A report on the independent inspection of fuel quality at fuel dispensing stations, oil depots and tank lorries

Samples collected from December 20, 2001 to January 18, 2002 in
the National Capital Territory (NCT) and National Capital Region (NCR) of Delhi

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C O N T E N T S

EXECUTIVE SUMMARY

The Centre for Science and Environment (CSE) has done an independent assessment of the fuel adulteration problem in the National Capital Territory of Delhi (NCT) and the National Capital Region (NCR) following a direction from the Environment Pollution (Prevention and Control) Authority (EPCA) under the Supreme Court order dated November 22, 2001. EPCA was directed by the Supreme Court to constitute an agency, which would independently carry out random inspection at petrol pumps, oil depots, and tank lorries in Delhi and give a report with regard to the quality of petrol and diesel available there. CSE started working on this project on December 20, 2001 and submitted the first draft to the EPCA on February 2, 2002. On February 4, 2002, the oil industry was asked to give its comment on the findings, which have been appended to this report.

Results: How much adulteration have we found?

The findings confirm our initial suspicion that adulteration is rampant, but it is difficult to detect

The tests conducted by the Society for Petroleum Laboratory (SFPL), NOIDA, set up under the direction of the Supreme Court for checking adulteration, are not adequate to detect adulteration.

The total number of samples for which test results are available to this report are 72. These include two adulterated samples sent by CSE. When the two adulterated samples that were deliberately sent by CSE are taken out from this list, the failure rate is about 8.3 per cent. This is a definite improvement over the past detection rate of the oil industry which, so far, has reported a failure rate of a mere 1-2 per cent.

This failure rate of 8.3 per cent, as interpreted by the SFPL however, is an underestimate. While interpreting the benzene data in petrol samples, SFPL has not taken into account the Supreme Court order that petrol must not have more than 1 per cent benzene. SFPL is still using the older specification of 3 per cent maximum limit while checking for adulteration. After correction, the total number of failed petrol samples increased to 15, that is, 30 per cent of the petrol samples. Thus, total sample failure rate increased to 26 per cent.

We did not expect to find adulterated diesel samples at this time, as the special drive to check diesel adulteration under the order of the Supreme Court was already on. In addition to the direction to EPCA, the Supreme Court had also directed the Department of Food and Civil Supplies under the Government of Delhi to organise a special drive to check adulteration of diesel. Thus, the element of surprise was missing.

Tests are inadequate to detect adulteration

What we have found is the tip of the (polluted) iceberg. We are convinced that it is quite irrelevant to count the number of adulterated samples as found in the lab. Our findings, presented in this report, show that the current fuel quality specifications and testing methods for fuel quality monitoring as prescribed by the Bureau of Indian Standards (BIS) are not even adequate to catch adulteration.

Fuel Testing Laboratory fails to detect adulterated diesel samples

CSE had deliberately sent three adulterated diesel samples for testing to check if these would show up in the tests prescribed for BIS standards. CSE mixed kerosene with diesel is the following proportions — 10, 15, and 20 per cent.

SFPL was able to detect only the sample contaminated with 15 per cent kerosene but declared the samples with 10 and 20 per cent kerosene contamination as conforming to all the BIS specifications of diesel. (The test results of these samples are annexed). The only parameter in which the sample contaminated with 15 per cent kerosene failed is sulphur content.

BIS specifies a broad permissible range for each fuel parameter which allows sufficient margin to cushion some amount of adulteration without violating the specifications. This essentially means that checking for compliance with fuel quality standards does not necessarily imply testing for adulteration. Since it is possible to adulterate without violating the standards, the tests carried out by the laboratory as specified by BIS do not detect adulteration.

Since fuel adulterants belong to similar hydrocarbon families as that of automotive fuels, though of varying composition, some amount to mixing is possible without changing the overall parameters of the fuel specifications. Unless tests are designed to track this variation as evidence for adulteration, a wide gamut of adulteration will never be caught.

Both kerosene and light diesel oil, which are the most popular adulterants for diesel, are so similar in chemical structure of diesel that these mix with almost no aberration in the properties of automotive diesel fuel. But experts point out that prolonged use of such a mix may impair engine performance and raise emissions. Moreover just not the environmental consequences but also the misuse of government pricing policy and subsidy are of equal concern. Illegal use of subsidised kerosene affects the poor and economy of the country.

Detecting adulterants in petrol is as difficult under the current BIS specifications. An intelligent mix can be worked out very precisely keeping in view the outer limits of the specifications. We have found that it is possible to calculate the amount of adulterant a fuel can take and still meet the BIS specifications. For instance, 91 octane petrol can be adulterated with 15 per cent low aromatic naphtha and still meet the minimum limit of 88 octane. Even if we consider petrol of 89 octane, it can still take 6 per cent naphtha mix. But 10-15 per cent adulteration can be immensely profitable. By mixing only 15 per cent naphtha with petrol a retail outlet can reap more than Rs 25,000 profit per day.

Inexplicable level of sulphur

We compared the fuel specifications of different batches of fuels as recorded at the Mathura refinery of the Indian Oil Corporation Limited (IOCL), Bijwasan depot (the fuel terminal in Delhi) where fuel comes through a pipeline from the Mathura refinery and the retail outlets. IOCL provided the detailes fuel specifications spanning over a month (December 3, 2001 — January 7, 2002). Any abnormal variation from the refinery specifications can be an indicator of something having gone wrong. We were stunned to note inexplicable variation in sulphur levels in fuels from the refinery to the retail end.

While the sulphur level in diesel at the refinery level ranges from 400-480 ppm, it reduces to a uniform consistent level of 200 ppm at the depot level. In the case of petrol sulphur, it is even more dramatic. While the Mathura refinery specifications show a range between 350 ppm and 450 ppm, the depot specification shows a ridiculously low level of 110 ppm.

In comparison, sulphur content in diesel at the retail outlet varies between 200 ppm and 300 ppm, and astonishingly, nearly 3 per cent of the samples record a 100-149 ppm level – a level which refineries do not even produce. The petrol sulphur specifications at the retail end vary between 200 ppm and up to 500 ppm sulphur content.

Clearly, there is a problem if fuel sulphur at the depot and at the retail end are so dramatically lower than what refineries are producing. The oil industry attribute this to the margin of reproducibility of the test methods that are allowed when tests are conducted in different laboratories under the current test methods. They add, it could be due to instrumentation confusion and calibration problems. When quizzed further, they dismissed the problem as very common and of no serious consequence as long as the standards were met.

But any test method with reproducibility variation of as much as 75 per cent as the case appears to be, is not acceptable. There are internationally accepted testing methods like the ASTM D5453-01 Standard Test Method for determination of total sulphur in light hydrocarbons, motor fuels and oils by ultraviolet fluorescence, and the ASTM D2622-98 Standard test method for sulphur in petroleum products by wavelength dispersive X-ray fluorescence spectrometry, which operate within the reproducibility variability of 10-12 per cent or upto 50 ppm maximum. But oil companies here are reporting an absurd variation of as much as 300 ppm. Does this mean 400 ppm sulphur in fuel recorded at the refinery is equal to 100 ppm recorded at the retail outlet?

In addition, it is important to note that it is not only exceeding of standards that indicates adulteration. Even drastically lower levels than a legally defined limit for fuel specifications can indicate adulteration. Dilution of petrol with a low sulphur adulterant, for instance, hexane, which is almost sulphur-less, can lower sulphur content in petrol drastically. But as these samples meet the stipulated sulphur level of 500 ppm, these are not considered suspect. If test methods are, therefore, not precise, how would one take action even when such discrepancies are detected? We believe, in the absence of any plausible explanation from the oil industry, these low sulphur results in the depot and retail outlets could be adulterated samples.

We need to tighten standards

Firstly, a large part of the problem we have found stems from the lax fuel quality standards which make adulteration easy but detection difficult. As key components of fuels like aromatics and olefins in petrol and polycyclic hydrocarbons in diesel are not regulated, these cannot even be benchmarked to detect aberrations. Even in the existing test methods some key tests that can be relatively more accurate in detecting adulteration like cetane rating in diesel, benzene content in petrol, or sulphur content in diesel are also not done in a routine manner.

Secondly, we have found that for most part fuel parameters fall within a narrow median range of the specifications and only a smaller proportion of the samples are at the margin. There are two lessons for us here. First, that it is possible to tighten the broad range allowed under the BIS specifications and align with better fuel quality norms worldwide and reduce the margin for impurities. Second, from the point of view of detecting adulteration, we are convinced that it is those samples whose properties are in the margin but still within specifications that would require confirmatory tests for more accurate detection that are not done currently.

Alternative tests show what goes undetected

In view of these serious limitations of the current test methods we wanted to check out through a limited set of tests that was possible within the severe time constraint on gas chromatography (Trace GC) with flame ionisation detector (FID). The purpose was to analyse individual hydrocarbon composition of the samples from retail outlet for more accurate fingerprinting and compare that with the reference samples of fuels as received from the depots in Delhi.

This study has given quite stunning results. It proves that these tests can detect dramatically high variations in parameters that are not even checked under the BIS specifications. In petrol samples, we observed astonishingly high variation in parameters like hexane, pentane, octane, and xylene, from the depot levels. In one case, pentane at the retail outlet is 10.631 per cent as opposed to average of 1.56 per cent at the depot level. While total-Xylene content at depot level is 3.32 per cent (average), at retail outlet it is 41.56 per cent. Since aromatics are not even regulated and tested under the BIS specifications, these tell tale signs will never be detected to confirm adulteration.

Therefore, in addition to improving the current testing procedures and fuel specifications, it is even more important to design alternative testing methods specifically designed to detect adulteration.

WHAT DO WE WANT

This study clearly shows that unless we take serious steps to improve the system to prevent and check adulteration, we will not even begin to touch the profitable business of adulteration. The current system gets compromised from testing methods that are not adequate to detect adulteration to penalty systems designed to let the manufacturers go scot-free. Distorted prices continue to encourage adulteration.

Make oil companies accountable for the quality of fuel at the retail end

Any extent of vigilance and surveillance will be meaningless unless strict liability is imposed on the oil companies to take full responsibility for the quality of fuels they sell at their retail outlets. As of now, the responsibility and penalty are all fragmented along the supply chain. Though retailers and transporters are penalised by the oil companies if malpractices are detected, the oil companies are not held accountable. To put it simply, consumers cannot sue the oil companies for adulterated fuels. Unless this is done, checks and balances in the system will not work effectively to prevent malpractices at any level. The best way that consumer pressure can be intensified on the oil companies is to develop a system of public rating of the retail outlets by the name of the oil companies on a monthly basis based on an independent inspection, testing and audit of the outlet. In a competitive market there are multiple oil companies rivalling for market share. This will become more severe with decontrol of the petroleum sector. In such a situation protection of brand name would be most critical for the oil companies to guard their market-share. Therefore, quality-based public rating of the retail outlets by the name of companies would work best in disciplining the supply chain and preventing the widespread malady.

Improve testing procedures and tighten fuel quality standards

Immediate attention should be paid to tightening the fuel quality standards and regulating some key parameters that are not done today, like aromatics, and olefins in petrol, and PAH in diesel. Even the broad range that is allowed under the current specifications should be adequately tightened. Tighter the net, easier it is to catch dubious samples.

Develop alternative testing procedures for more accurate detection

For more accurate detection, alternative testing methods and protocols should be adopted straight away and applied for surveillance. It is possible to create a library of different refinery samples of automotive fuels and possible adulterants. With the help of the standard library chromatogram, it will be much easier to detect fuel adulteration.

Centre for Science and Environment **February 5, 2002**

1. INTRODUCTION

1.1. Why has CSE undertaken this study?

The Supreme Court of India while hearing I.A. No. 151 of the Writ Petition {C} No 13029/85 filed by the Delhi Petrol Dealers Association regarding adulteration of fuel gave the following direction vide its order dated November 22, 2001:

"*Copy of this application be also sent to Shri Bhure Lal who should constitute an agency which would independently carry out random inspection at the petrol pumps, oil depots, and tank lorries in Delhi and give a report with regard to the quality of petrol and diesel available there. It will not be necessary for such an agency to give advance notice before lifting samples as it will be helpful if there is an element of surprise.*"

The Environmental Pollution (Prevention and Control) Authority of the National Capital Region (EPCA) held meeting with all the concerned agencies including the Society for Petroleum Laboratory (SFPL), Society for Indian Automobile Manufacturers, anti-adulteration cell of the Ministry of Petroleum and Natural Gas and Department of Food and Civil Supplies under the Government of Delhi to discuss the existing procedures being adopted by them for checking adulteration. After the deliberation it was decided that EPCA, through the state level coordination committees, would carry out surprise checks of the retail outlets by associating the Centre for Science and Environment (CSE), a non-governmental organisation in Delhi. The collected samples would be analysed in SFPL at NOIDA set up under directions of the Supreme Court (Order of July 28, 1998).

Following this decision the EPCA on December 26, 2001 directed the Centre for Science and Environment to undertake this operation as an independent agency.

1.2 Terms of Reference

EPCA authorised CSE to collect representative fuel samples from the petrol pumps, oil depots, and tank lorries (not exceeding 200 samples) and give the same to SFPL on behalf of the EPCA "for analysis of parameters as per Bureau of Indian Standards specification number 1460 of 2000. "CSE was further directed to collect and analyse the results from SFPL and interpret the data".

The terms of reference were subsequently extended via a communiqué dated January 15, 2002, when CSE requested for additional tests on gas chromatography in the pollution monitoring laboratory of the Indian Institute of Technology, Delhi, and in the laboratory of CSE. This request was made on the basis of the discussions in EPCA and CSE's own deliberation with the representatives of the oil companies, SFPL, Indian Oil Corporation Research and Development centre (IOC R&D Centre) and independent experts held on December 26, 2001. In these deliberations it had emerged that it was possible to meet the broad range of BIS specifications of fuel quality with an intelligent mix of adulterants to the extent of 5 to 20 per cent or so. It is difficult to detect adulteration in fuels unless there is larger amount of adulterants mixed, to make a distinct variation from the BIS specification, some of which have a wide range. The discussions indicated that checking for compliance with BIS fuel quality standards does not necessarily imply testing for adulteration. It is important to differentiate between detection of adulteration and monitoring of non-compliance with fuel quality standards. This means that it is possible to adulterate without violating the standards or in other words compliance with fuel quality standards does not necessarily mean that fuels are not at all adulterated. This poses a serious challenge for the designing of testing methods and protocol for fuel quality monitoring to address this problem of adulteration.

EPCA also observed in its interim report to the Supreme Court on Checking of Adulteration of Fuels in December 2001, that “besides testing of fuel samples in regard to compliance of BIS specifications, possibilities for prescribing testing procedures to check the presence of specific categories of adulterants will also need to be examined.” This means that it is possible to adulterate without violating the BIS fuel quality specifications. Experts feel that this type of adulteration would still have adverse impact on emissions and on the vehicle performance and durability of the vehicular engine.

There is a need for more precise tests that can detect adulteration with greater accuracy

In the meeting held at CSE on December 26, 2001, it emerged that even SFPL that was set up under the Supreme Court order of July 28, 1998, for monitoring fuel quality in the outlets of the National Capital Region, does not recognize this underlying finer difference between monitoring fuel adulteration and monitoring compliance of BIS specification. The secretary of SFPL said that the laboratory did not see its job as ‘detecting adulteration’, but only monitoring for non-compliance with BIS standards. SFPL’s terms of reference do not mention adulteration but state its objective as “to undertake and perform qualitative, analytical, specification and physical tests of petroleum fuel products”. This mandate is interpreted to say that this does not cover detection of adulteration *per se*. It is another matter that the purpose of the Supreme Court direction for setting up this lab was to check adulteration. As we will explain in this report, monitoring for non-compliance with BIS standards is able to detect adulteration only to some extent but there are possibilities that some of it would go undetected. SFPL, therefore, needs to design more precise and additional methods for such detection and surveillance.

In view of this, CSE felt that there is a need for more precise tests that can detect adulteration with greater accuracy. CSE therefore wanted to investigate the possibility of undertaking additional instrumental analysis for estimation of parameters of fuel samples other than the conventional BIS petroleum testing methods to cross check SFPL results. Samples were tested using gas chromatography with flame ionisation detector in the pollution monitoring laboratory of CSE. The testing that was to be done at the laboratory of the Indian Institute of Technology, Delhi had to be abandoned due to some instrument related problems and severe constraints of time.

1.3. Issues discussed in the report

Analysis of the results of samples collected during this drive and assessment of the testing procedures for fuel quality monitoring

- Assessment of the sampling procedures
- Assessment of the storage, transportation and distribution of fuels
- Assessment of the current technical approaches for controlling adulteration

- Assessment of current market based approaches for controlling adulteration
- Assessment of the current penalty system in preventing adulteration
- Responsibility of oil companies for the quality of fuels at the retail end.
- Recommendations

Though there is a wide range of distortions in the fuel market like tax evasion, mis-labelling of products, short-selling, over charging, lack of quality assurance of lube oils sold at the retail outlet, and manipulation of stock inventory at the retail outlet, we have restricted this report to factors that are related to the physical adulteration of fuels and related issues. We, however, believe that it is essential that the other related issues be taken up urgently.

There are too many fuel components and solvents as potential adulterants in the market

1.4. Possible adulterants

We list below the possible main adulterants, though there are far more fuel components and solvents as potential adulterants in the markets. The well known adulterants and their costs are listed (see table 1).

