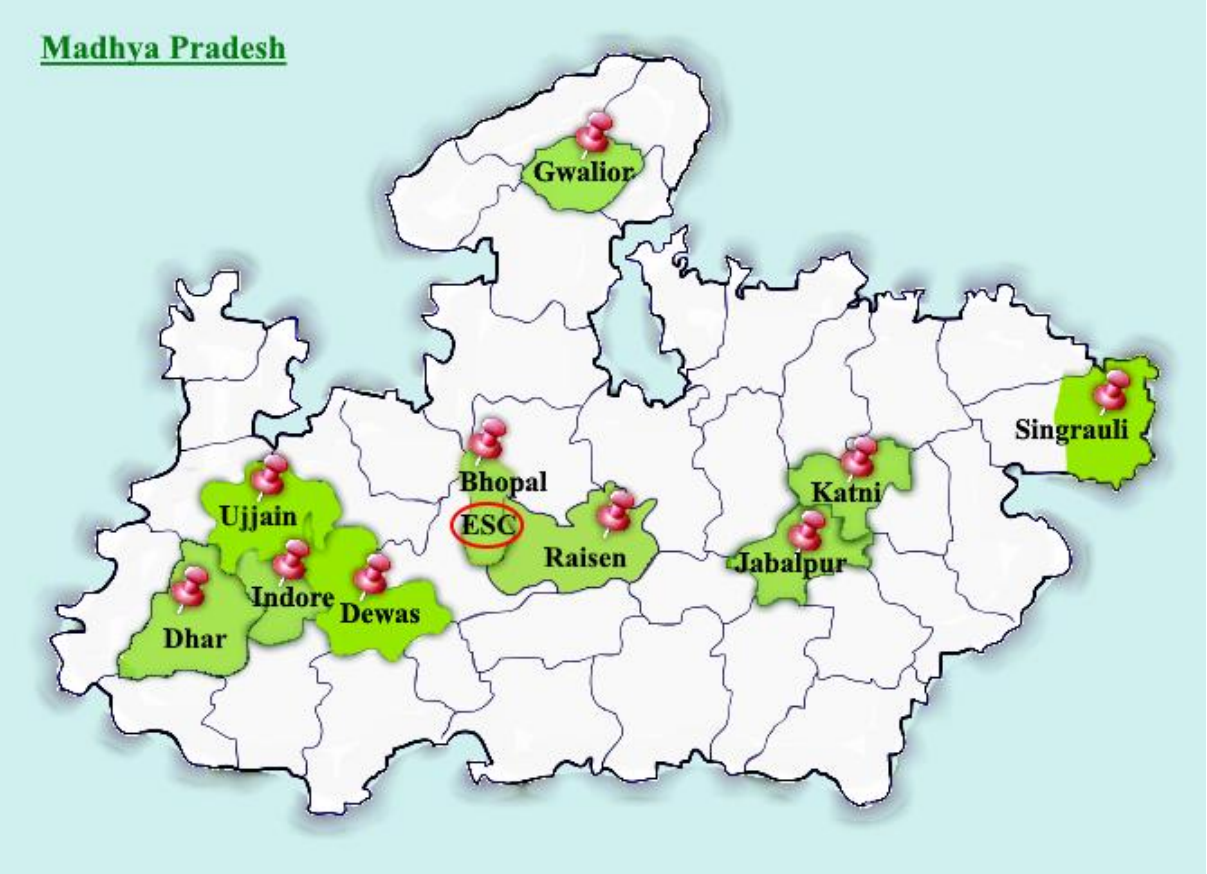
Among the gaseous part, the NO_2 was measured by Chemiluminescence principle, Sulphur dioxide was measured by Ultraviolet Fluorescence method with a measuring range of 0 to 20 ppm, the Ozone was measured by Non-Dispersive Ultraviolet technology to a sensitivity of 0.5 ppb in the range of 0 to 20 ppm. The carbon monoxide was measured by Non-dispersive Infra Red Spectroscopy method.

3.0 Remote check of CAAQMS performance :

Although all the CAAQMS installed in the State have microprocessor controlled analysers with auto calibration check mechanism which is triggered daily once in the morning at scheduled time but, owing to the above stated needs, the ESC MPPCB cross examines the systems periodically to ascertain the reliability of data.

S.No.	City	Location	District	Coordinate	Zone / Category
1	Bhopal	T T Nagar	Bhopal	23°14'00.9"N 77°24'02.1"E	Commercial
2	Dewas	Bhopal Chauraha	Dewas	22°58'05.7"N 76°03'50.8"E	Mixed Zone
3	Gwalior	City Center	Gwalior	26°12'12.4"N 78°11'35.7"E	Mixed Zone
4	Indore	ChhotiGwaltoli	Indore	22°43'09.7"N 75°52'11.6"E	Mixed Zone
5	Jabalpur	Marhatal	Jabalpur	23°10'07.0"N 79°55'56.1"E	Commercial
6	Katni	Gole Bazar	Katni	23°50'02.8"N 80°23'25.4"E	Commercial
7	Mandideep	Sector-D Industrial Area	Raisen	23°06'30.4"N 77°30'41.1"E	Industrial
8	Pithampur	Sector-2 Industrial Area	Dhar	22°37'29.1"N 75°40'30.9"E	Industrial
9	Singrauli	Surya KiranBhawan	Singrauli	24°06'32.3"N 82°38'44.1"E	Mixed Zone
10	Ujjain	Mahakaleshwar Temple	Ujjain	23°10'57.8"N 75°46'05.6"E	Mixed Zone

Recently a remote check of calibration of all the CAAQMS, installed in the State, was carried out. A total of 10 CAAQMS were remotely checked at different intervals from ESC, i.e. from 27.11.2020 to 16.12.2020. The location details are shown in the table above and the same is also shown in the map below.



Map showing locations of ESC and CAAQM Stations during study

4.0 The Criteria Pollutants

The CPCB has laid down ambient air quality standards for 12 criteria pollutants which are responsible for causing serious health and environmental hazards. Among the criteria pollutants eight are being monitored on continuous basis, viz. Particulate Matters, i.e. PM_{10}&$PM_{2.5}$, Nitrogen oxide (NO_x), Sulphur dioxide (SO_2), Ozone (O_3), Carbon monoxide (CO), Benzene (C_6H_6) and Ammonia (NH_3). The rest of the four parameters, viz. Nickel, Arsenic, Lead and BaP, are taken care under National Air monitoring programme. In the present study six parameters, which are responsible for AQI calculation, were considered for remote check of calibration of sensors.

5.0 Tools used for Remote Calibration Check :

The instrument should essentially have the Full-Duplex connectivity through Serial Port RS 232-485, Ethernet, USB and Using Protocol TCP-IP/ ModBus. The Analog signal connection 4-20 mA/0-1 V do not support this operation. The DAHS (Data Acquisition and Handling System) is directly connected to analyzers either on USB or Ethernet. During the process of remote check of calibration the analyzers are accessed remotely for log-in using the Application Installed at DAHS. Creation of .csv file from data, which is pushed from local DAHS on FTP is prone to tampering as it is not encrypted nor it has any security feature, is avoided.

The tools used for remote calibration are as follows :

- Remote Access Application like Remote Desktop, Skype, Team-viewer, Any Desk etc. to access DAHS (Data Acquisition and Handling system), and Analyzer during the calibration.
- Screen Recorder to record the remote calibration event for reference and review.
- Current snapshot of the remote Site to verify the network architecture and calibration activity at the site.
- Analyser support Application at remote end to trigger the command.

6.0 Process of Remote Calibration Check :

The creation of flag and execution of command are the principal part while carrying out the remote calibration check of analysers. Some parameters, as stated below, are required to be checked at the time of commencement of remote calibration check process :

- Actual concentration value of the span gas in cylinder and, accordingly,the concentration input in command server. It is ensured that the input concentration in command server is either low or high than the actual value of span gas to help the calibration team make certain that the analyser is sensing the inputs from the actual sample and it is not influenced or governed by the values set in the DAHS. A deviation of +/- 2% from the actual concentration requires necessary corrective measures.
- The unit of measurement in analyser should match with the unit defined in the calibrator.
- The Date and Time of analyzer, DAHS and calibrator should be same.
- DAHS and Analyzer are to be logged in remotely throughout the process of calibration.

Before commencing the remote check process the following are ensured :

- Execution of commands of Remote calibration is solely under control of ESC.
- The raw data from analyser should be accessible on a real-time basis.

- The analyzer should be accessible remotely during the calibration.
- Validity certificate of gas cylinders that are used in the process.
- Verification of availability of gas cylinders at site using IP-Camera/site snapshot.
- The command execution time and calibration report generation time should not differ.
- The schedule of remote check of calibration should be available on the portal and command execution by analyser should follow accordingly.

The process of remote check of calibration is completed in three steps, i.e. Zero check, Span check and Stabilization. These steps are preceded and followed by sample mode. The commands for all the steps are given in a single instance through DAHS. As soon as the span calibration is over the analyzer starts taking sample automatically from the source.

Initially a flag is created in the Logger defining the course of action which is followed during the instrument calibration check process. This flagging is important for execution of commands and successful accomplishment of the remote check of instrument performance. Date of calibration check process, timings to be followed by instrument during span and sample run at each step, concentration of sample gas etc. are scheduled in the Logger at the time of commencement of exercise.

A similar scheduling is done in the calibrator at the remote site where monitoring system is installed. Due care is taken to ensure that the scheduling in logger and scheduling in Calibrator at remote end are similar. If the scheduling is not matched the execution of command may be dropped or the process can behave in abnormal way showing absurd data.

The process of remote calibration of CAAQMS analysers does not require presence of anyone at the remote end but, owing to cylinder safety concern, the service provider's representative is asked to be present at the time of calibration for manually opening and closing of valves of span gas cylinders. Since this is new technology, and the remote calibration is also a new initiative, an officer from the concerned regional office of MPPCB is also asked to be present at the remote end to get an exposure and understanding about this process.

The ESC team members, who undertook the task of performance check remotely, included Shri. Pracheer Dixit System Administrator, Shri Abhishek Bhasker and Shri Dheeraj Wadukle. The study was performed under the supervision of Shri V.K. Ahirwar Director (Environment) and Dr. Rajendra Chaturvedi, Scientist, Environment Surveillance Centre, MPPCB. **The station wise report of calibration check, performed during 27.11.2020 to 16.12.2020 and published in March 2021, is detailed on the subsequent pages.**

City : Gwalior

CAAQMS location : City Centre

Date : 27/11/2020

Remote end support :

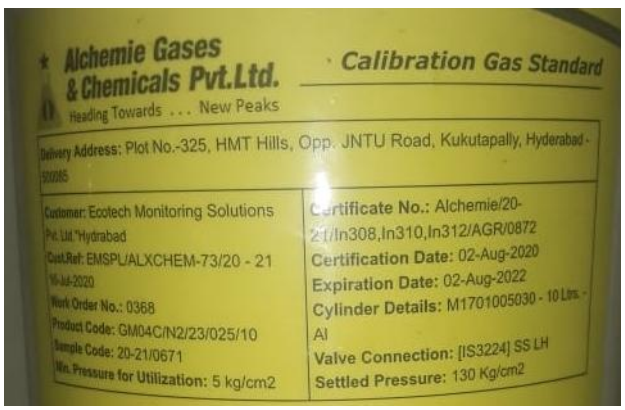
MPPCB Regional office, Gwalior - Shri R.K. Jain, Scientist
Service Provider - Shri Abdhesh Pratap Singh and Shri Jitendra Shrivas

1.1 - CAAQM Station

1.2 - Inside view of Station

Details of Span gases used for the purpose of calibration check are as follows:

- Carbon monoxide (CO) - 4955 ppm
- Nitrogen oxides (NOx) - 51mpp
- Sulphur dioxide (SO_2) - 50 ppm



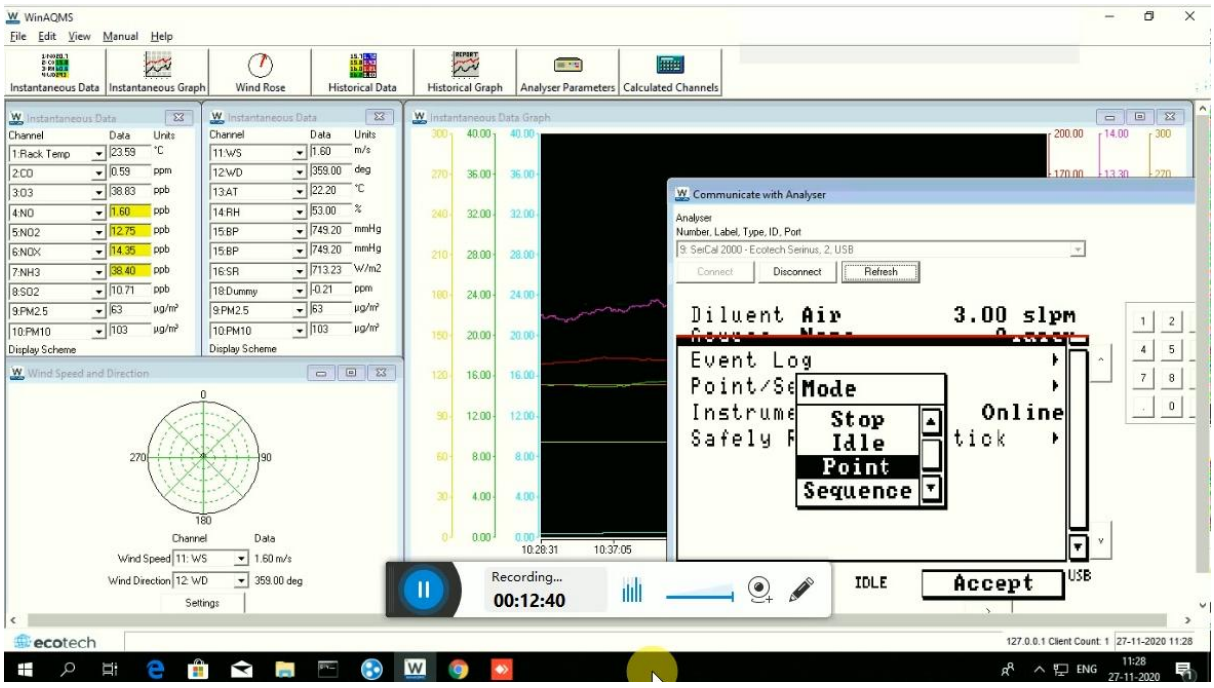
The test concentration of span gases used in the calibration check is as follows :

Carbon monoxide	– 40 ppm
Nitrogen oxide	– 400 ppb
Ozone	– 160 ppb
Sulphur dioxide	– 400 ppb

The process of remote check of calibration was triggered at 11.28 am. The parameters considered for the exercise were Nitrogen oxide, sulphur dioxide, Carbon monoxide, Ozone and Particulate matters, i.e. PM_{10} and $PM_{2.5}$.

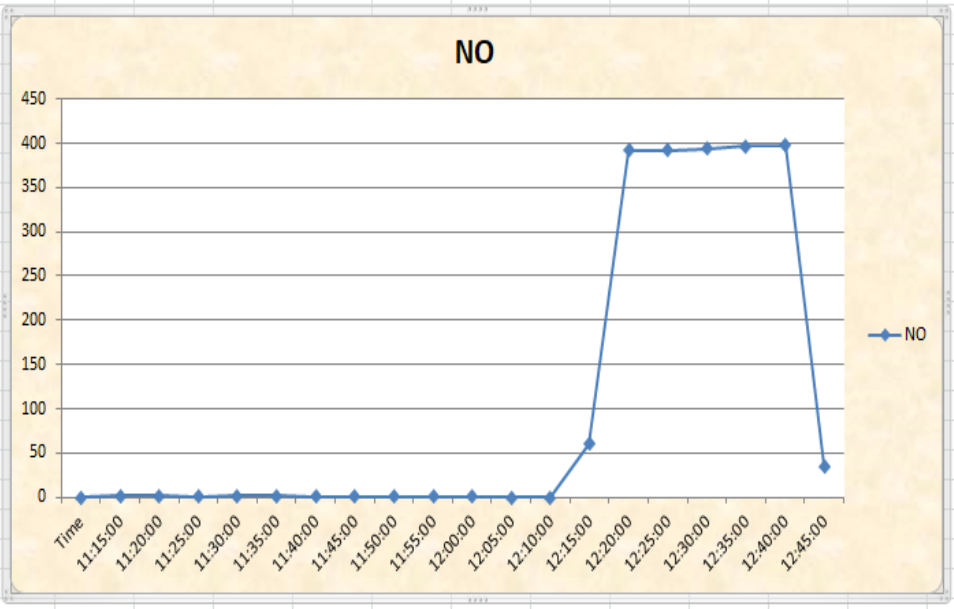
Firstly the NO_2 analyser was checked for its calibration. The span value of NO was observed to be 397.44 ppb against the given concentration of 400. The value during zero calibration was recorded as 0.01 ppb for NO and 1.45 ppb for NO_2. Thus the result was well within the range of acceptable deviation. The process, including calibrator and communication with analyser, is depicted in fig. 1.4 and 1.5.

This was followed by calibration check of SO_2 analyser. The timings for calibration control were set as 15 minutes for zero check, 15 minutes for span check and 10 minutes as stabilization time as shown in the fig. 1.6.



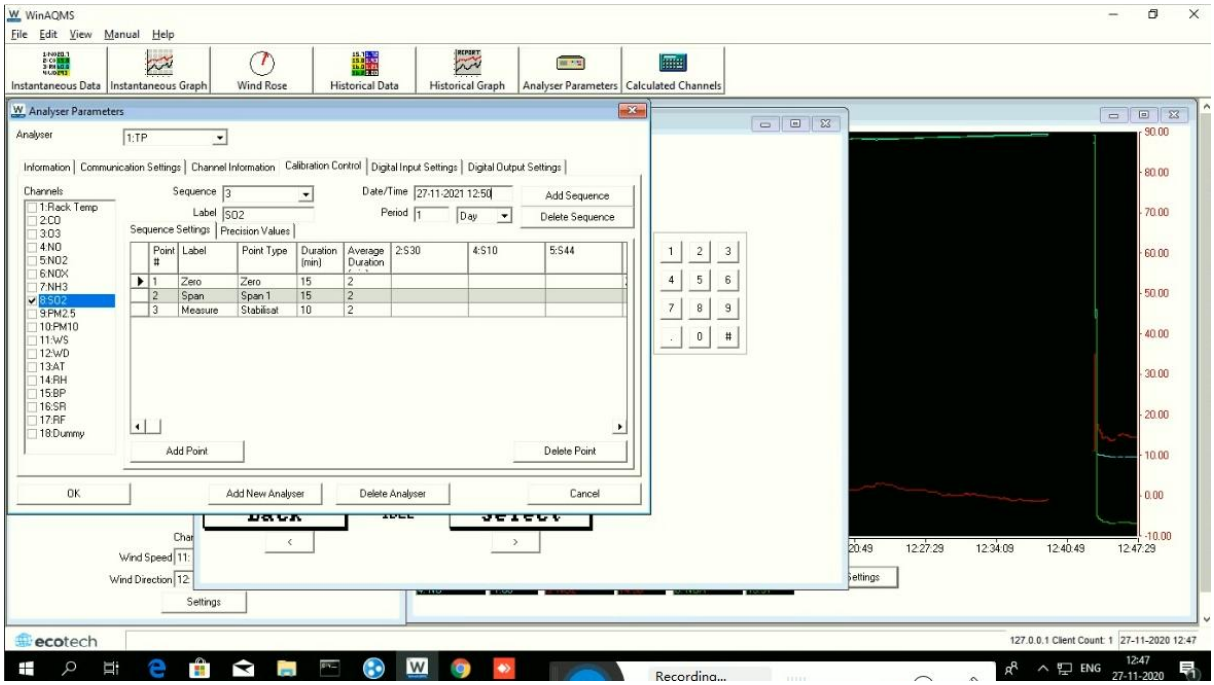
1.4 - Remote check of calibration of NOx analyzer

Time	NO
11:15:00	1.16
11:20:00	1.35
11:25:00	0.71
11:30:00	1.53
11:35:00	1.2
11:40:00	0.8
11:45:00	0.59
11:50:00	0.55
11:55:00	0.39
12:00:00	0.39
12:05:00	0.07
12:10:00	0.01
12:15:00	60.23
12:20:00	392.12
12:25:00	391.46
12:30:00	393.8
12:35:00	396.06
12:40:00	397.44
12:45:00	35.38



1.5- Performance check of NOx analyzer against specified test concentration

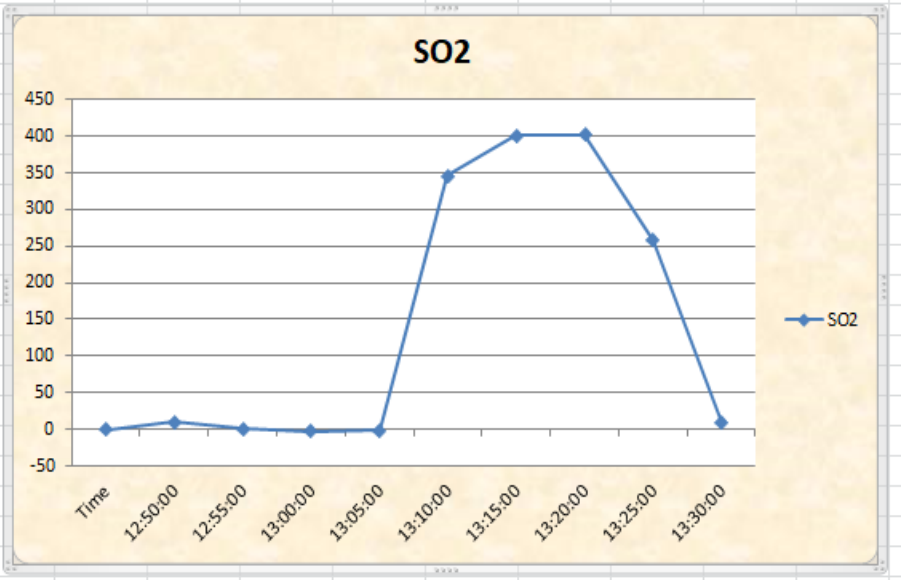
This was followed by calibration check of SO_2 analyser. The timings for calibration control were set as 15 minutes for zero drift check, 15 minutes for span drift check and 10 minutes for stabilization as shown in the fig. 1.6 and 1.7.



1.6 - Remote check of calibration of SO_2 analyzer

The span value was set to 400 ppb which was read as 401.4 ppb by analyser during calibration check. The zero run showed the value of SO_2 to be 1.54 ppb. Thus, both the values were found well within the deviation range indicating that the analyser is in good health and is sensing the parameter to its accuracy. Fig. 1.7

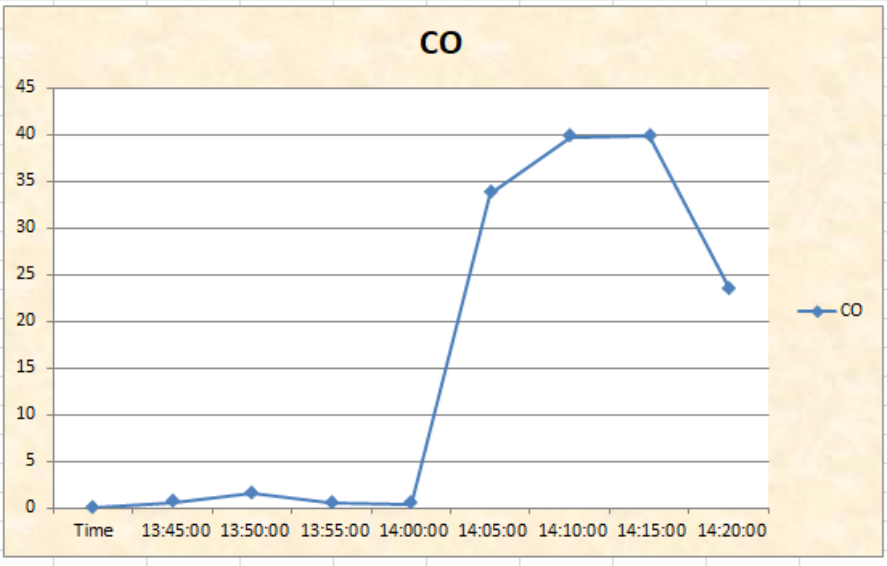
Time	SO2
12:50:00	9.74
12:55:00	1.03
13:00:00	-2.53
13:05:00	-1.78
13:10:00	345.21
13:15:00	400.15
13:20:00	401.85
13:25:00	257.65
13:30:00	8.72



1.7 - Performance check of SO_2 analyzer against specified test concentration

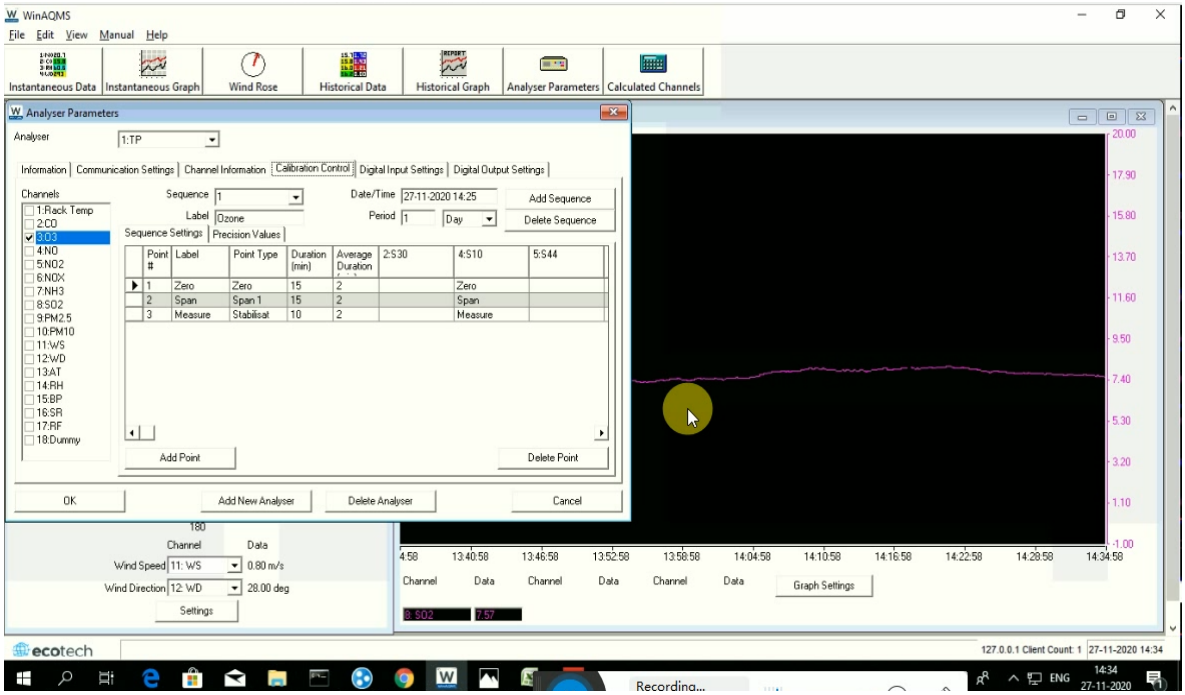
This was followed by calibration check for Carbon monoxide. The zero check time was set for 15 minutes, span check was set for 15 minutes and the stabilization time was set for 10 minutes. The test concentration of CO was set as 40 ppm in analyser calibration control and the calibrator. The value read by the analyser during Zero run was 0.29 ppm and during span gas run was 39.86 ppm. The observed values were well within the deviation range hence no correction in the calibration was required. Fig. 1.8

Time	CO
13:45:00	0.6
13:50:00	1.55
13:55:00	0.51
14:00:00	0.4
14:05:00	33.73
14:10:00	39.8
14:15:00	39.85
14:20:00	23.47



1.8 - Performance check of CO analyzer against specified test concentration

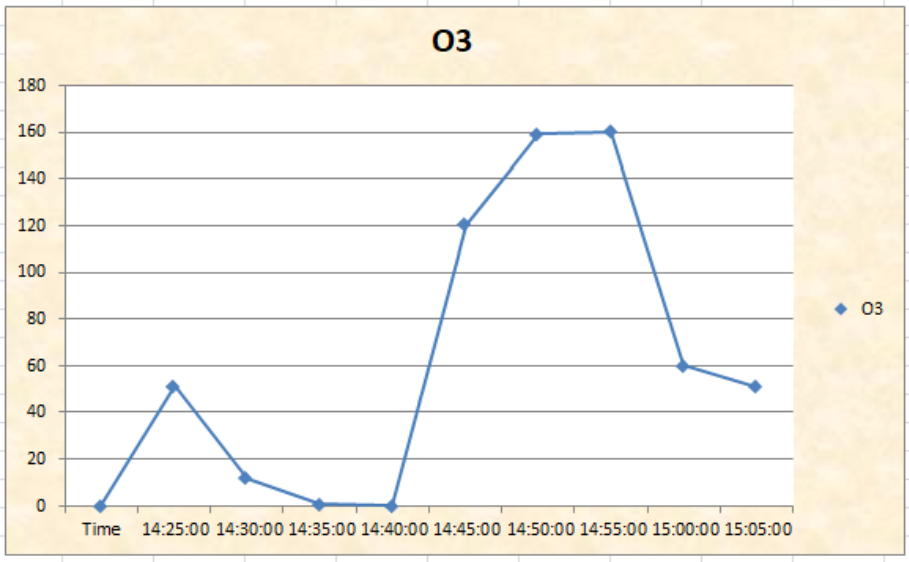
Next the calibration check for ozone analyser was performed at 1425 hours. The zero and span concentration check was set for 15 minutes with stabilization time of 10 minutes.



