



Redefining Mobility for the Future

Annual Report
2020-2021

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA



- Highlights of the Year 2
- Promoting Indigenous Technology Development 3
- Contributing to Aatmanirbhar Bharat 4
- ARAI Vision and Mission 5
- Governing Council 6
- Members 7
- Committees 8
- President's Statement 9-10
- Director's Report11
 - Operational Highlights (12-14)
- Overview of Operations 15-46
 - Research & Development (16-22)
 - Testing & Certification (23-28)
 - Role in Standardization (29-34)
 - New Facilities (35)
 - Human Resource Development (36)
 - Technology / Research Publications (37-38)
 - Business Development (39-41)
 - Events (42-44)
 - Knowledge Centre (45-46)
- Auditor's Report & Annual Statement of Accounts 47-51
 - Independent Auditor's Report (48-49)
 - Annual Statement of Accounts (50-51)
- ARAI Management Committee 52



Dr. Reji Mathai takes over as new Director - ARAI



Over the past five decades, ARAI has grown into a premier research and certification institute for the Indian Automotive Industry, under the able leadership of its past Directors and the Governing Council. The year 2020-21 saw a transition in ARAI's leadership with Dr. Reji Mathai taking over the reins as Director – ARAI in December 2020 upon superannuation of Mrs. Rashmi Urdhwareshe.

A Doctorate from IIT Delhi, he comes with a vast experience of more than 28 years in the field of alternative fuels, emission studies, and ambient air quality. Prior to joining ARAI, he was associated with Indian Oil Corporation Limited, Faridabad.

ARAI, under his leadership, along with Team ARAI, is set to embark on a new chapter of growth and a better tomorrow for all the stakeholders.

- ▶ **Successful transfer of in-house developed Technology know-how of AC and DC Charging Stations to our customers**
- ▶ **Design and development of Lightweight Aluminium Extrusion Profiles and its joining technique for bus superstructure building for inter and intra-city bus applications**
- ▶ **Patent on 'Joint for assembling a vehicle body', jointly filed by ARAI with Hindalco**
- ▶ **Patent granted for 'Dual Fuel System for induction of CNG into a diesel engine'**
- ▶ **Development of Technology Innovation Platform – TechNovuus, under a mandate of MHI for facilitating development of indigenous solutions through a collaborative approach**
- ▶ **Addition of Vehicle EMC Chamber for testing of vehicles, including Electric and Hybrid**
- ▶ **Addition of Engine Test facility catering to certification and development testing of Automotive, Tractor, CEV & Combined Harvester Engines**
- ▶ **Contribution to the Society in the fight against COVID-19 Pandemic:**
 - **Lightweight Face Shield development for the benefit of frontline workers.**
 - **Support to the industry for development of indigenous respiratory support devices through pre-compliance functional testing and R&D support.**

Promoting Indigenous Technology Development Initiatives of Ministry of Heavy Industries (MHI)



Technology and innovation are the core engines of a nation's growth and are reshaping the industry globally. Advent of new technologies has created unprecedented opportunities and is redefining competition. Many organizations are realising value through adoption of new technologies, as they are enabling them to become cost-effective, agile and productive.

Even though India has made significant progress in various spheres of science and technology, our industry encounters challenges of access to knowledge, skilled man-power and latest cutting-edge technologies. This is despite the fact that we, as a nation, have built a strong network of research institutions, trained manpower and an innovative knowledge base. This is primarily due to the significant presence of small and medium scale industries across the spectrum, whose adoption of new technology is not to the desirable extent.

To support the automotive sector, especially the manufacturing processes, the Ministry of Heavy Industries (MHI), Government of India, has launched various schemes/ programmes like FAME India II – to promote indigenous manufacturing of electric vehicles & its assemblies/sub-assemblies; Production Linked Incentive (PLI) Scheme – for manufacturing Advanced Chemistry Cell (ACC) battery; Capital Goods Scheme – for enabling an eco-system to boost capital goods growth; Industry 4.0 through SAMARTH Udyog Bharat 4.0 and R&D Technology Innovation Platforms – for collaborative technology development.

Under the FAME India Scheme, ARAI has already completed projects on preparation of draft standards for xEV charging stations, establishment of testing infrastructure for certification testing of electric & hybrid vehicles and indigenous development of AC-DC charging stations. Also, under the R&D programme of MHI, ARAI is currently working on development of e-axle powertrain kit for 3-W application and development of efficient battery thermal management system for 2-W & 3-W EV through design of innovative packaging material.

This year, MHI has taken up the scheme of R&D Technology Innovation Platforms to strengthen collaborative technology development. The platforms are to bring together all resources such as students, manufacturing experts, academia, entrepreneurs, researchers, etc. and the industry to identify problem statements (mainly of auto sector) and provide affordable solutions. Hence, the platforms will be enablers to develop an eco-system of solution providing Start-ups and result into manufacturing hubs for quality products, thereby making us not only more self-reliant, but also a globally recognized exporter of spares & components.

TechNovuus:

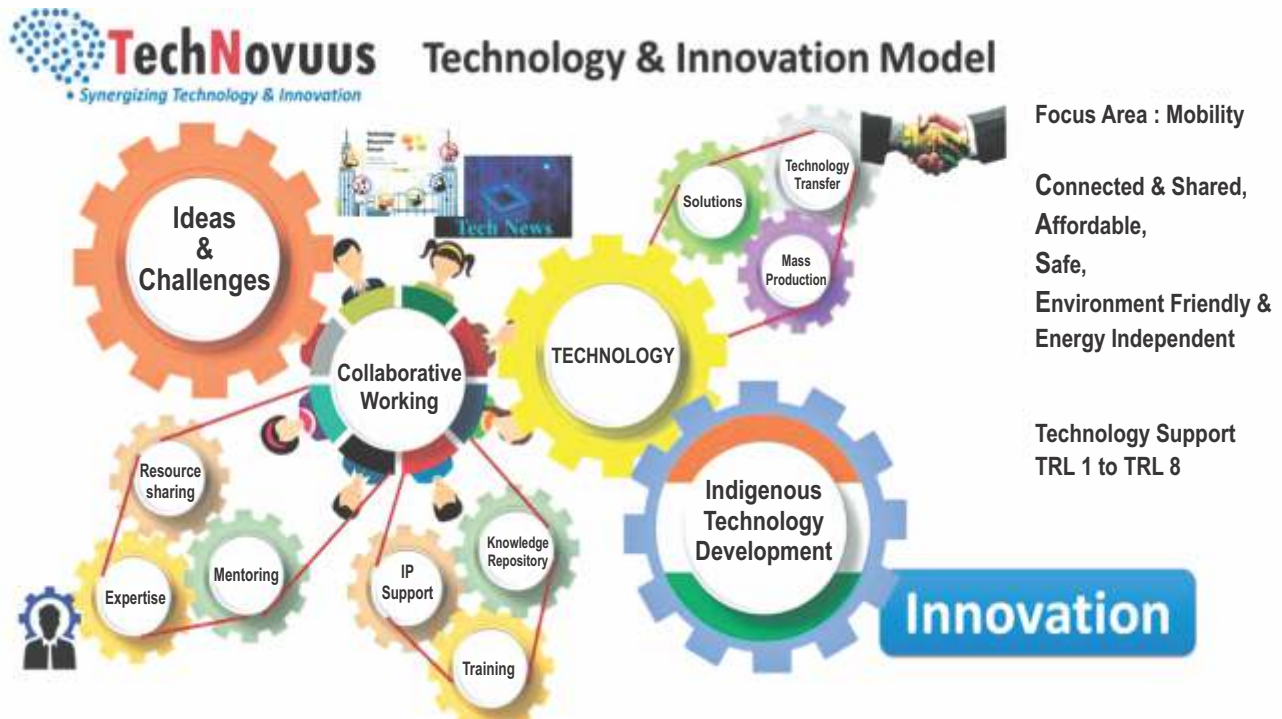
TechNovuus is the Technology Innovation Platform of ARAI set up under the aegis of MHI, which is a collaborative eco-system for enabling indigenous technology, innovation and solution development focused towards Indian mobility CASE (Connected & Shared, Affordable, Safe, Environment friendly & towards Energy Independence). It facilitates development of solutions for challenges related to mobility to start with, and will gradually cater to other sectors like Defence, Aerospace, Telecommunication, Railways, etc., providing an impetus to Government of India's Make in India and Aatmanirbhar Bharat programmes.

This platform consists of modules, viz. Collaborative Technology Solutions, Technology Consortium, Technology Discussion Forum, Technology Transfer Portal, Expert Connect and Resource Sharing Portal.

TechNovuus provides a promising opportunity for all the stakeholders as it envelopes various innovation phases like collaborative research and ideation; problem identification and solving; design thinking; proof of concept implementation; incubation and cross functional team building; and technology development & deployment, in India and by India, locally and collaboratively – for an Aatmanirbhar Bharat.

We, at ARAI, invite you to join us in shaping the future of mobility (<https://technovuus.araiindia.com>).

**Development of Technology Innovation Platform: TechNovuus
(under the aegis of Ministry of Heavy Industries, Govt. of India)**



ARAI developed indigenous solutions make their foray into market



**Transfer of Know-how of
AC and DC Charging Stations**

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 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 Automotive Industry in the areas of design and development and know-how for manufacturing and testing of components / systems according to national / international standards. ARAI shall strive to achieve international recognition in these areas.
- ARAI shall seek valuable guidance and support from our members, from time to time, to achieve growth and stability.
- With the globalization of economy and business, ARAI shall enlarge its scope of services to meet the requirements of automotive industry-worldwide.
- 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.

PRESIDENT

Mr. C.V. Raman
Chief Technical Officer (CTO) Engineering
Maruti Suzuki India Ltd.

VICE PRESIDENT

Mr. Rajendra M Petkar
President & Chief Technology Officer
Tata Motors Ltd.

DIRECTOR

(From 2nd Dec. 2020)
Dr. Reji Mathai

ARAI is under the Administrative Control of Ministry of Heavy Industries, Govt. of India.

MEMBERS

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

GOVT. OF INDIA REPRESENTATIVES**Mr. Shashank Priya**

Additional Secretary & Financial Adviser
Govt. of India
Ministry of Heavy Industries
Udyog Bhavan New Delhi -110 011

Mr. Amit Mehta

Joint Secretary
Govt. of India
Ministry of Heavy Industries
Udyog Bhavan New Delhi -110 011

Mr. R.K. Jaiswal

Development Officer (Engineering)
Govt. of India
Ministry of Heavy Industries
Udyog Bhavan New Delhi -110 011

OFFICE

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Off Paud Road, Kothrud
Pune 411 038, INDIA
Phone : +91-20-3023 1111, 3023 1200, 67621111
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.

INVITEES

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

SECRETARY TO THE GOVERNING COUNCIL

Mrs. Prajakta M. Dhere

STATUTORY AUDITORS

M/s Gunwani & Kolapkar, Chartered Accountants

Mumbai Office:

602, Pooja 7th Road,
Santacruz Mumbai - 400055

Pune Office :

Flat No. B-6, Ghodke Classic, Near Kamla Nehru Park,
Erandwane, Pune - 411 004

1. ARaymond Fastners India Pvt. Ltd.
2. Adient India Private Ltd.
3. Aargee Equipments Pvt. Ltd.
4. Ampere Vehicles Pvt. Ltd.
5. Ashok Leyland Ltd.
6. Atul Auto Ltd.
7. A.J. Auto Pvt. Ltd.
8. Bajaj Auto Ltd.
9. Behr-Hella Thermocontrol (India) Pvt. Ltd.
10. BEML Ltd.
11. BMW India Pvt. Ltd.
12. Bharat Forge Ltd.
13. Bharat Seats Ltd. ~
14. Bosch Limited
15. Brakes India Pvt. Ltd.
16. Chemito Infotech Pvt. Ltd.
17. Cooper Corporation Pvt. Ltd.
18. Cummins India Ltd.
19. Cummins Technologies India Pvt. Ltd.
20. Daimler India Commercial Vehicles Pvt. Ltd.
21. Delphi-TVS Diesel Systems Ltd.
22. Eicher Motors Ltd.
23. Enginetech Systems Pvt. Ltd.
24. Faurecia Automotive Seating India Pvt. Ltd. ~
25. FCA India Automobiles Pvt. Ltd.
26. Fiat India Automobiles Pvt. Ltd.
27. Force Motors Ltd.
28. Ford India Pvt. Ltd.
29. F P Seating Systems Pvt. Ltd.
30. Greaves Cotton Ltd.
31. Gromax Agri Equipment Ltd
32. Hero Electric Vehicles Pvt. Ltd.
33. Honda Cars India Ltd.
34. Hyundai Motor India Ltd.
35. India Japan Lighting Pvt. Ltd
36. India Kawasaki Motors Pvt. Ltd
37. JCBL Ltd.
38. Kanda Auto Pvt. Ltd.
39. Kia India Pvt. Ltd. *
40. Kirloskar Oil Engines Ltd.
41. Kohler Power India Private Limited
42. Lear Automotive India Pvt. Ltd.
43. Madras Engineering Industries Pvt. Ltd.
44. Mahindra & Mahindra Ltd.
45. Mahindra Heavy Engines Ltd.
46. Mahindra Electric Mobility Ltd.
47. Maruti Suzuki India Ltd.
48. Masstrans Technologies Pvt. Ltd.
49. Mercedes-Benz India Pvt. Ltd.
50. MLR Auto Ltd.
51. MSKH Seating Systems India (P) Ltd.
52. Piaggio Vehicles Pvt. Ltd.
53. P M Diesels Pvt. Ltd.
54. Randhawa Automobile Engineering Pvt. Ltd.
55. Renault Nissan Automotive India Pvt. Ltd. *
56. Rocket Engineering Corporation Pvt. Ltd.
57. Rotary Electronics Pvt. Ltd.
58. Simpson & Co. Ltd.
59. Skoda Auto Volkswagen India Pvt. Ltd.
60. S. M. Auto Engineering Pvt. Ltd.
61. SML Isuzu Ltd.
62. Spaco Technologies (India) Pvt. Ltd. ~
63. Tata Cummins Pvt. Ltd.
64. Tata Motors Ltd.
65. T.M. Automotive Seating Systems Pvt. Ltd.
66. Toyota Kirloskar Motor Pvt. Ltd.
67. Tractors and Farm Equipment Ltd.
68. Trimble Mobility Solutions India Pvt. Ltd.
69. TVS Motor Co. Ltd.
70. Vanaz Engineers Ltd.
71. Varroc Lighting Systems (India) Pvt. Ltd.
72. VE Commercial Vehicles Ltd.
73. Virama Laminates Pvt. Ltd.
74. Visteon Technical and Services Centre Pvt. Ltd. *
75. Volvo Group India Pvt. Ltd.
76. WABCO India Ltd.
77. Wheels India Ltd.

* New Membership

~ Withdrawal / Cancellation of membership

FINANCE & INTERNAL AUDIT COMMITTEE (FIAC)**CHAIRMAN****Mr. Rajendra M. Petkar**

Vice President- ARAI

President & Chief Technology Officer, Tata Motors Ltd.