Table 1: Comparison of prices of fuels and possible adulterants

Sr. No.	Fuels & solvents	Price
Transportation fuels		
1.	Diesel	Rs 17.90 per litre
2.	Petrol	Rs 28.00 per litre
Industrial Solvents		
1.	SBP spirit / SBP solvents	Rs 21.00 per kg
2.	C- 9 Solvent / Raffinates	NA
3.	C-6 Raffinates	NA
4.	Pentane	Rs 42.06 per kg
5.	Cixon	NA
6.	Solvent 90	Rs 26.40 per kg
7.	Hexane	Rs 17.12 per litre
8.	Heptane	NA
9.	Resol	NA
10.	NGL (Non fertilizer Neptha)	Rs 12.95 per kg
11.	Mineral Turpentine Oil	Rs 14.26 per litre
12.	Aromex	Rs 18.26 per kg
13.	Iomex	NA
14.	Furnace Oil (Fuel Oil) (Not available in NCT)	Rs 8.93 per litre
15.	Light Diesel Oil	Rs 12.95 per litre
16.	Kerosene	Rs 15.00 per litre

Note 1: Prices are indicative may not be exact market price

Source: Compiled from the following:
1. Solvent, Raffinate and Slop order (Acquisition, sale, Storage and Prevention of Use in Automobiles) 2000
2. Naphtha control order (GSR 518)

2. COLLECTION OF FUEL SAMPLES

Our investigation shows that, for a credible testing system, it is important to pay attention to the integrity of the sample itself. We have found that an utter lack of quality control in the field is compromising the quality of the samples. The flaw lies both with the procedures laid down for sample collection and instrument and sample containers as well as with the instruments being used for collection of samples (see table 2).

Table 2: Details of fuel samples collected

Sample collections place of	Number of retail outlets	15
NCT	**Total samples collected from NCT**	**66**
	Total petrol samples collected	38
	Total diesel samples collected	28
NCR	**Number of retail outlets covered in NCR Delhi**	**30**
	Total samples collected	**84**
	Total petrol samples collected	29
	Total diesel samples collected	55
Tank lorries	**Number of tank lorries**	**13**
	Total number of samples collected	**13**
	Total petrol samples collected	3
	Total diesel samples collected	10
Oil depots	**Number of depots covered**	**6**
	Total number of samples collected	**29**
	Total petrol samples collected	16
	Total diesel samples collected	13
Toral	**Total number of sample collection points**	**64**
	Total number of samples collected	**192**
	Total number of petrol samples collected	86
	Total number of diesel samples collected	106

Note: Total number of NCT samples are representative of five zones (North, East, West, South, Central). Except for the Central zone, all others are constitute about 20-22 per cent of the total NCT samples.

2.1. Details of samples collected

Utter lack of quality control in the field is compromising the integrity of samples

We began sample collection for this project in the National Capital Territory (NCT) as well as the National Capital Region (NCR) on December 20, 2001 and continued till January 18, 2002. The operation began with surprise sample collection from the retail outlets, tank lorries and depots. We utilised the existing infrastructure and established procedures for sample collection. Three member inspection teams were constituted with one representative from CSE and two from oil companies. Representatives of all the four oil companies — Indian Oil Corporation Ltd (IOCL), Bharat Petroleum Corporation Ltd (BPCL), Hindustan Petroleum Corporation Ltd. (HPCL) and IBP (formerly known as Indo Burma Petroleum) were involved in the process of sample collection.

During the course of sample collection operation, one case of adulteration at

Meerut was reported in the media. We therefore, made special efforts to collect samples from all the tankers that were seized by the Meerut police.

We worked hard to maintain a surprise element in sample collection. The location of retail outlets, tankers and depots listed for surprise checks were handed out to the inspection teams only when they congregated to leave the CSE office at the India Habitat Centre on a daily basis. The teams would collect the required material from the office and then proceed to the sampling sites. All teams were equipped with containers to collect samples, seals with numbers, and wires for sealing the containers etc.

To maintain secrecy, We took the precaution of holding back seal numbers of the containers given to SFPL and those of duplicate samples retained by CSE. SFPL was not informed about the seal numbers of the containers, of those retained with CSE or those left behind with the retailers. We have a complete record of all three types of seal numbers.

Thereafter, samples were sent as blind samples to SFPL for testing. CSE coded the samples to maintain secrecy.

2.2. Weaknesses in current sampling procedures

2.2.1 Receiving samples at the laboratory

There is no uniformity in application of sampling procedures in the field

We have observed that though directives on sampling procedures exist, in actual practice there is no uniformity in its application in the field. This leads to a lot of confusion as evident from our experience. Three different documents have been brought to our notice with respect to quality assurance in sampling.

1. Order from the Ministry of the Petroleum and Natural Gas (MoPNG) was passed under the Essential Commodities Act 1955, on December 28, 1998. This is the only legal guideline in this matter.

2. Industry quality control manual designed by the petroleum companies

3. Sampling guidelines defined by SFPL that was set up in 2000 under Supreme Court order and is under the management of the Indian Institute of Petroleum, Dehradun.

The specifications are not at all comprehensive and, in some cases, grossly inadequate with regard to a number of parameters like desired frequency of sample collection, and appropriate number of samples to be collected region-wise, season-wise or according to the market share of the fuel grades in a region. These are basic elements of fuel monitoring systems in European countries (see box 1: *Best practices in sampling: Some examples of the norms in Europe*).

2.2.2. Definition of a sample

The most glaring anomaly that has come to our notice is that there is no uniform legal definition for the quantity of samples to be collected, and of where and how to draw samples. Here are some instances:

i. **It is not clearly defined where the samples should be drawn from for best results either in the MoPNG order or in the SFPL sampling procedures:** Only the industry quality manual describes this in some length and that too only in

BEST PRACTICES IN SAMPLING: SOME EXAMPLES OF THE NORMS IN EUROPE

- **Each country shall define a set of appropriate regions based on either geographic or administrative criteria such as amount of fuel dispensed, number of dispensing sites, population distribution, and vehicle distribution. Each region may be further sub divided based on marketing and distribution patterns.**

- **For fuel grades with market shares of 10 per cent and above, the minimum number of fuel dispensing sites to be sampled and tested season-wise (summer and winter) are fixed. This could vary from 50 to 200 depending on the size of the country.**

- **Moreover, for each fuel grade with a market share of less than 10 per cent, taking petrol and diesel separately, the minimum number of fuel dispensing sites is to be calculated proportionally from the number of samples determined for the corresponding parent grade.**

- **Any region will have to first list all the principal supply points of petrol and diesel fuel (that is refineries, in land terminals, coastal terminals). Then they apply the variability factor to account for the number of different fuel types, which are distributed within the region, as well as the number of refineries, and supply terminals, in that region. If a certain region has only one refinery which supplies two terminals and if those three are the only supply points in that region, then the variability factor is 1 as all fuel types come from one production site. But if one or two terminals is supplied by another refinery, then variability is 2.**

- **This system has been worked out to ensure that the sampling is proportional to fuel volumes and also captures the fuel variability.**

Source: Automotive fuels – Unleaded petrol – Requirements and test methods, European Standard EN 228, of the European Committee for Standardization, 1999.

case of bulk storage. It states that for bulk storage samples should be drawn from different depths of the station tanks and tankers. According to the oil industry there is no provision for taking samples from different depths of tanker lorries and the tanks at the retail outlet. At retail outlets samples are always taken from the nozzles of the dispensers and never from the tanks. At bulk storage tanks at the terminal, CSE found that samples were drawn by the dip method in which a container tied with a long chain is let loose in the tank and taken out when it is full. It is difficult for CSE to assess how adequate this method is in drawing representative fractions from different depths of the tank or in drawing the bottom sample.

Decisions on sampling are adhoc with no established rationale

ii. **There are no clear guidelines with respect to preparing composite samples**: (see table 3) In the case of tank lorries having more than one chamber, samples are drawn from different chambers and then mixed in a bucket to make a composite sample. One of the glaring instances is the sampling done in a workshed in Meerut where the police seized tankers with adulterated fuel. At the time of the sampling, the lids on the tankers were found open. Since the team was not prepared with a sampler, they used ad hoc containers to draw samples from the tank and that too only from the surface.

iii. **It is also clear that decisions on the number of samples to be collected and tested are ad hoc and have no established rationale.**

iv. **As a normal practice, while collecting samples from one retail outlet, samples are not always drawn from all the tanks**. This implies that there are chances that some tanks can get selectively filtered. Nor is there any effort to make composite samples to cover all tanks in the retail outlet to overcome this problem.

Table 3: Comparison of the guidelines and legal provisions on sampling in different official documents

MoPNG order of 1998	Industry quality control manual	SFPL guidelines	Remarks
Section 5 (1): The officer authorised shall draw the sample from tank, nozzle, vehicle and receptacles.	**FOR BULK STORAGE:** Section 7.4: **TOP SAMPLE:** drawn not more than 15 cms (6 inches) below the top surface in a tank or sample collected from the sampling cock at the top of the pipeline. **UPPER SAMPLE:** taken at a level of 1/6 of the depth of product below the top surface in a tank. **MIDDLE SAMPLE:** taken at a level of half the depth below the surface in a tank **LOWER SAMPLE:** taken at a level of 5/6 of the depth of product below the top surface in a tank. **COMPOSITE SAMPLE:** **IN A VERTICAL TANK:** The composite sample shall be a mixture of an equal quantity of upper, middle and lower samples. **IN A HORIZONTAL TANK:** Composite sample shall be an all level sample. **FOR TANKER TANKS:** composite samples an all level sample from each tanker tank shall be withdrawn and mixed in amounts proportional to the quantity of the product, in each of the tank sampled. **BOTTOM SAMPLES:** Sample from the lowest part of the tank to check the presence of any extraneous matter such as water, sediments etc.	SFPL guidelines do not mention which is the best way to draw samples.	Though the industry quality manual mentions clearly that the samples should be drawn from different layers in tanks and trucks, it is not practised.

Sources:
i. Anon 2000, Industry Guidelines on Transport Discipline, Chapter 1, pg 1 – 13.
ii. Anon 2000, Sampling Procedure for Liquid Petroleum Fuels (Motor Gasoline, Kerosene and Diesel), Fuel Testing Laboratory, Noida.
iii. Anon 1998, Gazette Notification on Regulation of Supply and Distribution & Prevention of Malpractices order for Motor Spirit & High Speed Diesel, Ministry of Petroleum and Natural Gas, New Delhi, December 28.

2.2.3. Quantity of samples needed for testing

There is inconsistency between the guidelines of MoPNG order and SFPL with respect to the quantity of diesel samples.

- According to the MoPNG order, the authorised officer should take six samples of 1 litre each or three samples of 2 litres each of motor gasoline and 3 samples of 1 litre each of high-speed diesel.
- The SFPL guidelines state that all the samples of motor gasoline, kerosene, and

diesel fuel to be tested should be 3 samples of 2 litre each. Thus, SFPL specifies 3 samples of 2 litre each for diesel as well.

Oil companies claim that they follow the MoPNG directive and not the SFPL guidelines. The MoPNG order has not been amended in light of the new guidelines from the SFPL that came up in 2000.

The implication of this discrepancy is that the quantity of diesel samples being collected as per the MoPNG order is not sufficient to do all the tests specified under the BIS specifications. According to SFPL, a two-litre sample of diesel is essential to do all the BIS tests and to include cetane index and cetane number tests.

This confusion affected our operation initially. Three petrol samples of two litres each were collected from the first day itself, but for diesel three samples of only one litre each were collected in the first few days. The oil company representatives present at the time of the sampling were following the MoPNG order and not the SFPL guidelines though the samples were to be tested at SFPL. After about three days of sample collection, when we organised a meeting with the representatives of the oil companies, IOC R&D centre and independent experts, it was brought to our notice that for diesel two litre samples would be needed to do the full tests at SFPL. Therefore, all the one-litre samples had to be discarded.

Serious compromises were noticed in the quality of the instrument and equipment used for sampling

We have been informed that normally the vigilance officials collect one-litre samples of diesel. This means important tests like cetane are not carried out for these samples. Even SFPL despite their own stated guidelines, has been accepting one litre diesel samples. In fact, SFPL, guidelines mention that "currently SFPL is also accepting even one litre sample of diesel in line with MOPNG Gazette notification…" All the containers provided by the various oil companies for the anti fuel adulteration drive of the EPCA were of one litre capacity.

2.2.4. Quality of container

We noticed serious compromises in the quality of the instrument and equipment used for sampling. This was also largely because of the inconsistencies in the guidelines and norms, and was particularly glaring in the case of containers used for sampling (see table 4).

Since for most part of the sampling one litre containers were used, one sample consisted of two containers to make a two-litre sample of both petrol and diesel. SFPL was in possession of two litre containers, which were handed over to CSE only on January 14, 2002 when sampling was almost over. Before this neither SFPL nor the members of the oil industry informed CSE that two litre containers were available for collection of fuel samples.

Moreover, different oil companies provided different types of containers. The first are rectangular one-litre containers with a handle. Holes have been provided in the cap of the container and the handle to pass the wire for sealing. This seems to be the type mentioned by SFPL but they are one litre ones. The second type is a cylindrical one-litre container with holes in the cap as well as the neck of the container to pass the sealing wire. Some of the cylindrical containers were defective as the holes in the neck of the containers were missing. In such a situation, some teams have wound the sealing wire along the groove to screw the cap on while others have wound the sealing wire around the bottom of the container. This is called cage type sealing. SFPL advised us against this type of sealing as it can be easily tampered with. These containers were subsequently discarded.

Table 4: **Comparison of the guidelines and legal provisions on containers used for sampling**

MoPNG order	Industry quality control manual	SFPL guidelines	Remarks
Samples shall be taken in clean glass or aluminium containers. Plastic containers shall not be used for drawing samples. No guidelines for spot test of density of samples.	Stainless steel/ aluminium/ glass containers of one litre capacity may be used for all white oils. It is necessary to use aluminium containers meeting IS – 733 1956 specifications for Aluminium alloy with an approved, lined wooded box, to ensure that the samples reaches safely. Wooden box fitted with felt lining, locking and lifting arrangement may be used for sale transportation of the sample containers. No one informed us about this requirement. Some wooden boxes arrived when sampling was almost over.	Rectangular type of container of 2.2 litre capacity with screw type cap, handle on top, made of 16 SWG aluminium sheet, 30 mm dia hole, HDP/ Neoprene gasket.	Almost all containers given to us were 1 litre capacity. Only 40 containers provided by SFPL on January 14 2002 were of 2.2 litre capacity. Most containers were of cylindrical shapes. In many retail outlets jars provided to test density were made of plastic.

Sources:
i. Anon 2000, Industry Guidelines on Transport Discipline, Chapter 1, pg 1 – 13.
ii. Anon 2000, Sampling Procedure for Liquid Petroleum Fuels (Motor Gasoline, Kerosene and Diesel), Fuel Testing Laboratory, Noida.
iii. Anon 1998, Gazette Notification on Regulation of Supply and Distribution & Prevention of Malpractices order for Motor Spirit & High Speed Diesel, Ministry of Petroleum and Natural Gas, New Delhi, December 28.

There is scope for human error while using two different containers to make one sample and especially if all the containers have the same seal numbers. On one occasion there was confusion at one of the retail outlets and the label meant for the diesel sample was pasted on a petrol sample of a different tank as both had the same seal number. This was noticed at the time of mixing the fuels from two one-litre containers to make a composite sample in the lab.

2.2.5. Sealing of containers

Guidelines and norms for sealing of containers and testing of containers for leaks are extremely vague and confusing. The 'Industry Quality Control Manual' or the gazette notification from the MoPNG does not contain precise instructions on this matter or on the use of seal numbers (see table 5).

2.2.6. Leaking containers

We noticed that leaking of containers is a very serious problem. During sample collection the visiting teams checked for leak from below. But when we went to deliver sample batches to SFPL, each and every container was turned upside down to check if any of these were dripping. We were told that such checks are needed to ensure that the high-end volatile fraction of fuel does not evaporate from the containers. If the lighter hydrocarbons evaporate, the sample may fail for certain parameters. But nowhere is it mentioned that sample containers will be overturned and checked for leakage. It was clear from our field experience that no agency monitors this as this requirement is not mentioned in sampling procedures. SFPL procedures only mention that a neoprene gasket should be fitted on the container. But we found that even some of those were leaking. Even among the 40 containers that SFPL provided, some were leaking.

SFPL procedures only mention that a neoprene gasket should be fitted on the container. But we found that even some of those were leaking

Table 5: Comparison of guidelines and norms for sealing of containers

MoPNG order	Industry quality control manual	SFPL guidelines	Remarks
Does not mention anything about sealing. However states that the sample label should be jointly signed by the officer who has drawn the sample and the dealer and the transporters concerned and the label should contain information on product, name of retail outlet, quantity of sample, date, name signature, etc.	Sample container shall be properly closed and it shall be ensured that there are no leaks. Glass containers may be used, under specific conditions, as required by specific test, with new cork (the cork is to be used only once), or good quality metal screw caps.	Container should be with screw type cap, handle on top, made of 16 SWG aluminium sheet, 30 mm dia hole, HDP/ Neoprene gasket. Rectangular containers with a handle have to be used for sampling with an oil resistant neoprene gasket. One end of the sealing wire should pass through the two holes in the cap and one hole in the handle of the container. Both ends of the wire should be tightly fastened with a plastic seal.	There was divergence of views over seals first. SFPL suggests that seals with similar numbers should not be used on containers for the same tank of a particular retail outlet or even from different tanks of the same retail outlet. But IOC feels one batch of similar seal numbers should be used up at one go otherwise it would be easy to duplicate the numbers and used illegally. But there is no provision in any of the guidelines or norms.

