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ARAI
Progress through Research
Update
Transformation towards Progressive Mobility
Design, Development and Testing Services at ARAI
Azadi Ka Amrit Mahotsav
G20 भारत 2023 INDIA
Index Issue 2023-2024

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- Flex Fuel Emission Test Cell (VTC-02)
- Development of CPCB IV + Hydrogen & Natural Gas Genset Engine
- Test Facility for Chemical Characterization of Diesel Particulate Matter

Awards / Conferences / Seminars

- **2023 IESA Industry Excellence Award on Battery Safety**
- **Seminar on "Flex-Fuel Vehicles – An Indigenous Eco-Friendly Solution to Indian Auto Industry" – 24th June 2023**
- **Seminar on "Hydrogen as a Carbon-Neutral Fuel for Internal Combustion Engines" – 29th April 2023**
- **International Conference on Automotive Materials and Manufacturing (AM&M 2023)**
- **Two-Day International Conference on Advanced Powertrains for Mobility & Power Generation Applications | 15-16 September 2023**
- **Symposium on International Automotive Technology (SIAT) 2024 – Brief Overview**

❑ Digital Twin Laboratory

Digitization has become the key element in development cycle of Automotive systems and components, be it digitization of data and environment for effective tuning of AI and ML models or creation of digital twin systems for HIL Farm till digitization of material development and manufacturing process. Digitization is imperative for front loading of critical development and validation activities in the development cycle using simulation. A new Digital Twin laboratory has been established in ARAI to cater to the following emerging applications:

- Centre for system development using Artificial Intelligence and Machine Learning Techniques
- HIL Farm facility comprising of various “Hardware in Loop” System
- Centre for Integrated Computational Materials Engineering Simulation Platform

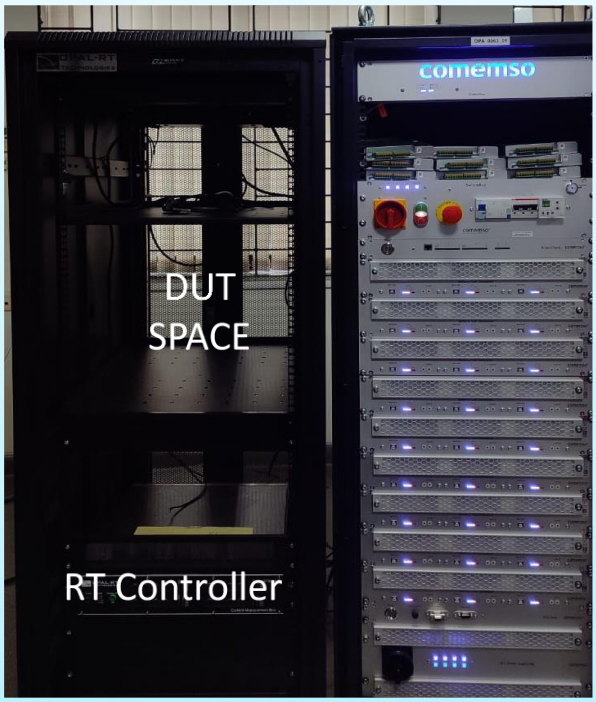
Creating hardware and software toolchain to develop AI and ML based algorithms to solve critical problems in the industry, creation of digital twin of plant model for simulation-based validation using HIL Farm and Integrated Computational Materials Engineering tool chain to establish material development process have been identified as key elements under this laboratory.

Modular 600 V HIL System

The modular 600 V HIL system catering up to 216 different cells has been established as a part of Digital Twin Lab at Chakan facility of ARAI. The system can be re-configured into one 300 V, one 200 V and one 100 V system or two 300 V systems depending on the category of vehicle being emulated.

The system has dedicated FPGA modules and Motor models for running motor emulation for MCU control validation. The system also has general purpose IOs for VCU and other auxiliary control validation.

The facility is being established at three locations in Hub and Spoke model with Pune being the Hub and Bengaluru and Guwahati being spokes. The Bengaluru spoke has a 100 V HIL system catering up to 36 cells, particularly catering to 2-wheeler and 3-wheeler applications. Both the Pune and the Bengaluru facilities are installed and commissioned and ready for operation.



❑ Atmospheric Chemical Transport Modelling: A tool for Researchers and Policy Makers

ARAI has recently developed atmospheric Chemical Transport Modelling (CTM) capability at its Pune campus. This facility includes a high-performance computing system to simulate atmospheric concentrations of pollutants using a CTM called Weather Research and Forecasting model with chemistry (WRF-Chem).

Atmospheric chemical transport models or CTMs, simulate the atmospheric concentrations and deposition fluxes to the Earth’s surface of air pollutants by solving the mass conservation equations that represent the emissions and atmospheric processes (such as transport, dispersion, transformations and removal of those air pollutants and associated chemical species, Refer Fig. 1). With the latest developments in science and technology, both meteorology and air quality are being simulated jointly so that the effect of chemical composition of the atmosphere on meteorological parameters (and vice-versa) is captured.

The chemical transport models deal with chemical reactions in the atmosphere, which makes them resource intensive in terms of data pre-processing / post-processing, which in turn, requires computational resources. Atmospheric chemical transport modeling uses differential equations, which requires initial conditions and boundary conditions.

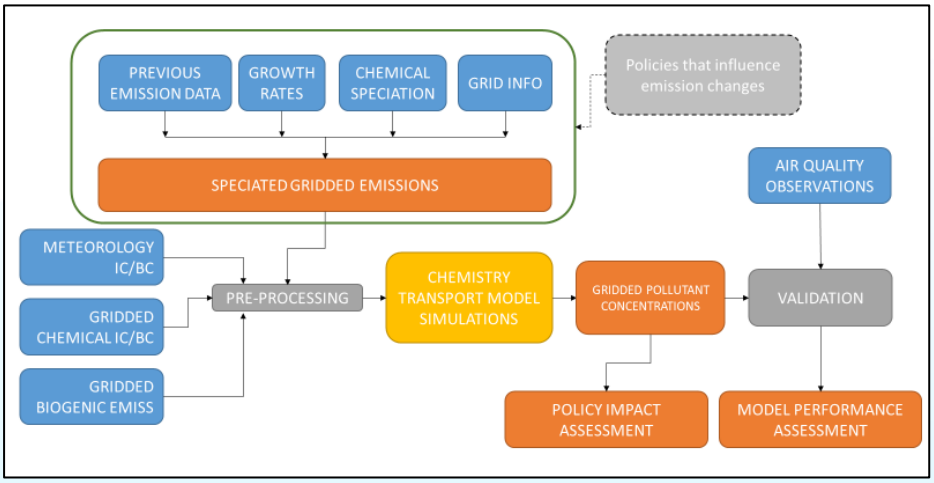


Fig. 1: Schematic diagram showing Chemical Transport Modelling facility at ARAI

Environment Research Laboratory (ERL) of ARAI is currently using its CTM system to understand the sources of particulate matter ($PM_{2.5}$) in Pune region. This system uses latest database of emissions along with meteorology to apportion the sources of $PM_{2.5}$ pollution in Pune city (Fig. 2(a)) and spatial distribution of $PM_{2.5}$ over Pune region (Fig. 2(b)). This system is being used to determine significant actions to control air pollution in Pune and improve the air quality. Additionally, such systems can also be used to simulate production of surface ozone due to changes in various emissions under different scenarios, in near future.

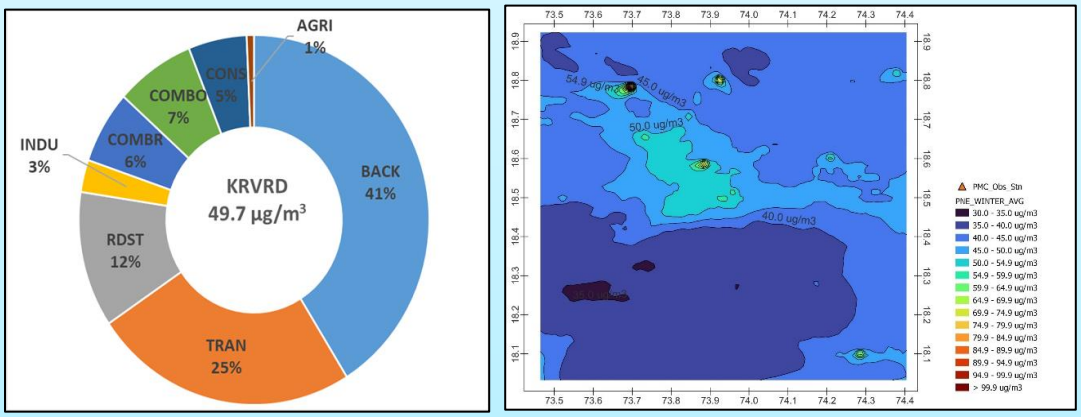


Fig. 2: a) Source Apportionment results at a typical location in Pune, b) Spatial distribution of PM2.5 concentrations simulated by WRF-Chem model

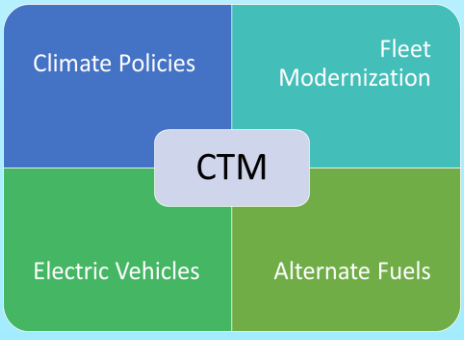


Fig. 3: Application areas of CTM

Chemical transport models are extremely useful for assessment of air quality impact of actions (Fig. 3) such as:

a) Fleet modernization (e.g. BS-VI norms),
b) Alternate fuels (E20/M15/E85, etc.),
c) Electric vehicles and
d) Co-benefits of climate policies in the Indian region.

Atmospheric chemical transport models are being increasingly used for source apportionment of air pollutants and exposure assessments as well as policy evaluation.

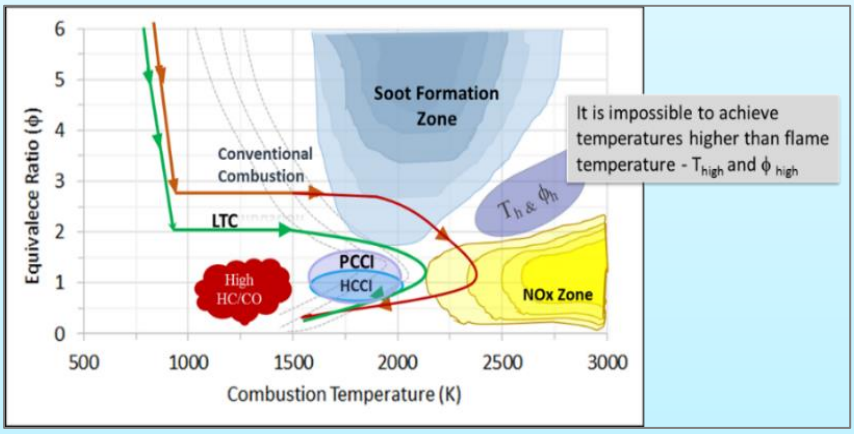
❑ Low Temperature Combustion – Fuel Neutral Concept

Background of the Work

- Europe has published Euro-VII proposals, which are much stringent than Euro-VI. The main objectives of Euro-VII are to reduce complexity of current emissions standards, provide up-to-date limits for all relevant pollutants and improve control of real-world emissions. Further conformity factor (CF) also proposed to maintain 1. Under this situation, dependency on aftertreatment system will increases to significantly, which further lead to increase overall cost of the product.
- In-line with on-road vehicles, off-road vehicles and Genset emissions are also made more stringent.
- Next level of European emissions (Euro VII) is proposing fuel neutral emissions limits.
- Now, it is high time to investigate Advanced combustion technology concepts like Low Temperature Concept (LTC) for lower NOx and PM emissions to reduce the load and associated cost on aftertreatment system significantly.

Low Temperature Concept:

Believe that it is right time to rework on concepts, like LTC for reducing emissions at source, which give leverage to minimize the dependency of complex and expensive after-treatment solutions, possible to pass on technology benefits to end user to minimize COO. In this endeavour, Engine Development Laboratory (EDL) of ARAI has taken up research work on ***"Low Temperature Combustion Concept on Diesel Engine", however LTC is fuel neutral concept.*** Below graph clearly shows that LTC concept is operating in <2000 K temperatures zone and also not passing through the PM and NOx formation zones.



