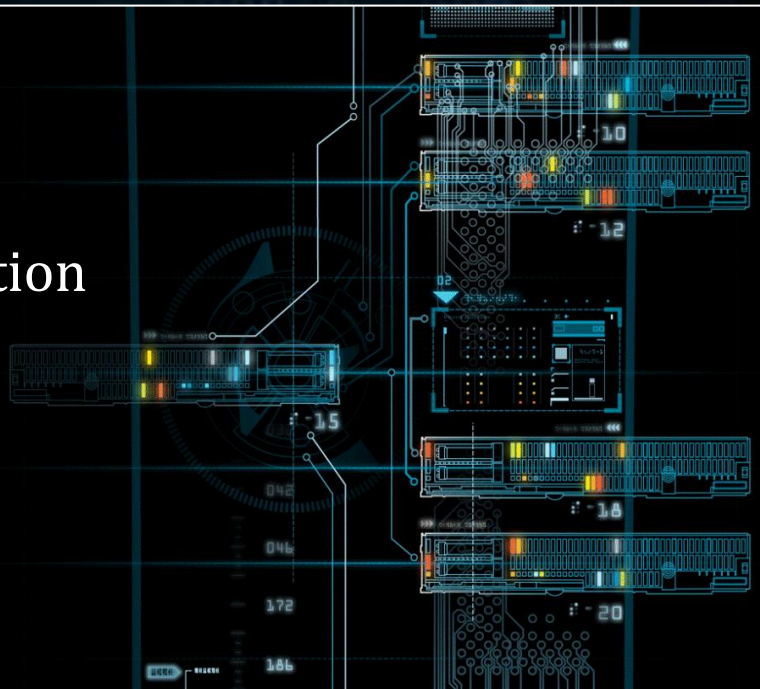# CEMS PERFORMANCE EVALUATION

Remote Calibration
March 2018

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Remote Calibration of CEMS Analysers

1.0   Background :

The   Central Pollution Control Board issued directions to all the SPCBs on 05.02.2014   regarding self monitoring of compliance by 17 category of highly polluting industries, CETPs and Common hazardous waste and bio-medical wastes incinerators for pollution control. As part of compliance M.P. Pollution Control Board issued directions to all the target industries/facilities on 12.08.2014 for installation of real-time monitoring systems, viz. continuous emission monitoring system (CEMS) and continuous effluent quality monitoring system (CEQMS). Later the scope of real-time monitoring was widened and industries were asked to install continuous ambient air quality monitoring system (CAAQMS) and IP-PTZ camera at strategic locations in their premises for remote surveillance purpose.

2.0   Creation of Environment Surveillance Centre :

A dedicated Environment Surveillance Centre (ESC) with modern gadgets was established in the State in January-2016 for real-time surveillance of industries. Data management policy, developed on need basis, is in place at ESC. IaaS and PaaS services of NIC (Web Server/Cloud VM) have been availed to avoid any possible risk of security breach and keep the data safe for desired period. High network security has been adopted at ESC to prevent security breach of wireless network and Data Network.

A responsive web application, environment surveillance management system (ESMS), has been developed on PHP based framework Laravel with PostgreSQL database in-house for automation and management of entire real-time monitoring system for speedy and hassle free operations. Another responsive web application document management system (DMS) has also been developed in-house on Jawa hibernate and struts 2 framework with database PostgreSQL for speedy service.

3.0   Present Status :

The industries in Madhya Pradesh have responded to this new monitoring technology and have installed real-time monitoring systems as part of compliance. Now, the spectrum of surveillance is being expanded. In addition to 17 categories of highly polluting industries, Red categories of industries are also being brought under scanner simultaneously and they too have been asked to put online real-time monitoring systems. Out of 85 highly polluting industries, 81 have complied and among 13 common treatment facilities 09 have complied till February 2018. A total of 189 establishments, including 17 categories industries and common facilities, have adopted real-time monitoring technology in the State.

Total CEMS counts in the State is 227. Apart from CEMS, total 81 CAAQMS, 57 CEQMS and 100 IP-Cameras have been installed by industries in the State.

4.0   Need of Performance Evaluation of CEMS :

The draft Rules on real-time monitoring, April 2015, states about provision of Remote Calibration in instrument/analysers for verificationof system performance.

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 and this can end up with the manipulated data reaching to the regulatory authorities. This ultimately defeats the basic purpose of monitoring and hinders Government's efforts for control of pollution.