MEMBERS**Mr. Balaram Pradhan**General Manager Finance
Mercedes-Benz India Pvt. Ltd.**Mr. Pankaj Gupta**Vice President – External Affairs & CSR
Skoda Auto Volkswagen India Pvt. Ltd.**Mr. Dinesh Gandhi**General Manager (Internal Audit)
Maruti Suzuki India Ltd.**Mr. Gopal Bhutada**General Manager - ERC
Tata Motors Ltd.**Mr. Chetan Kamdar,**Finance Director
Cummins India Ltd.**Mr. Rasesh Joshi**Head-Business Planning & Product
Development (F&A Business Planning)
Mahindra and Mahindra Ltd.**Mr. Pawan Agarwal**CFO
Kirloskar Oil Engines Ltd.**Mr. Mahendra K Harit**Finance Head for R&D
Ashok Leyland Ltd.**ARAI Members on FIAC****Dr. Reji Mathai**

Director-ARAI

Mr. Atul BhideDeputy Director
(Head- Finance & Accounts), Member Secretary**PROJECT EVALUATION & MONITORING COMMITTEE (PEMC)****CHAIRMAN****Mr. Aniruddha Kulkarni**

Vice President & Head, CVBU Engineering, Tata Motors Ltd.

MEMBERS**Mr. R.K. Jaiswal**Development Officer (Engineering)
Government of India
Ministry of Heavy Industries**Ms. Anuradda Ganesh**Director – Research, Innovation and
Compliance, India ABO
Cummins Technologies India Pvt. Ltd.**Mr. Pankaj Sonalkar**Chief of Electric Vehicle
Technology Centre
Mahindra & Mahindra Ltd.**Mr. Rajinder S Sachdeva**Chief Operating Officer
V E Commercial Vehicles Limited**Dr. S. J. Dhinagar**Vice President (Advanced Engg)
TVS Motor Co Ltd.**Mr. S. Sriraman**Sr. Vice President ((R&D)
Tractors and Farm Equipment Ltd.**Mr. Alok Jaitley**Sr Vice President (Engg)
Maruti Suzuki India Ltd.**Mr. S. Janardhanan**Vice President (Co-ordination)
Simpson & Co Ltd.**ARAI Members on PEMC:****Dr. Reji Mathai**

Director-ARAI

Mr. N. B. Dhande

Sr. Dy. Director, ARAI

Mr. Suyog Gadgil

Manager, Member Secretary

President's Statement



Mr. C.V. Raman
President, ARAI



Mr. Rajendra Petkar
Vice President, ARAI

Dear Members,

I am pleased to share with you an update on ARAI's performance for the Financial Year 2020-21. This year has been a challenging year for each one of us. COVID-19 pandemic has had a significant impact on lives, livelihoods, and the business. Operational challenges mounted due to restricted movements and disrupted business operations during the first few months of the pandemic. The effects of the global pandemic were noticeable as our revenue dropped by 29% to Rs. 255.40 crore as a result of the challenging backdrop. However, despite numerous issues due to the pandemic, Team ARAI delivered fairly good results, meeting the re-aligned revenue target.

Transition

After a journey across many roles at ARAI, Mrs. Rashmi Urdhwareshe retired as Director – ARAI. Her contribution to ARAI's growth and development has been truly commendable. Dr. Reji Mathai, who has succeeded her is well-known for his immense contribution in the field of engine and vehicle testing, emission studies, alternative fuels, ambient air quality, etc. Dr. Mathai brings strong and determined leadership, which, I am sure, will take ARAI to new heights.

Ensuring Business Continuity amidst the Pandemic

We stepped up to deliver on each of the priorities that guide our actions and our choices in this crisis period. We moved swiftly and released a manual with Do's and Don'ts for ensuring business continuity. Acting on periodic guidelines released by various authorities, we put in place robust safety measures for the employees, including temperature scans, shift rotations, social distancing, sanitizing, wearing of masks and use of Aarogya Setu app.

Throughout the pandemic, our employees adapted to new ways of working in order to ensure business continuity. Adoption of cloud services with enterprise grade security helped in creating digital workplace for our employees. Also, remote access solution was rolled out to the employees to work-from-home, thereby facilitating conduct of meetings, communications, and timely delivery of services.

Operational Performance

The pandemic introduced new challenges for our testing and certification assignments. I am pleased with how we have managed this situation leveraging our IT infrastructure to facilitate remote testing. All required lab controls were put in place for remote monitoring of the tests carried out by our engineers and at the same time, these tests were witnessed remotely by the customers.

Having created a strong portfolio of services, it has been our endeavour to make a breakthrough in the business of transfer of technology and know-how. Our efforts have led to a defining moment for us in 2020-21 as we successfully transferred in-house developed Technology know-how of AC and DC Charging Stations to our customers. Exclusive solutions require expert development and craftsmanship. With these qualities in mind, we collaborated with Hindalco – an industry leader in aluminium and copper, for design and development of Lightweight Aluminium Extrusion Profiles and its joining technique for bus superstructure building for inter and intra-city bus applications. The outcome of this collaborative work has been development of a superstructure, which is 35% lighter as compared to existing steel superstructures and also, meeting all regulatory requirements. A notable feature of this collaborative project has been filing of a patent on 'Joint for assembling a vehicle body' jointly by ARAI with Hindalco. Also, I am pleased to inform, this year a patent was granted to us for an invention on 'Dual Fuel System for induction of CNG into a diesel engine'.

Ability to leverage the ecosystem of alliances and partnerships through a collaborative and innovative approach is essential for building home-grown solutions. Considering this, we have developed our Technology Innovation Platform – TechNovuus, under the mandate of MHI. This platform brings together industry experts, researchers, start-ups and academia to build indigenous solutions for industry problem statements with a collaborative approach. To start with, this platform will facilitate development of solutions for challenges related to Mobility, and gradually cater to other sectors, like Defence, Aerospace, Telecommunication, Railways, etc. giving impetus to Government of India's Make in India and Aatmanirbhar Bharat programs.

Being in the automotive research and certification business, we strongly believe that we need to continually invest in R&D, facilities and capabilities to support the latest standards and strengthen the competitiveness of our services. In-line with this, we have been steadily upgrading our facilities with the technologies that ensure resolute focus on quality and future needs of the industry. Some of the major facilities added during the year included Vehicle EMC Chamber for testing of vehicles, including Electric and Hybrid, and Engine Test facility catering to certification and development testing of Automotive, Tractor, CEV & Combined Harvester engines.

We contribute significantly as Technical Secretariat for standardization and harmonization activities. This year, 17 Automotive Industry Standards (AIS), covering a wide range of subjects across different categories of motor vehicles were released.

We collaborate with industry and universities to ensure dissemination of knowledge and expertise. As a part of this, we organized online Proficiency Improvement Programs and e-Learning courses in various automotive engineering domains for up skilling of industry personnel. Through our collaborations with national and international universities, we continue to offer undergraduate, postgraduate and doctorate programs with specialization in automotive engineering. Apart from this, we conducted EV awareness programs at several engineering colleges for the benefit of students at the behest of MHI.

Supporting the Society in tackling the Pandemic

As a responsible institute, we joined the nationwide drive to fight the pandemic. We leveraged our simulation expertise to design and develop a highly protective, comfortable and lightweight Face Shield for the benefit of frontline workers. Over 20,000 Face Shields were manufactured and distributed to the frontline workers through Pune Municipal Corporation. Another contribution was design and development of prototype UV sanitizer, which is useful for sanitizing small objects, laptops, documents and handbags. Also, we deployed our capabilities and testing facilities to support the industry for development of indigenous respiratory support devices through pre-compliance functional testing and R&D support. I take this opportunity to record my appreciation for Team ARAI for their contribution in these challenging times.

Way Forward

In the coming year the continued impact of the pandemic would pose challenges as the economic performance is still to emerge out of the sluggishness. **As uncertainty grips the world, we at ARAI, remain resolute to find opportunities amidst the challenges and unearth new ways to emerge stronger. I am confident that we will prevail and overcome these uncertainties through our resilience.**

In closing, I take this opportunity to extend my sincere appreciation to the Vice President – ARAI and the Members of the Governing Council, Ministry of Heavy Industries (MHI), the Chairman and the Members of Finance and Internal Audit Committee, the Chairman and the Members of Project Evaluation and Monitoring Committee, ARAI Members, and Director – ARAI for their continued guidance and support. I wish to thank our employees, who have tirelessly worked to ensure that we continued to serve our customers through this extremely challenging year. I also would like to thank our customers, suppliers and associates for their overwhelming trust, support and confidence in ARAI.

I wish you all good health and inner strength to tide over these testing times.

C. V. Raman

Director's Report



Dr. Reji Mathai

Director - ARAI
director@araiindia.com

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 2021.

The year was indeed unique as the COVID-19 pandemic posed significant challenges globally, leaving behind adverse impact on the industry. And we too were no exception, as we closed the year with a drop in our Operational Income. Viewed in the context of the challenges, we ended in a much better position than we had expected during the first half of the year.

Looking back on my first year as Director – ARAI, I am encouraged by the progress we made despite the unprecedented challenges. It was an honour to be appointed as Director of ARAI. I have huge respect for the responsibilities that come with the role and I will do my utmost to provide thoughtful leadership in this changing landscape.

I am pleased to see that even in this unprecedented crisis, we achieved a major leap forward in terms of digitalization, as we are now using remote working and online meeting options more often and intensively. Using our expertise and resources, we contributed to the fight against COVID-19, while meeting our commitments to our customers and keeping our employees safe.

Our continued focus on R&D is showing results as we were able to commercialize in-house developed technical know-how on AC and DC Charging Stations. Similarly, we deployed our competencies to successfully deliver our services to the customers in areas like light weighting, engine development and material characterization.

I am pleased to see that even in this unprecedented crisis, we achieved a major leap forward in terms of digitalization, as we are now using remote working and online meeting options more often and intensively.

Today, innovation isn't just a competitive advantage, but rather a necessity for a country to become self-reliant. We see a strong intent from the Government of India in this regard to promote products developed with Indian R&D and which are manufactured in India.

Today, innovation isn't just a competitive advantage, but rather a necessity for the country to become self-reliant. We see a strong intent from the Government of India in this regard to promote products developed with Indian R&D and which are manufactured in India. FAME-India, PLI Schemes, Capital Goods Scheme, R&D Technology Innovation Platforms, etc. are some of the policy initiatives introduced by Government of India to support indigenous technology development and manufacturing. Our Technology Innovation Platform – TechNovuss, developed under the aegis of MHI is a step in this direction to facilitate a collaborative ecosystem for enabling indigenous technology, innovation and solution development.

We believe in creating value for the customer over and above the contractual obligations. This is based on the relationships built in the spirit of trust and collaboration. So, despite the lockdown restrictions, we successfully delivered our certification and testing assignments with restricted manpower. In certain instances, wherever remote testing was feasible, we executed such assignments online.

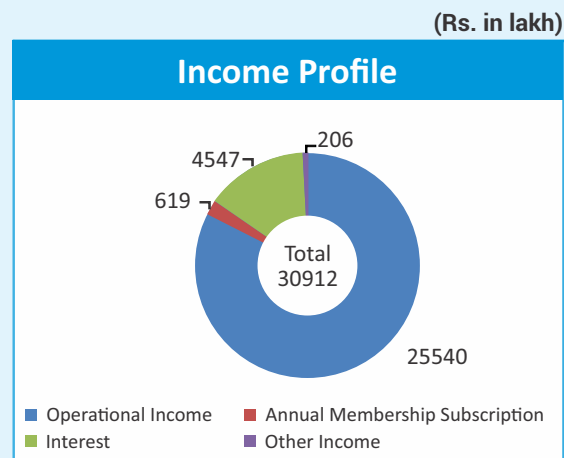
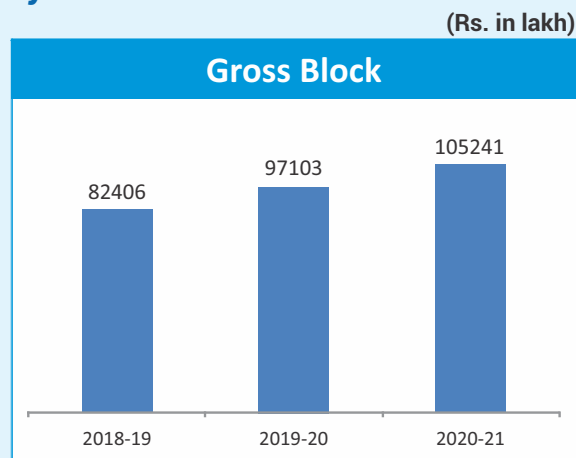
As the world hesitatingly limps back to normalcy, much would change. Business in a post-pandemic world will be full of new challenges and new opportunities. I am optimistic about the opportunities that are ahead of us and look forward to taking our Institute to greater heights and achieving many more successes in the years to come.

We believe in creating value for the customer over and above the contractual obligations. This is based on relationships built in the spirit of trust and collaboration.

On behalf of Team ARAI, I would like to thank the President, Vice President, the Members of the Governing Council, Members of Finance & Internal Audit Committee, Members of Project Evaluation & Monitoring Committee and Senior Officials from the Ministry of Heavy Industries (MHI) for their continued support. Also, I would like to express my sincere gratitude to the entire ARAI team for their exemplary contribution and efforts.

Dr. Reji Mathai

Key Indicators: 2020-2021



Operational Highlights

Finance & Accounts

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

■ Financial Performance

During the Financial Year 2020-21, Operational Income is Rs.25,540.41lakh as compared to Rs. 36,338.72 lakh in 2019-2020. Total Income is Rs. 30,913.36 lakh as compared to Rs. 41,712.82 lakh of last year. ARAI operational income is affected due to covid pandemic.

■ Investment of funds

The cash & bank assets available with ARAI have been invested in Scheduled Banks / Financial Institutions in various Deposit Schemes as per the Governing Council's guidelines.

■ MHI Supported Projects

Projects approved by MHI's (a) Main Committee out of Development Council for Automobile & Allied Industries (DCAAI) funds (b) Project Implementation and Sanctioning Committee (PISC) under FAME-India Scheme and (c) Apex Committee under Scheme on Enhancement of competitiveness in the Indian Capital Goods Sector (CG Scheme) are Non-Recurring Grant-in-Aid. ARAI also takes up R&D projects funded from its internal funds.

■ Appointment of Statutory Auditors

M/s. Gunwani and Kolapkar, Chartered Accountants, Pune were appointed as Statutory Auditors (In place of earlier M/s. P. G. Bhagwat) for the Financial Year 2020-21, in the Annual General meeting held on 22nd September 2020.

■ Membership Subscription

The total number of members of ARAI as on 31/3/2021 is 74 and the Annual Membership Subscription for the year under report is Rs. 619.13 lakh.

■ Recognition by DSIR

ARAI is recognized as a Scientific and Industrial Research Organization (SIRO) by the Department of Scientific & Industrial Research, Ministry of Science & Technology, Govt. of India for the period from April 2020 to March 2023.

