

# R&D STRENGTH & INNOVATION CAPABILITIES

Inspiring Innovation  
Engineering Dreams

# About BHEL

Established in 1964, BHEL is one of the largest & oldest engineering and manufacturing enterprises in India in the energy and infrastructure sectors. BHEL has a widespread network of 16 manufacturing facilities, 2 repair units, 8 service centres, state-of-the-art centres of excellence, 5 specialized institutes for carrying out advanced R&D in various engineering disciplines, and is currently executing projects at more than 150 sites across India and abroad. BHEL offers one-stop solutions backed by its core design, engineering and manufacturing strengths coupled with a committed pool of about 30,000 employees (including 9,000 skilled engineers), contemporary technologies and state-of-the-art manufacturing and testing facilities. The company undertakes projects and contracts in all modes including EPC, Supply, Supply & Supervision, Consortium partner, Contract Manufacturer, etc., as per customer requirement.

From making India self-reliant in power generation to setting up power-plants in Africa, CIS, South-East Asia and Far-East, BHEL has contributed close to 200 GW of power-generation capacity. BHEL has also been deeply involved in other industrial and strategic sectors offering our customers a comprehensive portfolio of products, systems and services in power (nuclear, hydro, solar and thermal), transmission (sub-stations, transformers, shunt-reactors, instrument transformers, switchgear), railways (rolling stock, propulsion, traction motors, transformers, etc.), defence, aerospace, oil & gas, battery energy storage systems & EV chargers and stand-alone products such as compressors, heat exchangers, motors, pumps, valves, etc., adhering to international standards. Besides a formidable presence in India, the company has a widespread footprint spanning 89 countries across all the inhabited continents of the world.





# Research & Innovations

BHEL has a strong engineering and R&D base for in-house development of technologies to address the market requirements, and is also focusing on flow of knowledge and information throughout the innovation ecosystem for growth of its workforce.

The research and developmental efforts of the company are not only aimed at improving the performance of the products of current manufacture, but also developing new products and systems using state-of-the-art technologies, relevant to the needs of the various business sectors.

BHEL has entered into technology collaboration agreement with leading global manufacturing and engineering companies. The company has successfully indigenized the technologies to meet the requirements of Indian customers and established manufacturing facilities at its own works.



**5200+**  
IP Equity



One of the  
**Highest R&D Spends**  
in engineering industry  
in India. **>2.5% of turnover**



**82 Technology**  
**collaborations**  
with Global OEMs



**Collaborative R&D**  
with leading academic institutions  
and research organisations of India



Bharat Heavy Electricals Limited

# Centres of Excellence



at Hyderabad,  
Telangana, India

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 Equipment & 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**

at Bengaluru,  
Karnataka, India

Centre of Excellence  
for  
**Power  
Electronics**

Centre of Excellence  
for  
**Control &  
Instrumentation**

## Research Institutes

**Ceramic  
Technological Institute  
(CTI)**  
Bengaluru

**Amorphous Silicon Solar  
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 is located at Hyderabad, spread over 140-acre complex. It is the pivotal Centre for carrying out all the research activities covering total product range of the BHEL. There are twenty-five functional laboratories and analytical groups including ten Centers of Excellence located in the Campus of Corporate R&D. These laboratories and Centres of Excellence are well equipped with state-of-the-art facilities and test set-ups, apart from advanced computational hardware and software to carry out research works.





# Centres *of* Excellence

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## Centre of Excellence for Intelligent Machines and Robotics

### OBJECTIVES

The Centre of Excellence for Intelligent Machines and Robotics (CIMAR) at Corporate R&D, Hyderabad is equipped with advanced equipment and software for continuous 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 focusses on developing new products and processes for effective utilisation of high cost production infrastructure like CNC machines and computer aided inspection set ups.

### FACILITIES

The centre is equipped 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 configuration and application-oriented development in robotics.

### CORE STRENGTHS

- Manufacturing automation
- 5-axis 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 printing of 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 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 a 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 BHEL-make motors, control valves, thermal humidifier for DMDE, turbo generators of different ratings, etc.

In the area of design evaluation, the centre 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, and design methodology for brush seals for steam turbines.

