GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

DEPARTMENT OF ENVIRONMENT

REVISIONS OF VEHICULAR EMISSION STANDARDS FOR BANGLADESH

(Bdesh-2 and Bdesh-3)

Draft Final Report - Part 1

December 2012

CLEAN AIR AND SUSTAINABLE ENVIRONMENT (CASE) PROJECT

(IDA CREDIT No. 4581-BD)

PROPOSED REVISIONS TO VEHICLE EMISSION STANDARDS FOR BANGLADESH: Draft Final Report - Part 1

Contents

PROPOSED REVISIONS TO VEHICLE EMISSION STANDARDS FOR BANGLADESH: Draft Final Report - Part 1

0.0 Executive Summary

A set of detailed and comprehensive vehicle emission standards were notified for the first time in Bangladesh to be applicable from July 2005. This consultancy under the Clean Air and Sustainable Environment (CASE) project has been commissioned to review the vehicle emission standards and recommend revisions to them if required in view of the increasing vehicle population in the country. A report dated September 2012 on the subject was prepared under the consultancy. The trends in growth and composition of vehicle population, fuel types, status of fuel quality standards and in-use vehicle emissions are discussed in the report. International trends in vehicle emission standards more specifically in Europe and Asian countries are discussed. Other factors that constrain and hence guide the efforts to tighten the emission standards particularly in the context of Bangladesh are considered while making recommendations on the next revisions to vehicle emission standards for the country.

The September 2012 report presenting recommendations on revisions to emission standards for Bangladesh was circulated by the CASE Project (DoE component) management to various stakeholders and other experts. Subsequently, the standards and the related issues such as fuel quality, vehicle manufacturing activities etc., in Bangladesh were discussed in a stakeholders' meeting on 13 December 2012 held at Paribesh Bhaban, Department of Environment. One significant suggestion during the meeting was made to stipulate two different sets of emission standards, one for the metropolitan areas of Dhaka and Chittagong, and another for the rest of the country. Taking into consideration the discussions held in the stakeholders' meeting and comments received from the other experts, the draft report on revisions to vehicle emission standards for Bangladesh has been finalized and is presented here.

The mechanism and methodology of enforcement of emission standards that need to be implemented have also been proposed and discussed in detail in the 'Enforcement of Emission Standards and I/M Programme: Draft Report – Part 2,' December 2012, prepared under the consultancy.

The findings and recommendations made in the present report are given below;

(i) Vehicle population in Dhaka today stands at about 708 thousands which accounts for 41 % of total vehicle population of 1,752 thousands in the entire country. The vehicle population growth since the year 2003 has been close to 135% both in Dhaka as well in whole of Bangladesh.

(ii) Although emission inventory data is not available but source apportionment studies of 2006 showed that the vehicles were the second largest contributors after the brick kilns, to carbonaceous content of airborne particulate matter in Dhaka. However, increasing population of the vehicles will make them the main contributor of air pollution in the city as the brick kiln activities in the neighborhood are bound to decline.

(iii) In Bangladesh, the 2005 standards were based on Euro 2 for the petrol/CNG light vehicles and Euro 1 for the heavy duty vehicles. Most of the Asian countries excepting Japan and South Korea (light duty vehicles) follow the Euro standards with a time lag depending upon the local conditions specific to that country.

(iv) Up to date trends in emission standards in EU are presented in the report with numerical values. For the Asian countries the trends in emission standards in terms of Euro levels are presented for a quick glance on the trends. Among the followers of EU regulations China, Hong Kong and India are leading the Asian countries.

(v) Nearly all the vehicles in Bangladesh are imported, the new ones from China, India and South Korea, and the reconditioned ones from Japan. Hence, the emission standards prevalent in these countries constitute an important factor to be considered besides the fuel quality and alternative fuel that is likely to be available in the country.

(vi) It is envisaged that fuel quality will undergo upgrading as most of the fuel is imported as the finished product and the refineries all over the world are producing fuels of superior quality to meet the demands of low emission vehicles in their own country and for exports.

(vii) Based on the above considerations two stages of revisions in the standards for the new registration vehicles have been proposed; the first in the year 2014 and the second in 2019. The second revision may be reviewed in the light of air quality data and emission inventory data that would be available in the meantime.

(viii) As the vehicle density is much higher in Dhaka metropolitan area and Chittagong compared to other cities of the country it perhaps would be more cost-effective to have more stringent emission regulations for Dhaka and Chittagong compared to rest of the country. Accordingly, two sets of emission standards for Bangladesh are proposed for implementation. The proposed standards for in-use vehicles (depending on vehicle type and vintage) are also different for the two different regions.

(ix) The proposed standards for the new registration vehicles in terms of Euro levels are given in the Table 0.1The emission limits and other information is presented in Annexure –A.

(x) Emission Inspection standards for compliance at the time of vehicle registration for the imported used cars and light duty passenger vehicles are also given in Annexure-A to ensure that these vehicles are in an acceptable good condition. No such standards for the motorcycles, 3-wheelers and commercial vehicles like buses/minibuses and trucks are proposed as import of used vehicles of these types is not allowed in the country.

(xi) The standards for the in-use vehicle inspections have been recommended and are given in Annexure-B. The emission inspection data collected by the DoE/CASE team were considered along with the low emission potential of the vehicles that are proposed to be introduced in the year 2014 and later. Motor cycle inspection standards for HC are suggested to be relaxed for the present vehicles as the

present HC standards for the motorcycles are significantly more stringent than those in China, India, Thailand etc., and nearly 80 % of motorcycles are seen to fail the inspection tests. The CNG 3-wheeler standards may be set at CO = 1.0 % as nearly 98 % vehicles tested gave CO emissions lower than this value. It is suggested that HC limit for CNG vehicles also is introduced to keep the engine in fuel-efficient mode of operating conditions. Car inspection standards are suggested to be in line with EU standards. Diesel vehicle standards are kept unchanged for the pre-2014 model vehicles but made a little tougher for the post 2014 diesel vehicles.

Table 0.1

Proposed Level of Emission Standards for the New Registration Vehicles

Vehicle Type	Vehicle Class as per the proposed RTTA	Standards from July 2014		Standards from July 2019	
		Dhaka & Chittagong	Rest of Bangladesh	Dhaka & Chittagong	Rest of Bangladesh
All Cars and light duty petrol and CNG vehicles with GVW≤ 3500 kg	Class E (Petrol and CNG)	Euro 3	Euro2	Euro 4	Euro 3
All cars and light duty diesel vehicles with GVW ≤ 3500 kg	Class E (Diesel)	Euro 2	Euro1	Euro 3	Euro 2
All commercial CNG vehicles > 3500 kg	Class A, B, C, and D (CNG)	Euro 3	Euro 2	Euro4	Euro 3
All commercial Diesel vehicles > 3500 kg	Class A, B, C, and D (Diesel)	Euro 2	Euro1	Euro 3	Euro2
Motorcycles	Class M	Euro 3	Euro 2	Euro 4	Euro3
3 –Wheeler (CNG)	Class T	Euro 3	As at present	Euro 4	Euro 3

(xii) Fuel quality specifications are to match the needs of the vehicles manufactured to comply with the revised emission standards. An important factor is that in Dhaka most cars, other light duty vehicles and three wheelers operate on CNG. Motorcycles are the primary users of gasoline and these use mostly the premium grade of gasoline as the regular grade of gasoline has a very poor octane number (80 RON). The regular grade gasoline should be suitably upgraded for use of motorcycles and its octane quality may be increased to 91 RON minimum in line with the practice in Europe and most other Asian countries. This improved regular grade gasoline is expected to meet the requirements of motorcycles as well as of most of new petrol cars and station wagons etc.

(xiii) Revisions to gasoline fuel quality particularly related to density, sulphur, content, gum content and hydrocarbon composition based on European specifications EN 228: 1999 and 2004 are recommended. Similarly, based on European diesel fuel specifications EN 590:1993 and 1999, the revised specifications for key diesel fuel properties viz., density, cetane number, sulphur, viscosity etc. are also recommended. Additional parameters such as polyaromatic hydrocarbons and lubricity of ultra-low sulphur fuels are also included from the year 2019. The proposed revisions to motor gasoline and diesel specifications are given in the Tables 0.2 to 0.4 , respectively.

(xiv) Already two grades of gasoline are being marketed in the country. Depending upon logistics, the oil companies may market diesel fuels of two different qualities one in the two metro-cities and another in rest of the country.

Table 0.2

Key Gasoline Fuel Characteristics to Meet the Revised Vehicle Emission Standards

Property	Regular			Premium			Method
	Current	2014	2019	Current	2014	2019	
Density, kg/m^3	-	720-775	720-775		720-775	720-775	@
Octane Number (R), min.	80	91	91	95	95	95	@
Sulphur, mg/kg	1000	500	150	1000	150	50	@
Gum content (solvent washed) mg/100 ml	-	5	5	-	5	5	ISO 6246
Lead content, g/l	0.013	0.013	0.005	0.13	0.005	0.005	@
Hydrocarbon composition*		-	-	-	-	-	ASTM D1319
		-	-	-	-	-	
Olefin, % vol	-	-	21	-	21	18	
Aromatics, % vol	-	-	42	-	42	35	

@ As in the current standards

* Benzene limit of 1% vol. max may be included from the point of health effects of benzene emissions from vehicles.

Table 0.3

Key Diesel Fuel Characteristics to Meet the Revised Vehicle Emission Standards in Dhaka and Chittagong

Property	Current	2014	2019	Method
Density, kg/m^3	820-870	820-860	820-845	@
Cetane number Cetane index	45 -	49 46	51 46	@ ISO 4264
Kinematic viscosity at 40 °C, mm^2/s	9.0 max at 38°C	2.0-4.5	2.0-4.5	@
Total contamination, mg/kg	-	24	24	EN 12662
Oxidation Stability, g/m^3	-	-	25	ASTM D 2274
Polycyclic Aromatic Hydrocarbons, % m/m	-	-	11	EN 12196
Sulphur total, mg/kg	5000	500	350	@
Distillation 90% recovery at °C 95% recovery at °C	- 375 -	- - 370	- - 360	@
Lubricity, corrected wear scar dia., µm	-	-	460	ISO 12156-1

@ As in the current standards

Table 0.4

Key Diesel Fuel Characteristics for Rest of the Country (excluding Dhaka and Chittagong)

Property	Current	2014	2019	Method
Density, kg/m^3	820-870	820-860	820-860	@
Cetane number Cetane index	45 -	45	49 46	@ ISO 4264
Kinematic viscosity at 40 °C, mm^2/s	9.0 max at 38°C	2.0-4.5	2.0-4.5	@
Total contamination, mg/kg	-	-	24	EN 12662
Oxidation Stability, g/m^3	-	-	-	ASTM D 2274
Sulphur total, mg/kg	5000	2000	500	@
Distillation 90% recovery at °C 95% recovery at °C	- 375 -	- 360 -	- - 370	@

PROPOSED REVISIONS TO VEHICLE EMISSION STANDARDS FOR BANGLADESH: Draft Final Report - Part 1

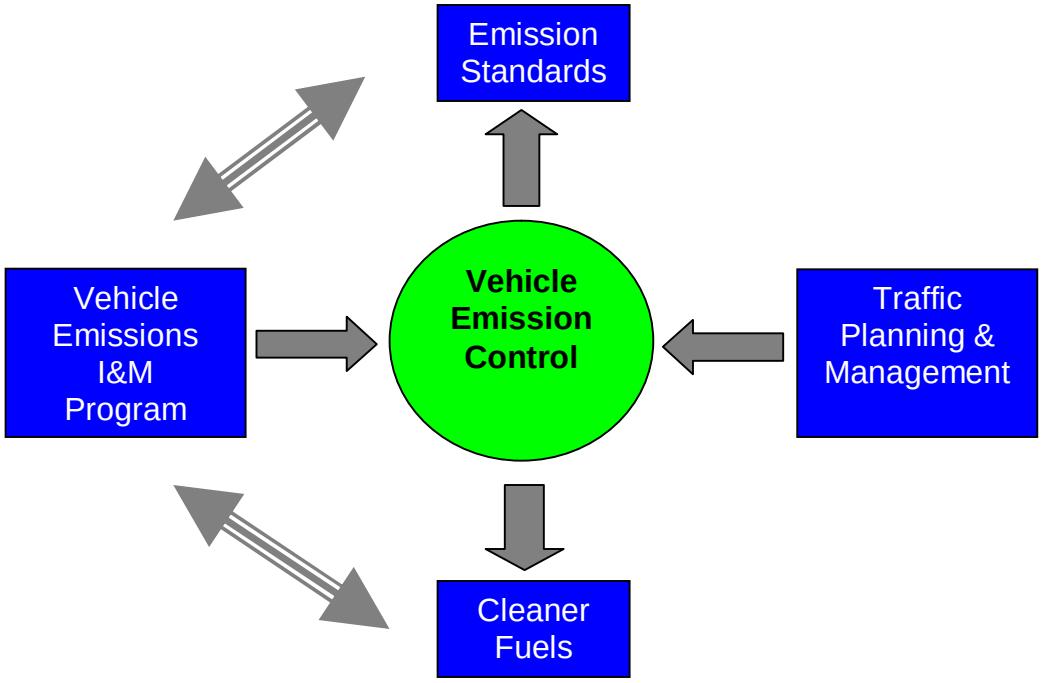
1.0 INTRODUCTION

Studies conducted by the atomic Energy Centre, Bangladesh Environment, Government of Bangladesh identified that the vehicular emission are the second largest contributor after the brick kilns to carbonaceous material in the airborne particulate matter in Dhaka city. Hence the vehicles are one of the principal contributors to air pollution. (*Begum et.a.l., Asian Journal of Atmospheric Environment, Vol. 5-4, December 2011*) The current vehicle emission standards in Bangladesh were introduced in the year 2005*(Bangladesh Gazette SRO 220-Law/2005 of 19, July 2005)*. For the new registration petrol vehicles the current emission standards are equal to Euro-II and for the diesel vehicles to Euro-I. As no laboratory facilities to measure mass emissions from vehicles exist in the country, inspection tests and limits to be conducted on the stationary vehicles were also notified that are required to be met at the time of registration. Simultaneously, emission standards for the in-service petrol/CNG motorcycles, three wheelers, cars and diesel vehicles were also notified by the Government. The in-service vehicle emission standards however, did not find explicit mention in the current motor vehicle rules. Roadside emission measurements done on in-service vehicles by the Department of Environment under CASE project showed high-level of emissions particularly from the diesel vehicles Lack of a robust vehicle emission inspection and maintenance (I&M) program and overall ineffective implementation of the vehicle emission standards (VESs) is believed to be one of the most important factors for a high pollution level in the Dhaka city**.**

The Department of Environment under the CASE project is implementing a Consultancy by Regulatory Enforcement Specialist for Vehicle Emission Control. Under this consultancy, the existing emission regulations are to be revisited and if necessary, revised to improve the efficacy of the vehicle emission control initiative and program in the country and more particularly in the Dhaka city. A road map of vehicle emission regulations for implementation up to the year 2020 may be also proposed as suggested by Dr. Khaliquzzaman of World Bank during a meeting with the Consultant on Aug. 27. This working paper presents the trends in the vehicle emission standards in the Asian countries and the European Union (EU). The most Asian countries have their national emission standards derived from the EU regulations, hence the importance of EU standards in comparison to those applicable in the USA. The emission standards in force in those countries from where vehicles are imported into Bangladesh is an important factor. It governs the level of automotive technology and the low emission potential that is more conveniently accessible for implementation in the country. Another important factor and constraint is the availability of the required quality of the motor fuels. Other factors include the cost effective level of testing and monitoring facilities that may be made available. Based on the above factors the vehicle emission standards for implementation in the coming years in Bangladesh are suggested in this paper.

2.0 A TYPICAL VEHICLE EMISSION CONTROL STRATEGY

Any strategy that is adopted to control vehicular air pollution on a sustainable basis has to address a multiple of issues related to vehicle technology, vehicle operation and maintenance, fuel and traffic management. The different factors that should be typically essential components of a vehicular air pollution control program are shown in Fig. 1. The emission standards are one of the four important factors. The other factors that are required to be addressed concurrently to make the emission control program more efficient and cost-effective include traffic planning and management, cleaner transport fuels and a vehicle inspection and maintenance (I/M) mandate. Of these, the vehicle emission inspection and maintenance forms another important task of this consultancy.



.

Figure 1: Elements of a vehicle emission control strategy.

The vehicle emission standards that may be implemented in a given situation are also governed by the automotive technology and the fuel quality that are available at affordable costs. The interdependence of emission standards on automotive technology and fuel quality and interactions are shown pictorially on Fig. 2. In the USA, which has been the flag bearer for the programs on reduction of vehicular air pollution, the approach has been to set emission reduction targets based on the air quality goals. Thus, the development of vehicle technology has been driven by the emission standards. The new emission control automotive technology and sometimes the emission and air quality standards per se (benzene and other air toxics) in turn demand a better quality fuel

Emission standards are different for the different categories of vehicles. The standards depend on the size of engine/vehicle such as motorcycles, cars, buses etc. and on application of vehicles namely light duty for individual passengers or heavy duty for

mass and passenger transport; the trucks and buses. The standards also depend on the fuel used. For example, for petrol and CNG fueled vehicles the standards are set only for carbon monoxide (CO), unburned hydrocarbons (HC) and nitrogen oxides (NOx). For the diesel vehicles smoke and particulate emission standards are also specified in addition to CO, HC and NOx as it is inherent in the functioning of diesel engines to emit black smoke in addition to the gaseous emissions.

