

+

RESEARCH AND TESTING FACILITIES AT CPRI



2007

CENTRAL POWER RESEARCH INSTITUTE

**New BEL Road
Post Box No. 8066, Bangalore - 560 080, INDIA**

Phone : 91-080-23601263, 91-080-23602329, 23604447
EPABX : 23601442, 23600921, 23600825, 23602919
Fax : 91-080-23601213
website: <http://cpri.in>
E-mail : sridhar@powersearch.cpri.res.in

+

CONTENTS

1.	CENTRE FOR COLLABORATIVE AND ADVANCED RESEARCH (CCAR).....	1
2.	HIGH POWER LABORATORY.....	4
3.	SHORT CIRCUIT LABORATORY.....	11
4.	ELECTRICAL APPLIANCES TECHNOLOGY DIVISION	20
5.	HIGH VOLTAGE DIVISION	24
6.	INSTRUMENTATION DIVISION	30
7.	INFORMATION TECHNOLOGY & IMPLEMENTATION DIVISION.....	37
8.	DIAGNOSTIC CABLES & CAPACITORS DIVISION	39
9.	DIELECTRIC MATERIAL DIVISION	56
10.	MATERIALS TECHNOLOGY DIVISION	62
11.	MECHANICAL ENGINEERING DIVISION	69
12.	EARTHQUAKE ENGINEERING & VIBRATION RESEARCH CENTRE	88
13.	POWER SYSTEMS DIVISION	98
14.	ENERGY CONSERVATION & DEVELOPMENT DIVISION	112
15.	THERMAL RESEARCH CENTRE KORADI, NAGPUR	118
16.	UHV RESEARCH LABORATORY HYDERABAD	124
17.	SWITCHGEAR TESTING & DEVELOPMENT STATION, GOVINDAPURA, BHOPAL	130
18.	REGIONAL TESTING LABORATORY, MURADNAGAR	138
19.	REGIONAL TESTING LABORATORY, KOLKATA.....	141

PROFILE

CENTRAL POWER RESEARCH INSTITUTE

The Central Power Research institute commonly known as CPRI, is presently an autonomous Society under the Ministry of Power. Set up in 1960 by the Government of India, it was re-organised into an autonomous society in 1978.

The Institute is managed by a Governing Body comprising members representing the Government, the electrical utilities, the industry, academic institutions etc. The Secretary to the Government of India, Ministry of Power is the President of the Governing Council. The Chief Executive of this Institute is the Director General who is also Member Secretary of the Governing Council.

MISSION OF CPRI

- Promote applied research in power system technology development.
- Become a national leader of international repute in total engineering consultancy for power sector.
- Provide prompt services to manufacturers and utilities in quality assurance testing and certification of products and goods delivered to power sector.
- Provide assistance to power sector in improving efficiency and reliability in all spheres of activity.
- Provide services in the area of condition monitoring, renovation, modernization and life extension of power plant and equipment through diagnostic and life extension studies for achieving economy & reliability in power systems.
- Update and upgrade technology to meet the growing needs of the power sector.

FACILITIES

The Institute has several research laboratories and testing facilities engaged in different specialised fields. It has at present about 300 engineers and scientists besides other supporting staff to guide and maintain various operations of the institute. The main setup of the institute is at Bangalore and its units are situated in Ghaziabad, Bhopal, Nagpur, Hyderabad, Kolkata and Guwahati.

EXPERTISE

CENTRAL POWER RESEARCH INSTITUTE (CPRI) is a premier autonomous society established under the Ministry of Power to serve as a National Laboratory to carry out applied research in Electrical Power Engineering. It also functions as an independent National Testing & Certification Authority for Electrical Equipment for ensuring their reliability and improve, innovate and develop new products and processes.

The Institute, since its existence for over four decades has built sophisticated facilities both in the areas of research & testing. The important facilities include 2500 MVA Short Circuit Testing with Synthetic Testing Facility at Bangalore. Ultra High Voltage Research Laboratory at Hyderabad, Short Circuit Testing Facility at Bhopal. Thermal Research Centre at Koradi, Nagpur and Energy

Research Centre at Thiruvananthapuram to cater to the R & D and testing needs of the power sector. A state-of-art test facility for seismic qualification of electric equipment has been set up and commissioned. The Institute has also commissioned the Real Time Digital Simulation (RTDS) facility.

The quest for quality is an on-going process at CPRI the reason why most of CPRI's laboratories are accredited under National Accreditation Board for Testing and Calibration of Laboratories (NABL), the National body for accreditation of laboratories as per ISO/IEC 17025 norms. CPRI Laboratories have been assessed by ASTA BEAB, UK for testing of LV and MV equipment as per ISO/IEC 17025 norms. CPRI has been assessed and determined to fully comply with the requirements of ISO / IEC 17025:2005-05. CPRI is therefore entitled to operate as an Indian CB Testing laboratory under the BIS as National Certification Body and to carry out testing within the IECEE CB Scheme. CPRI has been granted full membership of Short Circuit Testing Liaison (STL) club. CPRI became only the second member in Asia to get such distinction. CPRI has also been granted ISO 9001:2000 certification from NVT - KEMA for its research and consultancy. The Certification covers R&D, Sponsored research & consultancy activities of specified Divisions at Bangalore, Research at Energy Research Centre, Thiruvananthapuram and Thermal Research Centre, Nagpur.

The Institute takes up R & D programs keeping abreast with the latest technological developments in the areas of Generation, Transmission & Distribution of Power, some of which are sponsored by the Industries.

CPRI was instrumental in preparing the National Perspective Plan for R & D in Indian Power Sector with an R & D Road map for 15 years. This report is prepared for submission to the Ministry of Power by the Standing Committee on Research appointed by the Ministry. The Perspective Plan covers the vision of R & D, areas for research, fund requirements, likely benefits, policy issues and HRD challenges faced by the Power Sector.

Ministry of Power, Govt. of India, has also entrusted CPRI to act as a nodal agency to administer the Research Scheme on Power (RSOP) including the funding of research in the country. Techno-economic evaluation is the major responsibility of CPRI. During the current year, 34 research projects are being investigated by 13 organisations including 2 state utilities.

Central Power Research Institute has been appointed as Adviso-cum-Consultant (AcC) for the purpose of capacity building in the State Electricity Boards (SEB)/ Power Utilities of Karnataka, Kerala and Andhra Pradesh. The AcCs are appointed under the Accelerated Power Development & Reforms Program (APDRP) of Government of India. This prestigious consultancy appointment has been made by the Ministry of Power, Govt. of India considering CPRI's expertise in the areas of power transmission & distribution studies and also similar consultancy services rendered by CPRI to Electricity Regulatory Commissions in India. The efforts of strengthening of transmission and distribution systems in the country culminated in the initiation of the APDRP with the objectives of reduction in T & D losses both technical and commercial, ensuring reduction of outages, improvement in quality of power and enhancement of revenue earnings, a significant milestone in the era of Reforms in Power Sector.

The Institute also offers its expertise for conducting Third Party Inspection Services for power equipment procured by Utilities. So far the services have been utilised by Tamil Nadu State Electricity Board, APTRANSCO, APGENCO, Karnataka Power Transmission Corporation Ltd. (KPTCL), Uttar & Dakshin Haryana Bijily Viharan Nigam Ltd. and GRIDCO, Orissa etc.

+

+

CENTRE FOR COLLABORATIVE AND ADVANCED RESEARCH (CCAR)

Centre for Collaborative and advanced research has been established in 2006 with a view to promoting advanced research which will benefit power sector with advanced technologies. The main objectives of the centre are:

- To Provide infrastructure for professionals to carry out Research in power Development
- To create conducive environment for collaborative research between R&D Institutions, Industry and Academia.
- To execute projects based on Multi - disciplinary expertise from different institutions
- Dissemination of expertise through continuing education initiative and advanced degree program.
- Increase interaction globally among research organizations and groups.



CCAR Office

Need for a Center for Collaborative Research

Many utilities in India require research facilities and expert advice to address various issues and problems in the context of expansion and restructuring of the power sector. There is need for a nodal center to provide unified services in the form of collaborative research in advanced areas. Such a center would also enable upgradation of skills of engineers and professionals in power sector through workshops and training programs. Based on this, Government of India approved, the Center for Collaborative and Advanced Research (CCAR) to be located at CPRI's Bangalore unit. One program already initiated to take forward the R&D needs in The National Perspective Plan for R&D in Indian Power Sector, conceptualized by National standing committee for R&D.

Research Faculty and Scholars at CCAR

Professionals from industry and academia would be empanelled at CCAR as research faculty. Details indicating topics of interest and relevant industry/academic expertise are being sought. The professionals in active service and experts interested to work with CCAR can communicate personal details. CCAR would maintain a panel of professionals interested to work on collaborative projects for durations of two to six months.

The scholars shall be persons who have completed Ph.D, pursuing Ph.D or have completed master's degree. Interested persons are requested to communicate with detailed resume .

Collaborative Research at CCAR

The CCAR would endeavor to propose, manage and execute projects in the form of collaborative research by networking other institutions and industry. The present schemes of Ministry of Power, such as Research scheme on power (RSOP), National Perspective Plan for R&D in Indian Power Sector would be covered. Further

projects funded by other National and International agencies would also be taken up.

Present proposals cover sponsored staff of PSU's, doctoral and post doctoral scholars, certificate course in testing and commissioning, tie-up with leading universities for masters and doctoral programmes.

Certification Program on Testing

CPRI intends to give an intensive course on electrical equipment testing of 10 to 12 weeks duration leading to a certification as a qualified test engineer. The plan is in the process of finalisation.

Physical Infrastructure

The CCAR is an integrated complex with class rooms, an auditorium and residential facility for faculty and scholars. The residential facility for research faculty has ten family suites with integrated kitchenette. Residential facility for researchers consists of 30 rooms. All the above are fully furnished, with internet and TV connection. Facilities exist to conduct workshops/ seminars / tutorials / training programs etc.

HIGH POWER LABORATORY

The laboratory comprises (i) Direct Testing Facility of 2500 MVA capacity at 36/72.5 kV in three phase and 1400 MVA capacity, upto 245 kV in single phase for testing of Circuit Breakers and short circuit withstand capability tests on other apparatus viz., Power Transformers, Wave Traps, Reactors, Insulators, Lightning Arresters etc., and for short time current test upto 300 kA rms on Busducts, CTs, Isolators, Panels, etc., and (ii) a Synthetic Testing Facility for high power testing of EHV Circuit Breakers upto 63 kA, 245 kV full pole and unit testing of EHV Circuit breakers beyond 245 kV level.

The direct testing facility was commissioned in December 1990 and the Synthetic test facility was commissioned in December 1992. The main equipment/facilities are as follows:



Short Circuit Generator

The 14 kV, 3 phase, 3000/3600 rpm 50/60 Hz Generator is capable of delivering 3 phase power of 2500 MVA reckoned at the end of 0.08 secs after fault initiation at 36/72.5 kV in the test cells. The Generator is driven by a variable speed synchronous motor. A static excitation system comprising thyristor bridges and solid state controllers provide super excitation and flux regulation to ensure that the current is maintained constant.

Master Circuit Breakers (3 Nos.)

It is a specially designed half cycle, single pole, air-blast breaker with synchronised opening to achieve minimum arcing time.

Breaking Current : 120 kA rms at 14 kV, Breaking Time : 7 ms.

Make Switches (3 Nos.)

Capable of closing individually or sequentially through a synchronous test processor.

Making current : 430 kA peak, Making time : 6 ms

Air Core Reactors

14 kV Air Core Reactors 2.7 milli-ohms to 6.0 ohms for adjustment of test currents from 120 kA to 1.34 kA rms in steps of less than 5%.

Short Circuit Testing Transformers (6 Nos.)

Specially designed low induction density, single phase short circuit testing transformers rated at 14/42-42 kV, 1150 MVA, ensuring distortion free recovery voltages during short circuit test duties on circuit breakers.

Busbar System

This enables connection of Short Circuit Generator through Master Circuit Breakers, Make Switches and also Short Circuit Testing transformers in different combinations by means of remotely controlled disconnectors to the test cell. There are three bus bar systems as follows:

- 14 kV, 3 phase bus bar system rated for 40 kA rms;
- 72.5 kV, 3 phase and neutral busbar system rated for 110 kA rms;
- 245 kV, single phase busbar system rated for 40 kA rms;

TRV Circuit Elements for Direct Test Facility:

To adjust TRV parameters as per IEC/Indian Standards upto a voltage class of 72.5 kV.

+

Capacitor Bank of Direct Test Facility

Range of Capacitive Current switching tests on HV Circuit Breakers & Switches for

3 phase	-	36 kV, 600 A 12 kV, 235 A
Single phase	-	12 kV to 36 kV, 1250 A 72.5 kV, 630 A 145 kV, 750 A 245 kV, 950 A

Resistors Banks

For control of peak current during short circuit making tests upto a current level of 40 kA rms/100 kA peak

High current short circuit testing transformers:

Rating : 14/1.2 kV, 300 kA rms for 1.0 sec. for short time current tests on busducts, CTs, etc., and short circuit switching duty tests on LV circuit breakers, fuses, etc.,

Control Measurement and Recording System

- Synchronous test processor, 32 channels, 100 micro sec resolution
- Co-axial shunts
 - 140 kA, response time 4 micro secs; 50 micro ohm,
 - 14 kA, response time 0.6 micro sec; 500 micro ohm.
 - 300 kA, rise time 10 μ sec, 36 micro ohm
 - 100 kA, rise time 100 micro ohm, 3 Phase shunt
- Current transformers : Upto 150kA (Transient response type)
- Capacitive Dividers : Type RC 60 kV/380 kV
Type RCR 375 kV/1500 kV
Type RCR 60 kV/280 kV
- Resistive Divider : Type R 2 kV
- Optical fibre transmission lines DC- 15 MHz

6

+ RK

+

- Thermal Array Recorder - 16 channels
- Digital transient recorders 1 micro-second sampling rate with plotter interface, 8 channels
- Transient recorder 256 k samples/ch, 10 M samples/sec, 16 channels
- Digital oscilloscope, 100 MHz (Max. sampling rate 400M samples/sec.) 4 channels.
- Digital oscilloscope, 200 MHz, (Max. sampling rate 400M samples/sec.) 4 channels
- Oscilloscope, 250 MHz, 2 channels
- Six channel power analysers
- computerised data analysis system for analysis of oscillograms acquired during commercial and development tests
- Calibrator : High precision 7.5 digits multi-function, characterised by wide range coverage of DC voltage, DC current, AC current, frequency and resistance functions in a single unit for daily calibration of measurement links and periodic calibration of measuring instruments used in the test.
- High speed test processor : 4 input/output channels for synchronising the high current and high voltage source during synthetic testing.
- Circuit Breaker operational Analyser with Travel Characteristics Comparison Facility.

SYNTHETIC TESTING

FACILITY



7

+ RK

Method	: Parallel Current Injection
Injection Frequency	: 350 Hz to 1000 Hz
Injection Current	: 18 kA peak max.
TRV Circuit	: for two and four parameters as per IEC/Indian Standards
Main capacitor bank (C1)	: 400 kV, 18 μ F, 1.44 MJ
TRV capacitor bank (C2 & C3)	: 2.8 μ F/500 kV & 4 μ F/400 kV
Charger	: \pm 20 to \pm 440 kV DC
Spark Gap	: \pm 100kV to \pm 880 kV
Discharge Resistor	: 50 ohms
Reactor Banks	: Bank I - 0.1 to 400 mH Bank II - 0.1 to 200 mH
Damping Resistor	: 33 Ohms to 68 K Ohms

Two “Reignition Circuits” for prolonging the arcing time of the test breaker.

High Speed Making Device (For Synthetic Making Test Facility):

Rated upto 300 kV DC & 80 kA rms ; this device triggers automatically on pre-striking of test circuit breaker on closing.

SUPPLEMENTARY TESTS:

Facilities for conducting power frequency voltage withstand test, contact resistance measurement, winding resistance and inductance measurement, transformer turns ratio measurement, load-loss and no-load loss measurement & induced over voltage test on transformers, tapping loss for line traps, etc., are available with

certain limitations.

Facility for conducting mechanical endurance test on Circuit Breakers.

OTHER FACILITIES:

- **Assembly Room:**

For assembling the test equipment : It is equipped with a 10T EOT Crane and necessary material handling facilities.

- **Test Cells :**



- One explosion proof totally enclosed test cell of size L 28M x B 23M x H 22M provided with a 5T EOT crane for HV/ EHV Breaker testing, attached to Synthetic Test Facility.
- One outdoor test area of size L 12 M x B 10 M, for testing of Power transformers CTs, PTs and other oil filled apparatus.
- One outdoor test area exclusively for Power Arc Tests on insulator sets and also for testing of Line Traps, Reactors, LAs etc.
- One outdoor test area for LV switchgear and high current

+

tests upto 300 kA rms for Busducts, Disconnectors, Earth Switches etc.

- New MV Indoor test cell of size - L 20M x B 15M x H 13 M provided with 5 T EOT crane for direct test.

- **Auxiliary Power Supply**

- 0 - 300 V, 15 A DC

- 0 - 415 V, 250 A AC

- **Compressed Air supply :**

Available upto 200 bars for operation of the test apparatus and other purpose.

- **SF6 Gas Handling Facilities :**

Dry run compressor capacity of 5.7 cu.m/h with a final pressure of 50 bars and vacuum pump capacity of 16 cu.m/h with suction capacity less than 1 mill-bar.

- **Handling Facilities :**

- 8 T Mobile Crane,

- 5 and 10 T EOT Cranes

- 10 T Gantry Crane

- Fork lift (5T) truck

- **R&D Capabilities**

Development of interrupters, measurement systems for post arc current in circuit breakers, condition monitoring of circuit breakers, consultancy for setting up of short circuit laboratories.

+

SHORT CIRCUIT LABORATORY

The Short Circuit Laboratory has facilities to undertake tests for certification and development of low voltage switchgear and controlgear and other power system apparatus. The laboratory has 50 MVA short circuit test capacity.



The main power source to carryout the test at short circuit lab is a 50 MVA 12 kV 50 Hz 3-phase Short-circuit Generator coupled to a 3.3 kV, 750 kW slip-ring type induction motor. A DC generator is also coupled on the short-circuit generator shaft for excitation. The

S.C. generator is a salient pole machine with two windings per phase, which can be connected in either series or in parallel and also in star or delta connections as per the requirement. With this, four types of ratings viz., 3.46, 6.0, 6.93 and 12 kV supplying a short circuit currents of 8.34, 4.82, 4.17 and 2.41 kA respectively can be achieved. Along with the generator there are two 50 MVA Short-circuit Transformers to step down the voltage to the value required. One of the transformers is 12kV/415V and a Short-circuit current of 50 kA rms can be achieved at 456 Vrms recovery voltage. The other has taps both on the primary and the secondary. With that it is possible to test equipment up to 866V rating. This transformer is generally employed for testing MCBs, switches of all kinds and certain tests on fuse. The generator and transformers are specially designed to withstand repeated short circuits.

+

Apart from these, the lab has 12kV, 1250A, 40kA, breaking capacity of Vacuum Circuit Breakers which is used as the master breaker and a high-speed Make-switch with a point-on voltage wave closing facility. Resistor banks and Reactor (air-core) banks are available for adjusting the test current, power factor of the test circuit both on the source and load sides. The laboratory has also an ON-LINE testing facility.

A d.c. test facility is also available with which tests at 30kA.dc/600V & 3kA.dc/600V can be carried out. A 30kA d.c. for 3.0 seconds short-time currents test facility is also available at the lab.

The laboratory is equipped with modern digital measuring and recording systems. The high current measurements are made using non-inductive shunts (100kA, 10kA) and the voltages are measured using either resistive or capacitive voltage dividers or P.Ts. A digital waveform recorder with associated data acquisition system enables processing of the test data and preparation of test reports.



12

+RK

+

Testing & Certification :

Type tests and Routine tests on low voltage switchgears and controlgears, distribution transformers up to 11kV class and other power system apparatus can be undertaken in the Short Circuit Laboratory as per the relevant Indian Standards (IS) and International specifications (IEC, BS, CSA, UL, ANSI, IEEE)



Research & Development activities:

The laboratory undertakes applied research and helps in the development of indigenous products, mainly on low voltage switchgears and controlgears.



