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VIDYUT ANUSANDHAN SAMACHAR

QUARTERLY NEWSLETTER

CENTRAL POWER RESEARCH INSTITUTE

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ABOUT CPRI

Central Power Research Institute (CPRI) was established by the Government of India in 1960. It became an Autonomous Institute in the year 1978 under the aegis of the Ministry of Power, Government of India. For the last six decades, CPRI has been rendering dedicated service to the Power Sector.

Over the years, CPRI has developed expertise in generation, transmission, distribution systems and has established world-class facilities for research and testing in the areas of High Voltage, High Power, Short Circuit, Power Capacitors, Power Cables, Solar PV, Smart Metering & AMI, Power System Studies, Energy Studies, Tower Design, Vibration Studies, Seismic Performance, Liquid Dielectrics, Diagnostics, Condition Monitoring, Cybersecurity, Smart Grid Systems, Energy Storage, RLA studies and development of newer materials for Power Sector.

Activities of CPRI:

- *Applied Research in Power Systems Engineering.*
- *Independent Third-Party National Laboratory for Testing & Certification*
- *Consultancy & Field-Testing Services*
- *Customized & specilised training programes*

DIRECTOR GENERAL's MESSAGE

It gives me pleasure to place before you the fourth issue of the Vidyut Anusandan Samachar for the quarter October to December 2024. In the area of R&D, CPRI has made substantial progress in undertaking new collaborative research projects on emerging technologies. CPRI officers continue to make strides in getting patents awarded for their illustrious R&D capabilities. I compliment the concerned officers in this regard. I am pleased to see the Sustainable Agrarian Mission on use of Agro Residue in Thermal Power Plants (SAMARTH) advancing steadily towards its objectives.

Shri. B A Sawale,
Director General, CPRI

RESEARCH HIGHLIGHTS

Central Power Research Institute (CPRI) continues to play a pivotal role as the nodal agency for coordinating research in the Indian power sector. CPRI focused on supporting the SAMARTH Mission aimed at increasing the use of biomass in thermal power plants—a vital step toward making India's energy mix more sustainable and eco-friendly.

Project in Focus:

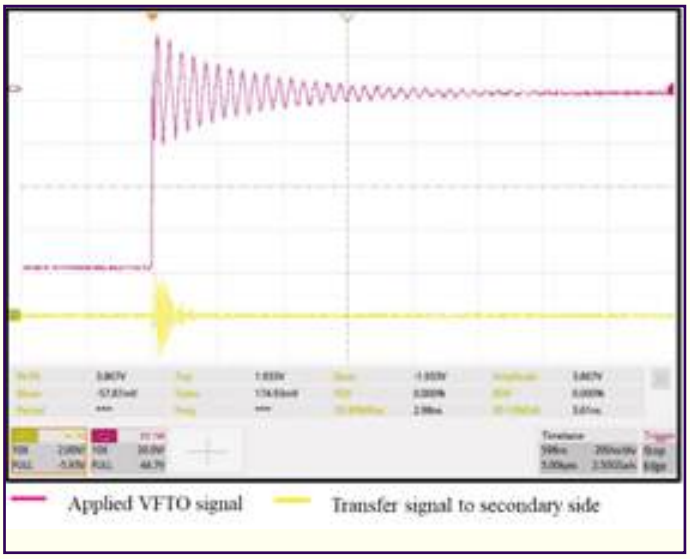
Investigations of Very Fast Front Transient Over voltages (VFTO) surge transfer effects in Gas Insulated Switchgear (GIS) Instrument Transformers through Capacitive and resistive paths

Nowadays, GIS systems have become very popular due to their advantages, such as occupying less space, the high dielectric strength of SF_6 gas, and lower maintenance costs. However, the generation of Very Fast Transient Overvoltage (VFTO) surges is a common phenomenon in Gas-Insulated Switchgear (GIS) during disconnector switching operations and fault conditions. Repetitive restrikes are generated at switch contacts due to the high dielectric strength of the SF_6 gas medium.