1.9 - Remote check of calibration of Ozone analyzer

The test concentration of ozone was set as 160 ppb which was read as 160.39 ppb by the analyser. The Zero run recorded the concentration of 0.26 ppb. As per the deviation range the analyser was found to work satisfactorily. Fig. 1.9, 1.10

Time	O3
14:25:00	51.46
14:30:00	11.8
14:35:00	0.59
14:40:00	0.22
14:45:00	120.31
14:50:00	159.13
14:55:00	160.21
15:00:00	60.09
15:05:00	50.88



1.10 - Performance check of Ozone analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters**. This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Katni

CAAQMS location : Gole Bazar

Date : 27/11/2020

Remote end support :

MPPCB Regional office, Katni - Shri Harish Rai, Chemist

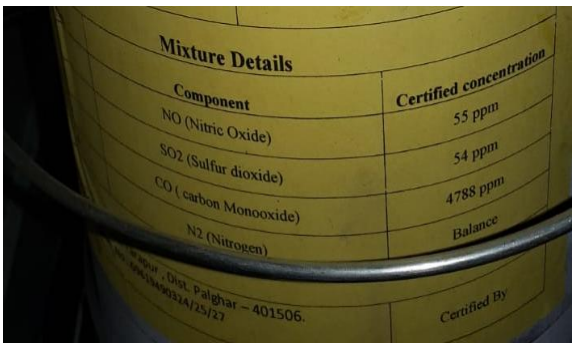
Service Provider – Shri Abdhesh Pratap Singh and Shri Avinash Gupta,

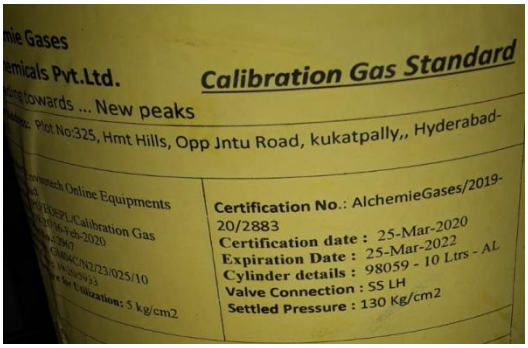
2.1 - CAAQM Station

2.2 – Inside view of Station

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 4788 ppm
- Nitrogen oxides (NOx) - 55 mpp
- Sulphur dioxide (SO_2) - 54 ppm



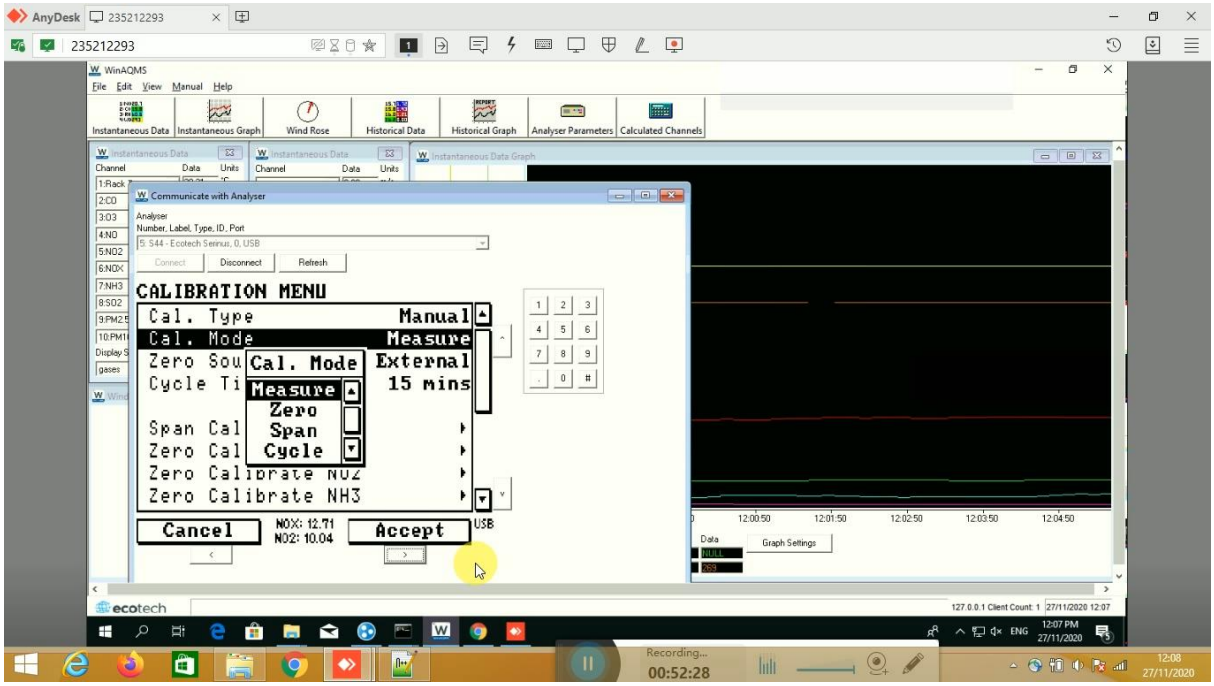


The test concentration of span gases used for the calibration check is as follows :

Carbon monoxide	– 4 ppm
Nitrogen oxide	– 40 ppb
Ozone	– 100 ppb
Sulphur dioxide	– 30 ppb

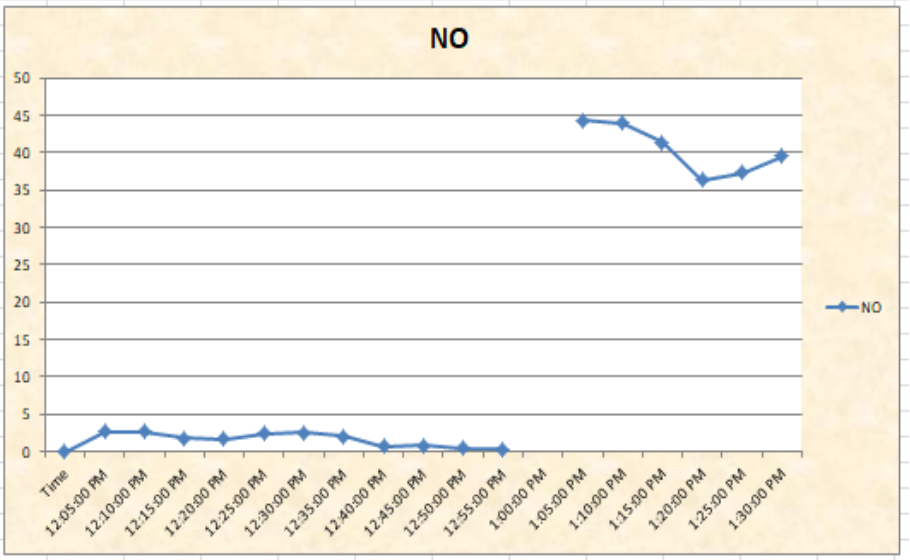
The process of remote check of calibration at Katni station was initiated simultaneously with Gwalior station at 12.08 pm. The parameters considered for the exercise were Nitrogen oxide, Sulphur dioxide, Carbon monoxide, Ozone and Particulate matters, i.e. PM_{10} and $PM_{2.5}$.

Firstly the NO analyser was checked for its genuineness. The span value of NO was observed to be 36 ppb against the given concentration of 40 ppb. The value during zero calibration was recorded as 0.7 ppb for NO. Thus the result was well within the range of acceptable deviation. The process, including calibrator and communication with analyser, is depicted in fig. 2.4 and 2.5.



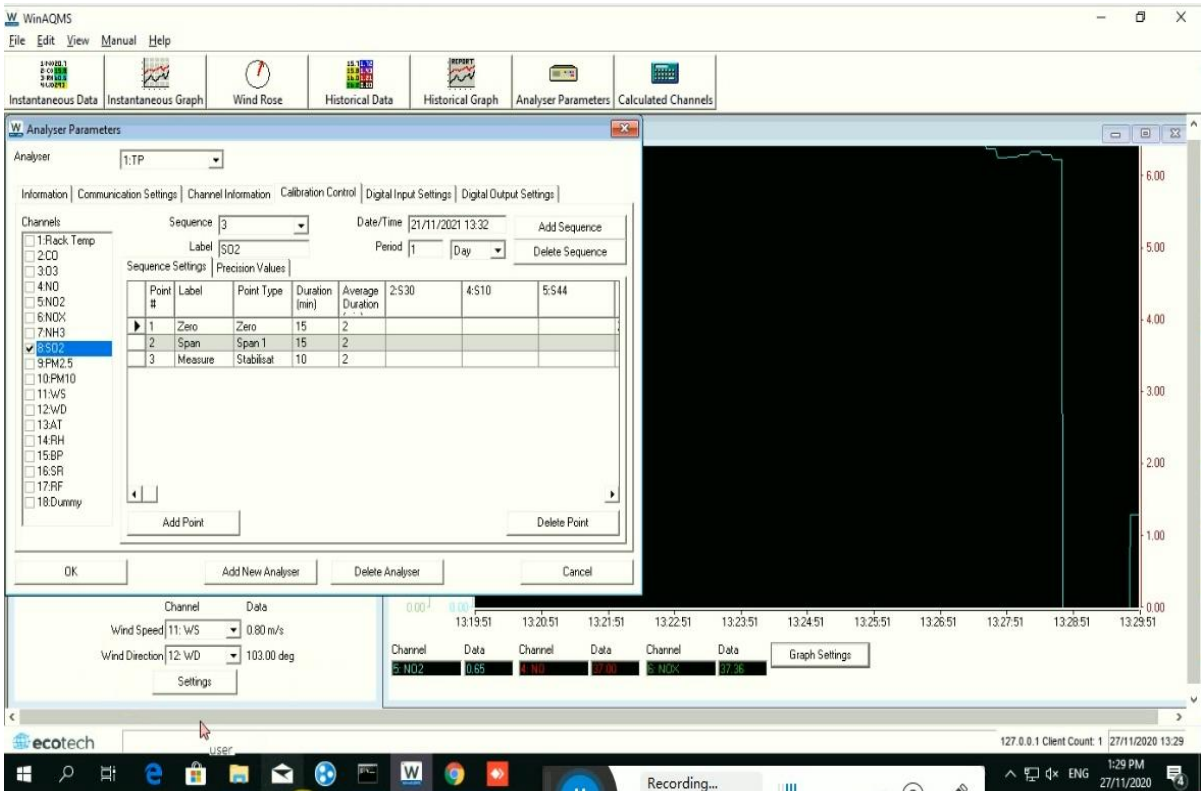
2.4 - Remote check of calibration of NOx analyzer

Time	NO
12:05:00 PM	2.69
12:10:00 PM	2.65
12:15:00 PM	1.81
12:20:00 PM	1.72
12:25:00 PM	2.41
12:30:00 PM	2.55
12:35:00 PM	2.03
12:40:00 PM	0.7
12:45:00 PM	0.76
12:50:00 PM	0.42
12:55:00 PM	0.37
1:00:00 PM	
1:05:00 PM	44.38
1:10:00 PM	43.95
1:15:00 PM	41.36
1:20:00 PM	36.35
1:25:00 PM	37.31
1:30:00 PM	39.53



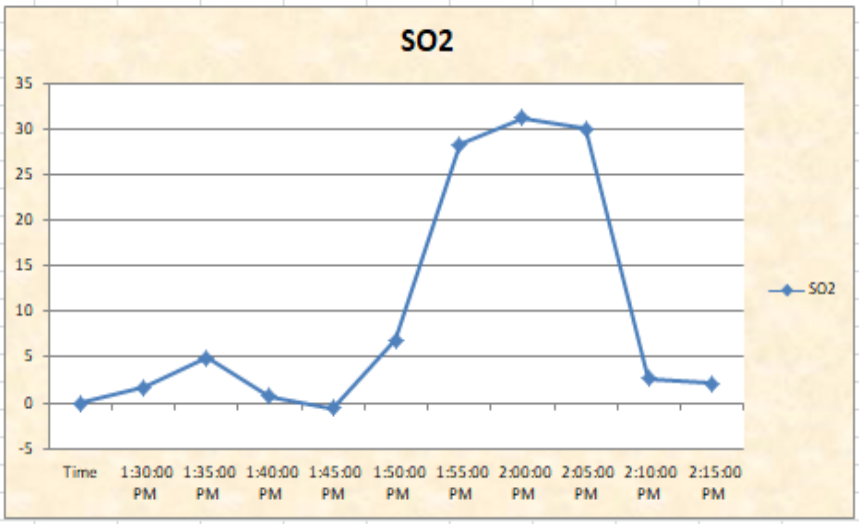
2.5 - Performance check of NOx analyzer against specified test concentration

This was followed by calibration check of SO_2 analyser. The timings for calibration control were set as 15 minutes for zero check, 15 minutes for span check and 10 minutes for stabilization, as shown in the fig. 2.6.



2.6 - Remote check of calibration of SO_2 analyzer

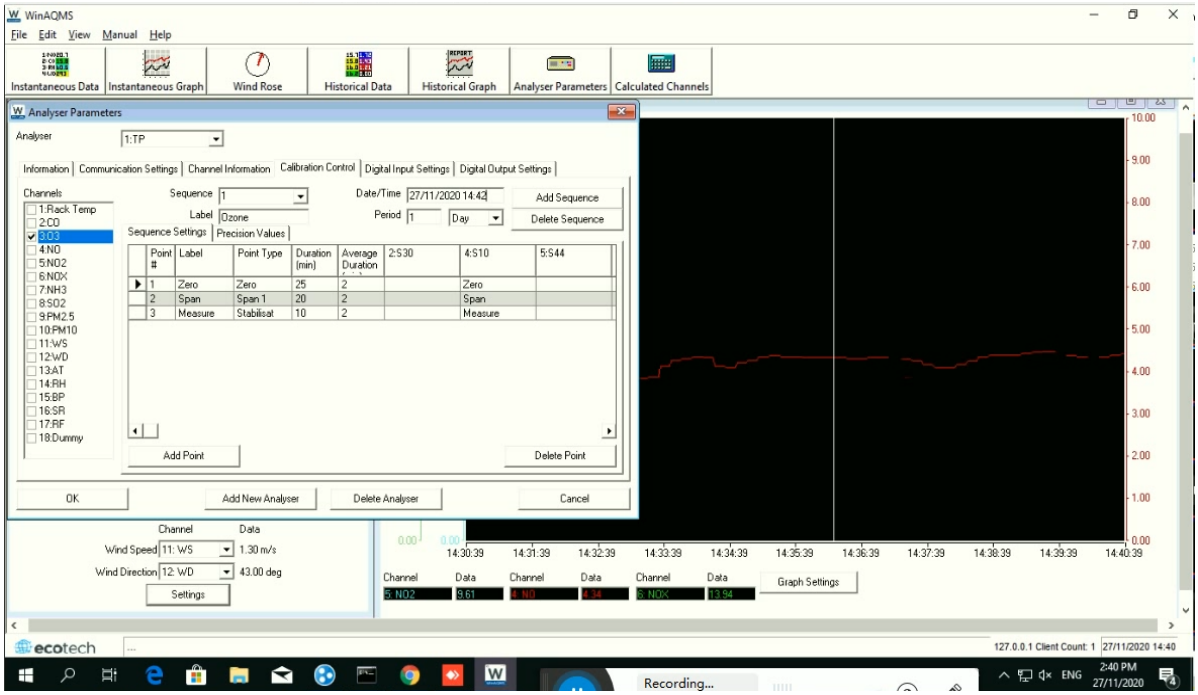
Time	SO2
1:30:00 PM	1.73
1:35:00 PM	4.91
1:40:00 PM	0.71
1:45:00 PM	-0.56
1:50:00 PM	6.87
1:55:00 PM	28.35
2:00:00 PM	31.18
2:05:00 PM	30.01
2:10:00 PM	2.71
2:15:00 PM	2.16



2.7 - Performance check of SO_2 analyzer against specified test concentration

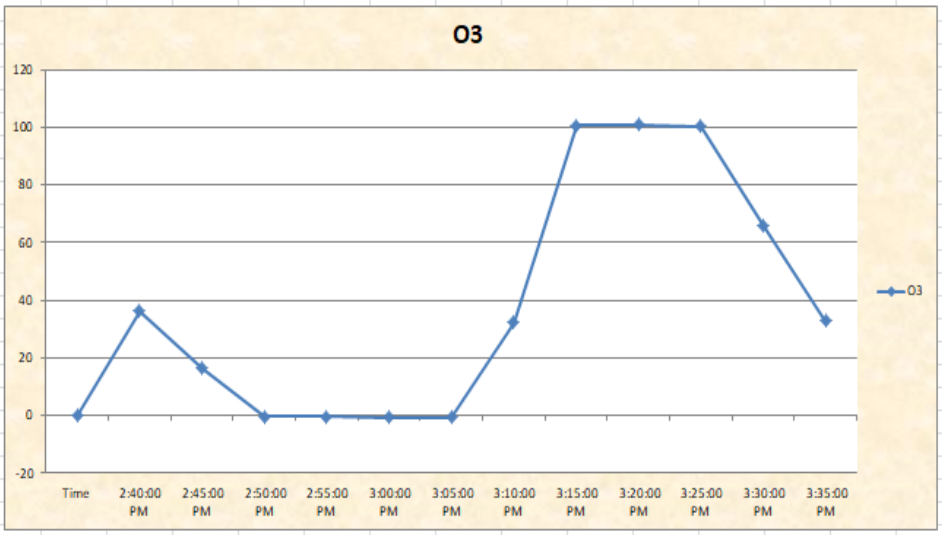
The span value for SO_2 was set to 30 ppb which was read as 29.8 ppb by analyser during calibration check. The zero run showed the value of SO_2 to be -0.80 ppb. Thus, both the values were found well within the deviation range indicating that the analyser is performing to its accuracy. Fig. 2.7

Next the ozone analyser was checked for its performance at 1442 hrs. The time set for Zero check was 25 minutes, span gas concentration check as 20 minutes and stabilization time as 10 minutes and the span gas concentration as 100 ppb for testing. The analyser recorded the value of span gas as 101.48 against the set conc. of 100 ppb. The zero check recorded the ozone conc. as - 0.53 ppb. Both these checks were found well within the deviation range proving the performance of ozone analyser as 'satisfactory'. Graphical views are depicted in fig. 2.8 and 2.9.



2.8 - Remote check of calibration of Ozone analyzer

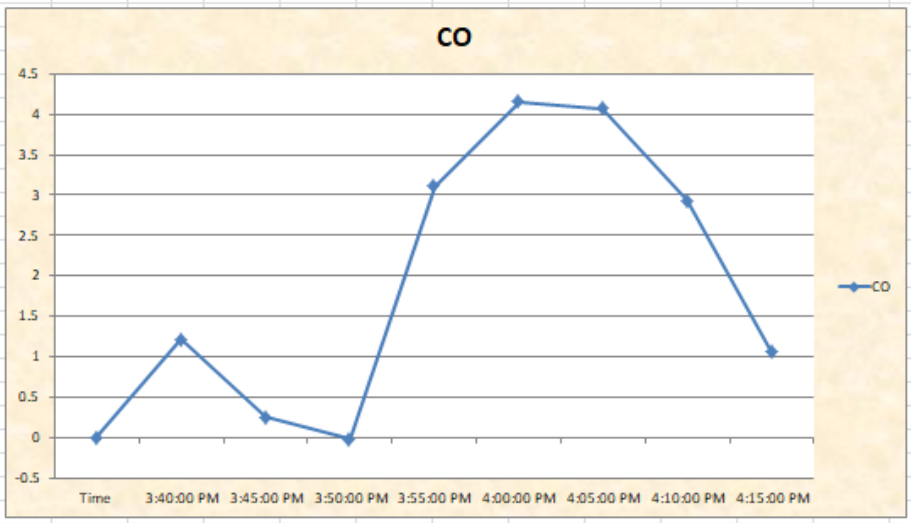
Time	O3
2:40:00 PM	36.34
2:45:00 PM	16.35
2:50:00 PM	-0.24
2:55:00 PM	-0.25
3:00:00 PM	-0.66
3:05:00 PM	-0.6
3:10:00 PM	32.41
3:15:00 PM	100.69
3:20:00 PM	101.09
3:25:00 PM	100.52
3:30:00 PM	65.85
3:35:00 PM	32.85



2.9 - Performance check of Ozone analyzer against specified test concentration

The accuracy of CO analyser was checked at 1540 hrs on the same day setting the zero calibration time 10 minutes and span gas check 15 minutes. The test concentration was set as 4.0 ppm. The ozone value recorded by analyser for zero calibration was – 0.05 ppm and for span calibration it was 4.07 ppm. The analyser values were found well within the stated deviation range hence the performance is considered to be satisfactory. Fig. 2.10

Time	CO
3:40:00 PM	1.22
3:45:00 PM	0.25
3:50:00 PM	-0.02
3:55:00 PM	3.11
4:00:00 PM	4.16
4:05:00 PM	4.07
4:10:00 PM	2.93
4:15:00 PM	1.06



2.10 - Performance check of CO analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters**. This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Ujjain

CAAQMS location : Mahakaleshwar Temple premises

Date : 27/11/2020

Remote end support :

Regional office, Ujjain - Sh. Pratim Khare, Scientist and Sh. H.S. Sharma, Jr. Scientist

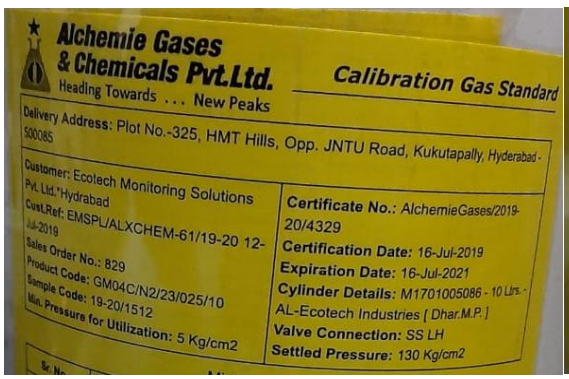
Service Provider – Shri Abdhesh Pratap Singh and Shri Ajay Rawat

3.1 – CAAQM Station

3.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 4771 ppm
- Nitrogen oxides (NOx) - 54.98 mpp
- Sulphur dioxide (SO_2) - 49.98 ppm



Parameter – NOx

Commencement time – 1450 hrs

Time set for Zero calibration – 20 min.

Observed concentration – (-) 0.34 ppb

Time set for Span gas calibration – 20 min.

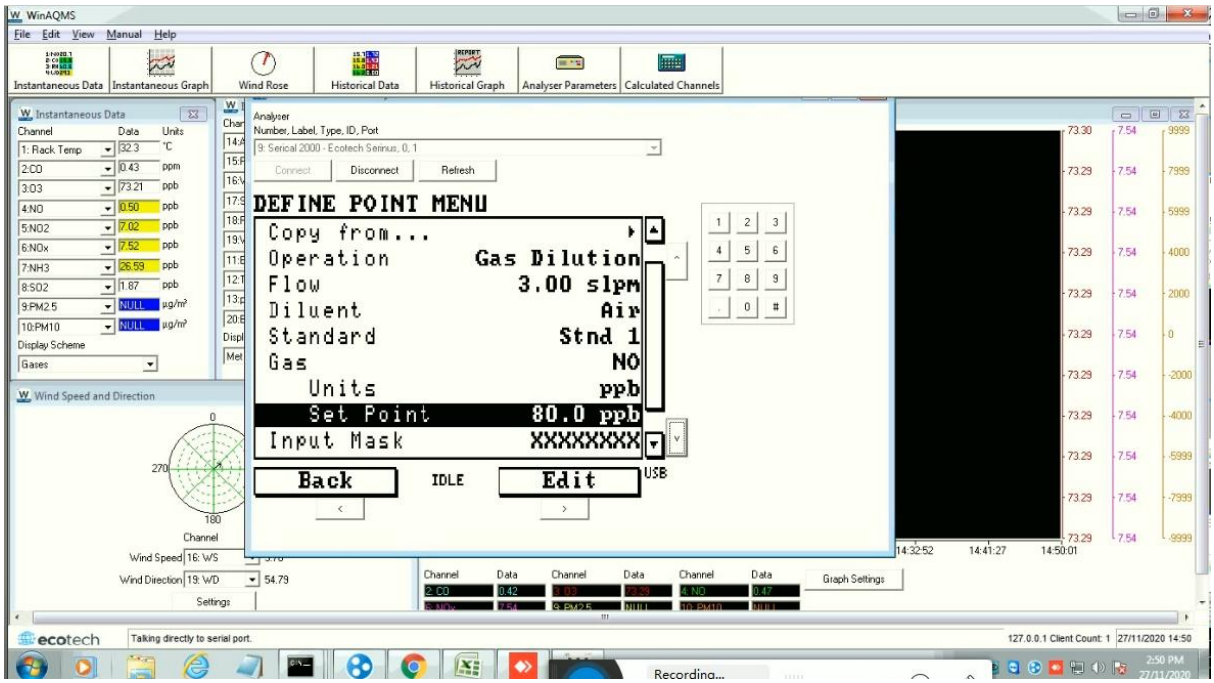
Span test concentration – 80 ppb

Observed concentration – 79.17 ppb

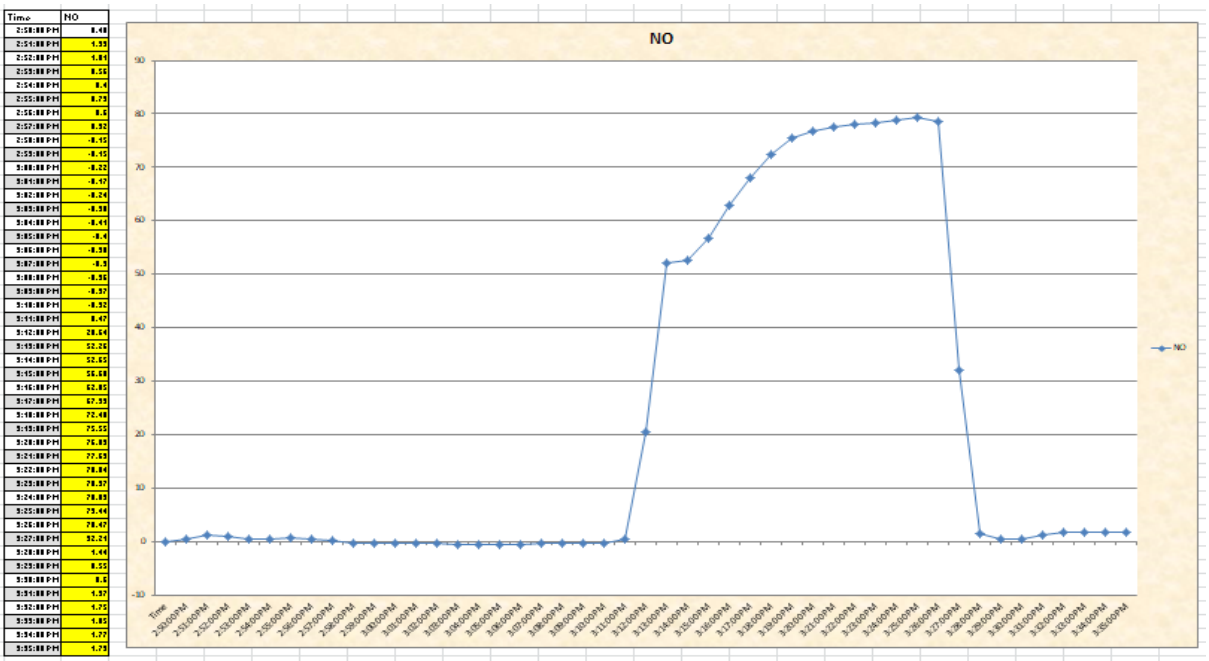
Stabilization time – 10 min.

