1.0 INTRODUCTION

Gasoline (Motor Spirit/MS) and Diesel (High Speed Diesel/HSD) are the major transport fuels in India. Adulteration of these transport fuels at the point of sale and during transportation has become an acute problem in the country. Transport fuels are often adulterated with other cheaper products or byproduct or waste hydrocarbon stream for monetary gains. For example, gasoline (petrol) is believed to be widely adulterated with naphtha, natural gas liquids, kerosene, waste solvents, byproduct petroleum stream, etc. With large number of adulterants available in the market, both indigenous and imported, the magnitude of the problem of fuel adulteration has grown into alarming proportions in the past few years.

The Motor Spirit and High Speed Diesel (Regulation of Supply and Distribution and Prevention of Malpractices) Order, 1998, defines adulteration as the introduction of a foreign substance into motor spirit / high speed diesel, illegally or unauthorized with the result that the product does not conform to the requirements and specifications of the product. The foreign substances are called adulterants which when introduced alter and degrade the quality of the base transport fuels.

2.0 CONVENTIONAL TRANSPORT FUELS (GASOLINE/DIESEL)

Since the birth of automotives in the 19th century, diesel and gasoline are used as the primary source of energy for the vehicles, though many alternate fuels like CNG, LPG, alcohol, dimethylether, biodiesel, methanol, etc. are emerging in the market. The conventional fuels are basically derived from crude oil, where crude oil is fractioned by continuous distillation into several fractions: Petrol (gasoline), kerosene (kerosene, paraffin oil), gas oil (heavy oil), vacuum gas oil, naphtha, lubricating oil and residue. These fractions are further processed through conversion, reforming and treatment processes to increase the yields and adjust the chemical composition of transport fuels and to remove the trace impurities. Finally, several streams are blended to produce transport fuels with the desired specifications. The composition of crude oil varies with the locality of occurrence, but all contains alkanes (straight and branched chain from about C_1 to C_{40}), cycloalkanes or napthenes, and aromatic hydrocarbons. The low –boiling fraction of almost all petroleum products are composed of alkanes; it is the composition of the higher boiling fraction, which differ according to the source of the petroleum. In addition to hydrocarbons, there are also present compounds containing oxygen, nitrogen, sulphur and metallic constituents.

Codes, standards or specifications for the gasoline and diesel have been laid down in different countries. National or other legally enforceable specifications represent the minimum quality that must be supplied and it is implicit that engine designers should ensure that their vehicles will run satisfactorily on such a quality of fuel. In India, the Bureau of Indian Standards (BIS) notifies the requisite specifications for petrol and diesel**. Annexure I & II** show BIS specifications for diesel & gasoline that are being implemented all over the country except in four metros, while in four metro cities Bharat stage-II fuel specifications are implemented.

3.0 COMMON FORMS OF FUEL ADULTERATION & POTENTIAL ADULTERANTS

Blending or mixing of adulterants into the base transport fuels exists in various forms and both the type and quantity of adulterants vary from place to place. Moreover, profitability, availability and blendability are the prominent factors governing the choice of adulterants. Specific types of adulteration may be broadly classified as follows:

- Blending relatively small amount of distillate fuels like diesel or kerosene into automotive gasoline.

- Blending variable amount (as much as 30%) of the gasoline boiling range hydrocarbons such as industrial solvents into automotive gasoline.

- Blending small amounts of spent waste industrial solvent such as used lubricants, which would be costly to dispose of in an environmentally approved manner- into gasoline and diesel.

- Blending kerosene into diesel, often as much as 20-30 percent.

- Blending small amount of heavier fuel oils into diesel.

There are several petroleum products in our country or abroad, which are close substitutes of petrol (Motor Spirit or MS) and high-speed diesel (HSD), and are available at considerably lower prices. The consequence is that these products are widely used as adulterants. Some of the possible adulterants available in Indian markets are listed in Table-1 & 2.

Table-1: Potential Adulterants for Gasoline (MS)

SL.	Solvent/Chemical	Source	Basic Cost (Rs.) KL/MT	Market Price (Rs.)*
1	Naphtha	Refineries	14950	NA
2	SBP	BPCL	13500+32% Exise+ST	20/lt
3	GAIL Solvents	Bijalpur	12000+32% Exise+ST	17-19/lt
4	GAIL Solvents	Pata	12000+32% Exise+ST	16-18/lt
5	Pentane	GAIL	10000+16% Exise+ST	14-16/lt
6	Cixon	IPCL	12000	NA
7	Solvent-90	IOC	26400	30-32/lt
8	Hexane	Refineries	13500+32% Exise+ST	20-24/lt
9	Resol	Reliance	11000	NA
10	Raffinate/Slop	Refineries	NA	NA
11	C6-C9 Raffinate	Petrochemicals	NA	NA
12	Naphtha/NGL	GAIL/ONGC	13760	NA
13	PDS Kerosene	Govt.	5000	7000/KL
14	Free Kerosene	Parallel Marketers	14500	NA
15	MTO	Refineries	16588	20-21/lt
16	Pyrolysis Gasoline	Naptha	NA	NA

		Crack		
17	Oxygenates	Refineries	15000	NA
18	Food grd. Hexane	Refineries	NA	NA
19	Benzene	Koyali	25937.6+32% Exise+ST	27-29/lt
20	Toluene	Koyali	27376.6	28-30/lt

*-Prevailing price (Approx.) in Delhi & Mumbai as on November 2000.

Source: Report of MoPNG Task Force to examine the use of solvent, raffinate and slop in automobile fuel.

Table-2: Potential Adulterants for Diesel (HSD)

SL.	Solvent/Chemical	Source	Basic Cost (Rs.) KL/MT	Market Price (Rs.)*
1	Aromex	Digboi	15254+ Excise+ST	22/lt
2	Iomex	NA	NA	NA
3	C9 Raffinate	Ptrochmcls	10000	NA
4	MTO	Refineries	12560	20-21/lt
5	PDS Kerosene	Govt.	5000	7000/KL
6	Free Kerosene	Parallel Marketers	14500	NA

*-Prevailing price (Approx.) in Delhi & Mumbai as on November 2000.

Source: Report of MoPNG Task Force to examine the use of solvent, raffinate and slop in automobile fuel.

4.0 CAUSES OF FUEL ADULTERATION

Financial incentives arising from differential taxes are generally the primary cause of fuel adulteration. In South Asia, gasoline carries a much higher tax than diesel, which in turn is taxed more than kerosene. Industrial solvents and recycled lubricants are other materials with little or no tax. Adulteration of gasoline & diesel is indulged primarily due to the significant price difference between these products and the adulterant. Various estimates have been made of the extent of financial loss to the national exchequer and the oil companies as a result of diversion of PDS kerosene, use of off-spec, low value hydrocarbons mixed with petrol/diesel, evasion of sales tax, etc.

There have been several independent studies conducted by private agency vis-à-vis the quality of petrol and diesel that gets dished out from the outlets to the ultimate consumer. A study by the Tata Consultancy Services concluded that more than 30% of Kerosene distribution intended for household consumption through PDS outlets flowed back to industry in one form or the other.

Most developing country governments have not yet established a monitoring regime and system of fines that can act as a strong deterrent to fuel adulteration. There are number of reasons for this, including poor governance, a lack of political will, lack of public awareness, weak regulatory agencies and a shortage or even

absence of technical staff & equipment for designing and conducting monitoring. Given these limitations, identifying and dealing with this abuse will require addressing problems on multiple fronts.

