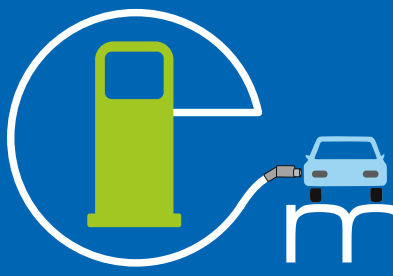
ARAI
Progress through Research

48th ANNUAL REPORT
2017-2018



empowering
mobility
the safe and intelligent way

The Automotive Research Association of India

ARAI
Progress through Research

The Automotive Research Association of India

ARAI Vision and Mission

Vision

ARAI has a strong base of state-of-the-art technology equipment, laboratory facilities and highly qualified and experienced personnel. With these assets, ARAI has goals, strategies and action plans to achieve the fullest customer satisfaction. These are:-

(a) to compete in service with excellence

(b) to obtain recognition and accreditation

(c) to cover global market

(d) to build commitment of all personnel

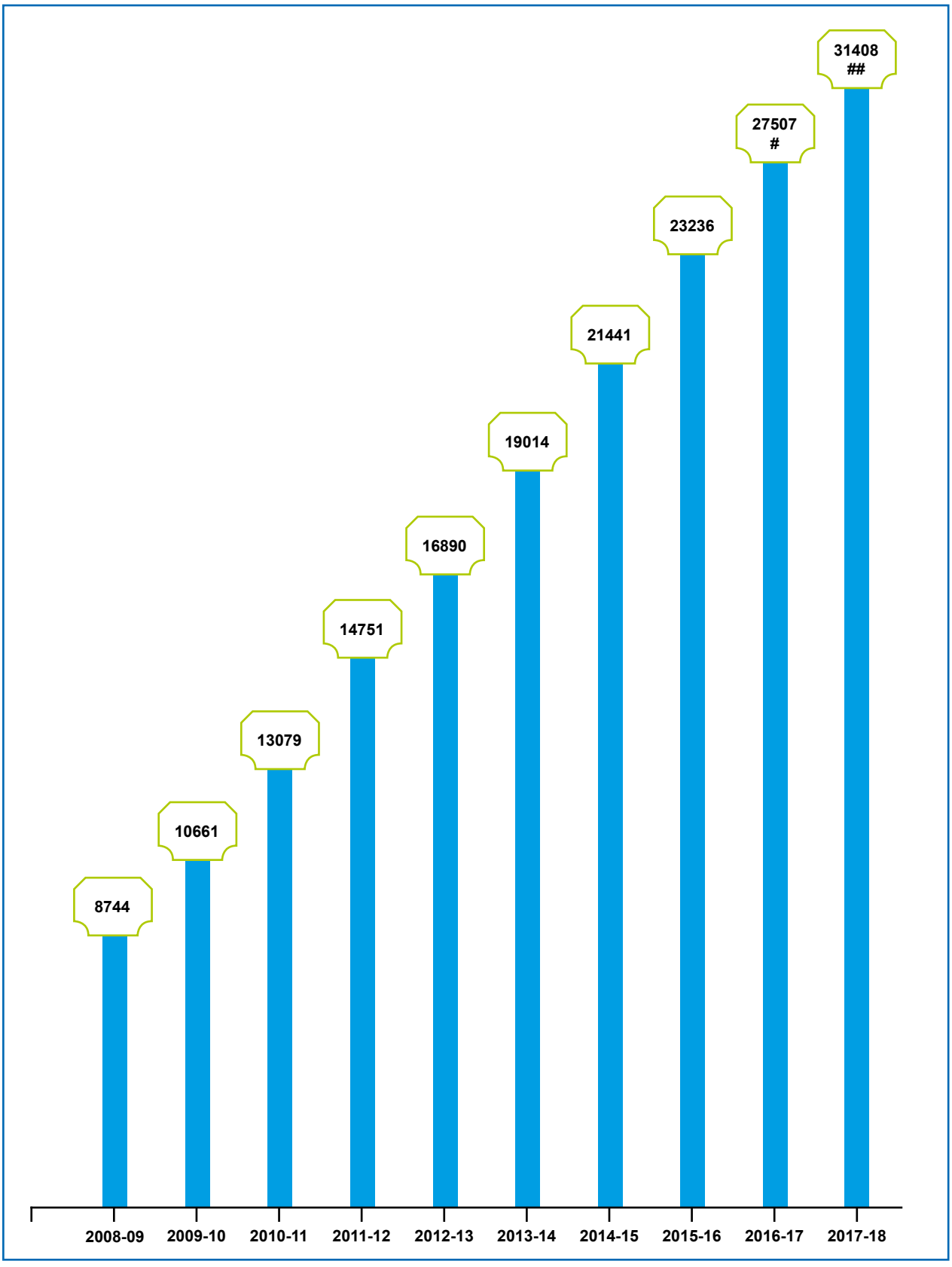
(e) to develop team spirit and sense of belonging amongst all.

Mission

- ARAI has been providing various services to the Indian Automotive Industry, in the areas of design & development and know-how for manufacture & testing of components / system to national / international standards. ARAI shall strive to achieve international recognition in these areas.
- ARAI shall seek valuable guidance and support from members, from time to time to achieve growth and stability.
- With the globalisation of economy and business, ARAI shall enlarge its scope of services to meet the requirements of automotive industries any where in the world.
- ARAI strongly believes that satisfaction of customer needs on continuing basis, is of prime importance to earn loyalty of customers. Therefore, emphasis shall be on meeting and exceeding customer needs through continuing quality improvement with active participation of employees and also customers.

TOTAL INCOME

(Rs. in lakh)



Above Income is excluding Interest on earmarked fund transferred to respective fund and funds transferred from R & D reserve fund.

\# Excluding Interest on earmarked fund transferred to respective fund Rs. 1407 lakhs and fund transferred from R & D reserve fund Rs. 66 Lakh.
Excluding Interest on earmarked fund transferred to respective fund Rs. 1691 lakhs and fund transferred from R & D reserve fund Rs. 152 Lakh.

Highlights of the year

- 15.4% growth in Operational Income over last year
- First BS VI Certificate issued in India by ARAI at the hands of Shri Nitin Gadkari, Hon'ble Minister, Ministry of Road Transport & Highways
- 'Centre of Excellence' in E-Mobility launched by Shri Anant Geete, Hon'ble Minister, Ministry of Heavy Industries & Public Enterprises
- Establishment of Environment Research Laboratory (ERL) and Virtual Calibration Centre (VCC)
- Prototype of Low Floor City Bus with Aluminium Superstructure meeting Bus Body Code AIS : 052 built successfully
- ISO 17025 Accreditation to Passive Safety and Powertrain Engineering Laboratories at Homologation and Technology Centre (ARAI - HTC), Chakan
- Certification of Electric Buses
- Solutions developed for implementing smart structure concepts in automobiles

Contents

Governing Council Members

PRESIDENT	:	Mr. Vikram Kirloskar, Vice Chairman, Toyota Kirloskar Motor Pvt Ltd,
VICE PRESIDENT	:	Mr. C.V. Raman, Sr. Executive Director-Engineering, Maruti Suzuki India Ltd
DIRECTOR	:	Mrs. Rashmi Urdhwareshe

MEMBERS

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

GOVT. OF INDIA REPRESENTATIVES

Dr. Subhash Chandra Pandey
Special Secretary & Financial Adviser,
Govt of India
Ministry of Heavy Industries & Public Enterprises
Department of Heavy Industry
Udyog Bhawan, New Delhi 110 011

Mr. Vishvajit Sahay
Joint Secretary (Auto)
Govt of India
Ministry of Heavy Industries & Public Enterprises
Department of Heavy Industry
Udyog Bhawan, New Delhi 110011

Mr. N. L. Goswami
Senior Development Officer (Sr. DO),
Govt of India
Ministry of Heavy Industries & Public Enterprises
Department of Heavy Industry
Udyog Bhawan, New Delhi 110 011

INVITEES

- Society of Indian Automobile Manufacturers
- Automotive Component Manufacturers Association of India
- Tractor Manufacturers Association
- National Automotive Testing and R&D Infrastructure Project

SECRETARY TO THE GOVERNING COUNCIL

Mrs. Prajakta M. Dhere

ADDRESS

Survey No. 102, Vetal Hill
Off Paud Road, Kothrud
Pune 411 038, INDIA
Phone : 91-20-3023 1111, 3023 1101
Fax : 91-20-3023 1104
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
Reg. No. F-48091/Pune dated 13-12-2016

AUDITORS

M/s. P. G. Bhagwat,
Chartered Accountants

Head Office :
Suites 101-102, 'Orchard',
Dr. Pai Marg, Baner,
Pune 411 045
Tel. Ph. 020-27290771 / 1772

ARAI Members

1. Adient India Private Ltd. (Formerly Johnson Controls Automotive Ltd.)
2. Ashok Leyland Ltd.
3. AMW Motors Ltd ~
4. Atul Auto Ltd.
5. A.J. Auto Pvt. Ltd.
6. Bajaj Auto Ltd.
7. Behr-Hella Thermocontrol (India) Pvt Ltd
8. Bharat Forge Ltd.
9. Bharat Seats Ltd.
10. Bosch Limited
11. Brakes India Pvt. Ltd. (Formerly Brakes India Ltd.)
12. Chemito Infotech Pvt. Ltd.
13. Cooper Corporation Pvt. Ltd. *
14. Cummins India Ltd.
15. Cummins Technologies India Pvt. Ltd.
16. Daimler India Commercial Vehicles Pvt. Ltd. *
17. Delphi-TVS Diesel Systems Ltd.
18. DSK Motowheels Pvt. Ltd.
19. Eicher Motors Ltd.
20. Eicher Polaris Pvt. Ltd.
21. Enginetech Systems Pvt. Ltd.
22. Faurecia Automotive Seating India Pvt Ltd
23. FCA India Automobiles Pvt. Ltd.
24. Fiat India Automobiles Pvt. Ltd.
25. Force Motors Ltd.
26. Ford India Pvt. Ltd.
27. F P Seating Systems Pvt. Ltd.
28. Greaves Cotton Ltd.
29. Gromax Agri Equipment Ltd. (Formerly Mahindra Gujarat Tractor Ltd).
30. Hero Electric Vehicles Pvt. Ltd.
31. General Motors India Pvt. Ltd.
32. Honda Cars India Ltd.
33. Hyundai Motor India Ltd.
34. India Japan Lighting Pvt. Ltd. *
35. India Kawasaki Motors Pvt. Ltd. *
36. International Cars and Motors Ltd.
37. JCBL Ltd.
38. Kanda Auto Pvt. Ltd.
39. Kirloskar Oil Engines Ltd.
40. Kohler Power India Private Limited (Formerly Lombardini India Pvt. Ltd.)
41. KPIT Technologies Ltd.
42. KSS Abhishek Safety Systems Pvt. Ltd.
43. Lear Automotive India Pvt. Ltd.
44. Madras Engineering Industries Pvt. Ltd.
45. Mahindra & Mahindra Ltd.
46. Mahindra Heavy Engines Ltd.
47. Mahindra Electric Mobility Ltd (Formerly Mahindra Reva Electric Vehicles Pvt. Ltd.)
48. Man Trucks India Pvt. Ltd.
49. Mansons International Pvt Ltd (Formerly Manson Automotive Rubber Pvt. Ltd.
50. Maruti Suzuki India Ltd.
51. Mercedes-Benz India Pvt. Ltd.
52. MSKH Seating Systems India (P) Ltd.
53. Piaggio Vehicles Pvt. Ltd.
54. P M Diesels Pvt. Ltd.
55. Power Electronics
56. Randhawa Automobile Engineering Pvt. Ltd.
57. Rinder India Pvt. Ltd.
58. Rocket Engineering Corporation Pvt. Ltd.
59. Rohan BRC Gas Equipment Pvt. Ltd.
60. Rotary Electronics Pvt. Ltd.
61. Simpson & Co. Ltd.
62. Skoda Auto India Pvt. Ltd.
63. S. M. Auto Engineering Pvt. Ltd.
64. SML Isuzu Ltd.
65. Spaco Technologies (India) Pvt. Ltd.
66. Sri Ramdas Motor Transport Ltd. ~
67. Tata Cummins Pvt. Ltd.
68. Tata Motors Ltd.
69. Toyota Kirloskar Motor Pvt. Ltd.
70. Tractors and Farm Equipment Ltd.
71. Trimble Mobility Solutions India Pvt. Ltd. *
72. TVS Motor Co. Ltd.
73. Vanaz Engineers Ltd.
74. Varroc Lighting Systems (India) Pvt. Ltd.
75. VE Commercial Vehicles Ltd.
76. Virama Laminates Pvt. Ltd.
77. Volvo India Pvt. Ltd.
78. Volkswagen India Pvt. Ltd.
79. WABCO India Ltd.
80. Wheels India Ltd.