■ Income Tax

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

Research and Development

During the year, the project supported by MHI on Establishment of Calibration Strategy for BS VI Real Driving Emission (RDE) by Virtual Technique was completed. The methodology developed reduces physical testing for different engine platforms and vehicle applications, as it uses a virtual approach. It is extendable to upcoming norms for NRMM and HD Hybrid (which are in discussion phase). Future legislative requirements like lower CF, cold phase inclusion and payload variations can also be studied with this virtual approach.

In addition to the above project, a technology innovation platform – TechNovuus has been developed with MHI's support, which facilitates collaborative research for indigenous technology development. Other projects currently being implemented under the support of MHI are :

- Development of an E-axle Powertrain Kit for 3-wheeler application in India
- Development of guidelines for accelerated validation of safety critical axle components due to increase in axle load specifications / norms, change in driving pattern and infrastructure
- Development of Efficient Battery Thermal Management System for Two and Three Wheeler EV application through design of innovative Packaging Material

Further, in order to enhance competencies and to meet industry's future requirements, new projects are being planned for implementation under internal funding in the areas of EV and Battery technology, NVH and Sound Quality, Alternate Energy/ Flex Fuels and Fuel Efficiency, Smart Materials and Material Characterization, and Tyre Characterization.

Model Inspection & Certification (I&C) Test Centres

ARAI has been identified by Ministry of Road Transport & Highways (MoRTH) for facilitating establishment of model test centres for Inspection and Certification (I&C) of in-use vehicles. Under this program, ARAI has facilitated establishment of I&C Centres at Nashik in Maharashtra, Nelamangala (Bengaluru) in Karnataka, Railmagra in Rajasthan and Surat in Gujarat. In addition to these centres, ARAI is currently facilitating establishment of centres in another five states and four centres for State Transport Departments of Karnataka and Maharashtra. Also, as per the instructions and approved procedure of Rajasthan State Government, ARAI has carried out audits of 12 vehicle fitness test centres belonging to private parties, for their authorization.

Business Development Initiatives

- Brand Building :
 - Webinars on 'Seating System Development: Challenges and Opportunities' and 'Ethanol Blending – A Step Towards Self-reliance in Energy' organized.
 - Showcasing of capabilities and capacities at virtual exhibitions, viz. Future Mobility Show 2021 and Aero India 2021.
- MoU with Praj Industries: For collaborative work on Bio-mobility technologies.
- MoU with University of Birmingham: For collaborative research in Air Quality Management and Alternate Fuels.
- Collaboration with Atal Innovation Mission (AIM) under TechNovuss Platform: For strengthening the innovation ecosystem in India with focus area as 'Automotive and Mobility Solutions'.

- MoU with Altair Start-up Challenge (ASC) under TechNovuus Platform: To support/mentor Start-ups through various programs, projects, activities in the areas of mutual interest.
- MoU with Micelio: To establish a framework for co-operation between the partners to support the Indian industry.
- New services and capabilities: E-motor/ e-powertrain calibration, performance validation & certification, EV Charger communication software development, Battery and BMS calibration, performance validation, cycle life testing, abuse testing/ safety assessment, validation of Battery Management System using HeRTS HIL System, new crash test load cases for Side Crash Test, Rear Impact Crash Test, 2W External Projections as per AIS-147, 2W Foot Rest Test as per AIS-148, Brake Test as per revised and new standards, Motor Shock Test as per IS:9000 (Part VII), weight optimization of Aluminium Trailer underbody, Air Bag simulation, Drywall partition acoustic simulation, test scenario generation for V&V of ADAS function, etc.
- Successful completion of transition audit by NABL as per ISO/IEC 17025:2017 for Testing and Calibration Scope.
- Extension of BIS scope as per LRS2020. New scope added Bicycle Reflector and Wheel Rims.
- Internal Auditor training to 44 NABL champions as per ISO/IEC 17025:2017.
- Various activities conducted during 'Swachhta Pakhwada' organized from 16th to 31st August 2020.

Continual Improvement Initiatives

ARAI strongly believes in continual improvement culture. To build and strengthen the operation excellence in our services, we have taken up following initiatives:

- Digitization of HR Processes: Adoption of a standard system, which is flexible, scalable and can be integrated with the existing ERP system.
- New platform for CMVR applications (CMVR-TAS): An online portal for customers seeking approval as per CMVR.
- ARAI Enquiry Management Tool: An online portal for managing new enquiries.
- Energy saving initiatives like solar plant installation, automation and modifications in utilities, etc.
- Installation of crusher machine to convert garden trash into manure as a green initiative.

Systems Compliance and Quality Management

- Successful renewal of NTSEL accreditation of Japan Motorcycle exhaust gas emission test TRIAS31-J044(2)-01.
- Successful completion of certification audits by TUV for the scope of ISO9001/ ISO14001/ ISO45001/ ISO27001.

Research & Development

Testing and Certification

Role in Standardization

New Facilities

Human Resource Development

Technology / Research Publications

Business Development

Events

Knowledge Centre

ARAI undertakes research and development programs to build competencies, capabilities and competitiveness, which, in turn, has reflected in its consistent growth. Leveraging its inherent strengths in different automotive engineering domains, ARAI has successfully executed various Government supported / industry funded / self funded research projects. Some of the research projects implemented during 2020-21 are listed below.

Design & Development

● **Development of Lightweight Aluminium Extrusion Profiles for Bus Superstructure**

Lightweight Aluminium Extrusion Profiles have been designed and developed indigenously for inter and intra-city bus superstructure. This development has been carried out with Hindalco Industries Ltd. The 9.8m AC Staff Bus built with this superstructure is 35% lighter as compared to existing steel superstructures for similar class of buses. The developed superstructure meets all the regulatory requirements, viz. Rollover as per AIS:052 (Rev.1), Modal Performance as per AIS:153, SUPD strength and other dimensional requirements as per CMV rules.



Indigenous development of extrusions and joining technique for transport application are the key highlights of this project. This outcome has resulted in filing of a Patent, titled 'A Joint for Assembling a Vehicle Body', jointly by ARAI and the industry partner. This development is a major step towards promoting 'Make in India'. Aluminum bus superstructure developed is best suited for Electric and Hybrid Electric buses for reducing weight penalty due to electrification.

● **Design and Development of AC Charge Point for Light Electric Vehicles (LEV)**

India has the potential to become a large electric mobility market, since light electric vehicles, i.e. 2W and 3W EVs are the most prominent segments for electrification. However, this calls for widespread presence of charging infrastructure to facilitate rapid and effective penetration of 2W and 3W EVs. Considering this, ARAI is leveraging its expertise in design, development, validation and testing of AC/DC charging stations, to develop India specific AC Charge Points for Light Electric Vehicles (LEV) with the support of Department of Science & Technology (DST). This LEV AC Charge point will be with various components, like safety interfaces, mobile app based user interfaces, controller and Bluetooth interface. The design of LEV AC charge point has been finalized, along with development of Bluetooth communication protocol and simulator, for its verification and validation. The developed prototype has been tested and validated. Deployment of prototype in the field and preparation and finalization of Indian Standard (IS) for LEV AC charge point is in progress.

● **Battery Management System (BMS) Validation**

With the exponential penetration of EVs in the market and the expected growth of this mobility category, the need for proven BMS has never been stronger. Determining the reliability and safety Battery Management System is done by validating the defined functionalities and requirements physically. However, this exercise is

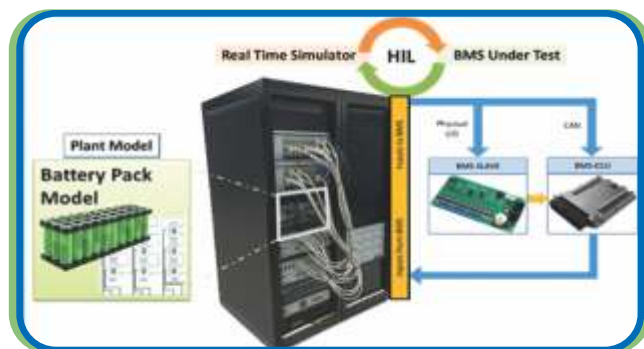
enormous due to the scale of hardware, data, use cases and scenarios, making it a costly and time consuming affair. Considering this, ARAI has developed methodology for verification and validation of BMS functionalities through the Hardware-in-loop (HIL) approach. Validation using HIL helps in reducing development time and cost, with added safety, as it eliminates the need of actual Li-ion cells and packs for testing. Hybrid and Electric Real-time Simulator (HeRTS), developed by ARAI, is deployed for development and validation of Battery Management Systems.

This HeRTS system can be customized and configured as per the requirements for development, verification and validation of Mobility CASE applications. It provides safe environment to simulate and validate BMS and Battery Packs for most test scenarios. It facilitates programmed control and emulates precisely the dynamic behaviour of each cell in the battery pack in a safe and controlled manner, without the requirement of physical tests on actual battery packs. Full matrix functional validation (with all possible fault scenarios) is possible because of this set up. Verification and validation of BMS and other control units, using this setup, ensures that the functionally safe product is developed and deployed into EV and xEV systems, thereby helping in development of cutting edge EV technology.

material characterization using machine learning and statistical models. As a part of this project, experimental data at 300°C, 350°C and 400°C and for different strain rates, viz. 0.005, 0.05, 0.5, 1.0, 3.0 and 7.0 was collected using compression testing machine. Further, the data was used for developing a machine learning model and also for training. This simple machine learning model fits well with the experimental data and has indicated good results. The detailed ML and Statistical model developed helps in predicting the strain-stress values from previously conducted experiments, while also forecasting output parameters for temperatures at which experiments cannot be performed.

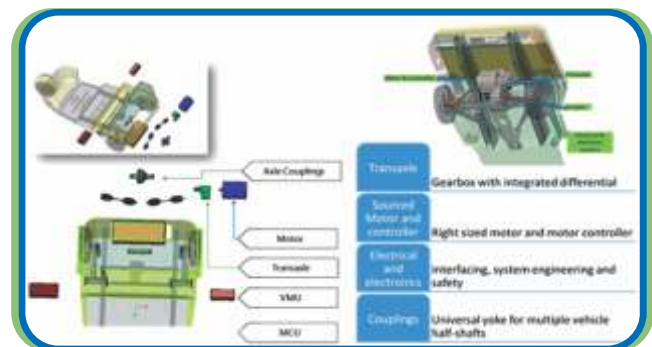
● **Development of E-axle Powertrain Kit for 3W Application**

The objective of this ongoing project, being implemented with the support of MHI, includes feasibility study and then deriving of optimum E-axle Platform suitable for retrofitment on in-use vehicles or for installation in OE vehicles of L5 category. This project involves designing and packaging of E-axle and related accessories with minimal modifications to existing vehicles and build demonstrator E-axles integrated on prototype vehicles based on L5 category of different applications (people carrier/load carrier). The final outcome targeted is development of working prototypes of E-axles for passenger carrier and goods carrier vehicle. Currently, proto manufacturing and its integration on both passenger and load carrier vehicles has been completed and testing & validation activity is in progress.



● **Development of AI/ML Model for Material Characterization**

Leveraging the strength of machine learning in technology development, ARAI has carried out



- **Engineering Support and Consultancy**

Consultancy and engineering support is being provided to the customer for converting conventional school bus to E-bus. As a part of this project, base vehicle has been tested to generate the data, along with scanning of vehicle, 3D CAD model generation and package investigation. Based on the findings, component sizing with respect to required capacities of motor and battery has been carried out. Integration of E-powertrain components is in progress, which will be followed with performance evaluation of the E-bus.

- **Conversion of Conventional Vehicle to Drive by Wire**

ARAI has developed the base framework for drive-by-wire functionality, which helps in integrating the drive-by-wire vehicle with user developed software that operates on the vehicle. With the help of this framework, a conventional vehicle has been converted to drive-by-wire successfully. Various systems, viz. steering, braking, acceleration and gear selection were automated to achieve this conversion.



- **Lithium ion Battery Module Development from Recycled Battery Materials**

Project on “Reduce, Reuse and Recycle of Lithium ion Battery”, with CSIR – National Chemical Laboratory (Principal Investigator), with the support of DST has been completed. In this project, feasibility of recycled electrode materials from used lithium ion batteries for preparing the anode and cathode for a new Li cell was studied.

Separator, electrolyte and current collector were new materials and initially focus was on electrode. Performance of the same was analyzed with incremental addition of recycled material along with virgin new materials. Subsequent to this, an optimized combination of new and recycled materials was arrived at. The proof of concept developed under this project will result in methodology development of a low cost and import independent battery.

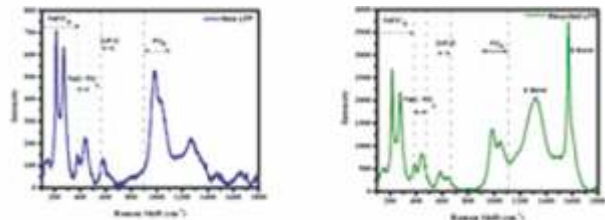


Figure 1. Raman plot for virgin (left) and recycled electrode.

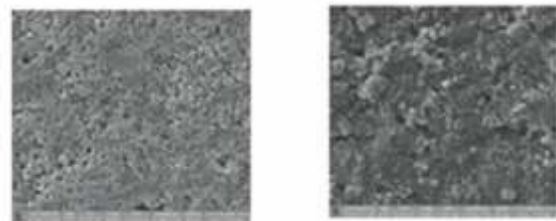


Figure 2. SEM image of electrode prepared from virgin (left) and recycled electrode.

- **Green Manufacturing of Automobile Forgings by Precision (Flashless) Forging**

Flashless Forging Process for crankshaft of two and three wheelers is being developed jointly with IITB and an Industry Partner under the project supported by DST, Government of India. Further to achieving weight saving of 100 grams per

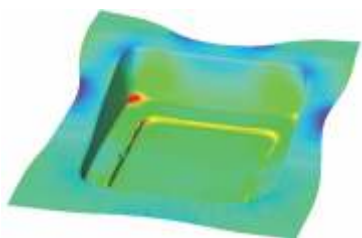


component in the last financial year, another 200 samples were produced during the year, to check repeatability. These samples were successfully subjected to machining trials with newly designed fixture to capture flashless component. Subsequent to these trials, weight saving of 100 grams per component was achieved, along with elimination of trimming operation. Also, scanning of dies and its comparison to original die was carried out to capture the die wear pattern. The process improvements carried out in the project have resulted in reduced energy consumption and thereby making the manufacturing process less energy intensive.



- **Deep Drawing Forming Process for Component Manufacturing and Die Design**

Manufacturing process and die design of component through deep drawing forming process has been undertaken at ARAI. Die profiles were designed based on the initial material and press details provided by the customer. Component and its manufacturing process herein was challenging due to the sharp components radius and sectional variation in deep drawing depth. With the help of iterative forming simulations, dimensions of the die profile were optimized along with thickness of the sheet. This exercise of using forming simulation technique has resulted in defect-free component with minimum number of forming stages at optimized material weight, with due consideration to press capacity constraint.