13

+RK

**Feasibility of Tests at Short Circuit Laboratory, CPRI, Bangalore for various Equipment
as per the IS / IEC / BS Standards / Publications/Specifications**

Sl.	Apparatus No.	Reference to	Nature of Test standards	Range of test
1.	Low Voltage Circuit Breaker	IEC : 60947-2 IA : 13947-2	<ul style="list-style-type: none"> Short Circuit Making and Breaking capacity** Overload Performance Short-time current Electrical Endurance 	<ul style="list-style-type: none"> AC 3 Phase - up to 50 kA upto 456V up to 20 kA upto 800V DC upto 30kA/400V AC upto 4/2 kA.rms@415/800V DC upto 5kA .dc/800 V AC- upto 50 kA. rms for 1.0 sec. & upto 30kA.rms for 3.0 secs DC upto 30kA.dc for 3.0 secs. AC upto 800 A.rms/460V DC upto 600A & upto 600V
2.	High Voltage Circuit Breaker	IEC : 62271 IS : 13118	<ul style="list-style-type: none"> Short-time current 	<ul style="list-style-type: none"> AC- upto 50kA.rms for 1.0 sec. & upto 30 kA.rms for 3.0 secs.
3.	Low Voltage Fuses [HBC/ HRC, Miniature]	IE : 60269 IS : 13703	<ul style="list-style-type: none"> Short Circuit Breaking capacity 	<ul style="list-style-type: none"> 50 kA upto 415V 20 kA upto 800V
4.	Circuit Breaker for Household application	IEC : 60898 IS : 8828	<ul style="list-style-type: none"> Short Circuit capacity All Type & Routine test 	<ul style="list-style-type: none"> AC 3 phase upto 25 kA / 456V upto 20 kA / 800V DC upto 30kA / 600 V

Sl.	Apparatus No.	Reference to	Nature of Test standards	Range of test
5.	Distribution Transformer	IEC : 60076 IEC : 60726 IS : 2026 IS : 1180 IS : 11171	<ul style="list-style-type: none"> Short Circuit [Dynamic & Thermal ability to withstand] All Type & Routine test. 	<ul style="list-style-type: none"> Upto 11kV Class Upto 500kVA rating
6.	Low Voltage Switches, Switch Fuse Combination units with HBC & Rewirable fuses.	IEC : 60947-3 IS : 13947-3	<ul style="list-style-type: none"> Rated fused short circuit current Rated making & breaking capacity, Short-time current Electrical Endurance Other Types tests 	<ul style="list-style-type: none"> AC 3 Phase upto 50kA / 456V upto 20kA upto 800V DC upto 30kA/600V AC upto 4/2 kA.rms@415/800V DC upto 3kA.dc/800V AC upto 50kA.rms for 1.0 sec. upto 30kA.dc for 3.0 secs. DC upto 30kA.dc for 3.0 secs. AC upto 800A.rms/600V DC upto 600A /600V
7.	Low Voltage Contractors/ Motor Starters	IEC : 60947-4-1 IS : 13947-4-1 UL : 508 C : 22.2	<ul style="list-style-type: none"> Rated making & breaking capacity Short-timecurrent Electrical Endurance All other Type & Routine test 	<ul style="list-style-type: none"> AC upto 4/2 kA.rms@415/800V DC upto 5kA.dc/600 V AC - upto 50kA.rms for 1.0 sec. & upto 30kA.rms for 3.0 secs. DC upto 30kA.dc for 3.0 secs. AC upto 800A.rms/600 V DC upto 600A / 600V

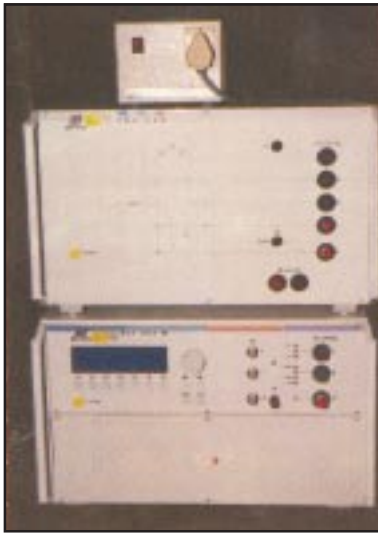
Sl.	Apparatus No.	Reference to	Nature of Test standards	Range of test
8.	Residual Current-operated	IEC :61008 IS : 12640 IEC :61009	<ul style="list-style-type: none"> All Type & Routine tests for AC type 	<ul style="list-style-type: none"> upto 10 kA rms
9.	Low Voltage Switchboard, Panel, Motor - Control Centre, system, Distin.-boards/pillars	IEC :60439 IS : 8623 IS : 5039	<ul style="list-style-type: none"> Short-time current 	<ul style="list-style-type: none"> AC 3 phase upto 50kA.rms for 1.0 sec. & upto 30kA.rms for 3.0 secs. AC 1 phase upto 35kA.rms for 1.0 sec. DC upto 30kA.rms for 3.0 sec.
10.	Reactor/ Line Traps Power Connectors Cable-Termination	IEC :60289 IS : 5553 IEC :60353 IS : 5561 IS : 13573	<ul style="list-style-type: none"> Short-time current 	<ul style="list-style-type: none"> AC 3 phase upto 50 kA.rms for 1 sec. & upto 30kA.rms for 3.0 secs. AC 1 phase upto 35 kA.rms for 1 sec. DC upto 30kA dc for 3.0 secs.

Sl.	Apparatus No.	Reference to	Nature of Test standards	Range of test
11.	Current Transformers Voltage Transformers	IEC :60044 IS : 2705 BS : 7626 IEC :60186 IS : 3156	<ul style="list-style-type: none"> Short-time current accuracy tests, all other type and routine tests Accuracy Test 	<ul style="list-style-type: none"> AC 1 phase upto 35 kA.rms for 1.0 sec. & upto 30kA.rms for 3.0 secs. upto 11 kV
12.	Energy Meters	IEC : 62052-11 62053-11 IS : 13779 14697,13010, 2675,13020	<ul style="list-style-type: none"> Short-time over current 	<ul style="list-style-type: none"> upto 10 kA
13.	HV Switchboard/ Panel	IEC :60694 Panel IS : 3427	<ul style="list-style-type: none"> Short-time current, IEC :62271-200 	<ul style="list-style-type: none"> AC 3 phase upto 50 kA.rms for 1.0 sec. & upto 30 kA.rms for 3.0 secs. DC upto 30kA.dc for 3.0 secs.
14.	HV Disconnecter /Isolators & Earth switch, HV Busduct	IS : 12729 IEC : 62271-102 IS : 9921 IS : 8084	<ul style="list-style-type: none"> Short-time current, DC 	<ul style="list-style-type: none"> AC 3 phase upto 50kA.rms for 1.0 sec. & upto 30kA.rms for 3.0 secs. upto 30kA.dc for 3.0 secs.

** Except Air Circuit Breakers (ACB)

Supplementary Tests Facility:

The laboratory has supplementary test facility to carryout tests, pre & post short-circuit tests, for the acceptance criteria. It is also equipped for other tests like temperature-rise test (up to 400A, 3 phase and 800A single phase), Electrical endurance test (up to 630 A, 436 V and up to 400A 690V) & Mechanical endurance test and some environmental tests (with climatic chambers up to 2.25 cubic metre capacity, from -40°C to +150°C temperature ranges & humidity control of 40% to 98%). as per IS:9000.



High voltage power frequency tests up to 100kV for 1min. & induced over-voltage tests up to 1000V @ 400Hz are possible to conduct at the supplementary tests laboratory. An impulse voltage generator (0-35 kV, 1.2/50 μ s) with the necessary measuring, recording systems are also available in the laboratory to perform test as per IEC 60060, IEC 61180 & IS 2071. Surge immunity facility is available to test LV equipment up to 3300A@8/20 μ s & impulse voltage up to 6.6kV@1.2/50 μ s as per IEC 61000-4-12.

Glow-wire tests (up to 960°C) and Ball Pressure tests can be done as per IEC 60695 & IS 11000.

Another ON-LINE testing set up is available for electrical endurance tests with two additional transformers of 500 and 1000kVA ratings.

Field Testing & Measurements :

The laboratory also undertakes the following measurement at site :

Sl. No.	Type of Test/ Measurement	Type of Equipment	Remarks
1.	Ratio error and Phase angle displacement, Turns Ratio, Composite error, Winding resistance Exciting current	Current Transformers	50ppm Standard CT.
2.	Turns Ratio	Voltage Transformers	
3.	No-load loss, Load loss, Turns Ratio, Winding resistance.	Distribution Transformers	These measurements can be performed at available power supply frequency.

The Short Circuit Laboratory is extensively used by the electrical industry and power utilities for testing, performance evaluation and certification of a large number of electrical equipment. The facility is also being used by the manufacturers for indigenous low voltage switchgear and controlgear development.

ELECTRICAL APPLIANCES TECHNOLOGY DIVISION

The objectives of the Electrical Appliances Technology Division is to provide testing & certification services and to take up R&D activities in the field of low voltage electrical power equipment enclosures and allied equipments. The division is playing a pivotal role in the development of electrical apparatus to be used in domestic, industrial and commercial sectors through the following seven laboratories.

1. **Ingress protection testing laboratory**

Ingress protection testing laboratory (IP lab) which undertakes tests of all electrical equipment enclosures, Rotating electrical equipment enclosures and Luminaires for their dust and water proofness as per IS:13947(part I)-1993/IEC-947-1(1988), IS:4691-1985, IEC:60529-2001-1989, IS:12063 1987 and IS:10322(part IV) - 1984.



2. **Flame proof testing laboratory**

Flame proof testing laboratory (FLP lab) which undertakes tests on Flame proof electrical equipment enclosures, intended for use in explosive hazard environments for their safety as per IS:2148-2004, IEC:60079-1 & IEC:60079-1 (2001-02)

3. **Fan testing laboratory**

Fan testing laboratory (Fan Lab) which undertakes tests on ceiling, table, pedestal fans as per IS:555-1979, IS :374-1979 and IS 1169-1967

4. **Rotating machine testing laboratory**

Rotating machine testing laboratory (RMT Lab) which undertakes tests on AC/DC machines upto 30 HP capacity as per IS:325, 996, 4722, 7539, and also temperature rise test on power components.

5. **Illumination laboratory**

Illumination laboratory undertakes tests on tubular fluorescent lamp, (TFL) as per IS:2418 (Part-1), conventional ballast for TFL (IS:1534 Part-1) Electronic ballast for TFL IS:13021 (Part 1&2) self balasted lamp (CFL) as per IS:15111 (Part-1&2) himinaises as per EN-60598-1 and similar items



6. **Battery testing laboratory**

Battery testing laboratory (BT Lab) which undertakes tests on automotive batteries and stationery cells as per IS:7372 and IS:1651.

7. **Domestic electrical appliances testing laboratory**

Domestic electrical appliances testing laboratory (DEA lab) which undertakes testing of household electrical appliances Like Heating appliances, Motor operated appliances as per relevant IS&IEC specifications. Also undertake testing of accessories like domestic switches, Sockets, plugs and conduits of insulating material as per relevant Standards / specifications.

Facilities are also available for undertaking power quality survey, and harmonic analysis through field measurements. Consultancy works undertaken on specific request from clients on problems connected with the above fields.

R&D capabilities:

Design & development of Domestic appliances, Luminaries and accessories, Electric fan regulators & improvement of electrodes in lead acid batteries.

Refrigerator Testing Laboratory

Central Power Research Institute, Bangalore has set up a new refrigerator testing laboratory with state of the art technology to test refrigerators of Direct Cooled (DC) and Frost Free (FF) type of capacity upto 350 litres at Electrical Appliance Technology Division.

The new test set up comprises of dust proof Environmental Walk In Chamber with floor space of 15ft x 10ft which can accommodate four samples which can be tested simultaneously. The environmental

conditions inside the chamber can be accurately adjusted with respect to temperatures from 10°C to 50°C, with humidity control from 10% RH to 98% RH and air velocity inside the chamber as per national and international standards.



The measuring instrumentation part consists of 48 channel programmable Data Acquisition System which accepts input from PT-100 temperature sensors used for measurement of temperatures inside the refrigerator and the environmental chamber, electrical parameters like power, energy consumption, voltage, current, frequency, power factor, etc. during the complete cycle of testing and all the above parameters are graphically represented on a real time basis.

The accuracy and repeatability of all the above instruments comply with national/ international standards and the requirements of Bureau of Energy Efficiency, Ministry of Power under their standards and labeling programme.

The refrigerator testing has been accredited by NABL to carry out tests in accordance with national and international standards like IS-1476: 2000, AS/NZS4474.1: 1997, ISO8561. This facility is open for commercial testing.

+

HIGH VOLTAGE DIVISION

The division comprises the following laboratories

- High Voltage Laboratory
- Pollution Laboratory
- Impulse Current Laboratory

The activities of High Voltage Division are

- Testing
- R&D
- Consultancy relevant to High Voltage Engineering

A. TESTING :

I. High Voltage Laboratory

The High Voltage Laboratory has dimensions of 54m (L) x 52m (W) x 42m (H) and an Outdoor Test Bay of area 55m x 55m equipped with a setup of 2 units of Cascade Transformers. Facilities are available for taking supply into the main laboratory for Indoor Tests.



Equipment available :

- Impulse voltage generator of 3 million volts. 150 kJ

+



- Impulse voltage generator of 1.2 million volts, 15 kJ
- Power frequency Cascade Transformers setup of 1200kV (ie. 2 nos. of 600 kV)
- Power frequency Transformers of 50 kV & 100 kV
- 600 kV Partial discharge free coupling capacitor
- Impulse Oscilloscopes (analog type) & peak voltmeters
- High resolution impulse analyzing system (Digital Oscilloscope)
- Steep front impulse measuring system
- One meter sphere gap of 1MV (Impulse & Power frequency voltages)
- Artificial rain equipment (small & big)
- 40 tonne Universal Testing Machine
- Hot & Cold bath for temperature cycle test
- Reference voltage divider 180 kV, AC/DC, 500 kV LI/SI

+

With the equipment installed at present, it is possible to undertake following tests on electrical equipment like power transformers, current transformers, potential transformers, air break switches, isolators, cables, bushings, insulators etc upto and including 400 kV system.

Types of Tests :

This Laboratory can undertake the following tests as per National & International Standards :

- Lightning impulse voltage tests upto 2,800 kV (Peak) level.
- Switching Impulse Voltage Dry & Wet Tests up to 1500 kV peak level.
- Steep front Impulse puncture test for insulators up to & including 33 kV insulators.
- Corona Inception and Extinction Test and RIV measurements upto & including 400 kV system
- Power frequency voltage Dry & Wet tests upto 1,000 kV (rms) level
- Porosity test
- Electro-Mechanical test upto 30 tonnes
- Mechanical performance/mechanical test upto 25 tonnes
- 24 hour mechanical test upto 25 tonnes
- Temperature cycle test on insulators upto & including 33 kV rating.
- Residual Voltage tests on full arrester upto 220 kV system at a maximum of 10 kA.
- Ferro Resonance tests on CVT at rated voltage upto 220 kV.
- Performance/Comparison tests on HV measuring Sytems.

+

II. Pollution Laboratory

The Pollution Laboratory has dimensions of 12M x 12M x 12M. An array of nozzles conforming to IEC specifications combined with a salt water pumping and air compressor provide the required salt fog. The power supply to the chamber is from one of the outdoor 600 kV, 2,000 kVA Cascade Transformers setup.



Equipment available :

- 600 kV, 3 Amperes AC source
- 100 kV, 6 Amperes AC source
- 150 kV, 1 Ampere DC source

With these equipment/facilities the Pollution Laboratory can carry out tests on insulators and insulator assemblies for systems upto and including 400 kV.

Types of Tests :

This Laboratory can undertake the following tests as per National & International Standards :

- Pollution test on insulators by salt fog/solid layer method upto 400 kV AC & 150 kV DC
- SF₆ Puncture withstand test facility for DC insulators
- Thermal runaway tests on insulators

+

- Ion migration test on DC insulators
- Salt fog tests on cable terminations
- Tracking & erosion tests on polymeric insulators as per IEC 61109-100 hours & 5000 hours.
- Pollution tests on single unit and two unit arresters as per IEC -60099-4, 2004.

III Impulse Current Laboratory

The Impulse Current Laboratory has been established in 1996 as a comprehensive test facility considering the importance of ZnO arresters which are being increasingly used by several Utilities. Its significance lies in the fact that, it has a unique Computer-controlled Impulse Current Generator incorporating all conceivable features in a single consolidated design and is perhaps the only one of its kind in this part of the world. All tests on ZnO blocks as per IEC 60099-4 and IS 3070 including accelerated ageing test and loss measurement on ZnO blocks can be carried out.



Impulse Current Generator 100 kV, 150 kJ

Equipment available :

- Impulse Current Generator of 100 kV, 150 kJ

Types of Tests :

This Laboratory can undertake the following tests as per National

+

& International Standards :

- All type tests on ZnO arrester blocks upto 11 kV

B. R&D ACTIVITIES :

- Corona and Radio Interference studies
- Pollution studies under AC & DC condition on insulators
- Pollution studies on zinc oxide surge arresters
- Ageing studies on RTV coated insulators and composite insulators
- Performance evaluation of polymeric insulators for its life expectancy
- Design & development of H.V. measuring systems e.g. voltage divider. Spherical electric Field strength meter, Ion current meter, low inductance resistive divider. Spherical electric steep-front impulses, Step Wave Generator, High Current shunts, Impulse measuring systems etc.
- Studies on Ion-migration in insulator under DC voltage
- Development of HVDC Insulators for optimal performance under polluted conditions

C. CONSULTANCY SERVICES

- Pollution level measurements at sites enrouting transmission line
- A.C. Electric and Magnetic field measurements under transmission lines and sub-stations
- D.C. Electric and Magnetic Field and Ionic current measurement under transmission lines and sub-stations
- Software for computation of Electric and Magnetic fields, corona loss, Radio Interference, Audible noise, etc for different configurations of transmission lines..

INSTRUMENTATION DIVISION

The Instrumentation Division is mainly engaged in contemporary R&D activities, Testing and Consultancy as indicated below:

RESEARCH & DEVELOPMENT:

Projects undertaken are by either CPRI or sponsored by Utilities, Government Institutions, Private organizations and small-scale industries (SSI). Technology transfer to interested entrepreneurs is done on systematically computed charges, terms and conditions.

The Division has been actively involved in R & D over the past two decades and has acquired expertise in the following areas:

- Energy Metering
- Condition Monitoring
- Power Electronics-Power Quality
- Power Sector Communication
- Protective Relay and Implementation of algorithms

Products have been developed in the above areas and technology for energy meter development is transferred to five manufacturers:

1. M/s. Accurate Meters Ltd., Noida
2. M/s. Seahorse Industries Ltd., Tiruchinappalli
3. M/s. B.B.S Electronics, Bangalore
4. M/s. Wellwin Industries, Chennai
5. M/s. Autometers Alliance Ltd., Noida

The following R & D projects are completed :

1. Prepaid Energy Meter
2. Street Light Controller.
3. Time Synchronizing Unit for EHV sub-station.



The technology know-how for Prepaid Energy meter is available for transfer.

Instrumentation Division has also recently completed R&D projects in the area of Automatic Meter Reading System and Field-testing of the Prepaid meters developed by ID in a distribution network.

The on-going projects in the Division are:

1. Total Metering System
2. Effect of Harmonic Influence on Electronic Energy meters

TESTING FACILITIES:

The Division has facilities for carrying out testing as per National & International Standards as indicated below:

- Energy Meter Testing Laboratory
- Relay testing Laboratory
- EMI/EMC Testing Laboratory
- Calibration Laboratory
- UPS Testing Laboratory

ENERGY METER TESTING LABORATORY (EMTL)

The EMTL is accredited by NABL & BIS. It is equipped to undertake TYPE/ACCEPTANCE/ROUTINE TESTING of both electromechanical and electronic meters of accuracy class 0.2 to 2

+

as per the following National & International Standards and their latest amendments.

1. IEC 62052-11:2003 - General requirements
2. IEC 62053-11:2003 - Electromechanical Meters
3. IEC 62053-21:2003 - Static Meters – Class 1.0 & 2.0
4. IEC 62053-22:2002 - Static Meters – Class 0.2 S & 0.5 S
5. IS 13010:2002 - Electromechanical Meters –
Class 0.5, 1.0 & 1.5
6. IS 13779:1999 - Static Meters – Class 1.0 & 2.0
7. IS 14697:1999 - Class 0.2 S & 0.5S
8. CBIP TR 88:1999 - [Central Board of Irrigation and
Power report]
- Class 0.2, 0.5, 1.0 & 1.5.
9. Facility for testing 0.1 and 0.05 Reference Standards.

The major equipments for Energy meter testing at CPRI are:

1. High precision Programmable AC Power source
2. Energy meter test gyr
3. Precision Reference energy standards of 0.02, 0.05, 0.1 class accuracy.



