

Emission Scenario on 2-Stroke and 4-Stroke vehicles in India



Progress Through Research

Role of ARAI

- **First ISO-9001 R&D and Testing & Evaluation Institute in India.**
 - ◆ **Nodal agency :**
 - **Certification**
 - **Regulations**
 - **Formulation of Standards**
 - **Implementation of R&D Programmes at National level**
 - **Central Motor Vehicle Rule (CMVR) Technical Committee**

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Role of ARAI

- ◆ **Nodal agency :**
 - **Automotive Industry Standard Committee (AISC)**
 - **Member Secretary – Standing Committee on Implementation of Emission Legislations.**
 - **High level committees representation - for policy decision.**
 - **Technical support to Ministry – Govt. of India.**

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Role of ARAI

■ R&D and Certification :

- ◆ Research & Development of engines, vehicles and its aggregates.
- ◆ Certification
- ◆ Formulation of Standards
- ◆ Consultancy
- ◆ Specific assignments in R&D and certification
 - Evolution of Inspection & Maintenance Programme for India.
 - Development of Emission factors.

continued ...

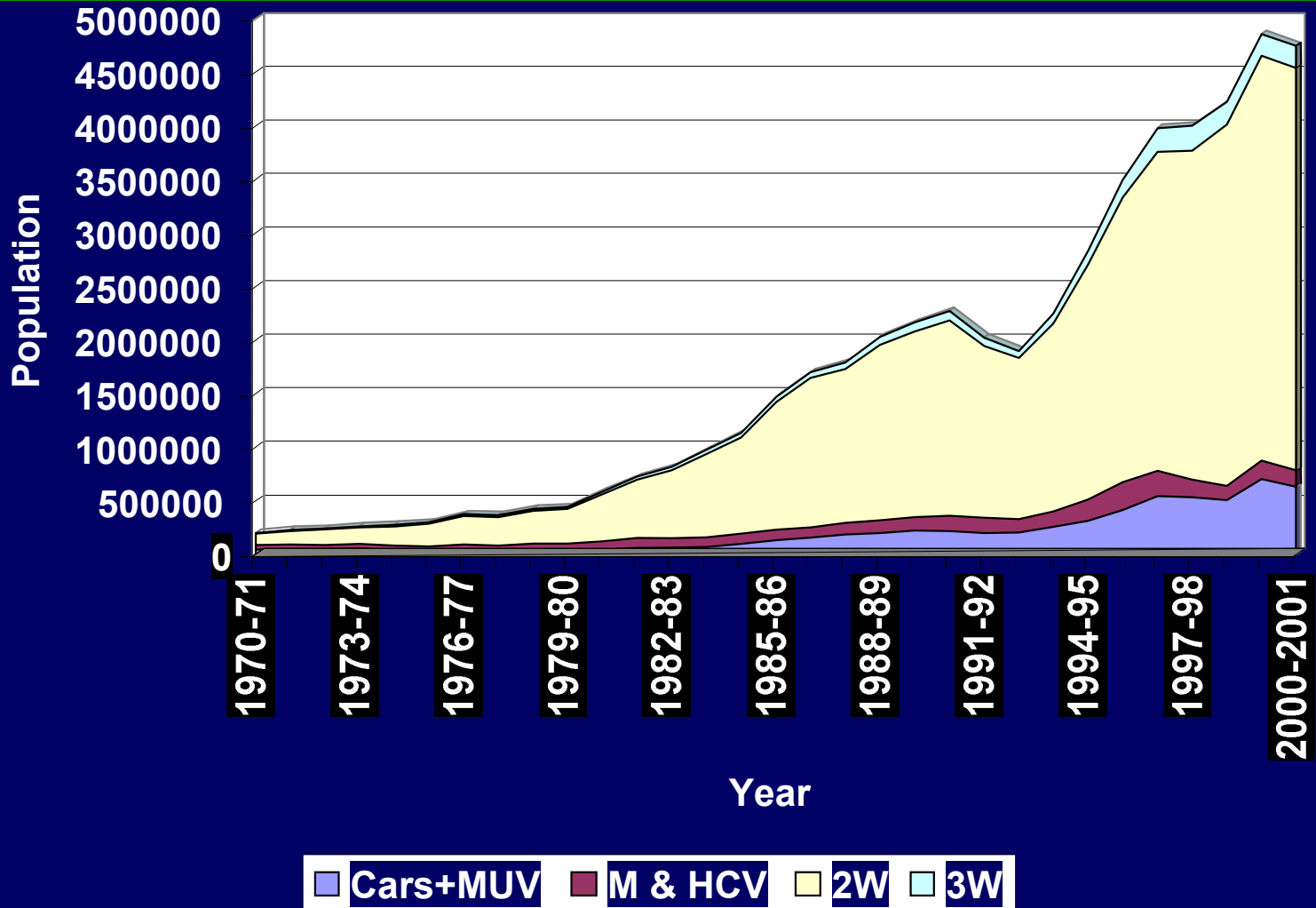
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Role of ARAI

- ◆ **Specific assignments in R&D and certification**
 - **Gasoline vehicle particulate measurement.**
 - **Life cycle prediction.**
 - **Noise and Vibration.**
 - **Gasoline / Diesel Engine design and development.**
 - **Alternate fuels – CNG, LPG, Methanol, Electric Vehicle etc.**
 - **Study of Adulteration of fuel.**

