



## ***New Capabilities / Development***

- **Advanced Photometry and Optics Laboratory, ARAI-HTC, Chakan**
- **ARAI's MARG 2.0: GIS based Tool for Vehicle Development through Road Condition Analysis**
- **India Specific Traffic Data Generation for Development of ADAS and AV Systems for India**
- **Automotive Cybersecurity and Software Update Certification of E/E Systems and Vehicles**
- **Digital Key for Cars: A Seamless Future**
- **Technical Support Cell**
- **Work Process Management Software (SHL-WPMS) for Component Certification**
- **PLI – AUTO ARAI PORTAL: For Production Linked Incentive Scheme (PLI) Applications of Advanced Automotive Technology (AAT) Products**
- **Establishment of Buzz, Squeak and Rattle (BSR) Test Facility for Automotive Component and Sub-system**
- **Meeting the EV Training Requirements**
- **ARAI Journal of Mobility Technology (Volume 5, Issue 1, January-March 2025)**
- **Structural Dynamics Lab is now ISO/IEC 17025 Accredited – Raising Testing Standard**
- **Canister Ageing Bench for Fuel Vapour ageing as per AIS 175 WLTP and GTR 19**
- **Testing Facility for Automotive Camera Monitoring System**
- **Implementation of Official Language Policy in ARAI**
- **ARAI Journal of Mobility Technology (Volume 5, Issue 2, April-June 2025)**
- **Making of an Integrated E-Axle based Powertrain for EV, HEV and FCEV – An efficient way of Electrification**
- **Electro-Mechanical Design and Development of Electric Motors for Mobility based Applications**
- **Innovative Methodology for Testing Cooling Modules in Heavy Commercial Vehicles and Buses**
- **TG: Technovus Engagements Update & Establishment of RADAR Scenario Emulator for Virtual Validation of RADAR Based ECU Controls under Digital Twin Lab**

- Test facility for Measurement of Extractable/Leachable Ionic contamination level on the surface of printed boards and assemblies by Ion Chromatography
- ARAI Journal of Mobility Technology (Volume 5, Issue 3, July-September 2025)

### ***Awards / Conferences / Seminars / Workshops***

- Workshop on Technology Prioritization for the Transport Sector
- Regional Workshop and Report Launch of Clean Air Project in India (CAP India)
- Symposium on International Automotive Technology (SIAT) 2026
- First Ever Global Autonomous BAJA hosted by ARAI along with Innovation showcase event INTELLIMOBILITY
- Seminar on Hydrogen – Emerging Technology Scenario for ICE Applications
- Seminar on General Lighting “Emerging Smart Trends in General Lighting” - 29th January 2025
- International Conference on Advanced Powertrains for Mobility and Power Generation Applications: 7th & 8th March 2025

## Advanced Photometry and Optics Laboratory, ARAI-HTC, Chakan

In our pursuit towards becoming the leading Global Automotive Certification, Testing and Evaluation Organization, ARAI has established state-of-the-art facility, viz. “Advanced Photometry & Optics Laboratory” at ARAI-Homologation and Technology Centre (ARAI-HTC), Chakan, to cater to the certification and evaluation requirements of all types of lighting devices used in automobiles as well as general lighting assemblies.

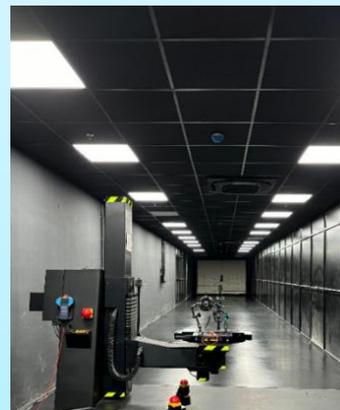
This facility is equipped for measure parameters such as Illuminance (lux) / Luminous Intensity (cd) / Luminance (cd/m<sup>2</sup>) / Colour Coordinate (x, y) / Colour Temperature (CCT) / Colour Rendering Index (CRI) / Dominant Wavelength / Coefficient of Luminous Intensity (mcd/lx) / Coefficient of reflection (cd/m<sup>2</sup>/lx) / Transmission ( $\tau$ ) & Diffusion ( $\sigma$ ) / UV radiation (k1, k2)

This facility will provide homologation services as per various national and international standards such as AIS, IS, UN regulations, FMVSS, CMVSS, ADR, SANs, etc.

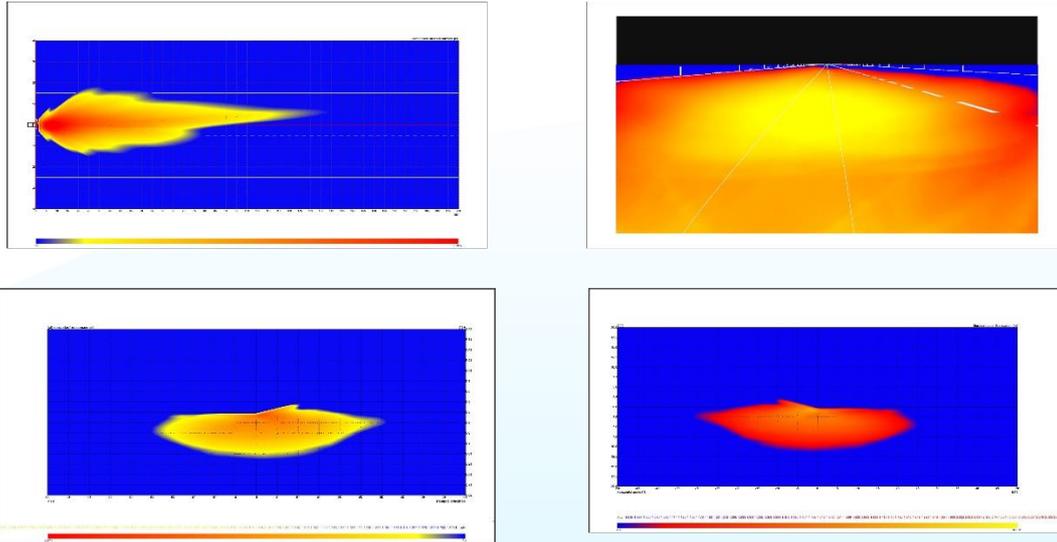


### a. Automotive Lighting and Signaling Devices:

State-of-the-art Type A multiple Goniophotometers are used for testing and certification of all types of light and light signaling devices viz. headlamp, including AFS and ADB technologies, stop lamps, direction indicator lamps, retro reflectors, etc. installed on the vehicles. The Lab is also equipped to perform testing of various light sources, viz. incandescent, Xenon, LEDs, replaceable LEDs, etc.



Additionally, this facility provides lamp light distribution data in the form of ISOLUX plots, ISO-candela diagram, bird's eye view plots and in the form of .IES files for analysis.



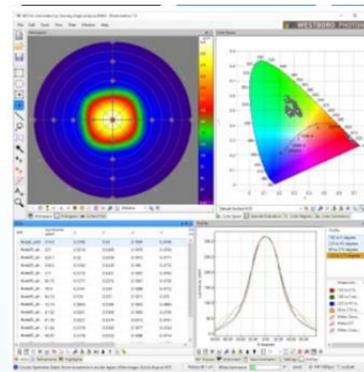
### b. Road Furniture Devices and other Lights:

Additionally, with this facility we can do testing and evaluation of road furniture devices, such as road studs, road delineators, retro reflective tapes as per various standards, such as ASTM, AIS, IS, etc.



### c. Imaging Colorimeter – Camera-based luminance meter

- High accuracy CCD based system provides precise measurements of luminance ( $\text{cd}/\text{m}^2$ ) and colour characteristics such as x, y co-ordinates, colour temperature, wavelength, etc.
- Evaluation of vehicle Instrument clusters, head-up displays, flat panel displays, avionics - aircraft and aerospace, illuminated products such as integrated displays, flight controls and indicators, cabin lighting, signage, wing position lights, etc.



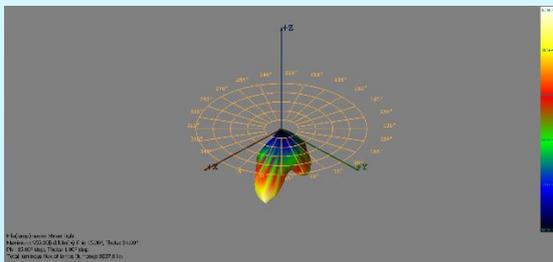
#### d. Testing and Certification of various Light sources and Luminaires under the gamut of General Lighting

- State-of-the-art Type C Mirror Goniometer with Spectroradiometer in accordance with LM 79-19, LM 75-01, EN 13032-1, CIE Publication No. 70
- Integrating sphere ( 2m dia and 1m dia) for testing of light sources
- Evaluation all types of indoor and outdoor lights, streetlights, flood lights, portable luminaires, etc. as per LM 79 as well as various IS and IEC standards.

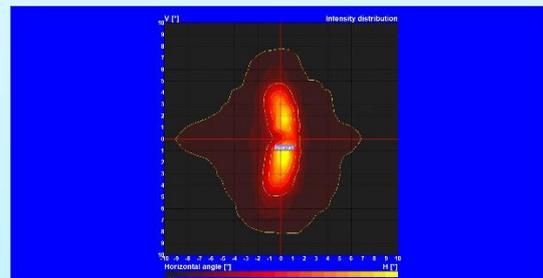


- **Compliance Testing as per following Standards**

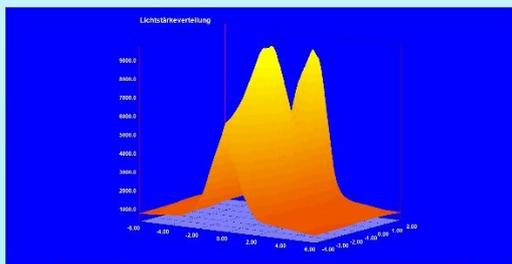
LM 79-2019, LM 79-08, IS 16106, IS 16102 (Part 2), IS 16103 (Part 2), IS 16107 (Part 2/Sec 1), IS 16107 (Part 2/Sec 2), IS 10322 (Part 5/Sec 1), IS 10322 (Part 5/Sec 2), IS 10322 (Part 5/Sec 3), IS 10322 (Part 5/Sec 4), IS 10322 (Part 5/Sec 5), IS 13383 (Part 1), IS 13383 (Part 2), IS 15111 (Part 2), IEC 62612, IEC 62717, IEC 62722-2-1, etc.



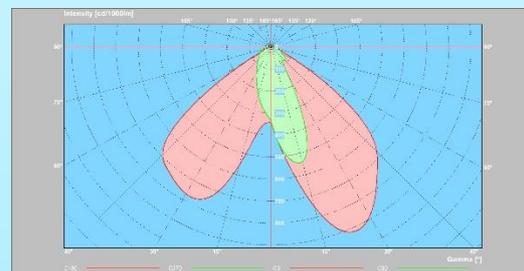
**Graphical view of C plane measurement**



**Isoline diagram**



**3D Isoline diagram**



**Polar diagram**

ARAI is the trusted partner of Indian lamp manufacturers for development, design validation, quality assessment and product conformity of their products.

ARAI has planned establishment of Optical Calibration Laboratory in near future.

## ❑ ARAI's MARG 2.0: GIS based Tool for Vehicle Development through Road Condition Analysis

Vehicle manufacturers always look for cost effective solutions to speed up development of new vehicles. Some of the major challenges are accurate measurement of vehicle performance and vehicle-reliability on different types of roads. This involves over-utilization of time, effort and money, especially when trying to understand how customers use their vehicles on various road conditions. Traditionally, the methods used to gather this information have been subjective and inconsistent.

To address these challenges, Structural Dynamics Laboratory (SDL) of ARAI has introduced MARG (Measurement Analysis of Road Geometry) 2.0, a ground-breaking Geographic Information System (GIS) based software tool designed to provide precise and objective road roughness data across India.

MARG 2.0 represents significant advancement in how vehicle OEs/Tire OEs/Tier 1 manufacturers can approach the challenges faced by them to accommodate diverse Indian conditions during design, testing and validation phases of product development.

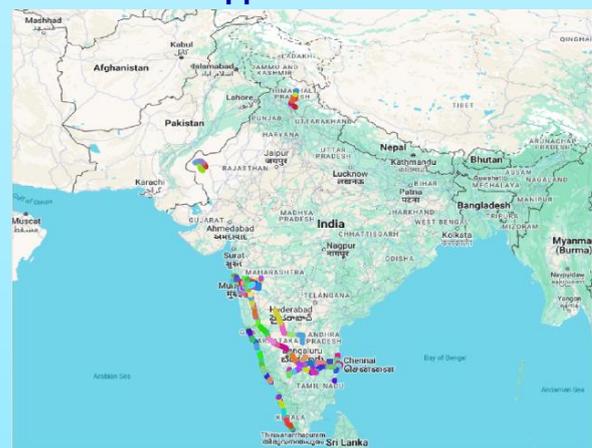
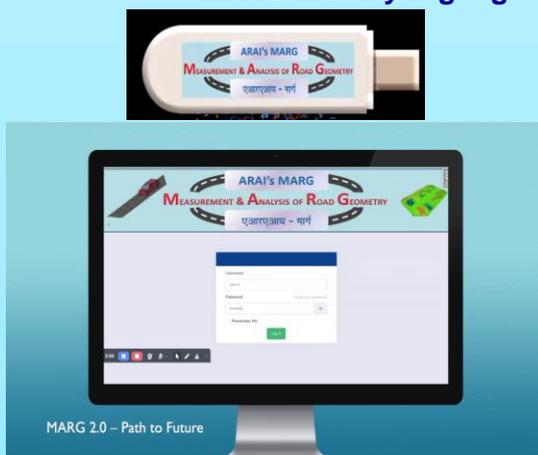
ARAI is supporting Automotive industry for transformation from traditional subjective decision making to scientific objective data driven decision making by providing advanced GIS based data in the form of road conditions / roughness [International Roughness Index (IRI)], i.e. MARG 2.0.

This innovative tool not only streamlines vehicle development process, but also helps in enhancing safety and reliability of vehicles on road. It includes geo referenced road roughness data from all across the country for different categories of typical Indian roads, viz. city, national highway, state highway, expressway, etc.

### Highlights of ARAI MARG Tool

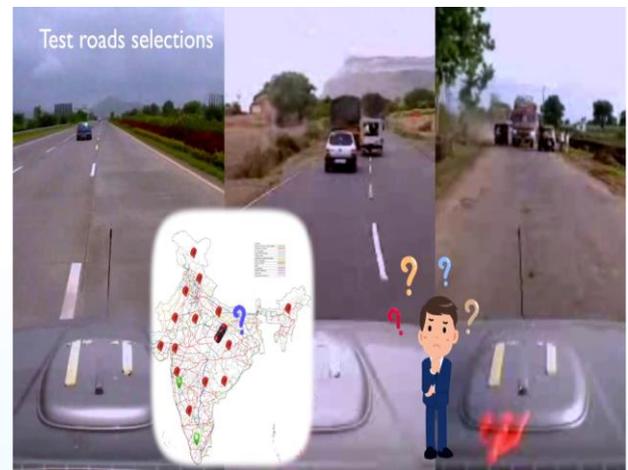
- MARG 2.0 comprises geo referenced road roughness (IRI) database of total 35,000 km, spread across 18 different states of India for different road categories, viz. city, national highway, expressway, state highway, village, sub-urban, etc. collected over the years. It provides detailed measurements of road roughness using IRI for every 100 meters of road.
- ARAI's MARG 2.0, a login-based software, offers several key features that make it an invaluable tool for vehicle and tire designers, durability and reliability engineers, quality engineers as well as manufacturers for target setting and understanding Indian road conditions.
- The tool includes geotagged photos of roads, allowing engineers to visualize the conditions they are analyzing while sitting at users' desk.
- Engineers can track changes in road conditions year-after-year on MAP to take decision on durability targets.
- MARG has in-built statistical analysis and data display tools, which help to identify the best representative test roads nearby OEM's facility / location that reflect diverse Indian road conditions.
- The tool provides insights into common road obstacles, like potholes and speed bumps, which are crucial for optimizing vehicle designs, particularly for electric vehicles (EVs).
- ARAI MARG 2.0 database is regularly updated and available for subscription.