Keeping in view of the growing demand for EMI/EMC test facilities in the country and new mandatory requirements introduced in

+

various International product standards, CPRI has setup the comprehensive test facility for EMI/EMC compliance testing to cater the needs of Manufacturer / Industry. The laboratory is equipped with the state-of-the-art instrumentation, which complies with the requirements of International standards. The testing is performed automatically and controlled through software. The test facility available is also extended for developmental activity. EMI/EMC tests are conducted as per following National / International standards.

1. IEC : 61000-4-2, 1995 : Electrostatic Discharge immunity test
2. IEC : 61000-4-3, 1995 : Radiated radio frequency
Electromagnetic field immunity test
using GTEM cell.
(max. size 0.4mx0.4mx0.4m)
3. IEC : 61000-4-4, 1995 : Electrical fast transient / burst
immunity test
4. IEC : 61000-4-6, 1996 : Radio frequency immunity test
5. CISPR 14-1, : Radio frequency interference,
CISPR -1,16-2 Emission, Radiated emission
using Absorbing clamp,
GTEM cell and correlate the data
obtained to Open Area Test Site

Single phase / Three phase Static watt-hour meters, Electronic Trivector meters, Static protective relays, Electronic equipments are some of the equipments on which these tests are performed.



EMTL is well supported by CPRI's other laboratories for Vibration/ Shock tests, IP(Dust & Water) tests, Short time over current tests, Impulse test, Material Characterization, thereby comprehensive test facility for Energy meters under one roof is available for users.

RELAY TESTING LABORATORY

Protective relay is a device which maintains the power system equipments and gives an output under an abnormal condition to ensure protection of the system. The basic objective of the protective relay is to isolate the faulty section in a power system as quickly as possible so that rest of the system functions normally. It is necessary to ascertain security, reliability, quality, sensitivity and speed of relays.

Various tests are recommended in National and International Standards to check the withstand capacity of a relay during fault conditions. During testing, protective relay is made to undergo simulated field conditions to check its performance. The relevant National / International standards recommend many tests to ascertain the relays effectiveness to perform its intended function.

CPRI has set up a comprehensive test facility for Protective relays. The Relay Testing Laboratory is equipped with Automatic Computer controlled test benches for carrying out Accuracy and operating characteristics. Additional software is available for Dynamic/ Transient testing and import of fault data from EMTP simulation & Digital Fault Recorder is also possible. Electromechanical, static & Numerical relays can be tested at this laboratory. The laboratory is accredited by NABL and conforms to ISO 17025 requirements.

The standards followed for type tests are IS: 3231 series IS: 5834 series and IEC: 60255 series. All types of relays like Current / Voltage operated, Differential, Distance, Directional, Frequency & Power relays etc. can be tested. Some of the special tests recommended for Numerical relays like tests with Transient waveforms, harmonic waveforms, Dip & Interruption can also be tested.

- Facility is extended for Developmental testing.
- CPRI also undertakes relay testing at site.



CALIBRATION LABORATORY

CPRI has set up state-of-art calibration services, accredited as per NABL norms and conforms to ISO 17025 requirements in the area of Electro technical as per National / International standards. The services include calibration of following instruments:

- Digital & Analog Voltmeters, Ammeters, Multimeters, Wattmeters, Panel meters (both DC & AC), Frequency meters
- Digital Temperature indicators / Thermometers & Impulse measuring system
- Hot & Cold temperature baths

The laboratory is equipped with Fluke Model 5500A Multi-Product Calibrator. The 5500A Calibrator is a fully programmable precision source. In combination with 5500A Calibrator / 50 TURN COIL, clamp on meters can be calibrated upto 550 Amps AC / DC current.



UPS TESTING LABORATORY

Use of UPS has increased manifold in the recent past due to the deteriorated power quality, increased use of computers, communication and medical equipments. The quality of UPS available in the market is very poor due to the use of inferior technology and substandard materials to reduce the price.

In order to help the users to procure good UPS and for the manufacturer to improve the quality of UPS, CPRI has set up UPS testing facility at Bangalore which is operational since one decade.

Facilities are available for testing UPS and inverters up to 10 kVA. Higher kVA UPS and inverters can be tested at site. The tests are carried out as per the manufacturers' specification or the buyers' requirements.

CONSULTANCY:

- RLA / R&M / Field testing – C&I and Protective relays
- Third Party Inspection of Energy meters and Protective relays

INFORMATION TECHNOLOGY & IMPLEMENTATION DIVISION

This division is the backbone of all IT activities at CPRI which caters to both Software and Hardware needs of the organisation. The division is built with the state of the art dedicated servers which runs on various platforms like Sun Solaris, SCO Unix, Linux and Windows. We also maintain NAS storage devices. The division also takes care of the LAN built with fiber optic backbone and internet service.



The CPRI web site <http://www.cpri.in> is designed and maintained by us. The division has successfully implemented Digital Library and Knowledge Management System for CPRI. This is a portal for “Seeking and Sharing” knowledge among

CPRI fraternity. This is accessible not only by Bangalore unit but also by all remote units of CPRI through VPN.

COMMUNICATION PROTOCOL LABORATORY

This division has established the state of the art Communication Protocol Laboratory which is unique in its kind in this part of the world. This is the only laboratory available outside Europe. This laboratory is equipped with test tools for carrying out protocol conformance tests as per the following standards:-

- a) IEC – 62056 - For Energy Meters.
- b) IEC – 60870 - 5- 101 - For RTU
- c) IEC – 60870 - 5 -103 - For Protective equipment
- d) IEC – 60870 - 5 - 104 - For RTU

+

- e) IEC 60870-6 TASE. 2-ICCP - For Control Centre
- f) IEC – 61850 - For Communication Networks and systems in substation will be functioning from 4th November 2007.
- g) Modbus - For Relays, Energy Meters, RTU etc.
- h) DNP - For Relays, RTU etc

The laboratory has already tested Energy Meters from foreign and Indian manufacturers for IEC 62056 and Modbus compliance. The laboratory extends support for developmental assistance and certification testing.

The laboratory also offers consultancy on Automation related to substations, distribution automation, SCADA etc., to all major utilities in the country. The laboratory also conduct training, seminar and conferences both at national and international level frequently to be ahead of the technology by updating our personal and also for personal from utilities, manufacturers, industry, educational institutions, etc from India and overseas.

CPRI has become a corporate member in International bodies such as UCAIUG (Utility communication Architecture International User Group), DNP (Distributed Network Protocol) User group, Modbus & OPC foundation etc. With this arrangement the test carried out in CPRI is of international standards and would be useful to manufacturers for marketing their products overseas.



A view of the Protocol laboratory

+

DIAGNOSTICS, CABLES & CAPACITORS DIVISION

The Diagnostic, Cables and Capacitors Division is mainly engaged in testing, consultancy and research & development activities relating to cables, capacitors, diagnostic testing of HV substation & power station equipment. The Division is also equipped with the facilities for temperature rise test and insulating materials testing.

The Division consists of the following Laboratories:

- Insulation Diagnostics Laboratory.
- Cables Laboratory.
- Capacitors Laboratory.
- Heat Run Test Laboratory.
- Flame Retardant Low Smoke (FRLS) Laboratory.

INSULATION DIAGNOSTICS LABORATORY:

Consultancy: The Laboratory has been rendering consultancy and field engineering services in the area of diagnostic testing of High Voltage substation and power plant electrical equipment. The activity involves condition assessment of insulation systems of the following substation/power plant electrical equipment.

- Turbo generators & associated electrical system.
- Hydro generators & associated electrical system
- HV motors
- Power transformers & HV Bushings
- Switchyard equipments like CTs, CVTs, PTs, LAs
- Power cables
- Bus bar insulation
- Resin cast CTs/PTs

The diagnostic field tests include the following:

Product/Apparatus:**Type of Tests conducted:****Hydro/Turbo Generators****Stator :**

- Dielectric loss angle (Tan delta) at 50 Hz
- Capacitance at 50 Hz
- Partial Discharge Test
- DC Leakage Current Test
- Insulation Resistance / Polarization Index Test
- Conductor Resistance Test
- Surge Comparison Test
- Electromagnetic Core Imperfection Detection (ELCID)
- Wedge Mapping test

Rotor :

- Insulation Resistance / Polarization Index Test
- RSO test
- Conductor Resistance Test
- Field Impedance

Power transformers

- Frequency Domain Analysis
- Dielectric Loss Angle at 50Hz
- Insulation Resistance / Polarization Index Test
- Capacitance at 50 Hz
- Recovery voltage measurement
- Surge comparison test
- Partial discharge test.
- Winding resistance measurement
- Transformer turns ratio
- Magnetic Balance test
- Step Voltage test

HV Motors

- Stator
- Dielectric loss angle at 50 Hz
- Capacitance at 50 Hz
- Partial discharge test
- DC leakage current test
- Insulation Resistance / Polarization Index Test
- Conductor resistance test
- Surge comparison test

Power cables

- Frequency domain analysis
- Dielectric loss angle at 0.1Hz (VLF test)
- Capacitance at 0.1Hz
- DC leakage test

EHV CTs/CVTs:

- Dielectric loss angle at 50Hz
- Insulation Resistance / Polarization Index Test
- Capacitance at 50Hz

Resin cast CTs

- Insulation resistance test
- Dielectric loss angle at 50Hz
- Capacitance at 50Hz
- Partial discharge test

Resin cast PTs

- Partial discharge test

Further in addition to the above, recently developed advanced techniques are employed for Residual Life Assessment (RLA) / Life Extension (LE) studies and appropriate remedial measures are suggested for Renovation & Modernization (R&M) of power plant.

+

Test equipment/sources

Mobile field-testing van equipped with the following test equipment:

- Electromagnetic core imperfection detector (ELCID)
- HV dielectric spectroscopy
- High voltage, 0.1 Hz cable diagnosis system (VLF)
- Transformer ratio arm bridge
- Automatic tan delta & capacitance test system & resonating inductor
- Standard capacitor, 80 KV
- Precision microprocessor based insulation tester, up to 5 KV
- Surge comparison tester -12KV
- HVDC test kit -70 KV
- Digital partial discharge detector system
- Recovery voltage meter
- Rotor Reflectometer
- Electronic wedge tightness detector
- Transformer winding resistance meter
- Testing transformers



CPRI Mobile Field testing laboratory



Partial Discharge Measurement on Turbo Generator Stator Winding



ELCID Test on Turbo Generator Stator Core

Laboratory Testing:

- Stator bars/coils of HV generators/motors
- Stator windings of HV motors
 - Polarization index (P.I) test
 - Tan delta & capacitance test

+



Diagnostic testing of HV Motor



RVM Test on Generator Transformer



Diagnostic Testing of Sub-station equipment



Diagnostic testing of Power Transformer

- Partial discharge (P.D) test
- Surge comparison test

LT motors for surge comparison test.

R & D Capabilities:

The Laboratory has experience & expertise to carry out detailed functional evaluation on various insulation systems like,

- Paper-oil insulation system
- Power Cable insulation system
- Rotating machine insulation system
 - Accelerated ageing studies on transformer insulation system.
 - Frequency domain diagnostic technique to evaluate the extent of insulation degradation in power equipment in service (HV dielectric Spectroscopy).

CABLES LABORATORY

TESTING is the major activity.

Test Facilities:

- Testing of underground Power Cables & accessories like indoor & outdoor terminations and straight through joints, XLPE cables upto 220 kV rating.
- Paper insulated lead sheathed cables, upto 33 kV rating.
- Elastometer insulated cables from 3.3 kV to 33 kV rating
- PVC insulated and PVC sheathed electric cables from 1.1 kV to 11 kV rating.
- P.D tests on CTs, LAs, bushings upto 132 kV rating.
- Tan delta measurements on CTs, Bushings upto 220 kV rating.
- Impulse tests on Power Cables ,Capacitors etc. upto 66 kV rating.
- Field testing of XLPE Cables. Capacitance measurement, conductor resistance & sheath resistance measurements.

Test equipments/sources:

- 600 kV, 600 kVA Partial discharge free series Resonant test set.
- 100 kV, 20 kVA (P.D) Partial discharge free test source and associated accessories.
- Partial discharge measuring and analysing system, ERA model and pulse discrimination system.
- 500 kV, 15 kJ Impulse voltage generator
- Micro processed based capacitance and tan delta bridges, transformer ratio arm bridges, the standard capacitors upto 600 kV for dielectric loss measurement of High Voltage Insulation.

- High Voltage A.C. sources with associated regulators and controls upto 300 kV, 120 kVA.
- High Precision automatic insulation resistance measuring kit.
- 200 kV water termination for testing of EHV cables.
- Splicing machines for preparation of cable insulation samples for physical tests.
- Electronic weighing balance 200gm of 0.1 mg accuracy.
- Profile projector of magnification upto 100.

Consultancy:

- Failure analysis of Power Cables .
- Failure analysis of Power Cable Accessories.

Research & Development Capabilities:

- Any specific problem on Power Cables & accessories.



+

POWER CAPACITORS LABORATORY

Power Capacitors Laboratory of CPRI, Bangalore has state-of-the-art facilities to cater to the requirements of Capacitor Manufacturers within the country and abroad for Research, Testing and Evaluation of Power Capacitors which have



applications as shunt capacitors, series capacitors, surge protection capacitors, motor capacitors, fan capacitors, fluorescent capacitors, etc. Tests are carried out as per National and International Standards and also developmental tests as per Customers' requirement. The laboratory is first of its kind in this part of the world.

Resources:

- Parallel Resonance Transformer of Rating: 50/40/30/20 kV ac, 6.8 MVA.
- Parallel Resonance Transformer rating: 70/38/16.5/7.1 kV ac, 1750KVA.
- HVDC Source of rating: 150 kV 500 mA.
- Discharge current test setup for Series Capacitors
- 3 Phase Transformer of rating: 975 KVA, 2.5kV ac.
- High Accuracy Capacitance/tan delta bridge system: Accuracy: 3.5×10^{-5} .
- Standard Capacitor: 1000 pF, 25 kV.
- Precision Current Comparator up to 5000A.
- Hot Air Oven: 1.8m x 1.8m x 2.0m (W x D x H), Ambient to 150°C, $\pm 1^\circ\text{C}$.
- Climatic Chamber: Size: 2m x 2.2 m x 2.5 m (W x D x H), Temperature: - 70°C to +100°C $\pm 1^\circ\text{C}$, Humidity: 10% to

+

95% \pm 2% RH.

- Impulse generator of rating: 500 kV, 15 KJ for HV capacitors
- Impulse generator of rating 35kV, 100 Joules for LV Capacitors,
- Storage oscilloscope (500 MHz), Scope-corder & Scope-meter
- Harmonic Generator up to 6kVA, 570V, 3ph, Harmonic generation up to 24th order.

Major Test Facilities:

- Output test / Capacitance & tan delta test
- High Voltage Tests
- Short Circuit discharge test
- Test of discharge device
- Thermal stability test
- Sealing test
- Impulse voltage withstand test
- Self healing test on MPP capacitors
- HV test for MPP capacitors
- Charge discharge test on LV capacitors
- Destruction test on LV capacitors
- Discharge current test for Series capacitors
- Disconnecting test on Internal fuses
- Electrical Endurance test for HV capacitors: Over voltage cycle test & Ageing test
- Endurance test on LV capacitors: Ageing test, Charge discharge cycle test and Destruction test
- Environmental tests on various equipments: Electrical, Mechanical, Automobile, Medical, ATMs, etc.

Type & Range of capacitors those can be tested:

Capacitor	Maximum Rating	Standard
HV Shunt capacitors (For Routine & Type tests)	3500 kvar, 16 kV, 50 μ F	IS 13925 Pt 1 –1998 IEC 60871 Pt 1 – 2005 IEEE Std. 18 – 2002
HV Shunt capacitors (For Endurance test)	1000 kvar, 20 kV , 8 μ F 1000 kvar, 9 kV, 50 μ F	IEC 60871 Pt 2 – 1999 IS 13925 Pt 2-2002
HV Series capacitors (For Routine & Type tests)	3500 kvar, 20 kV, 50 μ F	IEC 60143 – 1: 2004
HV Series capacitors (For Cold duty test)	1000 kvar, 16 kV, 8 μ F	IEC 60143 – 1: 2004
HV Capacitors for surge Protection (Reaffirmed Mar 2006).	0.33 μ F, 40 kV	IS 11548 - 1986
LV Motor capacitors	100 x 10 μ F, 440 V ac	IS 2993 – 1998. IEC60252 -1-2001
LV fan motor Capacitors (Reaffirmed March 06 Amendment No. 2)	100 x 10 μ F, 440 V ac	IS 1709 - 1984
LV Capacitors for Lighting	100 x 10 μ F, 440 V ac (Reaffirmed 2001)	IS 1569-1976 IEC 61048:1991, IEC 61049: 1991.
LV Power capacitors of self-healing type	100 kvar, 600 V ac 13341:1992	IS 13340:1993, IS IEC 60831(Pt.1):2004 IEC 60831(Pt.2):1995
LV Shunt capacitors of non self - healing type	100 kvar, 440 V ac	IS 13585 – 1:1994 IEC 60931(Pt.1):1996 IEC 60931(Pt.2):1995 IEC 60931(Pt.3):1996

ENVIRONMENTAL TESTS

Environmental tests are carried out on various electrical and non electrical equipment as per IEC 62271-100, IEC 60932, TEC-QM 333, etc.

- Low and High temperature test
- Humidity cycle test
- Thermal shock test
- Measurement of temperature coefficient of capacitance and tan delta, etc.,

R & D CAPABILITIES AND CONSULTANCY SERVICES

- Performance Evaluation of HT capacitor banks under switching Transients.
- Long term performance of LV& HV capacitors under simulated service conditions.
- Root cause analysis of failure of capacitor banks
- Performance Evaluation of LT Capacitors under Harmonics / Transients.
- Consultancy Services for Detection and Location (3D) of partial Discharges in electrical equipment like power transformers, power capacitors, etc. using Acoustic Emission Technique.
- Field engineering services for On-Line partial discharge measurement on power transformers in services.
- Laboratory can also help manufacturers for development of new types of capacitors for application and power sector.

Any specific problem of Power Capacitor Manufacturers, Utilities, Academic Institutions etc.

+



A view of HV capacitor test-bay



LV Capacitor Test Bay



6800 KVA, 50 kV Resonance Test System



Discharge current test setup for series capacitors



Arrangement for Ageing test.



Testing of Capacitor module of 66 kV CVT to determine Temperature Co-efficient of Capacitance at temperatures from -25 °C to 80 °C.

+

HEAT RUN TEST LABORATORY

TESTING is the major activity

Test Facility

Temperature rise test upto 3200 Amps Milli volt drop & resistance tests (wherever applicable) from 1.0 micro ohms to 20 kilo Ohms can be conducted on the following equipment, as per Indian (BIS) IEC, ANSI of ASTA standards.

- Distribution Boards
- LT & HT Busducts
- Isolators
- Circuit Breakers
- Control Panels
- Switches & Connectors
- CTs & PTs
- OLTCs
- Overhead Conductors & Connectors
- Heat cycle test on Conductors for Overhead Power lines, metal fittings of insulators for overhead Power lines, insulator & Conductor fittings of overhead Power lines
- Current cycle test on Electrical connector for Overhead conductors

The laboratory has been accredited by :

1. National Accreditation Board for Testing and Calibration
2. IEC EE CB scheme
3. Bureau of Indian Standards (BIS) Scheme
4. ASTABEAB certification Services, U.K.

+

FLAME RETARDANT LOW SMOKE (FRLS) LABORATORY

TESTING is the major activity

Test Facilities:

The Flame retardant low smoke cables laboratory carryout fire reaction tests on electric cables, insulating and composite materials like PVC/XLPE cable insulation/ sheath materials, fibre reinforced composite materials used for cable tray, channels; feeder pillar boxes, bushings, supporting insulators, energy meters, PVC conduit pipes, flooring materials, fabrics, and materials used in aerospace etc. Some of the important test facilities include

- Limiting Oxygen Index (Ignition property of Plastics) as per ASTM D2863, NCD1410, IS10810 (P-58), IS13501
- Temperature Index (Temp withstand before ignition) as per ASTM D2863, IS10810 (P-64)
- HCL (Acid gas content in plastics) as per IEC 754-1
- Zero Halogen Acid Test by PH & conductivity as per IEC 754-2
- Smoke Density (smoke evolved, and light transmission, visibility under fire)
 - As per ASTM D 2843, ASTM E 662, IEC 601034, IS 10810 (P-63) standards.
- Fire resistance test (Circuit integrity under fire conditions) as per IEC 331
- Flammability Test (The property of propagating fire) as per ASTM, UL, IS and Canadian standards

Toxity Index Test :

- To determine and quantify the various toxic gases released during combustion of electric cables as per NCD 1409 and NES 713 standards

+

Cone Calorimeter Test:



- To characterize the unwanted fire by determining the various parameters like
 - Rate of heat release
 - Rate of heat release per unit area
 - Mass loss rates
 - Time-to ignition
 - Effective heat of combustion Rates of release of toxic gas release
 - Critical ignition flux as per ISO 5660 and ASME1354 standards



NBS smoke box

INSULATION LABORATORY

The Dielectric laboratory has comprehensive testing and evaluation facilities on insulating materials and systems. Insulating materials are evaluated and tested for electrical, mechanical, physical and electro chemical properties. The Dielectric laboratory has undertaken consultancy work and sponsored projects for different power utilities and industries. Evaluation of class “H” insulation for traction motors and compatibility studies on enameled winding wires and varnished were two projects completed for RDSO, Ministry of Railways. Assistance has been rendered to BIS in formulation of various standards on insulating materials and systems and on enameled winding wires and has rendered consultancy employing FEM approach.