Sources:
i. Anon 2000, Industry Guidelines on Transport Discipline, Chapter 1, pg 1 – 13.
ii. Anon 2000, Sampling Procedure for Liquid Petroleum Fuels (Motor Gasoline, Kerosene and Diesel), Fuel Testing Laboratory, Noida.
iii. Anon 1998, Gazette Notification on Regulation of Supply and Distribution & Prevention of Malpractices order for Motor Spirit & High Speed Diesel, Ministry of Petroleum and Natural Gas, New Delhi, December 28.

The requirements of the testing laboratory have not been built into the standard code of practice for sampling

The total number of samples that could not be given to SFPL due to leakage are 53 and these had to be discarded. This led to a waste of 106 litres of fuel. These do not include the number of leaking containers among the retained or duplicate containers with CSE. If even one of the two containers that make one sample leaks, both have to be rejected. *This led to enormous waste in resources and staff time invested and deployed for this operation.*

When this problem of leakage was brought to its notice, CSE instructed all field staff to check the containers in a similar manner after sealing and to carry extra containers to replace the leaking containers. CSE also instructed SFPL not to accept or test the samples if the containers were found leaking.

Clearly, the requirements of the testing lab have not been built into the standard code of practice for sampling. However, oil industry officials including the state level coordinator informed CSE that SFPL had never overturned containers to check for leakage in the past (see table 6).

2.2.7. Other discrepancies observed in the field

1. In several retail outlets the dealers insisted that some of the underground storage tanks were empty. The oil company representatives on several occasions desisted from sharing the information that an *oil dip measure* is to be

Table 6: Guidelines on sealing, leakage and handling of containers is not explicit

MoPNG order	Industry quality control manual	SFPL guidelines	Remarks
The MPNG gazette notification has no mention of sealing of containers.	Sample container shall be properly closed and it shall be ensured that there are no leaks. Glass containers may be used, under specific conditions, as required by specific test, with new cork (the cork is to be used only once), or good quality metal screw caps.	Never fill the sample more than no leaks. of the container capacity and should be periodically checked for leakage.	None of the documents on sampling procedures define what will be considered as a leaking container.

Sources:
i. Anon 2000, Industry Guidelines on Transport Discipline, Chapter 1, pg 1 – 13.
ii. Anon 2000, Sampling Procedure for Liquid Petroleum Fuels (Motor Gasoline, Kerosene and Diesel), Fuel Testing Laboratory, Noida.
iii. Anon 1998, Gazette Notification on Regulation of Supply and Distribution & Prevention of Malpractices order for Motor Spirit & High Speed Diesel, Ministry of Petroleum and Natural Gas, New Delhi, December 28.

used to check every so-called empty tanks. This will show if any liquid is present in the tank or not. Also, the density of the liquid, if any, should be checked and noted irrespective of the quantity of fuel.

2. Similarly, many CSE representatives noticed that a particular pump was using all the nozzles to dispense fuel into vehicles. But when the team started collecting samples, suddenly one or more than one nozzle was declared “out of order”.

3. No standard is being maintained for the quality of filter paper used for spot test at retail outlets. For the density test, several outlets provided plastic jars.

4. Some of the retail outlets do not maintain record of density measured for different batches of fuels received on a daily basis. The *Market Discipline Guidelines* issued by the MoPNG state that non-availability of reference density at the time of inspection is an offence and the retailer can be penalised. Penalty includes immediate suspension of sales and supplies. But none of the oil industry representatives took cognisance of this offence. At one of the depots, CSE representative was not allowed to see the log book in which density measurements are recorded.

Oil companies representatives did not take cognisance of the offence of improper recording of density measurements at the retail outlets

3. TESTING FACILITIES

Testing of fuel samples for fuel quality monitoring is done at three levels in the National Capital Territory (NCT) and in the National Capital Region (NCR).

i. Spot checks at the retail outlet and at depots at the time of sample collection

ii. Spot checks with the help of a mobile lab conducted by the oil companies

iii. Tests done at the accredited testing laboratories

Spot checks at the retail outlet and at depots at the time of sample collection

Two types of tests are done at the retail outlet, tankers and at the depot at the time of taking samples:

- Density measurement
- Filter paper test

3.1. Issues in spot testing of fuel

CSE's field experience show that these tests are ineffective in catching adulteration as evident from the test results already available. While some samples from different retail outlets have failed (even on density measurement) these have not shown up in the routine density measurement at the site.

It is possible that the archaic hydrometers that are being used commonly for these tests are not at all precise in their reading. There is still no practice of using more advanced digital density meters, which is a normal practice in other countries.

Even filter paper tests have not shown any residues. In most cases, it was found that the filter papers provided for the ink-blot test were worn and old.

Spot checks at retail outlet are inadequate to detect adulteration

The problem is further complicated by extremely poor practices in recording the information on the basic parameters like density measurement.

During sampling the vigilance team did not carry testing kits. It appeared that it was not a mandatory practice. They relied mostly on the retailers themselves for the basics — filter paper, jars and hydrometer for density measurements, and so on. In most places plastic jars were provided for density measurement.

Even more glaring is the information brought to CSE's notice by the Petrol Dealers Association of Delhi. According to them, sometimes tankers deliver fuels not meeting the density specifications. They have provided documentary evidence from Gujarat that shows how products were received with a density less than the minimum permissible limit. The petrol dealers association of Delhi point out that there is considerable ad hocism in the system. If at the time of the delivery the density does not match the specification, the transporter, who is usually the driver of the vehicle, calls up the depot to check and changes are made on paper by the driver himself. The depot dismisses the anomaly as a clerical error.

Another problem that has been raised by the petrol dealers is that the invoice does not mention the actual temperature at which the fuel is filled in the tanker. This has implications for short selling of fuel i.e. selling less than the stated quantity of fuel. It is the natural property of substances to expand with heat — this increases the volume and decreases the density, keeping the mass constant. The rate of expansion increases with volatility of a substance. Dealers suspect that when tank lorries are filled at depot terminals, the fuel stored in high tanks has higher temperature, which increases the volume. Moreover, compared to the depot tanks the underground tanks of retail outlets have lower temperature. The volume of fuels shrinks at lower temperature so they get a lower amount of fuel. The dealers allege that the excess stocks, which accrue to the oil companies due to this, find their way into the parallel markets and are used for adulteration.

According to the Petrol Dealers Association of Delhi, the rate of expansion of petrol is 1.2 litres per 1000 litres per each degree celsius. The calculation has been done taking into account the highest median value for petrol density, 748 kg/m^3. Thus, if the temperature is 25ºC during filling the tank lorry at the depot and is 20^O C while delivering to the retail outlet, a 12,000 litre tank lorry will contain 72 litres less petrol. This estimate seems to be plausible, as even with the decrease in density, it still remains within the acceptable variability range of 0.0030.

Petrol dealers associations also complain that at the time of the delivery of the product they are only given the density of the product as a quality assurance. But at the time of surveillance they are tested against a large number of parameters. They demand that at the time of the delivery they should be given the full refinery or the terminal specs of the fuel. Since such specs are not verifiable on the spot, it will not serve any purpose for cross checking at a later date.

To address this concern, however, it is important to make on the spot fuel testing more sophisticated for accurate verification. For instance, infrared-based field octane-tests are used extensively in the West though this requires repeated re-calibration against engine tests, and requires sophisticated capability. According to the Motor Testing Centre, Sweden, it is possible to use portable gasoline analysers that can provide complete information about gasoline like octane, distillation points, oxygenates, benzene, aromatics, olefins, and saturates, quickly. On site calibration of these instruments is also possible[iii].

3.2 Issues in tests conducted by mobile labs

Oil companies also conduct tests in mobile labs. Tests conducted in mobile labs include density, boiling point, viscosity, flash point, and sometimes, furfural tests. To cross-check, some samples are sent to the laboratory for limited number of tests. According to the anti-adulteration cell set up under the MoPNG, mobile labs do manage to detect some anomalies but have not given any firm data on the exact percentage of failure rate. They confirm that they send samples for more detailed tests to SFPL but as mentioned earlier, only for a limited number of tests. It is explained that the small staff strength of the SFPL hinders application of complete set of tests for all parameters on a routine basis and that it also takes a lot of time. CSE has not been able to get the test results of the earlier tests conducted at SFPL.

Oil companies do not take responsibility for the quality of fuels during transit

4. TRANSPORTATION OF FUELS

There is considerable scope for malpractice during transportation of fuel, as oil companies do not take responsibility for the quality of fuels during transit.

There are two oil depots or terminals in Delhi that receive petroleum products from refineries — Bijwasan and Shakurbasti. While the Bijwasan depot is connected with a pipeline to the Mathura refinery and receives products almost entirely from that refinery, Shakurbasti receives products from refineries at Panipat, Koyali, and from Reliance Petroleum Ltd. Jamnagar. Shakurbasti receives the entire stock in tankers. From the two depots, tank lorries carry products to the respective retail outlets. Maintaining discipline during transit of fuels is very critical for quality control.

According to the estimates available from the state level coordinator, around 10 per cent of the tankers of the total fleet are owned by the oil companies for fuel transportation. The rest are all contracted out to transporters. Among these, retail outlet owners or the petroleum dealers in the region own nearly 50 per cent of the tankers. The industry guidelines on transport discipline, governs the contractual agreement with the transporters.

The key issues in transportation of fuels:

i. **The Industry Quality Control Manual (IQCM) absolves the oil companies from taking any direct responsibility of the quality of the product being delivered to the retail outlet**. The responsibility of the oil companies for its products ends as soon as the loading in the tanker is completed. According to the IQCM "transporters shall be responsible for providing tank lorry fit in all respects to carry petroleum products and transporting/delivering the same in good condition, as per specifications, to the Dealers/Consumers/Receiving Locations and shall be held accountable for any malpractice/adulteration enroute. The transporters are held responsible for any malpractice enroute."

   While the design and fittings of the tank lorry is approved by the Department of Explosives, the calibration certificate is issued by the Department of Weights and Measures. The onus of inducting trained crew to carry fuels also lies with the transporters as per the stipulations of the Motor Vehicles Act, and the driving licence of the driver is endorsed by the road traffic authorities.

   The discretion of taking any action against a particular tank lorry or fleet owner lies solely with the quality control department of the oil company. The IQCM states that a "tank lorry caught for having indulged in malpractices shall be immediately suspended by the location-in-charge. However, an investigation shall be conducted as per the procedure of the company, and approval of the appropriate authority obtained before the tank lorry is blacklisted".

   The manual further states that the period of the ban shall be two years. The decision for lifting the ban again lies with the oil company imposing the ban. A

PILFERAGE TO ADULTERATION?

A first hand account of fuel pilferage near Bijwasan depot, Delhi

On the morning of January 19, 2002, a team from CSE went near Bijwasan depot of the Indian Oil Corporation Limited. The vehicle in which they went was parked about 15 meters away from an enclosed area. The gate of this area was marked 'Lotus Nursery' with white paint. 'Lotus nursery' is located about 50 meters from the depot of the Indian Oil Corporation Limited.

Within a few minutes of the team parking their vehicle, a truck with the number DL 1GA8370, came near the gate of the nursery and parked itself at the side of the road. Within seconds, about three to four people/labourers came out of the nursery with 50 litre capacity cans and started drawing out fuel from the hoses attached to the tanker. The team could not make out if the locks (of the new locking system) were actually opened or some other mechanism was used to siphon off fuel. But it was clear that inspite of the tanker being locked, fuel was pilfered. Soon a Tata Indica with the number plate HR 26N 4551 came and parked itself near the truck. Some people started filling the Tata Indica from the cans filled with fuel drawn from the tank lorry. The team could not see whether the driver of the Indica paid any amount for the fuel.

Meanwhile, other tank lorries coming out of the depot with numbers DL16 2498 (belonging to Dalip Service Station), HR 474848 and HR 387081, also came and stood outside the nursery gate and the same operation of fuel being drawn out from the hoses of the lorries was carried out. About 15 minutes after this, another lorry with number HR 81G41715 came out from inside the nursery, which had a number of cans, similar to those in which fuel was being filled from the fuel tankers. These cans were covered with a blue plastic sheet. The entire chain of events took place within a span of just 25 to 30 minutes. While returning from the site, the team spotted a policeman under whose nose this illegal activity was taking place. He seemed to be monitoring the whole process.

We only saw pilferage, but if this is possible, then adulteration should be possible as well.

list of all such blacklisted/banned tank lorries showing their registration numbers along with their engine and chassis numbers shall be prepared and circulated to other regions and other oil companies so that tank lorries banned by one location/oil company are not engaged by other locations/oil companies. The locations are supposed to maintain all records of all such blacklisted/banned tank lorries with all relevant details in a register and exchange this information with their counterparts in other oil companies periodically.

ii. **The oil industry does not even take responsibility for loading and unloading of tankers**. The 'Bulk Transport Contract Agreement of the Indian Oil Corporation Limited' states that "the loading of tank trucks at the installation or depot or any other storage points or the unloading thereof will be the sole responsibility of the contractor even though the same is done with the help of the personnel of the Corporation…"

iii. When a tanker is caught having committed adulteration, the companies do not pick up samples to check its quality. The responsibility lies with the district administration. An illustrative case is the recently reported case that CSE investigated in Meerut. The company, Vishal Road-lines, that was caught with adulterated stock, is an authorised transporter of petrol and diesel. This agency had the authority to transport both petrol and diesel to retail outlets and solvents for industrial use. It was supposedly using its workplace to adulterate diesel with kerosene (see box: *Adulteration in action: observation on the Meerut adulteration case*). BPCL officials informed the CSE inspection team that, though the tanker was authorised to transport fuel by the company, it was not the responsibility of the company to check adulteration cases by conducting their own tests.

Fragmentation of responsibility makes the system more vulnerable to malpractices

Serious lapses were noted in the vigilance system. While the visiting team in Meerut observed five tankers at the site that were seized from the accused, the police records showed only two. In fact, local police officials requested the CSE representative not to collect samples from more than two tankers so that it would not create problems later on. The team took samples from three and found the other two empty.

Field investigation shows that fragmentation of responsibility and penalty makes the system more vulnerable to malpractices as there is no clear pressure from within the system to keep the operation clean across the entire supply chain.

If all parties across the supply chain are held liable then there would be counter checks on different parties.

ADULTERATION IN ACTION: OBSERVATION ON THE MEERUT ADULTERATION CASE

On January 6, 2002, Amar Ujala, a Hindi daily in Uttar Pradesh, reported that police had caught a transporters crew, authorised to transport BPCL's products to ex marketing installations, that include industries and retail outlets. CSE decided to get this matter investigated and draw samples for testing.

On January 17, 2002, a team comprising a representative of CSE and three members of different oil companies went to Meerut to get samples from these tankers.

At the time of the visit it was found that the local police had seized five tank lorries, of adulterated diesel. The team first met with the district magistrate (DM) who did not permit the team to take samples as the case was with the police. He informed the team that the case was being heard in the district court and the samples had already been sent to state level laboratory at Agra. He felt that if the results of the samples drawn for EPCA differed from that of the UP state fuel testing laboratory then there would be an attempt on the part of the offender to take benefit of doubt to absolve himself. Only after the EPCA chairperson intervened, did the DM allow the team to collect samples.

The DM then insisted that the seals of the tankers could only be broken in the presence of district supply officer, additional district magistrate and the territory manager of BPCL. This could be organised only at about 7 pm in the evening.

Samples were drawn in the presence of a police force, for security reasons from 8pm to 11pm. While the process was on, a shootout took place less than two kilometres from where the tankers were parked. The police forces then rushed to tackle the shootout and the team was left with no protection and only one torch.

It was already very dark when sampling began from the tankers parked in a go-down of the transporter. No electricity was provided to carry out the operation. The team found that the lids of all the tankers were open. The oil company representatives were ill equipped to do sampling from the tankers. They neither had hydrometers nor proper samplers for drawing samples from the tankers. So the team drew samples with the help of water bottles and milk jars that were locally available. The team could not even use the two-litre container that they were carrying for sample collection as it was too big to go through the opening of the tank.

A composite sample was made by mixing samples drawn from each of the round vents provided on the top of the tanker, and connected to different chambers of the tanker. The density of the fuels drawn from each of these vents was different. This could either mean different types of fuels in each of the chambers or that the adulterants did not form a homogeneous mixture and gave different density readings. The density readings of two of these tankers were even outside the range of the hydrometer (a maximum of 850). All samples drawn were then coded and sent to SFPL.

Table 7: **Variation in density of fuels drawn from different chambers of one tank seized in Meerut**

Tank lorry registration number of the tank lorry: UP 15 F 2258	
Chamber	1 0.8377
Chamber	2 0.8427
Chamber	3 0.8397
Chamber	4 0.8377
Tank lorry registration number: UP 15 J 0099	Density is greater than 0.850 therefore not in the range of hydrometer
Tank lorry registration number: UP 15 B 3521	Density not in the range of hydrometer more than 0.850

Note: Density has been converted according to ASTM table at 15 degrees centigrade
Source: As reported by the inspection team

5. ANALYSIS OF TEST RESULTS FROM SFPL-NOIDA

5.1 Key observations on the SFPL tests results:

- Test results of 72 fuel samples were available from the Society for Petroleum Laboratory at (SFPL) at the time of the submission of this report to the EPCA. Samples were tested according to all the parameters listed under BIS specifications.