The primary factors encouraging the practice of adulteration are the following:

- Existence of differential tax levels amongst the base fuels, intermediate products and byproducts. The adulterants being taxed lower than the base fuels give monetary benefits when mixed with replacing a proportion of the base fuels.
- Differential pricing mechanism of fuels and adulterants and easy availability of adulterants in the market.
- Lack of monitoring and consumers awareness.
- Lack of transparency and uncontrolled regulations in the production-supply & marketing chain for intermediates and byproducts of refineries.
- Non-availability of mechanism and instruments for spot-checking the quality of fuels.

5.0 TRANSPORT FUEL TAXES & FUEL PRICING MECHANISM IN INDIA

Tax rates on automotive fuels vary markedly from country to country, ranging from heavy subsidies for all fuels in Nigeria and Iran to high taxes in Europe. Most developing countries tax gasoline – considered consumption good of the rich- more heavily than diesel or kerosene, a consumption good of the poor. Many countries realizing the problems of air pollution and the need for infrastructure developments generate funds by levying higher tax on automobile fuels.

5.1 Objectives of Fuel Taxes

Taxes on transport fuels typically seek to satisfy multiple objectives including the following:

- Raising government revenue for general (non-transport) expenditure purposes.
- Efficiently allocating resources to and within the transport sector.
- Financing road infrastructure and maintenance.
- Reducing encroachments, congestions and environmental externalities of road transport.
- Redistributing income and meeting related expenses.

It is not possible to achieve all these objectives simultaneously through fuel tax policies alone. Most governments complement fuel taxation with other policy instruments – in particular to correct the externalities. In determining the levels and structure of fuel taxation, important compromises have to be made for the effects on government revenue generation, income distribution, the efficient use of roads and environmental pollution. In so doing, the attention must be accorded to the relative importance of each objective.

5.2 Problems of Differential Fuel Taxes

The problem with differential fuel taxation concerns the effects of inter-fuel substitution. The effect of differential taxation on consumption of non-transport fuels further complicates the matter. Imposing very different tax rates on close substitutes, and subsidizing certain fuels used by poor households, invites diversion of low priced fuel to other sectors and creates an incentive for fuel adulteration. For example, the diversion of rationed, low priced kerosene to transport uses (as an adulterant in diesel and gasoline) reduces the amount of kerosene available for the poor, who need it for lightening and cooking. The shortage of kerosene in turn leads to externalities as, the poor are forced to turn to bio-mass a significant source of indoor air pollution and health damage from cooking.

5.3 Fuel Pricing Mechanism in India

India has traditionally operated under an administered pricing mechanism (APM) for petroleum products. This system was based on the retention price concept under which the refineries, oil marketing companies and pipelines were compensated for operating cost and assured return of 12 % post tax on net worth. Under this concept, fixed level of profitability for oil companies was ensured subject to their achieving specified capacity utilization. Upstream companies namely ONGC, OIL and GAIL were also till recently under Retention Price concept and were assured fixed return. The administered pricing policy of petroleum product ensured that products like kerosene, used by the vulnerable sections of the society or product used by the transport sector and the agriculturist may be sold at prices that are insulated from volatility in the international oil market. The Govt. of India, Ministry of Petroleum and Natural Gas in 1995 appointed a Strategic Planning Group for making recommendations to meet the policy objectives and initiatives required for restructuring the oil industry. Based on recommendations of the Group, the Government of India had in November 1997 notified the detail phased out programme of dismantling the APM. The notification provides that the prices of petroleum products, except for PDS kerosene and domestic LPG will be market determined with effect from 1st April 2002. Dismantling of APM is triggering competition among oil refineries, while also providing product with reasonable cost and upgraded quality.

6.0 CONSEQUENCES OF FUEL ADULTERATION

Adulteration of transport fuel, which is currently a very flourishing business in our country, can lead to economic losses, increased emissions and deterioration of performance and parts of engines using the adulterated fuels. Some of the effects of adulteration are outlined below:

- Mal-functioning of the engine, failure of components, safety problems etc. The problem gets further magnified for high performance modern engines.

- Increased tailpipe emissions of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), particulate matter (PM) and can also cause increased emissions of air toxin substances.

- Adulteration of fuel can cause health problems directly in the form of

increased tailpipe emissions of harmful & sometimes carcinogenic pollutants. While indirectly in the form of diversion of PDS kerosene to the diesel sector for adulteration, thus prompting the use of biomass as domestic fuel which in turn leads to health problems of various types due to indoor air pollution. It may be noted that all forms of adulteration are not harmful to public health. Some adulterants increase emission of harmful pollutants significantly, whereas others have little or no effect on air quality.

- Significant loss of tax revenue: - Various estimates have been made of the extent of financial loss to the national exchequer as well as the oil companies as a result of diversion of PDS kerosene, use of off-spec, low value, hydrocarbons mixed with petrol and diesel, evasion of sales tax etc. Although these estimates vary over a wide range, it is safe to assume that the nation is losing at least Rs. 10,000 crores annually as a result of adulteration of fuel.

6.1 Adulteration & Emissions

Fuel adulteration causes marked effect on the tailpipe emissions of vehicles, as adulterants alter the chemistry of the base fuel rendering its quality inferior to the required commensurate fuel quality for the vehicles. This in turn affects the combustion dynamics inside the combustion chamber of vehicles increasing the emissions of harmful pollutants significantly. In some cases effects of adulteration are indirect- for example, large scale diversion of rationed kerosene subsidized for household use to the diesel sector for mixing with diesel not only hamper engine performance of diesel vehicles, but also deprives the poor of kerosene which can otherwise be used for cooking and as a consequence of lack of availability of subsidized kerosene force the poor to continue to use biomass which expose them to high levels of indoor pollution.

In general fuel adulteration can increase the tailpipe emissions of hydrocarbons (HC), carbon monoxide (CO), Oxides of nitrogen (NO_x) and particulate matter (PM). Adulteration of fuels can also cause emissions of air toxins like benzene and polyaromatic hydrocarbons (PAHs) both well-known carcinogens.

6.2 Impacts due to Gasoline Adulteration

Adulterating gasoline with kerosene causes increase in emissions, as kerosene is more difficult to burn than gasoline and this results in higher levels of HC, CO and PM. High sulphur contents of the kerosene can deactivate the catalyst and lower conversion of engine out pollutants. Kerosene addition may also cause fall in octane quality, which can lead to engine knocking. When gasoline is adulterated with diesel fuels, the same effects occurs but usually at lower levels of added diesel fuel. Both diesel and kerosene added to gasoline will increase engine deposit formation.

Gasoline may also be adulterated with gasoline boiling range solvent like toluene, xylene and other aromatics. With the 'judicious" adulteration, the gasoline would not exhibit drivability problems in motor vehicles. Larger amounts of toluene and /or mixed with xylene cause some increase in HC, CO, NO_x emissions, and significant increase in the level of air toxins –especially

benzene – in the tailpipe exhaust. The adulterated gasoline itself could have increased potential human toxicity if frequent skin contact is allowed.

Extremely high levels of toluene (45 % or higher) could cause premature failure of neoprene, styrene butadiene rubber and butyl rubber components in the fuel system. This has caused vehicle fires in some cases, especially in older vehicles.

