EPCA report number 16 (November 2005)

Supplementary report

Based on the order dated August 12, 2005 regarding the responses received on the EPCA report no. 14 on lambda measurements to improve the effectiveness of the in-use emission system.

(**In the matter of W.P.(C) No.13029 of 1985; M.C. Mehta v/s UOI & others**)

Environment Pollution (Prevention & Control) Authority
for the National Capital Region

1. Background: Introducing lambda regulations in the NCT of Delhi

In March 2005, EPCA submitted its report no. 14: *Special report on the introduction of an upgraded pollution under control certificate system in response to the Hon 'ble court's order dated February 4, 2005*. The report prepared after deliberations with all the concerned stakeholders detailed out the importance of lambda regulations if introduced as a regulatory norm in the NCT of Delhi for petrol cars fitted with three-way catalytic converters and a close-loop system.

Lambda regulation is important for petrol cars (in-use and new) fitted with three-way catalytic converter and a closed-loop control system. Delhi is getting Euro II cars from 2000, which are in most cases fitted with the advance emission control systems. The ability of catalyst to operate efficiently is dependent on it maintaining a sufficient oxygen storage capacity (OSC), and the engine's control system providing both the correct range of lambda and at the right frequency. For a correctly operating vehicle with closed loop fuelling control and a three-way catalyst there are far fewer faults that lead to excess emission than on older petrol cars. This makes it important that the lambda values fall within the accepted range.

The Hon'ble Supreme Court, in response to the EPCA report, in its order dated April 8, 2005 said, "the State Government, as prayed, is granted two weeks' time to file its response. List in the month of May 2005 for consideration of the Report on the aspect of introduction of lambda test." Based on the court's order, the transport department submitted its affidavit in May 2005. The Society of Indian Automobile Manufacturers (SIAM) also made a submission on the EPCA report in August 2005.

Subsequently the lambda matter was again heard on August 12, 2005. Upon hearing the parties, the Hon'ble court ordered, "The State has filed response to the report referred to No.14 of EPCA. Mr. U.U. Lalit, learned *Amicus Curiae* prays for short adjournment to look into it. It is pointed out by the State that the EPCA, in his meeting dated 30th July 2005, has fixed some norms. The EPCA may file the supplementary report".

EPCA is doing this supplementary report to inform the court on the introduction of the lambda regulation in the NCT of Delhi. This supplementary report contains the following;

1. Details of the submissions received from Delhi government and SIAM
2. EPCA's work to assess the effectiveness of lambda measurements in NCT of Delhi
3. EPCA's response to the submissions received based on the above deliberations and data collection

2. Submission on EPCA report

At the outset EPCA will like to point put that there is no disagreement as far as the implementation of the lambda regulation is concerned, between the different parties. The transport department of the Delhi government (in its affidavit of May 2005) and the SIAM through its submission of August 2005 to the Hon'ble court agree to the implementation of lambda regulation. SIAM has pointed their differences regarding the cut points for regulating lambda in the NCT of Delhi.

2.1 Transport department's affidavit

EPCA will like to point out that the transport department is in consonance with EPCA as far as the introduction of lambda regulation in the NCT of Delhi is concerned. The transport department requires some time for the actual implementation, which according to EPCA seems fair for smooth introduction of the lambda regulation. Based on the court order, the Delhi transport department in its affidavit has pointed out "the answering respondent would need at least a further period of six months to implement the lambda test on each and every PUC centre after availability of approved equipments, necessary cut points."

The affidavit accepts that a lot has been done in the direction of introduction of the lambda tests for the petrol driven vehicles equipped with three-way catalytic converter and having a closed loop system in the NCT of Delhi, but there are many things yet to be done for introducing the lambda regulation.

