

Thermal Research Center - A Hub for Knowledge Source in Thermal Generation Sector

Thermal Research Center, a unit of Central Power Research Institute, is to carry out Research and provide appropriate solution in the Thermal Generation.

This Center is recognized as “A Well Known Remnant Life Assessment Organization” for carrying out RLA Study of Boilers in India, awarded by Central Boiler Board, New Delhi, for conducting RLA Study of steam and process boilers under Indian Boiler Regulation 1950. Thermal Research Center is providing services in the areas of Non-destructive and Destructive testing, Failure analysis of power plant components, Condition assessment of power plant components, Condition assessment of civil structures with the latest technology and advanced equipment available. This Center has served almost all the power plants and other Industries of India in the last 18 years.

It was on 1st May 1993 that the Central Power Research Institute heralded a new structured hub for research in thermal generation sector, with the inauguration of its Unit in Central India at Koradi, Nagpur.

Thermal Research Center, a unit of Central Power Research Institute was established keeping in view the power scenario in India to improve the performance and to evolve solutions to the operational problems of thermal power plants.

The Center was established very near to the Koradi Thermal Power Station. The very nearness to the power stations helped the research officers of this Unit to acquire and sharpen the skills required in appreciating the operation and maintenance problems and challenges encountered in thermal power technology in a very short period of time. This is a valuable experience.

The Center was established as a capital project funded completely by Govt. of India at a sanctioned cost of ₹ 1718.17 lakhs.



INAUGURATION OF UNIT BY HONOURABLE UNION MINISTER OF POWER, SHRI N.K.P. SALVE ON 1 MAY 1993

The inauguration was done in the hands of the Honourable Union Minister of Power, Shri N.K.P. Salve.



VISIT OF:

SMT. JAYWANTIBEN MEHTA, HONOURABLE
MINISTER OF STATE FOR POWER ALONG WITH EX.
D.G., SHRI B.S.K. NAIDU

SHRI RANGAYYA NAIDU, MINISTER OF STATE FOR
POWER

1.0 OBJECTIVE OF THE CENTER

The main objective [1] of this Center was to carry out Research and provide appropriate solution in

the Thermal Generation Sector such as:

- Non-destructive evaluations.
- Condition assessment of power plant components, life estimation and extension studies, failure/risk analysis for renovation of vital power plant components.
- Evaluation of materials for performance characterization and prediction.
- Condition assessment and life estimation of turbine components.
- Condition assessment of RCC and Steel Structures of boiler and turbine.
- In situ oxide scale thickness measurement and life prediction of super heater coils.
- Evaluation and development of new technology in Thermal Power sector.
- Boiler tube leakages.
- Condenser tube thinning measurement.
- Flaw detection in thick section by TOFD.
- Flame temperature and Thermal insulation mapping.
- Remedial measures of fire side problems in thermal power plant.
- Performance evaluation of high temperature materials used for stress corrosion, fatigue and creep and materials conservation.
- Studies and analysis of heat pipes system.
- Provides training to plant Engineers.

In order to accomplish the above objectives, following divisions were established with various facilities, they are:

Engineering Material Division: Residual Life Assessment of power Plant Components, Image analysis system for metallurgical evaluation, In situ (field) Metallography (Replication) Test Facility, In situ (field) Hardness Test facility, In situ Chemical Analysis/Material Grade Identification Test Facility, Crack depth measuring facility, Failure analysis of power plant components.

Mechanical Engineering Division: 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 characterization 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, Dye penetrant test, Dimensional measurement Fibroscopic inspection of headers and tubes, Turbine and Generator, Thermographic inspection of Switchyard and other Mechanical and Electrical systems; and also Third Party inspection of passive fire protection system.

Civil Engineering Division: Condition assessment of RCC and STEEL structures in Power Plants and Process steam Industries; Tests offered for RCC and STEEL Structures: Ultrasonic, rebound hammer, Half-cell potential, Resistivity, Core test, Chemical tests, Cover-meter and sectional verification of reinforcement and Geometrical properties, sectional verification, ultrasonic thickness, hardness, Gravimetric analysis for Steel Structures.

