

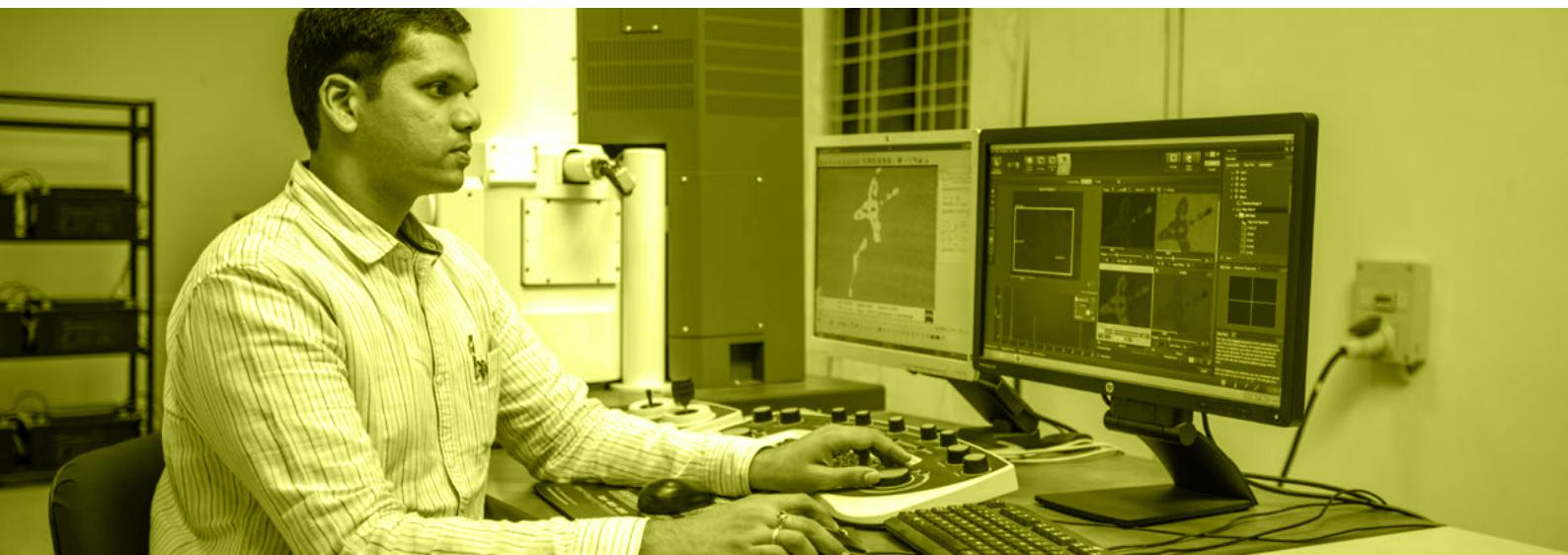
**Bharat Heavy Electricals Limited**

*Contributing to Create a New India*



**MAKING  
IN INDIA**  
since  
**1964**

# R&D Strength & Innovation Capabilities



Bharat Heavy Electricals Limited

# Centres of Excellence



at Corporate R&D,  
Hyderabad

Centre of Excellence  
for  
**Intelligent Machines  
& Robotics**

Centre of Excellence  
for

**Machine  
Dynamics**

Centre of Excellence  
for

**Compressors  
& Pumps**

Centre of Excellence  
for

**Nanotechnology**

Centre of Excellence  
for

**Ultra High Voltage  
Engineering**

(Transmission Equipments & Systems)

Centre of Excellence  
for

**Simulators**

Centre of Excellence  
for

**Computational  
Fluid Dynamics**

Centre of Excellence  
for

**Surface  
Engineering**

Centre of Excellence  
for

**Permanent  
Magnet Machines**

Centre of Excellence  
for

**Advanced  
Transmission Systems**

# Research Institutes

**Ceramic  
Technological Institute  
(CTI)**

Bengaluru

**Amorphous Solar  
Silicon Cell Plant  
(ASSCP)**

Gurugram

**Pollution Control  
Research Institute  
(PCRI)**

Haridwar

**Welding  
Research Institute  
(WRI)**

Tiruchirappalli

**Centre for  
Electric Transportation  
(CET)**

Bhopal

# Corporate R&D

H Y D E R A B A D

BHEL's Corporate R&D Division at Hyderabad is the pivotal centre for all the research activities. In its progressive march aimed at realising the objectives advocated by the principles of BHEL's vision, mission and values. Corporate R&D is spearheading the R&D efforts by utilising the advanced laboratory facilities and the manpower of highly qualified and experienced engineers, scientists and supporting staff.