### MARG 2.0 Key Highlights: Software Interface and Applications





**MARG 2.0 Application – Road Roughness data along with Geo Tagged Photograph**



**MARG 2.0 Application – Test Route Selection**



**MARG 2.0 Application – Analysis of Statistical Distribution of Road Condition (International Roughness Index)**



**MARG 2.0 Application – Analysis of Statistical Distribution of Road Condition as per ISO 8608 Classes**

## Use Cases

MARG tool is beneficial in various scenarios:

- ❖ For Vehicle & Tire OEM:
  - MARG 2.0 is useful for target setting, design and validation of vehicles / tires that are better suited to Indian roads, which can lead to improved durability and performance.
  - MARG 2.0 will be the beneficial tool for vehicle validation and market target setting. Organizations conducting vehicle durability tests can select appropriate roads based on the detailed analysis of objective Geo referenced road roughness data provided in MARG 2.0. It will help to ensure that finalized vehicle test targets / schedules are effective and relevant to customer duty cycle. On road durability test routes representative to any market roads can be decided using statistical analysis tools provided in MARG 2.0.
- ❖ For Urban Planners:
  - The insights gained from MARG 2.0 can help in planning road maintenance and upgrades, leading to safer driving conditions.
- ❖ For Researchers:
  - Academics studying vehicle dynamics and road safety can utilize data from MARG to support their research.

In totality, ARAI's MARG 2.0 is a GIS based Mathematical tool that simplifies complexities of vehicle development by offering precise understanding of Indian road conditions and insights into road geometry. This advancement will ultimately lead to creation of safer and reliable vehicles to meet the needs of Indian consumers, towards safer and more efficient transportation system.

## India Specific Traffic Data Generation for Development of ADAS and AV Systems for India

### Technology

Synchronously acquired multi-sensor India specific traffic dataset for ADAS and AV functionalities, specifically for India environment.

### Properties/ Features

- India Specific conditions are covered
  - Multiple states, major cities covering expressway, state highways, rural roads and ghat sections
  - India-specific vehicles – auto-rickshaws, tempos, trucks, buses, bikes, etc.
  - Seasonal variations: rain, winter, summer
  - Time: dawn, day, noon, afternoon, twilight
- The generated dataset consists of synchronous data from following sensors:
  - Camera sensors: 8
  - Lidar sensor: 64 channels
  - Mid-range radar sensor
  - Inertial Navigation Sensor – IMU + GPS
  - Vehicle CAN
- Captured raw data is in-time sync with each of the sensors

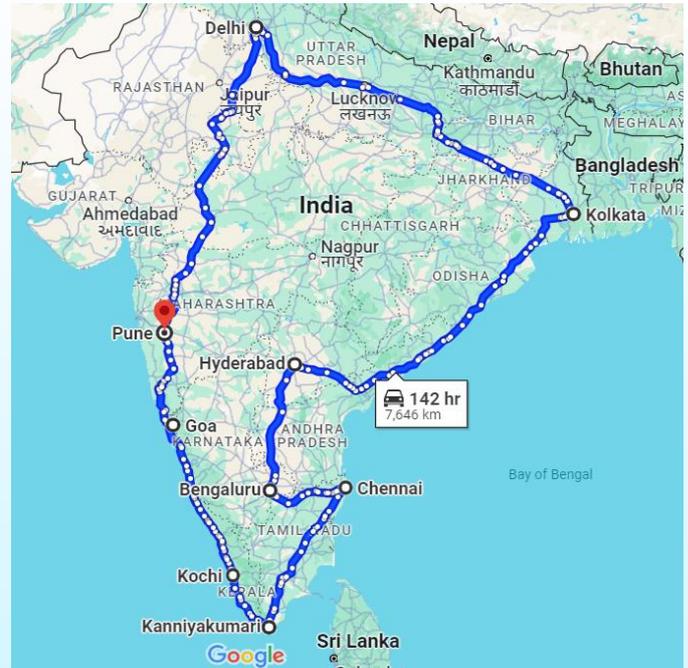


Figure 1 – Data Acquisition Route

### Application

The generated synchronous data can be used for –

- Training and validation of AI models for ADAS functions and autonomous vehicles
- Sensor fusion research
- India specific traffic events extraction
- India specific Traffic analysis and understanding
- Development of India-specific autonomous driving algorithms
- Testing and evaluation of autonomous driving systems for Indian cases
- Data-driven decision-making for urban planning
- Research in computer vision and machine learning
- Development of safety features for human-driven vehicles
- Creation of synthetic datasets

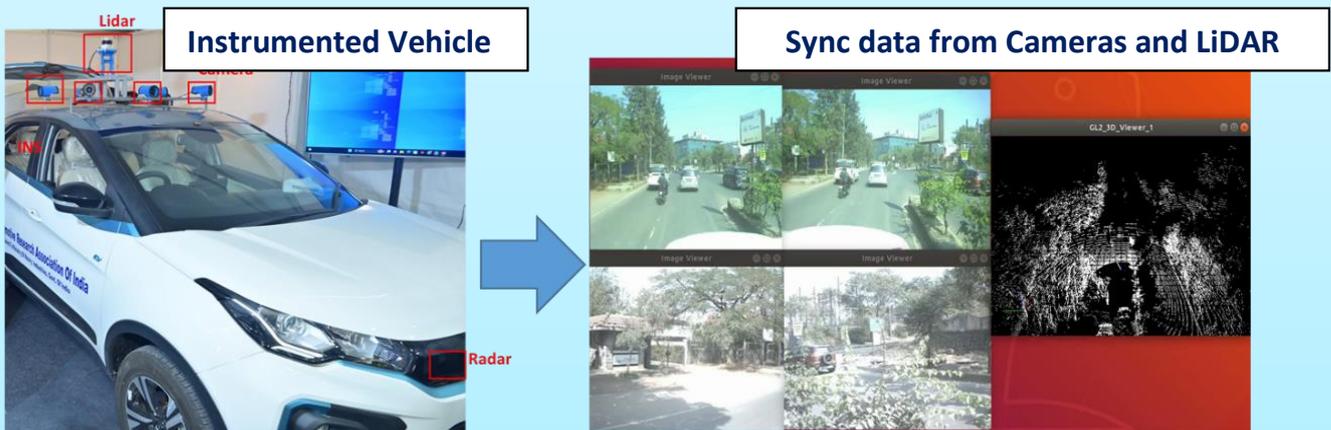
## Abstract

Now-a-days Advanced Driver-Assistance Systems (ADAS) is equipping cars and drivers with advanced information and technology to make them become aware of the environment and handle potential situations effectively, semi-autonomously. High-quality training and test data are essential in development and validation of ADAS systems, which lay foundation for autonomous driving technology.

Generation of synchronous multi-sensor datasets for Indian-specific traffic conditions represents a crucial milestone in developing accurate and reliable autonomous driving systems tailored to India's unique urban landscape. This comprehensive dataset combines data from various sensors such as cameras, lidars, radars, and GPS units, all synchronized to capture dynamic and often chaotic nature of Indian roads. By incorporating multiple sensor modalities, this dataset provides holistic view of traffic scenarios, including pedestrian behavior, vehicle interactions, road infrastructure and environmental factors peculiarly to Indian cities. The synchronous nature of dataset ensures that all sensor inputs correspond to the precise moment, allowing precise correlation and analysis of different data streams. This rich, multi-dimensional dataset serves as a valuable resource for training and validating AI models designed to navigate India's complex traffic environments, ultimately contributing to safer and more efficient autonomous vehicles adapted to local conditions.

## Beneficiary Industry

- Vehicle Manufacturers, Tier 1 suppliers
- Engineering Institutes working in AI / ML
- Developers and service providers working in ADAS / V areas
- Research Institutes and Startups developing algorithms for ADAS functionalities



**Figure 2 – Generation of Synchronous India specific Dataset from Instrumented Vehicle**



Modern vehicles have become totally connected objects and require communication to support a wide range of scenarios from information and entertainment purposes to new ways of operating the vehicle such as driver assistance, connected fleet and autonomous driving modes. This fast-paced functional evolution has significantly increased the attack surface of the connected car.

These advanced cars consist of several Electronic Control Units (ECUs) to support various safety-critical functionalities. The underlying systems are susceptible to safety and cyber-attacks as the involved ECUs are interconnected. Security attacks can lead to disrupting safe operations of component and vehicle while causing injury to passengers. As a result, large variety of defensive mechanisms is needed to prevent the hackers.

Europe has already started implementation of Cyber Security Management System (UN R155) and Software update Management system (UN R156) from June 2022. Automotive Industry Standards Committee (AISC) and CMVR - Technical Standing Committee (CMVR-TSC) has recently finalized AIS 189 for approval of vehicles for Cyber Security and Management Systems (CSMS) and AIS 190 for approval of vehicles for Software Update and Management System (SUMS). In future, scope of these standards will be expended to cover L category vehicles also. Many electric vehicles, especially 2-Wheelers, are coming with telematics connectivity and Over-The-Air (OTA) software update features.

Traditionally, the security team performs Threat Analysis and Risk Assessment (TARA) in evaluating the risk associated with security incidents. Real Penetration and Fuzz testing depends on the result of TARA.

In order to gear up to face this challenge, there is a need to establish tools required for various cyber analysis and testing of automotive electronics components and entire vehicle. ARAI is in the process of establishing cyber security testing Laboratory to cater to the homologation and testing requirements.

This Testing Laboratory will consist of following state-of-the-art facilities:

- 1. Tools for Threat and Risk Analysis**
- 2. Fuzz Testing Lab**
- 3. Penetration Testing Lab**
- 4. Side channel attacks**
- 5. Static and Dynamic code analysis**
- 6. Vulnerability Scanning tools**

This will help OE and component manufacturers to carry out development and certification activities in cyber security and software update with a view of ensuring safety and security of modern vehicles.

## ❑ Digital Key for Cars: A Seamless Future

Amendment No. 3 To AIS-076:2007: “Approval of Vehicle Alarm Systems (VAS) for M1 and N1 category of vehicles with regard to their Alarm Systems (AS)” describes new features of digital key unit used in modern vehicles.

The concept of a digital key is revolutionizing the automotive industry. Digital key allows users to unlock, start and share access to their vehicle using a smart device, like smartphone. The digital key system is being developed to provide more convenient, secure and user-friendly alternative to traditional keys.



### Key Features

**Digital keys offer numerous use-cases:**

**Unlocking the vehicle:** When smartphone is in close proximity, the system, through proximity sensors, can unlock or lock the car without requiring any user interaction. This is commonly referred to as passive entry.

**Engine start:** Engine can be started when the device is detected inside the vehicle, simplifying the process by just pressing START button.

**Key sharing:** Temporary either in-person or remote access can be granted to others, such as family members or service providers.

**Security Standards:** Given the sensitive nature of automotive security, development of digital key technology adheres to stringent safety requirements outlined by industry standards like AIS 076. The key aspects include:

- **Trustworthiness:** Digital key exchanges must come from verified devices to prevent malicious attacks.
- **Freshness and Binding:** Messages between the device and vehicle must ensure they are current and tied to the proper user, safeguarding against replay attacks or unauthorized access.

The technology behind digital keys relies on Secure Elements (SEs), Trusted Execution Environments (TEEs), and secure communication protocols, like Bluetooth, NFC and Global Platform, ensuring that the user experience is smooth and reliable.

Testing and Validation of digital key according to AIS 076 is augmented at ARAI. AIS 076 standard emphasizes robust security validation.

Cyber Security-related threats are important for digital key, Automotive digital key is connected to vehicles through smartphone that is enrolled with the software and connects both on cloud server. Manufacturers are thus involved in developing advanced cyber security systems to provide better security against hacking.

Car Connectivity Consortium (CCC) is an industry-wide collaboration aimed at developing global standards for smart device and vehicle connectivity. Comprising of leading automotive manufacturers, smart device companies and technology providers, CCC plays crucial role in driving interoperability between different brands and platforms. Its focus includes creating unified digital key eco-system that allows seamless communication between cars and mobile devices. By promoting these standards, CCC ensures enhanced security, user convenience and consistency across the automotive industry.

As the automotive industry moves towards connected vehicles, adoption of digital keys offers consumers greater flexibility and convenience. Standards, like AIS 076 ensure that this transition happens securely, making digital keys a safe and efficient solution for the future of mobility.

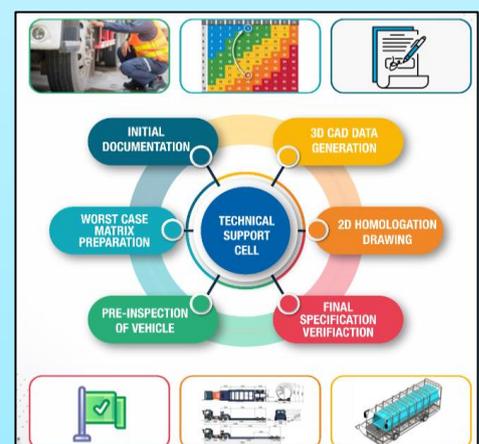
## □ Technical Support Cell

ARAI has launched Technical Support Cell (TSC) to provide homologation technical support, guiding clients through type approval process as per Central Motor Vehicles Rules (CMVR), with initial documentation and detailed guidance on necessary documentation and drawings. This Cell is dedicated to serve diverse market sectors, including EV start-ups, MSME component manufacturers and the unorganized sector of bus, truck and trailer body builders.

As Government of India and various state Governments have initiated schemes for startups and incentive for local manufacturing to boost electric mobility and promote development of electric vehicles, we have seen sudden rise in EV startups in last few years. These new entrants are typically unaware of CMVR Type approval, which is mandatory in order to register new vehicles, technical requirements, type approved components, Conformity of Production (COP) and whole homologation process, to avoid hindrances in their launching phase. Additionally, the unorganized sector, viz. bus body builders, truck body builders and trailer body builders, which are usually run by families, need guidance for compliance process.

To address these issues and cater to homologation support service to start-ups- EVs, MSME's and unorganised sector, ARAI Technical Support Cell (TSC) offers following services:

1. To understand customer requirement and connect them with respective departments
2. In case of Homologation technical support requirement
  - a. Understand Customer product and brief them about relevant CMVR type approval process
  - b. Support for initial documentation
  - c. Guidance for documentation and drawings. (Different Annexures, Various checklists as per different tests etc. as specified in CMVR.)
  - d. Co-ordination of test schedules in consultation with testing departments
  - e. Guidance for mock-up required for different tests
  - f. Pre-inspection and Gap analysis of proto vehicle

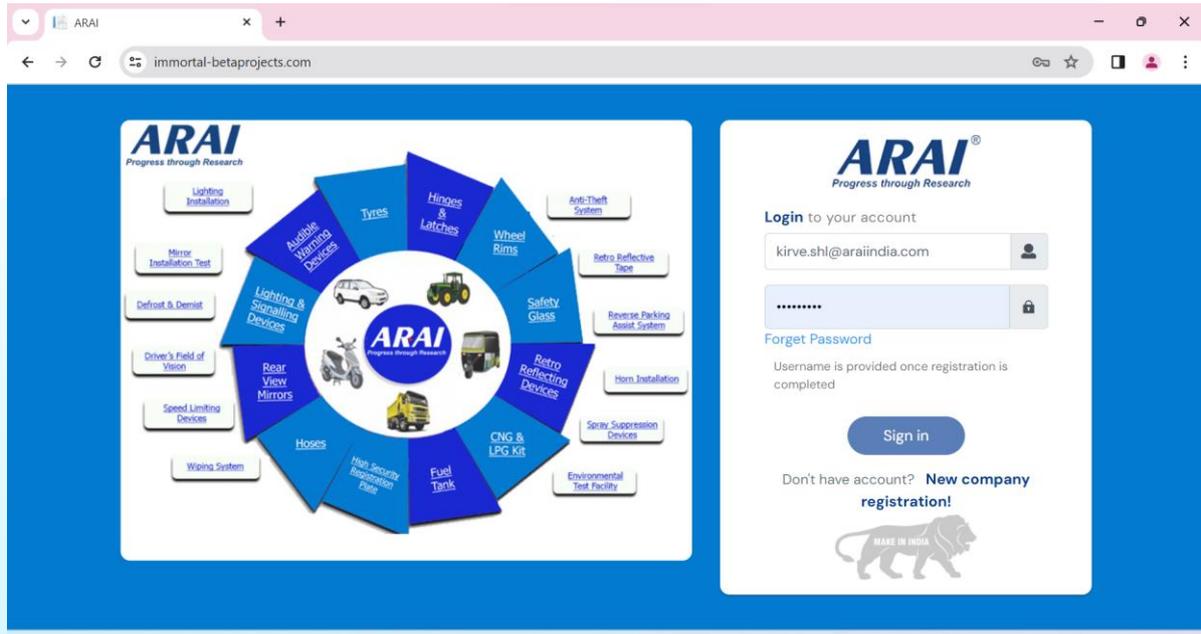


ARAI Technical Support Cell is headquartered in Pune and currently has a Regional Centre in Chennai. Plans of expansion are underway to ensure enhanced network support.