* *New membership*
~ *Withdrawal of membership*

Committees

Finance & Internal Audit Committee (FIAC)

CHAIRMAN

Mr. C.V. Raman
Chairman-FIAC, & Vice President-ARAI,
Executive Director – Engineering,
Maruti Suzuki India Ltd

Members:

Mr. N D Pathak
Executive Chairman,
Spaco Technologies (India) Pvt. Ltd.

Mr. R.R. Deshpande
Jt. Managing Director,
Kirloskar Oil Engines Ltd.

Mr. Jai Bhagwan Sharma
Finance Director,
Cummins India Ltd.

Mr. Venugopal P Rao
Head (NPI - CVBU Business Planning)
H8, III floor, NPI CVBU, Tata Motor Ltd.

Mr. Gajanan Chinchwadkar
Sr. General Manager - F&A
Mahindra & Mahindra Ltd

Mr. Suhas Kadlaskar
Vice President
Corporate Affairs & Human Resources
Mercedes-Benz India Private Limited

Mr. Pankaj Gupta
Vice President – External Affairs & CSR,
Volkswagen India Pvt ltd

Representative
Government of India,
Ministry of Heavy Industries & Public Enterprises,
Department of Heavy Industry,
Udyog Bhawan,
New Delhi 110 011

Mrs. Rashmi Urdhwareshe
Director-ARAI

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

Project Evaluation & Monitoring Committee (PEMC)

CHAIRMAN

Mr. Sudeep S Dalvi
Vice President - Product Design & Development Division
Quality Assurance Division
Toyota Kirloskar Motor Pvt. Ltd.

Members:

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

Mr. I V Rao
Executive Advisor,
Maruti Suzuki India Ltd

Ms Anuradda Ganesh
Director – Research, Innovation and Compliance, India ABO
Cummins Technologies India Pvt Ltd

Mr. Rajendra M Petkar
Head – Power Systems Engg,
Engineering Research Centre,
Tata Motors Limited

Mr. Vinay Harne
President -NPD,
TVS Motor Co.Ltd

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

Mr. Ashok Yewale
Dy. Chief Technology Officer (R&D)
Force Motors Limited

Mr. R. Narasimhan
Vice President (R&D),
Bajaj Auto Ltd.

Dr. N. Saravanan
Head (Engineering)
Ashok Leyland Limited

Mr. T R Kesavan
Chief Operating Officer,
Tractors and Farm Equipment Limited

Representaive
Government of India,
Ministry of Heavy Industries & Public Enterprises,
Department of Heavy Industry,
Udyog Bhawan, New Delhi 110 011

Mrs. Rashmi Urdhwareshe
Director-ARAI

Mr. N B Dhande
Sr. Deputy Director, ARAI

Mr. Suyog Gadgil
Deputy Manager
Member Secretary, ARAI

There is also a 'Sub-committee of PEMC' to review and monitor projects of ARAI - Forging Industry Division.

President's Statement

Mr. Vikram Kirloskar
President - ARAI

Mr. C. V. Raman
Vice President - ARAI

Dear Members,

It gives me great pleasure to communicate with you about another successful year of excellent performance and significant achievements. It was also a year of both continuity and change. Continuity in building on the strong certification and research expertise and change by way of adoption of processes for simplifying the way we work. We have the people and the leadership to guide through these changes and ensure our long term success. I congratulate Director and Team ARAI for this exceptional and sound performance.

"It was also a year of both continuity and change. Continuity in building on the strong certification and research expertise and change by way of adoption of processes for simplifying the way we work.

Operational Performance

Inducted in the ***'Hall of Fame'*** *by CNBC-TV18 OVERDRIVE*

Copyright granted *by Copyright Office, GoI*

SAE Foundation's ***'Engineering Excellence Award'*** *conferred to VP-ARAI and Director-ARAI*

Significant Achievements

2017-18 has been a year of some very significant achievements. It was a year in which, we were inducted in the 'Hall of Fame' at CNBC-TV18 OVERDRIVE Awards 2018, which indeed is a proud achievement for us. In addition to this, Mrs. Rashmi Urdhwareshe, Director – ARAI was conferred with 'Engineering Excellence Award' by SAE Foundation. It is a matter of further pride that Mr. C. V. Raman, Executive Director – Engineering, Maruti Suzuki India Ltd. and Vice President – ARAI also received the similar award in the same function.

Also, during the year ARAI was granted 'Copyright' for our databank on Chemical, Mechanical, Physical and Dynamic Properties of Automotive Grade High Strength Steels (AHSS) by the Copyright Office, Government of India.

Our commitment to excellence and innovation served us well once again in 2017-18, unlocking another year of strong performance. Our Operational Income grew by 15.4% as compared to last year. Also, we continued to extract value from our portfolio of opportunities, including the leadership position we enjoy in certification segment, by becoming the first certification agency in India to issue the first BS VI Certification. Our focus on research is building many more capabilities and competencies, resulting in new offerings to our customers, not limiting to automotive, but also to other sectors like defence, consumer durables and healthcare.

Excellence and Innovation

... we continued to extract value from our portfolio of opportunities, including the leadership position we enjoy in certification segment, by becoming the first certification agency in India to issue the first BS VI Certification.

We recognize technology is key for efficient managing of our processes. Accordingly, this year we commenced implementation of SAP which will enable bringing in a uniform system and a single platform for managing our business processes. Along with this, administrative procedures are being tightened with deployment of technology to enhance confidentiality and integrity of information. This, I am sure will further boost our credibility and trust amongst our customers.

We also recognize that for an institute like ours, cost savings alone cannot drive our long term performance. Growth is the key factor for long-term success and it means that our business is dependent on continuous innovation, whether this is in the form of development of new technologies / solutions or process improvements. And so, we continued to tread the path towards leveraging our strengths for developing reliable and affordable solutions through strategic research and collaborations. The year saw successful completion of five projects supported by Department of Heavy Industry (DHI) on lightweight forging process development; methodology development for estimating vehicle operating cost; power boosting of small (single & two cylinder) diesel engines by supercharging approach; development & implementation of smart structural system concepts; and preparation of draft standards for AC / DC Charging Stations for xEV application. In addition to these, another five projects (supported by DHI) and two projects (funded internally) are being implemented. A notable progression in one of the ongoing DHI supported projects is successful development of a prototype of light weight low floor city bus with Aluminium Superstructure meeting Bus Body Code (AIS – 052).

"Growth is the key factor for long-term success and it means that our business is dependent on continuous innovation, whether this is in the form of development of new technologies/ solutions or process improvements".

"At ARAI, we constantly take cognizance of the changing dynamics and appropriately build these into our plans in order to address the challenges and take advantage of the emerging opportunities"

At ARAI, we constantly take cognizance of the changing dynamics and appropriately build these into our plans in order to address the challenges and take advantage of the emerging opportunities. In line with this, we invested in technology, infrastructure, human resource development and internal processes in order to connect with our customers more effectively. The overall focus was on creating a portfolio that focuses on value and addresses the specific needs of our customers. We established Environmental Research Laboratory (for air quality & vehicle exhaust monitoring); Virtual Calibration Centre (for faster calibration of vehicles to meet BS VI norms); Transmission and Gear Box Test facility; in-house Test Rigs development for various tests etc. during the year. We firmly believe that these state-of-the-art facilities differentiate and put us ahead of our competition.

Fostering diversity of thoughts, disciplines and experience is fundamental to our approach. We are actively pursuing cross-functional development of our human resource across the institute. A separate cross-functional group christened as 'Technology Group', is working in the areas like Green Mobility, Adaptronics, Intelligent Controls etc. for developing technology solutions for the future. At the same time, we are also focusing on competency development in specific domains like BS VI, Simulation and Transmission.

The year saw us contributing to a great extent as a Technical Secretariat for standardization and harmonization activities. This year, nine Automotive Industry Standards (AIS) were released taking the total standards published till date to 187, covering wide range of subjects for different categories of motor vehicles.

On the knowledge dissemination front, our Training Centre organized about 50 Proficiency Improvement Programmes (PIPs) and Domain Training Programmes (DTPs) for industry personnel in various automotive engineering domains. Our Learning Centre through its collaborations with national and international universities continues to offer undergraduate, postgraduate and doctorate programmes with specialization in automotive engineering.

Looking Ahead

We move into the future with optimism and purpose, confident in our leadership role in developing solutions that unlock the potential for our progress. In doing so, we are committed to delivering superior value to our stakeholders, customers, partners and communities – safely, responsibly and ethically in any operating environment.

Looking Ahead

"We move into the future with optimism and purpose, confident in our leadership role in developing solutions that unlock the potential for our progress and prosperity. In doing so, we are committed to delivering superior value to our stakeholders, customers, partners and communities - safely, responsibly and ethically in any operating environment'

I take this opportunity to thank the Vice President & Members of the Governing Council; Director – ARAI; Department of Heavy Industry (DHI); the Chairman and Members of Finance and Internal Audit Committee; the Chairman and Members of Project Evaluation and Monitoring Committee; and ARAI Members for their valuable support. I would also like to thank all our employees, associates and last but not the least our customers for the continued support and faith reposed in us. I am sure, with your continued support we will race ahead with the same energy and positivity to build a vibrant future.

Vikram Kirloskar

Mrs. Rashmi Urdhwareshe
Director

Director's Report

The Governing Council of ARAI has great pleasure in presenting the Annual Report along with Overview of Operations and Audited Statement of Accounts for the year ending 31st March 2018.

2017-18 was an exciting year at ARAI as we demonstrated strong delivery and over 15% growth in Operational Income, which validates both the strength and the potential of our institute. I am grateful to the Governing Council and my colleagues at ARAI for all that they have done to deliver this.

We are driven by the quest to develop affordable solutions for our customers, thereby, enhancing access to otherwise expensive technologies. Our steadfast commitment to innovation has enabled us in designing & developing successfully an Aluminium Superstructure for a low floor city bus, which meets Bus Body Code AIS:052 requirements. Also, we leveraged our innovation model to develop solutions for implementing smart structure concepts in automobiles and in developing a simulator for interoperability of Bharat EV Chargers. We are now harnessing our capabilities in automotive electronics to develop intelligent vehicle technology features like parallel parking & lane keep assistance and converting IC Engine Vehicle to Hybrid Electric Vehicle (HEV).

We are driven by the quest to develop affordable solutions for our customers, thereby, enhancing access to otherwise expensive technologies.

Our strategy to build capacities and capabilities for meeting industry's future needs has demonstrated its value this year, with ARAI becoming the first certification institute in India to issue BS VI certification. Another noteworthy aspect in certification activity has been certification of Electric Buses. Similarly, the evaluation exercises carried out on medical equipment has added the healthcare sector to our clientele list.

Our business has evolved to a size and scale that is poised to address national as well as global opportunities

Our business has evolved to a size and scale that is poised to address national as well as global opportunities. We have crossed many credibility milestones in our journey so far, during which we have successfully delivered several assignments across our verticals. At the heart of this momentous journey are our dedicated, innovative and talented employees and the Governing Council that has been supportive and a guiding factor. I firmly believe our continuing success and sustainability will be determined by our ability to keep creating new solutions that meet our customers' needs.

I wish to thank Team ARAI for the continued dedication. It is their hard work and commitment to excellence that drives our institute day to day. We value the trust reposed on us by our stakeholders and customers. All these mean ARAI has a strong foundation, a clear path forward and a bright future.

