ARAI® Progress through Research Update

Towards Safer, Cleaner & Quieter World ...

Design, Development and Testing Services at ARAI

Index Issue 2017-2018

ARAI - Center of Excellence for Electric Mobility

In line with National Electric Mobility Mission and thrust of Government of India on Electric Mobility, rapid growth in Electric Vehicle development is envisaged in India.

ARAI, premier Automotive R&D and Certification Institute in the country, has set up Center of Excellence (CoE) for Electric Mobility to support automotive industry for development, evaluation and certification of Electric Vehicles. This Center of Excellence houses comprehensive state-of-the-art facilities for vehicles (2-wheelers, 3-wheelers, passenger cars, buses and commercial vehicles), their components such as traction batteries, motors, controllers, chargers, etc. The center also has capabilities in the area of light weighting, structural integrity, materials, simulation, etc. which are important for electric vehicle development.

Battery Performance and Safety Testing

- Evaluation Testing of EV Traction Batteries as per AIS 048, ECE R100, USABC, FreedomCAR Battery Test Manual, SAE J2464, UN38.3, ISO 12405, IEC and UL standards at Cell Level and Battery Pack Level for different battery chemistries such as lead acid, Li-ion, NiMH, etc. under environmental conditions.
- Performance testing, life cycle testing, safety/abuse (Thermal, Electrical, Mechanical) testing.
- Material characterization of battery electrodes and electrolytes for elemental, thermal, topographical analysis.

30 Channel Cell level Test System	EUCAR Level 6 Environmental Chamber	800V / 600A, 250 kW Pack Level Test System
		

Electric Motor Characterization

- Net Power, 30 Min Power and efficiency as per AIS 041 and ECE R85.
- Reliability, durability and overload capacity.
- Dynamic behavior and dynamic measurements.
- Evaluation of torque speed characteristics of electric motors, torque analysis.
- Power and efficiency maps of electric motors and converters/Motor Controller.
- Cold start performance measurement
- Testing of regenerative braking.
- Blocking tests
- Thermal Characteristics
- Overload Capacity

Power Meter

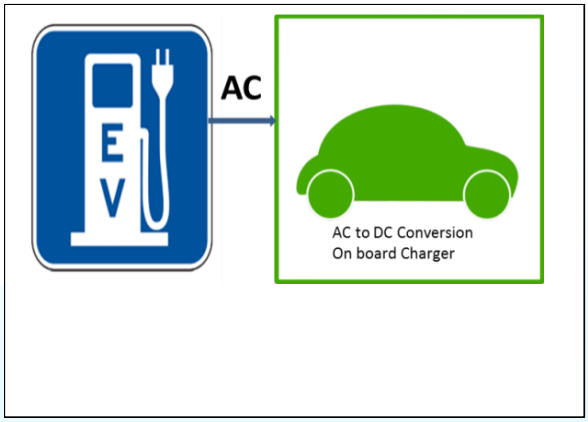
150kW and 220kW E-Motor Test bed With Environmental Chamber

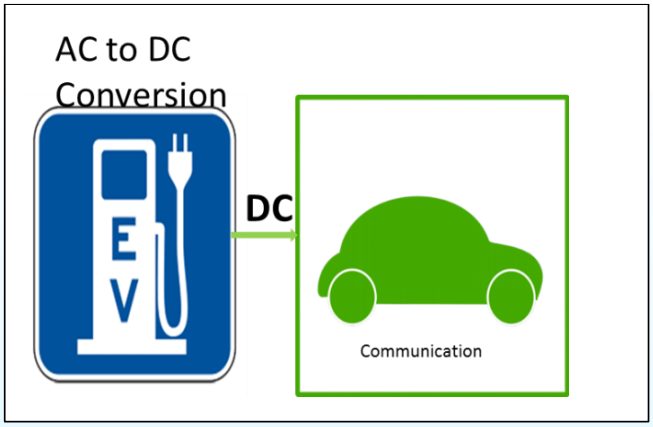
Vehicle Performance and Homologation as per CMVR on Chassis Dynamometer and Test Tracks (2 Wheeler, 3 Wheeler, 4 Wheeler Passenger cars, Commercial Vehicles and Buses)

- Electric Energy Consumption as per AIS 039 and ECE R101
- Electric Range measurement as per AIS 040 and ECE R101
- Power at Wheels as per AIS 041
- Brakes, Gradeability, Pass-by Noise
- Constructional and functional safety, EMC

Charger Testing and Certification

- Testing as per AIS 138 Part 1 and Part 2
- Testing as per Bharat EV Charger Specifications AC001 and DC001

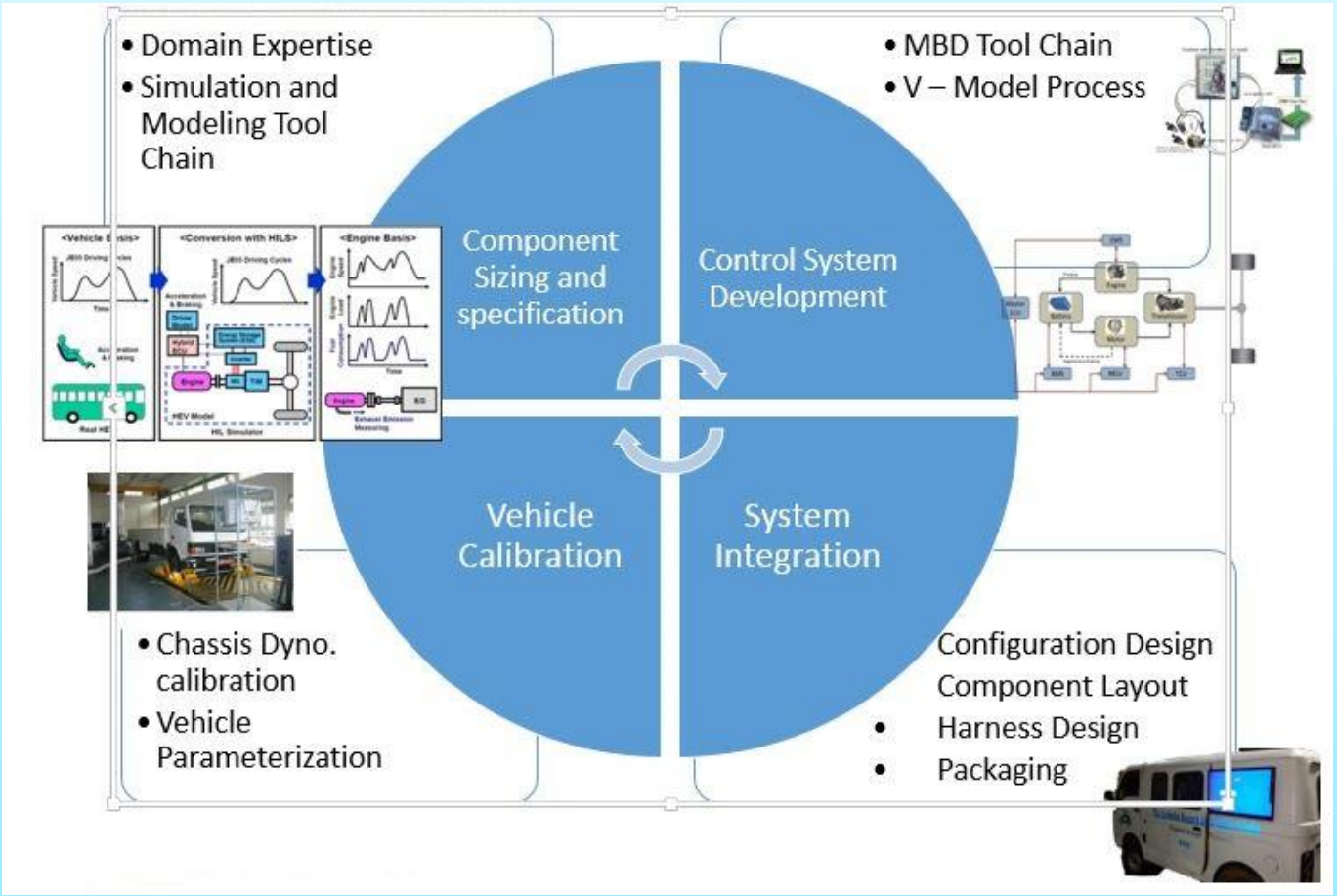


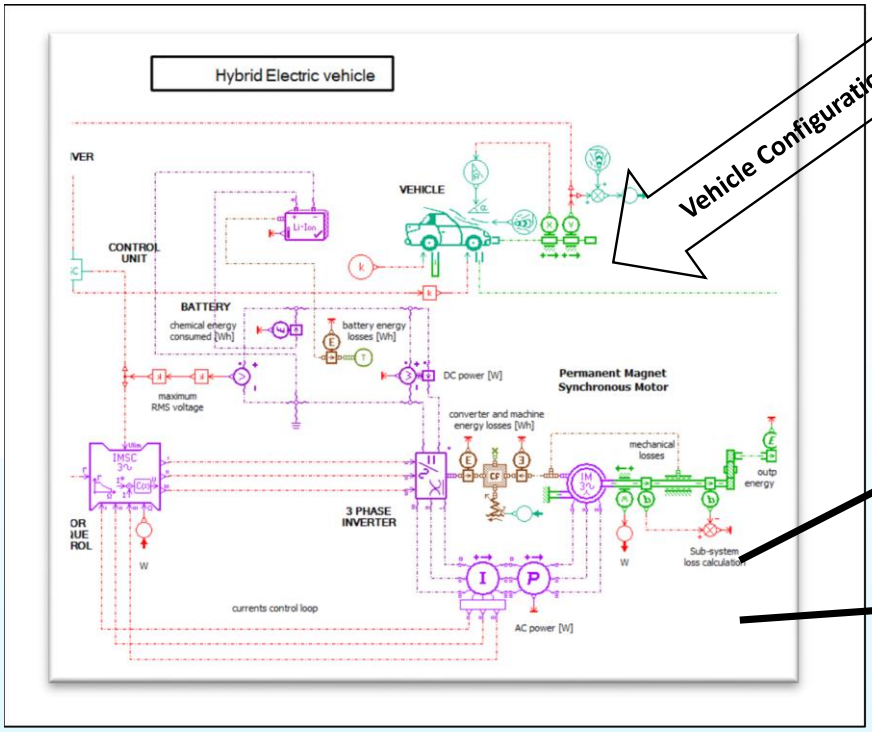


Electric Vehicle Development

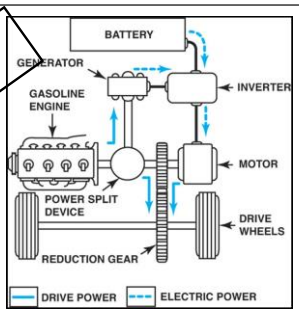
Competency in Electric vehicle development for,