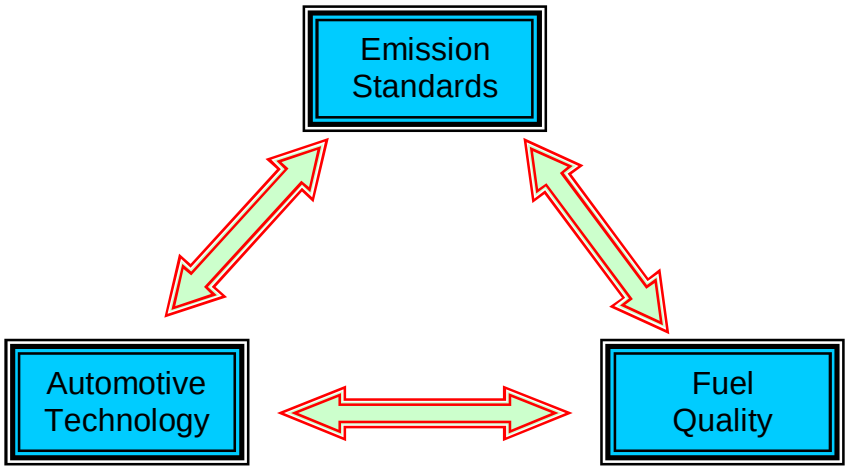


Figure 2: Inter-dependence of Emission Standards – Automotive Technology –Fuel Quality

3. 0 TRENDS IN GROWTH AND COMPOSITION OF VEHICLE POPULATION IN BANGLADESH

Growth of vehicle population in Dhaka city and Bangladesh is shown in Table 1 and Table 2, respectively (3). Since the year 2004 i.e., over a period of about the last 7 years, the vehicle numbers in Dhaka as well in the whole country of Bangladesh have grown by nearly 135%.

Dhaka city has presently around a total of 708 thousand motorized vehicles out of which cars and other personal passenger vehicles number nearly 250 thousand and motorcycles 303 thousand. The vehicle population and growth in different categories of vehicles in Dhaka since 2003 is shown in Figures 3 and 4, respectively. Some observation may be made on the trends in vehicle population growth in the Dhaka city. Since the end of the year 2003:

(i) The number of cars increased by 189 %
(ii) The number of motorcycles also increased by 153%.
(iii) The number of buses grew by over 400% close to 11,000 while the number of minibuses remained nearly static around 8,000 during this period. The overall growth for the minibuses and buses was by 96 %.

Table 1

DHAKA

NUMBER OF YEARWISE REGISTERED MOTOR VEHICLES IN DHAKA

Sl. No	Type of Vehicles	UP TO 2003	2004	2005	2006	2007	2008	2009	2010	2011	January to June 2012	Grand Total
1	Motor Car	67666	4734	5633	7403	10244	13749	17654	19557	10913	4494	182247
2	Jeep/St. W	32391	2114	3303	4546	4372	5077	6603	6657	4541	2094	72230
3	Taxi	9368	523	514	2662	0	0	10	0	0	0	10682
4	Bus	2614	779	726	949	1082	1144	914	1101	1214	535	11060
5	Minibus	7460	366	116	75	77	107	112	142	104	20	8583
6	Truck	20342	1437	1104	1460	630	1642	3160	4543	4711	2319	41588
7	Auto-rickshs	10657	2344	139	230	121	155	1144	1362	2463	1040	20291
8	Motor-Cycl	119299	7872	12679	16264	17303	23713	22093	30264	34357	16116	302180
9	Others	13167	1300	2361	2720	2913	2550	4666	12225	12741	4463	59336
TOTAL		303215	21471	26779	36359	36942	48137	56778	75881	71344	33687	708197

Table 2

BANGLADESH

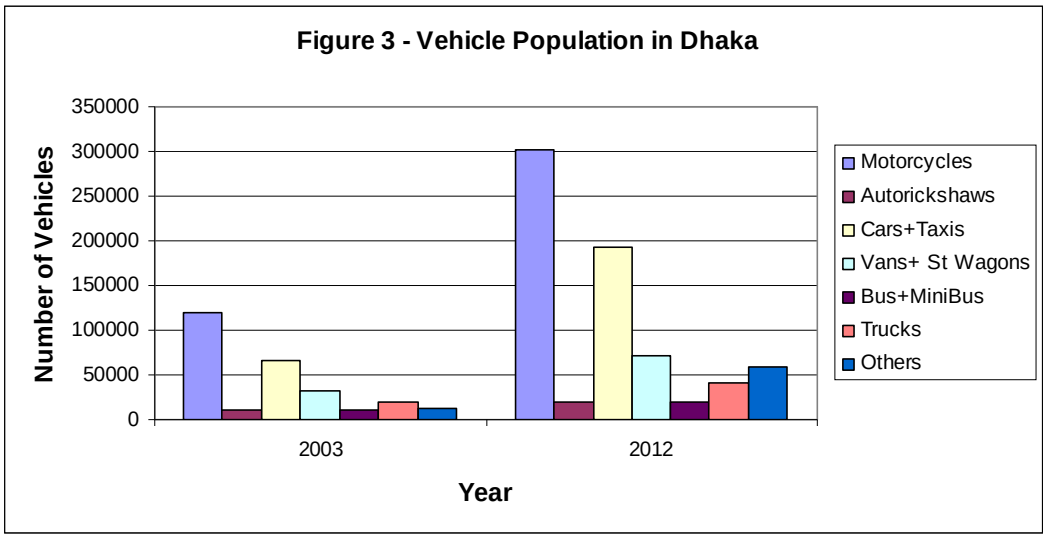
NUMBER OF YEARWISE REGISTERED MOTOR VEHICLES IN BANGLADESH

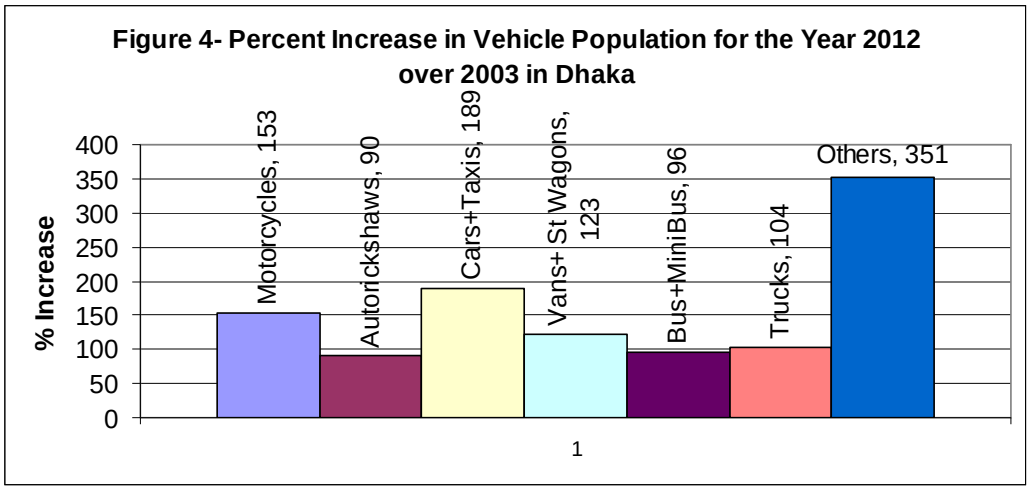
Sl. No	Type of Vehicles	UP TO 2003	2004	2005	2006	2007	2008	2009	2010	2011	January to June 2012	Grand Total
1	Motor Car	116196	5410	6431	8447	11941	16927	21461	20690	12473	5060	**225036**
2	Jeep/St. Wagon/ Microbus	49364	2514	3963	5540	5650	6537	9027	8040	5792	2450	**98877**
3	Taxi	10932	540	515	275	15	9	12	0	0	3	**12301**
4	Bus	30617	857	783	1020	1368	1342	1184	1233	1506	632	**40542**
5	Minibus	33364	622	361	241	382	307	320	311	333	122	**36363**
6	Truck	51375	2583	2791	3065	2521	2609	6561	10056	10068	4293	**95922**
7	Auto-rickshaw/ Auto-tempo	98479	8974	4877	6898	10530	19071	14902	19018	18002	8571	**209322**
8	Motor-Cycl	321347	24941	43226	51106	85131	93541	85142	88499	107927	48187	**949047**
9	Others	25726	2761	2931	3713	3734	4076	6634	13331	16383	5135	**84424**
TOTAL		**737400**	**49202**	**65878**	**80305**	**121272**	**144419**	**145243**	**161178**	**172484**	**74453**	**1751834**

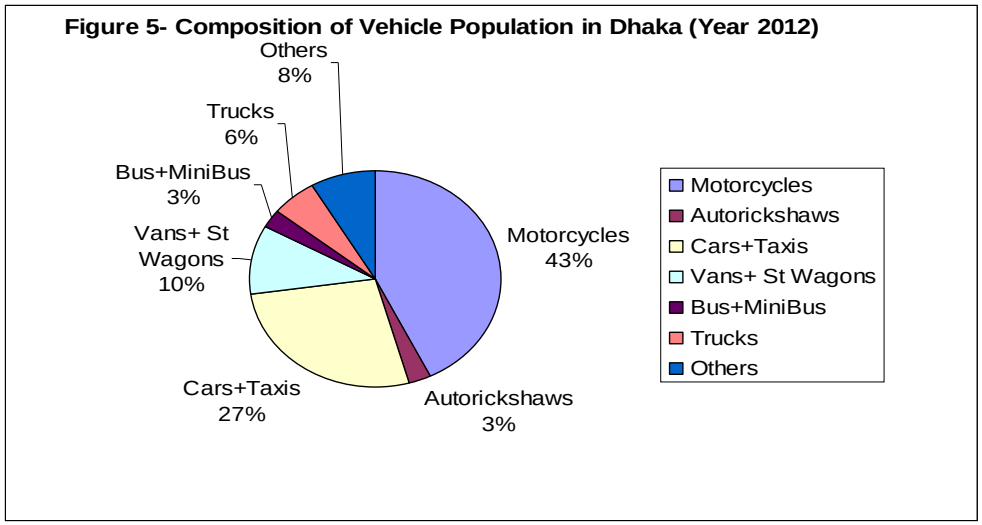
(iv) Three wheelers or auto-rickshaws after exit of 2-stroke baby taxis although doubled in numbers but their population is at a relatively low level. These number presently about 20000.

The composition of the vehicle population among different categories is shown on Fig 5. The number of individual vehicles has grown rapidly perhaps due to increase in the disposable incomes and also due to lack of good public transport.

The total population of registered motorized vehicles in the country stands at 1.75 millions. .The rest of the country excluding Dhaka city also has seen a high growth rate in the number of motorcycles. The motorcycles now number close to a million in Bangladesh. Auto-rickshaws or 3-wheelers appear to be a very important means of public transport in the countryside and their number more than doubled to a population of 209 thousand since 2003.







3.1 Vehicle Composition by Fuel Type

Bangladesh Road Transport Authority (BRTA) at present does not maintain vehicle registration records according to fuel used. They however, intend to do so in future. Through road emission inspection, the DoE/CASE enforcement team has collected data on the fuel used by the vehicles inspected by them. The data collected is summarized in Table 3. As the vehicles were inspected randomly, the fuel wise division of all the vehicles operating in Dhaka may be assumed in the same proportions. As expected all the motorcycles operate on petrol. More than 95 % cars and three wheelers presently use CNG due to its lower price than petrol. CNG fuelled commercial vehicles like delivery vans and small size goods carriers/mini- trucks, accounted for 44% and the CNG fueled minibuses and buses numbered 61%, the balance being diesel operated. There could have been some bias in favour of testing the diesel operated medium duty commercial vehicles and the buses as the inspection team might have tried to inspect as many diesel vehicles as possible to check for the smoke emissions. It is therefore, may be safe to assume that the CNG operated commercial vehicles already account for more than 50% in the city.

Table 3

Categorization of Vehicles in Dhaka by Fuel Used (4)*

S. No.	Vehicle Type	Total number tested	Fuel wise vehicle numbers tested			Percent vehicles as per fuel used		
			CNG	Petrol	Diesel	CNG	Petrol	Diesel
1	Motorcycles	124	-	124	-	-	100	-
2	Auto rickshaws	116	112	4	-	97	3	0
3	Cars/Taxis	113	108	5	-	96	4	0
4	Jeeps/ micro-buses/St. Wagons	58	47	2	9	81	3	16
5	Delivery Vans/mini-trucks	188	83	2	103	44	1	55
6	Minibus/Buses	92	56	-	36	61	-	39

* from the vehicle data collected by DoE/CASE emission inspection team

4.0 VEHICLE CLASSIFICATION AS PER THE REGULATIONS

Emission standards are specified for different categories of vehicles defined in the motor vehicle rules of a country or region. The emission standards specified depend on the type of vehicle as its application, pattern of driving and use, and technology differs from one type to another. The vehicles are categorized from the point of their application as well as for the taxation purposes. The EU countries and the USA categorize the vehicles somewhat differently and so is the case in the other countries. Vehicles in Bangladesh are being reclassified as compared to the Motor Vehicle Ordinance 1983 which is applicable at this point of time. A new classification has been proposed in the Road Transport and Traffic Act (RTTA) framed by the Dhaka Transport Coordination Authority (DTCA) under the CASE Project (5). The existing vehicle classification at present and that in the proposed RTTA are compared in Table 4. In the same table, the vehicle classification used in Europe as per EU Council Directive 92/53/EEC and the US Federal classification (6) are also given. The current and the proposed vehicle categories in Bangladesh as per their gross vehicle weight (GVW) compared in Figure 6 for a better appreciation of the changes proposed. The maximum GVW shown in the Fig. 6 is arbitrary selected based on the situation that may exist in practice. However, there is no maximum limit prescribed on the gross vehicle weight of the heavy duty vehicles (HDV) in the current or the proposed motor vehicle regulations/ Act.

The review of vehicle classification as used in the other countries shows that for the purpose of setting emission regulations, the vehicles are divided into a small number of broad categories. The vehicles employing or likely to employ similar emission control technologies are generally clubbed together. For example in the USA all the vehicles having GVW of more than 3856 kg (8500 lb) are classified as a single category termed as HDV. In EU countries, all commercial vehicles above 3500 kg are governed by the same set of emission standards and these vehicles are termed as heavy duty vehicles. In India too, a very broad category of vehicles having GVW greater than 3500 kg have to comply with the same emission standards. This practice is primarily based on the premise that these vehicles would be primarily used for freight purposes or as buses for public passenger transport. The standards for these are based in terms of g/kWh. These vehicles are expected to be powered mostly by the diesel engines, except that in the recent times CNG fueled HDVs have made inroads in several countries and cities.

Figure 6 - Four-Wheeler Vehicle Classification in Bangladesh

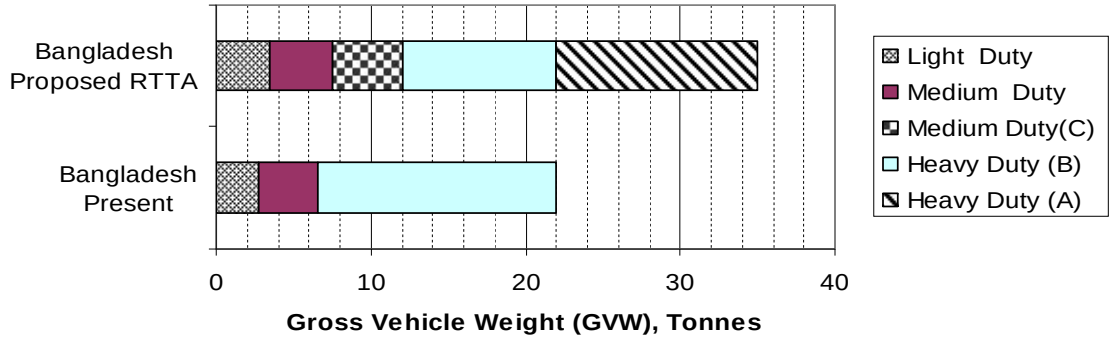


Table 4
Vehicle Classification in Bangladesh, India, EU countries and the USA (5,6)

Bangladesh			**India ***		**EU Directive 92/53/EEC**		**US Federal**	
MV Ordinance 1983	Proposed RTTA 2011		Type	Description	Type	Description	Type	Description
	Category	Description						
LDV GVW <= 2800 kg	E	GVW< = 3500	LDV (A) upto 6 persons	GVW <=2500	Passenger Vehicle M1	Upto 8 seats + driver	LDV	Less than 12 seats
MDV 2800 <GVW <= 6600	D	3500< GVW <= 7500	LDV (B)	2500 <GVW <= 3500	M2	More than 8 seats + driver GVW <= 5000	LLDT	GVW <= 2722 (6000lb)
HDV GVW >6600	C	7500< GVW <=12000	MDV and HDV	GVW >3500	M3	More than 8 seats + driver GVW > 5000	HLDT	2722 < GVW <= 3856 (8500 lb)
	D	12000 < GVW <= 22000			Freight Vehicles N1	GVW < 3500	HDV	GVW> 3856 or Frontal area > 45 ft^2
	E	GVW > 22000			N2	3500 < GVW <= 12000		
					N3	GVW> 12000		
	M	Motorcycles		Two Wheelers		Motorcycles and mopeds		Motorcycles
	T	Three Wheelers upto 8 seats + driver, GVW <= 2500		Three Wheelers				

* Vehicle Classification for emission regulations in Motor Vehicle Rules of India
LDV = Light duty vehicle, MDV= Medium Duty Vehicle, LLDT = Light light duty truck, HLDT = Heavy light duty truck
HDV = Heavy duty vehicle, GVW = Gross vehicle weight in kg.

5.0 CURRENT EMISSION STANDARDS FOR NEW REGISTRATION VEHICLES IN BANGLADESH

The vehicle emission standards presently in force in Bangladesh were implemented from the Year 2005 (2). The standards are in line with Euro 2 limits for the light duty vehicles and Euro 1 for the heavy duty vehicles. The motorcycles and 3 – wheelers emission standards were based on the standards prevailing in South and South-East Asian countries. The current standards for all the classes of vehicles are given in Tables 5 to 7. Part A (Table 5) is for the diesel vehicles and Part B (Table 6) gives emission standards for the petrol and CNG vehicles.

For ensuring that the reconditioned imported vehicles when manufactured would have met the standards specified for the new vehicles, simple inspection tests for CO and HC for the petrol/CNG vehicles and free acceleration smoke test limits for the diesel vehicles were also stipulated as given in Table 7 . These emission limits were more stringent than the limits specified for the in-service vehicles. The Table 7 however, does not stipulate any inspection standards for motorcycles at the time of registration.