These surges propagate as traveling waves through the GIS bus bar in either direction. The magnitude of these surges may reach up to 2.5 p.u. due to trapped charges on the load side under worst-case scenario.

These surges accelerate the aging phenomenon, particularly in the primary insulation (such as the solid insulation between compartments), and also degrade the breakdown strength of AIS equipment connected to the GIS bay (e.g., bushings, power cables, transformers). Simultaneously, these traveling waves can couple into secondary low-voltage systems via instrument transformers through their capacitive and resistive paths. Due to the high steepness and frequency content of the transferred signal, it can potentially damage highly sensitive Intelligent Electronic Devices (IEDs), such as relays and measuring equipment, through electromagnetic interference (EMI).

As part of an ongoing project, VFTO pulses, transient overvoltage factors, and various mitigation methods are being analyzed. Similar work has been carried out for a 420 kV Gas-Insulated Current Transformer under gas pressures of 0.5 bar (absolute). It was observed that the transferred overvoltage across the secondary windings was very high, approximately 9.0 kVp (extrapolated to Up = 1.2 × Um). The waveforms related to the transferred signal to the secondary side are shown in Figure 1. The frequency spectrum of the transferred signal was also analyzed using a spectrum analyzer to identify peaks in the high-frequency content. The evaluation was performed by applying the Fast Fourier Transform (FFT), as shown in Figure 1. It was observed that high-frequency peaks with an amplitude of 372.53 dBµV occurred at a frequency of 63.2 MHz. This confirms that the peak frequency observed lies within the specified frequency spectrum of the VFTO signal, as defined by the IEC 60071-1 standard



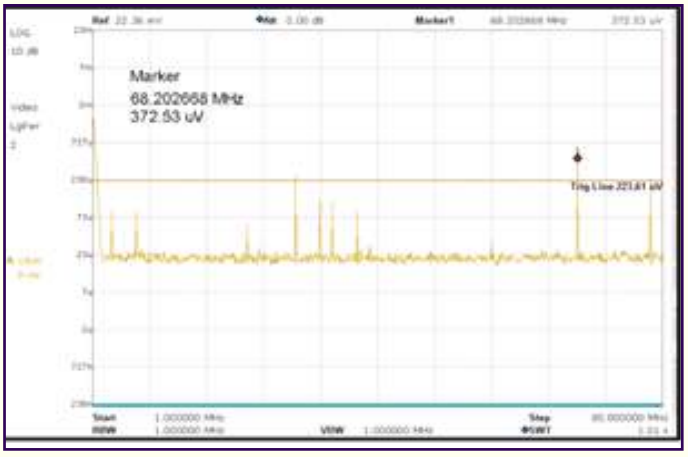


Fig. 1. Time domain and Frequency spectrum of VFTO transferred signal to secondary windings of 420 kV GIS Current Transformer

Further studies are underway to explore mitigation of surge transfer characteristics with high-frequency nanocrystalline sheets and ribbons with varying thicknesses and multiple layers for shielding transformer cores and secondary transmission cables. The ongoing research aims to optimize these methods to enhance the effectiveness of VFTO mitigation and safeguard critical electronic components in GIS systems.The project is being executed at UHV Research Laboratory, CPRI, Hyderabad

Impact of harmonics on Power Distribution Network due to Electric Vehicle Charging

The project focuses on analyzing the effects of DC/AC EV chargers on the power quality of the distribution grid, using data collected from EV chargers of different ratings to support large-scale deployment of EV. Current and voltage harmonics data was collected from Level 2/ Level 3 DC Chargers of rating 15 kW, 25 kW, 30 kW and 50 kW, 240 kW DC Super-fast charger and AC slow charger of rating 3.3 kW. Models of the said chargers were developed in MATLAB Simulink environment. Distribution system was modelled in simulation environment to study the impacts of these chargers on the distribution system with respect to harmonics, Total Harmonic Distortion (THD) and Total Demand Distortion (TDD), especially during simultaneous charging of EVs.