Ref. Picture - 3.4, 3.5

Observation : Analyser Performance is Satisfactory



3.4 - Remote check of calibration of NOx analyzer



3.5 - Performance check of NOx analyzer against specified test concentration

Parameter – CO

Commencement time – 1450 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.05 ppb

Time set for Span gas calibration – 15 min.

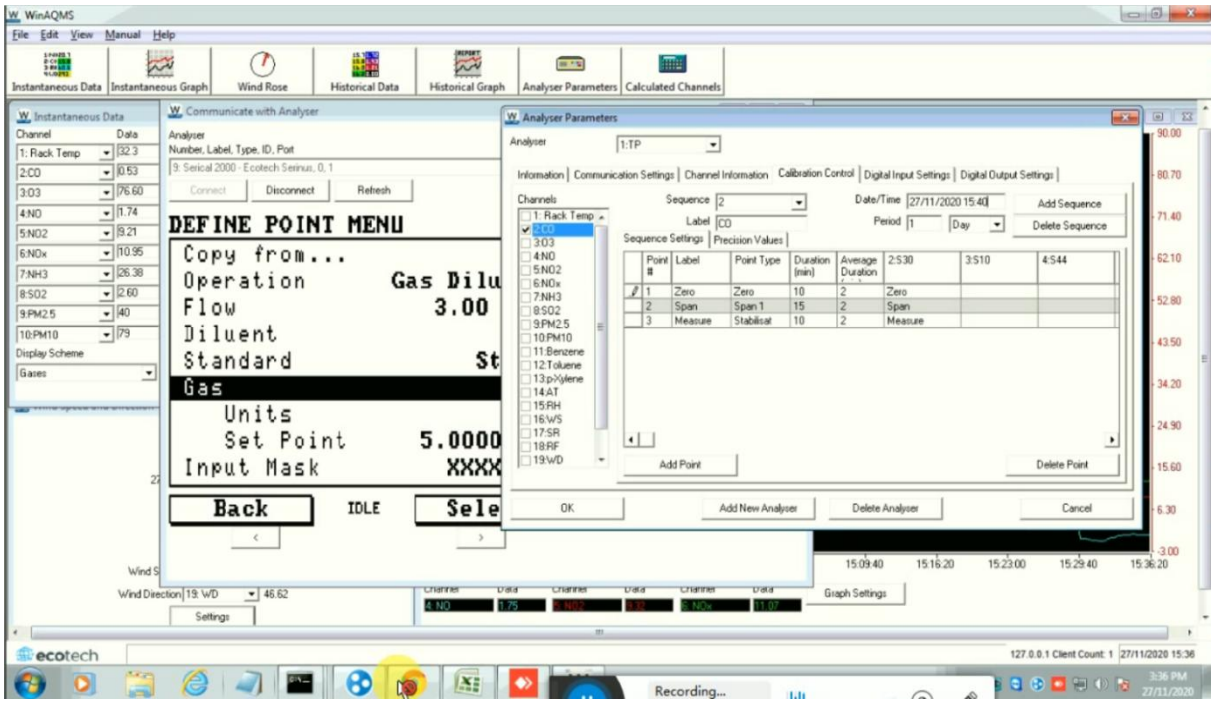
Span test concentration – 80 ppb

Observed concentration – 79.17 ppb

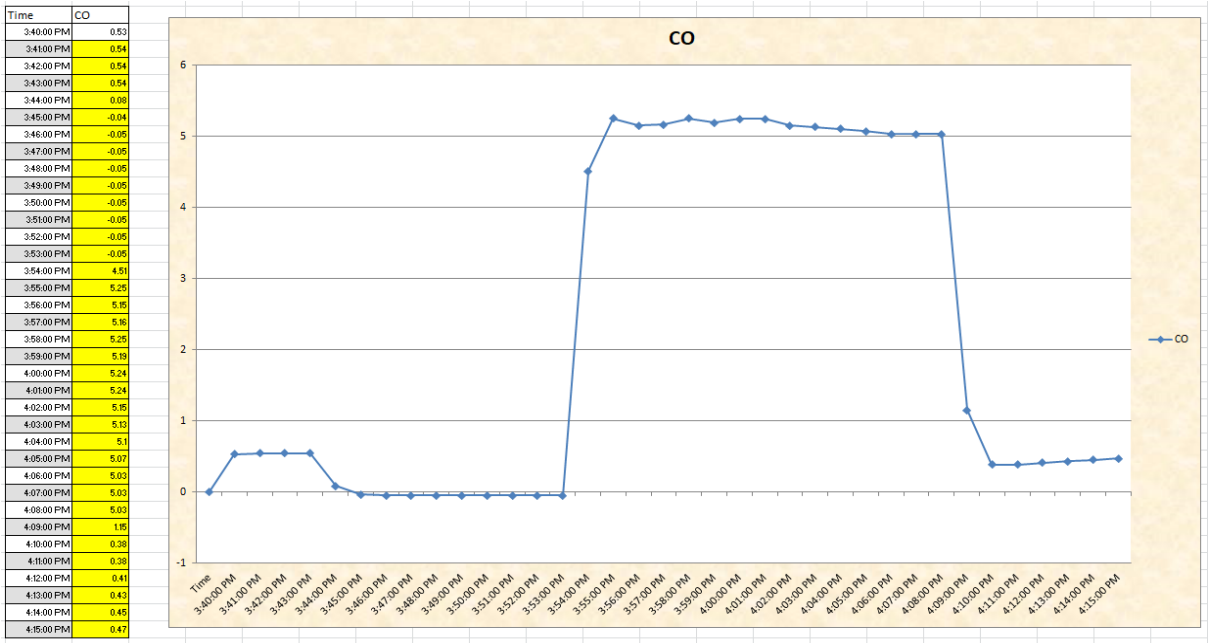
Stabilization time – 10 min.

Ref. Picture – 3.6, 3.7

Observation : Analyser Performance is Satisfactory



3.6 - Remote check of calibration of CO analyzer



3.7 - Performance check of CO analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1620 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 2.65 ppb

Time set for Span gas calibration – 10 min.

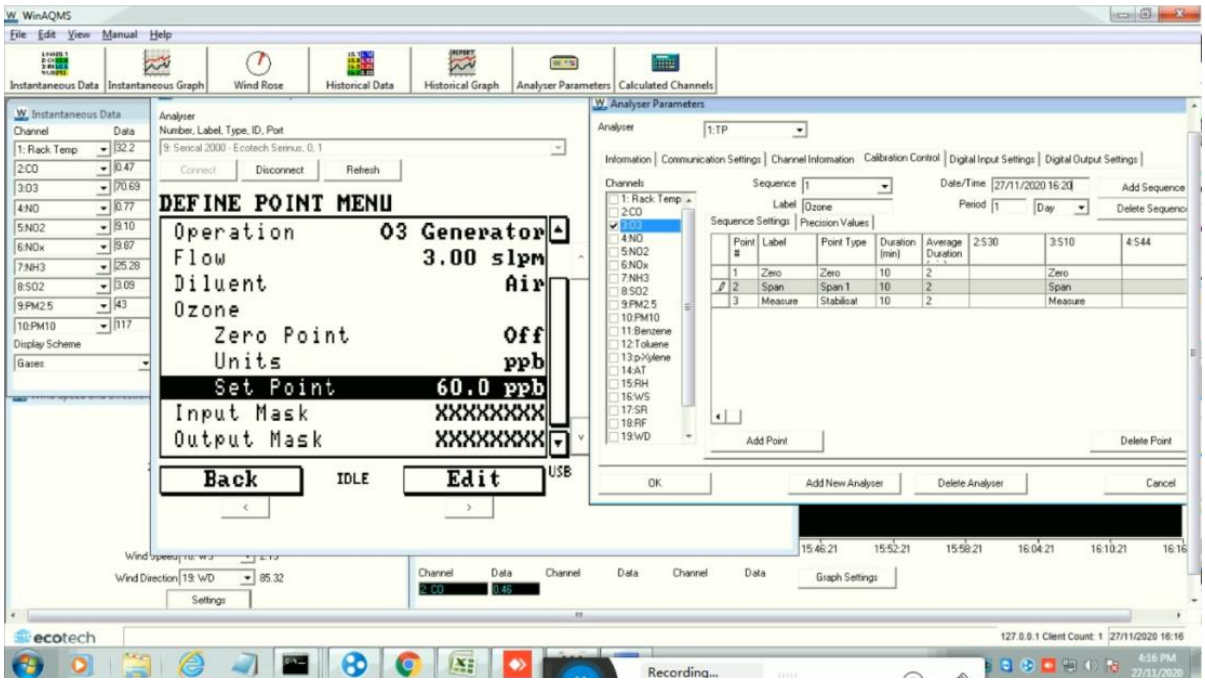
Span test concentration – 60 ppb

Observed concentration – 54.04 ppb

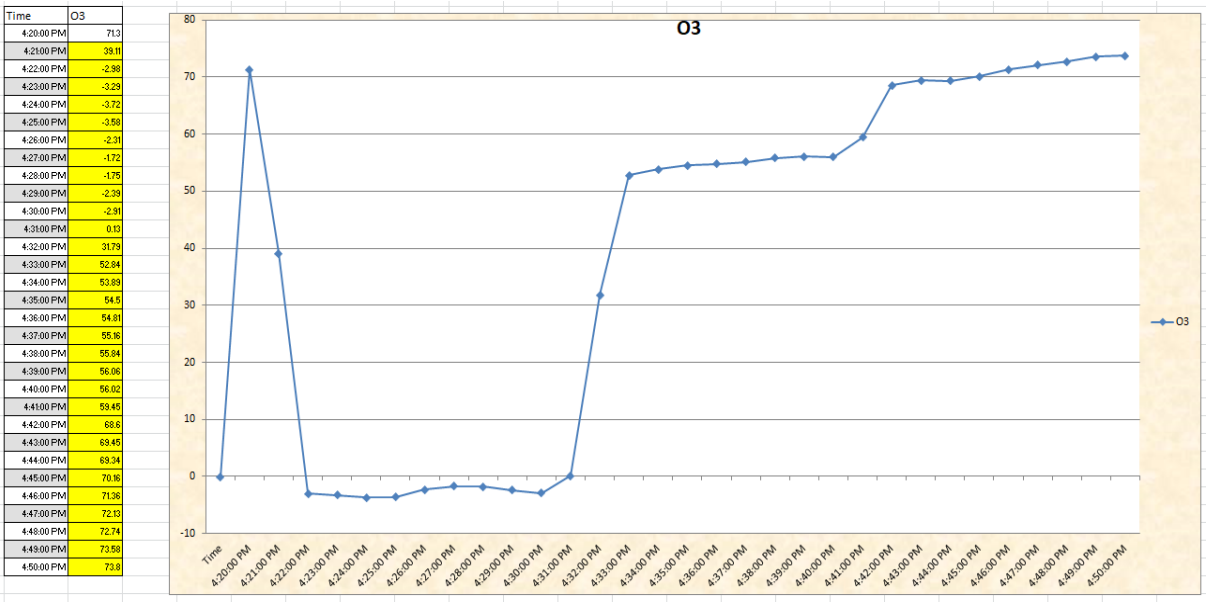
Stabilization time – 10 min.

Ref. Picture – 3.8, 3.9

Observation : Analyser Performance is Satisfactory



3.8 - Remote check of calibration of Ozone analyzer



3.9 - Performance check of Ozone analyzer against specified test concentration

Parameter – SO_2

Commencement time – 1700hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.05 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 30 ppb

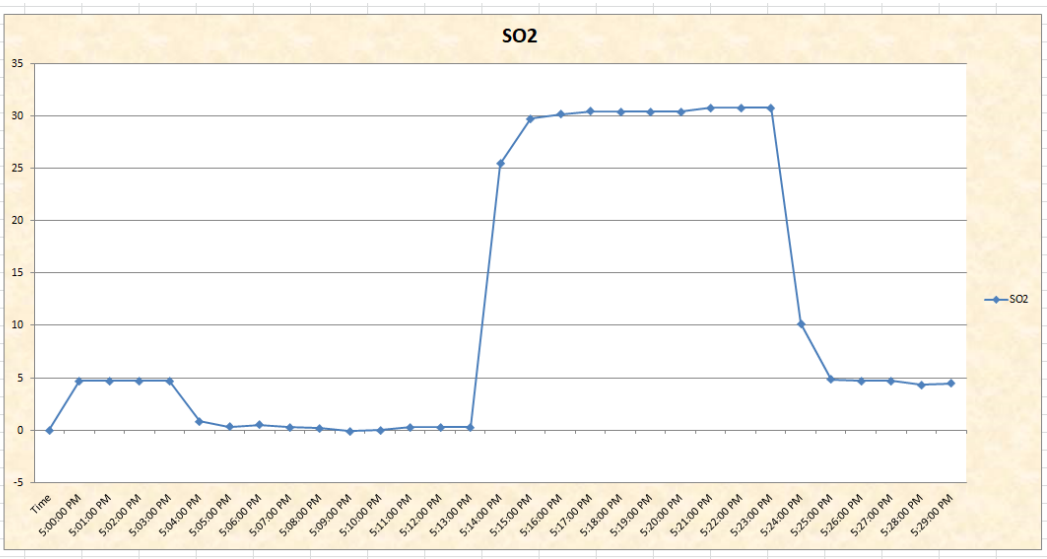
Observed concentration – 30.39 ppb

Stabilization time – 10 min.

Ref. Picture – 3.10

Observation : Analyser Performance is Satisfactory

Time	SO2
5:00:00 PM	4.71
5:01:00 PM	4.7
5:02:00 PM	4.7
5:03:00 PM	4.7
5:04:00 PM	0.65
5:05:00 PM	0.32
5:06:00 PM	0.52
5:07:00 PM	0.3
5:08:00 PM	0.19
5:09:00 PM	-0.08
5:10:00 PM	-0.03
5:11:00 PM	0.27
5:12:00 PM	0.27
5:13:00 PM	0.27
5:14:00 PM	25.46
5:15:00 PM	29.73
5:16:00 PM	30.18
5:17:00 PM	30.45
5:18:00 PM	30.41
5:19:00 PM	30.4
5:20:00 PM	30.38
5:21:00 PM	30.76
5:22:00 PM	30.76
5:23:00 PM	30.76
5:24:00 PM	10.15
5:25:00 PM	4.86
5:26:00 PM	4.7
5:27:00 PM	4.68
5:28:00 PM	4.3
5:29:00 PM	4.45



3.10 - Performance check of SO_2 analyzer against specified test values

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters**. This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Bhopal

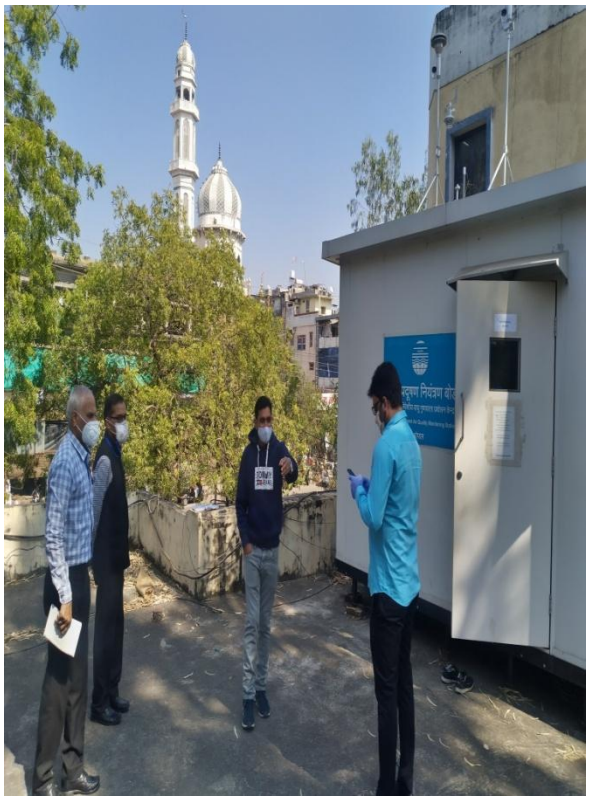
CAAQMS location : T.T. Nagar

Date : 28/11/2020

Remote end support :

MPPCB Regional office, Bhopal – Shri Jitendra Chandel, J.E. and Shri Anil.

Service Provider – Shri Abdhesh Pratap Singh and Shri JitendraVamne

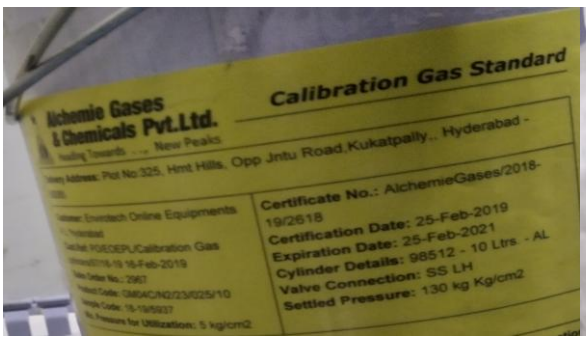


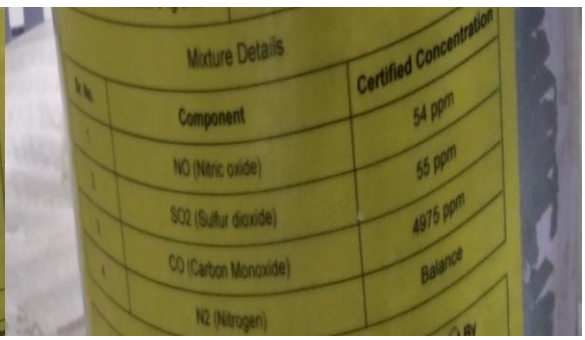
4.1 – CAAQM Station

4.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) – 4975 ppm
- Nitrogen oxides (NOx) – 54 ppm
- Sulphur dioxide (SO_2) – 55 ppm





Parameter – SO_2

Commencement time – 1335 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 1.14 ppb

Time set for Span gas calibration – 10 min.

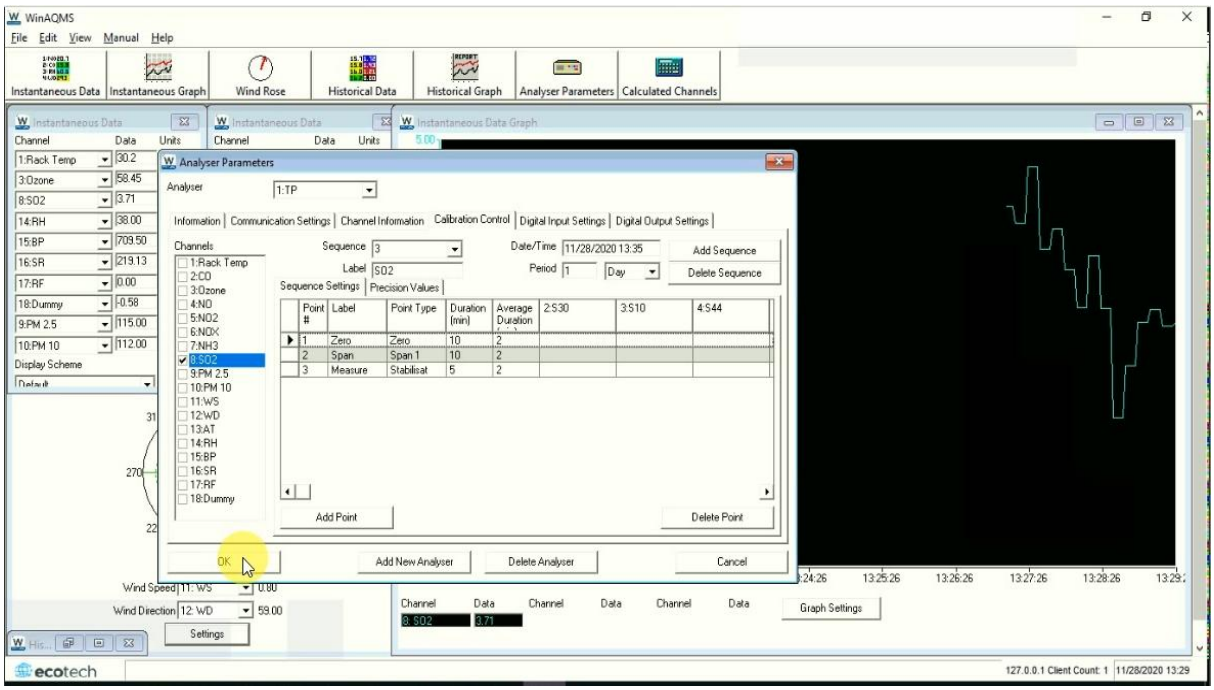
Span test concentration – 30 ppb

Observed concentration – 27.99 ppb

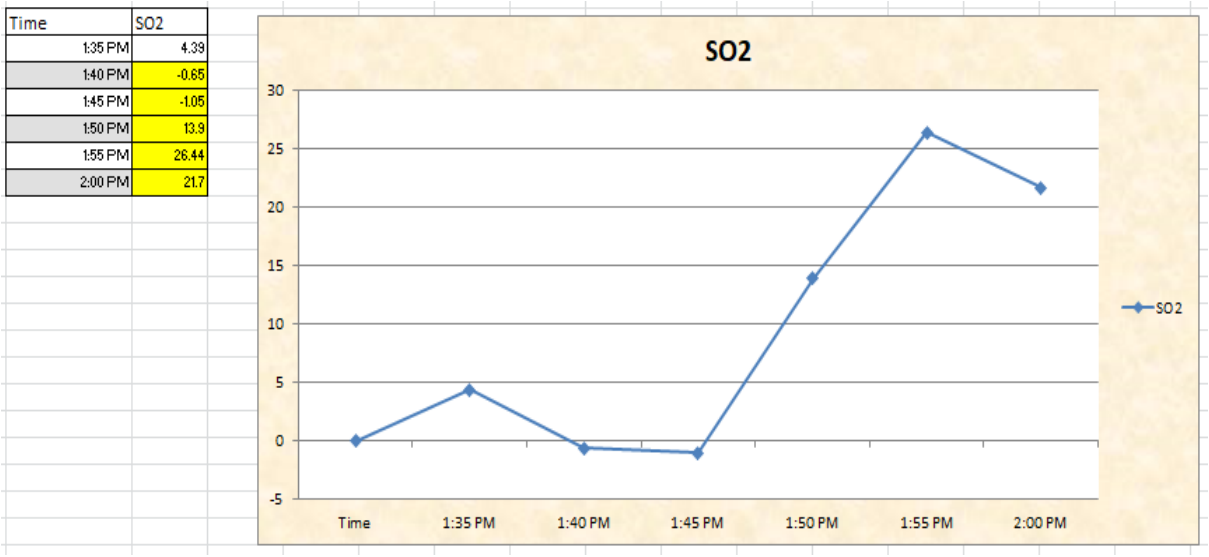
Stabilization time – 05 min.

Ref. Picture – 4.4, 4.5

Observation : Analyser Performance is Satisfactory



4.4 - Remote check of calibration of SO_2 analyzer



4.5 - Performance check of SO_2 analyzer against specified test concentration

Parameter – CO

Commencement time – 1435 hrs

Time set for Zero calibration – 15 min.

Observed concentration – (-) 0.19 ppb

Time set for Span gas calibration – 15 min.

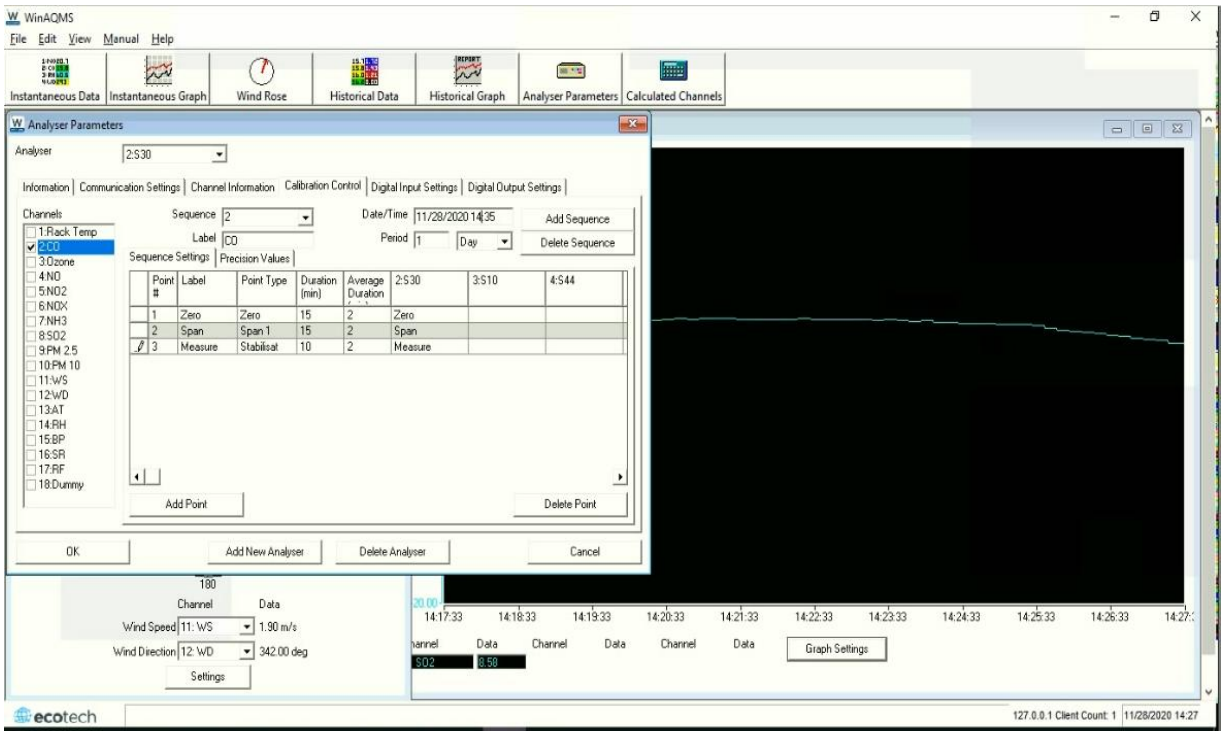
Span test concentration – 40 ppm

Observed concentration – 39.60 ppb

Stabilization time – 10 min.

