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ARAI

Progress through Research

Paving Pathways for Safe and Sustainable Mobility

55th Annual Report 2024-2025

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

Highlights of the Year

- Recognized with 'Outstanding Auto PLI Scheme Execution Award'
- TED 26 – Sectional Committee on Automotive Vehicles Running on Non-Conventional Energy Sources, Chaired by ARAI, has been recognised with 'Committee of the Year' award
- Over 19% growth in Operational Income as compared to previous Financial Year
- Certification of India's First Road Train Vehicle
- Development of pantograph mechanism for Over-head Automated Charging Device
- Transfer of AC-DC Charging Stations Technology Know-How
- Development of 'eMobility R&D Roadmap for India' under an initiative of Office of the Principal Scientific Adviser (PSA) to the Government of India

Join us at SIAT 2026, as we commemorate six decades of 'Progress through Research'

Launch of Symposium on International Automotive Technology (SIAT) 2026 by
Shri H. D. Kumaraswamy, Hon'ble Minister for Heavy Industries

Recognized for the Contribution in Promoting EVs in India

Recognized with
'Golden Peacock Innovative Product/ Service Award 2025'

Contents

Empowering Growth of Mobility Ecosystem with the Support of Ministry of Heavy Industries

Globally, mobility sector is experiencing substantial changes triggered not only by extensive technology development, but also by social demand. Major trends like software-defined vehicles, advanced safety features, electrification, connectivity, sustainability and mobility-as-a-service are continuing to shape future of the mobility sector. Further, additive manufacturing, artificial intelligence, Internet of Things and 5G are driving innovation and efficiency. India is also progressing on this path aided by various policies and schemes introduced by Government of India.

ARAI is also contributing in this direction through projects, which are being implemented under 'Scheme for Enhancement of Competitiveness in the Capital Goods Sector' of Ministry of Heavy Industries (MHI). Details of these projects, viz. Augmentation of existing Testing & Certification facilities in the area of safety, viz. Battery Safety, Verification & Validation (V&V) of Advanced Driver Assistance Systems (ADAS) and Cylinder Testing; establishment of Centre of Excellence for Intelligent Vehicle Technology (IVT); setting up of Common Engineering Facility Centre (CEFC) for Digital Twinning and Technology Innovation Platform – TechNovuus are given below.

- **Advanced Battery Safety Lab:**

  Facilities at this lab cater to testing and validation of advanced chemistry batteries as per national/international standards and regulations as well as customer specific design validation plan. The infrastructure at this lab has been designed so as to ensure safety of infrastructure, equipment and personnel in order to address hazards associated due to battery testing. Various safety measures considered include strong rooms to perform abuse tests, scrubber to process hazardous gases, effluent treatment plant to process contaminated water and chamber design to meet safety as per international guidelines. Some of the major equipment being established at this lab are given below.

  - Walk-in Chamber for Battery Testing
  - High Force Electrodynamic Vibration Shaker along with Climatic Chamber
  - Mechanical Shock Test System
  - Environmental Simulation facilities like Altitude, Salt Spray Chamber, Dust, Crush, Fire and Short Circuit Test facility

Advanced Battery Test Lab

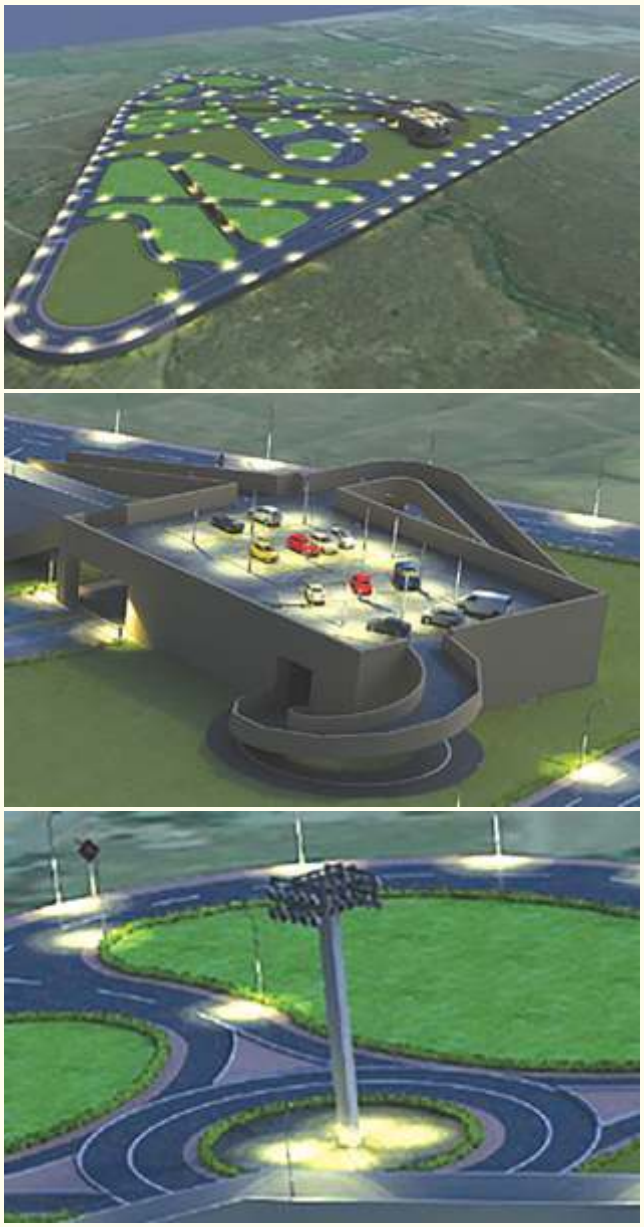
Climatic Chamber

Vibration Shaker

- **Modular Infrastructure for Verification & Validation (V&V) of ADAS:**

  This modular infrastructure is to support Start-ups, MSMEs, Research Institutes working in the domain of advanced/ intelligent vehicles and those engaged in developing control systems for different OEMs and Tier 1 manufacturers. Some of the major ADAS Test Track equipment procured include motion platforms, test dummies, driving robots, software, networking equipment, etc. Services to the industry using these facilities have already commenced.

  Along with these facilities being established with the funding support of MHI, ARAI is also establishing 'Simulated City' level test track with internal funding, which will be useful for field level validation of ADAS/ Autonomous Vehicles.



Simulated City Level Test Track

- **Cylinder Testing:**

  The facilities being established will serve the needs of automotive and industrial sectors, covering various types of cylinders (Type-I to Type-IV) for CNG, LPG, LNG, and HCNG gases application. These facilities will cater to type approval, batch testing, periodic certification and developmental testing requirements of the industry. Some of the major equipment being installed are given below.

  - Hydrostatic Burst Rig
  - Hydraulic Pressure Cyclic Rig
  - Volumetric Expansion Rig (Hydraulic)
  - CNG Pressure Cyclic Rig
  - CNG Permeation Rig
  - Ultrasonic Machine
  - Universal Testing Machine
  - Cyclic Walk-in-Chamber

- **Centre of Excellence (CoE) for Intelligent Vehicle Technology (IVT):**

  The three technology solutions envisaged for development at this CoE include (a) models for Indian traffic objects and infrastructure detection, (b) cost effective vision/ radar-based solution for Front Collision Warning System (FCWS) and (c) alert to mitigation adaptation use case for AEBS (Automatic Emergency Braking System). The first solution is for enabling India specific technologies for ADAS, second one focuses on technology indigenization and third one relates to creation of functional safety as per ISO 26262.

Instrumented Vehicle

Synchronous Data Acquisition

Annotated Dataset

- **Common Engineering Facility Centre (CEFC) for Digital Twinning :**

  Digital Twin Centre for Emerging Automotive Systems is being set up under Hub-Spoke model, with the hub at ARAI, Pune and two spokes located at Bengaluru and Guwahati. This CEFC will help MSMEs and Start-ups for product development, validation and training requirements. This centre will have facilities for system development using Artificial Intelligence (AI) and Machine Learning (ML) techniques (for digitalizing data and environment); Hardware-in-loop (HIL) Farms (for digitalizing plant for electronics & control); and Integrated Computational Materials Engineering (ICME) Simulation Platform (for digitalizing materials and structure). Currently, operations using some of the facilities have commenced at Pune and Bengaluru centres.

TechNovuus :

TechNovuus, a Technology Innovation Platform of ARAI, is a collaborative eco-system for enabling indigenous technology, innovation and solution development through an open innovation and technology development platform. It facilitates development of solutions for challenges related to mobility to start with and gradually will cater to

HIL Farm at Hub (Pune)

AI-ML and ICME at Hub (Pune)

RADAR Hill at Hub (Pune)

HIL Farm at Spoke 1 (Bengaluru)

Power HIL at Spoke 1 (Bengaluru)

other sectors like Defence, Aerospace, Telecommunication, Railways, etc., providing an impetus to Government of India's Make in India and Atmanirbhar Bharat programs.

This platform brings together solution providers and seekers to unlock the potential of new technologies that are driving and shaping the future technology revolution. It helps in addressing challenges in mobility area through India specific solutions using frugal and value engineering methodologies. It currently has over 17,500 registered users (200+ organizations, 100+ industrial experts, 600+ Academia participants and professionals).

Key highlights of activities carried out in 2024-25:

- ideathon iNTELLIMOBILITY: "Driving Safe Mobility" was conducted by TechNovuus on 5th and 6th October 2024 as a part of the innovation showcase feature. Out of 197 teams registered for this ideathon, 21 teams were invited to ARAI campus for special innovation showcase held during the first ever aBAJA, which was hosted by ARAI and organized by SAEINDIA. The top 3 ideas were rewarded at this event.
- Webinar series on Clean Energy Horizon, wherein 3 experts shared their insights on Alternative Fuels.
- New series of webinars with ARAI's Knowledge Centre - With more than seven hours of knowledge sharing with about 500 participants, this series was well received by the participants, especially researchers from the automotive industry.
- National Start-Up Week was celebrated from 10th to 16th January 2025 with Start-Up संगोष्ठी, a Webinar Series for new start-ups, students and enthusiasts. This series had Mr. Sudeep Ambare, CEO AMTIF; Mr. Umesh Rathod, Manager, Innovation Centre, Western Region, Maharashtra and Goa for AICTE's – Ministry of Education – Innovation Cell; and Mr. Ankit Machhar, Director – Ecosystem, Wadhwani Foundation as speakers. About 200 participants attended these webinar sessions and interacted with the experts.

ideathon iNTELLIMOBILITY: "Driving Safe Mobility"

Start-Up संगोष्ठी – Webinar Series for new Start-ups, Students and Enthusiasts

Webinar on 'Demystifying Open Access of Scientific Knowledge'

Webinar on 'Clean Energy Horizon'

Governing Council

PRESIDENT	**Dr. N. Saravanan,** President & Chief Technology Officer, Ashok Leyland Ltd.
VICE PRESIDENT	**Mr. Velusamy R,** President- Automotive Technology and Product Development, Mahindra & Mahindra Ltd.
DIRECTOR	**Dr. Reji Mathai**

ARAI is under the administrative control of Ministry of Heavy Industries, Govt. of India.

MEMBERS

1. Ashok Leyland Ltd.
2. Bosch Ltd.
3. Brakes India Pvt. Ltd.
4. Cummins India Ltd.
5. Cummins Technologies India Pvt. Ltd.
6. Eicher Motors Ltd. (Royal Enfield)
7. Fiat India Automobiles Pvt. Ltd.
8. Force Motors Ltd.
9. Hero MotoCorp Ltd.
10. Honda Cars India Ltd.
11. Hyundai Motor India Ltd.
12. Kirloskar Oil Engines Ltd.
13. Mahindra & Mahindra Ltd.
14. Maruti Suzuki India Ltd.
15. Mercedes-Benz India Pvt. Ltd.
16. Piaggio Vehicles Pvt. Ltd.
17. Skoda Auto Volkswagen India Pvt. Ltd.
18. Tata Cummins Pvt. Ltd.
19. Tata Motors Ltd.
20. Toyota Kirloskar Motor Pvt. Ltd.
21. Tractors and Farm Equipment Ltd.
22. TVS Motor Co. Ltd.
23. VE Commercial Vehicles Ltd.
24. Volvo Group India Pvt. Ltd.

GOVT. OF INDIA REPRESENTATIVES

Ms. Arti Bhatnagar
Special Secretary & Financial Adviser
Government of India
Ministry of Heavy Industries
Udyog Bhavan, New Delhi 110 011

Dr. Hanif Qureshi
Additional Secretary
Government of India
Ministry of Heavy Industries
Udyog Bhavan, New Delhi 110 011

Mr. Manoj Kumar Madholia
Director, MHI & Looking after Director (FPCAL) NAB
Government of India
Ministry of Heavy Industries
Udyog Bhavan, New Delhi 110 011

INVITEES

- Society of Indian Automobile Manufacturers
- Automotive Component Manufacturers Association of India
- Tractor and Mechanization Association

SECRETARY TO THE GOVERNING COUNCIL

Mrs. Prajakta M. Dhere
Sr. Genral Manager
Head-Governing Council Secretariat & Legal

REGISTERED OFFICE

Survey No. 102, Vetal Hill
Off Paud Road, Kothrud
Pune 411 038
Phone : 020-67621101, 6762 1122, 6762 1111
Email: director@araiindia.com

BANKERS

Bank of Baroda
HDFC Bank Ltd.

STATUS OF INSTITUTE

- Registered under The Societies Registration Act, XXI of 1860 Regn. No. 133/66 GBBSD dated 10.12.1966
- New Regn.No. Maha/2066/2016/Pune dated 13.12.2016
- Registered under The Maharashtra Public Trust Act, 1950, on 12th April, 2016 in Mumbai and subsequently transferred to Pune Reg. No. F-48091/Pune dated 13.12.2016

STATUTORY AUDITORS

M/s. Kirtane & Pandit
Chartered Accountants
5th Floor, Wing A, Gopal House
S. No. 127/ 1B/1, Plot A-1
Kothrud, Pune 411 038

Members

1. Action Construction Equipment Ltd.*
2. Adient India Pvt. Ltd. (formerly Johnson Controls Automotive Ltd)
3. A.J. Auto Pvt. Ltd.
4. Ammann India Pvt Ltd.~
5. ARaymond India Pvt. Ltd.
6. Ashok Leyland Ltd.
7. Ather Energy Pvt. Ltd.
8. Atul Auto Ltd.
9. Autocomp Corporation Panse Pvt. Ltd.
10. Bajaj Auto Ltd.
11. Behr-Hella Thermocontrol (India) Pvt. Ltd.
12. BEML Ltd ~
13. Bharat Forge Ltd.
14. Bosch Ltd.
15. Brakes India Pvt. Ltd.
16. BMW India Pvt. Ltd.
17. BYD India Pvt. Ltd.*
18. Caterpillar India Pvt. Ltd.**
19. Chemito Infotech Pvt. Ltd.
20. Classic Legends Pvt. Ltd.*
21. Cooper Corporation Pvt. Ltd.
22. Cummins India Ltd.
23. Cummins Technologies India Pvt. Ltd.
24. Daimler India Commercial Vehicles Pvt. Ltd.
25. Eicher Motors Ltd.
26. Enginetech Systems Pvt. Ltd.
27. Escorts Kubota Ltd.
28. Fiat India Automobiles Pvt. Ltd.
29. Force Motors Ltd.
30. F P Seating Systems Pvt. Ltd.**
31. Greaves Cotton Ltd.
32. Greaves Electric Mobility Pvt. Ltd. (Formerly Ampere Vehicles Pvt. Ltd.)
33. Gromax Agri Equipment Ltd. (formerly Mahindra Gujarat Tractor Ltd.).
34. Hero Electric Vehicles Pvt. Ltd.
35. Hero MotoCorp Ltd. *
36. Honda Cars India Ltd.
37. Hyundai Motor India Ltd.
38. India Japan Lighting Pvt. Ltd.
39. India Kawasaki Motors Pvt. Ltd.
40. Isuzu Motors India Pvt. Ltd.
41. JCBL Ltd.
42. JSW MG Motor India Pvt. Ltd. (formerly MG Motor India Pvt. Ltd.) #
43. Kabra Extrusion Technik Ltd.
44. Kia India Pvt. Ltd.
45. Kinetic Green Energy & Power Solutions Ltd.
46. Kirloskar Oil Engines Ltd.
47. Lear Automotive India Pvt. Ltd.
48. Madras Engineering Industries Pvt. Ltd.
49. Mahindra & Mahindra Ltd.
50. Mahindra Last Mile Mobility Ltd. *
51. Maruti Suzuki India Ltd.
52. Masstrans Technologies Pvt. Ltd.
53. Mercedes-Benz India Pvt. Ltd.
54. MLR Auto Ltd.
55. MSKH Seating Systems India (P) Ltd.
56. Octillion Power Systems India Pvt. Ltd.*
57. Omega Seiki Pvt. Ltd.
58. Piaggio Vehicles Pvt. Ltd.
59. Pinnacle Mobility Solutions Pvt. Ltd.*
60. P M Diesels Pvt. Ltd.
61. Randhawa Automobile Engineering Pvt. Ltd.
62. Rehlko Energy India Pvt. Ltd. (formerly Kohler Power India Pvt. Ltd.) #
63. Renault Nissan Automotive India Pvt. Ltd.
64. Rocket Engineering Corporation Pvt. Ltd.
65. Rotary Electronics Pvt. Ltd.
66. Simpson & Co. Ltd.
67. Skoda Auto Volkswagen India Pvt. Ltd.
68. S. M. Auto Engineering Pvt. Ltd.
69. SML Isuzu Ltd.
70. Stellantis Automobiles India Pvt. Ltd. (formerly PCA Automobiles India Pvt. Ltd.)
71. Stellantis India Pvt. Ltd. (formerly FCA India Automobiles Pvt. Ltd.)
72. Switch Mobility Automotive Ltd.
73. Tata Cummins Pvt. Ltd.
74. Tata Motors Ltd.
75. Terex India Pvt. Ltd.
76. T.M. Automotive Seating Systems Pvt. Ltd.
77. Toyota Kirloskar Motor Pvt. Ltd.
78. Tractors and Farm Equipment Ltd.
79. Trimble Mobility Solutions India Pvt. Ltd.~
80. TVS Motor Co. Ltd.
81. Vanaz Engineers Ltd.
82. VE Commercial Vehicles Ltd.
83. Visteon Technical and Services Centre Pvt. Ltd.
84. Volvo Group India Pvt. Ltd.
85. Wardwizard Innovations & Mobility Ltd.~~
86. Wheels India Ltd.
87. ZF Commercial Vehicle Control Systems India Ltd. (Formerly WABCO India Ltd.)