- Out of these samples, SFPL has detected 8 adulterated samples, which include 5 petrol and 3 diesel samples. But out of these 8 samples, 2 are dummy petrol samples sent by CSE. This effectively reduces the actual failed samples to 6. **Even then the failure rate is 8.3 per cent. In contrast, over the past year of its operation, SFPL has reported a failure rate of roughly 1-2 per cent.**

- This is particularly important as the checks — though carried out as independently as possible — were done at a time when the oil industry and its affiliates were aware of the Supreme Court order to EPCA to monitor adulteration.

- One of the reasons for a higher percentage of failure is that SFPL has done the full BIS tests including tests on key parameters like cetane and sulphur in diesel and benzene in petrol, which, as CSE was told, are not normally done for routine testing.

- CSE has noted serious discrepancy in the interpretation of the test results by SFPL. SFPL is still assessing petrol samples against the old specification of 3 per cent benzene in petrol as the BIS specifications have not been updated by the MoPNG on the basis of the Supreme Court order of May 10, 2000 that mandates 1 per cent benzene in petrol for the NCT and NCR.

- As a result, 12 petrol samples that have violated 1 per cent benzene specification mandated by the Supreme Court have been cleared by SFPL because these are still within 3 per cent limit. According to the SFPL analysis, only one petrol sample has failed on the benzene parameter which has recorded an extremely high benzene content of 11.3 per cent.

- When CSE reassessed the test results of the petrol samples on the basis of 1 per cent benzene specification the number of failed samples went up to 15 (excluding the two dummies). **This means about 26 per cent of the total fuel samples tested have failed and over 30 per cent of the petrol samples are adulterated.**

- The sulphur content of the fuel tested was found to vary greatly and was found progressively reduced between the refinery specifications, the depot and then the retail outlet. Some fuel samples at the depot had sulphur content as less as 110 ppm, as against the standard of 500 ppm. In the absence of any clear explanation from the oil industry we are forced to ask — is this fuel being diluted by some contaminant (with a solvent with almost no sulphur, for instance), which is reducing its total sulphur content?

- CSE's analysis confirms that the broad range of specs for different parameters allowed under the BIS keeps sufficient margin for adulteration. In addition, the fact that some key components, like aromatics and olefins in fuels are not even regulated makes detection even weaker.

One of the reasons for a higher percentage of failure is that SFPL has done the full BIS tests including tests on key parameters like cetane and sulphur in diesel and benzene in petrol

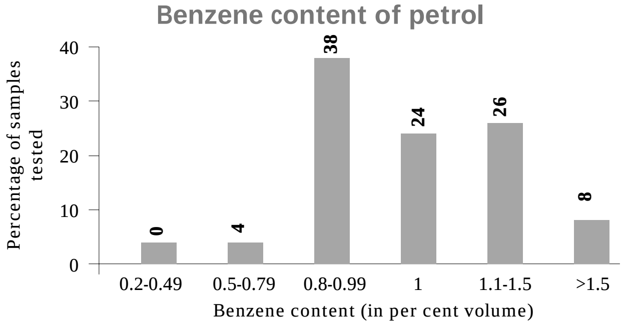
- Impact of 'intelligent mix' on emissions and on vehicle performance needs investigation. It is just not the environmental consequences but also the misuse of government pricing policy and subsidies that are of equal concern.

5.2 Analysis on different parameters

Nearly 51 per cent of diesel and 33 per cent of petrol samples show sulphur content less than 350 ppm at the retail outlets

5.2.1. Benzene results

Our analysis shows that about 42 per cent of the samples have benzene levels below 1 per cent, which is the norm mandated by the Supreme Court order for the NCT and NCR. Benzene levels are higher than 1 per cent in as much as 34 per cent of the samples. About 24 per cent of the samples are at the margin with one per cent benzene.

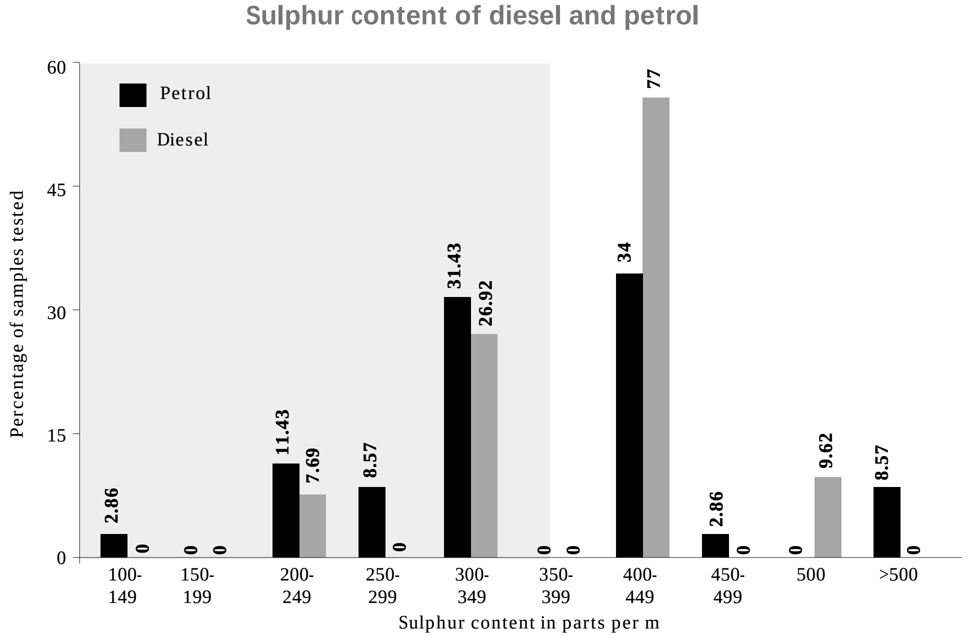


Note: Maximum permissible limit for benzene content in petrol — 1 per cent

5.2.2 Sulphur results

Notably, nearly 51 per cent of diesel and 33 per cent of petrol samples show sulphur content less than 350 ppm at the retail outlets. In fact, nearly 20 per cent of diesel samples recorded levels in the range of 200-300 ppm while, at the refinery, the levels were in the range of 350-450 ppm.

Not just the analysis of the SFPL data, but also the fuel specs we got from the Mathura refinery and IOC terminal at Bijwasan, show serious anomalies. CSE compared the fuel specs from the Mathura refinery, Bijwasan terminal in Delhi and



Note: 1. Permissible limit for sulphur content in diesel and petrol 500 ppm
2. Shaded area represents sulphur content of Euro III level

retail outlets to track the quality of fuel across the fuel supply chain. This exposed even more glaring discrepancies. For this comparison, CSE obtained the fuel specs in the following manner from the Indian Oil Corporation spaced over December 3, 2001 to January 6, 2002:

- Diesel specs for 8 days at the Mathura refinery
- Petrol specs for 7 days at the Mathura refinery
- Diesel specs for 11 days at the Bijwasan terminal
- Petrol specs for 7 days at the Bijwasan terminal

CSE found that from the refinery level to the retail outlet sulphur content in both petrol and diesel was progressively lower. While the sulphur content at the Mathura refinery level was mostly around 400 ppm, at the Bijwasan terminal level it was almost consistently 200 ppm. In the case of petrol it had even gone down to 110 ppm. At the retail end the range was from 200 to 349 ppm.

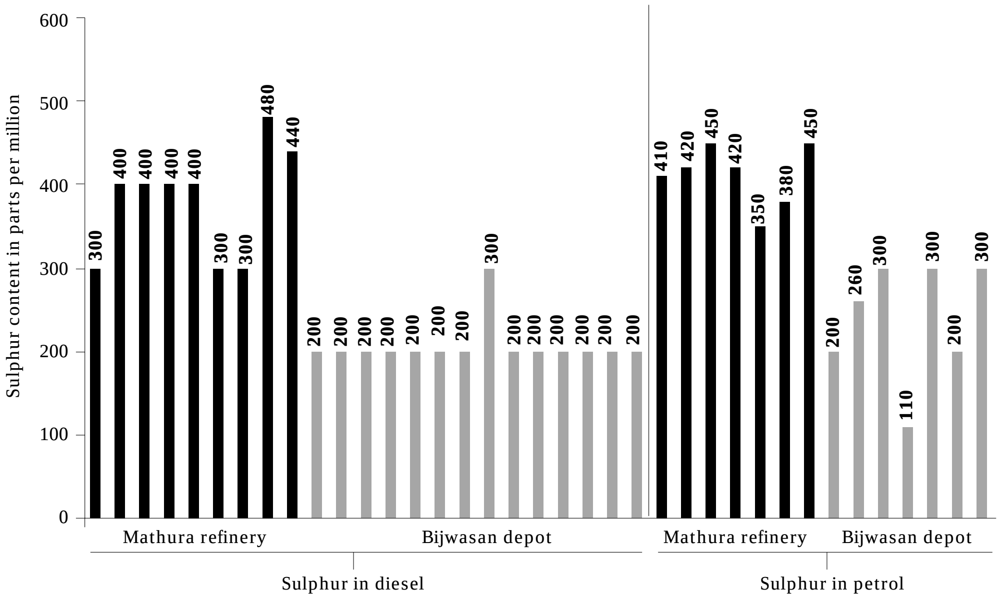
When CSE tried to check this out with the IOC R&D Centre, there was no clear answer. CSE was told that this could be due to different test methods applied at the retail and refinery ends. But CSE checked and found that after the introduction of the 500 ppm sulphur content fuels, the test method called IP 336 for diesel (supposedly appropriate for testing of low sulphur fuels) was adopted at both refineries and depots and also at SFPL.

The oil industry attributes this to the margin of reproducibility of the test methods that are allowed when tests are conducted in different labs under the current test methods. They add, it can be due to instrumentation confusion and calibration problems. They even dismiss the problem as very common and of no serious consequence as long as the standards are met.

Any test method with reproducibility variation of 75 per cent is not acceptable. Internationally accepted testing methods operate within the reproducibility variability of 10-12 per cent or upto 50 ppm maximum

Variation in sulphur content at the refinery and at the terminals in Delhi

Fuel specifications reported at the Mathura refinery and the IOC terminal at Bijwasan in Delhi for the period December 3, 2001 to January 6, 2002:



Note: Permissible limit for sulphur content in diesel and petrol 500 ppm

But any test method with reproducibility variation of as much as 75 per cent (as the case appears to be), is clearly not acceptable. There are internationally accepted testing methods like ASTM D5453-01 Standard Test Method for Determination of total sulphur in light hydrocarbons, motor fuels and oils by ultraviolet fluorescence, and ASTM D2622-98 Standard test method for sulphur in petroleum products by wavelength dispersive X-ray fluorescence spectrometry, which operate within the reproducibility variability of 10-12 per cent or upto 50 ppm maximum. But oil companies here are reporting an absurd variation of as much as 300 ppm. *Does this mean that 400 ppm sulphur in fuel recorded at the refinery is equal to 100 ppm recorded at retail outlet?*

Nearly 81 per cent of samples are in the range of 746-749.9. But the range of BIS specification is 710-770. This can clearly cushion some amount of adulteration

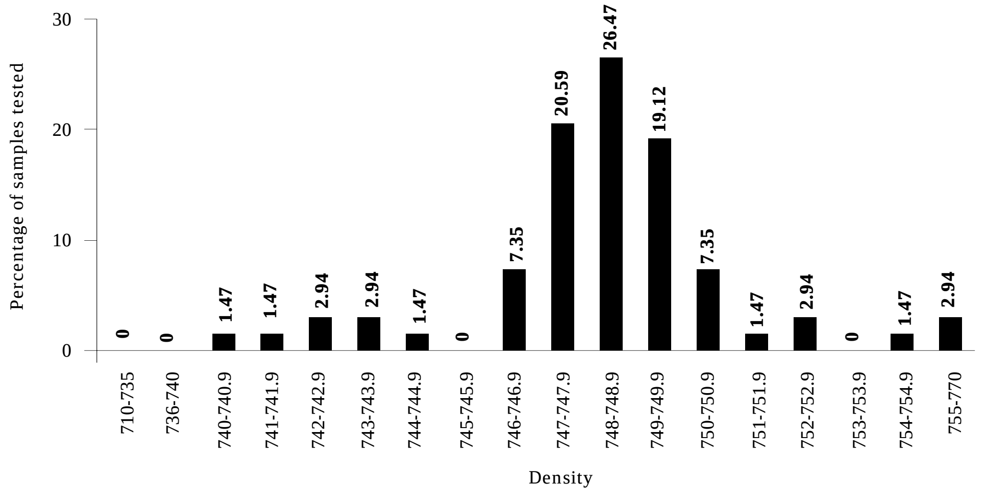
In addition, it is important to note that it is not only when samples exceed standards that it indicates adulteration. It is possible that drastically lower levels than the legally defined fuel specs can also indicate adulteration. Dilution of the fuel with low sulphur adulterant, for instance, hexane, which is almost sulphur less, can lower sulphur content in petrol drastically. But as these samples meet the stipulated sulphur level of 500 ppm, these are not considered suspect. If test methods are, therefore, not precise, how would one take action when such discrepancies are detected?

CSE is, therefore, forced to ask the reason for this discrepancy: Is it dilution or adulteration that is leading to lowering of sulphur concentration across the chain?

5.2.3. Density results

Petrol density

In the case of petrol samples, nearly 81 per cent of samples are in the range of 746-749.9. But the range of BIS specification is 710-770. This can clearly cushion some amount of adulteration with low volatility lighter components such as pentane (626) and hexane (659).

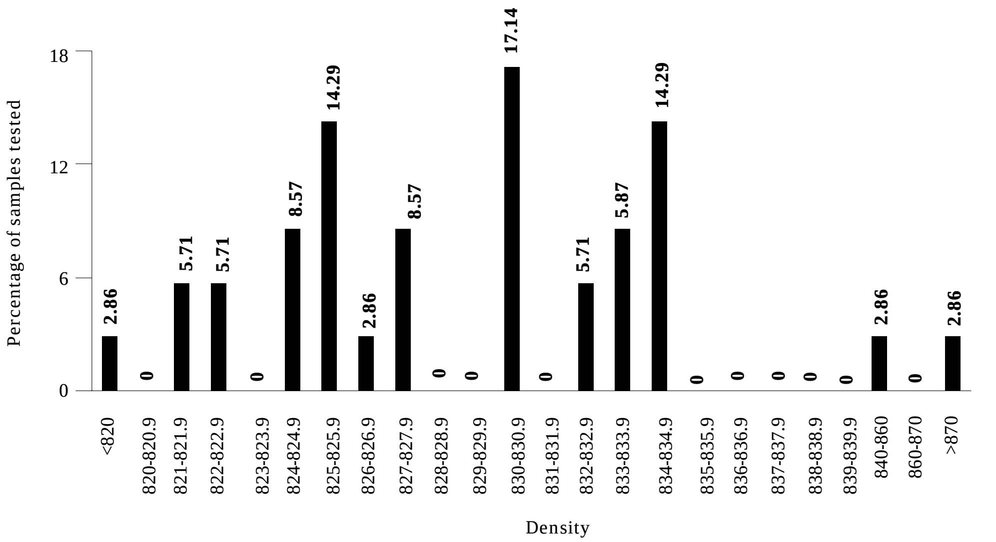


Note: Permissible range under BIS specifications 710-770 kg/cum

Diesel density

In the case of diesel, nearly 50 per cent of the samples tested fall in the range of 822-829 and 55 per cent in the range of 820-830. But the density specification is 820-860. This observed median range is quite close to the Swedish Class I diesel density range

Range of density of diesel



Note: Permissible range for density in diesel under BIS 820-860 kg/cum

of 800-820, or Worldwide fuel charter demands a density range of 820-845 and so on.

It is interesting to note that in the case of diesel density, we find a larger number of samples close to the margin.

5.2.4. Octane rating

Nearly 80 per cent of the samples fall within the range of research octane number 88-90.9. The minimum specification is 88. The samples at the high end and at the low end may indicate a problem and would require more precision tests to detect the problem. Octane is supposed to be a very important give away for adulteration. A small proportion of samples with both high octane and those close to the lower end can be an effective indicator of things going wrong. In fact, it is possible to work out an intelligent mix by calculating the amount of naphtha that can be mixed with petrol and still meet the minimum octane standards. For example:

It is possible to calculate an intelligent mix of adulterants and still meet the standards

If a refinery is producing 92 RON petrol, then how much naphtha can be mixed to it to still be able to meet the minimum petrol specification of 88 RON prescribed in the BIS, can be worked out as follows:

Low aromatic naphtha has octane in the range of 72 – 74.