Part (A)

Table 5 (a)
Bangladesh Emission Standards for Diesel Vehicles during Registration

Vehicle type	Emission Standards (g/km)			Test Procedure
	CO	HC + NOx	PM	
1	2	3	4	5
(i) Light duty (Not more than 8 seats in addition to driver & max. weight upto 2.5 tons)				
New Type Approval (TA)	2.72	0.97	0.14	91/441/EEC
Conformity of Production (COP)	3.16	1.13	0.18	
Imported used	3.16	1.13	0.18	
(ii) Medium duty (More than 8 seats in addition to driver but less than 15 seats & weight more than 2.5 tons but upto 3.5 tons)				
New TA	6.9	1.7	0.25	93/59/EC
COP	8.0	2.0	0.29	
Imported used	8.0	2.0	0.29	

Table 5(b)

Bangladesh Emission Standards for Heavy Duty Diesel Vehicles during Registration

Vehicle type	Emission Standards (gm/kWh)				TEST PROCEDURE
	CO	HC	NOx	PM*	
Heavy duty (More than 15 seats in addition to driver & weight more than 3.5 ton					91/542/EEC and ECE R 49.02
New TA	4.5	1.1	8.0	0.36	
New COP	4.9	1.23	9.0	0.4	
Imported used	4.9	1.23	9.0	0.4	

*For the diesel engines with 85kW or less power the limit is to be multiplied by a factor of to 1.7.

EC : European Council
EEC : European Economic Community.
COP : Conformity of Production.
km : Kilometer
TA : Type Approval.
ECE: Economic Commission for Europe.

Part B

Table 6 (a)

Bangladesh Emission Standards for Petrol and CNG Driven Vehicles during Registration (Light and Medium Duty Vehicles)

Vehicle type	Emission Standards (gm/km)		Evaporative Emissions (g/test)	Test Procedure
	CO	HC + NOx		
1	2	3	4	5
(2 and 3 wheeled) 4-stroke	4.5	3.0	-	ECE-40
Light duty (Not more than 8 seats in addition to driver & max. GVW. 2.5 tons)	2.2	0.5	2.0	94/12/EC
Medium duty (More than 8 seats in addition to driver but less than 15 seats & GVW more than 2.5 tons but max. 3.5 tons)	5.0	0.7	2.0	96/69/EC

Table 6 (b)

Bangladesh Emission Standards for Petrol and CNG Driven Vehicles during Registration (Heavy Duty Vehicles)

Vehicle type	Emission Standards (gm/kW-hr)			Evaporative emissions (g/test)	Test Procedure
	CO	HC/ NMHC*	NOx		
(a) Heavy duty (More than 15 seats in addition to driver & GVW. more than 3.5 ton)					91/542/EEC and ECE R 49.02 and *13- MODE Test Cycle
New TA (Petrol/ CNG)	4.5	1.1	8.0	2.0	
New COP(Petrol/ CNG)	4.9	1.23	9.0	2.0	
Imported used (Petrol/ CNG)	4.9	1.23	9.0	2.0	

* Applicable for CNG driven vehicles

CNG : Compressed Natural Gas
EC : European Council
ECE : Economic Commission for Europe
km : Kilometer
Hr : Hour
COP : Conformity of Production
EEC : European Economic Community
TA : Type Approval
kW : Kilo Watt

Part- C

Table 7

Bangladesh Emission Inspection Standards during Registration for Vehicles Mentioned in Part-A and Part-B

Vehicle type	Parameter	Emission Standard
1	2	3
At least 3 wheeled petrol and CNG driven vehicles	Idle CO Idle HC	0.5 %v/v 1200 ppm
	No load, 2500-3000 RPM CO HC Lambda	 0.3 %v/v 300 ppm 1± 0.03
	Visual check	3-Way catalytic converter fitted in the exhaust
Diesel naturally aspirated	Free acceleration smoke	1.2 m^{-1} smoke density (40 HSU)
Diesel turbo-charged	Free acceleration smoke	2.2 m^{-1} smoke density (61 HSU)

HSU : Hartridge Smoke Unit; ppm : parts per million ; m^{-1} : meter inverse

6.0 AN OVERVIEW OF EMISSION STANDARDS IN EUROPE AND ASIAN COUNTRIES

6.1 EU COUNTRIES

6.1.1 Light Duty Vehicles
Passenger Cars

Since the Euro 2 stage, EU regulations have specified different emission limits for diesel and petrol vehicles. Diesel cars and light commercial vehicles have more stringent CO standards but are permitted higher NOx emissions. Petrol fuelled vehicles do not have particulate matter (PM) standards until the Euro 4 stage. Beyond Euro 4 stage however, the vehicles with gasoline direct injection (GDI) engines are required to meet a limit of 0.005 g/km for Euro 5 and Euro 6. A particulate number standard (PN) is also part of Euro 6 standards, but it is not yet final. The standard is to be specified by the time when Euro 6 standards are due for implementation.The trends in emission standards in Europe with their respective date of implementation are given in Table 8.

Table 8
Emission Standards in Europe for Passenger Cars (M * vehicles) (6-9)

Level	Date of Implementation	CO	THC	NMHC	NOx	HC+ NOx	PM
Diesel Vehicles							
Euro 1[@]	July 1992	2.72 (3.16)	-	-	-	0.97 (1.13)	0.14 (0.18)
Euro 2	Jan. 1996	1.0	-	-	-	0.7	0.08
Euro 3	Jan. 2000	0.64	-	-	0.50	0.56	0.05
Euro 4	Jan. 2005	0.50	-	-	0.25	0.30	0.025
Euro 5	Sept. 2009	0.50	-	-	0.18	0.23	0.005
Euro 6	Sept. 2014	0.50	-	-	0.08	0.17	0.005
Petrol Vehicles							
Euro 1 [@]	July 1992	2.72 (3.16)	-	-	-	0.97 (1.13)	-
Euro 2	Jan. 1996	2.2	-	-	-	0.5	-
Euro 3	Jan. 2000	2.3	0.20	-	0.15	-	-
Euro 4	Jan. 2005	1.0	0.10	-	0.08	-	-
Euro 5	Sept. 2009	1.0	0.10	0.068	0.06	-	0.005**
Euro 6	Sept. 2014	1.0	0.10	0.068	0.06	-	0.005**

THC= Total unburned hydrocarbons, NMHC= Non-methane hydrocarbons,
PM= Particulate matter
** Before Euro 5, passenger vehicles > 2500 kg were type approved as light commercial vehicles N_1 ** Applies only to vehicles with direct injection engines*
[@]Values in brackets are conformity of production (COP) limits

6.1.2 Evolution of Emission Limits for Light Vehicles in Europe

The reductions in vehicle emissions for light duty vehicles stipulated by the EU standards up to Euro 4 level are shown in Fig. 7. The evolution of emission limits for petrol and diesel cars are shown in comparison to the pre-Euro 1 standard. For the petrol cars, the Euro 3 standards required nearly 72% reduction in CO and 81 % reduction in HC + NOx compared to the pre –Euro 1 emission standards. The Euro 5 regulations which are currently in force in Europe stipulate an overall reduction of nearly 88 % in CO and 92% in HC + NOx compared to 1990 levels. The CO emission limits for Euro 5 and Euro 6 are kept at the same level as Euro 4. In Euro 6 the HC + NO_x are the same as Euro 5. The Euro 6 emission levels are to be implemented in Sept. 2013 and remain unchanged compared to Euro 5 levels for the petrol passenger cars which permit only about 12% CO and 8 % HC+NOx compared to 1990 emission levels.

For the diesel cars, Euro 3 standards stipulated CO, HC+ NOx and PM emissions lower by 91%, 71% and 83%, respectively compared to 1990 emission levels. The Euro 5 levels are lower by 94%, 88% and 98% for CO, HC + NOx and PM, respectively. The Euro 5 standards implemented drastic reductions in PM emissions reducing these by 80% compared to Euro 4 levels The Euro 6 standards stipulate further reduction in HC + NOx emissions while keeping CO and PM unchanged compared to Euro 5 limits. Overall, the CO levels would be just 6 %, HC + NOx 9 % and PM only about 2% of the 1990 emission limits when Euro 6 standards are implemented in Sept. 2013.

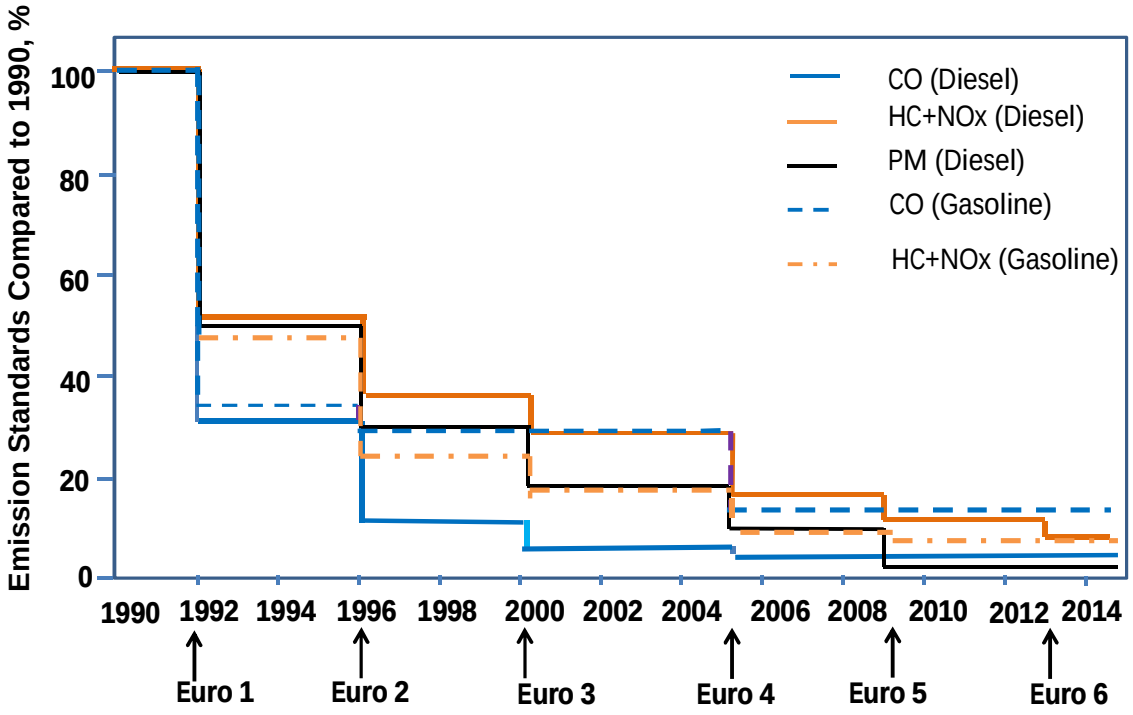


Figure 7: Evolution of EU Emission Standards for Light Duty Vehicles

6.1.3. Light Commercial Vehicles

The light commercial vehicles (N_1) are divided into three categories:
N_1- I GVW < =1305 kg
N_1- II 1305 < GVW <=1760 kg
N1- III 1760< GVW <= 3500 kg

Emission standards for the above three categories of the commercial vehicles are given in Table 9 below.

Table 9(a)
European emission standards for light commercial vehicles of GVW <=1305 kg (Category N_1-I), g/km (6-9)

Level	Date of Implementation	CO	THC	NMHC	NOx	HC+NOx	PM
Diesel vehicles							
Euro 1	Oct 1994	2.72	-	-	-	0.97	0.14
Euro 2	Jan 1998	1.0	-	-	-	0.7	0.08
Euro 3	Jan 2000	0.64	-	-	0.50	0.56	0.05
Euro 4	Jan 2005	0.50	-	-	0.25	0.30	0.025
Euro 5	Sept 2009	0.500	-	-	0.180	0.230	0.005
Euro 6	Sept 2014	0.500	-	-	0.080	0.170	0.005
Petrol vehicles							
Euro 1	Oct 1994	2.72	-	-	-	0.97	-
Euro 2	Jan 1998	2.2	-	-	-	0.5	-
Euro 3	Jan 2000	2.3	0.20	-	0.15	-	-
Euro 4	Jan2005	1.0	0.10	-	0.08	-	-
Euro 5	Sept 2009	1.000	0.100	0.068	0.060	-	0.005*
Euro 6	Sept 2014	1.000	0.100	0.068	0.060	-	0.005*

***** *Applicable for gasoline direct injection engines*

Table 9 (b)

European emission standards for Light Commercial Vehicles (1305 – 1760 kg) (Category N_1-II), g/km (6-9)

Level	Date of Implementation	CO	THC	NMHC	NOx	HC+NOx	PM
Diesel vehicles							
Euro 1	Oct 1994	5.17	-	-	-	1.4	0.19
Euro 2	Jan 1998	1.25	-	-	-	1.0	0.12
Euro 3	Jan 2001	0.80	-	-	0.65	0.72	0.07
Euro 4	Jan 2006	0.63	-	-	0.33	0.39	0.04
Euro 5	Sep t2010	0.630	-	-	0.235	0.295	0.005
Euro 6 (future)	Sept 2015	0.630	-	-	0.105	0.195	0.005
Petrol (Gasoline)							
Euro 1	Oct 1994	5.17	-	-	-	1.4	-
Euro 2	Jan 1998	4.0	-	-	-	0.6	-
Euro 3	Jan 2001	4.17	0.25	-	0.18	-	-
Euro 4	Jan 2006	1.81	0.13	-	0.10	-	-
Euro 5	Sept 2010	1.81	0.130	0.090	0.075	-	0.005*
Euro 6	Sept 2015	1.81	0.130	0.090	0.075	-	0.005*

Table 9 (c)

European emission standards for LCV (1760 - 3500 kg. (Category N_1-III) , g/km

Level	Date of Implementation	CO	THC	NMHC	NOx	HC+NOx	PM
Diesel vehicles							
Euro 1	Oct 1994	6.9	-	-	-	1.7	0.25
Euro 2	Jan 1998	1.5	-	-	-	1.2	0.17
Euro 3	Jan 2001	0.95	-	-	0.78	0.86	0.10
Euro 4	Jan 2006	0.74	-	-	0.39	0.46	0.06
Euro 5	Sept 2010	0.74	-	-	0.280	0.350	0.005
Euro 6	Sept 2015	0.74	-	-	0.125	0.215	0.005
Petrol vehicles							
Euro 1	Oct 1994	6.9	-	-	-	1.7	-
Euro 2	Jan 1998	5.0	-	-	-	0.7	-
Euro 3	Jan 2001	5.22	0.29	-	0.21	-	-
Euro 4	Jan 2006	2.27	0.16	-	0.11	-	-
Euro 5	Sept 2010	2.27	0.160	0.108	0.082	-	0.005*
Euro 6	Sept 2015	2.270	0.160	0.108	0.082	-	0.005*

6.1.4 Heavy Duty Vehicles

The heavy duty vehicle emission standards in EU countries are summarized in the Table 10. Dates in the tables refer to new type approvals; the dates for all type approvals are in most cases one year later.

Table 10
EU Emission Standards for HD Diesel Engines, g/kWh (smoke in m^{-1}) (6-10)

Level	Date of implementation	Test cycle	CO	HC	NOx	PM	Smoke
Euro 1	1992, < 85 kW	ECE R-49	4.5	1.1	8.0	0.612	
	1992, > 85 kW		4.5	1.1	8.0	0.36	
Euro 2	Oct. 1996		4.0	1.1	7.0	0.25	
	Oct 1998		4.0	1.1	7.0	0.15	
Euro 3	*Oct 1999 EEVs only*	ESC and ELR	*1.5*	*0.25*	*2.0*	*0.02*	*0.15*
	Oct 2000	ESC and ELR	2.1	0.66	5.0	0.10 0.13[a]	0.8
Euro 4	Oct 2005		1.5	0.46	3.5	0.02	0.5
Euro 5	Oct 2008.		1.5	0.46	2.0	0.02	0.5
Euro 6	Jan 2013		1.5	0.13	0.4	0.01	

EEV = Environmentally enhanced vehicle
a - for engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3000 min^{-1}

Since the Euro 3 stage (2000), the earlier steady-state engine test ECE R-49 has been replaced by two cycles:

(i) the European Stationary Cycle (ESC) and

(ii) the European Transient Cycle (ETC).

Smoke opacity is measured on the European Load Response (ELR) test. The following testing cycles apply to different Euro standards:

1. Diesel engines:
   - Euro III:
     (i) Conventional diesel engines: ESC/ELR test
     (ii) Diesel engines with "advanced after-treatment" (NOx aftertreatment or DPFs) and EEVs: ESC/ELR + ETC
   - Euro IV and later: ESC/ELR + ETC
2. Natural gas/ LPG engines
   - Euro III and later: ETC cycle

Emission standards for diesel engines that are tested on the ETC test cycle, as well as for other heavy-duty gas engines, are summarized in Table 11.

Table 11
Emission Standards for Diesel and Gas Engines, ETC Test, g/kWh (6-10)

Level	Date	Test	CO	NMHC	CH_4 [a]	NOx	PM [b]
Euro 3	*Oct. 1999 EEVs only*	ETC	*3.0*	*0.40*	*0.65*	*2.0*	*0.02*
	Oct 2000		5.45	0.78	1.6	5.0	0.16 0.21 [c]
Euro 4	Oct .2005.		4.0	0.55	1.1	3.5	0.03
Euro 5	Oct. 2008.		4.0	0.55	1.1	2.0	0.03
Euro 6	Jan. 2013.		4.0	0.16 [d]	0.5	0.4	0.01

a - for gas engines only (Euro III-V: NG only; Euro VI: NG + LPG)
b - not applicable for gas fueled engines at the Euro III-IV stages
c - for engines with swept volume per cylinder < 0.75 dm^3 and rated power speed > 3000 min^{-1}
d - THC for diesel engines

Euro 6 regulation have some additional provisions. The Euro 6 regulation also includes:

- An ammonia (NH_3) concentration limit of 10 ppm applies to diesel (ESC + ETC) and gas (ETC) engines.
- A particle number limit, in addition to the mass limit, is to be introduced in the implementing regulation. The number limit would prevent the possibility that the Euro VI PM mass limit is met using technologies (such as"open filters") that would enable a high number of ultra fine particles to pass.
- A maximum limit for the NO_2 component of NOx emissions may be defined in the implementing regulation.