- **Development of H4TC CNG Engine**

Under this project, BS-VI compliant 4 cylinder, turbocharged & intercooled, multi-point injection CNG engine has been developed from an existing BS-IV CNG engine. It involved baseline performance of existing BS-IV CNG engine to study the gap in existing emission levels and BS-VI emission levels to be achieved. The methodology adopted to achieve the objective included review of design parameters & simulation study to achieve targeted emission results, after-treatment review & selection, steady state calibration to achieve desired power performance, transient calibration to achieve BS-VI emission norms, BS-VI OBD-I calibration for emission & non-emission related faults, support for RDE & ISC and demonstration of BS-VI emission compliant CNG engine. Subsequent to carrying out these activities, BS-VI compliant multi-point injected, turbocharged & intercooled CNG engine has been demonstrated successfully.

Similar to the above project, another project on development of BS-VI compliant 6 cylinder, turbocharged & intercooled, multi-point injection CNG engine from existing BS-IV CNG engine is under execution.



- **Demonstration of CNG BS-VI Engine**

The objective of this ongoing project is to demonstrate BS-VI emission compliant CNG engine, using existing BS-IV CNG engine and compare difference in emissions using CNG of varying methane contents. Various activities completed include baseline BS-IV CNG engine performance study; gap analysis of existing

emission levels vis-à-vis required target, design review, thermodynamic 1-D simulation, flow homogeneity and injector location simulation, steady state calibration, after-treatment review, and combustion optimization to meet BS-VI norms. Currently, study of effect of gas composition on engine emissions is underway.



● Face Shield Development

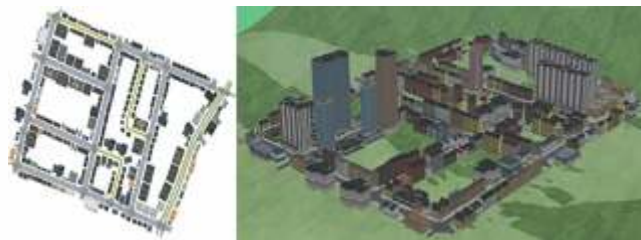
As India faced one of its biggest challenges caused by the COVID-19 pandemic, ARAI put in place various measures deploying its infrastructure and expertise to protect the employees, ensure business continuity and mitigate the spread of the virus. ARAI's capabilities in simulation and materials have been leveraged to develop lightweight Face Shield in very short time frame. Simulation techniques were extensively used in this development process. Over 20,000 Face Shields were produced and distributed free of cost, to the frontline workers in Pune region, as a part of CSR activity.



Design Optimization and Simulation

● Simulation Based V&V of AEBs

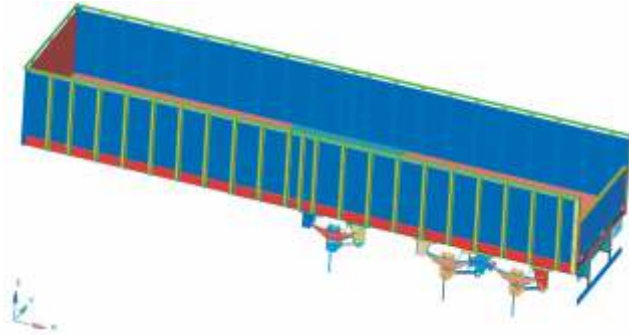
Advanced Driver Assistance Systems (ADAS) and Autonomous Driving (AD) simulation tools facilitate in creating virtual world from scratch and one of the approaches includes use of KML files from Google via Google Earth. Deploying this technique, a virtual city has been created in simulation environment emulating typical Indian urban driving environments. As a part of this exercise, over 200 AEB test scenarios have been created and rated based on Euro NCAP assessment documents. This has helped in establishing a simulation based V&V framework, which is not just useful for verification and validation of ADAS functions, but is also expected to be the crucial service needed by the industry in the coming years.



● Weight Optimization of Aluminium Freight Trailer

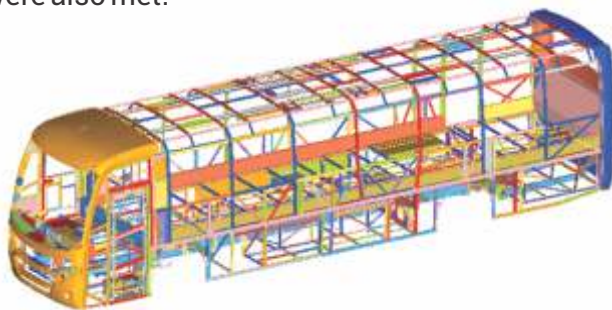
Weight optimization has been carried out through design modifications after assessing the structure for an Aluminium Trailer design. This involved structural modification on long members and cross members in terms of section modulus design, number of cross members, etc. The structural modifications have resulted in significant weight reduction of Aluminium Trailer and moreover, the optimized design meets structural strength requirements under standard road load condition in addition to regulatory requirement of AIS:093 (Rev-1). The optimized structure is ~50% lighter as compared to steel trailer design and also, payload capacity has increased by 2.5 Ton. The trailer prototype built by

Hindalco, with engineering inputs of ARAI, is successfully operating on the roads and has reduced the ownership cost of the customer.



- **Bus Superstructure Optimization**

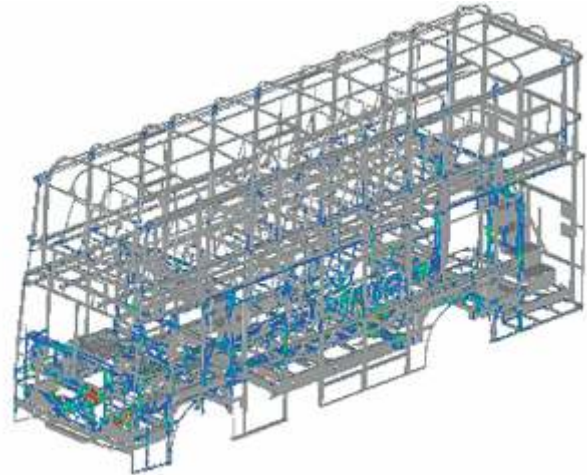
Weight optimization of bus superstructure has been completed successfully using simulation. The project involved evaluation initial design for different durability load cases, including fatigue and rollover to identify the areas with less stresses. Based on the functional requirements, weight optimization in terms of thickness reduction, cross section and complete elimination of bracket was carried out. At every stage of the project, the structure was re-evaluated to observe its compliance for all load cases. After several iterations, weight reduction of around 150 kg weight was achieved, as compared to existing bus structure and at the same time, strength and functional requirements were also met.



- **Structural Strength Evaluation & Design Modification of Double Decker Bus:**

Project on structural strength evaluation of double decker bus design under specified loading conditions (using FE simulation) was completed as per Annexure-III of Recommendatory Urban

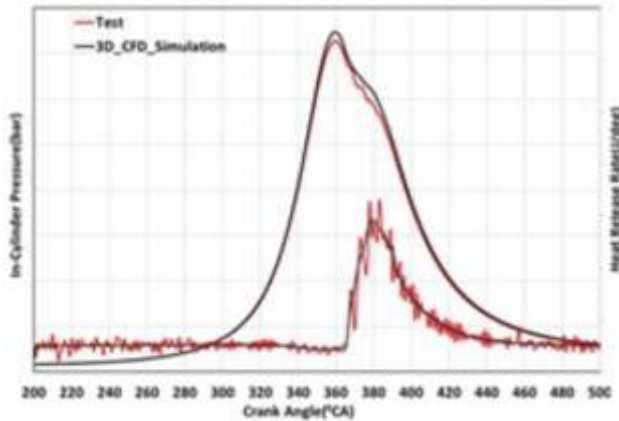
Bus Specifications - II (April 2013), issued by Ministry of Urban Development (MOUD) for a bus OEM. Further to the evaluation and baseline design results, DFM approach was used to decide required design modifications for their implementation by the customer in the double decker bus model.



- **Development of Off-road Engine with Mechanical Fuel Injection System**

Simulation approach has been used to derive optimum combustion hardware combination for Off-road engine (Diesel-GenSet) with mechanical fuel injection system to meet upcoming stringent emission regulations (TREM IV). In this project, CFD simulation approach was used to select the best hardware combination with defined NOx and PM after-treatment efficiencies. Hardware selection through CFD simulation helped in optimizing of combustion parameters, such as fuel injection pressures, nozzle configuration, injection timing variation, combustion chambers, compression ratio, EGR and port swirl combination to reduce number of hardware combinations for experimental evaluation. The base engine model was built in 3-D CFD software using various models, each representing a particular physical phenomena of diesel combustion, boundary and initial conditions taken from 1-D thermodynamic simulations, and which were validated with the base engine test results. It was observed that the simulation

results of performance, BSFC, 5-mode cycle NOx and PM emissions correlated well with the base engine experimental results (within $\pm 10\%$). Also critical combustion parameters such as start of combustion, PFP and MBF validated with very good agreement.



● Impact Simulation of EV and xEV Motor Assembly as per IS: 9000

Shock assessment of EV Powertrain motor assembly of HCV has been carried out. As motor size and weight are higher in HCV and in certain LCV applications, their testing requires generation of acceleration load equivalent to 300 m/s^2 (30g), and so the easier way out is to test the motor through simulation. In this project, the motor has been tested for shock as per IS:9000 (Part VII)-1979 (Reaffirmed 2016) through simulation, wherein it was subjected to half sine-shock pulses in Vertical, Transverse and Longitudinal directions. Also, load and boundary conditions were applied as prescribed in the standard. Further to this, it was observed that the mechanical integrity of the motor assembly was found to be intact, which indicates that motor structure meets the regulatory requirements.

In addition to design and development capabilities, Testing and Certification is ARAI's strength, as acknowledged by various authorities through their accreditations and recognitions as given below:

- **Recognition by National Traffic Safety and Environment Laboratory (NTSEL), Japan** to carry out the Tests as per TRIAS 31.
- **Recognition by RDW, Netherlands** as 'Technical Service Provider' to carry out CoP verification audits.
- **Accreditation by Land Transport Authority (LTA) and National Environmental Agency (NEA), Singapore** as 'Recognized Overseas Test Lab'.
- **Recognition by Department of Infrastructure, Australia** to provide Test Reports in compliance to ADRs (Australian Design Rules).
- **Accreditation by Telecommunication Engineering Centre, DoT** as "Conformity Assessment Body" for Testing of Telecom Equipment.
- **Accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL)** for various types of testing and calibration as per ISO/IEC 17025.
- **Recognition by Bureau of Indian Standards (BIS)** for various safety components as per concerned IS Standard.

During the year, ARAI has executed assignments relating to certification, testing, validation, evaluation, data analysis, etc. Details of some of the projects are given below:

Certification & Validation Projects

- **Type Approval & Certification**
 - BS-VI Certification
 - Truck Code, Trailer Code, Ambulance Code
 - Certification as per FAME Scheme
 - Electric Buses
 - CEV – Stage IV Emission Norms and new Safety Standards
- Export homologation – Construction Machinery testing as per British Standards
- Combined Harvester
- Motor Caravan
- NVH Testing on BS-VI buses as per AIS 153
- **Noise Compliance for Generator Sets**
 - Diesel Genset models as per CPCB guidelines
 - Extension of Type Approval Certificates to Generator Original Equipment Manufacturers (GOEMs) as per Central Pollution Control Board (CPCB) guidelines
 - Conformity of Production (COP) tests for OEM & GOEM plants
 - Conformity of Production (COP) tests for Petrol Genset models
 - Type Approval of Gas Generator models
- **Validation & Testing Assignments**
 - Fatigue and high strain rate characterization of steel sheets
 - Metallurgical failure analysis projects to find the root cause of failure
 - Crash tests
 - Seat Belt tests
 - Seat structure validation tests with 5th, 50th and 95th percentile dummies
 - Pedestrian Protection Tests
 - CoG measurement for off-road vehicles using tilt-table method
 - A-Pillar and Windshield Glass Impact Tests
 - Combined Vibration & Environmental validation of Generator Control Panels
 - Drop test of Helicopter fuel tank from 50 feet
 - Tilt angle determination of a sugarcane harvester

- Articulation test of Mine Proof Vehicle as per Ministry of Defence requirements
- Coal Mine machinery equipment noise level measurement under mining tunnel
- Pass-by Noise (PBN) measurement on export class of vehicle as per UN R51.03
- NVH Benchmarking of 2W & 3W Electric Vehicles
- Noise & Vibration measurement on Hand Held Road Roller
- Experimental Modal analysis and dynamic stiffness evaluation for BIW Structure of PV
- Noise & Vibration measurement on Pokers used at construction sites
- Performance analysis of HCV Axles to improve fuel efficiency
- Sound Power Level evaluation of CV Tyres



Noise & Vibration Measurement on Hand Held Road Roller



Experimental Modal Analysis and Dynamic Stiffness Evaluation for BIW Structure



Tilt Angle Determination of Sugarcane Harvester



Setup for Axle Power Loss Analysis



Articulation test of Mine Proof Vehicle



Sound Power Level evaluation of CV Tyres

Evaluation and Assessment Projects

- **Assessment of DME and LPG blend**

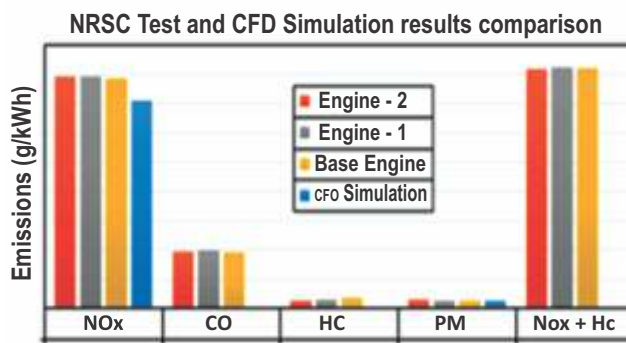
Project on “Di Methyl Ether (DME) and LPG blend (30%-70%) Assessment on a 3W” is being carried out at ARAI. The objective is to assess this blend for wide open throttle conditions (WOT) and emission performance, and optimization of LPG-DME blend configuration for vehicle performance. The methodology adopted includes baseline emission testing with gasoline and LPG along with WOT performance, engine out and tail pipe emission measurements. Various combinations of DME and LPG blend considered are 30:70, 50:50, 70:30 and 100% DME. Subsequent to this, calibration of vehicle performance for optimum DME blend will be carried out followed by demonstration of vehicle running on LPG-DME blend.