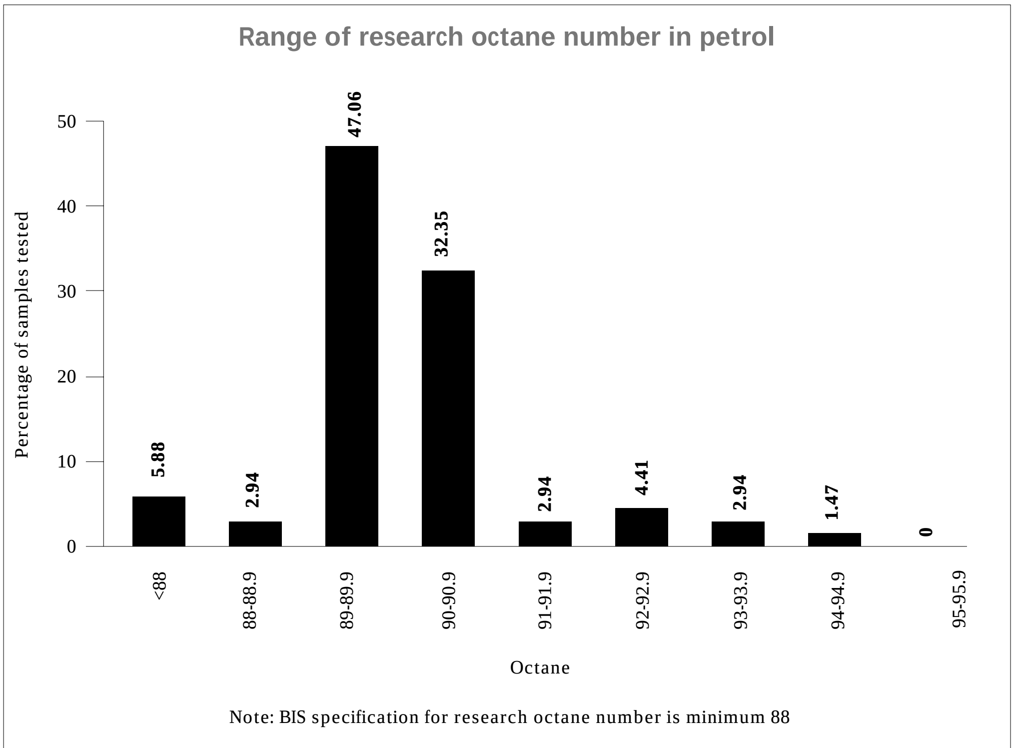
Suppose the quantity of petrol is ‘x’, so in a 100 per cent volume mixture of naphtha and petrol, the naphtha quantity will be ‘100 – x’. The formula to find out ‘x’ will be:

(Petrol quantity X Refinery produced petrol RON) + (Naphtha quantity X Naphtha RON) = (Total naphtha and petrol mixture X BIS RON requirement for Petrol)

$$(x) \times (92) + (100 - x) \times 72 = (100 \times 88)$$
$$(92x) + (100 \times 72) - (72x) = (100 \times 88)$$
$$(92x) - (72x) = (100 \times 88) - (100 \times 72)$$
$$20x = 100\ (88 - 72)$$
$$x = \frac{100 \times 16}{20} = 80$$

Quantity of Petrol required x = 80%
Naphtha required for diluting 92 RON petrol to get 88 RON petrol = (100 – 80) = 20%

Now, applying the value of 'x' in the formula gives:
$(80 \times 92) + (100 - 80) \times 72 = (100 \times 88)$
$(7360) + (20 \times 72) = 7360 + 1440 = 8800$
$8800 = 8800$
This shows that petrol with 92 RON can be adulterated with as much as 20 per cent of naphtha and still meet BIS spec of 88 RON. Similarly, 95 octane petrol can be adulterated with more than 30 per cent naphtha and 89 octane petrol can be adulterated with 6 per cent naphtha.

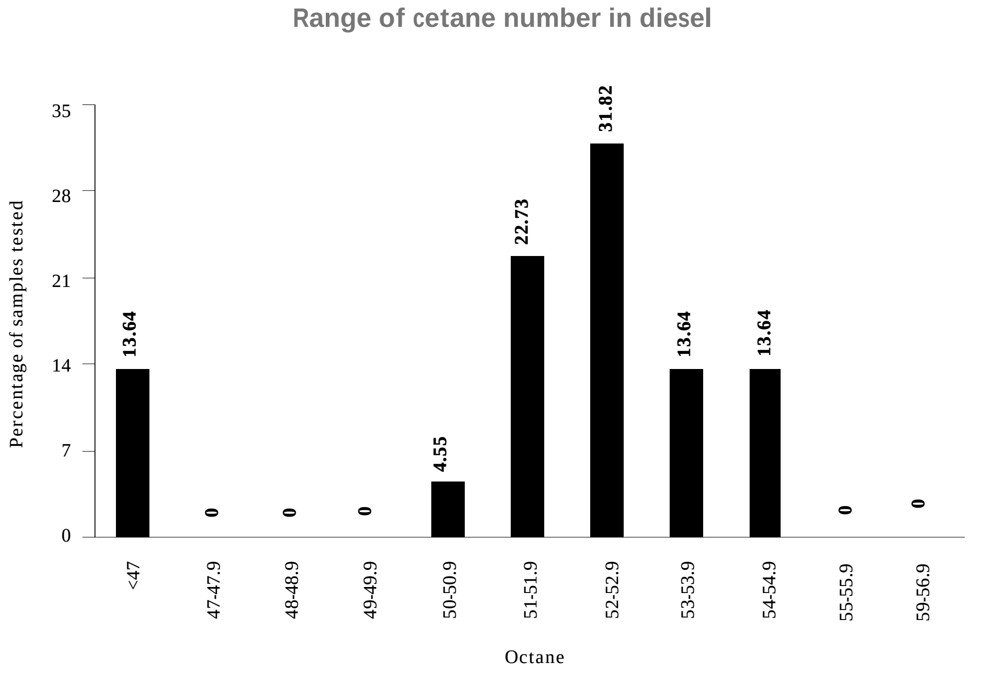


5.2.5. Cetane rating

Cetane rating is an important detection point for adulteration, but this is not even tested on a routine basis

Nearly 87 per cent of the samples have a cetane number in the range of 50-54.9 against the minimum number of 48. Cetane is considered one of the important detection points for adulteration. But it is evident that this test is not done on a routine basis. In fact, according to SFPL testing procedures a minimum 2 litre sample is needed to do the full test including cetane number and cetane index. But as a norm, we found out, oil companies and other vigilance agencies only collect 1 litre diesel sample for testing at SFPL. It is important to note all the three diesel samples that have failed in SFPL have failed on the cetane test.

In addition to the parameters mentioned above, it is very important to focus on some key components of the fuels like sulphur and benzene content for fuel quality monitoring.



Note: BIS specification for cetane number is minimum 48

5.3 Details of samples drawn and test results

Table 8: Number of samples at a glance

Particulars	Numbers
Total number of samples handed over to SFPL	145
Petrol samples handed over to SFPL	76
Diesel Samples handed over to SFPL	69
Total number of samples that could not be handed over to SFPL due to faulty containers provided by oil companies	53
Total number of leaking samples with CSE	99

Table 9: Failed diesel samples as per BIS specification

Total no. of Diesel samples		No. of samples that failed to meet the BIS standards		
22		3		
Parameter	Requirement as per BIS specs	**Sample 1** FTL/HSD/02/01/83 A6PHHYLVXD	**Sample 2** FTL/HSD/02/01/84 B6PHHYLVXD	**Sample 3** FTL/HSD/O2/01/85 C6PHHYLVXD
Cetane index (calculated) or	46 Min.	35.2	34.2	42.0
Cetane number Density at 15°C, kg/m3	48 Min. 820-860	39.2 841	33.2 898	43.7 798
Kinematic viscosity, cSt, at 40°C	2.0-5.0	1.67	3.38	1.05
Total sulphur, % wt.	0.05 Max	0.26	0.30	0.06

Table 10: Failed petrol samples as per BIS specification

Total no. of petrol samples		No. of samples failed and reasons for failure		
50		3		
Parameter	Requirement as per BIS specs	**Sample 1** FTL/MS/O2/01/11 A3URKDXWWP1 A3URKDXWWP2	**Sample 2** FTL/MS/02/01/12 B3URKDXWWP1 B3URKDXWWP2	**Sample 3** FTL/MS/02/01/07 A4VKDGULWP1 A4VKDGULWP2
RON Octane	88[1]/93[2] min.	80.1	78.4	89.9
Anti-knock index, (RON+MON)/2	84[1]/88[2] min.	77.9	76.6	85.7
Benzene, % Vol.	3.0 max.	1.3	1.1	11.3
Density at 15°C kg/m^3	710-770	747	746	749
Existent gum, g/m^3	40 max.	9.0	12.0	118
RVP at 38°C, kPa	35-60	46.9	46.5	58.8

1 For unleaded regular
2 AKI for unleaded premium
Note:
1: Failed parameters are in bold.
2. These test results are being reported by SFPL's as per 3% benzene cap.

Tables 11-14: Failed petrol samples according to Supreme Courts direction of 1 per cent benzene cap

Total no. of petrol samples		No. of samples failed and reasons for failure		
50		3		
Parameter	Requirement as per BIS specs	**Sample 1** FTL/MS/O2/01/11 A3URKDXWWP1 A3URKDXWWP2	**Sample 2** FTL/MS/02/01/12 B3URKDXWWP1 B3URKDXWWP2	**Sample 3** FTL/MS/02/01/07 A4VKDGULWP1 A4VKDGULWP2
RON Octane	88[1]/93[2] min.	90.2	89.7	90.3
Anti-knock index, (RON+MON)/2	84[1]/88[2] min.	86.5	85.5	86.0
Benzene, % Vol.	1.0 max.	1.2	1.2	1.8
Density at 15°C kg/m^3	710-770	748	748	747
Existent gum, g/m^3	40 max.	10.0	13	24
RVP at 38°C, kPa	35-60	49.0	48.2	49.5

Table 12

Parameter	Requirement as per BIS specs	**Sample 4** FTL/MS/O2/01/25 A2ORQNXQYP1, A2ORQNXQYP2	**Sample 5** FTL/MS/02/01/48 A1JWNRPVYP1, A1JWNRPVYP2	**Sample 6** FTL/MS/02/01/48 A5UDMPDQXP1, A5UDMPDQXP2
RON Octane	88[1]/93[2] min.	90.4	90.3	89.6
Anti-knock index, (RON+MON)/2	84[1]/88[2] min.	86.7	85.9	85.5
Benzene, % Vol.	1.0 max.	1.2	1.1	1.3
Density at 15°C kg/m^3	710-770	479	747	750
Existent gum, g/m^3	40 max.	8.0	14	15
RVP at 38°C, kPa	35-60	52.3	41.5	46.0

Table 13

Parameter	Requirement as per BIS specs	**Sample 7** FTL/MS/O2/01/51 C5UDMPDQXP1, C5UDMPDQXP2	**Sample 8** FTL/MS/02/01/52 D5UDMPDQXP1, D5UDMPDQXP2	**Sample 9** FTL/MS/02/01/62 A6VRQEKDZP1, A6VRQEKDZP2
RON Octane	88[1]/93[2] min.	89.7	89.5	89.6
Anti-knock index, (RON+MON)/[2]	84[1]/88[2] min.	85.5	85.6	85.7
Benzene, % Vol.	1.0 max.	1.1	1.2	1.3
Density at 15°C kg/m^3	710-770	749	749	749
Existent gum, g/m^3	40 max.	20	17	21
RVP at 38°C, kPa	35-60	47.5	47.0	50

Table 14

Parameter	Requirement as per BIS specs	**Sample 10** FTL/MS/O2/01/63 A6VRQNDXWP1, A6VRQNDXWP2	**Sample 11** FTL/MS/02/01/64 A6VRQVXPZP1, A6VRQVXPZP2	**Sample 12** FTL/MS/02/01/65 B6VRQVXPZP1, B6VRQVXPZP2
RON Octane	88[1]/93[2] min.	89.5	89.7	89.1
Anti-knock index, (RON+MON)/[2]	84[1]/88[2] min.	85.6	85.7	85.3
Benzene, % Vol.	1.0 max.	1.3	1.3	3.0
Density at 15°C kg/m^3	710-770	750	750	749
Existent gum, g/m^3	40 max.	16	17	19
RVP at 38°C, kPa	35-60	49.0	50.0	42.0

Note:
1 For unleaded regular
2 AKI for unleaded premium

5.4. Adequacy of BIS testing procedures

CSE's analysis of the test results available from SFPL show that the current test procedures and the fuel specs are not adequate to detect adulteration.

- The analysis confirms that the broad range of specs for different parameters allowed under the BIS keeps sufficient margin for adulteration.
- Lax standards, combined with the fact that some key components in the fuels are not even regulated, makes fuel quality monitoring even more difficult.
- The analysis of the SFPL test results confirms the need for alternative test methods and procedures for more accurate results and easy detection of adulteration.

5.4.1. Problems with broad range of fuel specifications

The question may be asked that if SFPL tests based on BIS specs have detected adulteration then what is the problem? Why does CSE feel that some amount of adulteration gets cushioned in the broad range allowed for various parameters?

The Indian Oil Company representatives argue that such broad ranges are needed to account for variation in the hydrocarbon composition of different crudes that are processed and the blending of different streams in the refineries. That this is a normal practice worldwide. It is true that worldwide a certain range is allowed for variation but comparison of the permissible range for certain parameters with those in Europe and the US shows that our specifications are lax and we allow greater margin for impurities.

The problem is that since adulterants belong to similar hydrocarbon families, though of varying composition, some amount of mixing is possible without changing the broad parameters of the fuel. Automotive fuels are derived from crude petroleum by refining, and are composed of hundreds of hydrocarbons. These hydrocarbons vary by class — paraffins, olefins, naphthenes and aromatics — and within each class by molecular weight and molecular structure. Different mixtures of these hydrocarbons give petroleum products like petrol, diesel and kerosene and determine their distinct characteristic properties. It is important to note, therefore, that other petroleum products like naphtha, light diesel oil and solvents, derived from crude, too may have the same class of hydrocarbon compounds as constituents that makes the adulteration of automotive fuels easy. The more similar the hydrocarbon components, easier the adulteration becomes. For example, while the density of petrol is regulated at 710-770 grams per cubic meter, that of naphtha is in the range of 750-820 grams per cubic meter. Similarly, while the distillation range of petrol is 35-215ºC, that of naphtha is between 30-215C.

CSE's analysis of the tests that are available from SFPL has brought out some important points. First of all, for most parts the actual observed range for different parameters fall within a much narrower median than the broader prescribed BIS range and is also fairly consistent over time. It is only a small proportion of samples that are in the margin — either lower or upper end of the range.

Therefore, for monitoring purposes it is very important to focus on these samples that fall within the permissible range but possibly, with an intelligent mix of adulterants, still meet the specs.

However, fuel quality monitoring could become more rigorous if other key components are also brought within the purview of regulations. As of now, India does not regulate olefins and aromatics in petrol and total aromatics and polycyclic aromatic hydrocarbons in diesel.

Fuel quality monitoring could become more rigorous if other key components are also brought within the purview of regulations. As of now, India does not regulate olefins and aromatics in petrol and total aromatics and polycyclic aromatic hydrocarbons in diesel

On the basis of what we have found out so far, it is important to note that testing of some parameters like sulphur and benzene content, cetane and octane tests are essential for routine monitoring. But we have noted that for regular surveillance the oil companies do not test for all these crucial parameters specified under BIS. In a situation where we are working with extremely lax fuel standards, missing out even some of them can make quality monitoring weak.

It is also very clear from the above analysis that if we are already able to maintain consistency in our production in terms of the median range we should be able to tighten the specs range for better quality control. It is also important to regulate some key fuel parameters that are not yet touched. These include aromatics, olefins, etc in petrol and PAH, etc in diesel. Tighter the standards, lesser the chances of wider margin for adulteration.

The issue for us is that even if 5-10 per cent adulteration may seem small it still gives considerable economic advantage to the culprit. A preliminary estimate shows that if a diesel tanker with a capacity of 12,000 litre is contaminated with 5 per cent kerosene, the profit would still be as attractive as Rs 6000 per tanker at the current prices of diesel and kerosene. If the total numbers of tankers are added up this would be a very large sum. This is also of policy concern as such practices lead to misuse of government subsidy and diversion of subsidised fuels like kerosene to the transportation sector that impacts upon the poor people apart from increasing emissions, and impairing engine performance and durability.

The key recommendation in the case of testing on the basis of BIS specifications would be to immediately set an expert committee with representatives from the petroleum industry, petroleum R&D organizations in the country, experts from the independent testing laboratories, and advisors from the international standards setting organizations like ASTM, IP, etc to assess and upgrade the current testing methods and procedures at the refineries, depots and fuel quality monitoring lab in our cities.

6. ANALYSIS OF TEST RESULTS FROM THE CSE POLLUTION MONITORING LAB

The Pollution Monitoring Laboratory of Center for Science and Environment conducted an analysis of petrol and diesel samples collected from some retail outlets and terminals of IOCL, BPCL and HPCL. The samples were analysed for the presence of individual hydrocarbons by gas chromatograph (Trace GC) with flame ionization detector (FID). The capillary column used was HP-1.

Alternative tests show high level of variation in key aromatic components which will never show up in normal BIS tests

Out of six samples from the retail outlet which were analysed, two samples (SPA and SPB) showed 1.720 per cent and 1.514 per cent of benzene respectively in comparison to depot samples, which had less than one per cent benzene content. These indicate possible contamination. Similarly, levels of other hydrocarbons, both aliphatic and aromatic, were found to be higher in the retail outlet samples. The aliphatic hydrocarbons found to be relatively higher in the retail outlet samples were pentane, hexane, heptane and octane. The aromatic hydrocarbons that were found to be higher were toluene and xylene, apart from benzene.

One of the retail outlet samples (coded SPA) showed the following concentrations (see table 15 and 16):

- 3.558 per cent hexane, whereas the depot samples show an average value of 2.029 with minimum value being 0.74 (HPPA) and maximum 3.122 (BP).
- 9.488 per cent toluene, whereas the depot samples show an average value of 5.091 with the minimum value being 0.026 (HPPA) and maximum 9.492 (BP).
- 3.006 per cent octane, whereas the depot samples show an average value of 0.851 with the minimum value being 0.298 (AP) and maximum 1.217 (BP).
- 41.562 per cent total xylene content, whereas the depot samples show an average value of 9.446 the minimum value being 2.488 (MSA) and maximum 17.18 (BP).