# Centres of Excellence

## 1 Centre of Excellence for Intelligent Machines and Robotics

### OBJECTIVES

The Centre for Intelligent Machines and Robotics (CIMAR) has been established at Corporate R&D, Hyderabad. The CIMAR is equipped with advanced equipment and software for continuing R&D in manufacturing automation, with the objectives of cycle time reduction, enhancement of productivity and quality, cost reduction and import substitution. Besides these, it will also develop new products and processes for effective utilisation of high cost production infrastructures like CNC machines and computer aided inspection set ups.

### FACILITIES

The centre is established with a 5-axis CNC machining centre, 3-D co-ordinate measuring machine (CMM), 6-axis articulated robot, 8-station advanced computer

aided part programming (CAPP) development-cum-training centre, sensors and ID (identity) laboratory. CIMAR works on projects related to advanced CAM, robotics, intelligent ID systems and consignment tracking. Expertise is available in the fields of advanced CNC part programming for 3-axis and 5-axis CNC machining, post processor development for any CNC machine tool configurations and application-oriented developments in robotics.

### CORE STRENGTHS

- Manufacturing automation
- 5-axes inspection
- Advanced CNC programming and proof machining
- Robotics
- Material handling automation
- RFID applications

### SIGNIFICANT DEVELOPMENTS

- The lab has been working in the area of manufacturing technology and has been involved in developments like implementation of 3D printed sand mould technology for Francis hydro turbine runner model, development of scoop milling technology for 5-axis manufacturing of 2D closed impellers, 3-Axis/5-Axis machining technology for the large size pump impeller blade casting on gantry machining centres, manufacturing 2D closed compressor impeller using 3D printing process, development of 5-axis scoop milling technology for turbo-generator fan shrouded 3D impeller, 5-Axis CNC manufacturing technology for proof-machining of hydro pump runner model etc.
- In the area of robotics, the lab has developed solar panel cleaning robot. This lab has also been involved in developments related to robotic work cell for TIG welding.
- In the area of RFID, the lab has designed and developed 865 MHz RFID BAP (battery assisted passive) tags and is presently involved in design, development and long term field trials of RFID based open yard management system at Bhusawal Site.



## OBJECTIVES

The Centre of Excellence for Machine Dynamics (COE-MD) has been established at Corporate R&D, Hyderabad, to bring together capabilities in the areas of rotating machine condition monitoring and expert diagnostics, as well as enhancement of expertise in the areas of machine dynamics like vibration, noise, tribology, and stress/strain analysis. Establishment of computer aided engineering facility in the centre helps in developing simulation studies for effective design evaluation of power plant equipment.

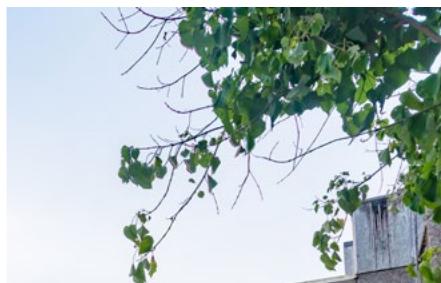
## FACILITIES

The centre is equipped with advanced telemetry system for blade vibration monitoring, special seals development facility for

improving leakage loss in steam turbines and test rig for simulating mechanical disturbance faults for verifying vibration diagnostic rules. Existing facilities in the area of acoustics have been upgraded using state-of-the-art technologies. Major facilities include 25-channel advanced telemetry system, simulation software for 3-D kinematics, static, quasi-static and non-linear dynamic solutions, test facility for advanced seals and vibration diagnostic rule development facility with fault simulation test rig and vibration monitoring system.

## CORE STRENGTHS

- Vibration diagnostics and field balancing
- Rotor dynamics
- Development of brush seals
- Applied FEM analysis



- Development of vibration condition monitoring systems
- Squeeze film damper bearings
- Application of AI and machine learning techniques for power plants
- Noise studies

## SIGNIFICANT DEVELOPMENTS

The lab is working for estimation and mitigation of noise in different equipment like reduction of noise for Bhopal make motors, control valves, thermal humidifier for DMDE, turbo generators of different ratings etc.