* New Membership
** Membership approved w.e.f. 1st April 2025
~ Withdrawal
~~ withdrawal w.e.f. 1st April 2025
name change

FINANCE & INTERNAL AUDIT COMMITTEE (FIAC)

CHAIRMAN

Mr. Velusamy R
Vice-President-ARAI,
President- Automotive Technology and Product Development,
Mahindra & Mahindra Ltd.

MEMBERS

Ms. Vandana Wadhwani
General Manager – Finance & Accounting, Mercedes Benz India Pvt. Ltd.

Ms. Sunayana
General Manager – Finance / Head – ERC Finance
Tata Motors Ltd.

Mr. Ankur Gupta
CFO B2B Business,
Kirloskar Oil Engines Ltd.

Mr. Milind Joglekar
Head – Taxation & Customs
Skoda Auto Volkswagen India Pvt. Ltd.

Mr. Chetan Kamdar
Finance Director,
Cummins India Technical Organisation,
Cummins India Ltd.

Mr. Banu Prasanna
Finance Controller - PD
Ashok Leyland Ltd.

Mr. Dinesh Gandhi
Vice President (Finance)
Maruti Suzuki India Ltd.

Mr. Rasesh Joshi
CFO
Mahindra Last Mile Mobility Ltd.

Members from ARAI

Dr. Reji Mathai
Director-ARAI

Mr. Atul Bhide
Deputy Director
(HoD- Finance & Accounts), Member Secretary

PROJECT EVALUATION & MONITORING COMMITTEE (PEMC)

CHAIRMAN

Mr. Aniruddha Kulkarni
Vice President & Head CVBU Engineering, Tata Motors Ltd.

MEMBERS

Mr. R. K. Jaiswal
Development Officer (Engineering),
Government of India,
Ministry of Heavy Industries

Mr. Rajinder S. Sachdeva
Chief Operating Officer,
V E Commercial Vehicles Ltd.

Mr. Alok Jaitley
Sr Vice President (Engg)
Maruti Suzuki India Ltd.

Mr. M. S. Anand Kumar
Sr. General Manager – R&D (Homologation)
TVS Motor Co. Ltd.

Mr. Abhijit Phadke
Director, CTCI Lab & Test Operations
Chief of Staff – Technical Leadership Team, India
Cummins Technologies India Pvt. Ltd.

Mr. S. Janardhanan
Vice President (Co-ordination),
Simpson & Co. Ltd.

Mr. S. Sriraman
Sr. Vice President ((R&D)
Tractors and Farm Equipment Ltd.

ARAI Members on PEMC:

Dr. Reji Mathai
Director-ARAI

Mr. Vijay Pankhawala
Sr. Dy. Director, ARAI

Mr. Suyog Gadgil
Sr. Manager-Member Secretary

President's Statement

Dr. N. Saravanan
President, ARAI

Mr. Velusamy R
Vice President, ARAI

Dear Members,

It is a pleasure in sharing with you Annual Report of ARAI, an institute built over a period of almost six decades of spirited and perseverant efforts by highly skilled human resource. Our performance during 2024–25 has been impressive, as we registered growth of ~ 19% over previous year and closed the financial year with an Operational Income of Rs.605.78 crore. This strong performance was a result of our focused investment in people, capacities and processes.

"This strong performance was a result of our focused investment in people, capacities and processes."

A significant achievement in certification domain this year was successful execution of Domestic Value Addition (DVA) Certification services under Auto PLI Scheme. It gives me great pleasure to state that ARAI has been recognized by Ministry of Heavy Industries with 'Outstanding Auto PLI Scheme Execution Award' for smooth execution of these projects. In addition to Type Approval Certification projects, we successfully executed numerous projects in alternate fuels domain, such as assessment of B100 fuel on CPCB II compliant genset engine, flex fuel retro-fitment kit evaluation on 4-wheeler, and evaluation of Iso-butanol blend with diesel on LCV for studying the impact on tailpipe emissions.

"We extensively rely on research and customer-centricity, which enables us to offer solutions and services of high-quality."

We extensively rely on research and customer-centricity, which enables us to offer solutions and services of high-quality. We constantly interact with the stakeholders to incorporate their opinions while working for innovative solutions. This has helped in providing solutions to our customers, while also identifying emerging needs. This relentless emphasis has yielded in 'Golden Peacock Innovative Product/ Service Award 2025' for our work on 'Development of Lightweight Aluminium Superstructure for Indian City application'. With regard to research accomplishments of this year, they included development of pantograph mechanism for overhead automated charging device, solutions for ADAS functionality verification and validation, methodology for generation of high definition maps, development of M100 2-wheeler, design of twin DG set solution and databank of material model cards for damage simulation.

Our dedication to excellence and integrity is manifested in every aspect of our operations. Continuing with this legacy, we contributed extensively at various national and international forums as a technical secretariat for formulation of standards and WP.29 activities. This has enabled in strengthening our collaboration throughout the mobility ecosystem. By prioritizing the needs of our stakeholders and upholding the highest standards of quality, we remain committed to delivering meaningful value to all our stakeholders.

"Our dedication to excellence and integrity is manifested in every aspect of our operations."

We continue to execute on our strategy of investing for the future and scaling of our capabilities. Our investments in facilities this year included 30 kW E-powertrain test facility for 2W & 3W; 350 kW transient dynamometer; 600 kW DC power source; Buzz, Squeak and Rattle (BSR) validation facility; 1000 kN UTM; test facility for automotive camera monitoring system; wheel rim impact test facility etc.

We also invested in learning and development for building skills and capabilities of our employees, as this brings in strong progress and cultivates an inclusive culture. Our e- modules, which facilitate self-paced learning, are enabling strong foundation of knowledge, skills and engagement. This year, we organized over 29,000 person-hours of training to facilitate upskilling and capability development of our employees. We look at holistic value creation, which involves strategic partnerships to expand our operational spectrum. During the year, we invested in collaborations with the industry and academia in areas like green mobility, automotive control systems, ADAS technology, etc., to strengthen our contribution to the mobility ecosystem. I believe, these investments will add more value in the coming years.

"We look at holistic value creation, which involves strategic partnerships to expand our operational spectrum."

Considering the need for knowledge dissemination across the mobility ecosystem, we engage with industry professionals and students through our ARAI Academy. This year was significant for our ARAI Academy, as it completed 20 years of training and skilling activities for industry professionals and students. Over these two decades, we have trained more than 21,000 working professionals and enabled skilling of about 2,700 pool of engineers.

We also recognize that climate change and environmental sustainability impact lives and livelihoods of people all around the world and as such, impacts all our stakeholders too. We recognize this, and hence we continue to deploy our domain expertise for addressing the effects of climate change.

"Delivering and engaging with our stakeholders is fundamental to our success, and which is also a core value proposition we believe in."

Delivering and engaging with our stakeholders is fundamental to our success, which is also a core value proposition we believe in. As we step into our 60th year of incorporation, we have demonstrated the strength and commitment required to meet our customers' expectations. Our sustainable competitive advantage is that we continually reinvent ourselves to meet our customers' evolving requirements and at the same time keep extending our commitment to delivering value to our stakeholders. As we continue to focus on innovation, value creation and forging stronger connections with our stakeholders, I am filled with optimism about our journey ahead in building on our legacy to achieve even greater heights.

In closing, I would like to express my gratitude to the Vice President – ARAI and Members of the Governing Council, Ministry of Heavy Industries (MHI), the Chairman and Members of Finance and Internal Audit Committee, the Chairman and Members of Project Evaluation and Monitoring Committee, the Chairman and Members of Project Review and Monitoring Committee, Members and Director – ARAI for their continued support. I would like to thank our customers, suppliers and associates for their overwhelming trust and support in our endeavour to build a thriving mobility ecosystem. I would also like to thank our employees for their commitment and hard work, which has brought consistent growth and created value for our customers and society at large.

Dr. N. Saravanan

Dr. Reji Mathai
Director - ARAI
director@araiindia.com

Director's Report

The Governing Council of ARAI has great pleasure in presenting the Annual Report and Audited Statement of Accounts for the year ending 31st March 2025.

Financial Year 2024-25 was another remarkable year for us. We closed the year with Operational Income of Rs.605.78 crore, which was about 19% higher than previous Financial Year. This performance demonstrates our resolve to evolve as a more resilient, flexible and agile institute, enhancing the potential for long-term growth.

"This performance demonstrates our resolve to evolve as a more resilient, flexible and agile institute ..."

Certification has been our forte for a very long period and we continue to consolidate our position in this domain. As in the past, we delivered significant number of certification assignments, living up to the trust reposed by our customers. This year, we executed projects on certification of Electric Buses, certification as per Ambulance Code, Trailer Code, etc. along with Domestic Value Addition under Auto PLI Scheme. A standout project in this domain was certification of India's First Road Train Vehicle.

"We continuously engage in development of technologies and up-gradation of existing solutions to meet customer requirements"

We continuously engage in development of technologies and up-gradation of existing solutions to meet customer requirements. As a part of this strategy, our departments are engaged in developmental work, which lead to innovative solutions for the mobility sector. Some of the significant achievements of this year on this front were demonstration of Pantograph Mechanism for Overhead Automated Charging Device, design of Electric Water Pumps for EV Cooling System and conversion of Fishing Boat Engines to LPG and Hybrid application.

We are passionate about serving the mobility sector and this is reflected in our performance. With the evolving technological demands, we continue to invest in futuristic developmental activities creating cutting edge infrastructure & thus I remain confident that we will continue delivering high quality services. As we continue with our growth journey, we remain committed to invest in building our capabilities, to align with emerging industry needs like ADAS and cybersecurity.

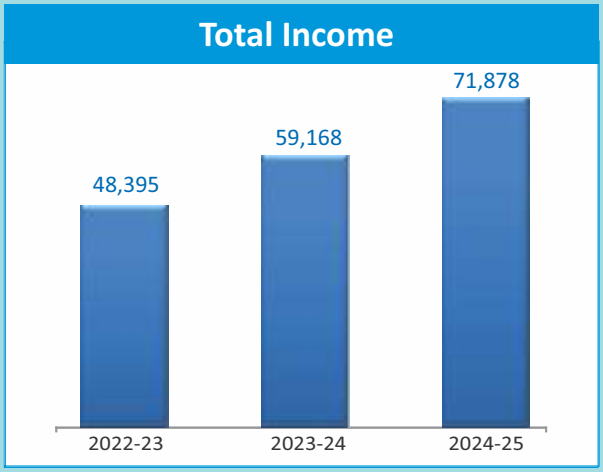
Moving ahead, our ecosystem is set to gain from our innovative technology investments in the fields of safety and sustainability. We are excited to be a part of this journey and will continue adding value to our customers. I am confident, with intense focus on emerging needs of our customers, we will be able to provide enduring value to our stakeholders.

"Moving ahead, our ecosystem is set to gain from our innovative technology investments in the fields of safety and sustainability"

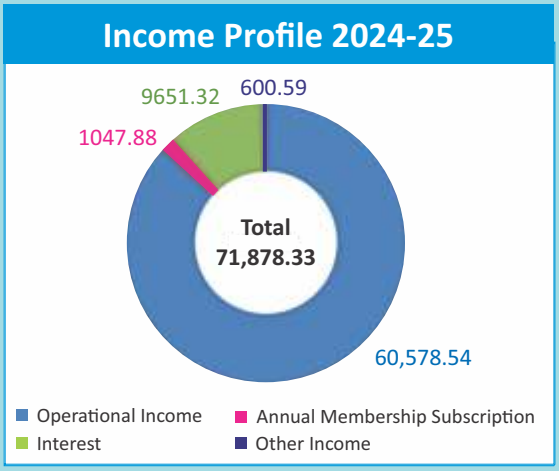
On behalf of Team ARAI, I would like to thank President, Vice President, Members of the Governing Council, Members of Finance & Internal Audit Committee, Members of Project Evaluation and Monitoring Committee, Members of Project Review and Monitoring Committee and Senior Officials from MHI for their invaluable guidance and support.

Dr. Reji Mathai

(Rs. in lakh)



(Rs. in lakh)



OPERATIONAL HIGHLIGHTS

- **Finance & Accounts**

Income & Expenditure Account, Balance Sheet and Auditor's Report are presented herewith.

- **Financial Performance**

  During the Financial Year 2024-25, Operational Income is Rs.60,578.54 lakh as compared to Rs. 50,872.16 lakh in 2023-2024. Total Income is Rs. 71,878.33 lakh as compared to Rs. 59,167.61 lakh of last year.

- **Investment of funds**

  The cash & bank assets available with ARAI have been invested in Scheduled Banks / Financial Institutions in term Deposits and in Government Securities as per the Governing Council's guidelines.

- **Appointment of Statutory Auditors**

  M/s. Kirtane & Pandit, Chartered Accountants, Pune were appointed as Statutory Auditors for the Financial Year 2024-25, in the Annual General meeting held on 9th September 2024.

- **Membership Subscription**

  The total number of members of ARAI as on 31/03/2025 is 82 and the Annual Membership Subscription for the year under report is Rs. 1047.88 Lakh.

- **Recognition by DSIR**

  ARAI is recognized as a Scientific and Industrial Research Organization (SIRO) by the Department of Scientific & Industrial Research, Ministry of Science & Technology, Govt. of India for the period from April 2023 to March 2026.

- **Income Tax**

  Central Board of Direct Taxes has approved ARAI for exemption purposes under Sec. 35 (1) (ii) of Income Tax Act, 1961, vide Notification No. 9/2007 (F.No. 203/18/2005-ITA –II) dated 28-3-2007 effective 01-04-2004.

- **Government Supported Projects:**

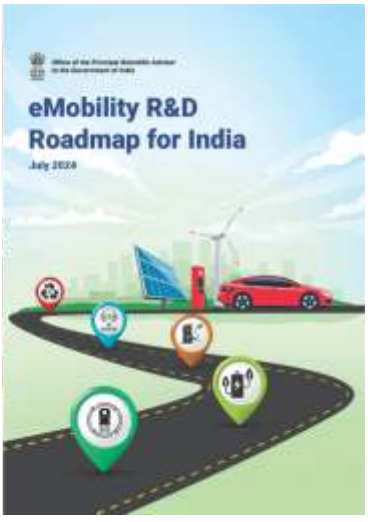
During the year, a project supported by the Office of Principal Scientific Adviser, Government of India on development of 'R&D Roadmap document for e-mobility in India' was successfully delivered. In this project, ARAI played a key role as a 'Project Assistance Unit' (PAU) to coordinate deliberations amongst Consultative Group on eMobility (CGeM) and Industry experts. The roadmap prepared offers clear and strategic framework to address challenges unique to the Indian context. It recognizes a multi-dimensional approach emphasizing rapid

absorption of proven global technologies, their adaptation to local conditions and a market-driven ramp-up in domestic production. It identifies four key focus areas, viz. Energy Storage Cells, EV Aggregates, Materials & Recycling as well as Charging & Refueling Infrastructure. Through well-defined implementation strategies, this initiative aims to strengthen indigenous capabilities, promote self-reliance and position India as a global leader in e-mobility within the next five years. This roadmap was launched on 16th July 2024 by Principal Scientific Adviser to Government of India.

ARAI is currently working on the following projects for enhancing capabilities & capacities.

- Projects supported by Ministry of Heavy Industries:
  - Development of web-based Technology Innovation Platform, viz., TechNovuus
  - Augmentation of existing facilities at ARAI, viz. Battery Safety Lab, Modular Infrastructure for V&V of ADAS and Cylinder Testing
  - Establishment of Digital Twin Centres for Emerging Automotive Systems
  - Establishment of Centre of Excellence (CoE) for Intelligent Vehicle Technology (IVT)
  - Setting up of Industry Accelerator – through ARAI-AMTIF (Section 8 company of ARAI)
- Project supported by Ministry of Electronics & Information Technology – Development of SiC based Battery Emulator (along with CDAC)
- Project supported by Ministry of Mines – Prototype Aluminium Seat Frame for passenger buses (along with Jawaharlal Nehru Aluminium Research Design & Development Centre)
- Project supported by Centre for Air Quality Management in National Capital Region and Adjoining Areas – Evaluation of Retro fitment of 2 & 3-wheeler vehicles with Electric Drive as an option for improvement in air quality in NCR
- Project supported by Ministry of New and Renewable Energy – Implementation of Pilot Projects for use of Green Hydrogen in the Transport Sector under National Green Hydrogen Mission (NGHM) – recently awarded

ARAI also undertakes projects under internal funding to enhance competencies and to meet industry's future requirements. These projects are in the areas of Material Model Card Development, Automotive Cybersecurity, ADAS, unmanned Aerial Vehicle, Dummy Kinematics, etc.



Launch of e-mobility R&D Roadmap for India

- **Model Inspection & Certification (I&C) Test Centres**

  ARAI has been identified by Ministry of Road Transport & Highways (MoRTH) for facilitating establishment of model test centres for Inspection and Certification (I&C) of in-use vehicles. Under this program, ARAI has facilitated establishment of I&C Centres in five states and is currently working in another five states. ARAI is also providing consultancy to transport department of Maharashtra state – for setting up I&C centres at forty-seven different locations across Maharashtra and also to Transport Department of Karnataka for setting up centres at two locations.

  Apart from this, ARAI has carried out audits of 13 vehicle fitness test centres of private parties in Rajasthan, six audits of Automated Testing Station (ATS) and five audits of Registered Vehicle Scraping Facility (RVSF).