It is important to ensure that the monitoring data being received at regulator's end is reliable, meaningful and reproducible. This requires a periodic evaluation/check not only of analysers but entire CEMS as a whole. The analyser is the key part in the entire system, which can be checked remotely too, hence MPPCB has initiated process to check the CEMS performance remotely for correctness of monitoring data being received at ESC. The prime aim is to sensitize the industry people and, at the same time, verify the reliability of the monitoring system at industry end. The process of remote calibration of CEMS analyser does not require presence of anyone at the remote end but, owing to cylinder safety concern, the industry representative is asked to be present at the time of calibration for opening and closing of valves of span gas cylinders manually which, otherwise, can be operated remotely too. 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 to this process.

5.0   Past Calibration Exercises :

During last one year remote calibration of CEMS analyser was exercised in 11 industries as listed below.

i.   M/s Jaypee Rewa Cement, Dist. Rewa (08.02.2017)
ii.   M/s Jaypee Sidhi Cement, Dist. Sidhi (09.02.2017)
iii.   M/s Prism Cement, Dist. Satna (08.02.2017 & 18.08.2017)
iv.   M/s ACC :Limited, Dist. Katni (23.02.2017)
v.   M/s Orient Paper Mill, Dist. Shahdol (19.04.2017 & 07.03.2018)
vi.   M/s KJS Cement, Dist. Satna (05.05.2017)
vii.   M/s Birla Corporation Ltd., Dist. Satna (23.05.2017)
viii.   M/s Ultratech Cement, Dist. Neemuch (15.06.2017)
ix.   M/s Reliance Cement Ltd., Dist. Satna (17.11.2017)
x.   M/s Heidelberg Cement, Dist. Damoh (16.01.2018 & 23.03.2018)
xi.   M/s Grasim Industries, Dist. Ujjain (22.02.2018)

The calibration was successful in majority of the cases but in few cases the calibration process was partially successful or failed.

**6.0   Discussion on Remote Calibration Exercise** :

The remote calibration of analyzers is done to check the performance of CEMS and ensure reliability and reproducibility of data and rectify the snags if any deviation is observed. Ideally the process takes about an hour for one cycle and during this period the sample line is cut off automatically.

The process involves Sample run, Zero Calibration and Span Calibration followed again by Sample run. For zero cal the command is given from server end which is executed by DAHS at the remote end.
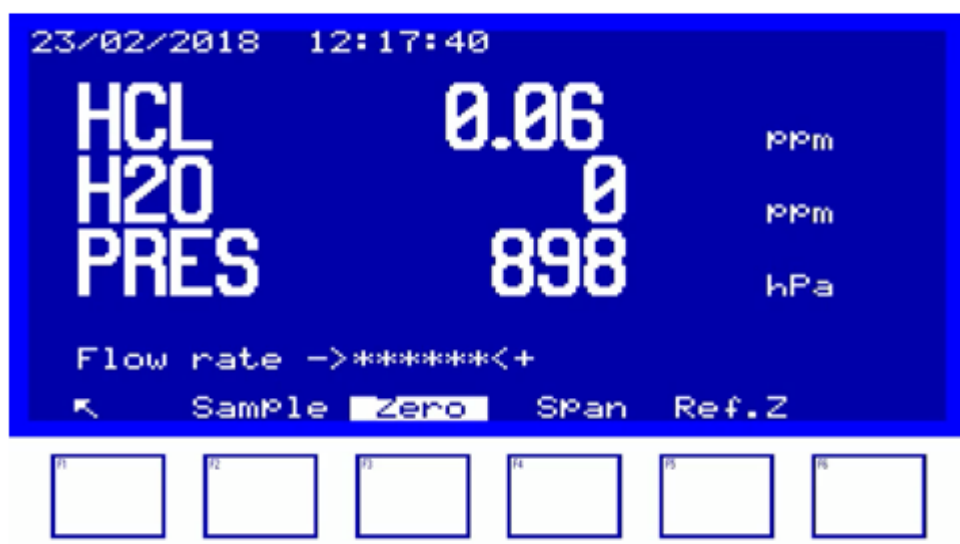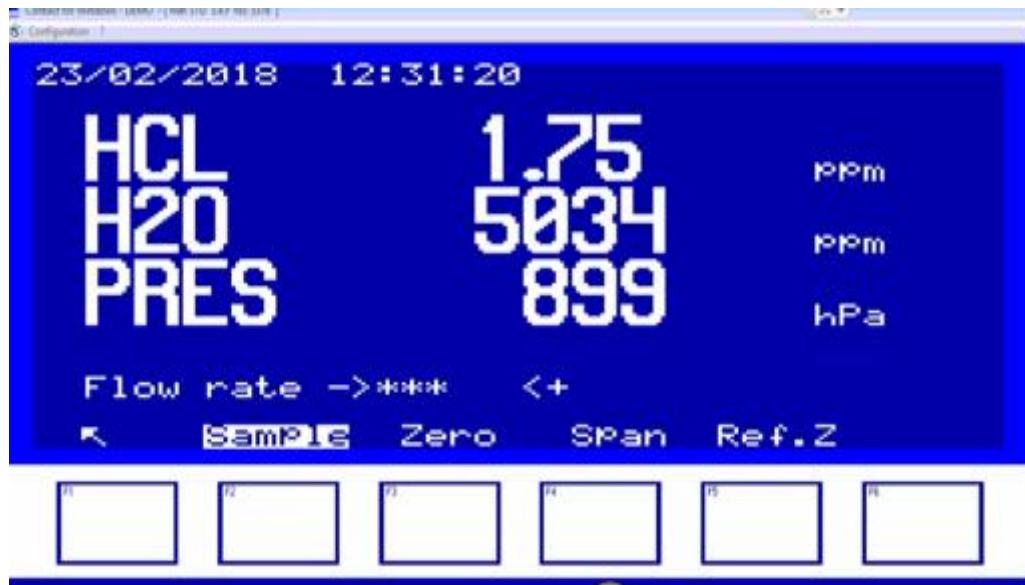