In the area of design evaluation, it has worked on rotor dynamic design evaluation of 800 MW CW pump, FD fans, performance evaluation and review of design for all the bearings (twelve nos.) for AUSC rotor trains, design methodology for brush seals for steam turbines.

In the area of vibration reduction is has resolved different vibration problems at sites such as:

- Bearing failure at Koradi-6 (R&M)
- Shaker test and vibration analysis of ACW pumps, DPL Durgapur
- 500 MW STG at Mauda and Khaparkheda (generator front bearing vibrations)
- 800 MW LP front bearing high vibration, Kothagudam unit 12
- Diagnosis of generator high vibration problem at SAIL, Rourkela based open yard management system at Bhusawal Site.

## OBJECTIVES

The Centre of Excellence for Compressors and Pumps (COE-CP) was set up at Corporate R&D, Hyderabad, to create facilities in terms of engineering design capabilities and experimental facilities with the focused aim of improving these two products which have sustainable growth potential over the years to come. The basic objectives of this COE-CP are multifold namely product orientation, efficiency enhancement, capability enhancement, product development suiting to variety of applications and service parameters, design automation, seamless integration of CAD-CAM and advanced test capabilities.

## FACILITIES

- High speed compressor test rig for single stage performance evaluation
- Fan test rigs (axial fans)

- Multi-chamber CWP sump model test rig for swirl reduction through design of vortex breakers
- Venturimeter test facility
- Spray nozzle valve test facility
- Design tool for compressors and turbines

## CORE STRENGTHS

- Design of turbine blade profiles
- Design and performance testing of centrifugal pumps and compressors
- Cascade testing of turbine blades
- Calibration of venturi meter, spray nozzle, etc.

## SIGNIFICANT DEVELOPMENTS

The lab has developed several product designs in the area of:

- Compressor – 380000 Nm<sup>3</sup>/hr capacity multi stage axial compressor for blast furnace application of RINL-Vizag.
- Roots blower – higher capacity oxidation roots blower of 18000 Nm<sup>3</sup>/hr. With 11500 mm WC head for FGD system with efficiency of 80%.
- ID fan – higher head ID fan for 660 MW plant designed to overcome additional resistance due to incorporation of FGD & SCR systems and 30% additional head achieved. This enables BAP-Ranipet unit to meet the R&M requirements of old power plants and new plants to meet MOEF pollution norms.

The Lab has designed venturitube for steam consumption measurement and estimation of disturbance factor in 250, 500, 600, 660 & 800 MW power plant with an accuracy of 1.2%.



**OBJECTIVES**

The Centre for Nano Technology (CNT) was established at Corporate R&D, Hyderabad, to explore the application of nano materials in products and systems relevant to BHEL. Material development for power plant components, nano structured coatings for wear and other applications, electrical insulating materials, solar cells, carbon nano tube applications, nano fluidics, fuel cells, nano material synthesis and nano sensors, are being explored at this facility.

**SIGNIFICANT DEVELOPMENTS**

- The lab is working for developing carbon nanotube based products and process. The lab has developed carbon nanotube yarn for current conductor applications. Presently the Lab is developing nano tube based mats for industrial and defense applications.
- In bowl mill area the lab has developed process to fabricate ceramic pads, metal-ceramic pad inserts, and bowl mill rolls with metal-ceramic composite inserts with enhanced operational life (>8000 hrs) for coal pulverization.
- The lab is developed nano coatings for specialized applications such as super hydrophobic coating for the thermal power plant applications to mitigate the corrosion and bio-fouling problems. Silicone rubber nanocomposites for low frequency sound absorption applications

**FACILITIES**

Major facilities at CNT for nano scale measurement, characterisation and analysis, fabrication and nano powder synthesis include atomic force microscope (AFM), contact angle measuring system, nano particle size analyser, BET specific surface area analyser, thin film research printer, ultra-sonicator, ultrasonic cleaner, vario-planetary mill, vibratory cup mill, air jet erosion tester and thermal cycling furnace.

**CORE STRENGTHS**

- Nano materials characterization
- Thin film solar material synthesis and characterization
- Nanomaterials synthesis by microwave
- Mechanical alloying of nanomaterials
- Nanocomposites preparation
- Functionalization and dispersion of nanomaterials



## OBJECTIVES

The Centre of Excellence – Ultra High Voltage Laboratory (COE-UHV) established at Corporate R&D, Hyderabad, has two distinct functional areas – high voltage dielectric test facility and centre for assembly of gas-insulated substation (GIS) modules in controlled environment.