Adulteration of gasoline by waste industrial solvents is especially problematic as the adulterants are so varied in composition. They will cause increased emissions, may even cause vehicle breakdown. Even low levels of these adulterants can be injurious and costly to vehicle operation.

For gasoline, any adulterant that changes its volatility can effect drivability. High volatility (resulting from addition of light hydrocarbons) in hot weathers can cause vapour lock and stalling. Low volatility in cold weather can cause starting problems and poor warm-up.

6.3 Impacts due to Diesel Adulteration

The blending of kerosene with automotive diesel is generally practiced by oil industry worldwide as a means of adjusting the low temperature operability of the fuel. This practice is not harmful or detrimental to tailpipe emissions, provided the resulting fuel continues to meet engine manufacturer's specifications (especially for viscosity and cetane number). However, high-level adulteration of low sulphur diesel fuel with higher –level sulphur kerosene can cause the fuel to exceed the sulphur maximum. The addition of heavier fuel oils to diesel is usually easy to detect because the resultant fuel will be darker than normal. Depending on the nature of these heavier fuel oils and the possible presence of additional PAHs, there could be some increase in both exhaust PM and PAH emissions.

7.0 STATUS OF FUEL ADULTERATION IN INDIA

As mentioned earlier adulteration of transport fuels at the point of sale and transportation has become a routine problem in India. There are several petroleum products available in our country, which are close substitute of gasoline and diesel, but are available at considerable lower prices. The price differential is usually in the range of Rs. 8 to 20 in case of petrol and Rs. 5 to 12 in case of diesel. Since kerosene is usually considered as poor man's fuel, Govt. of India has been subsidizing it for public distribution for several years. The subsidy on PDS kerosene during 2000-01 is estimated to be around Rs. 7500 crores. It is common knowledge that significant portion of this subsidized kerosene is being diverted for adulterating diesel. Several studies /survey carried out recently have together pointed out towards alarming rise in the cases of fuel adulteration in our country and some of them are as below:

- Tata Consultancy has conducted an extensive survey on the kerosene distribution pattern within the country. They arrived at the conclusion that more than 30% of Kerosene distribution intended for household consumption through PDS outlets flowed back to industry in one form or the other. This was a clear indication towards the

flourishing business of adulteration in our country.

- According to Anti Adulteration Cell of India, Naphtha is a commonly used adulterant for gasoline. The modus operandi is to import the product in huge quantity and divert it for adulteration. In a major seizure a few days ago, the Cell detected import of naphtha through the Mangalore port allegedly for adulteration of auto fuels in Kerala, Andhra Pradesh, Karnataka, West Bengal and Madhya Pradesh. The intention was to import and move the products to a factory in Pondicherry, where it got blended with other adulterant chemicals. Following the investigation, the Cell sealed 82 kL of naphtha, 31 kL of other products along with plant and machinery allegedly used for adulteration.

- Similarly a case of adulteration has also been reported from Uttar Pradesh in the city of Meerut, where an authorized transport company was caught with adulterated stock. This transport agency had the authority to transport both petrol & diesel to retail outlets and solvents for industrial use. The agency was supposedly using its workplace for adulterating diesel with kerosene.

- According to a news in "The Times of India", the State Government of Maharastra loses a whopping Rs. 81 lakh and Rs. 75.6 lakh every month on account of combined sales & excise tax revenue against petrol and diesel adulteration in Mumbai city alone. This is believed to be 10 percent of the genuine sale, industry source reveal.

- Various estimates have been made of the extent of financial loss to the national exchequer as well as the oil companies as a result of diversion of PDS kerosene, use of off-spec, low value, hydrocarbons mixed with petrol and diesel, evasion of sales tax etc. Although these estimates vary over a wide range, it is safe to assume that the nation is losing at least Rs. 10,000 crores annually as a result of adulteration of fuel. If to this is added the social costs as a result of environmental pollution, damage to vehicles and other engines, etc., the loss could be substantially higher.

- With the plethora of foreign car manufacturers making a beeline to set up manufacturing facilities in the country, their first and immediate concern is the quality of petrol that gets supplied to the users' cars. They have uniformly found that supplies are heavily adulterated and particularly the Octane content is much lower than the specification value of 87%.

- Recently under the direction of the Supreme Court, Environment Pollution Control Authority (E PCA) through a local NGO (CSE) carried out tests of fuel samples from retails outlets and other points. The results of the study reveal 8.3 % sample failure of the sample tested against 1-2 percent reported by oil companies in the past. The study further reveals that adulterated fuel in intelligent mix allowed retail outlets to reap a profit of more than Rs 25, 000 a day.

8.0 APPROACH FOR ADULTERATION DETECTION

A number of analytical techniques are available to detect adulteration. In all cases described below, it is important to have good sampling technique and access to a good petroleum analytical laboratory. For the majority of the tests, accurate data and analysis of original or uncontaminated fuel are also pre-requisite. Some of the approaches for detecting adulteration are outlined below:

(i) Full specification tests of the standards:

This may be quite time consuming and many parameters may be well within the requirements even if the fuel is adulterated. In fact fuel standards or specifications are framed to ensure that the fuel corresponds to certain level of quality commensurate to technology requirements of the vehicles. Parameters in the fuel standards may not necessarily stand as checkpoint for any sort of fuel adulteration.

(ii) Testing selected parameters:

This asks for testing some critical parameters, which are likely to be affected or altered by adulteration and adversely affect engine performance and emissions and can be evaluated. Lists of such parameters are given below in Table 3 &4. In general, many of the selected parameters may already be included in the full specification standards. However, dosage of multifunctional additive and cetane improver are intended for following the adulterants by dilution. However, convenient methodology for determination at refinery and outlet levels are yet to be lined up in the country.

Table-3: Selected Parameters for Gasoline Testing

1. Density
2. Distillation
3. Hydrocarbon Composition
   - Aromatic, Vol%
   - Olefins, Vol%
   - Benzene, Vol%
   - Sulphur, ppm
4. Stability
   - Existing gum
   - Potential gum
5. Octane Number
   - Research
   - Motor
6. 6. Multifunctional additives-dosage

Table-4: Selected Parameters for Diesel Testing

1. Flash Point
2. Density
3. Distillation
4. Sulphur
5. Polycyclic aromatics (+2 rings)
6. Total sediment
7. Cetane number
8. Cetane index
9. Multifunctional additives-dosage
10. Cetaneimprover-presence,

dosage: For diesel fuel without cetane improver, cetane index can be utilized. If dosage can be determined, it may be used for detection of adulteration based on depletion from original dosage.

(iii) Testing methods:

There can be several alternate approaches, some prominent approaches are:

- Use of conventional manual petroleum testing methods.

- Utilization of automated instruments for conventional petroleum testing. For example- gas chromatographic method is used for simulated distillation. A number of instrumental analysis methods have been developed for establishment of parameters of fuels.

(iv) Emerging instruments for fuel surveillance:

Several new instruments are available which claimed to carry out instrumental analysis for the estimation of key parameters of transport fuel. For example the following may be noted.

(a) Accurate and comprehensive fuel analyzer. The portable FO_xFTIR fuel analyzer is claimed to be ideal for the analysis of commercial fuels.

(b) ZeltexZX101CC Portable Octane analyzer.