EPCA would like to point out that since the submission of the transport department's affidavit in May 2005, all the concerned stakeholders have already carried out the necessary groundwork. For instance most of the equipment/suppliers of the 4-gas analysers, have already got the necessary approval for the RPM measurements. Moreover, as its commitment towards introduction of the lambda regulation, the transport department has issued a circular dated August 17, 2005, with the tentative revised format of the PUC certificate. The transport department has informed all the Pollution Under Control (PUC) centres in the NCT of Delhi, and the equipment/suppliers of the 4-gas analysers to be fully prepared. For the equipment/suppliers the transport department has asked to provide all the information regarding the availability of the 4-gas analyser and the RPM sensor capable of measuring lambda at high RPM duly approved by the testing agencies prescribed under CMVR 1989.

2.2 SIAM's submission

SIAM in its response to the EPCA report no. 14, says, "A suggested value of 1+/- 0.09 may be taken as the lambda limit, which can be reviewed subsequently. By which time manufacturers would be in a position to indicate values based on data collected and also limits could be scientifically arrived at by using the data generated in the pilot phase." It has pointed out that the vehicle manufacturers specify the lambda limits and only in the absence of any specified limit government uses limits 1+/- 0.03. SIAM feels that lambda measurement should be made mandatory but the norms should be fixed after collecting the requisite data.

SIAM accordingly has suggested that the field trails should continue for 24 months, in line with the European practice and the norms for the lambda to be fixed after collecting the requisite data. At the end of the 24 months, the manufacturers should be given the option of specifying the lambda range for their vehicles, in line with the European practice. Moreover it is of the viewpoint that lambda measurement frequency should be set for 'once a year', instead of every three months.

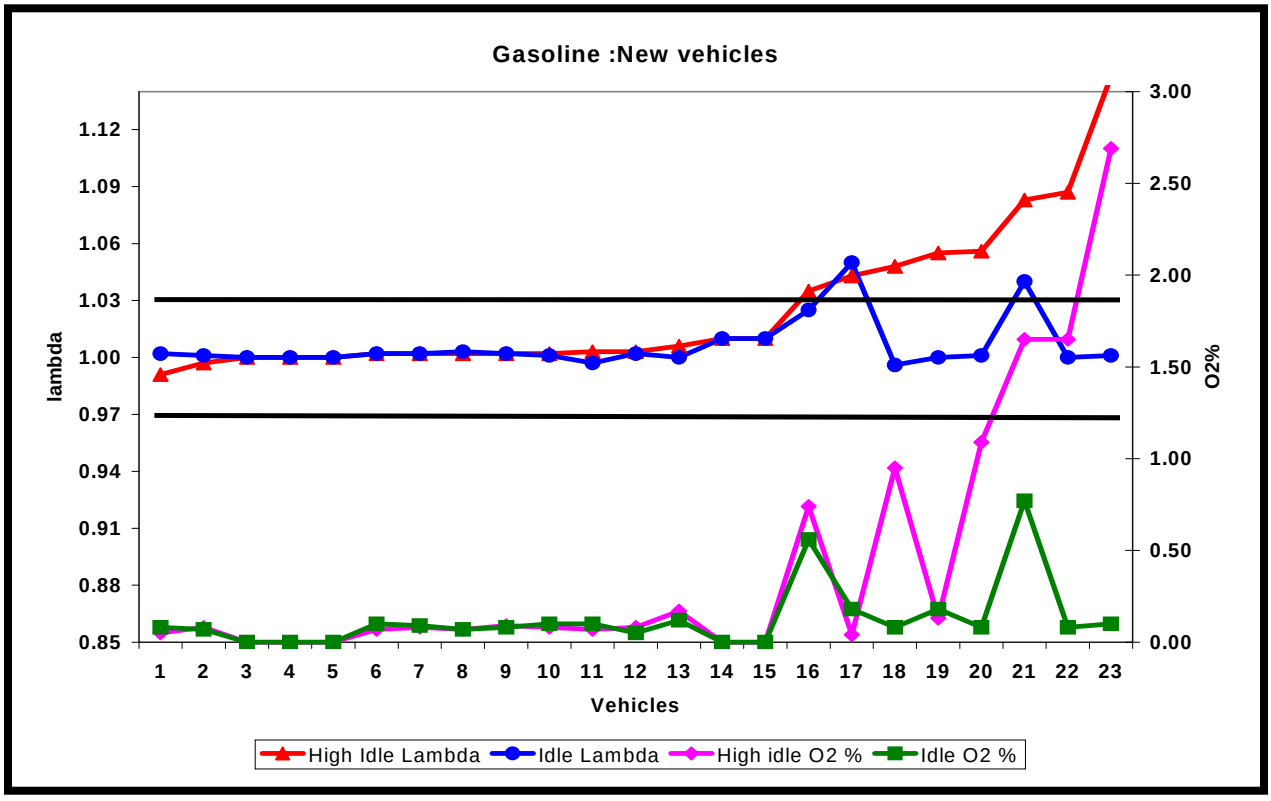
3. EPCA's initiation for lambda regulation