- **Business Development Initiatives**
  - MoUs for collaboration in areas like green mobility, technology transfer, testing and validation, research and development, automotive control systems, ADAS technology, knowledge-sharing, etc.
  - Workshops/ seminars like Digital Twin Summit, Manak Manthan, Hydrogen – Emerging Technology Scenario for ICE Application, Lightweight Sustainable Manufacturing Solutions for Clean Energy Mobility, Grand Finale of iNTELLIMOBILITY "Driving Safe Mobility", etc.
  - Exhibited capabilities and showcased innovation at the events like Bharat Mobility Global Expo 2025, The ADAS Show 2025, Automotive Testing Expo Chennai 2024, India International Supply Chain Conference – Aero, Space & Defence (IISCC – AS&D), Nextgen Mobility Show 2024, India Energy Storage Week 2024, India EV Show, Automotive Testing Expo Europe, etc.
  - Regional centres in Bangalore, Chennai and Hyderabad for enhancing ARAI's reach to capitalize business opportunities.
  - Marketing and brand-building initiatives – periodic updates on capabilities, events, etc. to the industry and stakeholders through ARAI website and social media channels along with Press/Media.
- **Capacity Building and Augmentation**

  ARAI continues to invest in facilities, thus upgrading testing capabilities to strengthen its position and deliver superior services to the customers. During the year, facilities installed included 30 kW E-powertrain test facility for 2W & 3W, 350 kW transient dynamometer, 600 kW DC power source, Buzz, Squeak and Rattle (BSR) validation facility, 1000 kN UTM, wheel rim impact test facility, canister ageing bench for fuel vapour ageing, test facility for automotive camera monitoring system, etc. In the coming year, facilities for advanced chemistry batteries testing, cylinder testing, simulated city level test track for field level validation of ADAS/ Autonomous Vehicles, etc. are expected to become operational.
- **Systems Compliance and Quality Management**

  Following audits/assessments were successfully completed during the year.
  - Re-certification audits of ISO 9001:2015, ISO 14001:2015, ISO 45001:2018 and ISO 27001-2013 for ARAI-Kothrud, ARAI-FID and ARAI-HTC
  - Lab assessment as per ISO/IEC 17025-2017 by IAS for addition of new testing scope of ANDC (NVH) at ARAI-FID
  - Desktop Surveillance Audit of load cell calibration lab as per ISO/IEC 17025-2017 by IAS

- ARAI-HTC Photometry lab assessment as per ISO/IEC 17025-2017 by NABL
- Renewal of NTSEL Recognition for HTC-ECL test facility for Exhaust Emissions Testing of Motor Cycles (WMTC) as per TRIAS 31-J044GTR002-01
- Onsite Surveillance assessment for Testing Scope as per ISO 17025 of ARAI-HTC, Chakan
- BIS Renewal of Recognition as per LRS2020
- Scope enhancement of ISO 17025 Mechanical Testing Scope ARAI-HTC, Passive Safety Lab at ARAI-FID and Structural Dynamics Lab at Kothrud

- **Continual Improvement Initiatives**
  - Technical Support Cell set up to serve EV Start-ups, MSME component manufacturers and unorganized sector of Bus, Truck and Trailer Body builders
  - Indigenous test system developed for validation of E-powertrain system
  - Test set up designed in-house for brake assembly durability testing
  - Rig developed in-house for roof strength evaluation as per European regulation
  - Facility for Automotive Camera Monitoring System testing established
  - Car Rear Target Dummy developed in-house for verification of brake specific complex electronics system requirements
  - Launch of PLI – Auto Portal for online DVA assessment and certification
  - Procurement of glove box to enhance safety of operator during battery cell experimentation
  - Installation of CPCB compliant DG Set
  - Successful commissioning of Solar Power Plants
  - Organizing of Fire Service Week at all sites

- **Environmental Sustainability**

  As a responsible organization, ARAI recognizes that climate change is a global challenge with far-reaching consequences. Its impact transcends borders and has potential to affect communities and ecosystems, including those connected to our operations and value chain.

  ARAI contributes to each of the seventeen SDGs through its operations – either directly or indirectly. In order to enhance its contribution for environmental sustainability in a more structured and strategic manner, a dedicated Sustainability Group has been formed at ARAI. This is a significant step to facilitate safe, sustainable and smart mobility solutions.

- **Environment, Occupational Health & Safety**

  ARAI believes in working in harmony with environment and accordingly recognizes that safety and well-being of employees is essential for fostering positive and productive workplace. In-line with this, ARAI focuses on environmental protection, occupational health and safety and also endeavours for continual improvement in its processes. Some of the events organized during the year in this regard are given below.
  - Celebration of National Technology Day on 8th May 2024
  - World Environment Day on 5th June 2024
  - Observance of Swachhta Pakhwada (16th to 31st August 2024)
  - Observance of Swachhata Hi Seva (17th September 2024 to 2nd October 2024)
  - Observance of Vigilance Awareness Week (28th October 2024 to 3rd November 2024)
  - Observance of 54th National Safety Week (4th to 10th March 2025)

Observance of Swachhta Pakhwada

- **Social Initiatives**

  ARAI believes in engaging with the society to support it in the areas of community development, education and health care. During the year, ARAI supported Viklang Punarvasan Kendra (VPK) in testing of their developed products, viz. 'below knee artificial modular leg samples'. These artificial leg samples are used as a walking aid by patients with below knee leg amputation.

Observance of National Safety Week

- **ARAI – AMTIF**

  ARAI-Advance Mobility Transformation & Innovation Foundation (ARAI-AMTIF) is a Section-8 company promoted by ARAI to nurture innovation and start up ecosystem in mobility space. MHI funded Industry Accelerator program is being implemented through ARAI-AMTIF, wherein ten different technologies are being supported to develop market ready solutions in the areas of E-mobility system & sub-systems; sensors, electronics & controls; and safety components. It is also supporting startups and innovators through Startup India Seed Fund Scheme (SISFS) of Department for Promotion of Industry and Internal Trade (DPIIT).

Visit of JASIC Delegation

Visit of JAMA Delegation

Research and Development

Certification and Testing

Role in Standardization

New Facilities

Human Resource Development

Publications and Patents

Business Development

Events

ARAI Academy

ARAI undertakes research and development programs to build competencies, capabilities and competitiveness, which in turn has reflected in its consistent growth. Leveraging its inherent strengths in different automotive engineering domains, ARAI has successfully executed various government supported/ industry funded/ internally funded research projects. Some of the research projects executed during 2024-25 are listed below.

DESIGN & DEVELOPMENT

- Over-head Automated Charging Device for Battery Electric Trucks

  An Over-head Automated Charging Device (OHACD) has been designed and developed indigenously for 'Centre of Excellence for Zero Emission Trucking' (CoEZET), IIT Madras. This development caters to the requirements of Indian EV ecosystems for fast charging, i.e. 600 kW Charging Power, 1000V Voltage and 600A Current. Key features of this include:

  - Inverted pantograph charging for medium and heavy-duty truck applications
  - Suitable for all cabin sizes of Indian trucks (12 ton and above) and height ranging between 2.2 m and 4.75 m
  - Lightweight design
  - Use of single actuator instead of multiple actuators/motors for vertical and lateral movement
  - Advanced communication standard, ISO15118-20 Wi-Fi based safe and reliable wireless communication

This concept was demonstrated at Bharat Mobility Global Expo 2025 in the esteemed presence of Shri H. D. Kumaraswamy, Hon'ble Minister for Heavy Industries; Dr. Hanif Qureshi, Additional Secretary – Ministry of Heavy Industries; and Shri Sudhendu J. Sinha, Advisor, NITI Aayog.

Demonstration of OH-ACD at
Bharat Mobility Global Expo 2025

- DC Fast Charging Scalable Software Stack

  Leveraging domain expertise, ARAI has developed a customized and scalable software stack for DC Fast Charging of 2 and 3-wheeler Electric Vehicles. The developed solution was compliant to regulatory mandates, including IS 17017-25. It was with a modular architecture and was seamlessly integrated with existing vehicle platforms of the customer. This project reaffirms ARAI as a trusted enabler for clean, connected and compliant EV technologies.

- eMobility R&D Roadmap for India

  ARAI has played significant role in development of eMobility R&D Roadmap for India under an initiative of Office of the Principal Scientific Adviser (PSA) to the Government of India. As a 'Project Management Assistance Unit', ARAI coordinated deliberations of Consultative Group of eMobility (CGeM) with industry experts for finalization of the roadmap. This roadmap offers a clear and strategic framework to address challenges unique to Indian context. It recognizes multi-dimensional approach emphasizing rapid absorption of proven global technologies, their adaptation to local conditions and a market-driven ramp-up in domestic production. Additionally, it highlights

faster and simpler avenues for clean slate R&D in technologies by Start-ups, who have been able to make significant impact in the eMobility technology landscape in India. The roadmap identifies four key focus areas: Energy Storage Cells; EV Aggregates; Materials & Recycling and Charging & Refueling Infrastructure. Through well-defined implementation strategies, this initiative aims to strengthen indigenous capabilities, promote self-reliance (Atmanirbhar) and position India as a global leader in e-mobility within the next five years. This eMobility R&D Roadmap for India was launched on 16th July 2024 by Principal Scientific Advisor to the Government of India

- Digital Twin of Indian traffic scenarios for ADAS functionality verification and validation

  This project was taken up internally to generate synthetic scenarios from real-world data. For this purpose, curated synchronized data was acquired from multiple sensors mounted on the vehicle. The acquired data was pre-processed and annotated to create synthetic scenarios for ADAS functions, viz. FCW, AEB & LKA. Thereafter, integration of vehicle dynamics with scenarios generated was carried out for validation. About 20 representative scenarios, covering ADAS functionalities, like AEB, LKA, FCW, have been generated. The outcome of this project has been development of capability for creating digital twin of real-world data into synthetic world.

Generation of Synthetic Scenarios from Real-world Data

- Development of Front Cross Traffic Alert (CTA) System

  In this ongoing internal project, algorithm is being built to predict 2Ws and pedestrians on-road trajectory for developing Cross Traffic Alert (CTA). To develop this system, key events have been extracted after data processing and annotation. Further to this, pilot algorithms for ego path planning have been developed. The algorithms are being tuned and optimized currently and further to this, developed hardware will be deployed on RPT for in-lab & on-vehicle testing.

Cross Traffic Alert Use Case

- Development of Lane Departure Warning (LDW) System

  Under this ongoing internal project, Lane Departure Warning System for India specific conditions (on roads without lane markings) is being developed. Herein, AI/ML model is being developed to detect road boundaries, even for roads without lane marking. As a part of this project, data processing and annotation work has been completed to extract key events and

pilot algorithms for drivable road detection have been developed. Tuning and optimization of the algorithms is currently ongoing. Subsequent to this, developed hardware will be deployed on RPT to carry out in-lab & on-vehicle testing.

- Batteries Interoperability in Heavy Commercial Vehicle

  Government of India's emphasis on Electric Vehicles (EV) is leading to increased focus of the industry for design and development of EVs. In this context, absence of standardization of battery packs remain a major concern. To address this, ARAI is working on the project for CoEZET, IIT Madras, on standardizing entire battery pack and its connection with EVs to safeguard interests of end-users. The outcome of this project will provide details on development of an Interoperability Communication Protocol for HCV Batteries of Electric Truck and validation of its interoperability. Also, guidelines for battery pack standardization are being developed under this project.

- Battery Aadhar

  ARAI is working on development of guidelines for implementation of Battery Aadhar System complying to international standards for CoEZET, IIT Madras. It will provide comprehensive digital record of battery's life cycle – starting from raw material extraction to manufacturing, usage and recycling or disposal. With the availability of critical data on battery performance and recycling, this initiative is expected to help in our drive towards sustainability and also, support technology development and Make in India.

- Methodology for Generation of High Definition Maps

  Methodology has been developed for effective corridor scanning using ARAI's high density resolution LiDAR under an internally funded project. In this development process, capability and infrastructure for LiDAR data handling,

Actual photograph of ARAI Campus

High Definition MAP of ARAI Campus

processing and storage has been established. Under this project, algorithm, mathematical methods, process and software tool chain for generation of HD map have been developed in-house. The digital twin of road corridors in HD map format provides realistic experience to driving expert in driving simulator environment. This is required for evaluation of vehicle and tire performance on the basis of vehicle dynamics, NVH, Ride-comfort, HMI and ADAS.

- Electric Water Pump for EV Cooling System

  Objective of this ongoing project is to design and develop two models of Electric Water Pump (40W and 80W) for automotive application. In this project, design is from concept level and its performance is being simulated with 1D-3D software. Wet rotor type PMSM motor, along with controller, has been designed and developed for this application. Various parameters related to motor design, such as rotor, rotor magnets and stator have been designed and optimized for no load and steady state performance using motor performance simulation software. The optimized design has been manufactured and currently, performance validation trials are being carried out on tailor-made test rig on the prototype.

Design of Electric Water Pump

- Design and Development of 4 Cylinder Engine for CNG Application

  Under this project, components and sub-systems for a 4-valve CNG engine are being designed. While developing this, it is also being made suitable for fulfilling mechanical requirements for diesel engine operation. This development process is from concept level and includes engine thermodynamic & mechanical design layout, FEA, CFD & various engine thermal & structural system simulations, 3-D CAD model preparation, 2-D drawings, etc. Interactions with vendors/ suppliers are also being carried out for component manufacturing & support during prototype development. The developed proto engine will be tested for performance validation, followed by engine calibration & testing on test bed for meeting the desired performance targets, along with BS-VI OBD II emission requirements. Currently, proto development of components is in progress based on the finalized design.

- Conversion of Fishing Vessel Engine

  ARAI has successfully carried out conversion of fishing vessel engines from gasoline to LPG and Diesel to Hybrid Electric for Department of Fisheries, Government of Maharashtra. These developments facilitate in improving fuel efficiency and reducing carbon emissions.

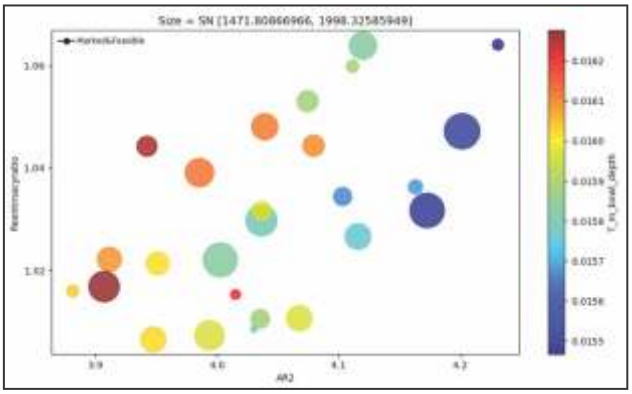
  In case of conversion to LPG, ARAI, jointly with M/s. Vanaz Engineers Ltd., has converted an existing 9.9 HP 2-stroke gasoline engine fishing vessel to run on LPG, wherein all the kit components are tested as per AIS-028. During LPG operation, this converted fishing vessel uses LPG liquid off-take cylinder system (19kg), along with ARAI patented separate pumpless (vacuum-based) lubrication system for taking care of lubrication. With regard to cutting off of LPG supply whenever engine is in turned off condition to ensure safety, cylinder

valve has an added provision of excess flow valve and also kit has vacuum mechanism. On fuel consumption front, for an hour of operation, fishing vessel required 3kg of LPG, as compared to 6 to 8 litres of gasoline. The technical and safety features of this LPG operated vessel have been successfully demonstrated.

Further, ARAI, jointly with ICAR Central Institute of Fisheries Technology (ICAR–CIFT), has developed India's first Electric/ Series Hybrid Electric fishing vessel on an existing 20HP diesel engine platform. This ground-breaking innovation marks a significant milestone in India's effort to decarbonize its marine fisheries sector, aligning with country's climate-resilient and sustainable development goals. Reduction of up to 50% in fuel consumption is possible compared to the baseline vessel configuration. Development (proof of concept), trials and performance verification of alternate energy and fuel systems have been completed successfully in the creek. This hybrid electric fishing vessel was launched and demonstrated on 26th May 2025.

- Upgradation of CNG engine to Diesel Engine meeting BS-VI Emission & OBD II Norms

  Under this ongoing project, existing 105 kW 4-valve CNG engine is being upgraded to 127 kW Diesel engine for truck/ bus application along with CRDI injection and after-treatment systems to meet BS-VI emission norms. The various activities in this project include 1-D & 3-D combustion simulation for combustion chamber, compression ratio, nozzle configuration, port swirl, recommendations/ selection of proprietary components, like FIS, EGR, TC, ETV/ ITV to meet target engine performance and engine-out emissions on WHSC cycle. Design of Experiments (DoE) has been performed to optimize some of the combustion chamber geometry parameters like aspect ratio, re-



entrancy ratio bowl depth and swirl number through 3-D combustion simulations. Presently, finalizing of the hardware combination is ongoing.

- Drive Cycle based Energy Audit and Range Estimation for Light Commercial Electric Vehicle

  Drive cycle-based energy audit and range estimation for Light Commercial Electric Vehicle has been completed. Herein, field trials were carried out and condensed drive cycle was developed for analysis. Required inputs, like air drag, battery OVC, motor efficiency map, etc. were generated through vehicle and aggregate level testing for building simulation model and it was validated with field range measurement. Further to this, vehicle energy audit and parameter sensitivity analysis was carried out for battery and motor sizing.

- Development of HCNG 3W meeting BS-VI Emission Norms

  This ongoing project is for development of HCNG 3-wheeler meeting BS-VI emission norms. Different activities being carried out for this development include baseline vehicle performance & emission assessment with CNG and HCNG, optimization of CNG vehicle for HCNG fuel with minor or without modifications in the hardware and review of FIE system and engine hardware based on baseline study and calibration. After finalization of required

modifications in the components, optimization of CNG vehicle for HCNG fuel will be carried out again. Thereafter, vehicle will be run on-road for durability and performance trials for parameters like gradeability, max. velocity and acceleration.