## FACILITIES

- Impulse voltage generator: 2800 KV, 280 kJ
- Gas filled test transformer: 1000 KV, 0.5A
- Partial discharge measurement system



- Clean room facility for GIS assembly
- VSRS storage system
- SF6 gas handling system
- Circuit breaker speed analyzer
- High current generator for heat-run testing of GIS modules.

## CORE STRENGTHS

- Electromagnetic field analysis
- Circuit analysis
- Design optimization and development of HV equipment
- Diagnosis and condition monitoring of power equipment
- Residual life assessment of electrical apparatus

- Online data acquisition and development of GUI based software for HV applications

## SIGNIFICANT DEVELOPMENTS

- The lab is working on development of 245 kV, 420 kV FOCT.
- In transformer technology this lab is providing solution for problems faced by Bhopal and Jhansi transformer group from traction transformers to 765kV HVDC transformers. The lab is working for development of new transformer technology and products like Scott Connected transformer.
- In ESP area the lab is developing spark gap based pulse power supply.



**OBJECTIVES**

To enhance the operational efficiency of the power plants based on the accumulated domain knowledge over several years, a state-of-the-art Centre of Excellence for Simulators (COE-S) has been established at Corporate R&D, Hyderabad. The COE-S not only highlights the extant power plant simulation capabilities of BHEL, but would also play a vital role in large-scale commercialisation activity in this advanced area.

**FACILITIES**

It has the facility for carrying out dynamic simulation studies for combined-cycle cogeneration plants and thermal power plants. In the recent past, many simulation studies were executed commercially for various combined-cycle cogeneration plants. The COE-S is capable of developing operator training simulators, carry out dynamic simulation studies and analyse operational problems and propose best possible solutions.

**CORE STRENGTHS**

- Operator training simulator for thermal, hydro and combined cycle power plants
- Dynamic simulation studies for thermal, nuclear and combined cycle cogeneration power plants
- Control loop testing – hardware in loop test
- PADO software modules for thermal and hydro power plant
- IEC 61850 compliant HMI for substation automation
- protocol gateways, fibre optic communication network and simulation systems for C&I control panels

**SIGNIFICANT DEVELOPMENTS**

- The lab is working for development of power plant simulation systems to commercialize as products. The lab has developed operator training simulators (OTS), compact generator simulator (CGS), sequence of events (SOE) simulator, performance analysis, diagnostics and optimization (PADO) software.
- The lab is providing different services to the sister units and customers as dynamic simulation studies, remote monitoring and diagnostic service (RMDS).



## OBJECTIVES

The Centre of Excellence for Computational Fluid Dynamics (COE-CFD) has been established at Corporate R&D, Hyderabad. This facility has enhanced BHEL's capability in the field of computational fluid dynamics (CFD), which is an important tool capable of giving designers valuable insights into the behaviour of fluid flow in complex geometries.

## FACILITIES

With advanced software and manned by technically capable and trained personnel, the COE-CFD will cater to a wide variety of products of the power and industrial sectors. The lab is equipped with high performance computing (HPC) system having state of the art hardware and HPC software with 144 parallel computational cores and 100 TB storage. The facility will meet computational analysis requirement in the areas of flow, thermal, stress, structural, electromagnetics, optimization etc. as part of design development for emerging technologies e.g. AUSC, defence, e-mobility, emission controls, industrial products, etc. CFD application software with latest versions with parallel licenses are available to fire job on multi-CPU. COE-CFD promotes CFD activities by means of R&D projects, site support activities and diagnostic investigations, collaborative research and joint research projects with similar institutions of repute. The centre also organizes seminars, lectures, training/short courses on CFD for the benefit of BHEL engineers

## CORE STRENGTHS

- CFD analysis
- Optimization of turbo machinery components for improved cad modelling of complex flow domains, mesh generation/grid automation
- Single phase/multi-phase flow analysis combustion analysis involving reacting flows
- Conjugate heat transfer analysis
- User defined function development to enhance solver capability
- High performance parallel computing



## SIGNIFICANT DEVELOPMENTS

The lab is involved in CFD analysis to estimate several flow and performance parameters in different products as:

- **Turbine:** Flow and thermal performance assessment of AUSC IP turbine casing during warm and hot start up condition. The outcome of the analysis parameters shall be used to analyze transient stress analysis by designer.
- **Cooling water pump:** Flow analysis of cooling water sump for Yadadri power plant (5x800 MW) to estimate flow vorticity in the pump chamber.
- **ESP:** Flow analysis of ESP system for improvement in flow characteristic for a 500 MW plant (renovation and modernization project) under emission control technology.
- **Defence sector:** Flow and thermal performance verification for newly designed 490 kW diesel alternator and flow analysis of main circulating line and main circulating pump.