6.1.5 Evolution of Emission Limits for HD Diesel Vehicles in Europe

Evolution of heavy duty vehicle emissions in EU countries is shown in Fig. 8. The two main pollutants of concern for the diesel vehicles are the NOx and PM. In Fig. 8, the emission limits for PM and NOx are plotted starting from the Euro 1 standards. The Euro 2 limits stipulated 12.5% lower NOx and 30% lower PM compared to Euro 1 standards. The Euro 4 and Euro 5 PM limits are just about 5 % of that of Euro 1 limits. However, when Euro 6 standards would be implemented in the year 2013, the PM emissions would be lowered by another 50%. The Euro 6 PM limits would be little under 3 % of the Euro 1 standards resulting over 97 % reduction in the PM emissions.

The NOx limits were reduced by 55 % from Euro 1 to Euro 4. The permissible NOx emissions were further lowered by about 43 % from Euro 4 to Euro 5 and will be reduced by another 75% in the year 2013 when Euro 6 standards would come into force. The Euro 6 NOx limits for heavy duty diesel vehicles would be just 5% of the Euro 1 limits, a reduction of 95%.

Obviously, compliance with such drastically reduced emission limits requires use of advanced exhaust after-treatment devices for PM and NOx control. Use of exhaust after-treatment devices e.g., continuously regenerating particulate traps and lean de-NOx catalysts necessary for meeting the Euro 5 and Euro 6 emission levels require use of high quality diesel fuels, which are almost free of sulphur besides improvements in other properties e.g., cetane number, lower 90 % evaporation temperature and closer control on fuel density and viscosity.

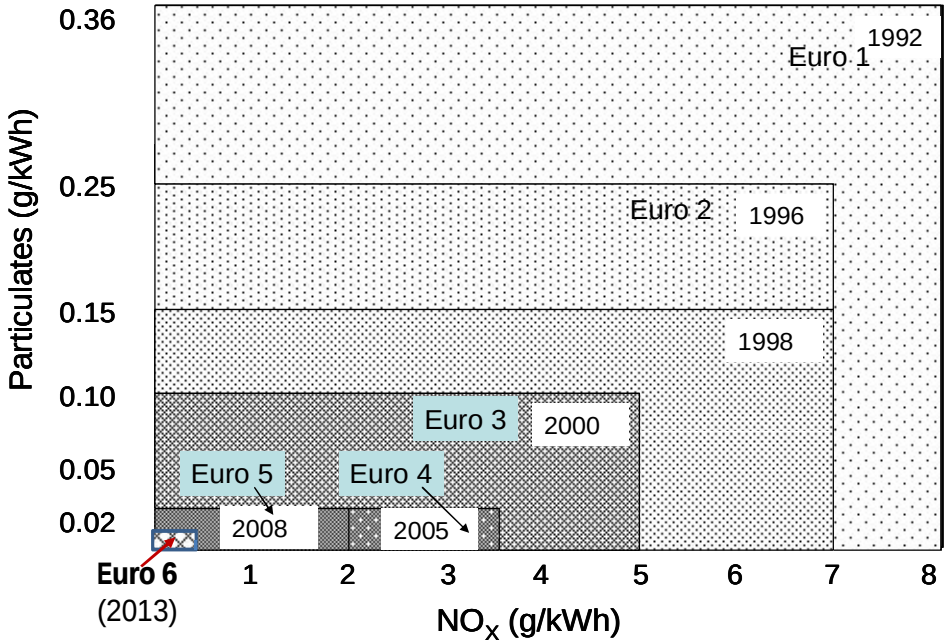


Figure 8: Evolution of HD diesel PM and NO_x standards in Europe (ESC limits)

6.1.6 Emission Durability

The E U regulations also prescribe durability requirements that are to be demonstrated by the vehicle manufacturers for type approval certification. Effective October 2005 for new type approvals and, October 2006 for all type approvals, the emission durability for different category vehicles are given in Table 12.

Table 12
Emission Durability Requirements in EU Countries

Vehicle Category	Period*	
	Euro 4 and 5	Euro 6
N1 and M2	100 000 km / 5 years	160 000 km / 5 years
N2 and N3 ≤ 16 ton M3 Class I, Class II, Class A, and Class B ≤ 7.5 ton	200 000 km / 6 years	300 000 km / 6 years
N3 > 16 ton M3 Class III, and Class B > 7.5 ton	500 000 km / 7 years	700 000 km / 7 years
* km or year period, whichever is the sooner		

6.2 EMISSION REGULATIONS IN ASIAN COUNTRIES

6.2.1 Light and Heavy Duty Vehicles

Most Asian countries excepting Japan follow the European system of emission regulations. The European standards have been adopted either directly or with some minor modifications in test procedure. For example, in India for the light duty vehicles the maximum speed is limited to 90 km/h in the extra-urban driving cycle (EUDC) part of the test cycle compared to 120 km/h specified in the European ECE 15 + EUDC or NEDC test procedure.

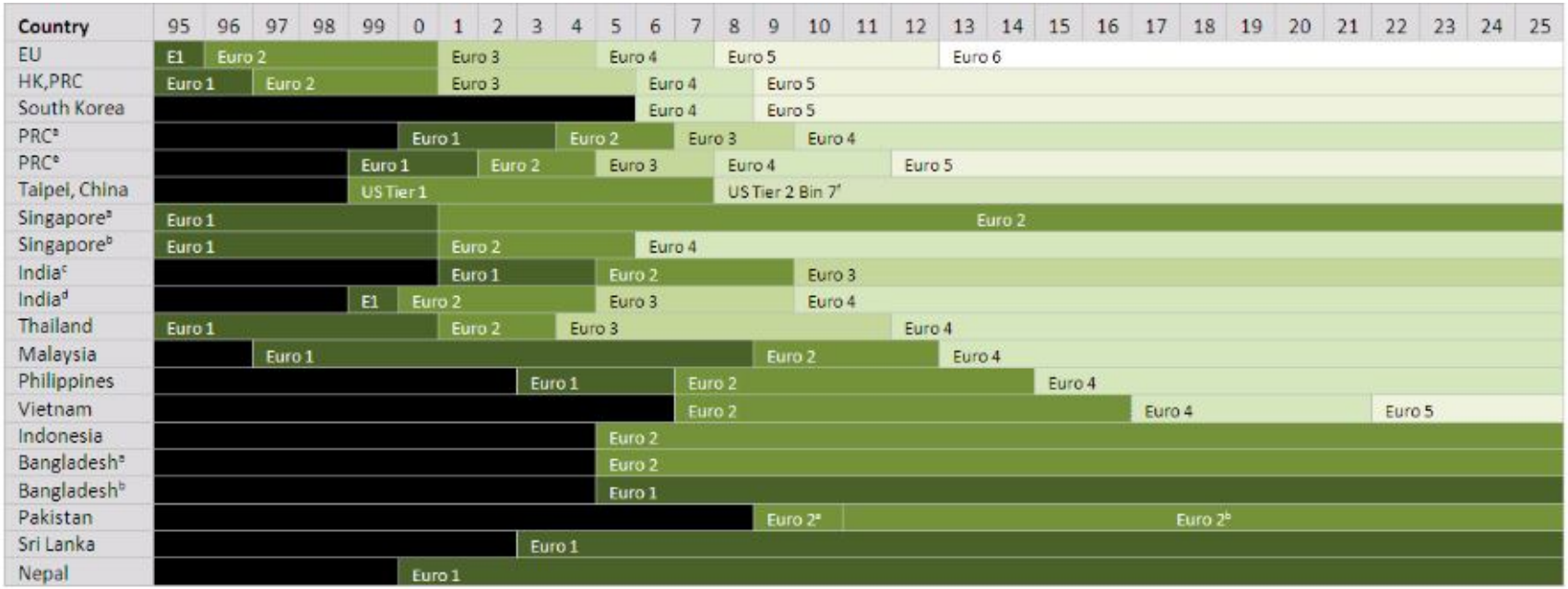
In the Asian countries the trends in emission regulations are compared in Fig 9 (11). As is seen, that most Asian countries now follow the European emission regulations: the test procedures and standards. However, the EU standards are being adopted for implementation implemented with a time lag depending upon local conditions of availability of requisite quality fuel, testing infrastructure, overall technological development and the economic conditions.

The trends in emission standards for heavy duty vehicles in the Asian and EU countries are compared in Fig. 10 . Again, most of the Asian countries have 5 to 15 year time lag compared to the asian countries. For the HD emission standards the quality of diesel fuel with respect to cetane number, final boiling point and tail end volatility, and more particularly the sulphur content is very important. The fuel thus becomes more and more expensive. Hence, many Asian countries are adopting the EU regulations at a relatively slower pace until the economics makes it possible to introduce such fuels and upgrade the other vehicle inspection and servicing infrastructure.

6.2.2 Motorcycles and Three-Wheelers

The motorcycle standards are compared in the Table 13. Most of the Asian countries specify the use European standards including the same test procedure (ECE 40) for motorcycles. In India, the standards different than the European standards have been adopted based on an Indian driving cycle. In future, Europe and other countries all over the world are moving towards testing on a World Motorcycle Test Cycle (WMTC). The standards for the three-wheelers are compared in Table 14 (10-12-14) It is in India, that diesel engine 3-wheelers are in use in large numbers. Hence the standards for the diesel powered 3-wheelers Indian standards only are given.

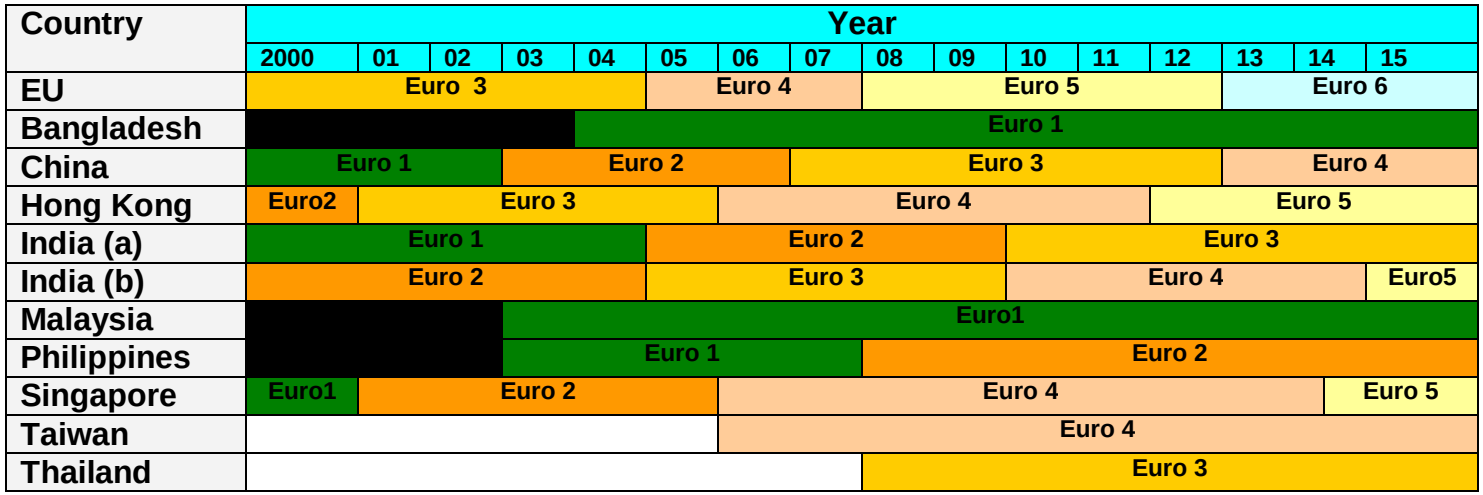
Figure 9
Trends in Emission Standards Implementation for New Light Duty Vehicles in EU and Asian Countries (11)



Notes:
*The level of adoption vary by country but most are based on the Euro emission standards
a – gasoline; b – Diesel; c – Entire country; d – Delhi, Mumbai, Kolkata, Chennai, Hyderabad, Bangalore, Lucknow, Kanpur, Agra, Surat, Ahmedabad, Pune and Sholapur; Other cities in India are in Euro 2; e – Beijing [Euro 1 (Jan 1999); Euro 2 (Aug 2002); Euro 3 (2005); Euro 4 (1 Mar 2008); Euro 5 (2012)], Shanghai [Euro 1 (2000); Euro 2 (Mar 2003); Euro 3 (2007); Euro 4 (2010)] and Guangzhou [Euro 1 (Jan 2000); Euro 2 (Jul 2004); Euro 3 (Sep-Oct 2006); Euro 4 (2010)]; f – Equivalent to Euro 4 emissions standards; Vietnam will implement Euro 3 standards for motorcycles by 2017.

Source: CAI-Asia. September 2011. Emission standards for new light-duty vehicles

Figure 10
Trends in Emission Standards for New Heavy Duty Vehicles in EU and Asian Countries



(a) In India excluding 11 large cities
(b) For the large cities from 4 cities in 2001 to 11 cities at present

Table 13
New Motorcycle Emission Standards in EU and Asian Countries

S. No.	Country	Vehicle Type	Level	Year	Emissions g/km				Durability km
					HC	NOx	HC+ NOx	CO	
1	EU*	M/cycles	Euro 3	2006 > 150 ≤ 150 cc	 0.3-0.8	 0.15 0.15	-	 2.0 2.0	18000
			Euro 4	2014	0.1-0.56	0.13 – 0.57	-	1.0 – 1.97	20000
			Euro 5	2017	0.1 – 0.38	0.07 – 0.3	-	1.0 – 1.4	30000
		Mopeds	Euro 2	2005	-		1.2	1.0	
			Euro 3	2014	-		1.2	1.0	
			Euro 4	2017	0.63	0.17	-	1.0	
2	China	M/cycles		2009	0.3-0.8	0.15		2.0	-
		mopeds		2009			1.2	1.0	
3	India	M/cycles all		2005			1.5	1.5	
				2010			1.0	1.0	
4	Japan	M/cycles 2-st		2005	3.0	0.1	-	8.0	
		4- St		2005	2.0	0.3	-	13.0	
		M/cycles < 125 cc		2007	0.5	0.15	-	2.0	
		M/cycles >125 cc		2007	0.3	0.15	-	2.0	
5	Taiwan	M/cycle all		2005	-	-	1.0-2.5	7.0 - 10.0	
				2008	0.3-0.8	0.15	-	2.0	
6	Vietnam	M/cycle	Euro 2	2007 ≤ 150 > 150 cc	 1.2 1.2	 0.3 0.3	 - -	 5.5 5.5	
			Euro 3	2017	0.3-0.8	0.15		2.0	
		Moped	Euro 2				1.2	1.0	
							1.2	1.0	

** EU standards are different for the motorcycles and 3 wheelers powered by positive ignition, (PI), compression ignition (CI) or hybrid engines

Table 14
Emission Standards for Three Wheelers in EU and Asian Countries

S. No.	Country	Vehicle Type	Level	Year	Emissions g/km				
					HC	NOx	HC+NOx	CO	PM
1	EU*	3- W Commercial vehicles	Euro 3	2014	1.0	0.25	-	4.0	-
			Euro 4	2017	0.55	0.25	-	2.0	-
2	China	3-W M/cycles		2009	1.0	0.25		4.0	-
		3-W mopeds		2009			1.2	3.5	-
3	India	3-W Petrol		2005 2010			2.0 1.25	2.25 1.25	
		Diesel		2005 2010			0.85 0.5	1.0 0.5	0.1 0.05

* EU specifies durability of 10,000 kms for the Euro3 and 11000 for Euro 4 mopeds

7.0 IN– SERVICE VEHICLE EMISSION STANDARDS

7.1 Bangladesh

Emission limits for the petrol/CNG vehicles already in service in Bangladesh are based on idle tests for CO and HC and for the diesel vehicles on free Acceleration smoke. The in-use vehicle emission inspection limits for the vehicles of different categories and vintage are given in Tables 15(a) – 15(c). The vehicles registered before implementation of 2004 rules were allowed relaxed emission limits keeping in view primarily the level of technology of those vehicles and that not adequate awareness existed among motorists before that and hardly any enforcement of the earlier emission standards was done.

Table 15 (a)
Bangladesh Emission Standards for In-Use Diesel Vehicle Registered before September 1, 2004 *(*2)

Vehicle Type	Test	Smoke Opacity		
		Effective 01 September, 2004-31 December, 2006	Effective 01 January, 2007-31 December, 2008	Effective 01 January, 2009
Buses	Free acceleration	80 HSU or 3.7 m^{-1}	70 HSU or 2.8 m^{-1}	65 HSU or 2.4 m^{-1}
Trucks and all other diesel vehicles	Free acceleration	90 HSU or 5.3 m^{-1}	80 HSU or 3.7 m^{-1}	65 HSU or 2.4 m^{-1}

Table 15 (b)
Emission Standards for Petrol and CNG Driven Vehicles Registered before September 1, 2004

Vehicle Type	Test	CO (% by volume)	HC (ppm)
1	2	3	4
4-wheeled petrol vehicles	Idle Speed	4.5	1,200
All CNG driven vehicles	Idle Speed	3.0	-
Petrol driven 2-Stroke engine 2 and 3-wheelers	Idle Speed	7.0	12,000
Petrol driven 4-Stroke 2 and 3-wheelers	Idle Speed	7.0	3,000

Note: Idle Speed RPM to be specified by the manufacturer.

Table 15 (c)
Emission Standards for Vehicle Registered after September 1, 2004

Vehicle Type	Test	CO (% by volume)	HC (ppm)	Lambda (λ)	Smoke
1	2	3	4	5	6
4-wheeled petrol and CNG vehicles.	Idle Speed	1.0	1200	-	-
	No load, 2500-3000 RPM	0.5	300	1.0 ± 0.03	-
Petrol driven 4-Stroke 2 and 3-wheelers	Idle Speed	4.5	1200	-	-
CNG driven 3-wheelers	Idle Speed	3.0	-	-	-
Naturally aspirated diesel vehicles	Free acceleration	-	-	-	65 HSU or 2.5 m^{-1}
Turbo-charged diesel vehicles	Free acceleration	-	-	-	72 HSU or 3.0 m^{-1}

Note: Idle speed rpm to be specified by the vehicle manufacturer.