Analyser image captured remotely during Zero Cal

During Span calibration a known concentration of certified gas is passed through the system and the obtained value is compared with the span gas concentration to check the drift if it is within permissible range or not.
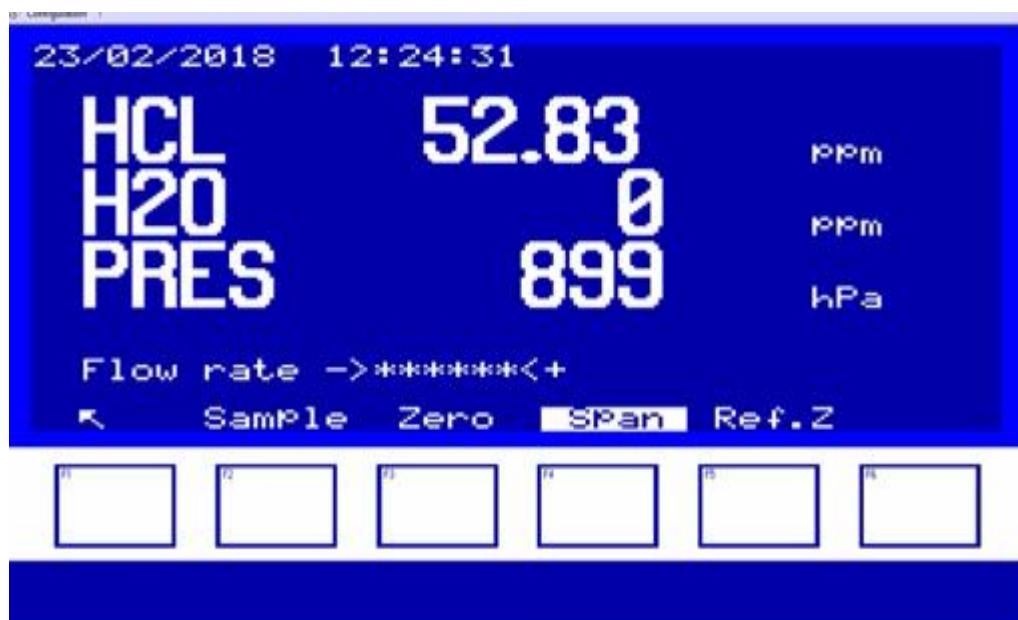
Analyser image captured at remote end during Span Cal

As soon as the span calibration is over the analyzer starts taking sample automatically from the source. After stabilization the parameter concentration displayed on the screen is compared with the concentration observed before the calibration process.