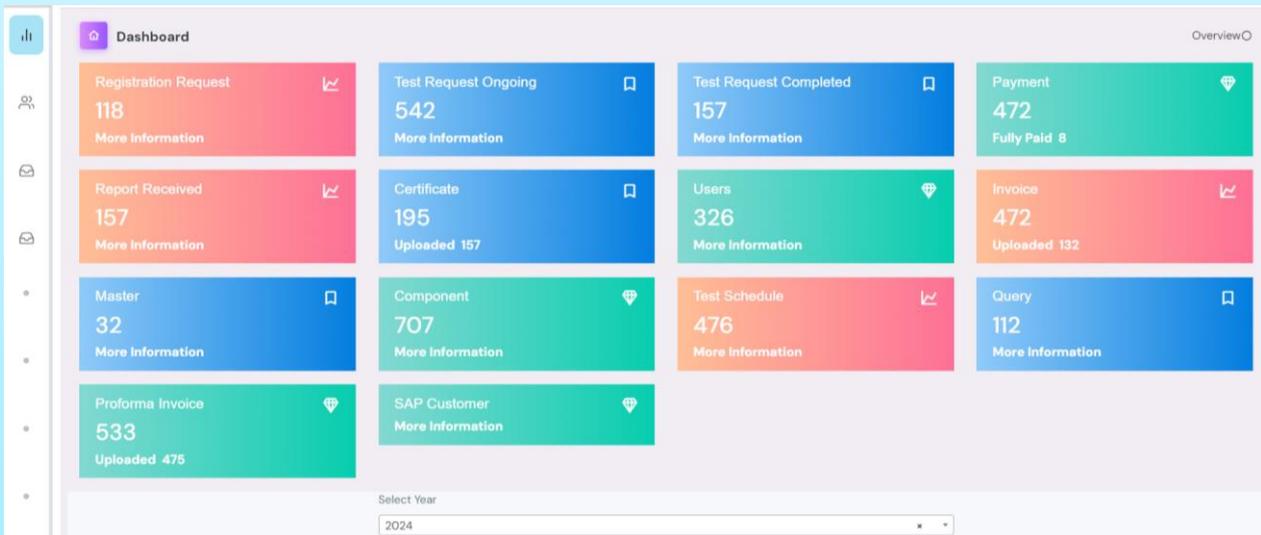
## ❑ Work Process Management Software (SHL-WPMS) for Component Certification

ARAI's Safety & Homologation Laboratory (SHL) has launched Work Process Management System portal to offer digital services to the automotive and component industry for testing and certification of their products.

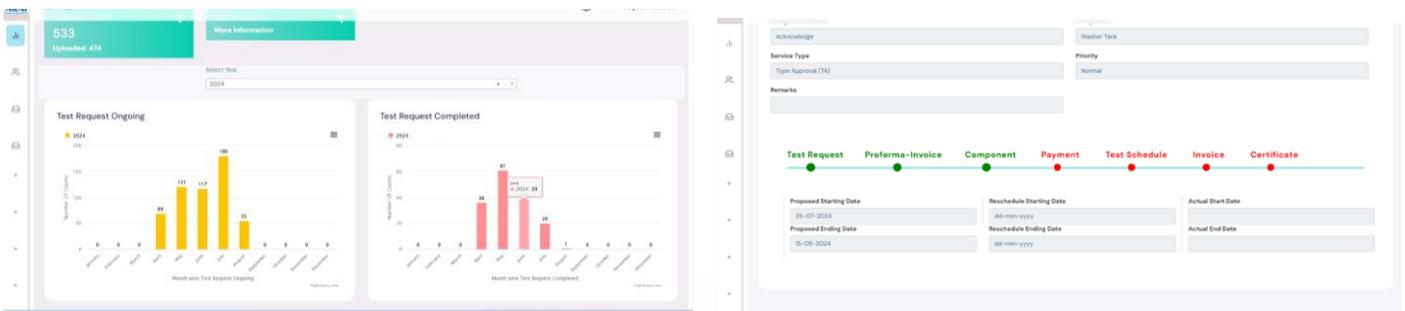
This customer-centric portal provides digital experience to the industry for their applications.



This portal facilitates customer registration as well as online application by providing requisite information and uploading of documents, such as ARAI Checklists, Drawings, E-certificates, etc., required for testing and certification of customer products. The user-friendly system flow guides customers in selection of critical safety components. Options for selection of different types of services, such as Type Approval Certification (TAC), Conformity of Production (CoP), Developmental Testing, Extension Testing, any Specific Performance Testing, etc. are available on the portal.



One of the important features of the portal is provision for uploading information regarding dispatch of test samples as well as payment details by the customers. On uploading of data on the portal, it is easy to track the details in the system and keep it accessible on the portal for future reference.



Additional advantage of online tracking of test request is available for ARAI users and customers. Using this facility, customer can view and track progress of ongoing testing and also receive updated status upon completion of testing and uploading of Report or Certificate.

Auto mail alerts to customers have been set at various stages, such as Proforma Invoice upload, Receipt of Components at ARAI, Probable date of completion of test, Final invoice upload, Certificate upload, etc.

Customer can view and download Proforma Invoice, Final Invoice and Certificate directly on the portal.

Test Engineers will find this portal useful because all the information related to testing can be organized online. This will reduce tracking as resultant testing time. Users will also receive auto periodic mail alerts communicating progress of testing. This facility can be extended to other type of services the Lab would like to offer in future as well. The portal will facilitate to monitoring of the complete test process, reduce testing time their increasing the overall efficiency.

**❑ PLI – AUTO ARAI PORTAL: For Production Linked Incentive Scheme (PLI) Applications of Advanced Automotive Technology (AAT) Products**

ARAI has recently launched its own PLI – Auto Portal to facilitate Domestic Value Addition (DVA) certification for Advanced Automotive Technology (AAT) products under the Production Linked Incentive (PLI) Scheme. This portal offers user-friendly interface for submission of application and uploading of documents, enabling efficient processing and transparency with online tracking and auto mail alerts for applicants. New users can register and manage their applications ensuring seamless interaction and timely updates throughout the certification process.



Using the login credentials, applicant can create request for DVA certification on this web portal, post the application is uploaded on MHI's PLI – Auto Scheme Portal. The user-friendly flow of the system is designed in reference to MHI-SOP dated 27th April 2023 that it can better guide the applicant to process their Applications in seamless and efficient way.



### Key Features:

1. Secured login with OTP.
2. Facility of New Applicant Registration.
3. Auto email for major stages and Notifications for every status change.
4. Calendar indicating major tasks as a part of Application tracking
5. Role-wise Dashboard design
6. Document upload and process facility designed in reference to MHI-SOP dated 27<sup>th</sup> April 2023.
7. Process friendly with easy click on notifications
8. Multiple Document upload facility against each head of Annexure VIII of SOP, e.g. Annexure IV undertakings up to 200 documents upload facility.
9. System for sharing remarks against each uploaded file by applicants. Version control for each document upload.
10. Quotation and Invoice uploads.
11. Download facility for Certificate and Reports.
12. Techno-Commercial Audit (TCA) reminders with TCA request creation for applicants in reference to its original Application.
13. Periodic Surveillance Assessment Reminders with Application request creation for applicants.

## ❑ Establishment of Buzz, Squeak and Rattle (BSR) Test Facility for Automotive Component and Sub-system

With the changing trends of mobility, comfort and evolving customer demands, NVH requirements for ICE and Electric Vehicles are becoming more crucial. Many times, buzz, squeaks and rattles in vehicles are the major source of customer dissatisfaction. ARAI has established BSR facility systems to help OEMs and their suppliers to develop and produce vehicles free of squeaks and rattles, with measurable quality. The state-of-the-art BSR facility having VPR+4D (Vertical Pitch and Roll with 4 DoF) can be used for product validation during design / development as well as for production verification, launch support and in-plant quality audits.



*Roof and Floor Console BSR*



*Instrument Panel BSR*

### SALIENT FEATURES

- Dedicated facility for BSR evaluation of components, sub-systems and full vehicle
- 5 DOF system to simulate vertical, fore aft, lateral, roll and pitch
- Quiet room with background noise of 25 dBA
- Provision to simulate sine, PSD, random and acceleration time history excitation profiles
- Acceleration levels up to 2.0 g rms
- Shaker table maximum payload of 315 kg

### APPLICATIONS

- Seats, Instrument panel and clusters, infotainment display units, door, steering system, sunroofs, floor and overhead consoles, HVAC control modules, RVM & ORVM, load floors, seat belts, gear shift levers, etc.
- All categories of vehicles up to SUV class
- Ideal for pre and post durability BSR evaluation in hot and cold environment conditions

## ❑ Meeting the EV Training Requirements

With faster adoption of electric vehicles, training requirements on different systems of electric vehicles have increased drastically. Various facilities are coming up at various locations in India to cater to the increasing demand. Since electric vehicle technology is completely different from conventional vehicle technology, the facilities shall be upgraded to cater to the present and future requirements as well. ARAI Academy houses different laboratory facilities catering to fossil fuel-based vehicle demonstrations, such as 75 kW engine Test Cell, various cut sections to demonstrate working of sub-systems, highlighting its working cycle in Automotive Engineering Systems Laboratory. All these facilities still find their relevance, as comparison between the two vehicles is necessary, while few of the systems such as braking system, HVAC and similar do not change dramatically. Over the years, these facilities have been utilized for training of working professionals and engineering students aspiring to work in the automotive industry.

In order to cater to the new requirements related to EV training, in addition to training of its trainers, ARAI Academy has set up a laboratory facility to include Hybrid Electric Vehicles and Electric Vehicle Laboratory. The source to deliver power to the wheels in EV requires combination of Battery and Motor. Hence, following equipment have been purchased:

1. Battery Cell and Pack Cyclor
2. Electric Motor Trainer Kit
3. Power Electronics Workbench
4. Personal Protection Equipment and Toolkit for EV System Handling
5. Exploded View of the EV Systems
6. MATLAB software platform for training on EV systems simulation.

Additionally, ARAI Academy has developed its own BMS Trainer Kit, through which the learner can get the knowledge of basic concepts of battery management system.

ARAI Academy welcomes prospective partners to engage with us in its journey of education in the Automotive world.

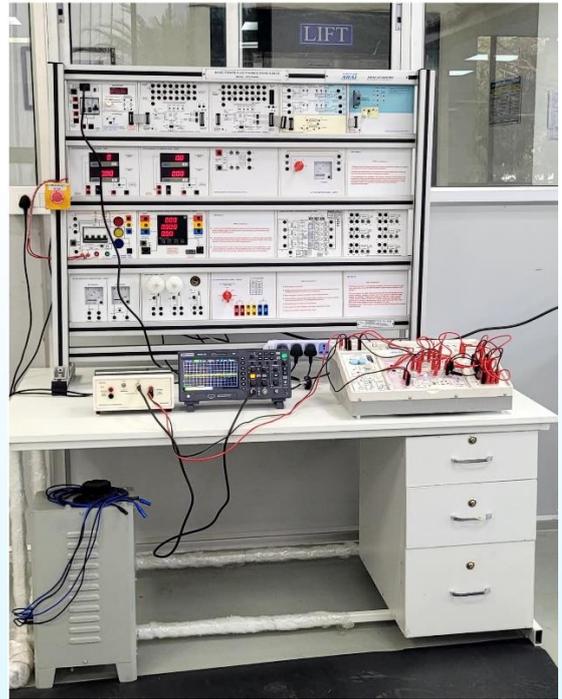
Academy organizes short training programmes scaling for the duration of one-day to three-days. Over the period, ~20 programmes are conducted in the field of Electric Vehicles, for imparting training to over 700 working professionals.

Major training programs conducted at ARAI Academy:

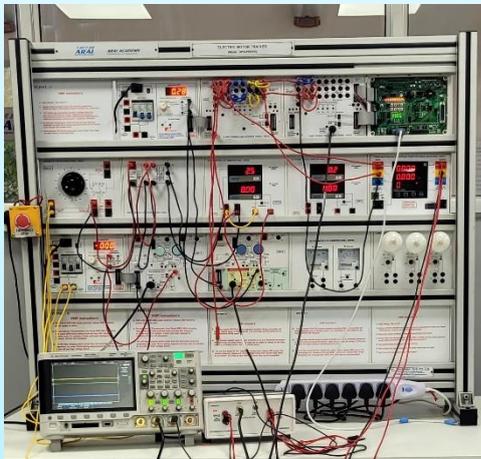
1. Electronic Systems for Smart Mobility.
2. EV Motors: Balancing Performance, Efficiency and Drives
3. EV Machine Modelling and Control using MATLAB/Simulink
4. Charging Infrastructure Technology Requirements and Interoperability
5. EV Batteries – Fires and Safety
6. EV – Fundamentals



**Battery Cell and Pack Cycler**



**Power Electronics Work Bench**



**Electric Motor Work Bench**



**Electric Vehicle Trainer Kit**



**EV Sub-system Breakout Board**

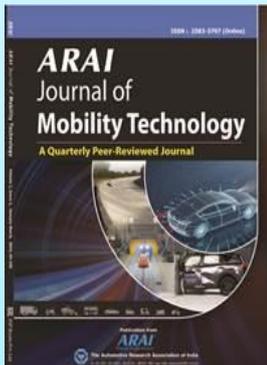


**Electric Motor Hardware-in-loop Test Set up**



**Battery Management System (BMS) Trainer Kit**

❑ **ARAI Journal of Mobility Technology (Volume 5, Issue 1, January-March 2025)**



[ARAI Journal of Mobility Technology](https://araijournal.com/index.php/arai) mainly focuses on automotive and related topics. It is available online and in print version. The aim of bringing out this journal is to help professionals, researchers and students share their original research in the field of mobility technology. One of its goals is to provide platform for publishing articles on variety of automotive and allied subjects. Papers published in this journal are taken up and well-promoted by the automotive and research communities.

The journal welcomes contribution from researchers all over the world and is aimed at scholars, academics and professionals in the automotive industry.