(v) Use of marker:

Various markers can be used to identify adulteration, such as kerosene in gasoline. Earlier kerosene was used as major adulterant for adulteration in gasoline and diesel fuel. For detection of adulteration of fuels with kerosene a blue dye and furfural were used. However, where visible dyes have been applied in South Asia, they have not been effective. It is believed that presently the range of adulterants has widened. Various chemical/biochemical markers are available in market e.g. Spectrace marker by Mortan international, petro markers by M/S GFI, Biocode markers by M/S Biocode ltd., etc. The marker is added in trace level with the fuel and whenever the product is to be tested, the marked chemical is detected and measured by specific instruments/ immunoassay. This detection test can also be easily carried out in field with equal accuracy as laboratory tests.

Properties of Markers

- They should be miscible with fuels
- Detectable by simple test procedures
- Difficult to remove from marked fuels
- Non-reactive with other fuel additives
- No interaction with material of construction and fuel impurities; and Should be cost effective

Limitations of Marker System

- Relatively a high cost option
- Difficult to maintain a constant dosage at low concentration
- May be leached out by water in the product tanks
- May interact with materials and fuel impurities

8.1 Key Issues Related to Adulteration Detection

There are several issues related to detection of fuel adulteration. A very sound system of fuel quality monitoring and surveillance is a pre-requisite to launch an adulteration detection programme. Institutions involved in the programme should have access to state of the art fuel testing laboratories and sample storage and handling facilities. Some of the key issues are described below:

1. Monitoring the quality and frequency:

To check adulteration a system of monitoring is suggested whereby fuel

samples will be collected from atleast 10 % of the fuel dispensing stations in a week. In this way all fuel stations will be covered in a period of three months. At one time three samples will be collected and sealed jointly by collecting and dispensing station.

2. Agency for collection of samples and co-ordination:

Since consumer interest is the prime objective of the quality surveillance program, consumer representatives groups should be involved in the process. The following organizations should be explored to take up the sample collection and surveillance activity.

(a) Society of Automobile Manufacturers (SIAM)
(b) Consumer forum
(c) NGOs interested in the field
(d) Representative from the local Transport Authority
(e) Civil Supplies Department
(f) Bureau of Standards; and
(g) Pollution Control Boards/Agencies

Moreover any quality conscious consumer may collect and get the fuel samples tested for quality assurance as and when he desires.

3. Testing laboratories:

In different cities the following possibilities should be explored

- Independent Government funded test laboratory to be managed under a society.
- Government test laboratory
- Private existing laboratory to be reinforced.
- Private new laboratory
- New laboratory to be set up in academic institute premises for the purpose.

There should be system of accreditation, periodic checking of quality for analysis by round –robin test and also withdrawing accreditation in case of consistent out-off-line performance in round –robin tests.

4. Sample collection, handling and storage:

The different aspects of sample collection, handling and storage including type of sample collector, need for inert gas blanketing etc. may be investigated and prescribed in a standard to improve the reliability of the monitoring process.

5. Product data sheet:

To facilitate subsequent analysis it is suggested that a product is also accompanied by a data sheet of analysis as it leaves the refinery or marketing installation in particular the item of short test based on tests on the dispatched product.

6. Handling failure samples:

In case of first failure, after identifying the source of contamination the controlling officer of the oil companies will take appropriate action for the group responsible for adulteration. The penalized person will have the possibility to appeal to the supervisor of the controlling officer in first case. The supervisor may review the case and dispose off the appeal keeping the samples collecting authority informed. Similarly an appealing point is to be conceived for repeated failure cases. However, the present practice of

penalizing the dealer and Oil Company being the judge is not yielding the desired results. Other practices include the practice in line with that of Australia, wherever the outlet belongs to a company, the quality aspects of that outlet is the sole responsibility of the parent oil company supplying the product and in case of any failure the company is penalized.

7. Disposal of spent sample:

If it is a pass sample it can be sent back to the pump through the Oil Company. The failed sample will be collected and returned to oil companies.

8. Funding the cost of fuel quality surveillance:

Charging a small tax either at the dispensing outlet or at the refinery outlet can cover the cost of fuel quality surveillance.

9. Annual market product quality survey:

Analogous to Octel, Ethyl and Parammins worldwide survey of fuel qualities transport fuel quality survey for summer and winter periods, covering at least 50 samples collected all over the country should be carried out.

9.0 SOME IMPORTANT MEASURES TO CONTROL FUEL ADULTERATION

Some important measures to control fuel adulteration are listed below:

- An important step in tackling fuel adulteration is reducing incentives and opportunities for adulteration. Though it is generally recognized that eliminating pricing differential is the most effective method of controlling adulteration, it will be difficult to eliminate differences among such a wide variety of fuels and solvents meant for different usages.

- Checking adulteration requires a credible monitoring and surveillance system. To ensure that the engine can give the desired performance including low emissions, it is necessary to ensure the fuel quality at the consumer end, which can be achieved by appropriate surveillance programs.

- Any anti-adulteration programme should be backed up by sound financial and legal framework. The fiscal framework should take into account-associated costs like monitoring & testing infrastructure. Policy for imposing severe penalty & exemplary punishment to the adulterators needs to be imbibed into legal framework to discourage adulteration.

- The manner in which retail fuels are distributed has an important bearing on fuel adulteration. For example, having large numbers of small, independent transport trucks operators moving fuels from terminals to the point of sale creates an environment conducive to adulteration. One effective “market based” approach is the practice in many industrialized countries whereby oil companies market at retail and assume responsibility throughout the supply chain to guarantee fuel quality in order to protect their public image and market share.

- One of the acceptable internationally accepted method for detecting and thereby preventing adulteration of fuels is the use of markers. A number of chemical and biochemical markers are available in the international market. Some of them are dyes, one of which is already being used in India to mark SKO (Superior Kerosene Oil) used for PDS (Public Distribution System).

- The Standard fuel test method being used today when properly executed should be able to give acceptable results. Precision and repeatability could be improved by setting up programmes for cross checking inter-laboratory variability.

- In Industrial countries, practices of adulteration are expected to be less or rare today; in part because public pressure has led most oil companies to take public image seriously and socially responsible behavior is considered as integral part of good business. Thus a culture of "Good Business" needs to be developed within the concerned industry to eradicate adulteration via awareness raising by Government organizations, NGOs, and citizens groups; independent checks by universities and research institutes to "name & shame" those who are not in compliance; efforts by trade associations to identify those retailers that comply in order to "upgrade" the market; international pressure on large oil companies operating in developing countries; and greater effort by governments to monitor and enforce regulations.

- Use of alternative fuels which are less prone to adulteration, can play a positive role in minimizing adulteration. Thus, promoting use of cleaner fuels like CNG, LPG etc can prove effective in dealing with adulteration.

- Taking & maintaining samples for checking fuel quality is not easy. Finding proper sample containers and not being personally harassed at retail outlets while sampling are just two of the very real operational problems to be resolved.

10.0 INTERNATIONAL EXPERIENCE IN DEALING WITH ADULTERATION

❖ Europe

In Europe currently National Standards Bodies such as British Standard Institute (BSI) carries out fuel quality checks. The failure cases lead to the penalties of filling station owner and fuel Supply Company. Belgium has been active on Fuel quality checks for last 3 yrs. Initially, 30 % fuel samples failed. Recently the situation has improved with the threat that the offending companies would be named & heavily fined. For checking fuel adulteration, a unified system of transport fuel quality monitoring system is being developed for implementation in EU.