Analyser image captured remotely during Sample run

The process of remote calibration appears to be very simple but number of checks are applied prior to start of the process. Basically there are two approach for calibration, viz. Server based and Cloud based. The Server based process is superior to Cloud based calibration, as briefly discussed below :

6.1   Server based method :

In this process the command is given from server system to DAH system at industry end which in turn gives command to the analyzer for calibration. Prior to calibration entire course is defined to the Server. To eliminate any possible chance of tampering with monitoring data, DAHS and analysers are also logged-in remotely from the server to watch the entire sequence and activity going at distant locations. This allows to view all the three screens at one place simultaneously and puts a check on any possible manipulation of data at any point. (Refer Snap 2.1, 2.2 & 2.3)

Some important information like concentration of span gas, expiry of span gas and refill dates of gas cylinders are collected from the remote site using IT communication tools at the time of calibration. This information helps to ensure that analyzer is not modulated for a false or programmed concentration. First the zero calibration is performed followed by span gas passing through the analysers. The concentration value of span gas, which is set in server prior to execution of command, is usually kept on much higher or lower side as compared to the actual span gas concentration. This helps to make certain that analyzer is actually sensing the input sample and is not influenced / governed by the values set in the server. Any deviation, +/- 2% from the actual concentration, attracts attention and warns for necessary corrective measures.
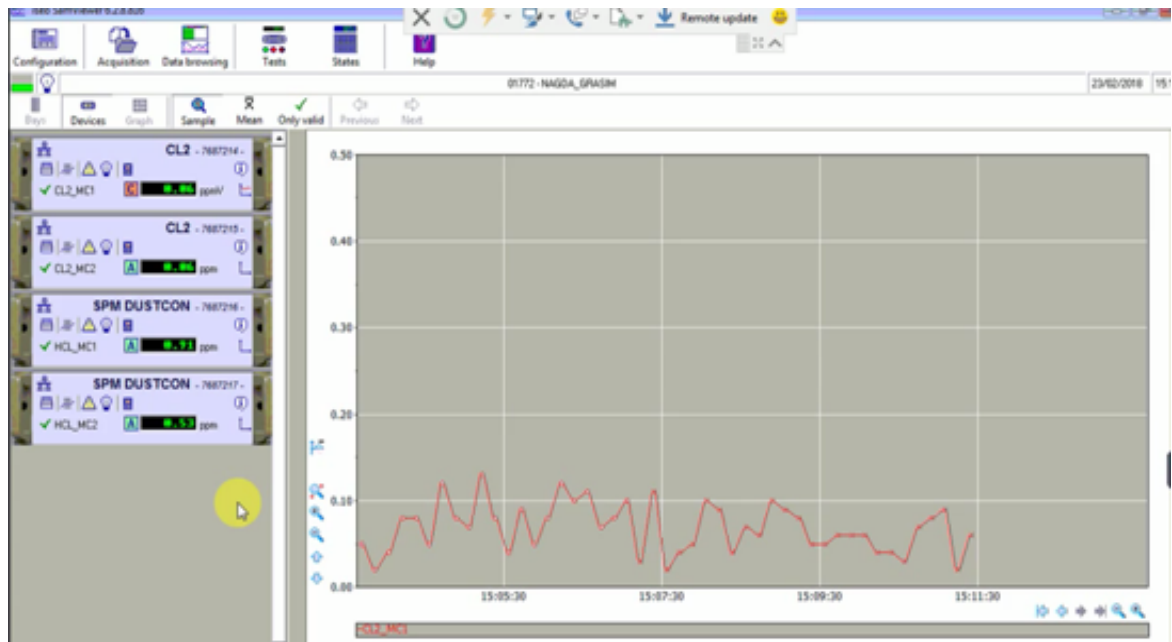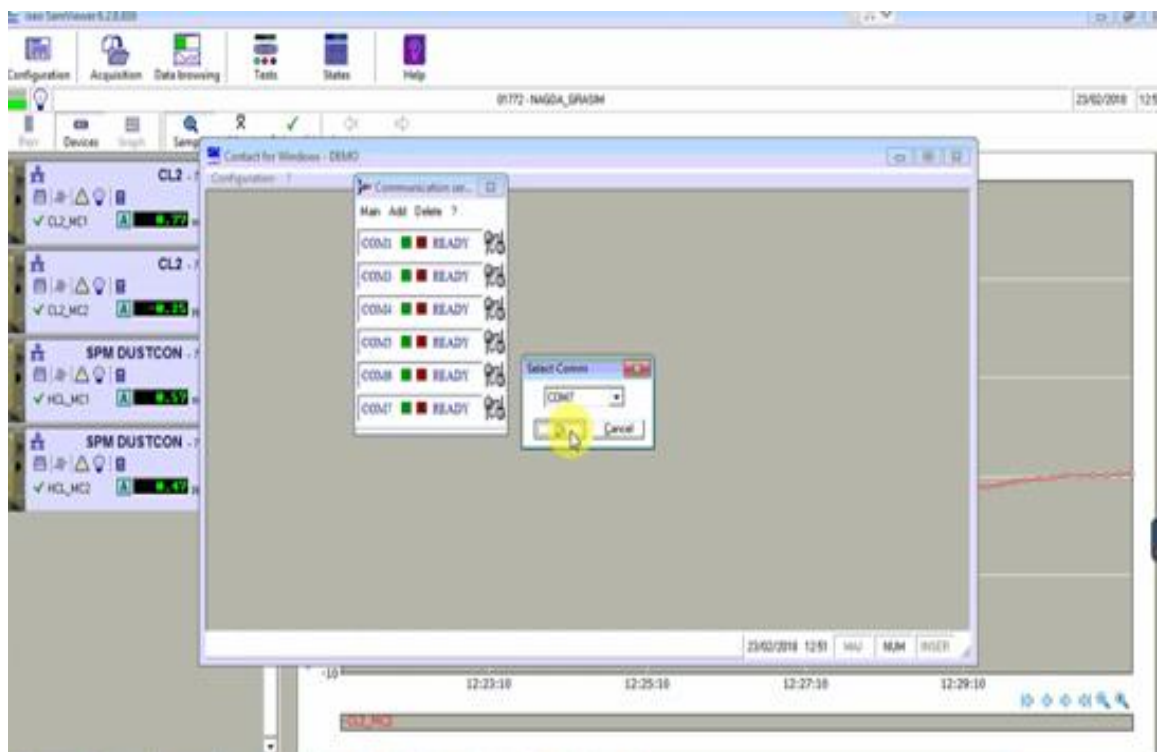
Remote access to DAHS during Calibration