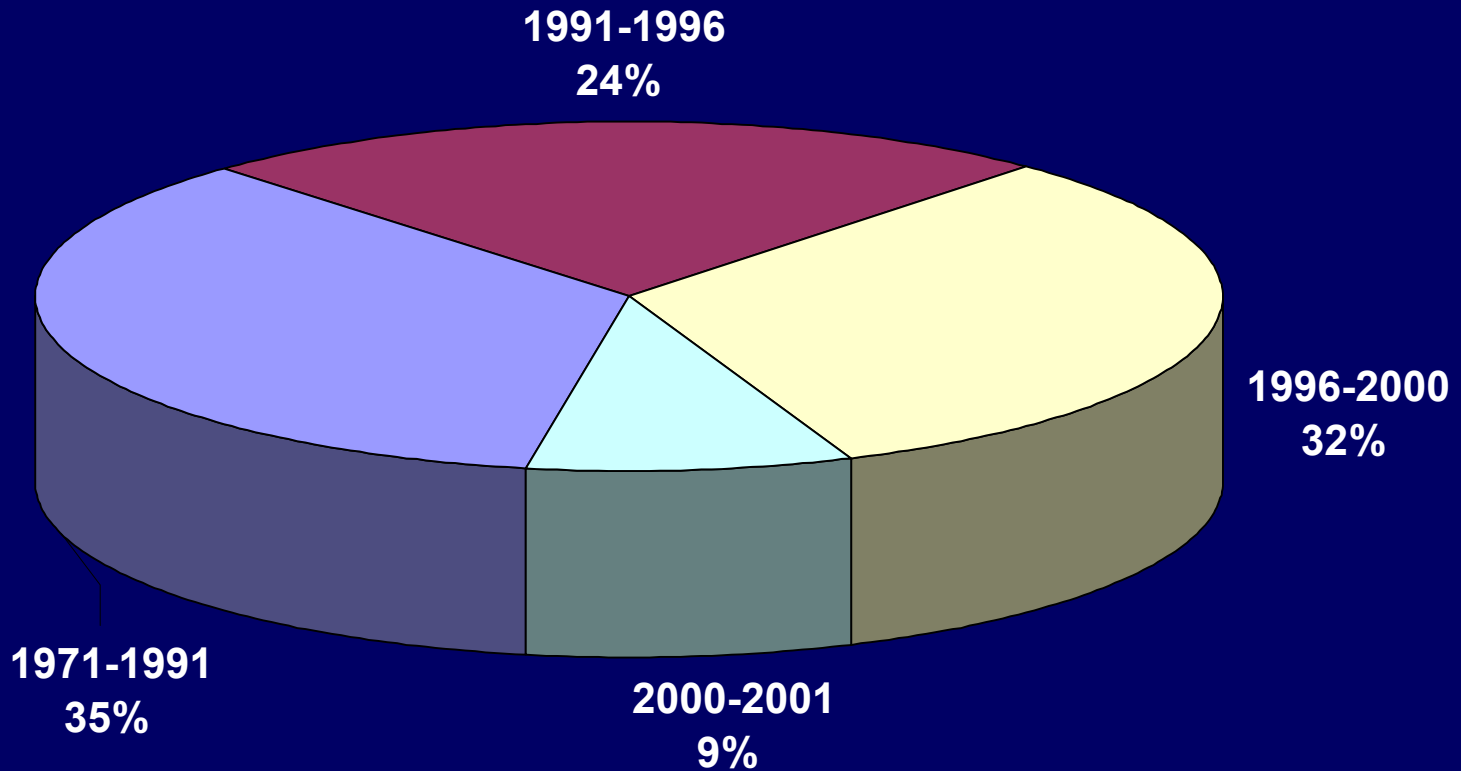
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Vehicle Population in India



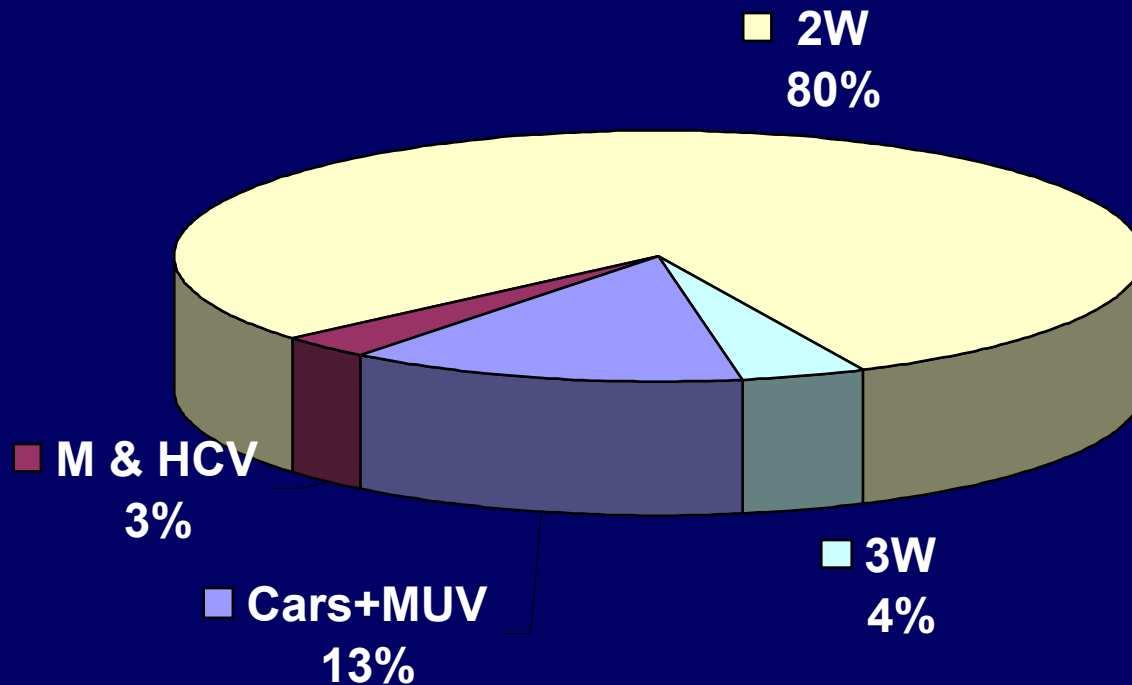
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Vehicle population - Vintagewise (Cumulative till March 2001)



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Vehicle Population - Category wise (2000 - 2001)



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Motor Vehicle Emission Control Programmes in India

- ◆ Formulation of Standards for new and in-use vehicles.
- ◆ Ensure appropriate emission control technologies through vehicle design – type approval.
- ◆ Compliance at production level quality – Conformity of Production (COP)

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Motor Vehicle Emission Control Programmes in India

- ◆ In-use vehicles emission control.
 - I&M programme
 - On road checks
 - Retrofitment – CNG / LPG
- ◆ Framing the specifications of fuel quality in line with emission legislation.
- ◆ Traffic Management.

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Landmarks of Emission Regulations in India

- **1984 : Introduction of idling CO and free acceleration smoke in State of Maharashtra.**
- **1989 : Applicability covering whole nation.**
- **1991 : Exhaust mass emission norms for gasoline vehicles below 3.5 ton GVW - only CO & HC.
Full load and free acceleration smoke regulations for diesel vehicles.**
- **1992 : Exhaust mass emission norms for diesel vehicles / engines above 3.5 ton GVW**

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Landmarks of Emission Regulations in India

- **1995 : Honorable Supreme Court mandated fitment of catalytic converter for gasoline passenger cars in Metropolitan cities.**
- **1996 : - Stringent norms for gasoline (CO, HC+NOx) and diesel vehicles.**
 - **No crankcase emission for gasoline vehicles.**
 - **Evaporative emission to be below 2 g/test for gasoline vehicles.**
 - **Cold start emission test for diesel vehicles below 3.5 ton GVW.**

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Landmarks of Emission Regulations in India

- **1998: Cold start emission test for gasoline vehicles below 3.5 ton GVW.**
- **1999: Preponement of India 2000 (Equivalent to Euro-I) norms for passenger cars in National Capital Region (Delhi)**
- **2000: - Bharat Stage II (Equivalent to Euro-II) norms for gasoline vehicles introduced in National Capital Region (Delhi)**
 - **Particulate limit values introduced for diesel vehicles.**

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Reduction of Emission Legislation : A Comparison - 2 Wheeler

