Orientation Conclave
Air Quality Management: Building Strategies for Clean Air
04th June 2019, Bhubaneshwar

Moqtik A Bawase
Environment Research Laboratory
Automotive Research Association of India (ARAI)
Contents of presentation

- ARAI - An Overview
- Regulatory Scenario – Emissions
- Inspection & Certification Program
- On Board Diagnostics (OBD)
- Remote Sensing Device (RSD)
- Summary
The Automotive Research Association of India

- Established in 1966 at Pune, India
- Human Resource of 730+
- Facilities & Infrastructure: Rs.773.44 Crore (USD 100 Mn)
- Affiliates in China & Korea
- Accredited with
  - ISO 9001, 14001
  - OHSAS 18001
  - NABL (ISO/IEC 17025)

**Laboratories:**
- Academy
- Forging Industry Division
- Homologation and Technology Centre
- Regional Centre South Chennai

- Corporate Office
  - ARAI, Kothrud, Pune
- Forging Industry Division
  - ARAI-FID, Chakan, Pune
- Homologation & Technology Centre
  - ARAI-HTC, Chakan, Pune
**Journey and Service Portfolio**

**Journey**

- **1966 – 1980**
  - Tools
- **1967**
  - Facility Establishment
- **1981 – 1990**
  - Experience
- **1991 – 2010**
  - Expertise
- **2010 Onwards**
  - Knowledge
  - Beyond 2010
  - Research

**Service Portfolio**

1. Certification Testing / Homologation
2. R&D – National Interest, Industry and Internal R&D Projects
3. Assisting GOI – Standards Formulation & Regulations Harmonization
4. Consulting Services
5. Education & Training

**ARAI**

**Progress through Research**

- **1970**
  - Testing House
- **2010 Onwards**
  - Testing + R&D House

**Supporting Projects**

- Celebrating *Golden Jubilee Year*
- *Golden Peacock Environment Management Award 2016*
- *Best Corporate Award* by SAEINDIA Foundation
- Numerous *Technical Papers awarded*
- *Recognized Overseas Test Lab*’ by LTA and NEA) Singapore
- Appointed as ‘*Technical Service Provider*’ by RDW, Netherlands for CoP verification audits
- Recognition by Department of Infrastructure, Australia to provide Test Reports in compliance to ADRs
R&D Roadmap

Major R&D Drivers

- Low Carbon Footprints / Improving Fuel Economy / Power Train engineering
- Pedestrian & Passenger Safety
- Light Weight Materials/structures
- Green Technologies
- Sustainable/Smart mobility
ARAIs Involvement in technology introduction

Examples:
- **Alternate Fuels:** CNG, LPG, Ethanol, biodiesel, H2, etc.
- **E-Mobility**
- **Safety Regulations:** ABS, ESC, Vehicular Crash
- **I&C Programs:** Model centres, scaling up
- **End of Life Regulations**
- **ITS Roadmap**
- **Source Apportionment Studies**
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Indian Auto Industry: **Highlights**

- 2nd largest bus manufacturer
- 3rd largest heavy trucks manufacturer
- 6th largest passenger vehicle manufacturer

### Total Production

<table>
<thead>
<tr>
<th>Segment</th>
<th>2015-16*</th>
<th>2016-17*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Vehicles</td>
<td>3.46</td>
<td>3.79</td>
</tr>
<tr>
<td>Commercial Vehicles</td>
<td>0.78</td>
<td>0.81</td>
</tr>
<tr>
<td>Three Wheelers</td>
<td>0.93</td>
<td>0.78</td>
</tr>
<tr>
<td>Two wheelers</td>
<td>18.83</td>
<td>19.92</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>24.02</strong></td>
<td><strong>25.31</strong></td>
</tr>
</tbody>
</table>

* In Million

### India – Highly Underpenetrated

<table>
<thead>
<tr>
<th>Segment</th>
<th>Vehicle per 1000 persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Vehicles</td>
<td>20</td>
</tr>
<tr>
<td>Two-wheelers</td>
<td>108</td>
</tr>
<tr>
<td>Buses</td>
<td>0.11</td>
</tr>
</tbody>
</table>

**High Headroom for Growth**

*Source: SIAM, ACMA, TMA, IMaCS Analysis*
Regulatory Scenario – Emissions

Vehicle Emissions

- Emission norms for Catalytic Vehicles
  - BS-I (Country)
  - BS-II (Metros)

- BS-III (Country)
- BS-IV (13 Cities)

1991 to 2000

- BS-II (Country)
- BS-III (11 Cities)

2001 to 2005

- Entire country for BS IV

2006 to 2010

By 2017

- BS-VI for all category vehicles

By 2020

Diesel Sulphur Reduction

- Sulphur 2500 ppm for entire Country

1991 to 2000

- Sulphur 50 ppm (13 Cities) & 350 ppm for entire Country

2001 to 2005

- Sulphur 50 ppm (13 Cities) & 350 ppm (11 Cities)