❖ United Kingdoms (UK)

In U.K, the following procedures are used by companies to comply with government quality guidelines and to avoid fraud in the handling and marketing of the petroleum products:

Audit checks are carried out by Customs Authorities. Samples of products are collected from retail outlets and analyzed for conformity with British standards for gasoline and diesel fuels.

The results are shared with the product suppliers. Any reasons for the

requirement are investigated and necessary remedial actions are taken. In parallel with Government audits, responsible petroleum companies do product quality checks from the point of manufacture to the point of sale.

❖ **United States of America (USA)**

In USA there are two systems. USEPA carries out tests on spot basis. During the complete lead phase out much vigil was kept and heavy fines were imposed for adulterated unleaded gasoline with leaded gasoline. The automobile manufacturers association conducts regular survey to assure proper fuel quality for the required performance of the vehicles.

❖ **Australia**

The Commonwealth Government has passed legislation to ensure Australian consumers receives high quality petrol & diesel. ***The Fuel Quality Standards Act 2000 and Fuel Quality standards regulations 2001*** provided the framework for enforcing national fuel quality standards. It regulates the supply of fuel to consumers, reduce toxic emissions and ensure that, by using clean fuels, modern vehicles fitted with advanced emission control technologies operate at peak performance. Commonwealth inspectors appointed under the Act will monitor compliance with fuel quality, legislation and assist with enforcement supplier or producer found guilty of supplying " off-spec" fuel may face penalties of upto $ 550,000.

❖ **Kenya**

Since June 1999, the Government of Kenya has been adding a Biocode marker to fuel as a trace, to designate fuel for local consumption (taxed) or for export (untaxed). The aim is to prevent fuel adulteration and preventing fuel traders from selling fuels designed for export on the domestic market as a way to avoid taxes. The system is said to have reduced adulteration and illicit trade, recovering US$30 million in taxes for government and US$ 50 million in sales for oil companies

❖ **Russian federation**

To give retail outlets an incentive to maintain high standards, the Moscow Fuel Association has started awarding blue quality sign to those meeting its quality standards. The retailer applying to the association signs a code of honor binding them to sell fuel meeting the standards. Any caught violating the standards are denied the quality sign.

❖ **Pakistan**

Shell, an oil company in Pakistan has upgraded about 200 new retail outlets. In addition to widespread fuel adulteration and short weighing, its marketing strategy is to compete on the basis of superior quality and service quality. To demonstrate its commitment to product quality, Shell has been dispatching chemists to its retail outlets where they test samples publicly.

10.0 INDIAN INITIATIVES TO CONTROL FUEL ADULTERATION

It is necessary to dispense auto fuels of the right quality to achieve the targeted emissions from vehicles. Therefore, adulteration of auto fuels should be discouraged in all its forms. Off late India has also taken some initiatives to tackle this problem. As per the Ministry of Petroleum & Natural Gas (MoPNG) following Steps have been undertaken to control Adulteration of Fuel in the country:

(a) The Ministry of Petroleum & Natural Gas has caused oil companies takes

various steps listed below to detect/ prevent adulteration of MS/HSD at retail outlets: -

- Filter paper Test,
- Furfural doping of PDS Kerosene,
- Density checks,
- Blue dyeing of kerosene,
- Regular/surprise Inspection of retail outlets,
- Joint inspection of retail outlets by the industry teams,
- Regular /surprise inspection by mobile laboratories,
- Special vigilance drives, etc.

(b) Further, in order to prevent diversion of kerosene meant for distribution under PDS for adulteration, MoPNG has directed the oil companies to ensure upliftment by the wholesalers as under:

- 60% by 10th of the month
- 25% during next week, and
- Balance 15% during the following week.

(c.) MoPNG has also advised State/UT Government from time to time

- To ensure upliftment of kerosene by the whole-sellers from oil companies as per upliftment pattern mentioned above.
- To identify loopholes in the distribution system.
- To review scale of distribution of kerosene to various cardholders, with regard to factors as availability of alternative fuels.
- To discontinue allocation of kerosene to the cardholders having double LPG connection and to discontinue allocation of kerosene for uses other than cooking and illumination.

(d) MS/HSD control order has been amended for providing testing of MS/HSD for various parameters of specification apart from density like Octane No. of MS, Cetane No. of HSD, and any other parameter of MS/HSD specification indicated in the order.

(e) The state Govt. authorities are empowered under the MS/HSD control order to conduct inspections at the retail outlets and take appropriate action against the erring dealers in case of any mal-practices/irregularities detected.

(f) MoPNG has also amended the kerosene control order making it mandatory for the parallel marketers to file end use certificate from their industrial customers.

(g) An independent fuel-testing laboratory has been set up at Noida as directed by Hon'ble Supreme court and as desired by EPCA for testing of samples drawn from retail outlets in the NCT/NCR.

(h) MoPNG have issued two control orders namely (i) the solvent, Raffinate and Slop (acquisition, sale, storage and prevention of use in automobile) order, 2000 in order to prevent unauthorized usage of these products for adulteration of MS/HSD at retail outlets.

(I) In addition to above, following measures are at advanced stage of implementation to prevent adulteration of MS/HSD: -

- Oil companies are undertaking trial of various marker systems to detect/prevent adulteration of MS/HSD.

- Oil companies are examining the feasibility of replacing the existing sealing system for the tanks carrying MS/HSD with Assa Abloy Security locking system in order to prevent en-route adulteration f MS/HSD by transportation /Tank truck crew.

- MoPNG has directed the oil companies to increase the number of mobile laboratories.

- Oil companies are setting up a number of laboratories equipped with facilities like CFR engines to test octane /cetane number of MS/HSD sample etc all over the country.

(j) Following methods are practiced for checking kerosene adulteration in MS:

- Filter paper test
- ASTM Distillation

However, both these methods are qualitative in nature and detection of low level of adulteration with SKO is not possible. For this IOCL (R&D) has done substantial work and based on the findings, addition of 20-ppm furfural was recommended.

(k) A method using GC as a powerful laboratory –based tool for detecting hydrocarbon-based adulteration was suggested. In this original GC Finger prints (chromatogram) on as many potential base fuels (pure fuels) such as automotive gasoline, diesel fuels and kerosene were essential .The approach was to generate chromatogram of the fuels procured from the market and than to compare the same against the chromatogram of the so called pure fuel for the hydrocarbons like hexane, heptane, etc. Any deviation in the concentration of hexane, heptane, etc in the fuel amounted to adulteration. However this method of detection of adulteration was later declared to be erroneous, arbitrary and irrelevant as it is claimed that there is nothing like pure gasoline, kerosene and diesel. Typically any of these fuels can be blended with different hydrocarbon streams of refinery meeting the product specifications characteristics as per relevant Indian and International norms.

10.1 Committees & Task Forces Constituted in India for Checking Fuel Adulteration

BIS Study Group on Adulteration
Bureau of Indian Standards (BIS) has constituted a task force to look into various aspects of fuel adulteration. The terms of reference of the study include reviewing current methods for testing of petroleum products, identifying strengths and limitations of currently used methods, reviewing of intermediate testing protocols and identification and validation of possible test methods.