Facilities available:

- Micro processor based UTM 50KN capacity (-70°C to 200°C).
- High resistance meter upto $10^{-16}\Omega$
- Automatic tracking comparator upto 1000VAC.
- Arc resistance tester.
- Rubber glove tester
- Power frequency capacitance and dissipation factor measuring bridges
- High frequency capacitance and dissipation factor measuring bridges
- Electrometer
- High pressure chamber for conducting investigation on gaseous dielectrics upto 5 bars
- Static Decay meter
- Tear Tester

- Surface Roughness Meter
- Impact Tester
- Stress Cracking Equipment
- Compression Molding machine (400°C)
- Micro - ohm Meter
- Liquid contaminant tracking and erosion test equipment

AREAS OF WORK

- Electrical and mechanical tests on conductors, electrical, mechanical and chemical tests on various solid insulating materials like paper, press board, polymeric molding materials. B stage epoxy mica and epoxy glass materials etc.
- Ageing studies on insulating materials
- Electrical tests on cable filling compound, capacitor fluids etc.
- Tests on Teflon, polypropylene, polyester, kapton films.
- Electrical tests on antistatic materials.
- Electro static field computations using FEM.

DIELECTRIC MATERIALS DIVISION

1. LIQUID DIELECTRICS LABORATORY

The activities are :

- (i) Testing and certification of new insulating oil for transformer as per IS:335(93) and IS: 12463(88) for acceptance purposes.
- (ii) Evaluation of service oil as per IS : 1866 - 2000 for maintenance purposes.

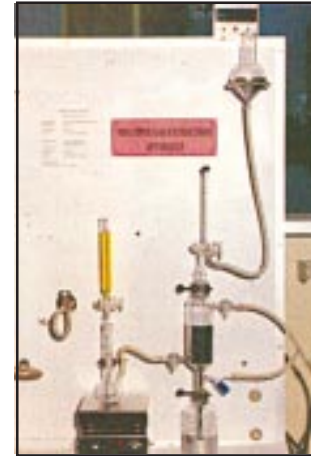
The major test equipment available are :

1. Breakdown voltage tester.
2. Dielectric dissipation factor measuring equipment.
3. Megohmmeter for measuring volume resistivity.
4. Tensiometer for measuring interfacial tension.
5. Moisture analyser.
6. Oxidation stability test set up (also as per IEC & BS)
7. Ageing characteristics determination setup.
8. Flash point determination apparatus.
9. Cloud & Pour point determination apparatus.
10. Oxidation Inhibitor Analysis facility.
11. UV and Visible Spectrophotometer.
12. Fourier transform infrared spectrophotometer.
13. High Performance Liquid Chromatograph.

Gas Chromatography Laboratory

The role of this laboratory is to analyse dissolved gases present in the oil of an operating transformer in order to detect internal faults if any in the transformer. The equipment used is a gas solid

chromatograph with extraction system. CPRI has also developed a low cost portable gas chromatograph to carry out test and assess the internal condition of transformer at site. The test covers preventive, predictive and corrective maintenance of transformers.



Condition assessment of solid insulation by Furan analysis

A new test facility has been created at CPRI in which condition of solid insulation can be assessed by analysing the degradation products of paper and pressboard in oil called furanic compounds using High performance liquid chromatograph (HPLC). From this test it is possible to assess the remaining life of transformer.

Suitable remedial measures can be taken depending upon the condition assessment.

Furanic compounds namely 5-Hydroxy methyl-2-furfural, 2-Furfural, 2-Acetylfuran, 5-Methyl-2-furfural and 2-furfuryl alcohol were analysed by HPLC. Using the statistical data available and range of furanic concentrations, assessment of solid insulation as healthy, initiation of degradation, degradation stage & low reliability stages and failure stages can be made.

Mobile Transformer Oil Test Facility

This mobile laboratory has all facilities including dissolved gas analysis to evaluate transformer oil samples at site as per IS : 1866-2000.



The major test equipments available are :

1. Breakdown voltage tester.
2. Dielectric Dissipation Factor measuring equipment.
3. Megohmmeter for measuring volume resistivity.
4. Tensiometer for measuring interfacial tension.
5. Moisture analyser for determining water content of transformer oil.
6. Flash point determination apparatus.
7. Gas Chromatograph.
8. Facility for acidity and sludge content determination.

The advantage of the mobile transformer oil test facility is that at a single electrical installation having large number (50-100) of transformers, both oil quality and transformer internal condition can be assessed in a short time of 10-15 days.

CPRI has entered into contract with KPCL, for undertaking oil testing at site for various transformers of respective substations.

Pilot Plant

The laboratory has established an all stainless steel plant for synthesis of dielectric liquids for use in power equipment such as capacitors, also established pilot plant for synthesis of Epoxy Novaloc and reclamation of Transformer oil.

2. LUBRICATING OIL LABORATORY

The laboratory has been set up to meet the quality assessment needs of industrial lubricating oils, turbine oils, etc.

The major test equipment available are:

- Aniline point apparatus.
- Apparatus for determining foaming characteristics.

- Water separability testing apparatus.
- Demusibility testing apparatus
- Cleveland open cup flash point determination apparatus.
- Oxidation stability test set up for steam turbine oils.
- Ramsbottom Carbon residue apparatus
- Apparatus for testing rust prevention characteristics
- Particle sizing and counting apparatus.

3. POLYMER LABORATORY

The polymer laboratory is involved in R&D of polymeric insulating materials for electric equipment. Wide range of thermoplastics and thermosets are extensively used as insulators, bushings, laminates, rods, tubes, support components, cables, sheathing sleeves etc., in power equipment. Improvement of the existing and development of the new processes and techniques constitute the R&D work of polymer laboratory which provides a guide to selection and development of polymeric materials made for specific requirements. The laboratory is currently involved in developing the flame retardant low smoke (FRLS) cable materials based on halogen & non-halogen polymers for cable applications. Investigations are being carried out to evaluate the factors such as environmental stability, heat resistance, flammability, mechanical and processing of polymer & other related systems. Polymer laboratory has well experienced technical personnel to advise polymer industries in setting up plants, process improvement, etc.

A. Polymer Processing

1. Brabender Plastic order.
2. Compression Moulding Press.
3. Laboratory synthesis of resins



+

B. Polymer Testing

- Brooke Field Viscometer
- Heat Distortion Temperature Apparatus
- Vicat Softening Point Apparatus
- Thermal Conductivity Apparatus (Thermoflizer)
- Melt Flow Indexer
- Density Gradient Column
- Environmental Stress Cracking Apparatus
- Gel Timer
- Shore D hardness tester
- Mooney Viscometer

C. Polymer Analysis

- Differential Scanning Calorimetry
- High temperature Thermogravimetric (TG)/Differential Thermal Analyser
- Fourier transform infrared spectrophotometer (FTIR)
- TG FTIR Hyphenated system

Specialised Polymer Services

1. TGA for determination of:

- (a) Ash content
- (b) Filler content
- (c) Thermal decomposition
- (d) Decomposition kinetics
- (e) Thermal rating.

+

2. DSC for the measurement of:

- (a) Glass transition temperature (T_g)
- (b) Crystallinity
- (c) Specific Heat
- (d) Oxidation induction time.
- (e) Cure studies of resin systems.
- (f) Melt temperature.

3. FTIR/ATR for the analysis of:

- (a) Samples in the form of liquid, powder and sheet/film
- (b) Transformer oil
- (c) Lubricants

4. TGA - FTIR for evolved gas analysis of the decomposed products.

5. The laboratory has set up all stainless steel pilot plant for manufacture of resins.

MATERIALS TECHNOLOGY DIVISION

The Materials Technology Division of CPRI is equipped with advanced and sophisticated materials evaluation facilities aimed at providing testing and consultancy services in the areas of materials engineering for the power sector, coal and other fuels, polymers, wear and corrosion resistant materials, ceramic materials and field services in the area of energy and environment including industrial solid waste utilization. The R & D areas are addressed to meet the requirements of the power sector. The major laboratories of the division are grouped as:

- Coal Analysis and Testing Laboratory.
- Analytical Facilities including Scanning Electron Microscopy, X-Ray Diffractometer, Particle Characterization and Spectroscopy.
- Materials engineering and Characterization including wear, Mechanical Properties, NDT and Failure Analysis.
- Corrosion Engineering and Accelerated Weathering Tests,
- Centre for Industrial Solid Waste Utilization.

THRUST AREAS OF RESEARCH

- Improvements in the life expectancy of components subject to heat, wear, erosion and corrosion.
- Fuel combustion reactivity studies and correlation with compositions.
- High technology ceramics and coatings for thermal shock and thermal barrier applications.
- Analytical Engineering Studies involving Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD).
- Value added products from Fly Ash and separation of Alumina, Magnetic and Cenosphere for high technology applications.
- Marble waste utilization for value added products.

- Remaining Life Assessment programmes for power plants.

CONSULTANCY AND TESTING SERVICES

Materials Characterization and Conditions Assessment in Thermal Power Plants.

- Remaining Life Assessment, Corrosion Mapping and inspection of pipes & hangers in thermal plants
- Environmental impact assessment of thermal plants and industries.
- Extensive material property Characterisation (SEM, EDAX, XRD, and ICP-AES).
- Failure Analysis of Engineering components.
- Condition monitoring of lubricating systems.
- Evaluations of wear life of components.
- Tribological Studies on metallic, polymer and ceramic systems.
- FEM and CFD analysis for stress, heat transfer, fluid flow and fatigue applications.
- Abrasive species characterization in coal and ash.
- Metallography and Image Analysis.
- Experimental fatigue and fracture toughness evaluation of materials.
- Fatigue testing of components.
- Preparation and evaluation of experimental alloys (melting and casting).
- Novel processing and application of Plasma Sprayable Powders.



+

- Remaining Life Evaluation of plant components.
- Field Metallography and NDE.
- Residual Stress Measurement.
- Particle/Powder characterization.
- Corrosion behaviour of materials.
- Artificial ageing of metallic and non- metallic materials using Weatherometer.
- Water analysis for physical and chemical properties.
- Blended Coal Firing Studies.
- Design and Development of Instrumented Drop Tube Furnace for coal combustion studies.
- Coal Abrasion Index (YGP) test rigs for Coal wear parameters.

Centre for Industrial Solid Waster Utilization:

- Comprehensive characterization of fly ash, bottom ash and pond ash.
- Trace metal analysis of coal, ash and effluent water.



+

- Manufacture of fly ash based cost effective building materials.
- Preparation of perspective plan for utilization and safe disposal of coal and ash and other industrial solid wastes.

MARKETABLE TECHNOLOGIES:

- Surface coatings for T & D hardware in saline environment.
- Technology for evaluation of solid particle erosion resistance.
- Cost effective techniques of preparing plasma sprayable powder for wear, corrosion and thermal barrier applications.
- Thermal shock resistant ceramics.
- Wear life estimation of engineering components.
- Building materials like bricks, blocks, tiles, and aggregates using industrial solid waste.
- Recovery of magnetite, alumina, cenospheres for high tech applications.
- Coal Abrasion Index facility
- Design and Development of Instrumented Drop Tube Furnace.

MAJOR FACILITIES AVAILABLE

Electron Microscopy:

- Scanning Electron Microscope (LEICA 4401).
- Energy Dispersive Spectrometer and Image Analyzer.



X-ray Testing:

- X-Ray Diffractometer (Panalytical).
- Residual Stress Analysis (Rigaku).
- X-Ray Fluorescence spectrometer (Panalytical)



+

Spectroscopy:

- Inductively Coupled Plasma Emission Spectrometer.
- UV/Visible Spectrometer.
- FT/IR Spectrometer.
- Polyvac 2000 Optical Emission Spectrometer for elemental analysis.

Particle Sizing & Analysis:

- Laser Beam Particle Sizer.
- Surface Area Analyser.
- Tap Density meter.
- Ultra Pycnometer.
- Porosity Meter.

Corrosion Testing & Analysis:

- Galvanostat and Potentiostat (EG & G).
- Weiss Umwelttechnik GMBH Corrosion Chamber & CM Equipment Silver Fog corrosion chamber.
- Atlas CI 4000 Weathermeter.

Mechanical Testing:

- Servo Hydraulic dynamic Testing Machine (10T & 5T).
- Instrumented Impact Tester (Dynatup).
- Comprehensive Hardness Testing Machines (Micro, Brinell, Vickers, Rockwell) (Zwic/Instron-Wolpert).
- Creep Testing Machine (SATEC).

Thermal Analysis:

- Thermal Analysis (TGA, DTA, TMA).
- Differential Scanning Calorimeter.
- Thermal Conductivity Apparatus.

+

Coal Testing & Analysis:

- Proximate Analysis.
- Ultimate analysis.
- Calorific Value.
- Abrasion Index.
- Hard grove Index
- Ash Fusion Temperature.
- Sulphur Analysis in coal.



Lubricant Testing & Analysis:

- Aniline Point Apparatus.
- Copper Strip Corrosion Tester.
- Foaming Test Apparatus.
- Demulsibility Apparatus.
- Rams Bottom Apparatus.
- Water Separability Apparatus.
- Laser Beam Particle Counter.

Metallography:

- High Resolution Microscope.
- Image Analyzer
- Field Metallography.

Tribology:

- Rubber Wheel Abrader.
- Pin-on-Disc Machine.
- Jet Erosion Set up.
- Tunnel Erosion set up.
- Flow Factor Tester.

- Four Ball Wear Tester.
- High Speed Tribometer.
- Multi-purpose Friction Wear Tester.
- Taber Abrader.

Fuel Evaluation:

- Burning Profile of Fuels.
- Ash Composition Evaluation.
- Combustion Evaluation of Coal and Biomass using Drop Tube Furnace and DTG based Activation Energy.

Centre for Industrial Solid Waste Utilization:

- Processing Equipment.
- Mixer, Grinder, Pelletizer, Granulator, Autoclave and High Temperature Furnace for processing for products development using Industrial Solid Waste.

Analytical Modeling and Evaluation:

- Finite Elemental Analysis (FEA).
- Computational Fluid Dynamics (CFD).
- NDE Test facilities.

Other Facilities:

- Experimental melting, casting and heat treatment laboratory.
- Polymer processing and evaluation.
- Magnetic Particle Inspection (MPI).
- Kraut Krammer USD-15, USN-60 ultrasonic flaw detectors.
- Isonic 2001 R Ultrasonic flaw detector with timed 'B' Scan facility.
- Dye Penetrant Inspection (DPI).
- In situ Steam side oxide scale measurement by ultrasonic Technique.

MECHANICAL ENGINEERING DIVISION

This division is engaged in the study of Mechanical Engineering problems in the electric power transmission systems so as to achieve economy & reliability and also offer solutions for the recurrent problems experienced by the electrical utilities. Design & Consultancy services for evolving optimized tower designs are also undertaken. In addition, this division has got the following laboratories to conduct R&D work and also to provide testing facilities to the manufacturers of transmission towers, line components & accessories etc.

The Mechanical Engineering Division of CPRI has been accredited by the "National Accreditation Board for Testing and Calibration Laboratories" (NABL), Govt. of India, on the basis of its compliance to ISO/IEC: 17025 series in the field of mechanical testing. Mechanical Engineering division consists of the following laboratories.

● TOWER TESTING STATION (TTS)

- Proto Type Tower Testing Station
- Structural Material Testing Laboratory
- Design Cell/Consultancy Services
- Model Tower Testing Laboratory
- Tower Foundation testing Centre

● VIBRATION LABORATORY

- Vibration Laboratory (40 m Span)
- Wake Simulation Laboratory (80 m Span)
- Type Test facilities for ACSR/AAAC Conductors
- Field Vibration measurement facility

TOWER TESTING STATION (TTS)

To provide adequate tower testing facilities in Public Sector, CPRI set up its Tower Testing Station in 1976. This Station is open for commercial tests as well as for R&D oriented tests. The decision of the CPRI in setting up the Tower Testing Station has been fully justified since there is huge demand for tower tests. Already more than 400 towers had been successfully tested within a span of 30 years as per Indian & International Standards.

PROTO TYPE TOWER TESTING STATION (PTTS)

- A test bed with Permanent Footings to withstand the loads like Uplift, Compression, Bending, Torsional Moments and Shears etc.
- Permanent Anchor Structures of adequate capacity to take Transverse, Longitudinal and Vertical pulls to be applied on to the test towers.
- Arrangements for applying any combination of given loads at a specified rate of increase.
- Load and deflection measurement facilities.
- Remote control of loading mechanism.
- Remote and precise reading of measuring instruments.
- Facilities for calibration of the measuring instruments

SALIENT FEATURES OF TOWER TESTING STATION

1	Tower Types that can be tested	: Square, Rectangular and Rotated base & Triangular base.
2	Maximum base width	: 26m x 26m for square based 22x11m for rectangular based.
3	Cross arm width	: 42 m (end to end)

4	Maximum height of anchor point	: 53m (taller tower up to 74 m tested successfully)												
5	Maximum overturning moment	: 25000 Tm												
6	Maximum pull per conductor	: 40 T												
7	Erection facility	: Aerial rope way and lifting tackle with high speed Electrical Winches												
8	Load measurement	: Strain gauge type load cells/Digital Indicators												
9	Deflection measurement	: Optical (Electronic Theodolite)												
10	Calibration facility	: 60 T capacity UTM (AMSLER SWISSMAKE)												
11	Load details	: <table border="1"> <thead> <tr> <th>Direction</th> <th>Capacity</th> <th>Pull of points</th> </tr> </thead> <tbody> <tr> <td>Transverse</td> <td>320t</td> <td>15</td> </tr> <tr> <td>Longitudinal</td> <td>320t</td> <td>21</td> </tr> <tr> <td>Vertical</td> <td>320t</td> <td>12</td> </tr> </tbody> </table>	Direction	Capacity	Pull of points	Transverse	320t	15	Longitudinal	320t	21	Vertical	320t	12
Direction	Capacity	Pull of points												
Transverse	320t	15												
Longitudinal	320t	21												
Vertical	320t	12												
12	Stub Load per Leg	: 650 T												
13	Requirements	: Conforms to IS : 802 (Part III)/IEC : 60652/ Clients Requirements												
14	Guaranteed Accuracy	: +/- 1 % for load & 5 mm for deflection												

FACILITIES AT PTTTS

60 Ton Universal Testing Machine (Amsler-Wolpert make) which has Traceability to National Standards, NPL, New Delhi used for calibration/ load verification of transducers used for tower testing and other transmission line accessories & hard ware like insulators, insulator strings, clamps, cables etc.,

Load application through electrical winches (both remote and local operation possible) and control through PLC/SCADA with auto report generation is being installed.

Load Measurement by strain gauge type load cells having an accuracy of less than $\pm 1\%$.

Deflection Measurement using electronic optical theodolite and graduated scale with 5mm accuracy

Tower Erection using aerial rope way and lifting tackle with two high speed Electrical Winches are provided. An erection contractor is identified for the purpose of erection of towers. The option of engaging the erection contractor or own erection gang is left to the discretion of the clients.

Strain Measurement of critical tower members: Twenty channel static indicator

Hooked up to a computer and a 100 channel interface system for critical member of test towers

Structural fabrication facility:

Tower Testing Station has a work shop with facilities for cutting, welding, drilling, punching, grinding, etc. also stocked good quantity of standard angle sections of both MS & HT and bolts & nuts used as immediate replacement of the failed members which can be availed on returnable basis by the client.