Graph 1: Brief Concept of Low Temperature Combustion Concepts

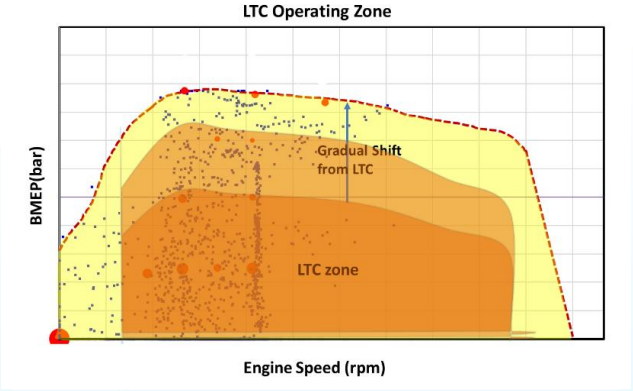
Engine Selection and Modifications:

The LTC concept evaluated on 6-cylinder diesel engine for commercial vehicle application and whole work carried out at ARAI, including selection of hardware suitable for concept evaluation using simulation approach followed by engine optimization and ECU calibration with critical combustion control in narrow LTC window giving optimal benefits in emissions.

Graph 2: Engine layout and critical components modified suitably to operate engine in LTC zone

LTC Engine Operating Zone:

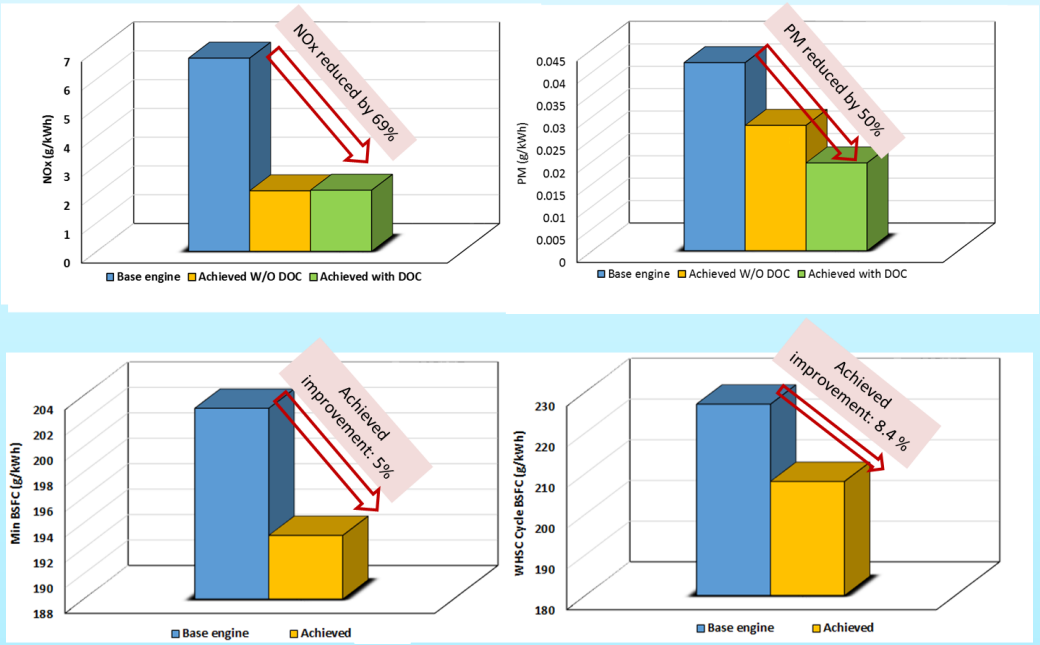
Extensive ECU calibration carried out using design of experiments method to arrive at the optimal settings where LTC zone has been defined in such a way that the combustion concept slowly shifted from LTC to conventional combustion to get maximum benefits in emissions and fuel efficiency improvement using this concept.



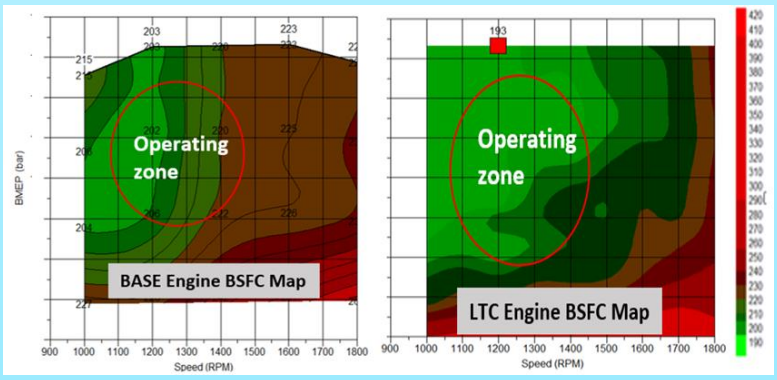
Graph 3: Gradual Shifting of LTC Zone from Low Load to High Loads (Critical part of LTC concept Development)

Engine-Out Emissions Achieved with LTC Concept:

Engine optimized for both WHSC and HTC cycles for engine-out emissions and below graph shows the results achieved with LTC concept showed 69% reduction in NOx and 50% reduction in PM as compared to base engine-out emissions. Apart from emissions, BSFC also improved in both WHSC and WHTC cycle by 5% and 8.4% respectively.



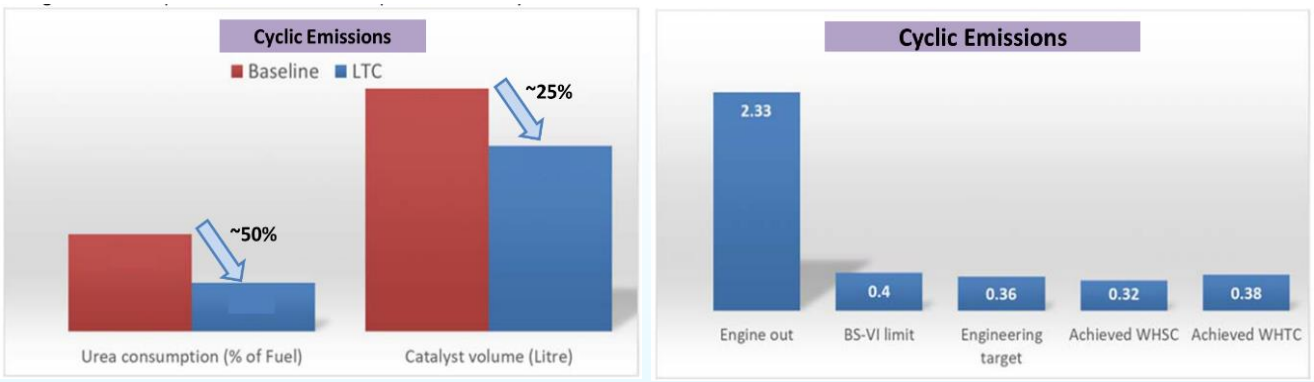
Graph 4: Engine Out Emissions with LTC Concept



Graph 5: Fuel Efficiency Improvement in Critical Operating with LTC Concept

Aftertreatment (SCR) Sizing Assessment:

Based on Engine-out emissions, aftertreatment sizing assessment carried out using simulation approach to meet BS-VI emissions. Results show that SCR volume reduced by 25% and urea consumption reduced by 50% in WHSC.



Graph 6: Urea Consumption and SCR Volume Sizing and Tail Pipe Emissions

Conclusions:

- LTC concept experimentally proved on 6-cylinder diesel engine to reduce engine-out emissions with improved fuel consumption.
- Strategies to achieve and control the combustion is established to simultaneous reduction of NOx & PM while improving BSFC as well.
- Lower engine-out emissions reduce the SCR volume by 25%.
- LTC concept can be the potential concept for upcoming EURO-VII norms since LTC is fuel neutral concept.

❑ Success Story: Efficient Battery Pack Thermal Management Using Thermal Interface Material

Due to the impact of global warming and climate change global automotive industry is switching from ICE vehicles to battery-powered electric vehicles (xEVs). The Indian market for battery-powered electric vehicles (xEVs) is growing exponentially, fueled by tumbling lithium-ion battery (LiB) prices and favourable Government policies. This has led to rise in sales of electric 2 and 3 wheelers. LiB's efficient and safe performance for tropical climatic conditions is one of the primary requirements for xEV to succeed in India.

Performance of LiB, however, is impacted due to ambient temperature as well as heat generated within the cell due to load cycle electrochemical reaction. The acceptable operating temperature region for LiB is normally between 20°C and 45°C and anything outside this region will lead to degradation of performance and irreversible damages. Therefore, understanding the thermal behaviour is very crucial for an efficient battery thermal management.

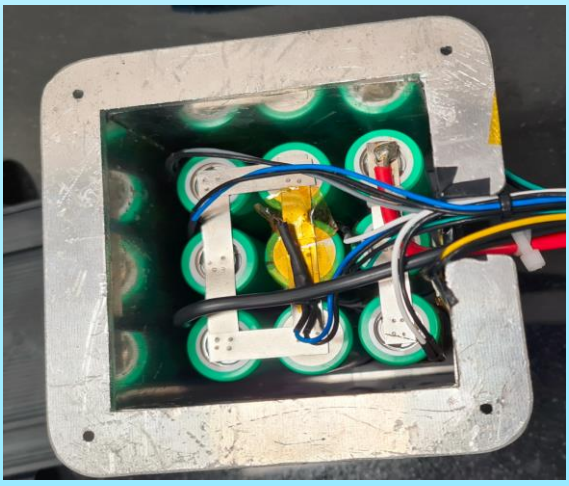
Background & Challenges

- Many a times battery packs for 2 and 3 wheelers with existing cooling strategies do not give desired performance, resulting in higher cell to cell temperature variation and high chances of thermal runaway.
- Designing a battery pack with optimum cooling performance with lower cost is challenging.

Story

ARAI has accomplished the challenging task of ‘development of a battery pack with effective cooling at extreme ambient temperature conditions’, for a leading EV OEM, to meet optimum cooling performance and low cost for manufacturing of battery pack. Primary objectives of battery thermal management are to limit battery cell temperatures below the allowed maximum cell temperature (Tmax), to minimize the cell temperature gradient (ΔT) and maintain the cell temperatures within the operating range for optimum performance and longevity of the battery system.

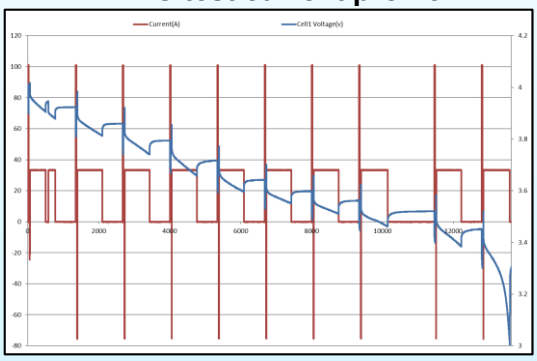
ARAI has developed state-of-the-art methodology for battery pack thermal management (BTMS) by incorporating thermal interface material (TIM) considering target application of 2 and 3 wheeled EVs. The role of thermally conductive and electrically insulating silicone encapsulant for thermal benefit and better thermal management was studied. First, single cell is tested for Hybrid Pulse Power Characterization [HPPC] to extract cell behavior during charging and discharging conditions at different ambient conditions. Equivalent circuit model of the cell was modelled from HPPC test and electro thermal virtual simulation of experiments were carried out at cell and module level. Methodology was applied to a 3x3 battery module of 3s3p configuration. The 3s3p battery pack is filled with thermal interface material and thermal performance of battery pack is evaluated using virtual 3-D CFD Model. A prototype of battery pack is manufactured and tested for validating computational results. Good correlation is observed and used for optimization of BTMS design. Further, thermal interface material combination is evaluated using 3-D CFD simulations and optimum cooling strategy with TIM has been finalized and proven on a prototype level successfully meeting the targets set for parameters like cell to cell temperature variation and maximum temperature. Based on the methodology developed, it is concluded that silicone-based TIM has greater role to play for efficient battery thermal management in the battery pack.