Findings from the study:

The findings from the study suggests the following:

- DC Level 2 EV chargers of rating 15 kW and 25 kW that are ubiquitous in commercial and public spaces, were found to give rise to significant amount of THD_i during the entire charging cycle. Further, the THD_i values were more than double

of that of the permissible limit when the EVs were charged between SOC 80% to 100%. The higher value of THD_i coupled with a high value of TDD during full-load, introduces severe power quality issues.

- Current unbalance is observed in 15 kW charger
- Level 3 Chargers such as 30 kW and 50 kW were found to generate higher THD_i for battery SOC beyond 80%.
- 30 kW Charger also exhibited poor power factor after 80% SOC
- For 240 kW DC Super-Fast Charger (for e-Bus), Voltage THD levels were within limits, but current THD levels increased near phase transition (from CC to CV phase) and safe temperature thresholds. Further, three phase current is found to vary with variation in operating temperatures demonstrating periods of increase and decrease in magnitude, thereby increasing the charging time. Thus, effective thermal management is crucial for chargers to reduce charging time period.
- From the field data collected from BESCOM Charging Station, voltage level is observed to dip below -10% of nominal value of 250 V (Line to Neutral) between 11 am to 1 pm (peak time) due to simultaneous charging of three to five EVs.
- The simulation studies carried out for 3.3 kW AC onboard chargers indicate that higher penetration of 3.3 kW AC chargers at residential level would introduce significant distortion in the current wave beyond permissible limit as per IEEE 519-2022 (5% limit on both THD_i and TDD).

These findings would assist in designing/ augmenting distribution systems for efficient deployment of EV chargers of various ratings. Further, the findings of this study underscore the necessity of investigating the other power quality aspects and coordinated charging of EVs in the light of increased adoption of EVs in India.

Patents Granted

1. **Patent Title:** Silica rich Soil Nutrient Support Material obtained through Dry Ash Beneficiation Patent Number: 555752 Date: 03.12.2024

   Inventors: Shri. P.Sampath Kumar, Smt.M.G.Sumangala, Dr. S. Seetharamu

2. **Patent Title:** Hot Blended Waste Particulate with Inorganic Catalyzed Disperse Phase for Construction Applications

   Patent Number: 554652 Date: 20.11.2024

   Inventors: Dr. M.G.Anandakumar, Shri.Sadashivamurthy, Dr. S. Seetharamu

3. **Patent Title:** Marble Dust as a Filler Material for Manufacture of Polymer Composites

   Patent Number: 554545 Date: 19.11.2024

   Inventors: Shri. K. Suryanarayana, Dr. M. Shekhar Kumar,Dr. S. Seetharamu

4. **Patent Title:** Multilayer Nanomullite Alumina Coatings for Wear and Erosion Resistance Applications

   Patent Number: 554510 Date: 18.11.2024

   Inventors: Dr.S. Vynatheya, Dr. S. Seetharamu, Shri. Ramakrishna

TECHNICAL SPOTLIGHT

Signing of MoU

Central Power Research Institue (CPRI) and Bharat Heavy Electricals Limited (BHEL) signed an MoU for collaborative Research and Development works of mutual interest on 28th November 2024 at CPRI, Bengaluru. The MoU was signed by senior official from both the organisations in the presence of Shri Jai Prakash Srivastava, Director (E R&D), BHEL and Shri B.A Sawale, Director General. Shri Rajesh Kohli, Chairman & Managing Director, HMT graced the occasion.

Central Power Research Institue (CPRI) and Karnataka Power Corporation Limited (KPCL) signed MoU on 18th December 2024 at KPCL. The MoU between CPRI & KPCL is to avail the technical services vide., Testing & Certification, Consultancy Sercies, Third Party Inspection and HRD by CPRI to KPCL when required.