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

- Bearing failure
- Shaker test and vibration analysis of ACW pumps
- 500 MW STG (generator front bearing vibrations)
- 800 MW LP front bearing high vibration
- Diagnosis of high vibration generator problem





## OBJECTIVES

The Centre of Excellence for Compressors and Pumps (COE-CP) was set up at Corporate R&D, Hyderabad, to create engineering design capabilities and experimental facilities with the focused aim of improving these two products which have sustainable growth potential in times to come. The basic objectives of COE-CP are multifold namely product orientation, efficiency enhancement, capability enhancement, product development suited to a 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
- Venturi meter 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

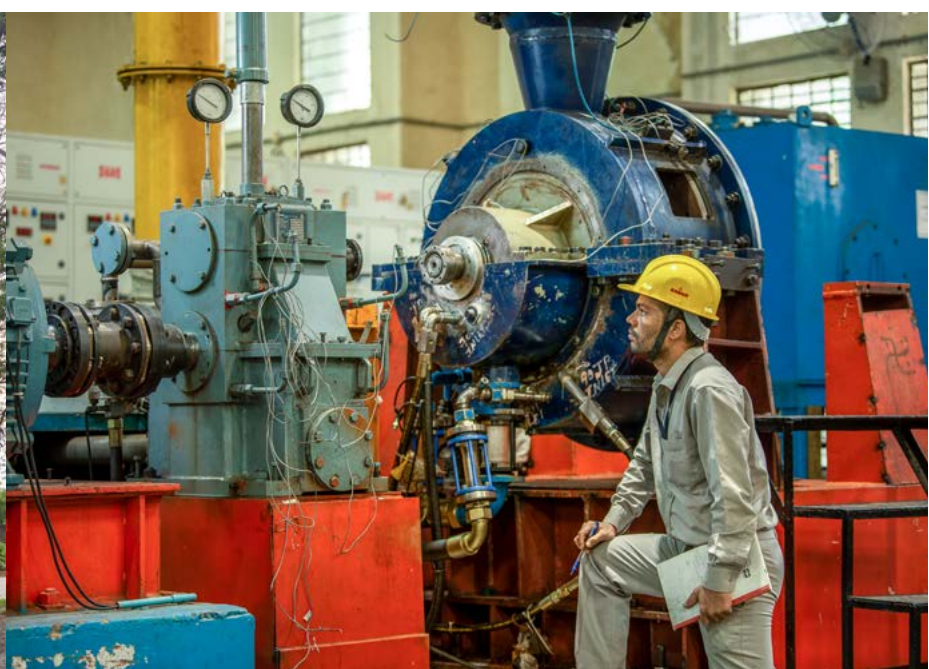
The lab has developed several product designs in the areas of:

- Compressors – 380000 Nm<sup>3</sup>/

hr capacity multi stage axial compressor for blast furnace application of RINL-Vizag

- Roots blowers – higher capacity oxidation roots blower of 18000 Nm<sup>3</sup>/hr with 11500 mm WC head for FGD system & efficiency of 80%
- ID fans – 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 BHEL unit to meet the R&M requirements of old power plants and new plants to meet MOEF pollution norms.

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





**OBJECTIVES**

The Centre of Excellence for Nanotechnology (CNT) was established to explore the application of nanomaterials in products and systems relevant to BHEL. Material development for power plant components, nanostructured coatings for wear and other applications, electrical insulating materials, solar cells, carbon nanotube applications, nanofluidics, fuel cells, nanomaterial synthesis and nanosensors, are being explored at this facility.

**FACILITIES**

Major facilities at CNT for nanoscale measurement, characterisation and analysis, fabrication and nanopowder synthesis include atomic force microscope (AFM), contact angle measuring system, nanoparticle 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**

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

**SIGNIFICANT DEVELOPMENTS**

- The lab is working for developing carbon nanotube based products and processes. The lab has developed carbon nanotube yarn for current conductor applications. Presently the lab is developing nanotube based mats for industrial and defence applications.
- In the bowl mill area, the lab has developed a process to fabricate ceramic pads, metal-ceramic pad inserts,

and bowl mill rolls with metal-ceramic composite inserts and enhanced operational life (>8000 hrs) for coal pulverization.

- The lab has developed nanocoatings for specialized applications such as super hydrophobic coating for the thermal power plant applications to mitigate the corrosion and bio-fouling problems. It has also developed silicone rubber nanocomposites for low frequency sound absorption applications.



**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
- SF<sub>6</sub> 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 (Fibre-Optic Current Transformer)
- In transformer technology this lab is providing solution for problems faced in traction transformers to 765 kV HVDC transformers. The lab is working for development of new transformer technology and products like Scott Connected transformer.
- In ElectroStatic Precipitator (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 plays 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 have been 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 the 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 plants
- 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 commercialise 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 services like dynamic simulation studies, Remote Monitoring and Diagnostic Service (RMDS) to the other units of BHEL and customers



## OBJECTIVES

The Centre of Excellence for Computational Fluid Dynamics (COE-CFD) at Corporate R&D, Hyderabad 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.