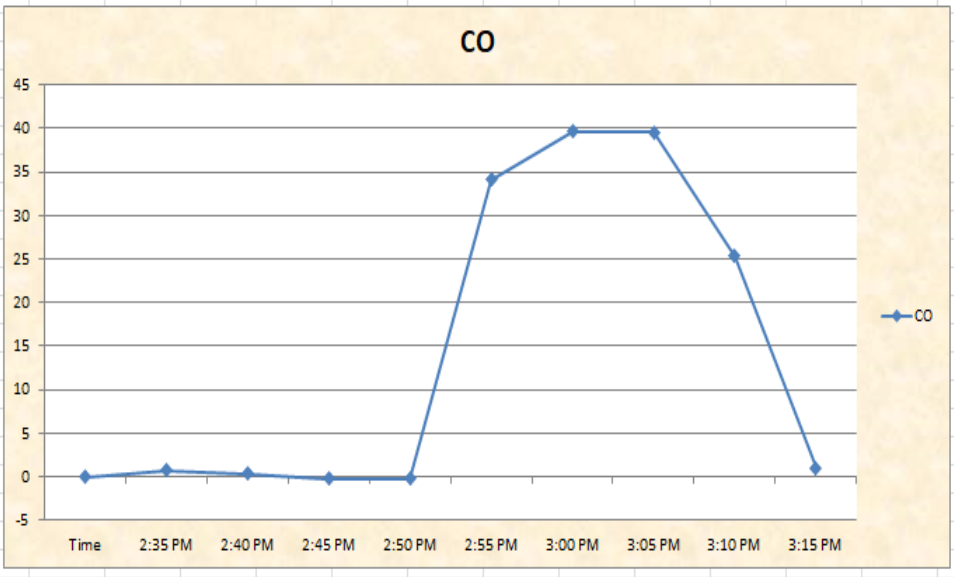
Ref. Picture – 4.6, 4.7

Observation : Analyser Performance is Satisfactory



4.6 - Remote check of calibration of CO analyzer

Time	CO
2:35 PM	0.72
2:40 PM	0.39
2:45 PM	-0.18
2:50 PM	-0.19
2:55 PM	34.12
3:00 PM	39.61
3:05 PM	39.6
3:10 PM	25.32
3:15 PM	1



4.7 - Performance check of CO analyzer against specified test concentration

Parameter – NOx

Commencement time – 1520 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.19 ppb

Time set for Span gas calibration – 10 min.

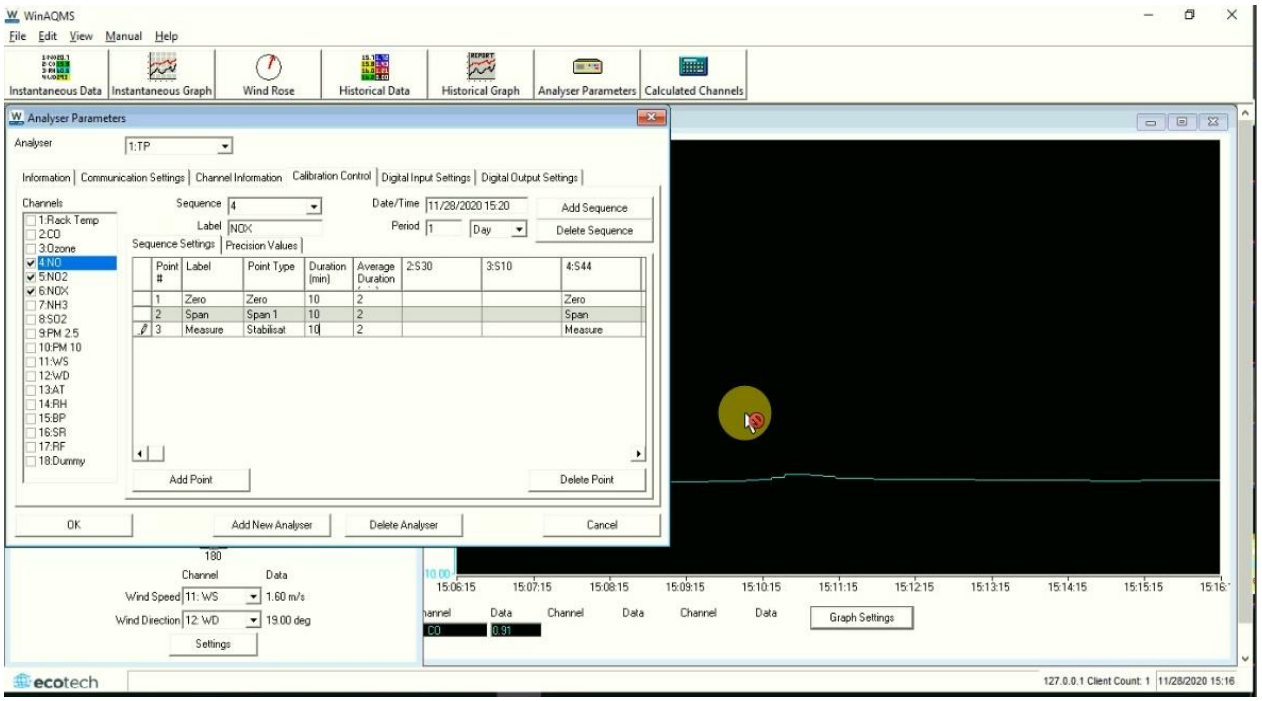
Span test concentration – 400 ppm

Observed concentration – 397.17 ppb

Stabilization time – 10 min.

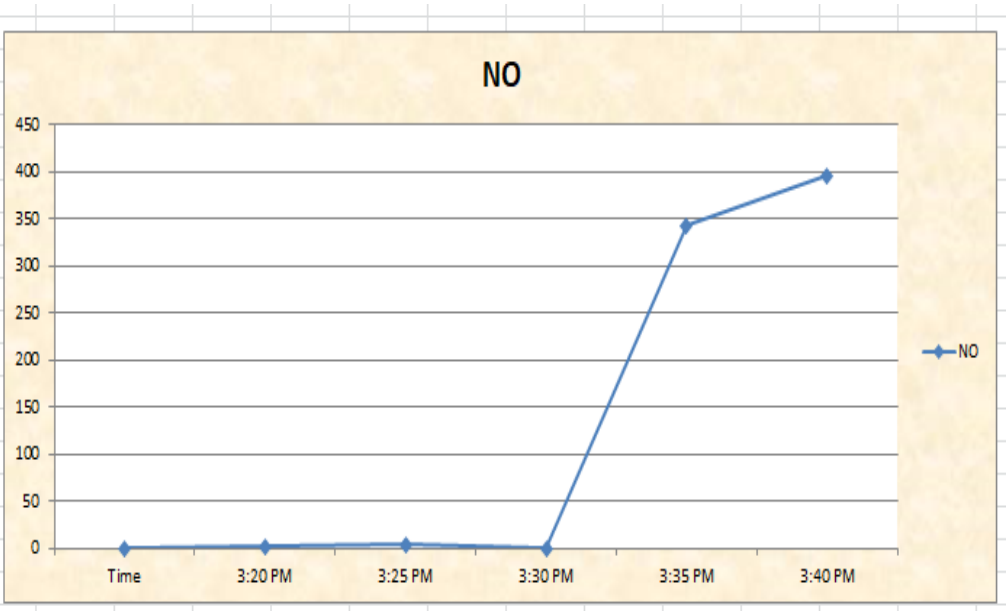
Ref. Picture – 4.8, 4.9

Observation : Analyser Performance is Satisfactory



4.8 - Remote check of calibration of NOx analyzer

Time	NO
3:20 PM	2.43
3:25 PM	3.5
3:30 PM	0.41
3:35 PM	342.75
3:40 PM	396.31



4.9 - Performance check of NOx analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1605 hrs

Time set for Zero calibration – 13 min.

Observed concentration – (-) 0.59 ppb

Time set for Span gas calibration – 13 min.

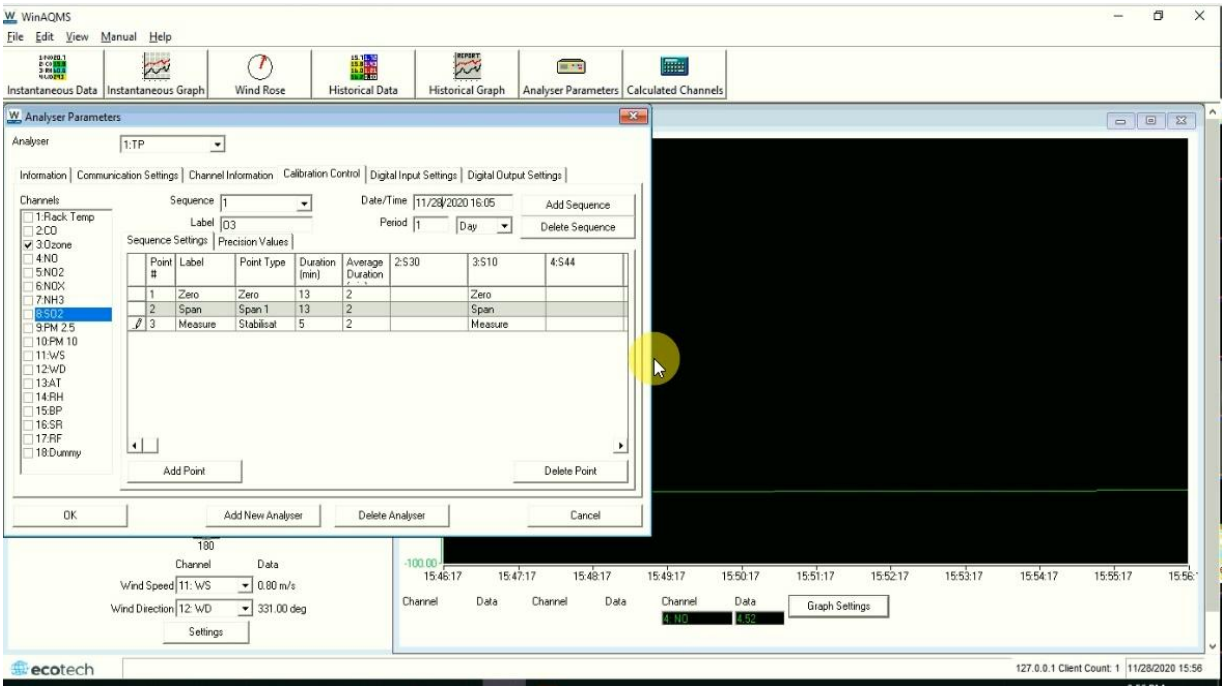
Span test concentration – 160 ppb

Observed concentration – 162.50 ppb

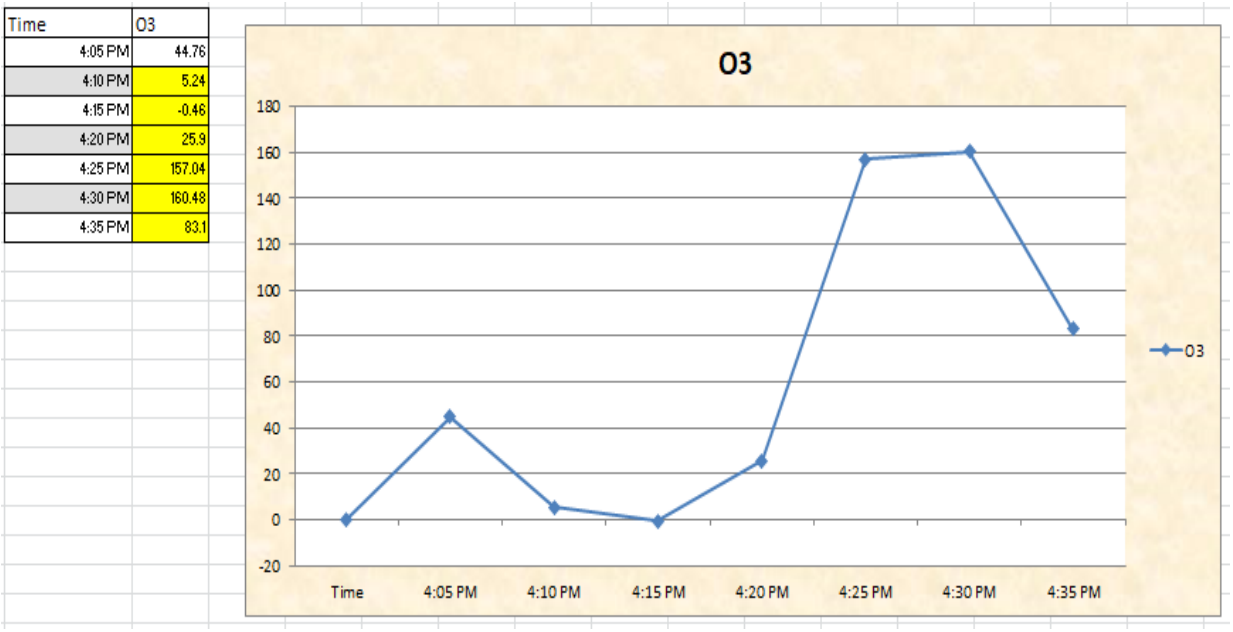
Stabilization time – 05 min.

Ref. Picture – 4.10, 4.11

Observation : Analyser Performance is Satisfactory



4.10 - Remote check of calibration of Ozone analyzer



4.11 - Performance check of Ozone analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Indore

CAAQMS location : Chhoti Gwaltoli

Date : 02/12/2020

Remote end support :

MPPCB Regional office, Indore - Shri D.K. Wagela, Chief Chemist, Smt. Padma Vyas, Scientist, Shri Atul Kotiya, Scientist and Shri R.M. Gamad, Scientist.

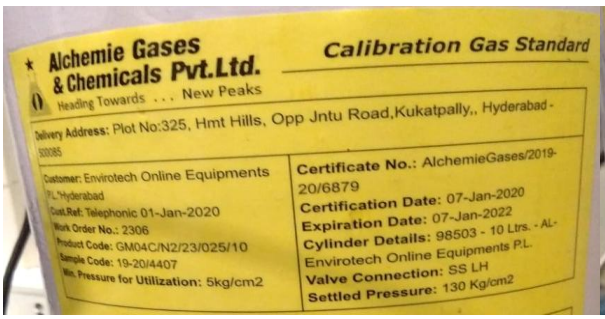
Service provider – Shri Abdhesh Pratap Singh and Shri Laxmi Narayan

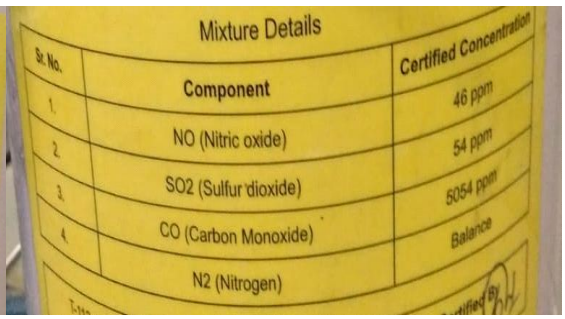
5.1 – CAAQM Station

5.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 5054 ppm
- Nitrogen oxides (NOx) - 46 ppm
- Sulphur dioxide (SO_2) - 54 ppm





Parameter – NOx

Commencement time – 1138hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.2 ppb

Time set for Span gas calibration – 10 min.

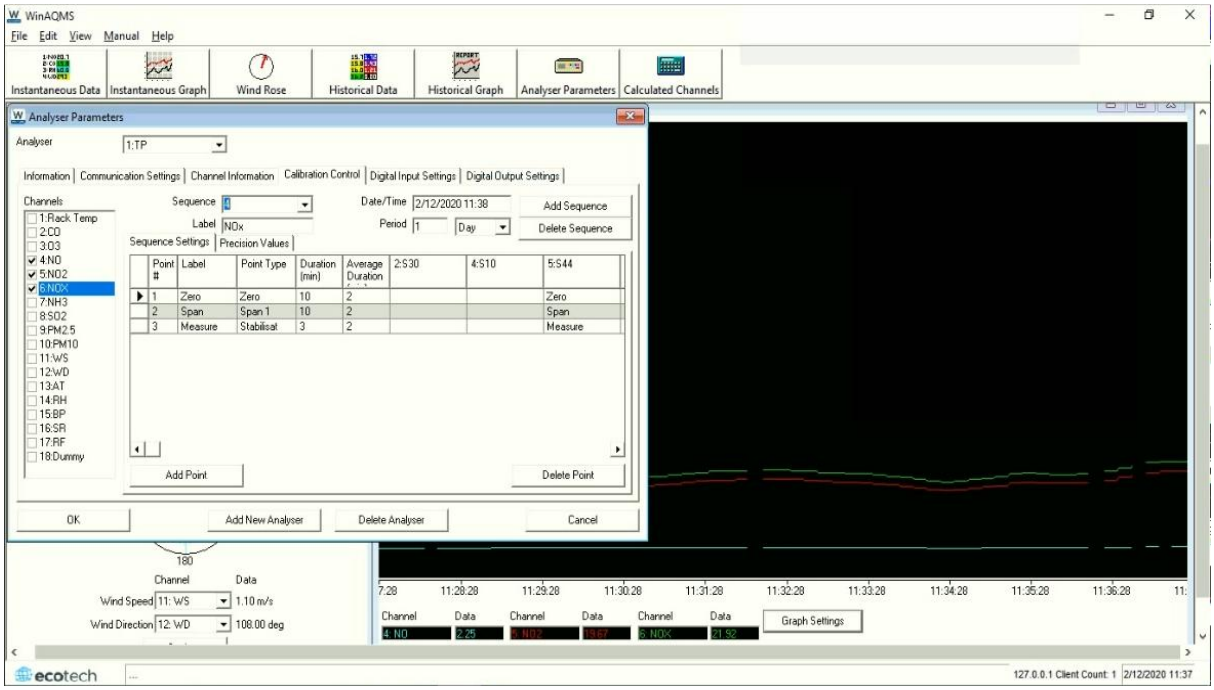
Span test concentration – 75 ppb

Observed concentration – 73.67 ppb

Stabilization time – 03 min.

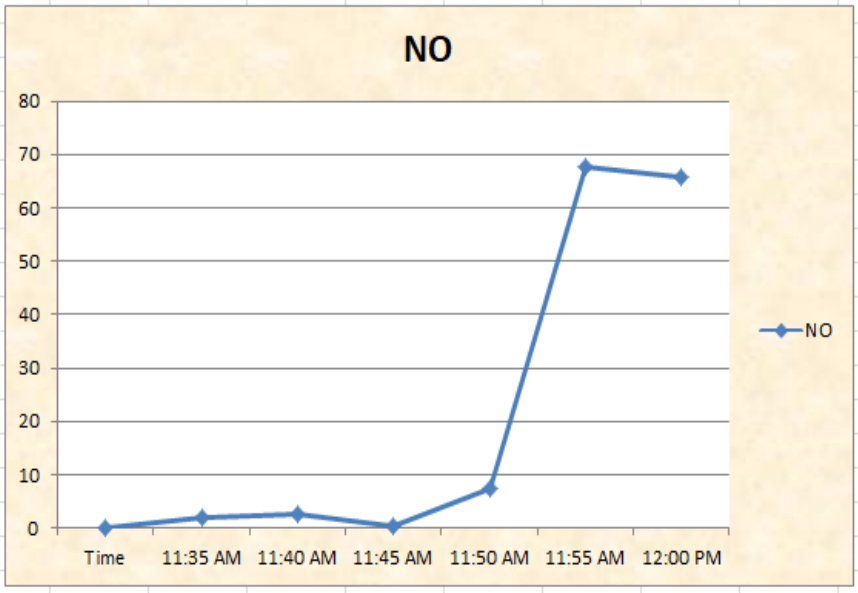
Ref. Picture – 5.4, 5.5

Observation : Analyser Performance is Satisfactory



5.4 - Remote check of calibration of NOx analyzer

Time	NO
11:35 AM	2.06
11:40 AM	2.47
11:45 AM	0.29
11:50 AM	7.43
11:55 AM	67.83
12:00 PM	65.72



5.5 - Performance check of NOx analyzer against specified test concentration

Parameter – SO_2

Commencement time – 1210 hrs

Time set for Zero calibration – 10 min.

Observed concentration – 0.12 ppb

Time set for Span gas calibration – 10 min.

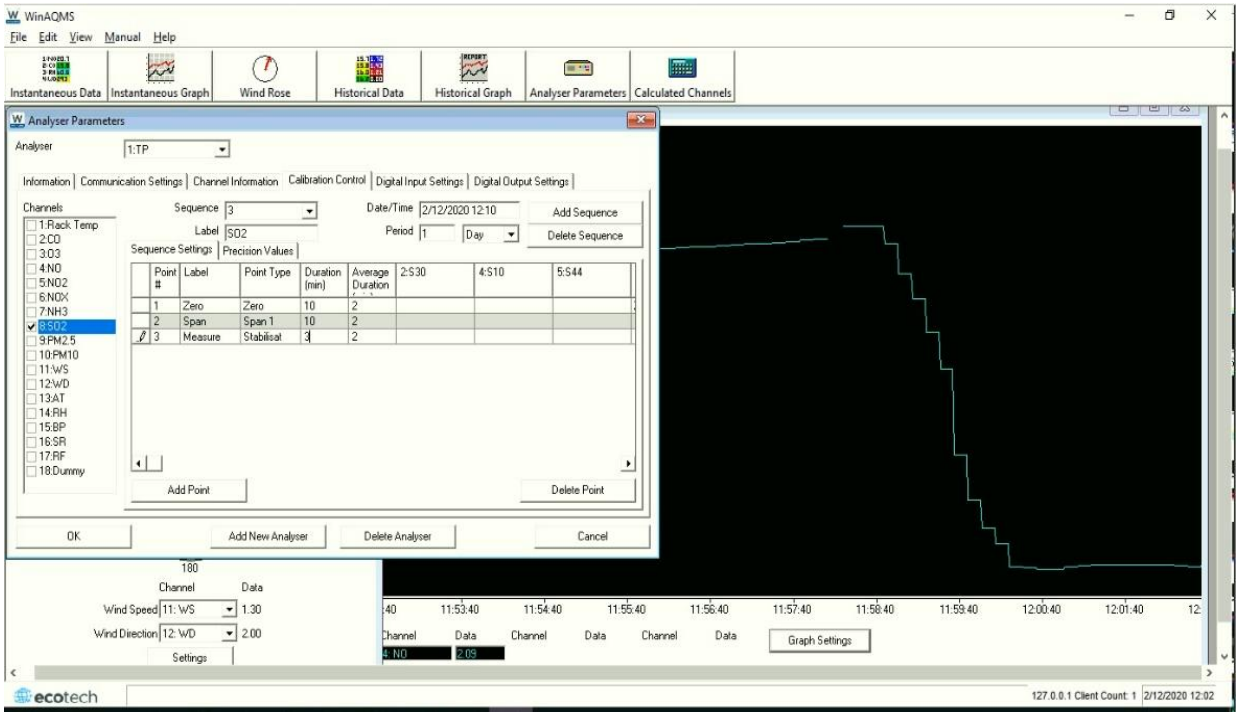
Span test concentration – 89 ppb

Observed concentration – 87.98 ppb

Stabilization time – 03 min.

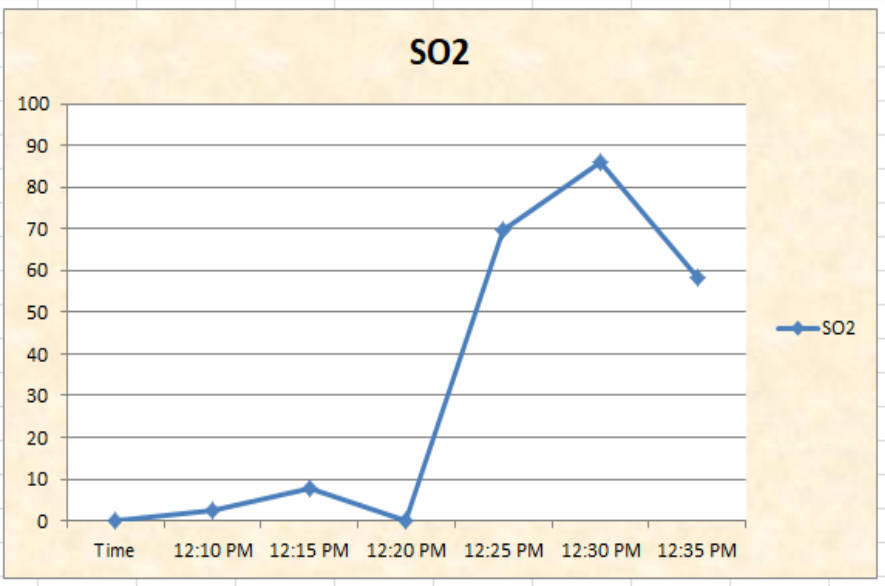
Ref. Picture – 5.6, 5.7

Observation : Analyser Performance is Satisfactory



5.6 - Remote check of calibration of SO_2 analyzer

Time	SO2
12:10 PM	2.38
12:15 PM	7.86
12:20 PM	0.04
12:25 PM	69.56
12:30 PM	85.89
12:35 PM	58.35



5.7 - Performance check of SO_2 analyzer against specified test concentration

Parameter – CO

Commencement time – 1245 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.03 ppm

Time set for Span gas calibration – 10 min.

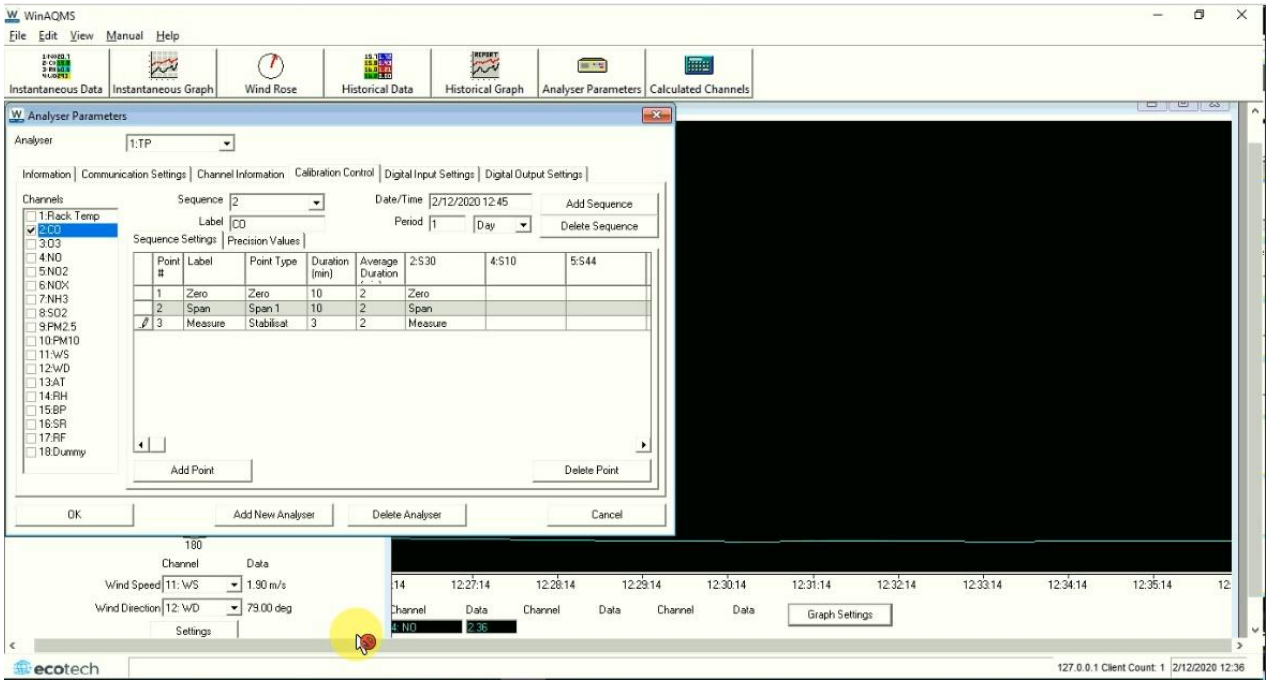
Span test concentration – 04 ppm

Observed concentration – 3.38 ppm

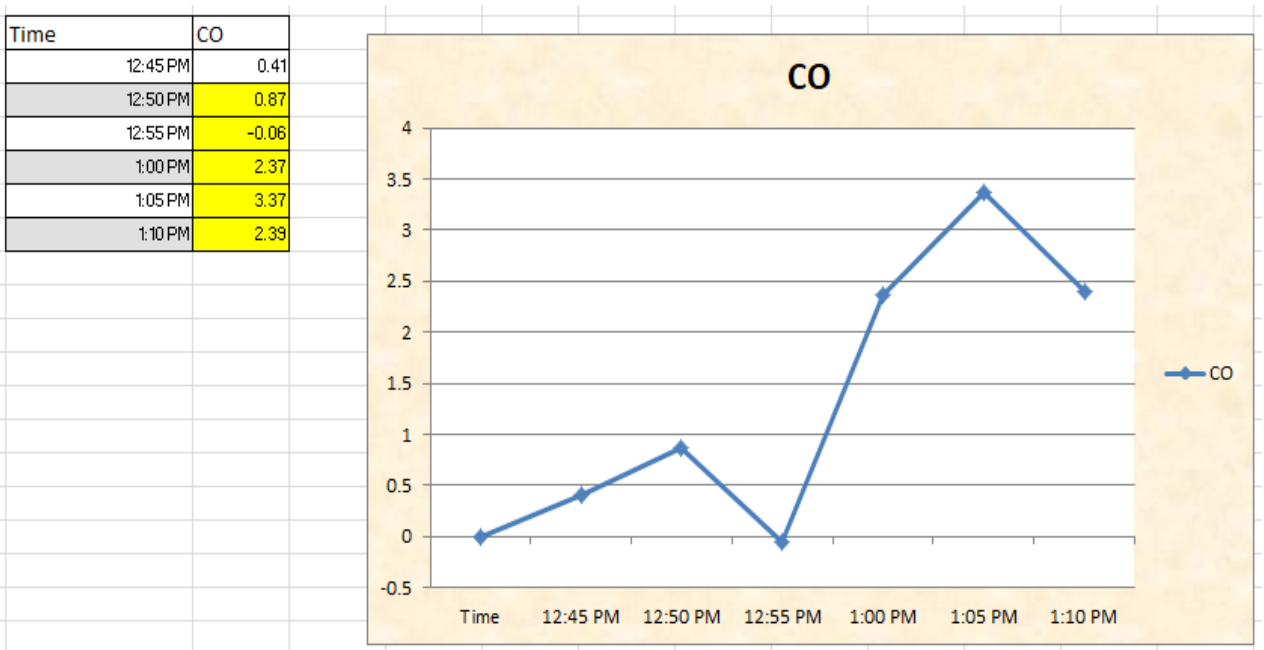
Stabilization time – 04 min.