Shri Yugal Agarwal, Joint Director & Shri. Rajaramamohana Rao Chennu, Engg. Officer have attended the 71st STL technical committee meeting on 5th November 2024. The meeting was organized by CREDA Lab at Lyon, France.

First Time Tests

Cables and Diagnostics Division, Bengaluru has conducted Thermal Cycle test and Voltage Endurance test on 1350 kVA , 10 kV Stator Coils (5 Nos) for the first time for M/s. Siemens Gamesa Renewable Power Pvt. Ltd., Nellore, Andhra Pradesh.

Test setup for Thermal Cycle Test on Stator Coils

Setup for Voltage Endurance Test on Stator Coils

Consultancy and Field Testing

- Thermal Research Centre (TRC) Nagpur conducted Remaining Life Assessment study on the 210MW Boiler at Unit No. 3 of MSPGCL, KhTPS Khaperkheda during Nov-Dec 2024.The study involved various tests in compliance with IBR Regulations 391(A), followed by providing suggestions and recommendations to the plant authorities. The work was successfully completed, to the satisfaction of the plant authority.

- Thermal Research Centre (TRC) Nagpur offered consultancy services for R&M studies to MSPGCL at NTPS Nashik and BTPS Bhusawal during Oct-Nov 2024. The scope included condition assessment, restoration, and strengthening of RCC flue gas stacks for 210 MW boiler units. This effort ensured enhanced operational reliability and structural integrity.

- TRC Nagpur provided specialized consultancy service to NALCO's Captive Power Plant in Angul, Odisha. The service involved a detailed condition assessment of the rail foundation supporting the stacker cum reclaimer system. This assessment aimed to ensure the structural stability and operational efficiency of critical material handling equipment.

- TRC Nagpur extended its specialized consultancy service to the Surat Lignite Power Plant of Gujarat Industries Power Co. Ltd., Nani Naroli, Surat, Gujarat. The service focused on a comprehensive condition assessment of the RCC structure of the turbine generator (TG) deck for Unit #1. This evaluation aimed to determine the structural integrity and recommend measures for restoration and reinforcement.

OVERSEAS CUSTOMERS

Testing for overseas customers

CPRI has been rendering testing services to many overseas customers. Few of those services are listed below;

Cables and Diagnostics Division, CPRI Bengaluru carried out type test on 6.35/11 kV, 3C X 240 Sq.mm, Cu/XLPE/CWS/PVC/SWA/PE Cable as per IEC 60502-2 for M/s. DOHA Cables, Qatar. The test was witnessed by Mr. Mazin Aziz, M/s. Dubai Electricity & Water Authority (DEWA), Dubai & Mr. Anoop Kallumpurathu Varghese, M/s. DOHA Cables, Qatar

Energy Efficiency & Renewable Energy Division, CPRI Bengaluru carried out first commercial tests of Power Magnetic Immunity Tests, Radiated Immunity Tests, Conducted Immunity tests and Conducted Emission Test on EV Chargers of 22kW AC EVSE as per IEC 61851-21-2 standard for M/s. ChargeNET, SriLanka.

Short Circuit Laboratory, CPRI, Bengaluru carried out Short-time withstand current test and peak withstand current tests at 25kA rms for 3 s with 62.5 kApeak on 12kV 1600A 1 Phase Neutral Earthing Isolator Panel. The test was witnessed by Mr. Meng Fee Chiat from M/s. Any Ohm Sdn. Bhd., Malaysia

High Power Laboratory, CPRI, Bengaluru, carried out short time withstand test and peak withstand current tests at 40kA rms for 3 seconds with 100kA peak on 145kV outdoor disconnector and earthswitch. The test was witnessed by Mr. Nashron Fajuri Rozali, Chief Engineer, from M/s. Tenaga Switchgear Sdn. Bhd., Malaysia.