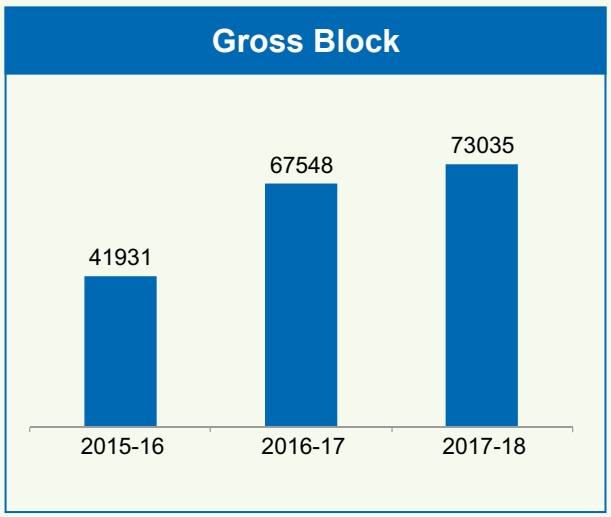
Looking towards the future – we are working to develop generations of talent inside and outside our organization; proudly and responsibly leading in the certification business; and leveraging technology to improve efficiency and productivity. And above all, we are creating value for our stakeholders, customers, partners and communities.

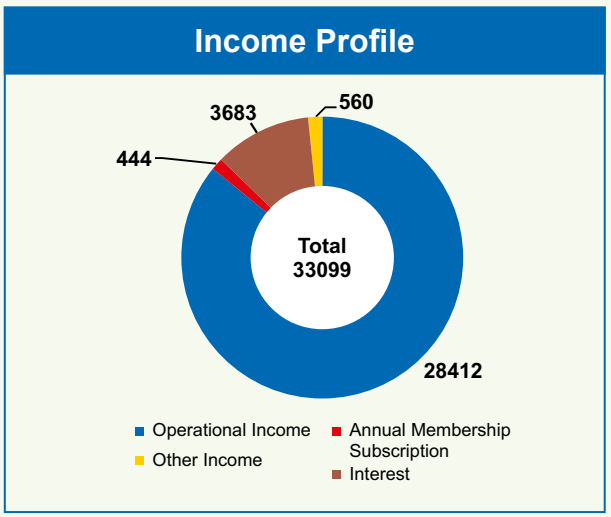
...we are working to develop generations of talent inside and outside our organization; proudly and responsibly leading in the certification business; and leveraging technology to improve efficiency and productivity

On behalf of Team ARAI, I would like to thank the President, Vice President, Senior Officials from the Department of Heavy Industry (DHI), Members of the Governing Council, Members of Finance & Internal Audit Committee, Members of Project Evaluation & Monitoring Committee, and ARAI members for their continued support.

Mrs. Rashmi Urdhwareshe

Key Indicators: 2017-18





Operational Highlights

Finance & Accounts

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

- **Financial Performance**

  ARAI has continued to show excellent performance during the Financial Year 2017-18. The Income Target has been achieved and Operational Income has gone up by 15.43% to Rs. 28,411.82 lakh as compared to Rs. 24,614.67 lakh in Financial Year 2016-17. Total Income, including membership subscription, interest, etc. has reached a figure of Rs. 33,099.33 lakh (excluding funds transferred from R&D reserve fund) as compared to Rs. 28,913.41 lakh of last year. This is the result of several measures undertaken in overall ARAI governance, in areas such as finance, purchase, invoicing procedure, time management, productivity improvement, competence building, Human Resource Development, etc.

- **Investment of funds**

  The cash & Bank assets available with ARAI have been invested in Scheduled Banks / Financial Institutions in various Deposit Schemes as per Government guidelines.

- **DHI Supported Projects**

  Projects approved by the Sanctioning Committee out of Automobile Cess Funds are funded by Department of Heavy Industry (DHI), Ministry of Heavy Industries & Public Enterprises, Government of India are Cess Projects and projects approved by DHI's Project Implementation and Sanctioning Committee (PISC) under FAME-India Scheme are Plan Projects. ARAI also takes up R&D projects funded from its internal funds.

- **Appointment of Statutory Auditors**

  M/s P.G. Bhagwat, Chartered Accountants, Pune was appointed as Statutory Auditors for the Financial Year 2017-18, in the Annual General Meeting held on 7th September 2017.

- **Membership Subscription**

  The total number of members of ARAI as on 31st March 2018 is 78 and the Annual Membership Subscription for the year under report is Rs. 444.31 lakhs.

- **Recognition by DSIR**

  The Department of Scientific & Industrial Research, Ministry of Science & Technology, Govt of India, has renewed recognition to ARAI, as a Scientific and Industrial Research Organisation (SIRO), for further period from April 2017 to March 2020.

- **Income Tax**

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

Research Projects

During the year, five DHI supported projects were successfully completed. The same along with their outcome are given below.

- Study and development of Lightweight Forging Process for automotive components
  - Lightweight forging process achieved using multi material concept
  - Forged Connecting Rod of Steel and Aluminium developed
  - Mathematical tools developed for die wear, load and friction prediction
- Development of Duty Cycle of Public and Goods Transport Vehicle separately (intercity bus and truck application) and arrive at guidelines for estimating vehicle operating cost models with respect to pavement conditions
  - India specific usage pattern / duty cycle generated for intercity bus and 16 ton truck for design optimization and testing
  - Understanding the effect of pavement conditions on the vehicle operating cost viz. fuel consumption & tire wear
  - Mathematical model for prediction of Vehicle Operating cost with respect to pavement condition
- Study of multi-disciplinary approaches / challenges in light weighting / performance improvements with focus on design optimization of components, systems
  - Multidisciplinary Optimization of Chassis – Combined effects of all aspects like structural stiffness, modal frequencies and durability studied for arriving at guidelines for design and development of efficient structures
  - Smart Structure Concept Implementation – Software, Hardware & Controls designed & developed for IMA (Inertial Mass Actuator) and implemented on steering wheel for vibration reduction
  - Different Smart Structure Applications – Proof of Concept (POC) developed using smart materials and smart structure techniques for structural health monitoring (SHM), energy harvesting, shunt damping, use of IOT (Internet of Things) technique and actuator developments
- Supercharging of Small (Single and Two Cylinder) Diesel Engines
  - Power boosting of Single & Two Cylinder Engines by supercharging approach successfully demonstrated
- Preparation of Draft Specifications and Standard for AC/DC Charging Stations for xEV Application under Indian Conditions
  - Standards for AC and DC Charging Stations for xEV Application under Indian conditions prepared
  - Specifications of Bharat EVSE AC and DC prepared

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 of in-use vehicles. Under this programme initiated by MoRTH, ARAI has already facilitated establishment of Nashik Test Centre in Maharashtra, Nelamangala – Bengaluru, Surat - Gujarat. In addition to this centre, ARAI is currently facilitating establishment of such centres in another five states and three more centres for a State Transport Department. Apart from this, ARAI has been awarded with contracts for ten more centres by one of these states.

ARAI – Homologation and Technology Centre (ARAI – HTC), Chakan

ARAI's Homologation and Technology Centre (ARAI – HTC) at Chakan is providing services to the industry with a customer centric approach. This centre has achieved two significant milestones during the year. The Passive Safety and Powertrain Engineering laboratories at this centre have received NABL accreditation for ISO 17025. The other milestone achieved is it has crossed a landmark of 100 crash tests conducted for the customers.

Business Development Initiatives

- Organizing of International Transportation Electrification Conference India (ITEC India 2017) jointly with SAE India, IEEE IAS
- Organizing of Asian Automotive Institutes Summit (AAIS) jointly with JARI, Japan
- Hosted conference on Industry 4.0 organized by FICCI and ARAI
- Introduction of new services, viz. BS VI Certification & Development Testing, On-road Emission Measurement for LDV & HDV using PEMS, Testing of Charging Stations, Stretcher Validation on Sled as AIS 125, Virtual Testing for Windscreen Wiping Area, Multi-domain Simulation of Vehicle Interior Components, Design & Development of Air Suspension etc.
- Collaboration with 'The Energy and Resources Institute' (TERI), Delhi as a consortium partner for an on-going DHI funded project on 'Source Apportionment study of Particulate matter for identification of major sources in Delhi NCR'
- MoU with Transvalor, France for carrying out collaborative research & development in the area of die wear prediction

Systems Compliance and Quality Management

- Successful NABL Assessment of enhanced Mechanical Testing Scope of HTC-PSL (Crash Test Facility) & HTC-PTL (Vehicle Test Cell)
- Successful completion of BIS Surprise Audit for Tyres & Safety glass scope
- Successful completion of NABL Desktop Audit-2017 for Calibration Department and Testing Scopes
- System documentation as per revised standards ISO9001-2015 & ISO14001-2015
- Adoption of updated Standards-ISO9001-2015 & ISO14001-2015: Four new system procedures added and 21 existing procedures reviewed and updated
- In-house Internal Auditor Training on ISO 9001-2015 imparted to 36 internal auditors by experienced trainers from TUV SUD
- MPCB Consent to Establish granted for ARAI – HTC Phase II and ARAI – FID Phase II (Academy)
- MPCB Consent to Operate renewed for ARAI – Kothrud

Corporate Social Responsibility (CSR)

ARAI considers Corporate Social Responsibility (CSR) as a very important part of its business. Our approach has been to make enduring social impact by supporting programmes of NGOs in the areas of education, health, community development etc. so as to build sustainability. This year, we provided financial assistance to 12 NGOs to support their programmes in areas relating to education, healthcare, water conservation, community development etc.

Implementation of 'Go Green' Initiatives

At ARAI, we are committed to protect our environment by bringing in environmental friendly initiatives. During the year, a host of initiatives on reducing energy consumption, saving water, etc. were implemented.

- Plantation of native and medicinal plants across ARAI
- Real time power factor controllers to minimize energy consumption
- Use of LED light fixtures for energy conservation
- Timer for power on / off switching of street lights
- Air condition systems planned with Green Gas Technology with variable speed compressor
- VRF Air Conditioning System planned with R410 for office areas
- Test cells HVAC systems to be with optimized fresh air for energy efficient operations
- Motion detectors at toilets and passage area
- Zero discharge facility

ARAI
Progress through Research

Overview of Operations

- Development and Testing Activities
- Human Resource Development
- Corporate Social Responsibility (CSR)
- Technology / Research Publications
- Business Development
- Events
- Knowledge Centre
- ARAI Homologation and Technology Centre (ARAI - HTC), Chakan

Development and Testing Activities

ARAI undertakes research, developmental, testing and certification projects for the automotive industry. Some of the projects in design, development, validation and evaluation areas undertaken during 2017-18 are given below.

- **Lightweight Bus Proto Building**

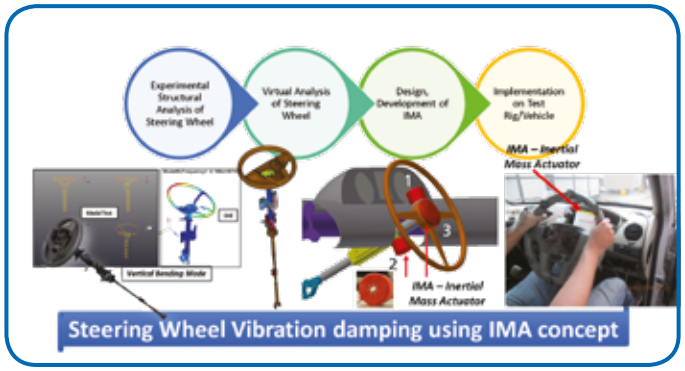
  This is a DHI supported project on building lightweight bus prototypes (low floor and semi-low floor) with Aluminium Superstructure for Indian city application meeting Bus Body Code, AIS:052 requirements. Also, design for a High Deck bus is being developed in this project. Under this project, Aluminium Superstructure has been designed, developed and integrated with

Prototype of Low Floor Bus with Aluminium Superstructure

the steel chassis of 12 m low floor bus after removing the steel superstructure considering Indian road load inputs. The integration activity, while building this prototype, has been carried out with mechanical fasteners and welding has been totally eliminated for better strength and load carrying capacity. Further, the Aluminium Superstructure has been seamlessly integrated with other bus sub systems like air-conditioning system, instrument panel, passenger entry and exit door. This developed prototype meets the Bus Body Code AIS:052 requirements and also strength requirements mentioned in UBS-II of MoUD. It is also equipped with fire detection and suppression system (FDSS) along with ITS for enhanced safety. Improved bus fuel saving for city application, corrosion resistance and low bus body maintenance cost are some of the salient features. Similarly, prototype building of a semi-low floor bus and design of high deck bus with aluminium superstructure meeting bus body code, AIS:052 requirements are nearing completion.