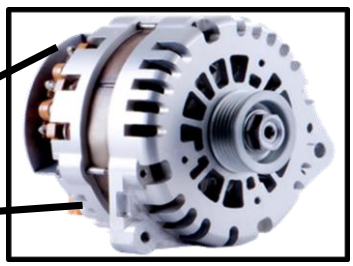
- Component (Motor, Battery) sizing and specifications using simulation tools
- Control System development
- System integration
- Vehicle calibration





Vehicle Configuration

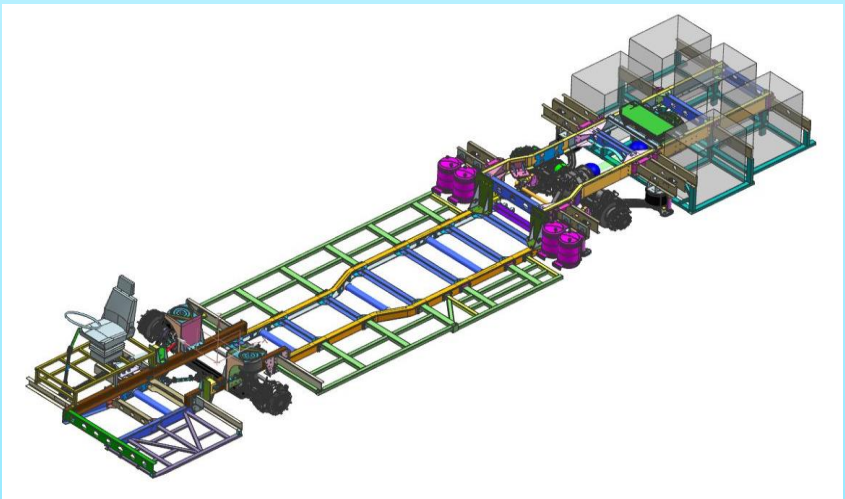




Component Sizing

Lithium Ion Battery Technology from Space to Automotive

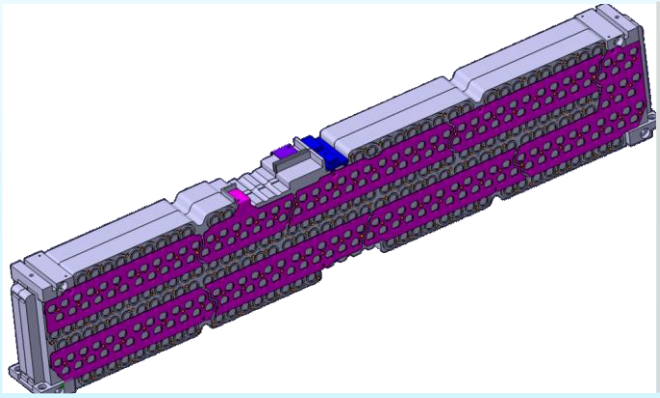
Chassis Design and Development for Electric City Bus



Electric Bus Chassis Layout

- Design of Bus chassis for maximum strength and minimum weight
- Modular design of Chassis for compatibility of different Power pack viz. Electric/Other Fuels
- Seamless Vehicle Integration Capabilities considering all External & Internal Packaging with chassis aggregates
- Vehicle Performance Prediction viz. Tractive effort calculation for Motor selection including wheel slip, Steering performance predictions
- Driveline calculations & selection
- Brake calculations considering Electric bus weight distribution
- Steering system kinematic analysis using MBD. Prediction of Bounce steer, Re-bounce steer, under steer, over steer, etc.
- CAE analysis of Electrical Bus Chassis as per standard load cases
- Optimization of chassis with virtual

Rechargeable Energy Storage System (REESS) Evaluation using CAE



Evaluation of REESS (Battery Pack) main components.

- Battery Disconnect Unit (BDU)
- Battery Array consisting of
  - Battery Cells (Li-ion or Lead Acid)
  - Separating Shield
  - Locking Structure (Bolts)
- Battery Management System
- Battery Tray (for Mounting)
- Battery Casing (for Packaging)

Four Poster durability of Electric Vehicle in Climatic Chamber for structural adequacy

- ✓ Laboratory Simulation of Roads & tracks for Durability Evaluation
- ✓ Environmental simulation for temperature, humidity and sunlight

Suspension Evaluation of Electric vehicles using Multi axis Technique	Evaluation of Battery Structure and supports using Multi-axis Shaker table “MAST”
	

Friction Measurement Facility at ARAI

To understand various frictional power losses of different components of IC engine and overall frictional power of the engine, friction measurement of Internal Combustion (IC) engine is essential.

This activity is quite critical and important, as results of friction analysis are useful in overall engine development activity for improvement of fuel economy and reducing CO_2 emissions.

Power Train Engineering (PTE) department of ARAI, with vast experiences in respective fields of engine development and testing, has established Motoring dyno facility, along with 2 quadrant power control driveS with accurate control of speed.

Coolant and oil conditioning systems are installed to ensure various boundary temperature conditions required for friction audit. Oil conditioning system is capable of maintaining temperature control between 40 and 150 ^{o}C and coolant conditioning system is capable to maintain temperature control between 30 and 90 ^{o}C with ±1 ^{o}C accuracy. This ensures accurate measurement of friction power of engine at different desired conditions. Additionally engine data acquisition system provides accurate acquisition of various temperature and pressure parameters.

Brief Specification of the Facility

Sr. No.	Equipment /facility	Range	Accuracy
1	Power	60kW @1500 rpm	-
2	Speed	0-7500 rpm	± 1 rpm
3	Torque	Max 382 Nm @1500 RPM	± 0.5 % of reading
4	Temperature Measurement	0 – 200 ^{o}C	± 2 ^{o}C
5	Pressure Measurement	0 – 10 bar	± 0.02 bar

Salient Benefits of the System

- Highly accurate torque and speed measurement with ultra-precision HBM make T12 torque flange.
- Control of various test boundary conditions with respect to oil and coolant temperature.
- One spot assessment of engine friction and its components.
- High repeatable performance

Characteristic Cure and Photographs

Retained Austenite and its Measurement

Introduction of Retained Austenite

Austenite (γ) is a face-centered cubic phase in steels formed at high temperatures. During quenching and other heat treating operations, austenite can be transformed into other phases such as marten site (body-centered tetragonal phase, α). Hardening of steels requires heating to an austenitic phase and quenching to room temperature to produce hard martensitic phase. Austenite is FCC phase that is stable above temperature of 735° C. Due to incomplete transformation, some austenite is retained at room temperature. Austenite that does not transform to marten site upon quenching is called *retained austenite* (RA). Thus, *retained austenite* occurs when steel is not quenched to the $\mathbf{M_f}$, or marten site finish, temperature; that is, low enough form 100% marten site. Because $\mathbf{M_f}$ is below room temperature in alloys containing more than 0.30% carbon, significant amounts of untransformed or retained austenite may be present, intermingled with marten site at room temperature.

Due to different unit cell sizes of austenite than marten site or ferrite and its metastable nature at room temperature, whenever given the opportunity, austenite will transform into marten site and along with dimensional changes it also incorporate great deal of internal stress in a component, often manifesting itself as a crack.

The role of retained austenite in these microstructures is complex, as it can have both positive and adverse effects on properties and performance of these steels. Too much retained austenite can result in lower elastic limits, reduced hardness, lower high cycle fatigue life and dimensional instability. Too little retained austenite, however, can result in poor fracture toughness and reduced low cycle fatigue and rolling contact fatigue life.

Bearing industry, gear industry and tools and die industries are the ones, who look after the percentage of retained austenite, however, applications where dimensional accuracy, hardness of component after heat treatment is involved, also needs to be carefully monitored.

Measurement of Retained Austenite

Retained austenite can be measured by metallography or by x-ray diffraction. Metallography, destructive technique, can be used to determine retained austenite content only if sufficient quantity is present. Metallographic point and linear counting methods were tedious and subject to large errors when the retained austenite content was less than ten per cent. Since austenite is non-magnetic and structural magnetization of ferrite and marten site are similar, it is possible to determine the amount of retained austenite by magnetic techniques. However, reliable measurements by magnetic methods are only possible in complete absence of cementite.