The Union Ministry of Shipping, Road Transport & Highways (MoSRTH) in its notification dated February 10, 2004 GSR 111(E) said: "Provided that in case of petrol vehicles, fitted with 3-way closed loop catalytic converters, the government of the respective state of UT, as the case may be, may by notification in the official gazette, specify the introduction of measurement of LAMBDA (dimensionless value representing the burning efficiency of an engine in terms of the air/fuel ratio in the exhaust gases) and tighter emission norms for in-use vehicles…"

EPCA from more than one year has been working to ensure that this regulation, provided by the ministry as an optional tool to city governments is introduced in key hot spot cities of India. By making the lambda tests mandatory for all in-use petrol vehicles, which are fitted with the three-way catalytic converter and a closed loop system, will ensure that the lambda is maintained within its range. This would provide the room so that the catalytic converter can work most efficiently. As explained above, if the lambda is maintained in its range, the conversion efficiency of the catalytic converter for all the three pollutants is maximised. Euro II was introduced in Delhi way back in the year 2000, as a result of which most of the petrol vehicles are already having three-way catalytic converter and a closed loop system. Further as more and more vehicles are added, which are Euro III, EPCA feels that it is very important that lambda be measured from these vehicles.

EPCA have held various meetings with the ARAI on this issue. On the direction by EPCA, the ARAI conducted studies to gauge the lambda values from both the petrol and CNG vehicles and accordingly the ARAI conducted tests on the new and in-use vehicles. In an EPCA meeting with the ARAI held on October 16, 2004, ARAI presented the results of their studies, which were startling. It was observed that out of the 23 new gasoline vehicles tested by ARAI, close to 8 vehicles were failing on lambda. *(See Graph: New petrol vehicles failing)*.

Graph: New petrol vehicles failing



This study therefore, found that introducing lambda regulation is imperative as new vehicles were failing this basic regulatory test. EPCA then started working on the mechanisms and

modalities of how the lambda measurements should be introduced in the city. In December 2004, EPCA wrote to all the automobile manufacturers to know, at the earliest, if they have specifications for lambda value for their vehicles, which are different from the international practice of adopting the 1+/- 0.03 range. This would enable ECPA to proceed further, to implement the lambda test. This information was to be given to EPCA by January 15, 2005.

EPCA received only two responses – from M/s Mahindra and Mahindra Ltd (M&M) and M/s General Motors Ltd (GM). M&M indicated that they would not be keen on the introduction of lambda in the city. The companies took the position that they are not in a position to give any specification of lambda value for their vehicles, as this was not a requirement so far. EPCA has noted this contention with considerable surprise; as it is evident that if companies have been following international practice then they should have been able to provide EPCA with a specified range for lambda, irrespective of the fact that the Indian government had not included it in the type approval certificate as yet.

The fact is that the new regulation of the government has already mandated the (optional) use of lambda. In the meeting convened on February 5, 2005, which was represented, by all the stakeholders- the SIAM, the Transport department, the PUC instruments manufacturers, and the ARAI it was therefore, agreed to implement the lambda regulation in Delhi, to begin with for all in-use petrol vehicles fitted with three-way catalytic converters, with a closed loop system. Based on this agreement certain key decisions were taken at the meeting so that lambda measurement could be implemented from May 15, 2005.