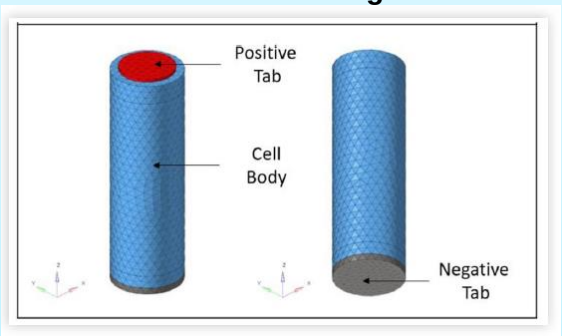
3S3P Battery Pack

Cell Level Tester

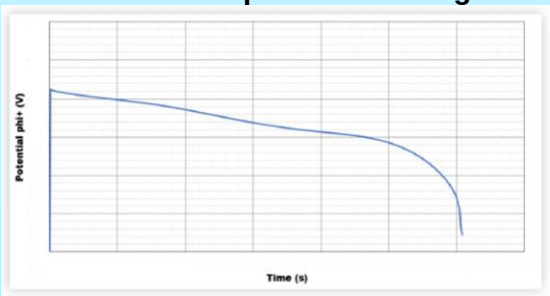
HPPC test current profile



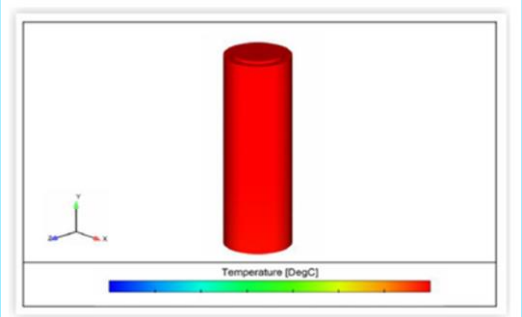
Mesh model for single cell



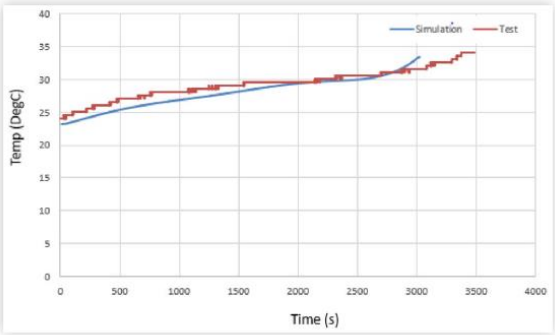
Potential drop at 1C discharge



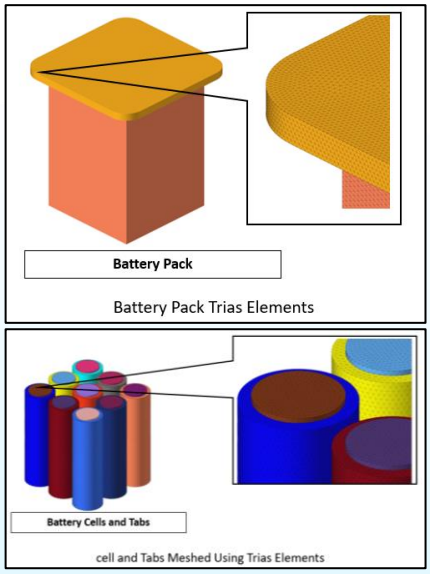
Temperature rise at 1C discharge



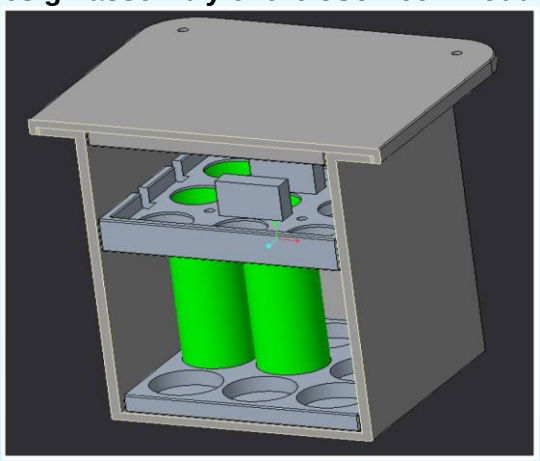
Correlation of temperature profile of Li cell at 1C discharge cycle



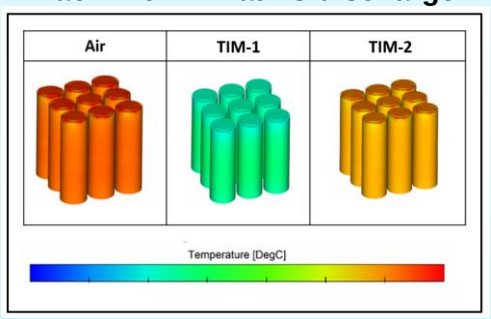
Mesh model for module



Design assembly of the 3S3P cell module



Thermal Simulation of Li Battery Pack with TIM at 1C discharge



Benefits:

- Design battery pack with efficient thermal management with affordable cost.
- Reduce overall design time using CFD simulation and also reduce development cycle time with least prototypes.
- First time right approach for development providing integrated battery thermal management solutions for vehicle specific application.
- Design, Simulation, Prototype Development, Benchmarking / Scanning, Cell Testing and Battery Pack Testing facilities under one roof can be commercially exploited by customers for specific applications.

❑ Annotated Database Generation for India Specific Object Detection for ADAS

Technology

Annotated images with 2-D bounding box for Indian road and traffic conditions suitable to train machine learning algorithms to develop ADAS functionalities

Properties/ Features

- The generated dataset consists of 200,000 images with corresponding annotation.
- All the annotations are verified and validated with open-source algorithm
- India Specific objects are covered
    - Sensors – Multiple Cameras, Lidar, Radar, INS (IMU + GPS)
    - No. of images – 500,000 Synchronous raw images
    - Annotated images – 200,000 2-D bounding box annotated images
    - 13 different classes, viz. Bike, Rider, Pedestrian, Truck, Tempo, Car, Auto-rickshaw, Traffic-light, Traffic-signal, Bicycle, Animal, Train, Bus
    - Annotation will be available with universally accepted .xml and .txt format
- Data can directly be used for training Machine Learning algorithms
- Separate viewer tool is developed for viewing images with embedded annotations

Application

- Training data set for machine learning algorithms for detection and recognition of India specific objects
- Developed algorithm validation with use of labelled data
- Development of various ADAS functionalities

Scale of Validation Achieved

The annotated data is validated with the use of open source ML algorithms to get object detection accuracy beyond 90%. The same dataset will be validated with vehicle-in-loop systems with real time data.

Abstract

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

ADAS uses technology, like radar, vision and combinations of various sensors, including LIDAR to automatize dynamic driving tasks, like steering, braking and acceleration of vehicle for controlled and safe driving. To integrate these advanced technologies, ADAS needs labeled data to train the algorithm to detect various objects and movements of driver. Image annotation is one the well-known services to create such training data for computer vision.

There are number of open source annotated datasets available, viz. COCO, KITTI, etc. But these datasets are limited to either US or European road environment scenarios. There is hardly any dataset available for India Specific road conditions. In order to capture all the India Specific objects on road, ARAI is capturing data through various environmental conditions, road conditions and annotating objects on the collected camera images. 2-D bounding boxes are being used to annotate objects in an image. These annotation files are available in open-domain formats, viz. PascalVOC and YOLO.

Beneficiary Industry

- Vehicle Manufacturers
- Research Institutes working in AI / ML
- Startups developing algorithms for ADAS functionalities
- Enthusiasts developing ML algorithms for autonomous vehicle functionalities

❑ Creep Testing for Plastics and Metals

Creep in materials can be defined as any permanent inelastic strain that occurs under constant stress at ambient or non-ambient conditions over long period. The rate at which this deformation occurs depends not only upon the magnitude of applied stress, but also on time and temperature.

During the creep test, specimen prepared as per standards ASTM D2990 and ASTM E139 are subjected to static load at high temperatures. The specimen strain is recorded over a long duration of test, typically few hundreds to over 1,000 hours. Creep curves can be generated using this data, depicting long-term behavior of materials.

Creep tests are long duration tests and are typically performed on multiple specimen at once. Hence, the creep testing facilities are typically equipped with multiple stations.

Applications:

Creep data is important for design engineers to establish relationship between stress, temperature and creep rate of materials. This relationship can be employed to ensure that the component subjected to sustained loads at elevated temperature over long periods does not fail below its yield strength.

Creep tests are also important from the aspects of quality control, safety assessment and research & development.

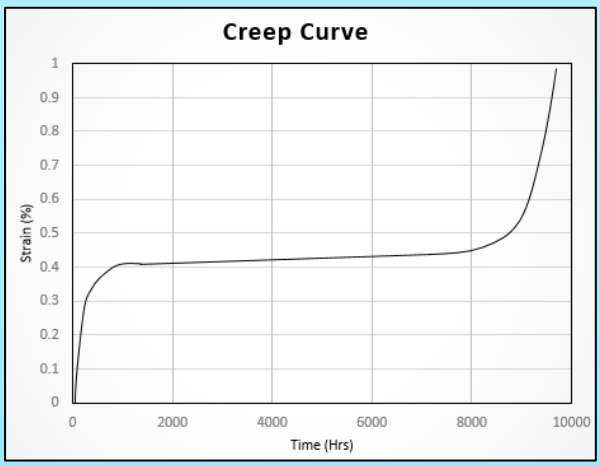
Typical applications include automotive parts, structural components, consumer products, electrical and electronic devices, packaging materials, medical devices, springs, etc.

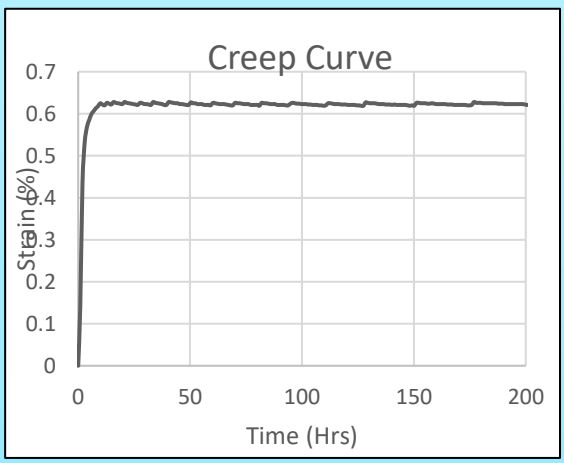
Creep Testing facility

ARAI has established creep testing facility at Fatigue & Materials Center of Excellence (FMCE) at ARAI-HTC, Chakan.

The system has three loading stations, each equipped with separate temperature chamber. Its salient features are as follows:

- Load capacity: 20 kN
- Strain measurement by extensometers (GL 50 mm)
- Temperature range: RT to 450 °C
- Reference standards: ASTM E139, ASTM D2990, ISO 899-1, ISO 899-2
- Load relaxation testing services can also be offered for components such as springs, bolts, etc.





❑ Load Cell Calibration facility under ISO/IEC17025 -2017 accreditation by IAS

Team at ARAI's Calibration Lab has over 20 years of experience in performing calibration activities for Mechanical, Thermal, Electro-technical and Fluid flow types of equipment in various parameters.

New Calibration Facility

Now Load Cell Calibration Facility under ISO/IEC17025-2017 is set up in ARAI Calibration Lab. This facility accredited by IAS (International Accreditation Service -USA).

ilac-MRA IAS INTERNATIONAL ACCREDITATION SERVICE®

CERTIFICATE OF ACCREDITATION

This is to attest that

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA (HTC)
PLOT NO. E-1/1, MIDC CHAKAN INDUSTRIAL AREA, PHASE-III, TALUKA KHED
PUNE, 410 501, REPUBLIC OF INDIA

Calibration Laboratory CL-274

has met the requirements of AC204, *IAS Accreditation Criteria for Calibration Laboratories*, and has demonstrated compliance with ISO/IEC Standard 17025:2017, *General requirements for the competence of testing and calibration laboratories*. This organization is accredited to provide the services specified in the scope of accreditation.

Effective Date May 16, 2023
Expiration Date June 1, 2024

IAS ACCREDITED

President

Visit www.iasonline.org for current accreditation information.

Calibration of Load cells by back to back comparison method using Traceable Load Cells, S type load cells, Pan cake type load cells, Dummy Load cells can be done using this facility.

Scope of accreditation:

CALIBRATION AND MEASUREMENT CAPABILITY (CMC)*

MEASURED QUANTITY or DEVICE TYPE CALIBRATED	RANGE	UNCERTAINTY[1,2] (±)	CALIBRATION METHOD OR PROCEDURE, STANDARD EQUIPMENT (OPTIONAL)
Mechanical			
Load Cell (Tension & Compression)	100 N to 5 kN	1.2%	By Comparison method using standard load cell with Indicator and force source
	5 kN to 50 kN	0.09 %	
	50 to 100 kN	0.11 %	

❑ ARAI Knowledge Centre Services for the Automotive Industry

ARAI Knowledge Centre is a special library and one of the renowned libraries in India. It has specific collection on automotive and allied subjects, with over 25,000 books and standards available on various automotive engineering subjects. National and international standards, such as IS, ISO, DIN, BS, ASTM, and JASO as well as technical reports and seminar/conference proceedings, such as SAE, IME, FISITA, and SIAT, are also available. Additionally, it subscribes to a few national and international journals such as International Journal of Crashworthiness, International Journal of Electric & Hybrid Vehicles, Journal of Vibration and Acoustics, Journal of Mechanical Design, Noise Control Engineering Journal, ATZ, and MTZ. An extended Knowledge Centre is established at ARAI-Chakan to provide information services to ARAI Academy students. These two Knowledge Centres serve professionals, faculty, students, NGOs and various Government organizations.

Membership:

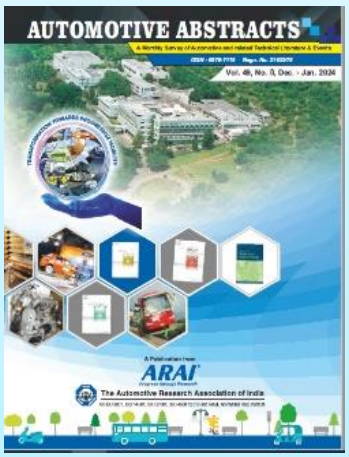
ARAI Knowledge Centre offers annual membership to educational and research institutes, companies and professionals in automotive domain. It also offers daily, weekly and monthly memberships for reference purposes.