Figure 1: X-Ray Diffractometer at ARAI

X-ray diffraction techniques are commonly non-destructive and can precisely measure retained austenite concentrations as low as 0.5 percent. Obviously, therefore, x-ray diffraction analysis of retained austenite is most often the preferred analysis technique. Austenite, due to its structural difference from other phases in steel, produces diffraction peak at different locations than ferrite and marten site. In simple terms, the amount of retained austenite can be correlated to the ratio of the integrated intensity of the austenite peak to the integrated intensity of peaks associated with other phases. Figure 2 shows difference between XRD plots of samples having different retained austenite. Red plot shows 11-12% RA and blue plot shows less than 1% RA.

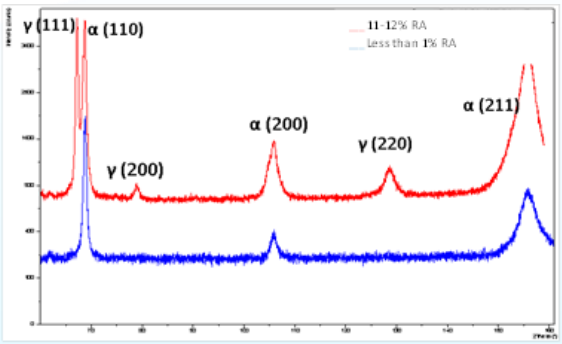


Figure 2: X-Ray Diffraction plots for samples of less than 1% & 11-12 % RA

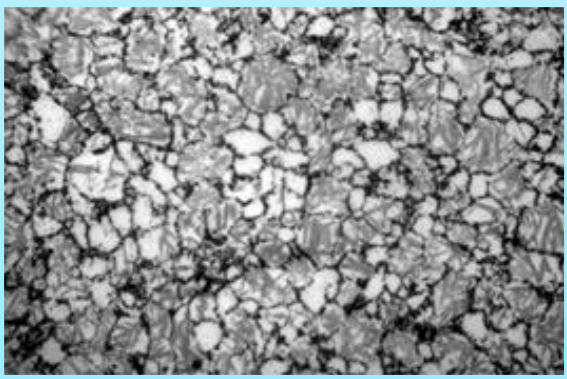
X-ray diffraction patterns depend upon both crystal structures and amounts of phases present in the sample. If crystals are randomly oriented, intensity of diffraction peaks produced by each phase is proportional to the amount of the phase present. Interpretation of x-ray pattern is straightforward and less than 0.5 percent retained austenite can be detected.

Two-peak method is the quickest method of analysis, however, unfortunately, many variables, such as preferred orientation, grain size, etc. can significantly affect the results and hence make two-peak measurement erroneous. Method of Averbach and Cohen in accordance with ASTM is also widely used. Integrated intensities of austenite (200) and (220), and ferrite (200) and (211) diffraction peaks are measured on automated diffractometers, providing four austenite / ferrite peak intensity ratios. Use of multiple diffraction peaks minimizes effects of preferred orientation and allows interference from carbides to be detected.

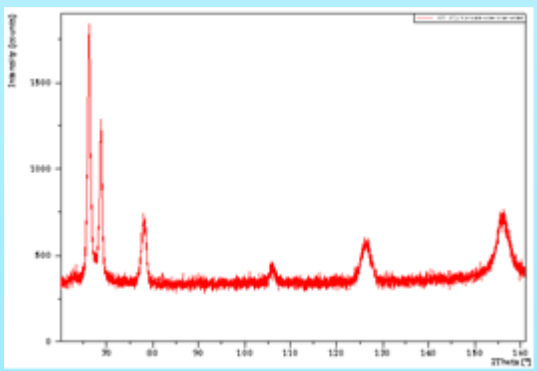
Facility at ARAI for retained austenite measurement

ARAI has Multipurpose X-Ray Diffractometer of PANalytical make X'PERT Pro model. This is vertical goniometer powder XRD with scanning range of 5 to 162° 2θ. With X-ray source of Cobalt, Copper and Chromium, variety of materials can be tested for phase identification, phase quantification, residual stress analysis, microscopic texture analysis, etc. This equipment is equipped with ICDD database for phase identification. Figure 1 shows the facility at ARAI.

Figure 3 shows difference between metallographic method and XRD method. Metallographic method results in retained austenite as 27-28%, which is calculated with image analysis software, however, human intervention is needed for threshold limit definition. XRD plot of same sample reveals Retained austenite % as 42.6.



Optical microscope image at 1000X magnification.
Etchant: Nital 4% (RA % 27-28%)



By X-Ray Diffraction method, % of Retained Austenite = 42.6%

Figure 3 : Results of Metallographic Technique and XRD Technique for Retained Austenite Measurement

❑ Calibration Laboratory at ARAI

Calibration Laboratory at ARAI is well equipped to serve calibration needs of internal as well as external customer. The laboratory is accredited as per ISO IEC 17025 by NABL. It also undertakes turnkey calibration assignments and onsite calibration services covered under NABL Accreditation. The calibration facilities have traceability to National / International level.

❖ Addition of New Facility

To meet customer requirements, new facility for EMC calibration is recently established, which caters to calibration of -

- Line impedance Stabilization Network (LISN), Attenuators, Pre-amplifiers, CDN, Connectors
- Electrostatic Discharge Generators (ESD)
- Combination Wave Generators, EFT generators required for Conducted Immunity Test.

➢ Capabilities of ARAI Calibration Lab

PARAMETERS

Electrical	Multimeters, Calibrators, Shunt, Oscilloscopes, Function Generators, Counters, Indicators etc.
EMI / EMC	LISN ,CDN ,Attenuators, Pre amplifiers, RF connectors ,Surge Generators, Combination Wave Generators, ESD Simulator
Temperature & Humidity	SPRTs / PRTs, Thermocouples., RTD Sensors, Environmental Chambers, Temp Baths etc.
Pressure	Pressure Gauges, Transmitters, Manometers, Vacuum Gauges , Pressure Systems etc.
Mass & Balance	Micro Balances, Weighing Scales, Fractional Weight Sets, Weights, Load Cells, Torque Sensors etc.
Sound & Vibration	Sound Level Meters, Accelerometers Calibrators, Microphones, Vibration Analyzer s etc.
Speed	Contact / Non Contact Tachometers & Pulse Engine Tachometers etc.
Load, Torque & Flow	Dial Type Load Gauges, Load Cells , Blow By Meters (Air Media) etc.

➢ Various Facilities at Calibration Lab

❑ THERMAL CALIBRATION

NABL

CMC: Calibration Measurement Capability

A) Primary Calibration

B) Secondary Calibration

Primary Calibration (Fixed Point Cell)	Range	CMC (±)
Boiling Point of Ln2	-196°C	0.015°C
Mercury	-38.8344°C	0.0049°C
TPW	0.01°C	0.004°C
Gallium	29.7646°C	0.005°C
Indium	156.5985°C	0.0007°C
Tin	231.928°C	0.0058°C
Zinc	419.527°C	0.008°C
Aluminium	660.323°C	0.016°C

Secondary Calibration	
Range	CMC (±)
-50 to -40°C	0.1°C
-40 to 25°C	0.06°C
25 to 650°C	0.1°C
650 to 1200°C	1.30°C to 1.32°C
20 to 90% RH at 25°C to 40°C	1.50 %RH

❑ MECHANICAL CALIBRATION

A) Comparator Balance

Comparator Balance	
Range	**CMC (±)**
Up to 22 g	0.006 mg to 0.012 mg
Up to 220 g	0.07 mg
Up to 610 g	0.28 mg
Up to 5100 g	10 mg
Up to 12 Kg	300 mg
Up to 150 Kg	3 g

B) Mass

Mass	
Range	**CMC (±)**
1 mg to 500 g	0.0021 mg to 0.3 mg
1 Kg to 5 Kg	2 mg to 5 mg
10 Kg to 100 Kg	200 mg to 1 g
1 mg to 500 g (E2 Class) Weight Set Calibration Facility newly added	

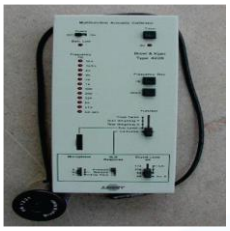
C) Pressure

Pressure (at Lab and Onsite)	
Range	**CMC (±)**
0 to 1000 bar g	0.016% rdg
0 -250 mbar g	0.1 mbar
0 – 25 bar g	0.014% rdg
0 – 2.5 bar A	0.013% rdg
-250 mbar to 0 mbar	0.1 mbar
-0.1 to -1 bar g	0.016% rdg

D) Acceleration

Accelerometer @ Lab (Piezoelectric, Piezo Resistive, Capacitive, etc.)	
Range	**CMC (±)**
Accelerometers (0.1 to 10 g)	(3 Hz to 10 kHz) 0.8% to 1.8%
Vibration Shakers, Exciters (0.5 g to 10 g)	(10 Hz to 10 kHz) 1.28% to 1.44%
Vibration Meters for Acceleration (0.5 g to 10 g) for Displacement (0.01 mm to 5 mm)	(10 Hz to 5 kHz) 2.06%

E) Sound Level



Sound Level	
Range	**CMC (±)**
31.5Hz to 16 kHz At 94 dB	0.3dB to 0.6 dB

F) Speed

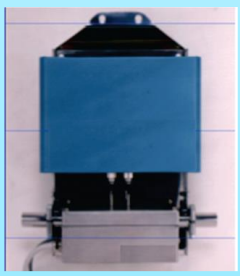
Speed Calibration	
Range	**CMC (±)**
Non- Contact Mode 100 to 10000 rpm	2 rpm
Contact Mode 100 to 5000 rpm	2 rpm