Ref. Picture – 5.8, 5.9

Observation : Analyser Performance is Satisfactory



5.8 - Remote check of calibration of CO analyzer



Time	CO
12:45 PM	0.41
12:50 PM	0.87
12:55 PM	-0.06
1:00 PM	2.37
1:05 PM	3.37
1:10 PM	2.39

5.9 - Performance check of CO analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1330 hrs

Time set for Zero calibration – 05 min.

Observed concentration – 0.36 ppb

Time set for Span gas calibration – 10 min.

Span test concentration – 220 ppb

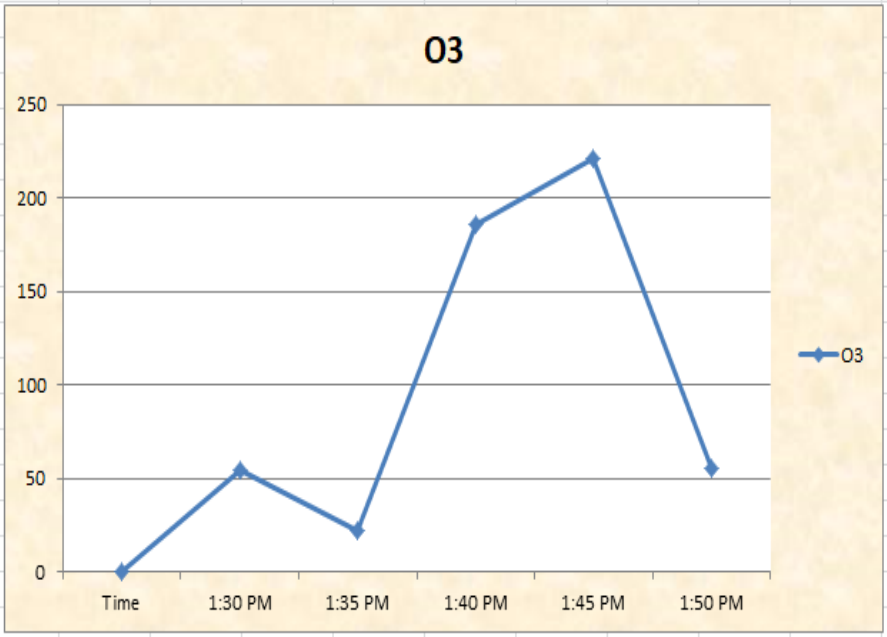
Observed concentration – 221.70 ppb

Stabilization time – 03 min.

Ref. Picture – 5.10

Observation : Analyser Performance is Satisfactory

Time	O3
1:30 PM	54.29
1:35 PM	22.17
1:40 PM	185.92
1:45 PM	221.48
1:50 PM	55.46



5.10 - Performance check of ozone analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration, viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Jabalpur

CAAQMS location : Marhatal

Date : 02/12/2020

Remote end support :

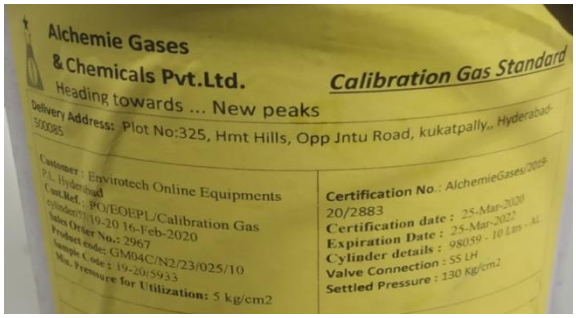
MPPCB Regional office, Jabalpur –Shri Sunil Khare, Scientist, ShriV.K. Baghel, Scientist, Shri Brijendra Singh, Jr. Scientist
Service Provider – Shri Abdhesh Pratap Singh and ShriVipin Jaiswal

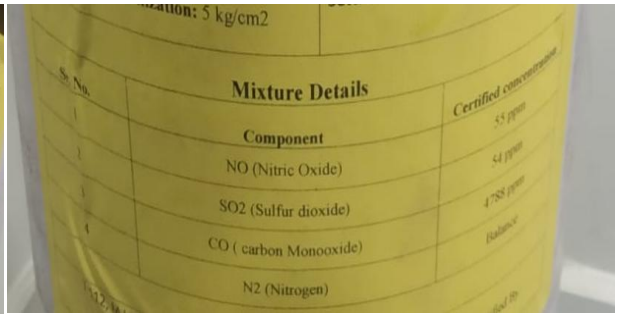
6.1 – CAAQM Station

6.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 4788 ppm
- Nitrogen oxides (NOx) – 55 ppm
- Sulphur dioxide (SO_2) – 54 ppm





Parameter – SO_2

Commencement time – 1230 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.32 ppb

Time set for Span gas calibration – 10 min.

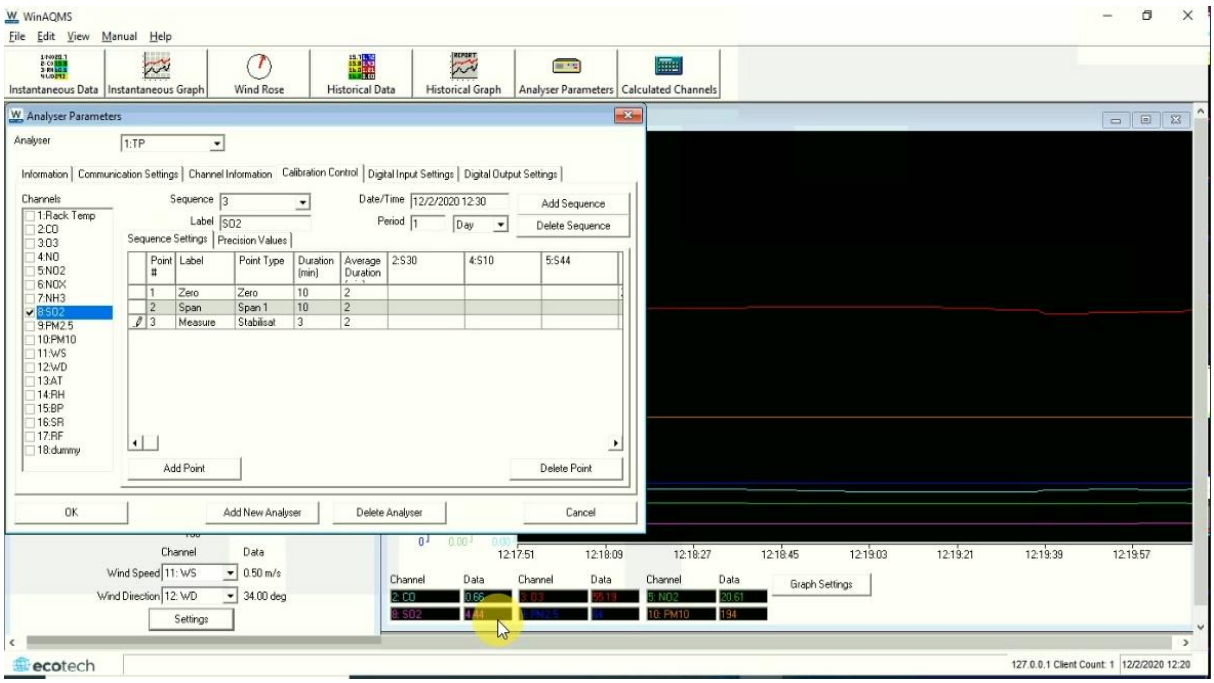
Span test concentration – 102 ppb

Observed concentration – 97.52 ppb

Stabilization time – 03 min.

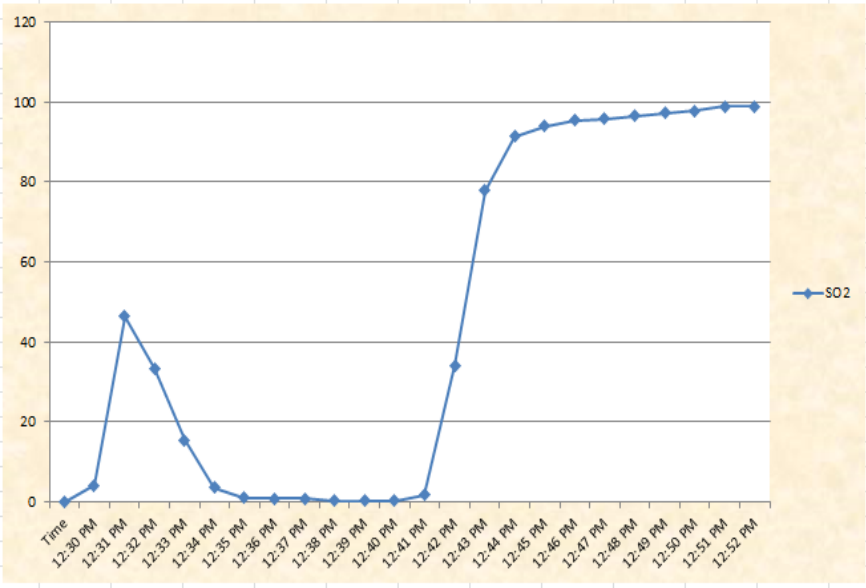
Ref. Picture – 6.4, 6.5

Observation : Analyser Performance is Satisfactory



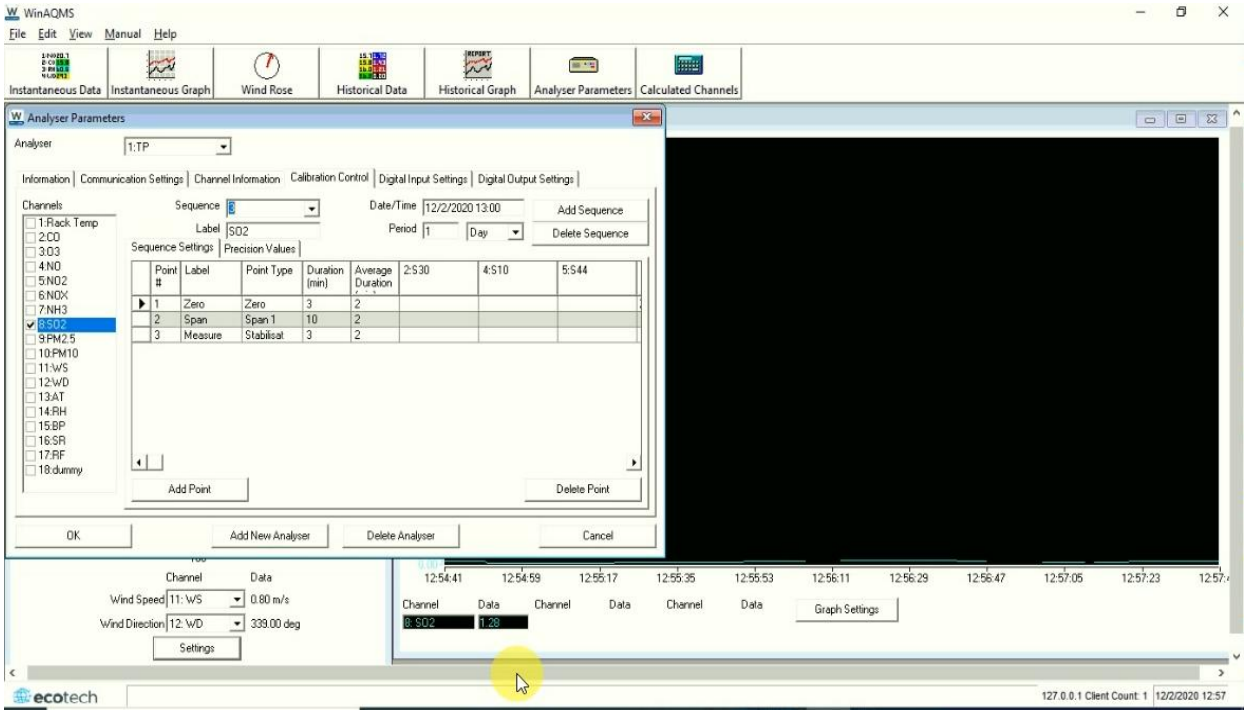
6.4 - Remote check of calibration of SO_2 analyzer

Time	SO2
12:30 PM	4.05
12:31 PM	46.43
12:32 PM	33.49
12:33 PM	15.53
12:34 PM	3.54
12:35 PM	1
12:36 PM	0.78
12:37 PM	0.83
12:38 PM	0.32
12:39 PM	0.37
12:40 PM	0.27
12:41 PM	1.83
12:42 PM	34.19
12:43 PM	77.81
12:44 PM	91.33
12:45 PM	94.04
12:46 PM	95.45
12:47 PM	95.84
12:48 PM	96.45
12:49 PM	97.17
12:50 PM	97.88
12:51 PM	98.86
12:52 PM	98.86



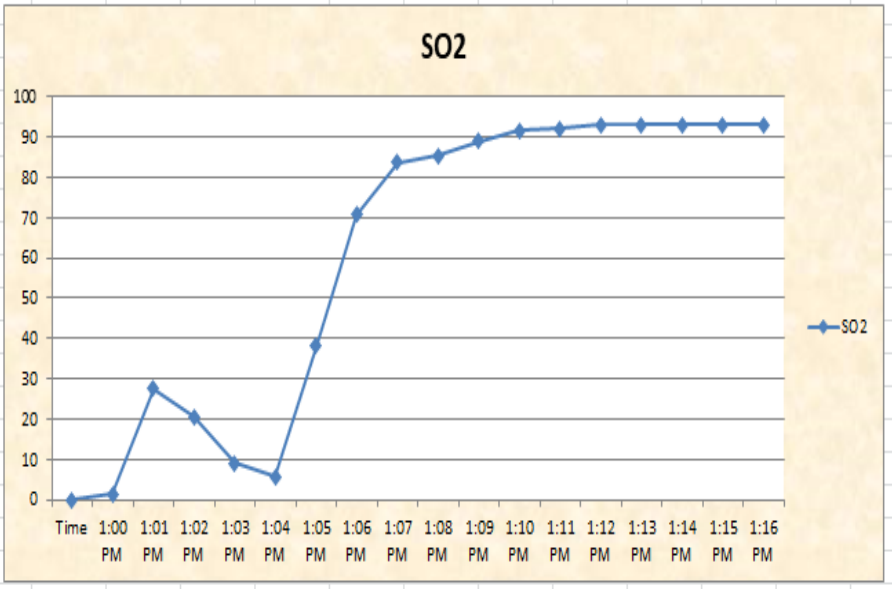
6.5 - Performance check of SO_2 analyzer against specified test concentration

Parameter – SO_2 (Repeated)
Commencement time – 1305 hrs
Time set for Zero calibration – 03 min.
Observed concentration – (-) 0.32 ppb
Time set for Span gas calibration – 10 min.
Span test concentration – 93 ppb
Observed concentration – 92.96 ppb
Stabilization time – 03 min.
Ref. Picture – 6.6, 6.7
Observation : Analyser Performance is Satisfactory



6.6 - Remote check of calibration of SO_2 analyzer

Time	SO2
1:00 PM	1.25
1:01 PM	27.49
1:02 PM	20.62
1:03 PM	9.07
1:04 PM	5.65
1:05 PM	38.09
1:06 PM	70.72
1:07 PM	83.65
1:08 PM	85.36
1:09 PM	88.85
1:10 PM	91.63
1:11 PM	92.13
1:12 PM	92.9
1:13 PM	93.01
1:14 PM	92.98
1:15 PM	92.98
1:16 PM	92.98



6.7 - Performance check of SO_2 analyzer against specified test concentration

Parameter – NOx

Commencement time – 1325 hrs

Time set for Zero calibration – 05 min.

Observed concentration – 1.16 ppb

Time set for Span gas calibration – 10 min.

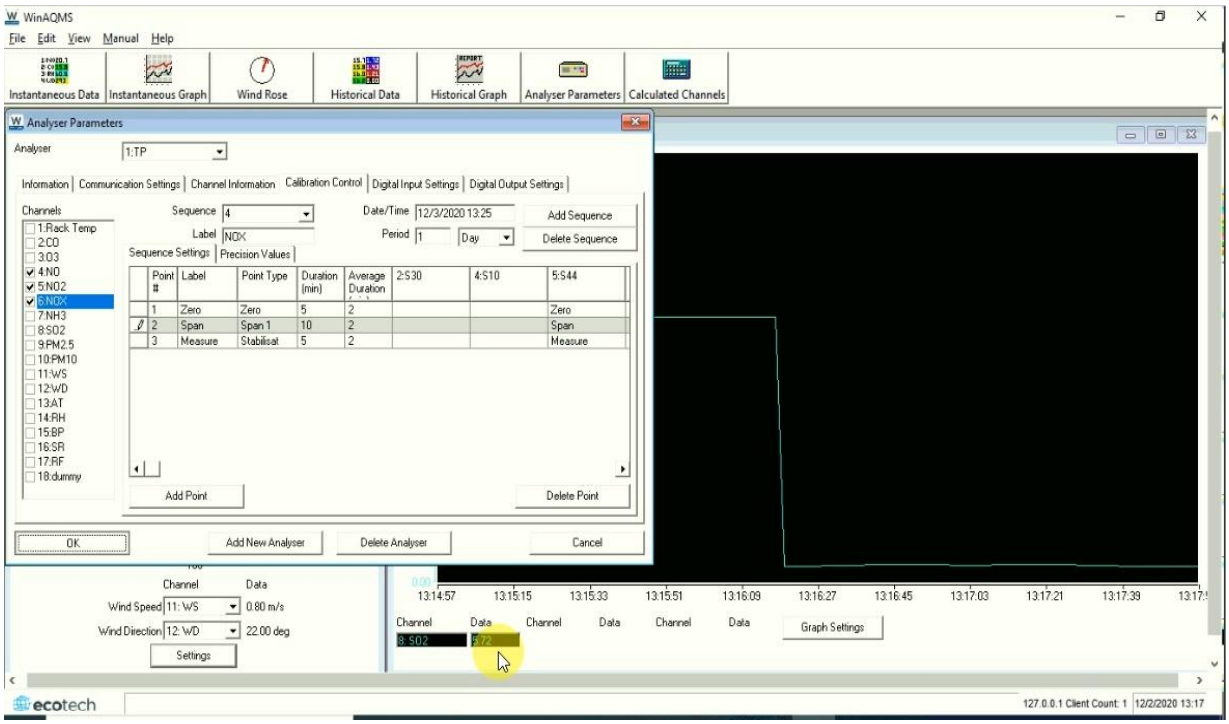
Span test concentration – 147 ppb

Observed concentration – 144.45 ppb

Stabilization time – 05 min.

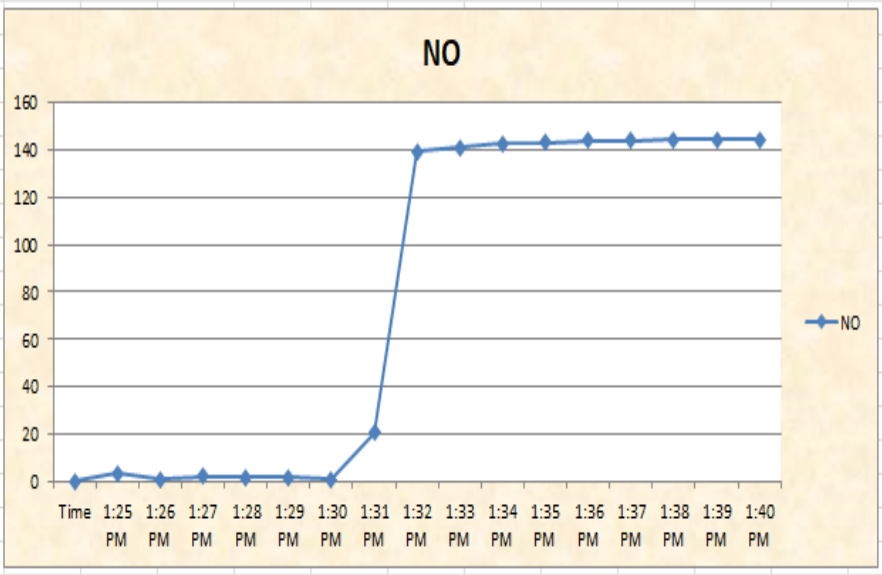
Ref. Picture – 6.8, 6.9

Observation : Analyser Performance is Satisfactory



6.8 - Remote check of calibration of NOx analyzer

Time	NO
1:25 PM	3.38
1:26 PM	0.85
1:27 PM	2.14
1:28 PM	1.9
1:29 PM	1.48
1:30 PM	0.85
1:31 PM	20.45
1:32 PM	139.3
1:33 PM	140.92
1:34 PM	142.76
1:35 PM	143.02
1:36 PM	143.92
1:37 PM	144.1
1:38 PM	144.4
1:39 PM	144.36
1:40 PM	144.54



6.9 - Performance check of NOx analyzer against specified test concentration

Parameter – CO

Commencement time – 1348 hrs

Time set for Zero calibration – 05 min.

Observed concentration – 0.15 ppm

Time set for Span gas calibration – 15 min.

Span test concentration – 04 ppm

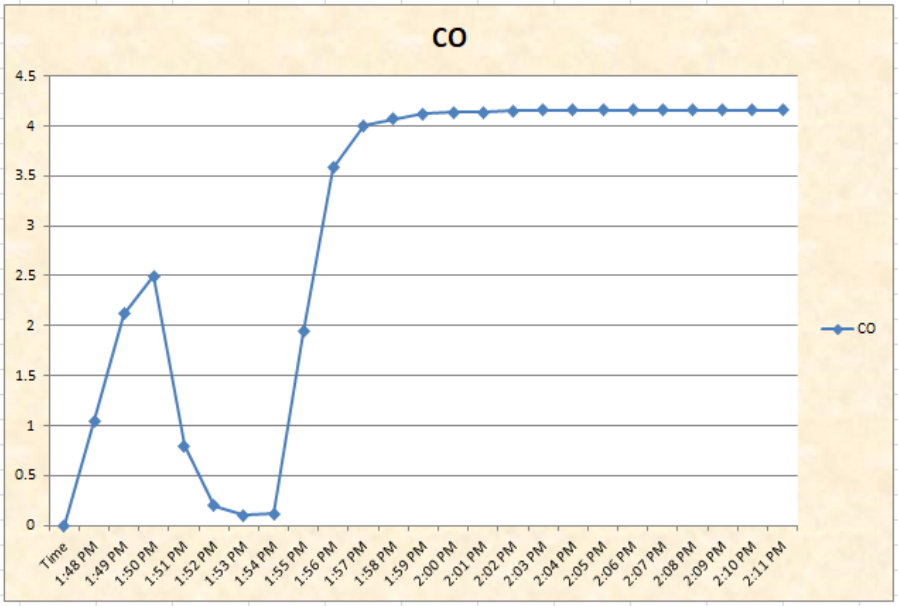
Observed concentration – 4.16 ppm

Stabilization time – 03 min.

Ref. Picture – 6.10

Observation : Analyser Performance is Satisfactory

Time	CO
1:48 PM	1.05
1:49 PM	2.12
1:50 PM	2.5
1:51 PM	0.8
1:52 PM	0.2
1:53 PM	0.1
1:54 PM	0.12
1:55 PM	1.94
1:56 PM	3.58
1:57 PM	4
1:58 PM	4.07
1:59 PM	4.12
2:00 PM	4.14
2:01 PM	4.14
2:02 PM	4.15
2:03 PM	4.16
2:04 PM	4.16
2:05 PM	4.16
2:06 PM	4.16
2:07 PM	4.16
2:08 PM	4.16
2:09 PM	4.16
2:10 PM	4.16
2:11 PM	4.16



6.10 - Performance check of CO analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1415hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.25 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 177 ppb

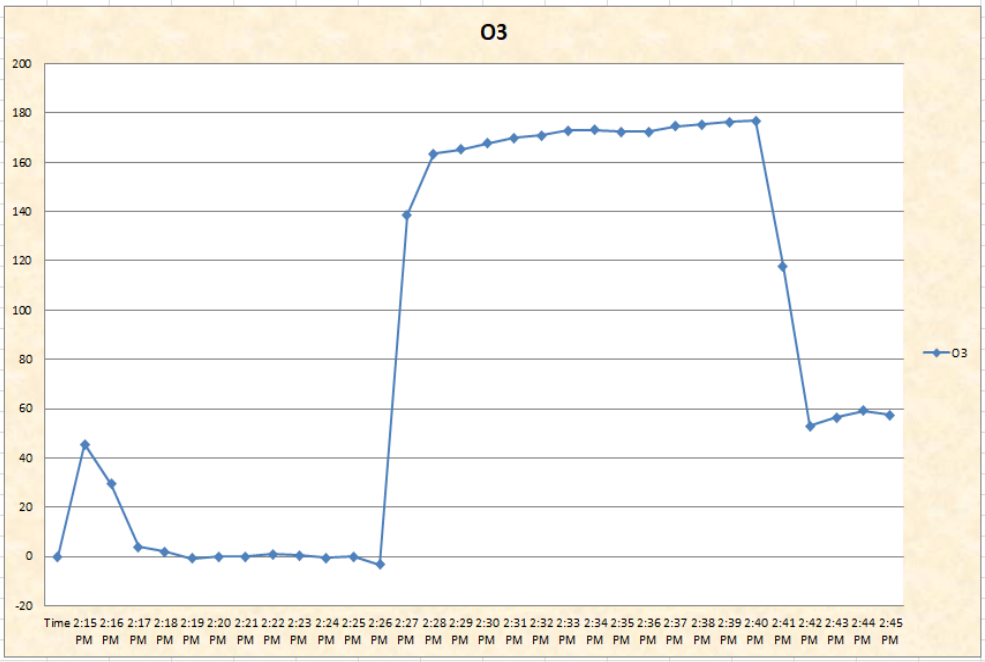
Observed concentration – 176.67 ppb

Stabilization time – 05 min.