First edition of the journal for the year 2025 (**Volume 5, Issue 1, January-March 2025**) has been released online. If case of any requirement of full-text papers, please feel free to contact us. For more details, you can visit the website at <https://araijournal.com/index.php/arai>

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<b>Editor-in-Chief &amp; Publisher:</b> Dr. S. S. Thipse	<b>Publication Format:</b> Online & Print Version
<b>Publication Started:</b> 2021 (Oct)	<b>Frequency:</b> 04 Issues per year (January, April, July, October)
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<b>Subject:</b> Engineering (Automotive)	<b>Impact Factor:</b> 6.73 (RPRI)

## Table of Contents

### Editorial

<i>Dr. Sanjay Arole</i> .....	(vii)
-------------------------------	-------

### Research Papers

1. <a href="#">A Reduced Order Model of the Mechanical Dynamics of the Operating Mechanism in a Molded Case Circuit Breaker using MATLAB</a> <i>Akash Pathak and Dr. T R Milind</i> .....	1397
2. <a href="#">Enhancing Tractor Safety on Roads with A Multistage Overtake Warning System</a> <i>Onkar Kaniche, Mohan Vadnere and Sourabha Gokhale</i> .....	1410
3. <a href="#">The Application of Virtual Reality in Automotive Design</a> <i>Rohit Uttam Sanil, Shubh Vinayak Koli, Omkar Kamlesh Gawli and Ameya Nijasure</i> .....	1423
4. <a href="#">Failure Analysis of Metal Oxide Varistor used in Wireless Charger of Automotive Vehicle</a> <i>Srishti Bhatt and Dr. Shirish C. Bali</i> .....	1433
5. <a href="#">Mathematical Modeling &amp; Heat Transfer Analysis of Lithium-ion Battery Pack for Electrical Mobility</a> <i>Dr. Gangaraju Srinivas Sharma, Dr. Gangaraju Lakshmi Kameswari and Dr. U. Ashok Kumar</i> .....	1446
6. <a href="#">Failure Resolution of Exhaust Manifold used in Commercial Vehicle Engines</a> <i>Abdul Rahiem A, Krishnamoorthy K, Sunilraj S, Sarathaswin B and Dr. Koorella Krishna</i> .....	1455
7. <a href="#">Simulation of Autonomous Tractor using ROS</a> <i>Harsha S. K. V, Ganesh Y, Chandan P, A Pranav and Sharanbassappa S Patil</i> .....	1463
8. <a href="#">IC Engine Injector Sleeve O-Ring - Field Failure Resolution</a> <i>Santosh M, Deepalakshmi R, Koorella Krishna SVBR and Sivakumar G K</i> .....	1473
9. <a href="#">An Enhanced Vacuum for Brake Booster with Venturi Effect</a> <i>Yogesh Suryavanshi, Ravikant Raju and Vinod Deshmukh</i> .....	1480

### Technical Paper

10. <a href="#">Raw Emissions Determination and Calculations for Blended Fuel – HCNG</a> <i>Debjyoti Bandyopadhyay, Prasanna Sutar, Shailesh Sonawane, Sandeep Rairikar, Dr. Sukrut Thipse and Onkar Sale</i> .....	1489
--	------

### Journal Indexed in



### ❑ Structural Dynamics Lab is now ISO/IEC 17025 Accredited - Raising Testing Standard

Structural Dynamics Lab (SDL) of ARAI has achieved ISO/IEC 17025:2017 Accreditation for performance, durability and vibration testing across multi-diversified sectors.

This international certification is a recognition of technical competency, rigorous quality management and unwavering commitment to accurate, reliable testing.

This ISO 17025 Accredited Testing Capabilities now includes:

- Railway and Metro Systems — Bogie Frames, Axle Boxes
- Structural Components — Reinforcement Coupler Bars
- Electronic and Mechanical Components — Vibration Testing for performance and durability

This Lab has established competency of bogie frame / axle box (railway / metro application) validation as per EN13749/UIC515/UIC615 by conducting laboratory static and fatigue tests using up to 18 servo-hydraulic actuators simultaneously. Axle Box validation by conducting laboratory cyclic tensile test, low cycle fatigue test and high cycle fatigue test as per IS 16172.

SDL is also equipped with 6,000 kgf electro-dynamic shaker integrated with environmental chamber for vibration testing. Now, this facility is also ISO 17025 Accredited for conducting validation as per following standards:

- IEC 61373:2010 - Railways
- JSS 55555:2020 - Defence
- JIS D 6101:1995 - Automotive
- IEC\_60068\_Part2\_Sec6:2007: Defence, Aerospace
- IEC\_60068\_Part2\_Sec78:2020: Defence, Aerospace

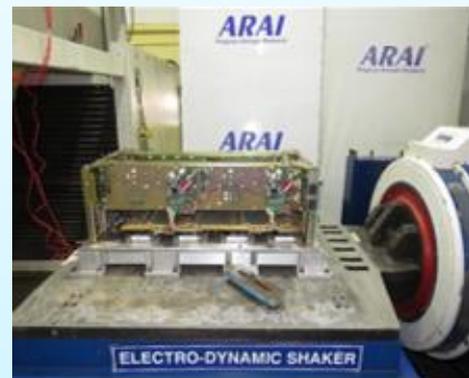
For any further information and testing requirement, please reach us on [info@araiindia.com](mailto:info@araiindia.com); [shinde.sdl@araiindia.com](mailto:shinde.sdl@araiindia.com) (+91-20-6762 1510)



***Driver Seat***



***Dine Table***



***Electrical Control Units***



***Bogie Frame Testing for Railway/Metro***



## **Specifications:**

- Canister Loading with Fuel Vapour and Butane
- Fuel Vapour Loading Rate up to 300 g/h (selectable)
- Butane Loading Rate up to 220 g/h (selectable)
- Fuel Evaporation Unit
- Fuel adaptability: Gasoline fuel with Ethanol content up to 85 % (E85)
- Operating Temperature: 10 to 40 Deg C
- Gasoline Density Measurement (GDM) Sensor
- UUT Weighing Scale: Weighing Capacity 6.2 kg
- ATEX Proof Installation
- Online trend data information
- Online 1Hz data ASCII export
- Combined MS Excel report

## **Test Standards:**

The system is compliant and can perform Automatic Test Sequence as per following standards:

1. INDIA - AIS 137 Part 1,2, 3 and AIS 175
2. UN ECE GTR-19 (WLTP EVAP)
3. ECE Regulation No. 83 Annex 7 (Type IV Test)
4. Europe Directive 70/220/EEC, 715/2007/EC, 692/2008/EC, 1151/2017/EC, 1154/2017/EC, 168/2013/EC
5. EPA CFR 40 Part 86.153-98
6. EPA CFR 40 Part 1066 (referring to EPA Part 86)
7. CARB CCR 13 Part 1976, LEV 1-3
8. CHINA GB 18352.5-2013, Beijing 6 (Draft)
9. JAPAN JASIC 11-3-49 Part 8

## **Applications:**

- Canister aging / stabilization as per AIS, ECE, CARB regulations as above
- Canister working capacity evaluation
- Standard canister conditioning
- Puff-Loss Simulation
- Leak check procedure
- Combined-System for flexible use of Butane/N2 or Fuel Vapor/N2 mixture with Real fuel aging (300 Cycles) followed by 5 cycles of Butane/N2 for BWC determination
- BWC validation

## ❑ Testing Facility for Automotive Camera Monitoring System

**Automotive CMS Testing Facility** is set up in Safety and Homologation Lab (SHL) at ARAI – Kothrud. It is equipped to perform full validation and performance testing of camera-based indirect vision systems in accordance with National and International standards (**AIS 001, ISO 16505 and ECE R46**). These standards define minimum safety and quality requirements for replacing traditional mirrors with electronic displays. AIS 001, ISO 16505 and ECE R46 provide comprehensive framework to assess **image quality, system latency, field of view, ergonomics, durability, and operational reliability**, all of which are systematically tested in this facility.



Fig 1: CMS System

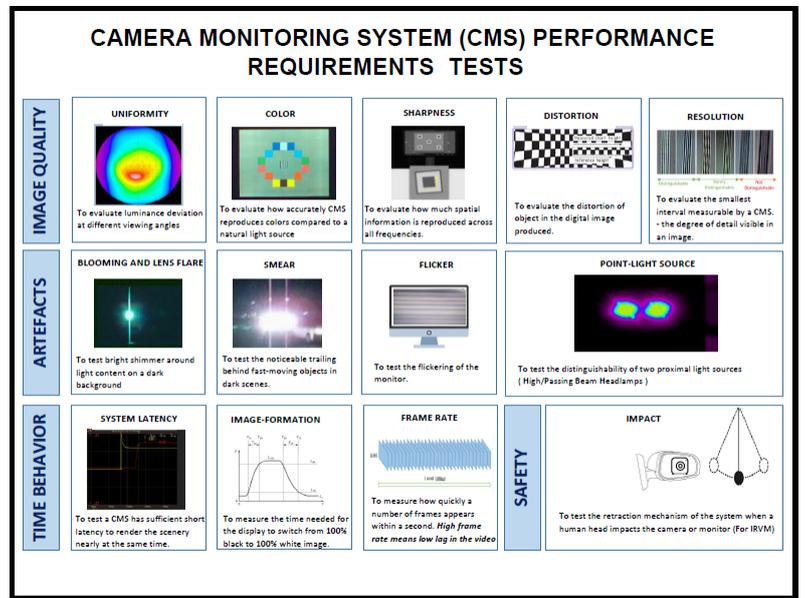


Fig 2: Performance Test Requirements for CMS

### Core Capabilities:

- **Image Quality Evaluation**
  - Resolution, luminance, contrast ratio and sharpness assessments
  - Glare and blooming effects under high dynamic range conditions
  - Visibility testing under various ambient light levels (including night and tunnel simulations)
- **Field of View (FoV) & Coverage Testing**
  - Camera placement and viewing angle measurements to meet indirect vision coverage zones
  - Verification of compliance with minimum horizontal and vertical FoV requirements
- **Latency & Real-Time System Performance**
  - Measurement of end-to-end system delay (camera sensor to display output)
  - Ensures latency remains within AIS 001, ISO 16505 and ECE R46 limits to maintain driver safety and real-time awareness
- **Display Readability & HMI Ergonomics**
  - Testing under daylight and nighttime conditions for readability and visibility
  - Human factor studies for optimal positioning, driver distraction minimization, and image interpretability
  - Assessment of display flicker, ghosting, and visual comfort during long-term use
- **Environmental & Durability Testing**
  - Temperature cycling from -40°C to +85°C
  - Ingress protection (IP67/IP69K) for camera housing
  - Resistance to vibration, mechanical shock, and UV exposure in line with ISO 16750 and ISO 20653

➤ **Fail-Safe & Diagnostic Functionality**

- Testing of fallback mechanisms in case of camera/display failure
- System self-monitoring and diagnostic capability validation

➤ **Electrical & EMC Compatibility**

- EMI/EMC testing to ensure interference-free operation in vehicle environments
- Voltage variation, short circuit and power cycle durability testing

In alignment with **AIS 001, ISO 16505 and ECE R46**, CMS Test Facility ensures that automotive camera systems are not only compliant with international safety regulations but are also optimized for real-world performance and driver acceptance. This facility provides platform for the OEMs, Tier 1 suppliers and Indian CMS manufacturers for the development of their product by accelerated certification and market readiness with confidence including export market.



*Inauguration of CMS Lab*

**Test Infrastructure:**

- Programmable lighting tunnels (day/night, backlighting, and glare scenarios)
- Environmental chambers and vibration test rigs
- ISO-compliant image quality test charts and calibration tools Real-time latency

❑ **Implementation of Official Language Policy in ARAI**

**Official Language (OL) Policy of Government of India**

As per Article 343 of Constitution of India, Hindi in Devanagari script is the official language of the Union, supported by the Official Languages Act, 1963. English is also permitted for official purposes and both are used in complementary manner.

In ARAI, implementation of Official Language Policy is guided by the directives of Department of Official Language (Ministry of Home Affairs) and Ministry of Heavy Industries.

**Implementation of OL in ARAI:**

In compliance of the Orders/ Rules, Official Language Policy is implemented in ARAI through:

- Official Language Implementation Committee (OLIC): As per the directives of Department of Official Language, an Official Language Implementation Committee (OLIC) has been constituted under the chairmanship of Director-ARAI. This committee regularly reviews the progress made in use of Hindi in ARAI on quarterly basis. It gives appropriate suggestions and recommends measures to be taken for effective implementation of official language policy. Its report is submitted to Department of Official Language (Ministry of Home Affairs) and Ministry of Heavy Industries.



- Bilingual Documentation: Technical manuals, tender documents, safety instructions and internal communications are increasingly issued in both Hindi and English.
- Hindi Workshops: Regular Hindi language workshops are organized to train engineers, supervisors and administrative staff in Hindi.



### Industry-Specific Applications

- Instructions, SOPs and safety signage are displayed in trilingual (Marathi, Hindi, English) to ensure clarity for the workforce.
- Technical Communication: While English is often used for highly technical communication, Hindi is promoted for routine administrative work and internal documentation.
- Customer Interaction (for Govt. vehicle units): Bilingual communication helps serve diverse customers across India, especially in rural or semi-urban areas.

### Compliance, Monitoring & Encouragement

- Parliamentary Committee on Official Language conducts inspections to assess implementation of Rajbhasha usage in official work.
- Incentives are provided to employees who perform official work in Hindi.



**ARAI Journal of Mobility Technology**, a technical journal, focuses on automotive and related topics. It is available online and in print version. The journal was started to help professionals, researchers and students share their original research in the field of mobility technology. One of its goals is to provide platform for publishing articles on variety of automotive and allied subjects. Papers published in this journal are well-promoted and respected in the automotive and research communities.

The journal welcomes contributions from researchers all over the world and is aimed at scholars, academics and professionals in the automotive industry.

Second edition of the journal for year 2025 (**Volume 5, Issue 2, April-June 2025**) has been released online. If you need any full-text papers, feel free to contact ARAI. For more details, please visit the website: <https://araijournal.com/index.php/arai>

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<b>Editor-in-Chief &amp; Publisher:</b> Dr. S. S. Thipse	<b>Publication Format:</b> Online & Print Version
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### Table of Contents

#### Editorial

[Revolutionary Nanomaterials .... Small But Big in Performance and Greener than Conventional Materials](#)  
*Mr. Avinash Arankalle* ..... (vii)

#### Research Papers

- [Experimental Evaluation & Analysis for the Biogenic Content of Ethanol-Blended Gasoline using Accelerator Mass Spectrometry \(AMS\)](#)  
*Dr. Sandeep Garg and Rajnesh Singh* ..... 1501
- [Reduced Order Modeling with AI for Model-in-the-Loop Simulation](#)  
*Kiran Vernekar, Neeharika Kurumaju and Kavya H M* ..... 1516
- [Self-Driving Waste Collection Vehicle](#)  
*Suman Kumar Adhya* ..... 1527
- [Data Driven Parametric Study on Vehicle Maneuverability](#)  
*Yadav Prashant, Ramamoorthy Bhavankumar, Karuppaiah Haresh-Durai and Jagtap Santosh* ..... 1536
- [Effect of Rear Suspension Bump Stopper on Two Wheeler Main Structure Fatigue Life](#)  
*Rajesh Kumar, Mohit Kumar, Md Irfan, Deepak Kumar Nirala and Ashish Kumar* ..... 1550
- [Failure Analysis of Leaf Spring used in Electric 3 Wheelers](#)  
*Jagadeesh Selvaraj, Mahadevan Pichandi, Hemanth Gupta E and Meenakshi Sundaram S* ..... 1559
- [Hose Routing Optimization Methodology and Case Study using Hose Simulation](#)  
*Nazmin Khan* ..... 1576
- [An Optimality and Comparative Analysis of Transducers for Proving Ground Correlation for a Two-Wheeler](#)  
*Mohit Kumar, Rajesh Kumar, MD Irfan, Deepak Kumar Nirala and Ashish Kumar* ..... 1584
- [Designing a Smart Instrument Cluster for Electric Two-Wheeler with Advanced Features & Connectivity](#)  
*Subhajit D. Basu, Prashant M. Joshi and Sakshi N. Arey* ..... 1595

#### Technical Paper

- [The Performance Evaluation of Vehicle Longitudinal and Lateral Dynamics Parameters and Behaviour using MATLAB-Simulink and RoadRunner](#)  
*Mohammad Rafiq B. Agrewale and Ujjwal Vaish* ..... 1606

#### Journal Indexed in



and more..

## ❑ Making of an Integrated E-Axle based Powertrain for EV, HEV and FCEV – An efficient way of Electrification

Rise in greenhouse gas emissions, which is resulting into ozone layer depletion and global warming effect, is alarming to control CO<sub>2</sub> emissions by drastically reducing fossil fuel consumption of the vehicles. This need has already started trend towards extreme downsizing and down speeding of Internal Combustion Engines (ICE) for making them highly efficient. However, to address present greenhouse effect along with exponential decay of fossil fuels, there is a need to achieve CO<sub>2</sub> emissions less than 100 g/km or to achieve practically zero carbon footprint using an alternate powertrain.