Fig. 2.2 - Remote access to both Analyzer and DAHS

6.2   Cloud based method :

The Cloud based method of remote calibration seems to be very convenient and can be performed from any desk, but owing to few fatal flaws, which are avoidable, it is less acceptable.

In this system the Cloud has its own database server to take data from DAHS at industry end and execute it on portal. While placing command to the analyzer for calibration the command goes to analyzer via cloud database and DAHS. The strange part is that, unlike in server based method, the command execution process can not be viewed as the entire process goes at backhand on the portal. The calibration parameters like span gas value, calibration time etc are also pre-assigned by the service provider and can not be changed at the time of calibration raising doubt on the integrity of the method. It is also not possible in the existing cloud based calibration method to ascertain whether command is going to the CEMS analyzer or not nor there is provision to see the analyzer behavior and its response during the process. This is shown sequentially as follows through screen-shots of actual remote calibration :
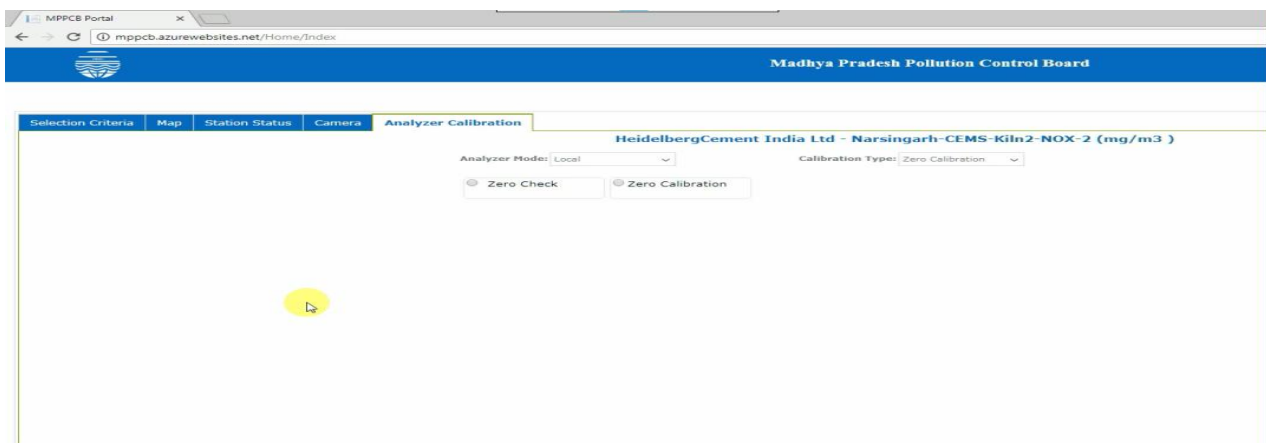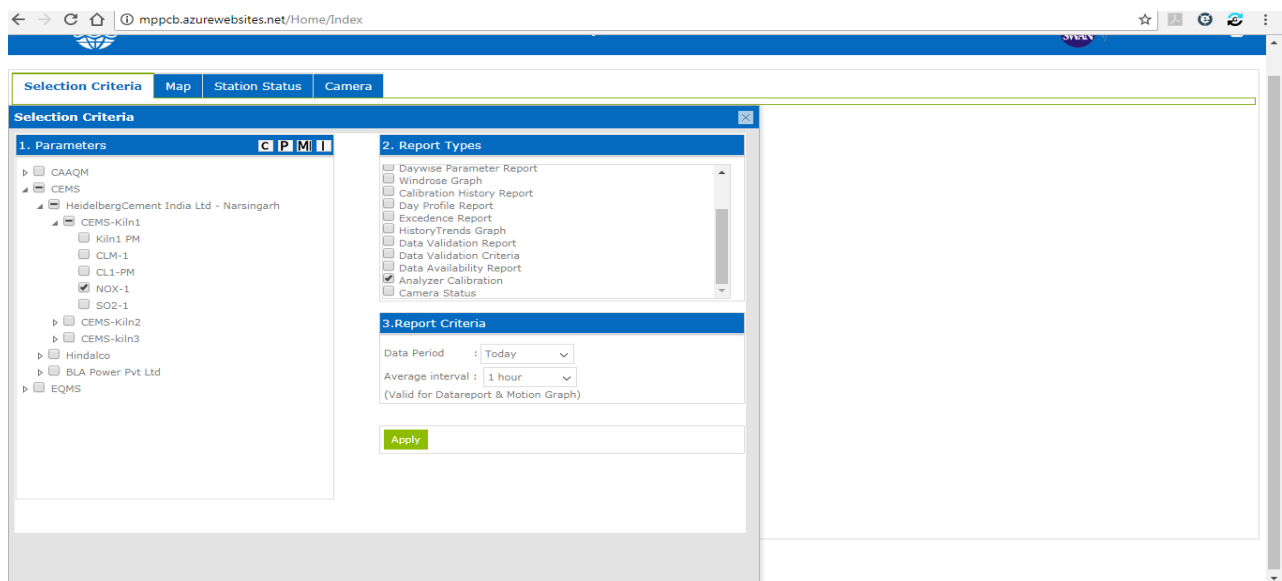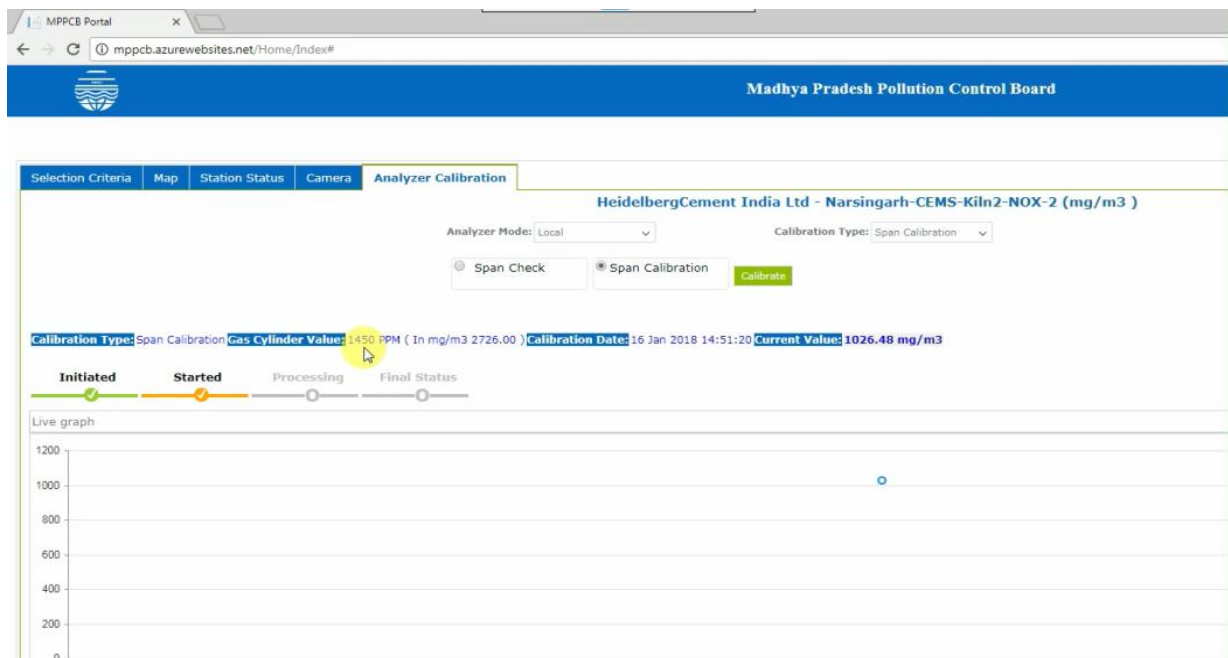
In nutshell the cloud based remote calibration process goes automatically as per pre-programmed track with no control or checks at regulators' end.