- **Smart Structures**

  This DHI supported project was on implementing smart structures (vehicle concepts) in automobiles. These smart structures facilitate monitoring and enhancement of mechanical properties of parts with the help of advanced methods of structural dynamics, signal processing and through integration of novel sensors and actuators. This project has helped in building competency in design and development of energy efficient light weighting structures / vehicle concepts with focus on design optimization. It involved various activities like vibration damping of components, use of inertial mass actuators, multi-disciplinary optimization of chassis components, structural health monitoring of automotive components, energy harvesting using piezo-materials etc. PoCs developed in this project are useful in technology enhancement of different automobile components, viz. steering, suspension, chassis etc. and to enhance vehicle performance in multi-disciplinary aspects.



- **Green Mobility – Converting IC Engine Vehicle to Hybrid Electric Vehicle (HEV)**

  ARAI had previously configured and built an Electric Vehicle (EV) out of a conventional intra-city Public Transport Small Commercial Vehicle. To take this competency further, ARAI is now working on converting an IC Engine Vehicle to Hybrid Electric Vehicle (HEV) with focus on technology demonstration of stability, durability and safety aspects. The methodology includes studying different architectures & components of HEV; benchmarking & target setting; control strategy development; design of transmission, mounting of motor, controller & battery; cooling system; and necessary design modifications in the existing vehicle. This is followed by virtual simulation for vibration, durability and crash analysis using CAE techniques. The developed prototype comprises of indigenously designed hybrid vehicle components, which have been integrated and assembled on the existing vehicle. The current status is that the motor has been integrated with the existing transmission & mounted on the vehicle. Subsequent to this, its functional testing has been completed successfully on Chassis-dyno in EV mode. HEV control strategy development and calibration of the vehicle is in progress.

- **Clean Energy – Lithium-ion Battery Pack for EV**

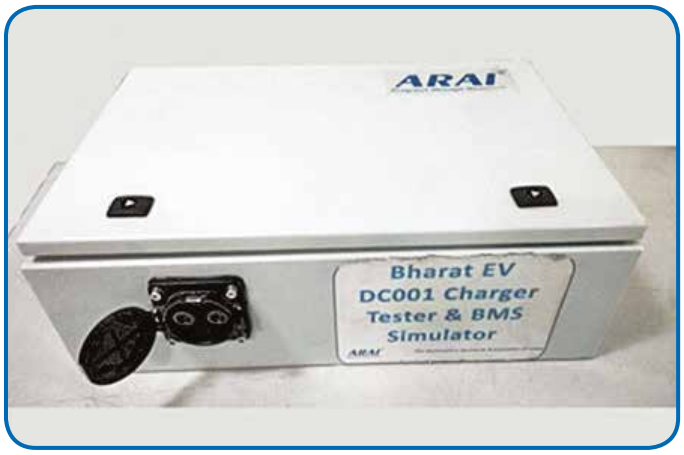
  This project is on design and development of a modular Battery module of an EV Battery Pack. It also includes developing a methodology for Multi-dimensional Electro-chemical and thermally coupled simulation for different chemistry of Lithium-ion batteries using simulation software. Under the project, literature survey has been carried out to study the cells, their electrochemistry, interior structure as well as thermal management requirements for the battery pack along with study of different testing standards of batteries. Further to this, geometry and chemistry of different batteries was analyzed for selection of appropriate battery for the targeted application. Subsequent to this, Electro-chemical and Thermal analysis of the batteries was carried out to study the heat generation rate for different load cycles, capacity fade testing of batteries, internal resistance determination, capability testing and road profile testing. Further, virtual validation of the design modules for static strength and thermal management has also been completed. The battery module being designed in this project will provide firm support to the assembled batteries and will have efficient thermal management system to maintain temperature uniformity throughout the module. The present status of the project is that Multi-dimensional Electro-chemical and thermally coupled simulation for different chemistry of Lithium-ion batteries has been completed and its validation is in progress. Also, validation of the developed RPT model of the module is in progress.

RPT Model of Modular Battery Module

- **Simulator for Interoperability of Bharat EV Charger (BEVC) DC-001 Chargers**

  A Simulator, useful while testing Charging Stations, has been developed in-house at ARAI. This developed simulator is ARAI's contribution to 'Make in India'

initiative of the government. It simulates vehicle environment and conditions during offline testing and validation of BEVC DC-001 charging stations. It is capable of interfacing with different types of DC charging stations. Salient features of this simulator include simulation of vehicle level environment, useful for system inspection, verification & validation, communication protocol validation, fault simulation, data logging etc.



Bharat EV DC001 Charger Tester

- **Power Boosting of Single and Two Cylinder Diesel Engines using Supercharger**

  This DHI supported project on power boosting of single and two cylinder diesel engines by supercharging approach has been successfully completed. The outcome achieved was demonstration of enhanced specific power from single & two cylinder diesel engines by supercharging approach with 30-40% increase in power over NA version and offering downsized diesel engines. For this purpose proto engines with supercharging configuration were built, which involved engine identification; baseline data generation, validation & optimization; design of modified components & its prototype development. The proto engines with SC configuration were then optimized to achieve the targeted objectives.

Two Cylinder Supercharging for Off-Road Application

- **Dual Fuel (Diesel-CNG) Engine for CEV**

  This project, a first of its kind for off-road application, was on conversion of existing diesel engine to dual fuel operation. It involved establishing the engine calibration strategy to achieve maximum diesel replacement and demonstrating the stable & fuel efficient dual fuel vehicle operation in field. The key milestones achieved include:

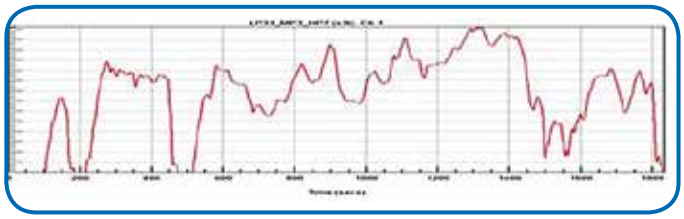
  - Demonstration of diesel replacement on engine & vehicle
  - Dual fuel engine performance & emission demonstration on engine dynamometer with finalized dual fuel system configuration.
  - Maximum 70% diesel replacement in field operation
  - Average 42% diesel replacement as per customer field duty cycle
  - 8% improvement in BSFC observed on engine test bed for customer duty cycle
  - Average 70% reduction in smoke levels on engine test bed for customer duty cycle

Dual Fuel (Diesel-CNG) Engine for CEV

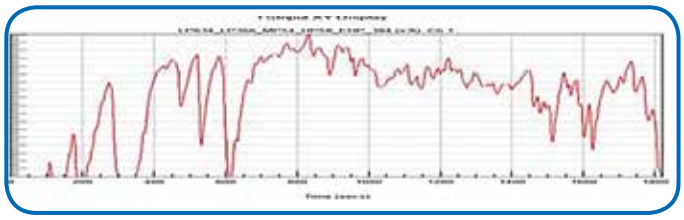
- **Duty Cycle of Public Transport Vehicle**

  Under this DHI supported project, duty cycle has been developed for intercity Bus & Heavy Commercial

Vehicle – 16 ton (HCV). It involved development of an On-Board Data Logger Device for acquisition of GPS & OBD parameters, instrumentation of Fleet Bus / HCV-16 ton with On-board Data Logger, real world vehicle usage pattern data collection in the northern, central and southern regions in India and condensed Duty Cycle development. Condensed duty cycle of 30 minutes which statistically represents real driving pattern was developed from a vast quantum of data acquired. Also, a mathematical model for predicting Vehicle Operating Cost (VOC) components under different vehicle operating conditions, viz. road type (concrete vs. asphalt), road traffic condition, hilliness, road roughness condition has been developed covering aspects like tire wear, fuel consumption and vehicle maintenance.



Generated Duty Cycle for Truck



Generated Duty Cycle for Bus

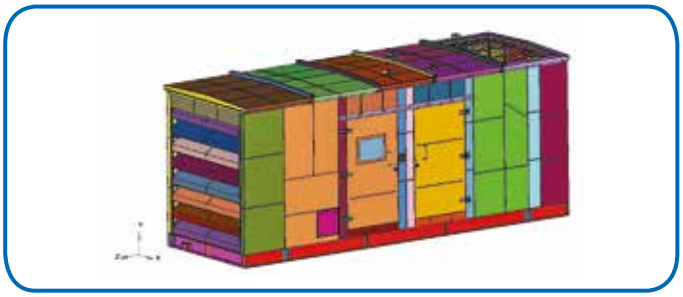
- **Synchronizer Gear Shifting Force Prediction**

  The objective of this project was prediction of gear shifting force for actuator selection in hybrid transmission. Herein, MBD approach was used for modelling and simulation of 5 speed manual and 7 speed automatic transmission gear pairs. It involved detailed modelling of synchronizer assembly, capturing physical behaviour for all synchronizer pairs and correlation of simulation results with test data for sliding ring force.

MBD Model for Hybrid Transmission

- **SEA Simulation**

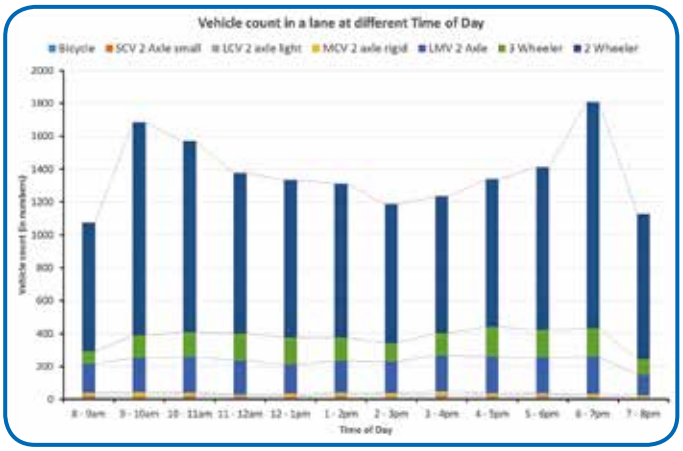
  SEA Simulation software was deployed in various projects during the year. A significant one was on design optimization of high capacity DG Set enclosure (including canopy & silencer) to meet CPCB norms of 75 dB(A) @ 1 metre along with validation. The outcome of the project was 11% reduction in enclosure volume and 27% reduction in silencer volume. Another significant project successfully undertaken was designing of air cooled DG Set enclosure (including canopy & silencer) with noise level of 73 dB(A) @ 1 metre along with validation.