7.2 Europe and Other Asian Countries

7.2.1 Petrol/CNG Cars

The in-use vehicle emission standards for the petrol and CNG light duty vehicles in EU and several Asian countries are given in Table 16 (6-9). emission inspection standards for the light duty vehicles operating on petrol and CNG, are based on idle tests. Some standards including the EU standards stipulate only the idle CO limit (the member states

Table -16
Inspection Test Limits for In-Use Petro l/CNG Vehicles in Europe and Asian Countries

Country	**Vehicle type**	**Test**	**CO % vol.**	**HC ppm**	**Other Requirements/ Remarks**
EU	Without 3-W catalysts	Idle	3.5	-	-
	With 3-W catalysts	Idle	manufacturers limit or 0.5 max	-	
		Fast idle at 2000 rpm	0.3	-	λ = 0.97 -1.03
UK	Cars Pre 1992 model year	Idle	3.5	1200	-
	post 1992 model year	Idle	0.5	-	
		Idle 2500-3000 rpm	0.3	200	λ = 0.97 -1.03
Bangladesh	All petrol and CNG from 2004	Idle	1.0	1200	
		Fast idle 2500-3000 rpm	0.5	300	λ = 0.97 -1.03
China	Cars	Idle	3.5	700	
India*	Cars other than Euro 2	Idle	3.0	1500	
	Euro 2 and later	Idle	0.5	750	
		Fast idle 2500 rpm	To be measured	To be measured	λ to measure and report
Japan	Petrol vehicles 4-stroke	Idle	4.5	1200	
	2-stroke		4.5	7800	
Malaysia	Cars	Idle	3.5	600	
Singapore	cars	idle	3.5	-	
Taiwan	Cars	Idle	3,5	600	
Thailand	Cars	Idle	4,5	600	
Vietnam	Cars	Idle	4.5	1200	

*For CNG & LPG vehicles the measured Hydrocarbon value is converted using the following formula and then compared with the limits
- For CNG Vehicles- Non Methane Hydrocarbon, NMHC = 0.3 x HC
- For LPG Vehicles- Reactive Hydrocarbon, RHC = 0.5 x HC

are free to stipulate additional parameters or more stringent regulations). However, most countries today specify also the idle hydrocarbon emissions EU specification added a high speed idle test for the vehicles fitted with the 3-Way catalytic converters. At the high idle speeds, the exhaust gas temperatures increase and the catalyst starts functioning. The high idle speed test thus, enables to know if the catalyst is functional or not. The following important remarks in relation to trends in-service vehicle emission standards may be made;

(i) In Europe since the introduction of Euro 1 standards, the inspection test limits have remained the same. As the more advanced emission control systems needed by Euro 4 or Euro 5 vehicles do not necessarily reduce idle emissions any further, the limits have been retained at the levels specified for the Euro 1 vehicles.

(ii) In Europe, in addition to the emission inspection tests, use of On- Board Diagnostics (OBD) systems on the vehicles has been made mandatory. EU Directive 98 /69/EC required OBD systems to be fitted from 2000 (8). An OBD system consists of a computer included in the vehicle's electronics for detecting operational malfunctions of the engine control system. The OBD system continuously monitors the functioning of important engine parameters that affect emissions and the functioning of the emission control systems like EGR, catalytic converter etc. In case of failure of the emission control systems, the dashboard flashes the warning signal and prompts the operator to get the vehicle repaired. The OBD is not the substitute of inspection tests but it complements the maintenance of vehicles.

(iii) For the CNG and LPG fuelled vehicles, the HC limits have been effectively put at a higher level in the Indian standards as the unburned HC from the CNG/LPG vehicles consists of a high amount of methane. As methane is not photo-chemically reactive its emissions are to be deducted from the total HC measured when comparing with the limits permitted by the standards.

7.2.2 Motorcycles and Petrol/CNG 3 –Wheelers

The emission inspection limits for motorcycles and, the petrol and CNG fuelled 3-wheelers in different countries are compared in the Table 17. As the motorcycles do not use 3-Way catalysts their CO and HC limits are set at a higher level than those for the 4-wheeled vehicles.

Secondly, for the 2-stroke engine motorcycles a higher HC limit is permitted due to its inherent design problems. However, in most countries the production of 2-stroke engine motorcycles is nearly stopped or is being phased-out. For the CNG vehicles the corrections to HC is applied in India as discussed above.

Table 17
In-Use Emission Inspection Standards for Motorcycles and Petrol/CNG 3-Wheelers in Asian Countries

Country	Vehicle type	Test	CO % vol.	HC ppm
Bangladesh	Motor cycles	Idle	4.5	1200
	3-Wheelers Petrol	Idle	4.5	1200
	3- W CNG	Idle	3.0	-
China	Motorcycles Post 1996 4-Stroke	Idle	4.5	2200
	2-stroke		4.5	8000
India*	Motorcycles and 3-Wheeler	Idle		
	Pre 2000, 2/4-Stroke		4.5	9000
	Post 2000, 4- Stroke		3.5	4500
	Post 2000, 2-stroke		3.5	6000
Japan	Motorcycles 4-stroke	Idle	4.5	1200
	2-stroke		4.5	7800
Malaysia	All Motorcycles	Idle	3.5	600
Singapore	All Motorcycles	idle	4.5	-
Taiwan	All Motorcycles	Idle	3,5	2000
Thailand	All Motorcycles	Idle	4,5	10000

*For CNG & LPG vehicles the measured Hydrocarbon value is converted using the following formula and then compared with the limits.
- For CNG Vehicles- Non Methane Hydrocarbon, NMHC = 0.3 x HC
- For LPG Vehicles- Reactive Hydrocarbon, RHC = 0.5 x HC

7.2.3 Heavy Duty Diesel Vehicles

Diesel smoke emission inspection standards for different countries are given in are given in Table 18. The diesel smoke inspection in most countries is done using free acceleration (FA) test due to its low cost and ease of implementation. In FA test, the accelerator pedal is fully pressed with the vehicle stationary in neutral gear and peak smoke value is recorded. For the turbo-charged vehicles, a higher smoke limit is permitted due to non-functioning of turbocharger during free acceleration mode of engine operation. However, the free acceleration test does not represent diesel engine operation in actual conditions. At best, FA smoke is supposed to have a directional correlation with the smoke emitted during the real-life vehicle operation. In view of the deficiency of FA test, some countries like Hong Kong and Singapore have implemented annual smoke emission inspection tests under full engine load operation on a chassis roller dynamometer. The test is carried out in 4th gear or 3rd gear engine operation with accelerator fully pressed and the engine operated at 100, 90 and 80 % of maximum engine speed. The test takes about 15 to 20 minutes. However, such a tests can be implemented only in a centralized inspection station and the chassis dynamometer system needed is expensive equipment. In Europe practically all countries still use FA test for diesel smoke inspection.

Table 18
In-Use Diesel Smoke Emission Inspection Standards in Europe and Asian Countries
(6-9,15)

Country	Vehicle type	Test	Smoke Limit	
			Opacity, % HSU	Absorption Coefficient, m^{-1}
EU	> 3.5 ton GVW Naturally Aspirated	Free Accn.	-	COP value or 2.5 max.
	Turbocharged		-	COP value or 3.0 max.
Bangladesh	Naturally Aspirated	Free Accn.	65	2.5
	Turbocharged		72	3,0
China	All	Free Accn.	4.0 Bosch	-
Hong Kong	HDV	Full Load	60	
India*	All, naturally aspirated or turbocharged HDV, diesel cars and three wheelers	Free Accn.	65	2.45
Malaysia	All diesel HDV	Free Accn.	50	
Singapore	HDV	Full Load test on chassis rolls at 100, 90 and 80 % of rated speed	50	
Taiwan	HDV	Free Accn. and Full Load	40	
Thailand	HDV	Free Accn.	45	
Vietnam	HDV	Free Accn.	72	

***** For CNG buses and other heavy duty vehicles the standards for the petrol/CNG cars apply, The measured Hydrocarbon value is converted using the following formula and then compared with the limits
- For CNG Vehicles- Non Methane Hydrocarbon, NMHC = 0.3 x HC
- For LPG Vehicles- Reactive Hydrocarbon, RHC = 0.5 x HC

7.3 Frequency of Emission Inspection

Frequency at which the in-use vehicles are inspected varies quite a bit among the different countries. More frequent inspections may be expected to keep vehicles in good mechanical condition and at low emission levels. On the other hand, cost of inspection increases and a large number of inspection centers are required. The cost-benefit analysis is difficult to carry out as the benefits of low emissions are to be quantified and compared with the cost of inspection and repairs if done. In Eurpoe, a new light duty vehicle is exempted from inspection for three years. After 3 years , the cars and other light vehicles are required to submit themselves for annual inspection. On the other extreme are

countries like India where all the new vehicles after one year are required to present themselves for inspection every 3 months.
The purpose of in-use vehicle emission inspection is to identify and repair the gross polluters as it is often said that 20 to 30 percent bad vehicles contribute 70 to 80 % of total vehicular pollution. More frequent emission inspection needs a very large number of inspection centers in a large city with high vehicle population. To monitor functioning of a large number of inspection centers so that the emission inspections are done correctly and fraudulent practices are not resorted to, requires a very well organized and technically skilled supervisory government/neutral body. In practice, it has been found to be very difficult. In Table-19 frequency of emission inspection followed in EU and some other countries are given.

Table 19
Emission Inspection Frequency

Country	Vehicle Type	Vehicle age before Ist inspection, years	Frequency of inspection, years (months)
EU	Cars	3	1
	LCV <3.5 ton	4	2
	HDV, taxis, ambulances	1	1
Germany	Cars, no catalyst or oxi .cat.	1	1
	Cars, 3-W catalyst	3	2
	Diesel < 3.5 ton	3	2
	Diesel > 3.5 ton	1	1
India	All	1	1/4(3 months)
Singapore	Private cars, light vehicles	2	2
	Commercial vehicles, taxis, trucks	1	1

8.0 RECOMMENDATIONS ON REVISION OF EMISSION STANDARDS FOR BANGLADESH

8.1 Factors Influencing Emission Limits

The following factors among others may be kept in view when arriving at recommendations of future emission standards in Bangladesh;

(i) Contribution of vehicle emissions to air pollution and its impact on air quality in urban areas,
(ii) Contribution of different categories of vehicles to total emissions,
(iii) Available fuel quality and plans for its upgradation,

(iv) Likely use of alternative fuels like CNG,
(v) Emission standards in force and the future plans thereof in the countries from where the vehicles are imported and the emission standards being followed in other countries who also depend on vehicle imports.

These are some of the important technical factors which affect the selection of emission limits to be implemented in a given region or country who do not manufacture vehicles bu import their needs. There could be several other factors related to economics, infrastructure etc which would also influence the decisions on vehicle emission standards as a measure to improve air quality in a given country. Some of the above technical factors are discussed here in the light of available data which is however, rather limited.

8.1.1 Contribution of Vehicles to Air Pollution

Vehicle emission inventory for Dhaka is being developed under CASE project. Earlier projections on emission inventory done around 2000-01 have little relevance today as the vehicle population, vehicle technology and fuel type have had a large change in the meantime. Although, vehicle emission inventory and its relative contribution to air pollution in Dhaka is being studied, the source apportionment studies conducted by Atomic Energy Center, Dhaka, Bangladesh *[Begum et. Al., Atmospheric Environment, (45 (2011) 7705-7713]* put the vehicles in the year 2006 as the second largest contributors after the brick kilns to air pollution in Dhaka. The vehicles in near future may be expected to become the primary contributors to air pollution due to;

(i) Fast increasing population of motorized vehicles as the economy of the country grows,
(ii) The brick kilns are easier to control being the point source and these activities may also be moved away from the city, reducing their contribution to air pollution in Dhaka
(iii) Contribution of other sources like domestic burners which use natural gas is expected to ber low as these use a lot of excess air, are a steady combustion appliance and are low emitters of CO (generally < 0.01 %) and unburned fuel (methane)

Directionally one may conclude that to keep the air pollution in Dhaka city under check, progressively stricter vehicle emission standards would have to be implemented.

8.1.2 Fuel Quality

Petrol

For implementation of standards equal to Euro 1 and better the petrol and CNG vehicles have to be necessarily equipped with catalytic converters. In the modern petrol vehicles the 3-Way catalytic converter coupled with a closed loop feedback controlled port fuel injection (PFI) has become a standard technology. Besides it, several other technologies like evaporation emission control, PCV for crankcase emission control and EGR etc., complement the emission reduction technology from petrol vehicles. The main

requirements of the fuel for catalyst equipped low pollution vehicles powered by the petrol engines are;

(i) Lead free
(ii) Low sulphur content (< 150 ppm)for high efficiency of the catalytic converter say the Euro 3 emission levels
(iii) High oxidation and storage stability, and use of deposit control multi-functional additives for trouble free operation of the port fuel injection system
(iv) Appropriate volatility characteristics

Lead free fuel is an essential requirement for the exhaust catalyst equipped vehicles as lead is a poison for the catalyst. Lead free gasoline has already been introduced in Bangladesh since 1999. Low sulphur is a desirable characteristic. Normally, sulphur content in gasoline is quite low (< 500 ppm) compared to diesel. Further lower sulphur content improves the efficiency of the catalytic converters. Fuel stability and volatility affect emissions over a long period of vehicle operation and do not have a direct adverse effect on the operation and efficiency of the catalytic converters as lead and sulphur have. High fuel oxidation and storage stability, use of deposit control additives and narrower controls on fuel volatility help in maintenance of vehicles at a low emission level over a longer period of operation.

Motorcycles, if necessary use only the oxidation type catalytic converters for CO and HC emission reduction. Three-Way catalysts still do not find application on motorcycles due to their complexity of hardware and operation.

The present petrol specifications in Bangladesh are given in Annexure C. The regular grade gasoline is of a very poor quality especially in respect of octane quality that is 80 RON min. only. It is due to this reason that most motorcycle dealers advise their clients to use premium grade gasoline for their vehicles. The regular grade gasoline in fact, should be made compatible with the requirements of motorcycles as most gasoline in cities like Dhaka is used primarily by the motorcycles, the 3-wheelers and cars being mostly CNG operated. The petrol quality may not be a major obstacle in introduction of the next stage (Euro 3) of emission regulations in Dhaka city and Chittagong as a large fraction of petrol is imported in Bangladesh and usually most refineries in the world produce fuels of a quality required to meet the needs of low pollution vehicles.

CNG

In Dhaka nearly 95% of the passenger cars, taxis and 3-Wheelers and about 80 % of station wagons are fuelled by CNG. About 50% of buses are also CNG operated. CNG has very little sulphur and no lead. There are no engine operation related issues concerning volatility or storage stability of CNG. The CNG vehicles also use spark ignition engines. The only exceptions are the dual-fuel diesel-CNG engines which in any case are not suitable for meeting Euro 2 or Euro 3 emission standards for heavy duty vehicles. The CNG vehicles are well suited like the petrol cars/vans for the use of advanced catalytic converters to achieve Euro 3 emission targets.

Diesel Fuel

For the diesel vehicles more advanced emission controls are directed towards reduction of PM and NO_x emissions. The CO and HC emissions from the diesel vehicles are not of major concern. The diesel fuel characteristics that are important for low pollution engines/vehicles include;

(i) Sulphur content: it is important from the point of PM emissions. Sulphur < 500 ppm for Euro 2 and < 350 ppm for Euro 3 is required
(ii) Cetane number preferably 48 and above for good combustion
(iii) Lower final and 90 % or 95% boiling temperatures for good engine combustion, low deposits and hence low emissions over a longer period of engine operation

Diesel fuel produced in Eastern Refinery contains about 1 % m/m sulphur. According to Dr . Khaliquzzaman of WB, actual sulphur content is somewhere around 0.2 - 0.5 % as the imported diesel of low sulphur content is mixed with high sulphur diesel produced by the local Chittagong refinery. The current standards in Bangladesh specify 0.5% max. sulphur in diesel fuel (Annexure C). As most of the petroleum fuels, petrol and diesel in Bangladesh are imported as finished product, a high sulphur level has been retained in the specifications due to high cost of low sulphur imported fuel. Moreover, almost half the diesel is used in agriculture machinery. Introduction of low sulphur diesel for transport will require a separate distribution system which is considered unfeasible. However, this situation is about to change. The petroleum refineries in the Middle-East from where the low cost, high sulphur (i.e., about 500 ppm) diesel are imported will be producing the fuels of superior quality needed now all over the world. Also, there are on-going deliberations on capacity increase of the Chittagong refinery to 4 million tons/annum. This refinery is also slated to be equipped with the hydro-desulphurization units and will produce low sulphur fuels when the refinery expansion work is completed. Hence, introduction of Euro 2 emission levels for diesel vehicles appears quite feasible in the next few years.

In the city of Dhaka, already more than 50% buses are operating on CNG. The diesel trucks are not permitted to enter the city during day. If all the city- buses are mandated for CNG alone operation, then Euro 2 standards for heavy vehicles can be easily implemented for Dhaka.

The second option is to introduce low sulphur diesel in Dhaka city if the logistics so permit and have Euro 2 regulations for all HDVs in Dhaka first and in the rest of the country in due course of time when low sulphur diesel (<500 ppm) is made available everywhere in the country.

8.1.3 Emission Standards in the Countries of Vehicle Import

- In Bangladesh, the reconditioned/used vehicles are imported primarily from Japan. These vehicles in most cases are only 3 years old. Japanese standards for the new vehicles are as stringent as currently in the USA and Europe. Hence even the 3 to 5 year old Japanese cars would have been originally manufactured to Euro 4 or a higher level.
- Nearly all the new vehicles: motorcycles, 3-wheelers, cars, buses are imported from China, India, Japan and South Korea. The current emission standards relative to Euro levels in these countries are given in Table 20.