400 kV M/C type 'QA' tower



765 kV S/C type 'D' tower

STRUCTURAL MATERIAL TESTING LABORATORY (SMTL)

The Structural Material Testing Laboratory aptly compliments the tower testing station. A sophisticated Universal Testing Machine (UTM) with a facility of force & position control using computer has been used for the verification of load measuring devices, testing & development activities. A broad range of materials, alloys, composites & transmission line accessories were tested as per relevant standards. Also used for pre/post testing calibration of load measuring equipment, this is a pre-requisite for full scale testing of transmission towers.

SALIENT FEATURES OF UTM

1.	Type of Machine	Universal testing Machine
2.	Make	Wolpert Amsler (Swiss Make)
3.	Capacity	60 tons
4.	Application	
	a) Calibration	Tension & Compression load transducers
	b) Possible tests	Tensile, Compression, Bending, Double Shear & hardness of Structural Materials & Transmission Line accessories
5.	Load Ranges (in tons)	Variable up to 60 T
6.	Clamping Device	Mechanical
7.	Control system	Hydraulic, PC based, Position/Force control
8.	Free clamping device	
	a) Maximum	1625 mm
	b) Minimum	75 mm
9.	Free Column spacing	640 mm
10.	Gripping capacity	
	a) Flat specimen	0 to 60 mm
	b) Cylindrical	3 to 60 mm diameter
11.	Gripping Length	90 mm
12.	Span for Bend tests	
	a) Maximum	1150 mm
	b) Minimum	200 mm
13.	Double Shear Specimens	
	Diameter	5 to 25 mm in steps of 1 mm
	Length (minimum)	135 mm
14.	Hard copy facility	Plot of Load Vs. Deflection/ Time

HYDRAULIC POWER PACK/RAM : PLC Controlled

Capacity : 100T

Stroke : 750 mm

Speed : 1 - 50 T/min.

This facility provides a versatile facility to test insulator strings of all configurations (like 'T' 'V' & Quad) and other non standard hardware samples.

TEST RIG :

The test rig, complete with anchor, pulley blocks, electrical winches, load measuring instruments etc., provides a versatile facility to test long samples of insulators, conductors, wire ropes etc., the facility of 80 ton test rig has been used with an electrical winch. The test rig complete with anchor pulley blocks, electrical winches, load measuring instruments etc., provides a versatile facility to test ropes, insulators/insulator strings, long conductor samples, accessories and similar structures.

SALIENT FEATURES OF TEST RIG

1.	Type of Sample	ACSR Conductor, Insulators Strings, Conductors, Insulator fittings, Long samples of steel wire ropes, guy wires and rope like structures
2.	Parameters	
	Maximum length	130 m
	Maximum load	80 T
	Equipage	i) 40 T anchorage - 2 nos. ii) 80 T anchorage - 1 no. iii) 80 T lead block - 1 no. 4 sheave pulley block for load Multiplication - 2 nos.

Load Application	5 T capacity electric winches with multi-sheave pulley blocks.
Load Measurement	Strain gauge type load cells and Digital Indicators
Applications	<p>a) Commercial: Testing of long samples like ACSR conductor, Insulators Strings, conductor/ Insulator fittings & rope like structures for ultimate strength, Testing of long samples of steel wire ropes and rope like structures.</p> <p>b) R&D : To determine mechanical properties of steel wire ropes and ACSR conductors</p>

DESIGN CELL/CONSULTANCY SERVICES

Design Cell caters to the design, analysis, and checking of support structures of Transmission lines. With a sophisticated computer, reliable software and a team of dedicated engineers, the cell undertakes design of towers for new transmission lines, analysis and checking of towers designed earlier for further optimization of weight, checking the adequacy of existing towers for up-rating a line, redesign of existing towers with least modifications for upgrading, preliminary designs for submission of tenders, design of special towers like multi - circuit towers, narrow based towers, rectangular based towers, triangular based towers etc. Several such projects were completed successfully in the past and several others are being executed.

COMPUTER SOFTWARE FACILITIES AVAILABLE:

- i) CPRI -TOWER ANALYSIS & DESIGN SOFTWARE (CTADS)
- ii) STRUCTURAL ANALYSIS & DESIGN (STAAD-PRO 2004)
- iii) CAD/CAM Software
- iv) AutoCAD 2006

LIST OF COMPLETED CONSULTANCY PROJECTS

1. Design approval of 132 kV 2 phase & 3 phase towers for M/s. L&T, Chennai
2. Design approval of substation structures 220 kV & 400 kV for M/s. Steel Industrials Limited, Kerala
3. Design approval of 220 kV D/C for M/s. KPTCL, Bangalore
4. Design approval of 132 kV & 220 kV towers for Railway Electrification M/s.CORE, Allahabad
5. Up-gradation of 110 kV D/C to 132 kV D/C for M/s. EMC Calcutta
6. Design approval of 90m, 60m, 50m, 35m Communication tower and its foundation for M/s.ARM Ltd, Hyderabad
7. Up-rating of 66kV D/C line with twin Mink ACSR for M/s.KSEB
8. Design of tower, foundation & Submission of GA/Shop drawings of 132 kV S/C "B" type tower to M/s.Techno Corporation, Agartala
9. Design & Submission of GA/Shop drawings for 66 kV and 110 kV & 220/66 kV Multi -Circuit towers for M/s.KPTCL, Bangalore
10. Design & Submission of GA/Shop drawings for 33 kV, 132 kV & 275 kV towers for M/s. Unimeker Sdn Bhd, Malaysia

11. Design checking/approval of 100m, 90m, 60m, 50m microwave towers for M/s. IMI Software, Hyderabad
12. Design checking/analysis of 220kV D/C towers with Optical Ground wire for M/s. Reliance Energy Ltd., Mumbai
13. Design checking/analysis of 220/110kV multi-circuit (narrow based & broad based) with optical ground wire for M/s. Reliance Energy Ltd., Mumbai
14. Design approval of 132 kVD/C and 220kV D/C 2 phase & 3 phase towers and its foundation for M/s. Ramjee Power Construction Ltd., Ranchi
15. Upgradation of 132 kV to 220 kV (S/C & D/C) using insulated cross arms for M/s. PSEB Chandigarh
16. Design checking/ approval of 400kV D/C river crossing tower for M/s. Hirakud Industrial Works Ltd.
17. Design of 66kV D/C, 110kV D/C and M/C to M/s. Reliance Salgaocar Power Company, Goa
18. Design checking/approval of 90m, 80m, 50m micriwave towers for M/s Tata Tele Services Ltd., Mumbai

MODEL TOWER TESTING LABORATORY (MTTL)

The increased demand for electrical power forces the utilities around the world to construct more and more new lines. The developing countries like India in addition face shortage of resources to meet the demand. Cost effective design with out sacrificing the reliability of the transmission line hence becomes mandatory. Towers are repeated structures and cost nearly one third of the total line cost. Hence even a small saving on a tower results in huge saving. Testing of the line components like towers and their foundations become very essential. Model testing is one of the effective tools available for design engineers to arrive at the most optimum tower design.

ADVANTAGES OF MODEL TOWER TESTING

A Transmission line tower is an indeterminate space frame and is designed normally with a number of simplifying assumptions. The sequence of steps involved in finalizing transmission tower design can be arranged in three stages viz.

- i) Mathematical modeling / computer aided design
- ii) Model testing
- iii) Prototype testing

It is highly desirable to verify that the tower can withstand the most critical loads. Therefore to predict the exact behavior of the Prototype tower up to failure, testing of an exact scaled down physical model is necessary. Model testing fills up the gap between mathematical modeling & prototype testing and it helps the designer to arrive at an economical design. The fabrication of the model is very cheap compared to proto- type.

The loads handled and overturning moment of the test bed required are comparatively small and hence facilities and equipage required for handling these are cheap. Also, in cases where full size test is not possible / practicable the model tests can be resorted to for verification of designs.

LABORATORY FACILITIES

Model Tower Testing Laboratory of CPRI is well equipped with required machinery for fabrication & assembly manned with skilled technicians. Exact scaled down models of skeletal structures are fabricated with minimum tolerance. Facilities are available to simulate the field conditions and the design loads on the structures can be applied in three mutually perpendicular directions at the required points on the tower. Electronic gadgets viz. strain recorders, Bridge & Balance units, are available to measure both static & dynamic strain in the critical members. Theodolites are used to record deflections in the transverse and longitudinal directions.

Exact scaled down tower and tower like structure models are fabricated with up most precision. Since dead weights are used for applying loads, load generation & measurements becomes very simple and accurate. The Laboratory is equipped with sophisticated instruments ensuring reliable and accurate measurement. Hence model testing becomes a very efficient tool to perfect the analytical design especially for non conventional structures.

1. Maximum Base width of model tower
that can be tested : 1.295 m
2. Uplift capacity of Test bed : 1.36 T
3. Height of loading structures : 8.0 m
4. Method of loading : standard cast iron
dead weights
5. Strain measurement : strain gauge technique

DESIGN AND DEVELOPMENT CAPABILITY

Scaled down models of Transmission line towers like self supporting, guyed towers with hinge supports, triangular or rectangular based towers and special structures like river crossing towers etc., micro wave tower / antenna towers (pin jointed structures that are designed with angle sections) can be tested with adequate precision.

A number of projects taken up have been completed with the objective of reducing the weight of transmission towers there by achieving considerable savings; some of these are listed below:

- a. Design and Development of 132 kV D/C Guyed tower for MPEB, BHOPAL
- b. Design and Development of Triangular Based Tower
- c. Design and Development of Rectangular based Tower

- d. Development of 400 kV Narrow Based Tower
- e. Design and Testing of 220 kV Four Circuit Towers for M/s APTRANSCO, Hyderabad
- f. 220 kV Four Circuit Towers were successfully tested for M/s Tata Electric Companies, Mumbai
- g. Design and Development of 132 kV two phase tower for Indian Railways, Allahabad

TOWER FOUNDATION TESTING CENTRE

This center has heavy duty sampling outfit for collecting undisturbed soil samples from the required site and field density Kit and Penetrometer for in situ testing to evaluate the engineering properties of the soil. It is equipped with 100 ton capacity hydraulic jacks, deflectometer and loading frames to conduct uplift test. The above facility has been established to cater for the following.

- To render assistance in research investigations and in developing mathematical model for rational and economical design of tower foundations.
- To verify the foundation design for a specific transmission line.
- To verify the adequacy of a foundation after construction.

VIBRATION LABORATORY

Vibration in transmission line conductors are known to cause breakage of conductors. Mechanical failures of insulator strings are also observed in transmission lines. CPRI has a well equipped vibration laboratory for studying vibration problems with forced excitation systems. The Institute has carried out extensive investigations in this field and successfully developed methods to effectively damp the vibrations. These methods relate to such aspects as location of dampers, self damping of conductors, passive damping methods etc.

This laboratory has a test rig with a clear span of 40 m to carry out the damper efficiency test on single conductor/earth wire. The vibration laboratory of CPRI has been accredited by NABL on the basis of its compliance to ISO/IEC:17025 in the field of mechanical testing. Vibration laboratory is open for commercial testing and certification of various types and makes of vibration dampers and other transmission line accessories.



SALIENT FEATURES

Test Span: 40 m (Single conductor)
 : Electro Dynamic Shaker System
 Frequency - upto 5.4 k Hz
 Displacement - 14 mm (PP)
 Velocity - 1 m/Sec
 Acceleration - 615 m/Sec²

WAKE SIMULATION LABORATORY

The wake simulation laboratory has been established to undertake R&D and testing activities on bundle conductors, spacer dampers and other transmission line accessories. This is a unique facility in the country for testing bundle conductors.

This laboratory has a test rig with a clear span of 80m conforming to IS, IEEE, and IEC standards. It has suitable anchorages to string bundle conductors to appropriate tensions and also has all facilities

for conducting tests on spacer dampers, bundle conductors, line accessories etc. Fatigue/Vibration testing of single, double, triple & quadruple insulator strings (both suspension & tension type) is undertaken.

SALIENT FEATURES :

Test Span: 80 m (bundle conductors)
 : **Electro Mechanical Shaker system**
 Eccentric shaft type
 DC motor Thyristor control drive
 Frequency - 3 to 25 HZ
 Amplitude - 1.5 mm to 8 mm

TYPE TEST FACILITIES FOR ACSR/AAAC CONDUCTORS

A facility has been established to take care of all the type tests of ACSR/AAAC Conductors both in-house and field testing/inspection as per relevant BIS/BS/ASTM standards

The facility includes :

- Tensile Testing Machine
- Torsion Testing Machine
- Hydraulic loading Equipment
- DC Resistance measuring Equipment
- UTS test, stress strain test, Zinc coating test, wrapping test, preece test etc.

RESEARCH & DEVELOPMENT (R & D)

The research work carried out has the main objective of developing better designs of towers by the use of new configurations, new materials & new types of structures etc. Fatigue/vibration analysis of overhead conductors, vibration dampers, insulator strings etc. The following are some of the completed research projects in mechanical engineering division.

TOWER TESTING STATION

- i) Feasibility studies of six phase transmission line (Mechanical Aspects)
- ii) Standardization of transmission line towers
- iii) Rationalization of steel sections for tower economy
- iv) Investigation of failure of 11 kV structures.
- v) Probability based design of transmission line towers
- vi) Enhancement of foundation strength using micro piles
- vii) Dynamic analysis of transmission line towers
- viii) Design & development of telescopic mast
- ix) Optimum design of tower foundation using Geo grid for weak soils
- x) 132 kV compact Pole
- xi) Experimental determination of stresses during proto type tower testing
- xii) Development of optimal bracing pattern for transmission line towers

VIBRATION LABORATORY

- i) Performance evaluation of vibration dampers
- ii) Dynamic behavior of twin/quad spacer dampers
- iii) Evaluation of self damping capacity of ACSR conductors
- iv) Dynamic performance of conductors and line hardware
- v) Fatigue performance of insulators/strings
- vi) Online monitoring and analysis of field vibration of transmission lines
- vii) Evaluation of stress-strain curve for ACSR conductors
- viii) Study of vibration performance of double tension insulator string subjected to wind induced motion
- ix) Design & Development of 6-R dampers
- x) Self damping measurement of ACSR & AAAC conductors

TESTS & STANDARDS

Sl. No.	Product/ Material Tested	Specific Tests Performed	Standards/ Reference
1	Transmission Line Towers (up to 800 kV)	Proto -type tests	IS:802 (Part III) -1978 IEC:60652-2002
2	Transmission Line Accessories/ Hardware material	a) Tensile b) Bending strength test c) Residual Strength (Tensile) d) Slip Strength & Mechanical Strength (Tensile) e) Compression f) Mechanical Failing load	IS:5350 (Part III)-1971 IEC:60168-1994, IS:2544-1973, IS:731-1971, IS:5300-1969 IS:5350 (Part III)-1971 IEC:60168-1994, IS:2544-1973, IS:1445-1977 IEC:60797-1984 IS:2486 (Part. I)-1993 IS731-1971 IS:5350 (Part III)-1971 IEC:60168-1994, IS:2544-1973 IEC:60383-1993, IS:731-1971
3	Transmission Line Conductors	Breaking Load / Ultimate Tensile Strength (UTS) test	IS:398(Part 1 to 5) -1992
4	Compression Clamps	Slip Strength/ Mechanical Strength etc.	IS:2486(Part I)-1993
5	Mid Span Joints	Mechanical Failing Load Test	IS:2121(Part III)-1981

+

6	I & V Suspension Tension Strings	Mechanical Failing Load Test	POWER GRID Specification		
7	Structural Steel	a) Tensile b) Bend c) Weld ability	IS:2062-1992		
8	Steel wire ropes	Load test	IS:2266-1977		
9	Electrically Operated / Hand Operated Winches	Proof Load test	Client's Specification		
10	Chain Pulley Block up to 20 T	Load test	Client's Specification		
11	Transducers	Load Verification	IS:9281 (Part II)		
12	Vibration dampers	a) Dynamic characteristics test b) Damper efficiency test c) Fatigue test	IS:9708	1993	
13	Spacer/Spacer dampers	a) Movement Test b) Clamp Slip test c) Clamp bolt torque test d) Assembly torque test e) Tensile load test f) Compression & pull off test g) Log decrement test h) Vibration test ● Longitudinal vibration test ● Vertical vibration test ● Sub-span oscillation test	IS:10162	1982	

86

+ RK

+

14	Insulators & Insulator strings of Single/Twin/Triple/Quad suspension OR tension type	a) Twenty four hours mechanical strength test b) Mechanical Failing load test c) Fatigue/ Vibration test	IS:731	1971	
15.	Conductors/ cables	Type test	IS:398,ASTM B 231,232		

87

+ RK

EARTHQUAKE ENGINEERING & VIBRATION RESEARCH CENTRE

The Earthquake Engineering and Vibration Research Centre is equipped with necessary facilities for providing testing, research and consultancy services in the areas of seismic and vibration qualification of instruments / equipment for nuclear power plants and other generating stations as well as manufactureres and utilities in the field of aerospace, railways and automobiles as per National and International Standards. In addition, this centre offers consultancy in checking the design adequacy of structures / bridge models for seismic qualification.

(A) TEST FACILITY FOR SEISMIC QUALIFICATION OF EQUIPMENT

This centre consists of state of the art Triaxial Shaker System with 6 degrees of freedom, with 128 channel data acquisition system, experimental modal analysis software and finite element analysis softwares.

The centre is capable of performing a diverse range of vibration tests on equipment, sub-assemblies and components. The centre is fully equipped to enable R&D and product development to meet the seismic requirements stipulated in national and international standards.

The tri-axial shaker system with six degrees of freedom is capable of performing a diverse range of seismic qualification test requirements on equipment, sub-assemblies and components. These tests are intended to qualify the test samples regarding their seismic qualification requirements.

The facility conforms to IEEE 344, IEC 60068-3-3 and other International Standards.

The main features of the triaxial shaker system :

- | | | | | |
|----|--|---|-------------|-------------|
| a. | Table Size | 3.0 x 3.0 m | | |
| b. | Mode of Axis | TRI-AXIAL | | |
| c. | Degrees of Freedom | Six (3 translatory + 3 rotational motion) | | |
| d. | Pay load | 10 T | | |
| e. | Max. Height of the specimen | 10 m | | |
| f. | AXIS | X | Y | Z |
| | Displacement | ± 150 mm | ± 150 mm | ± 100 mm |
| | Velocity | ± 1000 mm/s | ± 1000 mm/s | ± 1000 mm/s |
| | Acceleration | ± 1 g | ± 1 g | ± 1 g |
| g. | Frequency range | 0.1 to 50 Hz | | |
| h. | Yawing moment | 10 ton. m | | |
| i. | Overturning moment | 40 ton. m | | |
| j. | Actively controlled in 6 degrees of freedom | | | |
| k. | System consists of 4 vertical actuators & 4 horizontal actuators | | | |



(B) DYNAMICS LABORATORY

1. Vibration Test System :

Vibration test system is used for the design of components, equipment and for experimental verification of their safe functional capability under vibrational and shock loads in accordance with national & international standards.

Brief specifications :

Force rating (Sine)	: 26.7 kN
Frequency range	: 5 to 3500 Hz
Displacement (Peak to Peak)	: 50.8 mm
Velocity (Peak)	: 1800 mm/s
Acceleration levels (Peak)	: 100g (Bare Table)
Types of Vibration	: SINE RANDOM SINE ON RANDOM RANDOM ON RANDOM SHOCK

2. Climatic chamber with vertical vibration interface

Brief specifications :

Test chamber material	: Stainless steel
Volume	: 1000 litres \pm 5%
Temperature	: -70C to +180° C
Accuracy	: \pm 0.50K in Space & time
Humidity range	: 10 to 98% Rh
Humidity accuracy	: \pm 5%

Rate of change of temperature	: 10 ⁰ C/min. average
Maximum weight of Specimen	: 100 kg

The facility is useful in examining the behaviour of components instruments when they are subjected to change in temperature, humidity and vibration.

3. Drop Testing Machine :

Drop testing machine is capable of studying behaviour of equipment and adequacy of packaging when they are subjected to Mechanical drop or sudden jerks in transportation. It is a PC controlled equipment with built in calibration facility.

Brief specifications :

Machine type	: Drop testing machine with strong structure designed with guide columns and free drop platform.
Weight of Specimen	: 227 kg {Maximum}
Height of Specimen	: 1000 mm
Drop height {max}	: 1830 mm
Base plate {WxL}	: 1520 x 11200 mm
Drop Platform size	: 760 x 690 mm
Control mechanism	: Pneumatic-electric control System.

4. Shock testing machine with software :

Shock testing machine is used to conduct qualification tests on equipment like energy meters, relays, electronic & electrical equipment which experiences shocks during operation, handling and transportation. This is a PC controlled equipment with built-in calibration facility.