Visit of overseas customers

Team from SEL USA and India visited SGRL, CPRI, Bangalore on 13th November 2024. During their visit, SGRL team had discussion on the activities and the works going on in the areas of mutual interest. Also CPRI team participated in the presentation on Cyber Security delivered by Mr. Ryan Bredtich – Senior Vice President, SEL R&D and on Single Pole Trip and Shunt Reactor Protection – IEEE STD by Mr. Kamal Garg – Principal Engineer, SEL ES at CCAR, CPRI Bengaluru.

SGRL Officers with SEL Team at CPRI, Bengaluru on 13 November 2024

Mr. Andrea and Mr Filippo of Bhopal ABB Ltd Italy visited CPRI Bhopal

Mr. Roberto and Mr Carlo of ABB Ltd Italy visited CPRI Bhopal

Mr. Ricardo Sanchez, Canada visited CPRI Bhopal

Mr. Benjamin LE CAER, France visited CPRI Bhopal

LEGACY DESK

Technical Article

CPRI Services for Power Generation Sector

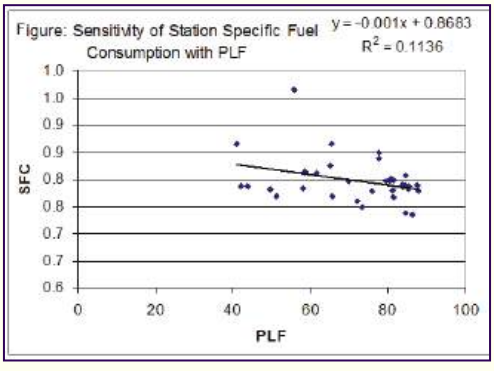
CPRI has been providing services to the power generation sector in the areas of energy audit, performance studies, RLA, R&M etc,. for coal fired thermal power plants, hydro-electric plants, nuclear power plants, gas turbine power plants, diesel engine power plants and renewable energy power plants etc.

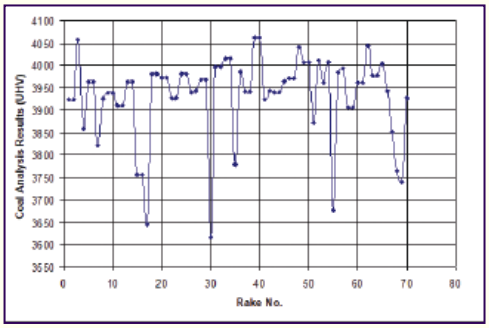
The services include:

- Energy efficiency performance evaluation of the primary components like Boiler, Turbine, Generator, in-house auxiliaries (boiler feed pumps/condensate extraction pumps/cooling water pumps; ID/FD/PA fans, mills/pulverizers) and out-lying auxiliaries (water handling/river water plants, bottom/fly ash handing systems/ coal yard equipment/ crushers/ conveyors/ junction towers).
- Studies on renovation/ modernization/ upgradation of power plant components leading to run/repair/replace decisions.
- Studies on heat rate assessment/ technical minimum/load ability/load limitations.
- Studies on water management in thermal power plants.
- Studies on project planning/delay analysis of projects.
- Studies on fuel replacement to cleaner fuels like RLNG, etc.
- Studies on efficiency of operations and maintenance staff vis a vis their remuneration.

CPRI evaluates the performance of equipment and conducts assessments based on international codes and practices such as ASME, BS, BIS, DIN, etc. The measurements are based on standard calibrated portable field-compatible instruments. The instrumentation in the plant is also used based on its calibration.

Some typical sample analysis is shown below.