## OBJECTIVES

The Centre of Excellence for Surface Engineering (COE-SE) has been set up at Corporate R&D, Hyderabad, to further augment BHEL's predominant position as a pioneer in carrying out R&D in surface engineering which has been successfully implemented at various power stations for power equipment such as turbine blades and boiler tubes, industrial establishments, space programmes and other important applications. The COE-SE is a major facility for BHEL's frontier research projects for exploring the use of nano materials for surface engineering applications.

## FACILITIES

The COE-SE is equipped with a host of advanced equipment for surface treatment and coating like the latest robot-controlled laser hardening and cladding system, which is one of the unique facilities in India, in addition to robotic thermal spray, image analyser, macro-micro hardness tester, on-line control and monitoring system of thermal spray parameters and mechanical grit recovery system.

## CORE STRENGTHS

- Surface coating and modification
- Thermal spray coatings
- Soft polyurethane coating
- Laser hardening and cladding
- Plasma ion diffusion



## SIGNIFICANT DEVELOPMENTS

- The lab is working on development of new coatings or coating techniques. The lab has developed laser peening process for improving fatigue properties on GT buckets, implementation of epoxy based polymer coatings on water walls and tube plates of condenser for 210 MW Tuticorin Thermal Power site to resist sea water corrosion, evaluation
- To meet statutory requirement, the lab has developed silver plating process for different generator components using cyanide free chemicals.





## OBJECTIVES

The Centre of Excellence for Permanent Magnet Machines (COE-PMM) has been established at Corporate R&D, Hyderabad, to carry out advanced research work in this new technology area and develop special PM machines to cater to the need of various power plants, industries, applications in railways, strategic applications and wind power generation.

## FACILITIES

The state-of-the-art facilities established at the COE-PMM includes 80 kJ high voltage impulse magnetiser with special coils and fixtures for magnetising high-energy NdFeB and SmCo magnets, B-H curve tracer for characterising magnets at various temperatures, Helmholtz coil system for testing batch magnets, high precision instrumentation facilities for recording electrical parameters and torque measurements and electromagnetic analysis software for 3-D parametric design optimisation. The centre has also

developed in house capabilities for the design and mathematical analysis for these PM machines using electromagnetic field approach.

## CORE STRENGTHS

- Superconducting machines design and development.
- Electromagnetic analysis of rotating machines
- Design and development of special electrical machines for various applications
- Design and development of brushless excitors for hydro applications



- Medium and higher rating PM machines
- Pilot excitors for thermal power stations brushless excitors

## SIGNIFICANT DEVELOPMENTS

- The lab is working in development of different electrical motors. For e-vehicle applications, the lab has developed **150 kW water cooled permanent magnet motor for electric bus, 70 kW and 130 kW water cooled compact induction motor for electric bus.**
- The lab is providing testing services to BHEL sister units. The lab has done type testing of 03 Nos 2.5 kVA, 1500 rpm PMGs for Hyderabad unit.
- The lab is working in different development projects of strategic importance. The lab has developed and tested 350 kW reserve propulsion motor for strategic applications. The lab has undertaken testing of DC-AC controller for 50 kW permanent magnet frequency converter for strategic applications.





## SIGNIFICANT DEVELOPMENTS

- The lab is working for development of transmission system products including substation automation system (installed at 4 x 270 MW Bhadravati Thermal Power Station) HVDC controls and protection, SCM (shaft current monitor) system.
- The lab undertakes several system studies. The lab is equipped with state-of-the-art RTDS system. The lab has undertaken study and modelling of fixed series compensation on RTDS, validation of LVRT (low voltage ride through) control software on RTDS, study of FSC failure at PGCIL Wardha and techniques for mitigation, use of RTDS facility for the testing of SEE controller with PSS-4B.
- The lab has initiated field trial of digital substation at PGCIL Bhiwadi site as Joint Collaborative Project between BHEL and PGCIL under Prime Minister's Vision-2022.