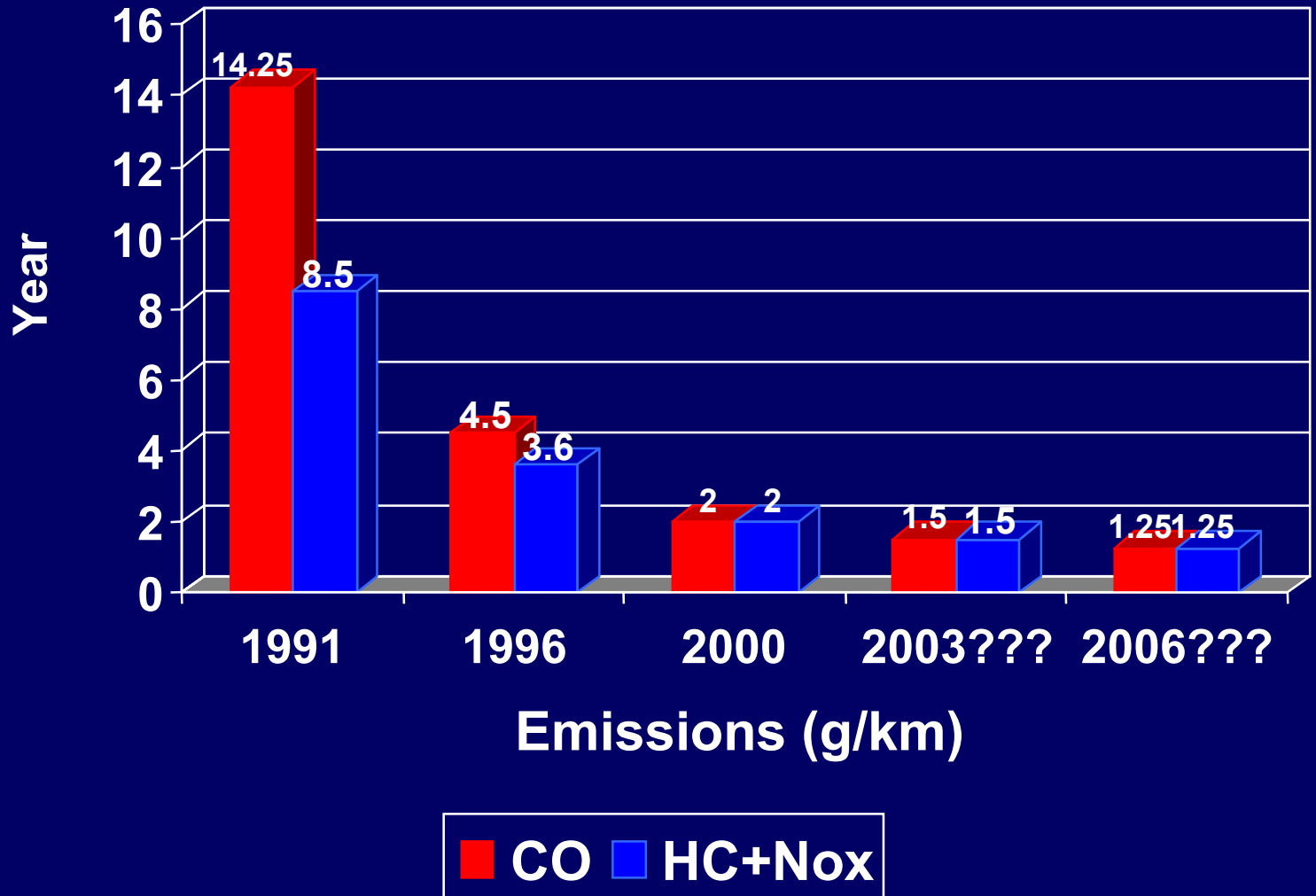
Year	Emission Level in % w.r.t. 1991		% Redn. w.r.t Prev. Year		Limit Values (g/km)	
	CO	HC+ NOx	CO	HC+ NOx	CO	HC+ NOx
1991	100	100	100	100	14.25	8.5 *
1996	32	42	68	58	4.5	3.6
2000	14	24	56	44	2.0	2.0
2004**	11	18	25	25	1.5	1.5
2006**	9	15	17	17	1.25	1.25

- For Ref. Mass 170 kg ; * Only for HC

** Under discussion

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Emission Norms for 2 Wheelers in India



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Indian Driving Cycle for 2 wheelers - Break Down by Phases

Phase	Time (s)	%
Idling	16	14.81
Cruising	13	12.04
Acceleration	42	38.89
Deceleration	37	34.26

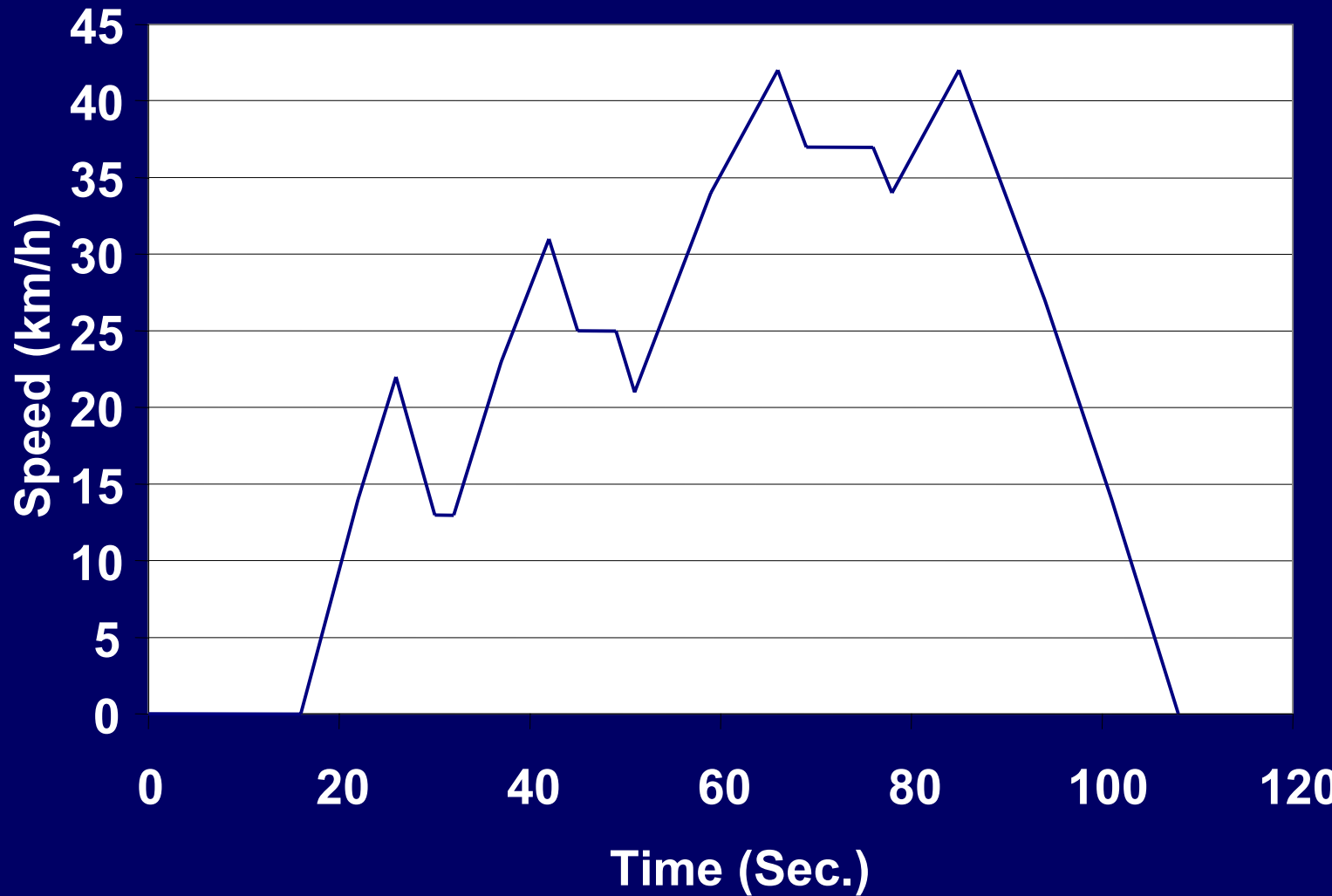
Average Speed During Test : 21.93 km/h

Theoretical Distance covered per cycle : 0.658 Km.