- OPTION 1: Membership for Reference
- OPTION 2: Membership with Book Borrowing Facility

This membership facility helps students, faculty and professionals to keep updated in automotive domain. (Use this link https://forms.office.com/r/ePnGS0U3LR to browse the detailed information).

ARAI Publications

1. Automotive Abstracts (ISSN No. 0970-7115) – A bi-monthly publication of ARAI keeps readers in touch with the latest information in the Automotive world. It is one of the Indian periodicals, which has been guiding the readers through recent research and developments in mobility sector since 1975. Abstracts of articles published in most of the leading Journals / Periodicals on automotive technology and International Symposia are included in this publication. Its in-depth coverage of different topics in the automotive domain can help one meet the challenges one faces every day and make one's product / services better more competitive.



Abstracts were taken directly from sourced documents such as conference proceedings and national and international journals, covering global automotive literature and related subjects. These abstracts are generally classified and arranged under different subject headings.

Besides Technical Abstracts, it also includes Automotive Industry Standards (AIS), Technical Innovations in ARAI and forthcoming events in the automotive domain all over the world. The subscription period of this publication is April to March (6 issues per year).

2. ARAI Journal of Mobility Technology (ISSN No. 2583–3707 (Online) is a quarterly print and online peer-reviewed publication covering automotive and related topics, serves as a premier platform for researchers, academics, industry professionals and enthusiasts to disseminate innovative work and ground-breaking research in the field of mobility technology. The main aim is to foster collaboration and knowledge exchange among the experts and meet needs of professionals, academia and industry as well as for further dissemination of original research in all the fields of automotive technology. One of the objectives of this journal is to provide platform for publication of articles covering various automotive and and allied topics.

Manuscripts published in this journal will get high publicity and acquire high reputation among automotive and research communities. The impact factor is 6.73

Papers: High-quality research papers / articles are invited from scholars, academicians and professionals associated with automotive field from academia and industry. Manuscripts of sufficient quality that are relevant to the journal's aims and scope will be reviewed. To submit papers, please visit https://araijournal.com/index.php/arai/about/submissions. Topics of interest include, but are not limited to:

- Autonomous Vehicles and Driver Assistance Systems
- Electric and Hybrid Vehicle Technologies
- Vehicle Dynamics and Control
- Intelligent Transportation Systems
- Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communication
- Sustainable Transportation
- Human Factors and Ergonomics in Mobility Design
- Novel Propulsion Systems
- Infrastructure and Traffic Management
- Connected Mobility and Smart Cities

Subscriptions: Subscribers will receive four print copies annually as well as immediate access to the online journal, which includes full online access to all current and past articles. Two types of subscriptions:

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❑ Establishment of Advance NVH Development Centre at FID, Chakan -ARAI, Pune

With the changing trend of mobility and evolving customer demands, NVH requirements for Electric Vehicles and other mobility segments like Metro, Railway, Aerospace and building acoustic, etc. are becoming more crucial. To cater to these assessment and development needs, ARAI has established **'Advanced NVH Development Centre'** at ARAI-HTC, Chakan. This Centre has coupled reverberation chambers and Anechoic Chamber.

1. **The state-of-the-art coupled reverberation chambers** to meet the requirements of international standards as per ISO 10140-2. Also, the test facility is having horizontal window for carrying out impact isolation, which is one of its kind in India.

Specifications:

- Coupled Reverberation Chambers - 250 m3 and 210 m3
- Cut-off Frequency: 80 Hz
- Frequency Range: 80 Hz to 10000 Hz
- Background Noise: ≤ 25 dB(A)
- Large Size Vertical & Horizontal test windows of 10 - 12 m2

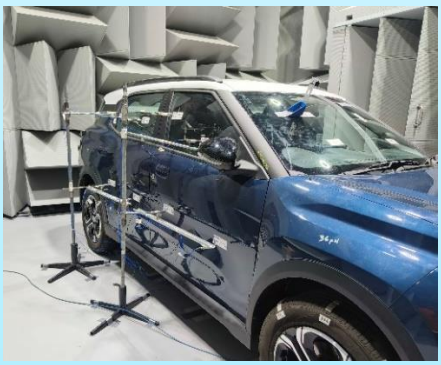
This facility will be used for acoustic evaluation in terms of sound transmission loss and sound absorption of metro and railway floor panels, acoustic roofing system of airport and road noise barrier. Additionally, the facility will provide support for acoustic development of building material like drywall, acoustic doors and windows, glass partitions and absorbing panels for auditorium, CFRP materials used for defence and aerospace applications.

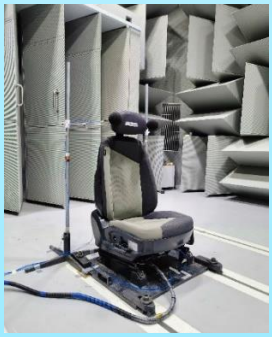
2. **The anechoic chamber** meets requirements of ISO 3745 and ISO 26101 international standards. This facility will be extensively used for NVH assessment of Electric vehicles, development of sound package, structural evaluation from NVH perspective and EV component level development like various motors, HVAC control system and compressor, cooling system, door slam noise, etc. for NVH performance and sound quality of the same.

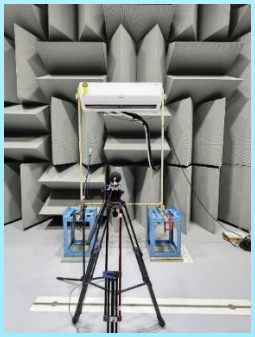
Leveraging the vast experience and expertise in NVH development, this facility will also provide NVH development support for domestic appliance, like air conditioner, mixer- grinder, kitchen chimney, ceiling fan, medical appliances, industrial equipment, etc.

Specifications:

- Room Volume: 125 m3
- Background noise ≤ 16 dBA and 100 Hz cut-off frequency
- Provision for auxiliary / accessories noise isolation
- Chamber height of 4.5 m to evaluate taller components/appliances







❑ ARAI Industry Connect: ADAS V&V Conclave 2023

ARAI is executing project titled 'Augmentation of Modular Infrastructure for Verification and Validation of Advanced Driver Assistance Systems (ADAS)' under Scheme for Enhancement of Capital Goods Sector - Phase II. The project aims to verify and validate advanced driver assisted functions in the real-world environment and India specific scenario.

ADAS Conclave India 2023 was conducted at Pune International Exhibition & Convention Centre (PIECC), Moshi on 23rd November 2023. The Conclave was inaugurated at the auspicious hands of Shri Rajnesh Singh, Director, Ministry of Heavy Industries, Govt. of India. Shri. Rajendra Petkar, CTO-Tata Motors Limited, was the Chief Guest at the Conclave.

The conclave started with welcoming the dignitaries by Dr. Reji Mathai, Director-ARAI, followed by Mr. Rajnesh appealing the auto industry to use ADAS V&V facility available with ARAI. Representatives of 38 Auto Industries attended to Conclave. Theme talk at the Conclave on 'Relevant of ADAS for India - A Perspective through Accident Research' was delivered by Mr. Girikumar Kumaresh from Bosch Global Software Technologies Private Limited., Bangalore. He opined that 'ADAS itself is a very big tagline with 100 products inside the tag of ADAS. How much % of safety we are going to deliver to the ecosystem is a big question, ADAS is for saving life and for user comfort.

The Conclave featured technical talks on 'Integrated Approach for ADAS Verification and Validation', which was delivered by Mrs. Ujjwala Karle from ARAI, followed by 'ADAS Regulatory Scenario' by Shri. Konaki Ramu, from ARAI and 'Test Instrumentation for ADAS' by Thomas Semlitsch, 4activeSystems GmbH, Austria. Mainly focusing on what ARAI has as ADAS verification and validation package, which is required for robustness of system. Mrs. Ujiwala also elaborated on India's different traffic objects, varied infrastructures and scenarios and how ARAI is committed to give few thousands of km of dataset as base set across India, which will be available to multiple users. Having 1 lakh annotated images in hand, ARAI is willing to partner with OEMs and tier1s who are interested to create India specific ADAS strategy solutions. She emphasized how ADAS solution has to be local and India relevant. She proudly affirmed ARAI's readiness with smart city ADAS test track covering typical scenario, routes, roads, passes for vehicle level testing. She also mentioned how ARAI certified competencies can be used for testing, validation and certification. She concluded with how jointly the Auto Industry and ARAI can implement ADAS effectively in India for a safer tomorrow.

Panel Discussion on 'Paving Road for Success of ADAS in India' with contribution from Mr. Aniruddha Kulkarni of TATA Motors, Dr. Tapan Sahoo of Maruti Suzuki India Ltd., Mr. Vinoth Ponnusamy from Mahindra & Mahindra, Mr. Jaidev Venkataraman from Valeo and Mr. Ganesh Rao, Continental Autonomous Mobility., Bangalore, was the high point at the Conclave. The Panel discussion was moderated by Mr. Sumantra Barooah of ET Auto.

Live Demonstrations:

The Conclave also hosted live demonstrations of ADAS V&V. The main attraction of the conclave was ADAS test equipment those were used to demonstrate India case scenario faced by ADAS vehicles. These comprehensive set of ADAS Test Track Equipment allows to simulate complex test scenarios on the test track for thorough evaluation of ADAS in close-to-real-world scenario.

ADAS test equipment includes motion platforms (1 for GVT -100 kmph and 2 for VRU- 80 and 20kmph), articulated test dummies, set of driving robots, networking and communication equipment, etc. to allow vehicle level track testing for ADAS features.

The same was attended and very much appreciated by the Conclave participants.

The Conclave also showcased Data Acquisition (DAQ) set up installed in both car and bike. This set up is specifically to generate comprehensive database tailored to Indian driving conditions, which can be further used for development as well as verification and validation of ADAS features specific to Indian road conditions.

The conclave was concluded with the applauding remarks from the attendees and overall the conclave received overwhelming feedback from the Auto Industry.

❑ Accelerated Development of Vehicle Platform through H I L approach

- **Objective:** Function validation and development of EV powertrain components.
- **Methodology for execution:** All vehicle components are integrated on drivetrain test bench along with signal emulation system.
- **Deliverables / Outcomes:** Development and Validation of critical powertrain components such as VCU, E Axle, OBC-DC-DC-PDU, BMS (with battery pack) of vehicle.

Integration Testing

Hardware–In–Loop testing plays prominent role in reducing development time. All vehicle components can be integrated on test bench and their performance can be validated even before the prototype vehicle is built, refer below Table *for Equipment available at ARAI*. Validation of vehicle at powertrain component level is simplified with the help of road load simulation (RLS) while the other vehicle components (such as BIW, suspension, brakes and steering) are still in development stage. The following vehicle level testing can be done at powertrain level with emulation and integration of vehicle components.

1. Tuning and calibration of E-Motor and VCU.
2. E-Powertrain Performance validation in Drive, Coast, Reverse, Derating, Regeneration and Creep modes.
3. Integration of various components over CAN and their performance validation.
4. Functionality checks of various vehicle components (Hardware and their functions) w.r.t software updates.
5. AC and DC Charging validation with help of Charging station.
6. Validation of different safety functions (corresponding hardware along with software) for effective operation from the prototype stage.
7. Thermal derating validation of EV Powertrain components.
8. Validation of vehicle fault codes.
9. Validation of park lock and its functions.

EV manufacturers must test integration of entire powertrain system for:

- **System-level Functionality:** Overall functionality of powertrain, ensuring communication and coherent functioning of all the systems up to component level in various test case conditions as per real life scenarios.
- **Vehicle-to-grid (V2G) integration:** Ability of vehicle to communicate with and interact with electrical grid.
- **Parasitic load and Range estimation:** Parasitic load such as lighting system and thermal management system can be simulated and range of Electric vehicle can be estimated at powertrain level using vehicle simulation applications for various driving cycles such as WTP, MIDC, etc.