## OBJECTIVES

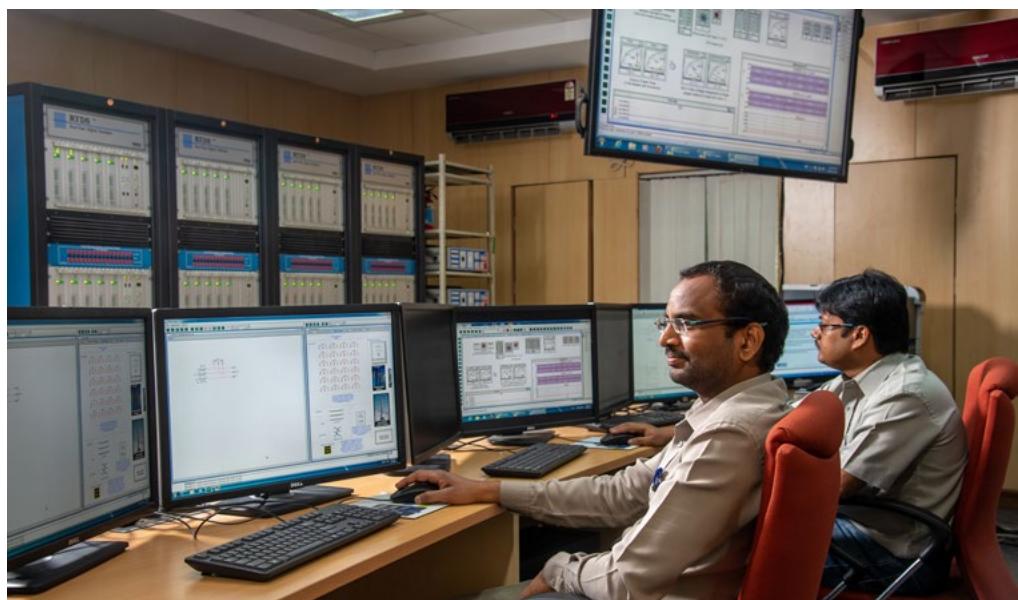
The Centre of Excellence for Advanced Transmission Systems (COE-ATS) has been established at Corporate R&D, Hyderabad, for addressing technologies related to bulk power transmission emanating from growth of energy generation in India. The centre is involved in developing technologies pertaining to HVDC, UHVAC up to 1200 kV, reactive power management, substation automation, wide area protection (WAP), etc.

## CORE STRENGTHS

- Analytical and simulation studies for power system applications
- Dynamic performance studies
- IEC 61850 products development & testing
- Real time embedded systems for power system applications
- Synchrophasor technology for wide area measurement

## FACILITIES

Core facilities of COE-ATS include state-of-the-art real time digital simulator for hardware in loop testing of the developed controllers, industry standard system studies software PSS/E to carry out required studies and advanced test facilities for development of numerical relays with IEC 61850 compliance.



# Research Institutes

at BHEL



## OBJECTIVES

- Focus on research and development in science and engineering of ceramics and allied fields.
- Application of ceramic and advanced materials for energy and environmental purposes and more specific to BHEL's present and future needs.
- Upscaling of lab research to pilot scale level so that product/technology can be demonstrated for further commercialization.
- Prototype fabrication and demonstrated in actual applications/sites of the technology or products developed.
- Technical support to BHEL units related to ceramics, insulators and new products
- Assisting business groups in identifying new business, new technologies, collaborators, technology providers.
- Conducting collaborative research with many premier institutes for faster upscaling of lab technology available.

## SIGNIFICANT DEVELOPMENTS

- The lab is working for development of different rating ceramic and silicone based insulators for different applications. The lab has developed 400kV 120kN long-rod composite insulators, 500 kV HVDC composite Long-rod Insulator. The lab is presently working for development of composite insulators with 1600 mm creepage for Indian Railways.
- In SCR area the lab has indigenously developed SCR honeycomb and plate catalysts which were installed at NTPC Simhadri. At present a project was taken up with an objective to evaluate primary raw materials from different sources, which is required for

the manufacturing of SCR plate catalysts. Results under this development have been shared with the manufacturing unit for meeting the SCR system requirement of minimum De-NO<sub>x</sub> efficiency of 80%.