Equivalent Distance for the test (6 Cycles) : 3.948 Km.

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Indian Driving Cycle for 2 wheelers



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Fuel Specifications : Gasoline

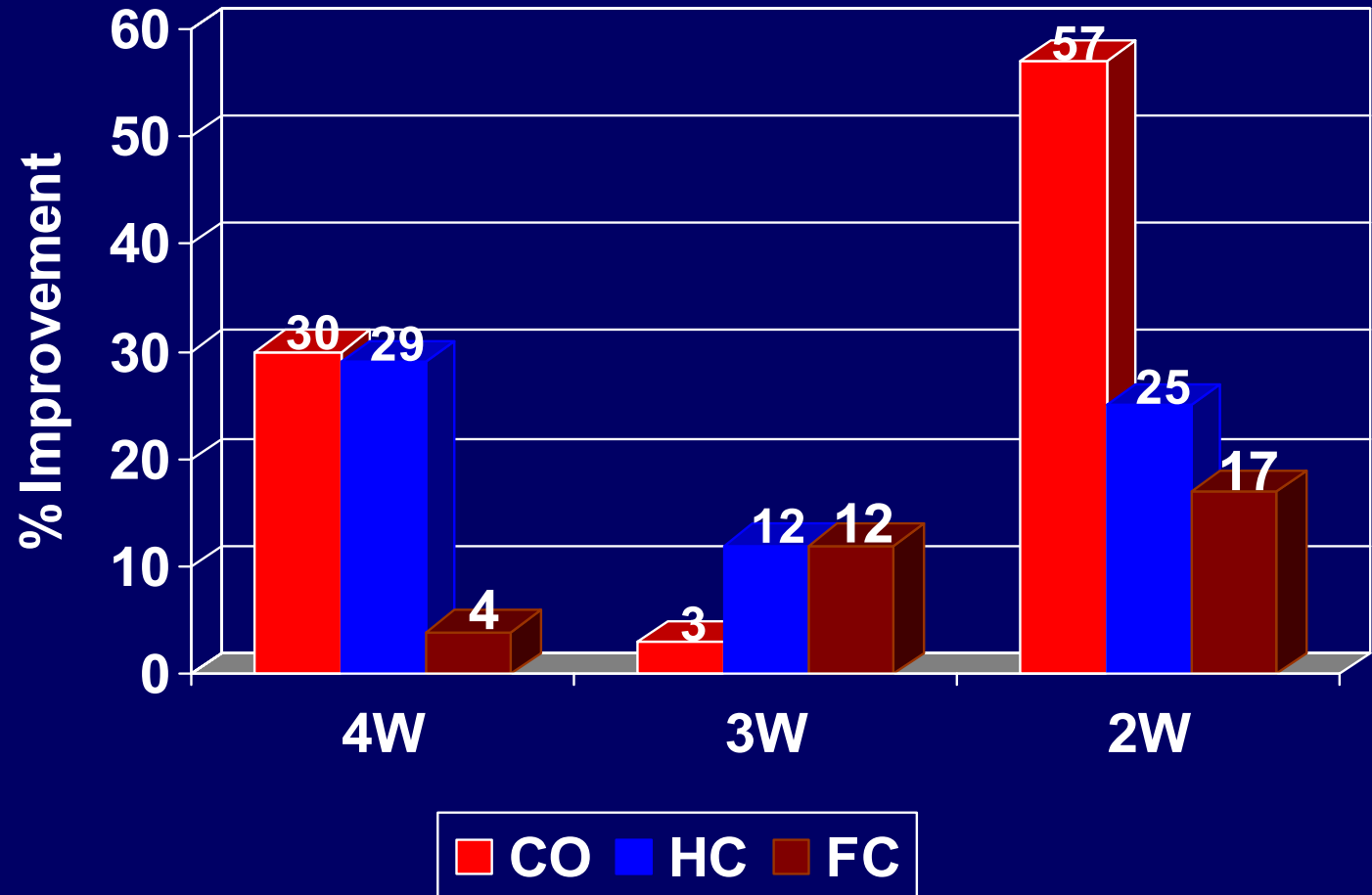
Parameters	Existing
Research Octane Number	95 min.
Motor Octane Number	85 min.
Density	748 – 768
RVP	0.56 – 0.64 bar
Aromatics	45% vol. (incl. Max 5% vol. Benzene) (Max. 1% vol. Benzene) *
Sulphur	0.04% Max. (100 ppm) *
Lead	0.005 g/litre
Phosphorus	0.0013 g/litre