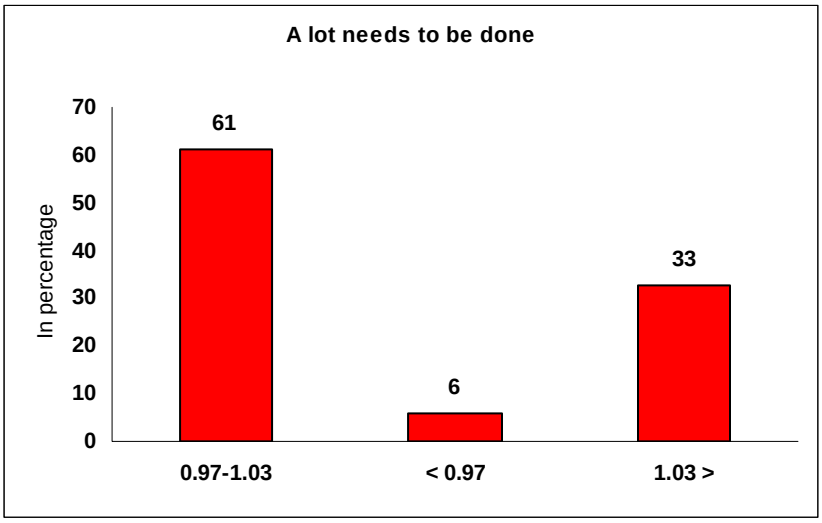
3.1 Pilot study to smoothen implementation

Taking the fact into consideration that Delhi would be the first city in the country to implement a mandatory lambda tests as part of the PUC programme, it was decided that to begin with a pilot study would be undertaken for a period of three months from February 15, to May 15, 2005. This period would be used to generate the necessary data for the introduction of the lambda tests in the NCT of Delhi.

EPCA feels it important to point out that this pilot study of 3 months was initiated in spite of the fact that both the ARAI and the SIAM have over last few months already generated sufficient data on the lambda measurement. But on requests from ARAI and the automobile companies, represented by SIAM, EPCA thought it would be important to introduce a pilot study programme, so that more data would be generated before introducing the lambda tests and the key steps for its implementation identified.

EPCA again on the April 30, 2005 called a final meeting for the implementation of the lambda regulations. All the stake holders- SIAM, ARAI, the Delhi transport department and the PUC equipment/suppliers represented the meeting. ARAI presented the results of the initial stages of the pilot study. Currently however at the initiation of the transport department, there is a data set of 1,462 in-use vehicles, as the pilot phase has been extended. (See Graph: Data from the pilot study with (1+/- 0.03) cut points)

Data from the pilot study with (1+/- 0.03) cut points



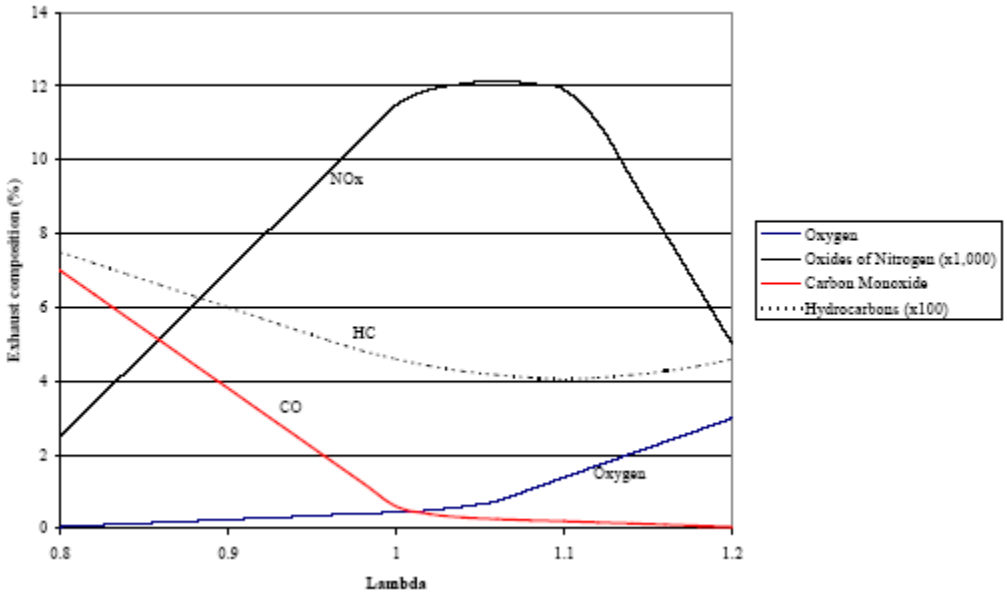
Though as per the initial agreement between the stakeholders, the pilot study was to be carried out for 3 months. But EPCA would like to point out that the pilot study is still underway and in its last meeting with the transport department on July 30, 2005 to assess the preparedness for introducing the lambda regulation, it was agreed upon that the number of pilot centers would increase from the current 10, to slowly cover all the stations. Thus with each passing day, more and more vehicular data has been gathered; only to further strengthen the capability of the operators, so that when lambda regulation is actually implemented, the PUC centers are well versed with the operational issues.