- Conversion of BS-III compliant Diesel Genset Engine to meet BS-IV Emission Norms

  This project was on conversion an in-use BS-III compliant diesel genset engine to meet BS-IV emission norms. Design review of cylinder head, block, piston pack and engine oil was carried out and recommendations were provided to the customer for converting CI engine to SI engine. Further to this, calibration was done by the customer on steady-state dynamometer and engine calibration was carried out by ARAI for transient performance and BS-IV emission norms. In addition to this, OBD-II trials for BS-IV were also carried out by ARAI.

- GISSMO Material Card Databank

  Complex simulation conditions, like crash require simulation of complete material behaviour, including different failure modes, damage accumulation & crack propagation. MAT_024, MAT_ADD_EROSION (GISSMO) models are part of such material representation, which are used in crash simulations. Considering this, databank of six latest materials used in BiW & reinforcement areas has been generated under this internal project. The developed material models are useful for providing accurate simulations in complex events, such as automotive crash. They take into consideration various failure criteria, different loading conditions and damage accumulation. They cover two Aluminium, four AHSS (Dual Phase Steel, HSLA Steel and CHSP Steel) having material codes (material grades) AL7075, AL6082, DP780, CHSP45R, HSLA350, HSLA420. These material cards are available in different bundles and will be useful for designers in design of lightweight, safe and crashworthy vehicle structures.

- Material Model Cards

  Plastics and composites have non-linear behaviour and hence, it is very difficult to capture the same in virtual scenario. So, in order to capture these non-linearities across anisotropic properties and for better virtual simulation, this internal project has been taken up. Under this ongoing internal project, material model cards, viz. MAT_157, MAT_187 are being developed. These were selected based on required attributes & automotive application. While developing these material model cards, competency has been generated in sample preparation by injection molding & machining process and different characterization campaigns required for isotropic and anisotropic polymer materials. The project is nearing its completion and these material cards will be available for the industry shortly.

  Similar to this project, material model cards are being developed for foam materials under another project, as they are widely used in applications requiring energy absorption and impact mitigation. Further, to cater to the increasing demand of virtual simulation of advanced and non-conventional materials in different solvers, competency is being enhanced for development of material model cards for futuristic materials.

SIMULATION BASED DESIGN SOLUTIONS

- BHARAT VECTO– Vehicle Energy Consumption Calculation Tool

  Currently, India is following Constant Speed Fuel Consumption (CSFC) approach for homologation of HDVs (>3.5t) which is not a realistic representation of real drive cycle fuel consumption and not followed globally. Physical testing of vehicular real drive fuel consumption on road is very complex, time consuming and expensive. Globally, many countries like, USA, Japan, Canada, South Korea, China and countries in Europe, have moved to simulation method to measure fuel consumption. This simulation tool provides a credible, standardized way of comparing fuel efficiency of different vehicles to regulators and stimulates innovation and competition among manufacturers to develop fuel-efficient vehicles in cost-effective manner. Europe has developed VECTO simulation method and it is part of Euro-VII.

  India is going for BS-VII in line with Euro-VII, but has no real drive cycle-based fuel consumption methodology for India. Hence, it is required to establish standardized methodology considering India specific vehicle categories and driving conditions – for both conventional vehicles and EVs to align with BS-VII requirements.

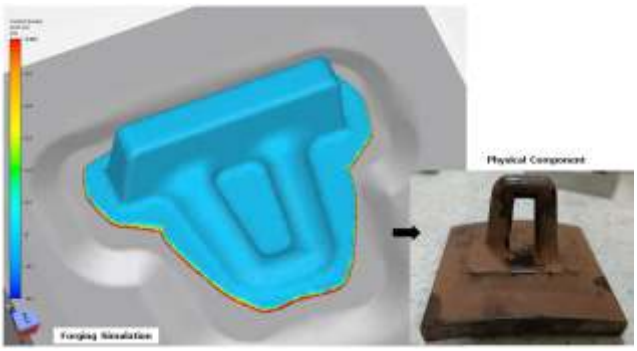
  Based on the directives of SCOE – MoRTH, ARAI has taken up, this project on "Development of Bharat VECTO" in collaboration with OEMs and SIAM for India HDVs > 3.5t for calculation of real drive fuel consumption. This project was formally launched by Shri Nitin Gadkari, Hon'ble Minister of Road Transport and Highways on 17thJanuary 2025 at Bharat Mobility Global Expo 2025, Bharat Mandapam, New Delhi.

  Under this project, field data of 19 vehicles will be acquired for 6-mission profiles which covers India vehicle categories and application. Bharat VECTO will be available for homologation methodology for calculation of real drive fuel consumption/ CO_2 emissions for buses and trucks (GVW > 3.5t). ARAI is aiming to make this tool available by end of financial year 2026-27.

- Forging Process of Lug Suspension for Defence Applications

  ARAI has successfully developed forging process for lug suspension component having application in fighter planes. In this project, process for tool development and component manufacturing was designed. The component manufactured with developed design has the required grain flow inside the component. Further, comparison of testing results of this

Launch of Bharat VECTO Project at Bharat Mobility Global Expo 2025

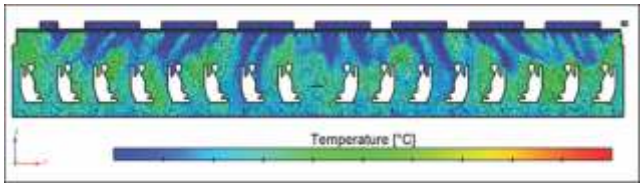


Development of Forging Process for Lug

component vis-à-vis the one manufactured using conventional process, indicates better strength, metallurgy and fatigue properties. Also, near-net forging process design has resulted in reduced post forging machining requirements and energy consumption.

- Optimization of Climate Control System

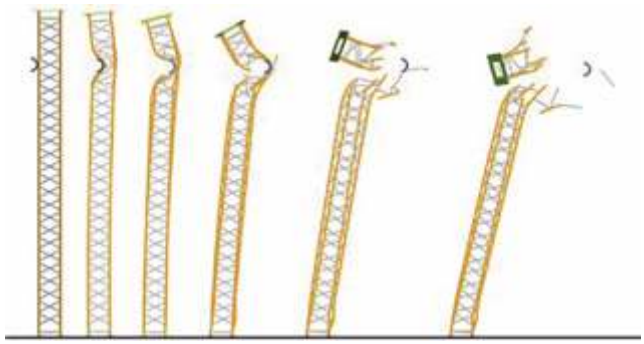
HVAC systems of Vande Bharat Coaches have been evaluated for optimization. For this purpose, HVAC systems were instrumented for data acquisition and parameters like temperature, air velocity, pressure and humidity of cabin climate were measured and analyzed to study the operational pattern. Thereafter, simulation exercise was carried out to identify the cause of condensation problem in HVAC system of coaches. This exercise gave insights on probable causes for non-uniform cooling, duct design issues, ineffective heat load management, etc. Further, based on the analysis, design changes were suggested to address the condensation problem.



Temperature Contours inside Passenger Compartment

- Competency in Frangibility Evaluation

Lattice Poles, used at airports, are mandated to be evaluated for frangibility. ARAI has developed competency in evaluating this subject as per International Civil Aviation Organization (ICAO) 9157-6 standard using FEA method. For carrying out this evaluation, ARAI has developed a test set up, which facilitates impacting of lattice pole at a fixed height with the help of a semi-cylindrical object of fixed mass and size. In this test set up, this semi-cylindrical object represents an aircraft wing.

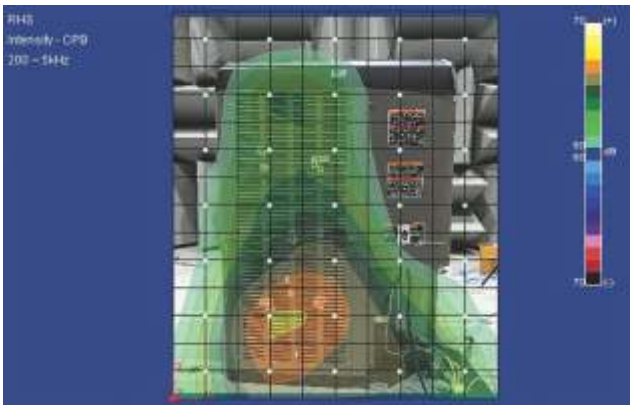


Lattice Poles Frangibility Performance Assessment

With the help of this set up, frangibility performance of the lattice pole is evaluated by measuring energy and force imparted on impactor by the pole against target values.

- Noise Reduction Solutions for White Goods

This project was on development of methodology in Hemi-anechoic Chamber for noise reduction in outdoor unit of air conditioner. To develop noise reduction solution, critical noise & vibration sources contributing to noise generation were identified, along with their probable path of transfer. Thereafter, sound intensity and transfer path analysis technique was used to analyze structure-borne and airborne sources. Subsequent to this, design solution for noise reduction was developed by modifying noise transfer pathways, viz. acoustic insulation, jacket & baffle configuration.



Transfer Path Analysis of White Goods

OTHER DESIGN & DEVELOPMENT INITIATIVES

- EV and EVSE Simulator for testing and validating DC Fast Charging of Light Electric Vehicle as per IS17017-25 standard
- Test Automation System for Vehicle in loop validation
- Competency for approval of vehicles with regard to 'Cyber Security and Cyber Security Management System' (CSMS) as per AIS-189 and 'Software Update and Software Updates Management System' (SUMS) as per AIS-190
- Normal Mode Helical Antenna (NMHA) for immunity to onboard transmitter testing at vehicle level
- Competency and rig development for Roof Strength evaluation as per ECE R29
- M100 2-wheeler meeting cold startability requirements
- Design of 4 Valve CNG Engine to meet BS-VI Emission Norms
- Design analysis of Marine Gear Box, Crank Shaft and Balancer Shaft
- Design modifications and analysis of engine sub-systems and components
- Design optimization of Intake Port of 3 Cylinder Engine
- Design and Virtual Validation of Aluminium Seat for Passenger Bus application
- Python-based vehicular exhaust emission model for city level emission inventorization
- Mobile test fixture for on-site PM measurement from a stationary vehicle
- Methods to estimate emissions originating from Wind-blown Dust and Stone Crushers & Ready-mix Concrete (RMC) batching plants

Technology Know-how Transfer of AC and DC Charging Stations

Certification and testing are ARAI's strengths as has been acknowledged by various authorities through their accreditations and recognitions as given below.

- *Accreditation by NABL for Virtual Testing (ARAI is the only test agency in India and one of the very few in the world to obtain accreditation for virtual test scope)*
- *Recognition by RDW, Netherlands as 'Technical Service Provider' to carry out CoP verification audits*
- *Accreditation of load cell calibration facility as per ISO/IEC 17025:2017*
- *Renewal of BIS Recognition as per LRS2020 for various safety components as per relevant IS Standard*
- *Successful completion of:*
  - *Re-certification audits of ISO 9001:2015, ISO 14001:2015, ISO 45001:2018 and ISO 27001-2013 for ARAI-Kothrud, ARAI-FID and ARAI-HTC*
  - *Lab assessment as per ISO/IEC 17025-2017 by IAS for addition of new testing scope of ARAI-FID ANDC (NVH)*
  - *Desktop Surveillance Audit of load cell calibration lab as per ISO/IEC 17025-2017 by IAS*
  - *ARAI-HTC Photometry lab assessment as per ISO/IEC 17025-2017 by NABL*
  - *Renewal of NTSEL Recognition for HTC-ECL test facility for Exhaust Emissions of Motor Cycles (WMTC) as per TRIAS 31-J044GTR002-01*
  - *Onsite Surveillance assessment for Testing Scope as per ISO 17025 of HTC-Chakan*
  - *Scope enhancement of ISO 17025 Mechanical Testing Scope for ARAI-HTC, PSL lab at ARAI-FID and SDL lab at Kothrud*

TECHNICAL SUPPORT CELL

Mobility sector in India is rapidly evolving with the advent of new technologies and policies. This is leading to rapid transformation in mobility landscape and creating unprecedent opportunities for all the stakeholders. Further, this is resulting in enhanced presence of MSMEs, start-ups and unorganized sector in the mobility domain. However, these companies face a major challenge in understanding of required documentation and approval process relating to CMVR type approval. So, in order to support and guide these companies, ARAI has set up Technical Support Cell (TSC). This cell serves diverse customers from EV Start-ups, MSME component manufacturers and unorganized sector of bus, truck and trailer body builders.

Technical Support Cell at ARAI facilitates customers' interaction with the experts in relevant departments at ARAI based on their specific developmental and certification requirements. It offers extensive homologation technical support to the customers and guides them through CMVR type approval process. It assists them with initial documentation and provides detailed guidance on necessary documents and drawings. TSC coordinates test schedules with testing departments, offers mock-up guidance for

various tests and conducts pre-inspection and gap analysis of prototype vehicles. This initiative will facilitate in ensuring that the customers are well-prepared and supported and in turn fostering their success.

ARAI has executed numerous projects relating to certification, testing, validation, evaluation, etc. during Financial Year 2024-25. Details of some of the projects are given below.

CERTIFICATION & TESTING PROJECTS

- Type Approval & Certification
  - Over 350 Certificates issued under PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-Drive) and Electric Mobility Promotion Scheme (EMPS)
  - Certification of India's First Road Train Vehicle
  - 80 Domestic Value Addition (DVA) Certifications under PLI Scheme
  - Strip down activity of vehicles under FAME-II
  - Over 200 CMVR Type Approval Certifications for E-20 and OBD II B compliance for various vehicle categories
  - Testing and Certification under Basic Customs Duty Exemption notification
  - Export Homologation as per EPA & UN ECE Regulations for Tractor and Automotive Engines
  - Whole Vehicle Safety CoP (WVSCoP) First Cycle and Constant Speed Fuel Consumption CoP (CSFC-CoP) certifications
  - Testing and certification of CEVs (rear-view mirror, field of vision and lighting installation) as per national and international standards
  - Advanced Emergency Braking Systems (AEBS) certification as per AIS-162
  - Lane Departure Warning System (LDWS) certification as per AIS-188
  - Certification services to tyre industry as per AIS-142
  - CoP Audits on behalf of RDW Netherlands
  - Testing for BNCAP Star Rating
  - First ISC & IUPR First Cycle for Heavy Duty Vehicles
  - In-Service monitoring on CEV as per Bharat Stage V
  - Mass Emission testing as per US EPA FTP 75 and HWFET Test Procedures
- Noise Compliance for Generator Sets
  - Diesel Genset models as per CPCB guidelines
  - Extension of Type Approval Certificates to Generator Original Equipment Manufacturers (GOEMs) as per the guidelines of Central Pollution Control Board (CPCB)
  - Conformity of Production (COP) tests for OEM & GOEM plants
  - Conformity of Production (COP) tests for Petrol Generator Sets
  - Conformity of Production (COP) tests for Gas Generator Sets

EVALUATION AND VALIDATION PROJECTS

- Evaluation of Flex Fuel Hybrid Vehicle

  Under this project, various ethanol blends (E85, E93, E100) with hydrous and anhydrous combination were evaluated to assess emission and vehicle performance with respect to MIDC legislative cycle. This evaluation was for identifying the gap in emissions, along with effect of hydrous and anhydrous ethanol with reference to Indian legislative cycle. Based on the evaluation study, observations on emission and vehicle performance with possible causes were submitted to the customer.

- Structural Validation of Suspension Assembly in Real-time Environment:

  System-level validation of Air Suspension Assembly for Commercial Vehicle was carried out using RLDA (Road Load Data Acquisition) for durability testing. Real-time simulation of Wheel Force Transducer (WFT) loads and critical strain channels was performed using time series data acquired from various test tracks. This approach enabled replication of real-world conditions. Through an iterative simulation process, drive files were generated for different test tracks, which were used for actual durability testing and validation of suspension assembly.

Structural Validation of Rear Suspension

- Structural Durability Testing of Cooling Module Assembly

  To assess structural integrity of cooling module assembly (comprising of intercooler, Charge-Air-Cooler and Radiator) for commercial vehicles, ARAI has developed an innovative methodology for multi-axial durability testing. This approach replicates real-world field conditions within a controlled laboratory environment. Field data collected from torture track testing was utilized to generate drive files for durability simulations. ARAI's custom-designed 7-actuator test rig enabled real-time simulation of time-series data in X, Y and Z directions, accurately reproducing multi-axial acceleration profiles. Additionally, critical operating parameters, such as coolant temperature and pressure, were maintained at predefined levels to mirror actual vehicle conditions.

  Durability testing was conducted over a specified duration, ensuring comprehensive evaluation of cooling performance of modules. This advanced methodology offers realistic and reliable framework for structural validation and durability assessment of cooling systems in commercial vehicles.

Structural Durability Testing of Cooling Module Assembly

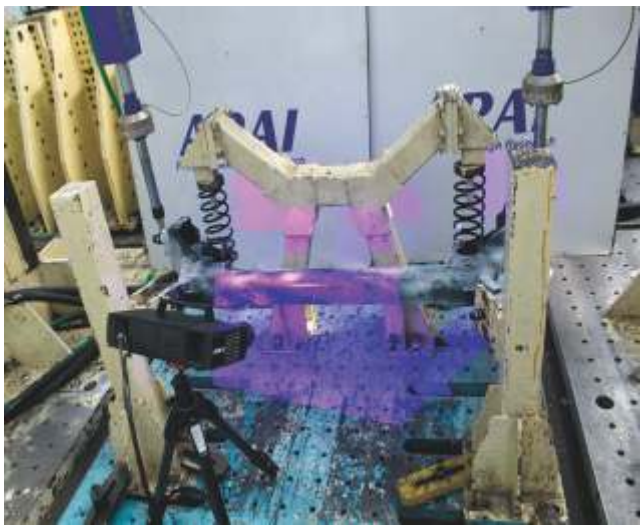
- Toe Angle and Camber Angle Verification

  As part of our commitment to precision engineering and vehicle dynamics optimization, a project dedicated to verifying the Toe angle and Camber angle of the Rear Twist Beam of passenger car under varying vehicle loading conditions was undertaken. This verification was conducted using advanced 3D scanning technology.