* Euro III fuel specifications

Next revision expected in 2003 - under discussion

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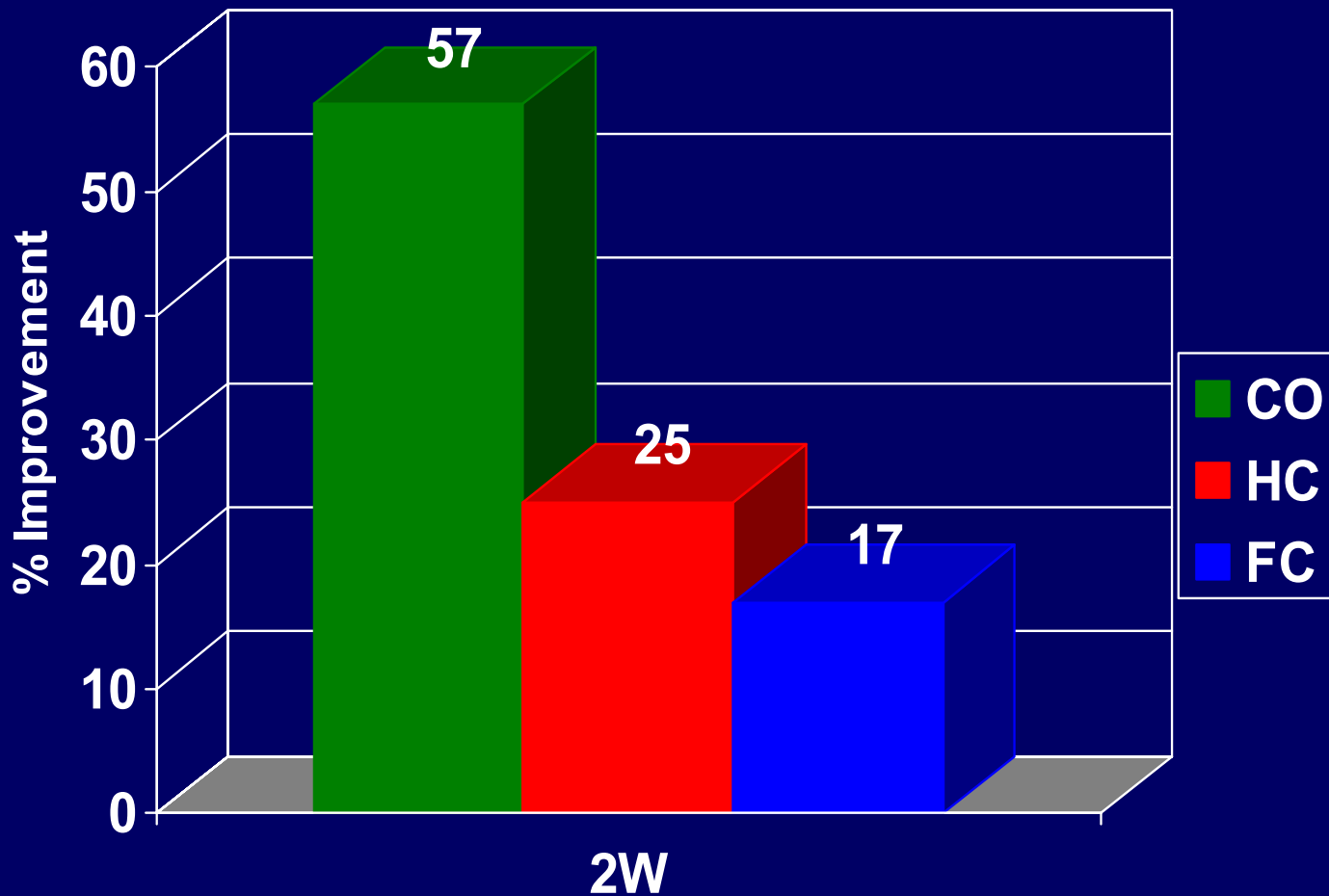
Benefits due to Proper Maintenance



Source: SAE Paper# 981379 by ARAI

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Average % Improvement due to Maintenance

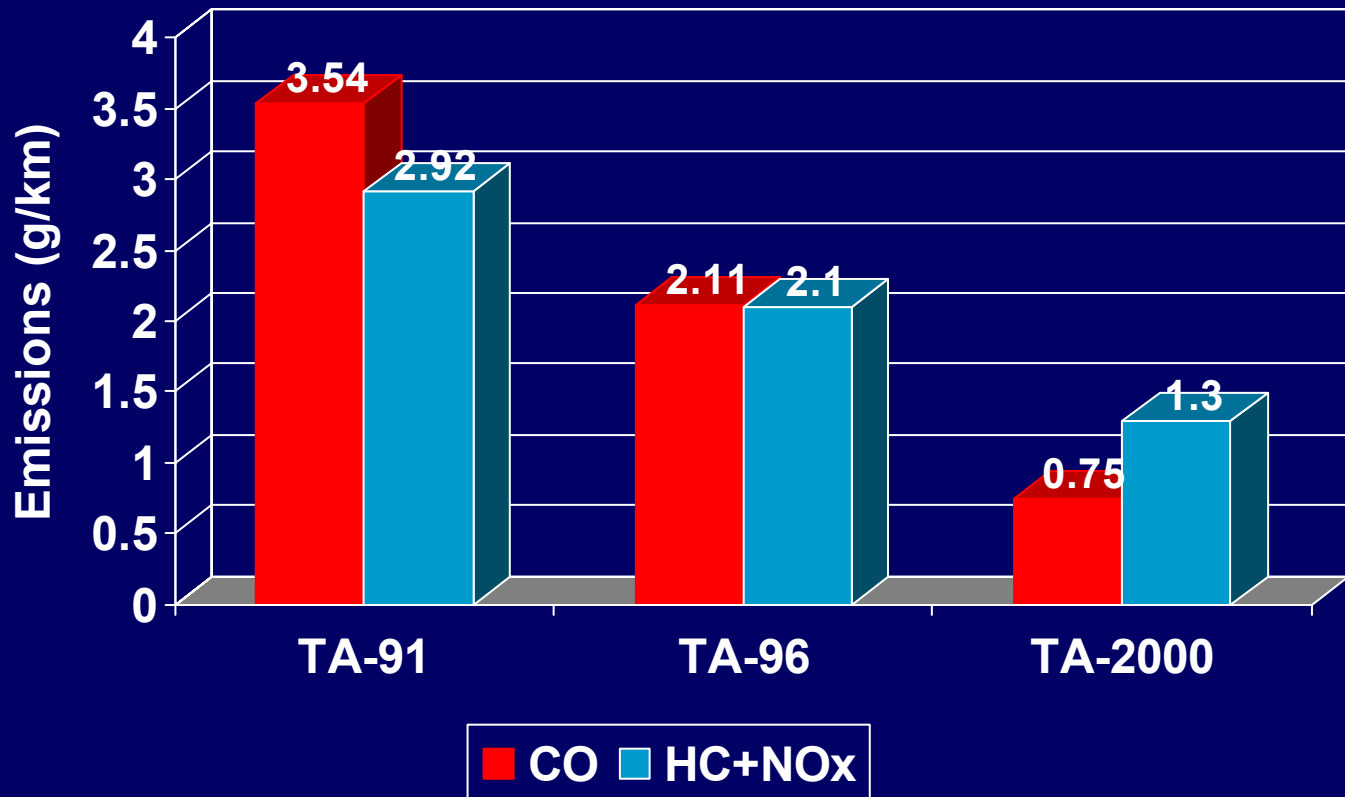


Source: SAE Paper # 981379 by ARAI

Sample Size : 14 Nos.