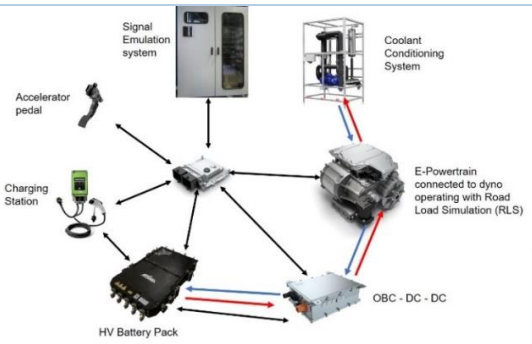


Fig: Integrated Vehicle Components for H I L Testing

Fig: Actual Setup for H I L Testing

Table: Equipment available at ARAI

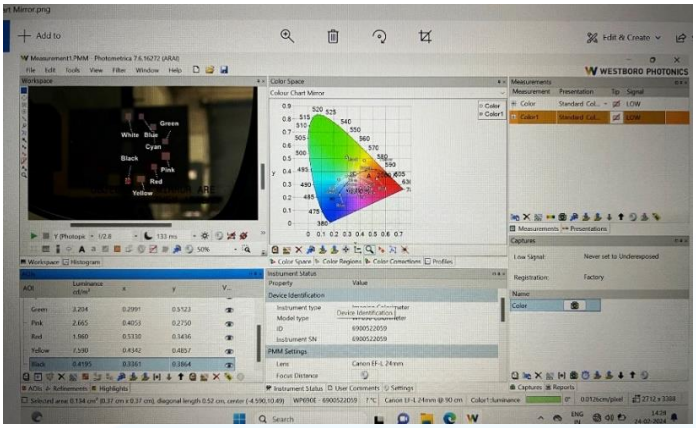
Equipment	Max Capacity
Driving Dynamometer – 1 No	330kW (700Nm, 8000rpm)
Absorbing Dynamometers - 4 No's	263kW (2500Nm, 3000rpm)
Summation Gearboxes - 2 No's	500kW (15000Nm, 1000rpm)
Conditioning Units – 3 No's	20° – 140°C ,1-10 bar, 2 - 430 LPM
DC Power Source	250kW, 1000A, 1200V

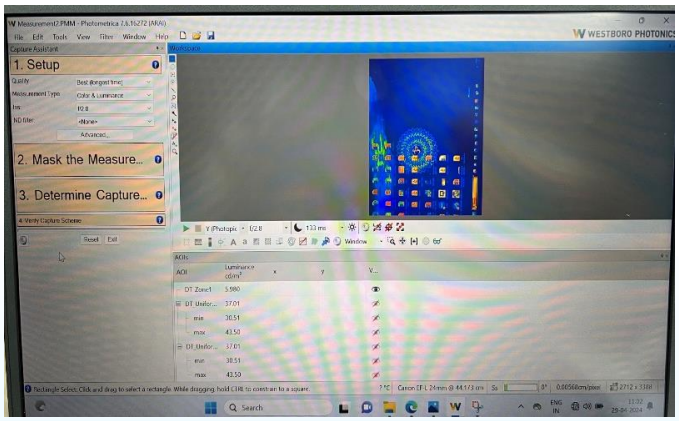
❑ Imaging Colorimeter

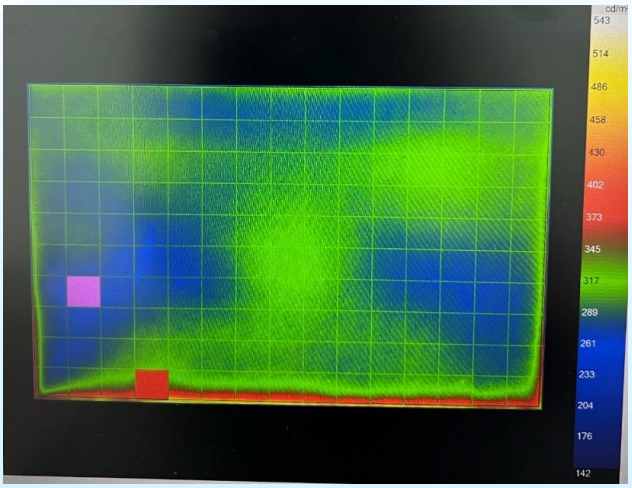
Advanced Photometry and Optics Laboratory augments state-of-the-art **Imaging Colorimeter** which offers expanded measurements other than traditional spot measurement devices. It is a scientific-grade camera system designed to make accurate measurement of luminance and chromaticity. Calibrated to replicate human photopic response to brightness and color, it is an enhanced facility based on CCD camera technology that provides consolidated solution for chromaticity and Luminance measurement of Vehicle Instrument Clusters, Automotive Infotainment Displays, Avionics, HUDs, etc. This instrument is engineered to meet customer's requirement during DVP cycle for greater accuracy, higher measurement dynamic range and better productivity.

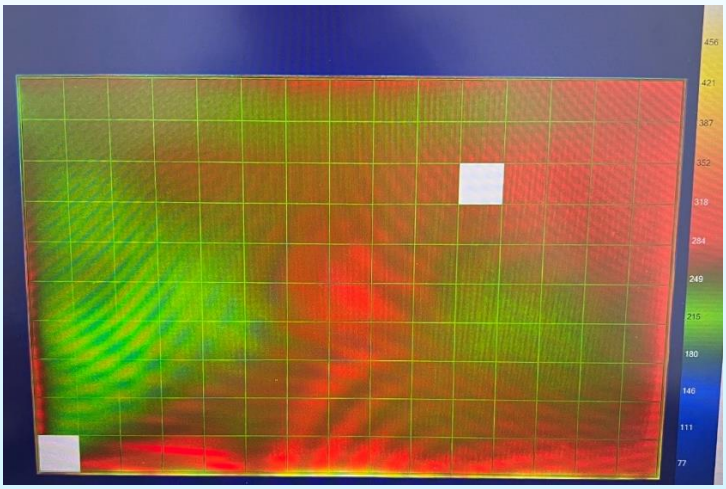
Highlights of Imaging Colorimeter:

- 9 MP tristimulus colorimeter having 24mm focal length electronically controllable aperture and focus
- Can measure luminance in the range of 0.05 cd/m^2 to 1,00,000 cd/m^2. Special ND filters used to measure luminance greater than 1000 cd/m^2.
- Can extrapolate an image size of 382 X 478 mm at 1 m distance
- Accuracy & Repeatability of measurement of luminance is ± 3% and Chromaticity is ± 0.003
- Measurement parameters include Luminance, CIE Chromaticity (x,y co-ordinates), Tristimulus values X, Y, Z, u', v', CCT, Dominant Wavelength and color purity, Uniformity of Displays, etc.

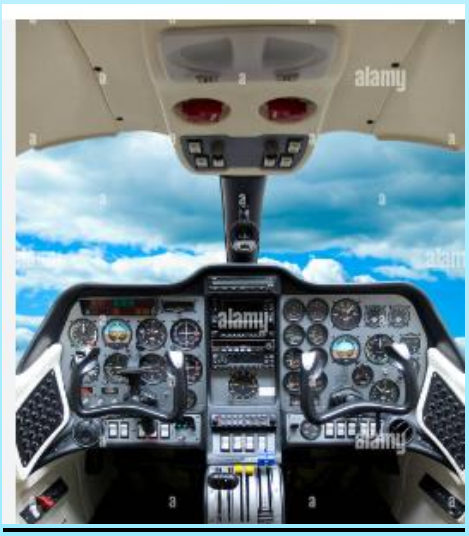




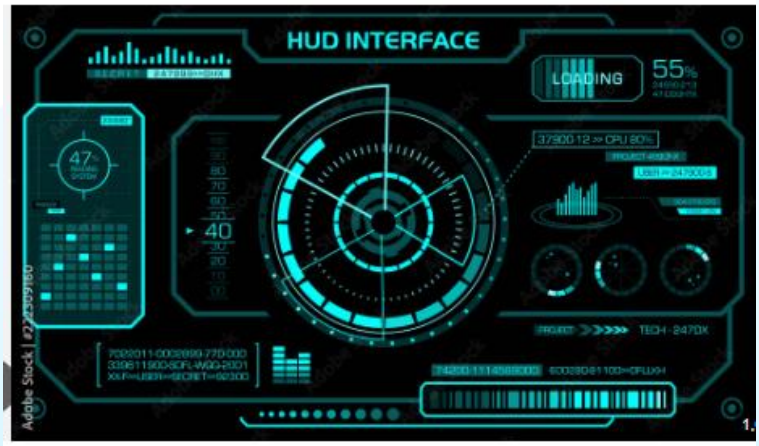




Typical Applications:



- Evaluation of display panels for its uniformity, brightness, colour characteristics measurements, e.g. flat panel displays, near eye displays, mobile displays, TV screen displays, etc.
- Testing of various instrument clusters used in automobiles.
- Evaluation of ghost image (blurred displays).
- Aerospace instrument panels
- Back-lit keyboards and graphics
- Beam Pattern Distribution
- Any type screen / panel / display requires to be evaluated based on its brightness and colour characteristics
- Heads Up Displays (HUD)



Measurement of :

- HUD Contrast
- HUD Luminance
- HUD Uniformity
- HUD Rotation
- HUD Distortion
- HUD FOV
- HUD Ghost Image
- HUD Location

❑ Framework for the Verification & Validation (V&V) of Advanced Driver Assistance Systems (ADAS) from Indian perspective

Introduction

Autonomous vehicles are a promising technology help to achieve the goal of zero accidents. But to achieve this goal, autonomous vehicles have to perform better than human drivers. This requirement makes these technologies very complex. Uncertain and complex traffic scenarios where these technologies will operate, add to the complexity.

Advanced Driver Assistance Systems (ADAS) are a stepping stone to fully autonomous vehicles. Global efforts are being undertaken to help accelerate the implementation of ADAS in vehicles. For e.g. Euro NCAP has framed test and assessment protocols for Autonomous Emergency Braking Systems (AEBS). These protocols form the basis for the development and testing of AEBS for a majority of organizations in the ADAS and Autonomous Vehicle market space.

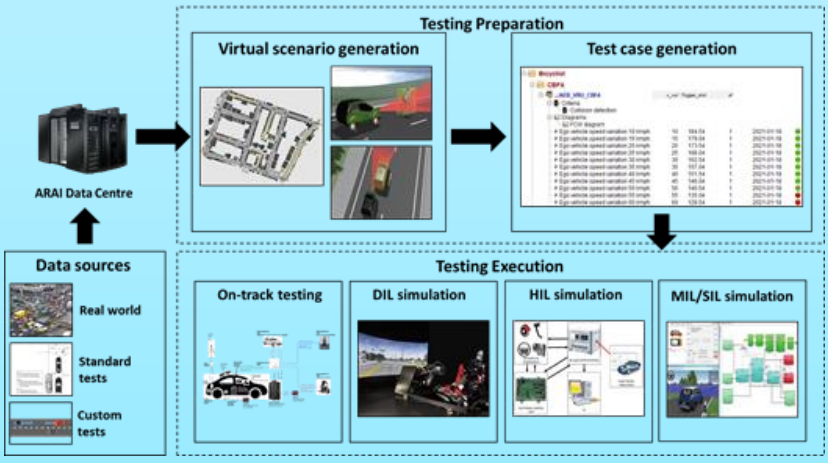


Figure 1: Integrated approach for ADAS V&V

These systems are slowly being incorporated in Indian vehicles as well. They need to be validated for safe operation in Indian traffic conditions and should not intervene unnecessarily during extreme uncontrolled traffic scenarios like bumper to bumper driving. Also, the software needs to be validated for fail safe operation. For this purpose, the control system needs to undergo rigorous verification and validation exercise to deem it safe for Indian operation.

ARAI INITIATIVE

ARAI Smart City Test Track Details

Under the Intelligent Vehicle Technology Program, ARAI is spearheading the development, testing, verification and validation of ADAS technologies for Indian use cases. The team is actively working on establishing complete ADAS V&V toolchain from the lab to the proving ground.

In order to enable thorough on-track testing of ADAS against Indian driving scenarios, ARAI has an underdevelopment ADAS Smart City Test Track. Spread over an area of over 20 acres, the test track incorporates various features reminiscent of typical Indian roads, thus emulating a fake city environment for autonomous and ADAS related testing.

Figure 2: ADAS Smart City Test Track Facility

The key features of the test track mainly include the following:

- Inner city roads with lane marking as per IRC 35
- Foot-paths, street lights and round-about as per IRC 41
- Small and large S-curves with lane marking as per IRC 35
- 4- way junction with 2 lane roads.
- Unpaved rural roads.
- Roads with manhole covers, iron bridges for rivers.
- Bus Stop, traffic signals and movable traffic signs.

Apart from this, the test track also leverages the capacity to conduct test scenarios as per various regulatory and NCAP scenarios.

ARAI Test Track Equipment:

To conduct on-track testing of ADAS, ARAI possesses comprehensive set of special ADAS Test Track Equipment to enable end-to-end closed-loop testing. For simulating complex scenarios involving moving as well as stationary objects on the road, the equipment set consists of purpose-built soft test dummies, which comply to ISO 19206 series standards. This enables the dummies to be detected by sensors such as cameras and RADARs, which are a commonplace in various ADAS.

For the testing purposes, the dummies include the following:

- Global Vehicle Target
- Articulated Adult dummy
- Articulated Child dummy
- Adult Bicyclist dummy
- Child Bicyclist dummy
- Global Motorcycle Target

These dummies are designed in such a way that upon a crash with the Vehicle-Under-Test (VUT), they disassemble without causing any damage to the test vehicle. The dummies are also very easy to reassemble, thus making the same standard conditions available for further testing without a change in scenario for consistent and recursive results.