Brief Specifications :

TABLE SIZE	: 1000 x 1000 mm
Weight of specimen	: 450 kg
Acceleration (range)	: 30 to 5500 m/s ²
Pulse duration	: 2 ms to 60 ms (Programmable)
SHOCK PULSE	: a) Half sine wave
GENERATORS	: a) Saw tooth wave : b) Square wave
ACCELERATION AMPLIFIER	
No. of channels	: 8 channels
Frequency Range	: 0.1 Hz to 20 kHz
Sensitivity	: 0.1 to 100 pc/g

C. Multi channel Spectrum Analyser with Software and built in calibration facility.

This is a condition monitoring equipment used to identify machine faults, diagnosis, alignment, dynamic balancing performance and conditioning of wide range of industrial and power plant

machinery and equipment. Also used for vibration, noise and process parameter measurement in field conditions, structural testing and analysis.

Brief Specifications :

No. of channels	: 8 Analog channels & 8 additional process parameter channels
Frequency range	: DC to 4 kHz
Dynamic measurement	: Better than 60 db
Accuracy	: $\pm 0.1\%$ of the full scale value
FFT & Spectrum Analysis	: Possible
Bandwidth	: DC to 4 kHz in 800 lines in Steps.
Software Modules	: a. Machinery condition Evaluation b. Fault diagnostics c. Field balancing d. Shaft alignment e. Rolling element bearing evaluation f. Expert system
Main processing System	: Latest processor with input / output drives & accessories built around laptop computer for field measurement.

D. Single Axis Actuator with Digital Controller :

This equipment can be used to carry out fatigue tests to and to evaluate the dynamic characteristics of equipment components weighing up to 100 kgs.



Brief specifications :

Force rating	: 10 kN
Frequency range	: 0.1 to 150 Hz
Displacement	: ± 50 mm
Accuracy	: $\pm 1\%$
Operating pressure	: 280 bars
Types of Vibration	: Sine, Random, Sweep single frequency

E. 1000 kN Universal Testing Machine with associated fixtures :

This equipment can be used to carry out tensile, compression, bending, hardness and shear tests on specimens of ferrous, non-ferrous materials, stranded conductors, cables, insulators, etc. It is controlled through PC from load measurement to load

control. This equipment has self-calibration facility. Specimens can be tested as per IS, BS, ANSI, ASTM & DIN standards.

Brief Specifications :

High precision control of loads by closed loop system.

Maximum load	: 1000 kN
Load range	: 1000, 500, 200, 100, 50 & 20 kN

i. Tensile Tests

a. Grip to grip distance	: 50 to 1800 mm
b. Maximum elongation	: 600 mm
c. Grips for rods	: upto 65 mm dia
d. Grips for flats	: upto 65 mm

ii. Compression Tests

a. Plate dia	: upto 300 mm
--------------	---------------

iii. Bending tests

a. Length of Bending Specimen	: 25 to 1150 mm
-------------------------------	-----------------

iv. Hardness tests

a. Ball dia	: 10 mm
Strain gauge extensometer	: 50 mm gauge length with Variable extensions upto 105 mm.

F. Accelerometer Calibration facility :

Accelerometer calibration facility is an accurate and fully integrated system that performs traceable calibrations using back to back comparison method for charge mode or voltage mode

+

accelerometers and velocity transducers. The system allows for graphical spectrum display of Sensitivity, Deviation, Control Reference, Phase information and print a calibration certificate displaying the full frequency response and sensitivity of the test accelerometer.

G. Non-contact type Laser Vibrometer :

Non-contact type Laser Vibrometer is used to measure the two dimensional distribution of vibration velocities on the basis of laser interferometry. The measurement data is digitally recorded in the Workstation. The software controls the data acquisition and analyse the measurement data.



Brief Specifications :

- X & Y precise deflection Mirrors : 12 bit digitally controlled
- Position resolution of mirrors : 0.002⁰
- Velocity range : 0.5 μm/s to 2m/s
- Working distance : 50mm to 200 m
- Scanning angle : ± 12.50⁰
- Measurement : Time, frequency,

+

functions

spectrum, autopower, gross power and FRF.

Data Acquisition system

- : 4 channel, 20 kHz / channel
- 6400 FFT lines
- 2 channels with DAC to control shakers with sine, random, triangle, rectangle pulse.
- Multi-shaker excitation with MIMO software.
- Cosine correction with laser Scan angle.

H. Video Digital Recording & Editing System :

This is a high speed Digital Camera with progressive scan readout around 125 frames per second and has frame grabber with real time transfer to system and on-board VGA memory and integrated display, capable of capturing low contrast images accurately. It has a feature of high resolution capture handling large fields with fine details, non-destructive pseudo colour overlay. Software is suitable for managing image capture, transfer, analysis, processing, calibration, graphics and display. Additional Image Analysis Software is also available.

These features will help in investigation of failure of components/ structures when subjected to seismic vibration.

Thus, the Earthquake Engineering and Vibration Research Centre is equipped with state-of-the-art facilities for Earthquake and Vibration Simulation, Shock and Drop Testing machines and other Vibration measurement and Analysis equipment.

POWER SYSTEMS DIVISION

INTRODUCTION:

Power systems Division with its state-of-the-art facilities and latest software tools offers a wide range of power system simulation services, including real time performance analysis of various types of controllers such as FACTS, HVDC, SVC and protection relays. It has been conducting studies for the past two decades for its own needs and at the request of utilities and manufacturers. To carry out such studies the division possesses two types of simulators - Hybrid (Transient network Analyzer (TNA), High Voltage DC simulator (HVDC), Digital (Real Time Digital Simulator (RTDS) and various Power System Analysis Software Packages. Furthermore the Division is ISO accredited.

The Power system Division has expertise to undertake the following studies :

- Transmission System studies
- Distribution System studies
- Protection System studies
- Grounding System studies

The various consultancy services offered are:

- ❖ Transmission System Studies
 - Transmission Planning & Power Evacuation
 - Study of Power Swing Phenomena
 - Stability
 - Short circuit
 - Reactive power compensation (Sizing and location of capacitors)
 - Sizing of static VAR compensator

- Insulation Co-ordination
- Islanding
- Filter Design
- Performance analysis of controllers such as FACTS, HVDC, SVC
- HVDC system
- ❖ Protection System Studies
 - Relay coordination
 - Overcurrent & earth fault
 - Distance relay
 - Equipment Protection setting calculations (Generators, Motors, transformers etc.
 - Dynamic testing of protection schemes on RTDS
- ❖ Grounding System Studies
 - Soil Resistivity & Ground Resistance measurements at site
 - Design of Ground Mat for HV/EHV Installations (Power House, switchyards including GIS etc.)
- ❖ Equipment used for Measurement of Soil Resistivity & Ground Resistance measurements:
 - Digital earth Tester DET 2/2
 - Digital earth tester DET 2
 - Digital earth loop tester
- ❖ Distribution system studies
 - Technical and commercial loss estimation

+

FACILITIES FOR SIMULATION:

❖ REAL TIME DIGITAL SIMULATOR - A STATE OF THE ART FACILITY:

The all-digital Real Time Simulator facility (from RTDS Technologies, Canada) established at the Power Systems Division of CPRI allows accurate and reliable simulations of three-phase electromagnetic and electromechanical transient phenomenon in electric networks both for closed loop equipment testing and offline simulation studies. The RTDS works in continuous real time to provide solutions to power system equations fast enough, with a typical time step of 50 usecs to accurately represent conditions in the actual power system. The real time features facilitates interfacing of physical devices - controllers and protective relays to the simulator and operate them under 'real life' conditions.

RTDS Applications:

- General AC and DC systems operations
- Interactions of AC and DC systems
- Integrated protection and control systems
- Control system for synchronous machines, HVDC, SVC, FACTS and custom power devices
- Protective relaying schemes
- Advanced Education and training

RTDS Benefits:

- Increase system reliability, security, stability and efficiency of equipments and network
- Improved system understanding, knowledge and insight
- Minimize equipment I system failure
- Reduced project/equipment commissioning time
- Maximize quality and quantity of studies

+



RTDS FEATURES:

RTDS HARDWARE:

- Four Racks (dimensioned for 18, 3 phase nodes/buses per rack and upto 56 single phase switches)
- 10 no.'s Triple Processor Cards (3PC) per rack
- Each 3 PC Card - 3 SHARC type processors with a computational speed of 40-120 MFlops
- 1 no. Giga Processor Card (GPC) per rack
- Each GPC Card - two no's of IBMPPC750GX Rise processor and 2 no.'s coprocessors with 1.0 GFlop computational speed
- Each rack can be operated independently

INPUT / OUTPT INTERFACE & MONITORING

- DOPTO (Optical isolated digital input and output card) interface up to 24 digital input and 24 digital output signals, (range +/- 10 volts peak)

+

- DITS (Digital Input Time Stamp card) : interface of time critical digital signals from an external controller, Six digital input signals per DITS Card - Required for Improved Firing algorithm
- FDAC (Fiber Optic Digital to Analog converter) interfacing signals with large dynamic ranges
- OADC (Optically isolated Analogue Input) interfacing analog signals from external equipment, (range +/- 10 V true differential analog input)
- 220 Vdc Digital output interface (16 no's dry contacts, used to bring high voltage digital inputs into the RTDS or alternatively, used to send digital outputs from the RTDS to dry contacts (with high voltage ratings»

AMPLIFIERS:

- External amplifiers connected in the test loop between RTDS and equipment under test - provides secondary level voltages and currents
- Two No's - 3 phase voltage amplifiers (frequency response :dc to 10kHz , rated 250 Vrms phase-to-ground)
- Eight No's - single phase Current amplifiers (frequency response :dc to 5 kHz, rated 90 Amps peak for 1 sec, and 18 Arms continuous)

RTDS SOFTWARE:

- **User friendly Graphical User Interface (RSCAD)**
 - Circuit assembly & Data entry using Draft module
 - Simulation output - monitored during runtime through plots, meters
 - Simulated power system operated interactively using switches, pushbuttons, sliders
- **Power System Software - Component Model Library & Compiler**

102

+ RK

+

- TLINE - Computation of transmission line parameters from tower configuration
- CABLE - Computation of cable parameters from cable configuration
- **Control System Software - Component Model Library & Compiler**
 - Supports standard control blocks

Simulation models- Component Model Library:

- Synchronous machines inclusive of exciter & Speed Governors
- Induction machines
- Three-phase two winding and three winding transformers (Linear and with saturation)
- Multiphase transmission lines, DC lines, Cables with distributed parameter (constant or frequency-dependent) or PI model
- Measurement Transducers - CVT , CT
- FACTS Devices
- Series Capacitors
- Circuit Breakers and switches (thyristors, GTO's, IGBT's)
- MOV protected Series compensation
- Faulted Line model
- Voltage & Current sources
- Passive R, L, C Impedances
- HVDC valve Groups (6 pulse & 12 pulse) with generic controls
- AC Filters
- Industrial Loads (Induction motors, DC motors, Dynamic load, Arc furnace)
- User defined models

103

+ RK

Advanced features:

- Improved Firing Algorithm for power electronics
- Embedded Valve Groups
- Load flow initialization
- Switched Filter Component
- Model stacking capability for optimized processor usage

Modes of operation:

- Manual mode
 - Open Loop (no feed back, COMTRADE play back)
 - Closed Loop (real time feed back)
- Automatic Batch mode (Script file facility)
- **TRANSIENT NETWORK ANALYZER (TNA):**
 - A Hybrid simulation facility with scaled down analog models of power system.-components

Modeling Features: 3 phase transmission line PI sections, Single phase and 3 phase transformer banks with saturation, Linear or non-linear Shunt Reactors, Static Var Compensators (6 pulse or 12 pulse TSC or TCR) with generic controls, Load models, Circuit Breakers (manually programmable or computer controlled to close at any instant of sine wave with 1⁰ accuracy, and with possibility to simulate current chopping, current zero opening or pre-strike phenomenon), Synchronous machines, Lightning Arresters (gap type and gap less type), Voltage & Current sources.

Operating Voltage: 10 Vrms to 100 Vrms phase-to-ground

Studies that can be performed:

- Statistical distribution of switching surges
- Energizing and reclosing transients on lines, cables, open ended transformer lines

- Switching surge reduction by means of controlled closing and pre- insertion resistor
- Single pole reclosing
- Load rejection & Ferro resonance studies
- Transient Recovery over voltages
- Fault initiation surges
- Requirement on surge arrester location and rating

HVDC SIMULATOR

- A Hybrid simulation facility with low power models of power system components

Modeling Features: Converter Bridges (12 pulse), Converter Transformer (12 pulse group), DC & AC line pi-sections, AC Harmonic filters, Smoothing Reactors Circuit Breakers (solid state and relay type), Surge Arresters, Electronic Synchronous Machines, SVC model including control system, Converter Control & Pole Control.

Simular Ratings : Udn : 40V/12 pulse, Idn : 200 mA/12 pulse, Pdn : 8 w/12 pulse on DC side, 10V RMS phase-to-ground on AC side

Studies that can be carried out are:

- Dynamic performance study and factory system testing of control and protection systems for HVDC systems
- Studies of Dynamic performance of an integrated AC/DC power system
- Studies of equipment stress in case where exact simulation of the commutation process is essential

SYSTEMS & SOFTWARE CAPABILITIES FOR DIGITAL SIMULATION:

SYSTEMS:

- DEC Alpha workstation
- SUN workstation
- Pentium IV Servers / PCs
- Printers, Plotters and Digitizer

SOFTWARES:

SIMPOW (Windows NT Version 10.2.105)

- Package for static and dynamic simulation of power system
- Models of all network components involving transmission elements, HVDC converter stations, static VAr components, series capacitors, prime movers and rotating machines with their controls, protection equipment, and loads
- Supports Dynamic Simulation Language a built-in high level programming language, allows user-defined modeling of any power system component such as regulators and primary components, e.g. drive systems, FACTS devices and special machines
- Optimal power flow analysis
- Stability Analysis
- Transient stability
- Small signal stability of generators and automatic control systems
- Small disturbance angle stability e.g. controller interaction, Tuning of Power System Stabilizers (PSS), Sub synchronous resonance)
- Short circuit Studies
- Eigen Value Analysis

EMTP IATP & EMTDC (Ver. 4.0)

- Time-domain power systems analysis and simulation package that can be used for the design and performing of power system studies such as (a) Transmission system design & performance - Insulation coordination of transformers, breakers & arresters, Fast front and Steep front studies (b) Power quality studies - Harmonic Analysis including Filter design (c) Power electronic design (d) Electric machine performance (e) Distributed generation studies (f) Control system design & optimization - coordination of FACTS, HVDC including STATCOM, VSC (g) Protection system validation.

HIWAVE (Filter Design Package)

- Design of filters - Examine and reduce harmonic disturbances in power systems
- Includes a user customized library for modeling of almost all harmonic sources

MIPOWER (RELAY COORDINATION SOFTWARE)

- Over current and Earth fault relay coordination
- Distance relay coordination

MATLAB SIMULINK

- Simulation studies for grid - wind turbine interaction

GMAT - GROUNDING SYSTEM SOFTWARE

- In-house developed software for Ground mat design for grounding system for HV / EHV substations / power stations
- Incorporates design methods that are based on latest developments and techniques in power system grounding practices including the Indian codes of practice in Earthing.
- Software is written based on the method described in the latest version of ANSI/IEEE Standard 80/1986 - Guide for safety in AC substations.

+

- Other features are incorporated based on the recommendations of CBI & P, India, and IS 3043/1987 - code of practice for earthing in India.
- Non-uniform soil model is a 2-layer soil model proposed by J.Endrenyi, consisting of a top layer soil of resistivity p_1 to a depth 'h' from the surface of soil and a bottom layer of resistivity p_2 extending up to infinite depth.
- The effect of spreading gravel on the surface of substations can be studied using this software.
- Effective placing vertical ground rods can be studied.

COMPLETED & ONGOING CONSULTANCY PROJECTS

- **Transmission System Studies**
- Assess the additional transmission requirements for 10th and 11th plan period for Southern, Northern, Eastern and North Eastern regions of India' for Power Finance Corporation.
- Interactions of HVDC controllers for newly planned ~VDC lines using RTDS for Power Grid Corporation of India Ltd.
- SSR studies for Balia - Lucknow series compensated lines for M/s Siemens
- Power System studies, Overvoltages & Protection coordination studies for Raichur Thermal Power Station, KPCL, Bangalore.
- Studies for SVC Sizing for MIS Sharq Steel Rolling Mills LLC, Sultanate Of Oman
- Load flow study of transmission and subtransmission in network of Maharashtra for the year 2004-05 & 2005 -06, 2006 -07 for Maharashtra Electricity Regulatory Commission
- Study to investigate failures of HV motors and associated soft starters in Mangalore Chemicals and Fertilizers Ltd., Mangalore

+

- Switching and Dynamic overvoltages for URI Power station, NHPC, Faridabad.
- Planning studies upto 11th plan end for Himachal Pradesh State Electricity Board

Protection studies

- Dynamic testing of distance relays for M/s Siemens, GE and AREVA.
- Dynamic testing of transformer differential relays for M/s. Siemens, AREVA.
- Protection coordination studies for 400 kV series compensated lines of Gorakhpur - Muzafarpur and Gorakhpur - Purnea lines for M/s. Siemens
- Relay co-ordination studies for Neelachal Ispat Nigam Ltd., Orissa.

Distribution System Studies

- Estimation of technical & commercial losses in transmission & distribution systems for APERC (Andhra Pradesh Electricity Regulatory Commission)
- Estimation of 11 kV and L T line losses for SPDCL, Tirupati
- Estimation of technical & commercial losses in distribution systems for KSERC (Kerala State Electricity Regulatory Commission)
- Developing the criterion for allotting additional distribution outlets for MERC
- Industrial System studies for Rourkela Steel Plant

Grounding System Studies

- Design of Grounding system for the 1000 MW Tehri Hydro Power Project in UP. The main features are design of under ground power house ground mats, 400kV, GIS grounding system and those in all the access tunnels (Ad its).

+

- Design of earth mats for power house and switchyards of 2x30MW Tuirial hydro electric project, Mizoram for BHEL.
- Design of Earth mat for 4x33MW Teesta Low Dam HE Project for M/s. GEA Energy Systems India Ltd., Chennai (Ongoing)
- Design of Grounding system for AC/DC switchyards at Talcher and Kolar converter stations of the 2000MW, ± 500 kV, Talcher-Kolar HVDC east - south inter connector-II project (for Siemens, Germany).
- Design of Grounding system Tintibi 132kV substation, Bhutan.
- Measurement of Earth resistance for:
 - Tehri Hydro Power Project, Tehri for M/s. THDC, Tehri
 - Nuclear Power Plant, Kaiga for M/s. BHEL and Gammon India Ltd.
 - Rajasthan Atomic Power Plant For M/s. NPCIL, Rajasthan
 - Raichur Thermal Power Station for M/s. KPCL.



Soil Resistivity Measurements Underway at Teesta Hydro Electric Project Site

+

R&D PROJECTS

- Investigation of Grid connected Wind Turbines & Diesel Generator interaction.
- Investigation of application of FACTS devices in Indian Power System.
- Study of dynamic performance of protection relays using RTDS
- Bench marking programmes for testing the Full Spectrum Simulator development on the Real Time Digital Simulator at CPRI as a part of the “Full Spectrum Simulator “ (sponsored under NAMPET and coordinated by CDAC)

ENERGY CONSERVATION & DEVELOPMENT DIVISION

EC & DD has comprehensive infrastructure, computational facilities and a team of qualified Engineers for providing energy services like conducting Energy audits and training Energy Managers. We have been rendering the Energy audit and Energy conservation service for a variety of customers for more than one and a half decade and have undertaken audits in several energy intensive industries, thermal power stations (TPS), hydel power stations, Port trusts, oil refineries, refrigeration and air conditioning plants and buildings, etc. The services encompass the generating, distribution and utilization segments of the power sector. Besides the fuel sector is also covered.

EC & DD has been accredited by Bureau of Energy Efficiency (BEE), New Delhi for conducting Energy audit in thermal power plants, process industries, buildings and commercial establishments. CPRI has several BEE certified and foreign trained Energy Auditors in its team. The Energy Conservation & Development Division is ISO 9001 certified.

The experience profile of EC & DD in the area of Energy Service is as follows:

1. Consultancy services

- Energy audit & Energy conservation studies profile:
- Thermal Power Stations (Coal, Gas, Atomic, Oil, etc.): 75
- Hydel Power Stations: 10
- Medium scale process & manufacturing industries: 50
- Port Trusts: 10
- Water pumping stations: 5
- Buildings: 30

- Hospitals: 5
- Star hotels: 5
- Airports: 5

Technical energy audits (with aims ranging from identifying ways of conserving energy to evolution of a new blue print for the energy system) provide insight into the modes of better utilization of fossil resources and high-grade energy and exploration of renewable energy solutions.