- **Combustion Parameters Assessment**

Under this project, combustion hardware parameters and suitable hardware combinations for performance, emissions (Smoke, NO) and BSFC improvement of 3.82 ltr NA diesel engine for 60HP power rating have been assessed using 3-D CFD Simulation approach. Combustion bowl shape, port swirl number, Static Injection Timing (SIT) and EGR to achieve the target of customer specified NOx and PM were the main parameters considered for assesment. Base engine model was built in 3-D CFD software using various models, each representing a particular physical phenomena of diesel combustion, boundary and initial conditions taken from 1-D thermodynamic simulations, and which were well validated with

base engine test results. It was observed that the simulation results of performance BSFC, 8-mode cycle NOx and PM emissions correlated well with the base engine experimental results (within $\pm 10\%$). Also critical combustion parameters, such as start of combustion, PFP and MBF validated with very good agreement. Some of the combustion hardware combinations were simulated for 8-mode cycle emissions and one of the optimized combustion hardware combinations was observed to be very close to the targeted engine-out emissions. The same optimized combustion hardware configuration has been verified on steady-state emission measurement on engine test bed. Particularly, No_x, PM and BSFC have shown very close correlation (within $\pm 10\%$) between the simulation and experimental output.



- **Clean Air Project in India (CAP India)**

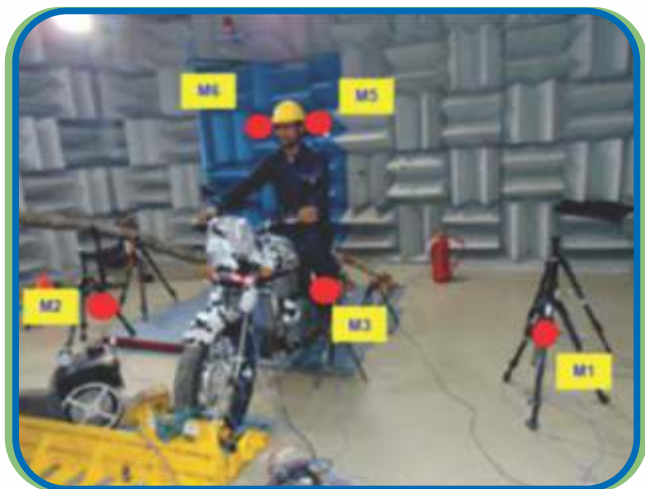
ARAI is currently implementing “Clean Air Project in India” in Pune and Nashik (partial role) cities for Swiss Agency for Development and Cooperation



(SDC). This project is for supporting India’s efforts to improve air quality and contribute to public health, environment and climate change mitigation. It emphasizes on improved data measurement and analysis of clean air, development and implementation of clean air policies and action plans, and raising awareness for clean air. As a part of the project, field activities, including vehicular surveys in Pune and ambient sampling in Nashik, have been carried out.

● **Noise Source Identification**

Project on Identifying major Noise Sources responsible for Exterior Noise Radiation on 2-Wheeler has been executed. As a part of this project, pass-by noise measurements were carried out on test track and then co-related with the measurements obtained on chassis dyno in hemi anechoic chamber. Subsequent to this, the speed at which maximum noise occurs during the pass-by test, was identified along with critical noise radiated frequencies.



● **In-cab NVH Levels & Sound Quality Analysis**

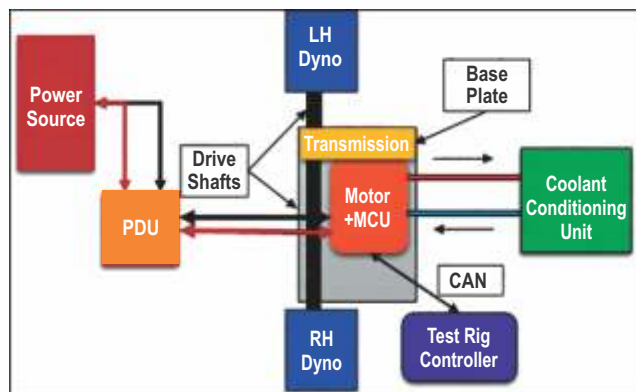
Under this project, overall noise and vibration levels were measured inside an Electric Bus at various conditions along with analysis of sound quality with due consideration to operator and passenger ear level noise perception. Subsequent to this, it was observed that overall noise levels

are low, but of high frequency and so, sound quality needs to be addressed in most of the vehicles. Using the in-house expertise, advanced NVH analysis technique and suitable acoustic enclosure for electric motors in bus, high frequency noise was reduced and sound quality was improved.

● **Durability Testing**

EV Driveline:

Durability testing of EV Driveline has been carried out successfully at ARAI. The complete driveline of the electric vehicle, comprising of E-Motor, Transaxle, Drive shafts and MCU, was mounted on the test bench. The motor, along with its transmission, was controlled through MCU over CAN communication and highest motor speed was achieved. The specimen behaviour was analyzed by monitoring vibration levels at different phases of test. Also, functionality of various driveline components, like park-lock, lubrication pump, etc. was validated and the drivetrain was successfully tested for 1,000 hours, i.e. about 1.75 lakh km. of running.



● **Transfer Case**

Transfer case was tested in various loading conditions for performance and durability, with accelerated duty cycle for 17 hours. Different torque at front and rear axle locations were simulated during this testing. Efficiency of transfer case was measured for various operating conditions and was observed to be in between 90 and 95%. Also, noise and vibration measurement

was performed on the test specimen. Chain mesh whine orders were also analyzed to correlate with OEL noise contribution.



Measurement and Analysis Projects

- **Upgradation of India Specific Dataset for Machine Learning**

Advanced Driver Assistance Systems (ADAS) are enabling drivers to handle different situations effectively semi-autonomously. They automate dynamic driving tasks, like steering, braking and acceleration of vehicle for controlled and safe driving with use of radar, vision and various sensors, including LIDAR. However, development and validation of such systems require high quality training and test data, and integration of these technologies requires labeled data to train the algorithm for detecting various objects and moments of driver. Image annotation is one of the well-known services to create such training data for computer vision and even though there are a number of open source annotated datasets available, there are hardly any datasets available for Indian Specific road conditions.

So, in order to capture the India specific objects on road, an exercise was taken up for capturing data for various environmental and road conditions and annotating objects through cameras. This exercise has been taken further this year with addition of 25,000 annotated images to the already annotated 20,000 images for Indian specific conditions. This entire dataset is now

being used to check improvement in the performance of the object detection algorithm. The below image shows detection of different classes with different models and different number of training images generated using the data.



- **Emission Inventories Development**

ARAI is a part of consortium of National Super-computing Mission (NSM) for Urban Modelling to work on project titled 'Urban Modelling Development of Multi-Sectorial Simulation Lab and Science-based Decision Support Framework to address Urban Environment Issues. Under this project, development of high-resolution emission inventories and conducting dispersion modelling analysis for four Indian cities, viz. Bengaluru, Pune, Bhubaneswar and Ahmedabad is being undertaken. This project involves primary data collection for generating activity data in the selected cities, development of high-resolution city-level emission inventories, projection of baseline emission loads, development of control scenarios for future, conducting city-level dispersion modelling analysis and chemical speciation and receptor modelling based source apportionment of PM_{2.5} (only for Bengaluru city). Various activities completed during the year include GIS mapping of various features, secondary data-based emission inventory preparation, wintertime sampling and chemical analysis of PM_{2.5} samples for Bengaluru city.

- **Emission Inventory and Source Apportionment Study**

For Bhopal City :

ARAI is working on generation of emission inventory of pollutants and particulate matter (PM_{10} and $PM_{2.5}$) source apportionment for Bhopal city. This project involves sampling and laboratory analysis of PM_{10} and $PM_{2.5}$ using speciation samplers at identified locations; PM_{10} and $PM_{2.5}$ source apportionment study through receptor modeling using CMB 8.2 model; development of GIS – based gridded (2 km x 2 km resolution) emission inventory for air pollutants, viz. particulate matter less than $10_{\mu m}$ and $2.5_{\mu m}$ (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), carbon monoxide (CO) and oxides of nitrogen (NOx) for base year 2020; projecting baseline emission loads using growth rate method for future years along with plan control actions in consultation with the stakeholders; generating spatial distribution of PM_{10} and $PM_{2.5}$ concentrations using suitable dispersion model; and preparation of comprehensive action plan for reducing, control and abatement of PM_{10} and $PM_{2.5}$. Under this project, following activities were completed during the year.

- ▶ GIS mapping of various features, including roadways, population, land use and land cover, crematoria, airport, etc.
- ▶ Chemical analysis of winter time $PM_{2.5}$ and PM_{10} samples collected during January 2020 for carbon fractions, ions and elements.
- ▶ Receptor modelling for quantification of sources of $PM_{2.5}$ and PM_{10} .

For Angul-Talcher, Rourkela, Kalinga Nagar-Jajpur Road in Odisha:

ARAI's expertise in generating emission inventories and particulate matter source apportionment has resulted in it being awarded with a project for non-attainment cities of Angul-Talcher, Rourkela, Kalinga Nagar - Jajpur Road in Odisha. The project activities will be the same as the ones being undertaken in case of the project for Bhopal city and they include sampling and laboratory analysis of PM_{10} and $PM_{2.5}$ using speciation samplers at identified locations; PM_{10} and $PM_{2.5}$ source apportionment study through receptor modeling using CMB8.2 model; development of GIS – based gridded (2 km x 2 km resolution) emission inventory for air pollutants; projecting baseline emission loads for future years, along with plan control actions in consultation with stakeholders; generating spatial distribution of PM_{10} and $PM_{2.5}$ concentrations; and preparation of comprehensive action plan for reduction, control and abatement of PM_{10} and $PM_{2.5}$. Based on this, information on industries, thermal power plants and mines has been compiled and GIS mapping for various features has been completed.

- **Air Quality Modelling**

ARAI is working on analyzing historic trends of air quality, developing baseline and future anthropogenic emission scenarios (considering proposed policies and regulations with special focus on transport sector) and prediction of air quality conditions for respective emission scenarios in Pune city. As a part of this study, historic data of air quality and source contribution in Pune city has been analyzed. Further, GIS mapping of various features, including roadways, population, land use and land cover, brick kilns, crematoria, airport, etc. has been completed along with its quantification.

Role and Contribution in Various National and International Committees / Forums

| | |
|---|--|
| Automotive Industry Standards Committee (AISC) | <ul style="list-style-type: none"> ● Secretariat Services to AISC ● Participated in 2 meetings of AISC and several meetings of Technical Panels working under AISC |
| CMVR - Technical Standing Committee | <ul style="list-style-type: none"> ● Technical Secretariat Services to CMVR-TSC ● 2 meetings of CMVR - TSC held during the year |
| Standing Committee on Implementation of Emission Legislations (SCoE) | <ul style="list-style-type: none"> ● Technical Secretariat Services to SCoE ● Participated in 2 meetings of SCoE during the year |
| CPCB Standing Committee | <ul style="list-style-type: none"> ● Technical support to CPCB Standing Committee ● Contribution in formulation of standards on noise as a Member of National Committee |
| Bureau of Indian Standards (BIS) | <ul style="list-style-type: none"> ● Technical guidance / expertise to BIS ● Chairmanship of 5 TED (Transport Engineering Department) Sectional Committees of BIS |
| WP.29 | <ul style="list-style-type: none"> ● Technical Secretariat Services for National Committee on WP.29 matters and Core Group on WP.29 related activities ● ARAI was part of 15 delegations that participated in Technical Sessions of WP.29 and GR meetings during the year ● Coordinated WP.29 India sub-group activities on GRPE, GRE, GRBP, GRSP, GRSG, GRVA |

FORMULATION OF SAFETY STANDARDS



New AIS

- (i) AIS-017 (Part 6): Procedure for establishing Whole Vehicle Safety Conformity of Production (WVSCOP) for L, M, N category of vehicles, E-rickshaws & E-carts
- (ii) AIS-137 (Part 8): Technical Specifications and Related Test Procedure for Type Approval and Conformity of Production (COP) of PUC Equipment (Gas Analyzer and Smoke Meter) as per CMV Rules 115, 116.
- (iii) AIS-137 (Part 9): Test method, Testing Equipment and Related Procedures for Type Approval and Conformity of Production (CoP) Testing of Quadricycle (L7 category) vehicles for Bharat Stage VI Emission Norms as per CMV Rules 115, 116 and 126
- (iv) AIS-156: Specific Requirements for L Category Electric Power Train Vehicles
- (v) AIS-157: Safety and Procedural Requirements for Type Approval of Compressed Gaseous Hydrogen Fuel Cell Vehicles
- (vi) AIS 158: Code of Practice for Type Approval of Modular Hydraulic Trailers towed by Puller Tractor of Category N3
- (vii) AIS-160: Safety Requirements for Construction Equipment Vehicle(s)
- (viii) AIS-163: Procedure for Type Approval of Special Purpose Vehicles (SPVs) for compliance to Central Motor Vehicles Rules (Cash Van, Mobile Canteen)
- (ix) AIS-167: Constructional and Functional Requirements for Special Purpose Vehicle – Two Wheeled First responder – Fire
- (x) AIS-170: Remote Sensing Devices for on-road Emissions Monitoring – Product Specifications and Program Guidelines
- (xi) AIS-171: Safety Requirements for Type Approval of Anhydrous Ethanol & Ethanol Blended Motor Gasoline (EBMG) Vehicles (for Blends > 20%)

Revised AIS

- (i) AIS-004 (Part 3) (Rev. 1): Automotive Vehicles – Requirements for Electromagnetic Compatibility
- (ii) AIS-024 (Rev.1) (Part A) and AIS-028 (Rev.1) (Part A): Safety and Procedural Requirements for Type Approval of Gaseous Fueled Vehicles – Part A (Automotive Application) and Code of Practice for use of Gaseous Fuels in Internal Combustion Engine Vehicles – Part A (Automotive Application)
- (iii) AIS-024 (Rev.1) (Part B) and AIS-028 (Rev.1) (Part B): Safety and Procedural Requirements for Type Approval of Gaseous Fuel Agricultural Tractors – Part B (Agricultural Tractors Application) and Code of Practice for use of Gaseous Fuels in Internal Combustion Engine Agricultural Tractors – Part B (Agricultural Tractors Application)
- (iv) AIS-024 (Rev.1) (Part C) and AIS-028 (Rev.1) (Part C): Safety and Procedural Requirements for Type Approval of Gaseous Fuel Vehicles – Part C (CEVs Application) and Code of Practice for use of Gaseous Fuels in Internal Combustion Engine Construction Equipment Vehicles (CEVs) - Part C (CEVs Application)
- (v) AIS-038 (Rev. 2): Specific Requirements for Electric Power Train of Vehicles
- (vi) AIS-088 (Rev.1): Performance Requirements of Rear Marking Plates (Rear Warning Triangles) for Automotive Vehicles, Agricultural Tractors their Trailers and Semi-Trailers

Amendments to Existing AIS

- (i) Amd 8 and 9 to AIS-007 (Rev.5): Information on Technical Specifications to be submitted by the Vehicle Manufacturer
- (ii) Amd 2 to AIS-009: Automotive Vehicles – Installation Requirements of Lighting and Light-signaling Devices for L Category Vehicles, their Trailers and Semi-Trailers

- (iii) Amd 3 to AIS-009 (Rev.1): Automotive Vehicles – Installation Requirements of Lighting and Light-signaling Devices for L Category Vehicles, their Trailers and Semi-Trailers
- (iv) Amd 5 to AIS-023 (Automotive Vehicles – Seats, their Anchorages and Head Restraints for Passenger Vehicles of Categories L7, M2, M3 and Goods Vehicles of Category N – Specifications)
- (v) Amd 1 to AIS-024 and AIS-028 (Rev.1) (Part A): Safety and Procedural Requirements for Type Approval of Gaseous Fuel Vehicles and Code of Practice for use of Gaseous Fuels in Internal Combustion Engine Vehicles (Revision-I) (Part A) (Automotive Application)
- (vi) Amd 2 to AIS-048: Battery Operated Vehicles – Safety Requirements of Traction Batteries
- (vii) Amd 1 to AIS-057 (Rev.1): Provisions concerning the Approval of Retro-Reflecting Devices for Power Driven Vehicles and their Trailers
- (viii) Amd 3 to AIS-071 (Part 1): (Automotive Vehicles – Identification of Controls, Tell-Tales and Indicators)
- (ix) Amd 3 to AIS-075: Approval of Vehicles with regard to their Protection against unauthorized use – Four Wheeled Vehicles
- (x) Amd 4 to AIS-110: (Automotive Vehicles – Temporary – Use Spare Wheel/ Tyres and Run Flat Tyres)
- (xi) Amd. 3 to AIS-125 (Part 1): Constructional and Functional Requirements for Road Ambulances
- (xii) Amd 1, 2 and 3 to AIS-137 (Part 3): Test Method, Testing Equipment and Related Procedures for Type Approval and Conformity of Production (COP) Testing of M and N Category Vehicles having GVW not exceeding 3500 kg for Bharat Stage VI (BS VI) Emission Norms as per CMV Rules 115, 116 and 126
- (xiii) Amd 1 to AIS-143: Performance Requirements and Test Procedures of Braking Systems for Wheeled High Speed Rubber Tracked Earth Moving Machines and all types of Construction Equipment Vehicles
- (xiv) Amd. 5 to AIS-145: Amendment No. 5 to Additional Safety features for Category M and N Vehicles
- (xv) Amd 6 to AIS-153: Additional Requirements for Bus Construction.