- A new development has been initiated for enamel coating of plates used in APH & GGH applications. The project scope includes of Identification of raw materials used in enamel coating techniques, establishment of coating methodology and processes, design of experiments and optimization of process to achieve desired coatings as per standard, evaluation of developed coatings and scale-up and establishment of coating technology process for typical plates used in power plants.

## CORE STRENGTHS

- Ceramic processing techniques
- Fabrication technologies for ceramics
- Ceramic products/prototypes/system development
- Materials characterization/analysis
- Synthesis and applications of nano ceramics
- Silicone rubber product development



### OBJECTIVES

The Amorphous Silicon Solar Cell Plant (ASSCP) is an R&D facility dedicated to the development of crystalline and thin film photovoltaic (PV) technologies since its inception in 1988-89. Areas of research include development of high efficiency silicon-based homo-junction solar cells, development of passivated contacts solar cell such as PERC and advanced concepts, development of high efficiency silicon-based heterojunction solar cells and development of equipment for solar cell processing/testing. The broad scope of operations of ASSCP are listed below.

- Develop PERC structure through establishment of individual process steps and subsequent integration of these steps for achieving high efficiency and cost reduction.
- Develop technology through experimental trials with new cell processes recipes, pastes, screen designs and cell structures to achieve better efficiencies and/or cost reduction in production process.
- Act as resource centre to SPV production group at Bengaluru by providing testing and characterization support and giving feedback for process improvement.
- Keep track of latest and futuristic PV technology trends and evolve PV roadmap and provide technical feedback to relevant BHEL units.

### CORE STRENGTHS

- Processing of bulk and thin film silicon solar cells and modules
- Characterization of bulk and thin film semiconductor materials and devices
- Design and development of applications based on solar cells and modules operation and maintenance of high vacuum equipment

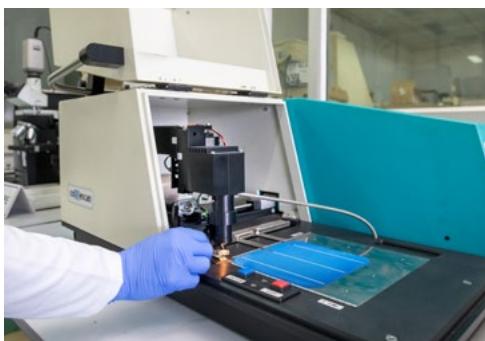
### SIGNIFICANT DEVELOPMENTS

The lab is involved in development of indigenous technology for solar PV to reduce the cost and enhance efficiency. The lab has developed a

technology for fine line printing of solar cells using Zero-degree mesh screens. The lab has developed centrifugal dryer for drying mono crystalline Si wafers as an improved alternative to the oven process.

The lab is presently executing several projects as:

- A MNRE funded 3-year project titled **Development of high efficiency (21%/19%) PERC type of c-Si/mc-Si solar cells** jointly with NISE.
- Loss analysis of silicon solar cells and thereby efficiency enhancement by 0.3 % under consultancy with SERIS, Singapore is under progress
- Cost reduction of solar cells using dual print concept



## OBJECTIVES

Pollution Control Research Institute (PCRI), is an OHSAS and ISO 9001 certified institute, set up by the Department of Heavy Industry (Government of India), under United Nations Development Programme (UNDP), at the Haridwar unit. The institute is actively engaged in providing services for environmental clearance of power projects, preparation of environmental statement of industries, conducting environmental monitoring for regulatory requirements and consultancy services.

## FACILITIES

The institute is equipped with latest analytical facilities for carrying out studies related to environmental pollution and control. They include atomic absorption spectrophotometer, gas chromatograph, UV VIS spectrophotometer, flue gas analyser, bomb calorimeter, VOC analyser, PM10 & PM2.5 samplers, multi gas analyser for work place monitoring, sound level meter with octave filter, heat stress meter, illumination meter, noise dose meter, bacteriological air sampler and automatic bacteriological colony counter

## CORE STRENGTHS

- Evolve technologies and provide consultancy services to control pollution with respect to air, water, noise and solid waste.
- Equipped with modern monitoring and analytical facilities. The expertise is continually upgraded through association with renowned experts in the field.
- Recognized by Ministry of Environment & Forests, Central Pollution Control Board and a number of State Pollution Control Boards as Consultant and Approved Laboratory.