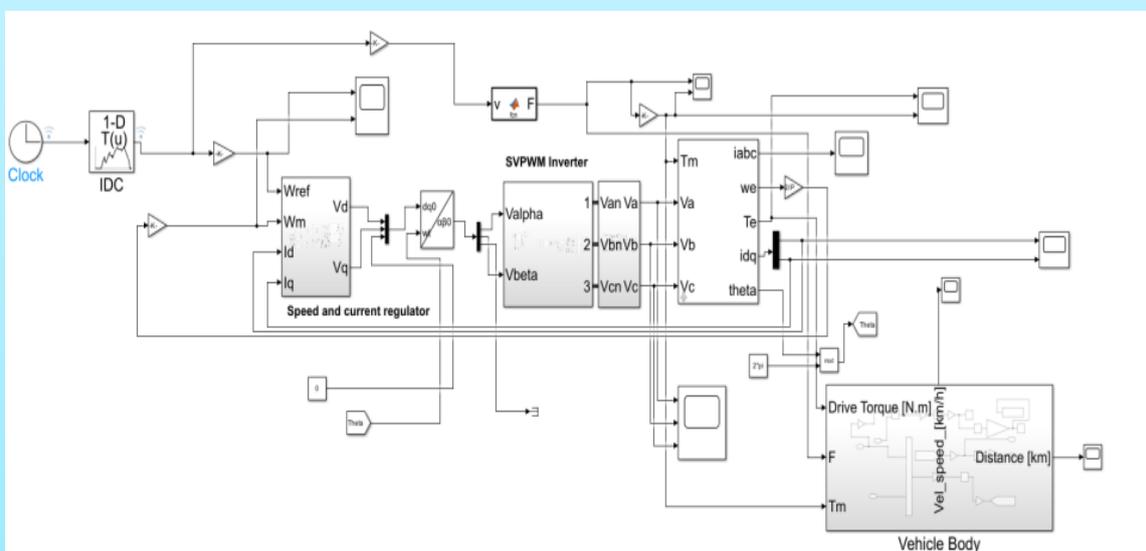
Electrification is one of the promising solutions, which is three-fold in present situation. The first level of electrification comes in the form of Hybrid Electric Vehicle (HEV) technology followed by Battery Electric Vehicles and Fuel Cell Electric Vehicles as second and third level of electrification, respectively. In all these technologies a common thread is running in the form of an efficient electric drivetrain.

Use of E-Axle based powertrains in EV, HEV and FCEV offers additional complimentary benefits apart from other technology options described above. E-Axle based powertrains offer flexibility in generating three variants of vehicle using one electric drivetrain architecture, viz. making EV, HEV & FCEV. Compactness, modularity, scalability, flexibility along with efficient cooling system management and control over active current losses due to use of bus bars, which have implicit advantages of E-Axle based powertrains.

Two major challenges need to be addressed and resolved while designing E-Axle based powertrains by doing concurrent vehicle engineering. This is mainly due to increased unsprung mass that needs to be handled by suspension system and exposed electric drive components to excitation loads more than 5g.

By proper layouting for effective vehicle mass distribution and required CG location, which is essential from overall vehicle dynamics, more space can be offered by E-Axle based powertrains by increasing battery energy density for getting more electric range in case of BEVs. This add-on space benefit extends help in packaging of hydrogen fuel cell integrated with batteries having power cells in case of FCEVs. Thus, E-Axle based powertrains prove to be most modern way of making EVs, HEVs and FCEVs.

To cater to this emerging need, ARAI has designed range of E-Axle based Powertrains as OE and Retrofitment solution for vehicles having GVW in the range of 1.5 to 5 Tons. Out of these solutions for 1.5 Ton GVW vehicle is physically developed which is tested and validated for road worthiness trails viz Range, Max Velocity, Gradeability and durability while running for approx. 1 lakh kilometer on road.



**Fig. 1: Equation Driven High Fidelity Based Mathematical Model of Electric Vehicle's DriveTrain**



Fig.4 shows fleet of vehicles, which is running on road with GVW and has logged cumulative running of 60,000 km without any mechanical, thermal and electrical issues.



**Fig. 4: Fleet of SCV (1.5 Ton GVW) Running with Retrofitted E-Axle Powertrain**

On similar lines, design of E-Axle based powertrains for 2.5,3.5 and 5 Ton GVW Vehicles is ready and in the process of making prototype for testing and validation purpose.

## ❑ **Electro-Mechanical Design and Development of Electric Motors for Mobility based Applications**

In order to meet the target of achieving minimum 30% electrification by end of 2030, there is need to work in all aspects of product development in the area of electric drive train which will be economical, affordable, flexible, durable and reliable. To achieve this the only answer is to promote indigenization supported with local available resources and raw material to avoid further geo political and geo graphical challenges.

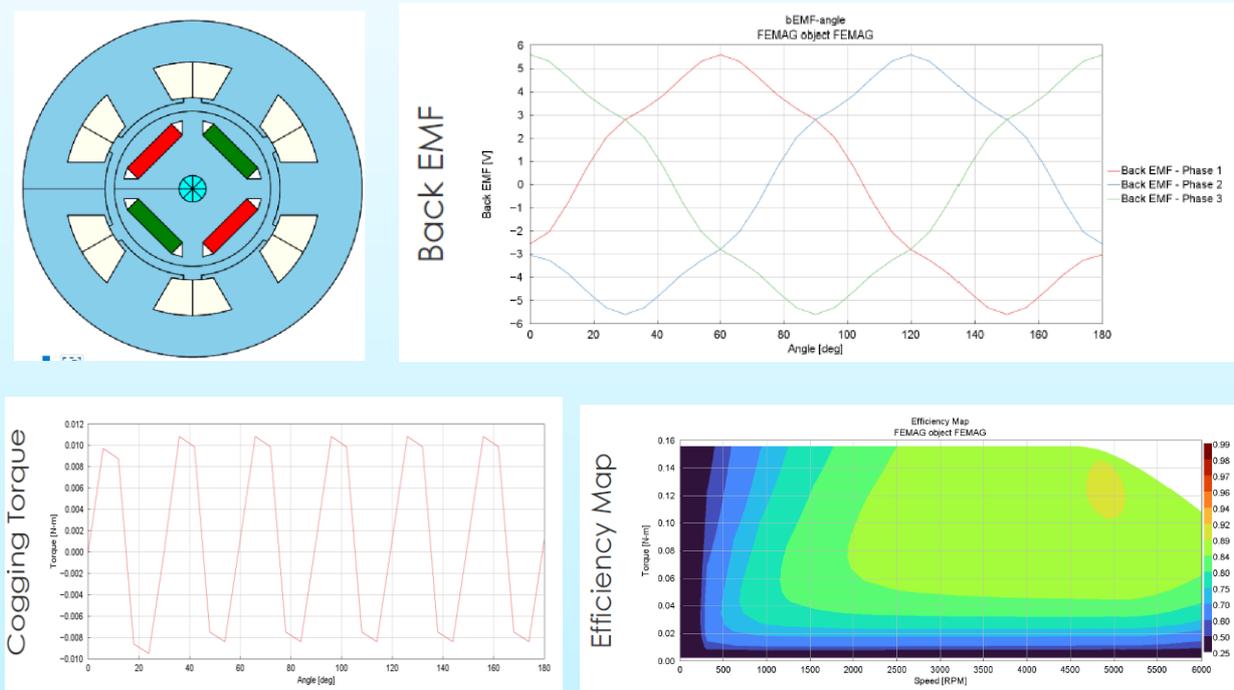
Major components viz. Battery, Bi directional inverters, DC DC converters, PDU, MCU, BMS, VCU, Motors, Dashboard, Sensors and wiring harness makes a complete Bill of Material (BOM) which essentially need to get developed with the approach mentioned above for increasing the penetration of E Mobility not only in on-road segment but even in off highway, defence, railway, marine and in aviation sectors. Hence its essential to design these products from concept apart from manufacturing and assembly in India.

Considering this need ARAI have developed competency in the area of electro mechanical design of motors viz induction and PMSM motors to start with which will get followed by Switch Reluctance Motor for Mobility based Applications and have started demonstrating in various used cases. However, efforts are going in the direction to bring value addition in the conventional design topology and processes to handle the above-mentioned requirements and challenges. Three used cases are mentioned here in brief which will be the futuristic technology options to offer having certain unique technical advantages over present one.

### **Case Study No. 1 - Making of PMSM electric motor with wet rotor concept for coolant pump**

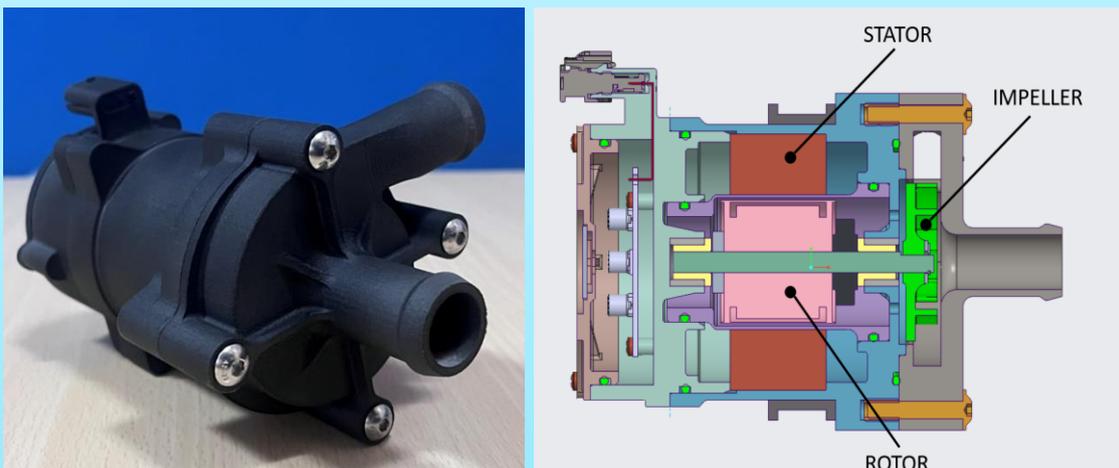
Design and development of PMSM electric motor with wet rotor concept for coolant pump for EV application is carried out where electromechanical design of motor has been made from clean sheet. Most of the electric motors used in coolant pump are BLDC motors. However, considering advantages in terms of efficiency and performance, PMSM is used in place of BLDC motor for the application under consideration.

By knowing the max coolant flow and corresponding pressure head needed to be delivered by water pump for cooling of battery, motor and inverter of EV, constant / peak power, torque and operating speed of motor is estimated. Once these specifications and packaging boundary conditions known, various design iterations are carried out mainly to improve power to weight ratio, efficiency over the speed range and to reduce cogging torque and torque ripple. This is achieved by doing extensive optimization of various design parameters such as number of poles, stator & stack geometry, air gap, type of magnet, calibration factors for iron and mechanical loss, etc. Considering the typical application where rotor is in contact with coolant, special focus has given on design of low reluctance path between stator and rotor poles. The performance of e-motor is analysed for no-load and steady state conditions. The optimized design is manufactured and simulation results are compared with experimental results. During experimentation Motor Electromagnetic Torque and Speed is controlled by giving variable PWM input to MCU through VCU to obtain various flow rates as per demand from the coupled water pump. Fig.1 shows simulation driven process which is used to optimise an integrated design of PMSM with water pump to meet target specifications.



**Fig. 1 Simulation Driven Product Development Process - Making of PMSM with Wet Rotor**

Two prototypes of PMSM having rated power as 80 & 40 Watts are made based on the optimised design and evaluated extensively for its performance and durability by using special tailor-made test rig for doing validation trails of electric water pumps. Fig.2 shows prototype of PMSM coupled with water pump along with cut section to reveal more details.



**Fig. 2: Integrated PMSM with Water Pump for Electric Vehicle Cooling System**

## Case Study No. 2 - Design and Development of Conventional and 3 in 1 E-Axle powered with PMSM

ARAI have designed and developed Conventional E-Axle-based powertrain as OE and retro fitment solution for range of CV's having GVW in the range of 1.5 – 5 Tons. Out of this, one prototype of E Axle based powertrain is implemented into base ICE vehicle having GVW 1.5 Ton to make it electric vehicle (Refer Fig.3).

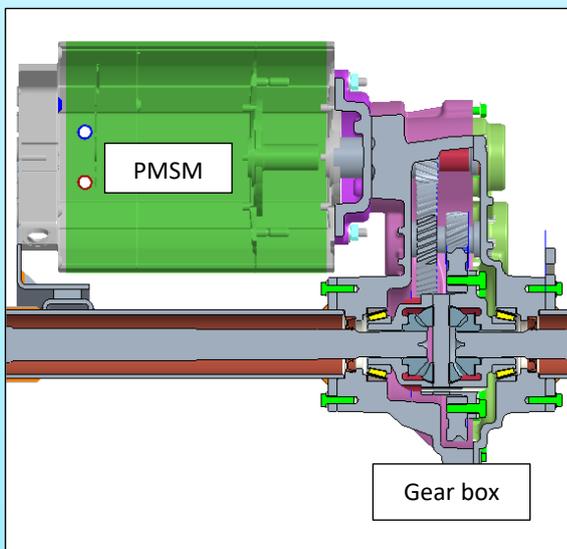
After converting base diesel vehicle to the electric vehicle, performance trails were conducted on the road for validation purpose. Major targets viz. Range, Max Velocity, Gradeability and Acceleration are met up to the expectations. Later further four number of vehicles driven in the city which has accumulated total mileage of 100000 kms till date without any electrical and mechanical issues.



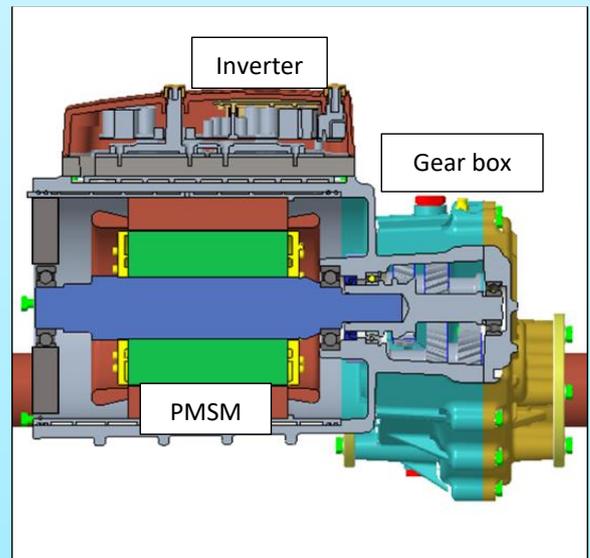
**Fig.3 : Design and Development of Conventional E-Axle for SCV**

Compactness, modularity, scalability, flexibility along with efficient cooling system management are the implicit advantages of E Axle based powertrains. These advantages further get multiplies if we go for 3 in 1 (gearbox + Stator housing + Inverter) architectures which are predominantly used in independent suspension-based vehicles. This type of architecture offers control over active current losses due to use of bus bars in place of using high voltage wiring harness.

ARAI has completed design of such 3 in 1 E axle for rigid axle version where an integrated PMSM is designed from concept with the similar approach explained in Case study No.1. Fig.4 shows comparison of cut section of conventional and 3 in 1 design for the same vehicle configuration where prototype of conventional E Axle is produced and validated. Prototype making of 3 in 1 unit is under development stage. Later it will get evaluated for similar validation trails used for validation of conventional E Axle based powertrain.



Conventional E-axle

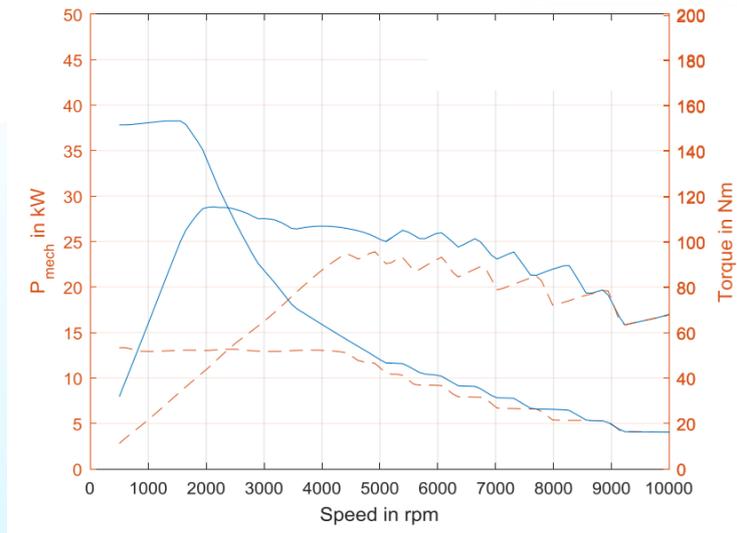


3 in 1 type of E-axle

**Fig. 4: Comparison of Conventional and 3 in 1 E Axle based Powertrain for SCV Application**

### Case Study No. 3 - Making of Light Weight, High Speed Induction Motor

ARAI is in the process of developing light weight, high speed induction motor which will be a parallel solution to PMSM which have dependency on rare earth magnet material. PMSM type performance is possible achieve with this new design due to light weight casted aluminium rotor as one of the design features responsible for the same.