As seen from the Table 20, the new vehicles manufactured in these countries meet Euro 3 to Euro 5 level of emission standards. Hence any imported vehicle has already been built to Euro 3 or better level. After, some time only Euro 4 or better vehicles would be available for import. If the emission standards in Bangladesh are kept at Euro 2 levels then, the vehicle suppliers at manufacturers' or vehicle dealers' stage will remove the advanced systems and retune the vehicle for the Bangladesh market. It is not likely that these vehicles would be available at a significantly lower price compared to the models being manufactured at the normal assembly lines of the manufacturers. Therefore, there is a strong case that the emission standards in Bangladesh are also upgraded so that these are in tune with the countries of vehicle imports or the import of vehicle technology in case the vehicles are being manufactured locally. This is illustrated (at least partly) by the examples of Malaysia, Philippines and Vietnam who propose to leapfrog from Euro 2 to Euro 4 for light duty vehicles and Singapore for all the diesel vehicles (refer Fig 9).

Table 20
Current Emission Standards in China, India, Japan and South Korea Relative to Euro Levels

Vehicle type	Year 2012 Level of Emission Standards Relative to Euro Standards			
	China	India*	Japan**	South Korea***
Cars and Light Commercial vehicles	Euro 4	Euro 3 and Euro 4	Euro 5 or better	Euro 5
Heavy Duty Vehicles	Euro 3	Euro 3 and Euro 4	Euro 5 or better	Euro 4
3-Wheelers	Euro 3	Better than Euro 3	-	-
Motorcycles	Euro 3	Better than Euro 3 on CO but similar on HC+NOx on Indian driving cycle	Euro 3	-

***** *India uses an India specific driving cycle for motor cycle and 3-wheelers.*
***Japan uses their own driving cycles for cars and HD vehicles*
**** South Korea uses US Federal test procedure for cars and ECE procedure for HD vehicles*

8.2 Views of Stakeholders

The draft report on revisions to emission standards prepared under this consultancy was circulated by the management of CASE project to a number of stakeholders and experts. A stakeholders' meeting attended by representatives, Bangladesh Petroleum Corporation Ltd, Bangladesh Road Transport Authority, Uttara Motors, Bangladesh Automobile Manufacturers' Association, Bangladesh University of Engineering and Technology and DoE was held on 13 December, 2012 to discuss the proposed revisions. The discussions held in the meeting are summarized in Annexure D. One significant proposal was to stipulate different vehicle emission standards for the two large cities viz., Dhaka and Chittagong than the rest of the country. The deliberations of the stakeholders' meeting and comments received from experts of the World Bank, Norwegian Institute of Air Research (NILU) and Prof. P. Hopke, International Consultant, CASE Project were taken into account to finalize the report and make the final recommendations on revision of the emission standards.

8.3 Proposed Revisions to Emission Standards for New Registration Vehicles

Due to high concentration of vehicles in Dhaka and Chittagong more stringent emission standards for these two cities may be considered compared to the rest of country. Such differential system of emission standards is already being used in China and India. Different and more stringent standards apply to Beijing and Shanghai compared to other parts of China. In India too, one step more stringent regulations apply to 11 major cities which include Delhi, Mumbai, Kolkata, Chennai, Bangalore, Kanpur, Agra etc., compared to rest of the country. As mentioned earlier, in the meeting with stakeholders on 13 December, 2012 (Annexure C) it emerged that a differential system of emission regulations also may be applied to Bangladesh. In this system, the cities of Dhaka and Chittagong would have more stringent regulations than the rest of the country. Such a system would also make it possible for the emerging local motorcycle manufacturers/assemblers to meet the lower level of regulations and market their vehicles to customers outside Dhaka and Chittagong where the vehicle density is low and the vehicular air pollution problem is not of a serious concern. Accordingly, two different sets of emission regulations are being finalized and suggested in this report.

Based on the considerations of growing vehicular population particularly in large cities, emission standards in the Asian countries and in the countries from where the vehicles are imported into Bangladesh and likely scenario of transport fuels quality discussed earlier in the report, the suggested two levels of Emission standards for the different categories of vehicles are given in Table 21. The revisions in the standards are proposed up to the year 2019 in two steps. One may also call these Bdesh - 2 and Bdesh - 3 standards.

The detailed emission standards for the new registration vehicles (the new vehicles and imported used vehicles at the time of first registration in Bangladesh) are given in Annexure –A.

Table 21
Proposed Level of Emission Standards for the New Registration Vehicles in Bangladesh

Vehicle Type	Vehicle Class as per the proposed RTTA	Standards from July 2014		Standards from July 2019	
		Dhaka & Chittagong	Rest of Bangladesh	Dhaka & Chittagong	Rest of Bangladesh
All Cars and light duty petrol and CNG vehicles with GVW≤ 3500 kg	Class E (Petrol and CNG)	Euro 3	Euro2	Euro 4	Euro 3
All cars and light duty diesel vehicles with GVW ≤ 3500 kg	Class E (Diesel)	Euro 2	Euro1	Euro 3	Euro 2
All commercial CNG vehicles > 3500 kg	Class A, B, C, and D (CNG)	Euro 3	Euro 2	Euro4	Euro 3
All commercial Diesel vehicles > 3500 kg	Class A, B, C, and D (Diesel)	Euro 2	Euro1	Euro 3	Euro2
Motorcycles	Class M	Euro 3	Euro2	Euro 4	Euro3
3 –Wheeler (CNG)	Class T	Euro 3	As present	Euro 4	Euro 3

8.3.1 The Year 2014 Revisions (Bdesh -2)

The next revision is proposed to be implemented starting from July 1, 2014. In the meantime consultations with the stakeholders may be held and the legal processes necessary to notify regulations/rules may be completed.

The proposed motorcycle standards need a bit more explanation. The 2004 Bangladesh standards stipulate CO limits of 4.5 g/km and HC+ NOx of 3.0 g/km max. on ECE 40 test cycle for the petrol 2 and 3 wheelers. The Euro 2 standards for motorcycles stipulate 5.5 g/km CO, 1.2 g/km HC and 0.3 g/km NO_x. The 2005 Bangladesh standards were formulated based on the standards in force at that time in Taiwan and India and are more stringent on CO but are relaxed on HC+NOx compared to Euro 2. China already implemented Euro 3 standards in the year 2009. Japan has similar to Euro 3 standards

since 2007. India produces motorcycle that have lower CO emissions when tested on the Indian driving cycle lower than the Euro 3 but a little higher on $HC+NO_x$ equal to 1.0 g/km which is slightly higher than the Euro 3 (combined $HC + NO_x$ value of 0.95 g/km in Euro 3 for motorcycles < 150 cc) . Although, there is no direct comparison of the emissions on ECE 40 and Indian driving cycles but it may be assumed that the Indian emission limits are similar to Euro 3 limits for motorcycles of less than 150 cc cubic capacity. The imported motorcycles in Bangladesh (primarily from India and China) may be required to meet the Euro 3 regulations for the motorcycles from the year 2014.

8.3.2 The Year 2019 Revisions (Bdesh-3)

The emission standards may be revised to next stage after another 5 years or so i.e., from July 2019. During the intervening period detailed data on air quality would be available and updated emission inventory would also be available. Based on the data the revisions proposed for the year 2019 may be reviewed in the year 2017 if there is a need to advance the implementation date.

.

8.3.3 Inspection Test of New Registration Imported Used Vehicles

In Bangladesh, used cars and other light duty passenger vehicles only are permitted for import. Only the new motorcycles, auto-rickshaws, minibuses, buses or trucks can be imported and no used vehicles of any of these categories can be imported.

Although, at the time of registration it is being proposed that the vehicle dealers should produce documents certifying that the imported used vehicles had been manufactured to comply with the new vehicle emission standards as given in Annexure – A Tables 1 (A), 2(A), 5(A) and 6(A), yet as these vehicles have already been used for several thousand kilometers and for a few years of operation, these should be subjected additionally to simple emission inspection tests such as the idle emission tests for petrol/CNG vehicles and free acceleration smoke test for the diesel vehicles. Accordingly, emission limits for inspection of these vehicles are given in Table 7(A) of the Annexure-A. These limits have been kept at somewhat more stringent levels than the inspection limits for the in-use vehicles to ensure that the used vehicles in good condition only are imported.

It may be noted that no such limits for motorcycles, 3-Wheelers and other commercial petrol/CNG/diesel vehicles are given as import of these types of used vehicles is not allowed by the government.

8.4 Proposed Revisions to In-Use Vehicle Emission Inspection Standards

The suggested emission inspection standards for the petrol/CNG vehicles of all types and diesel vehicles are given in Annexure-B. Two different sets of in-use vehicle emission standards for the two metro-cities and the rest of the country are proposed taking into account the technology level of vehicles expected to operate in these regions.

The frequency of emission inspection proposed is also, given for different vehicle types in the Annexure B. The first inspection of personal high technology vehicles like cars/ LDVs is proposed to start after 3 years of manufacture as being practiced in Europe. For all commercial vehicles and low technology private vehicles like motorcycles, mandatory emission inspection is to start after one year of manufacture. Subsequently all vehicles are proposed to undergo mandatory inspection once every year.

8.4.1 Petrol/CNG Four-Wheeled Vehicles

.

For the 4-wheeled petrol and CNG vehicles registered after July 2014, the standards equal to those stipulated by EU since the Euro 1 standards are suggested. Since the Euro 1 standards the petrol/CNG vehicles use 3-way catalytic converters as the primary emission control technology, and the inspection standards have remained the same since then. For the CNG 4 wheelers vehicles registered before 2004 HC limits may also be applied. Although, most HC emissions from CNG vehicles are methane which is not photo-chemically reactive, the limit on HC will ensure that the engine is functioning without partial misfiring and a better fuel efficiency of the vehicle results. With partial engine misfiring, CO may still remain within the limits.

These limits also apply to CNG buses powered by the dedicated spark ignited engines.

8.4.2 Petrol/CNG 3- Wheelers

In Dhaka, very few petrol 3-wheelers are in operation. Of a total of 123 three-wheelers inspected by the DoE/CASE team, all were CNG operated and passed the emission limit of 3.0 % CO. Only 3 out of 123 vehicles had CO above 1% and 2 vehicles above 1.5%. It is therefore, suggested that the emission limits for the CNG three-wheelers are brought down to 1.% CO max., and HC limits of 1200 ppm (Annexure B, Table 1B) are also introduced. For the petrol 3-wheelers out of Dhaka and Chittagong also, the emission limits are suggested. For the CNG vehicles no differentiation is necessary among the two metro-cities and the rest of the country.

8.4.3 Motorcycles

During roadside inspection, the DoE/CASE team measured from a total of 196 motor cycles out of which 46 were pre- 2004 motorcycles and 102 were post–2004 motorcycles. Another 48 motorcycles tested did not carry the registration papers. For the motorcycles registered prior to 2004, presently very relaxed standards apply (CO limit 7.0 % max, HC 3000 ppm max.). Data collected during roadside checks by the DoE under CASE project is shown in Fig. 11. The following observations may be made;

(i) There is no significant difference in the emission levels among the motorcycles registered up to the year 2004 and those during the post-2004 year period.

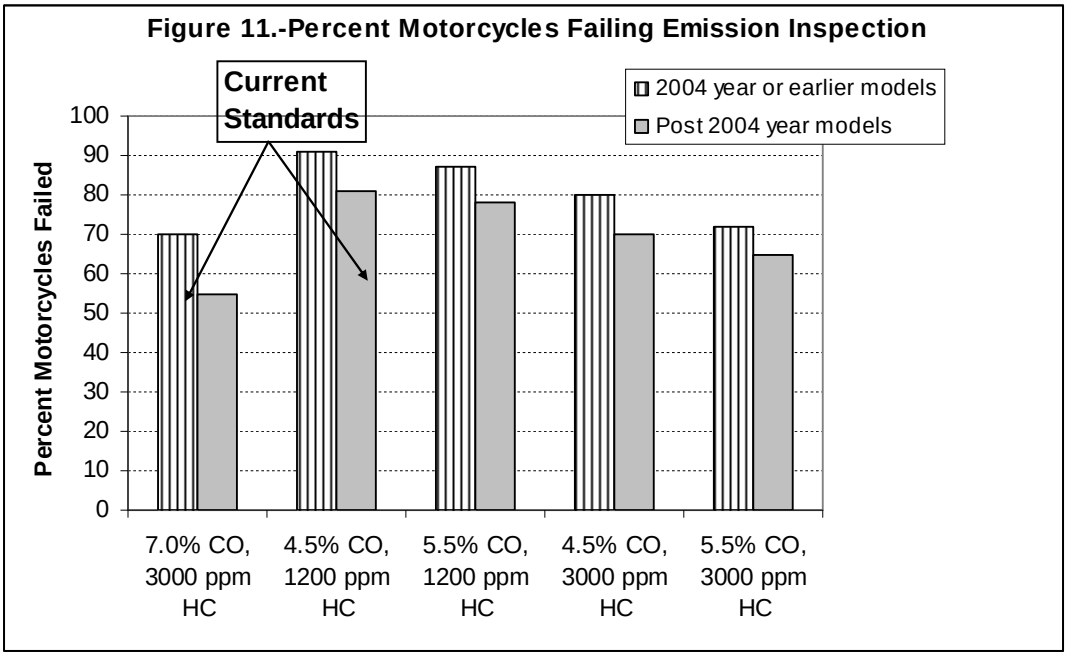
(ii) In both the categories, a large number of motor cycles are failing the inspection limits.

(iii) In general it was seen that more vehicles failed on HC alone than the CO.

(iv) The HC limits in Bangladesh for in-use motor cycles for the post 2004 models are one of the toughest in Asia. It is suggested that it may be relaxed to 3000 ppm.

(v) Even the 4.5 % CO and 3000 ppm HC limits if applied to all the models nearly 75% motor cycles still fail.

Figure 11.-Percent Motorcycles Failing Emission Inspection



Although, there is a need to control emissions from the motorcycles but for practical reasons, it is suggested that for all pre- 2004 motor cycles and petrol 3 –wheelers a relaxed standards of 7.0% CO and 3000 ppm HC is retained. For the motorcycles registered between 2004 and 2014 the HC limits are relaxed from 1200 ppm to 3000 ppm while maintaining CO equal to 4.5 % as before. For post-2014 motorcycles the inspection limits may be tightened (Annexure B, Table 1B) for the cities of Dhaka and Chittagong as Euro-3 motorcycles are proposed to be introduced from the year 2014. For the rest of the country pre-2014 standards may be applied.

8.4.4 Diesel Vehicles

Roadside emission inspection by the DoE/CASE team shows that the diesel vehicles are still very high emitters of smoke. Of the 436 diesel vehicles inspected 316 vehicles (72%) failed the standards. However, there is no point in relaxing the standards as the current standards are fairly relaxed. The EU standards in real practice are more stringent then the 2..5 m^{-1} (65 HSU) as the vehicles are to meet the emission value observed during COP tests which is usually much less than the 2.5 m^{-1} limit. In the other countries, the smoke limit is being tightened in the range of 50 to 60 HSU. The failure of so many diesel vehicles to meet the smoke standards is mainly the problem of enforcement rather then the technical problem. It would be prudent to continue with the

present limits for the pre-2014 diesel vehicles and tighten for the post 2014 year vehicles which are proposed to be of Euro 2 level technology in Dhaka and Chittagong. For the rest of the country earlier limits may apply. The proposed smoke limits for in-use diesel vehicles are given in Annexure B, Table 2B.

9.0 FUEL QUALITY IMPROVEMENTS

To meet the revised more stringent vehicle emission standards, the quality of motor gasoline and diesel fuel also needs improvement. The improvements required in the quality of automotive fuels are discussed below.

9.1 Motor Gasoline

In Bangladesh, two grades of gasoline, regular and premium are marketed. Current specifications of these gasolines are given in Annexure C. The characteristics that need improvements specifically from the point of vehicles meeting the revised emission standards relate to;

(i) Density
(ii) Lead content
(iii) Gum content
(iv) Sulphur, and
(v) Hydrocarbon composition

Density affects the calibration of fuel system and hence it needs to be controlled. As more advanced catalytic converters would be employed to meet the more stringent emission standards, limits on lead and sulphur contents are further lowered. The gum content and hydrocarbon composition particularly the olefin content are related to fuel stability and consequently influence the performance of the engine fuel system in long run. Fuel olefins also increase the content of more reactive hydrocarbons in the vehicle exhaust gases. In gasoline, now the benzene content is also limited to 1% by vol. maximum as it is a known carcinogen. Also, the total aromatic content is controlled so that the benzene content of unburned HC emissions is kept low.

As the regular grade gasoline has a very low octane number, the motorcycle dealers advise the customers instead to use premium grade gasoline. In general, the motorcycles use less advanced engine technology compared to cars. For use by the motorcycles therefore, the regular grade gasoline should be suitably upgraded especially its octane number should be increased close to 90 RON. The premium grade of 95 RON should be used primarily by the high end cars and other light duty vehicles.

As mentioned earlier, the DoE survey found that more than 96 % cars are CNG operated. As for CNG, lead is non-existent, sulphur is very low and there are no oxidation or storage stability concerns. CNG properties are specified more to control its energy content and handling problems.

The main characteristics of gasoline to meet the proposed revised standards for the years 2014 and 2019 are given in Table 22. These are based on the EN 228: 1999 and 2004 gasoline specifications of Europe used to meet the Euro 3 and Euro 4 regulations (6-8). As mentioned earlier, the upgraded regular grade gasoline may be preferentially marked throughout the country to meet the needs of motorcycles and other petrol vehicles.

Table 22
Key Gasoline Fuel Characteristics to Meet the Revised Vehicle Emission Standards

Property	Regular			Premium			Method
	Current	2014	2019	Current	2014	2019	
Density, kg/m^3	-	720-775	720-775		720-775	720-775	@
Octane Number (R), min.	80	91	91	95	95	95	@
Sulphur, mg/kg	1000	500	150	1000	150	50	@
Gum content (solvent washed) mg/100 ml	-	5	5	-	5	5	ISO 6246
Lead content, g/l	0.013	0.013	0.005	0.13	0.005	0.005	@
Hydrocarbon composition*		-	-	-	-	-	ASTM D1319
		-	-	-	-	-	
Olefin, % vol	-	-	21	-	21	18	
Aromatics, % vol	-	-	42	-	42	35	

@ As in the current standards

* Benzene limit of 1% vol. max may be included from the point of health effects of benzene emissions from vehicles.