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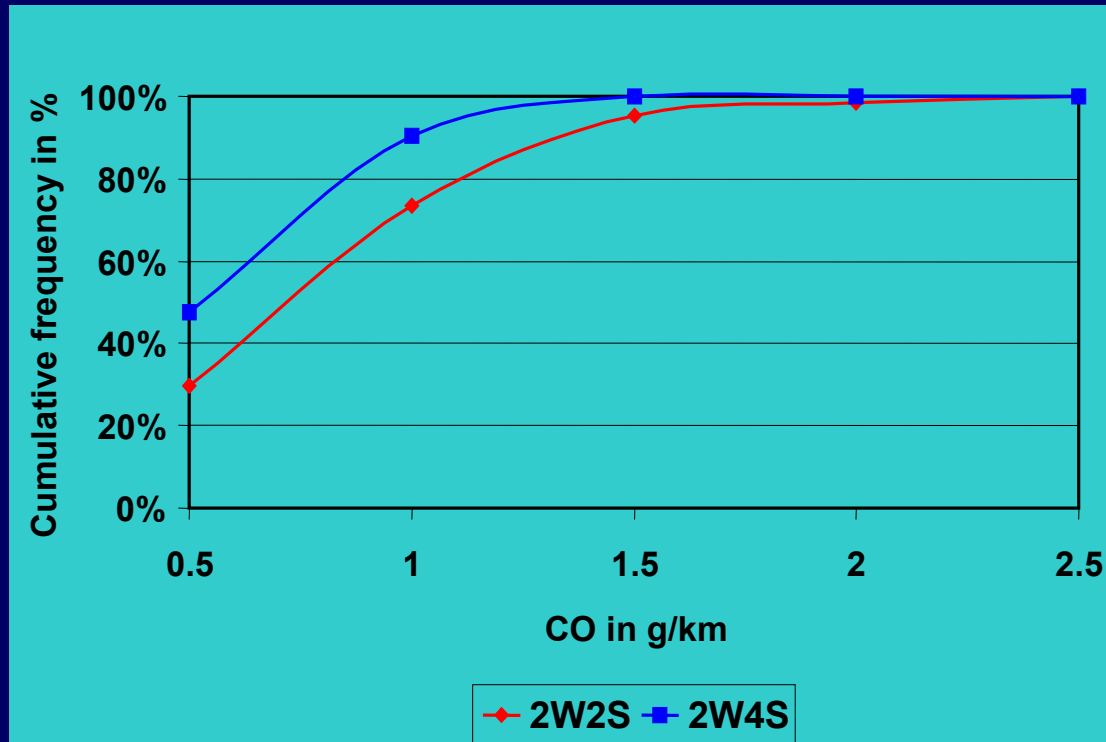
Average Emission Reductions



The average CO and HC emissions of MY 2000 Vehicles have reduced to 21 % and 44 % of emission levels of MY '91 Vehicles

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2 Stroke Vs 4 Stroke - CO (TA - 2000)

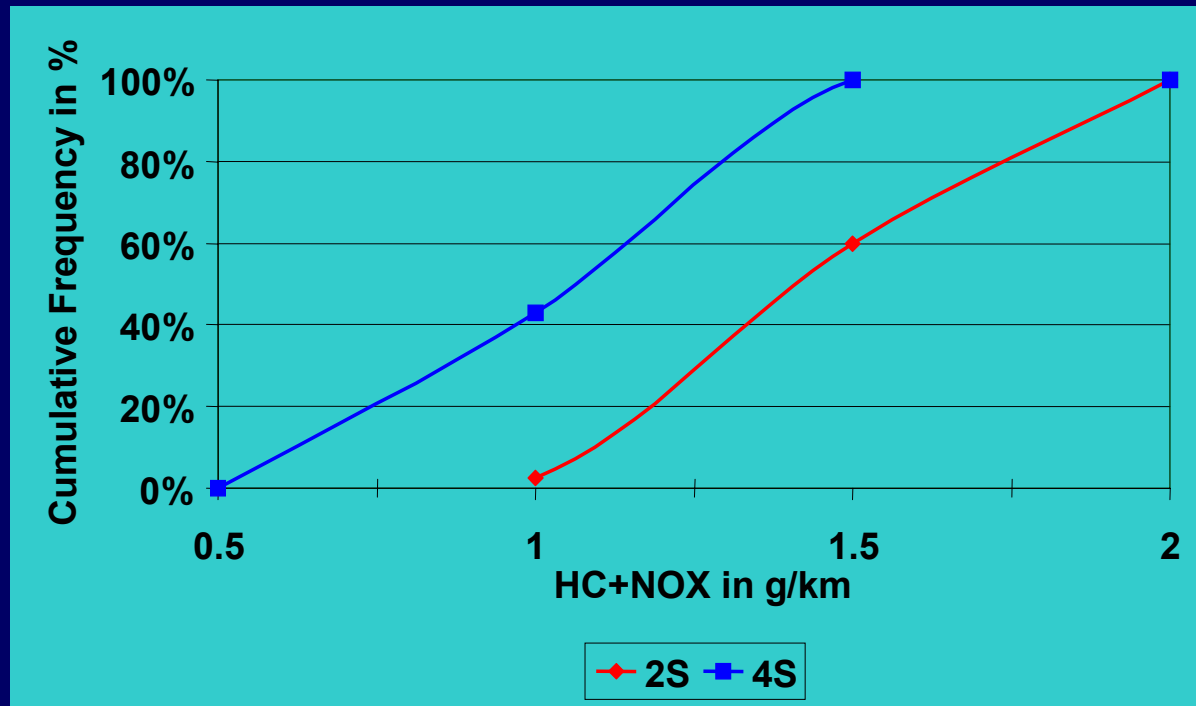


90 % of 4 stroke vehicles are below 1.0 g/km

90 % of 2 Stroke vehicles are below 1.3 g/km

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2S Vs 4S - HC+Nox (TA - 2000)