AIS Standards Finalized

(To be released in the Year 2021-22)

- (i) AIS-164: Construction and Functional Requirements of Insulated Vehicles
- (ii) AIS-168: Specific Requirements for A6 and A7 Category Electric Power Train Agricultural Tractors
- (iii) AIS-169: Guidelines on Provisions for Adapted Vehicles of categories M1, N1 and M2
- (iv) AIS-172: Intelligent Transport Systems – Forward vehicle collision warning systems – Performance requirements and test procedures

Cooperation with Bureau of Indian Standards (BIS)

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

- TED 2: Automotive Prime Movers, Transmission Systems and Internal Combustion Engines
- TED 6: Automotive Body Chassis Accessories and Garage Equipment
- TED 22: Transport Tractors, Trailers and Industrial Trucks

- TED 26: Automotive Vehicles Running on Non-Conventional Energy Sources.
- TED 29: Passive Safety Crash Protection Systems

CMVR and its Implementation

CMVR - Technical Standing Committee

CMVR-TSC has identified following subjects of national importance for formulation of Policy/ Norms/ Standards and implementation thereof:

- Advanced Emergency Braking Systems
- Protective Devices for 2 W
- Fire Safety in Passenger Compartment of Buses
- Intelligent transport systems – Forward vehicle collision warning systems – Performance requirements and test procedures
- Creation of new vehicle category L2e-P in line with EU 168/2013
- Provisions to attach an additional trailer to the truck (Road Train Vehicles)

International Cooperation and Harmonization of National Standards

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

- Proposal for Amendment 4 to UN GTR No. 3 (Motorcycle braking)
- Proposal for Amendment 2 to UN GTR No. 6 (Safety glazing)
- Proposal for Amendment 3 to UN GTR No. 6 (Safety glazing)
- Proposal for Amendment 2 to UN GTR No. 16 (Tyres)
- Proposal for Amendment 3 to UN GTR No. 19

(Evaporative Test Emission Procedures for the Worldwide Harmonized Light vehicles Test Procedures (EVAP WLTP))

- Proposal for a new UN GTR on the determination of Electrified Vehicle Power (DEVP)
- Proposal for Amendment 1 to UN GTR No. 7 (Head restraints)
- Proposal for Amendment 6 to UN GTR No. 15 (WLTP)
- Proposal for Amendment 1 to UN GTR No. 18 (On-Board Diagnostic (OBD) systems for L-category vehicles)
- Consideration of amendments to Mutual Resolution No.3 Concerning Vehicle Interior Air Quality (VIAQ)
- Mutual Resolution No. [4] concerning Panoramic Sunroof Glazing

Participation in Technical Sessions of WP.29 – Highlights

During the year, India participated in several technical sessions of WP.29, its subsidiary working parties and Informal Group meetings. Indian delegations participated in the GR and WP.29 sessions through virtual platform. Secretariat at ARAI provided technical and other support to these national delegations for the sessions.

Worldwide Harmonized Light Vehicles Test Procedure (WLTP)

WLTP IWG has been formally dissolved subsequent to completion of developing of WLTP GTR and its transposition to a new UN Regulation 154 in the GRPE meeting held in June 2020. However, GRPE and members involved in formulation of WLTP GTR will continue to work on amendments as and when required on the WLTP procedure. India is actively monitoring developments on WLTP and its amendments, if any. India has agreed to adopt WLTP into Indian regulation. Accordingly, following Sub-groups have been constituted under AISC Panel on WLTP to work on different aspects for implementation of WLTP.

- RDE with WLTP – Chaired by ICAT
- Type I Test – Chaired by SIAM
- Type IV Test – Chaired by ARAI
- Coast down – Chaired by ARAI
- Infrastructure – Chaired by ARAI

Environmental and Propulsion Performance Requirements (EPPR) for L – Category Vehicles

Under Phase-2 of EPPR-IWG, work on amendment 4 to GTR No.2 and On-Board Diagnostic Systems (OBD2) to amend GTR No. 18 was completed during the year. EPPR Group is currently working on GTR 2 amendment 5 and new GTR on Durability of Pollution control devices. ARAI participated in 9 EPPR meetings held online during the year. The major inputs given by India during these EPPR sessions included;

- Indian delegation requested EPPR via an informal document to put in abeyance India-specific 3W in Amd5, which was agreed upon by the IWG, as the India specific 3W, is low powered and low max speed vehicles and hence would have difficulty in negotiating acceleration and speed requirements of WMTC cycle.
- India also submitted an informal document to include alternative fuels into the scope of GTR 2, which was appreciated by the EPPR Chair and is currently under discussion.
- Indian delegation was requested by USA/EPPR to provide historical perspective of vehicle classification criteria for GTR2. Indian delegation had internal meeting and the historical development and discussions were presented to EPPR in its 40th Session.

Type Approval Certification

ARAI has carried out Type Approval and Certification for several safety components and emission norms as per safety standards and emission norms for different categories of vehicles. Also, it has initiated work for safety norms to be implemented in 2021-22. Major highlights are given below.

Safety Standards and Emission Norms Implemented in 2020-21:

- Safety Standards:
 - Revised brake standard for 3W for L5-M and L5-N (All Models)
 - Vehicle Reverse Parking Alert System RPAS for M2, M3 and N category
 - Safety Provisions for 3W for L5-M and L5-N (All Models)
 - CMV Rule 93 (Overall Dimensions of Motor Vehicle) for all motor vehicles as applicable
 - Provisions for Color of vehicle registration number and color of its background for all motor vehicles as applicable
 - Addition of provisions for Puncture repair kit under CMV Rule 138 for M1 category
 - Implementation of AIS 157 under CMVR 115 (HFCV) for M and N category
 - HSRP implementation and green strip (above third registration plate) requirement for BS VI vehicles for all motor vehicles as applicable
 - Addition of provisions for Wheel chair entry/housing/ locking arrangement for Wheel chair for differently abled passengers and passengers with reduced mobility for all Transport Vehicles
 - Implementation of AIS-154: Tyre Pressure Monitoring System (TPMS) under CMV Rule 95 for M1 ≤3.5 T and N1
- Emission Standards:
 - Bharat Stage VI (BS VI) for all motor vehicles as applicable
 - Implementation of BS VI norms for Quadricycles for L7 category
 - Addition for provisions for CSFC Diesel for M3 and N3 with GVW of 12 T and above
 - Implementation of AIS-024 & AIS 028 (Rev.1)

and Fuel specs as per IS 17314:2019 under CMVR 115 for all motor vehicles as applicable

- Mass emission standard for flex-fuel ethanol (E20) for all motor vehicles as applicable

Safety Standards and Emission Norms for Implementation in 2021-22:

- Safety Standards:
 - Various safety requirements for Construction Equipment Vehicle (CEV) as per AIS-160 (Part 1) and emission sound pressure level at operator's ear position (Phase I)
 - Revised Brake Standard IS 11852 (2013) for M2, M3 and N category
 - Revised Brake Standard AIS 151 or IS 15986 (2015) for M1 and N1 category
 - Electronic Stability Control System (ESC) (if fitted) for M1 and N1 category
 - Brake Assist System (BAS) (if fitted) for M1 and N1 category
 - Implementation of Modular Hydraulic Trailer requirements as per AIS-158 under CMV Rule 125 for MHT
 - Insertion of provisions for vehicle recall for all motor vehicles as applicable
 - Front passenger Airbag requirements as per AIS 145 for M1 category
 - Safety Glass (Quality Control) Order, 2020 for all motor vehicles as applicable
 - Quality Control Order for Wheel Rims for all motor vehicles as applicable

- Implementation of revised wheel rim standards for various vehicle categories for all motor vehicles as applicable
- Implementation of 146 on Two Wheelers Stand for L1 and L2 category
- Implementation of 147 on Two Wheelers External Projection for L1 and L2 category
- Implementation of 148 on Two Wheelers Foot Rest for L1 and L2 category
- Emission Standards:
 - Implementation of TREM / CEV IV norms for Agricultural Tractors and CEV

Notifications issued in 2020-21 for Implementation of Safety Standards and Emission Norms in future after 31st March 2022:

- Safety Standards:
 - Various safety requirements for Construction Equipment Vehicle (CEV) as per AIS - 160 (Part 2) and emission sound pressure level at operator's ear position (Phase II)
- Emission Standards:
 - OBD Stage II-A Thresholds for BS-VI vehicles for all motor vehicles as applicable
 - Implementation of TREM / CEV V norms for Agricultural Tractors and CEV
 - OBD Stage II-B Thresholds for BS-VI vehicles for all motor vehicles as applicable

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



Whole Vehicle Hemi-anechoic
EMC Chamber



Ammonia Measurement
System from Engine Exhaust



Upgraded Conditioned Air Handling Unit (CAHU)
for High Altitude Simulation



Servo Hydraulic Test System for
Fatigue Characterization



High Performance Liquid
Chromatography (HPLC) System



Upgradation of Shaker – To meet Railway
and Energy sector requirements

- Special Sensors for Developmental Crash Testing
- Barrier Handling System for Crash Test Facility
- PO Dummy for evaluation of CRS
- Portable Gas Analyzer for Ambient Air Monitoring
- Pass - by noise measurement system
- Data Center concept for ADAS/AV to store and analyze captured data

Human Capital is one of the key pillars of ARAI's continued success. It is the collective commitment of our people to the values of the Institute that has enabled us to sail through more than five decades and will guide us in the years to come.

We worked closely to ensure that there was minimum disruption during the COVID-19 lockdowns and employees felt safe, consulted and cared for. Based on the advisories released by the authorities, guidelines for best practices were released to the employees on a regular basis for staying safe. Safety protocols like thermal scanning, use of Aarogya Setu app, periodic sanitization drives, ergonomic redesign of workspaces and cafeteria were followed across locations. It is commendable to note that all the employees showed exemplary commitment and ensured business continuity despite regulatory restrictions.

Work from Home (WFH)

With work-from-home taking precedence, our team sprang into action ensuring employees' safety and business continuity. From framing appropriate employee-centric policies related to Work from Home to walking the employees through the remote working tips and ways to sustain team morale and team productivity, our Human Resource and IT teams managed the show for all employees. The employees were trained on various technology tools and team collaboration platforms to support a long-term Work from Home model.

Employee-centric Initiatives

COVID-19 vaccination drive was initiated for vaccination of employees and their families. Also, Term Life Insurance and Group Medical Insurance policies were revised to enhance the coverage for the benefit of the employees.

Learning and Development

We believe in nurturing our talented and skilled employees and accordingly invest in learning and development; employee engagement; wellness initiatives; and opportunities to collaborate and learn on cross functional projects to strengthen their capabilities. Our training programmes cater to a wide variety of employee profiles, addressing technical, functional, behavioural, and leadership needs. During the year 2020-21, a total of 15,713 man-hours of training was imparted to the employees, majority of which was online due to the pandemic situation & social distancing norms.

Digitization of HR Processes:

With our upcoming projects at Chakan and Takwe taking shape, our human resource is bound to increase and at the same time, will bring forth challenges of managing the HR processes under one roof. To address this challenge, digitization of our HR Processes has been taken up. As part of this we are in the process of adopting a standard Human Resource Management System which is flexible, scalable and can be integrated with existing ERP system to cater to our current as well as future needs. To start off with, it will have some of the base modules like Personnel Data Management, Time Office, Leave Management and Payroll application in the initial phase and few advanced modules in the later stage.

Facilitating Conducive Work Environment

We thrive to build an all-inclusive and empowering work environment focused on enhancing employee experience and employee engagement. To strengthen the connects, we organize cultural programs during our Annual Day celebration to encourage employees as well as their family members to showcase their talents. However, this year's Annual Day was celebrated online considering the restrictions. On this occasion, employees' who had completed 25 years of service were felicitated by Director – ARAI. Also, yoga sessions were conducted online for the employees as part of wellness programs. Other events like International Women's Day, Independence Day, Republic Day, National Safety Week and Blood Donation Camp were conducted adhering to social distancing norms.