Thermal Research Center is providing services in the areas of Non-destructive and Destructive testing, Failure analysis of power plant components, Condition assessment of power plant components, Condition assessment of civil structures with the latest technology and advanced equipments available. This Center has served almost all power plants and other Industries of India in the last 18 years.

2.0 RENOVATION AND MODERNISATION

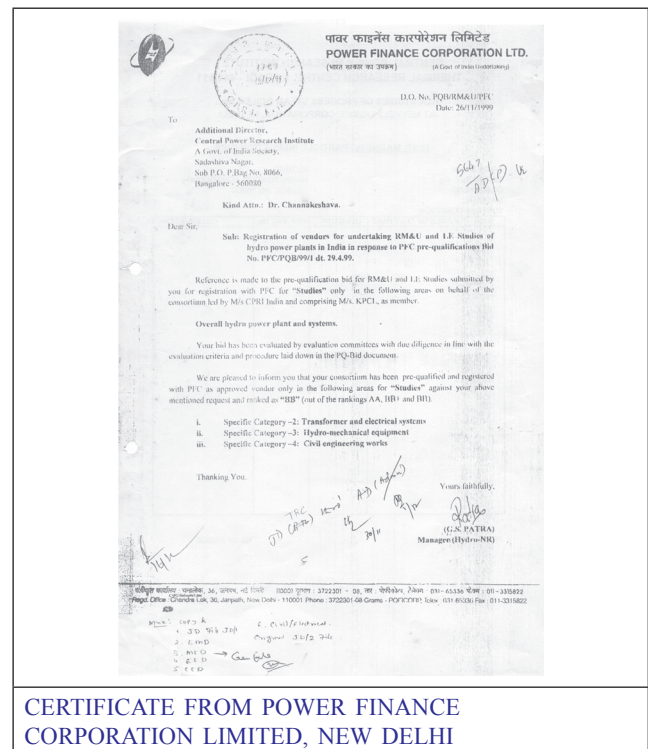
It was in 90s that the Govt. planned and launched a huge programme for Renovation and Modernization for Thermal and Hydrogeneration plants. The Power Finance Corporation Ltd.

(PFC) was appointed as the nodal organization for funding and implementation with the involvement of Central Electricity Authority (CEA) for necessary scrutiny of R&M proposals.

The programme had two distinct stages. The first one to conduct a R&M study to establish the need and extent of the Renovation and Modernization. The R&M study identified the specific areas of Run/Repair/Replace/Refurbish. The technique and methodology used based on which these requirements are identified and recommended are conducting Remaining Life Assessment (RLA), Condition Assessment, Performance Audit, Forced Outage Analysis, Root Cause Analysis, New Technology Options Review, etc.

The other stage was to carry out the R&M works identified in the R&M study. These two stage process thus identified two categories of vendors: study vendor and works vendor.

By this time, since this Center had already conducted RLA studies, and several other Divisions of CPRI had demonstrated experience in other areas including Energy Audit, Electrical Diagnostics, the Institute bagged the recognition of “Power Finance Corporation Limited, New Delhi” with a ranking of BB+ in Thermal sector.



CERTIFICATE FROM POWER FINANCE CORPORATION LIMITED, NEW DELHI

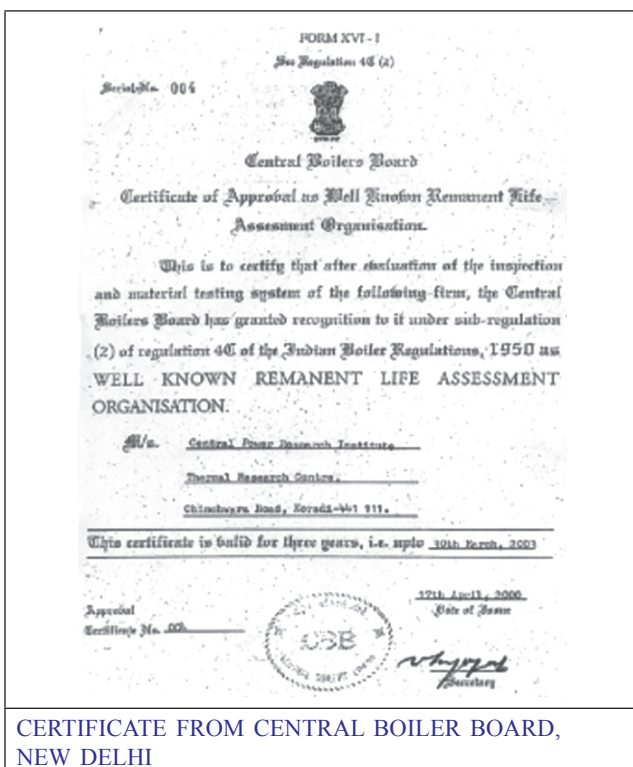
Under this programme, the Center had co-ordinated the R&M study in the following stations:

- ✦ 4 × 210 MW TPS, Bhatinda
- ✦ 4 × 210 MW IP TPS, Delhi
- ✦ 4 × 210 MW TDL TPS, Panipat
- ✦ 3 × 120 MW HTPS, Kasimpur, Harduaganj
- ✦ 1 × 62.5 MW Bhusawal TPS
- ✦ 2 × 210 MW Boiler at Tuticorin TPS

CPRI was an R&M Consultant to MSEB for R&M programme of 4 × 110 MW Koradi TPS and 2 × 62.5 MW Nashik TPS.

3.0 RESIDUAL LIFE ASSESSMENT OF BOILERS

In the year 2000, this Center was recognized as “A Well Known Remnant Life Assessment Organization” for carrying out RLA Study of Boilers in India. This recognition was awarded by Central Boiler Board, New Delhi for conducting RLA Study of steam and process boilers under Indian Boiler Regulation 1950.



CERTIFICATE FROM CENTRAL BOILER BOARD, NEW DELHI

The technique and methodology used for conducting RLA study based on the Table-I and II of IBR 391(A). On the basis of detailed investigation and analysis of all the results (Non-destructive and destructive/laboratory), the suitability of boilers for continued operation as per IBR stipulation with specific recommendations of Run/Repair/Refurbish has been provided to the concerned power/process plant authorities.

This Center has conducted more than 100 RLA studies for different power plants and process industries.

Some of the plants covered under RLA study are:

National Thermal Power Corporation: Anta, Badarpur, Dadri, Farraka, Korba, Kawas, Kahalgaon, Rihand, Ramagundam, Singrauli, Talcher, Unchahar, Vindhyachal.

State Electricity Board: APGENCO, CSPGCL East and West, Korba, MPPGENCO Sarni, Chachai, DVC Chandrapura, Koradi TPS, Chandrapur TPS, Bhusawal TPS, Nasik TPS, Paras TPS, Parli TPS, IB TPS, Orissa, TDTPS, Panipat, TANGEDCO, Tuticorin, Singareni Collieries, Kothagudam, NALCO, Angul, Ukai TPS, Wankbori TPS, Kerala and many more.

Other Process Industries: HOCL, Kochi, IOCL, Panipat, BALCO, Korba, NHPC, Champa, KPCL, Bangalore, Raipur Alloys, SEML, Raipur, Grasim Industries, Nagda, IOCL, Bongaigaon, JK Paper Mills, Jaypore, ITC, Khammam, Jindal Power, Raigarh and many more.