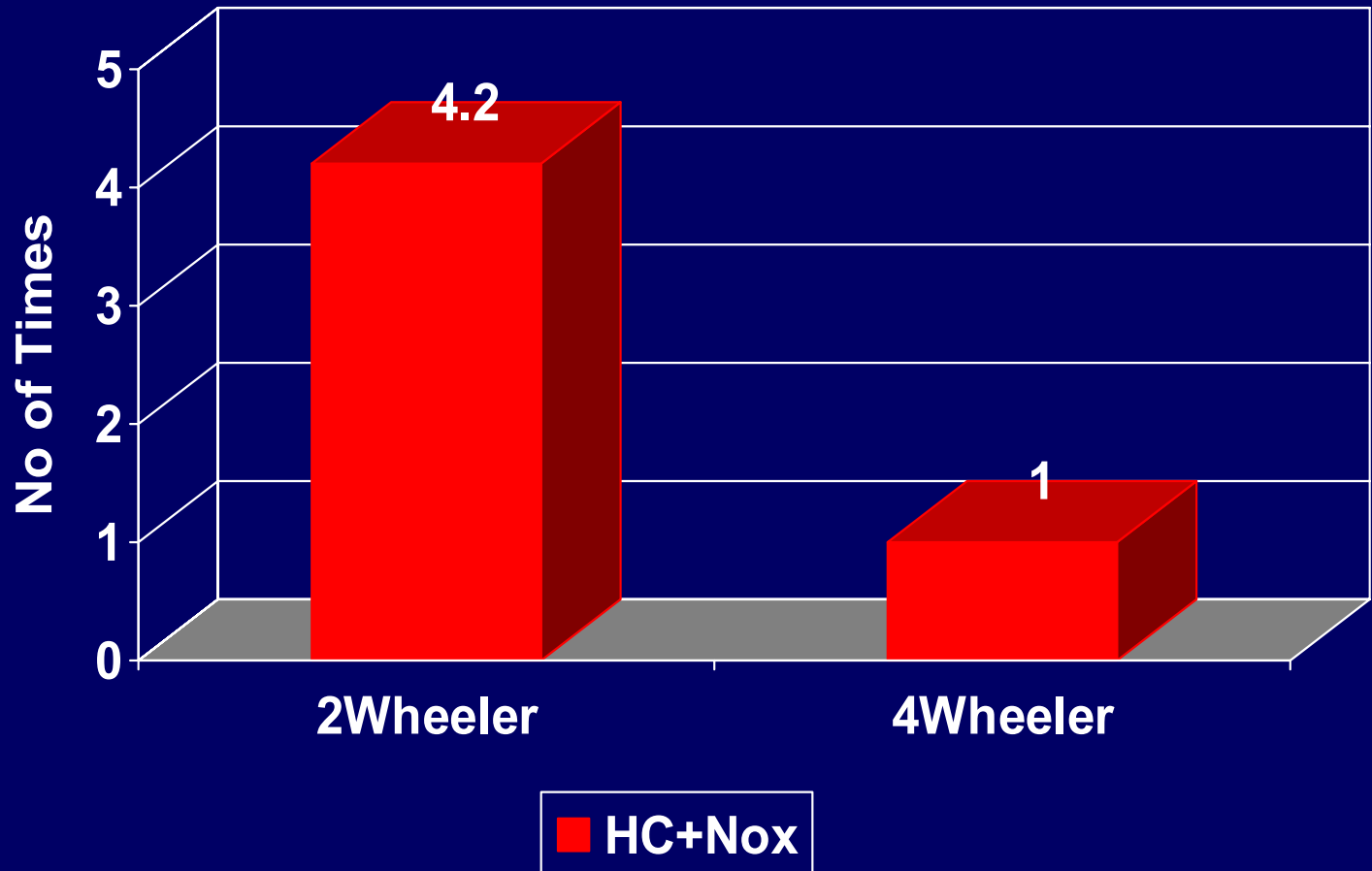


90 % of 2 Stroke vehicles had HC+Nox less than 1.8 g/km

90 % of 4 Stroke vehicles had HC+Nox less than 1.3 g/km

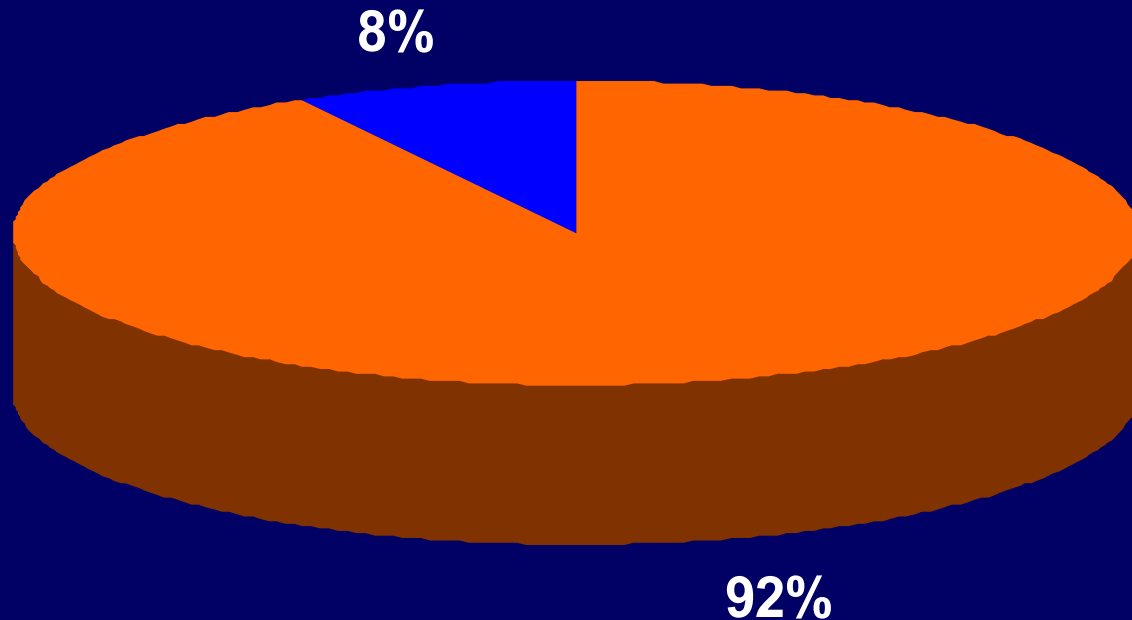
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Comparison of a 2 Wheeler emission to a 4 Wheeler emissions - HC+NOx



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SIAM I/M Camp Data 2 Wheeler



Idling CO Limit : 4.5%

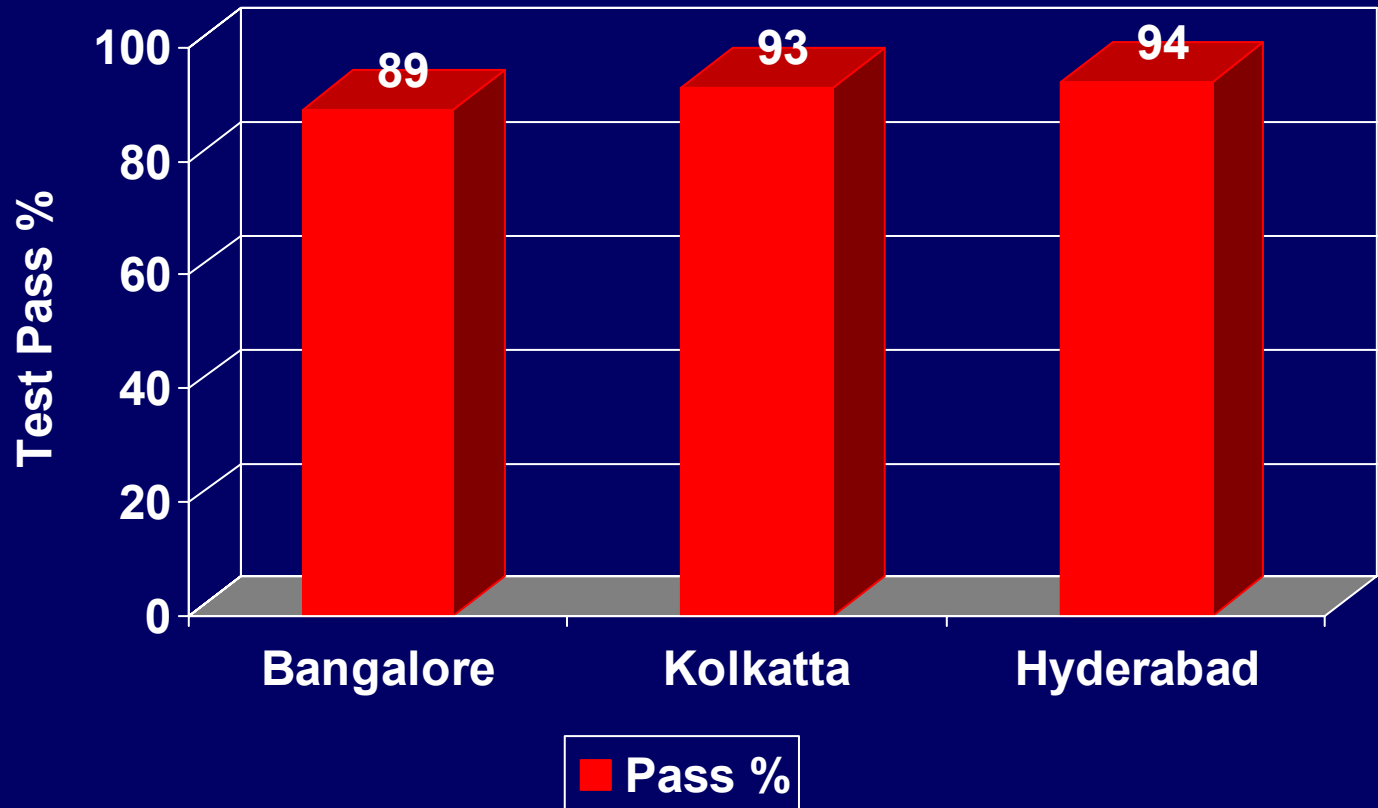
Sample Size : 14278 Nos.