- **Certification, Validation & Testing Projects**
  - BS-VI Certification and Development Testing
  - Evaluation as per FAME guidelines
  - Type Approval of EVs and HEVs as per Crash Norms
  - Type Approval of Child Restraint Systems as per AIS 072
  - Assessment of Survival Space for Buses as per UN R66.02
  - Full-fledged testing of Child Restraint Systems as per AIS 072 and UN R44
  - Testing of Large Passenger Buses for Laden Rollover condition as per UN R66.02 requirements
  - Stretcher Validation on sled as per AIS 125 (Ambulance Code)
  - TRIASS 33 Rear Impact Crash Test

- Testing of Charging Stations
- Testing of Vehicle Tracking System as per AIS 140
- Testing of Vehicle Safety Functions as per AIS 145 covering speeding alarm, safety belt alarm, reverse parking assistance system, etc.
- Testing of Ambulance Electrical Safety as per AIS 125 covering electrical installations in Ambulance
- Noise Compliance Test for Unmanned Aerial Vehicle at 300 m slant height from ground
- Wiring harness (AIS 024-28, AIS 052, AIS 123 and AIS 140)
- Auto interior materials for flammability
- Brake-fluid and hoses
- Latches and hinges
- PU foam for bus seats (AIS 052)
- Painted panels (AIS 052)
- EPDM rubber weather strips (AIS 085) and rubber mounting (AIS 066)
- Measurements of Truck Cabin Ventilation System for Category N2 & N3 Vehicles as per AIS 056 Rev. 01
- Constructional & Functional Requirements for Road Ambulances as per AIS 125 (Part 1)
- Measurement of Air Intake Depression and Exhaust Back Pressure as per Part IV & Part X- Sub part B of MoRTH/ CMVR/ TAP-115/ 116-Issue 4
- Compliance to requirements of Central Motor Vehicle Rules (CMVR) 1989 for Constant Speed Fuel Consumption Test as per IS:11921-1993
- Code of Practice for Bus Body Design & Approval as per AIS 052 (Rev 1) & its Amendment No. 1 to 8 for Sleeper Coach Buses
- Initiation of trials on vehicles as per UN R 151 with related instrumentation and Calculation methods
- Validation trials for endurance running-in of Passenger Cars & 2-W vis-à-vis Indian road, load and climatic conditions
- Tyre Testing for fuel efficiency benchmarking on different makes of tyres
- Evaluation of Coast Down parameters as per AIS 137 for BS VI Vehicles

- **Traffic Survey for Pune Metro** has been carried out to measure hourly and lane-wise traffic distribution by considering different parameters like total count of passing vehicles and category identification of flowing traffic i.e., truck, bus, 2W, 3W, etc.



Human Resource Development

ARAI comprises of a synergistic family of around 700 employees. We, at ARAI, constantly strive to build and sustain an engaging work environment that inspires our employees to showcase their excellence. It has been our pursuit to unlock the superior potential of our workforce through various training programmes targeted at enhancing domain skills and leadership development.

Leadership Development

Outbound leadership development programme was initiated to build, groom and develop leadership competencies in-line with ARAI's strategy for the future. This intervention was for building an empowered team culture, challenge processes and foster a culture of continuous improvement. This programme helped in setting up open channels of communication between senior management team members and the second line.

Developing Competencies

It has been our pursuit to focus on unlocking the latent skills and developing competencies of our employees through a variety of learning initiatives like classroom training / workshops / lectures by experienced trainers. Implementation of these initiatives resulted in imparting of 19979 man-hours of training to the employees in technical, behavioural and functional areas. Moreover, considering the emerging needs of the industry, specific training programmes for competency development in BS – VI, Simulation, Transmission and Autonomous Vehicle were also organized.

Competency Mapping

Competency mapping exercise has been taken up at ARAI, which will help in succession planning and career development of the employees. As part of this exercise, a systematic approach is being adopted for understanding the critical processes, identifying job specific competencies (technical & behavioural) and mapping them with the existing scenario. This is being planned for both junior and senior level executives.

Facilitating Conducive Work Environment

We, at ARAI, endeavour to build and sustain an engaging work environment that inspires people to devote skills and efforts for enhancing productivity and engagement. Our Annual Day celebration is one such gathering, where not only the employees, but also their family members are encouraged to actively participate and showcase their talents in various cultural activities. The competitions organized in various sports emphasized the importance of fitness and helped in building team spirit. Further, during the year, we recognized the achievements of the employees by way of various awards like model employee of the year, special recognition award, welfare awards, merit awards for employees' children etc. Other events organized during the year included celebration of Independence Day & Republic Day; National Safety Week; Blood Donation Camp; Yoga Day; and Environment Day.

Environment Day Celebrations –
Pledging to Protect the Environment

Yoga Day Celebrations –
ARAI Employees at a Yoga Session

Corporate Social Responsibility (CSR)

Corporate Social Responsibility (CSR) has been an integral part of ARAI's activities since 2008. In line with this commitment and as a socially responsible organization, ARAI has invested voluntarily in various CSR programmes aimed at making a difference to the lives of marginalized communities. These activities are carried out by ARAI employees voluntarily, through SRSG (Social Responsibility Support Group). The projects supported under CSR are primarily in the areas of Education, Healthcare, Community Development and Environmental Protection. During 2017-18, ARAI has provided financial assistance to NGOs for various procurements under their welfare projects as given below.

COMMUNITY DEVELOPMENT:

- Ambulance for mentally challenged students of Swa-Aadhar Kendra, Osmanabad
- Artificial limbs for 30 disabled persons to Navbharat Vikas Foundation (affiliated to Bharat Vikas Parishad, Pune)
- Diesel Generator Set for the students of Torana Rajgad Parisar Samajonnati Nyas, At. Post Velhe, Dist. Pune
- 50 Bunk Beds to The Mother Teresa Samajik Vikas Sanstha, Latur & Pune
- LCD projector and sponsorship of trophies to Deepastambha Charitable Trust
- Lockers for the benefit of resident students of The Sri Sai Guru Seva Sanstha, Pune
- CCTV System to Pakhar Sankul, Solapur

EDUCATION:

- School bus to Swatantrya Veer Savarkar Education Trust, Dahanu, Dist. Thane
- Computer accessories to Amcha Ghar, Uttan, Bhayander, Thane for their computer lab
- Science laboratory apparatus and lab furniture to New English School, Pimple, Tal. Purandar, Dist. Pune

HEALTH:

- Blood Collection Monitors to Janakalyan Raktapedhi, Pune

WOMEN EMPOWERMENT:

- Embroidery Machines for physically challenged women to Shree Chaitanya Charitable Trust, Pune

Ambulance to Swa-Aadhar Kendra, Osmanabad

Computer Accessories to Amcha Ghar, Uttan, Bhayander, Thane

Blood Collection Monitors to Janakalyan Raktapedhi, Pune

Technology / Research Publications

- 'Design Methodology for Gear Shift Map of Automated Manual Transmission' by R. V. Mulik & S. S. Ramdasi of ARAI and Vikram Mali & Ashok Mache of Vishwakarma Institute of Information Technology in August 2017 at 2nd International Conference on Advances in Materials and Manufacturing Applications, IConAMMA – 2017, Bengaluru
- 'Simulation of Radiated Emission as per AIS-004 using Feko' by H. Rajesh, S. S. Dandge and R. S. Mahajan in August 2017 at Altair Technology Conference, Pune
- 'Multiple Control Parameters and Functional Mode Considerations for Gasoline EMS Engine Control Unit – A Survey' by Supriya J. Kalyankar-Narwade & C. Ramesh Kumar (ARAI Academy Students) and Dr. S. A. Patil of ARAI in August 2017 at International Conference on MicroElectronic Devices, Circuits and Systems (ICMDCS), Vellore
- 'Design and analysis of Governor System in Diesel Engines using MBD Approach' by M. S. Bhatkhande in October 2017 at MSC International User Conference 2017, Bangalore
- 'Production and engine performance & emission evaluation of karanja & jatropha based biodiesel' by Akash Patel (ARAI Academy Student), Nagesh Chougule (CoEP), J M Babu (VELTECH University) and Aatmesh Jain & Dr. K. C. Vora of ARAI in October 2017 at 19th Asia Pacific Automotive Engineering Conference (APAC) & SAE-China Congress 2017, China
- 'Optimization and Parametric Analysis of Under Run Protection Devices for Heavy Commercial Vehicle' by Ashpak Kazi (Academy Student), M.R.B. Agrewale & Dr. K. C. Vora in October 2017 at 19th Asia Pacific Automotive Engineering Conference (APAC-2017), China
- 'Risk Management for Public Transport System' by Ashlesha Ithape, Shubham Bannore & Manish Ingale (ARAI Academy Students) and K. P. Wani & Dr. S. A. Patil of ARAI in November 2017 at Annual Urban Mobility India Conference 2017 (UMI 2017), Hyderabad
- 'DG Set Noise Control' by P. S. Yadav in November 2017 at ANV 2017
- 'Enclosure Noise Simulation' by P. S. Yadav in December 2017 at ESI 2017
- Key note on 'Automotive NVH Future Perspective' by N. V. Karanth in December 2017 at ANV 2017
- Key note on 'Digital Twin' by N. V. Karanth in December 2017 at ESI 2017
- 'Material Characterization of Lithium-ion Battery Cells by Scanning Electron Microscopy & X-Ray Diffraction Techniques' by P. K. Ajeet Babu, Asmita S. Waghmare, Suhail M. Mulla, Ujjwala S. Karle and M. R. Saraf in December 2017 at International Transportation Electrification Conference India (iTEC-2017), Pune
- 'Dynamic charge acceptance estimation of Lithium-ion Batteries for Electric and Hybrid Electric Vehicles for enhanced regenerative capabilities' by Mahesh Padmanabh in December 2017 at International Transportation Electrification Conference India (iTEC-2017), Pune
- 'Development, Analysis and Testing of an Electric Vehicle' by Dr. K. C. Vora, M.R.B. Agrewale & M. M. Desai of ARAI, Himanshu Mishra of Mahindra & Mahindra, and Omkar Narkar (VIT University) in December 2017 at International Transportation Electrification Conference India (iTEC-2017), Pune
- 'Design & Optimization of A-pillar of Passenger Car' by Shreyas Sarage (ARAI Academy Student), M.R.B. Agrewale & Dr. K. C. Vora in December 2017 at 4th International Conference on Computational Methods in Engineering and Health Sciences, (ICCMEH-2017), Bengaluru
- 'Design and Analysis of Two Wheeler Hybrid Electric Vehicle for Optimized Performance with Indian Driving Condition' by Rushikesh Joshi, Nagesh Choughule & Manish Ingale (ARAI Academy Students) and K. P. Wani & Dr. S. A. Patil of ARAI in December 2017 at 7th International Conference on Power Systems (ICPS), Pune

- 'Study of combustion behaviour and emission formation of compression ignition engine under transient operating conditions using simulation tools' by M. Nikhil (VIT University) and Dr. Brijesh Patel of ARAI in December 2017 at 11th Asia-Pacific Conference on Combustion (ASPACC) 2017, Sydney, Australia
- 'Effect of in-cylinder injection strategies on performance and emissions of gasoline direct injection engine using simulation tools' by P. Kamlesh (VTU), D. Sourabh of Convergence Science and Dr. Brijesh Patel of ARAI in December 2017 at 11th Asia-Pacific Conference on Combustion (ASPACC) 2017, Sydney, Australia
- 'Transient simulation of a heavy duty turbocharged multi cylinder diesel engine' by V. Sandeep (VIT University), S. K. Pandey & V. Devanandh of Ashok Leyland and Dr. Brijesh Patel of ARAI in December 2017 at 11th Asia-Pacific Conference on Combustion (ASPACC) 2017, Sydney, Australia
- 'Numerical investigation of advanced low temperature combustion techniques in diesel engine' by K. Nikhil (COEP), S. Sreedhara (IIT Bombay) and Dr. Brijesh Patel of ARAI in December 2017 at 11th Asia-Pacific Conference on Combustion (ASPACC) 2017, Sydney, Australia
- 'Development of SCR system with optimized DEF dosing strategy to meet BS-VI emission norms' by K. Dhanyakumar, K. Prachetas, S. Swapnil & P. Amit of Cummins and Dr. Brijesh Patel of ARAI in December 2017 at 11th Asia-Pacific Conference on Combustion (ASPACC) 2017, Sydney, Australia
- 'Quasi-dimensional thermodynamic simulation study of downsizing on a 4 cylinder turbocharged engine' by R. Prajit (VTU), V. Devanandh, S. K. Pandey, K. Senthilnathan & S. Krishnan of Ashok Leyland and Dr. Brijesh Patel of ARAI in December 2017 at 6th International Conference on Advances in Energy Research (ICAER) 2017, IIT Bombay, Mumbai
- 'Evaluation of Selective Reduction Catalyst (SCR) for heavy duty diesel engine using 1D simulation' by M. P. Samant, H. B. Chaudhari and Dr. N. H. Walke in January 2018 at GT User Conference, Pune
- 'Aerodynamics Analysis of Bus Model using Mounting of Fairing and Perforated Structure' by Vishwajeet Kumar & Jayesh Kumar (ARAI Academy students), Kushal Kumar Chode, (VIT University, Vellore) and M.R.B. Agrewale & Dr. K.C. Vora of ARAI in January 2018 at 1st International Conference on Innovations in Mechanical Engineering (ICIME-2018), Hyderabad
- 'Design & Development of Adjustable Handle Bar' by Utkarsh Singh (ARAI Academy Student) and M.R.B. Agrewale & Dr. K.C. Vora of ARAI in January 2018 at International Conference on New Frontiers in Engineering, Science & Technology (NFEST-2018), New Delhi
- 'Analysis of vehicle compatibility with respect to bumper design of M1 vehicles under crash' by Daspute Dheeraj Hari (ARAI Academy Student) and M.R.B. Agrewale & Dr. K. C. Vora of ARAI in January 2018 at Multicon-International Conference On Advances in Mechanical Design, Manufacturing, and Thermal Engineering (IC-DMTE 2018), Mumbai
- 'Aluminium Superstructure City Bus for Indian Road Conditions' by Mr. N. V. Karanth in February 2018 at Arkey Conference on Aluminium & Magnesium as sustainable light weight solution for transport sector, Pune
- 'Effective use of Aluminium in Automotive Light Weighting' by Mr. P. A. Nirmal in February 2018 at conference on Development of Aluminium Alloys & downstream products for Defence, Aerospace & other strategic applications, Nagpur
- 'Aerodynamic Analysis of Commercial Vehicle Using the Platooning Concept' by Aditya Ghawre & Bhuvanesh Jain (ARAI Academy Students) and M.R.B. Agrewale & Dr. K. C. Vora of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai
- 'Computational Aero-acoustic Analysis of Passenger Car with ORVM' by Pathikrit Bhowmick, Dhruv Malhotra & Pranjal Agarwal (ARAI Academy Students), A. Satheesh (VIT University) and M.R.B. Agrewale & Dr. K.C. Vora of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai
- 'Characterization of Soot Microstructure for Diesel and Biodiesel Using Diesel Particulate Filter' by Ritwik Raman, K Jayanth & Indranil Sarkar (ARAI Academy