**Fig. 5: Target Performance Curve – Light Weight High Speed Induction Motor**

Fig. 5 shows target performance for meeting with light weight, high speed induction motor for SCV application. It is aimed to achieve motor efficiency above 90% for wider speed range. Developed motor will be an ideal candidate for SCV & LCV's with either mono motor E axle or with Twin Motor E axle-based version.

### ❑ Innovative Methodology for Testing Cooling Modules in Heavy Commercial Vehicles and Buses

#### Background:

Cooling module is a critical component in heavy commercial vehicles and buses, ensuring that the engine and other vital systems operate within optimal temperature ranges. Efficient cooling is essential to prevent overheating, which can lead to engine failure, reduced performance and increased maintenance costs. However, testing these cooling modules in a laboratory setting poses significant challenges. Traditional testing methods often fail to replicate the complex, multi-axial forces experienced in real-world conditions, making it difficult to validate the design accurately and efficiently.

#### Challenges in Accelerated Testing:

**Replication of Real-World Conditions:** Simulating the exact conditions that cooling modules face in the field, including varying temperatures, pressures and mechanical stresses is complex.

**Time Constraints:** Accelerated testing methods must compress the equivalent of years of wear and tear into a much shorter timeframe without compromising the accuracy of the results.

**Resource Intensive:** Traditional methods can be resource-intensive, requiring extensive instrumentation and set up.

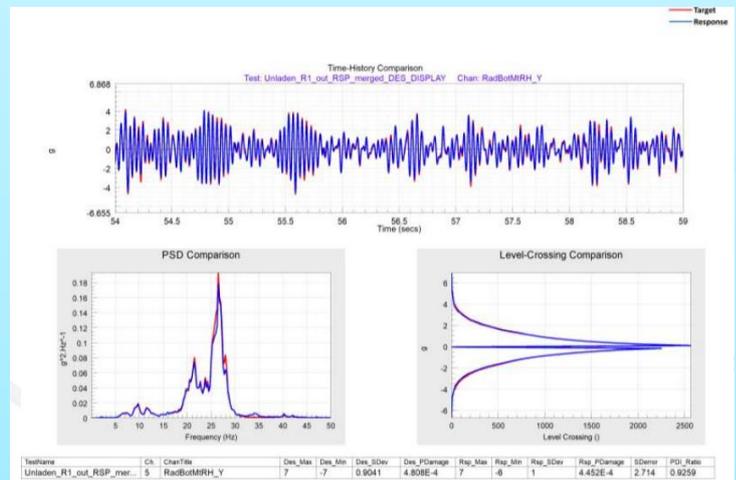
## Innovative Multi-Axial Test Setup by ARAI

ARAI's Structural Dynamics Lab (SDL) has developed innovative multi-axial test set up to address certain challenges. This set up uses real-time field data to validate cooling modules under conditions that closely mimic actual operational environments. Tests can be conducted with actual circulation of coolant, maintaining necessary temperature and pressure, ensuring high degree of accuracy and reliability.

### Key Advantages

- **Accelerated Durability Testing:** The innovative setup significantly reduces testing time, allowing for faster validation of cooling module designs.
- **Real-World Correlation:** Utilizing actual field data ensures that the test conditions closely match real-world scenarios, improving the reliability of the results. Simulation of real-time field data can be replicated and compare in terms of statistical, spectral & damage parameters with close math with 90% to 95% of target data.
- **Continuous Operation:** The facility operates in three shifts, 24 hours a day, six days a week, maximizing testing throughput.
- **Proven Methodology:** The test methodology has been validated through multiple successful projects, demonstrating its effectiveness and reliability.
- **Experienced Team:** ARAI's team of experts has extensive experience in delivering complex testing projects, ensuring high-quality results.
- **Comprehensive Services:** The lab offers a full suite of services, including instrumentation, Road Load Data Acquisition (RLDA), in-lab simulation, drive file creation, and durability testing, all under one roof.

This innovative approach by ARAI represents a significant advancement in the field of cooling module testing, providing manufacturers with a reliable, efficient and accurate method to validate their designs and ensure durability and performance of their products in real-world conditions.



## ❑ TG: Technovuus Engagements Update & Establishment of RADAR Scenario Emulator for Virtual Validation of RADAR Based ECU Controls under Digital Twin Lab

**TechNovuus** is a collaborative eco-system for enabling indigenous technology, innovation and solution development through an open innovation and technology development platform. TechNovuus facilitates development of solutions for challenges related to mobility, while gradually expanding to other sectors like Defense, Aerospace, Telecommunications, Railways, etc., providing an impetus to the Government of India's Make in India and Aatmanirbhar Bharat programs.

### TechNovuus Internship Program

Technovuus has facilitated more than 290 students to gain industry experience through this internship program since its inception.

Each student has been individually selected based on their unique skills by different departments within ARAI to work on live projects. This tailored approach ensures that students can contribute effectively to ongoing projects while gaining valuable hands-on experience in their respective areas of expertise.

### Technovuus Webinar Series

ARAI-Technovuus celebrated National Start-Up week from 10<sup>th</sup> to 16<sup>th</sup> Jan 2025 with Start-Up संगोष्ठी, a Webinar Series for Start-Up New Entrant, Students and Enthusiasts. This series had Sudeep Ambare, CEO- AMTIF, who spoke on the topic "Skills for Start-Ups" followed by session by Umesh Rathod, Manager, Indovation Centre, Western Region, Maharashtra and Goa for the AICTE's - Ministry of Education - Innovation Cell. He spoke on "Viksit Bharat: Future Trends in Automotive Industry". The third session was on "Perfecting Your Investor Pitch: Tips and Techniques for Innovators and Entrepreneurs in the Mobility Sector" by Ankit Machhar, Director-Ecosystem, Wadhvani Foundation. Close to 200 participants attended these webinar sessions and interacted with the experts. It was decided to keep this series live looking at the responses from the participants. Accordingly, the next session was successfully completed on 21<sup>st</sup> February 2025, which had Amey Vaze, Managing Partner & Consultant, SWANHANS Technology Consultancy LLP, as the speaker, who spoke on "Market Needs, Idea Generation and Systematic Scaling of the Solution".

The image contains two promotional posters for Technovuus webinars. The left poster is titled "Celebrates 'NATIONAL START-UP WEEK - 10 TO 16 Jan 2025' with 'Start-Up संगोष्ठी'". It features three speakers: Sudeep Ambare (CEO, AMTIF), Umesh Rathod (Manager, Indovation Centre), and Ankit Machhar (Director-Ecosystem, Wadhvani Foundation). The date is 15, 16 Jan 2025, duration is 1 HOUR, and it is a live session. The right poster is for a webinar on "FRIDAY 21 Feb 2025" at "3 PM - 4 PM" featuring Amey Vaze (Managing Partner & Consultant, SWANHANS Technology Consultancy LLP) as the speaker. The topic is "Market Needs, Idea Generation and Systematic Scaling of the Solution". Both posters include a "REGISTER NOW" button and a QR code.

ARAI Knowledge Centre - Kothrud in collaboration with ARAI-TechNovuus, organized next webinar as a part of the collaborative series on "Understanding Measurement Uncertainty: Key Concepts and Practical Applications" on 6<sup>th</sup> March 2025. This webinar was open to professionals, researchers, students, faculty, engineers in the field of automotive research and other scientific disciplines. It was especially relevant for those who were curious about the fundamentals of measurement uncertainty and its evaluation.

The author also discussed the key aspects of the book. The webinar was led by the expert, Mr. Swanand Rishi, Scientist F, Electronics Test & Development Centre (ETDC), Pune & Author of the book titled "A Practical Handbook on Measurement Uncertainty: FAQs and Fundamentals for Metrologists". At the end of the session, participants had clear understanding on measurement uncertainty.

**Understanding Measurement Uncertainty: Key Concepts and Practical Applications**

**Speaker**  
Swanand Rishi  
Author: "A Practical Handbook on Measurement Uncertainty"

**06.03.2025**  
2 PM - 4 PM  
Microsoft Teams

**Key Focus Areas**

- ✓ Fundamental concepts
- ✓ Assumptions and ideas in measurement uncertainty
- ✓ Concepts from practical perspective
- ✓ Book discussion

**Diagram:** True Measured  
X-U X X+U  
Error Uncertainty

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### Establishment of RADAR Scenario Emulator for Virtual Validation of RADAR Based ECU Controls under Digital Twin Lab:

With the introduction of ADAS features in vehicles, the sensing elements play a major role in how accurately the controls work. With the regulations also being in draft stage viz. AIS 162 (Advanced Emergency Braking Systems), AIS 186 (Blind Spot Information Systems), AIS 187 (Moving Off Information Systems), AIS 188 (Lane Departure Warning Systems), more emphasis is placed on virtual validation techniques. The sensing elements for ADAS includes RADAR, Camera, GPS – INS Systems, LiDAR and Ultrasonics. For effective virtual validation, the sensing elements need to be brought inside the LAB to validate the different False Positives and False Negatives scenarios. Also, for a thorough validation of L2+ ADAS, the vehicle needs to be driven for a large number of kilometers, which may not be possible on Roads or on Test Tracks. Hence the virtual validation techniques are indispensable when it comes to ADAS validation.

ARAI has established a state-of-the-art RADAR Over the Air Scenario Emulator for enabling virtual validation of RADAR based control Systems. The RADAR is housed inside an anechoic chamber to make it free from interferences. The RADAR Echoes are being generated by the antennae which is being controlled by the virtual Simulation running on the Real-Time Environment. The Antennae are motorised to exactly emulate the angle of arrival of the echoes to the RADAR. The RADAR Housing has vertical motion to accurately emulate the elevation angle.



**Fig. 1: RADAR OTA Scenario Emulator**



**Fig.2: Inside View**

Following are the high-level capabilities of the RADAR Scenario Emulator.

Bandwidth	5 GHz
Frequency Range	76-81 GHz
Range	5.6 to 299m
Speed	+/-500Km/h
No of Targets	2

The Simulation environment can also replicate the real-world open scenario data captured using the vehicular data acquisition systems. These data can then be curretted, processed and digitized and used in simulation environment in conjunction with the RADAR Scenario Emulator. Thereby the virtual validation ensures the validation of the RADAR and control systems on real world Indian Scenarios in Digital Environment.



Fig. 3: Real world Data



Fig. 4: Digitized Real-world data

#### Applications:

- RADAR characterization
- Validation of RADAR based control systems like AEB, ACC.
- Validation using real world data specifically for Indian use cases.

### ❑ Test facility for Measurement of Extractable/Leachable Ionic Contamination Level on the surface of printed boards and assemblies by Ion Chromatography

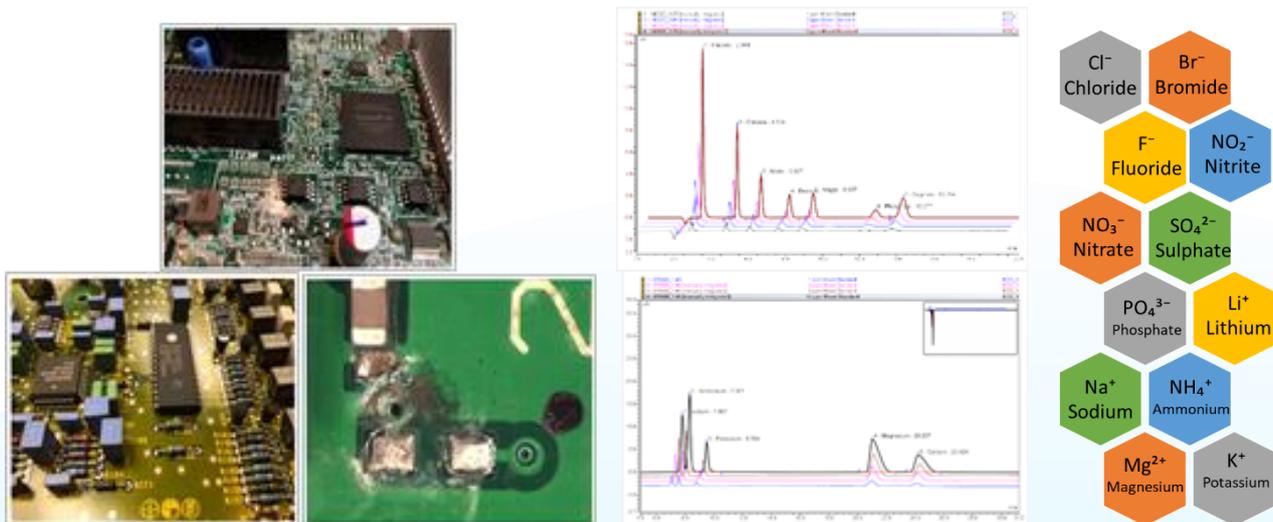
Ions such as chloride, bromide, fluoride, nitrite, nitrate, sulphate, phosphate, lithium, sodium, ammonium, potassium, calcium and magnesium, if present in the material or product, are considered as sources of ionic contaminants and can have detrimental effects on quality, safety and performance.

ARAI has established a test facility as per IPC-TM-650 for measurement of extractable ionic contamination, which is crucial for various industries, including pharmaceuticals, electronics and environmental science. Accurate measurement of ionic contamination ensures compliances with regulatory standards and helps maintain integrity of the products and processes. Fig. 1 explains the source and effects of ionic contamination.



Fig. 1: Sources and Effects of Ionic Contamination

The process involves extracting these ions from sample matrix and quantifying them using analytical technique such as Ion chromatography. A few examples of PCB samples are shown in Fig. 2.



## Table of Contents

### Editorial

Mr. Bala Pachyappa

### Research Papers

- [Analysis of the Impact of Combine Harvester Dynamics on the Accuracy and Reliability of Ultrasonic Stubble Height Measurement](#)  
*Pawar Mahesh, Koparde Prashant, Sewalkar Swarupanand and Syngal Kuldeep* ..... 1619
- [Designing A Quality Control Module Using Arduino UNO for Diesel Exhaust Fluid](#)  
*Rajveer Singh Sodhi, Soham Satish Kokje, Pratham P. Sawant*..... 1638
- [Energy Optimization in Hybrid Electric and Plug-in Hybrid Vehicles using Machine Learning and Intelligent Transportation Systems](#)  
*Sunil Kumar Maddela, G. Yamuna Sree and U. Venkatesu* ..... 1648
- [Speed Control of PMSM Motor by FOC Method Using MATLAB & Simulink](#)  
*Shivaguru Prakash G* ..... 1665
- [Need of On-Board Diagnostics Compliance in Battery Electric Vehicle \(BEV\)](#)  
*Nitin Sangale, Prasad Yerraguntla, Prasad Warule, Rahul Singh and Boreddy Peddi Reddy* ..... 1674
- [Impact of Automated Grade Control in Crawler Dozers for Job Sites in India](#)  
*Akshay Sononi, Neelam Kumar Sarma, Rajeev Kumar and Kathleen L Roberts* ..... 1690
- [An Overview of Emerging UWB Standards and Protocols](#)  
*Parvez Patel and Ekta Rathod* ..... 1702
- [An Intelligent Advisory System for a Vehicle Driver Posture Assessment & Advisory for Fatigue-Free Drive](#)  
*Fyaz Farook and Ravishankar Choulge* ..... 1713
- [Vehicle Speed Limiter with Collision Detection by Cloud/GPS Using Embedded System-Intelligent Transportation Systems \(ITS\)](#)  
*Parthasarathy Navaneethakrishnan* ..... 1731

### Technical Paper

- [Exploring Optimal Path Planning: A Comparative Study of Algorithms for Automated Guided Vehicles](#)  
*Vijay Barsale, Darshan Behere, Tushar Bhosale, Debjyoti Bandyopadhyay, Shailesh B Sonawane and Dr. Sukrut S. Thipse* ..... 1742

### Journal Indexed in



## ❑ Workshop on Technology Prioritization for the Transport Sector

The “Viksit Bharat” initiative of Government of India aims to transform India into a developed nation by 2047. The great vision of “Viksit Bharat” articulated by Hon’ble Prime Minister of India, Shri Narendra Modi, cannot be achieved, without implementation of innovative technologies, and addressing the green initiatives. To address the challenges and identify and develop climate-resilient and sustainable technologies crucial for the transport sector, ARAI in association with Technology Information, Forecasting, and Assessment Council (TIFAC), New Delhi, organized Workshop on Technology Prioritization for the Transport Sector, from 30<sup>th</sup> and 31<sup>st</sup> July 2024 at ARAI’s state-of-the-art facility. This workshop aimed at identifying and prioritizing next-generation sustainable technologies for the transport sector, aligning with India’s vision of achieving net-zero emissions by 2070.