Biocode marker system: Upon successful demonstration of above technique, field trails were conducted at Sabarmati Terminal., Ahemdabad. However, the marker did not meet the requirements due to inconsistency in doping and tedious process of testing the samples.

Spectrace Technique: M/s Rohm & HAAS have developed a new NDT for checking fuel adulteration. Based on successful demonstration, the same has been recommended for field trial at HPCL terminal at Vashi. The result of this trial reveals that chemical characteristics of the doped MS are in line with the BIS specifications and the marker responds to addition of adulterants in different proportions. The marker was also found to be stable.

More trials with this technique are scheduled to be carried out in Delhi.

R&D marker system: IOCL R&D has developed a chemical based marker system, which is to be field tried at Devenghunti terminal of IOC near Bangalore.
Study group of the Task force evaluated various type of marker system . Evaluation was done jointly by IOC R& D and BPCL R&D at IOC, R&D centre. Details of the evaluation are mentioned in **Annexure-V**

CPCB Working Group on Adulteration
Central Pollution control Board has constituted a Working Group to formulate fuel specifications for the year 2005 under the Inter- Ministerial Committee to formulate Auto Oil Programme for year 2005 constituted by MOEF. One of the terms of reference was to draw a strategy for monitoring the fuel quality at the petrol pumps to check adulteration.

MoPNG Task Force on Adulteration
Ministry of Petroleum & Natural Gas has constituted a Task Force to examine the use of solvent, raffinate and slop in automobile fuel. The Task Force identified various possible fuel adulterants for gasoline and diesel (Table-3&4). The recommendations of this Task Force are:

- The chemicals/solvents, which are potential adulterants, are presently cheaper than gasoline and diesel. The prices of these solvents should be brought at par with conventional fuels to discourage adulteration.

- If prices cannot be increased for any reason, then the solvents should be included under the Solvent, Raffinate and Slop (Acquisition, Sale, Storage and Prevention of use in Automobile) Order, 2000. Any petroleum derivatives having a density 0.66 to 0.94 g/ml at 15 degrees centigrade and /or boiling range 35 to 380 degrees centigrade may be covered under the subject control order. The samples from the suspected stocks would be tested in any authorized laboratories for full BIS specifications compliance.

- The Task Force felt that return streams from petrochemical plants to the refineries may be getting diverted for adulteration, as such all return streams from petrochemicals after removal of necessary ingredient should be returned to the nearest refinery and the onus of return will be with the users only. Moreover, no slop is to be allowed to be market directly.

Anti-Adulteration Cell
Government of India has set up an Anti Adulteration Cell headed by a Director General. The functions of the Anti Adulteration Cell are: -

1. Prevention of adulteration and other malpractices in the sale of petroleum products.

2. To conduct inquiries into complaints against Dealer Selection Boards.

3. To act as a coordinating agency for oil companies and Central/State Governments departments in the matters related to adulteration of fuel.

For any complain /information regarding fuel adulteration customers can contact to anti- adulteration cell at numbers given in the following table:

Table 5: Contact numbers & E- mail addresses of four zones of anti-adulteration cell for launching complain against adulteration.

Designation	Telephone (Office)	Telephone (Residence)	Fax	E-mail
Director General	26104611	26111280	26104632	dg@antiadulterationcell.com
Jt. Director (HQ)	26104502			
Dy Director (A & F)	26713590			
North region (STD code-011)				
Regional Director	26104711		26714268	rdn@antiadulterationcell.com
Jt. Director	26104428			
Sr. Dy. Director	26104703			
Dy. Director	26104703			
Dy. Director	26104428			
West region (STD code-022)				
Regional Director	26540371	26504376	26540372	rdw@antiadulterationcell.com
Dy. Director				
South region (STD code-044)				
Regional Director	28207531	24363121	28254003	rds@antiadulterationcell.com
Jt. Director	28253808			
Dy. Director	28253808			
Dy. Director	28253808			
East region (STD code-033)				
Regional Director	22204532		22211441	rde@antiadulterationcell.com
Dy. Director	22204532			
Asstt. Director	22204532			

Auto Fuel Policy Report

A Committee of Experts was constituted by the Government of India to lay down the road map for auto fuel policy in the country. Besides other issues, the Committee also recognized the problems of fuel adulteration and recommended the following:

- Expansion of the tank lorry locking system introduced in metro cities to other cities.
- Depending on the results of the pilot projects for the use of special markers to detect and prevent adulteration in petrol and diesel, a scheme for the use of these markers on commercial basis be implemented.

- ❖ Encouraging setting up of consumer pumps by the transport companies operating city public transport.
- ❖ Independent inspection and checks by agencies other than the oil companies.
- ❖ Setting up of an independent anti-adulteration cell and the joint inspection approach put in place in the NCT of Delhi under the directions of the Supreme Court has brought about improvements in fuel quality. Inspections by joint teams of anti-adulteration cell state civil supplies and State Pollution Control Boards in polluted cities should be taken up.
- ❖ Responsibility for dispensing the right quality of fuels should be made obligatory to the oil companies.

11.0 CONSUMERS FRONT: ANTI-ADULTERATION TIPS

Consumers are the sufferers of this malpractice. Any quality conscious consumer has the right to be assured of the quality of the products and if he desires he can get his sample checked for adulteration. Some easy and important checks can be conducted at the retail outlet for MS/HSD: -

Filter Paper Test: For MS. First the mouth of nozzle is cleaned to remove stains. Then, a drop of petrol is put on the filter paper from the nozzle. The petrol dropped on the filter paper is allowed to evaporate for 2 minutes. The petrol should evaporate without leaving any stain on the filter paper. If the colour left on the paper is pinkish, it is the colour of MS and not a stain. Dealers are expected to provide filter paper to customers on demand.

Density test: This is a very simple test for both MS and HSD. This test takes approximately 5 to 10 minutes. Product is taken in a glass jar and then a Hydrometer (separate Hydrometers for MS and HSD) available with the dealer is immersed in the product. A Thermometer is also immersed into the product jar simultaneously without touching the walls of the jar. The readings of Thermometer and Hydrometer are taken. Then, with the help of a conversion chart, the density is converted to 15^0C and this is compared with the recorded density/reference density, which can be seen from the density register maintained by the dealer. If the variation between the observed density and recorded/ reference density is within $\pm$ 0.0030, then the product density can be considered to be correct. If the difference is more than $\pm$ 0.0030, then it indicates possibility of adulteration.

Water contamination checks: For both MS and HSD can be done with the help of a dip rod and water finding paste, available with the dealer.

In case of lubricants: the customer must check the seal of container, date of manufacture and name of the manufacturer. For convenience of 2/3 wheelers, Retail Outlets provide 2-T dispensers/2-T mix dispensing units and also keep tamper proof 2-T pouches.

12.0 RECOMMENDATIONS

Bringing down the price differential between adulterants and base fuel products appears to be an effective step in discouraging this practice, but it may not be possible to increase the prices of products like kerosene, etc which caters to poor people. There exist various technical measures are available to tackle this problem but those measures give benefit only when backed up by very good system of monitoring and

surveillance. Moreover, petroleum products being complex hydrocarbon mixtures with batch-to-batch variations, certain inevitable mixing between different batches in transit and in storage, availability of wide variety of adulterants, the detection methods may not be easy. Nevertheless conscious & systematic efforts can reduce adulteration to a great extent. Some of the possible measures are enlisted as follows

- Responsibility: The oil companies should be legally responsible for the failure of any product fully meeting the required specifications or detection of any admixture of low duty product, byproducts or waste products in the outlet of the company carrying the banner of the company. Any fault by the transporter or the dealer will be still within the jurisdiction of the Oil Company.