4. EPCA's observation

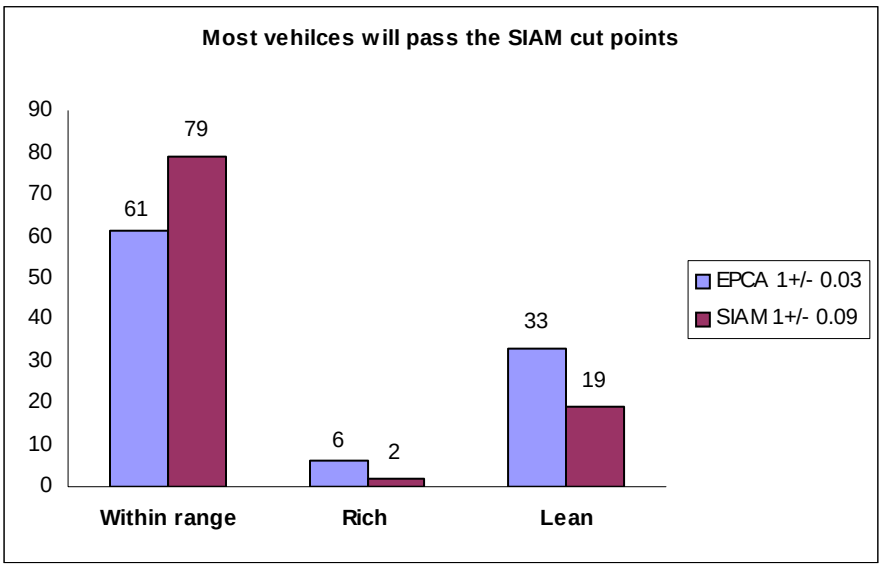
Thus it is evident from the assessment above, as far as the introduction of the lambda regulation for petrol cars fitted with three-way catalytic converters and a closed loop system is concerned, there are no disagreements and also no lack of preparedness among the agencies involved. The only issue as far as SIAM is concerned is on the necessary cut points to be adopted. EPCA at this juncture will like to reiterate its stand, that the internationally accepted cut points (1+/- 0.03), are the only valid cut points for regulation. It's only by adhering to this range, that one can envisage a proper functioning emission control system.

Modern three-way catalysts require the air-fuel ratio (A/F) to be as close to stoichiometry (the amount of air and fuel just sufficient for nearly complete combustion) as possible. This is because three-way catalysts simultaneously oxidize Hydrocarbons (HC) and Carbon monoxide (CO), and reduce Oxides of Nitrogen (NOx). Since HC and CO are oxidized during A/F operation slightly lean of stoichiometry, while NOx is reduced during operation slightly rich of stoichiometry, there exists a very small A/F window of operation around stoichiometry where catalyst conversion efficiency is maximized for all three pollutants. Said another way, three-way catalysts work with exhaust conditions where the net oxidizing and reducing chemistry of the exhaust is approximately equal, allowing the catalyst to promote complete oxidation/reduction reactions to the desired exhaust components, carbon dioxide (CO_2), water (H_2O) and nitrogen (N_2).