Thus, the existing Cloud based remote calibration process, as shown above, can not be trusted for the reasons mentioned at para 6.2. A cloud based operations can be driven by a software without even accessing the analyser. For this, once the process of calibration is initiated, a pre definite structure in software database for each different parameter is followed sequentially with specific steps and time duration for calibration. The following sample table structure can perform Zero and Span calibration automatically :

Process_step_id (PK)	Process _id	Process_name	Exe_date_time	Exe_duration	seq
1001	101	Zero Check	Current_date_time	5 min	1
1002	101	Zero Check	Current_date_time	4 min	2
1003	101	Zero Check	Current_date_time	3 min	3
1004	102	Span calibration	Current_date_time	5 min	2
1005	102	Span calibration	Current_date_time	4 min	1
1006	102	Span calibration	Current_date_time	3 min	3

Based on above facts, it is recommended that, irrespective of mode of calibration, the regulators should have direct access to the analyser through individual dedicated IP. The static IP assigned to the analysers should be accessible without intervention of any database.

The use of FTP for transmission of data to the cloud or MPPCB's server is not recommended. Remote calibration can not be performed if FTP server is used to push the data. Calibration is also difficult if IP network is not properly established. Use of any database server like DAHS or cloud-based database is also not recommended to make sure that unaltered data is transmitted directly to the MPPCB.

6.3   Data Flow Architecture :

The architecture of the network plays a crucial role in success of remote calibration. The industry is advised to connect the analyzer on Ethernet network and assign IP address to each analyzer but some industries are still using serial cable despite having provision of Ethernet port on analyzer as shown in network diagram below :
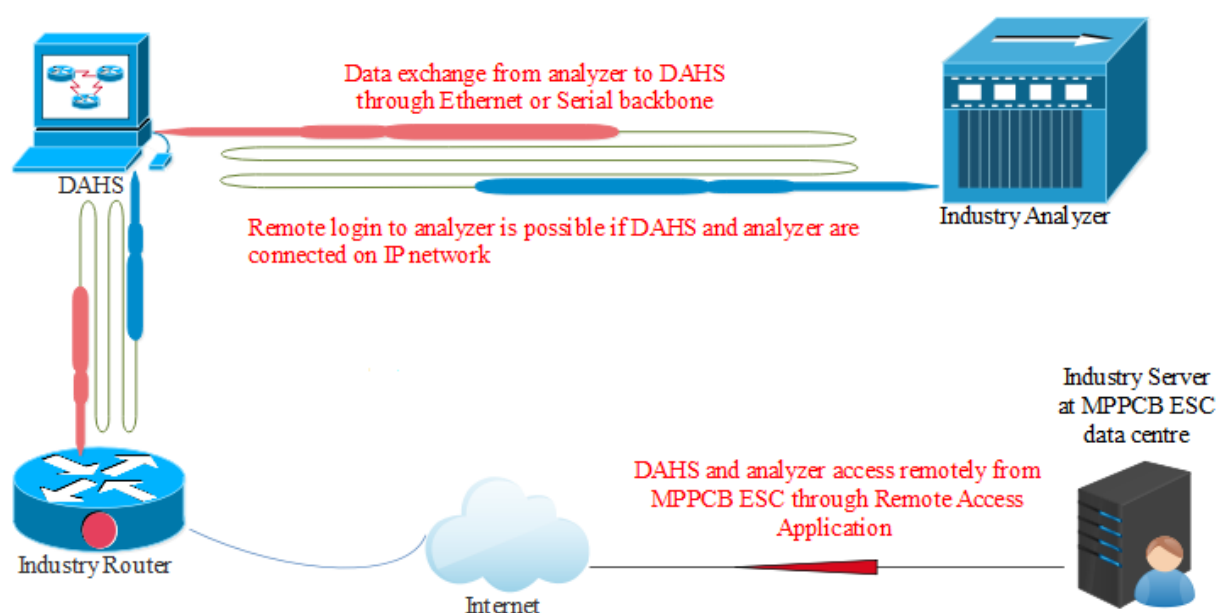
Sketch showing Existing Network