This workshop focused on critical domains, such as road, rail, air and water transport to advance decarbonization of India’s transport sector by identifying next-generation and climate-resilient technologies. The workshop sought to align technological developments with nation’s broader goals of sustainable growth and energy security. By leveraging the STEEP framework (Social impact, Technological feasibility, Environmental benefits, Economic viability and Policy alignment), participants analyzed technologies to assess their potential for addressing urban air quality challenges, reducing reliance on fossil fuels and achieving energy efficiency.

Over 70 innovative technologies in the sector, such as Source of Energy, Advanced Battery Chemistry, Direct Electric Supply and Charging Infrastructure, Alternative fuels, Hydrogen Internal Combustion Engine, Material, etc. were discussed and evaluated, with an aim of creating a pathway toward sustainable development.

During the Inaugural Address, Dr. Reji Mathai, Director - ARAI, underscored the importance of advancing clean technologies in the transport sector. Dr. Mathai further stated that collective efforts from stakeholders across industries, academia and policy makers will be essential for driving India towards sustainable future. Dr. Gautam Goswami, Head of Foresight & Vision Division at TIFAC, highlighted the strategic role of upgrading India's transport infrastructure to meet sustainability goals. Dr. Goswami also emphasized the importance of adopting interdisciplinary approach, involving diverse stakeholders, to address the pressing challenges of urban air quality, energy security and climate change. Shri Pankaj Sonalkar, Managing Director, Kalyani Powertrain Ltd., stressed the importance of developing robust, affordable and scalable technologies that are accessible to all. This session witnessed release of "**Technology Factsheet for the Transport Sector**", a comprehensive guide to the latest sustainable technologies.



***Release of Technology Factsheet for the Transport Sector***

The event brought together participants, including representatives from diverse sectors, leading automotive OEMs, startups, academic institutes and research bodies. The key areas discussed were adoption of alternative fuels, such as hydrogen and bio-fuels, development of advanced battery technologies, implementation of smart infrastructure for optimized transport networks, etc. The participants were actively engaged in ranking and scoring technologies using insights shared during the workshop. This exercise emphasized the need to align technological advancements with broader national imperatives, such as sustainability and energy security.

Notable contribution of Dr. Anuradda Ganesh, Senior Advisor (Technical), Cummins India, was the discussion on barriers to adopt advanced technologies and emphasized innovation as the key to achieving competitive and sustainable growth.



***Discussion and brainstorming activity***



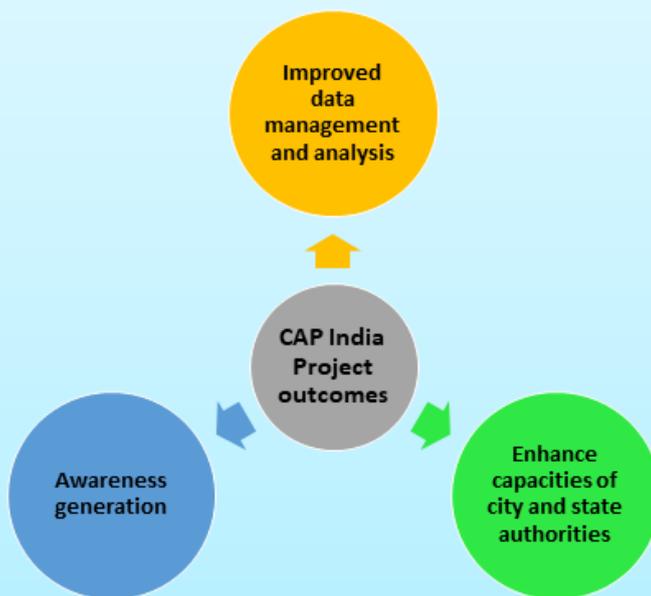
***The Participants***

The workshop led to several key outcomes, such as identification of technology with high potential for carbon emission reduction, recommendation for integrating sustainable practices into transport policy frameworks and to support cross-sectoral innovation and investments, ensuring cleaner, greener, and more sustainable transportation landscape for the future. The workshop on Technology Prioritization for the Transport Sector successfully united stakeholders to identify and prioritise sustainable technologies critical for decarbonizing India's transport sector. By leveraging the steep framework, participants provided valuable insights to shape the future polices and support India's net-zero and "Viksit Bharat" goal. The release of the Technology Factsheet for the Transport Sector marked a significant milestone, offering roadmap for sustainable innovation. This collaborative effort has set the stage for cleaner, greener, and more resilient transportation future, emphasizing the importance of innovation, policy alignment, and collective action.

### ❑ Regional Workshop and Report Launch of Clean Air Project in India (CAP India)

In response to Govt. of India's National Clean Air Program (NCAP) launched by Ministry of Environment, Forest and Climate Change (MoEFCC), Swiss Agency for Development and Co-operation (SDC) initiated long-term (4 years) 'Clean Air Project in India (CAP India)' in November 2019 in Pune, Nashik, Kanpur and Lucknow. Overall objective of the project was to support India's efforts to improve air quality while contributing to public health, environment and climate change mitigation. ARAI has executed various project components of the CAP India for Pune.

The project also directly contributed to achieving the objectives of the National Clean Air Program (NCAP) of India through technical assistance in improving air quality at regional and specifically at urban scale in four focused cities in India. To achieve the aim, the project focused on three outcomes (see Figure 1).



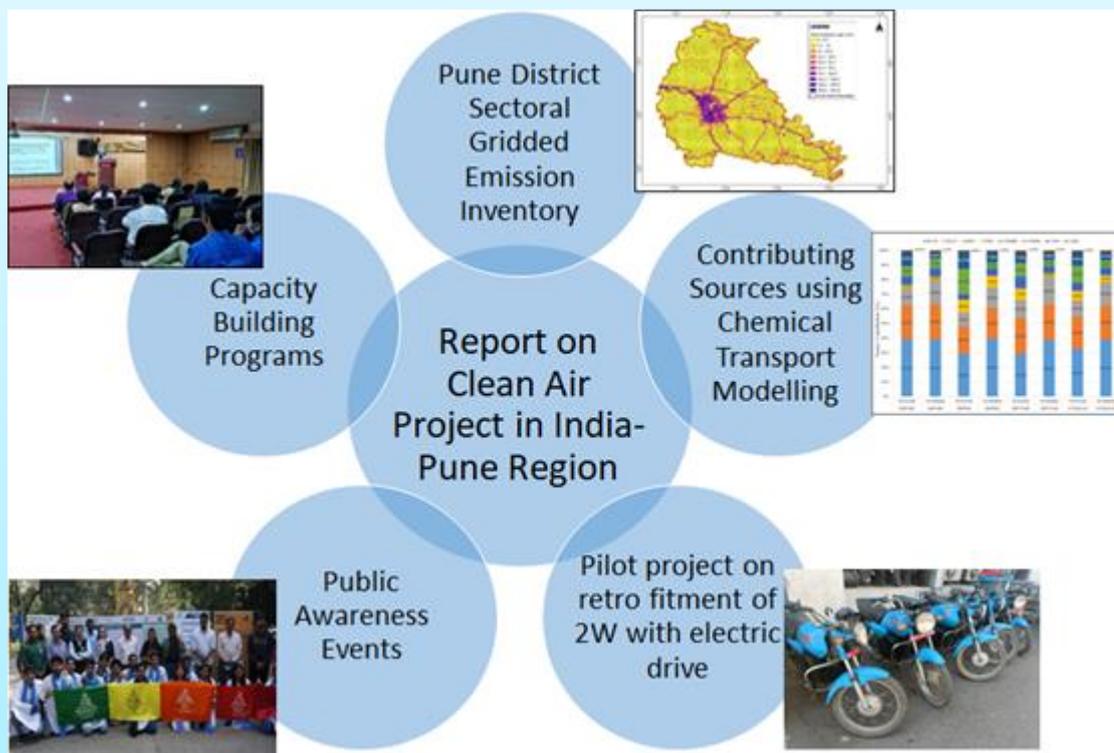
**Figure 1: Targeted project outcomes in CAP India project**

To showcase the findings and communicate the learnings from the project, a regional workshop was organized in Pune on 8<sup>th</sup> August 2024 at ARAI, Pune. Key stakeholders, such as Ministry of Environment, Forest and Climate Change (MoEFCC), Central Pollution Control Board (CPCB), State Pollution Control Boards and Municipal Corporations, Smart City Cell, Research Institutes, Non-governmental organizations (NGOs) who are responsible for suggesting and implementing solutions on the ground participated in the regional workshop. Report on "Clean Air Project in India: Pune Region" was launched during the workshop at the hands of Dr. Avinash Dhakne, Member Secretary-MPCB, Shri Sanjay Shinde, Deputy Commissioner (Env), Pune Municipal Corporation in the presence of Dr. Reji Mathai, Director-ARAI and senior officials from SDC, TERI and SIAM.



**Figure 2: Dissemination of project outcomes to the stakeholders and launch of the report during the regional workshop**

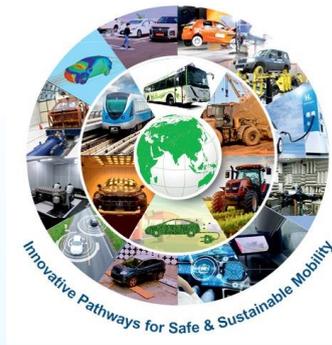
The report contains information on district level emission inventory for Pune for all sectors, sources contributing to the air pollution based on state-of-the-art tools and techniques for chemical transport modelling, pilot project on retrofitment of 2W with electric drive, various capacity building programs and public awareness events conducted during the project, proposed clean air action plan for Pune region.



This workshop facilitated large-scale dissemination of the project's results and promote cross-learning among the officials to replicate and scale the steps taken in pilot demonstrations, awareness generation, capacity building, and scientific assessments under CAP India. Participants were oriented on the benefits and high potential of the project outcomes for reducing air pollution in cities using scientifically backed methods, fostering the possibility of broader adoption across different states.



## Symposium on International Automotive Technology, 2026



### SIAT & SIAT EXPO 2026

28<sup>th</sup> to 30<sup>th</sup> January 2026 | PIECC Pune, INDIA

**Symposium on International Automobile Technology (SIAT)** is a benchmark biennial international event, widely acclaimed by the automotive fraternity. The last Symposium, viz. SIAT 2024, held in January 2024, has set a quality benchmark of delegate participation, presentation of papers / keynotes, panel discussion, etc. With the participation of 330 exhibition booths by domestic as well as overseas OEMs, the concurrent SIAT EXPO 2024 could also transact sizeable business over a period of 3 days.

ARAI, in association with SAE India SAE International (USA), is organizing 19<sup>th</sup> edition of SIAT, viz. **Symposium on International Automotive Technology, 2026 (SIAT 2026)**, from **28<sup>th</sup> to 30<sup>th</sup> January 2026** at Pune International Exhibition & Convention Centre (PIECC), Pune (India). The theme of **SIAT 2026** is '**Innovative Pathways for Safe and Sustainable Mobility**'.

SIAT 2026 will bring together automotive experts, researchers, technocrats and professionals all over the world, on common platform for presentation of papers / keynotes, discuss technological advancements, challenges ahead, growth perspective, etc. and exchange ideas focusing on advanced automotive technologies.

First Announcement of the Symposium was launched by Shri H. D. Kumaraswamy, Hon'ble Union Minister, Ministry of Heavy Industries, Government of India during the Bharat Mobility Global Expo 2025.

Please browse First Announcement of the Symposium using the below appended weblink.

Reference Technical Bulletin (RTB), containing technical articles, advertisements, case studies, will also be published on this occasion.

<https://cms.araiindia.com/MediaFiles/First Announcement Call for Papers 12285.pdf>

### TOPICS OF SIAT 2026

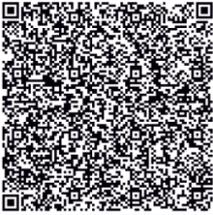
- Active and Passive Safety
- Advanced Driver Assistance Systems (ADAS)
- Advanced Powertrain Technology
- Advanced Vehicle Dynamics
- Agriculture Tractors
- Alternative Fuels
- Automotive Lighting
- Autonomous Vehicles
- Construction Equipment Vehicles
- E-mobility
- Emission Measurement & Control Technology
- Circularity and LCA
- Harmonization of Regulations
- Hydrogen Fuel Cell and Hydrogen I.C. Engine
- Intelligent Transportation Systems (ITS)
- Materials & Manufacturing
- Noise, Vibration & Harshness (NVH)
- Mass Mobility Systems
- Simulation, Modelling and Digital Twin Technology
- Structural Reliability
- Testing & Evaluation
- Vehicular Technology
- Tyre Technology
- Automotive Cyber Security
- Artificial Intelligence in Automobile
- Software Defined Vehicles

## CALL FOR PAPERS

The papers presented in SIAT 2026 will bear SAE numbers and will find place in SAE International database as well as will be published as Symposium Proceedings. Technical Papers / Keynotes are invited from the Automotive fraternity world-over, for presentation in the Symposium. Please upload abstracts of papers on 'SAE MyTech Zone', using the below appended link or QR Code, on or before 30<sup>th</sup> April 2025, for review.

<https://www.sae.org/servlets/techpapers/enterAbstractForPapers.do?method=formView&evtSchedGenNum=36&prodGrpCd=SPEC&evtName=SIAT>

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## SIAT EXPO 2026

The concurrent SIAT EXPO 2026 will provide opportunity to the automotive and allied industry to showcase spectrum of their products, automotive testing and validation tools as well as services to the large gathering of experts. The exposition will attract automotive OEMs, Tier-I, Tier-II and Tier-III suppliers, start-ups, equipment manufacturers, CAD/CAM/CAE tool providers, technologists and engineering service providers. The Exhibition would be open to automotive fraternity and interested public, providing an excellent opportunity for business promotion, networking and dissemination of information. SIAT EXPO 2026 layout will be hosted on the websites of ARAI and SIAT 2026.

## SPONSORSHIP OPPORTUNITIES

Options for sponsorship support to SIAT 2026:

- Platinum Sponsor
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- Silver Sponsor
- Bronze Sponsor
- Associate
- Event Sponsor

SIAT 2026 will attract large number of delegates from India and abroad, besides visitors to the concurrent Exposition and provide worldwide publicity to the sponsors through displays and branding during the Symposium and the Exposition, so also through Symposium Proceedings, Advertisements in Technical Reference Bulletin, Information Booklet, Website, etc. Sponsors will also be entitled for free Delegates Registration. In nutshell, SIAT will add immense value and give wide visibility to the valued brands among the automotive fraternity world-over. Please share your choice of sponsorship at [siat2026@araiindia.com](mailto:siat2026@araiindia.com).



For registration & further details, please contact:

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For booking of stalls in SIAT EXPO 2026, please contact:

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For more details, please visit: <https://siat.araiindia.com>

## ❑ First Ever Global Autonomous BAJA hosted by ARAI along with Innovation showcase event INTELLIMOBILITY

In its 17th edition, national-level engineering-student competition - BAJA SAEINDIA, transformed the competition landscape by introducing new avenues to address current challenges in the mobility industry at the academic level, leveraging applied engineering practices. The theme, "Multiverse of Mobility", highlighted the significant milestone this year, by introducing two new categories along the ever-popular mBAJA (IC Engine) and eBAJA (Electric) categories. aBAJA (Autonomous) and hBAJA (Hydrogen) categories symbolize a leap into the future of mobility, aligning with the Host Institute "ARAI's" dedication to provide engineering students with a global platform for learning, experimentation and growth. Embracing the developing technology and alternative fuels will nurture and equip the participants to tackle the challenges the mobility industry encounters.