9.2 Diesel Fuel

For the diesel vehicles to meet PM limits of Euro 2 and Euro 3 standards, sulphur content of diesel fuel was reduced. Density and viscosity are controlled within closer limits to meet the calibration requirements of fuel injection system. Other properties like, cetane number, tail end volatility, content of total contaminations or sediments, lubricity etc., have to meet the needs of the engine for good performance over its lifetime. The current specifications of key diesel fuel properties and those needed to meet the year 2014 and 2019 emission targets in Dhaka and Chittagong are compared in Table 23. These are based on the EN – 590:1993 and 1999 diesel fuel specifications of Europe that were specified to meet the Euro 2 and Euro 3 regulations (6-8). The diesel fuel specifications for the rest of the country are given in Table-24.

Table 23

Key Diesel Fuel Characteristics to Meet the Revised Vehicle Emission Standards in Dhaka and Chittagong

Property	Current	2014	2019	Method
Density, kg/m^3	820-870	820-860	820-845	@
Cetane number Cetane index	45 -	49 46	51 46	@ ISO 4264
Kinematic viscosity at 40 °C, mm^2/s	9.0 max at 38°C	2.0-4.5	2.0-4.5	@
Total contamination, mg/kg	-	24	24	EN 12662
Oxidation Stability, g/m^3	-	-	25	ASTM D 2274
Polycyclic Aromatic Hydrocarbons, % m/m	-	-	11	EN 12196
Sulphur total, mg/kg	5000	500	350	@
Distillation 90% recovery at °C 95% recovery at °C	- 375 -	- - 370	- - 360	@
Lubricity, corrected wear scar dia., µm	-	-	460	ISO 12156-1

@ As in the current standards

Table 24

Key Diesel Fuel Characteristics for Rest of the Country (excluding Dhaka and Chittagong)

Property	Current	2014	2019	Method
Density, kg/m^3	820-870	820-860	820-860	@
Cetane number Cetane index	45 -	45	49 46	@ ISO 4264
Kinematic viscosity at 40 °C, mm^2/s	9.0 max at 38°C	2.0-4.5	2.0-4.5	@
Total contamination, mg/kg	-	-	24	EN 12662
Oxidation Stability, g/m^3	-	-	-	ASTM D 2274
Sulphur total, mg/kg	5000	2000	500	@
Distillation 90% recovery at °C 95% recovery at °C	- 375 -	- 360 -	- - 370	@

10.0 CONCLUSIONS AND RECOMMENDATIONS

The September 2012 report presenting recommendations on revisions to emission standards for Bangladesh was circulated by the CASE Project (DoE component) management to various stakeholders and other experts. Subsequently, the standards and the related issues such as fuel quality, vehicle manufacturing activities etc., in Bangladesh were discussed in a stakeholders' meeting on 13 December 2012 held at Paribesh Bhaban, Department of Environment. One significant suggestion during the meeting was made to stipulate two different sets of emission standards, one for the metropolitan areas of Dhaka and Chittagong, and another for the rest of the country. Taking into consideration the discussions held in the stakeholders' meeting and comments received from the other experts, the draft report on revisions to vehicle emission standards for Bangladesh has been finalized and is presented here.

The findings and recommendations made in the final report are given below;

(i) Vehicle population in Dhaka today stands at about 708 thousands which accounts for 41 % of total vehicle population of 1,752 thousands in the entire country. The vehicle population growth since the year 2003 has been close to 135% both in Dhaka as well in whole of Bangladesh.

(ii) Although emission inventory data is not available but source apportionment studies of 2006 showed that the vehicles were the second largest contributors after the brick kilns, to carbonaceous content of airborne particulate matter in Dhaka. However, increasing population of the vehicles will make them the main contributor of air pollution in the city as the brick kiln activities in the neighborhood are bound to decline.

(iii) In Bangladesh, the 2005 standards were based on Euro 2 for the petrol/CNG light vehicles and Euro 1 for the heavy duty vehicles. Most of the Asian countries excepting Japan and South Korea (light duty vehicles) follow the Euro standards with a time lag depending upon the local conditions specific to that country.

(iv) Up to date trends in emission standards in EU are presented in the report with numerical values. For the Asian countries the trends in emission standards in terms of Euro levels are presented for a quick glance on the trends. Among the followers of EU regulations China, Hong Kong and India are leading the Asian countries.

(v) Nearly all the vehicles in Bangladesh are imported, the new ones from China, India and South Korea, and the reconditioned ones from Japan. Hence, the emission standards prevalent in these countries constitute an important factor to be considered besides the fuel quality and alternative fuel that is likely to be available in the country.

(vi) It is envisaged that fuel quality will undergo upgrading as most of the fuel is imported as the finished product and the refineries all over the world are producing fuels of superior quality to meet the demands of low emission vehicles in their own country and for exports.

(vii) Based on the above considerations two stages of revisions in the standards for the new registration vehicles have been proposed; the first in the year 2014 and the second in 2019. The second revision may be reviewed in the light of air quality data and emission inventory data that would be available in the meantime.

(viii) As the vehicle density is much higher in Dhaka metropolitan area and Chittagong compared to other cities of the country it perhaps would be more cost-effective to have more stringent emission regulations for Dhaka and Chittagong compared to rest of the country. Accordingly, two sets of emission standards for Bangladesh are proposed for implementation. The proposed standards for in-use vehicles (depending on vehicle type and vintage) are also different for the two different regions.

(ix) The proposed standards for the new registration vehicles in terms of Euro levels are given in the Table 0.1. The emission limits and other information is presented in Annexure –A.

Table 25
Proposed Level of Emission Standards for the New Registration Vehicles

Vehicle Type	Vehicle Class as per the proposed RTTA	Standards from July 2014		Standards from July 2019	
		Dhaka & Chittagong	Rest of Bangladesh	Dhaka & Chittagong	Rest of Bangladesh
All Cars and light duty petrol and CNG vehicles with GVW≤ 3500 kg	Class E (Petrol and CNG)	Euro 3	Euro2	Euro 4	Euro 3
All cars and light duty diesel vehicles with GVW ≤ 3500 kg	Class E (Diesel)	Euro 2	Euro1	Euro 3	Euro 2
All commercial CNG vehicles > 3500 kg	Class A, B, C, and D (CNG)	Euro 3	Euro 2	Euro4	Euro 3
All commercial Diesel vehicles > 3500 kg	Class A, B, C, and D (Diesel)	Euro 2	Euro1	Euro 3	Euro2
Motorcycles	Class M	Euro 3	Euro 2	Euro 4	Euro3
3 –Wheeler (CNG)	Class T	Euro 3	As at present	Euro 4	Euro 3

(x) Emission Inspection standards for compliance at the time of vehicle registration for the imported used cars and light duty passenger vehicles are also given in Annexure-A to ensure that these vehicles are in an acceptable good condition. No such standards for the motorcycles, 3-wheelers and commercial vehicles like buses and trucks are proposed as import of used vehicles of these types is not allowed in the country.

(xi) The standards for the in-use vehicle inspections have been recommended and are given in Annexure-B. The emission inspection data collected by the DoE/CASE team were considered along with the low emission potential of the vehicles that are proposed to be introduced in the year 2014 and later. Motor cycle inspection standards for HC are suggested to be relaxed for the present vehicles as the present HC standards for the motorcycles are significantly more stringent than those in China, India, Thailand etc., and nearly 80 % of motorcycles are seen to fail the inspection tests. The CNG 3-wheeler standards may be set at CO = 1.0 % as nearly 98 % vehicles tested gave CO emissions lower than this value. It is suggested that HC limit for CNG vehicles also is introduced to keep the engine in fuel-efficient mode of operating conditions. Car inspection standards are suggested to be in line with EU standards. Diesel vehicle standards are kept unchanged for the pre-2014 model vehicles but made a little tougher for the post 2014 diesel vehicles.

(xii) Fuel quality specifications are to match the needs of the vehicles manufactured to comply with the revised emission standards. An important factor is that in Dhaka most cars, other light duty vehicles and three wheelers operate on CNG. Motorcycles are the primary users of gasoline and these use mostly the premium grade of gasoline as the regular grade of gasoline has a very poor octane number (80 RON). The regular grade gasoline should be suitably upgraded for use of motorcycles and its octane quality may be increased to 91 RON minimum in line with the practice in Europe and most other Asian countries. This improved regular grade gasoline is expected to meet the requirements of motorcycles as well as of most of new petrol cars and station wagons etc.

(xiii) Revisions to gasoline fuel quality particularly related to density, sulphur, content, gum content and hydrocarbon composition based on European specifications EN 228: 1999 and 2004 are recommended. Similarly, based on European diesel fuel specifications EN 590:1993 and 1999, the revised specifications for key diesel fuel properties viz., density, cetane number, sulphur, viscosity etc. are also recommended. Additional parameters such as polyaromatic hydrocarbons and lubricity of ultra-low sulphur fuels are also included from the year 2019.

(xiv) Already two grades of gasoline are being marketed in the country. Depending upon logistics, the oil companies may market diesel fuels of two different qualities one in the two metro-cities and another in rest of the country.

(xv) The mechanism and methodology of enforcement of emission standards that need to be implemented have also been proposed and discussed in detail in the 'Enforcement of Emission Standards and I/M Programme: Draft Report – Part 2,' December 2012, prepared under the consultancy.

REFERENCES

1. Begum et.al., Asian Journal of Atmospheric Environment, Vol. 5-4, December 2011
2. Bangladesh Gazette SRO 220-Law/2005 of 19, July 2005
3. Official website of Bangladesh Road Transport Authority, *www.***brta***.gov.bd*
4. Emission Inspection of In-Use Vehicles in Bangladesh, Ram K. Saha, Clean Air and Sustainable Environment (CASE) Project, December 2012.
5. Proposed Road Transport and Traffic Act, 2011, CASE Project, Dhaka Transport Coordination Board (DTCB), June 2011.
6. Motor Vehicle Emission Regulations and Fuel Specifications : Appendix to Part 1 – 2004-2005 Update, Appendix to Report 5/06, CONCAWE, Brussels, June 2006
7. Motor Vehicle Emission Regulations and Fuel Specifications – Part 1, 2004-2005 Update, June 2006.
8. Motor Vehicle Emission Regulations and Fuel Specifications- Part 2 Historic Review (1996-2005), Report No. 6/06, CONCAWE, Brussels, June 2006.
9. DieselNet: www.dieselnet.com/
10. B P Pundir, *IC Engines: Combustion and Emissions*, Alpha Science, Oxford, 2010.
11. Road Map to Cleaner Fuels and Vehicles in Asia, , CAI-Asia Fact Sheet no 17, September 2011.
12. Ricardo Engineers, UK , Interim Presentation 2011/12 , 6 months to December 2011.
13. Managing 2 and 3 Wheelers in Asia, CAI –Asia Centre, Phillipines, 2011
14. Proposed New Emission Standards for Two and Three Wheeled Vehicles in Europe, International Council for Clean Transportation (ICCT) Policy Update, No. 9, November 8, 2010.
15. Technical Regulations, SIAM (Society of Indian Automobile Manufacturers) India, www.siamindia.com/
16. Central Motor Vehicle Rules, Government of India, 2011.

ANNEXURE -A

Proposed Emission Standards for Bangladesh for the year 2014 and year 2019

Table 1(A)

Proposed Emission Standards for Light Duty Diesel Vehicles during Registration (New and Imported used) for Dhaka Metropolitan Area and Chittagong

(An emission compliance certificate obtained by the vehicle manufacturer or the supplier from an internationally accredited emission testing laboratory/agency is to be produced for clearance of vehicle imports and also at the time of vehicle registration)

Vehicle type	Emission Standards (g/km)					Test Procedure
	CO	HC	HC + NOx	NOx	PM	
Effective from July 2014						
Light duty (Class E) (Not more than 8 seats in addition to driver & max. weight upto 2.5 tons)	1.0	-	0.7	-	0.08	93/59//EC 96/69/EC
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & weight more than 2.5 tons but upto 3.5 tons	1.5	-	1.2	-	0.17	
Effective From July 2019*						
Light duty (Class E) (Not more than 8 seats in addition to driver & max. weight upto 2.5 tons)	0.64	-	0.56	0.50	0.05	98/69/EC
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & weight more than 2.5 tons but upto 3.5 tons	0.95	-	0.86	0.78	0.10	

* The proposal to be reviewed in 2017 in view of the air quality and emission inventory data collected during the intervening period.

Table 2 (A)

Proposed Emission Standards for Light Duty Diesel Vehicles during Registration (New and Imported used) Rest of Bangladesh (excluding Dhaka and Chittagong)

(An emission compliance certificate obtained by the vehicle manufacturer or the supplier from an internationally accredited emission testing laboratory/agency is to be produced for clearance of vehicle imports and at the time of vehicle registration)

Vehicle type		Emission Standards (g/km)					Test Procedure
		CO	HC	HC + NOx	NOx	PM	
Effective from July 2014							
Light duty (Class E) (Not more than 8 seats in addition to driver & max. weight up to 2.5 tons)							93/59//EC
New Vehicles	TA COP	2.72 3.16	- -	0.97 1.13	- -	0.14 0.18	
Imported used vehicles (COP values)	-	3.16	-	1.13	-	0.18	
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & weight more than 2.5 tons but upto 3.5 tons							
New vehicles	TA COP	6.9 8.0	- -	1.7 2.0	- -	0.25 0.29	
Imported used vehicles (COP values**)**	-	8.0	-	2.0	-	0.29	
Effective From July 2019*							
Light duty (Class E) (Not more than 8 seats in addition to driver & max. weight up to 2.5 tons)		1.0	-	0.7	-	0.08	93/59//EC 96/69/EC
Light Commercial Vehicles (Class E)(More than 8 seats in addition to driver but less than 15 seats & weight more than 2.5 tons but upto 3.5 tons		1.5	-	1.2	-	0.17	

* The proposal to be reviewed in 2017 in view of the air quality and emission inventory data collected during the intervening period.

Table 3 (A)

Proposed Emission Standards for Heavy Duty Diesel and CNG Vehicles (Class A, B, C and D ; GVW> 3.5 Ton) during Registration for Dhaka and Chittagong

(An emission compliance certificate obtained by the vehicle manufacturer or the supplier from an internationally accredited emission testing laboratory/agency is to be produced for clearance of vehicle imports and at the time of vehicle registration)

Effective Date	Test Cycle	**Emission Standards (gm/kWh)**				**Smoke** m^{-1}	**Test Procedure**
		CO	**HC**	**NOx**	**PM#**		
July 2014 Diesel	R -49	4.0	1.1	7.0	0.15	-	91/542/ EEC
CNG	ETC	5.45	NMHC= 0.78 CH_4 = 1.6	5.0	-	-	1999/96/EC
July 2019 Diesel	ESC ELR	2.1	0.66	5.0	0.10 0.13*	0.8	1999/96/EC
CNG	ETC	4.0	NMHC= 0.55 CH_4 = 1.1	3.5	-	-	

PM standards apply only to diesel vehicles

* for engines with swept volume per cylinder < 0.75 dm^3 and rated power speed > 3000 min^{-1}

.

Table 4 (A)

Proposed Emission Standards for Heavy Duty Diesel and CNG Vehicles (Class A, B, C and D; GVW> 3.5 Ton) during Registration For Rest of Bangladesh (excluding Dhaka and Chittagong)

(An emission compliance certificate obtained by the vehicle manufacturer or the supplier from an internationally accredited emission testing laboratory/agency is to be produced for clearance of vehicle imports and at the time of vehicle registration)

Effective Date	Test Cycle	Engine size	**Emission Standards (gm/kWh)**				**Test Procedure**
			CO	**HC**	**NOx**	**PM#**	
July 2014	R -49 (Diesel and CNG)	<85 KW	4.5	1.1	8.0	0.612	91/542/ EEC
		> 85 KW	4.5	1.1	8.0	0.36	
July 2019	R -49 (Diesel)	All	4.0	1.1	7.0	0.15	1999/96/EC
	ETC (CNG Engine)	All	5.45	NMHC=0.78 CH4 = 1.6	5.0	-	

PM standards apply only to diesel vehicles

Table 5(A)

Proposed Emission Standards for Petrol and CNG Driven Light Duty Vehicles Motorcycles, Three Wheelers during Registration for Dhaka and Chittagong (Class E, M and T of proposed RTTA)

(An emission compliance certificate obtained by the vehicle manufacturer or the supplier from an internationally accredited emission testing laboratory/agency is to be produced for clearance of vehicle imports and at the time of vehicle registration)

Vehicle type	Emission Standards (gm/km)				Evaporative* Emissions (g/test)	Test Procedure
	CO	HC	HC+ NOx	NOx		
Effective Date July 2014						
Motor cycles All	2.0	0.8	-	0.15	-	ECE-40
3 Wheelers	4.0	1.0		0.25	-	ECE 40
Light duty ,Class E (Not more than 8 seats in addition to driver & GVW≤. 2.5 tons)	2.3	0.2	-	0.15	2.0	98/69/EC
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & 2.5 < GVW . ≤.3.5 tons)	5.22	0.29		0.21	2.0	
Effective July 2019						
Motorcycles ≤ 150 cc >150 cc	2.0 2,0	0.8 0.3	-	0.15 0.15	-	ECE R-40
3-Wheelers	2.0	0.55		0.25		ECE R-40
Light duty ,Class E (Not more than 8 seats in addition to driver & GVW ≤. 2.5 tons)	1.0	0.10		0.08	2.0	98/69/EC
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & 2.5 < GVW ≤.3.5 tons)	2.27	0.16		0.11	2.0	

* Not applicable for CNG vehicles

Table 6(A)

Proposed Emission Standards for Petrol and CNG Driven Light Duty Vehicles Motorcycles, Three Wheelers during Registration for Rest of the Country (excluding Dhaka and Chittagong) (Class E, M and T of proposed RTTA)

(An emission compliance certificate obtained by the vehicle manufacturer or the supplier from an internationally accredited emission testing laboratory/agency is to be produced for clearance of vehicle imports and at the time of vehicle registration)

Vehicle type	Emission Standards (gm/km)				Evaporative* Emissions (g/test)	Test Procedure
	CO	HC	HC+ NOx	NOx		
Effective Date July 2014						
Motorcycles	5.5	1.2	-	0.3	-	ECE-40
3 Wheelers	4.5	-	3.0	-	-	ECE 40
Light duty ,Class E (Not more than 8 seats in addition to driver & GVW≤. 2.5 tons)	2.2	-	0.5	-	2.0	98/69/EC
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & 2.5 < GVW ≤.3.5 tons	5.0	-	0.7	-	2.0	
Effective July 2019						
Motorcycles	2.0	0.8	-	0.15	-	ECE R-40
3-Wheelers	4.0	1.0		0.25	-	ECE R-40
Light duty ,Class E (Not more than 8 seats in addition to driver & GVW ≤. 2.5 tons)	2.3	0.2	-	0.15	2.0	98/69/EC
Light Commercial Vehicles (Class E) (More than 8 seats in addition to driver but less than 15 seats & 2.5 < GVW ≤.3.5 tons)	5.22	0.29		0.21	2.0	

*Not applicable for CNG vehicles

Table 7(A)

Emission Inspection Standards during Registration of Reconditioned Imported Passenger Vehicles (Class E) Mentioned in Tables 1A, 2A, 5A and 6A Applicable for 2014 and 2019 Standards*

Vehicle type	Parameter	Emission Standard
4 wheeled petrol and CNG driven vehicles	Idle CO Idle HC	0.5 %v/v 1200 ppm
	No load, 2500-3000 RPM CO HC Lambda	 0.3 %v/v 300 ppm 1± 0.03
	Visual check	3-Way catalytic converter fitted in the exhaust
Diesel naturally aspirated	Free acceleration smoke	m^{-1} smoke density 1.6 (50 HSU)
Diesel turbo-charged	Free acceleration smoke	m^{-1} smoke density 2.1(60 HSU)

* import of used motorcycles, three-wheelers, commercial light duty vehicles, heavy duty vehicles like buses, minibuses and trucks is not permitted.