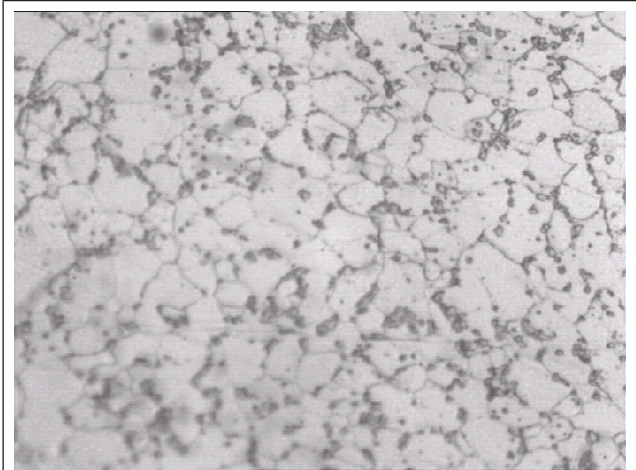
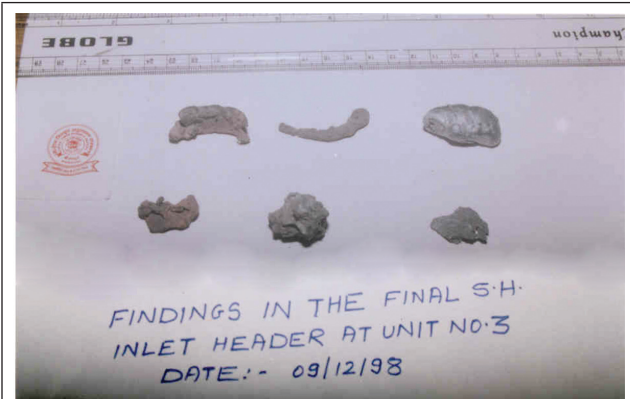
This Center has also conducted condition assessments of RCC and concrete structures for many power plant and process industries.

Some of the major clients are: NTPC, Unchahar, NTPC, Badarpur, NTPC, Kawas, BALCO, Korba.

4.0 INVESTIGATIONS DURING PLANT OUTAGE

Investigations of forced outage and conducting failure analysis leading to identifying the root

cause of outage or failure have been one of the major consultancies that this Center provides. Till now, more than 400 such assignments have been undertaken. The main outcome of the consultancy has helped the power stations to take remedial measures and improve operation and maintenance practices to avoid such failures.



METALLURGICAL CREEP FAILURE (MICROSTRUCTURE EVIDENCE-INSITU REPLICA TAKEN AT SITE IN THE INVESTIGATION)



FOREIGN ENTRAPPED OBJECTS FOUND DURING FORCED OUTAGE INVESTIGATION OF BOILER TUBE FAILURE (STEAM STARVATION)



FAILURE INVESTIGATION OF THINNING IN BOILER TUBE



HEAVY OXIDE SCALE GROWTH LEADING TO OVERHEATING AND CONSEQUENT FAILURE

Some interesting Findings during Failure Analysis/Forced Outage Analysis.

4.1 R&D Projects

Thermal Research Center has taken up several R&D projects in the area of Boiler and Turbines. All the projects have enhanced the knowledge and added new research facility. The outcomes

of the projects are:

- *Fireball Simulator for Boiler (10.1.3)*: “A fireball simulator has been designed, developed and operating regime of pressure and flow rate for a stable fireball has been experimentally demonstrated” [2].
- *Combustion characterization of Coal and Fuel Oil using FETF (10.1.4)*: “Specific experiments were conducted to find out relative effect of coal particle size” [3].
- *Kinetics of Corrosion and Erosion of Boiler Tube Material using FETF (10.1.6)*: “The mechanism of high temp. corrosion kinetics of boiler tube materials under simulated conditions was studied and analysed the results helped in interpretation of failure of boiler tubes by high temp corrosion mechanism.” [4]
- *Comparative Evaluation of various NDT Techniques for identifying the thinning in Steels (10.1.7)*: “Experiments were conducted on various test blocks by various NDT Methods to determine the specific NDT methods with respect to a particular application” [5].
- *Reconfiguring the fibroscopic inspection System for improved quality reporting and improved life of the equipment (10.1.8)*: “The outcome increased the testing quality and the test result can be converted into a CD which in turn can be displayed in a normal PC to plant authority” [6].
- *Condition assessment of Turbine Rotor from Bore Inspection (10.1.9)*: “A bore sonic test system has been designed and developed” [7].
- *Flaw characterization by Ultrasonic Time of Flight Diffraction (TOFD) Technique*: “TOFD based inspection system has been developed for characterizing flaws in simple geometry components.” [8].
- *Damage assessment in Boiler Tubes, Drums and headers (10.1.12)*: “An ultrasonic inspection method has been developed for in-situ measurement of hydrogen damage in boiler tubes and a system for measuring ovality in boiler drum, headers etc. has been designed and developed” [9].
- *Condition Assessment of Complex Geometry Power Plant Components by Ultrasonic Time of Flight Diffraction (TOFD) Technique. (10.1.14)*: “Number of Complex geometry specimens with EDM notches simulating the actual plant components have been designed and developed and also a Mathematical models have been developed for sizing cracks in complex structures.” [10].
- *Conversion of Transformer Heat Losses into useful Electrical Energy*: “Design of suitable heat pipe to trap the heat energy from transformer core” [11].