Ref. Picture – 6.11

Observation : Analyser Performance is Satisfactory

Time	O3
2:15 PM	45.42
2:16 PM	29.47
2:17 PM	4.09
2:18 PM	1.89
2:19 PM	-0.76
2:20 PM	-0.16
2:21 PM	0.11
2:22 PM	0.82
2:23 PM	0.39
2:24 PM	-0.47
2:25 PM	-0.02
2:26 PM	-3.28
2:27 PM	138.64
2:28 PM	163.44
2:29 PM	165.19
2:30 PM	167.79
2:31 PM	169.84
2:32 PM	171.1
2:33 PM	172.98
2:34 PM	173.22
2:35 PM	172.38
2:36 PM	172.59
2:37 PM	174.58
2:38 PM	175.4
2:39 PM	176.4
2:40 PM	176.94
2:41 PM	117.84
2:42 PM	53.11
2:43 PM	56.49
2:44 PM	59.25
2:45 PM	57.36



6.11 - Performance check of Ozone analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Mandideep

CAAQMS location : Industrial Area

Date : 04/12/2020

Remote end support :

MPPCB Regional office, Mandideep, Dist. Raisen- Shri Praveen Kothari, Jr. Scientist

Service provider – Shri Abdhesh Pratap Singh and Shri Rajkumar Prajapati

7.1 – CAAQM Station

7.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 5151 ppm
- Nitrogen oxides (NOx) – 55 ppm
- Sulphur dioxide (SO_2) – 55 ppm

Parameter – SO_2

Commencement time – 1200 hrs

Time set for Zero calibration – 10 min.

Observed concentration – 2.99 ppm

Time set for Span gas calibration – 10 min.

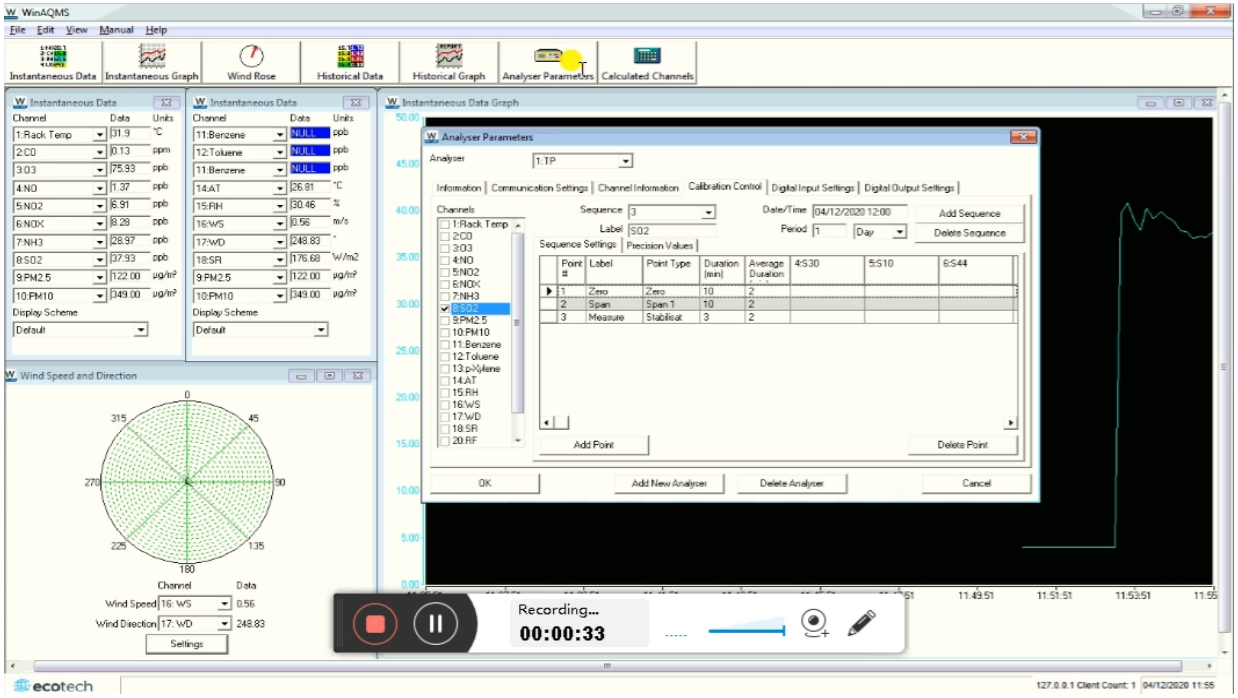
Span test concentration – 133 ppb

Observed concentration – 51 ppb

Stabilization time – 03 min.

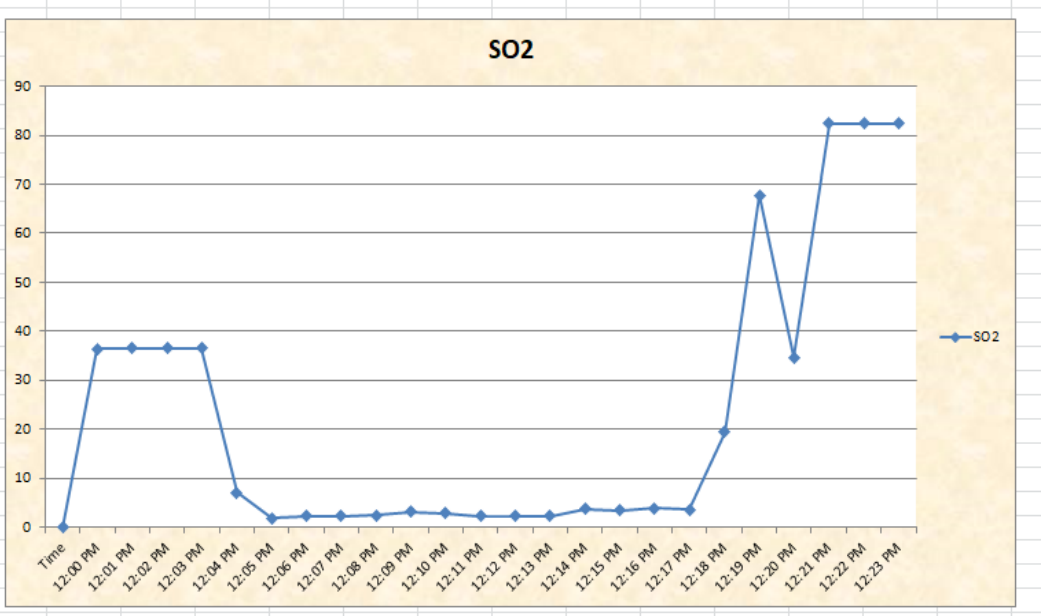
Ref. Picture – 7.4, 7.5

Observation : Analyser Performance is Unsatisfactory / Result Failed



7.4 - Remote check of calibration of SO_2 analyzer

Time	SO2
12:00 PM	36.43
12:01 PM	36.51
12:02 PM	36.51
12:03 PM	36.51
12:04 PM	7.11
12:05 PM	1.85
12:06 PM	2.33
12:07 PM	2.24
12:08 PM	2.46
12:09 PM	3.09
12:10 PM	2.89
12:11 PM	2.23
12:12 PM	2.23
12:13 PM	2.23
12:14 PM	3.67
12:15 PM	3.41
12:16 PM	3.84
12:17 PM	3.54
12:18 PM	19.45
12:19 PM	67.83
12:20 PM	34.58
12:21 PM	82.49
12:22 PM	82.49
12:23 PM	82.49

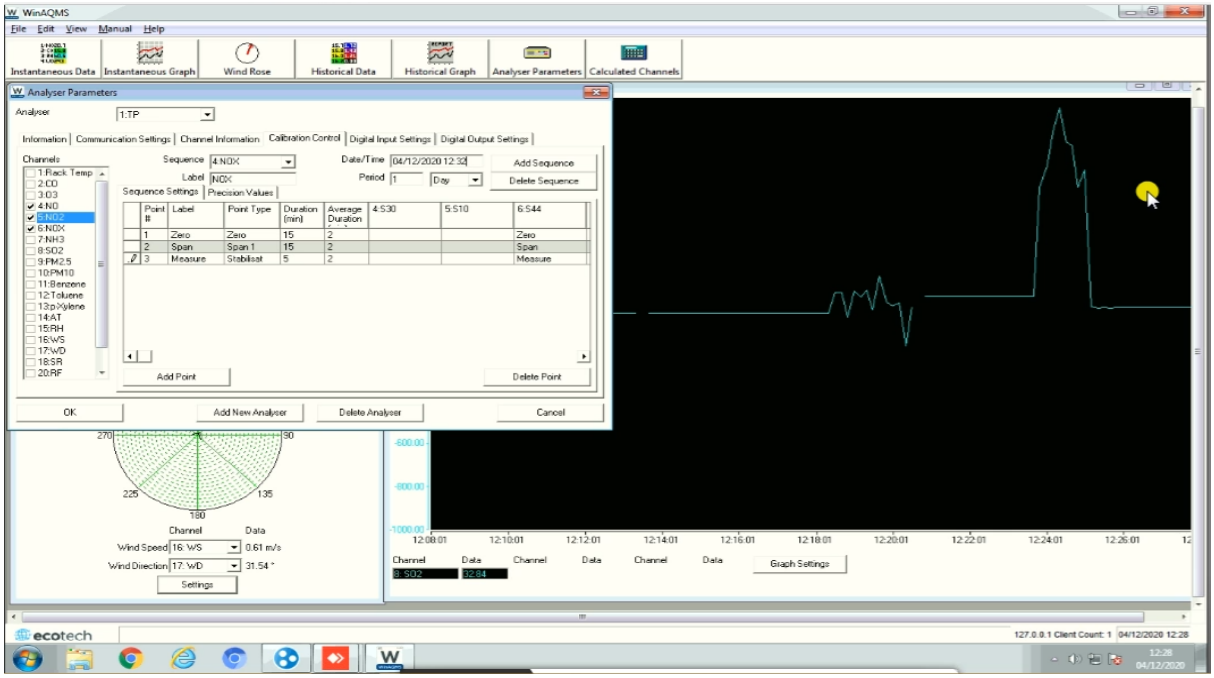


7.5 - Performance check of SO_2 analyzer against specified test concentration

The gas flow at the CAAQMS site could not be set properly leading to erroneous result and unsatisfactory performance of the SO_2 analyser.

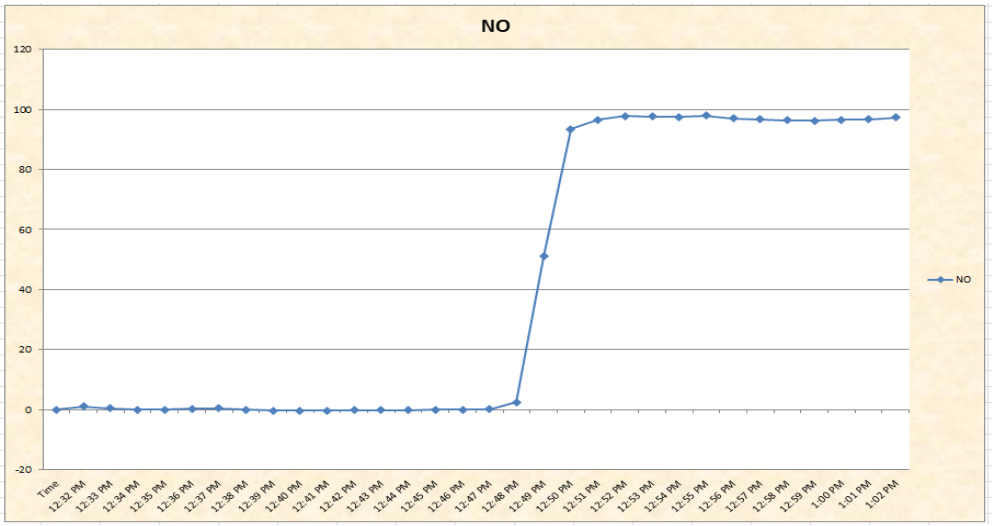
Parameter – NOx

Commencement time – 1232 hrs
Time set for Zero calibration – 15 min.
Observed concentration – 0.08 ppm
Time set for Span gas calibration – 15 min.
Span test concentration – 105 ppb
Observed concentration – 97 ppb
Stabilization time – 05 min.
Ref. Picture – 7.6, 7.7
Observation : Analyser Performance is Unsatisfactory / Result Failed



7.6 - Remote check of calibration of NOx analyzer

Time	NO
12:32 PM	1.08
12:33 PM	0.52
12:34 PM	0.08
12:35 PM	0.08
12:36 PM	0.29
12:37 PM	0.44
12:38 PM	0.01
12:39 PM	-0.38
12:40 PM	-0.3
12:41 PM	-0.23
12:42 PM	-0.12
12:43 PM	-0.17
12:44 PM	-0.19
12:45 PM	-0.06
12:46 PM	0.01
12:47 PM	0.14
12:48 PM	2.42
12:49 PM	51.01
12:50 PM	93.35
12:51 PM	96.57
12:52 PM	97.75
12:53 PM	97.69
12:54 PM	97.53
12:55 PM	97.92
12:56 PM	96.99
12:57 PM	96.67
12:58 PM	96.39
12:59 PM	96.28
1:00 PM	96.47
1:01 PM	96.73
1:02 PM	97.28



7.7 - Performance check of NOx analyzer against specified test values

The gas flow could not be set properly at site leading to erroneous result and unsatisfactory performance of the NOx analyser.

Parameter – Ozone

Commencement time – 1320hrs

Time set for Zero calibration – 10 min.

Observed concentration – 0.68 ppb

Time set for Span gas calibration – 15 min.

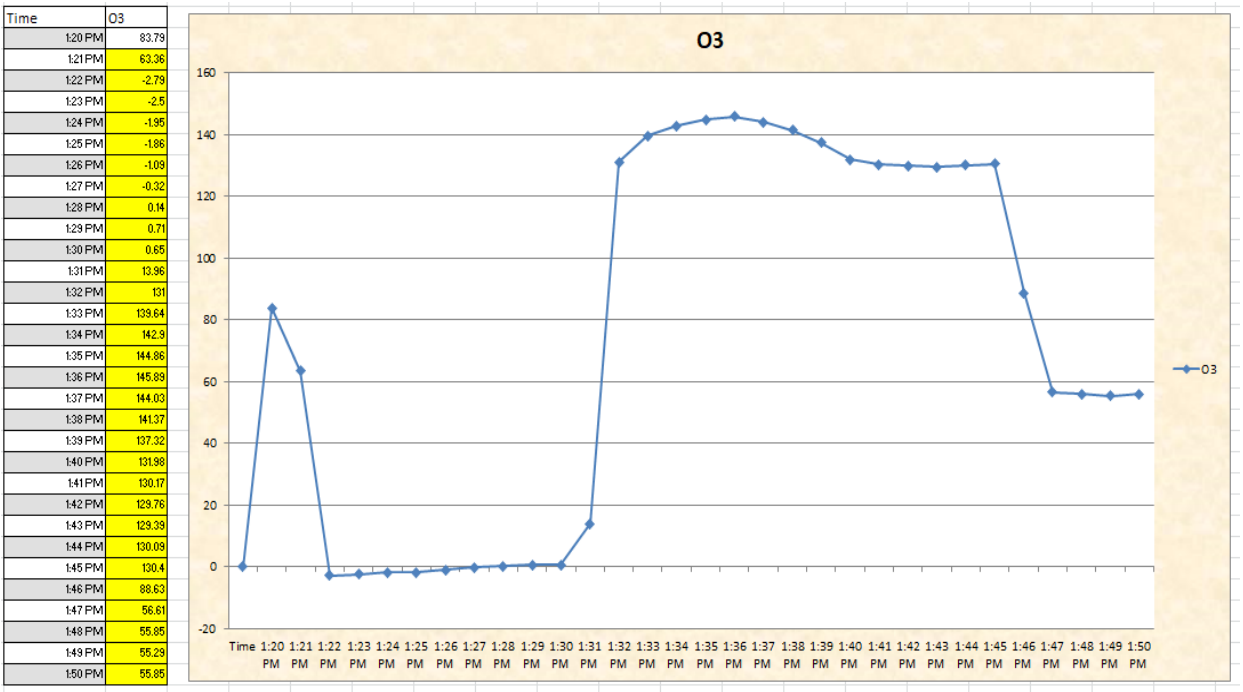
Span test concentration – 125 ppb

Observed concentration – 130.24 ppb

Stabilization time – 05 min.

Ref. Picture – 7.8

Observation : Analyser Performance is Satisfactory



Time	O3
1:20 PM	83.79
1:21 PM	63.36
1:22 PM	-2.79
1:23 PM	-2.5
1:24 PM	-1.95
1:25 PM	-1.86
1:26 PM	-1.09
1:27 PM	-0.32
1:28 PM	0.14
1:29 PM	0.71
1:30 PM	0.65
1:31 PM	13.96
1:32 PM	131
1:33 PM	139.64
1:34 PM	142.9
1:35 PM	144.86
1:36 PM	145.89
1:37 PM	144.03
1:38 PM	141.37
1:39 PM	137.32
1:40 PM	131.98
1:41 PM	130.17
1:42 PM	129.76
1:43 PM	129.39
1:44 PM	130.09
1:45 PM	130.4
1:46 PM	88.63
1:47 PM	56.61
1:48 PM	55.85
1:49 PM	55.29
1:50 PM	55.85

7.8 - Performance check of Ozone analyzer against specified test concentration

Parameter – CO

Commencement time – 1410 hrs

Time set for Zero calibration – 05 min.

Observed concentration – 0.65 ppm

Time set for Span gas calibration – 15 min.

Span test concentration – 07 ppm

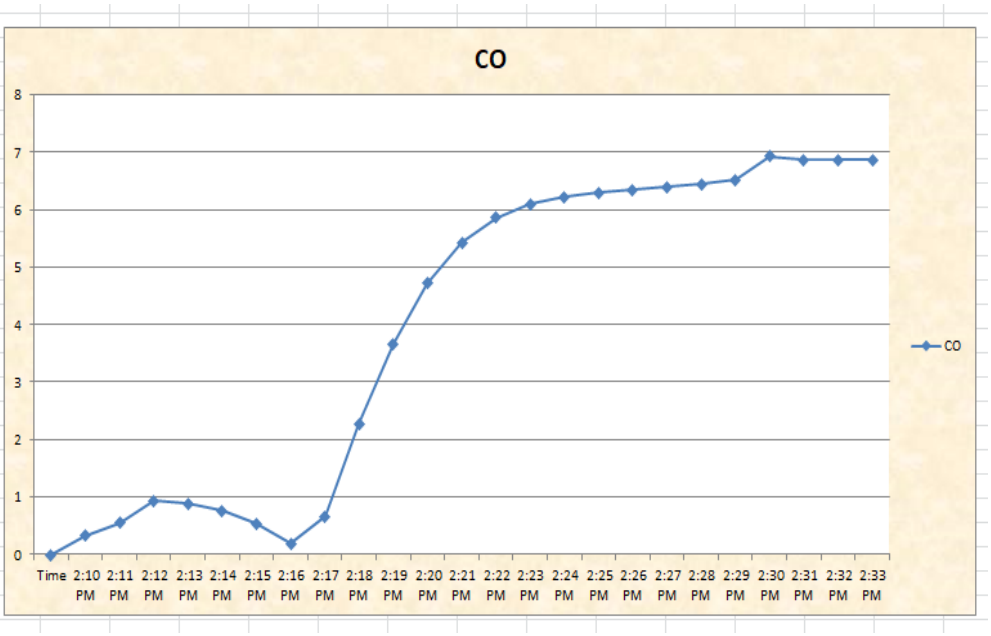
Observed concentration – 6.72 ppm

Stabilization time – 03 min.

Ref. Picture – 7.9

Observation : Analyser Performance is Satisfactory

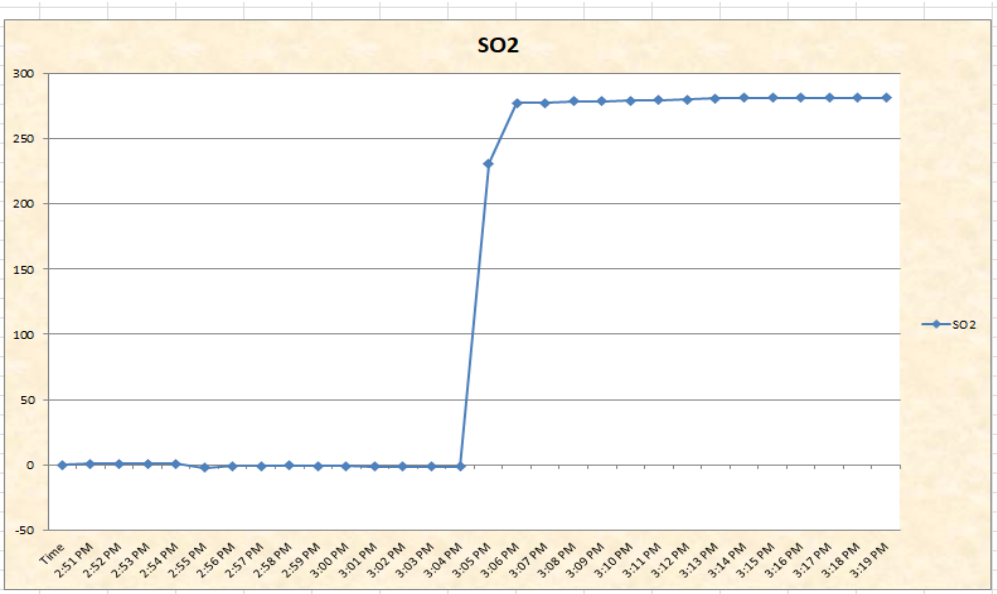
Time	CO
2:10 PM	0.33
2:11 PM	0.55
2:12 PM	0.94
2:13 PM	0.88
2:14 PM	0.77
2:15 PM	0.54
2:16 PM	0.19
2:17 PM	0.67
2:18 PM	2.27
2:19 PM	3.67
2:20 PM	4.72
2:21 PM	5.42
2:22 PM	5.86
2:23 PM	6.09
2:24 PM	6.22
2:25 PM	6.29
2:26 PM	6.35
2:27 PM	6.4
2:28 PM	6.44
2:29 PM	6.52
2:30 PM	6.93
2:31 PM	6.86
2:32 PM	6.86
2:33 PM	6.86



7.9 - Performance check of CO analyzer against specified test concentration

Parameter – SO_2 (Repeated)
Commencement time – 1451 hrs
Time set for Zero calibration – 10 min.
Observed concentration – 1.16 ppb
Time set for Span gas calibration – 15 min.
Span test concentration – 280 ppb
Observed concentration – 281.51 ppb
Stabilization time – 03 min.
Ref. Picture – 7.10
Observation : Analyser Performance is Satisfactory

Time	SO2
2:51 PM	0.73
2:52 PM	0.73
2:53 PM	0.73
2:54 PM	0.73
2:55 PM	-2.27
2:56 PM	-1.15
2:57 PM	-0.69
2:58 PM	-0.39
2:59 PM	-0.66
3:00 PM	-1.09
3:01 PM	-1.24
3:02 PM	-1.26
3:03 PM	-1.26
3:04 PM	-1.26
3:05 PM	230.88
3:06 PM	277.52
3:07 PM	277.77
3:08 PM	278.81
3:09 PM	278.93
3:10 PM	279.49
3:11 PM	279.67
3:12 PM	280.07
3:13 PM	280.9
3:14 PM	281.52
3:15 PM	281.45
3:16 PM	281.56
3:17 PM	281.5
3:18 PM	281.5
3:19 PM	281.5



7.10 - Performance check of SO_2 analyzer against specified test concentration

Parameter – NOx

Commencement time – 1529 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.39 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 83 ppb

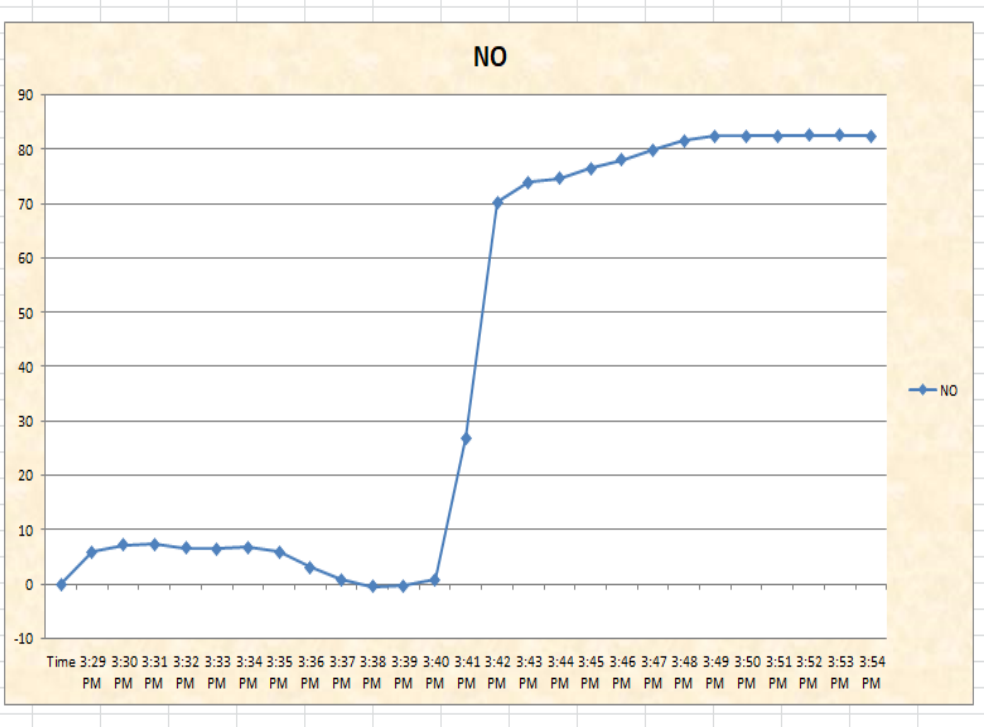
Observed concentration – 82.5 ppb

Stabilization time – 03 min.

Ref. Picture – 7.11

Observation : Analyser Performance is Satisfactory

Time	NO
3:29 PM	5.93
3:30 PM	7.25
3:31 PM	7.26
3:32 PM	6.68
3:33 PM	6.49
3:34 PM	6.84
3:35 PM	5.87
3:36 PM	3.21
3:37 PM	0.89
3:38 PM	-0.45
3:39 PM	-0.32
3:40 PM	0.88
3:41 PM	26.88
3:42 PM	70.21
3:43 PM	73.98
3:44 PM	74.64
3:45 PM	76.5
3:46 PM	78.03
3:47 PM	79.91
3:48 PM	81.66
3:49 PM	82.53
3:50 PM	82.35
3:51 PM	82.45
3:52 PM	82.59
3:53 PM	82.59
3:54 PM	82.43



7.11 - Performance check of NOx analyzer against specified test value

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Pithampur, Dist. Dhar

CAAQMS location : Industrial Area

Date : 04/12/2020

Remote end support :

MPPCB Regional office, Pithampur, Dist. Dhar - Shri Rajesh Gabhe, Chemist

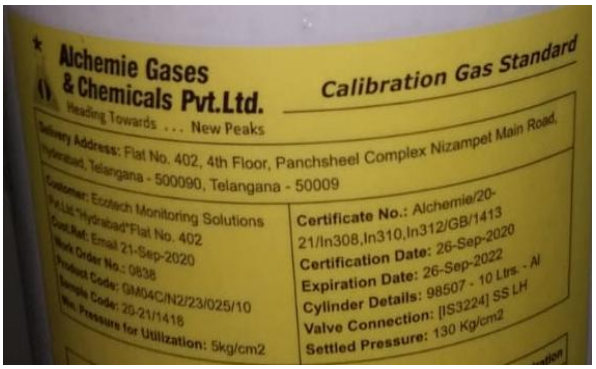
Service provider – Shri Abdhesh Pratap Singh and Shri Amresh Pal

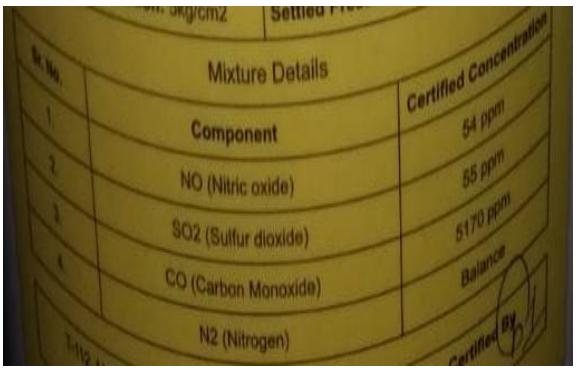
8.1 – CAAQM Station

8.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 5170 ppm
- Nitrogen oxides (NOx) – 54 ppm
- Sulphur dioxide (SO_2) – 55 ppm





Parameter – NOx

Commencement time – 1250 hrs

Time set for Zero calibration – 10 min.