❑ ELECTRO TECHNICAL CALIBRATION

DC & AC Voltage	100 µV to 1000 V & 1 mV to 1000 V (10 Hz to 300 kHz)
DC & AC Current	10 µA to 20 A & 10µA to 20 A (10 Hz to 5 kHz)
Resistance	1 Ω to 1GΩ
Discrete Standard	25 Ω, 100 Ω, 300 Ω & 400 Ω
Thermometer	-250 to 1768°C
RTD	-200 TO 850°C
Capacitance	3 nf to 30 mf

❑ FLUID FLOW CALIBRATION

A) Blow-by Meter



Blow-by Meter (Air Media)	
Range	**CMC (±)**
10 to ≤ 30LPM	1.5%
> 30 to ≤ 100LPM	1.05%
> 10 to ≤ 200 LPM	1.02%

B) *PLU Calibration (Non-NABL Facility)*

Fuel Flow Meter Calibration (DFL & PLU)	
Range	**CMC (±)**
1 Lph to 50 Lph	0.3% rdg

- **LOAD CELL CALIBRATION**

  Range 0 to 100kN : Compression and Tension Mode

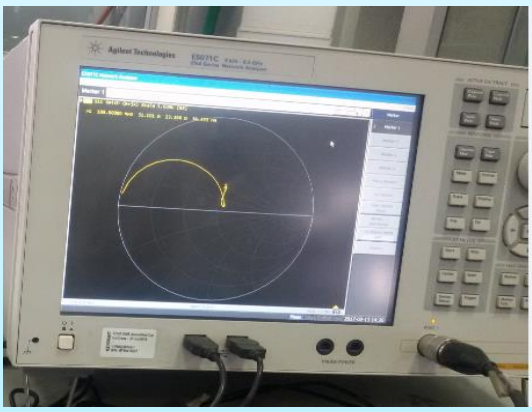
- **UTM MACHINE CALIBRATION**

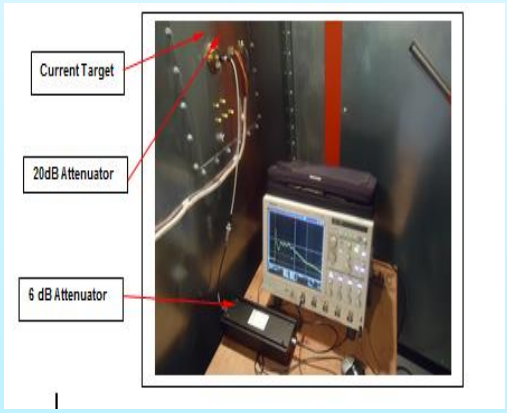
  Range 0 to 100kN : Compression and Tension Mode

- **STEERING TORQUE CALIBRATION**

  Range 100 Nm to 1000 Nm

NEW Facility Calibration of EMC instrument





Line Stabilisation network (LISN)Impedance

Preamplifier

CDN

Attenuator

ESD Simulators for Voltage Ipk,Ipkatt1 & rise/Fall Time

Combination Wave Generators

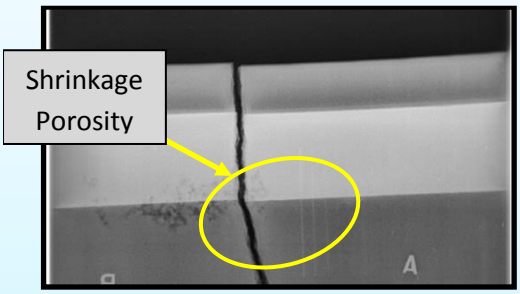
- Different types of Generators Voltage,Rise, Fall time and Time duration

❑ Failure Analysis and Residual Stress Measurement Facilities at ARAI – Forging Industry Division

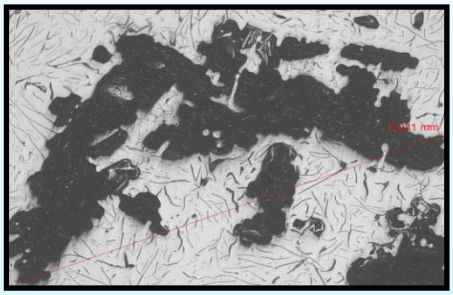
ARAI – Forging Industry Division specializes in carrying out failure analysis and residual stress measurement of various automotive / non-automotive components by available state-of-the-art in-house facilities and equipment. Systematic approach of failure analysis has provided root causes of failures and remedial solutions to be adopted in process to avoid such incidents in future.

Case 1: Failure Analysis of Wheel Drum

In typical failure analysis of wheel drum casting multiple discrepancies such as presence of shrinkage porosity, lower Hardness and tensile strength and deviations in dimensions at failure locations lead to failure. It was recommended to improve casting process at various stages to avoid failure of component.



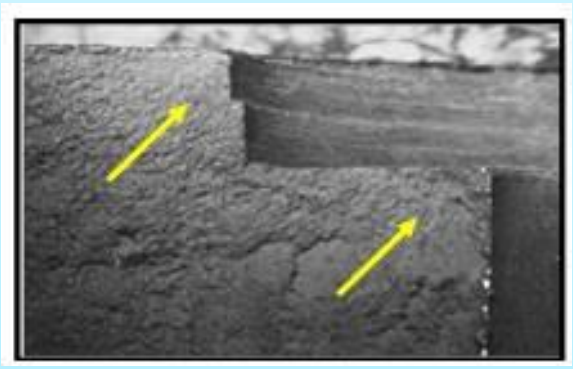
Shrinkage Porosity seen in X-ray Radiography



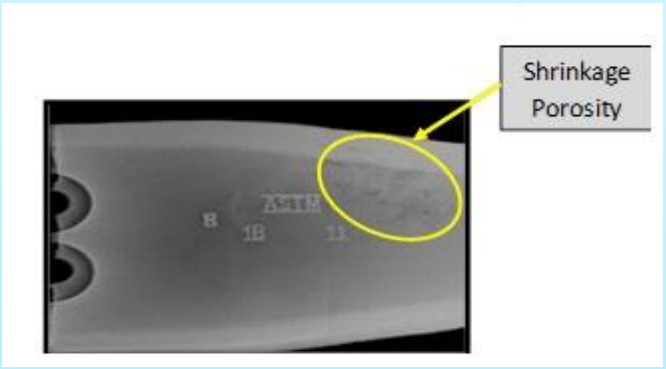
Porosity seen in Microstructure

Case 2: Failure analysis of Support Bracket

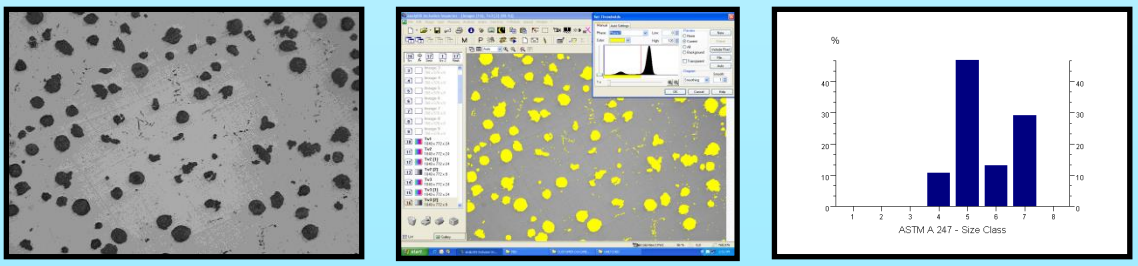
Failure analysis of support bracket showed presence of shrinkage porosity at multiple locations near and at mounting holes from where fracture initiated. Deviation in dimensions and lower Tensile & Yield strength also observed. Microstructure showed lower nodularity which decreased strength of component.



Fracture starting from mounting hole



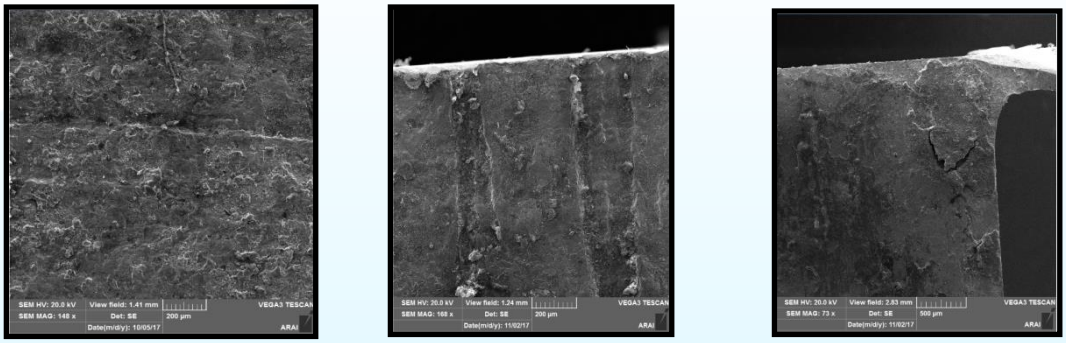
Shrinkage porosity seen in X-ray radiography



Quantification of nodularity by image analysis showing less nodularity of bracket

Case 3: Failure Analysis of Leaf Spring

Another case of failure analysis on leaf spring, showed prominent presence of surface imperfections (in the form of parallel lines/rolling marks) on surface along with presence of tensile and lower magnitude of compressive residual stresses, which lead to failure of leaf spring by fatigue. It was recommended to improve surface finish of final component and improve shot peening process parameters to induce higher magnitude of compressive residual stresses.