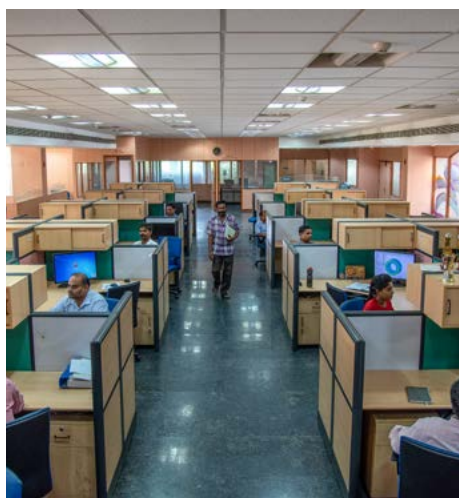
## FACILITIES

With advanced software and manned by technically capable and trained personnel, the COE-CFD caters to a wide variety of products of the power and industrial sectors. The lab is equipped with high performance computing (HPC) systems 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 control, industrial products, etc. CFD application software with latest versions with parallel licenses are available to fire jobs on multi-CPU.

COE-CFD promotes CFD activities by means of R&D projects, site support activities, 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 and 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 product areas such as:

- **Turbines:** 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 pumps:** Flow analysis of cooling water sump for Yadadri power plant (5x800 MW) to estimate flow vorticity in the pump chamber.
- **ESPs:** 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 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. This includes the latest robot-controlled laser hardening and cladding system, which is one of the unique facilities in India. In addition, it has 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 coating
- Soft polyurethane coating
- Laser hardening and cladding
- Plasma ion diffusion



## SIGNIFICANT DEVELOPMENTS

- The lab is working on development of new coatings or coating techniques. It 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 Thermal Power Plants to resist sea water corrosion.
- Other developments include

evaluation of high temperature impact behavior of stellite overlay and HVOF coating for AUSC control valve application, development of HVOF sprayed Cr3C2-NiCr coating on grade T91 tubes of AUSC boiler, and establishment of laser cladding process using IN625 powder for dimensional repair/rebuilding of rotor shaft.

- 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 to carry out advanced research work in this new technology area and to develop special PM machines to cater to the needs of various power plants, industries, applications in railways, strategic applications and wind power generation.

## FACILITIES

The state-of-the-art facilities at the COE-PMM include 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 design and mathematical analysis of 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 exciters for hydro applications
- Medium and higher rating PM



machines

- Pilot exciters for thermal power stations' brushless exciters

## SIGNIFICANT DEVELOPMENTS

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







## OBJECTIVES

The Centre of Excellence for Advanced Transmission Systems (COE-ATS) has been established for addressing technologies related to bulk power transmission. 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.

## FACILITIES

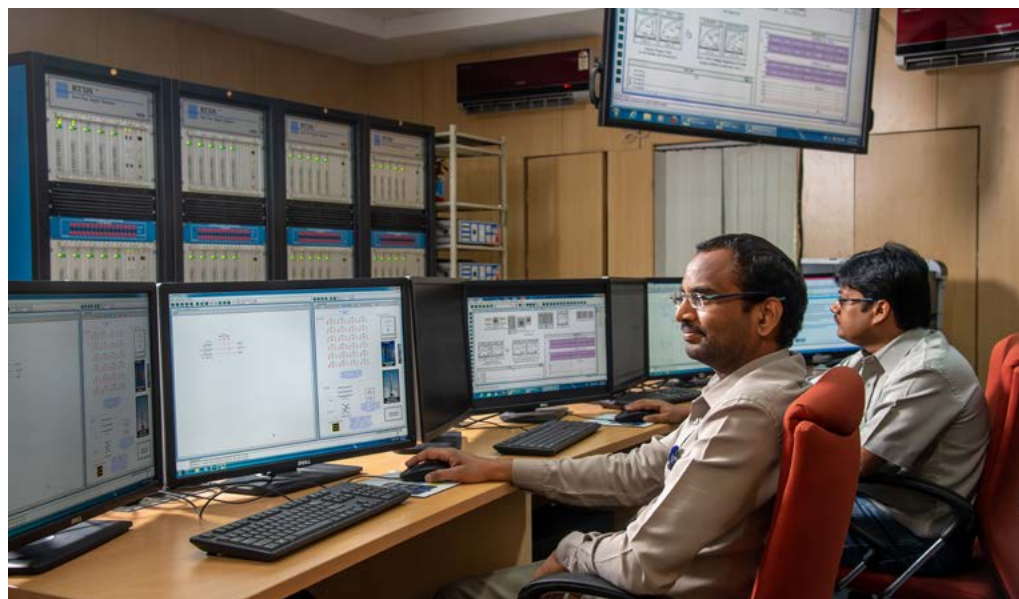
Core facilities of COE-ATS include state-of-the-art real time digital simulator for hardware in loop testing of the developed controllers, industry standard system studies software PSS/E to carry out required studies and advanced test facilities for development of numerical relays with IEC 61850 compliance.