2006 to 2010

2020

- Sulphur 10 ppm
Progressive tightening of Vehicle emission standards

20 times reduction (95%)
NOx (gm/kWh)
HCV - Diesel

36 times reduction (97%)
PM (gm/kWh)
HCV - Diesel

6.25 times reduction (84%)
NOx (gm/km)
Passenger Car - Diesel

31 times reduction (97%)
PM (gm/km)
Passenger Car - Diesel

## In use vehicles

<table>
<thead>
<tr>
<th>Current Legal Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CMVR Rule # 62</strong></td>
</tr>
<tr>
<td>Fitness Certificate mandatory for all Transport vehicles. (Buses, Trucks, Taxis and Auto-Rickshaws)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>New Transport vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness certificate valid for Initial Two years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non Transport vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial registration is valid for a period of 15 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pollution Under Control (PUC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline vehicles are tested for Idle CO/HC emissions</td>
</tr>
</tbody>
</table>
Type Approval and CoP Regulations

- Strong Type Approval System
- Very strong CoP System
- Weak Inspection and Maintenance Mechanism

**Type Approval**
- Notifying agencies: MoRTH, MoEF, etc.
- TA certificates: Issued by Testing Agencies
- Very Similar to UN-ECE regulations
- Extensive laboratory testing

**CoP**
- Third Party Conformity
- Safety Components are covered in CoP
- Vehicle level CoP-Emission Tests by Test Agencies
- Random Selection of samples

**Annual Fitness Check**
- Visual Inspection
- Pollution under Control (PuC) test at authorized garages
- Document verification by Transport Departments
Emissions from Vehicle: Mitigation Strategies

- Increase share of public transport
- Banning of 10 year old commercial vehicles
- Restrict entry of commercial vehicles inside cities
- ITS and Traffic Management
- Periodical Technical Inspection (PTI)- I&C Centers
- Enhancing Driver Skills
- Use of CNG for new Public transport buses
- Advancement of Emission norms- BS VI
- Bio-Fuels
- E-Mobility
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I&C for Roadworthiness

Need of Inspection & Certification practices

- Type approved new vehicles
- In-use Old vehicles

Factors affecting...
- Fuel Quality
- Driving Habits
- Maintenance Practices
- Infrastructure
- The aging factor

Benefits of I&C Program

- Road Accidents
- Atmospheric pollutions from vehicles
- Noise Emissions
- Fuel Consumption

Networking & Data
- Live database
- Centre / Person based analysis
-控制 of quality
- Input for ELV & recyclability initiatives

Reduction in

- Awareness of
- Increased life of vehicles
- Improvement in maintenance culture
- Avoidance of unnecessary repairs
- Improvement in quality of garages
- Continuous renewal of the vehicle fleet

Other Aspects

Concerns

Safety & Emissions

Test Data Generation

To overcome the difficulties faced during fitness checks with existing infrastructure

More no. vehicles can be tested

Reduces burden on the inspector

More no. vehicles can be tested

Reduces burden on the inspector

Safety & Emissions
Establishment of Inspection & Certification Centers in India

- 10 Model I&C Test Centers being established in 1st phase.
- Another 10 Model I&C Test Centers are getting established in 2nd phase.

Centres facilitated by ARAI under MoRTH Project

- Nasik, Maharashtra
- Bengaluru, Karnataka
- Railmagra, Rajasthan
- Hyderabad, Telangana
- Surat, Gujarat
- Cuttack, Odisha
- Cochin, Kerala
- Puducherry
I&C Test Center – MoRTH Project

NASIK, MAHARASHTRA

BENGALURU, KARNATAKA

RAILMAGRA, RAJASTHAN

HYDERABAD, TELANGANA

SURAT, GUJARAT

CUTTACK, ODISHA
I&C Test Center

- Required test equipment are laid out in such a way that vehicles are tested one after the other
- Automated test report generation for following vehicle tests: Safety, Emission, Visual Inspection
Tests Carried out in I&C centre

- Emission Test
- Head Light Test
- Brake Test
- Speedometer Test
- Suspension Test
- Side Slip Test
- Visual Inspection
- Under Body Inspection
- Joint Play Test
Current practices for fitness checks of in-use vehicles

Tests under CMVR Rule 62

- The following safety and emission tests are conducted using appropriate equipment
  - Headlamp beam (Beam focus)
  - Brakes (Measure Stopping distance on road)
  - Exhaust emission (or PUC test)
    - Idle Emission Test for gasoline vehicles
    - Free Acceleration Smoke test for Diesel vehicles
ARAI role in setting up I&C test centres in the country

- Civil & Infrastructure set-up
- Installation & Commissioning of test lane equipment
- Supervision of operation
- Auditing of the test centre