Surface imperfections (in the form of parallel lines/rolling marks)

Along with various metallurgical testing, residual stress measurement is gaining significance and is very useful to anticipate multiple functional parameters, for improving product quality, safety and reduce catastrophic failures in components. Characterization of residual stresses, along with routine quality check, is gaining importance with increased demand from OEMs and Tier 1 and 2 suppliers to assure component quality, durability and avoiding premature failures in service.

ARAI-FID is equipped with portable residual stress analyzer of Proto (Canada) make, which works on principle of X ray diffraction and Bragg's Law. Multiple automotive and non-automotive components can be analyzed to know change in residual stress pattern w.r.t. various processing and critical areas, which may attribute to failure. In the hydro-formed steel shell shown below, residual stress pattern is analyzed to stresses near and away from failure locations.

RSA on steel shell for defence application

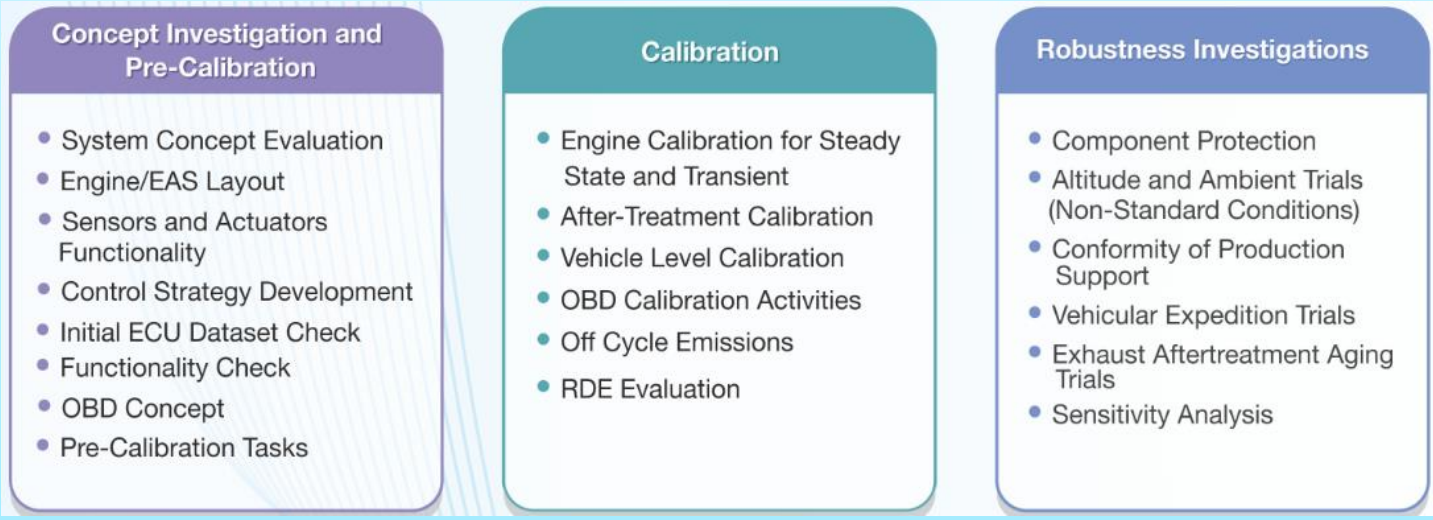
ARAI–FID has residual stress analyzer of make, iXRD, which is in continuous usage for analyzing various components such as Gears, Crankshafts, Connecting rods, Axle shafts, Brackets, Compressor Valves, Leaf Springs, Heavy Engine Blocks, etc. and more than 3000 measurements are taken per year by serving around 50 different customers.

Virtual Calibration Facility at Virtual Calibration Centre (VCC)

Developments for BS VI and TREM IV / TREM V require significantly higher calibration efforts as well as development time due to complex engine and after-treatment controls. Development has to pass through concept definition, detailing, prototype development and calibrations for engine-out basis steady-state and transient emissions, after-treatment, OBD, Vehicle level performance, Off-cycle emissions, including RDE, etc. This calls for long duration occupancies on high end Engine and Chassis Dynamometers followed by extensive Field Trials.

Virtual Test Bed facility at ARAI Virtual Calibration Centre (VCC) is aimed at significant reduction in the BS VI and beyond development time and resource requirements. In the Virtual Test Bed based calibration physical engine, after-treatment and vehicle are replaced by advanced real time models. Calibrations can be done for engine and vehicle level emissions. The system can be used for complete development i.e. from concept investigation, emissions calibration, OBD calibration, vehicular performance to field trials including ambient, altitude and Real Drive Emissions evaluations, etc.

ARAI Virtual Calibration Facility



Virtual Calibration Portfolio

ECU, with certain maturity achieved with virtual calibration, can be directly taken-up for real testing on engine dynamometer, chassis dynamometer and in the field, gives significant advantage with reduction in requirement of real testing. In addition to reduction in real testing time and prototype component development efforts, this provides advantage of improved calibration quality because of high reproducibility and good extrapolation capability. The facility can configure engine and after-treatment devices. It can be used for all category / application engine and vehicle calibration. Besides Diesel and Petrol engines / vehicles, it can be used for engines with alternate fuels and hybrid vehicles.

Advantages of virtual calibration -

- Improved calibration quality with high repeatability and excellent extrapolation quality
- Calibration independent of weather condition, location and prototype availability
- Minimized usage of expensive test facilities
- Faster time to market
- Reduced fuel consumption leading to reduction in CO_2 emission

Services are offered for developments of products for stringent emission level compliance demanded by BS VI, TREM IV / TREM V, etc. and aiming at reduced number of prototypes. The virtual calibration facility is integration of ARAI's expertise in Simulation and Hardware-in-loop (HiL) testing, and experience in Calibration with following unique advantages of ARAI as a Development Partner –

- Strong competency and thorough experience in building predictive plant models
- Calibration expertise for wide range of engine, after-treatment and vehicles with different fuels
- Expertise in hardware-in-loop integration and calibration
- NABL certified engine test cell facilities for acquiring accurate input data
- One stop solution from concept investigation to real world emission calibrations

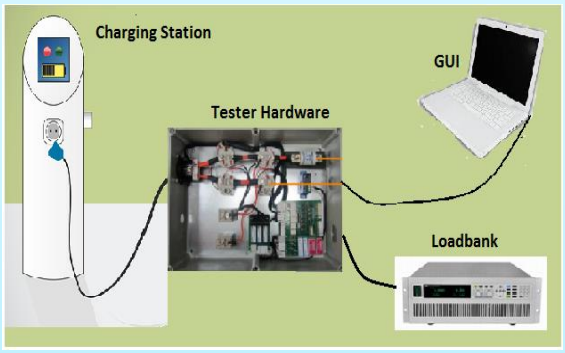
Evaluation of Electric Vehicle Conductive Charges (AC/DC)

In line with National Electric Mobility Mission and thrust of Government of India on Electric Mobility, rapid growth in Electric Vehicle development is envisaged in India. ARAI has set up Centre of Excellence (CoE) for Electric Mobility to support automotive industry for development, evaluation and certification of Electric Vehicles. It is essential to have convenient and safe infrastructure for charging electric vehicles. Availability of infrastructure is a major factor in consumer acceptance.

ARAI is ready with all requisite facility and competency for providing complete support for development, validation and certification of these chargers as per various National / International standards like AIS 138, IEC 61851, Bharat EV AC-001, Bharat EV CD-001, etc. Apart from physical verification, following important activities are involved in compliance to Bharat EV AC-001, Bharat EV CD-001.

1.0 EV to EVSE Communication and Interoperability for Bharat EV Charger- DC001

ARAI has developed simulator for simulation of Electric Vehicle environment for offline testing of Charging Station. With the help of this simulator, validation of protocol can be done with multiple use cases to ensure interoperability of DC charger.



2.0 Characteristics and operating condition for AC/DC chargers

Environment Requirements

a) Ambient Temperature Range: 0°C to 55°C as per 11.11.1.2 of AIS 138 Part 1
b) Ambient Humidity: 5% to 95% as defined in Section 11.2 of AIS 138 Part 1
c) Storage temperature: 0 to 60°C

Mechanical Requirement

a) Ingress Protection: The minimum IP degrees for ingress of objects is IP 54

b) Mechanical Impact: As per IEC 61851-1 Section 11.11.2

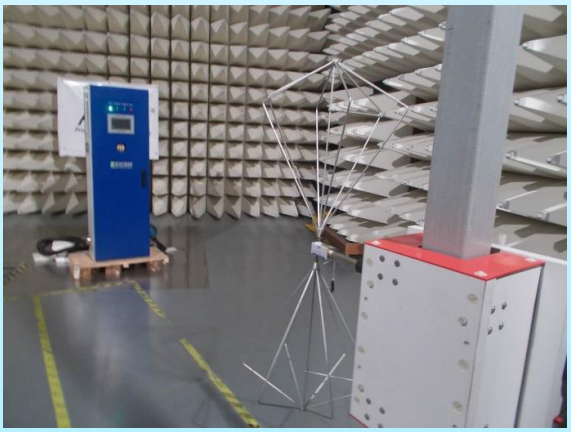
c) Mechanical Stability: As per section 11.11.2.2. of AIS 138 Part 1

Electrical Protection Requirements

a) Earth Presence Detection (Socket-EVSE)
b) Earth Continuity Check (EVSE-EV)
c) Over Current and Short-Circuit Protection
d) Leakage Current Protection (RCD)
e) Dielectric Withstand Voltage

EMI / EMC Testing

a) Immunity to electrostatic discharge
b) Supply voltage dips and interruptions
c) Fast transient bursts
d) Voltage surges
e) Radiated Emission (Only for DC charger)



3.0 EVSE – CMS Communication for AC/DC Charger

EVSE should be able to communicate with CMS using Open Charge Point Protocol (OCPP) 1.5 or higher versions compatible to OCCP1.5.

a) Communication interface: Reliable Internet connectivity

b) It should authorize the operation, before electric vehicle start or stop charging. EVSE should respond to CMS for the queried parameters. Reservation, cancellation addition and deletion of EVSE should be possible from CMS.

c) Metering: Grid responsive metering as per units consumption of the vehicle.