Observed concentration – 1.0 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 207 ppb

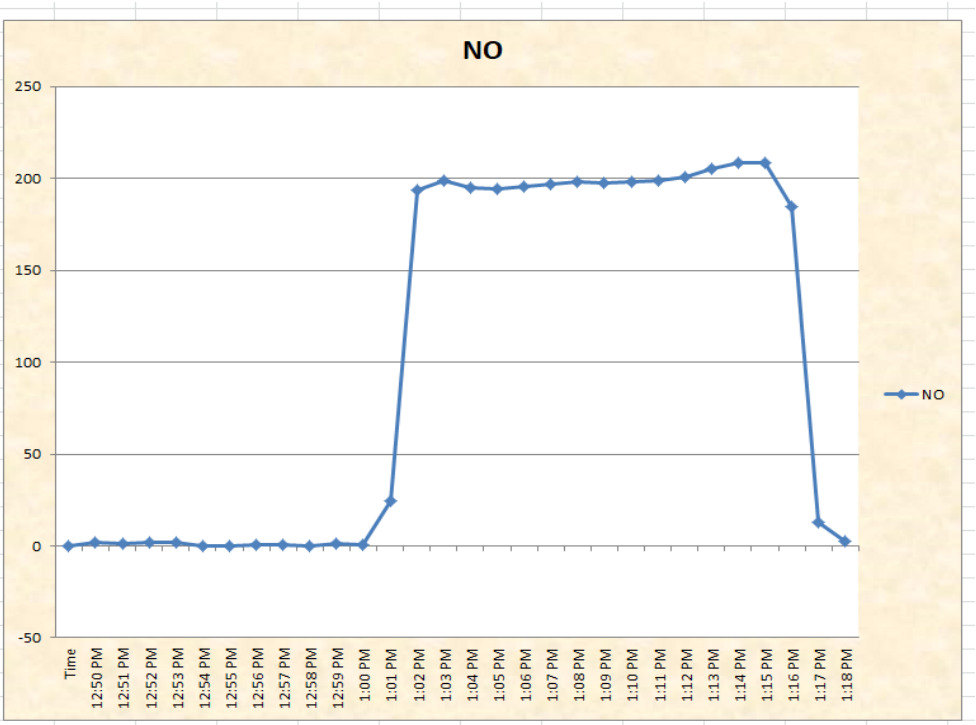
Observed concentration – 208.3 ppb

Stabilization time – 05 min.

Ref. Picture – 8.5

Observation : Analyser Performance is Satisfactory

Time	NO
12:50 PM	2.2
12:51 PM	1.5
12:52 PM	1.9
12:53 PM	2.2
12:54 PM	-0.3
12:55 PM	-0.1
12:56 PM	0.8
12:57 PM	0.5
12:58 PM	0.1
12:59 PM	1.2
1:00 PM	0.7
1:01 PM	24.3
1:02 PM	193.7
1:03 PM	198.8
1:04 PM	194.9
1:05 PM	194.3
1:06 PM	195.3
1:07 PM	196.9
1:08 PM	197.8
1:09 PM	197.6
1:10 PM	198.2
1:11 PM	198.9
1:12 PM	200.7
1:13 PM	205
1:14 PM	208.2
1:15 PM	208.4
1:16 PM	184.5
1:17 PM	13.1
1:18 PM	2.8



8.5 - Performance check of NOx analyzer against specified test concentration

Parameter – CO

Commencement time – 1322 hrs

Time set for Zero calibration – 10 min.

Observed concentration – 0.07 ppm

Time set for Span gas calibration – 15 min.

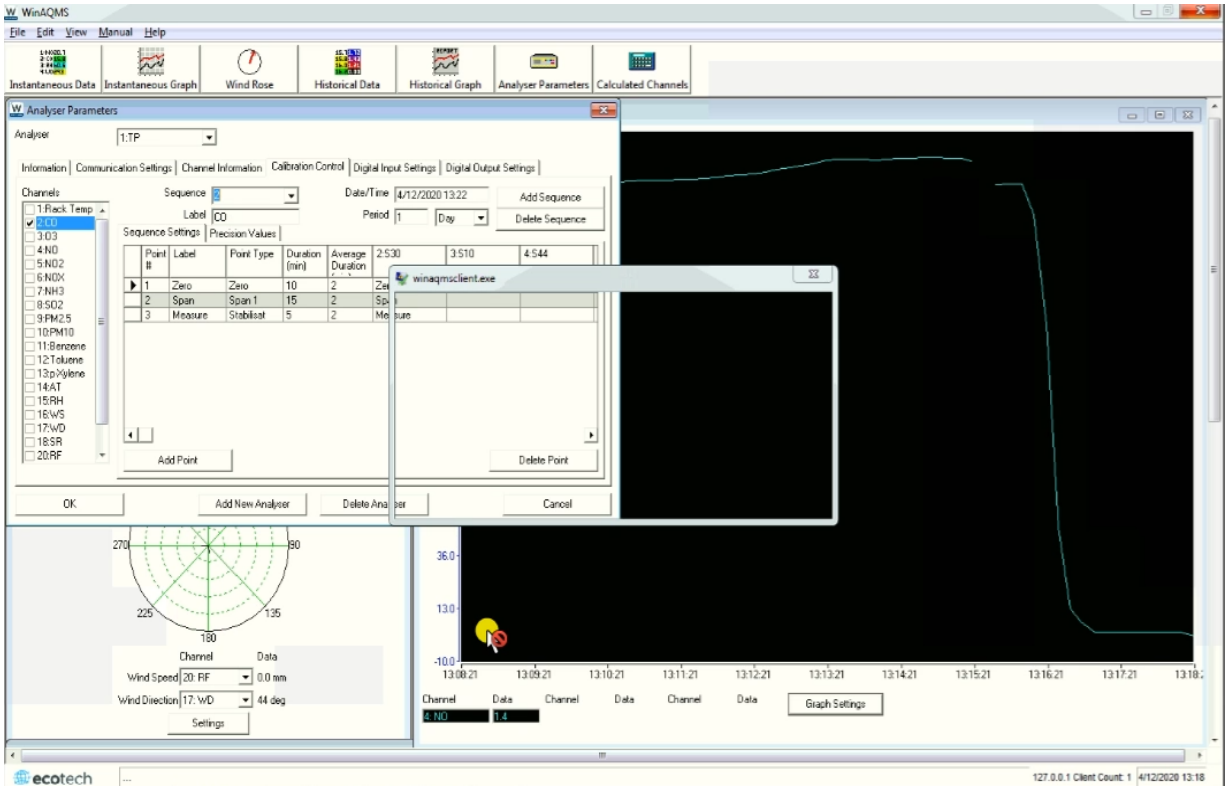
Span test concentration – 05 ppm

Observed concentration – 5.04 ppm

Stabilization time – 05 min.

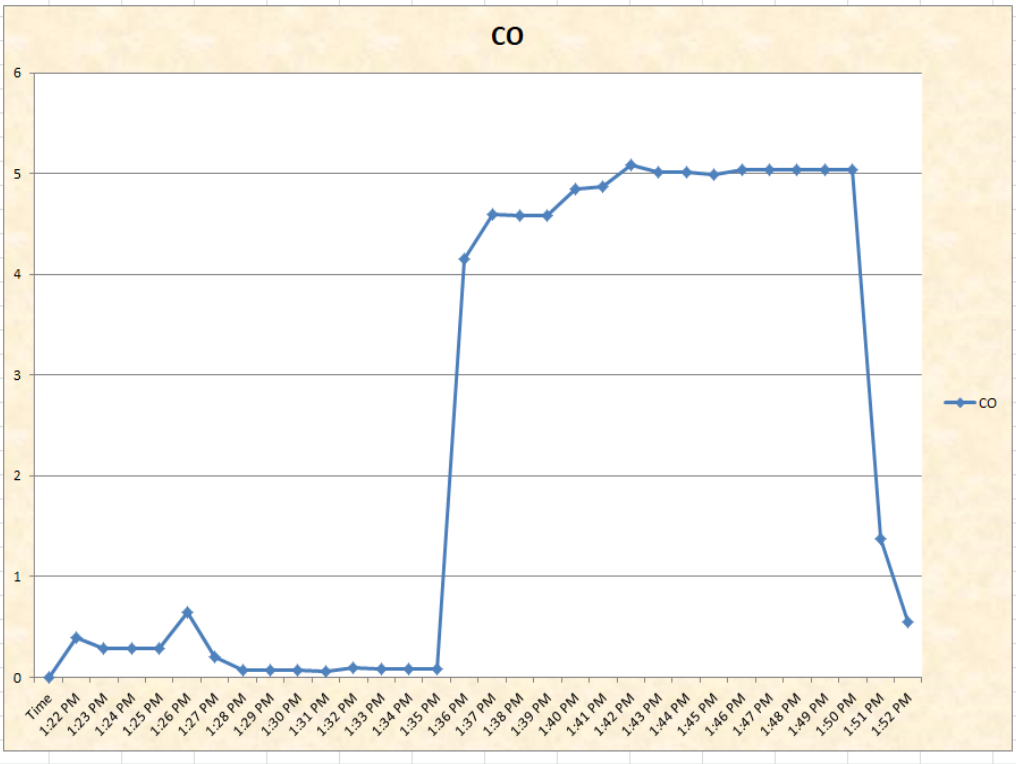
Ref. Picture – 8.6, 8.7

Observation : Analyser Performance is Satisfactory



8.6 - Remote check of calibration of CO analyzer

Time	CO
1:22 PM	0.39
1:23 PM	0.29
1:24 PM	0.29
1:25 PM	0.29
1:26 PM	0.65
1:27 PM	0.2
1:28 PM	0.07
1:29 PM	0.07
1:30 PM	0.07
1:31 PM	0.06
1:32 PM	0.09
1:33 PM	0.08
1:34 PM	0.08
1:35 PM	0.08
1:36 PM	4.15
1:37 PM	4.6
1:38 PM	4.58
1:39 PM	4.58
1:40 PM	4.85
1:41 PM	4.87
1:42 PM	5.08
1:43 PM	5.01
1:44 PM	5.01
1:45 PM	4.99
1:46 PM	5.04
1:47 PM	5.04
1:48 PM	5.04
1:49 PM	5.04
1:50 PM	5.04
1:51 PM	1.38
1:52 PM	0.55



8.7 - Performance check of CO analyzer against specified test concentration

Parameter – SO_2

Commencement time – 1355 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.1 ppb

Time set for Span gas calibration – 15 min.

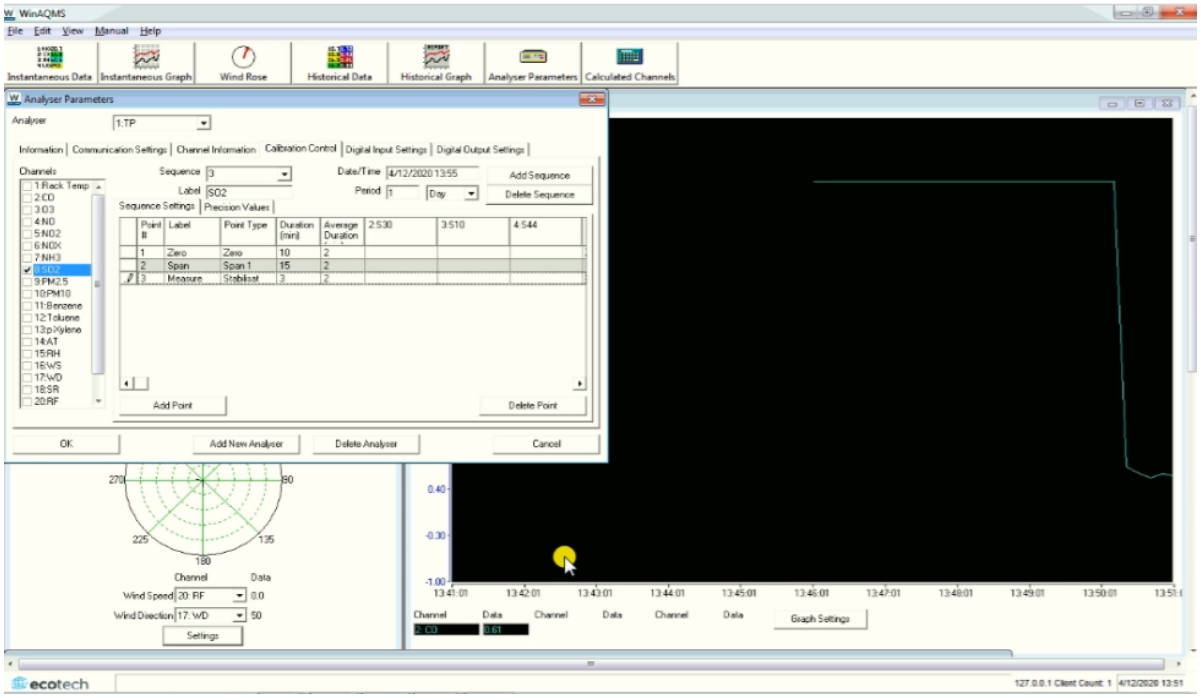
Span test concentration – 94 ppb

Observed concentration – 94.6 ppb

Stabilization time – 03 min.

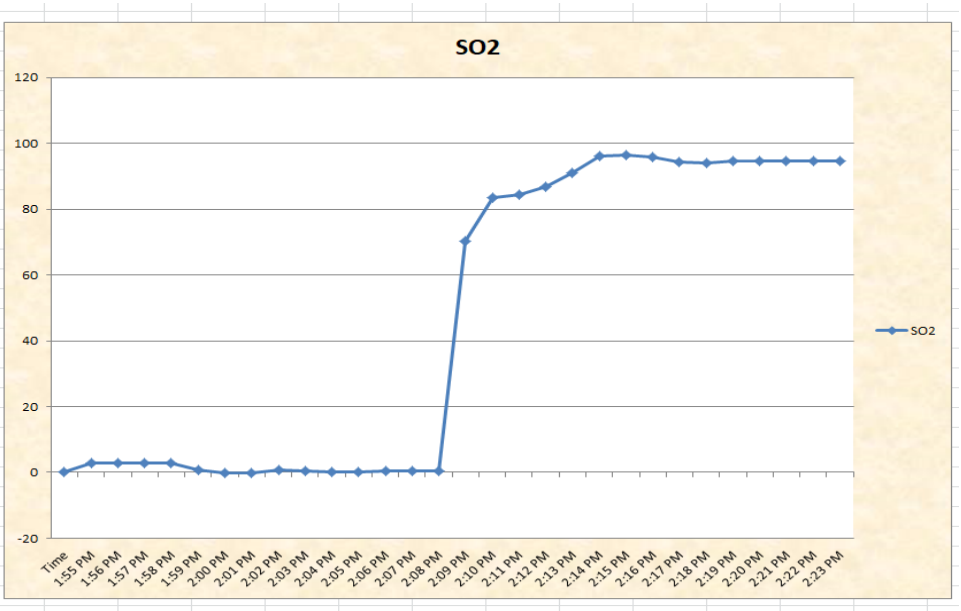
Ref. Picture – 8.8, 8.9

Observation : Analyser Performance is Satisfactory



8.8 - Remote check of calibration of SO_2 analyzer

Time	SO2
1:55 PM	2.7
1:56 PM	2.8
1:57 PM	2.8
1:58 PM	2.8
1:59 PM	0.8
2:00 PM	-0.3
2:01 PM	-0.1
2:02 PM	0.7
2:03 PM	0.4
2:04 PM	0
2:05 PM	0.2
2:06 PM	0.3
2:07 PM	0.3
2:08 PM	0.3
2:09 PM	70.3
2:10 PM	83.4
2:11 PM	84.3
2:12 PM	86.7
2:13 PM	91.1
2:14 PM	96.2
2:15 PM	96.4
2:16 PM	95.7
2:17 PM	94.3
2:18 PM	94
2:19 PM	94.5
2:20 PM	94.7
2:21 PM	94.6
2:22 PM	94.6
2:23 PM	94.6



8.9 - Performance check of SO_2 analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1435 hrs

Time set for Zero calibration – 10 min.

Observed concentration – 0.4 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 230 ppb

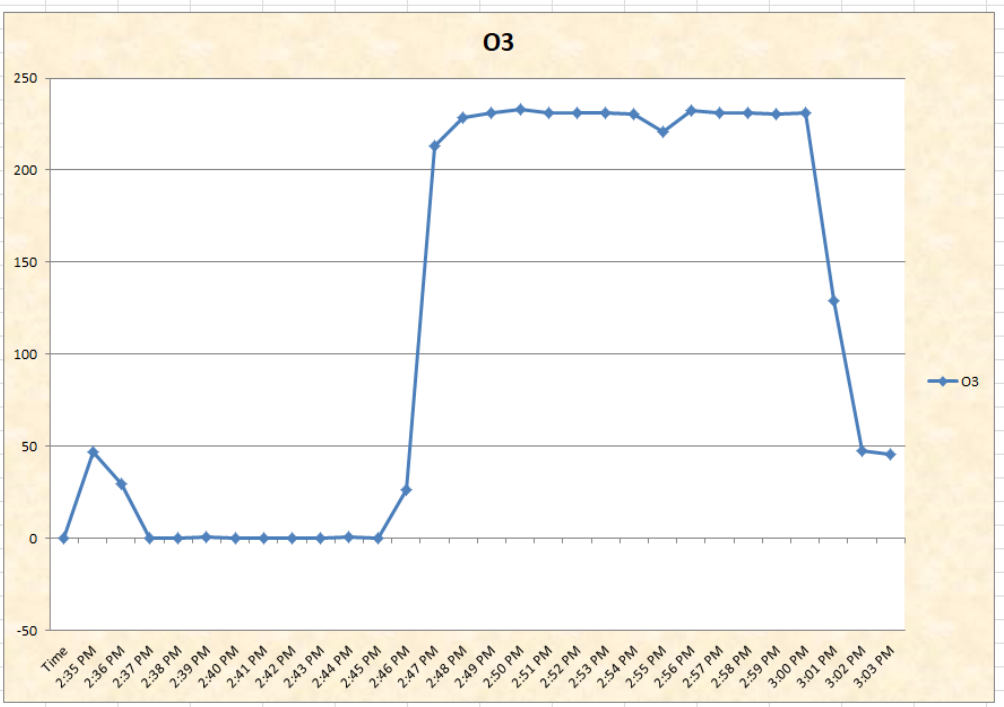
Observed concentration – 230.8 ppb

Stabilization time – 03 min.

Ref. Picture – 8.10

Observation : Analyser Performance is Satisfactory

Time	NO
2:35 PM	47
2:36 PM	29.4
2:37 PM	0
2:38 PM	-0.2
2:39 PM	0.6
2:40 PM	0.2
2:41 PM	0.3
2:42 PM	0.1
2:43 PM	0.3
2:44 PM	0.6
2:45 PM	0.3
2:46 PM	26.1
2:47 PM	213.3
2:48 PM	228.3
2:49 PM	231.4
2:50 PM	232.8
2:51 PM	231.3
2:52 PM	231.1
2:53 PM	231.1
2:54 PM	230.5
2:55 PM	220.8
2:56 PM	232.2
2:57 PM	231.3
2:58 PM	231.2
2:59 PM	230.3
3:00 PM	231.3
3:01 PM	129
3:02 PM	47.8
3:03 PM	45.8



8.10 - Performance check of Ozone analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City /Date : Dewas / 04.12.2020

CAAQMS location : Bhopal Chauraha

Remote end support :

Regional office, Dewas - Shri P.C. Uchariya, SSO and Shri Dileep Keshre, Chemist

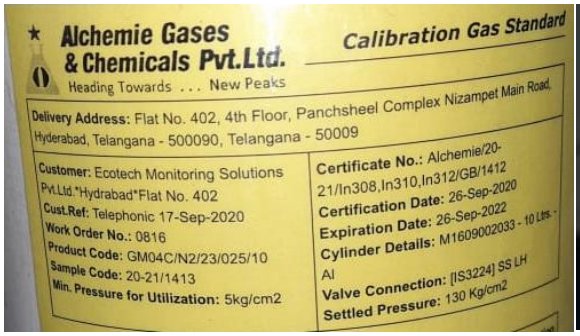
Service provider – Shri Abdhesh Pratap Singh and Shri Ravi Patel

9.1– CAAQM Station

9.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 5150 ppm
- Nitrogen oxides (NOx) – 54 ppm
- Sulphur dioxide (SO_2) – 55 ppm

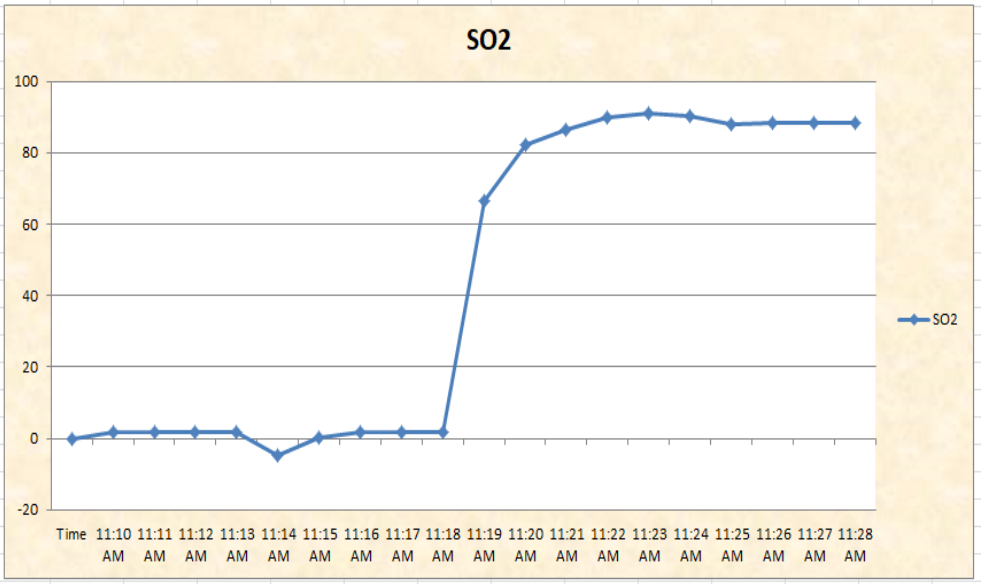


The calibration check at Dewas location was performed on 02.12.2020 but due to problem in calibrator the exercise was put off and rescheduled on 04.12.2020.

Parameter – SO_2

Commencement time – 1112 hrs
Time set for Zero calibration – 05 min.
Observed concentration – (-) 0.3 ppb
Time set for Span gas calibration – 10 min.
Span test concentration – 89 ppb
Observed concentration – 89.2 ppb
Stabilization time – 03 min.
Ref. Picture – 9.4
Observation : Analyser Performance is Satisfactory

Time	S02
11:10 AM	1.8
11:11 AM	1.7
11:12 AM	1.7
11:13 AM	1.7
11:14 AM	-4.7
11:15 AM	0.1
11:16 AM	1.7
11:17 AM	1.7
11:18 AM	1.7
11:19 AM	66.6
11:20 AM	82.2
11:21 AM	86.5
11:22 AM	89.9
11:23 AM	91.2
11:24 AM	90.4
11:25 AM	88.1
11:26 AM	88.4
11:27 AM	88.4
11:28 AM	88.4

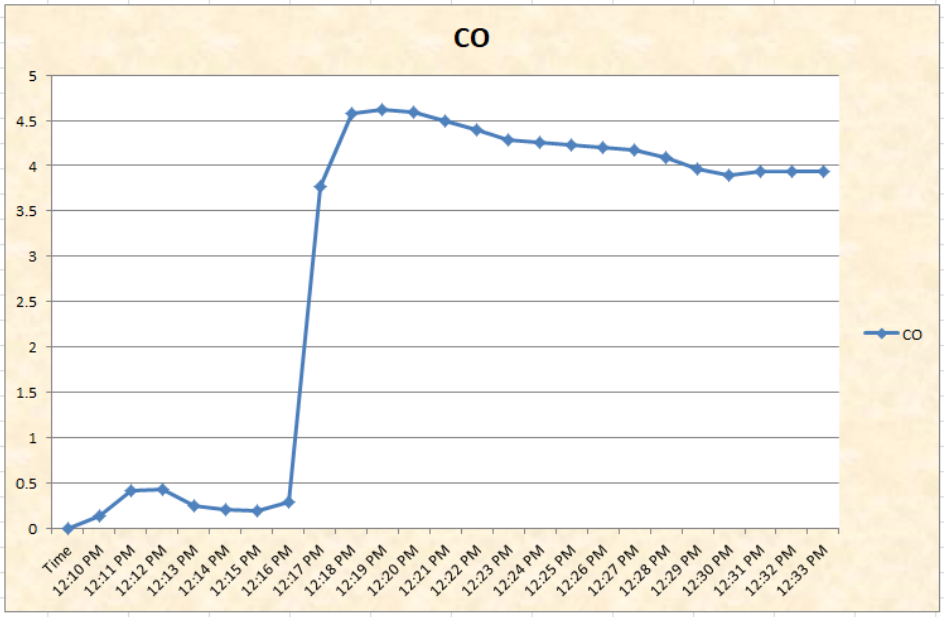


9.4 - Performance check of SO_2 analyzer against specified test concentration

Parameter – CO

Commencement time – 1210 hrs
Time set for Zero calibration – 05 min.
Observed concentration – (-) 0.31 ppm
Time set for Span gas calibration – 15 min.
Span test concentration – 04 ppm
Observed concentration – 3.92 ppm
Stabilization time – 03 min.
Ref. Picture – 9.5
Observation : Analyser Performance is Satisfactory

Time	CO
12:10 PM	0.14
12:11 PM	0.41
12:12 PM	0.43
12:13 PM	0.24
12:14 PM	0.21
12:15 PM	0.19
12:16 PM	0.29
12:17 PM	3.77
12:18 PM	4.57
12:19 PM	4.62
12:20 PM	4.59
12:21 PM	4.5
12:22 PM	4.4
12:23 PM	4.28
12:24 PM	4.25
12:25 PM	4.23
12:26 PM	4.2
12:27 PM	4.17
12:28 PM	4.09
12:29 PM	3.96
12:30 PM	3.9
12:31 PM	3.94
12:32 PM	3.94
12:33 PM	3.94



9.5 - Performance check of CO analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1241 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.31 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 178 ppb

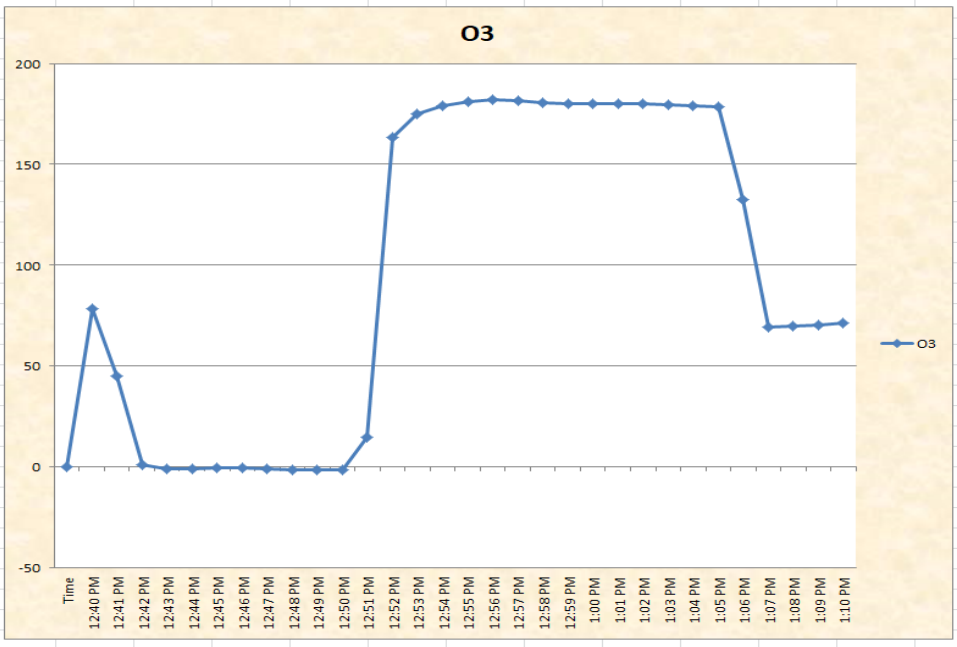
Observed concentration – 178.9 ppb

Stabilization time – 05 min.