  The process began with a detailed scan and measurement of dimensions of Rear Twist Beam at the component level. The scanning results were then compared against corresponding CAD model data to verify

dimensional accuracy. To study the change in Toe and Camber angle during actual loading conditions, the component was mounted on a specially designed fixture that replicates vehicle's mounting geometry. 3-D scanning of entire Twist Beam under different loading conditions, viz. with and without coil spring, laden and unladen, in-phase and out of phase, were carried out. This enabled accurate measurement and verification of the Toe and Camber angles, ensuring component's performance aligns with design expectations.

This verification plays an important step to study the dimensional variation inadvertently induced during manufacturing. This initiative not only reinforces our focus on data-driven validation, but also enhances our capability to deliver robust and reliable suspension systems.



Scanning of Twist Beam

- Validation Projects for Construction Equipment Vehicles

  ARAI has demonstrated its capabilities in validation of various sub-assemblies of CEV for homologation and development. One of the projects in this area was validation of CEV cabin for Roll Over Protective Structure (ROPS) as per ISO 12117-2 for higher machine mass

Roll Over Protective Structure (ROPS) Test as per ISO 12117-2

application. To perform this validation, test rig was developed by upgrading the existing loading fixtures and actuators to support the required high-load requirements. Further, in another project, design validation of sub-assemblies of a CEV of machine mass of 50-ton for global market was carried out. Herein, test loads were validated with virtual simulation results and actual field load data. Subsequent to this, extensive testing was done involving uni-axial and bi-axial loading scenario, simulating dig-dump & loading duty cycle of the machine.

- Performance Verification of Railway Compressor

  Considering Government of India's focus on localization, railway sector is witnessing localization of various systems. However, this necessitates thorough validation of localized products and systems. To cater to this need, ARAI offers evaluation services for performance verification of such systems. One of the various projects executed in this area was on performance verification of air compressors, which support braking and HVAC functions of a train. This verification was done using the test set up, which had associated power supply circuit and instrumentation to record temperature to capture power consumption

Performance Verification of Railway Compressor

while running compressor under variable loading conditions. The system was operated for long duration in different environmental conditions to understand performance and power requirements of the compressor units.

- Validation as per Design Verification Plan (DVP)

  Various projects on validation as per Design Verification Plan (DVP) for Passenger Cars and Light Commercial Vehicles were executed at ARAI. They included over 70 tests for aggregates like leaf spring, chassis, cabin, grab handle, foot step, door, tailgate, cargo, seats, parking brake, wiper, etc. The various tests conducted under these projects included BIW front end torsion stiffness, lateral & torsional stiffness of doors, torsional rigidity of hood & tailgate, local stiffness of BIW, etc. These projects provided end-to-end solutions encompassing understanding of load cases, development of test rigs and analysis of results.

- Export Homologation of Off-Highway Vehicles

  ARAI works with various manufacturers & European notified bodies to cater to homologation requirements as per international standards/regulations. During the year, more than 35 export homologation projects relating to noise & vibration for off-highway vehicles, like compactors, excavators, loaders, etc. were executed as per European norms. In these projects, sound power levels and sound pressure levels, as per applicable ISO standards, were evaluated. Also, human exposure to whole body and hand-arm vibration was assessed as per the guidelines of ISO 2631 & ISO 5349-1 standards.

- Dynamic Stiffness Evaluation

  Torsional dynamic stiffness of Body in White (BIW) with and without sunroof, was evaluated. For this purpose, BIW was excited using four electro-dynamic shakers in Z direction at front and rear strut locations to measure positive vertical vehicle direction vibration response at

Tailgate Stiffness Measurement

Torsional Dynamic Stiffness Evaluation of BIW

all four strut locations. Then accelerations were calculated from measured transfer functions and torsionally acting unit forces. Based on this evaluation, displacements were arrived at, for calculating the curve progression of global torsional stiffness of BIW.

- Onsite Evaluation of Open Plan Office

  This project was for evaluating different room accoustic parameters for open plan offices of an MNC in different cities. Under this project, room acoustic parameter evaluation was carried out as per ISO 3382-Part 3. This included comparative study on Reverberation Time (RT), Speech Transmissibility Index (STI) and Speech Privacy Distance for different zones with different acoustic material treatments, like acoustic baffles, wall panels and clouds. Further to this, suggestions were given for achieving better room acoustic performance in all office zones.

Acoustic Parameter Evaluation of Rooms in Open Plan Office

- Sound Quality Evaluation

  Sound Quality (SQ) metrics are significant in deciding perceived sounds in silent vehicles and also for non-automotive components. ARAI provides sound quality evaluation services to various industries using its Hemi-anechoic chamber facility with background noise of 15 dBA. With the help of this facility, ARAI has executed various projects on evaluation of

Sound Quality Assessment of Electric Vehicle Sunroof Assembly

sound quality metrics of EV DC-DC charger, sunroof assembly and electric toothbrush. The different parameters evaluated in these projects included loudness, sharpness, roughness, fluctuation strength, tonality, pitch and prominence ratio.

- Door Mirror Vibrations Improvement

  This project was to identify root cause of mirror vibrations through experimental modal model and improve the design. Herein, modal testing in free-free and constrained condition was performed at different stages of mirror construction, i.e. base frame, housing, scalp, housing cover, side repeater, glass holder, glass,

Experimental Modal Testing of Door Mirrors

motor folding, actuator and full model. Thereafter, test to FE correlation was performed at each stage with correlation accuracy of 1st five natural frequencies within ± 10 Hz. Vibrations of structure in the speed range of 100 kmph were optimized after evaluation of dynamic properties viz. eigen values, eigen vectors and damping ratios at every stage of modal testing.

MEASUREMENT AND ANALYSIS PROJECTS

- Assessment of Energy Consumption and Estimation of CO_2

  ARAI has undertaken a Project on assessment of energy consumption and estimation of CO_2 emissions for Heavy Duty Vehicles using differentiated products of an oil company through simulation approach. In this project, base vehicle tests were carried out for generation of required inputs, viz., real-world usage pattern, drag, CSFC and coast down values required for model building. Also, component (engine, gearbox & differential) level performance and efficiency map were measured with differentiated oil & fuel combinations. With the generated input data, vehicle simulation model was built in VECTO/ GT DRIVE and validated with measured real drive fuel consumption. This model is useful to predict real drive fuel consumption at vehicle with any differentiated oil or fuel grades by providing specific component level efficiency map and also to predict vehicle level fuel consumption. Energy audit and tank-to-wheel efficiency estimation is also completed in this project.

- Measurement of Wheel Lashing Loads on Passenger Vehicle during Transportation

  This project focused on quantifying the wheel lashing loads experienced by an imported passenger vehicle during transportation within the container, across Indian road conditions. To facilitate accurate data collection, the vehicle was equipped with sensors, such as Wheel Force Transducers (WFTs), Accelerometers, and Camera system. Measurements were conducted for more than 4,000 kilometres along designated routes across India. Data was validated and analysed in terms of statistical and spectral parameters.

Instrumented Vehicle inside Container

- Comprehensive Validation of Newly Developed Bogie Suspension for Heavy-Duty Tipper Vehicle

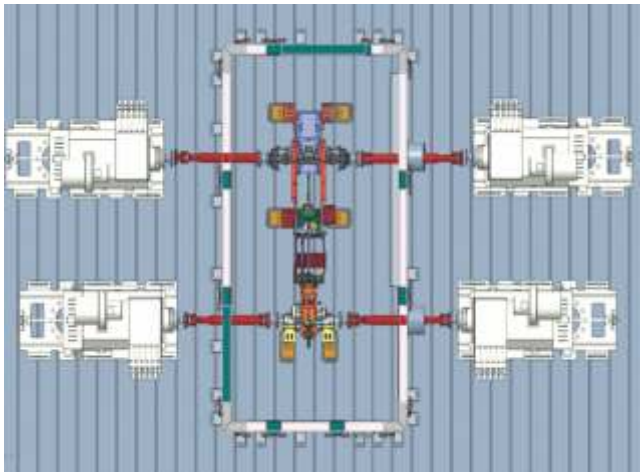
  The newly developed bogie suspension system for a heavy-duty tipper vehicle underwent thorough validation through Finite Element (FE) analysis, Multi-Body Dynamics (MBD) simulation and Service Load Data Acquisition (SLDA). Key components of the suspension such as V-stay, radius rod, bump stopper, and bolster bracket were instrumented with strain gauges to measure load versus strain characteristics in laboratory conditions across relevant directions.

  Subsequently, SLDA was conducted on an instrumented vehicle at the designated coal mining site to capture real-world duty cycle data. The collected data was validated and analyzed to finalise methodology for durability. Final durability assessments of critical components

like V-stay and radius rod were performed using FE analysis. This integrated approach provides robust methodology for complete validation and durability testing of bogie suspension system, ensuring its suitability for demanding operational environments.

- NVH Assessment of EV Tractor

  NVH assessment was carried out for a 4 WD EV Tractor Driveline. For this assessment, both front and rear axles of tractor were rotated at different speeds to maintain constant vehicle velocity test condition as per vehicle configuration. Then load was applied on the drivetrain with the help of dynamometers to measure noise. Along with this, gear whine, noise from hydraulic system and corresponding valves were also measured. Further, contribution of different gears in overall noise was identified and measured.



Layout of EV Tractor in Powertrain Test Bed

- Clean Air Project in India (CAP India)

  ARAI has successfully completed Clean Air Project in India (CAP India), which was supported by The Swiss Agency for Development and Cooperation (SDC). Under this project, chemical transport modelling-based source apportionment of fine particulate matter ($PM_{2.5}$) and future scenario analysis was conducted. WRF-Chem model with locally developed emission inventory was used for assessment of source contributions from different polluting sectors in the Pune region. In addition to this, pilot project on "Retro-fitment of older IC engine based two wheelers with electric drive" has been carried out in association with the industry partner. Two air pollution sensitization events at two public places in Pune city were also organized along with TERI, PMC and MPCB.

- Development of Emission Inventories and Source Apportionment Studies

  Emission inventory and source apportionment studies for Angul-Talcher, Rourkela, Kalinga Nagar–Jajpur Road, Bhubaneswar-Cuttack and Balasore regions for Odisha State Pollution Control Board (OSPCB) were successfully completed. The exercise involved chemical analysis of pollutants (including $PM_{2.5}$, PM_{10}, gases and VOC), source apportionment of $PM_{2.5}$ and PM_{10}, development of baseline emission inventory, dispersion modelling and analysis of future scenarios. Further to this, action plan for control of air pollution in these cities was prepared and submitted to OSPCB.

  Similar study is being undertaken for Gurugram, Sonipat and Panipat regions for Haryana State

Field Work for Development of Emission Inventories and Source Apportionment Studies

Pollution Control Board (HSPCB). Further, emission inventories are being developed for the project supported by Centre for Development of Advanced Computing (C-DAC), Pune under National Supercomputing Mission (NSM) for Urban Modelling, which aims at developing high resolution emission inventories and conducting dispersion modelling analysis for four Indian cities, namely Bengaluru, Pune, Ahmedabad and Nagpur.

- Measurement of Undiluted Exhaust Emissions and Determination of Elemental Carbon (EC)

  Project on measurement of exhaust emissions and determination of diesel particulate matter (DPM), Noise, Vibration and for operators' field of view assessment before commissioning of vehicle in the underground mines was successfully completed. Under this project, measurements were carried out at the site as per the guidelines defined by Directorate General of Mines Safety (DGMS) for diesel vehicles operated in the underground mines.

Other Validation & Evaluation Assignments

- Functional Safety assessment of Auto-Balancing ECU for a 2-wheeler
- Assessment of Real-world Driving Emissions (RDE) of in-use BS-VI Diesel and CNG Heavy Duty Vehicles
- Assessment of B100 fuel on CPCB II Compliant Genset Engine
- Assessment of Flex Fuel Hybrid Brazilian vehicle in Indian scenario
- Evaluation of Flex Fuel Retro-fitment kit on 4-wheeler (E20 and E85 fuel)
- Evaluation of Iso-butanol blend with Diesel on LCV and its impact on tailpipe emission
- Evaluation of multifunction fuel additive on emission and fuel economy as per PCRA procedure, along with vehicle performance
- Establishing Deterioration Factors (DF) for Diesel Passenger Car as per R154.02 regulation
- HVAC testing and validation of truck cabins
- Durability testing of Railway/ Metro Bogie Frame & Axle Box, Reinforcement Couplers as per ISO/ IEC 17025 accreditation
- Vibration testing of Electronic & Mechanical Components as per ISO/IEC 17025 accreditation
- Fatigue testing of Bus-bars for EVs, Synchronous Belt, Ammunition Warhead
- Wind Pressure test on Noise Barrier
- Impact isolation class evaluation of raised floor tiles
- Noise evaluation of ducted Air Conditioner in Hemi-anechoic Chamber
- Sled test on Ejection Seat (defence application)
- ADAS data acquisition
- Developmental test of Underground Mining Truck for export homologation
- Load capacity evaluation of e-Trolley for use at the airport
- Evaluation of fuel consumption for Wheel Loaders and Excavators
- Dynamic testing of RCC structure
- Environmental testing and validation of battle tank's secondary engine
- Vibration test on UAV as per MIL 810 standard for structural validation
- Strain and acceleration measurement of 30 mm Turretee Gun during firing trials
- Testing and validation of High-speed Train Components as per IEC61373:2020
- Evaluation of Climate Control System of High-speed Train Coach
- Fuel compatibility test on Metals as per SAE J1747
- Particulate Matter chemical speciation

Role in Standardization

ROLE AND CONTRIBUTION IN VARIOUS NATIONAL AND INTERNATIONAL COMMITTEES/ FORUMS

Automotive Industry Standards Committee (AISC)

- Secretariat Services to AISC
- Organized and participated in one meeting of AISC and several meetings of Technical Panels working under AISC

CMVR – Technical Standing Committee

- Technical Secretariat Services to CMVR-TSC
- Participated in 2 meetings of CMVR-TSC

Standing Committee on Implementation of Emission Legislations (SCoE)

- Technical Secretariat Services to SCoE
- Participated in 2 meetings of SCoE

CPCB Standing Committee

- Technical support to Central Pollution Control Board Standing Committee on Emissions (CPCB-SCOE)
- Contribution in formulation and upgradation of standards on Emission for Power Generating Set Application as a Member of SCOE
- Contribution in formulation of standards and certification related to Emission for Retrofit Emission Control Devises (RECDs) for In-use DG sets
- Contribution in formulation and upgradation of standards on Noise as a Member of CPCB – SCOE

Bureau of Indian Standards (BIS)

- Participation in various Sectional Committees of BIS
- Chairmanship of five TED (Transport Engineering Department) Sectional Committees of BIS

WP. 29

- Technical Secretariat Services for National Committee on WP.29 matters and Core Group on WP.29 related activities
- ARAI participated in Technical Sessions of WP.29 and GR meetings during the year as a member of various Indian delegations.
- Coordinated WP.29 India sub-group activities on GRPE, GRE, GRBP, GRSP, GRSG, GRVA

FORMULATION OF SAFETY STANDARDS

NEW AIS, REVISED AIS AND AMENDMENTS TO EXISTING AIS

New AIS

1. AIS-157A: Type Approval of Hydrogen Powered CEV (Liquid/Compressed Gaseous Hydrogen)
2. AIS-162: Type Approval of motor vehicles of categories M2, M3, N2 and N3 with regard to Advanced Emergency Braking Systems (AEBS)
3. AIS-178: Provisions for Adapted Vehicles of categories L1, L2, L5M and Tricycles
4. AIS-180: Specific requirements for motor vehicles intended for the carriage of Dangerous and Hazardous Goods with regard to their constructional features
5. AIS-181: Approval of Tank vehicles with regard to Rollover Stability
6. AIS-182: Approval of vehicles with regard to ISOFIX anchorage systems ISOFIX top tether anchorages and i-Size seating positions
7. AIS-183: Type Approval requirement for Three-wheeled Moped of L1-1 category
8. AIS-186: Approval of motor vehicles with regard to the Blind Spot Information System for the Detection of Bicycles
9. AIS-187: Approval of motor vehicles with regard to the Moving Off Information System for Detection of Pedestrians and Cyclists
10. AIS-188: Lane Departure Warning Systems (LDWS)
11. AIS-189: Approval of vehicles with regards to Cyber Security and Cyber Security Management System and Interpretation Manual for AIS-189 on Cyber Security and Management Systems (CSMS)
12. AIS-190: Approval of vehicles with regards to Software Update and Software Updates Management System and Interpretation Manual for AIS-190 on Software Updates and Management Systems (SUMS)
13. AIS-191 (Part 1) Approval of vehicles with regard to Emergency Lane Keeping System (ELKS)
14. AIS-192: Event Data Recorder
15. AIS-193: Automotive Vehicles - Steering Equipment's - Method of Evaluation
16. AIS-195A: Hydrogen Powered Construction Equipment Vehicles
17. AIS-201: Full Frontal Collision
18. AIS-204: Requirements for School Vans
19. AIS-206: Type Approval of Hydrogen Powered L Category Vehicles (Compressed Gaseous Hydrogen)

Revised AIS

1. AIS-100 (Rev.1): Requirements for the Protection of Pedestrian and other Vulnerable Road Users in the event of a collision with a motor vehicle
2. AIS-101 (Rev.1): Requirements for the Protection of Fuel System in the event of Rear Impact of a motor vehicle