Manufacturing Process Parameter Design by Dilatometry Technique

Introduction

Today Forging and Heat treatment process has become a science which was earlier considered as art. To manufacture high strength component with optimal cost, heat treatment process optimization is vital. Component heat treatment cycle is normally decided by standard thumb rule. Quantification of the effect of time, temperature and its rate (i.e. cooling and heating) is seldom analyzed for heat treatment optimization. In this article transformation temperatures are quantified for different thermal cycle using dilatometry technique and the ideal hardening temperature is identified for 40Cr4 material.

One of the major areas to reduce the cost of the vehicle is to reduce component production costs and this can be achieved if significant energy is saved during the manufacturing process. There is a huge potential in developing cost effective production technologies in India without compromising the technical requirements. Forging and heat treatment of steel components are major energy intensive processes in the production cycle. In today's scenario heat treatment cycle in forging industries is designed through trial and error/thumb rule/experience/literature. Introduction of new materials and also chemistry modified materials is common. Saving of a few kWs in the process can translate into a larger increase in energy efficiency because of the 'mass-production effects' and this leads to huge cost saving. This will be useful for the Indian manufacturing industry, which is undergoing a major paradigm shift in terms of its production capacity and also implementing new technologies.

Quenching Dilatometer

Dilatometry technique is used for the study of phase transitions in a material by measuring its linear strain. Strain occurring because of microstructural changes is one of the important parameter used in studying the phase transformation. This technique is aimed at establishing direct link between discrete values of strain and specific microstructure constituents in materials. Continuous Cooling Transformation (CCT) and Time Temperature Transformation (TTT) curves are obtained as the output.

The test specimens are held between the two push rods of the dilatometer. The sample is heated by induction principle. Cooling is achieved by a combination of controlled reduction in the heating current and injection of helium gas onto the sample. Dimensional change is measured along the longitudinal axis of the sample and temperature change is measured by means of thermocouple welded to the surface of the sample midway along its length. Refer Fig 1 for a typical sample. ASTM Standard A1033-10 gives the procedure for quantitative measurement and reporting of hypo eutectoid carbon and low-alloy steel phase transformations. 40Cr4 is used as a typical material for studying the effect of hold temperatures and different cooling rates and also for the determination of critical temperatures i.e. austenite start and finish temperatures. **Quenching dilatometer facility is available at ARAI**

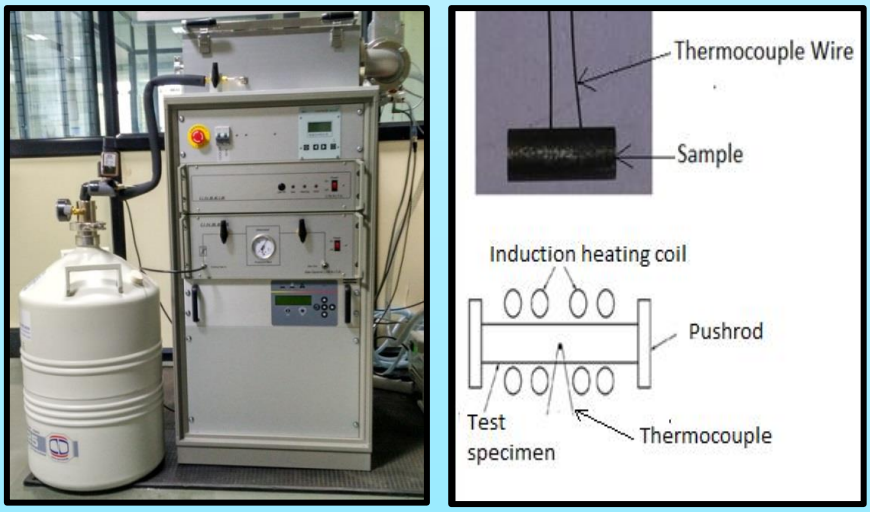


Fig 1: RITA L78 Quenching Dilatometer, Make: - Linseis GmBH, Germany

International Transportation Electrification Conference (ITEC) India 2017

Future of the Transportation Sector is poised for a transformation, primarily driven by regulations and demand for more efficient vehicles. Globally, the automotive industry is gradually shifting towards Hybrid and Electric Vehicles (EVs) due to environmental challenges and energy concerns. In line with the global developments, the need for electrification of the automotive industry in India is also well recognized. A significant step in this direction has been Government of India's 2030 Electrification Vision. Combination of regulatory support from the Government in promoting EVs, and efforts by the industry to meet the challenge and use the opportunity so created will go a long way in implementing this vision.

ITEC INDIA 2017 organized from 13th to 15th December 2017 by ARAI in association with SAEINDIA and IEEE Industry Applications Society at Pune; was a step in this direction to deliberate on issues which will facilitate smooth transition from conventional vehicles to advanced electrified vehicles. With deliberations focusing on components, systems, standards, grid interface technologies, efficient power conversion for all types of electrified transportation; ITEC INDIA 2017 has added momentum to our journey of resetting the future of mobility through an efficient and appropriate Electric Vehicle Ecosystem.

ABOUT ITEC INDIA 2017

ITEC India is a biennial event focused on e-mobility and electric vehicle technology. ITEC India 2017 was jointly organized by SAE India, IEEE IAS and ARAI. The event was supported by Ministry of Heavy Industries and Public Enterprises, Govt. of India and Bureau of Energy Efficiency. ITEC India 2017 was the second edition of ITEC in India, after ITEC India 2015 organized in Chennai in August 2015. In its second edition itself, ITEC India 2017 set new benchmark in all aspects.

Key highlights of ITEC India 2017 are 120 technical papers presented by experts from industry, research organizations and academia alike; with representation from 14 countries. Over 30 keynotes were presented by eminent speakers from across the globe. The three day event also featured a panel discussion with eminent people representing different sectors such as vehicle manufacturers, research organizations, testing organizations, academia, etc. Theme of the panel discussion was ***"Electric Vehicle Ecosystem – Resetting the Future of Mobility"***.

Concurrent exposition featured over 35 stalls displaying different products, technologies, services, etc., with participation from Indian and international organisations alike, in the field of e-mobility. Prominent exhibitors in the exposition were AVL, Horiba, Honda Cars, Siemens, ABB, Asia Electric, A Raymond, Tata Consultancy Services, Greenfuel Energy, Sun Lectra, Dynafusion, etc. representing different products & service areas such as electric/hybrid electric vehicle manufacturers, battery swapping solution providers, simulation tool providers, traction motor manufacturers and suppliers, chargers, etc. The key highlight of the exposition was participation of numerous Indian organisations working in and providing indigenous products and solutions.

Another highlight of the event was display of electric vehicles, with the participants getting a chance to interact with and get a feel of the vehicles.

The conference was inaugurated at the hands of Dr. Abhay Firodia, President SIAM & Chairman Force Motors, in the presence of Mr. Doug Patton, President SAE International, Dr. Tomy Sebastian, President IEEE IAS, Dr. R K Malhotra, President SAE India and Mrs. Rashmi Urdhwareshe, Chair Steering Committee ITEC India 2017, Director ARAI and Vice President SAE India.

Inauguration By Dr. Abhay Firodia, President SIAM & Chairman Force Motors

Shri Anant Geete, Hon'ble Minister, Ministry of Heavy Industries and Public Enterprises, Govt. of India, was the Chief Guest at the Valedictory Function. ARAI's E-Mobility Center of Excellence was also launched at the hands of Shri Anant Geete during the Valedictory Function.

Dignitaries at the Valedictory Function

Inauguration of ARAI E-Mobility COE

Visit of Dignitaries to Exposition

Visit of Dignitaries to Vehicle Display

Significance of ITEC India 2017 lies in the fact that three different organisations, representing three different domains viz.; IEEE from the electrical domain which dominates electric powertrain, SAE from the mobility engineering domain and ARAI from the automotive engineering, involving different domains, regulations, testing and validation and technology application area;, coming together to deliberate and discuss different aspects, challenges, opportunities and solutions for affordable and effective electrification of road vehicles in India taking into consideration different aspects of the complete ecosystem involved.

❑ ARAI Crash Lab Gets Busy with Certification, Developmental, Validation and Benchmarking Crash Testing Services

Introduction

- ARAI inaugurated new Crash Test facility on 4th January 2016 at its Homologation and Technology Centre (HTC), Chakan.
- Capable of conducting variety of crash tests such as Frontal, Side, Rear, Pole Side Impact, etc.
- Correlation exercises carried out with more than six leading global test centers.
- Facility accredited for ISO/IEC 17025 by National Accreditation Board for Testing and Calibration Laboratories (NABL)

- On 27th October 2017, ARAI celebrated milestone of 100th crash test.
- More than 135 crash tests carried out for both domestic as well as foreign customers.