CPRI have conducted energy efficiency studies along with other Energy Auditors & ESCOs in major buildings like Rail Bhavan, Sanchar Bhavan, IGI Airport and AIIMS, New Delhi. The studies have identified major energy saving potentials in Lighting system, HVAC system, Water pumping system, etc.. By optimizing the loading pattern & operational time of various loads, about 10-12 % yearly energy consumption can be reduced/controlled.

Some of the specialized areas of energy services are:

- Boilers and combustion systems
- Steam turbines
- Auxiliaries: pumps, fans, mills, blowers, etc. and associated motors
- Heat exchangers
- Condensers
- Cooling towers
- Utilities: compressed air, water pumping, air conditioning, refrigeration.
- Gas turbines
- Hydro turbines
- Electrical distribution networks

The studies include:

- Heat rate optimization
 - Benchmarking of energy parameters
 - Capacity adequacy analysis
 - Forced outage analysis
 - Design deficiency analysis
 - Reverse engineering
 - Power quality
 - Demand Side Management
2. Training programmes in energy conservation, renewable energy systems, distribution loss reduction, demand side management, safety and energy audit. Over 30 programs are conducted. Under the DRUM over 450 distribution engineers have been trained.
 3. Renovation & Modernisation of thermal power stations, hydel power stations, process industries, electrical networks and sub-stations: 20 plants have been studied and recommendations on cost economic renovation and modernization.
- 4. Renewable energy applications**

Some of the areas are:

- Solar, wind and rain data analysis
- Application engineering for solar, wind and biomass energy sources.
- Solar photovoltaic test laboratory

The lab has facilities for testing and certification of energy efficient and renewable energy devices and systems. The lab also undertakes field-testing of large systems and units, which

cannot be easily installed at site. Some of the test facilities are:

- Solar photovoltaic lantern (Approved by Ministry of Non-conventional Energy Sources, Government of India)
- Compact fluorescent lamp
- Solar home lighting

5. Research & Development

ECDD takes up R & D projects for the energy sector. Some of the areas of R & D are energy conservation, modeling and simulation and development of energy instrumentation. Recent projects are:

- Flexibility analysis of high energy steam/water piping.
- Development of techniques for energy analysis of steam turbines
- Development of pulverized coal flow simulator
- Development of pulverized coal flow meter
- Showcasing of energy conservation measures in an office building

+

List of Calibrated portable Instruments available at EC & DD for Energy Audit

Sl. No.	Instrument Used	Parameter measured	Range	Accuracy
1.	Ultrasonic flow meter (Make: Panametrics)	Water flow through pipes	13 mm to 5000 mm	± 2%
2.	Ultrasonic flow meter (Make: Ultraflux)	Water flow through pipes	20 mm to 10000 mm	± 1%
3.	Ultrasonic thickness gauge (Make: Ultraflux)	Thickness of pipes	1.5 mm to 99.9 mm	± 0.1 mm
4.	Digital anemometer (Make: Lutron)	Air velocity	0.4 to 30 m/s	± 2%
5.	Digital RTD temperature indicator (Make: Delta Ohm)	Temperature of water	-70 to 400°C	± 0.2 °C
6.	Infrared thermometer (Make: Chino-laxon)	Surface temperature	-40 to 500°C	± 1 % or ± 2 °C
7.	Portable power analyzer Voltage Current Power Harmonic (Make: ENERCON)	Electrical parameters V, A, W, PF, kWh, kVARh, Hz,	0-600 V LT & all HT 0 – 5 A; 0 – 100 A 0 – 1000 A Upto 50 th harmonic	± 0.5% ± 0.5% ± 1%
8.	Digital relative humidity meter (Make: Rotronic)	Relative humidity (RH) of air	0 – 100%	± 1%
9.	Digital pressure gauge (Make: Altop)	Pressure of water / air	0 – 10 bar	± 0.25%
10.	Digital pressure gauge (Make: HBM)		0 – 100 bar	± 0.20%
11.	Lux meter (Make: Delta Ohm)	Lux	0 – 200,000 Lux	± 5%

116

+ RK

+

Sl. No.	Instrument Used	Parameter measured	Range	Accuracy
12.	Non contact digital tachometer (Make: Lutron)	Speed of motor and other equipment 19999rpm	Photo:5-99999 rpm Contact: 0.5-19999rpm	± 0.05%
13.	Combustion analyzer (Make: Kane May)	Oxygen & CO in flue gas	O2: 0-21 % CO:0-4000ppm	± 0.2% ±20 ppm<400 ppm and ± 5ppm>400 ppm
14.	Iso-kinetic coal sampler (Make: Storm Tech.)	To measure pulverized coal flow	0-45 m/s	k-factor – 0.93
15.	Digital Manometer (Make: Dwyer)	To measure differential pressure	0-49.7 kPa	± 1.0%
16.	Double arm Pitot tube - 2m length	To measure fluid flow	0-45 m/s	k-factor - 0.877



Ultrasonic water flow measurement in progress

117

+ RK

THERMAL RESEARCH CENTRE, NAGPUR

The Thermal Research Centre is situated at the vicinity of Koradi Thermal Power Station, about 12 km from Nagpur on Chhindwara Raod. Central Power Research Institute, Thermal Research Centre, Koradi obtained the certificate of “WELL KNOWN REMANENT LIFE ASSESSMENT ORGANISATION” for carrying out RLA studies of boilers issued by the Central Boiler Board. TRC unit recognized as ISO 9001- 2000 Certified Organisation.

OBJECTIVES:

The main objective of the Thermal Research Centre is to tackle operation and maintenance problems of Power Stations which generates power in the country in addition to:

- Condition assessment, life estimation and extension studies, failure / risk analysis for renovation of vital power plant components.
- Energy Conservation in power plants and improvements in efficiencies of combustion auxiliaries & interconnected systems.
- Investigation of fuel treatment, ignition studies, coal characteristics. Pilot scale studies for coal gasification, slurry fuels, beneficiation, efficient combustor designs, pressurized Fluidized Bed Combustion etc.
- Performance evaluation of high temperature materials used for stress corrosion, fatigue & creep and materials conservation.
- Evaluation of materials for performance characterization & prediction employing stress & vibration analysis, wear / erosion studies.
- Insulation energy audit, Hot spot measurement in Boilers, switch yards, transformers etc. i.e. Thermographic Inspection.
- Flaws /crack depth in weld joints and other parts of the equipment by ultrasonic TO FD.

- In-situ Oxide scale measurement in Super Heater & Re-heater tubes and life estimation.
- Condition assessment of condenser tubes by eddy current method.
- Internal condition assessment of headers and tubes by Fibroscopic Inspection.
- Coal analysis for various contents including third party inspection.
- Environmental pollution impact assessment on the basis of field data, modeling and combustion studies to control NOx emission.
- Condition assessment and end of functional service life Evaluation of RCC & STEEL structures in Thermal Power Plants & Process steam Industries.

RESEARCH DIVISIONS & LABORATORIES:

The Thermal Research Centre is pioneer in carrying out Remanent Life Assessment, Renovation and Modernization and Life Extension studies, Non Destructive Evaluation (NDE) of Thermal Power Station plant equipments like Boilers, Turbines, Condensers etc. In order to accomplish the above goals following five divisions are established with various facilities namely:

1. Engineering Material Division

- Residual Life Assessment of power Plant Components
- Image analysis system for metallurgical evaluation
- In-situ (filed) Metallography (Replication) Test Facility
- In-situ (field) Hardness Test facility
- In-situ Chemical Analysis / Material Grade Identification Test Facility
- Crack depth measuring facility
- Air Jet Erosion Test Rig Facility

2. Environmental Engineering Division

- Ion-chromatography facility for water condition monitoring (individual ion analysis)
- Dissolved oxygen meter
- Semi-micro COD equipment
- Colorimetric environmental lab (elemental analysis, pH, conductivity & TDS)
- Pollution monitoring & Impact assessment laboratory
- NO_x SO₂ analyzer
- Flue gas analyzer (O₂, CO, CO₂, Efficiency, draught pressure etc.)
- Stack gas loading and sizing sampler for dust load measurement.
- X – Ray Fluorescent elemental analysis system
- Mobile Environmental Monitoring Station

3. Mechanical Engineering Division

- Stress & Vibration analysis
- Flame Temperature, hot spot survey, switchyard inspection, insulation audit facility
i.e. Thermographic Inspection
- Condenser tube leakage detection by eddy current testing
- Non Destructive Testing facilities for Power Plant and Process Industries.
- In situ Oxide scale measurement facilities
- Detection of crack, flaws etc. in weld by ultrasonic test
- Flaw characterisation by ultrasonic Time of Flight Diffraction (TOFD) technique

- Magnetic particle Inspection test facility
- Video Image scope for remote visual inspection for boiler, turbine, and other components
- Sound level meter and analyzer with processing system for sound level monitoring

4. Combustion Engineering Division

- Sulphur Determination in coal, Calorific Value of coal
- C, H, N Detection facility in coal
- Third Party Inspection of Coal

5. Civil Engineering Division

- Condition Assessment of civil structures
- Life Evaluations studies of RCC and Steel Structures

SERVICES OFFERED TO POWER SECTOR & OTHER INDUSTRIES:

Consultancy in operational and maintenance problems of thermal power generation, RLA, R&M and the following services are provided to various clients:

1. Residual Life Assessment of all types of Boilers ranging from process Steam Boiler to 500MW Boilers.
2. Residual Life Assessment of all types of Waste Heat Recovery Boilers & Steam Turbines.
3. Residual Life Assessment of Hydro Power Plant equipments.
4. Renovation & Modernisation and Life Extension studies of Boilers, Turbines and other plant equipments.
5. Wear and erosion control of vital power plant components.
6. Failure Analysis of Power Plant Components.
7. Health Assessment / Condition Assessment of Condenser Tubes.
8. Detection and sizing of flaws (e.g. cracks) in complex geometric plant components.

9. Coal analysis for various contents including third party inspection.
10. Environmental pollution impact assessment on the basis of field data, modeling and combustion studies to control NO_x emission.
11. Condition assessment and end of functional service life Evaluation of RCC & STEEL structures in Thermal Power Plants & Process steam Industries. etc.



Coal fired boiler – 210 MW



Waste Heat Boiler in Ammonia Plant



Steam Turbine LP Turbine



Runner of Hydro Power Plant



TOFD Test on Steam Turbine



Core sampling during RLA study on Foundation of Wagon Trippler

R&D, Demonstration & Pilot Scale Studies on:

1. Fuel evaluation and treatment, coal combustion characteristics.
2. Beneficiation, efficient combustor designs pressurized FBC.
3. Energy conservation in power plants and improvements in the efficiency of combustors, auxiliaries and interconnected systems
4. Performance evaluation of high temperature materials used for stress corrosion, fatigue, creep and materials conservation.
5. Environmental pollution impact assessment on the basis of field data, modeling and combustion studies to control Ox emission.
6. Power plant waste utilisation and development of technologies for value added products from waste.
7. On-line instrumentation for analysis of water, coal, drum level, furnace control, failures and various processes.
8. Kinetics of corrosion & erosion of boiler tube materials using FETF system.
9. Flaw characterization by ultrasonic time of flight diffraction (TOFD) technique.
10. Damage assessment in boiler tubes, drums and headers.
11. Performance evaluation and life improvement of boiler tube components through Plasma spray coating.
12. Condition assessment of complex geometry power plant components by ultrasonic TOFD technique.

IMPORTANT CLIENTS:

All State Electricity Boards, NTPC'S Thermal Power Stations, Hydro Power Plants, Combined Cycle Power Plants, Process Industries, Public undertaking companies, Private Industries. etc.

ADDRESS :

Unit Head, Central Power Research Institute, Thermal Research Centre, Koradi – 441 111, Dist. : Nagpur (Maharashtra State); Phone : 07109 – 262 255; Fax. 07109 – 262 170.

UHV RESEARCH LABORATORY, HYDERABAD

INTRODUCTION

UHV Research Laboratory was commissioned in 1993, with the objectives.

- To provide design data valid for the country's particular climatic, environmental and operating conditions, for transmission system above 400 kV.
- To provide necessary facilities in the development and testing of UHV equipment.

The above mentioned objectives are realized by the following facilities:

Experimental line

An experimental transmission line of 720 m length, divided into central suspension span of 360 m, and two dead end spans of 180 m each. There is facility to vary the conductor to tower clearance, conductor to conductor clearances and conductor to ground clearance. This facilitates the study of radio noise, audible noise, corona loss etc.

Mock-up tower

The purpose of the mock-up tower is to study the air gap clearance at transmission towers under switching surge stress. The arrangement comprises two conductor bundles strung between two dead end towers 80 m apart with a mock-up tower located in between.

Pollution test chamber:

The pollution test chamber is one of the largest in the world with a diameter of 24 m and a height of 27 m. Salt fog test can be conducted for insulators, bushings etc., upto 1000 kV class.

Cascade transformer:

The cascade transformer, comprising two units rated 800 kV each (total rating is 1600 kV) is used for energizing the experimental line, pollution chamber and testing equipment. The equipment has an extension unit which can generate oscillating switching surge impulse of up to 2000 kV peak.

Impulse Generator:

The impulse generator is used for switching impulse and lightning impulse tests on air gaps and equipment insulation. The impulse generator rating is 5 MV, and 500 kJ with 25 stages and a height of 23 m.

Electrical Interference and Audible Noise measurement facilities.

The laboratory has the state of art facilities to measure the Radio & TV Noise from AC/DC overhead power lines and sub-stations as per ANSI/IEEE Std. 430-1986, ANSI/IEEE Std. 302-1981 and CISPR-18 up to 1000 MHz range. The facility comprises of two EMI test receivers ESHS-10 & ESVS-10, Loop antenna, Rod antenna, Bi-conical antenna and Log periodic antenna of Rohde & Schwarz, Germany make. The precision impulse sound level meter CEL-414/3C make: Lucas CEL Instruments Ltd., UK, covers the audible noise measurement.

Research Activities

- Corona, radio interference and audible noise measurement in experimental transmission line, operating-transmission lines, sub-stations and corona cage.
- Measurement of aeolian vibration & subspan oscillations of transmission lines.
- Frequency response Analysis on Power transformers.
- Air gap insulation breakdown studies.
- Pollution studies on EHV/UHV insulators and surge arresters
- RTV coating studies.

TESTING ACTIVITIES:

The following commercial and investigatory tests can be carried out as per National and International Standards. The laboratory has been accredited by NABL in accordance with IEC 17025:2005.

Sl.No.	Name of the apparatus / test
1.	Insulator strings/solid core/hollow porcelain/long rod bushing / insulating materials. System voltage upto 800 kV. <ul style="list-style-type: none"> ● Impulse voltage withstand / flash over tests - lightning & switching. ● Power frequency withstand / flashover test (Dry & Wet) ● Pollution test (salt fog and solid layer methods)
2.	Lightning arresters upto 800 kV system voltage. <ul style="list-style-type: none"> ● Pollution test (ANSI method) ● Radio interference voltage test



Interference measurements in progress near a HVDC Line

3. Isolator / CB / AB switches upto 800 kV system voltages
 - * Lightning & switching impulse test (Dry & Wet)
 - * Power frequency withstand test (Dry and Wet)
 - * Combined voltage withstand test
 - * Visible corona (discharge) test
 - * Radio interference voltage test
4. Power / distribution transformer (upto 100 MVA)
 - * Lightning & switching impulse test
 - * Power frequency withstand test (Dry)
5. CT / VT / CVT / Bushing / Grading capacitor / Arrester Housing and Power connector and other equipment upto 800 kV system voltages.
 - * Lightning & switching impulse test (Dry & Wet +/- ve Polarities)
 - * Power frequency voltage withstand test (Dry & Wet)
 - * C and tan delta measurements
 - * Visible corona (discharge) test
 - * Radio interference voltage test

+

- 6. Coupling capacitors / grounding capacitive reactors/ RVT.
 - * Lightning & switching impulse test (Dry & Wet +/- ve Polarities)
 - * Power frequency voltage withstand test (Dry & Wet)
 - C and tan delta measurements
 - Visible corona (discharge) test
 - Radio interference voltage test
- 7. Discharge test on grading / coupling capacitors upto 800 kV
- 8. Chopped impulse test (fast transient test) on CT/PT upto 800 kV.
- 9. Measurement of Electrical Interference and audible Noise from AC/DC sub-stations & transmission lines

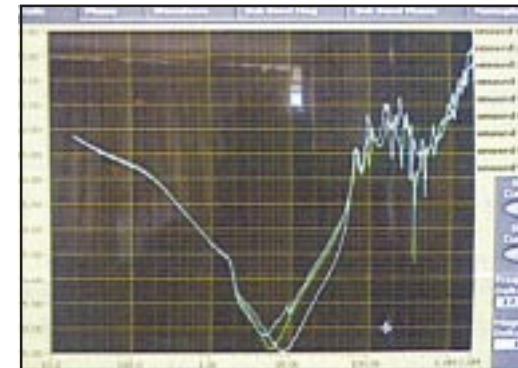


800 kV Circuit Breaker erected for testing

+

CONSULTANCY SERVICES:

1. The unit can take up Radio Interference measurements for HV AC / DC transmission lines.
2. The unit can take up work to investigate the mechanical condition of windings of the power transformers at site using Frequency Response Analyser. The responses can also be taken before commissioning of new units / before transporting to site from manufatuturers works.



Typical frequency response

+

SWITCHGEAR TESTING & DEVELOPMENT STATION, GOVINDAPURA, BHOPAL.

This unit situated adjacent to the BHEL premises at Bhopal, the capital city of Madhya Pradesh, has two main testing stations for conducting short circuit tests they are:

STATION I

Direct short circuit test station of 1500 MVA capacity utilizing a specially designed short circuit alternator. This station mainly caters to short circuit tests on high and medium voltages switchgears, transformers and other allied equipment.

STATION II

On line testing station drawing test power upto 100 MVA from the MPEB grid. This station mainly caters to short circuit tests on low voltage switchgears, transformers and other allied equipment.



View of Short Circuit Generators

Test facilities available at CPRI, Bhopal :

- Short circuit tests upto 200kArms, 1100 Volts for LT equipments and Short time current tests upto 200kArms for one second or 100kArms for 3 seconds.

+

- Short circuit making and breaking capacity test facility for medium voltage and LT circuit breakers.
- Capacitor bank switching test, cable charging and line charging test facility for medium voltage circuit breakers.
- Internal arc fault test facility for metal enclosed switchgear and motor terminal boxes.
- Short circuit dynamic and thermal withstand test facility for Distribution and Power Transformers.
- Short circuit breaking capacity test facility for LT & HT fuses.
- Making and breaking capacity test facility for air break, oil and vacuum switches.
- Short time current test facility for current transformers, power connectors, reactors, spacers and spacer dampers for bundle conductors, Isolators, earth switches and on load tap changers.
- Making and Breaking capacity test facility for medium and LT Contactor.
- High and Low short circuit current (pressure relief) test facility for Lightning Arresters.
- Short time current test facility for HT & LT busducts.
- DC test facility upto 80kA, 1550 V for testing DC Switchgear.
- Short circuit withstand capability test on voltage transformers (VTs).
- High voltage motor current switching test upto 6.6kV with simulated induction motor circuit for circuit breakers.
- Electrical and mechanical endurance test facility for HT/LT switches, HT/LT breakers, HT/LT contactors, MCBs, RCCBs, starters and tap changers etc.
- Test facility for degree of ingress protection (IP test).
- High voltage dry and wet power frequency withstand test facility upto 350kV.
- Temperature rise test facility upto 25kA in three phase set up.

+

- Temperature rise test and loss measurement facilities upto 20MVA, 132kV class Power Transformers.
- Limits of current error and phase displacement test facility for Current Transformers of rating upto 12.5kA.
- Limits of voltage error and phase displacement test facility for Potential Transformers of rating upto 132kV.
- Impulse voltage test facility with impulse generator of capacity 20kJ, 800kV.
- Facilities for calibration of AC/DC voltmeters, ammeters, ohmmeters, wattmeters and energy meters.
- Partial discharge test facility.
- EMC/EMI test facility for full compliance as per National & International standards for electronic equipments/instruments/components.
- Energy Meter test facility.
- Transformer oil test facility for new oil and serviced oil.