Republic Day Celebration

- 'Aluminium for Curbing GHG Emissions in Indian Public Transport Buses' by M. A. Patwardhan, P. A. Nirmal and P. Jawale in April 2020 at SAE World Congress, Michigan, USA
- 'Active HESS for Electric Two Wheeler' by Akshay Walvekar (Academy Student) and Dr. Y. K. Bhatshvar & Dr. K. C. Vora of ARAI in July 2020 at ADMMS'20 Conference
- 'Significance of Driving Cycle on Performance Parameters and Range in Small Electric Vehicle' by S Vignesh (ARAI Academy Student) and Dr. M. Rafiq B. Agrewale, Dr. Y. K. Bhatshvar & Dr. K. C. Vora of ARAI in September 2020 at IEEE International Conference on Smart Technologies for Power, Energy and Control (STPEC), VNIT, Nagpur
- 'Concept Design and Analysis of Mini E-Tractor' by Vaibhav Chorge (ARAI Academy Student) and Amitabh Das, Dr. M. Rafiq B. Agrewale, Dr. Yogesh Bhatshvar & Dr. K. C. Vora of (ARAI) in September 2020 at International Conference on Advances in Design, Material, Manufacturing and Surface Engineering for Mobility (ADMMS-2020), Chennai
- 'Comparative study of molded and flat dash sample sound transmission loss using experimental and simulation technique' by M. P. Joshi, P. P. Kamble and S. K. Jain presented in December 2020 at 3rd International Conference on Automotive Materials & Manufacturing 2020 (AM&M 2020), Pune
- 'Development of a Simulation Model for Electrification of a Conventional Mini Bus' by Sharath (ARAI Academy Student) and Dr. Yogesh Bhatshvar, Dr. M. Rafiq B. Agrewale & Dr. K. C. Vora of ARAI in January 2021 at International Conference on Sustainable Energy and Future Electric Transportation (SeFet), GRIET, Hyderabad
- 'Design of Modular Architecture for EV and HEV for Passenger Cars' by Midhun Muraleedharan (ARAI Academy Student) and Amitabh Das, Dr. M. Rafiq B. Agrewale & Dr. K. C. Vora of ARAI in March 2021 at International Conference on Innovations in Product, Process and System Design (ICIPPSD), SVVV, Indore.
- 'Comparative Analysis of Powertrain Optimization for Small Electric Vehicle based on Range and Weight for Retro-fitment' by S Vignesh (ARAI Academy Student) and Dr. Y. K. Bhatshvar, Dr. Mohammad Rafiq B. Agrewale & Dr. K. C. Vora of ARAI in March 2021 at International Conference on Advances in Mechanical Engineering and Nanotechnology (ICAMEN) 2021, Manipal University, Jaipur
- 'Fuzzy Logic Based Energy Management Strategy for Series Hybrid Electric Two-Wheeler' by Pushkar Sarade (ARAI Academy Student) and Amitabh Das, Dr. Y. K. Bhatshvar & Nilesh Sakle of ARAI in March 2021 at ICRCOE 2021
- 'Quality Biodiesel Production and Engine Performance & Emission Evaluation using blends of Castor Biodiesel' by Mr. Aatmesh Jain and Dr. K. C. Vora in March 2021 at International Symposium on Fuels & Lubricants (ISFL 2021)
- 'Study of Effect on Engine Performance using 15% HCNG Blend versus CNG using a Simulation Approach' by Dr. K. P. Kavathekar, Dr. S. S. Thipse, S. D. Rairikar, S. B. Sonawane, P. S. Sutar, and D. Bandyopadhyay published in June 2020 in Advances in Mechanical Engineering
- 'Evaluation of Compatibility of Elastomeric Component of Master Cylinder with Brake Fluid' by M. A. Bawase, R. Naik and Dr. S. S. Thipse published in August 2020 in Journal of Polymer & Composites
- 'Vibrational spectroscopy: an effective technique for characterization and failure analysis of automotive materials' by Y. Patil, R. Naik, M. A. Bawase and Dr. S. S. Thipse published in October 2020 in Research Journal of Chemical Sciences

- 'Chemical composition and source attribution of PM2.5 and PM10 in Delhi-National Capital Region (NCR) of India: results from an extensive seasonal campaign' by M. A. Bawase, Y. Sathe, H. Khandaskar and Dr. S. S. Thipse published in January 2021 in Journal of Atmospheric Chemistry
- 'Polymer/fuel interaction and properties of typical automotive fuel-system polymers exposed to methanol blended (M15) gasoline' by M. A. Bawase, S. Chaudhari and Dr. S. S. Thipse published in February 2021 in Polymer Testing
- 'Surface and satellite observations of air pollution in India during COVID-19 lockdown: Implication to air quality' by Y. Sathe, P. Gupta, M. A. Bawase, L. Lamsal, F. Patadia and Dr. S. S. Thipse published in March 2021 in Sustainable Cities and Society
- 'NVH Assessment, Source Identification and Noise Control of Excavator' by M. D. Kandalkar and D. S. Mole' in 'Vol 6, Issue 2 (2020) in 'International Journal of Pollution and Noise Control'
- 'Evaluation of Performance and Emission Characteristics of a Compression Ignition Diesel Engine with Castor Bio-diesel Blends' by Shashwat Tewari, Krunal Pardasani & Bikramjit Singh (Academy Students); Aatmesh Jain of ARAI; and Bibhuti Bhusan Sahoo (Faculty, VIT) published in SN Applied Science Journal

New Services & Capabilities

EV / HEV:

- Assessment of Electric Vehicles for compliance to FAME India Scheme Phase II requirements
- E-motor/ E-powertrain calibration, performance validation, certification
- EV Charger communication software development
- Battery and BMS calibration, performance validation, cycle life testing, abuse testing/ safety assessment
- Validation of Battery Management System using HeRTS HIL System
- Conversion of conventional vehicle to Drive by Wire
- Design and integration of 3W E-Axle
- Training on Homologation of Retrofitted EV & Hybrid EV as per AIS-123

SIMULATION:

- Target Site assessment towards Hostile Vehicle Mitigation
- Motor Shock Test as per IS:9000 (Part VII)
- Simulation of molten flow through a Twin Screw Extruder in an L-shaped die
- Weight optimization of Aluminium Trailer Underbody
- Wheel forming process through spinning operation
- CFD simulation of nozzle spray of windshield washer system
- Double Decker Bus Rollover
- Turbocharger burst analysis
- Air Bag simulation
- Drywall partition acoustic simulation
- Test scenario generation for V&V of ADAS function

MATERIALS:

- Analysis of sulphates and nitrates in coolant sample by ion chromatography
- Acoustic characterization of molded/ formed part of sound package materials

STRUCTURES:

- New crash test load cases for Side Crash Test, Rear Impact Crash Test, Oblique Side Pole Impact, Post-Crash Fuel Leakage evaluation, Photogrammetric measurements on crash test cars
- A-Pillar and Windshield Glass Impact tests
- Tyre Rolling Resistance test facilities for tyre labelling as per AIS:142 and other international standards
- Strain & Temperature measurement on Pumps at elevated temperature operation
- Combined Vibration & Environmental validation of Generator Control Panels
- Methodology for accelerated testing and field failure reproduction of exhaust system components using Electrodynamic Shaker Test system
- Facility developed to test Railway bogie frame
- Test rig developed for simultaneous testing of all 4 doors
- Test rig developed for gear shift force and displacement measurements
- Measurement of noise reduction of glass partitions and glass cubicles as per ASTM E336
- Noise and Vibration Assessment of Tower Crane
- 2W External Projections as per AIS-147
- 2W Foot Rest Test as per AIS-148
- Brake Test as per revised and new standards
- Testing as per AIS-134: Safety measures for occupants of Three Wheeled Vehicles (L5M and L5N Category)
- Ground Clearance, TCD TCCD and Coast Down Tries Standards for Japanese Homologation
- CMVR compliance to CEV manufactured after 1st April 2021 as per GSR 673 (AIS 160 Phase-I)
- ADAS Data Acquisition
- CoG measurement for off-road vehicles using tilt-table method

Brand Building

- Webinars Organized :
 - Webinar on 'Seating System Development: Challenges and Opportunities' with focus on seat design and development was organized by ARAI. Panel discussion involving industry experts from OEMs and seat manufacturers; had participation of over 100 delegates, including students.
 - Webinar on 'Ethanol Blending – A Step Towards Self-reliance in Energy' organized by ARAI focused on use of ethanol as a fuel, whereas over 140 delegates participated.
- Showcasing of capabilities at Virtual Expos, viz. Future Mobility Show 2021 and Aero India 2021
- Reached out to the industry through periodic updates on capabilities, events, new developments, etc. on social media platforms, viz. LinkedIn, Instagram, Facebook, Youtube and Twitter



Virtual Stall at Future Mobility Show 2021

Technical Collaborations/ Strategic Tie-ups

- MoU with Praj Industries: For collaborative work on Bio-mobility technologies
- MoU with University of Birmingham: For collaborative research in Air Quality Management and Alternate Fuels
- Collaboration with Atal Innovation Mission (AIM) under TechNovuss Platform: For strengthening the innovation ecosystem in

India with 'Automotive and Mobility Solutions' as focus areas.

- MoU with Altair Start-up Challenge (ASC) under TechNovuus Platform: To support/mentor Start-ups through various programs, projects, activities in areas of mutual interest
- MoU with Micelio: To establish framework for cooperation between the partners to support the Indian industry



MoU with Praj Industries



Collaboration with Atal Innovation Mission (AIM)

Interactions with the Industry

During the year, ARAI hosted senior level delegations of various organizations and also visited many customers as part of business promotion. The core idea of these interactions was to explore potential business avenues and collaborative opportunities. During these interactions, ARAI's capabilities and facilities were presented and demonstrated to the customers. They included ARAI's service offerings in the areas of certification, validation

support, engine testing, component testing, transmission, EV, NVH, ethanol, fuel/lubricant analysis, skill development initiatives, etc. The industry interactions have helped in understanding certification and development programs of the customers, and created new leads for future business opportunities.



Interactions with the Industry

Workshops/ Training Programs/ Expert Talks Organized

- Online Training Programs on following subjects for Senior Officers of State Road Transport, Public Transport and National Highway Authorities at the behest of Ministry of Road Transport & Highways (MoRTH)
 - Homologation of Electric Buses as per CMVR
 - BS-VI Emission Certification for 2W, 3W, 4W, HDV and Real Drive Emissions
 - Homologation requirements for Buses, Trucks & Trailers
 - New Alternate Fuels including LNG and its technologies for engines
- Homologation of Retro-fitted Buses as per CMVR
- BS-IV and BS-VI Norms for gaseous fuel vehicles and OBD requirements
- Overview of vehicle safety & certification of CNG/LPG conversions and New Regulations
- First Generation and Second Generation Biofuels for Vehicles
- Role of After treatment system for BS-VI Vehicles
- I&M Centres, Planning and Operation
- Fire Safety for Vehicles
- Training Program on 'Prioritization of strategies in the city air quality management plans for Pune' under Clean Air Project in India
- Co-organizer of Smart India Hackathon (SIH) 2020 Software Edition
- Workshop on Electric Truck Homologation (N1, N2 and N3 category vehicle)
- Keynote address on 'Control Air Pollution – defer Climate Change' at AICTE's online Short Term Training Program
- Address on 'Towards Safer Mobility: Achieving Vision Zero' at online webinar organized by Autocar India
- Expert talk on 'Advances in Air Pollution Measurement & Analysis'
- Expert talk on 'PM source apportionment techniques and the contribution of vehicle exhaust' at Clean Environment and Aerosols Network Workshop
- Expert talk on 'Take a deep breath: the battle for clean air' at Shaping Mobility Webinars series

International Conference on Automotive Materials and Manufacturing 2020

The third edition of the International Conference on 'Automotive Materials and Manufacturing 2020' (AM&M 2020) was organized in digital mode from 3rd to 4th December 2020 by ARAI in partnership with ASM International – Pune Chapter and SAE India; in association with ACMA, COEP, IIT Kanpur, IIT Mumbai, NCL, DRDL, ARDE, ARC Hyderabad, Bharat Forge, Tata Motors, AIFI, JNARDDC, Mahindra & Mahindra Ltd. and Lite Auto Components Pvt. Ltd. The conference was inaugurated by Mr. R. Velusamy, Chief of Global Product Development – Automotive Division, Mahindra & Mahindra. Prof. B. B. Ahuja, Director College of Engineering Pune was the Guest of Honour at this event. The other dignitaries present on this occasion included Dr. Bala K. Bharadwaj, President SAEINDIA; Ms. Diana M. Essock, FASM Chairman ASM International; Dr. Reji Mathai, Director – ARAI; Mr. N. V. Marathe, Sr. Deputy Director, ARAI; and Mr. S. S. Nibandhe, Sr. Deputy Director, ARAI and Convener AM&M 2020. The theme of this edition of the conference was 'Advances in Automotive Materials and Manufacturing for Future Mobility'.

AM&M 2020 witnessed a participation of over 400 delegates and comprising of experts, technocrats and professionals from the field of materials and manufacturing technologies. This conference had 4 Keynotes and 31 Technical Presentations spread over 8 technical sessions. They were in the areas of Materials Engineering and Manufacturing Technologies, viz. Composite/Polymer, Artificial Intelligence, Process Design & Simulation, Battery Materials, Lightweight Materials, Additive Manufacturing, Advance Material Characterization, and Failure Analysis & Prediction.

A Panel Discussion on 'Materials for E-Mobility' was organized during this conference. The distinguished panelists for this event included Dr. S. Manivasagam, Global Head – Vehicle Engineering, Tata Technologies Ltd; Mr. Shrikant R. Marathe, Former Director – ARAI and Engineering Consultant; Mr. Kinshuk Roy, Vice President – Applications Engineering, JSW Steels Ltd; Mr. Kumar Prasad Telikepalli, Director, Matter Motor Works; Mr. S. J. R. Kutty, Head, VATS, ERC, Tata Motors Limited; Dr. Rüdiger Heim, Deputy Head, Fraunhofer Institute for Structural Durability and System Reliability (LBF). This Panel Discussion was moderated by Mr. Udayan Pathak, Chairman – ASM International (Pune Chapter).

A virtual exposition organized concurrently had participation of 8 organizations showcased their latest technologies through virtual stalls. The poster presentation held at the conference evinced keen interest from the student community.

The valedictory function was graced by Mr. Rajendra Petkar, President & Chief Technology Officer, Tata Motors and Vice President – ARAI as a Chief Guest. Prof. Nangia, Professor of Chemistry University of Hyderabad and Former Director CSIR – NCL was a Guest of Honour at this event.



Automotive Materials and Manufacturing 2020

Sweden-India Transport Innovation & Safety (SITIS)

SITIS is an Indo-Swedish safety and innovation partnership for establishing a platform for applied research and innovation in the area of safe, secure and sustainable transports and smart cities. Launched in February 2020, SITIS is a direct outcome of the joint declaration on Sweden-India Innovation Partnership agreement signed between the Prime Ministers of Sweden & India.

SITIS aims at fostering innovation and drive progress in road traffic safety in India. It is a bilateral knowledge sharing platform involving stakeholders from the industry, academia and government agencies from both the countries.

ARAI, one of the partners of this platform, is a permanent invitee on SITIS Governing Board. As a partner, ARAI will participate in various bilateral initiatives/ projects on road safety. The first program taken up under this was a virtual training program for senior officials of Transport Department on 'The Road to Vision Zero'.

The Road to Vision Zero

'The Road to Vision Zero' – a three-day online training program was organized for the senior officials of Transport Departments during 4th to 6th November 2020 jointly by Ministry of Road Transport & Highways, (MoRTH), Government of India and ARAI, along with Swedish Transport Administration under Sweden-India Transport Innovation & Safety (SITIS) platform. It was inaugurated by Mr. Nitin Gadkari, Hon'ble Minister of Road Transport & Highways, Government of India and H. E. Klas Molin, Ambassador of Sweden to India. The other dignitaries present on this occasion included Mr. Kamal Bali, Chairman, SITIS & CEO, Volvo Group India, Mr. N. V. Marathe, Officiating Director, ARAI and Mr. A. V. Mannikar, Sr. Deputy Director, ARAI.