Ref. Picture – 9.6

Observation : Analyser Performance is Satisfactory

Time	O3
12:40 PM	78.2
12:41 PM	45.3
12:42 PM	1.1
12:43 PM	-1.2
12:44 PM	-1
12:45 PM	-0.5
12:46 PM	-0.5
12:47 PM	-0.8
12:48 PM	-1.3
12:49 PM	-1.5
12:50 PM	-1.5
12:51 PM	14.5
12:52 PM	163.3
12:53 PM	175
12:54 PM	178.9
12:55 PM	181.2
12:56 PM	182.2
12:57 PM	181.4
12:58 PM	180.4
12:59 PM	180.2
1:00 PM	180.2
1:01 PM	180.1
1:02 PM	180
1:03 PM	179.6
1:04 PM	179.2
1:05 PM	178.7
1:06 PM	132.7
1:07 PM	69.3
1:08 PM	69.9
1:09 PM	70.2
1:10 PM	71.1



9.6 - Performance check of Ozone analyzer against specified test concentration

Parameter – NOx

Commencement time – 1325 hrs

Time set for Zero calibration – 10 min.

Observed concentration – (-) 0.31 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 225 ppb

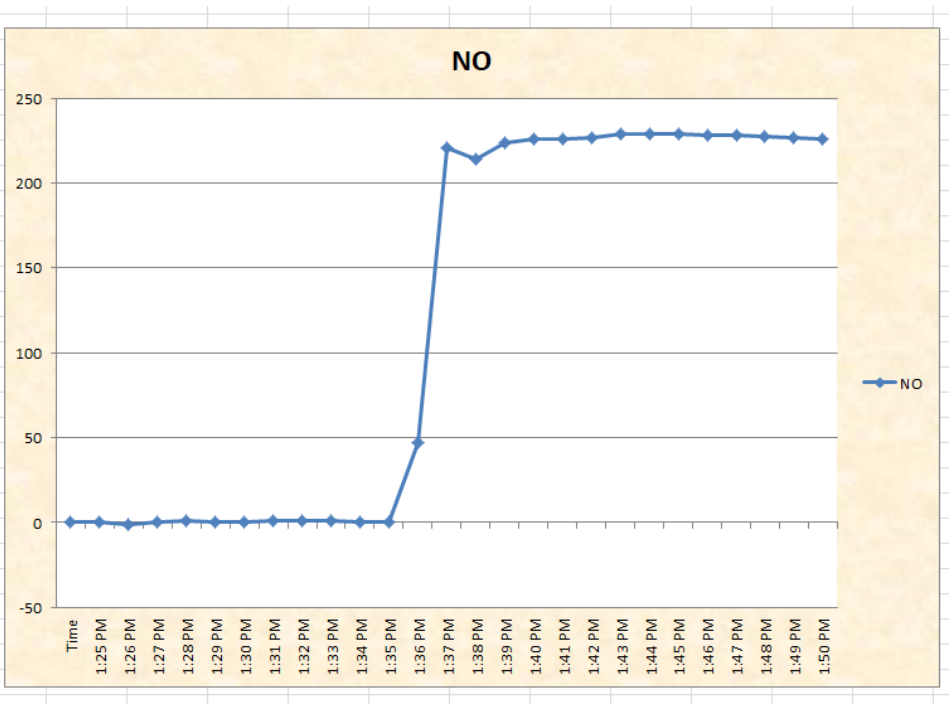
Observed concentration – 226.4 ppb

Stabilization time – 05 min.

Ref. Picture – 9.7

Observation : Analyser Performance is Satisfactory

Time	NO
1:25 PM	0.6
1:26 PM	-1
1:27 PM	0.5
1:28 PM	0.8
1:29 PM	0.5
1:30 PM	0.6
1:31 PM	0.8
1:32 PM	0.7
1:33 PM	0.7
1:34 PM	0.5
1:35 PM	0.5
1:36 PM	47.3
1:37 PM	221
1:38 PM	214.3
1:39 PM	223.4
1:40 PM	225.9
1:41 PM	225.7
1:42 PM	226.6
1:43 PM	228.6
1:44 PM	229.1
1:45 PM	228.9
1:46 PM	228.4
1:47 PM	227.9
1:48 PM	227.3
1:49 PM	226.7
1:50 PM	226.1



9.7 - Performance check of NOx analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

City : Singrauli

CAAQMS location : Surya Kiran Bhawan

Date : 16/12/2020

Remote end support :

MPPCB Regional office, Singrauli- Shri Ramkumar, Assistant Engineer

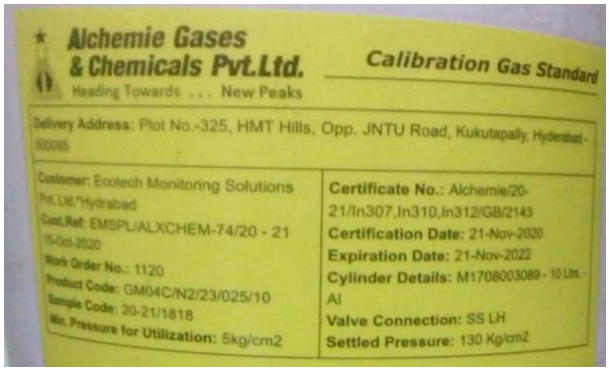
Service provider – Shri Abdhesh Pratap Singh and Shri PavanYadav

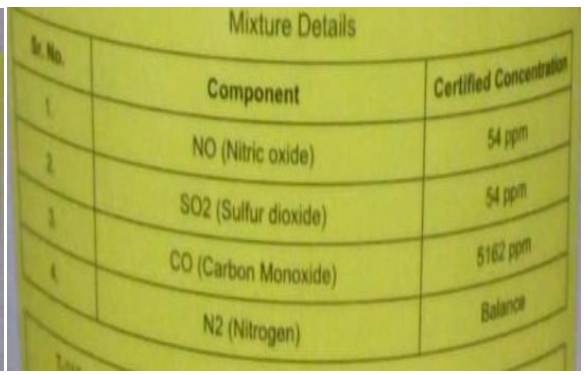
10.1 - CAAQM Station

10.2 – Inside view

Details of Span gases used for the purpose of calibration check are as follows :

- Carbon monoxide (CO) - 5162 ppm
- Nitrogen oxides (NOx) – 54 ppm
- Sulphur dioxide (SO_2) – 54 ppm





Parameter – SO_2

Commencement time – 1140 hrs

Time set for Zero calibration – 15 min.

Observed concentration – (-) 0.42 ppb

Time set for Span gas calibration – 15 min.

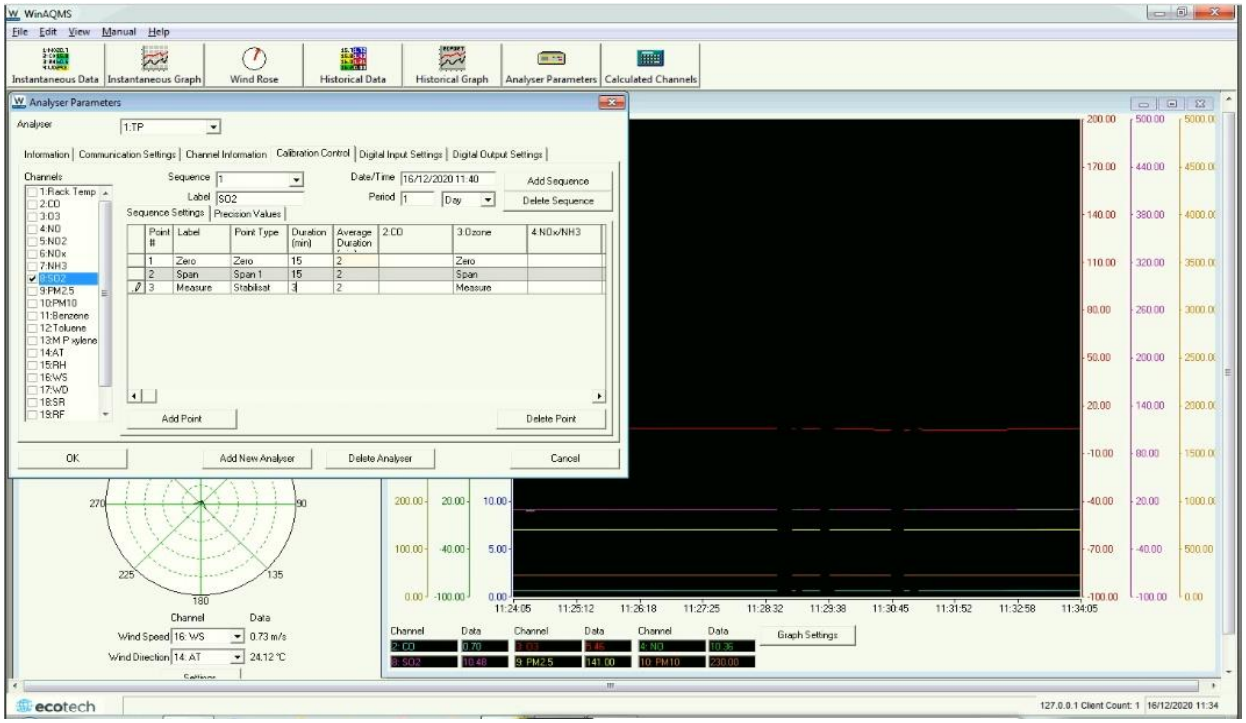
Span test concentration – 220 ppb

Observed concentration – 222.28 ppb

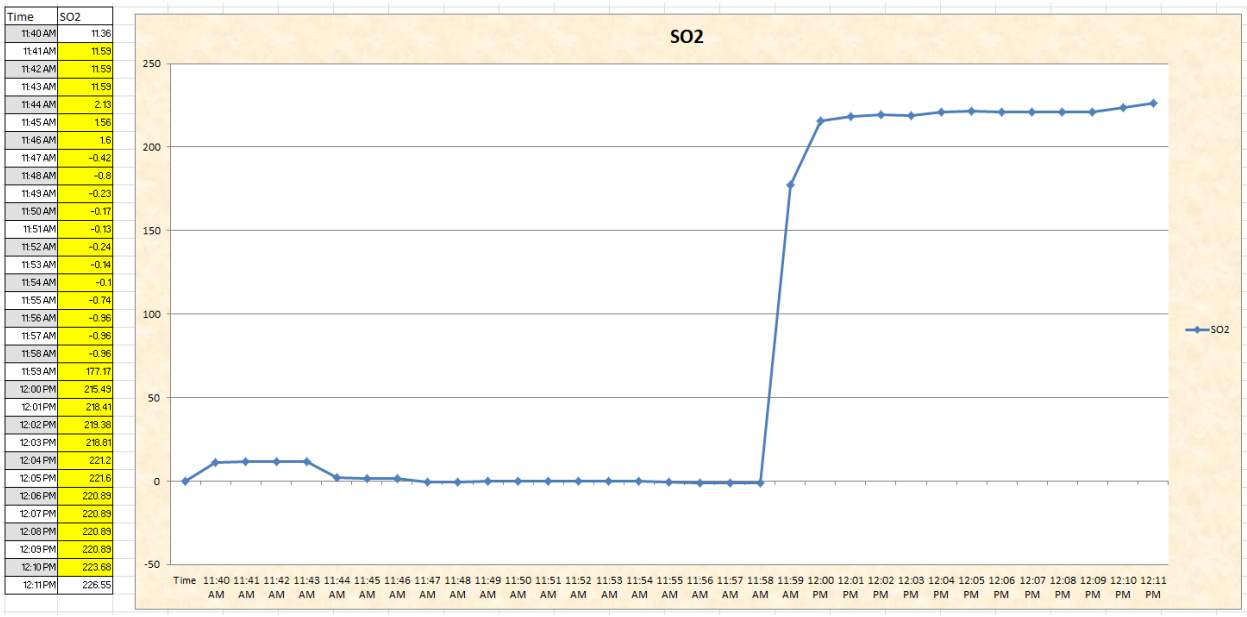
Stabilization time – 03 min.

Ref. Picture – 10.4, 10.5

Observation : Analyser Performance is Satisfactory



10.4 - Remote check of calibration of SO_2 analyzer



10.5 - Performance check of SO_2 analyzer against specified test concentration

Parameter – Ozone

Commencement time – 1220 hrs

Time set for Zero calibration – 15 min.

Observed concentration – 0.45 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 165 ppb

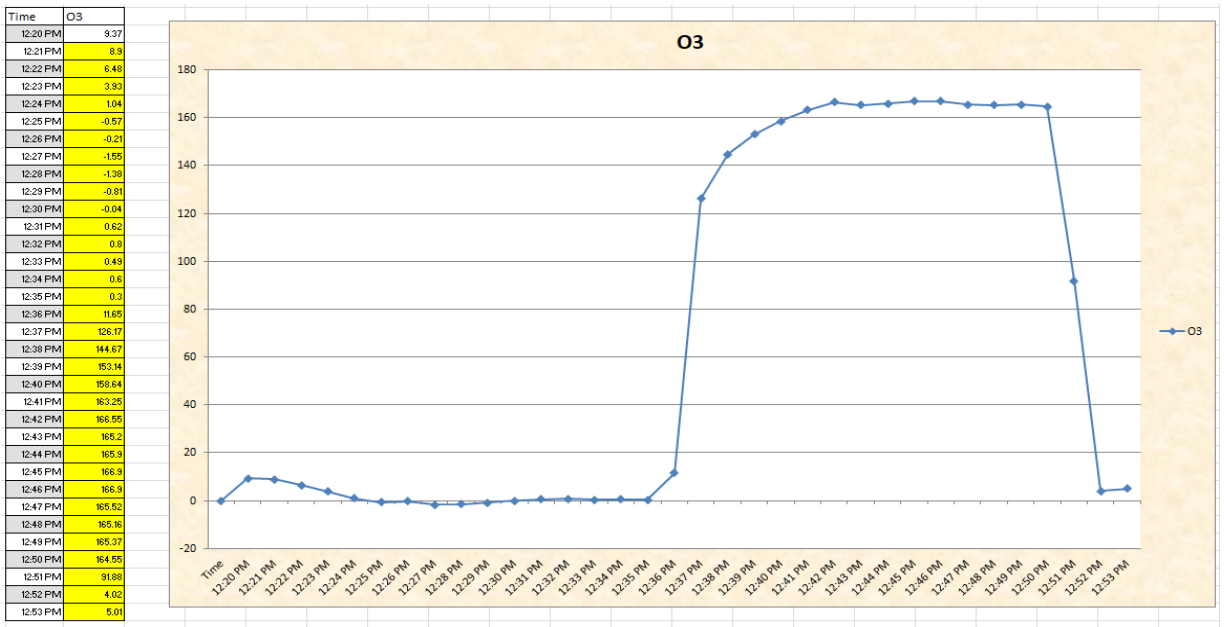
Observed concentration – 164.96 ppb

Stabilization time – 03 min.

Ref. Picture – 10.6, 10.7

Observation : Analyser Performance is Satisfactory

10.6 - Remote check of calibration of Ozone analyzer



10.7 - Performance check of Ozone analyzer against specified test concentration

Parameter – CO

Commencement time – 1305 hrs

Time set for Zero calibration – 15 min.

Observed concentration – (-) 0.21 ppm

Time set for Span gas calibration – 15 min.

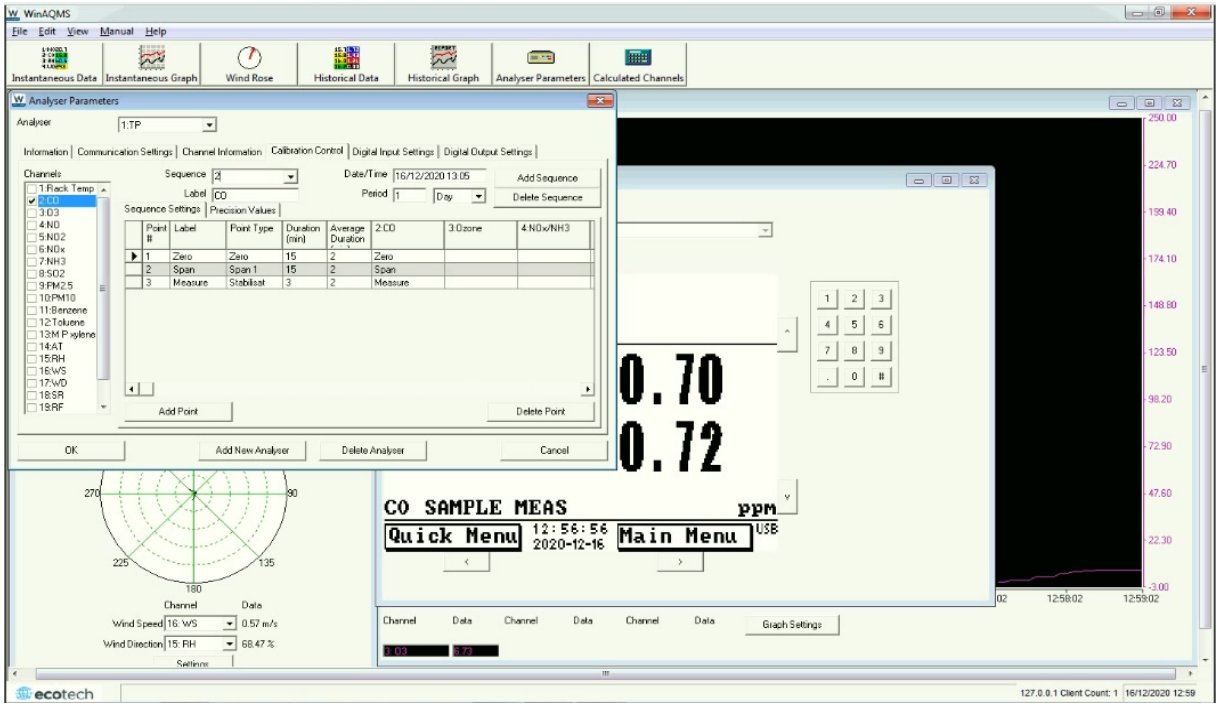
Span test concentration – 3.48 ppm

Observed concentration – 3.92 ppm

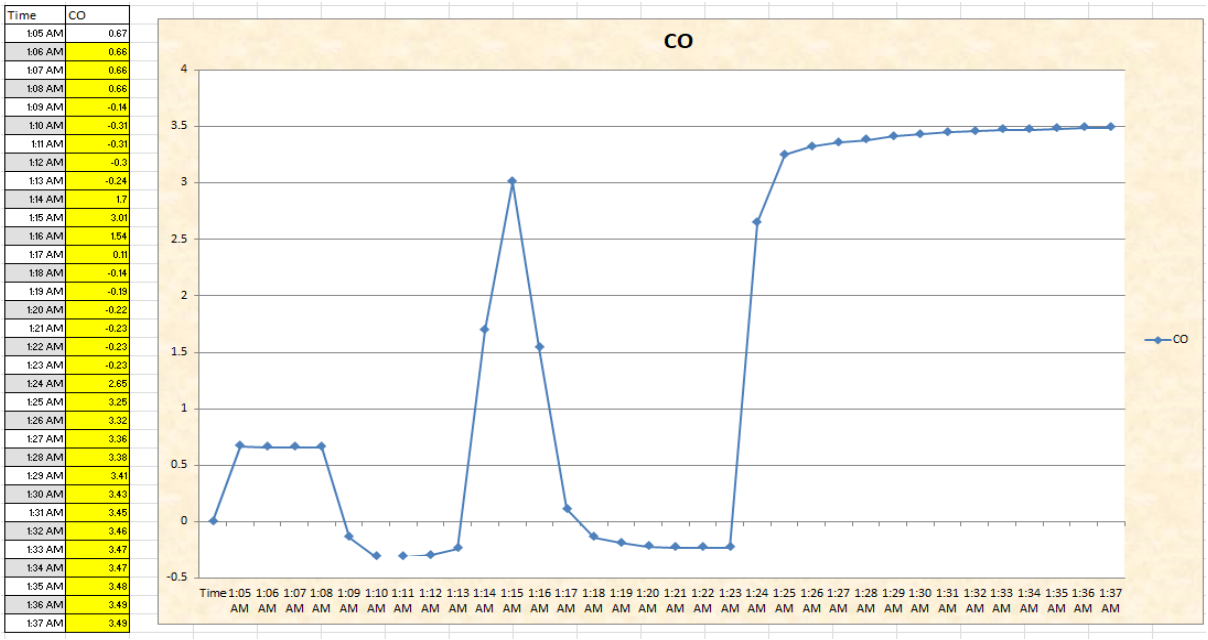
Stabilization time – 03 min.

Ref. Picture – 10.8, 10.9

Observation : Analyser Performance is Satisfactory



10.8 - Remote check of calibration of CO analyzer



10.9 - Performance check of CO analyzer against specified test concentration

Parameter – NOx

Commencement time – 1340 hrs

Time set for Zero calibration – 15 min.

Observed concentration – (-) 0.07 ppb

Time set for Span gas calibration – 15 min.

Span test concentration – 145 ppb

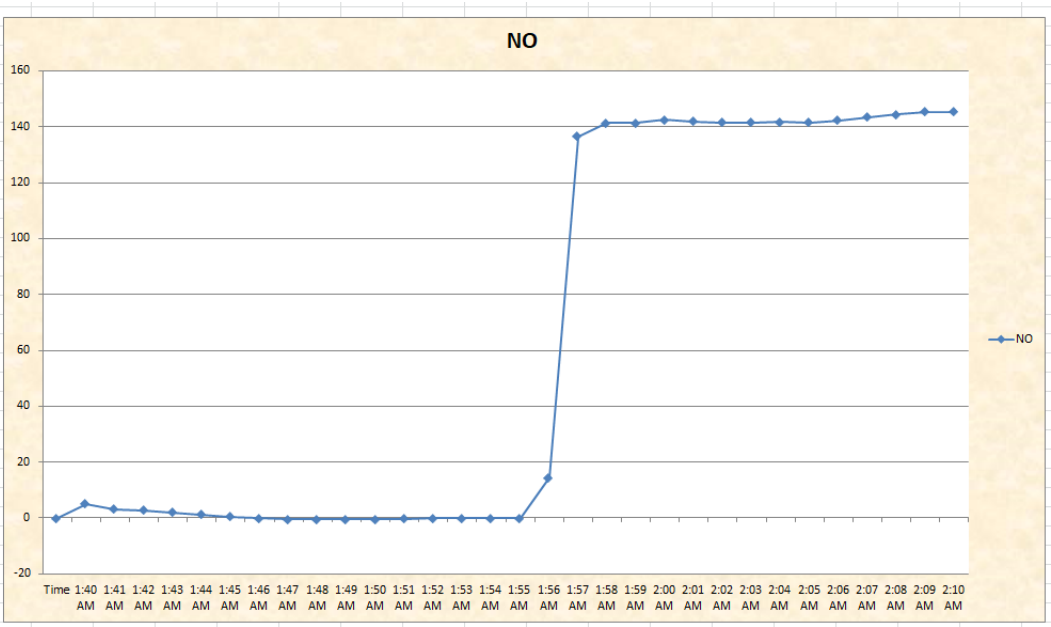
Observed concentration – 145.35 ppb

Stabilization time – 03 min.

Ref. Picture – 10.10

Observation : Analyser Performance is Satisfactory

Time	NO
1:40 AM	5.05
1:41 AM	3.22
1:42 AM	2.72
1:43 AM	2
1:44 AM	1.22
1:45 AM	0.47
1:46 AM	-0.12
1:47 AM	-0.49
1:48 AM	-0.43
1:49 AM	-0.45
1:50 AM	-0.43
1:51 AM	-0.3
1:52 AM	-0.17
1:53 AM	-0.05
1:54 AM	-0.06
1:55 AM	-0.09
1:56 AM	14.52
1:57 AM	136.6
1:58 AM	141.39
1:59 AM	141.37
2:00 AM	142.47
2:01 AM	141.93
2:02 AM	141.51
2:03 AM	141.61
2:04 AM	141.63
2:05 AM	141.62
2:06 AM	142.35
2:07 AM	143.4
2:08 AM	144.35
2:09 AM	145.3
2:10 AM	145.41



10.10 - Performance check of NOx analyzer against specified test concentration

This was followed by **check of reliability and accuracy of $PM_{2.5}$ and PM_{10} parameters.** This test was done on-site taking system parameters into consideration,viz. flow rate, suction device performance, mechanical strength of filter strips, weight of filter strip, lamp intensity, leak detection in sample line, temperature etc. All the system diagnostics were found to comply the SOPs.

Conclusion :

The methodology of online real-time monitoring and the architecture of data flow is presently not supported by any legal backing and, therefore, there is fair possibility of tampering of data generated through automated monitoring systems. This can end up with the manipulated data reaching to the Central Server and ultimately to the regulatory authorities. This ultimately defeats the basic purpose of monitoring and hinders Government's efforts in controlling pollution.

The draft Rules on real-time monitoring, April 2015, states about provision of in-built Remote Calibration facility in instrument/analysers for verification of system performance. This remote calibration facility can also be used to ensure that the monitoring data being received at regulator's end is reliable, meaningful and reproducible. This requires evaluation not only of analysers but of entire CAAQM system.

The analyser is the key part in the system, which can be checked remotely too alongwith other system diagnostics, hence MPPCB periodically checks the CAAQMS, installed at strategic locations in the State, performance remotely for correctness of monitoring data being received at central server at ESC.

This study, conducted during 27.11.2020 to 16.12.2020, is a part of regular performance check of CAAQMS network by the ESC and this would help to establish the credibility of real-time monitoring data. The remote check process at Mandideep and Jabalput station was repeated during the exercise for cross verification of observed outcomes.

Based on the outcome of the observations of remote check of zero and span drift of selected gaseous parameters **it can be concluded** that the response of analysers at all the CAAQM locations in the State is satisfactory. This also establishes that the data being received at central server end is verified and tamper proof. The test span concentrations monitored by the analysers were well within the prescribed deviation range and, therefore, no calibration correction was required at any of the station. The functioning of all the CAAQMS is satisfactory and the site ambient **monitoring data is genuine and reliable.**

Based on the past studies, and looking to the consistency in data and tolerance of monitoring system, the existing period of calibration cycle of CAAQMS can be raised. The calibration cycle may, however, also depend on the operating conditions and the pollution load at particular location. The stability of sensors and data observed in the present study might be due to the fact that the monitoring instrument used are not old, and, as the systems get older the frequency of calibration cycle may need to be reassessed.