Many technical papers are published through this Center. Most of the publications show the outcome of the new techniques and the same have benefited for power sector and other industries. Some of the publications of this Center are given in Table 1.

The advance knowledge available with the engineers of this Center has encouraged filing of patents in the area of Non-destructive testing. The patents filed are:

1. An Inspection Method for Characterization of Surface Breaking Inclined Cracks based on Ultrasonic Time of Flight Diffraction (TOFD) - Application No. 102/KOL/2010 Dt. 3.2.2010. S.K. Nath, K. Balasubramaniam, C.V. Krishnamurthy, B.H. Narayana
2. Development of an Inspection Method for Sizing of Defects in Complex Geometry Weld-Applied. S.K. Nath, B.H. Narayana, K. Balasubramaniam.

TABLE 1

TECHNICAL PAPERS FROM TRC, NAGPUR (1993–2010)

Particulars		Name of the paper	Publication details (Year etc.)	Conference/Journal (Publisher)	Authors
Conference	National	Condenser Condition Assessment by Eddy Current Technique	1995	Performance Evaluation and Condition Assessment in Power Plants and Process Industries	CPRI, TRC, Nagpur
		Ferrography – A Useful Technique in Wear Debris Analysis for Better Condition Monitoring of Lubricated System	-do-	-do-	-do-
		Flame Temperature Measurement	-do-	-do-	-do-
		Condition Assessment of Electrical Installations by Infrared Thermography	-do-	-do-	-do-
		Condition Assessment of Boiler Tubes by Remote Visual Imagescope	-do-	-do-	-do-
		On Site Material Identification Using Portable Optical Emission Spectrometer and Hardness Tester	-do-	-do-	-do-
		Health Assessment of Boiler Pressure Parts by Conventional NDT Techniques	-do-	-do-	-do-
		Metal Sensitisation in Austenitic Stainless Steel Super Heater Tube – A Case Study	-do-	-do-	-do-
		Fibroscope of Headers	1997	RAM Engineering, IIT, Kanpur	T.M. Rao

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Particulars		Name of the paper	Publication details (Year etc.)	Conference/Journal (Publisher)	Authors
Conference	National	Conditional Assessment of Some Critical Parts in Power Plants – CPRI Experience	1998	SLAET-98, IIT, Delhi	T.M. Rao
		Improvised ISIS for Reliable Defect Detection Capability	Dec. 7-9, 2001	NDE 2001 (Indian Society for Non-destructive Testing)	S.K. Nath B.H. Narayana G. Pandian
		Hydrogen Damage Detection in Tubes of Utility Boilers	Dec. 9-12, 2004	NDE 2004 (Indian Society for Non-destructive Testing)	R. Ranjan K. Saha S.K. Nath
		On-line Condition Monitoring of Power Transformer and Switchyard	-do-	-do-	T.M. Rao S.P. Kalambe
		Condition Assessment of Condenser Tubes – A Case Study	-do-	-do-	R. Ranjan
		Condition Assessment of Power Plant Components by Ultrasonic Time of Flight Diffraction (TOFD) Technique	12th October 2007	Performance Monitoring and Energy Conservation through Renovation and Modernization of Power Plant and Process Industries (CPRI, Nagpur)	S.K. Nath
		Energy Conservation through R&M of Power Plants and Process Industries	-do-	-do-	T.M. Rao