*Chief Guest – Sh. Nitin Gadkari,
Hon'ble Minister, MoRTH, Government of India*



*Guest of Honour – H. E. Klas Molin,
Ambassador of Sweden to India*

During this training program, presentations were made by experts from academia, research, industry and authorities on subjects like road safety work in Sweden, model for safe traffic, human factors, counter measures & design principles, emerging technologies, Euro NCAP and the role of safe vehicles, powered two wheelers in the safe system, vulnerable road users, road design and traffic environment, traffic safety cameras, safety benefits of implemented measures, police traffic strategy and traffic regulation. The presentations provided insights into how Sweden has managed to bring down fatalities dramatically despite the increase in vehicular population using Vision Zero approach. More than 150 officers from various states participated in this training program.

Upcoming Event: SIAT 2021

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

Seventeenth edition of ‘Symposium on International Automotive Technology’ (SIAT 2021) is scheduled to be held from 29th September 2021 to 1st October 2021. This edition of SIAT is being held through a virtual platform due to disruption caused by the COVID-19 pandemic. The central theme of this edition of the symposium is ‘Redefining Mobility for the Future’ in tune with the latest trends and futuristic mobility challenges faced by the automotive industry.

Over 140 technical papers, including over 40+ keynotes and 10+ Plenary Keynotes, on various subjects will be presented across 6 Technical Tracks at this symposium. Apart from the symposium proceedings, Technical Reference Bulletin in digital format will be a part of the technical feast for the delegates. SIAT EXPO 2021, which will be held concurrently with the symposium, will provide an excellent platform to the industry to showcase their latest technologies. Also, students will have an opportunity to display their technical skills through Student Poster Presentation competition.

Detailed information on the event, registration, expo booking, etc. can be accessed at <https://siat.araiindia.com/>

Supporting SAEINDIA Activities

ARAI is associated with SAEINDIA’s wide spectrum of activities, which are carried out for the benefit of practicing engineers, engineering students and school children. During the year, ARAI supported following training and

educational programs, workshops and lecture series.

- Tech Talk Series
- Off-Highway Series
- SAEINDIA Western Section Electronics Forum
- Global Online Proficiency Improvement Program on Virtual Powertrain Calibration
- Faculty Development Webinar
- SAEINDIA Student Competitions
- TIFAN-2021
- National Level Virtual Technical Event ‘AUTOSPARX 2021’

These programs included lectures by experts for the benefit of industry professionals, faculty and the student community. They covered a wide range of topics like Electric and Hybrid Electric Vehicle Technology, Electrification of Off Highway Vehicles, Electromagnetic Interference (EMC-EMI), Virtual Powertrain Calibration, Fuel Cell Electric Vehicles, etc.



Holistic Overview of Electric Vehicles



TIFAN-2021

ARAI undertakes knowledge dissemination and skill development activities through its Learning Centre (LC), Training Centre (TC) and Library. This includes training and educational programs to enhance human resource skills for meeting the growing needs of automotive industry. ARAI carries out these activities at ARAI – Forging Industry Division (ARAI – FID), Chakan.

LEARNING CENTRE

Learning Centre conducts undergraduate, post graduate diploma, postgraduate and doctorate programs with specialization in Automotive Engineering through collaborations with various universities. It has tie-ups with Indian Universities, viz. VIT University (Vellore), VELTECH University (Chennai), College of Engineering (Pune), Christ University (Bengaluru), Savitribai Phule Pune University – Department of Technology (SPPU-DOT) and Cummins College of Engineering for Women (COEW), Pune. In the year 2020-21, ARAI has signed MoUs with Rajarambapu Institute of Technology (Islampur, Sangli), Chitkara University (Near Chandigarh) and MIT-World Peace University (Pune) for commencing Post Graduate Diploma in Electric & Autonomous Vehicles, M. Tech in Automotive Engineering and Ph.D programs respectively.

Further, Electric Vehicle Awareness programs mooted by Ministry of Heavy Industries and Road Safety Awareness program mooted by Ministry of Road Transport & Highways (MoRTH) were conducted with support of ASDC and AICTE during the year.

Also, 10 Qualification Packs relating to Electric Mobility were developed for ASDC/ NSDC.



MoU with Rajarambapu Institute of Technology for PG Diploma in Electric & Autonomous Vehicles

The Learning Centre is equipped with lab facilities in the areas of IC Engine, Noise & Vibration, Simulation, CAE, GTEM and Auto Electronics & Embedded Systems. During the year, lab facilities in Automotive Engineering System, DAQ and Experimental Setup in Noise and Vibration lab, and EMI – EMC were added for the benefit of the students. These facilities are extensively used by the students for gaining hands-on training, experience and for their academic projects.



Automotive Engineering Systems Lab



MoU with MIT World Peace University for Ph.D. in Automotive Engineering



EMI – EMC Lab

TRAINING CENTRE

Training Centre organizes Proficiency Improvement Programs (PIPs); Domain Training Programs (DTPs), and also offers E-learning Online Courses for students as well as working professionals. During the year, 45 online PIPs and 7 online DTPs were organized, wherein lectures were given by ARAI personnel, academicians and eminent industry experts, including speakers from abroad. These PIPs & DTPs had participation of about 3800 delegates and were conducted in the following areas of automotive engineering.

Online Proficiency Improvement Program (PIPs):

- Electric Vehicles
- Vehicle Dynamics & Control with MATLAB
- Metallurgy for Non – Metallurgist
- Electric Vehicles: Batteries & BMS
- Design & Analysis of ATV using ANSYS Software
- Real Driving Emissions (RDE): Regulations & Virtual Approach to RDE Testing
- Virtual Powertrain Calibration (Implementation to meet Regulations and Improve Product Quality)
- Brake System Design & Safety
- Electric Vehicle (including Charging Infrastructure)
- Global Technical Conference on 'Fuel Cell Technology for Making EV's More Sustainable and Acceptable'
- Powertrain Engineering
- SWOT Analysis & Goal Setting
- How to write Technical Books
- Fundamental of Automotive Electricals & Electronics
- Advance Lithium-ion Battery for EV
- Crash Safety of Vehicle (including Electric Vehicle)
- Hybrid Electric Vehicle (HEV)
- How to Write SAE Technical Paper
- Emission Type Approval
- Standard & Technology for EV Charging Infrastructure
- Transmission Control System
- High Performance Polymers in Automotive & Tubing
- Engine Electronics & Management Systems
- Advance Battery Technology: Beyond Li-ion
- Alternative Fuels
- Automotive Sensors & Actuators
- Development of ADAS Systems
- Reliability Engineering
- Selective Catalyst Reduction for BS VI
- Combustion Fundamental
- Automotive Emission Control
- Micro grid technology and O&M of Micro grid Battery
- Swappable Battery Technology for EV
- Automotive NVH
- Failure Analysis
- Selective Catalyst Reduction for BS VI
- Automotive Aerodynamics and Styling
- Electric Vehicle: Development, Validation & Certification
- Failure Mode Effect Analysis (FMEA)
- Simulation & Optimization of Thermal Management System of xEV
- Engine Testing & Certification
- Forging Technology
- Benchmarking: An Engineered Approach
- Automotive Testing & Certification
- Advances in Plastic Moulding

Online Domain Training Programmes (DTPs):

- Engine Performance & Trouble Shooting
- Automotive Regulations
- EV Testing, Certification & FAME II
- Drive Train System & Diagnosis
- Engine Technology
- EV/HEV Technology
- New Automotive Technology

E-Learning Courses (ePIPs):

- Reliability Engineering
- Engine Electronics & Management Systems
- Fuel Cell Technology
- Real Driving Emissions (RDE)
- Selective Catalytic Reduction (SCR)
- Emission Type Approval (including BS-VI): 2, 3, 4 Wheeled Vehicles
- Combustion in IC Engines
- HC/CO Emission Formation
- Emission Measurement Techniques



Independent Auditor's Report
Annual Statement of Accounts



To,

The members of
AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

OPINION -

We have audited the financial statements of AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA, PUNE, ("ARAI") which comprise the Balance Sheet as at March 31st, 2021, and the Income and Expenditure Account for the year then ended, and notes to the financial statements, including a summary of significant accounting policies. In our opinion, the accompanying financial statements of the entity are prepared, in all material respects, in accordance with accounting principle generally accepted in India.

BASIS OF OPINION-

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

EMPHASIS OF MATTER -

We draw your attention to Note no. 09 in Notes to Accounts, which describes the management's evaluation of impact of uncertainties related to COVID-19 and their assessment of recoverability and carrying value of its assets comprising of tangible assets, inventories and other current assets as at the Balance sheet date. Our opinion is not modified in respect of this matter.

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

Management of ARAI is responsible for the preparation of the financial statements in accordance with relevant laws as applicable and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error. In preparing the financial statements, management is responsible for assessing the entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the entity or to cease operations, or has no realistic alternative but to do so. Those charged with governance are responsible for overseeing the entity's financial reporting process.

AUDITORS' RESPONSIBILITIES FOR THE AUDIT OF FINANCIAL STATEMENTS -

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

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

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

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

**For M/s Gunwani & Kolapkar,
Chartered Accountants**

Ghanasham Ranade
(Partner)
(Firm Registration No.128698W)
(Membership No. 100151)
Pune, Dated 25th June 2021

(RS IN LAKHS)

| PARTICULARS | SCH NO | AS ON 31-03-2021 | AS ON 31-03-2020 |
|--|--------|--------------------|--------------------|
| SOURCES OF FUNDS | | | |
| 1. GENERAL & OTHER FUNDS | | | |
| A) GENERAL FUND | 1 | 1,05,308.14 | 1,02,788.07 |
| B) R & D RESERVE FUND | 2 | 29,895.01 | 28,076.77 |
| C) REPLACEMENT OF EQUIPMENT/MACHINERY FUND | 3 | 13,649.05 | 12,829.57 |
| D) ENDOWMENT FUND | 4 | 4.53 | 3.25 |
| | | 1,48,856.74 | 1,43,697.66 |
| 2. PROJECT FUNDS (NET) | 5 | 1,302.89 | 1,180.39 |
| 3. CURRENT LIABILITIES AND PROVISIONS | 6 | 13,017.00 | 15,748.89 |
| TOTAL | | 1,63,176.64 | 1,60,626.96 |
| APPLICATION OF FUNDS | | | |
| 1. FIXED ASSETS | 7 | 77,173.17 | 77,273.74 |
| 2. CURRENT ASSETS, DEPOSITS AND ADVANCES | | | |
| A) INVENTORIES | 8(A) | 30.14 | 23.83 |
| B) SUNDRY DEBTORS | 8(B) | 2,992.40 | 4,994.59 |
| C) DEPOSITS, CASH & BANK BALANCES | 8(C) | 78,060.56 | 71,627.06 |
| D) ADVANCES AND OTHER ASSETS | 8(D) | 4,603.91 | 6,391.29 |
| E) SUNDRY DEPOSITS | 8(E) | 316.46 | 83,353.23 |
| TOTAL | | 1,63,176.64 | 1,60,626.97 |
| NOTES TO THE ACCOUNTS | 13 | | |

Dr. Reji Mathai
 Director

C. V. Raman
 President

Rajendra Petkar
 Vice President

 AS PER OUR
 REPORT OF EVEN DATE
FOR M/s. GUNWANI AND KOLAPKAR
CHARTERED ACCOUNTANTS
 Firm's Reg. No. 128698W

GHANASHAM RANADE
 PARTNER
 Membership No. 100151

 Date : 25th June 2021

Place : Pune

Income and Expenditure Account for the Year Ended 31st March 2021

(RS IN LAKHS)

| PARTICULARS | SCH NO | AS ON 31-03-2021 | AS ON 31-03-2020 |
|---|-----------|---------------------|---------------------|
| INCOME | | | |
| OPERATIONAL INCOME | - | 25,540.41 | 36,338.72 |
| ANNUAL MEMBERSHIP SUBSCRIPTION (NET) | | 619.13 | 584.05 |
| SIAT INCOME | | 0.00 | 0.39 |
| FUNDS TRANSFERRED FROM R&D RESERVE FUND | | 62.35 | 162.07 |
| INTEREST | 9 | 4,546.99 | 4,545.41 |
| OTHER INCOME | 10 | 206.83 | 244.25 |
| TOTAL | | 30,975.71 | 41,874.89 |
| EXPENDITURE | | | |
| OPERATIONAL EXPENSES | | 2,503.99 | 3,793.90 |
| ARAI R&D PROJECTS | | 62.35 | 162.07 |
| SALARIES & OTHER ALLOWANCES | 11 | 13,554.15 | 16,189.08 |
| EMPLOYEE RELATED EXPENSES | | 268.86 | 360.19 |
| ESTABLISHMENT EXPENSES | 12 | 3,805.87 | 4,979.03 |
| DEPRECIATION | | 5,478.00 | 4,973.52 |
| LESS: DEPRECIATION ON GOVT. FUNDED ASSETS | | 2,238.74 | 2,359.00 |
| SIAT EXPENSES | | 4.41 | 40.10 |
| EXCESS OF INCOME OVER EXPENDITURE | | 7,536.82 | 13,735.98 |
| APPROPRIATION | | | |
| A) INTEREST ON EARMARKED FUNDS TRANSFERRED TO RESPECTIVE FUNDS | | | |
| - R &D RESERVE FUND | | 1,880.60 | 1,899.50 |
| - REPLACEMENT OF EQUIPMENT/ MACHINERY FUND | | 819.48 | 811.35 |
| B) SIAT SURPLUS / (DEFICIT) TRANSFERRED TO GENERAL FUND | | (4.41) | (39.71) |
| EXCESS OF INCOME OVER EXPENDITURE (NET) | | 4,841.15 | 11,064.83 |
| TOTAL | | 30,975.71 | 41,874.89 |
| NOTES TO THE ACCOUNTS | 13 | | |

Dr. Reji Mathai
Director

C. V. Raman
President

Rajendra Petkar
Vice President

AS PER OUR
REPORT OF EVEN DATE
FOR M/s. GUNWANI AND KOLAPKAR
CHARTERED ACCOUNTANTS
Firm's Reg. No. 128698W

GHANASHAM RANADE
PARTNER
Membership No. 100151

Date : 25th June 2021
Place : Pune

ARAI Management Committee



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



N. V. MARATHE
Senior Deputy Director
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Powertrain Design,
Noise Vibration &
Harshness & Infrastructure
Development



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Passive Safety Lab, Engineering
Design & Simulation, Structural
Dynamics Lab, Fatigue and
Materials Centre of Excellence



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Academy,
Knowledge Centre



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Certification Lab.



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Department, Calibration Lab,
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Chakan



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Finance &
Accounts Department



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General Manager
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Governing Council
Secretariat & Legal

ARAI PRESERVING THE ECOSYSTEM



View from ARAI Point





ARAI
Progress through Research

The Automotive Research Association of India

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

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