Amendments and Corrigendum to Existing AIS

1. Corrigendum 1 to AIS-001 (Rev.2) (Part 1): Automotive Vehicles - Approval of Devices for Indirect Vision intended for use on A, M, N Category and L Category with Bodywork Vehicles - Specification
2. Amendment 1 to AIS-002 (Rev.2) (Part 1): Automotive Vehicles - Approval of Devices for Indirect Vision intended for use on L category

with bodywork vehicles, M and N category - Installation Requirements

3. Amendment 13 to AIS-007 (Rev.5): Information on Technical Specifications to be submitted by the vehicle manufacturer
4. Amendment 4 to AIS-038 (Rev.2): Specific requirements for Electric Power Train of Vehicles Part I: Requirements of a vehicle with regard to specific requirements for the Electric Power Train Part II: Requirements of a Rechargeable Electrical Energy Storage System (REESS) with regard to its safety
5. Amendment 3 to AIS-039 (Rev.1): Electric Power Train Vehicles – Measurement of Electrical Energy Consumption
6. Amendment 2 to AIS-040 (Rev.1): Electric Power Train Vehicles - Method of Measuring the range
7. Amendment 1 to AIS-041 (Rev.1): Electric Power Train Vehicles measurement of Net Power and the Maximum 30 Minute Power
8. Amendment 4 to AIS-046: Automotive Vehicles - Hand-Holds for Three, Four and more than Four Wheeled Motor Vehicles – specification
9. Amendment 1 to AIS-049 (Rev.1): Electric Power Train Vehicles - CMVR Type Approval for Electric Power Train Vehicles
10. Amendment 3 to AIS-071 (Part 2): Automotive Vehicles - Control Location and Operation requirements
11. Amendment 5 to AIS-093: Code of Practice for Construction and Approval of Truck Cabs & Truck Bodies
12. Amendment 9 to AIS-113: Code of Practice for Type Approval of Trailers/ Semi-Trailers of categories T2, T3 and T4 being towed by motor vehicles of categories N2 and N3
13. Corrigendum 1 to Amendment 5 to AIS-119 (Rev.1): Specific Constructional requirements for Sleeper Coaches
14. Amendment 5 to AIS-123 (Part 1): CMVR Type Approval of Hybrid Electric System intended for Retro-fitment on vehicles of M and N Category having GVW ≤ 3500 kg
15. Amendment 2 to AIS-123 (Part 2): CMVR Type Approval of Hybrid Electric System intended for Retro-fitment on vehicles of M and N Category having GVW exceeding 3500 kg
16. Amendment 4 to AIS-123 (Part 3): CMVR Type Approval of Electric Propulsion Kit intended for conversion of vehicles for Pure Electric Operation
17. Amendment 9 to AIS-137 (Part 3): Test Method, Testing Equipment and related procedures for Type Approval and Conformity of Production (COP) Testing of M and N category vehicles having GVW not exceeding 3500 kg for Bharat Stage VI (BS-VI) Emission Norms as per CMV Rules 115, 116 and 126
18. Amendment 2 to AIS-142: Evaluation of Tyres with regard to Rolling Sound Emissions and/or to Adhesion on Wet Surfaces and/or to Rolling Resistance
19. Amendment 1 to AIS-149: Conformity of Production (CoP) procedure for verifying compliance to Constant Speed Fuel Consumption Norms for vehicles with GVW/ GCW exceeding 3.5 tonnes
20. Amendment 1 to AIS-151: Automotive Vehicles Uniform provisions concerning the approval of vehicles of categories M1 and N1 with regard to Braking
21. Amendment 2 to AIS-157: Safety and Procedural requirements for Type Approval of Compressed Gaseous Hydrogen Fuel Cell Vehicles
22. Amendment 5 to AIS-160: Safety requirements for Construction Equipment Vehicles(s)

23. Amendment 6 to AIS-160: Safety requirements for Construction Equipment Vehicles(s)
24. Amendment 1 to AIS-174: Specific requirements for Electric Power Train Construction Equipment Vehicle(s)
25. Amendment 2 to AIS-174: Specific requirements for Electric Power Train Construction Equipment Vehicle(s)

AIS Standards Finalized (To be released in the Year 2025-26)

1. AIS-008 (Rev.3): Lighting Installation and Signalling Devices for four wheeled vehicles
2. AIS-009 (Rev.3): Lighting Installation and Signalling Devices for two and three wheeled vehicles
3. AIS-031 (Rev.1): Approval of Large Passenger Vehicles with regard to the Strength of their Superstructure
4. AIS-034 (Rev.3) (Part 1): Filament Light Source
5. AIS-034 (Rev.3) (Part 2): Gas Discharge Light Source
6. AIS-098 (Rev. 1): Offset Frontal Collision
7. AIS-099 (Rev. 1): Side Impact Provisions
8. AIS-115 (Rev. 1) (Part 1): Driver – Perceived Noise Level of Agricultural Tractor & Forestry Tractors
9. AIS-115 (Rev.1) (Part 2): Permissible Sound level at Bystander of Agricultural Forestry Tractors
10. AIS-185: Advanced Emergency Braking Systems for M1, N1 category vehicles
11. AIS-198: TA of Light Signalling devices and systems for power-driven vehicles
12. AIS-199: TA of Road Illumination devices (Lamps) and systems for power driven vehicles
13. AIS-200: TA of Retro-Reflective devices and markings for power driven vehicles and their trailers
14. AIS-202: Two Three-Wheeler Quiet Road Transport Vehicles (2-3 W QRTV)
15. AIS-205: On-board weighing in commercial vehicles
16. AIS-213: Procedure for the measurement of emissions and fuel consumption with air-conditioning system in operation for M1 category vehicles.

COOPERATION WITH BUREAU OF INDIAN STANDARDS (BIS)

Indian Standards on automotive safety components and systems are formulated in various TED (Transport Engineering Department) Sectional Committees of BIS. Transformation/ adaptation of AIS into IS is one of the major activities in TED. Additionally, ARAI provides technical guidance/ expertise to BIS and also, has the responsibility of Chairmanship of following TED Sectional Committees.

- TED 4: Automotive Braking Systems, Vehicle Testing, Steering and performance Evaluation Sectional Committee
- TED 22: Transport Tractors, Trailers and Industrial Trucks
- TED 26: Automotive Vehicles Running on Non-Conventional Energy Sources
- TED 29: Passive Safety Crash Protection Systems
- TED 34: Springs and Suspension Systems Sectional Committee Sectional Committee

TED 26: Sectional Committee, chaired by ARAI, has been recognised with 'Committee of the Year' award

CMVR AND ITS IMPLEMENTATION

CMVR Technical Standing Committee and Standing Committee on Emissions (SCoE)

CMVR-TSC and SCoE have identified following subjects of national importance for formulation of Policy/Norms/Standards and their implementation:

- Provisions for accessibility for people with reduced mobility in Type-I Buses
- BNCAP 2.0
- Automotive lighting glare
- Review of enhanced safety provisions for E-Rickshaw
- Advanced Driver Assistance Systems
- On-board weighment in Commercial Vehicles
- Battery durability
- Bharat Stage VII Emission Norms

INTERNATIONAL COOPERATION AND HARMONIZATION OF NATIONAL STANDARDS

ARAI provides Technical Secretariat for National Committee on WP.29 matters and Core Group on WP.29 related activities. India became signatory to 1998 Agreement under UN ECE as part of our commitment to harmonization of automotive regulations. Under this agreement Global Technical Regulations (UN GTRs) are being formulated. During this year, India has voted in favour of following documents in 193rd session of WP.29 held during 25th to 28th June 2024.

- Amendment 3 to UN Global Technical Regulation No. 9 (Pedestrian safety)
- Amendment 1 to UN GTR No. 21 (Determination of Electrified Vehicle Power (DEVP))
- Amendment 1 to UN GTR No. 22 (In-vehicle Battery Durability for Electrified Light-Duty Vehicles)
- Amendment 1 to UN GTR No. 24 (Laboratory Measurement of Brake Emissions for Light-Duty Vehicles)
- Corrigendum 1 to Amendment 1 to UN Global Technical Regulation No. 13 (Hydrogen and Fuel Cell Vehicles)
- Amendment 4 to Mutual Resolution No. 1

Participation in Technical Sessions of WP.29 – Highlights

During the year, India participated in several technical sessions of WP.29, its subsidiary working parties and Informal Group meetings. Secretariat at ARAI provided technical and other support to these national delegations for attending sessions at United Nations, Geneva, Switzerland.

TYPE APPROVAL CERTIFICATION

ARAI has carried out Type Approval and Certification for several safety components and emission norms as per safety standards and emission norms for different categories of vehicles. Also, it has initiated work for safety norms to be implemented in 2025-26. Major highlights are given below.

Key Safety Standards and Emission Norms Implemented in 2024-25:

- Safety Standards:
  - Two Wheeled Combi Vehicles
  - Requirements of Construction Equipment Vehicles fitted with Electric Power Train
  - Stage 2 Safety Norms for CEV
  - Rolling Sound of C1, C2 and C3 Category Tyres
  - Revised Standards for Devices for Indirect Vision or Rear-view Mirrors
- Emission Standards:
  - CEV V Emission Norms and Stage 2 Noise Limits

Notifications for Implementation of Safety Standards and Emission Norms in future (after 31st March 2025):

- Safety Standards:
  - Environment Protection (End-of-Life Vehicles) Rules, Extended Producer Responsibility (EPR)
  - Mandating Air Conditioning (AC) in Truck Cabin
  - Safety Belt Reminder Standards for rear occupant seat for M1
  - Cancellation of Body built Buses self-certification and clarifying need for type approval of body-built buses
- Emission Standards:
  - OBD Stage II-B Thresholds for BS-VI vehicles for 2/3 W Motor Vehicles
  - Implementation of TREM V for Agricultural Tractors

Note: Please refer concerned AIS and relevant notification for applicability of the standard to the vehicle category.

TED 26 Sectional Committee, Chaired by ARAI, recognized with 'Committee of the Year' Award

New Facilities

30kW E-powertrain Test Facility

350 kW Transient Dyno

Canister Ageing Bench for Fuel Vapour Ageing

Advanced Acceleration Sled Test Facility

Interior Fitting and Steering Safety Test Facility

Airbag Test Facility

Ammonia & Multi Component Measurement System

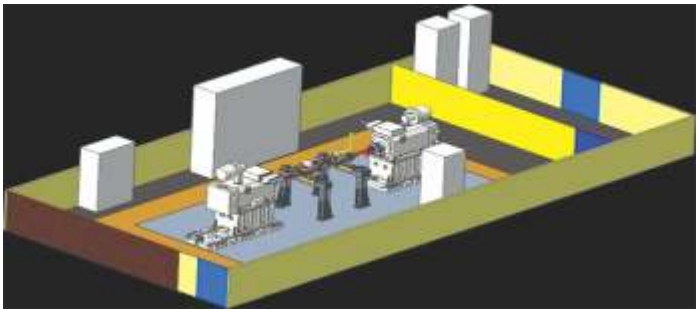
Harmonics and Flicker Emission Measurement Setup

UTM 1000 kN

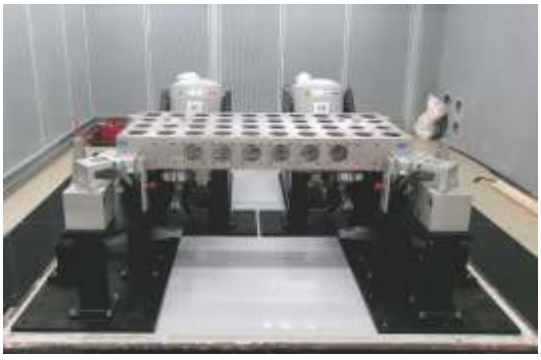
HF MAST

Wheel Rim Impact Test Facility

600 kW DC Power Source



400 kW 2 Dyno Test Rig (Upcoming Facility)



Buzz, Squeak and Rattle Validation Facility

High Energy Impact Test (HEIT) Facility (Upcoming Facility)

Anti-vibration Table

At ARAI, we believe that committed and motivated human capital is the core strength, which ensures in maintaining the legacy of achieving goals year after year. We recognize importance of aligning our employee-related strategies with ever-changing aspirations of our human capital. So, we focus on initiatives oriented on employee motivation & engagement, their well-being and professional development. We implement impactful programs to create the workplace where everyone feels valued and empowered. Through our Human Resource Management System (HRMS), we provide our employees with various HR services in a seamless digital mode through web and mobile application.

Employee Well-being

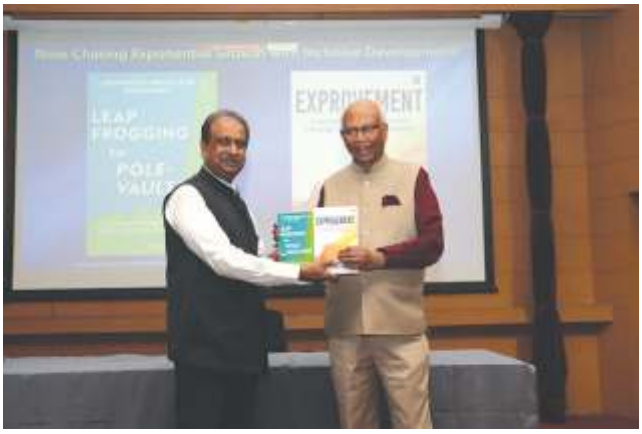
We believe that sustainable future starts with health. So, employee well-being is a key priority and we are committed to it with strong focus on physical, mental and social wellbeing of employees. Through our training programs, we focus on empowering employees with skills to meet the health needs of tomorrow. Our initiatives for employee well-being include health insurance policy, group term life insurance policy, safety shoes and uniforms. During the year, training programs on fire safety, first aid and awareness sessions on TB (for personnel engaged in housekeeping and gardening) were conducted in addition to functional, technical and behaviour trainings.

Learning and Development

Talent is a key priority for us. We offer an innovative work environment for our employees to excel. We believe that investing in our employees will ultimately result in a stronger, effective and more valuable human resource. We, therefore, provide best learning experiences and training programs. Every year, a carefully designed training calendar is shared with the employees, enabling them to select functional, technical and behaviour trainings – virtual or in-person, based on their requirements. During the year, a total of 29,082 person-hours of training was imparted to the employees.

Employee Engagement

We believe in the power of 'togetherness' and so, we organize various programs for keeping our employees motivated and engaged. We organize plethora of events, which help in nurturing a sense of belonging. During the year, activities on Annual Day, Independence Day, Republic Day, International Women's Day, World Environment Day, National Safety Week, National Vigilance Week, Hindi Pakhwada, Swachhata Pakhwada, Ek Ped Maa Ke Naam and various sporting events were organized. One of the initiatives was organizing of the address by distinguished scientist Padma Vibhushan Dr. Raghunath Mashelkar on the occasion of National Technology Day. Also, to capture the pulse of activities, innovations and spirit; an in-house magazine, viz. ARAI Spandan, was launched at the hands of Dr. Reji Mathai, Director – ARAI during Annual Day celebrations held on 10th December 2024. Further, during the Hindi Pakhwada conducted from 14th to 28th September 2024, various competitions were organized.



Dr. Raghunath Mashelkar addressed ARAI Employees on National Technology Day

Papers Published/ Presented

- 'Lightweight Forging - A way Forward' by A. R. Kumbhar in June 2024 at IAMS-Automotive Manufacturing Summit 2024, Pune
- 'Role of Manufacturing Simulation in Product Development Cycle and future demands of Polymers' by Kinsuk Koley in September 2024 at 'Polymer 360' Conference, Pune
- 'Crash Safety of vehicle and Bharat NCAP - CAE based Certification' by Nachiket A Kulkarni in November 2024 at Crash Safety of Vehicle and Bharat NCAP, Pune
- 'Electromagnetic Interference measurement study from various Electric Drive Train' by Abhijit B Mulay, Gokul M and Jinay M Patel in December 2024 at SAEINDIA International Mobility Conference (SIIMC 2024), New Delhi
- 'Effect of vibrational abuse on the electrodes of Nickel Manganese Cobalt (NMC) and Lithium Iron Phosphate (LFP) 18650 cells' by Ms. Asmita Manwatkar, Sachin Pandit, Ms. Medha Jambhale and Nitin Mahagaonkar in December 2024 at SAEINDIA International Mobility Conference (SIIMC 2024), New Delhi
- 'Analyzing the Effect of Silicon Carbide and Flyash Reinforcement on the Phase Morphology and Mechanical Properties of 7075 Aluminum Alloy produced through Stir-Casting Process' by Ms. Asmita Manwatkar, Ms. Medha Jambhale and Nitin Mahagaonkar in December 2024 at SAEINDIA International Mobility Conference (SIIMC 2024), New Delhi
- 'Enhancing Child Safety in India via introduction of Bharat NCAP' by Divyan Jaju in December 2024 at TUV SUD Protection of Children in Cars Conference, Munich, Germany
- 'Static and Dynamic Study of Camera Monitoring System (CMS) in replacement to Rear View Mirror in Indian Scenario' by Dr. B V Shamsundar, Ms. Sonali Tambolkar and Ankit Sinha in December 2024 at SAEINDIA International Mobility Conference (SIIMC 2024), New Delhi
- 'Hydrogen-enriched Compressed Natural Gas transition for Low-Emission operation in Stationary Genset Engines' published by Debjyoti Bandyopadhyay, Prasanna S. Sutar, Shailesh B. Sonawane, Sandeep Rairikar & Dr. S S Thipse from ARAI; Shubham Tule, Yogesh Aghav & Krishna Lakshminarasimhan from Kirloskar Oil Engines Ltd.; and Sauhard Singh, Sumit Kumar Mishra, Tapan Bera & Rajesh Badhe from Indian Oil Corporation Ltd. in Journal of Sustainability for Energy
- 'An Experimental Investigation of Unregulated Pollutants from a Multi-Cylinder Diesel Engine: Impact of Ethanol Blending on Aldehyde Emissions' published by Shailesh Sonawane, Ravi Sekhar, Arundhati Warke, Dr. S S Thipse, S. D. Rairikar and Jeetendra K. Purohit in Journal Européen des Systèmes Automatisés