Students) and Aatmesh Jain & Dr. K. C. Vora of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Performance of Diesel Particulate Filter using Metal Foam combined with Ceramic Honeycomb Substrate' by Hardik Sarasavadiya, Indranil Sarkar, Manthan J. Shah, Ritwik Raman & K Jayanth (ARAI Academy Students) and Aatmesh Jain of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Investigation of Twin Cylinder Direct Injection CI Engine Characteristics using Calophyllum Inophyllum Biodiesel Blends' by Pathikrit Bhowmick, Dhruv Malhotra & Pranjal Agarwal (ARAIAcademy Students) and Aatmesh Jain & Dr. K. C. Vora of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Design And Development Of Fuzzy Logic Control For Semi-Active Suspension System' by Jaydeep U. Funde & N. D. Dhote (ARAI Academy Students) and K. P. Wani of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Design, Analysis and Simulation of a Novel Transmission system for Two-Wheelers' by Enanko Moulick (ARAI Academy Student) and K. P. Wani of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Autonomous Steering Control for Lane Changing maneuver by Gourish Hiremath (ARAI Academy Student) and K. P. Wani of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Development of Data Logger system in two wheeler with Automated Manual Transmission' by Makh Nachiket & Ashish Sonawane (ARAI Academy Students) and K. P. Wani & Dr. S. A. Patil of ARAI in February 2018 at 3rd International Conference on Innovative Design, Analysis & Development Practices in Aerospace and Automotive Engineering (I-DAD 2018), Chennai

- 'Low temperature combustion with two-shot injection strategies for simultaneous reduction of NOx and PM in compression ignition engines' by K. Nikhil (COEP), R. Vehzan & S. Sreedhara of IIT Bombay and Dr. Brijesh Patel of ARAI in February 2017 at International Conference on Sustainable Energy and Environmental Challenges (SEEC-2017), Mohali

Business Development

New Additions - Services & Capabilities

- **EV / HEV:**
  - Testing of charging stations, vehicle tracking system, vehicle safety functions and ambulance electrical safety as per Standards
  - Measurement of AC and Battery Performances under different temperature and driving conditions
  - Characterization of battery materials
  - Performance evaluation of battery operated locomotive

- **Safety:**
  - Child Restraint Systems testing as per AIS072 and UN R44
  - Large Passenger Buses testing for laden rollover condition as per UN R66.02
  - Stretcher validation on Sled as AIS 125 (Ambulance Code)
  - TRIASS 33 Rear Impact Crash test
  - Assessment of high speed camera models

- **Structures:**
  - Brake duty cycle measurement and analysis
  - Vehicle pulling analysis during braking using WFTs
  - Multi axis testing of Air Suspension System of bus
  - Junker vibration test on bolt
  - Torsional stiffness and rigidity study
  - Durability testing of Bonnets, Doors, Tailgates etc.
  - Durability validation of bridle assembly used in naval application
  - Design & development of air suspension
  - Development of test rigs using generic in-house electronics, controller and pneumatic actuators
  - Continuous photography during material testing to capture crack propagation

- **Simulation:**
  - Front bumper guard evaluation through pedestrian lower legform impact simulation as per AIS:100
  - Synchronizer gear shifting force prediction for Hybrid Transmission
  - Simulation based design of products for healthcare application
  - Virtual testing for windscreen wiping area
  - Multi-domain simulation of vehicle interior components
  - MBD model tuning and optimization

- **Emissions:**
  - BS VI Certification and Development Testing
  - On-road emission Measurement for LDV and HDV using PEMS

- **Materials:**
  - Poisson Ratio measurement at non-ambient conditions
  - Strain measurement on round tensile specimen (aluminum)
  - Stress controlled fatigue testing of sheet metals
  - Testing of copper cladded aluminum wires as per JASO D611 and ISO 6722-2
  - Sand paper abrasion testing of automotive cables
  - Fluid compatibility of Bearings (Plastic + Metal) and its characterization
  - Certification of cables for CNG Genset application

• Brand Building

- Organized International Transportation Electrification Conference India (ITEC India 2017) jointly with SAE India, IEEE IAS
- Organized Asian Automotive Institutes Summit (AAIS) jointly with JARI, Japan
- Hosted conference on Industry 4.0 organized by FICCI and ARAI
- Capabilities in design, development, testing and certification of automobiles and automotive components showcased at over 25 exhibitions / seminars
- Technology Day organized at a PSE
- Supplier Meet organized at an OEM

ARAI Stall at Auto Expo 2018

ARAI Stall at ITEC India 2017 Conference

Asian Automotive Institutes Summit (AAIS)

ARAI Stall at Automotive Testing Expo, Korea

• Technical Collaborations / Strategic Tie-ups

- Collaboration with 'The Energy and Resources Institute' (TERI), Delhi as a consortium partner for an on-going DHI funded project on 'Source Apportionment study of Particulate matter for identification of major sources in Delhi NCR'
- MoU with Transvalor, France for carrying out collaborative research & development in the area of die wear prediction

• Workshops / Training Programmes Conducted

- One day Workshop on 'Bus Body Code (AIS : 052)' organized at the behest of Ministry of Road Transport & Highways (MoRTH) for Bus Body Builders, Transport Department Personnel, Representatives of Engineering Colleges
- Workshop on 'Electric Vehicle Technology' for Start-ups
- Workshop-cum-Training Programme on 'Gaseous Fuel & Vehicle Technology for BS IV and BS VI Norms' for Motor Transport Department Officers
- Three Workshops on 'Injection Molding Simulation'
- Workshop on 'Injury Biomechanics'
- Workshop on 'Hostile Vehicle Mitigation' in collaboration with HORIBA-MIRA
- Workshop & Training on Inspection & Certification organized for RTO personnel at Vijayawada and Ajmer

Workshop on 'Bus Body Code (AIS : 052)'

Workshop on 'Electric Vehicle Technology'

Events

INAUGURATION OF ERL AND VCC:

ARAI has established 'Environment Research Laboratory' (ERL) and 'Virtual Calibration Centre' (VCC) for conducting applied research in ambient air management and calibration of vehicles to meet BS VI norms respectively. These facilities were inaugurated by Shri Anant Geete, Hon'ble Minister for Heavy Industries & Public Enterprises, Government of India, on 28th February 2018 at ARAI, Pune. Shri Vishvajit Sahay, Joint Secretary, DHI was also present on this occasion.

Inauguration of Environment Research Laboratory (ERL) by Shri Anant Geete, Hon'ble Minister for Heavy Industries & Public Enterprises, Government of India

Shri Anant Geete, Hon'ble Minister for Heavy Industries & Public Enterprises, Government of India and Vishvajit Sahay, Joint Secretary, DHI at Virtual Calibration Centre (VCC)

Environment Research Laboratory (ERL):

ERL has been established at ARAI with an endeavour to conduct applied research in the field of ambient air management, vehicle exhaust, indoor air quality and vehicle cabin-air for protection of environment and improvement in the quality of precious human life. The research work at ERL will help in understanding the sources & mechanism of pollution caused by automobile exhaust. Further, impact on ambient air will also be studied using scientific tools and techniques at this laboratory. It will also study the effectiveness of control interventions through data & information generated in respect of the corrective actions taken for pollution control from vehicle exhaust. This laboratory is equipped with state-of-the-art facilities for air quality & vehicle exhaust monitoring; analysis of non-regulated pollutants; and evaluation of different fuels.

Virtual Calibration Centre (VCC):

Virtual Calibration Centre with Virtual Test Bed (VTB) has been established at ARAI. This centre is an integration of ARAI's experience and expertise in Simulation, Hardware-in-loop (HiL) Testing and Calibration for BS VI for future product developments with reduced number of prototypes and also to accelerate the time to market. It enables calibration of vehicles to meet BS VI norms at a faster pace as it is carried out in HiL environment. In VCC the physical engine, after-treatment systems and vehicle are replaced with real time high accuracy models retaining real ECU and the critical hardware. The system is suitable for calibration of single to eight cylinder engines of various power capacities, as well as after-treatment systems like DoC, NOx, After-treatment (SCR, LNT), Diesel Particulate Filter (DPF) and Gasoline Particulate Filter (GPF) etc.

ASIAN AUTOMOTIVE RESEARCH INSTITUTES SUMMIT

Asian Automotive Research Institutes Summit (AAIS) is an annual summit initiated by Japan Automobile Research Institute (JARI), Japan. Representatives of various Asian countries from research institutes, academic institutions, test agencies and government officials participate in this summit. The 6th edition of Asian Automotive Research Institutes Summit (AAIS) was organized by ARAI in association with JARI at Pune during 27 – 28 November, 2017. It brought together stakeholders from various Asian countries and served as an ideal forum for exchange of ideas in the areas of automotive technology, regulatory framework, best practices and co-operation for business development. This summit was inaugurated at the hands of Dr. A. R. Sihag, Secretary (HI), Government of India. The other dignitaries at the inaugural function included Dr. Masao Nagai, President, Japan Automobile Research Institute (JARI), Japan; Mr. Shigeru Handa, Managing Director, JARI, Japan; Mr. Jerry Wang, Assistant Vice President, Automotive Research & Testing Centre (ARTC), Taiwan; and Mrs. Rashmi Urdhwareshe, Director – ARAI.

About 37 experts from 8 Asian countries participated in this event and deliberated in areas like active & passive safety, advanced driver assistance systems, smart & intelligent transport systems, future powertrain, future of diesel, future fuels, electric vehicle / hybrid electric vehicle / fuel cell vehicle technology, real driving emissions, end of life, recycling etc. During this event, 29 technical presentations (including 4 Plenary Keynotes) were presented and out of which 15 technical presentations were by international experts.

ITEC INDIA 2017

Launch of ARAI's Centre of Excellence in E-Mobility

International Transportation Electrification Conference (ITEC) is a biennial event which focuses on e-mobility and electric vehicle technology. The second Indian edition of this conference, ITEC India 2017 was organized by ARAI in association with SAE India and IEEE Industry Applications Society at Pune during 13 – 15 December 2017. This conference was supported by Ministry of Heavy Industries and Public Enterprises and Bureau of Energy Efficiency.