## 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

## SIGNIFICANT DEVELOPMENTS

- The lab is working for development of transmission system products including substation automation system (installed at 4x270 MW Bhadradi Thermal Power Station) HVDC controls and protection and SCM (shaft current monitor) system
- The lab undertakes several system studies and is equipped with state-of-the-art RTDS system. It 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 for PGCIL 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 a PGCIL project site as a Joint Collaborative Project between BHEL and PGCIL under Hon'ble Prime Minister's Vision-2022





## OBJECTIVES

Located in Bengaluru, Karnataka, the mission of this Centre of Excellence (COE) for power electronics with emphasis on IGBT & Controller technology is to build in-house capability and to bridge know how and know why gap in this critical area resulting in:

- Improvement in existing product designs for better performance
- Development of know-why and know-how capabilities
- Development of new products and processes

## FACILITIES

### Testing facility:

Entire Traction Converters can be type tested ensuring quality, customer satisfaction and confidence in equipment supplied thereby strengthening EDN's business position in the area of power and Traction.

### Software facility:

The software / simulation test facilities are used in design, modelling & analysis of the

propulsion system including controllers, rapid prototyping of the product, real-time closed loop performance study etc.

Details of facilities established under the COE are as follows.

- Back-to-Back testing of IGBT based systems
- Functional testing of IGBT based converter/Inverter
- Type Testing of IGBT Converters / Inverters including back-to-back full load testing.
- Gate driver evaluation facility
- Real-time (On-line) testing of power circuits / controllers using Real time digital simulator (RTDS).
- Multidisciplinary software package for analysing and designing of power electronic systems
- IGBT tester
- MATLAB Simulation software
- Absorption of technology through study of collaborator's controllers
- Controller lab for Loco system
- Controller lab for EMU system
- EMI/EMC testing for burst and surge testing.

### Other equipment/facilities:

Equipment such as Vacuum circuit breakers, Isolators, Converter transformer, LT distribution panels, Synchronous generator, AC motors, Speed measuring system, Noise and acoustic control system, Remote monitoring system, UPS, Variable frequency Drives (VFDs), Compressor etc. are located in the test bed area.

## CORE STRENGTHS

- Design and Testing of Power Electronic Systems for Defence
- Design and testing of Power Conditioning Unit for Renewables:  
3 Ø for general applications and single Ø for traction applications.
- Design of Variable Frequency Drives
- Testing of Traction converters

## SIGNIFICANT DEVELOPMENTS

The development projects completed include the following:

- 500 kW, 630kW and 1.25MW Solar PCU developed and installed in various PV plants.
- 850 kW Grid interactive single phase solar PCU developed, suitable for direct injection into 25kV line and installed for Indian Railways
- Design and development of Power Converter for critical defence applications
- Design, development, testing and certification of 120kW DC EV charger





## OBJECTIVES

The CoE for Control & Instrumentation has been established at EDN Bengaluru for design and development of electronic module and development of software solutions in-house for power plant DCS, to enhance the capability and to bridge the know why gap in critical areas resulting in:

- Improvement in existing product designs for better performance (maxDNA & ValmetDNA)
- Development of know-why and know-how capabilities
- Development of new products and processes
- Development of Software based solutions

## FACILITIES

- PCB Design
- Logic Analyser
- Data analytic servers and SAN (Storage Area Network)
- Monitoring station for industry 4.0 solutions

## CORE STRENGTHS

- Design of controller and IO modules
- FPGA based designs
- Design of MIL grade modules
- Embedded software development
- Solution development with software languages such as C, C++, COM, JAVA, Python etc
- Real Time Operating Systems – QNX, Linux, Ucos
- RTL Hardware languages - VHDL

## SIGNIFICANT DEVELOPMENTS

### Hardware developments:

- Development of Control Electronics for
- Electronic module level for Power plants DCS
- Advanced Digital Sub Station IED- Bay control Unit, Merging Unit
- Military Grade Common Controller platform for Defense projects of BHEL