This A/F window, usually, has the range of 1+/- 0.03. Any relaxation of this range will only nullify gains that are derived by maintaining the A/F ratio within the right range. Having a look at the graph one can arrive at a better understanding: (Concentrations of emissions in the raw exhaust as a function of lambda)



As is evident from the graph above, if the A/F window is relaxed, NOx, will also increase considerably- a point of critical significance in India, as currently we don't measure NOx from in-use vehicles.

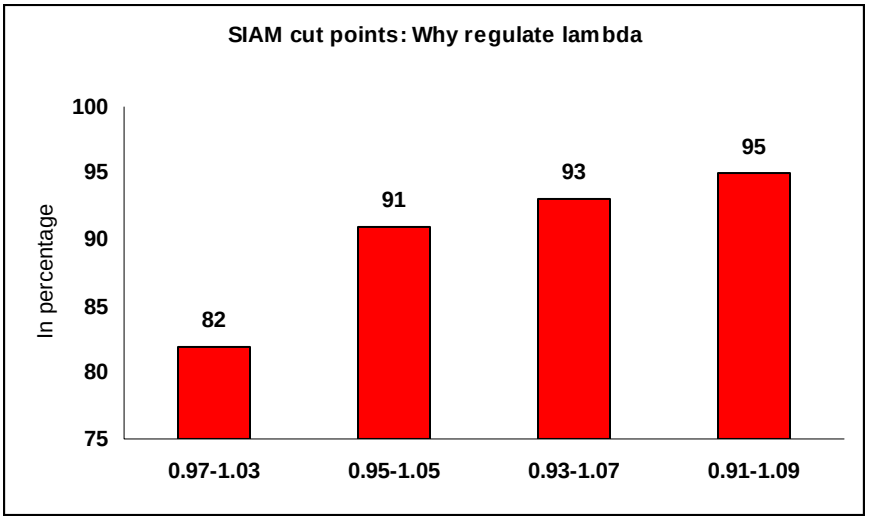


Source: Anon 2005, Submissions to EPCA, Delhi Transport Department, June-August

Moreover, if the SIAM recommended cut points (1+/- 0.09) are implemented, hardly any vehicle will fail the lambda tests, even though the vehicles might have problems. Applying

the SIAM's cut point to the data provided by the Delhi transport department to EPCA shows that the pass rate of vehicles would increase from 61 per cent to 79 per cent.

Pass rate with SIAM's cut points



Similarly SIAM's data from its pilot centers, which was provided earlier, shows that if their recommended cut points are implemented 95 per cent of the vehicle will pass the tests. As the above graph shows, with each successive relaxation of the cut points, the need for regulating lambda only diminishes.

EPCA will like to point out that SIAM's point number 12, in its submission, "as per International practice, the Lambda limits are specified by vehicles manufacturer and only in the absence of any specified limit, governments use limits 1+/- 0.03" is factually not correct. It is actually the other way around. EPCA would like to take stern note of the fact that such attempt by SIAM will only confuse the court and delay the implementation of the lambda regulations in the NCT of Delhi.

5. EPCA's recommendations and directions sought from Hon'ble Court

Based on the affidavit of the Delhi transport department, and submission from SIAM, EPCA concludes that relaxing the cut point with any range, other than the internationally accepted range, will not in anyway help to improve the in-use vehicles and the in-use emission inspection programme. After analysing the data EPCA is assured that by relaxing the cut point, very few vehicles fail the lambda tests. For instance, the tests done by SIAM reveal that accepting a lower cut off point would mean that as many as 95 per cent of the vehicles would pass the tests. This clearly makes the entire exercise redundant.

EPCA thus seeks the following directions from the Hon'ble court:

1. **The Delhi transport department should introduce lambda regulations as part of the PUC tests, with the cut points of 1+/- 0.03, as accepted internationally,**

within 3 months for petrol cars fitted with three-way catalytic converter and a closed loop system

2. **ARAI and SIAM should provide all the necessary support to the Delhi transport department for smooth implementation of the lambda regulations**