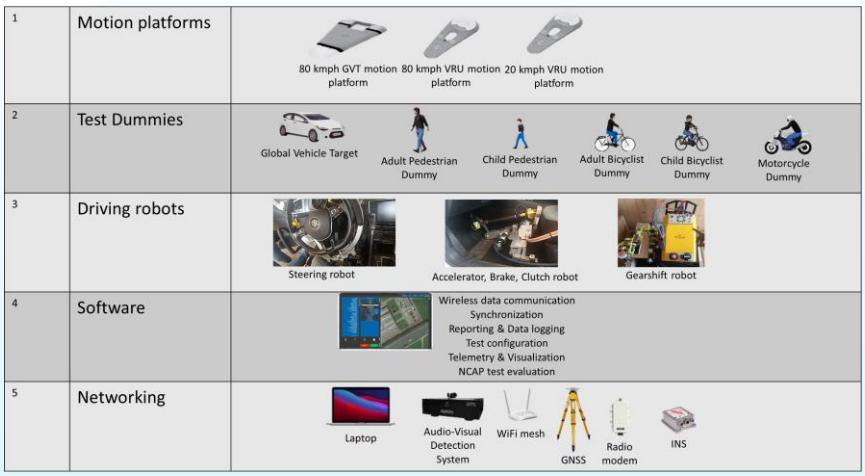


Figure 3: Available ADAS Test Track Equipment

All robotic motion platforms are equipped with integrated inertial navigation systems capable of receiving RTK corrections, thus allowing to position them with centimeter-level accuracy on the test track. The large robotic motion platform is meant for moving the Global Vehicle Target with a maximum speed of 100 kmph. The other dummies, also termed as Vulnerable Road User dummies, are mounted on two small robotic motion platforms, one capable of a maximum speed of 20 kmph and the other capable of a maximum speed of 100 kmph.

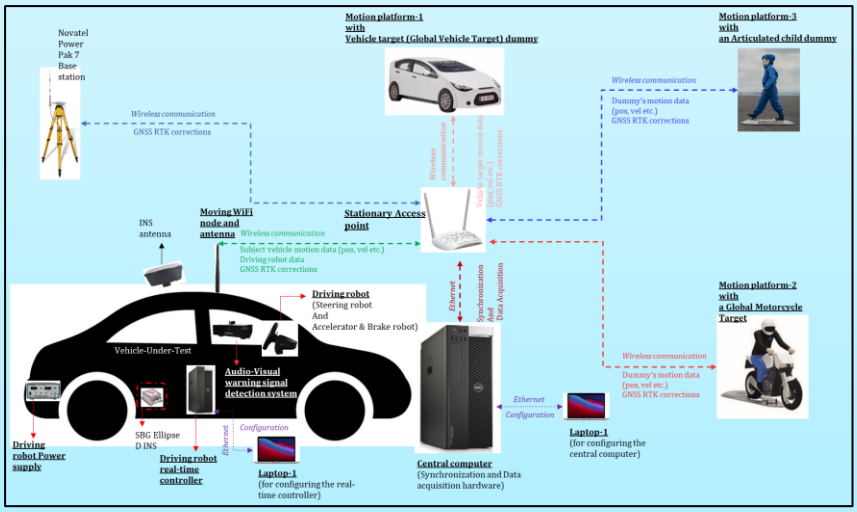


Figure 4: Architecture of the test track equipment set up

The equipment set also consists of a comprehensive set of driving robots, complete with steering robot, accelerator, brake and clutch pedal robots and a gearshift robot with the ability to be configured for both manual and automatic gearboxes. The equipment set is connected wirelessly to each other to allow for precise synchronization. Test scenarios are configured through a centralized test configuration software and uploaded wirelessly to all the equipment set. RTK corrections are also wirelessly transmitted via dedicated GNSS base station.

All the equipment set is connected wirelessly to each other to allow for precise synchronization. Test scenarios are configured through centralized test configuration software and uploaded wirelessly to all the equipment set. RTK corrections are also wirelessly transmitted via dedicated GNSS base station.

❑ Electric Vehicle Charging Station in Climatic Chambers

EV charging station is installed in the Climatic Chamber where it is possible to charge electric vehicles at extreme ambient conditions. The charging station has two separate chargers for provision of AC and DC Charging. This facility will be useful along with the Chassis Dynamometer for EV range determination at different ambient temperatures, battery performance evaluation and battery thermal management system validation exercises.

Operating Temperature range: -20 ºC to +50 ºC

Charger 1: Output rating: 120 kW Max power with single gun operation
OR 60 kW max power with simultaneous both gun operations.

No. of DC outputs/guns: 02
DC Output 1: CCS2, 60 kW or 120 kW DC
Output 2: CCS2, 60 kW or 120 kW

Charger 2: Output rating: 22 kW max power single gun
No. of AC Output: 01 CCS2, 22 kW AC

Built-in Safety Features:

- Over Current
- Over Voltage and Under Voltage
- Ground Fault Detection
- Surge Protection
- Emergency Stop Button
- Polarity Reverse Protection
- Charge Cable Temperature Detection
- Earth Presence Detection

❑ Upgradation of 4-Wheeler Emission Measurement Test Cell (VTC-01) for WLTP Requirement

In line with the European Union and Japan, Emission Legislation of India has also adopted Test Procedure (WLTP) for exhaust emission compliance, which is anticipated to become mandatory as of 2027. Vehicles those comply with WLTP are already being exported by a few OEMs to the European market.

OEMs will commence WLTP compliant car development at least two years ahead of mandatory compliance in Indian market as well. A comprehensively equipped mass emission test facility with all WLTP features was required to support (i) OEMs for COP testing of export models; (ii) Development and validation of newly designed WLTP cars; and (iii) Type approval of WLTP compliant vehicles for both domestic as well as international markets.

ARAI has always been at the forefront of establishing testing facilities well in advance before implementation of any regulation. Emission Certification Lab of ARAI has upgraded its 4-wheeler emission testing facilities by installing new 150 kW 4x4 (Double Axle) chassis dynamometer with new test cell automation system to fully accommodate WLTP-based emission requirements. The upgraded test facility is readily available for the industry for development, validation and certification of their vehicles as per national and international emission regulations,

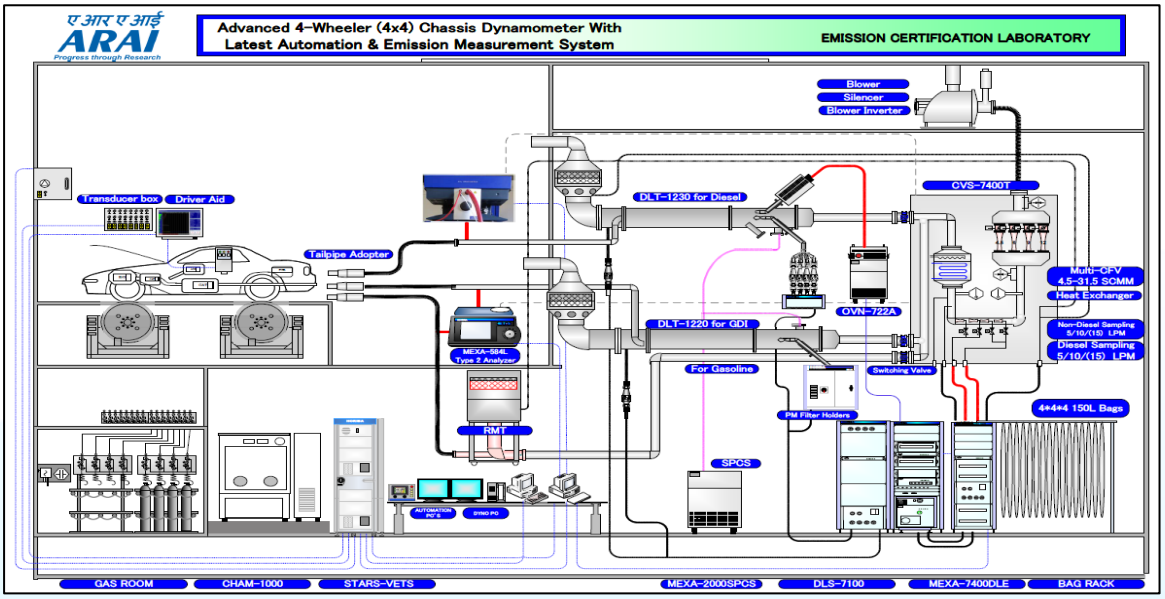


Fig 1 : Equipment Layout of VTC-01

Salient Features of Upgraded Test Cell (VTC-01)

Vehicle	Inertia	450 Kg to 4820 Kg
	Wheel Base	1800 mm to 4200mm
	Drive Axle	FWD, RWD, AWD & 4X4.
	Powertrain	ICE, HEV & EV
Regulations		European (up to EURO 6), Indian (up to BS VI), EPA (up to TIER III)
Pollutant	Gaseous	CO, CO2, THC, CH4, NMHC, NOX, NO2
	Particle	PM & PN
Fuel		Gasoline up to E20, Diesel, CNG & LPG

Fig 2 : Inauguration of Upgraded VTC-01

❑ Flex Fuel Emission Test Cell (VTC-02)

Government of India is promoting increased use of ethanol in gasoline fuel as well as development of Flex fuel vehicle to reduce fossil fuel dependency and carbon footprint. In line with the same, this state-of-the-art facility, set up in ARAI, is the only facility in India, to cater to mass emission testing of all types of fuel blends up to E100 and M100 on 2/3/4-wheeled vehicles, conforming to national and international regulations.

Emission testing for domestic certification and export homologation, fuel consumption, constant speed fuel consumption tests, can be done on 2-W, 3-W and 4-W, including quadricycles, using the fuels such as petrol, diesel, CNG, LPG, HCNG, methanol blends up to M100, ethanol blends up to E100, DME, DME+LPG, bio-diesel blends and bi-fuel, dual fuel.

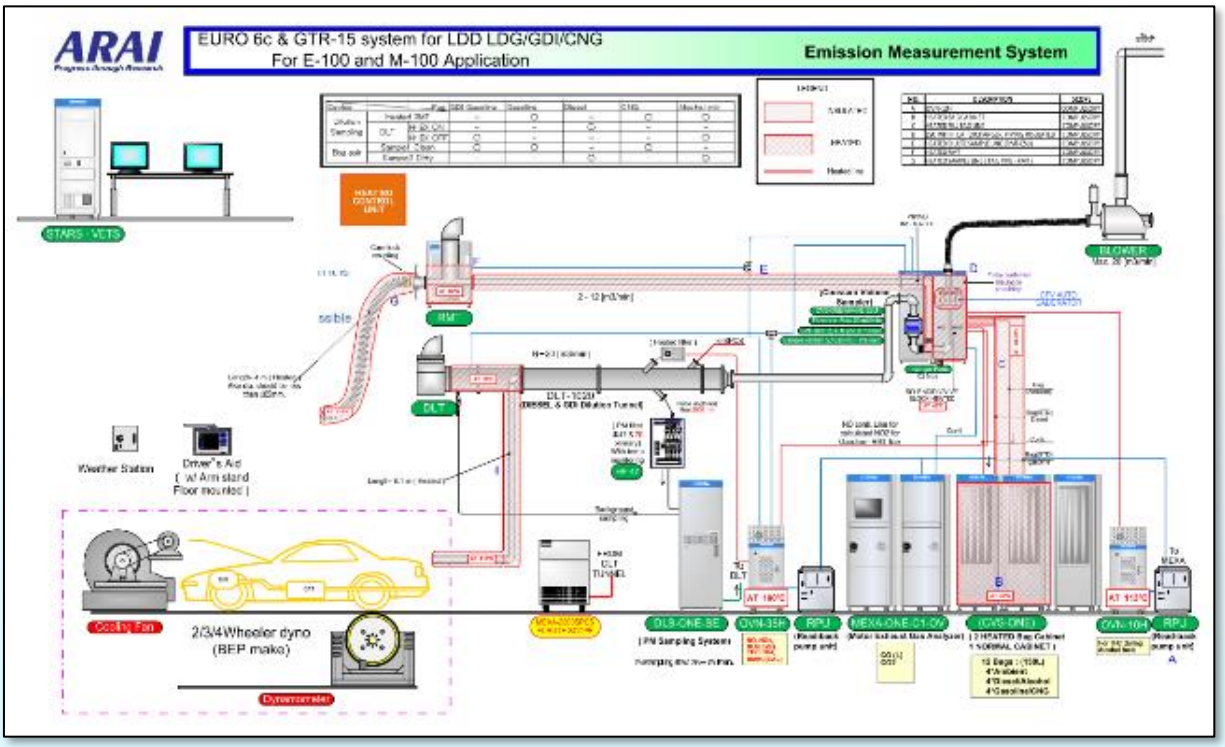


Fig. 1: Equipment Layout of VTC-02

Fig. 2 : Newly Installed Flex Fuel Test Cell

Fig 3 : Inauguration of Vehicle Test Cell

Capability of Test Cell:

Dyno Speed	0 to 200kmph
Load	100 – 1500 Kg
Capacity	50 kW
Dilute Pollutants	CO, THC, CH4, NOX, CO2,
Modal Pollutants	CO, THC, CH4, NO, NOx, CO2,

❑ Development of CPCB IV + Hydrogen & Natural Gas Genset Engine

Catalyzing Better Power

We imagine global transition that is fueled by cleaner energy, led by fusion of innovation and tradition to break higher ground. Integration of hydrogen and natural gas in generator technology stands out as a beacon of change, by offering unique power solution, combining efficiency and environmental consciousness. We have, therefore, developed Hydrogen Fuel Enhanced Combustion (HFEC), a renewable source blended with alternative fuels, to reduce carbon footprint.