- Traction Control Electronics modules

### Software developments:

- Software Solutions for Power and Industry
- Industry 4.0 Solutions
- Remote Monitoring And Diagnostic Services (RMDS) for power plants
- Plant Automation Live Monitoring (PALM) for power and industrial plants
- Distant SCADA for remote operation and control of SCADA systems for Solar Photovoltaic plants
- Augmented reality based solution for Power plant (binocularAR)
- Performance monitoring of traction equipments (TRACK)
- Power House Internet Software for Hydro power plants



## Research Institutes

in BHEL

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Electromagnetic Resonance  
Fatigue (ERF) testing machine,  
TESTRONIC 150 kN  
Model No: 9601 / 207



## 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 demonstration 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

## 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

## SIGNIFICANT DEVELOPMENTS

- Development & field testing of SCR Catalyst modules (plate & honeycombs) at KPCL-Bellary & NTPC-Simhadri sites
- Development & road testing of ceramic honeycomb for catalytic converters & Diesel particulate filters (DPF)
- Thermal storage honeycombs & application testing in steel plants
- Microfiltration ceramic membrane for water filtration
- Membrane Contactor for CO<sub>2</sub> capture. Demo plant in BHEL's plant at Tiruchirappalli.
- Membrane based technology for production of hydrogen from coal gas
- Synthesis of Nanomaterials and applications. Nanofluids for close circuit applications
- Ceramic lined Coal Nozzles for enhanced life
- $\pm 800\text{kV}$  420kN HVDC Composite Insulator Development & Testing compliance
- Composite Insulator with 1600mm Creepage for overhead traction lines in highly-polluted areas in Indian Railways
- Ceramic pouring tubes for Rail wheel casting
- NCA based cathode material development for Li-ion batteries
- High purity Alumina JAS tubes for FGD (ongoing)
- Photo-catalytic water splitting for green H<sub>2</sub> production (ongoing)



## 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 the development of high efficiency silicon-based homo-junction solar cells, development of passivated contact solar cell such as Passivated Emitter and Rear Cell (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 is 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, 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

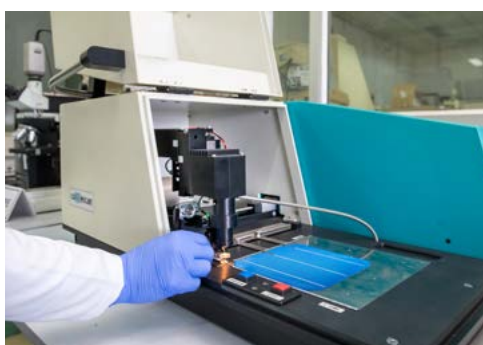
## SIGNIFICANT DEVELOPMENTS

The lab is involved in development of indigenous technology for solar PV to reduce cost and enhance efficiency. It 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 'Ministry of New and Renewable Energy' (MNRE), Govt. of India, funded 3-year project -Development of high efficiency (21%/19%) PERC type of c-Si/mc-Si solar cells jointly with National Institute of Solar Energy (NISE).
- Loss analysis of silicon solar cells and thereby efficiency enhancement by 0.3 % under consultancy with SERIS, Singapore
- 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 the United Nations Development Programme (UNDP), at Haridwar. The institute is actively engaged in providing services for environmental clearance of power projects, preparations of environmental statement of industries, conducting environmental monitoring for regulatory requirements and consultancy services.

## FACILITIES

The institute is equipped with the 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. This 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

- Conducted studies on Environmental Management in the past and is currently executing a number of studies for various government bodies/private industries.
- Providing 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 the addition of a 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, and 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 requirements.

## 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 sites with services ranging from welder training, welding sensitisation, failure analysis and 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 the Chandrayan Mission.





**OBJECTIVES**

Centre for Electric Transportation (CET) has been established at Bhopal with assistance from the United Nations Development Programme (UNDP) to act as a focal point for systems oriented research in the field of electric transportation. CET has the capability for analysis and testing of rail vehicles for 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 0-750 V 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 Ø 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), 500 amp 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 0.01-1100 Hz.

- Type testing facility for AC motors for suburban 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-Ø AC supply, current of 400 amp and frequency up to 200 Hz.

**CORE STRENGTHS**

- Analyse and test all aspects of electrically powered vehicle designs so as to improve their performance, reliability and efficiency.
- Type testing facility for AC traction motors for suburban trains and combined system testing facility for suburban trains.
- Integrated system testing of main motor generator (MMG) projects to be supplied to the 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 500 kW 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 newly 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





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