- Oil Company's role: Responsibility for dispensing the right quality of fuels should be made obligatory to oil companies. Being in their jurisdiction, the oil companies should be required to closely examine the transport and retailer facilities and conduct appropriate checks to control and prevent adulteration.

- By-product Outlet: Refiners and Petrochemical complexes should not be allowed to sell any byproduct or intermediate product to the market but only to a refinery for further processing into specification products. Products like slack wax, tank sludge should also be considered for refinery processing.

- By-product Disposal Follow-up: If any byproducts are sold out or the final disposal of byproducts from chemical processing, solvent preparation, solvent regeneration units, etc. need to be transparent and the disposal and ultimate usage pattern need to be verified at regular intervals.

- Passport for Transport Fuel Batches: Transport fuels should have passport containing principal characteristics, which the batch will carry till the retail outlets. This will help in identification of adulterants at the outlets. Appropriate analytical methods for this need to be established. Moreover, there should be expansion of the tank lorry locking system introduced in metros to other cities.

- Legal Framework: There is further need to develop legally binding and legally enforceable penalty system. Penalty system should be severe and imposed upstream. In case of an abuse in fuel market the penalty should be imposed on all concerned along the supply chain-the company, transporters and dealers and the actions taken should be exemplary to discourage adulteration practice.

- Sample Collection & Analysis: A legally acceptable system of sample collection and analysis in accredited laboratories of selected parameters and full specification testing needs to be worked out and implemented.

- Independent Sample Testing: Setting up of an independent anti-adulteration cell and the joint inspection approach put in place in NCT of Delhi under the directions of the Supreme Court brought about improvement in fuel quality. Inspections by joint teams of anti-adulteration cell, state civil supplies

and state pollution control boards officials in polluted cities should be taken up.

- Surprise Checking: Rigorous surprise checking of samples from pumps should be carried out independently and in case of non-compliance; the responsible oil company may be named and highlighted in medias. This will compel the oil companies to protect their brand image and ultimately mount pressure on the oil companies to be effectively vigilant about the quality of fuels sold in their retail outlets.

- Compliance Certification/Awards: A system of monitoring and award for the fuel stations may be initiated in the cities. Bodies like Central Pollution Control Board can undertake monitoring of samples from various outlets and award compliance certificate to the stations. Upon non-compliance of samples the respective fuel station may be stripped off its compliance certificate. This when practiced would motivate the petrol pump owners for good & quality conscious business.

- Markers: Special marker systems are now available in International Markets and some pilot projects on markers are also going on in India. These markers may be adopted for detecting adulteration.

- Research & Development: R&D organization should be directed to conduct studies to assess the impact of adulteration on quantum & toxicity of emissions and results of such studies can be useful in creating public awareness.

- Good Business Practices: Voluntary initiatives of the oil companies like ' Pure for Sure" as initiated by BPCL needs to be encouraged by the Government.

- Awareness: Consumer organizations at city/town level with necessary support of concerned authorities can serve as watchdog to check adulteration.

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Annexure-I

BIS petrol specifications (IS 2796: 2000)

S. No.	Characteristics	Unit	Requirements	
			Unleaded regular	Unleaded premium
1.	Colour, Visual		Orange	Red
2.	Density @15°C	Kg/m^3	710-770	710-770
3.	Distillation:			
	(a) Recovery up to 70°C (E70)	% Volume	10-45	10-45
	(b) Recovery up to 100°C (E100)	% Volume	40-70	40-70
	(c) Recovery up to 180°C, (E180), min	% Volume	90	90
	(d) Final Boiling Point (FBP), max	°C	215	215
	(e) Residue, max	% Volume	2	2
4.	Research Octane Number (RON), min		88	93
5.	Anti-Knock Index (AKI), min		84	88
6.	Existent gum, max	g/m^3	40	40
7.	Potential gum, max	g/m^3	50	50
8.	Sulphur, total, max	% mass		
	(a) For Notified areas		0.05	0.05
	(b) For the rest		0.10	0.10
9.	Lead content (as Pb), max	g/l	0.013	0.013
10.	Reid Vapour Pressure (RVP), max	KPa	35-60	35-60
11.	Vapour Lock Index (VLI = 10 RVP+7E70)			
	(a) Summer, max		750	750
	(b) Other months, max		950	950
12.	Benzene content, % vol. max			
	(a) For notified areas		1.0	1.0
	(b) For metros		3.0	3.0
	(c) For the rest		5.0	5.0
13.	Copper strip corrosion for 3 hrs @50°C, max	rating	Not more than No. 1	Not more than No. 1
14.	Water tolerance of gasoline-alcohol blends, temp. for phase separation, °C max.			
	(a) Summer, max	°C	10	10
	(b) Winter, max	°C	0	0
15.	Engine intake system cleanliness	MFA used	To report	To report

Source: Bureau of Indian Standards (BIS)

Annexure II

BIS diesel specifications (IS 1460: 2000)

S. No.	Characteristics	Unit	Requirements
1.	Acidity, inorganic		Nil
2.	Acidity, total, mg of KOH/g, max	mg of KOH/g	0.2
3.	Ash, max	% mass	0.01
4.	Carbon residue (Ramsbottom) on 10% residue, max	% mass	0.3 Without additives
5.	Cetane number (CN), min OR Cetane index (CI), min		48 46
6.	Pour Point, max as per OCC Directive		
	(a) Winter (Nov-Feb), max	°C	3
	(b) Summer, max	°C	15
7.	Copper strip corrosion for 3 hrs @100°C, max		Not worse than No. 1
8.	Distillation:		
	(a) at 350°C, min recover	% volume	85
	(b) at 370°C, min recover	% volume	95
9.	Flash point		
	(a) Abel, min	°C	35
10.	Kinetic Viscosity @40°C	cst	2.0-5.0
11.	Sediment, max	% mass	0.05
12.	Density @15°C	kg/m^3	820-860
13.	Total Sulphur, max		
	(a) For notified areas	% mass	0.25
	(b) For the rest	% mass	0.25
14.	Water content, max	% volume	0.05
15.	Cold filter plugging point (CFPP)		
	(a) Winter (Nov-Feb), max	°C	6
	(b) Summer, max	°C	18
16.	Total sediments, max	mg/100ml	1.6

Source: Bureau of Indian Standards (BIS)

Annexure-III

Table : Indian petrol specifications required to meet *Bharat Stage II* emission norms