Another sample coded SPB showed following concentrations:

- 10.631 per cent pentane, whereas the depot samples show an average value of 1.564 with the minimum value being 0.937 (HPPA) and maximum 2.276 (MSC).

Table 15: Analysis of petrol samples from depots and retail outlets

Analysis of petrol samples from depot and retails outlets

Components	Depot:IOCL					Depot:BPCL		Depot:HPCL		Average
Per cent	MSA	MSB	MSC	MSD	AP	BP	CP	HPPA	HPPB	values for each HC
Pentane	1.14%	2.109	2.276	1.905	0.959	1.343	1.843	0.937		1.564
Hexane	1.125	2.746	2.538	2.448	1.01	3.122	2.5	0.74		2.028625
Benzene	0.215	0.629	0.585	0.604	0.232	0.701	0.781	0.232		0.497375
Toluene	1.676	5.601	7.273	6.347	2.38	9.492	7.934	0.026		5.091125
Heptane	0.808	0.358	0.47	4 0.43	1.012	3.395	0.39	0.249		0.8895
Octane					0.298	1.217	1.038			0.851
Decane										
m-Xylene	0.215	0.848	1.109	1.032	0.328	1.522	1.296	0.317		0.833375
p-Xylene	1.187	4.53	5.879	5.534	1.773	7.921	6.716	1.69		4.40375
o-Xylene	1.086	4.321	5.587	5.209	1.649	7.737	6.475	1.608		4.209
Total xylene	2.488	9.699	12.575	11.775	3.75	17.18	14.487	3.615		9.446

Table 16: Analysis of petrol samples from depots and retail outlets

Components	Average	Retail Outlet Samples				
Per cent	values of hydrocarbons in depot samples	SPA*	SPB*	SPC	SPD	SPE
Pentane	1.564	2.954	**10.631**	1.819	0.682	1.526
Hexane	2.028625	3.558	**5.701**	2.592	0.537	0.425
Benzene	0.497375	**1.72**	**1.514**	0.559	0.446	**0.054**
Toluene	5.091125	9.488	6.154	4.229	1.849	0.109
Heptane	0.8895	4.661	3.711	1.619	0.794	0.054
Octane	0.851	3.006	1.238			0.108
Decane			2.377			0.622
m-Xylene	0.833375	**3.5039**	**1.764**	0.753	0.266	**0.062**
p-Xylene	4.40375	**19.173**	6.49	3.953	1.472	3.139
o-Xylene	4.209	**18.886**	7.278	3.84	1.451	0.127
Total xylene	9.446	41.5629	15.532	8.546	3.189	3.328

Source: Data Provided by CSE Pollution Monitoring Laboratory, New Delhi

- 5.701 per cent hexane, whereas the depot samples show an average value of 2.029 with the minimum value being 0.74 (HPPA) and maximum 3.122 (BP).
- 6.150 per cent toluene, whereas the depot samples show an average value of 5.091 with the minimum value being 0.026 (HPPA) and maximum 9.492 (BP).
- 15.532 per cent total xylene content, whereas the depot samples show an average value of 9.446 with the minimum value being 2.488 (MSA) and maximum 17.18 (BP).

This clearly shows that of the samples tested from six retail outlet, two samples failed on account of some of the aliphatic and aromatic hydrocarbons content when compared to the depot samples, indicating the presence of contaminants or adulterants.

The tests show that some adulteration occurs between the refinery and the retail outlet. This also indicates that BIS test methods are so far ineffective to detect critical parameters like total aromatics and contamination by low boiling point fractions. These can only be normally detected by taking the average chromatograms of refinery samples and retail outlet samples, by using modern and sophisticated instruments like GC with FID or GC with AED.

7. NEED FOR ALTERNATIVE TESTING METHODS

Analysis of the SFPL test results show that even if the fuel quality parameters are not static they are still fairly steady and within a narrow range. But there are a few which are within the specs but very close to the margin. Anything is possible in these cases. It could be variability within the product streams but it could also be a case of adulteration. But today these samples get away as these meet standards and there are no supplementary and precision tests to confirm doubts.

There are alternative and supplementary test methods that are possible for more precise detection of any range of adulteration. These tests go beyond the testing of routine and regulated parameters like density, distillation, octane/cetane tests and focus on finger printing of the composition of the fuel itself. These include analysis and comparing of the hydrocarbon families or hydrocarbon analysis of the fuels. Gas chromatography-mass spectroscopy or atomic element detection tests are done for more precise detection.

There are alternative and supplementary test methods that are possible for more precise detection of any range of adulteration

We are not the first to recommend the need for alternative methods. Expert committees set up by the government of India have made similar recommendations in the past but no action has been taken. A sub committee that was set up by the Central Pollution Control Board (CPCB) under the chairmanship of P K Mukhopadhyay noted in its report that no system is completely suitable for all possible variants of adulteration[iv]. The committee suggested developing alternative testing methods along with the conventional BIS methods. It recommended the use of instrumental analysis for simulation or estimation of parameters of fuel samples, for instance, gas chromatogram and simulated distillation. It cites a number of instrumental methods developed to establish the parameters of fuels. The report states the need for further improvement in test methods even for conventional parameters. It states, “for mid-range FT-IR (Fourier Transform Infra red Spectroscopy) is emerging as a useful potential tool for the prediction of density, research and motor octane number, aromatics, olefins, benzene, and oxygenate content in gasoline. Similarly, for diesel fuel cetane number, cetane index, density, total aromatics, and polycyclic aromatics can be estimated with adequate precision.”[v]

So far even these recommendations have not been built into any policy on fuel quality monitoring. It is important to initiate research programmes to develop testing protocol for alternative methods like gas chromatography with atomic emissions detection for more accurate fingerprinting of samples to detect anomaly. Required instrumentation for such tests should be reviewed and adopted.

It is possible to create a library of different refinery samples of automotive fuels and possible adulterants. With the help of the standard library chromatogram it will be much easier to detect fuel adulteration.

These methods are in use in other countries for surveillance purpose. According to information available from California Air Resources Board, GC methods are used for detection of samples adulterated with non taxed fuels. For instance, diesel is a highly regulated and taxed commodity in California. Identification of the source refinery or refineries of field samples and detection of the presence of other petroleum products are important steps in enforcing tax and environmental regulations. Gas chromatography with atomic emissions has proven to be a useful tool for determining the origin of market place diesel fuels. The chromatographic distribution of sulphur, nitrogen and carbon, taken as a group are unique for diesel fuel produced by each refinery in California. The chromatogram of diesel obtained from retail outlets and tankers are qualitatively compared with a library of chromatograms of known samples of California diesel, 49 state diesel, jet fuel, kerosene and gas oil. The library is derived from samples obtained directly from all of California's refineries as well as ships bringing imported diesel fuels to California. Samples that cannot be linked to a known library sample or a combination of known sample are identified as abnormal. Samples that appear to be blended with an untaxed component (for example, jet fuel) are identified as adulterated.[vi]

In California chromatogram of fuels from retail outlets are qualitative compared with a library of chromatograms of known samples. Indian Oil industry rejects such a proposal as impossible

7.1 The reservations of the oil industry on alternative test methods

Testing for adulteration by the gas chromatography method requires a reference fuel against which the collected fuel samples can be tested. The chief objection raised against this method is that it is not possible to provide such a reference fuel. According to the oil industry, the characteristics of a final product at the refinery depend to a large extent on the type of crude oil from which it has been processed.

According to MoPNG, the major crude oil markets are the Middle East and Far East. The other markets for crude oils like Venezuela, Mexico, North Sea are not normally competitive for import of crude oil mainly due to freight economy. Therefore, most of the crude oil imports are of Middle East origin, namely, from UAE, Saudi Arabia, Kuwait, Iran and Iraq. However, a part of the total requirement, in particular sweet crude oils, are met from the far-east (Malaysia) and West Africa.

So the industry argues that refining the crude to manufacture a product involves complex processes at different phases, starting with distillation of the crude. Automotive fuels are composed of hundreds of hydrocarbons of different classes in different proportions. Moreover, different byproducts of different processes are mixed (blending). According to the oil industry, no two batches of products manufactured at the same refinery are of the same composition, even if they are manufactured from the same crude.

The broad range of properties allowed in the BIS specifications for automotive fuels allow a lot of streams to be mixed. When byproducts are mixed with diesel and petrol at the refinery it is called blending and it is done in such a way that the end product meets the specifications. This also serves the dual purpose of using the byproducts in an economically productive way and to get rid of the problem of disposal of these streams had they not been useful.

Since gas chromatography is a sensitive method, it will show variations among samples as aberrations if fuels collected at the retail outlet, oil tanker or depot are of a different batch than the one from which they received the supply. Moreover, fuel stocks get mixed when a new supply is mixed with the existing stock at the tanks.

It is true that product compositions change depending on crude slate mix, blending operations, and how various units are run (including the cut points for products which in turn determine the volumes of different products made). It is also true that if pipe lines are used for transporting of different fuels, as is being done from

Mathura refinery to Bijwasan terminal in Delhi, there can be considerable scope for cross contamination depending on how products are batched, and how refineries deal with the interface between gasoline and kerosene, kerosene and diesel, coming through the pipe line.

But in view of the wide variety of alternative methods that have been developed worldwide for precision tests, it is possible to compare and track quality across the entire supply chain. According to scientists, gas chromatography can give a picture of the hydrocarbons and hydrocarbon families present in a sample. Thus if specifications are set for hydrocarbon families like olefins and aromatics, the task of comparison will become much easier. This is all the more reason why these parameters should be regulated right away.

No information is available from the petroleum industry or the IOC R&D Centre on whether they have seriously studied this method or not. The only instance of application of such a test for checking adulteration in India done in the public domain and brought to our notice is the one done by the Indian Institute of Technology, Chennai based public charitable trust, CONCERT. CONCERT, has examined the possibility of other tests which can be effective. According to them the only reliable test is to X-ray the signature of various molecules in an admixture through a Gas Chromatograph Test (GC). CONCERT has obtained reference samples from the Madras Refineries Limited (MRL) and also samples from retail outlets. It was found that one can obtain unique and individual fingerprints of each and every molecule and also its proportion to the total.

The petroleum industry, instead of clouding the solution further only by citing scientific uncertainties, should focus on developing and replicating methods along the lines that have already been developed by international testing agencies

It is important that the petroleum industry, instead of clouding the solution further only by citing scientific uncertainties, should focus on developing and replicating methods along the lines that have already been developed by American Standard Test Method (ASTM) or the Institute of Petroleum (UK) or South West Research Institute, USA, etc for such tests.

It is very important to note that, unlike the West where abuses in the fuel market are very limited and involve only a few adulterants, in India we are talking about at least 16 commonly known hydrocarbons. Most of these have overlapping physical and chemical composition. For instance, super LDO that Reliance Petroleum Ltd markets in Delhi as an industrial fuel or for generator sets, is supposed to be 95 per cent similar in composition to diesel but it is a much cheaper fuel. This has higher chances of going undetected except for the fact that it has very low cetane of 30. According to market observation, this LDO is more widely used to adulterate diesel than kerosene. But, certainly, monitoring of a wide variety of combination of adulteration would require tests that can detect the anomaly with greater accuracy.

8. PREVENTING ADULTERATION

We will need to design an effective framework for preventing adulteration. The framework will need to include different elements from testing methods to designing an enforceable penalty and liability system. We are detailing some issues below.

8.1. Technical methods: Marker system

The oil industry has tried to develop a marker system for detection of adulteration. But this has not been effective at all. The Mukhopadhyay committee report states that earlier kerosene was used as a major adulterant in petrol and diesel. The IOC

R&D Centre investigated this. At the instance of the Oil Coordination Committee, blue dye and furfural were added to kerosene for detection. But estimation of blue dye and furfural in transport fuels is not being carried out. Thus this marker system is not being utilised adequately.[vii] However, some test results available from oil companies show that furfural tests are being conducted. But it has also been brought to our notice that the antidote to blue dye is already in the market. Either this dye is chemically neutralised or is filtered through a clay like substance that absorbs the dye. Lot of doubts have also been raised with respect to the stability of furfural in the fuel for reliable detection.

Colour or chemical coding of only kerosene will not help as there are too many adulterants in the market now. The solvent and naphtha control order that was recently passed by MoPNG lists as many as 16 commonly known adulterants.

Now it is proposed that chemical markers be added in ppm level into the fuel and not the adulterant. Monitoring of the concentration and dilution of these markers at the retail end can be useful in detecting adulteration. But there are doubts over the effectiveness of the tracer method. There are doubts about maintaining constant dosages at low concentration, the problem of leaching and laundering of the marker and even its depletion in the fuel because of its interaction with trace impurities in the fuel itself. However, the IOC R&D Centre is working on this method.

Though the government of India has issued a licencing policy for key adulterants, state governments have done nothing to implement it

But there are now doubts if this kind of marker system can be implemented at all. In Delhi, for instance, fuels come from different refineries and no one is sure how doping of fuels with different markers and dosage will behave and can be reliably traced once different refinery streams flow into the same tanks. But, clearly, this is an area that the government will have to look into seriously.

8.2. Regulatory measures

Licensing of fuel supply to regulate the end use

The main incentive for adulteration is the skewed taxation policies of the government on petroleum products and availability of a wide variety of low priced hydrocarbons in the market. High taxes on petrol make it vulnerable to adulteration with cheap solvents and naphtha. Diesel on the other hand, is vulnerable to mixing of subsidised kerosene and cheaper LDO that are very similar to its chemical structure.

The government has taken the initiative recently to issue a control order to license the use and supply of some commonly known adulterants in the market. Comparison of the current prices of the solvents with diesel and petrol shows the cheapness of these fuels. (see table 17: Possible Adulterants)

The control order from the MoPNG on the use of naphtha and solvents came into effect in 2000. These orders essentially state that that no person shall either acquire, store and/or sell naphtha and solvents in the schedule without a licence issued by the state government or the district magistrate or any other officer authorized by the central or the state Government. The solvent order was subsequently amended to make an exemption for small scale users by stating that “no such licence shall be required for consumption of 50 KLs per month or less and storage of 20 KLs or less of solvents listed in the schedule combined”.

These orders further stipulate that every person engaged in the sale or trading of

Table 17: Comparison of prices of fuels and possible adulterant

Sr. No.	Fuels and solvents	Price
Transportation fuels		
1	Diesel	Rs 17.90 per litre
2	Petrol	Rs 28.00 per litre
Industrial Solvents		
1	SBP spirit / SBP solvents	Rs 21.00 per kg
2	C- 9 Solvent / Raffinates	NA
3	C-6 Raffinates	NA
4	Pentane	Rs 42.06 per kg
5	Cixon	NA
6	Solvent	90 Rs 26.40 per kg
7	Hexane	Rs 17.12 per litre
8	Heptane	NA
9	Resol	NA
10	NGL (Non-fertilizer Naptha)	Rs 12.95 per kg
11	Mineral Turpentine Oil	Rs 14.26 per litre
12	Aromex	Rs 18.26 per kg
13	Iomex	NA
14	Furnace Oil (Fuel Oil) (Not available in NCT)	Rs 8.93 per litre
15	Light Diesel Oil	Rs 12.95 per litre
16	Kerosene	Rs 15.00 per litre

Note 1: Prices are indicative may not be exact market price
Source: Compiled from the following:
Solvent, Raffinate and Slop order (Acquisition, sale, Storage and Prevention of Use in Automobiles) 2000
Naphtha control order (GSR 518)

these products, either imported or indigenous, for any purpose whatsoever, shall file end-use certificates from consumers to whom he sells, and furnish customer-wise sales to the district magistrate or to the state civil supplies authorities on a quarterly basis.

The solvents listed in the schedule are:

1. SBP spirits/SBP solvents
2. C-9 solvents/raffinates
3. C-6 raffinates
4. Pentane
5. Cixon
6. Solvent 90
7. Hexane (Food Grade), IS 3470
8. Heptane
9. Resol
10. NGL
11. MTO, Mineral Turpentine Oil, Petroleum Hydrocarbon solvents IS 1745 (version 1991)
12. Aromex
13. Iomex
14. Furnace Oil (FO) IS 1593 (1982)
15. LDO Light diesel oil, (IS 1460)

The actual implementation of this order rests with the state government. But

DISCARDING OR ADDING: PROBLEM IN DISPOSING OF REJECTED FUELS

According to the petrol dealers association there is considerable scope of diverting different fuels that have gone off specs, for whatever reason, for adulteration. The normal procedure for disposal of off specs fuels is to downgrade the fuel and use it for other purposes. For example, when LDO is rejected, it is downgraded to fuel oil. Similarly, when Aviation Turbine Fuel is rejected, it is downgraded to Superior Kerosene Oil. Rejected diesel and petrol are sent back to the refinery where these are re-refined. But it is suspected that this may not happen all the time. No record has been provided to show what is the magnitude of rejects every year. It is suspected that aviation fuel, which is cheaper and is a superior fuel may even be intentionally declared off specs to be diverted and mixed with higher value fuels.

According to oil company officials, the rectification/ liquidation/ down gradation process is decided on the basis of what level of adulteration the petroleum product specification the rejected product meets. This is tested in the laboratory and then it is decided at what ratio of adulterant and product it will be liquidated. In terms of percentage, if diesel has been mixed with 16 per cent kerosene it can be liquidated in the ratio of 1:160 and its quality is tested to check if it meets the specifications for diesel again. If it does, then it is marketed. It is not clear, however, how tests are conducted to detect the proportion of adulteration.