Continued

Particulars		Name of the paper	Publication details (Year etc.)	Conference/ Journal (Publisher)	Authors
Conference	National	Condition Monitoring of Switchyard Equipment - CPRI Experience	-do-	-do-	S.P. Kalambe
		Condition Monitoring of Boiler Water Wall Tubes Affected by Hydrogen Damage under High Heat Flux Zone	-	-	R. Ranjan
	International	Improved Availability Assurance of Power Plants by NDE Based Condition Monitoring	1996 (355-362)	3 rd International Conference on Power Development in Afro-Asian Countries, Kathmandu (Nepal)	S.K. Nath B.H. Narayana
Journal	National	Ultrasonic Non-Destructive Evaluation (NDE) Based Internal Inspection of Pressure Vessels for Better Maintenance Practice	September 2011; Vol. 10, No. 2, pp. 65-67	Journal for Non-Destructive Testing and Evaluation	S.K. Nath B.H. Narayana
	International	Sizing of Surface-breaking Cracks in Complex Geometry Components by Ultrasonic Time-of-flight Diffract (TOFD) Technique	April 2007; Vol. 49 No. 4, pp. 200-206	Insight (British Institute for Non-destructive Testing and Condition Monitoring (BINDT))	S.K. Nath K. Balasubramaniam C.V. Krishnamurthy B.H. Narayana

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Particulars		Name of the paper	Publica- tion details (year etc.)	Conference/ Journal (Publisher)	Authors
Journal	International	The above Paper got Republished in another Journal based on the request of the Publisher	September 2007; Vol. 3, No. 37, pp. 10–15	NDT World Review	S.K. Nath K. Balasubramaniam C.V. Krishnamurthy B.H. Narayana
		An Ultrasonic Time of Flight Diffraction Technique for Characterization of Surface-Breaking Inclined Cracks	Feb. 2009; Vol. 67, No. 2, pp. 141–148	Material Evaluation – American Society for Non-destructive Testing (ASNT)	S.K. Nath K. Balasubramaniam C.V. Krishnamurthy B.H. Narayana
		Reliability Analysis of Time of Flight Diffraction Characterization of Inclined Cracks	March 2009; Vol. 67, No. 3, pp. 342–349	Materials Evaluation– American Society for Non-destructive Testing (ASNT)	S.K. Nath K. Balasubramaniam C.V. Krishnamurthy B.H. Narayana
		Detection and sizing of Defects in Complex Geometry Weld by Ultrasonic Time of Flight Diffraction (TOFD) Inspection	October 2009; Vol. 131, No. 5, 051501-9	Journal of Pressure Vessel Technology – American Society for Mechanical Engineer (ASME)	S.K. Nath K. Balasubramaniam C.V. Krishnamurthy B.H. Narayana
		Reliability Assessment of Manual Ultrasonic Time of Flight Diffraction (TOFD) Inspection for Complex Geometry Components	March 2010; Vol. 43, No. 2, 152–162	NDT & E International (ELSEVIER)	S.K. Nath K. Balasubramaniam C.V. Krishnamurthy B.H. Narayana

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- [4] Kinetics of Corrosion and Erosion of Boiler Tube Material using FETF (10.1.6)-1997 to 2000: M.V. Rao.

- [5] Comparative Evaluation of various NDT for identifying the thinning in steels (10.1.7)-1997-1999: S.K. Nath/T.M. Rao
- [6] Reconfiguring the fibroscopic inspection System for improved quality reporting and improved life of the equipment (10.1.8)-1999 to 2001: G. Pandian
- [7] Condition assessment of Turbine Rotor from Bore Inspection (10.1.9): 2000-2002: S.K. Nath.
- [8] Flaw characterization by Ultrasonic Time of Flight Diffraction (TOFD) Technique.-2002 to 2005: S.K. Nath/ Ch. Rabikumar.
- [9] Damage assessment in Boiler Tubes, Drums and headers (10.1.12)-2002 to 2004: R. Ranjan/S.K. Nath/K. Saha/ Ch. Rabikumar.
- [10] Condition Assessment of Complex Geometry Power Plant Components by Ultrasonic Time of Flight Diffraction (TOFD) Technique. (10.1.14)-2005 to2007: S.K.Nath.
- [11] Conversion of Transformer Heat Losses into useful Electrical Energy.-2009 to 2011: T.M. Rao.