Spectrum of Testing

Compliance to Indian crash regulations - AIS 096, AIS 098, AIS 099, AIS 101	UN ECE crash standards with ECE Technical witness	Pre-certification tests	Testing for Bharat NCAP*
Proto Validation (PV) and Design Validation (DV) testing	Airbag ECU Calibration Crash Tests	NCAP tests and star rating calculation	Restraint system optimization testing
Developmental tests as per customer specifications	Front structure optimization testing	Bonnet and vehicle packaging optimization testing	Benchmarking Crash, and Sled testing

**As per draft protocols of proposed Bharat NCAP*

Enhanced Capabilities for Developmental Crash Tests

- New safety regulations and increasing customer demands are driving manufacturers to revamp vehicle and component designs.
- This has led to increase in developmental and validations testing needs.
- ARAI has procured specific instruments and softwares in addition to NATRiP consignment, with functionalities over and above those required for certification tests.
- ARAI has always been flexible to consider procurement of any specific equipment / instrument as per the need of development projects wherever it is feasible.

Various Stages where ARAI can partner with customers to provide testing services

Summary of Facilities, Equipment and Instrumentation in Passive Safety Lab of ARAI

Equipment / Software	Application
3D CMM with Scanner attachment	Deformation study of vehicle.
Advanced **motion analysis** software	Study of dummy and vehicle kinematics.
Advanced **Injury Analysis** with NCAP calculation modules	Detailed analysis, comparison of different tests, NCAP calculation and comparison.
High speed cameras - Miniature on board / off board	Underbody, top, onboard and various other views can give more information per test.
Miniature **onboard LED** lighting system	Small size light heads to illuminate intrinsic areas Ex. For Pedal movement, seat slider etc.
Tear Down of vehicle – pre and post test	Competent for complete vehicle tear down for structural/component analysis.
Dedicated customer preparation rooms	Complete confidentiality right from vehicle entry to exit from Lab.
Vehicle Scrap	Dismantling of all parts, defacing and scrapping of entire vehicle.
Static rollover facility	For post-test fuel leakage assessment.
Total number of **channels** available for acquiring onboard data	In addition to dummy channels additional channels related to sensors mounted on vehicle can be acquired.
Accelerometers	All types of developmental tests such as Airbag sensor calibration, restraint system evaluation crash tests, etc.
Current sensors	
Voltage sensors	
Airbag pressure sensor	
Belt displacement sensor	
Gyro sensors	
Webbing load cell	
Event switches	
Instrumented dummies: HIII 50th %tile, HIII 95th %tile, HIII 5th %tile ES2, ES2 Re, Q-series family (Child Dummy), P3 Child Dummy, SIDIIs, BIORiD II	As per the standard, NCAP, developmental or customer requirements.
Ballast Dummies: HIII 50th %tile, HIII 95th %tile, HIII 5th %tile	
Full-fledged Dummy Calibration Facility	In house dummy calibration facility

Electric / Hybrid Vehicle Crash Testing

- With the global shift towards electric mobility on a mass scale, OEMs are introducing more Electric and Hybrid Electric vehicles into the market.

- Present norms have been amended in 2016, to include additional post-crash electrical safety assessment.

- Already conducted several crash tests for vehicles with voltage more than 60 VDC - Crash test with evaluation as per additional Electrical requirements.



- The facility is equipped with electrical safety equipment such as ARC / Flame resistance overall (clothing) and insulated tools for conducting EV and HV crash testing.

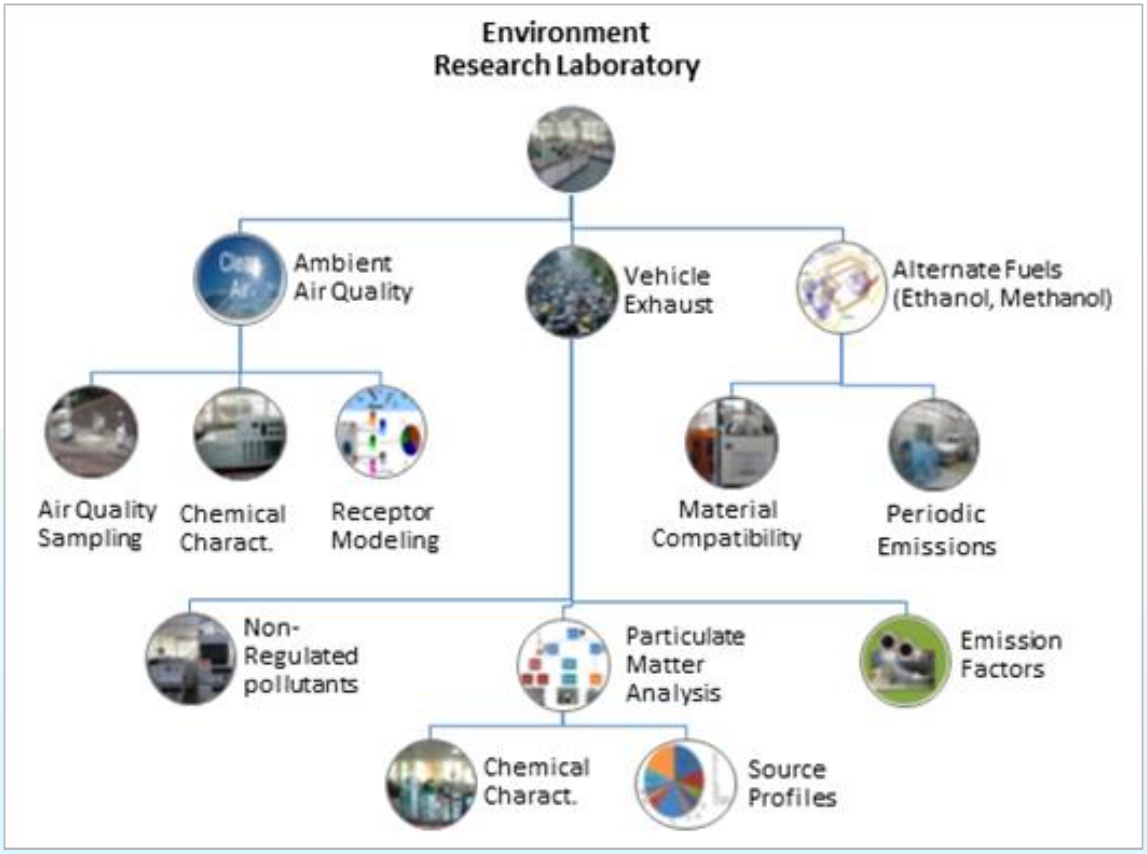
- ARAI is geared up to support Automotive Industry to move towards electrification of vehicles.

❑ Setting up Environment Research Laboratory (ERL) for focused Research in the field of Environment Pollution Control

With the advent of rapid urbanization, transportation requirements have increased manifold in the recent years and is likely to be ever-increasing in the years to come. As a result, automobiles have become one of the major contributors to air pollution throughout the country. It is, therefore, imperative to carry out focused research in the field of vehicle exhaust and air quality to have better judgment of the sources, mechanism of pollution caused by automobile exhaust and its impact on ambient air using scientific tools and techniques. Renewable energy sources, such as ethanol / methanol blended fuels, which can offer certain widespread socio-economic benefits including value addition to agriculture feedstock in addition to reduction in dependence on foreign crude. However, thorough evaluation of such alternate fuels for their impact is warranted before utilizing them as an automotive fuel.

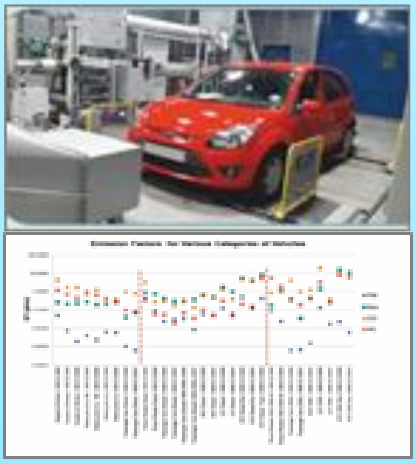
ARAI's Environment Research Laboratory (ERL) is set up to conduct applied research and evaluation in the field of vehicle exhaust, ambient air. It provides crucial services for ambient air monitoring and testing of pollutants for assessment of levels and identification of polluting sources.

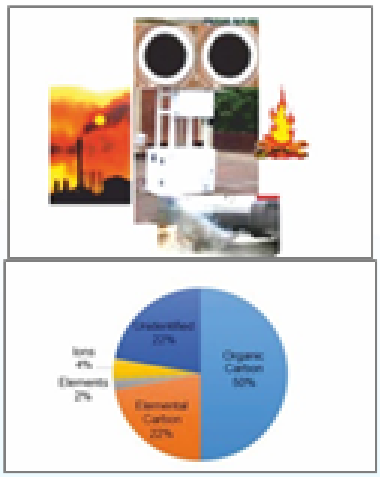
ERL undertakes project to understand challenges with the use of alternate fuels on material compatibility, emissions and performance. It endeavours to provide services for air quality measurement and control for non-exhaust emissions generated from vehicles.



ERL is equipped with state-of-the-art facility for air quality and vehicle exhaust monitoring and analysis of non-regulated pollutants, evaluation of different fuels and has competency in analysis and evaluation in following areas to combat growing pollution woes.