ITEC India 2017 was inaugurated at the hands of Dr. Abhay Firodia, President – SIAM & Chairman – Force Motors; in the presence of Mr. Doug Patton, President – SAE International; Dr. Tomy Sebastian, President – IEEE IAS; Dr. R. K. Malhotra, President – SAE India; and Mrs. Rashmi Urdhwareshe, Chair Steering Committee – ITEC India 2017, Director – ARAI & Vice President – SAE India. The theme of this conference was 'Electric Vehicle Ecosystem – Resetting the Future of Mobility'. The conference featured advanced research and applications in electrified transportation, including electric vehicles, hybrid electric vehicles and plug-in hybrid electric vehicles as well as heavy-duty, rail, off-road vehicles, airplanes and ships. During this conference, 30 keynotes and 120 technical papers were presented by Indian as well as international experts from industry, research organization and academia. It also featured a panel discussion, wherein eminent experts from OEMs, research & testing organizations and academia deliberated on the conference theme. An exposition, organized concurrently with this conference, had over 35 stalls wherein, various products, technologies and services in the area of e-mobility were showcased.

The valedictory function of this conference was graced by Shri Anant Geete, Hon'ble Minister, Ministry of Heavy Industries & Public Enterprises, Government of India as the Chief Guest. During this event, ARAI's 'Center of Excellence' in E-Mobility was also launched at the hands of the Hon'ble Minister.

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. SAEINDIA Western Section (SAEI WS) organizes training and educational programmes, workshops and knowledge dissemination activities for enhancing human resource skills to meet the growing industry requirements. During the year, ARAI supported following activities of SAE India.

- **Eminent Speaker Series Lectures**
  - 'Future of IC Engines and Liquid Transport Fuels' by Mr. Douglas Patton, President of SAE International 2017 and Executive Vice President & Chief Technology Officer, DENSO International America, Inc.

- 'Nano Engineered Materials for Future Aerospace and Automotive Applications' by Dr. Ajit D. Kelkar, Professor and Chair, Nanoengineering at North Carolina A & T State University

- **Workshops**
  - 'Welding Technology' workshop by Mr. Martin Dos, Mr. Vinay Mundada, Mr. Sanjay Nibandhe & Dr. K. C. Vora
  - 'Hybrid Fuel Cell Vehicles : Potential Power Source for the Future' workshop by Dr. P. Karthikeyan

- **Other Activities**
  - AWIM (A World In Motion) – A national level competition for school children
  - AWIM Master Teacher Training Program (MTTP) held at ARAI, Pune – 12 teachers, 15 students and 10 industry professionals participated in this training programme
  - BAJA SAEINDIA held at two locations Pithampur and Ropar
  - SAEINDIA Off-Highway Board's unique competition named TIFAN (Technology Innovation Forum for Agricultural Nurturing) for engineering and agricultural engineering students

Eminent Speaker Series Lecture by Mr. Douglas Patton

Workshop on Welding Technology

Workshop on Hybrid Fuel Cell Vehicles

Participants at AWIM National Olympics

Knowledge Centre

Knowledge dissemination and skill development activities are carried out through Knowledge Centre since 2004. It includes training and educational programmes to enhance human resource skills for meeting the growing needs of the automotive industry. Knowledge Centre at ARAI carries out these activities through Learning Centre (LC), Training Centre (TC) & Library.

LEARNING CENTRE

Learning Centre conducts undergraduate, postgraduate and doctorate programmes with specialization in Automotive Engineering through collaborations with various universities. It has tie-ups with VIT University (Vellore), VELTECH University (Chennai), Christ University (Bengaluru), College of Engineering (Pune), University of Alabama (USA), Tennessee Tech University (USA), Loughborough University (UK) and Technical University of Braunschweig (Germany). Brief summary of the joint programmes conducted is given below.

UNIVERSITY	SPECIALIZATION
VIT University, Vellore	B. Tech. in Mechanical Engineering with specialization in Automotive Engineering
	M. Tech. in Automotive Engineering
VEL TECH University, Chennai	B. Tech in Mechanical Engineering with specialization in Automotive Engineering in association with GARC, Chennai.
	M. Tech. in I. C. Engines
Christ University, Bengaluru	B. Tech. in Automobile Engineering
College of Engineering, Pune	M. Tech. in Automotive Technology
Alabama Birmingham, USA	M. S. in Mechanical Engineering with Automotive Engineering Emphasis

TRAINING CENTRE

Training Centre organizes Proficiency Improvement Programmes (PIPs) & Domain Training Programmes (DTPs). This year, 24 PIPs & 4 DTPs were organized through Kothrud location and 17 PIPs were organized through ARAI FID-Chakan location, wherein training was given by ARAI personnel, academicians and eminent industry experts, including speakers from abroad. These PIPs & DTPs had a participation of about 1400 delegates and were conducted in the areas of Automotive Engineering, Emission, Safety, NVH, Engines, Automotive Electronics, Materials, Manufacturing, Quality and Industrial Engineering.

Proficiency Improvement Programmes (PIPs)

- Hybrid Drives, Traction & Controls
- Engine Design and Development
- Engine Control Systems
- Advanced Model based Design
- Material Failure Mode Analysis
- Exterior Noise Evaluations: Challenges & Solutions
- Automotive Engineering
- Basic + Advanced Automotive Engineering
- Engine Testing & Certification
- Powertrain Engineering
- Impact Biomechanics and Injury Criteria for the Assessment of Advanced Automotive Safety Systems
- Futuristic Automotive Technologies
- Advanced Heat Transfer
- Systems Engineering
- Advanced Fuels - Technology & Regulations
- Connected Vehicles
- Hybrid Fuel Cell Vehicles: Potential Power Source for Future
- Design of Vehicle Driveline
- Powertrain NVH
- Engine Emission & Control
- Digital Control Systems
- Ricardo Software
- Computer Integrated Manufacturing
- Metallurgy for Non-Metallurgist
- Design and Analysis of Experiments
- Advanced Manufacturing Technology
- Product Design & Life Cycle Management
- Basic & Advances in Heat Treatment
- Industrial Robotics and Dynamics
- Integrated Manufacturing System
- Welding Technology
- Impact testing: A tool to gain early part performance
- Human Factor Engineering
- Failure Analysis (Including Engine Components)
- Additive Manufacturing Technology
- Maintenance Engineering

Domain Training Programmes (DTPs)

- Testing of Seating Systems
- Engine Operating Parameters
- Design Aspects of Combat Vehicle Engine
- Vehicle Testing & Certification
- Latest Trends in Design and Development of I. C. Engine (Focus on Diesel Engine)

Online Proficiency Improvement Programmes (e-PIPs)

- Engine Electronics & Management System
- Reliability Engineer
- e-PIP Topics being planned for the future:
  - Fuel Cells
  - Fundamentals of Automotive Emissions
  - After Treatment Devices
  - Alternative Fuels
  - Automotive Engineering
  - Powertrain NVH
  - Combustion Simulation
  - Battery Operated Vehicles

Blended Proficiency Improvement Programmes (b-PIPs)

- Engine Electronics & Management System
- Excellence Through Quality
- PIP Quality & Reliability Engineering

Other Programmes Organized

- Teachers Camp on Challenges & Opportunities in Materials Engineering
- Faculty Development Programme at MIT College of Engineering, Pune

LIBRARY

The library at Knowledge Centre has resources in print and digital formats for catering to the information needs of in-house researchers, faculty members, academy students, professionals, and various government organizations. It has a collection of around 23000 books & standards, 75000 SAE Technical papers, 500 SAE Special publications and Academy Project Reports on various topics like powertrain, electric & hybrid vehicles, emissions, NVH, brakes, fatigue, vehicle dynamics, safety, automotive electronics, automotive materials, management, soft skills, etc.

During 2017-18, 79 books, 4 e-books & 30 standards were added and 34 journals, SAE digital library, SANS standards from South African Bureau of standards & selected sections of BIS standards were subscribed. It also has signed a mutual agreement with InterrRgs Ltd. UK for multi user subscription (5 concurrent users) for automotive EC Directives and ECE Regulations (intranet only). Over 19500 professionals and students (including E- visitors) availed its services during the year. Also, it circulates its monthly publication 'Automotive Abstract' (soft / hard versions) to its subscribers. This year, the existing library software was upgraded to open source web-based integrated library software – KOHA Library Web OPAC and which has been made available on www.araiindia.com.

PIP on Engine Emission & Control in Association with ECMA

PIP on Failure Analysis in Association with ASM International

e-PIP on Engine Electronics & Management System

Teachers Camp on Challenges & Opportunities in Materials Engineering

ARAI – Homologation and Technology Centre (ARAI – HTC), Chakan

ARAI's Homologation and Technology Centre (ARAI – HTC) at Chakan celebrated its second anniversary during 2017-18. This centre has achieved two significant milestones during the year, the first one being NABL accreditation for ISO 17025 for Passive Safety & Powertrain Engineering laboratories and the second being crossing a landmark of 100 crash tests. Some of the major projects executed at ARAI – HTC include the following:

- Crash Tests
- Type Approval of Child Restraint Systems (CRS)
- Evaluation of vehicle models for Occupant Protection
- BS-VI Certification and Development Testing
- Off-road Engine Testing for Tier IV final – EPA
- Junker Vibration Test on Bolt
- Cold start-ability Testing using engine rpm and battery voltage measurement
- Capturing of crack propagation using 100 kN Material Test Rig (continuous photography of the testing carried out at specific intervals)

Also, ARAI is establishing a 'Centre of Excellence' in E-mobility under FAME-India Scheme of Department of Heavy Industry, Government of India at this centre. The facilities at this centre will cater to development, testing, evaluation and calibration requirements of electric, hybrid electric vehicles and associated sub-systems under one roof. The state-of-the-art facilities being installed include traction motor test beds, battery emulators, battery performance test system with environmental chamber and chassis dynamometer with emission measurement system for heavy commercial vehicles. Of this, 150 kW E-motor test system has already been installed at this centre.

During the year, Mr. Girish Shankar, Secretary (HI), Government of India visited ARAI - HTC. He appreciated the various facilities at ARAI - HTC. Also tree plantation was carried out during this visit. Also, many top management teams from various organizations visited and appreciated the impressive infrastructure and facilities installed, at ARAI - HTC.

150 kW E-Motor Test Bed

250 kN Pulsator Test Machine

TGTC Dyno

Secretary (HI), Government of India Planting a Tree Sapling

Auditors' Report & Annual Statement of Accounts

ARAI
Progress through Research

- Independent Auditors' Report
- Annual Statement of Accounts

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

Independent Auditors' Report

To,
The Members of
The Automotive Research Association Of India, Pune

Report on the Financial Statements

We have audited the accompanying financial statements of **The Automotive Research Association of India** which comprises the Balance sheet as at 31st March 2018 and Income and Expenditure Accounts for the year then ended and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance in accordance with the accounting principles generally accepted in India, including the Accounting Standards.

This responsibility also includes maintenance of adequate accounting records for safeguarding of the assets of the Association and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Association's preparation and fair presentation of the financial statements 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. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to explanation given to us, financial statements give a true and fair view in conformity with the accounting principles generally accepted in India:

i. In the case of the balance sheet of the state of affairs of the Association as on 31st March 2018 and

ii In the case of income and expenditure account of the SURPLUS for the year ended on that date.