- PDI & Commissioning module
- For supervision of the test centre
- For auditing of the test centre
- For assessment of the garages

- Proposal submission
- Framing of technical specification of test lane equipment
- Assistance to MoRTH for tender preparation and tender evaluation

- AIS standard for test procedure
- CMVR 62 & 63 revision
- Training to RTO personnel
- Test centre auditing for authorization
## I & C Regime in India: Capacity Requirement

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>2020</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial Vehicles</strong></td>
<td>LCV +HCV = 33 million vehicles</td>
<td>No. of Lanes reqd. = 1662</td>
<td>Centres reqd. = 416</td>
</tr>
<tr>
<td></td>
<td>LCV +HCV = 85 million vehicles</td>
<td>No. of Lanes reqd. = 4311</td>
<td>Centres reqd. = 1078</td>
</tr>
<tr>
<td><strong>Passenger Vehicles</strong></td>
<td>Population= 63 million vehicles</td>
<td>No. of lanes reqd. = 2392</td>
<td>Centres reqd. = 598</td>
</tr>
<tr>
<td></td>
<td>Population= 163 million vehicles</td>
<td>No. of lanes reqd. = 6204</td>
<td>Centres reqd. = 1551</td>
</tr>
<tr>
<td><strong>2 Wheeler</strong></td>
<td>Population= 258 million vehicles</td>
<td>No. of lanes reqd. = 6523</td>
<td>Centres reqd. = 1631</td>
</tr>
<tr>
<td></td>
<td>Population= 670 million vehicles</td>
<td>No. of lanes reqd. = 16918</td>
<td>Centres reqd. = 4230</td>
</tr>
</tbody>
</table>

**Above lane requirements are based on following assumptions:**
- 2 shift operation
- 275 working days in one year.
- Based on the vehicle population data available from year 2013 by MoRTH- Provisional (10% vehicle growth for every year is considered.)
- Source: MoRTH Transport Wing
I&C: International Scenario

**United Kingdom**
- **Applicability**
  - For both Private & Transport vehicles
- **No. of Vehicles**
  - 519 motor vehicles per 1000 people
- **No. of I&C Centers**
  - 18300 MoT Garages

**Japan**
- **Applicability**
  - For both Private & Transport vehicles
- **No. of Vehicles**
  - 588 motor vehicles per 1000 people
- **No. of I&C Centers**
  - 27000 inspection centers

**Germany**
- **Applicability**
  - For both Private & Transport vehicles
- **No. of Vehicles**
  - 588 motor vehicles per 1000 people
- **26.6 million vehicles inspected in 2013**
I&C: Proposed Phase- Wise Approach

Phase 1
• In the first phase, cities with significant transport vehicles should introduce a modern Inspection and Certification regime
• In these cities, a modern inspection regime should be first introduced for commercial vehicles
• It may then be extended to rest of India for commercial vehicle category

Phase 2
• Introduce the I & C regime to private vehicles including 2 wheelers
• Start initially with older vehicles (more than 9 years old)

Phase 3
• Extend the regime to newer fleet in private vehicles category (3-9 year old)
Challenges: Enforcement of I&C regulations

- Limited capability of inspection facilities to cater inspection of vehicles according to CMVR rules
- Increasing vehicle volumes in major cities
- Awareness of this programme to the society
- Integration of test lanes with central data base
- Record & analysis of available Test data
- Establishing the impact assessment of I & C system on air quality & Road safety
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On Board Diagnostics (OBD)

OBD is a computer based system for storing and detecting codes which identify operational malfunctions within the engine and emission control systems.

The purpose of OBD is to inform the driver when an emissions-related system or component malfunctions or deteriorates beyond agreed thresholds.
OBD Monitors

Positive Ignition Vehicles

- Monitoring Reduction in the efficiency of Catalyst – With respect to emissions of THC
- O2 (Oxygen Sensor)
- Secondary Air System
- Coolant Temperature
- EGR (Exhaust Gas Recirculation)
- Fuel Tank leakage and evaporation
- Fuel system
- Emission control system / components
- Circuit continuity for all emission related power train components
- Distance traveled since MIL (Malfunction Indicator Lamp) ON

Compression Ignition Vehicles

- Reduction in the efficiency of the Catalyst
- Electronic Fuel Injection system
- Particulate Trap (If provided)
- Coolant Temperature
- EGR (Exhaust Gas Recirculation)
- Fuel system
- Emission control system / components
- Circuit continuity for all emission related power train components
- Distance traveled since MIL (Malfunction Indicator Lamp) ON
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Remote Sensing Device (RSD) is able to measure vehicles emissions circulating under **real driving conditions**. It is a mobile system that can be deployed easily in strategical locations as required.