The Industry Quality Control Manual mentions that the "disposal of a contaminated product shall be as per advice from quality control department". According to the 'Bulk Transport Contract Agreement of the Indian Oil Corporation Limited "the contractor agrees to ensure that the products entrusted to him by the Corporation in terms of his agreement do not get adulterated/contaminated by any act or omission on the part of his crew. In the event of a failure of the product in quality control checks at the premises of the dealers/consumers/storage point of the corporation or enroute, the location from which the product was despatched will be immediately informed.

It further states, "in such cases of adulteration/contamination, the Corporation at its discretion may treat the product downgraded and unload the same at any of the storage points. In such cases, the difference in cost arising out of down gradation of the product will be recovered from the contractor at prices to be determined by the Corporation along with other incidental expenses that may be incurred". We do not know how effectively this system works in practice.

the Delhi government has not yet worked out the detail of licensing the use of these products and to keep an official record of their supply and end use.

On the contrary, there is concern over the exemption granted up to 50 litre of solvents for small scale users. CSE's investigation near the Bijwasan depot showed that products from tankers were being removed in 50 litre cans. This needs investigation to see to what extent this provision in the law is being used as a loophole to bypass the legal order.

The government must design an effective system of inventory and accounting system for petroleum products.

8.3. Fiscal measures

8.3.1. Distortions in pricing

Though it is universally recognised that pricing is the most effective method of controlling adulteration, there is no clear answer as to how prices would behave once the administrative price mechanism gets dismantled in April this year. Even then, subsidy on kerosene and LPG is likely to continue.

It is also not clear how the prices of a wide variety of fuels will behave in the market. It will be very difficult to eliminate differences among such a wide variety of fuels and solvents meant for different usages.

But the government should immediately look into this issue and come up with a fiscal policy to eliminate price differences.

PARALLEL MARKETING

The system of petty fuel dealers is a special problem that CSE observed in the NCR region of Uttar Pradesh. This is a government licensing system to give marketing rights of only diesel in areas where retail outlets have not been set up. The objective is to ensure supply of diesel for agricultural purposes. But distribution of licenses is again in the hands of the district administration and the quality assurance system is also entirely with district administration. It is suspected that petty dealers supply adulterated fuel even to vehicles at cheap rates. According to the sources of district supply office in Meerut many of these petty dealers are involved in malpractices. The petty dealers are not supposed to operate within a periphery of five kilometers of any retail outlet and they can store diesel in drums of four kilolitres capacity and can only sell diesel to customers who require 15-20 litre of diesel. Petty dealers can buy diesel from any retail outlets. There is no check on the quality of the fuel marketed by these dealers.

CSE has noticed that the pricing policy is working at cross-purpose with the intended environmental benefits of fuel quality regulations. The most important example is the introduction of 500 ppm sulphur diesel in the NCT and NCR under the Supreme Court order. The unimaginative policy of the government to price this quality diesel higher than the 2500 ppm diesel that is available outside the NCT and NCR has pushed demand beyond the NCR region. Currently, 500 ppm sulphur diesel in the NCR costs Rs 17.18 per litre as against Rs 16.40 for 2500 ppm sulphur diesel available outside NCR. Petrol Dealers Association in Delhi estimate a drop in sale of diesel of nearly 30 per cent in the NCT and NCR and allege that transporters are now moving out of the NCR to buy low priced but poorer grade of diesel. Even during our sampling operation along the highways near Delhi, we noted empty diesel tanks in retail outlets which was explained as due to slump in demand in this region. The Haryana Petrol Dealers Association has given the estimates on the trend in sales in diesel in Panipat and Karnal after the introduction of 500 ppm sulphur diesel to corroborate this fact (see table 18).

Table 18: **Comparison of trend in diesel sales after introduction of 500 ppm sulphur in two districts of Haryana in the NCR**

Year	Panipat (kilolitre)	Karnal (kilolitre)
April – December 2000	1,00,773	1,09,480
April-December 2001	77,692	1,30,501

Source: Haryana Petrol Dealers Association, 2002, Personal Communication, January.

This anomaly must be corrected immediately to remove incentives for using poorer quality of fuel or adulterating costlier fuels with cheaper fuels.

8.3.2 The profitable business of adulteration

Due to skewed prices, the incentive to adulterate is very high. An indicative estimate shows that if a retail outlet adulterates petrol with 15 per cent naphtha it can earn a profit of Rs 25, 215 per day. This estimate is based on the average volume of sales in retail outlets.

8.4. Enforcement measures

8.4.1. Penalty system

It is extremely serious that the current penalty system that has been described in the Marketing Discipline Guidelines issued by MoPNG are not legally binding. According to the officials of the anti-adulteration Cell of MoPNG, these are not

Table 19: An estimate of likely profit from mixing 15 per cent naphtha with petrol

Item	Estimate
Pump owners commission	Rs 0.613 per litre of petrol sold
Average quantity of petrol sold at a petrol pump per day	10,000 litre per day
Stipulated commission received by pump owners @ Rs 0.613 per litre	10,000 = Rs 6,130
After adding 15 per cent naphtha	
Price of naphtha	Rs 12.13 per litre
Price of petrol	Rs 28.94 per litre
Price of petrol after adulteration, which is marketed in the same price	Rs 26.418 per litre
Profit made per litre of petrol by adulterating it	Savings made per litre Rs 2.512
Price of adulterant for adulterating 10,000 litres of petrol	Rs 18,195
Price of petrol if pump would have sold pure petrol:	Rs 2,89,400
Price of adulterated petrol sold	Rs 2,57,810
Profit per day on estimated total sales of 10,000 litres of adulterated petrol	Rs 25,215

Source: Computed by Centre for Science and Environment based on the current market prices.
Note:
1. The estimate of petrol sales in a retail outlet is an average of observed sales in high selling retail outlets in NCT Delhi.
2. The figure of petrol sale in a petrol pump, are average figures observed in the market.
3. Price of naphtha is in kg based on the market price provided by IOC.

legally binding and the respective oil companies can modify the guidelines[viii].

Even more serious is the fact that the recent modifications made in the guidelines by MoPNG have actually reduced the severity of the penalty and lowered penalty fees. The modifications proposed in the penalty system for different types of offences for 1999-2001 are more lax. (See table 20) The existing penalty that includes penalty fees of Rs 1,00,000, and suspension of sales and supplies of all products for 45 days for the first offence of adulteration has been lowered to Rs 20,000 and suspension of supplies for 30 days.

In case the product is off-spec, fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days. When product is on-spec, fine of Rs 25,000 & suspension of sales and supplies of all products for 30 days.

The existing penalty system is too weak to act as an effective deterrent. Penalty is imposed on the retail outlets according to the number of offences recorded against the same outlet. Penalty is supposed to get stricter with each passing offence and dealership is terminated after the third offence.

The information that is available on the nature of action taken for offences show how meaningless this exercise is. The list of action taken on retail outlets between January 1, 2001 and December 12, 2001 by the Indian Oil Company (IOC) shows that out of 18 penal cases, 3 dealerships were terminated while the rest are still operating after completing the suspension period of 15 to 30 days. Even out of the three outlets that were terminated, two are operating under different names.[ix]

Table 20: Comparative statement of penal actions in marketing discipline guidelines (MDG) 1998 and proposed MDG 2001 for retail outlets of oil industry

Sl No.	Established major irregularities	MDG 1998 Penal Action			Proposed MDG 2001 Penal Action		
	Nature of irregularity	1st action	2nd action	3rd action	1st action	2nd action	3rd action
1.	Adulteration of MS/HSD	Fine of Rs 1,00,000 & suspension of sales and supplies of all products for 45 days. If fine notpaid within 45 days, extension of suspension of sales and supplies of all products for another 30 days. If the fine is not paid even within the extended period of 30 days, the dealerhsip will terminated.	Termination		Fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	Termination	
2.	Short delivery of products (weights & measures seals tampered)	Fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	Termination		Fine of Rs 10,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 25,000 & suspension of sales and supplies of all products for 30 days.	Termination
3.	Unauthorized storage facility	Fine of Rs 20,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	Termination	Fine of Rs 5,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 10,000 & suspension of sales and supplies of all products for 30 days.	Fine of Rs 25,000 & suspension of sales and supplies of all products for 45 days.
4.	Not providing inspection stock/sales	Fine of Rs 20,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 20,000 and suspension of sales and` supplies of all products for 30 days.	Termination	Fine of Rs 5,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 10,000 & suspension of sales and supplies of all products for 30 days.	Fine of Rs 25,000 & suspension of sales and supplies of all products for 45 days.
5.	Unauthorized purchase/sales/ exchange of MS/ HSD	Fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	Termination		When product is on-spec, fine of Rs 5,000 & suspension of sales and supplies of all products for 15 days. In case the product is off-spec, fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	When product is on-spec, fine of Rs 25,000 & suspension of sales and supplies of all products for 30 days. In case the product is off-spec termination	When the product is off-spec termination.

Sl No.	Established major irregularities	MDG 1998 Penal Action			Proposed MDG 2001 Penal Action		
	Nature of irregularity	1st action	2nd action	3rd action	1st action	2nd action	3rd action
6.	Established case of selling off-spec lubes	Fine of Rs 20,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 20,000 & suspension of sales and supplies of all products for all products for 30 days.	Termination	Fine of Rs 10,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 25,000 & suspension of sales and supplies of all products for 30 days.	Termination
7.	Unauthorized purchases/sales/ exchange of lubes	Fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	Termination.		Fine of Rs 5,000	Fine of Rs 10,000 & suspension of sales and supplies of all products for 15 days.	Fine of Rs 25,000 & suspension of sales and supplies of all products for 30 days.
8.	Non-availability of reference density at the time of inspection: Suspension of sales and supplies of all products immediately. Samples to be drawn and sent for testing within 24 hours. If the product meets specification, sales & supplies of all products to be resumed after warning letter.	Fine of Rs 20,000 & suspension sales and supplies of all products for 30 days.	Termination		Fine of Rs 20,000 & suspension of sales and supplies of all products for 30 days.	Termination	

Source: Marketing Discipline Guidelines of the Oil Industry

8.4.2. Liability system

Policies will have to be designed to make the oil companies accountable and liable for the quality of products at the retail end. Only if vertical accountability and liability is established along the entire supply chain will it be possible to ensure more effective checks and balances to prevent malpractices. It is important to note that the Mukhopadhyay Committee in its report states, "in Europe currently National Standard Bodies, such as British Standards Institute etc, carry out quality checks. The failure cases lead to penalties of filling station owner and the fuel supply company." The report cites the example of Belgium where a few years ago, 30 per cent of fuel samples frequently failed. But, recently, with the threat that the offending companies would be named in case of any malpractice and heavily fined, the situation has improved.[x]

In the US, if the Environmental Protection Agency (EPA) finds off-specification petrol or diesel fuels, under the Clean Air Act, every party upstream of the violation can be held liable. Fines can be issued up to US $27,500 per day per parameter. These fines can be mitigated only by demonstrating that the violation was not intentional and by the presence of a well-designed oversight programme.[xi]

In India, retail outlets are known by the name of the oil companies. But these retail outlets are not necessarily vertically integrated with refineries of the same oil

PURE FOR SURE: THE BHARAT PETROLEUM LTD CAMPAIGN

This programme has been launched by the Bharat Petroleum Corporation Ltd (BPCL) to certify its brand quality in Delhi. Out the 87 retail outlets of BPCL in the NCT region of Delhi 44 have so far got certificates for 'Pure for Sure'. By the end of February 2002, BPCL officials expect the number of 'Pure for Sure' outlets to go up to 60 in the NCT region. There are also pure for sure retail outlets in the NCR region.

This is done on the basis of certification of quality and quantity for supply point (depot), distribution (lorry tankers) and dispensing point (retail outlets) by an audit check by Germany based TUV (TÜV Rheinland Sicherheit und Umweltschutz GmbH). It is also possible to de-certify any retail outlet at any point of time.

At the retail outlet level, the following criteria are taken into account to certify a dealer/retail outlet as pure for sure:

1. **Dealer enrolment: Seminars and workshops are held with dealers to make them aware of the need for assuring quality to the customer.**

2. **Special meetings are held with the dealers to discuss the inefficiencies at the retail outlets and how they can be removed. For example, traffic jams in front of pump or problems with dispensing units and so on.**

3. **Delivery salesmen at the outlet are trained by BPCL officials and, later, surveys are carried out to find out if they are following the rules and regulations prescribed.**

4. **Inspection of stocks for non-`Pure for Sure, outlets are carried out once every quarter but in case of 'Pure for Sure' outlets, it is carried out every 45 days.**

5. **Samples are collected every month from the outlet and they are tested for every specification in BIS including octane rating.**

6. **Delivery accuracy meters are fixed at the outlet which are checked every fortnight by officials.**

7. **Mystery audits are conducted by mystery customers who are asked to go and visit the outlet and give their feedback to BPCL about the particular outlet.**

Monitoring of the supply chain

At the depot, filling of the tankers is not done through the conventional overhead manhole type filling covers but the process of bottom loading is resorted to which minimises evaporative losses as well as losses due to leakage. Apart from this BPCL is in the process of installing a complete vapour recovery system at the Bijwasan depot and also at one of the retail outlets as a pilot project to minimise evaporative losses.

All lorry tankers carrying fuel to these retail outlets are specially designed to integrate devices to minimise chances of pilferage as well as adulteration on the way. For example, they employ a six point sealing system and an abbloy locking system. Apart from this, all the important joints from where pilferage may occur are welded so that, if anyone tampers with them, these will immediately break, (for example the flag joint and discharge line.)

Specially designated people from the company who also carry out surprise checks along the way, physically handle all locks. Every time a lorry tanker decants in a 'Pure for Sure' retail outlet, two samples are drawn for testing. The frequency at which samples are drawn from retail outlets are also increased and a strict check is kept on them. All samples are drawn and tested by officials from an independent laboratory – TUV.

LIABILITY PROVISIONS IN THE US

United States Environment Protection Agency (EPA) enforces a number of environmental regulations on the quality of gasoline and diesel fuel. The maximum penalty for violations is US$27,500 per day (Rs 13.45 lakh), per violation, plus the economic benefit of the violator from non-compliance. EPA generally mitigates penalties based on the severity of the violation, the economic benefit, prior history of violations and size of business. In addition to the Clean Air Act, which gives EPA general authority to regulate fuels, there are more specific regulations as specified in the Code of Federal Regulations (CFR).

US fuels regulations have liability provisions based on two concepts: One is presumptive liability: under that scheme all upstream parties who actually distributed any fuel that is in the tank where the violation is found, as well as the facility itself where the violation is found, are liable unless they can meet the defence requirements set forth in the rules. To meet a defence parties must show they did not cause the violation, and that they had an adequate oversight program, including taking of samples and testing of fuel, aimed at deterring such violations.

The second concept applies to refiners of gasoline or diesel fuel. This concept is called vicarious liability. Under this concept, a refiner can be liable for the violation at a retail outlet displaying the brand of the refiner or any marketing subsidiary of the refiner, even if the refiner did not actually manufacture any of the gasoline in the storage tank of the retail outlets distribute that gasoline. The reason for this is that such refiners exercise significant control over retail outlets displaying their brand, even if the retail outlet is owned by an independent retail business. Thus, to have a defence, the "branded refiner" must show a contract with the retail outlet and a periodic sampling and testing program for its retail outlets designed to prevent such violations. There are some other defences as well. These are all set forth in the regulations at 40 CFR Part 80. This system works pretty well despite the fact that here too, they do not require segregation of fuel of different refiners. They only require different types of fuel to be segregated (e.g., summer gasoline must not be mixed with winter gasoline once the summer standards are in effect).[xii]

companies. In India the companies buy from each other and share the market. As a result, the retail outlets, though they are known by the name of various oil companies, do not necessarily sell fuel from the refineries of the same company — which essentially means only the service at the retail outlet can be branded and not the product. Only recently, some oil companies have taken the initiative to protect their brand image by evolving some public strategy of certifying quality of services and products at selected retail outlets. The 'Pure for Sure' programme of the Bharat Petroleum Ltd. is such an example. This company has started a process of certifying their retail outlets on the basis of quality checks.

At present, therefore, accountability and responsibility, and even penalty, gets fragmented along the supply chain. Since the companies see their responsibility ending at the terminal point, the onus shifts to the transporters and the retailers when malpractices occur. If companies are not held responsible for the quality of their product, their surveillance will always remain slack and will perpetuate adulteration. It is appalling to see how the corrupt system has beaten all methods devised so far to detect adulteration with such ingenuity.

In the US and Europe, after years of adverse publicity, oil companies have become more concerned about their public image, and are averse to having their products associated with anything illegal. They are very active in identifying adulteration and protecting their brand name.

8.5. Independent testing for adulteration

For public accountability of the oil industry there is a need for independent fuel quality monitoring system in the city, which currently is absent. In fact, the formation of the SFPL, as it is formally called, is an outcome of the Supreme Court order of July 28, 1998. According to the order "two independent fuel testing laboratories are to be established by June 1, 1999". This order was based on the recommendations of the EPCA to check adulteration.

The first progress report of the EPCA, March-June, 1998, states, "the EPCA requested the chief secretary of Delhi, secretary excise and the additional secretary, MoPNG to take necessary steps to check adulteration of fuels which was contributing significantly to air pollution. Ministry of Petroleum is being requested to set up two independent fuel testing labs. AIAM (now called SIAM) and other non-profit making organisations have agreed in principle to manage and operate these labs. These were discussed in the EPCA as early as March 1998 and then recommended in their first report to the Supreme Court". The EPCA wanted the laboratory to be an autonomous agency. Thus, a society was formed to make it completely unbiased and impartial.