Joint development by ARAI with the leading Govt. oil marketing company and the leading Genset OEM, has led to development of genset technology powered by blend of hydrogen and natural gas. It represents significant step forward in our transition towards cleaner energy sources. By leveraging the strengths of both the fuels, our innovative approach aims to deliver reliable and environment-friendly power generation.

Harnessing the Power of Hydrogen

Hydrogen, known for its clean-burning properties and abundant availability, has long been hailed as a key player in the renewable energy landscape. Thus, it holds immense potential as a sustainable fuel source, offering zero-emission energy production when utilized in fuel cells or internal combustion engines.

In the realm of domestic energy solutions, integration of hydrogen fuel into natural gas generators acts as a catalyst, effectively reducing carbon emissions while optimizing efficiency. By blending hydrogen with natural gas, generators produce lower carbon emissions than traditional fossil fuel-based generators, contributing to greener energy eco-system.

Synergy with Natural Gas

As a reliable and readily accessible energy source, natural gas complements hydrogen's attributes in the HFEC generator system. As a well-established fuel for power generation, natural gas provides stability and scalability to the energy infrastructure. This ensures consistent power supply even in challenging conditions.

Moreover, synergistic combination of hydrogen and natural gas enhances safety and overall efficiency of generator operations. The blend optimizes combustion dynamics, resulting in cleaner exhaust emissions and improved performance metrics, such as power output and fuel economy.

Advantages of H_2 + NG Generators

Integration of hydrogen and natural gas in generator technology presents a compelling choice for existing and new genset engine applications. Benefits of hydrogen and natural gas blending are enhanced by using novel ignition and fuel calibration strategies, aftertreatment and other minor engine modifications. The advantages of HCNG gensets include:

- Lower carbon fuel utilization to ensure no smoke is emitted from genset exhaust.
- Significant reduction in NMHC, NO_x and CO emissions compared to similar gensets complying with CPCB-II norms.
- Up to 18% lower CO_2 emissions as compared to diesel gensets with similar output.

Driving Innovation and Adoption

The advent of HFEC generator technology represents a paradigm shift in the energy landscape, signaling transition towards cleaner, more sustainable power solutions. Shaping the future of engines with robust ECU and electronic governors suitable for synchronization operation, NO_x control diagnostics, in-built gas pressure reduction system and 3-way catalytic convertors for emission control.

Conclusion

The technology developed by ARAI complies with CPCB IV+ emission norms to foster hydrogen eco-system. Genset OEM leads this transition with HFEC, where power is cleaner to build the world enriched with 75-year-old legacy to ensure an uninterrupted power supply that powers 1 million gensets across the world. This joint development by ARAI with the leading Govt OMC and the Genset OEM strive to pioneer sustainability with power generation solutions where each blended element promises better power and limitless tomorrow.

❑ Test Facility for Chemical Characterization of Diesel Particulate Matter

Test facility for determination of Soluble Organic Fraction (SOF) and Inorganic Fraction (IOF) fraction from particulate matter, collected on filter paper from vehicular/genset exhaust, is established in Environment Research Lab (ERL) of ARAI. Diesel particulates form a very complex aerosol system. Schematic diagram of composition of diesel exhaust particulates (Fig. 1) and its chemical characterization (Fig. 2) is given below:

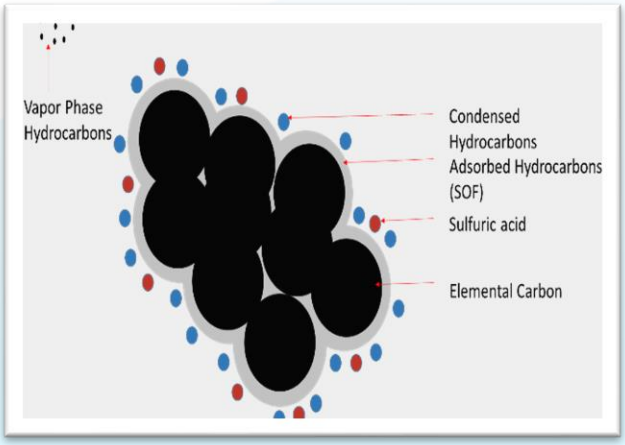


Fig 1: Particulate Composition

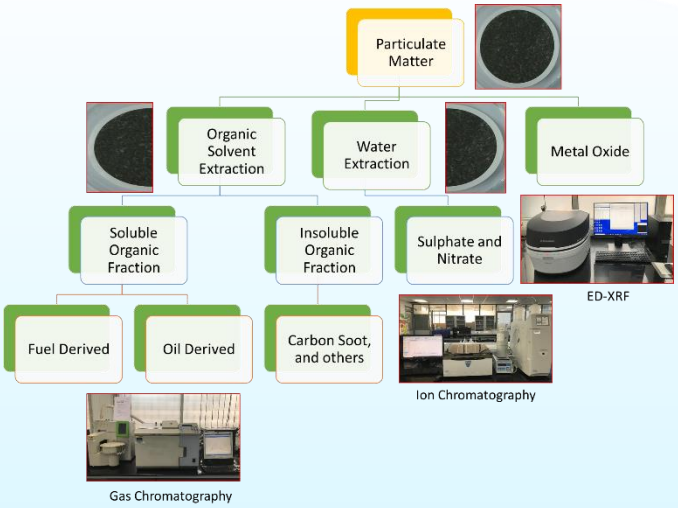


Fig 2: Schematic representation of chemical characterization of diesel particulate matter

As shown in Fig. 3, SOF is typically composed from higher boiling end diesel fuel hydrocarbons called as fuel derived fraction and engine oil derived hydrocarbons called as oil derived fraction. Carbon soot fractions in engine is generated via pyrolysis of fuel molecule, i.e. when there is insufficient oxygen available for complete oxidation. Ash fraction is generated by ash compound present in fuel, air and due to material disintegration. The Sulphur present in both fuel and oil is responsible for the sulphate fraction in the particulate matter. Nitrates in the particulates can be primarily attributed to the oxidation of nitrogen in the air during combustion.

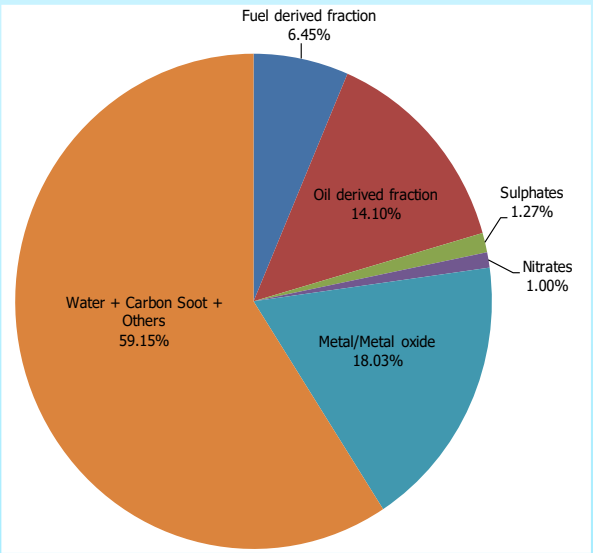


Fig 3: Typical Composition of PM

Composition of exhaust particulate matter evaluated through detailed chemical characterization can provide useful information on the contributions from probable sources quantitatively, which can help in designing better emission control technologies, such as particulate filters and catalytic converters.

❑ 2023 IESA Industry Excellence Award on Battery Safety

ARAI has received prestigious "**2023 IESA Industry Excellence Award on Battery Safety**". The award was presented to Director - ARAI on 3rd May 2023 in New Delhi, during the "India Energy Storage Week 2023 – Conference and Expo on Energy Storage, EV and Green Hydrogen in India" by Indian Energy Storage Alliance.

This award is in recognition of ARAI's complete support to the Electric Vehicle Industry in design, development and validation of Traction Batteries to establish compliance to these additional requirements in a phased manner, so also for granting several battery approvals within a short span of time.

ARAI emerged as a winner by scoring high on the several key evaluation criteria, besides high competition.

❑ Seminar on "Flex-Fuel Vehicles – An Indigenous Eco-Friendly Solution to Indian Auto Industry" – 24th June 2023

Alternate Fuel Centre (AFC) at ARAI had organized seminar on "Flex-Fuel Vehicles – An Indigenous Eco-Friendly Solution to Indian Auto Industry" on 24th June 2023, with a view of disseminating knowledge on new trends, laws and anticipated developments in the field of flex fuel vehicles for the Indian automotive industry. Over 270 delegates, including those from the business world and academia, attended the conference. With the involvement of the delegates, this seminar was an assembly of the industry's finest intellect of vehicle manufacturers (passenger vehicles, including 2-wheeler and 4-wheeler and Heavy-duty vehicles), OMCs, Sugar Manufacturing Associations, Fuel system suppliers, test facility providers and Test Agencies.

This event was inaugurated by Dr. Reji Mathai, Director - ARAI, in the presence of Dr. S. S. Thipse, Sr. Deputy Director and Mr. Shekhar Gaikwad, IAS, Former Sugar Commissioner, Maharashtra, was the Guest of Honor for this seminar.

This seminar had eminent speakers and comprehensive understanding of the modifications required in internal combustion engines and vehicles to optimize performance and maximize the benefits of flex-fuel technology.

Mr. Shekhar Gaikwad, IAS, Ex Sugar Commissioner, Maharashtra, explained the contribution made by the sugar industry to Indian economy. The pivotal role of the sugar industry in supplying ethanol to the automotive sector in India.

Mr. P. S. Ravi, Executive Director- Corporate Entities, BPCL, elaborated the storage, production, handling, rational usage and uniform blending of ethanol. He also shared the success stories of the current 1,000 E20 dispensing outlets and another 6,000 by December 2023, besides an impressive target of 10,000 outlets by March 2024 by the OMCs

Dr. S. S. Thipse, Sr. Deputy Director Head of Engine Development Lab showcased the ARAI development efforts for ethanol technologies and Legislative Norms for Flex-Fuel Vehicles.

Mr. Tarun Agarwal, Executive Officer, Maruti Suzuki India Limited highlighted the OEM perspective for flex fuel vehicle and challenges in development of 4-Wheeler Flex Fuel Vehicle.

Mr. K U Ravindra, Vice President - Engineering and Mr. Rajesh C, Lead System Engineer, Bosch India Limited, showcased the Challenges for Development of Flex-fuel system for 2 and 4-Wheeler considering Indian Scenario and Upcoming Regulations.

Dr. Alok Kumar, Sr. General Manager, Hero MotoCorp Ltd. spoke about OEM perspective for Flex Fuel 2-Wheeler Development considering BS VI Regulations.

Mr. Kazuya Tsurumi, Jr. Corporate Officer - Head Mobility Solution Business, Horiba, Japan highlighted the Developmental Challenges for Flex Fuel Test Facility Requirement and Safety Constraints.

Dr. Ravindra Utgikar, Vice President - Praj Industries Ltd., spoke about the Road-Map for Bio-Ethanol Production Considering Indian Scenario.

Mr. Roger Guilherme, Manager of Biofuel and Product Development at R&D Volkswagen SAM (South America) made presentation on the insights on development challenges of Flex Fuel Vehicles (FFVs) based on Volkswagen's rich experience in the field. He also highlighted successful implementation of Flex technologies in Brazil since 2003.

The event received encouraging feedback in all respect. The seminar succeeded in accomplishing its purpose of knowledge sharing and providing platform for exchange of thoughts between the experts and the participants. The event concluded with the Vote of Thanks by Mr. S. D. Rairikar, Deputy General Manager.

❑ Seminar on "Hydrogen as a Carbon-Neutral Fuel for Internal Combustion Engines" – 29th April 2023

ARAI's research wing - Alternate Fuel Center (AFC) had organized seminar on "Hydrogen as a Carbon-Neutral Fuel for Internal Combustion Engines" on 29th April 2023, with an aim towards sharing of knowledge on new trends, regulations and upcoming trends in Hydrogen fuel for Internal Combustion Engines. The conference witnessed participation of over 300 delegates from the industry as well as Academia. This seminar was an Assembly of the best minds in the Industry with the participation of the representatives of vehicle manufacturers (passenger vehicles including 2-Wheeler & 4-Wheeler and Heavy-duty vehicles), CGD companies, Simulation software companies, Gas Fuel system suppliers, Government officials from CHT (MoPNG) and Test Agencies.