- The RSD detects and measures vehicle emissions as the **vehicle drives by**.
- When the vehicle breaks the **infrared (IR) and ultraviolet (UV) beam** sent across and back a single lane road.
- Since it can obtain a complete record in less than a second, these devices are designed to obtain **large quantities of data**.
- Also, since it is a non-intrusive technique, the RSD audits circulating vehicles **without interfering with the traffic flow**.

The RSD (Remote Sensing Device) is the only technology able to measure **all traffic emissions (CO, CO2, HC, NOx, PM)** as well as provide kinetic conditions and license plate picture of every vehicle driving by, all non-intrusively and instantly.
Result

"THE ENTIRE PROCESS IS COMPLETED IN LESS THAN 1 SEC"
**Key components of the RSD**

- **Source detector module (SDM)** houses two internal modules: the Source and the detector. The Source emits a beam of infrared and ultra violet (IR/UV) light. The Detector detects the vehicle emissions gases via the reflected IR/UV light beam.

- The **Corner Cube Mirror (CCM)** is a simple reflector that returns the IR/UV beams. The CCM returns the IR/UV back to the SDM.

- **Speed / Acceleration Bar**: The Emitter/Detector are mounted to the bar. Each Emitter/Detector contains a laser and detector. The Laser beam is broken by the tires of the vehicle and the detector send the information for processing.

- The **CCTV Camera** captures a digital image of the vehicles. This image is intended to be used as a visual vehicle identification.

- The RSD monitors environment conditions i.e. temperature, pressure, and relative humidity through **Weather Station**.
### RSD: Advantages & Benefits

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| Real data                 | • Real emissions data for any individual vehicle  
                          • It does not relies on projections or models                                      |
| Accuracy                  | • RSD correlate with other analytical devices such as PEMS and OBS by 85-95%                                                                  |
| Effectiveness             | • High emitting vehicles must to be individually identified since 5% of the fleet contributes with over 50% of total emission |
| Closing the gap           | • Current emission control is not performed under real driving conditions, not even tested for NOx or HC                                      |
| Quick checks              | • Vehicles are measured continuously within 0.6 seconds; not only in the periodical statutory emission tests                                  |
| Usability                 | • Practical, quick to deploy at strategic locations (mobile units) and very easy to operate                                                 |
RSD: Challenges

- Policymakers have struggled to integrate such systems into mandatory enforcement programs, or to use them to replace I/M programs.
- Absence of regulatory framework for emissions remote sensing.
- Defining detailed cut-points for different vehicle categories and pollutants.
- Location of measurement
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Summing up…. Integrated Approach for Clean Air

**Auto Industry**
- Adoption of Advanced Technology (Electric, Hybrid...)
- Fuel Efficient Vehicles

**Vehicle Owners**
- Good Maintenance Practices (Acceptability for I&M)
- Better Driving Habits

**Policy Makers**
- Policy Framework
- Transport Management
- I & M Regime

**Oil Industry**
- Provision of Clean Fuel

**Oil Industry**
- Leapfrogging to BS-VI
- Alternate fuels—(safety, materials, performance)

- Adequate I & M centres
- Use of advanced emission measurement techniques

- Significant investments
- Infrastructure
- Implementation
- Studies on air quality on continuous basis

- Providing specified Fuel nationwide
- Availability of uniform quality throughout India
- Huge investments
Thank You
Initiatives to control emissions...

<table>
<thead>
<tr>
<th>Fuel Efficiency Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• India has planned the introduction of progressive fuel efficiency regulation from year 2015 to 2020.</td>
</tr>
<tr>
<td>• Fuel economy standards for passenger cars are being made applicable from April 2017 and next stage norms from the year 2021, as per S.O. 1072 (E) dated 23rd April 2015.</td>
</tr>
<tr>
<td>• Fuel economy standards for heavy commercial vehicles are being worked out by PCRA.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Promotion of Bio - CNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Final notifications for Bio-CNG is released vide G.S.R. No. 498 (E) dated 16th June 2015.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Improvisation of driving habits through setting up of Driver Training Schools:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Under 10th plan, MoRTH has sanctioned 13 Institute of Driving Training and Research (IDTR).</td>
</tr>
<tr>
<td>• Under 11th Plan, MoRTH has approved 8 IDTR on PPP basis</td>
</tr>
</tbody>
</table>
Usage of Bio fuels such as ethanol and bio diesel.

Carbon dioxide (CO2) released when ethanol is used in vehicles is offset by the CO2 captured when crops used to make the ethanol are grown.

Promotion of alternate fuels: Final notification G.S.R. 412 (E) dated 19th May 2015 for flex fuel ethanol (E85) and ethanol (ED95) vehicles is already released.

In future, ITS enablement & End of Life (old vehicle scrapping policy) vehicle management to be enforced. Vehicular retirement policy: MoHI and MoRTH are working on this.