Source: SIAM I/M Camp Data (Bangalore, Hyderabad and Kolkotta)

■ Pass ■ Pass After Maintenance

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2 Wheeler - Idle Test Pass %



There is higher % of idle test pass seen

Idling CO Limit : 4.5%

Source: SIAM I/M Camp Data

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ARAI Developed Pumpless Lubrication System for 2 stroke vehicles

- Meets the lubrication requirements of a 2 stroke engine operating on liquid fuel as well as gaseous fuel
- Low cost solution for new and in use vehicle emission reductions
- Smoke intensity reduction by 99 % and particulate matter by 70 %
- CO and HC emission reduction upto 14% and 17 % respectively
- Lubrication oil saving by 71%

SAE Paper # 2001-02-0028

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Highlights of Joint Study by World bank and ARAI on gasoline particulate emissions from In-use Two Stroke Three Wheelers

- The gasoline particulate mass emissions were ranging from 0.16 to 2.7 g/km
- Solvent extraction on particulate filter papers removed 98 - 99 % of deposits consisting of oil droplets
- Particulate mass emissions increased with higher concentration of lubrication oil added
- The mechanical condition of the vehicle (reflecting both vehicle technology and maintenance) had by far greatest impact on emissions

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Highlights of Joint Study by World bank and ARAI on gasoline particulate emissions from In-use Two Stroke Three Wheelers (Contd....)

- The gasoline fuel adulterated with kerosene gave higher Particulate emissions
- JASO - FC grade low smoke lubricant does not lower PM emissions
- The oxidation catalyst halved HC emissions and lowered particulate emissions by about one third

Source: SAE Draft Paper

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Summary

- 80 % of vehicles in India are of 2 Wheelers
- Tighter emission norms for 2-Wheelers have been implemented in India
- Two stroke vehicles were fitted with catalytic converters for compliance of tighter norms
- The 4 stroke vehicle CO and HC+Nox emissions were less than 2-stroke vehicles
- Since the introduction of tighter emission norms in 1991, the average idling CO emissions of two wheelers have reduced considerably

(Contd...)

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Summary (Contd...)

- Higher % of Idle test pass was noticed for two wheelers during SIAM I/M Camp
- A single 2 Wheeler emits approximately 4 times of a 4 Wheeler HC+Nox emissions
- ARAI developed pumpless lubrication system for 2 Stroke vehicles reduces exhaust emissions, Smoke intensity and Particulate matter. Lubrication oil saving by 71%.

(Contd...)

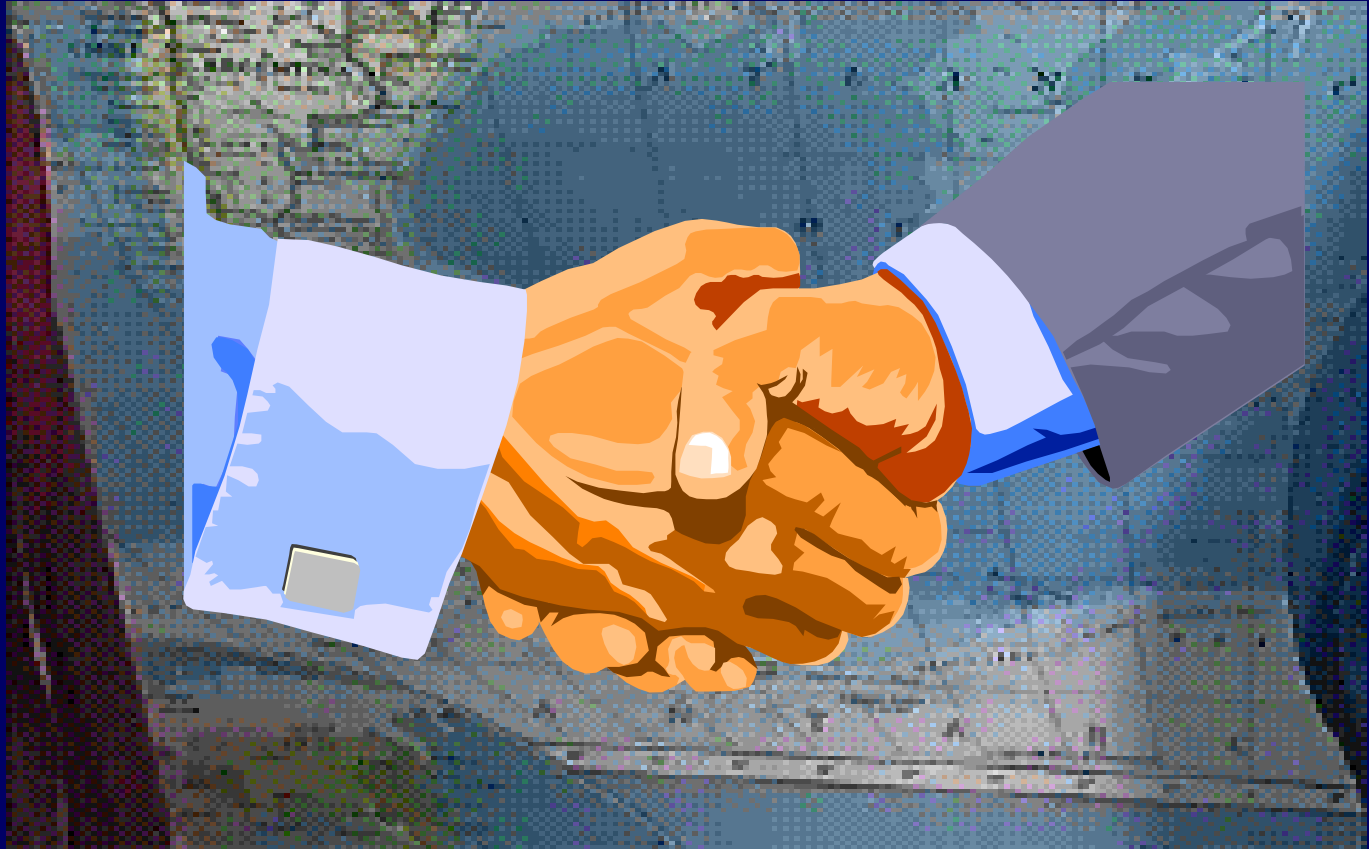
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Summary (Contd...)

- Proper maintenance of vehicles improves the emission performance and fuel economy
- Two stroke gasoline particulate emissions contained 98 - 99% of oil droplets
- The particulate emissions increased with higher lubrication oil added
- JASO - FC grade low smoke lubricant does not lower PM emissions

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THANK YOU
For your kind Attention



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