This event was inaugurated by Dr. Reji Mathai, Director - ARAI, in the presence Mrs. Anuradda Ganesh, who was the Guest of Honor at this seminar.

This seminar had eminent speakers who discussed various topics, viz. Hydrogen ICE development, its storage and compatibility, Safety and legislative regulation, types of hydrogen fuel and its production, engine performance and emission overviews, etc.

Dr. S. S Thipse, Sr. Deputy Director and Head of Engine Development Lab, highlighted legislative norms, rules and regulations for Hydrogen ICE.

Mr. Alok Sharma, Executive Director, Centre for High Technology, Govt. of India, spoke on the National Green Hydrogen Mission in Jan 2022 and how the mission seeks to make India green Hydrogen Energy Hub. He also covered various Facets of Hydrogen – Status and Challenges. Various hydrogen storage options and hydrogen transportation and its challenges, besides use of hydrogen in the mobility sector and in IC engines

Mr. Krishnan Sadagopan, Senior Vice President, Ashok Leyland Ltd. and Independent Director, Indian Oil Corporation Limited highlighted the New Experience by Experiments. H_2ICE opportunities and potential for Medium and heavy-duty commercial vehicle segment.

Mr. K U Ravindra, Vice President, Engineering, Bosch Limited, discussed the Fuel System development (Injection system, Ignition system, air management system, after-treatment system, Combustion design and engine control).

Mr. David Worth, Director, Engine Management Systems, Westport Fuel System USA, presented the overview of PFI and DI systems for H2 engine, highlighting various systems like air handling system, fuel system calibration insights, etc. for H_2ICE.

Mr. Nayan Pandya, Managing Director, Cryogas Equipment Pvt. Ltd. elaborated advancement in hydrogen storage and its challenges.

Mr. Vivek Kumar, Principal Engineer- Hydrogen Solutions, Ansys Software Pvt Ltd. and Mr. Pravin Nakod, Fluid Applications Head, India and ASEAN, Ansys Software Pvt Ltd made presentation on Powering the Future of Hydrogen Adoption with Simulation.

Mr. Vivek Seshan from Reliance Industries Limited, highlighted the Development of Hydrogen fuel infrastructure and Reliance efforts for promotion of Hydrogen vehicle programs in India.

Mr. Abhijit Phadke, Director, Lab and Test Operations, Cummins Tech Centre India described about the Development Challenges for Hydrogen Test Cell Facility Requirement and Safety Constraints.

Summarizing this, ARAI has received encouraging feedback on the technical contents of the presentations made in the seminar and there is a demand to have a repeat session of the same.

Shri. S D Rairikar proposed vote of Thanks, expressing gratitude to one and all in successful organization of the event and making it more meaningful.

❑ International Conference on Automotive Materials and Manufacturing (AM&M 2023)

4th International Conference on Automotive Materials and Manufacturing, 2023 (AM&M 2023) was organized by ARAI, in association with SAE India and ASM International (Pune Chapter), at Chakan, Pune from 31st May to 2nd June 2023. The central theme of Conference was “Shaping Progressive Mobility through Emerging Materials and Manufacturing Technology”.

The conference was inaugurated by Dr. Hanif Qureshi, Joint Secretary, Ministry of Heavy Industries, Government of India. During the inaugural address, Dr. Qureshi emphasized the need to bring in a greener approach in the automobile manufacturing industry to face the challenges ahead and provide eco-friendly solutions. “The automotive sector is an important part of the growth story of the emerging modern India. This sector is now more than $120 billion and is about 7% of the size of the Indian economy. It contributes more than 35% of the jobs in the manufacturing sector. We look forward to new challenges as governments around the world are talking about stringent emission norms and fuel efficiency.” He added that the industry is looking for advanced materials that would help them in reducing environmental impact. “This is the time when the Indian automobile sector is oiled for growth, but along with this growth, there are certain challenges as we have to look for advanced materials and processes, which will hasten our journey towards not only better automobiles and better fuel efficiency, but also reduced environmental impact through improvement in manufacturing processes,” Dr. Qureshi said. Mr. Deepak Garg, Managing Director, Sany Heavy Industries Pvt. Ltd., the Guest of Honour, at the event highlighted the significance of the Indian automobile industry and the need for its further expansion. He said, “Indian automobile industry is a significant contributor to India's GDP. It is currently accounting for almost 49% of the manufacturing GDP and over 7% of total GDP. The rapidly growing automotive industry is now worth more than $2,222 billion, contributing almost 8% of the country's total exports and generating employment of more than 37 million people. As India targets to surpass GDP of $5 trillion by 2025, the goal set by Hon’ble Prime Minister of India, with a long-term potential to reach $30 billion by 2050, coupled with the target to achieve net zero emissions by 2070, the significance and potential for the automobile sector will increase further."

The conference witnessed over 60 presentations, including keynotes by renowned industry leaders, in automotive, space and defence sectors as well as academics. There were two panel discussions held on futuristic topic of “Big data analytics for Materials and Manufacturing” and “Materials for sustainable mobility”. The concurrent exposition had participation of 28 industries and startups, showcasing their innovative technologies and services. The Materials Pavellion gave opportunity to budding engineers to put forth their innovative ideas to industry professionals. More than 300 delegates, from various industries, research organizations and academia attended this conference. During the conference, high energy was seen that brought these professionals closer to exchange the ideas and innovations.

The conference concluded on 2nd June. Mr. Lalitkumar Pahwa, MD – Pahwa MetalTech was the Chief Guest at the Valedictory Function. Shri Vijay Mittal, Joint Secretary, Ministry of Heavy Industries, Government of India, addressed the gathering online, highlighting that India can emerge as one of the leaders in the automotive industry in the coming years. He praised the organizers for conducting the conference, where ideas were exchanged for development of the sector. He opined that the conference has been highly productive and added value to the past. Over the years, the India automotive industry has emerged as one of the world's leading and fastest growing auto markets. Demographically and economically, India's automotive industry is well-paced for growth, meeting both the domestic and export opportunities," Sh. Mittal said.

He said that the country can become a big base for manufacturing if there is a focus on developing local resources.

He highlighted in his address, that "India can emerge as a world-class automotive manufacturing base if indigenous solutions are developed in the emerging automotive areas. Government of India is working for facilitating safe and clean mobility eco-system through regulations and fostering innovation with an underlying belief that technology is the important determinant of growth and development. He indicated, Ministry of Heavy Industries has been promoting technology development, encouraging domestic manufacturing of high-end products and boosting electric mobility through various schemes," he added.

The participants shared encouraging feedback on the Conference for overall organization, topics, sessions, various innovative ideas, challenges and the way forward discussed in the panel discussions and keynotes.

❑ Two-Day International Conference on Advanced Powertrains for Mobility & Power Generation Applications | 15-16 September 2023

International Conference on Advanced Powertrains for Mobility & Power Generation Applications was jointly organized by ARAI & SAEINDIA Western Section at Hotel Radisson Blu Hinjewadi.

The major topics covered in this conference were upcoming challenges due to under-discussion Euro VII emission norms, Hydrogen ICE and Flex Fuel technology, making of an efficient and cost effective Conventional / E-Axle based drive trains for EVs, Advances in motors and motor controllers (IM / PMSM / SRM), Power Electronics, MCU, BMS, Battery, Charging Technology, Hydrogen Fuel Cell Electric Vehicle Technology for Mobility and Power Generation Applications, Dual Clutch Transmission / AMT Design Considerations, Strong Hybrids / Series Hybrids / Range Extender Based Hybrids, etc.

Ms. Anjali Pande, Chief Operating Officer, Cummins India & Vice President, ARAI-GC, inaugurated the Two-Day International Conference on "Advanced Powertrains for Mobility & Power Generation Applications" presided over by Dr. Reji Mathai, Director-ARAI & Chairman SAEINDIA Western Section.

The Conference witnessed presentation of 14 technical papers, 12 keynotes and 2 panel discussions by the eminent experts. Around 150 industry professionals from various industries attended this event and appreciated the technical contents presented and discussed over two days.

❑ Symposium on International Automotive Technology (SIAT), 2024 – Brief Overview

ARAI, in association with SAE India and SAE International, had organized Symposium on International Automotive Technology 2024, (SIAT 2024) from 23rd - 25th January 2024, at Pune International Exhibition & Convection Center (PIECC), Pune (India).

The theme for SIAT 2024 was “Transformation Towards Progressive Mobility” aptly focused on innovative solutions for evolving mobility challenges.

Dr. Mahendra Nath Pandey, Hon’ble Minister for Heavy Industries, inaugurated the Symposium on virtual platform. Dr. Hanif Qureshi, Additional Secretary, Ministry of Heavy Industries; Dr. David Shutt, CEO - SAE International; Dr. N. Sarvanan, President and CTO, Ashok Leyland, Chairman – SIAT 2024 Steering Committee and President – ARAI; Dr. Reji Mathai, Director – ARAI and Chairman – SIAT 2024 Organizing Committee and Shri V. V. Shinde, Sr. Deputy Director and Convener – SIAT 2024 were present on the dais.

Hon’ble Minister also inaugurated the new facilities of ARAI, viz. Advanced Photometry Lab, NVH Development Centre, Advanced Acceleration Sled and Foundation Stone laying of MRC Takwe. MoU with M/s. CENEX, UK was also exchanged in the presence of all the dignitaries.

Symposium Proceedings containing Technical Papers, Technical Reference Bulletin (TRB) and Safety Handbook, were released at the hands of Hon'ble Minster during the inaugural function.

The Symposium hosted 3 augmented Plenary Sessions, wherein various domain specialists enlightened the audience. The topics of Plenary Sessions were Sustainable Technologies for Next Decade, Safe Mobility and Solutions for Future Mobility.

Large number of delegates cherished the opportunity of listening to the eminent experts from automotive domain during the Panel Discussion on "Transformation Towards Progressive Mobility". Dr. N Sarvanan, President & Chief Technology Officer, Ashok Leyland Ltd.; Dr. Marc Stehlin, Head - Technology Center, Skoda Auto Volkswagen India Pvt. Ltd.; Mr Sanjay Parashar, Executive Director (Supplies), Indian Oil Corporation Ltd.; Dr.Tapan Sahoo, Executive Director (R&D), Maruti Suzuki India Ltd. and Dr. Reji Mathai, Director, ARAI were the members of the Panel and Mr. Kavan Mukhtyar, of PwC India was the moderator.

The Automotive experts presented 174 technical papers and 37 keynote papers on various subjects, viz. E-mobility, ADAS, Alternate Fuels, Hydrogen, Advanced Powertrain, Vehicle Dynamics, Testing and Evaluation, etc. in the Symposium.

The concurrent SIAT EXPO 2024 was the biggest ever event organized so far, spread over 10,200 sq.mtr. area and comprising of over 330 stalls divided in five zones. There were 216 exhibitors from India, USA, UK, Japan, Germany, Austria, France, Finland, etc. which is a testimony of the popularity of SIAT across the globe. For the first time, a dedicated special pavilion for Medium, Small Scale Industry and Start-ups was put up wherein over 70 such companies participated. The EXPO also showcased pavilions, viz. UK Pavilion represented by 15 UK based companies; ARAI Pavilion showcasing spectrum of its capabilities, future plans and new initiatives, including Technovuus and AMTIF.

The Student Poster Presentation Competition organized to encourage the upcoming generation for bringing up their technical skills. Total 15 posters were selected for display in the area of Safe Mobility, Sustainable Mobility and Intelligent Mobility.

Futuristic technologies and products were displayed in the Technology Pavilion. Main emphasis was on hydrogen as a future fuel. Hydrogen fuel cell, Hydrogen IC engine powered truck, hydrogen engine and Type-IV cylinder for the storage of hydrogen were on display.

Valedictory function of the Symposium concluded with the address by the Chief Guest, Dr. N. Sarvanan, President & CTO of Ashok Leyland, Chairman – SIAT 2024 Steering Committee and President – ARAI. He also released the “MARG 2.0” software for virtual analysis. Dr. Reji Mathai, Director -ARAI, summarised the takeaways of SIAT 2024.

The Awards for the Best Technical Papers, Expo Stalls, Micro-Small-Start-up Stalls and Student Poster Presentation Competition were presented to the winners. Mr. V.V Shinde, Convenor – SIAT 2024, proposed the vote of thanks.

SIAT 2024 and SIAT EXPO 2024 received an overwhelming response in all respect. In addition to 2,000 delegates, more than 7,000 visitors made their way to the Symposium and Exposition and created a new record in the history of SIATs.

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Progress through Research

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