## SIGNIFICANT DEVELOPMENTS

- Studies on Environmental Management in the past and is currently executing a number of studies for various government bodies/private industries.
- Providing its services in the areas of pollution control, environmental impact assessment, environmental monitoring, environmental audit, hazardous waste management, ground water and surface water quality assessment studies.
- Development and establishment of environmental/chemical laboratories.design of experiments and optimization of process to achieve desired coatings as per standard, evaluation of developed coatings and scale-up and establishment of coating technology process for typical plates used in power plants.



## OBJECTIVES

The Welding Research Institute (WRI) has been established at the Tiruchirappalli unit to develop and introduce highly productive advanced welding processes and technologies to improve quality and productivity of fabrication shops and to enhance R&D capability through addition of state-of-the-art research facility.

## FACILITIES

The facilities include friction stir welding system, CNC gantry welding system, laser hybrid welding system, pulsed SAW system, water jet cutting system, thermal cycle simulator, welding simulation facility.

## CORE STRENGTHS

- Applied research in welding domain for industrial projects.
- Mechanical and metallurgical characterization of materials, welds and welding consumables.
- Failure analysis and residual life assessment of components.
- Skill development for welding domain across welders, welding supervisors and welding professionals. It runs scheduled courses and training programs throughout the year. Programs of specific nature are also organized as per customer requirement.

## SIGNIFICANT DEVELOPMENTS

- Established welding technology for advanced ultra supercritical boilers (AUSC) for high thickness nickel alloy materials.
- This is in addition to providing welding and allied services to all AUSC projects concerned with BHEL.
- WRI has attended to welding related issues at BHEL site with services ranging from welder training, welding sensitisation, failure analysis, NDT services.
- It has established itself as a premier centre for dissimilar material joining for defence and space applications. bimetallic adaptor welded at WRI was part of Chandrayan Mission.



## OBJECTIVES

Centre for Electric Transportation (CET) has been established at Bhopal with the assistance from United Nations Development Programme (UNDP). The centre is envisaged to act as a focal point for systems oriented research in the field of electric transportation. CET has capability for analysis and testing of rail vehicles for their performance, reliability and energy efficiency. CET can also provide assistance in development and introduction of urban mass transit systems.

## FACILITIES

- Provision for different types of power supply prevalent in Indian Railways for powering locomotives, EMU, MEMU, and metro. They include 0-750V 3x800 amp DC power supply, 0-1500V 2x800 amp DC power supply, 25 KV single phase 50 Hz 4 MVA AC power supply, 800 KVA auto transformer with tapping of 1150/100/750 V 3 3  $\Phi$  50 Hz AC supply and MG set which provides current up to 180 amp from 0-230 volts.
- DC motor generator set which can be used as prime mover with power up to 750 KW and 1500 rpm and as for regenerative loading up to 1000 amp, 750 volts of rotating machines, up to 1050 rpm, and other static equipment.
- Load bank of 3 nos. resistance bank of 5 ohms (reconfigurable 0.25 ohms), 500amp and 16 nos. resistance banks of 1.8 ohms, 50 amp.

- Vibration testing facility for conducting vibration testing of traction equipment, consisting of a 250 KN servo hydraulic actuator powered by 210 bar hydraulic power supply. The actuator can provide a maximum displacement of +/- 75 mm over a frequency range of 0.01-1100Hz.
- Type testing facility for AC motors for sub-urban trains which can be utilized for conducting various tests called in IEC 60349-2 for type testing of inverter fed traction motors up to the ratings of voltage of 1400 V 3- $\Phi$  AC supply, current of 400 amp and frequency up to 200 Hz.
- Integrated system testing of main motor generator (MMG) projects to be supplied to Indian Navy.

## SIGNIFICANT DEVELOPMENTS

- System design for 1600 HP AC-AC DEMU
- System design for diesel electric tower car (DETC)
- Facility for integrated testing of 500KW MMG projects
- Continuous heat run, one-hour heat run and characteristics test done on newly developed traction motor for DEMU application.
- Heat run test on developed 1 MW industrial drive
- Type test including continuous heat run, one-hour heat run and characteristics test done on newly developed traction motor IM3302 for MEMU application.
- System testing for newly developed regeneration system of WAG7 locomotive
- Type testing of NA5105AZ alternator developed for naval application



# Powering Progress

## Brightening Lives



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