Unit 1	Heat rate performance test	
Test UHR	2744.37	kcal/kWh
DHR	2634.0	kcal/kWh
Dev due to Boiler	46.3	kcal/kWh
Dev due tc Turbine	62.9	kcal/kWh
Dev due tc Generator	1.1	kcal/kWh
Test efficiency	31.3	%
Design efficiency	32.6	%
Overall difference	1.3	%
Overall difference	110.3	kcal/kWh

Table: Evaluation of Maintenance staff [Scale: Max: 5, Min:1]

Particulars	Education Qualification	Knowledge	Experience	Level of motivation
Boiler	4	4	4	4
Turbine	4	4	4	4
Electrical	4	4	4	4
C& I	4	4	4	4
Coal	4	4	4	4
Chemistry	4	4	4	4
HRD	4	4	4	4
Efficiency	4	4	4	4

Authour :
M. Siddhartha Bhatt
Director (Retd,) C.P.R.I

INDUSTRY TRENDS

India's present renewable energy scenario and the effective transition from conventional to renewable energy.

Presently, India is the world's 4th largest consumer of electricity which is about 122 billion units, and the 3rd larger country to produce renewable energy with installed capacity of about 174.53 GW (including large Hydro). This is an increase of about 396% in the last 8.5 years and about 42.5% of the country's total capacity as on March 2025. India has an increasing energy demand to fulfill the economic development plans that are being implemented.

The developing countries are competing for a greater share of finite fuel stocks and the call of the hour is to search for innovative ways to meet this need which has become more urgent than ever. The provision of increasing quanta of energy is a vital pre-requisite for the economic growth of a country. It is a fundamental requirement to the economic and social fabric of nations, which contributes to the wellbeing and quality of life for their citizens.

The sources for electricity production such as coal, oil, and natural gas have contributed to one-third of global greenhouse gas emissions. Traditionally exploited natural resources is outpacing supply and the conventional industrial practices are contributing to undesirable climatic change. It is essential to raise the standard of living by providing cleaner and more reliable electricity.

The world is poised to switch on to cleaner energy at a faster pace through renewable energy sources like solar, wind, biomass, green hydrogen etc., Thus, the transition from conventional energy sources to renewable energy is considered very apt in the present energy scenario both for India and the world over. The urgency for drastically reducing CO2 emissions will be the main tailwind for the renewables energies as the only way to meet the target.

India commitment to generate energy through renewables saw the highest year on growth in renewable energy additions of 9.83% in 2022. India's announcement to reach net zero emissions by 2070 and to meet 50% of its electricity requirements from renewable energy sources by 2030 so as to reach 500 GW renewable energy capacity. This is considered a hugely significant moment for the global fight against climate change.

The renewable energy components and its installed capacity presently in India are as follows:

- Wind power: 41.9 GW
- Solar Power: 63.3 GW
- Biomass/Co-generation: 10.2 GW
- Small Hydro Power: 4.93 GW
- Waste To Energy: 0.52 GW
- Large Hydro: 46.85 GW

The country is pioneering a new model of economic development that can avoid the carbon-intensive approaches, many countries have pursued in the past, and this model can provide a blueprint for other developing economies.

Author:
Dr. M.G. Anandakumar,
Joint Director & Head,
Business Development Division

CONFERENCE/ SEMINAR/ WORKSHOP/ TRAINING

- Electrical Appliances Technology Division had organised one day workshop on **"Need of Ingress Protection Testing for enclosures, test standard and Procedure"** at CPRI, Bengaluru. Director General Shri B.A Sawale, inaugurated the workshop and delivered the inaugural address. Director Shri S.K. Das has delivered welcome address. Dr. P. Chandra Sekhar, AD/HoD (EATD) delivered vote of thanks.

- Dr. M. Selvaraj, Joint Director & HoD was invited for the expert panelist for IEEE, ISGT-24 Asia Conference organised by IEEE- PES Bengaluru at Radisson Blu Atria Hotel during 10-13 November 2024. A session titled **"Futuristic Smart Energy Initiatives for MegaCities"** was conducted on 12th November 2024. Topic on "Solutions to RoW problems of mega cities with Innovative Support Structures" was presented during the event.