ANNEXURE – B

Proposed In-Use Vehicle Emission Standards for Bangladesh for the year 2014 and year 2019

Table 1(B)

In-Use Petrol and CNG Vehicle Emission Inspection Standards for Dhaka and Chittagong

Vehicle Type	Test	Registered before Sept 1, 2004		Registered from Sept 1, 2004 to June 30, 2014		Registered from July 2014	
		CO %	HC, ppm	CO % Vol.	HC, ppm	CO % Vol.	HC, ppm
4 –Wheeled Vehicles							
Petrol	Idle	4.5	1200	1.0	1200	0.5	1200
	Fast idle at 2500- 3000 rpm	-	-	0.5	300 $\lambda = 1.0 \pm 0.3$	0.3	200 $\lambda = 1.0 \pm 0.3$
CNG	Idle	1.0	1200	1.0	1200	0.5	1200
	Fast idle at 2500- 3000 rpm			0.5	300 $\lambda = 1.0 \pm 0.3$	0.3	200 $\lambda = 1.0 \pm 0.3$
2 and 3 Wheelers Petrol driven (2-stroke vehicles not allowed to register after 2004**)**							
4-stroke	idle	7.0	3000	4.5	3000	4.0	2000
2-Stroke	idle	7.0	12,000	NA	NA	NA	NA
3 Wheelers CNG driven**							
All	idle	3.0	1200	1.0	1200	1.0	1200

Table 2(B)

In-Use Petrol and CNG Vehicle Emission Inspection Standards for Rest of the Country excluding Dhaka and Chittagong

Vehicle Type	Test	Registered before Sept 1, 2004		Registered from Sept 1, 2004 to June 30, 2014		Registered from July 2014	
		CO %	HC, ppm	CO % Vol.	HC, ppm	CO % Vol.	HC, ppm
4 –Wheeled Vehicles							
Petrol	Idle	4.5	1200	1.0	1200	1.0	1200
	Fast idle at 2500- 3000 rpm	-	-	0.5	300 $\lambda = 1.0 \pm 0.3$	0.5	300 $\lambda = 1.0 \pm 0.3$
CNG	Idle	1.0	1200	1.0	1200	1.0	1200
	Fast idle at 2500- 3000 rpm			0.5	300 $\lambda = 1.0 \pm 0.3$	0.5	300 $\lambda = 1.0 \pm 0.3$
2 and 3 Wheelers Petrol driven (2-stroke vehicles not allowed to register after 2004**)**							
4-stroke	idle	7.0	3000	4.5	3000	4.5	3000
2-Stroke	idle	7.0	12,000	NA	NA	NA	NA
3 Wheelers CNG driven**							
All	idle	3.0	1200	1.0	1200	1.0	1200

Table 3(B)
In-Use Diesel Vehicle Smoke Emission Inspection Standards for Dhaka and Chittagong

Diesel Vehicle type	Test	Smoke Emission Limit, HSU (m^{-1})		
		Registered before Sept 1, 2004	Registered from Sept 1, 2004 to June 30, 2014	Registered from July 2014
Naturally aspirated	FA	65 (2.5)	65 (2.5)	60 (2.1)
Turbocharged	FA	72 (3.0)	72 (3.0)	65 (2.5)

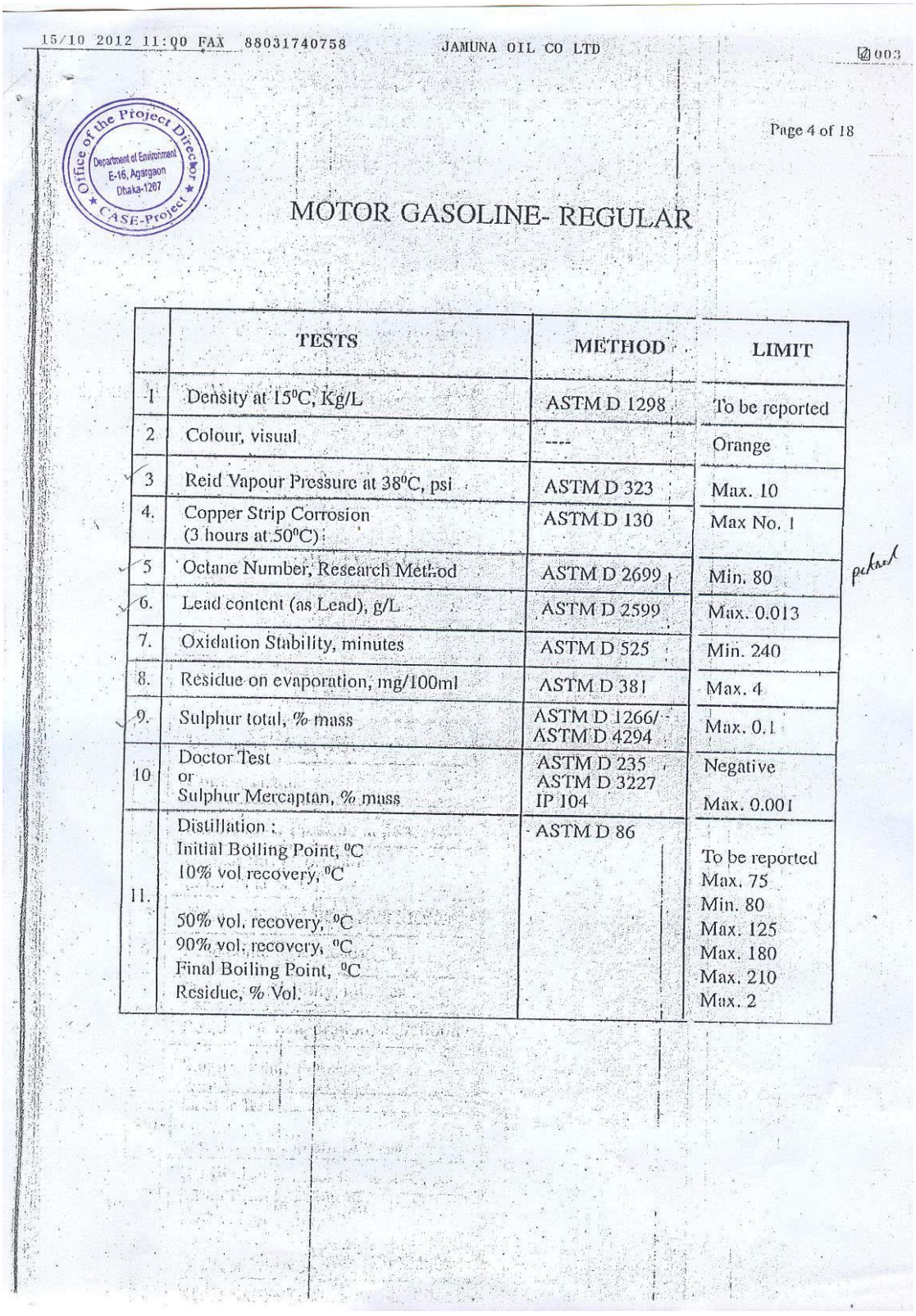
Table 4(B)
In-Use Diesel Vehicle Smoke Emission Inspection Standards for Rest of the Country excluding Dhaka and Chittagong

Diesel Vehicle type	Test	Smoke Emission Limit, HSU (m^{-1})		
		Registered before Sept 1, 2004	Registered from Sept 1, 2004 to June 30, 2014	Registered from July 2014
Naturally aspirated	FA	70 (2.8)	65 (2.5)	65 (2.5)
Turbocharged	FA	72 (3.0)	72 (3.0)	72 (3.0)

Table 5(B)
Frequency of Emission Inspection for In-Use Vehicles

Vehicle Category	Age of vehicle for Ist Inspection, years	Frequency of inspection, years
Cars/Light duty vehicles (Petrol/CNG)	3	1
3-Wheelers (CNG?Petrol)	1	1
Motorcycles	1	1
CNG Buses	1	1
All Diesel Vehicles	1	1

ANNEXURE - C
FUEL QUALITY SPECIFICATIONS IN BANGLADESH



15/10 2012 11:00 FAX 88031740758 JAMUNA OIL CO LTD 003

Office of the Project Director Department of Environment E-16, Agargaon Dhaka-1207 CASE-Project

Page 4 of 18

MOTOR GASOLINE- REGULAR

	TESTS	METHOD	LIMIT
1	Density at 15°C, Kg/L	ASTM D 1298	To be reported
2	Colour, visual	----	Orange
3	Reid Vapour Pressure at 38°C, psi	ASTM D 323	Max. 10
4.	Copper Strip Corrosion (3 hours at 50°C)	ASTM D 130	Max No. 1
5	Octane Number, Research Method	ASTM D 2699	Min. 80
6.	Lead content (as Lead), g/L	ASTM D 2599	Max. 0.013
7.	Oxidation Stability, minutes	ASTM D 525	Min. 240
8.	Residue on evaporation, mg/100ml	ASTM D 381	Max. 4
9.	Sulphur total, % mass	ASTM D 1266/ ASTM D 4294	Max. 0.1
10	Doctor Test or Sulphur Mercaptan, % mass	ASTM D 235 ASTM D 3227 IP 104	Negative Max. 0.001
11.	Distillation : Initial Boiling Point, °C 10% vol recovery, °C 50% vol. recovery, °C 90% vol. recovery, °C Final Boiling Point, °C Residue, % Vol.	ASTM D 86	 To be reported Max. 75 Min. 80 Max. 125 Max. 180 Max. 210 Max. 2

MOTOR GASOLINE- PREMIUM

	TESTS	METHOD	LIMIT
1	Density at 15°C, Kg/L	ASTM D 1298	To be reported
2	Colour, visual	----	Red
3	Reid Vapour Pressure at 38°C, psi	ASTM D 323	Max. 10
4.	Copper Strip Corrosion (3 hours at 50°C)	ASTM D 130	Max No. 1
5	Octane Number, Research Method	ASTM D 2699	Min. 95
6.	Lead content (as Lead), g/L	ASTM D 2599	Max. 0.013
7.	Oxidation Stability, minutes	ASTM D 525	Min. 240
8.	Residue on evaporation, mg/100ml	ASTM D 381	Max. 4
9.	Sulphur total, % mass	ASTM D 1266/ ASTM D 4294	Max. 0.1
10	Doctor Test or Sulphur Mercaptan, % mass	ASTM D 235 ASTM D 3227/ IP 104	Negative Max. 0.001
11.	Distillation : Initial Boiling Point, °C 10% vol. recovery, °C 50% vol. recovery, °C 90% vol. recovery, °C Final Boiling Point, °C Residue, % Vol.	ASTM D 86	 To be reported Max. 75 Min. 80 Max. 125 Max. 180 Max. 210 Max. 2

10 2012 10:44 FAX 88031740758 JAMUNA OIL CO LTD 001

DGM (RO) - DKA.
for kind information please.
15/11/12

Page 11 of 18

HIGH SPEED DIESEL (HSD)

	TESTS	METHOD	LIMIT
1	Density at 15°C, Kg/L	ASTM D 1298	Min. 0.82 Max. 0.87
2	Colour, ASTM	ASTM D 1500	Max. 3.0
3	Neutralization Value Strong Acid No, mg KOH/gm Total Acid No, mg KOH/gm	ASTM D 664/ ASTM D 974	 Nil Max. 0.2
4	Ash, % mass	ASTM D 482	Max. 0.01
5.	Carbon Residue (Conradson) on 10% bottom, % mass	ASTM D 189	Max. 0.2
6	Cetane Number	ASTM D 613	Min. 45
7	Cetane Index (calculated)	ASTM D 976	Min. 45
8	Pour Point, °C	ASTM D 97	Max.9 (*Wipter*) Max.12 (Summer*)
9	Copper Strip Corrosion (3 hours at 100 °C)	ASTM D 130	Max. No. 1
10	Flash Point PM (cc)/Abel, °C	ASTM D 93/ IP 170	Min. 32
11.	Kinematic Viscosity at 38 °C, cst	ASTM D 445	Max. 9.0
12	Sulphur total, % mass	ASTM D 4294	Max. 0.5
13.	Sediment, % mass	ASTM 473	Max. 0.01
14.	Water content, % vol.	AsTM D 95	Max. 0.1
15.	Distillation : 90% vol. recovery, °C	ASTM D 86	 Max. 375
*	Winter shall be the period from November to February (both months inclusive) and rest of the months of the year shall be called as summer)		

ANNEXURE -D

Summary of Discussions: Stakeholders' Meeting on Proposed Revision to Vehicle Emission Standards for Bangladesh held on 13 December, 2012

A stakeholders' meeting was called by the CASE Project and was held on 13 December at the offices of Department of Environment. Representatives of Bangladesh Petroleum Corporation Ltd., BRTA, Uttara Motors, Bangladesh Automobile Manufacturers' Association, Head, Mechanical Engineering, Bangladesh University of Engineering and Technology, Department of Environment and others participated in the meeting.

At the end of presentation by Dr. B. P. Pundir, Enforcement Specialist, CASE Project (DoE Component) the following comments and observations were made by the participants of the meeting. Response given by Dr Pundir to the points raised during discussions follows each of the respective points.

(i) Prof. Ehsan, Head Mech. Engg, BUET:

Presently about 75% of the trucks operating in Dhaka are CNG operated. He said that fuel quality is the main problem and 5 to 10% content of marketed fuel is not what it should be, Scrapped vehicles are not deleted from the BRTA statistics.
He further added that unless emission inspection of in-service vehicles is made mandatory no significant benefits would be obtained. Further, the local motorcycle manufacturers/ assemblers would be unable to meet the Euro 3 standards and they need to survive.

Dr Pundir:
The required fuel quality changes have also been included along with the revisions to emission standards. Yes, a mechanism to test and monitor the fuel quality at the retail outlets need to be established by the government or BPCL Motorcycles' population is growing at a fast rate in the country and these are also high polluters as revealed by the roadside emission inspection tests done by the CASE team.. If the standards for the motorcycles are kept at a relaxed level then after 5 years or so, the problem will go out of control. Necessary motorcycle technology is available as all countries around Bangladesh such as China and India are manufacturing motorcycles meeting Euro 3 levels. The local assemblers need to get their motorcycle prototypes and periodically the production motorcycles tested and certified by one of the approved laboratories in any of the Asian countries e.g., Singapore, China or India.
A report on mandatory inspection and maintenance of in-use vehicles is already under preparation and will be submitted for consideration shortly.

(ii) Dr Sultan Ahmed, DoE:
Government policy on CNG is not known and CNG may not be available for use of vehicles for a long enough period. Traffic management is also important for emission control and who would inspect vehicles?

Dr Pundir:

As the requirement of CNG by the vehicles is rather small compared to the needs of power industry, it will be perhaps prudent to specifically reserve gas for vehicular use for a longer period say 25 years or so, as it is a cleaner fuel. Secondly, Bangladesh imports all its liquid petroleum fuel requirements, so the use of CNG helps here too. An Auto-fuel policy should be framed as early as possible for Bangladesh. The vehicle emission inspection need be done either by Transport Department or DoE. Traffic management is perhaps being studied by DTCA.

(iii) Dr Nasir Uddin, PD

Perhaps two sets of standards one for Dhaka and Chittagong and a relaxed set of standards for rest of the country may perhaps be better. This may also help the local motorcycle manufacturers/assemblers.

Dr Pundir

Although, Dhaka and Chittagong account for nearly 65 to 70% of total vehicle registrations in the country at present, this suggestion can be implemented as being practiced in China and India.

(iv) Prof Hopke

For improving air quality a long term plan, say for 10 years or more need to be prepared.

Dr Pundir

The standards for implementation from 2014 and 2019 are being proposed that covers a total tenure of revised standards of about 10 to 12 years from now. A still longer plan can be prepared only if data on present and projected air quality, vehicle population and emission inventory are available from studies specifically designed to do that.

(v) Uttra Motors

Most motorcycles owners use only the premium grade gasoline as the regular grade gasoline has a very poor octane number. Their motorcycles need RON of about 88 to 89 units.

Dr Pundir

In this report, improvements in quality of regular as well as premium grade gasoline are being proposed. A RON of 91 for regular grade is proposed. As most of the gasoline in Dhaka is used by motorcycles the improved regular grade nay be marketed preferentially with premium grade in less quantities.