Autonomous BAJA SAEINDIA (aBAJA SAEINDIA) 2024, held at ARAI, Pune, brought together five teams from leading engineering colleges across India for three days of rigorous competition. These teams demonstrated their ability to innovate and push the boundaries of autonomous technology, showcasing their talent in both dynamic and static events. Before the official start of the competition, pre-event readiness checks were conducted to ensure the preparedness of all the teams to face the challenges ahead. These included comprehensive technical inspections of electrical, mechanical and autonomous systems as well as trial runs on the dynamic event tracks, such the Object Detection, Classification, and Tracking (ODCT) and Remote Driving System (RDS). This phase provided teams the opportunity to fine-tune their vehicles and make necessary adjustments, ensuring their readiness to meet the high standards set by the competition.



Day 1 of aBAJA SAEINDIA 2024 roared to life on 4<sup>th</sup> October 2024 with an electrifying atmosphere as five autonomously operational vehicles were prepped and ready to navigate the tracks of ARAI, Kothrud in Pune. The excitement was palpable as 150 participants from 5 teams eagerly awaited the opportunity to showcase performance of their vehicles. The day featured a blend of technical insights and formal ceremonies, beginning with the Static Events, including Business Presentation and Design Evaluation. The Business Presentation provided students with an opportunity to experience entrepreneurship, exposing them to boardroom discussions and cultivating a business mindset. In the Design Evaluation, teams demonstrated their design thinking, engineering expertise and ability to develop both software and hardware architecture for their autonomous systems, showcasing the culmination of their hard work and dedication.



Day 2 showcased an impressive blend of innovation and engineering expertise as teams took part in dynamic events designed to push their autonomous vehicles to the limits of precision, reliability and technical sophistication. The day began with a safety briefing followed by rigorous evaluations, including the Safety Driver Takeover Brake Test, once again reaffirming that safety remains paramount in BAJA SAEINDIA. Teams then participated in dynamic events such as Object Detection, Classification and Tracking (ODCT) test, which assessed the perception capabilities of their vehicles using RADAR and camera inputs to detect regular traffic objects, along with the Throttle and Brakes Actuation tests, which evaluated efficiency of their longitudinal controller actuated through Throttle-By-Wire and Brake-By-Wire systems. In parallel with the dynamic events, the first round of the iNTELLIMOBILITY Ideathon took place, where teams presented innovative solutions to real-world mobility challenges. These concepts were evaluated for their creativity, feasibility and potential impact, setting the stage for the final round on Day 3. This ideathon, along with the day's events, provided students with invaluable hands-on experience, bridging academic knowledge with practical application in advanced technologies.



Day 3 marked the culmination of Autonomous BAJA SAEINDIA 2024 with the much-anticipated Re-remote Driving System (RDS) event, which truly tested the precision, control and technical prowess of the participating teams. Replacing the traditional endurance race, the RDS event posed complex challenges as teams navigated their autonomous vehicles around the track, controlled remotely, for the specified duration. This event showcased not only the engineering excellence behind the vehicles but also emphasized the advancements made by each team in Drive-By-Wire technology, stepping towards autonomous technology.



The day concluded with the grand valedictory ceremony, celebrating the hard work, dedication and innovation exhibited by all the participants throughout the competition. The ceremony was graced by an esteemed line-up of dignitaries, their insightful addresses underscored the potential of the participants and highlighted the role of initiatives like aBAJA in driving future innovations in engineering and mobility.



## □ Seminar on Hydrogen – Emerging Technology Scenario for ICE Applications

ARAI conducted seminar on Hydrogen – Emerging Technology Scenario for ICE Applications on 26<sup>th</sup> November 2024 in Pune.

The global automotive sector's increasing demand for alternative fuels, rising fuel costs and emission reduction targets have driven development of H2ICE technology. Hydrogen is seen as a key decarbonizing solution for vehicles. To support this, ARAI's Alternate Fuel Centre organized seminar to provide platform for experts to share their insights and work in the field.

The seminar received valuable sponsorship support from several organizations, like M/s. Tata Motors, M/s. A B Process Technologies, M/s. BPCL, M/s. Phinia, M/s. Sciometric Technologies, M/s. Bosch, M/s. Schaeffler, M/s. IOCL, M/s. AVL, M/s. Advantek, M/s. Comsol, M/s. MNGL, M/s. Bender, M/s. Kistler, M/s. Horiba, M/s. MGL, M/s. Madhuchit, and M/s. Praj Industries. Additionally, ARAI - TechNovuus served as the outreach partner for the event. The seminar was attended by pan-Indian OEMs, OMCs and academic stalwarts, attracting overall footfall of over 250 delegates.

**Dr Reji Mathai, Director ARAI** covered following important points in his Welcome Address:

- Transportation sector, responsible for about 30% of environmental pollution, urgently needs to shift to clean energy solutions derived from renewable sources.
- India is promoting clean energy through programs supporting biofuels, natural gas and hydrogen.
- Hydrogen is the cleanest fuel discovered as it does not contain any carbon and hence is environmentally friendly.
- Government of India launched National Green Hydrogen Mission in January 2022. The mission seeks to make India a green Hydrogen Energy Hub. The mission outcomes projected by 2030 are:
  - Development of green hydrogen production capacity of at least 5 MMT (Million Metric Ton) per annum with an associated renewable energy capacity addition of 125 GW.
  - Total investment will be to the tune of ₹ 8 lakh crore.
  - Creation of over 19 lakh jobs.
  - Cumulative reduction in fossil fuel imports of over ₹ 1 lakh crore.
  - Abatement of nearly 50 MMT of annual greenhouse gas emissions.
- As a part of National Hydrogen Mission, funds have been allocated for -
  - Development of fueling Infrastructure in dedicated corridors.
  - Pilot trials of vehicles in the corridors and,
  - R&D Projects for development of Hydrogen vehicles.

Dr. S S Thipse, Sr. Deputy Director and Convenor of Hydrogen seminar made detailed presentation on regulatory framework for use of H2ICE vehicles.

- He briefed about the standards and regulations of H2ICE.
- While explaining the need for alternative fuels, he talked about the vision for Aatmanirbhar Bharat, Greenhouse gas mitigation and how use of alternate fuels can boost the Indian economy.
- He touched upon various types of H<sub>2</sub>, including Green, Grey, Blue and Turquoise.
- He elaborated H<sub>2</sub> program roadmap for India.
- He also briefed on various aspects of National Green H<sub>2</sub> Mission. He also elaborated on the role of ARAI in H<sub>2</sub> program and how ARAI represents in various forums/committees and represent India.
- He also indicated that ARAI is coming up with H<sub>2</sub> testing facility at ARAI-HTC Chakan.

Dr. Thipse emphasized that the ARAI-organized event provides a vital platform for discussing H<sub>2</sub>ICE technology and its potential to reduce urban pollution. The seminar explored the green hydrogen ecosystem, including storage, mobility and infrastructure, with insights from leading countries. It also highlighted the importance of skill development and employment opportunities to support India's green hydrogen transition.

During the technical sessions Shri Saravananaraja T, Senior GM at Tata Motors, emphasized India's energy independence goals by 2047 and Net Zero emissions by 2070, with Tata aiming for Net Zero by 2040 for passenger vehicles and 2045 for commercial vehicles, exploring H<sub>2</sub>ICE to enhance performance and reduce costs. Shri Rajesh M Badhe of Indian Oil R&D shared insights on the hydrogen value chain, while Dr. Jean-Luc Beduneau of Phinia Delphi highlighted that their H<sub>2</sub>ICE system is nearing serial production, demonstrating performance comparable to diesel with ongoing real-world validation. Dr. Shabana Shaikh from Advantek addressed fuel system components and integrated design considerations for H<sub>2</sub>ICE applications. Shri K U Ravindra of Bosch highlighted hydrogen engines as sustainable and cost-effective powertrains, emphasizing the importance of infrastructure development and advanced fuel system technologies for emission compliance.

Shri Atul Tare from Praj Industries provided an overview of bio-hydrogen production for bio-mobility and Shri Sameer Badve of A B Process Technologies stressed the importance of safety protocols, emergency responses and training for hydrogen infrastructure. Dr. Deepak Kasturi of Schaeffler discussed technological innovations like Variable Valve Train and H<sub>2</sub> injectors that enhance engine efficiency and reduce emissions.

Finally, Shri Naresh Phansalkar of Tenneco introduced ATS-One-Box, an integrated solution combining hydrogen oxidation catalysts and urea dosing to streamline hydrogen engine systems, all underscoring a collective push towards cleaner, efficient, and safe hydrogen-powered mobility solutions.

## Highlights of the Seminar

Automotive sector is witnessing burgeoning interest in H<sub>2</sub>ICE technology driven by escalating conventional fuel costs and stringent regulatory mandates for emissions reduction.

- Insights into the technological landscape of H<sub>2</sub>ICE applications in automotive engineering.
- Perspectives on the hydrogen value chain, emphasizing supply chain dynamics and integration.
- Exploration of advancements and challenges in H<sub>2</sub>ICE technology, focusing on R&D initiatives.
- Examination of hydrogen infrastructure, handling protocols and safety standards.
- Discussion on fuel system components and calibration methodologies for hydrogen engine optimization.
- Overview of hydrogen storage solutions, including tank types, pressure management and safety compliance.
- Design considerations for after-treatment systems in H<sub>2</sub>ICE to meet emission standards.
- Comprehensive analysis of bio-hydrogen production processes and their implications for bio-mobility.

## Glimpses of Hydrogen Seminar



*Dr. Reji Mathai, Director- ARAI, Felicitating the Chief Guest, Shri C V Raman of M/s. Maruti Suzuki India Ltd.*



**Group Photograph with the Chief Guest and eminent Speakers**

**□ Seminar on General Lighting “Emerging Smart Trends in General Lighting” - 29<sup>th</sup> January 2025**

Safety and Homologation Lab, ARAI Academy and TechNovuus jointly organized "Seminar on Emerging Smart Trends in General Lighting" on 29<sup>th</sup> January 2025 at ARAI-FID, Chakan. The objective of this seminar was to facilitate knowledge sharing on the advancements in general lighting technologies, explore upcoming trends and discuss the challenges currently faced by the industry.

Drawing on ARAI's extensive experience in optical measurements, ARAI has set up state-of-the-art facilities for testing general lighting systems. As a part of the seminar, participants were offered exclusive lab visit to the newly commissioned Advanced Photometry and Optics Laboratory at ARAI-HTC, Chakan, providing insights into the capabilities and innovations integrated into the facility.

The seminar was inaugurated by Shri S. D. Rane, Head & Director – BIS, Pune along with Shri A. A. Badusha, Sr. Deputy Director; Ms. M.S. Jambhale, Sr. Deputy Director; Dr. B. V. Shamsundara, Sr. Deputy Director and Ms. J. M. Kirve, Deputy Director.



Over 70 delegates and 12 speakers from various fields of general lighting, including lamp manufacturers, Designers, Architects, Associations, Academicians, etc. were a part of the event.

Eminent speakers from the general lighting area shared their valuable knowledge in their presentations on the topics such as importance of dark night sky, mitigating challenges evolving lighting technologies, LED lighting in Indoor and outdoor lighting, connecting solutions for simplifying the outdoor lighting installations, future of LED Lighting: Innovations and Trends.

Panel discussions on the following two emerging areas, viz. Incorporating Energy Efficiency in Lighting and Trends of Smart Lighting – Industry Viewpoint, were arranged during the Seminar

Following the completion of all technical sessions, a guided visit to Advanced Photometry and Optics Laboratory at HTC, Chakan was organized for all delegates and speakers. The visit provided first hand insight into the cutting-edge testing capabilities and infrastructure developed by ARAI on optics laboratory, which includes general lighting.

The feedback received from speakers as well as delegates was overwhelmingly positive and encouraging. The seminar successfully fulfilled its objective of fostering knowledge sharing, enabling meaningful exchanges between industry experts, and effectively showcasing ARAI's advanced capabilities and facilities at ARAI-HTC, Pune.

### □ **International Conference on Advanced Powertrains for Mobility and Power Generation Applications: 7<sup>th</sup> & 8<sup>th</sup> March 2025**

This Conference was jointly organized by ARAI, SAEINDIA Western Section & BOSCH Global Software Solutions Pvt. Ltd. at The Hotel Orchid Balewadi.

Dr. Sushil Ramdasi (Deputy Director, In-charge -Powertrain Design, ARAI) was the convener & Mr. Dattatraya R. Kurade (General Manager, Mobility strategy, Pune, Bosch Global Software Technologies Pvt. Ltd.) was the co convener of the conference.

**Mr. Sudeep Dalvi** (Senior Vice President & Director-Technical, Toyota-Kirloskar Motors) was the Chief Guest of the conference.

The said conference was a groundbreaking event aimed at exploring cutting-edge advancements in automotive technology. It brought together renowned experts, industry leaders, and researchers to discuss the latest trends in powertrain technology.

With a focus on sustainable and advanced technologies such as EURO VII readiness, electrification, hydrogen fuel cells, and powertrain optimization, the conference showcased insightful keynote speeches, engaging panel discussions, and detailed technical sessions.

The conference covered challenges due to upcoming Euro7 emission norms, Hydrogen ICE and Flex Fuel technology, making of an efficient & cost effective Conventional / E Axle based drive trains for EV's, Advances in Motors and motor controllers (IM / PMSM / SRM), Power Electronics, MCU, BMS, Battery, Charging Technology, Hydrogen Fuel Cell Electric Vehicle Technology for Mobility & Power Generation Applications, Strong Hybrids / Series Hybrids / Range Extender Based Hybrids, etc.

#### **Highlights of the Conference:**

There were total **15 technical presentations**, **09 Keynote addresses** and **2 Panel discussions** conducted in which an eminent personality from top organizations were participated. Around 100 industry professionals from various industries attended this event and appreciated the technical contents presented and discussed over two days.

Following is the brief summary of points presented and discussed during presentations and panel discussions.

#### ICE Based Powertrains for Mobility & Power Generation Applications (EURO VII / H2 ICE & Flex Fuel):

- The challenges and cost implications of EURO VII implementation along with strategies for compliance
- The future of powertrains beyond EURO VII regulations
- The future trends in power generation technologies viz ICE and Fuel Cell based
- India Specific Alternate Fuel Based Powertrain Technology & Government Initiatives, Rules, Regulation & Testing Infrastructure
- Breakthroughs in emission measurement technology for EURO VII and beyond
- Toyota's experience in pioneering alternative fuels and global trends in hydrogen adoption
- Advancements in hydrogen and flex fuel injection technology
- Fuel Injection Systems for Hydrogen ICE and Flex Fuel Engines
- Multifuel Pathway for India and Honda's perspective towards Ethanol Blending

#### Penetrating Electrification in Commercial Vehicles:

- Readiness and acceptance of electrification in mass transportation based on facts and figures
- Indigenisation of E-Mobility from an Indian Perspectives
- Physics Based Models to XiL Controls Development for xEVs
- An Indigenous, Efficient and Non-interruptive Supply Chain & Eco-system for all kind of EV's for Indian Market
- Complimenting Product Development Process by use of Advanced Testing Solutions (EV & H FCEV)
- Advances in Motor Controller & Power Electronics Technology
- Digital Twinning for V &V and Calibration of xEV Control Units
- Advances in Motor Technology
- Mahle's Perspective and Technology Readiness in xEV & Flex Fuel Based Powertrains
- Updating on PLI, Rules, Regulations and Certification of Electric Vehicles, Systems & Components
- Sodium Ion Battery Technology for EV's and its Readiness for Mass Implementation

#### Promoting hydrogen Fuel Cell & Electrolyser technology with due consideration for making viable Business Case

- Bosch Readiness for Migrating towards E Mobility (EV & HFCEV)
- Accelerating EV & Hydrogen FCEV Technology from an Indian Perspective
- Innovative Based Solutions for Hydrogen Electrolysers and Fuel Cell Technology

We thank our Eminent Speakers, Sponsors, and Participants for participating in this wonderful conference.

We congratulate Dr. S. S. Ramdasi (Convener), Mr. Dattatraya R. Kurade (Co-Convener) for successful conference.

## Glimpses of the conference:



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