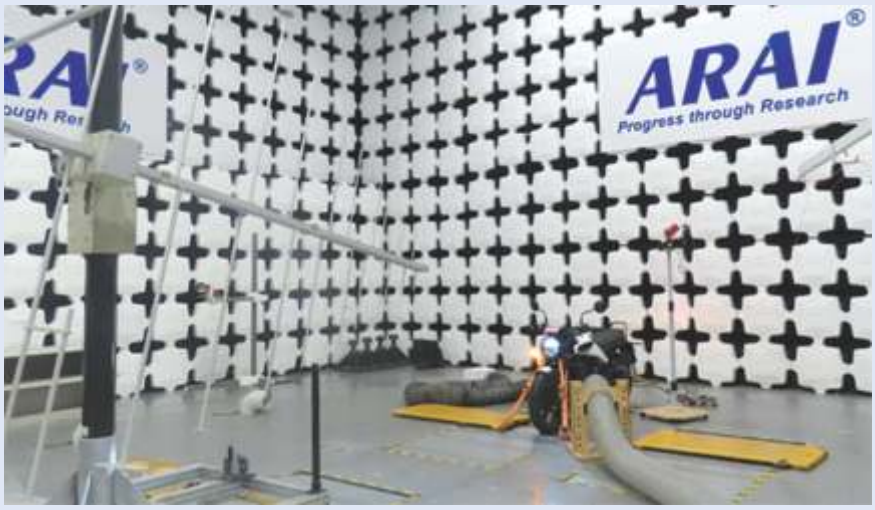
Technical Reports Published

- Emission Inventory and Source Apportionment Study of Bhopal City in Madhya Pradesh
- Emission Inventory and Source Apportionment Study of Angul Region in Odisha
- Emission Inventory and Source Apportionment Study of Talcher Region in Odisha
- Emission Inventory and Source Apportionment Study of Rourkela Region in Odisha
- Emission Inventory and Source Apportionment Study of Kalinganagar-Jajpur Region in Odisha
- Emission Inventory and Source Apportionment Study of Bhubaneshwar Region in Odisha

- Emission Inventory and Source Apportionment Study of Cuttack Region in Odisha
- Emission Inventory and Source Apportionment Study of Balasore Region in Odisha
- Chemical Transport Modelling based Source Apportionment of $PM_{2.5}$ and Future Projections over Pune Region
- Pilot Project: Retro-Fitment of 2 Wheelers with Electric Drive

Patents granted in 2024-25 by The Patent Office, Government of India

- An Apparatus for EMC testing of an Antilock Braking System for a Two–Wheeler (Inventors: Abhijit Mulay and Anand Deshpande)
- A System facilitating AC charging of a light electric vehicle and a method thereof (Inventors: Anand Deshpande, Abhijit Mulay and Sreekumar Uthaman)



Apparatus for EMC Testing of Antilock Braking System for a Two–Wheeler
(Patent granted by The Patent Office, Government of India)

Launch of ARAI Spandan (an in-house magazine)

New Services, Capabilities & Products

- Databank of Material Model Cards for damage simulation
- Export Homologation of Agricultural Seat as per EU 1322/2014
- Export Homologation of Off-Highway Vehicles as per International Standards/ Regulations
- Certification under 'Electric Mobility Promotion Scheme (EMPS) 2024' and 'PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme'
- Consultancy for EMC vehicle level debugging
- EMC, Electrical and Environmental validation for AAT Products for PLI Automobile & Auto Components
- Cybersecurity requirements-verification for digital key system
- Advanced Emergency Braking System (AEBS) testing as per AIS-162
- Lane Departure Warning System (LDWS) Testing as per AIS-188
- BSIS testing as per AIS-186
- MOIS testing as per AIS-187
- Advanced Driver Distraction Warning (ADDW) testing as per EU2019/2144
- Intelligent Speed Assistance System (ISA) testing as per EU2021/1958
- Driver Drowsiness and Alertness Warning System (DDAWS) testing as per AIS-184 and EU2019/2144
- RRR calculation as per AIS-129 Part 2
- Evaluation of fuel consumption for Wheel Loaders and Excavators
- Developmental test of Underground Mining Trucks for export homologation
- Knee mapping sled tests as per various NCAP protocols
- Occupant Restraint System evaluation through acceleration sled
- Canister Ageing by fuel vapour as per AIS 175 WLTP and GTR 19
- n-service monitoring testing for Non-road vehicles using PEMS
- n-service Conformity (ISC) and In-use Performance Ratio (IUPR) testing as per BS-VI OBD Stage II
- Functional Safety assessment of Auto-Balancing ECU for a two-wheeler
- AVAS 2.0 version deployment on low cost 16-bit controller
- Car to LCV Brake Assembly durability test
- Performance and Durability testing of Railway/ Metro Bogie Frame & Axle Box, Reinforcement Couplers, Vibration testing of Electronic & Mechanical Components
- Evaluation and optimization of climate control system of High-Speed train
- Evaluation of fatigue properties of plastic at subzero temperature (- 30 deg C)
- Door Lock and Key durability test
- Body Floor durability test
- Exterior aerodynamic drag evaluation of Alloy Wheel designs
- Wheel Trim rheology
- Wishbone suspension optimization
- Consultancy for EV Tractor Homologation (2WD & 4WD)
- Tie Rod optimization
- Anti-vehicle barrier design
- Component validation by FE Simulation for Mat 169
- Torpedo cell parts molding simulation
- Engine valve seat thermal analysis

- Performance and vibration characteristics evaluation of hydraulic pump
- Testing of Automotive Camera Monitoring System
- Testing and certification of CEVs – Rear-view mirror, Field of Vision and Lighting installation as per national and international standards
- Buzz, Squeak and Rattle (BSR) noise evaluation of driver and rear seats
- Sound transmission loss evaluation of CFRP panels at low frequency for aerospace application
- Integration of AVAS unit on EV and solution to meet AVAS upcoming regulation
- Vibratory Road Roller Sound Power reduction
- Speech Intelligibility evaluation
- Sound Transmission loss evaluation of CFRP panels
- Door Mirror vibrations improvement using Experimental Modal testing approach
- Ionic analysis of Circuit Boards by Ion Chromatography Method as per IPC-TM-650
- Determining content of extractable Siloxanes by GC/MS analysis
- Measurement of CO gas when 1% Methane (CH4) is injected into intake of diesel utility vehicles operated in underground mines
- Calibration of load cells used in dummy
- Seat belt load cell calibration

In-service Monitoring Test of Non-road Vehicles

Export Homologation of Agricultural Seat

Body Floor Durability Test

Knee Mapping Sled Test

BSR Noise Evaluation of Driver and Rear Seats

Integration of AVAS unit in an EV

Rear-view mirror, Field of Vision and Lighting Installation Testing of CEV

Sound Transmission Loss Evaluation of CFRP Composite Panels

Engagements for Brand Building

- Showcasing of expertise and innovation at expos, viz. Automotive Testing Expo Chennai 2024, CII Nexgen Mobility Show 2024, Bharat Mobility Global Expo 2025, India International Supply Chain Conference Aero, Space & Defence (IISCC – AS&D), India Energy Storage Week (IESW), India EV Show, Automotive Testing Expo Europe 2024, Swachh Vayu Diwas 2024, 2nd Rosefield Conference on Lubricants and Fuels, The ADAS Show 2025, etc.
- Initiatives under Creative and Communication Cell
  - Over 2,00,000 LinkedIn users subscribed to ARAI's account
  - Press conference conducted to update the media on developments and technological advancements at ARAI
  - Explored various traditional and social media platforms for marketing and brand-building
  - Publications, like The Economic Times, The Times of India, ETAuto, Financial Express, etc. published articles and interviews on ARAI enhancing the brand image
  - Periodical updates on capabilities, events, developments, etc. to the industry and stakeholders through website and social media channels of ARAI

- Regional Centres at Bangalore, Chennai and Hyderabad catalysed ARAI's presence in respective regions and capitalized business opportunities

ARAI Stall at Bharat Mobility Global Expo 2025

ARAI Stall at CII Nexgen Mobility Expo 2024

Interactions with Industry :

During the year, ARAI actively engaged with senior-level delegations from both domestic and international organizations. These engagements included hosting of visits, exhibitions and meetings at ARAI's facilities as well as outreach visits to key customers, aimed at fostering business development and exploring collaborative opportunities. Through these interactions, ARAI showcased its comprehensive capabilities and state-of-the-art infrastructure. Presentations and demonstrations highlighted ARAI's service offerings across wide spectrum, including certification; validation support; engine and component testing, transmission systems; electric vehicles (EVs); noise, vibration and harshness (NVH); ethanol and alternative fuels; fuel and lubricant analysis and skill development initiatives, along with in-house indigenous technology development. These industry interactions not only enhanced mutual understanding of customer requirements in certification and development programs but also generated valuable leads, paving the way for future business opportunities.

Technical Collaborations/ Strategic Tie-ups

- MoU with Stadt Karlsruhe (Economic Development Department of the city of Karlsruhe, Germany) in the areas of innovation, R&D, technology development, validation & evaluation and engineering services for safety, sustainability and reliability in mobility and related fields
- MoU with Foundation for Science Innovation and Development (FSID) for R&D activities in the mobility space
- MoU for collaboration towards Simulation & Testing Services across India & Europe with GDTech SA, Belgium
- MoU with Hexagon Manufacturing Intelligence India Pvt. Ltd. for development of Material Model Cards

MoU with Stadt Karlsruhe

MoU with FSID

- MoU with Altair Engineering India Pvt. Ltd., for Fostering technology and digital transformation goals
- MoU with SIMMOL BV for Battery Management Systems
- MoU with Infineon Technologies Asia Pacific Pte Ltd., for automotive embedded system development in the areas of power electronics, ADAS and cyber security

Conferences/ Workshops/ Training Programs Organized

- Digital Twin Summit
- Seminar on 'Emerging Smart Trends in General Lighting'
- Seminar on 'Hydrogen – Emerging Technology Scenario for ICE application'
- Conference on 'Lightweight Sustainable Manufacturing Solutions for Clean Energy Mobility'
- International Conference on Advanced Powertrains for Mobility & Power Generation Applications
- India's first Autonomous Baja organized in collaboration with SAEINDIA
- Workshop on completion of Clean Air Project in India (CAP India) project for dissemination of project outcomes to the stakeholders and launch of the report
- India-EU Workshop on 'Standardization Strategy and Trustable Testing Possibilities in India and the EU' organized jointly with the Office of Principal Scientific Adviser (PSA) to the Government of India
- Workshop on 'Charging Infrastructure Technology Requirements and Interoperability'
- 18 training programs organized at the behest of MoRTH for RTO/ STU on Safety, Alternative Fuels, EVs, CMVR, Vehicle Evaluation, Passive Safety, BS-VI Emissions Certification, Flex Fuel Vehicle Technology and its readiness for India, LNG as a new alternate fuel for heavy-duty application, Hydrogen as a carbon neutral fuel for India, automotive fuel cylinder and fire safety for vehicles, Bio mobility for automobile fleet and its new fuel technologies, etc.
- MANAK MANTHAN 2025' – jointly organized with Bureau of Indian Standards (BIS)
- Expert Talk on 'Characterization and Modelling of Polymeric Materials for Automotive Applications' at Polymer 360 – Technical Meet


Emerging Smart Trends in General Lighting Seminar

Workshop on BS-VI Emission Certification for RTO

ARAI in Media

Testing Times for the Standard Bearers

It is an entity few other than genuine motorheads have heard of. But it has an impact on pretty much every vehicle that is driven on Indian roads. ARAI (Automotive Research Association of India) is the organisation mandated with making sure the vehicles you buy in India meet standards. From Bharat NCAP (New Car Assessment Program) safety standards, to fuel efficiency figures under test conditions, to ensuring homologation of vehicles, this is the entity that tests and certifies automobiles sold in the country. It does all of this out of its 260 acre base in Pune, equipped with a large number of testing facilities.

Incorporated in 1966, the cooperative industrial research association under the Ministry of Heavy Industries has had quite the journey thus far. But what is happening now is clearly new. It, along with the entire automotive industry, is now in the middle of the big energy transition, from fossil fuels to electric and other alternative sources of energy. That kind of change is what the phrase paradigm shift was conjured for. It means that ARAI, one of India's most important entities in the automotive sector, is now in the middle of retooling itself for a new era of testing electric vehicles.

In an exclusive interview with ET's **Liaee Philip**, **Reji Mathai**, director of the ARAI, answered several pertinent questions around electric vehicles, safety and more. Edited excerpts:

What is the paradigm shift in certification for internal combustion engine (ICE) and EVs? Is ARAI finding the transition for certification and testing a bit overwhelming?

In the case of EVs, the focus of certification is primarily on safety of the vehicle, (battery, controllers etc) and also on its range performance from a customer point of view, whereas for ICE, it is emissions and vehicle safety that play a pivotal role in determining the validation process. ARAI has requisite facilities for certification of EVs as per AIS (Automotive Industry Standards) notified under CMVR (Central Motor Vehicles Rules) as in case of ICE.

Is the ICE testing for fuel efficiency and homologation for easier compared to testing and certification for safety and performance for EVs?

We are comparing testing of ICE which has been established for the last 3 decades with that of EV which has been in place since the last 5-6 years. However, standards and procedures for safety and performance testing of EVs are now well established. Test Agencies and EV manufacturers are well versed with the homologation process. So, there is not much difference in the degree of difficulty of ICE vs. EV homologation.

How does ARAI engage with automakers during the certification process to ensure they meet safety and performance standards, especially for new EV models?

ARAI acts as an interface between the automakers, the government and the end-user. Knowledge dissemination through seminars and conferences and stakeholder consultations are held regularly. Moreover, the standards are formulated through a consultative process. Many EV players such as startups are now to the homologation process. ARAI has set up a cell to provide necessary guidance to such players. We support them in terms of the homologation process and understanding of standards. We also help EV makers in developmental testing and validation before certification of new models.

How does ARAI ensure that its testing methodologies align with international standards, particularly with the global automotive market becoming more integrated?

India participates in global efforts of harmonisation of vehicle regulations under UNECE (United Nations Economic Commission for Europe) Working Party 29 (WP.29). ARAI has been attending these meetings at the UN as part of the delegation representing India. Hence Indian automotive standards, including EV standards, are aligned and are on a par with the global regulations and standards.

What are the specific challenges ARAI faces when testing the safety and performance of EV batteries, and how are you addressing them?

Battery safety testing involves a number of battery abuse tests, such as vibration, mechanical shock, crash, short circuit, thermal propagation, fire, temperature variation, etc. These tests are required to be carried out in a safe environment because of the probability of occurrence of fire or explosion. Battery performance tests are typically long duration tests and hence pose a challenge of test equipment capacity constraints. However, ARAI is setting up an advanced battery safety facility with the support of the Ministry of Heavy Industries to meet the increasing testing requirements, specially for commercial vehicle application.

As the market shifts towards EVs, how does ARAI foresee the future of ICE vehicles in terms of testing requirements and standards?

In the ICE sector, a number of fuel options are being explored, namely alternate fuels including CNG, ethanol and hydrogen. The present diesel and gasoline fuel is expected to co-exist along with the EVs. Major research and application development efforts are being carried out in hydrogen-powered IC engines. Hence, ARAI is gearing up with the required testing infrastructure for certification of all types of IC engines. The future mix of vehicles will be defined by future government policies, availability of infrastructure for new fuels and acceptance by customers. ARAI continues to upgrade its testing capabilities in alignment with the global and domestic requirements.

ARAI is setting up an advanced battery safety facility with the support of the Ministry of Heavy Industries to meet the increasing testing requirements, specially for commercial vehicle application

ARAI was established in 1966 | Operates under the Ministry of Heavy Industries

Offices and representatives in Chennai, China and Korea

Based in Pune | 700+ employees

The Economic Times, 15th December 2024

ARAI gears up for future mobility: Advancing standards, alternative fuels and AI-driven testing

ARAI is working alongside other government and industry bodies towards defining quality standards for these fuels to ensure consistency in performance and emissions control.

Shweta Bharat Mehrotra • ET Auto

ET Auto, 3rd February 2025

BBC NEWS தமிழ்

Home | World | India | Sri Lanka

45 children die in accidents every day in India - how to transport them safely in vehicles?

We spoke to Rahul Mahajan, Deputy Director and HoD Passive Safety Lab and Engineering Design & Simulation at the Automotive Research Association of India (ARAI), who shared his industry expertise with us.

Rahul Mahajan, who says that two-wheelers are inherently unstable, says that if children are taken on two-wheelers due to unavoidable circumstances, they should also be made to wear helmets.

BBC News, 8th March 2025

H2-ICE VEHICLES TO HIT ROADS IN 2-3 YEARS: ARAI'S DR SUKRUT S THIPSE

India is gearing up to introduce hydrogen-powered vehicles in its commercial segment. Hydrogen Internal Combustion Engine (H2-ICE) technology is poised to hit the roads in the next two to three years. **Shahkar Abidi** reports.

Expressing his optimism about the imminent commercialisation of the technology, Dr Sukrut S Thipse, senior deputy director at the Automotive Research Association of India (ARAI) and head of the Engine Development Lab, said, "In 2-3 years, you will see actual H2-ICE vehicles on the road." He was speaking to *Autocar Professional* on the sidelines of a seminar titled 'Hydrogen: Emerging Technology Scenario for ICE Application', hosted by

through collaborative efforts involving fuel producers, researchers, and component manufacturers – will be essential. Currently, almost all major parts required for the development of hydrogen-ICE technology tend to get imported, he pointed out.

As the global automotive industry shifts toward greener technologies, India's ambition to embrace H2-ICE technology represents a significant step toward decarbonising its heavy vehicle segment. Whether the necessary ecosystem can be built swiftly enough remains to be seen.

Autocar Professional, 15th December 2024 Edition

Launch of Web Portal for Online Processing of DVA Assessment and Certification

PLI – Auto ARAI Portal, offering streamlined service for Domestic Value Addition (DVA) certification under Production Linked Incentive Scheme (PLI) for Advanced Automotive Technology (AAT) Product Applications was launched on 12th June 2024 by Dr. Reji Mathai, Director – ARAI in the presence of Senior leadership team of ARAI. 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 applicants can register and manage their applications ensuring seamless interaction and timely updates throughout the certification process. Using the login credentials, applicants can create request for DVA certification on this web portal.

Launch of PLI – Auto ARAI Portal

Workshop on Technology Prioritization for the Transport Sector

ARAI, in association with Technology Information, Forecasting, and Assessment Council (TIFAC), organized workshop on 'Technology Prioritization for the Transport Sector' on 30th and 31st July 2024. It 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 like road, rail, air and water transport to advance decarbonization of India's transport sector by identifying next-generation and climate-resilient technologies. It was attended by representatives from OEMs, startups, academic institutes and research bodies. 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, Materials, etc. were discussed and evaluated, with an aim of creating a pathway towards sustainable development.