But this laboratory is not in the public domain nor are its test results ever made public. SFPL has given the contract to run the lab to the Indian Institute of Petroleum (IIP). SFPL operates under instruction from IIP. All samples are received by SFPL and then handed over to the lab and all the reports are given to SFPL for onward transmission to the agencies who requested testing. The results are confidential and only a few agencies can ask for tests to be conducted. In Delhi, the agencies include the Food and Civil Supply department of the Delhi government, State Coordinator Office, Oil Coordination Committee, and the Ministry of Petroleum and Natural Gas. When EPCA asked for the results of the past tests, only the summary results were given and not the full test results.

In order to maintain the independent nature of the laboratory a representative

INDIAN INSTITUTE OF PETROLEUM, DEHRADUN INVESTIGATES FUEL ADULTERATION THAT LED TO WIDESPREAD FUEL PUMP FAILURES IN MARUTI CARS

Very little is known about the impact of adulterated fuel on emissions and vehicle engine components. Maruti Udyog Limited (MUL), one of the largest car sellers in India, has provided some information on limited evidence of effect of adulterated fuel on the vehicle.

A large number of fuel pump failures on the Maruti model of Esteem were reported in 1998. MUL therefore, collected fuel samples from affected vehicles. The samples were sent to Indian institute of Petroleum (IIP), Dehradun, a petroleum research organisation and an accredited certification agency for mass emissions tests for vehicles in India. IIP initially confirmed that all samples met BIS requirements. But on further investigation, it found that some paint solvent was mixed with the fuel. This shows how initially adulterated fuel met the specifications and adulterant was not detected in routine tests.

In May 2001, similar problems occurred in Nagpur, Maharashtra. Four-stroke engines reported failures due to poor octane rating of the fuel. Similar problem has been reported in the North East recently and is again suspected to be a case of fuel adulteration.

The automobile industry feels that oil companies do not respond to clarifications/guidance sought on problems like this.

The automobile industry feels that fuel quality assurance from oil companies shall have a definite impact on manufacturers to extend warranties.

The automobile industry is worried that if Euro III emissions standards make on board diagnostic –II (OBD) requirements mandatory, then adulteration would pose a serious problem. To offer any technology to meet this requirement, consistency of fuel and the right quality is important. These controls should be in place before OBD is mandated.

The automobile industry demands that fuel testing laboratories be totally independent in nature to ensure proper checks.

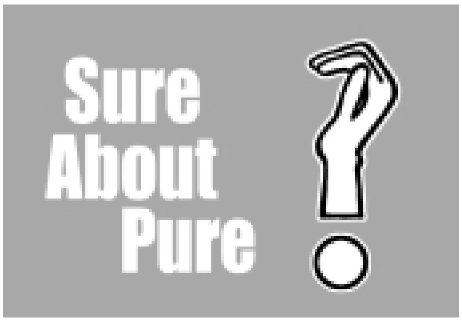
governing council has been created with representation from the automobile industry, concerned ministries of the government and civil society groups. But in its functioning and for all practical purposes the lab is still dominated by the petroleum industry.[xiii]

In the cost sharing arrangement the lab has received Rs 68 lakh from the MoPNG, Rs 25 lakhs from the Delhi government, a one-time fund of Rs 2 crore from Society for Indian Automobile Manufacturers (SIAM). Although the MoEF had committed to contribute Rs 35 lakhs for 2000-01 and Rs 50 lakh for 2001-02, only Rs 25 lakh has been given so far. The Ministry of Heavy Industries and the Ministry of Road transport and Highways are expected to contribute Rs 50 lakhs each.

SFPL was set up at a cost of Rs 11.2 crores. The total budgetary requirement of the lab per annum is Rs 3 crores. One of the problems is lack of adequate technical staff. As against the sanctioned staff strength of 14, SFPL only has 4 technical staff.

In any surveillance system, secrecy and lack of transparency will only help to perpetrate the crime further. Consumers in Delhi have the right to know about the results of the surveillance to be able to chose among the retail outlets.

The laboratory can be considered truly independent only if other stake-holders like consumer groups and the automobile industry can initiate and demand surveillance tests to check out the quality of products from refineries and involve the SFPL in the operation. This is practiced in other countries. For instance, in Mexico, this issue came up a couple of years ago because Pemex supplies fuel to the entire country and Pemex itself monitors product quality. The automobile industry then hired the Southwest Research Institute in the US, a premier fuel testing laboratory, for random and surprise tests on fuels.[xiv]



It is expected that the automobile industry would be equally concerned in the future if-on road durability tests for emissions are enforced in this country. As of date durability tests are conducted only for type approval and conformity of production tests. But, for on road durability compliance, checks on adulteration of fuels will have to be very effective.

Capacities of SFPL will have to be further improved to be able to undertake larger volume of tests. At the moment, under routine condition, it is limited to 40 to 45 samples per month and that too not for all the parameters. In fact, the second fuel testing laboratory that was to be set up under the same court order of July 28, 1998, was dropped on the premise that this lab would be able to conduct at least 200 tests a month. The aim and objective of the lab should include detection of adulteration and adulterants. It should not confine itself merely to checking the BIS specs.

The laboratory should be able to undertake tests for consumer groups and the automobile industry on demand. Necessary legal powers can be defined for agencies and officers outside the oil industry who can aid in sample collection for such tests.

It is also important to improve the capacity of SFPL to undertake more tests, more sophisticated tests, and conduct complete tests on a regular basis and to make test results public.

9. RECOMMENDATIONS

Our investigation shows that the current product quality monitoring system is extremely weak and stems largely from weak regulations and enforcement, skewed market prices of petroleum products and lack of accountability in the petroleum sector. Unless this is corrected, the root cause of the problem cannot be eliminated. Immediate intervention is needed in the operational, technical and economic areas. While there is consensus that skewed prices are responsible for adulteration, no solutions have been possible so far for political reasons.

This study clearly shows that, unless we take serious steps to improve the system to prevent and check adulteration, we will not even begin to touch the profitable business of adulteration. The current system gets compromised — from testing methods that are not adequate to detection of adulteration to penalty systems designed to let the manufacturers go scot-free.

Make oil companies accountable for the quality of fuel at the retail end
Any extent of vigilance and surveillance will be meaningless unless strict liability is imposed on the oil companies to take full responsibility for the quality of fuels they sell at their retail outlets. As of now, the responsibility and penalty are all fragmented along the supply chain. Though retailers and transporters are penalised by the oil companies if malpractices occur, the oil companies are not held accountable. To put it simply, consumers cannot sue the oil companies for adulterated fuels. Unless this is done, checks and balances in the system will not work effectively to prevent malpractices at any level. The best way that consumer pressure can be intensified on the oil companies, is to develop a system of public rating of the retail outlets by the name of the oil companies on a monthly basis, based on an independent inspection, testing and audit of the outlet. In a competitive market, there are multiple oil companies rivalling for market share. This will become more severe with decontrol of the petroleum sector soon. In such a situation, protection of brand name would be most critical for the oil companies to guard their market share. Therefore, quality based public rating of the retail outlets by the name of companies would work best in disciplining the supply chain and preventing the widespread malady.

Improve testing procedures and tighten fuel quality standards
Immediate attention should be paid to tightening the fuel quality standards and regulating some key parameters that are not done today; like aromatics, and olefins in petrol, and PAH in diesel. Even the broad range that is allowed, under the current specifications, should be adequately tightened. Tighter the net easier it is to catch dubious samples.

Develop alternative testing procedures for more accurate detection
For more accurate detection, alternative testing methods and protocols should be adopted straight away and applied for surveillance. It is possible to create a library of different refinery samples of automotive fuels and possible adulterants. With the help of the standard library chromatogram, it will be much easier to detect fuel adulteration.

Centre for Science and Environment **February 5, 2002**

LIST OF ABBREVIATIONS FOR ADULTERATION REPORT

NCT	— National Capital Territory
NCR	— National Capital Region
EPCA	— Environment Pollution (Prevention and Control) Authority
CSE	— Centre for Science and Environment
SFPL	— Society for Petroleum Laboratory
BIS	— Bureau of Indian Standards
MoPNG	— Ministry of Petroleum and Natural Gas
ASTM	— American Standard Test Method
GC	— Gas Chromatography
FID	— Flame Ionisation Detection
IOC R&D Centre	— Indian Oil Corporation (Research and Development) Centre
IIP, Dehradun	— Indian Institute of Petroleum (Dehradun)
DM	— District Magistrate
MoEF	— Ministry of Environment and Forests
SIAM	— Society of Indian Automobile Manufacturers

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CSE DUMMY SAMPLE WITH 10 PER CENT ADULTERATION

FUEL TESTING LABORATORY, NOIDA

(Constituent of Society for Petroleum Laboratory)

Managed by INDIAN INSTITUTE OF PETROLEUM, DEHRADUN

Detailed Analysis Report of Diesel Fuel as per IS:1460-2000 (Fourth Revision)

Report No. : FTL/HSD/02/02/ 130 **Date: 7.2.2002**

Code no. B4ORGVRFVD

Date & Time of Sampling: NA

Type of Sample: **HSD** Seal No: 096646,314952

Date & Time for sample recd. at FTL : 30.1.2002

Sample inspected for proper sealing/leakage : Seal Intact, No leakage

Room Temp. 20..5……°C Atm.Pressure …733 mm of Hg

S.N.	CHARACTERISTICS	RESULT	REQ.	METHOD
1.	Acidity, inorganic, mg KOH/g	Nil	Nil	P:2
2.	Acidity, total, mg KOH/g	<0.05	0.20 Max	P:2
3.	Ash, % wt.	0.002	0.01Max	P:4
4.	Carbon residue (Ramsbottom), % wt. On 10% residue	0.06	0.30^{x} Max	P:8
5.	Cetane Index (calculated) or Cetane number	47.4 49.4	46 Min 48* Min.	D4737
6.	Pour point, °C	-6	+3 (W)$^{\$}$,Max +15 (S),$^{\#}$Max	P:10
7.	Copper strip corrosion,3hrs at 100 °C	No 1	Not Worse than 1	P:15
8.	Distillation, % v/v, recovered a) at 350 °C, b) at 370 °C,	 91.0 95.0	 85 Min. 95 Min.	P:18
9.	Flash point, °C (by Abel)	56.0	35 Min.	P:20
10.	Kinematic viscosity, cSt, at 40 °C	2.94	2.0-5.0	P:25
11.	Sediments, % Wt.	<0.01	0.05Max.	P:30
12.	Density at 15 °C, Kg/M^{3}	845	820-860	P:32
13.	Total Sulfur, % Wt.	0.04	0.25$^{@}$ Max. 0.05^{+} Max.	P:33/IP336
14.	Water content, % Vol	ND	0.05 Max.	P:40
15.	Cold filter plugging point (CFPP),°C	-6	+6(W),$^{\$}$ Max. +18 (S),$^{\#}$ Max.	P:110
16.	Total sediments, mg per 100ml	-	1.6 **Max.	UOP 413

^{x} The limit is applicable prior to addition of cetane number improver, $^{\$}$:Nov.- Feb.(Both months inclusive) $^{\#}$ Rest of the months; ND: Not detectable, * Method is not applicable to pure hydrocarbons or fuels containing cetane improvers or fuels derived from coal. $^{@}$ To Indian Navy for defense 0.2% by Wt.Max. $^{+}$ For notified areas. ** At refinery or manufacturer's end.

Inference: The product meets the specification of HSD

Analysed by
GCK, R Badola, GBT

Reviewed by
Dr.R.L.Sharma
In-charge

Checked by
8/2/02
Dr.G.B.Tiwari
Dy.In-charge

Dr. R.L. SHARMA
Incharge
***Fuel Testing** Laboratory*
***B-14, Sector-62**, Noida*

CSE DUMMY SAMPLE WITH 15 PER CENT ADULTERATION

FUEL TESTING LABORATORY, NOIDA

(Constituent of Society for Petroleum Laboratory)

Managed by INDIAN INSTITUTE OF PETROLEUM, DEHRADUN

Detailed Analysis Report of Diesel Fuel as per IS:1460-2000 (Fourth Revision)

Report No. : FTL/HSD/02/02/ 132 **Date: 7.2.2002**

Code no. C4ORGVRFVD

Date & Time of Sampling: NA

Type of Sample: **HSD** Seal No:096629

Date & Time for sample recd. at FTL : 30.1.2002

Sample inspected for proper sealing/leakage : Seal Intact, No leakage

Room Temp. 20..5……°C Atm.Pressure …733 mm of Hg

S.N.	CHARACTERISTICS	RESULT	REQ.	METHOD
1.	Acidity, inorganic, mg KOH/g	Nil	Nil	P:2
2.	Acidity, total, mg KOH/g	<0.05	0.20 Max	P:2
3.	Ash, % wt.	0.002	0.01Max	P:4
4.	Carbon residue (Ramsbottom), % wt. On 10% residue	0.08	0.30[X] Max	P:8
5.	Cetane Index (calculated) or Cetane number	50.4 51.6	46 Min 48[*] Min.	D4737
6.	Pour point, °C	-6	+3 (W)[$],Max +15 (S),[#]Max	P:10
7.	Copper strip corrosion,3hrs at 100 °C	No 1	Not Worse than 1	P:15
8.	Distillation, % v/v, recovered a) at 350 °C, b) at 370 °C,	92.5 97.0	85 Min. 95 Min.	P:18
9.	Flash point, °C (by Abel)	48.5	35 Min.	P:20
10.	Kinematic viscosity, cSt, at 40 °C	2.43	2.0-5.0	P:25
11.	Sediments, % Wt.	<0.01	0.05Max.	P:30
12.	Density at 15 °C, Kg/M^3	833	820-860	P:32
13.	Total Sulfur, % Wt.	**0.09**	0.25[@] Max. 0.05[+] Max.	P:33/IP336
14.	Water content, % Vol	ND	0.05 Max.	P:40
15.	Cold filter plugging point (CFPP),°C	-4	+6(W),[$] Max. +18 (S),[#] Max.	P:110
16.	Total sediments, mg per 100ml	-	1.6 [**]Max.	UOP 413

[X] The limit is applicable prior to addition of cetane number improver, [$]:Nov.- Feb.(Both months inclusive) [#] Rest of the months; ND: Not detectable, [*] Method is not applicable to pure hydrocarbons or fuels containing cetane improvers or fuels derived from coal. [@] To Indian Navy for defense 0.2% by Wt.Max. [+] For notified areas. [**] At refinery or manufacturer's end.

Inference: The product does not meet the specification of HSD

Analysed by
GCK, R Badola, GBT

Reviewed by
Dr.R.L.Sharma
In-charge

Checked by
8/4/02
Dr.G.B.Tiwari
Dy.In-charge

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Incharge
***Fuel Testing** Laboratory*
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CSE DUMMY SAMPLE WITH 20 PER CENT ADULTERATION

FUEL TESTING LABORATORY, NOIDA

(Constituent of Society for Petroleum Laboratory)

Managed by INDIAN INSTITUTE OF PETROLEUM, DEHRADUN

Detailed Analysis Report of Diesel Fuel as per IS:1460-2000 (Fourth Revision)

Report No. : FTL/HSD/02/02/ 133 **Date: 7.2.2002**

Code no. D4ORGVRFVD

Date & Time of Sampling: NA

Type of Sample: **HSD** Seal No: 314933

Date & Time for sample recd. at FTL : 30.1.2002

Sample inspected for proper sealing/leakage : Seal Intact, No leakage

Room Temp. 20..5……°C Atm.Pressure …733 mm of Hg

S.N.	CHARACTERISTICS	RESULT	REQ.	METHOD
1.	Acidity, inorganic, mg KOH/g	Nil	Nil	P:2
2.	Acidity, total, mg KOH/g	<0.05	0.20 Max	P:2
3.	Ash, % wt.	0.003	0.01Max	P:4
4.	Carbon residue (Ramsbottom), % wt. On 10% residue	0.05	0.30^X Max	P:8
5.	Cetane Index (calculated) or Cetane number	51.2 52.3	46 Min 48* Min.	D4737
6.	Pour point, °C	-6	+3 (W)$,Max +15 (S),# Max	P:10
7.	Copper strip corrosion,3hrs at 100 °C	No 1	Not Worse than 1	P:15
8.	Distillation, % v/v, recovered a) at 350 °C, b) at 370 °C,	91.0 96.0	85 Min. 95 Min.	P:18
9.	Flash point, °C (by Abel)	45.5	35 Min.	P:20
10.	Kinematic viscosity, cSt, at 40 °C	2.43	2.0-5.0	P:25
11.	Sediments, % Wt.	<0.01	0.05Max.	P:30
12.	Density at 15 °C, Kg/M^3	828	820-860	P:32
13.	Total Sulfur, % Wt.	0.04	0.25@ Max. 0.05+ Max.	P:33/IP336
14.	Water content, % Vol	ND	0.05 Max.	P:40
15.	Cold filter plugging point (CFPP),°C	-5	+6(W),$ Max. +18 (S),# Max.	P:110
16.	Total sediments, mg per 100ml	-	1.6 ** Max.	UOP 413

X The limit is applicable prior to addition of cetane number improver, $:Nov.- Feb.(Both months inclusive)
Rest of the months, ND: Not detectable, * Method is not applicable to pure hydrocarbons or fuels containing cetane improvers or fuels derived from coal. @ To Indian Navy for defense 0.2% by Wt.Max.
+ For notified areas. ** At refinery or manufacturer's end.

Inference: The product meets the specification of HSD

Analysed by
GCK, R Badola, GBT

Reviewed by
8.2.02
Dr.R.L.Sharma
In-charge

Checked by
8/2/02
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