Energy Meter Test Setups

+



Moisture Meter



Tan Delta Resistivity meter



Flash Point



Breakdown Voltage Tester



Gas Chromatograph



Sulphur Analyser

Transformer Oil Testing Facility



132kV Switch Yard of Station - II



Test Setup for Switching test on OLTC

100 MVA On Line Testing Station



Table -1

THE FEASIBILITY OF TESTS FOR VARIOUS EQUIPMENTS AS PER THE IS/IEC STANDARDS AT CPRI, BHOPAL

Sl. No.	Equipment	Standards	Remarks
1	H.V. Circuit Breaker H. V. Breaker Switchgear Panel with Circuit Breaker	IS:13118, I 991/IEC 56,1987; IEC-62271-100,2003; IEC TR 62271-308, 2002; IEC 62271-200, 2003, IEC 60694, 1996; IS: 3427, 1997/ IEC 298, 1990; IEC 62271-200, 2003 IEC62271-110, 2005 IS:3427, 1997/IEC 298, 1990; IEC 62271-200, 2003	All the tests feasible upto Test upto 50kArms at12kV, 11kArms at 24kV, 16.0kArms at 36kV and STC test upto 200kArms for 1.0 Sec. except radio interference voltage test. Test upto 6.6kV & 3.3kV at 100 & 300 Amps Upto 50 kArms at 12kV, 11 kArms at 24kV, 16 kArms at 36kV for 0.3Sec.
2	H.T. Switches/ Line Sectionalizer/ Capacitor Switch/ Load Break Switch	IS:9920-1,1981; IS:9920-2, 2001 with amd. No. 1&2 2001; IS:9920-3, 1982; IS:9920-4, 1985; IEC 60265-1, 1998; IEC: 60265-2, 1988 with amd. No. 1, 1994; IEC:60694, 1996.	All the tests feasible except test to satisfactory operation under ice condition,
3	Alternating Current Disconnecter (Isolators) and Earthing Switches	IS:9921-1, 1981; IS:9921-2 & 3, 1982; IS:9921-4 & 5, 1985; IEC 62271-102, 2001	All the tests feasible except the following: i) Test to prove satisfactory operation under ice condition, ii) Test to prove satisfactory operation at minimum & maximum ambient temperature and iii) Measurement of radio interference level.
4	Power & Distribution Transformers Traction Transformers Dry type transformers Single Phase Pole mounted Distribution Transformer	IS:2026-1,1977 with amd No. 1, 1981, amd. No.2, 1983 & amd. No.3, 1985; IS:2026-2, 1977; IS:2026-3, 1981 with amd. No. I,1994; IS:2026-4, 1977 with amd. No. I, 1984, amd. No.2, 1993; IEC: 60076-1, 2000; IEC: 60076-2,2000 IEC: 60076-3, 2000; IEC: 60076-5, 2000; IS:1180-1, 1989, amd. No.1, 1994; IS:1180-2, 1989; IEEE C 57.12.00, 1993; IEEE C 57.12.90,1993, IS: 11171,1985 IEC: 60310, 2004 IEC: 60076-11, 2004 IEEE C 57.12.00, 1993; IEEE C 57.12.90, 1993	All the tests feasible (Short circuit test upto 40 MVA, 220kV Class) Except the following i) Measurement of the harmonics of the no load current ii) Measurement of acoustic level iii) Measurement of zero sequence impedance
5	Line Traps	IS: 8792, 1995; IS: 8793, 1995	12kV, 50kAmps for 0.2Sec. (depending on line trap impedance)
6	Spacers for Bundle Conductor.	IS: 10162, 1982/Test as per established practice of CPRI.	Fault current test upto 50kArms for 0.1second.
7	Insulator strings	Test as per established practice of CPRI.	Power Arc tests 50kArms at 12 kV 11kArms at 24 kV 16kArms at 36 kV



Sl. No.	Equipment	Standards	Remarks
8	Surge Arrestors	IS:3070-1, 1985; IS:3070-3, 1993; IEC:60099-1, 1999; IEC:60099-4, 2001; IEC:60099-5, 2000	Following tests are feasible: i) Power frequency voltage withstand & spark over test. ii) Pressure relief test upto 50kArms at 12kV, 11kArms at 24kV, 16.0kArms at 36kV. For high Current test & also associated low Current test. iii) Lightning voltage and standard lightning impulse spark over test. iv) Visual examination of porcelain housing
9	H.T. Fuses/ Distribution Fuse Boards and Cut Outs	IS: 9385-1,1979; IS:9385-2 & 3,1980; IS: 9385-4,1983, IEC: 60282-1,2005; IEC: 60282-2,1997; IEC: 60282-3, 1976; IS: 2675, 1983; IS:13947(Part-I), 1993; IEC6094 7-1,1999; IS:12063,1987	All tests feasible, Short circuit breaking test upto 50kArms at 12kV, 11kArms at 24kV, 16.0kArms at 36kV.
10	Motor Terminal Box	Test as per established practice of CPRI.	Tests Feasible are: i) Through fault current test Upto 200kArms for 1.0 Sec. ii) Internal fault current test upto 50kArms for 0.1 Sec. at 12 kV, Upto 11kArms for 0.1Sec. at 24 kV, 16kArms for 0.1 Sec. at 36 kV
11	Autoreclosures	IS: 7567, 1993; ANSI/IEEE C-37.60-2003	All ratings as per Standard, Short circuit make-break test Upto 50kArms at 12kV, 11kArms at 24kV, 16.0kArms at 36kV.
12	HT Contactor	IS: 9046, 1978 & IEC: 60470, 2000; IS: 13118, 1991	Verification of Rated making and Breaking Capacity Test
13	Current Transformer	IS:2705 (Part -I), 1992 with amd. No.1, 1996; IS:2705 (2 to 4),1992, am2-2002 & IEC 60044-1, 2003; IEC 60044-3, 1980; IEC 60044-6, 1992	All tests feasible except switching impulse voltage withstand test
14	Voltage transformers	IS: 3156 (Part-I, 2 and 3), 1992; IEC: 60044-2, 2003; IEC: 60186, 1987 with amd. No.1, 1988 and amd No. 2, 1995	Short circuit withstand capability test upto 220kV class and partial discharge upto 66kV class
15	Reactors	IS:5553-2, 1990; IS:5553-3, 1990; IS:5553-4, 1989; IS:5553-6, 1990; IS:5553- 8, 1990 and IEC:60289, 1988	All tests feasible except inrush current withstand test
16	Interconnecting busbar above 1000V & upto 36kV (Busducts)	IS 8084,1976 aml-1979, am2-1979, am3-1981	All the tests feasible, Short circuit test upto 200kArms for 1.0 sec.
17	Neutral Grounding Resistor units	Test as per established practice of CPRI	Short Time Current test/ Temp. rise test Upto 200 kArms for 1.0 sec.

+

Sl. No.	Equipment	Standards	Remarks
20	Motor starters for voltage not exceeding 1000V	IS 13947 (Part-4/Sec.I), 1993, aml-1997; 60947-4-1,2000	All tests Feasible
21	Air Break Switches, Air Break Connectors, Air Break Switch Disconnector fuse combinations for voltage not exceeding 1000V	IS 13947 (part-I & 3), 1993; IEC 60947-1, 1999 Am2-2001; IEC 60947-3, 2001	All tests Feasible
22	Composite unit of air break switches for rewirable type switches for voltage not exceeding 650V, AC-21, 100A	IS: 10027, 1981	All tests Feasible
23	Contactors for voltages not exceeding 1000V semi conductor contactor	IS 13947 (Part-4/Sec.I), 1993, aml-1997; IEC 60947-4-1, 2000; IEC 60947-4-2, 1995	All tests Feasible
24	DC Breakers	IS 13947 (part-I), 1993; IS 13947 (Part-2), 1993 aml-1994; IS 13947 (Part-3), 1993; IS 13947 (Part-4/Sec.I), 1993 aml-1997; IEC 60947-1,1999 Am2-2001; IEC 60947-2, 2003	Test feasible are Short Circuit duty tests upto 80kA DC, 1.55kV DC. Tripping characteristics and Temperature Rise Test
25	Circuit Breaker for overcurrent protection for house hold & similar installations (Miniature Circuit Breaker, MCB)	IS 8828, 1996; IEC 60898, 1995; IEC 60898-1, 2002	All tests Feasible
26	Residual current operated circuit breakers	IS: 12640 (Part – 1), 2000; IS: 12640 (Part – 2), 2001	All tests Feasible
27	LV fuses for voltage not exceeding 1000V	IS 13703 (Part-I & 2), 1993; IEC 60269-1, 1998; IEC 60269-2,1986 aml-1995, am2-2001; IEC 60269-2-1, 2000 aml-2002; IEC 60269-3,1987 aml-1995 am2-2001; IEC 60269-3-1, 1994 aml-1995	All tests Feasible
28	Semiconductor Fuses	IS 13703 (Part-1 & 4), 1993 IEC 60269-4,1996	All tests Feasible
29	Carrier Bases and Rewirable type fuses	IS 2086, 1993 with one amendment	All tests Feasible
30	D type (AC/DC) fuses,	IS 8187,1976 amd. 1--1980	All tests Feasible
31	For enclosed distribution boards and cutouts 1000V	IS: 2675, 1983	All tests Feasible
32	Factory built assemblies of switchgears and controlgears for 1000V (LT Panels & Busducts)	IS 8623 (Part-I), 1993; IS 8623 (Part-2), 1993; IEC 60439-1,1992 aml-1995, am2-1996; IEC 60439-2,1987 aml-1991; IEC 60439-1, 1999 aml-2004; IEC 60439-2, 2000	All tests Feasible
33	Electric Power Connectors above 200A	IS 5561,1970	All tests feasible except tensile and galvenising tests
34	ON load Tap Changer (diverter Switch and Selector Switch)	IS: 8468, 1977; IEC 60214 -1, 2003	All tests feasible except switching tests upto 300kV, 700A.

+

Sl. No.	Equipment	Standards	Remarks
35	Electronic and Electromechanical and Energy Meters and Trivector Meter	IS: 13779, 1999; IS: 14697, 1999; IS: 13010, 2002; CBIP Technical Report No. 88; IEC 62052-11, 2003; IEC 62053-11, 2003; IEC 62053-21, 2003; IEC 62053-22, 2003; IEC 62053-23, 2003	All tests Feasible
36	EMC/EMI Tests on Electronic Equipments/ Components	IEC 61000-4-2, 2002; IEC 61000-4-3, 2006; IEC 61000-4-4, 2004; IEC 61000-4-5, 2005; IEC 61000-4-6, 2006; IEC 61000-4-11,2004; IEC 61000-4-12, 2006; CISPR11, 2004; CISPR14, 2005; CISPR 22, 2006	All tests Feasible
37	Calibration of Energy reference meters	--	Upto accuracy of 0.02 class of Active Energy/Reactive Energy
38	Oil Testing	IS: 1866, 2000 (For Serviced Oil); IS: 335, 1993 (For New Oil)	Following tests are feasible: i) Interfacial Tension ii) Flashpoint iii) Breakdown Voltage iv) Water Content v) Dielectric Dissipation Factor vi) Resistivity vii) Acidity viii) Sludge Content ix) Dissolved Gas Analysis x) DBPC content xi) ASTM ageing xii) Density xiii) Sulphur Content

REGIONAL TESTING LABORATORY, MURADNAGAR / GHAZIABAD.

INTRODUCTION

The Regional Testing Laboratory (RTL) is located at Muradnagar in the NTPC's Central Satellite Earth Station campus, 15 km away from Ghaziabad. In order to service our customers in a better way the laboratory going to be shifted to new location NOIDA by mid 2008.

OBJECTIVES

The laboratory is set up with a view to cater to the testing, certification and evaluation needs of electrical power equipment manufacturing industry. Act as a liaison unit of CPRI with various clients in the northern region and coordinate their test requirements which are beyond the scope of the Regional Laboratory but within the capabilities of Bangalore and other units.

LABORATORIES:

The laboratories established at RTL are :

High voltage laboratory
Liquid Dielectric Laboratory
Cable and Capacitors Laboratory
Insulation Laboratory

HIGH VOLTAGE LABORATORY

Test facilities:

- Impulse voltage generator, 600 kV, 15 kJ
- Power frequency testing transformer, 200 kV, 15 kVA
- Radio Interference voltage meter
- Wet test arrangement

Equipment that can be tested:

Standard lightning impulse voltage withstand test on : Distribution

transformers upto 1000 kVA. Instrument transformers upto 110 kV, HV switch gears, bus ducts, fuse units upto 110 kV.

Insulators upto 66 kV.

Dry and wet power frequency voltage withstand tests on the insulator (upto 66kV) upto a test voltage level of 200 kV (RMS).

Dry, wet power frequency and standard lightning impulse voltage sparkover tests, front of wave sparkover tests on lightning arresters of voltage rating upto 120 kV.

RIV measurements on High voltage equipment:

LIQUID DIELECTRICS AND COAL LABORATORY

Test facilities for testing new and old transformer oils.

- Gas chromatograph with data processor
- Specific resistance, dissipation factor bridge
- Moisture meter
- Automatic titrator
- Automatic interface tensiometer
- Flash point apparatus
- UV Visible spectrophotometer
- Break-down voltage tester
- Fourier transform infra red spectrophotometer
- High performance liquid chromatography
- Cloud and pour point apparatus

CABLES AND CAPACITORS LABORATORY

Test facilities:

- Temperature rise test set up 5000 Amps
- DC test facility upto 80 kV DC, 50 m Amps
- AC power frequency test facility upto 60 kV, 150 m Amps
- Thermal stability test set up
- Universal testing machine upto 100 kN

+

- Capacitance and dissipation factor bridge
- Partial discharge set up upto a test voltage level of 100 kV (RMS)
- Loading coils upto 2000 Amps at 5 Volts

Cables and accessories which can be tested :

All type tests as per the relevant Indian Standards on

Paper insulated, lead covered cables upto 33 kV

PVC insulated, PVC sheathed cables upto 11 kV

XLPE cables upto 33 kV

Cable accessories like termination and joints upto 11 kV.

FRLS TESTS ON CABLES & INSULATIONS

- Smoke Density Test as per ASTM D 2843
- Oxygen Index Test as per ASTM D 2863
- Temperature Index Test as per ASTM D 2863
- Halogen Acid Generation Test as per IEC 754-1

INSULATION LABORATORY

Test facilities:

Measurement system to measure arc resistance and comparative tracking index on solid insulating materials.

Capacitance and dissipation factor bridge from power frequency to 1000 kHz.

Folding endurance, Tear resistance test equipment

Humidity chamber

+

**REGIONAL TESTING LABORATORY,
KOLKATA**

OBJECTIVE

RTL Kolkata is set up with a view to cater to the testing, certification and evaluation needs of electrical power equipment manufacturing industries, utilities and consumers in the eastern region. It also acts as a liaison unit of CPRI with various clients in the region and coordinates their test requirements, which are beyond the scope of RTL Kolkata but within capabilities of Bangalore and other units of CPRI. The facilities available at the laboratory are also used in research and consultancy activities.

FACILITIES

The Laboratory is equipped with facilities to carry out testing and certification of insulating oils in power transformers as per IS 1866-2000. The Dissolved Gas Analysis on power transformers, an important diagnostic tool is available at RTL Kolkata for assessing the internal condition of the transformers. The laboratory has the test facilities like . High Performance Liquid Chromatography (HPLC) to evaluate Furfural content which is an important diagnostic tool for assessing the condition of solid insulation in power transformers. The facility is also being used for assessing the Inhibitor level in the transformer oils.

MOBILE TEST FACILITY

The Mobile Transformer Oil Test Facility has all facilities including Dissolved Gas Analysis to evaluate transformer oil samples at site as per IS: 1866 - 2000 to assess the condition of oil and internal condition of transformers.

The advantage of the mobile transformer oil test facility is that at a single electrical installation having large number (50-100) of transformers both oil quality and transformer internal condition can be assessed in a short time of 10-15 days.

+

DISSOLVED GAS ANALYSIS

The Centre has expertise in conducting dissolved gas analysis of transformer oil, which is a powerful diagnostic technique to assess the internal condition of power transformers. Annually more than 1000 transformers are assessed for internal condition by dissolved gas analysis and more than 10% of transformers are saved from destruction. The test covers preventive maintenance of transformers.

MAJOR EQUIPMENT

- ❖ Mobile Oil Testing Laboratory
- ❖ Break Down Voltage Tester
- ❖ Tan delta & Specific Resistance Bridge
- ❖ Tensiometer
- ❖ Gas Chromatograph
- ❖ Flash Point Test Apparatus
- ❖ Moisture Analyzer
- ❖ Auto Titrator
- ❖ Fourier Transform Infrared Spectrophotometer
- ❖ High Performance Liquid Chromatograph



+

RIGHT TO INFORMATION ACT, 2005

CONTACT OFFICERS AT CPRI:

In accordance with the guidelines of the Right to Information Act, 2005 enacted by Government of India, CPRI has nominated the following two officers;

Shri. S. Sridhar

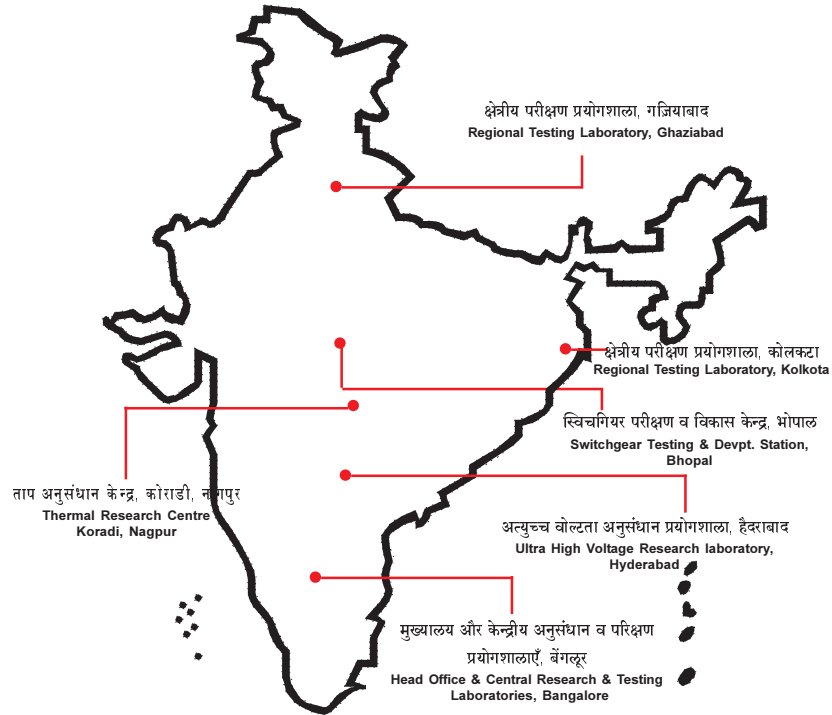
Public Information Officer,
Additional Director,
Marketing Publicity & planning Division,
Central Power Research Institute,
P.B.No.8066, New BEL Road,
Bangalore-560080
Ph: 080-2360 4447, Mobile: 9448277508
Fax: 080-2360-1213,
Email ID sridhar@powersearch.cpri.res.in,
cprisridhar@yahoo.co.in

Shri. Suhas. S. Bagalkotkar

Asst.Public Information officer,
Joint Director,
Marketing Publicity & planning Division,
Central Power Research Institute,
P.B.No.8066, New BEL Road,
Bangalore-560080
Ph: 080-2360 2329, Mobile: 9448474530
Fax: 080-2360-1213,
Email ID suhas@powersearch.cpri.res.in

+

केन्द्रीय विद्युत अनुसंधान संस्थान के एकक Units of Central Power Research Institute



144

+ RK

+

CPRI UNITS

Additional Director

Switchgear Testing & Devpt. Station
Govindpura
Bhopal 462 023
Tel : 0755 -586682
Fax : 0755 - 587774
Telegrams : Powersearch
E-mail : cpribpl@sancharnet.in

Additional Director

UHV Research Laboratory
Post Bag No. 9, Uppal P.O.
Warangal Highway
Hyderabad - 500 039 (A.P)
Tel : 040 - 720 3622
EPABX : 040 - 720 3112/7204701
Fax : 040 - 720 3378
Telegrams : CENTPOWER
E-mail : uhvac@netlinx.com

Joint Director

Regional Testing Laboratory
NTPC (CSES) Campus
Pipeline Road
MURADNAGAR 201 206
Tel : 01232 - 41284, 27890
Fax : 01232 - 27890
E-mail : rtlecpri@rediffmail.com

For information / details you may please contact.

Addl. Director
(Planning)
Ph : 2360 4447

Central Power Research Institute

P.B. No. 8066, Bangalore - 560 080.
Fax : 2360 1213
website: <http://cpri.in>
E-mail : cpriidhar@yahoo.co.in
E-mail : sridhar@powersearch.cpri.res.in

145

+ RK