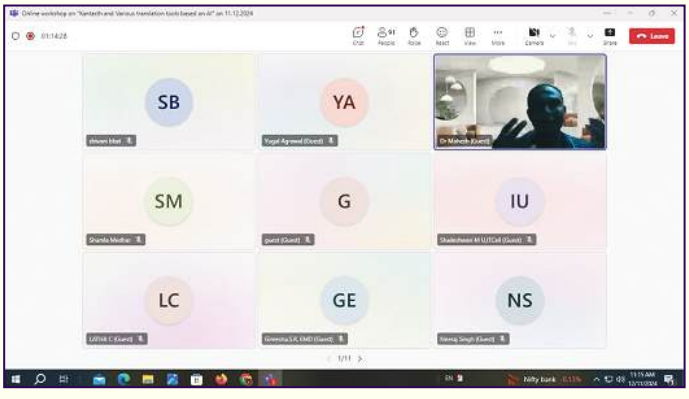
- Cables and Diagnostics Division has conducted training program for officials of M/s. NALCO on **"Condition monitoring tests on in service transformers "** for diagnostic tests on substation equipment.

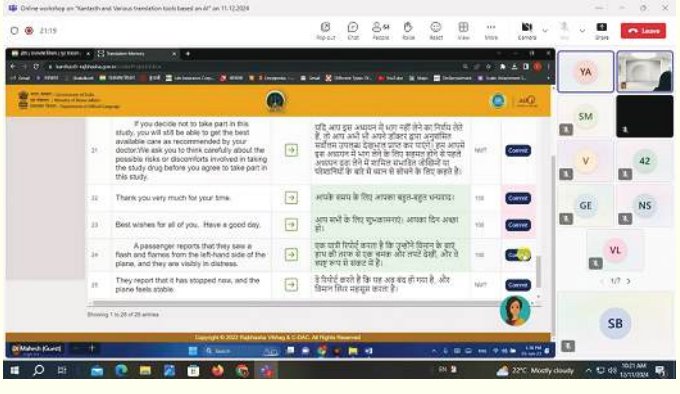
- Dr. Amit Jain was invited as a panelist in panel **"IEEE PES -New Talent, Integration of Renewable Energy and Grid Challenges"** in the International Conference of IEEE ISGT-Asia 2024 held at Bengaluru during 10-13 November 2024 and participated in the panel discussion on 11th November 2024.

Workshop on "Kanthasth and Various Translation Tools Based on AI"

An online workshop on "Kanthasth and Various Translation Tools Based on AI" was conducted on 11th December 2024. The Speaker was Dr. S.N. Mahesh, Assistant Director, CAIR, DRDO, who provided valuable insights into the advancements in AI-driven translation technologies.

During the workshop, the Speaker extensively covered the features and functionalities of Kanthasth, a Memory based Translation Software, highlighting its applications in real-time language translation and text processing. In addition to Kanthasth, he also elaborated on other widely used AI-based translation tools such as Google Translation, Bhasha and several others, explaining their capabilities, limitations and comparative advantages. These AI-based translation tools significantly save time by automating the translation process. They help in quickly converting text from one language to another. The workshop witnessed active participation around 95 Officers / Employees from Bengaluru and other units, reflecting a strong interest in AI-based translation technologies.





EVENTS

Swachh Bharat Diwas

The Swachh Bharat Diwas 2024 celebrated across all CPRI units. CPRI Bengaluru under the 'Swachhata Hi Sewa (SHS) 2024', celebrated Swachh Bharat Divas in coordination with MSR Nagar Residents Welfare Association, on 2nd October 2024 at MSR Nagar. Shri Lahar Singh Siroya, Hon'ble Member of Parliament, Rajya Sabha, was the Chief Guest. Shri B.A. Sawale, Director General, CPRI presided over the function.