Major landmark achievements through project of National Importance

Source apportionment of particulate matter for Pune city, Delhi, NCR and a Coal Field in India.	
	Development of Emission factor for Indian in-use vehicles

Source profiling of Vehicle Exhaust Emissions	
	Material compatibility of Ethanol blended fuel (E10 and E20) for its use as an automotive fuel

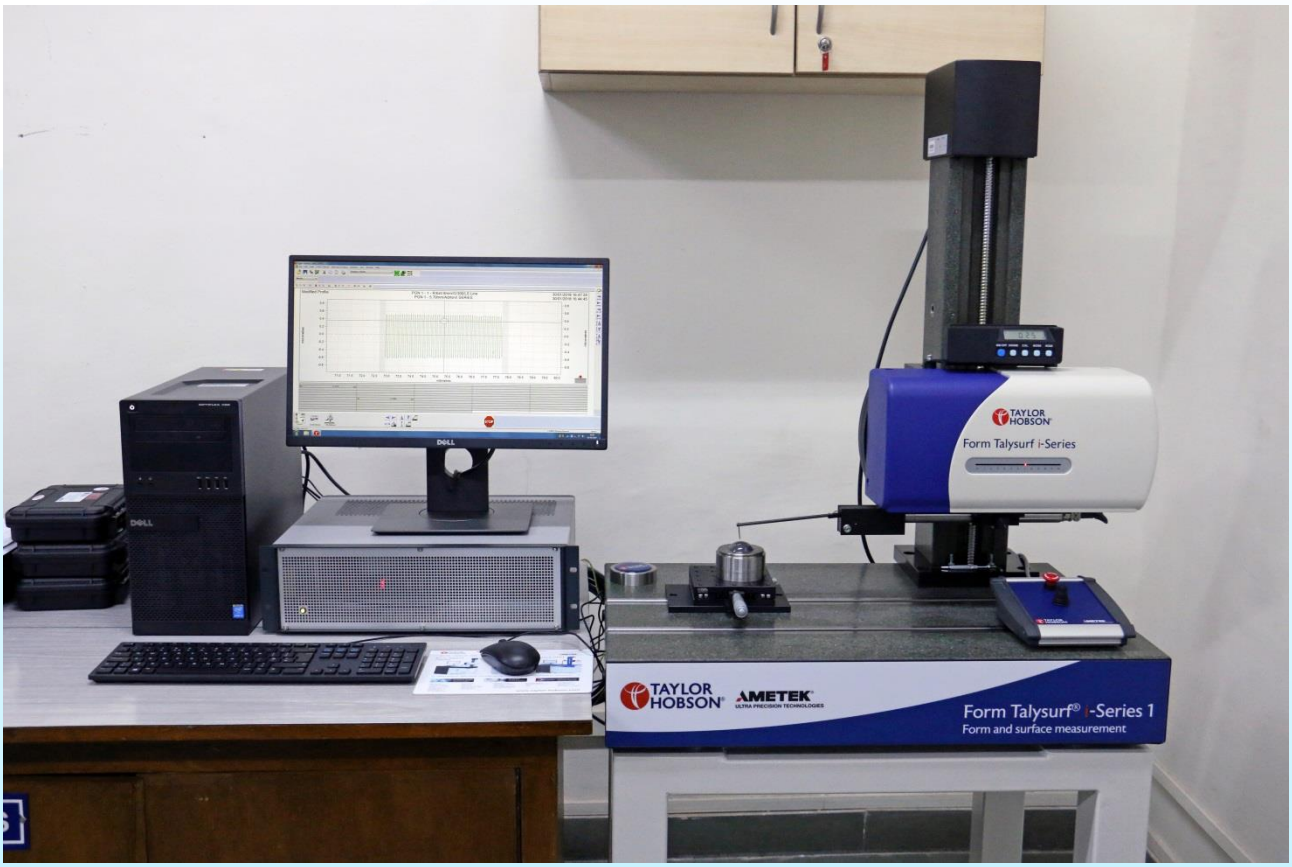
Prospective Work Areas for future

ERL endeavours to conduct applied research in the field of ambient air management, vehicle exhaust, indoor air quality and vehicle cabin-air for protection of environment and improvement in the quality of precious human life.	

FORM TALYSURF-i-Series – Surface Roughness & Contour Measuring Instrument

System for Contour and Surface Finish Measurement now at ARAI

The 'Form Talysurf i- Series' is a high accuracy instrument capable of simultaneous surface finish and contour measurement. The system's low noise axes and high resolution gauge ensures measurement integrity with choice of gauge ranges providing versatility for variety of applications.



Application:

Powerful Software for analysis of surface finish and form, ideally suited for automotive components as well non-automotive components.

Parameters

More than 28 primary roughness parameters and 24 waviness parameters, which covers all engineering applications surface finish and contour analysis.

Full traceability to international standards.

Technical Specifications

Model: Form Talysurf i - Series

Make: Taylor Hobson, UK

Vertical Column Movement: 450 mm

Max. Horizontal Tracing length: 120 mm

Surface Roughness Vertical Measuring range: 1 mm

Surface Roughness Accuracy: < 0.25 µm

Contour Vertical Measuring range: ± 14 mm

Contour Measurement Accuracy: ± 0.0033 mm

Symposium on International Automotive Technology, 2019 (SIAT 2019)

Symposium on International Automotive Technology (SIAT), widely acclaimed by global automotive fraternity, is a benchmark biennial international event, organized by ARAI, that serves as a platform for exchange of ideas and brainstorming for the automotive industry, with participation of eminent worldwide experts in various automobile arenas.

We are delighted to announce forthcoming edition of SIAT, viz. SIAT 2019, the 16th in the series, being organized by ARAI, in association with SAEIINDIA, NATRiP and SAE International (USA), at Pune (India), from 16–18 January 2019.

Theme of SIAT 2019 is **"Empowering Mobility – The Safe & Intelligent Way".**

SIAT 2019 will focus on recent advances in various automotive areas, such as Safety, Emissions, Engines, Noise, Electric Mobility, Electronics, Intelligent Transportation, Vehicle Dynamics, Materials, Alternate Fuels and Simulation and Modelling. It will also bring to fore innovative ideas and solutions in automotive technologies to meet future challenges.

SIAT 2019 will witness presentation of over 200 technical papers, including 40 keynotes, on various subjects by renowned experts world over. Apart from Symposium proceedings, Technical Reference Bulletin, containing technical articles, case studies and product information, will be published and will be a part of delegate kit.

Over 1,500 delegates, representing around 20 countries, along with professionals, engineers and academicians, are expected to attend the Symposium.

New Venue

Hitherto, all earlier SIATs were held in ARAI premises (in Pune). However, considering the caliber and status of SIAT and due emphasis on ambience, central location, accessibility and ample space, SIAT 2019 and SIAT EXPO 2019 would be held at fresh scenic location, viz. Oxford Golf Resort – Hill Top, Mumbai- Bangalore Highway, Bavdhan, Pune 411 045.

Programme of SIAT 2019:

SIAT 2019			SIAT EXPO 2019
16 January 2019	Wednesday	Inaugural Session & Technical Sessions	Inaugural Session & Exhibition
17 January 2019	Thursday	Technical Sessions	Exhibition
18 January 2019	Friday	Technical Sessions & Valedictory Session	Exhibition

Topics:

Total below mentioned 22 topics are identified for presentation of papers and keynotes:

1. Active & Passive Safety
2. Advanced Driver Assistance Systems (ADAS)
3. Advanced Powertrain Technology
4. Advanced Vehicle Dynamics
5. Agricultural Tractors
6. Alternative Fuels
7. Autonomous Vehicles
8. Construction Equipment Vehicles
9. Electric &Hybrid Electric Vehicular Technology
10. Emission Measurement & Control Technology
11. Harmonization of Regulations
12. Intelligent Transportation Systems (ITS)
13. Materials & Manufacturing
14. Noise, Vibration & Harshness (NVH)
15. Public Transportation Systems
16. Simulation & Modelling
17. Structural Reliability
18. Testing & Evaluation Techniques
19. Tyre Technology
20. End of Life & Recycling

Awards:

TECHNICAL PAPERS

(Specified Category)

- Best International Paper
- Best Oral Presentation
- Best Paper on Safety
- Best Paper on Simulation & Modelling
- Best Indian Paper on Environmental Pollution
- Innovation Award on Vehicle Electrification
- Mahesh Modi Environmental Technology Award

(Open Category)

- First Prize
- Second Prize
- Third Prize

EXHIBITION STALLS

(Best Display)

- First Prize
- Second Prize
- Third Prize

STUDENT POSTER PRESENTATION

- First Prize
- Second Prize
- Third Prize

SIAT EXPO 2019:

SIAT EXPO 2019, being organized concurrently, would offer an appropriate platform, facilitating spectrum of national / international companies to showcase automotive technology, products as also automotive testing / validation tools, engineering services.

The exposition will attract automotive OEMs, Tier-I/II/III suppliers, CAD/CAM/CAE tool providers, technologists, engineering service providers and test agencies, along with India's finest automotive industry SMEs. Exhibitors will showcase new products, technologies and services, while providing information to potential business partners worldwide, including clients, distributors, exporters, importers, manufacturers and suppliers.

SIAT EXPO 2019 will be an excellent platform for promotion of national / international business, networking and dissemination of information.

SIAT 2019 Website

Please visit website : < http://siat.araiindia.com >, for more details about SIAT 2019 and SIAT EXPO 2019.

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