The IoT based network solution, which allows direct remote access and controls over analyzer across existing network infrastructure, can be used to connect and exchange the data.
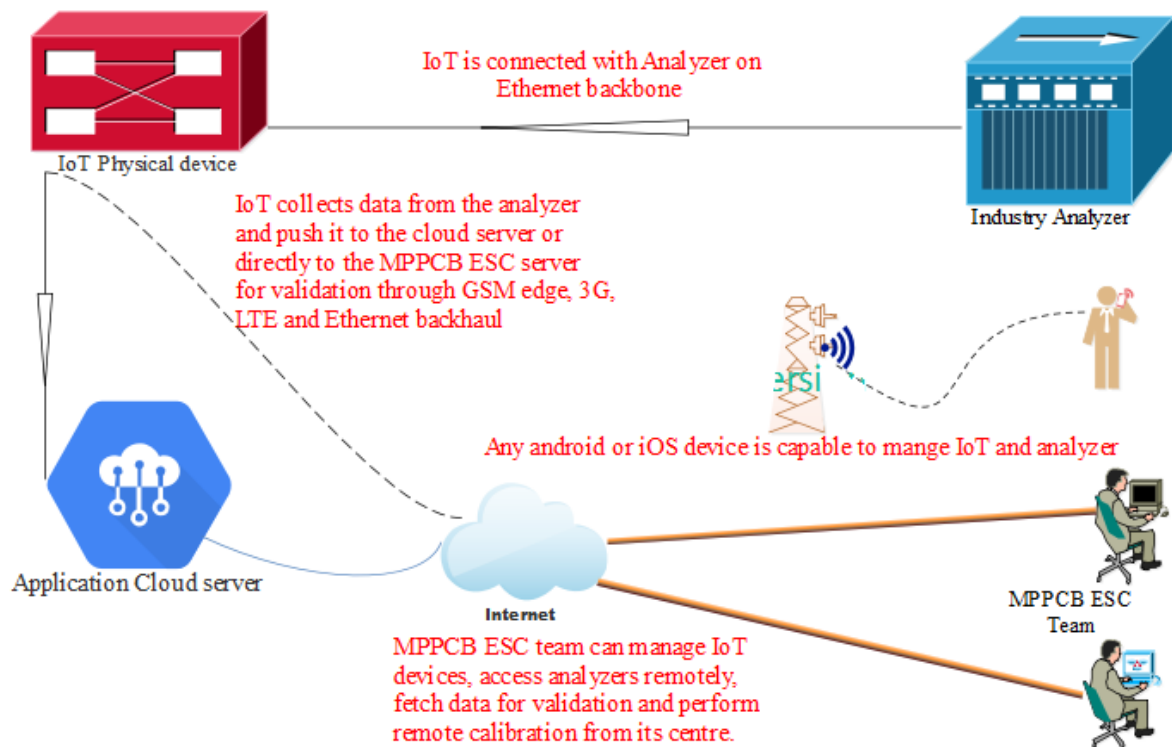
Sketch showing IoT based Network

Among two of the above discussed modes of remote calibration, the Server based remote calibration process can be preferred. The cloud based process can be used if the control provisions are provided at the regulators end. It is also recommended that, irrespective of mode of calibration, the regulators should have direct access to the analyser through individual dedicated IP login. The static IP assigned to the analysers should be accessible remotely at regulators' end without intervention of any database.