Swachhata Hi Sewa at CPRI, Bengaluru

Swachhata Hi Sewa at CPRI, Hyderabad

Swachhata Hi Sewa at CPRI,, Bhopal

Constitution Day

CPRI Bengaluru and its units celebrated Constitution Day (Samvidhan Divas) on 26th November 2024. The Constitution Day, also known as "National Law Day", is celebrated in India on 26th day of November every year to commemorate the adoption of the Constitution of India. On 26th November 1949, the Constituent Assembly of India adopted to the Constitution of India, and it came into effect on 26th January 1950.

State Level Painting Competition 2024 on Energy Conservation

The State Level Painting Competition 2024 on Energy Conservation was held in the premises of Center for Collaborative and Advanced Research (CCAR), CPRI, Bengaluru on 22nd November 2024. The competition was well attended by both Group A and B participants with a participation of 48 students in Group A and 50 students in Group B. The Prize Distribution Ceremony of the Painting Competition was held at S J Auditorium, CPRI, Bengaluru. Prizes were distributed to the winners of both A & B Groups.

Winners of Group A

Winners of Group B

Karnataka Rajyotsava Celebrations

CPRI, Bengaluru celebrated 69th Karnataka Rajyotsava on 14th November 2024. Director General Shri B.A. Sawale, inaugurated the function.

During the celebration, a brief introduction about Kannada and Karnataka culture was presented by the talents from CPRI fraternity. A cultural program was presented by In- House talents showcasing various cultural programs and humorous skits. The program was well appreciated by the audience.

Vigilance Awareness Week 2024

Central Power Research Institute (CPRI) and its units had organized 'Vigilance Awareness Week' from 28th October to 3rd November 2024, under the theme 'Culture of Integrity for Nation's Prosperity'. During the week, activities including pledge-taking by employees, display of banners, pamphlets, awareness campaigns emphasizing vigilance, integrity etc. were undertaken. The event was aimed at fostering a collective commitment by the staff to combat corruption and uphold national integrity.

Pledge administer at CPRI, Nagpur

Pledge administer at CPRI, Hyderabad

Voluntary Blood Donation Day

'National Voluntary Blood Donation Day' is observed across the country on 1st October to create awareness on the importance of the blood donation by individual. This program was first started on 1st of October 1975 by the Indian Society of Blood Transfusion and Immunohematology.

National Voluntary Blood Donation Day was observed at CPRI Bengaluru and its units on 1st October 2024. CPRI employees and other allied staff including women employees voluntarily donated blood during the event.

Blood donation camp at CPRI Bhopal

Blood donation camp at CPRI Bengaluru

Blood donation camp at CPRI Hyderabad

Inter-Organizational Competition in Hindi:

As part of the Inter-Organizational Competitions, Official Language Section (OLS) CPRI, had organized an essay writing competition on the topic "आर्थिक विकास की कीमत - भ्रष्टाचार एवं प्राकृतिक आपदाएँ " on 15th October 2024 in Hindi at CCAR Auditorium for all Central Government Offices under TOLIC - 2.

The competition witnessed participation from officials representing 20 organizations. The topic was chosen in light of CPRI's Vigilance Awareness Week, emphasizing the critical balance between economic growth, corruption, and environmental challenges. Six participants were awarded cash prizes.

Power Research – A Journal of CPRI is a biannual publication by the Central Power Research Institute, Bangalore, India. The journal focuses on research and innovative applications in the generation, transmission, distribution, utilization, and conservation of electric power within the power and energy sectors. It serves as a platform for technical and managerial professionals across utilities, R&D institutions, planners, industries, and academia.

The journal invites authors to contribute original, high-quality research papers addressing current or futuristic topics of relevance to the power and energy sector, spanning concepts to practical field applications.

All submissions undergo a rigorous peer review process by subject experts. Detailed instructions for authors are available on the journal's official website.

https://cprijournal.in/index.php/pr