For M/s P.G.Bhagwat
Chartered Accountants
Firm's Reg. No. 101118W

Abhijeet Bhagwat
Partner
Membership No. 136835

Place: Pune
Date: 8th August 2018

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

Balance Sheet as on 31St March 2018

(RS IN LAKHS)

PARTICULARS	SCH NO		AS ON 31-03-2018		AS ON 31-03-2017
SOURCES OF FUNDS					
1. GENERAL & OTHER FUNDS					
A) GENERAL FUND	1	71,395.92		63,042.48	
B) R & D RESERVE FUND	2	25,035.79		24,120.68	
C) REPLACEMENT OF EQUIPMENT/ MACHINERY FUND	3	11,358.03		10,734.55	
D) ENDOWMENT FUND	4	15.88		14.85	
E) ARAI ACADEMY ALUMNI ASSOCIATION FUND	5	10.58	1,07,816.20	8.93	97,921.49
2. PROJECT FUNDS (NET)	6		2,781.98	-	3,630.36
3. CURRENT LIABILITIES AND PROVISIONS	7		10,578.54	-	10,018.45
TOTAL			**1,21,176.72**		**1,11,570.30**
APPLICATION OF FUNDS :					
1. FIXED ASSETS	8		51,292.19		49,945.88
2. CURRENT ASSETS, DEPOSITS AND ADVANCES			-		
A) INVENTORIES	9(A)	73.99		35.32	
B) SUNDRY DEBTORS	9(B)	2,955.48		3,176.34	
C) DEPOSITS, CASH & BANK BALANCES	9(C)	63,537.04		56,044.16	
D) ADVANCES AND OTHER ASSETS	9(D)	3,062.77		2,111.15	
E) SUNDRY DEPOSITS	9(E)	255.24	69,884.53	257.46	61,624.42
TOTAL			**1,21,176.72**		**1,11,570.30**
NOTES TO THE ACCOUNTS	14				

Mrs Rashmi Urdhwareshe
Director

Vikram Kirloskar
President

C V Raman
Vice President

AS PER OUR
REPORT OF EVEN DATE
FOR M/S P G BHAGWAT
CHARTERED ACCOUNTANTS
F.R No 101118W

ABHIJEET BHAGWAT
PARTNER
Membership No. 136835

Date : 8th August 2018
Place : Pune

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

Income and Expenditure Account for the Year Ended 31St March 2018

(RS IN LAKHS)

PARTICULARS	SCH NO		YEAR ENDED 31-03-2018		YEAR ENDED 31-03-2017
INCOME					
OPERATIONAL INCOME	-		28,411.82		24,614.67
ANNUAL MEMBERSHIP SUBSCRIPTION	-		444.31		430.46
SIAT 2017	-		14.37		798.94
FUNDS TRANSFERRED FROM R&D RESERVE FUND	-		151.98		66.33
INTEREST	10		3,683.24		2,774.30
OTHER INCOME	11		545.49		295.02
TOTAL			**33,251.21**		**28,979.74**
EXPENDITURE					
OPERATIONAL EXPENSES	-		2,594.60		2,445.09
ARAI R&D PROJECTS	-		151.98		66.33
SALARIES & OTHER ALLOWANCES	12		12,970.06		11,809.74
EMPLOYEE RELATED EXPENSES	-		334.14		332.20
OPERATION & ESTABLISHMENT EXPENSES	13		3,911.06		3,395.91
DEPRECIATION	-	3,388.11		3,291.84	
LESS: DEPRECIATION ON GOVT. FUNDED ASSETS		1,378.32	2,009.79	1,324.71	1,967.13
SIAT / GOLDEN JUBILEE EXPENSES	-		15.58		588.56
EXCESS OF INCOME OVER EXPENDITURE			11,264.00		8,374.78

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

Income and Expenditure Account for the Year Ended 31St March 2018

(RS IN LAKHS)

PARTICULARS	SCH NO		YEAR ENDED 31-03-2018		YEAR ENDED 31-03-2017
APPROPRIATION					
A) INTEREST ON EARMARKED FUNDS TRANSTERED TO RESPECTIVE FUNDS					
- R &D RESERVE FUND		1,067.09		1,187.34	
- REPLACEMENT OF EQUIPMENT/ MACHINERY FUND		623.48	1,690.57	219.83	1,407.17
B) SIAT					
- SURPLUS (DEFICIT) OF SIAT 2017 TRANSFERRED TO GENERAL FUND		(1.21)	(1.21)	210.38	210.38
C) EXCESS OF INCOME OVER EXPENDITURE (NET)			9,574.65		6,757.23
TOTAL			**33,251.21**		**28,979.74**
NOTES TO THE ACCOUNTS	**14**				

Mrs Rashmi Urdhwareshe
Director

Vikram Kirloskar
President

C V Raman
Vice President

AS PER OUR
REPORT OF EVEN DATE
FOR M/S P G BHAGWAT
CHARTERED ACCOUNTANTS
F.R No 101118W

ABHIJEET BHAGWAT
PARTNER
Membership No. 136835

Date : 8th August 2018
Place : Pune

ARAI
Progress through Research

ARAI Organisation Chart

Mrs. Rashmi Urdhwareshe
Director-ARAI
director@araiindia.com

RESEARCH & DEVELOPMENT DIVISION 1

Structural Dynamics Lab.; Automotive Materials Lab. Technology Group

Mr. M. R. Saraf
Senior Deputy Director
mrsaraf.sdl@araiindia.com

Noise, Vibration & Harshness Lab., CAE

Mr. N. V. Karanth
Senior Deputy Director
karanth.nvh@araiindia.com

RESEARCH & DEVELOPMENT DIVISION 2

Powertrain Engg., Prototype Mfg. Dept.

Mr. N. V. Marathe
Senior Deputy Director
nvmarathe.edl@araiindia.com

Automotive Electronics Dept.

Mr. A. A. Deshpande
Deputy Director
deshpande.aed@araiindia.com

HOMOLOGATION DIVISION

Vehicle Evaluation Lab. Homologation Management & Regulation

Mr. A. A. Badusha
Senior Deputy Director
badusha.vel@araiindia.com

Safety & Homologation Lab., Passive Safety Lab.

Mr. A. V. Mannikar
Senior Deputy Director
mannikar.shl@araiindia.com

Emission Certification Lab.

Mr. K. Srinivas
Senior Deputy Director
srinivas.ecl@araiindia.com

Homologation & Technology Centre and FID, Chakan

Mr S. S. Nibandhe
Deputy Director
nibandhe.cp@araiindia.com

SERVICE DIVISION

Business Development & Corporate Planning

Mr. N. B. Dhande
Senior Deputy Director
dhande.dts@araiindia.com

Academy & Knowledge Centre

Dr. K. C. Vora
Senior Deputy Director
vora.pga@araiindia.com

Central Maintenance Cell

Mrs. M. S. Mainkar
Senior Deputy Director
mainkar.ecl@araiindia.com

Human Resource Management & Administration

Dr. M. V. Uchgaonkar
Deputy Director
uchgaonkar.pah@araiindia.com

Finance & Accounts, Purchase, and Stores

Mr. A. B. Bhide
Deputy Director
bhide.acc@araiindia.com

Quality Management Department, Calibration Lab

Mr. V. K. Jadhav
General Manager
jadhav.gmd@araiindia.com

Infrastructure Development

Mr. C.S. Mukhedkar
General Manager
mukhedkar.pas@araiindia.com

Governing Council Secretariat

Mrs. P. M. Dhere
Deputy General Manager
Secretary to the Governing Council
dhere.acc@araiindia.com

UPCOMING EVENT: SIAT 2019

'Symposium on International Automotive Technology' (SIAT) is a prestigious event organized biennially by ARAI in association with SAEINDIA, NATRiP and SAE International (USA). It serves as an important forum for exchange of ideas & brainstorming for the automotive industry and is widely acclaimed by the global automotive fraternity.

Sixteenth edition of 'Symposium on International Automotive Technology' (SIAT 2019) is scheduled to be held at Pune during 16 – 18 January 2019. The theme of this edition is 'Empowering Mobility – The Safe & Intelligent Way'. This edition of SIAT will focus on recent advances in various automotive areas such as Safety, Emissions, Engines, Noise, Electric Mobility, Electronics, Intelligent Transportation, Vehicle Dynamics, Materials, Alternate Fuels and Simulation & Modelling. It will also bring forth innovative ideas & solutions in automotive technologies to meet future challenges.

Over 200 technical papers, including 40 keynotes, on various subjects will be presented in this symposium by renowned experts. Apart from Symposium Proceedings, Technical Reference Bulletin, containing technical articles, case studies and product information will be published. Over 1500 delegates (professionals, engineers and academicians) from over 20 countries are expected to attend this symposium. SIAT EXPO 2019 will also be held concurrently at the same premises. This exposition will serve as a platform for facilitating spectrum of national / international organizations to showcase their automotive technologies, products, automotive testing / validation tools and engineering services.

For information on the symposium and exposition please visit our website, at https://siat.araiindia.com or get in touch with Mr. A. A. Badusha, Senior Deputy Director – ARAI, Convener – SIAT 2019 (siat2019@araiindia.com) and Mr. R. S. Mahajan, General Manager – ARAI, Coordinator – SIAT EXPO 2019 (siatexpo2019@araiindia.com).

Centre of Excellence for E-mobility

In line with National Electric Mobility Mission and focus of Government of India on Electric Mobility, significant growth in Electric Vehicle development is envisaged in India. We believe that technology advances and increasing stringent regulatory norms will push more automotive designers to electrify power train.

ARAI, the premier Automotive R&D Testing and Certification institute in the country, has geared itself to support automotive industry for development, evaluation and certification of EV. Towards this purpose, ARAI has set up comprehensive state-of-the-art Center of Excellence (CoE) for Electric / Hybrid Electric vehicles (2W - 3W, Passenger cars, Buses, Commercial vehicles) and their components such as traction batteries, motors, controllers, chargers etc.

This 'Centre of Excellence' in E-mobility is being established at ARAI - Homologation and Technology Centre (ARAI-HTC), Chakan under FAME – India Scheme of Department of Heavy Industry, Government of India. The facilities at this Centre will cater to development, testing, evaluation and calibration requirements of electric, hybrid electric vehicles and associated sub-systems under one roof. The state-of-the-art facilities being installed include traction motor test beds, battery emulators, battery performance test systems with environmental chamber and chassis dynamometer with emission measurement system for heavy commercial vehicles.

It will support Government's Electric Mobility Mission to scale up Electric Vehicles (EVs) in India and automotive vehicle and component manufacturers.

List of Facilities under Center of Excellence for E-Mobility:

- 100 kW DC Power Supply-cum-Battery Emulator
- 250 kW DC Power Supply-cum-Battery Emulator
- 150 kW Electric Motor Test Bed
- 220 kW Electric Motor Test Bed
- 250 kW Battery Pack Level Tester
- Battery Module Level Tester
- Battery Cell Performance Test System with Environmental Chamber
- HCV Chassis Dynamometer

Electric Motor Test Bed

ARAI
Progress through Research

The Automotive Research Association of India

POLICIES

ENVIRONMENTAL, OCCUPATIONAL HEALTH AND SAFETY POLICY

At ARAI, we carry out our activities with due attention towards environmental protection, occupational health and safety and endeavour for continual improvement in environmental, health and safety performance of employees and stakeholders by pursuing following goals:

- Prevention strategies for incidents leading to accidents and pollution.
- Compliance to all current applicable Environmental, Occupational Health and Safety legislations/ regulations and other requirements to which the organization subscribes.
- Commitment towards elimination of hazards and reduction of Occupational Health and Safety Risk.
- Conserving natural resources by optimizing usage, minimizing waste generation, opting for recycling wherever feasible and eco-friendly disposal of waste.
- Commitment to employees consultation and participation in Occupational Health and Safety implementation.

Mrs. Rashmi Urdhwareshe
DIRECTOR

INFORMATION SECURITY POLICY

At ARAI, we recognize that safeguarding information and intellectual property belonging to us and our interested parties; is an important responsibility to be fulfilled; for which we are committed to:

- Safeguard the Confidentiality, Integrity and Availability of information and intellectual property; that is vital for the success of our business
- Constantly monitor, evaluate and continually improve our Information Security systems and policies to keep them effective and relevant with the changing needs and legislation
- Abide and adhere with the Information Security policies and procedures prescribed from time to time.

Mrs. Rashmi Urdhwareshe
DIRECTOR

QUALITY POLICY

In our pursuit towards advancement of Automotive Technology and providing quality service to Auto Industry, we are committed to

- provide research & development, testing, certification, calibration and Skill development service for developing safe, reliable and eco-friendly vehicles / components.
- harmonise Indian automotive standards to global standards.
- strive for customer satisfaction through continual improvement of our processes.
- Satisfy applicable requirements.

Mrs. Rashmi Urdhwareshe
DIRECTOR

ARAI

Progress through Research

The Automotive Research Association of India

(Under the administrative control of to Ministry of Heavy Industries & Public Enterprises, Govt. of India)

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