Launch of Report on Clean Air Project in India: Pune Region

Based on National Clean Air Program (NCAP) of Ministry of Environment, Forest and Climate Change (MoEFCC), Swiss Agency for Development and Co-operation (SDC) had initiated 'Clean Air Project in India' (CAP India) for Pune, Nashik, Kanpur and Lucknow. Under this project, ARAI executed various project components for Pune region. 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.

Subsequent to completion of the project for Pune region by ARAI, concluding workshop was organized on 8th August 2024. The report on 'Clean Air Project in India: Pune Region' was launched during this event by Dr. Avinash Dhakne, Member Secretary – MPCB, Shri Sanjay Shinde and Deputy Commissioner (Env), Pune Municipal Corporation, in the presence of Dr. Reji Mathai, Director – ARAI and senior officials from SDC, TERI and SIAM. This workshop facilitated in large-scale dissemination of the project outcome and promoted cross-learning among officials to replicate and scale the

steps taken in pilot demonstrations, awareness generation, capacity building and scientific assessments. Representatives from MoEFCC, Pollution Control Boards, Smart City Cell and Municipal Corporations attended this workshop.

Launch of Report on
Clean Air Project in India: Pune Region

Seminar on Hydrogen – Emerging Technology Scenario for ICE Application

A Seminar on 'Hydrogen – Emerging Technology Scenario for ICE Application' was organized with the support of Ministry of Heavy Industries (MHI) and Ministry of New and Renewable Energy (MNRE) on 27th November 2024. Shri. C. V. Raman, Chief Guest and Member, Executive Committee, and Former CTO, Maruti Suzuki India Limited inaugurated this event in the presence of Dr. Prasad Chaphekar, IRS, Deputy Secretary, MNRE; Shri Rajesh Khanna, Head-Planning Tata Motors Limited & Convener of the Seminar; Dr. Reji Mathai, Director-ARAI and Dr. S. S. Thipse, Sr. Deputy Director -ARAI.

It provided a platform for discussing H_2ICE technology and its potential to reduce urban pollution. It explored green hydrogen ecosystem, including storage, mobility and infrastructure, with insights from leading countries. It also highlighted importance of skill development and employment opportunities to support India's green hydrogen transition. The seminar was attended by over 250 delegates from various OEMs, OMCs and Academia.

Hydrogen – EmergingTechnology Scenario for
ICE Application Seminar

Seminar on Emerging Smart Trends in General Lighting

Seminar on 'Emerging Smart Trends in General Lighting' was organized by ARAI on 29th January, 2025 at ARAI-Forging Industry Division (FID). Shri S. D. Rane, Director and Head of Bureau of Indian Standards, Pune, inaugurated the event in the presence of Mr. A. Akbar Badusha, Senior Deputy Director, ARAI. The event covered insightful presentations, engaging panel discussions and informative visit to Advanced Photometry and Optics Laboratory of ARAI-HTC at Chakan, Pune. It

Emerging Smart Trends in General Lighting Seminar

brought together industry leaders, innovators, designers and decision-makers to deliberate emerging trends in general lighting industry, their advantages, challenges and sustainability aspects.

Manak Manthan 2025

ARAI, in association with BIS, organized Manak Manthan 2025, a workshop focusing on Tyres, Wheel Rim and Safety Glass, on 14th February 2025. During this workshop, important revisions/

MANAK MANTHAN 2025

amendments and wide circulation drafts were shared with manufacturers, industrial and trade bodies, chambers of commerce, industry associations, PSUs, regulatory bodies, laboratories, civil society groups and academia. Panel discussion and brainstorming sessions on existing and upcoming standards focusing on the auto industry were also conducted.

India-EU Workshop on Electric Vehicles Charging Technology

The first India-EU Workshop on Electric Vehicles Charging Technology was organised by ARAI and the European Commission's Joint Research Centre (JRC), with the support of Office of the Principal Scientific Adviser (PSA) to the Government of India in Pune on 24th February 2025. It addressed key policy and technical aspects of EV charging, covering all size classes of electric vehicles, and focussed on standardisation and strategic cooperation. It featured expert presentations, policy dialogues and panel discussions on following critical topics.

- EU and Indian charging standards, and requirements pertaining to infrastructure, communication and interoperability targets
- Insights on the future strategic directions in India and the EU in sustainable mobility, including potential synergies leading to economies of scale

India-EU Workshop on Electric Vehicles Charging Technology

- EV Charging system testing capabilities and pre-normative research, with focus on facilities at ARAI and JRC
- Industry perspectives to enhance India-EU collaboration in EV charging

This workshop was attended by Dr. Monoranjan Mohanty (Adviser) and Dr Hafsa Ahmad (Scientist) from Office of the Principal Scientific Adviser to Government of India; Dr. Reji Mathai, Director, ARAI; Mr. Abhihit Mulay, Deputy Director, ARAI and Mr. Nitish Kumar Jain, Deputy Director, Bureau of Indian Standards. Participants from European Commission included Dr. Liliana Pasecinic, Dr. Harald Scholz, Dr. Saki Gerassis and Mr. Dirk Groβmann. Stakeholders from the Indian and European industry also participated in this workshop.

Upcoming Event: SIAT 2026

The 19th edition of 'Symposium on International Automotive Technology' (SIAT 2026) is being organized by ARAI, in association with SAEINDIA and SAE International (USA), from 28th to 30th January 2026 at Pune International Exhibition and Convention Center, Pune. The theme of this edition is 'Innovative Pathways for Safe and Sustainable Mobility'. It is expected that this symposium will witness presentation of over 240 technical papers, including keynotes on futuristic topics by renowned experts from all over the world. These papers will be published in the form of Symposium Proceedings. Technical Reference Bulletin, containing technical articles, case studies, products/ services information, etc. will also be brought out to commemorate this event.

Aligning with the theme of the event, topics like Active and Passive Safety, E-mobility, Autonomous Vehicles, Simulation & Modelling, Advanced Driver Assistance Systems, Circularity & LCA, Automotive Cyber Security, Artificial Intelligence in Automobile, Software Defined Vehicles, Fuel Cell, Hydrogen IC Engine, etc. will be deliberated in this panel discussion.

The concurrent exposition, SIAT EXPO 2026, will offer an excellent platform for OEMs from India and abroad to showcase and demonstrate spectrum of their products, technologies, innovations and service capabilities around 350 stalls.

Supporting SAEINDIA Activities

ARAI is associated with SAEINDIA's wide spectrum of activities, which are carried out for the benefit of practicing engineers, engineering students and school children. During the year, ARAI supported following programs organized jointly by ARAI and SAEINDIA Western Section.

- Conference on Automotive Weathering Technology
- BAJA SAEINDIA 2025
- AWIM Pune Olympics
- Confluence'25: International Symposium on Automotive Cybersecurity
- Conference on Lightweight Sustainable Manufacturing Solutions for Clean Energy Mobility
- International Conference on Advanced Powertrains for Mobility & Power Generation Applications

ARAI Academy, an initiative of ARAI for imparting training to industry professionals and student community, has completed 20 years on 10th May 2024. Over this fulfilling journey, ARAI Academy has skilled over 2,700 human resources, conducted 35,000 person-days of training, catering to more than 21,000 working professionals through over 400 short-duration upskilling training programs. ARAI Academy collaborated with various universities and industry partners to develop and run programs to bridge the gap between the industry expectations and Academia. Through various collaborations with academic institutes, this year ARAI Academy had over 100 students on its campus pursuing Bachelors, Post-Graduate Diploma, Masters and Doctoral degrees from various academic institutes.

Highlights of Activities :

- Collaboration with ASDC to launch two NSQF level 5.5 courses of 60 hours with 60% or more practical and hands-on for students. These two programs are on (a) Fundamentals of Electric Vehicle Battery Pack Design and (b) Fundamentals of Electric Vehicle Powertrain Design.
- Certified Short-term Training Programs (PIPs and DTPs):
  - 31 PIPs and 16 DTPs were organized, featuring lectures by experts from ARAI, academicians and OEMs. Out of these, four training programs were conducted online to reach out to the global audience.

    These programs were on (a) Electric Vehicles: Architecture, Motors, Battery, High Voltage and Safety, (b) ICE Technology: ICE emissions, NVH, (c) Automotive Regulations and (d) Exclusive and Emerging Automotive Technology Trends
  - Over 1195 delegates participated and 2225 person-days of training was imparted
- Exclusive Training Programs:
  - Considering the significance of automotive cybersecurity in rapidly evolving mobility sector, training program on this subject was organized jointly with M/s ETAS Automotive India Ltd. Over 40 delegates participated and benefited from this program.
  - Training program on 'Agile Methodologies & Innovation Techniques for Solving Industrial Challenges' was organized, which had participation of 17 employees from Tier-1 organization.
  - Three training programs in EV domain were conducted with the support of MoRTH for the Officers of State Transport Department.
  - Training program on 'Safety Aspects and High Voltage EV' was organized, which had participation of over 100 EV automotive professionals.
  - Training programs relating to Bharat NCAP, Functional Safety, ADAS and Autonomous Vehicles, Vehicle Dynamics & Testing and Electric Motors were conducted.

- eModules – anywhere and anytime learning platform:
  - Four eModules, of about five hours duration in two languages – English and Hindi, prepared under Annual Capacity Building Program of Ministry of Heavy Industries.
  - Fifteen eModules developed and onboarded on Learning Management System (LMS). The topics of these eModules include Reliability Engineering, Engine Electronics & Management System, ICE Emission Systems, HEV Architecture, Fuel Cell, etc.
  - Five eModules in the field of Hybrid and Electric Vehicles have been prepared and the same will be available on Learning Management System (LMS) shortly. They are on (a) Fundamentals of HEV and EV Technology (b) EV Propulsion Unit (c) Batteries for EV (d) BMS and BTMS for EVs and (e) Charging Technologies for EVs.
  - The eModules so developed facilitate learners to review the sessions multiple times before final assessment and certification from ARAI Academy.
- Conference on 'Lightweight Sustainable Manufacturing Solutions for Clean Energy Mobility' organized jointly with SAEIndia Western Section and LWT.
- Training program on Charging Infrastructure and Interoperability was organized, wherein over 50 delegates from automotive EV OEMs, charging station manufacturers as well as battery manufacturers participated.
- Knowledge disseminated to STEM as well as engineering students and their faculty members. A total of 567 students and 37 faculties from 13 different institutes benefitted from this initiative.

MoU with ASDC


Training Program on Automotive Cybersecurity


Lightweight Sustainable Manufacturing Solutions for Clean Energy Mobility Conference

Training Program on Charging Infrastructure and Interoperability

Independent Auditor's Report
&
Annual Statement of Accounts

Independent Auditor's Report

To,

The Members of
The Automotive Research Association of India

Report on the Audit of the Financial Statements

OPINION

We have audited the financial statements of THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA, PUNE ("ARAI") which comprise the Balance Sheet as at March 31, 2025, the Income and Expenditure Account and Receipt and Payment Account for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion, the accompanying financial statements give a true and fair view of the financial position of the entity as at March 31, 2025 for the year then ended in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India (ICAI).

BASIS OF OPINION

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the entity in accordance with the Code of Ethics issued by ICAI and we have fulfilled our other ethical responsibilities in accordance with the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

RESPONSIBILITIES OF MANAGEMENT AND THOSE CHARGED WITH THE GOVERNANCE FOR THE FINANCIAL STATEMENTS

Management of ARAI is responsible for the preparation of the financial statements in accordance with relevant laws as applicable and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the entity or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the entity's financial reporting process.

AUDITOR'S RESPONSIBILITIES FOR THE AUDIT OF FINANCIAL STATEMENTS

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the entity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the entity to cease to continue as a going concern.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Report on Other Regulatory Requirements

Further, we report that: -

a. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit.

b. In our opinion, proper books of accounts as required by law have been kept by ARAI so far as it appears from our examination of those books.

c. ARAI's Balance Sheet, the Statement of Income and Expenditure and Receipts and Payments Account dealt with by this Report are in agreement with the books of account.

For Kirtane & Pandit LLP
Chartered Accountants
Firm Registration No.W10057/105215W

Parag Pansare
Partner
Membership No: 117309
UDIN: 25117309BMJDQD9887
Pune, June 30, 2025

Balance Sheet as on 31st March 2025

(RS IN LAKHS)

PARTICULARS	SCHEDULE NO	AS ON 31/3/2025	AS ON 31/3/2024
I EQUITY AND LIABILITIES			
1. **OWNERS' FUNDS**			
A RESERVES AND SURPLUS	3	2,19,169.58	1,89,413.18
		2,19,169.58	1,89,413.18
2. NON-CURRENT LIABILITIES			
A OTHER LONG-TERM LIABILITIES	4	4,047.25	4,049.35
B LONG-TERM PROVISIONS	5	2,864.22	2,613.73
		6,911.47	6,663.08
3. CURRENT LIABILITIES			
A TRADE PAYABLES			
I TOTAL OUTSTANDING DUES OF MICRO, SMALL AND MEDIUM ENTERPRISES	6	411.79	1,072.58
II TOTAL OUTSTANDING DUES OF CREDITORS			
OTHER THAN MICRO, SMALL AND MEDIUM ENTERPRISES	6	2,564.59	2,880.25
B OTHER CURRENT LIABILITIES	7	17,663.17	15,524.31
C SHORT-TERM PROVISIONS	5	279.18	306.43
		20,918.73	19,783.57
TOTAL		**2,46,999.78**	**2,15,859.82**
II ASSETS			
1. NON-CURRENT ASSETS			
A PROPERTY, PLANT AND EQUIPMENT AND INTANGIBLE ASSETS	8		
I PROPERTY, PLANT AND EQUIPMENT		79,024.28	73,174.14
II INTANGIBLE ASSETS		812.39	441.89
III CAPITAL WORK IN PROGRESS		7,544.78	6,815.34
IV INTANGIBLE ASSET UNDER DEVELOPMENT		-	
B NON-CURRENT INVESTMENTS	9	15,975.56	13,042.72
C OTHER NON CURRENT ASSETS	10	16,717.43	62,064.70
		1,20,074.46	1,55,538.80
2. CURRENT ASSETS			
A INVENTORIES	11	186.86	15.35
B TRADE RECEIVABLES	12	5,454.98	6,802.76
C CASH AND BANK BALANCES	13	1,14,406.11	46,525.47
D SHORT TERM LOANS AND ADVANCES	14	6,235.06	6,385.84
E OTHER CURRENT ASSETS	15	642.32	591.62
		1,26,925.33	**60,321.03**
TOTAL		**2,46,999.78**	**2,15,859.82**
BRIEF ABOUT THE ENTITY	**1**		
SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES	**2**		
THE ACCOMPANYING NOTES ARE AN INTEGRAL PART OF THE FINANCIAL STATEMENTS			

Dr.Reji Mathai
Director

Dr. N. Saravanan
President

Mr.Velusamy R.
Vice President

AS PER OUR REPORT OF
EVEN DATE ATTACHED
FOR M/S KIRTANE AND PANDIT LLP
CHARTERED ACCOUNTANTS
Firm's Reg. No. W10057/105215W

Parag Panasare
PARTNER
Membership No. 117309

Date : 30 June, 2025
Place : Pune

Statement of Income and Expenditure for the Year Ended 31st March 2025

(RS IN LAKHS)

PARTICULARS	SCHEDULE NO	YEAR ENDED 31/3/2025	YEAR ENDED 31/3/2024
I REVENUE FROM OPERATIONS	16	60,578.54	50,872.16
II OTHER INCOME	17	7,279.66	6,317.16
III TOTAL INCOME (I+II)		**67,858.20**	**57,189.32**
IV EXPENSES:			
A OPERATIONAL EXPENSES		5,974.05	5,537.55
B EMPLOYEE BENEFITS EXPENSES	18	23,951.91	22,365.94
C DEPRECIATION AND AMORTIZATION EXPENSES	19	5,014.69	4,480.05
D OTHER EXPENSES	20	7,592.22	7,176.55
TOTAL EXPENSES		**42,532.86**	**39,560.09**
V SURPLUS/(DEFICIT) BEFORE TAX (III- IV)		25,325.34	17,629.23
VI SIAT SURPLUS / (DEFICIT) TRANSFERRED TO GENERAL FUND		30.89	260.57
VII SURPLUS/(DEFICIT) TRANSFERRED TO GENERAL FUND (V-VI)		**25,294.45**	**17,368.66**

Dr.Reji Mathai
Director

Dr. N. Saravanan
President

Mr.Velusamy R.
Vice President

AS PER OUR REPORT OF
EVEN DATE ATTACHED
FOR M/S KIRTANE AND PANDIT LLP
CHARTERED ACCOUNTANTS
Firm's Reg. No. W10057/105215W

Parag Panasare
PARTNER
Membership No. 117309

Date : 30 June, 2025

Place : Pune

ARAI Management Committee

Dr. Reji Mathai
Director - ARAI
director@araiindia.com

Akbar Badusha
Senior Deputy Director

Anand Deshpande
Senior Deputy Director

Dr. Sukrut Thipse
Senior Deputy Director

Vikram Shinde
Senior Deputy Director

Ms. Medha Jambhale
Senior Deputy Director

Dr. Nagesh Walke
Senior Deputy Director

Vijay Pankhawala
Senior Deputy Director

Dr. Prasanna Bhat
Senior Deputy Director

Ms. Ujjwala Karle
Senior Deputy Director

Rahul Mahajan
Senior Deputy Director

Dr. Belavadi Shamsundara
Senior Deputy Director

Atul Bhide
Deputy Director

Charudatta Mukhedkar
Deputy Director

Ms. Prajakta Dhere
Senior General Manager

Sandeep Gongle
Senior General Manager

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ARAI

Progress through Research

The Automotive Research Association of India

(Under the Administrative Control of Ministry of Heavy Industries, Govt. of India)

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