	Characteristics	Unit	Requirements	
			Unleaded Regular	**Unleaded Premium**
1	Colour, visual		Orange	Red
2.	Density @ 15 C,	kg/m3	710-770	710-770
3.	Distillation			
	a) Recovery up to 70 ^{0}C (E 70)	% volume	10-45	10-45
	b) Recovery up to 100 ^{0} C (E 100)	% volume	40-70	40-70
	c) Recovery up to 180 ^{0} C (E 180), min.	% volume	90	90
	d) Final Boiling Point (FBP), max ^{0}	C	215	215
	e) Residue, max.% volume		2	2
4	Research Octane Number (RON), min		88	93
5	Anti-Knock Index (AKI), min		84	88
6.	Existent Gum, max	g/m 3	40	40
7.	Potential Gum, max	g/m 3	50	50
8.	Sulphur, total, max.	% mass	0.05	0.05
9.	Lead content (as Pb), max.	g/l	0.013	0.013
10	Reid Vapour Pressure (RVP), max.	kPa	35-60	35-60
11	Vapour Lock Index (VLI= 10RVP+7E70)			
	a) Summer, max		750	750
	b) Other months, max		950	950
12	Benzene Content, max	% volume		
	a) For the Metros		3.0	3.0
	b) For the rest		5.0	5.0
13	Copper strip corrosion for 3 hrs @ 50 0 C, max	rating	Not more than No.1	Not more than No.1
14	Water tolerance of Gasoline-alcohol blends, temp. for phase separation			
	a) Summer, max 0	^{o} C	10	10
	b) b) Winter, max	^{o} C	0	0
15	Engine intake system cleanliness	MFA used	To report	To report

Note **:**

1. Indian standard specification for petrol namely IS 2796 : 2000 shall be applicable for test methods and all other provisions / details
2. Benzene content in petrol shall be reduced from the existing limit of 3 per cent max. for the 4 metros (Delhi, Mumbai, Kolkata & Chennai) and 5 per cent max. in the rest of the country independent of implementation of *Bharat Stage II* vehicular emission norms. The Benzene content shall be reduced progressively to 1 per cent max. in the mega cities (NCT/ NCR, Greater Mumbai, Kolkata, Chennai, Bangalore, Hyderabad & Ahmedabad) by April 2005.For the rest of the country, the maximum limit of Benzene content shall be 3 per cent from April 2005.
3. These standards specifications have been finalised by the Expert Committee after discussions with the automobile and oil industry.

Annexure-IV

Table : Indian diesel specifications required to meet *Bharat Stage II* emission norms

Sl.No	Characteristics	Unit	Requirement
1.	Acidity, inorganic		Nil
2.	Acidity, total, mg of KOH/g, max	mg of KOH/g	0.2
3.	Ash. max	% mass	0.01
4.	Carbonresidue (Ramsbottom) on 10 % residue , max	% mass	0.3 without additives
5.	Cetane number (CN), min Or Cetane index (CI), min		48* 46*
6.	Pour point, max, as per OCC Directives a) Winter (Nov-Feb), max b) Summer, max	 ^{o}C ^{o}C	 3 15
7.	Copper strip corrosion for 3 hrs @ 100 0 C, max		Not worse than No.1
8.	Distillation : a) at 350 0 C, min recover b) at 370 0 C, min recovery	 % volume % volume	 85 9
9.	Flash point a) Abel, mi	^{0} C	35
10.	Kinematic viscosity @ 40 ^{0} C	cs t	2.0-5.0
11.	Sediment, max	% mass	0.05
12.	Density @ 15 ^{0} C,	kg/m 3	820-860(820-870*)
13.	Total Sulphur, max.	% mass	0.05
14	Water content, max	% volume	0.05
15.	Cold filter plugging point(CFPP) a) Winter (Nov-Feb), ma b) Summer, max	 ^{c}o ^{c}o	 6 18
16.	Total sediments, max	mg/100ml	1.6
17.	Lubricity, corrected wear scar diameter (wad 1,4) @ 60 0 C, max	um, (micron)	460

* For diesel processed from Assume crude, either CN of 45 min or CI of 43 min and density of 820-870 shall be applicable

Note :

1. Indian Standard specification for diesel fuels namely IS 1460 : 2000 shall be applicable for test methods and all other provisions / details
2. These standards specifications have been finalised by the Expert Committee after discussions with the automobile and oil industry.

Annexure-V

Comparison of various marker Systems to check Fuel Adulteration.

Parameter	M/s. BASF, Germany	M/s. GFI, Israel	M/s. UCM, USA.
1. Status of Testing	Evaluated in labs of IOC (R& D), jointly by BPCL & IOC (R&D) groups.	Evaluated in labs of IOC (R& D), jointly by BPCL & IOC (R&D) groups.	Evaluated in labs of IOC (R& D), jointly by BPCL & IOC (R&D) groups.
2. Detection Technique	NIR	XRF	Colarimeter
3. Marker used	Sudan 77A	Petromark ^{1M}	1494 DB
4. Performance during Testing: a. Accuracy	Deviation<5%	Deviation<10%	Deviation<5%
b. Reproducibility	RSD<2.0%	RSD<3.0%	RSD<2.5%
c. Detection limit	> 3% adulterant can be detected	> 3% adulterant can be detected	> 3% adulterant can be detected
d. Ease of operation	Portable & Easy to operate	Not Portable & required skilled manpower	Portable & Easy to operate
e. Remarks	Party should submit an alternate method of detection	Party should demonstrate the markers through a portable detection unit and should submit an alternate method of detection.	Party should submit an alternate method of detection

Annexure VI
Market fuels used in vehicles with spark ignition engines (petrol)

Country	
Reporting year	
Parent of national fuels grade	

Parameter	Unit	Analytical and statistical results					Limiting value ([1])			
		Number of Samples	Mini-mum	Maxi-mum	Mean	Standard deviation	National specifications		According to 98/70/EC	
							Mini-mum	Maxi-mum	Mini-mum	Maxi-mum
Research octane No.	-								95	-
Motor octane No.	-								85	
Vapour pressure, DVPE	KPa								-	60.0
Distillation: - evaporated at 100°C - evaporated at 100°C	 %(v/v) %(v/v)								 46.0 75.0	 - -
Hydrocarbons analysis - olefins - aromatics - benzene	 %(v/v) %(v/v) %(v/v)									 18.0 42.0 1.0
Oxygen content	%(m/m)								-	2.7
Oxygenates: - Methanol - Ethanol - Iso-propyl alcohol - Tert-butyl alcohol - Ethers with five or more carbon atoms per molecule - other oxygenates	 %(v/v) %(v/v) %(v/v) %(v/v) %(v/v) %(v/v) %(v/v)								 - - - - - - -	 3 5 10 7 10 15 10
Sulphur content	Mg/kg								-	150
Lead content	G/l								-	0.005

([1]) The limiting values are 'true values and were established according to the procedures for limit setting in EN ISO 4259:19. The results of individual measurements shall be interpreted following the criteria described in EN ISO 4259:1995

Number of samples in month			
January		July	
February		August	
March		September	
April		October	
May		November	
June		December	
		Total	

Annexure VII

Market fuels used in vehicles with compression ignition engines (diesel)

Country	
Reporting year	
Parent of national fuels grade	

Parameter	Unit	Analytical and statistical results					Limiting value ([1])			
		Number of Samples	Mini-mum	Maxi-mum	Mean	Standard deviation	National specifications		According to 98/70/EC	
							Mini-mum	Maxi-mum	Mini-mum	Max-imum
Cetane No	-								51.0	-
Density at 15°C	Kg/m^3								-	845
Distillation aromatic hydrocarbons	°C								-	360
Sulphur content	%(^{m}/m)								-	11
	Mg/kg								-	350

([1]) The limiting values are 'true values and were established according to the procedures for limit setting in EN ISO 4259:19. The results of individual measurements shall be interpreted following the criteria described in EN ISO 4259:1995

Number of samples in month			
January		July	
February		August	
March		September	
April		October	
May		November	
June		December	
		Total	

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