

Thermal Insulation Audit Report Of Leading Paper Plant



PERMAWELD PVT. LTD
Energy Efficiency Division
Making Maintenance a Profit Center



Acknowledgements

We are thankful to the management for giving us the opportunity to be involved in this very interesting and challenging project. We would be happy to provide any further clarifications, if required, to facilitate implementation of the recommendations.

We received full co-operation and support from the concerned personnel from all the departments. We would like to particularly thank:

Shri.

Shri.

Shri.

Shri.

and all other supporting staff who have given full co-operation and support. They took keen interest and gave valuable inputs during the course of study.



Table of Contents

Acknowledgements.....	2
Executive Summary.....	6
1 Introduction	7
2 Methodology and Approach	7
2.1 Approach.....	8
2.2 Tagging	8
2.3 Instruments.....	9
2.4 Calibration of Instruments.....	10
2.5 Heat Loss Calculation	14
Considerations:	14
Model Calculation	15
3 Heat Consumption Profile.....	18
3.1 Steam Generation at PAPER PLANT	18
3.2 Specification of Running Boilers	18
3.3 Specification of Running Turbines	18
3.4 Total Heat Consumed by Boilers in 2016.....	19
3.5 Summary of Boilers.....	22
3.6 Power Generated by Turbo Generator	22
3.7 Present Insulation Material Details.....	23
3.8 Current Steam Temperature Drop in the System	24
3.9 Cost Details	24
4 FBC #3 Boiler	25
4.1 Boiler Surface Area Losses:	25
4.2 Feed Water Network:.....	25
4.3 Fan Ducts:.....	25
4.4 HP Steam Lines and header:	25
4.5 Graphical Summary of Losses in FBC #3 Boiler	26
4.6 Summary of FBC #3 Boiler.....	26
5 FBC #4 Boiler	27
5.1 Boiler Surface Area:	27
5.2 Feed Water Network:.....	27

5.3	Fan Ducts:.....	27
5.4	Flue Gas Network.....	27
5.5	HP Steam Lines:.....	27
5.6	Graphical Representation of Losses in FBC #4 Boiler	28
5.7	Summary of FBC #4 Boiler.....	28
6	BHEL Recovery Boiler	29
6.1	Boiler Surface Area:	29
6.2	Feed Water Network:.....	29
6.3	Fan Ducts:.....	29
6.4	HP Steam Lines.....	29
6.5	MP Steam Lines and header:	29
6.6	LP Steam Lines	30
6.7	Soot Blower Steam Lines.....	30
6.8	No Cladding Area:	30
6.9	Graphical Representation of Losses in BHEL Recovery Boiler	30
6.10	Summary of BHEL Recovery Boiler.....	31
7	Enmas Boiler	32
7.1	Boiler Surface Area:	32
7.2	HP Steam Lines.....	32
7.3	MP Steam Lines.....	32
7.4	Feed Water Network:.....	32
7.5	No Cladding Area:	32
7.6	Graphical Representation of Losses in ENMAS Boiler	33
7.7	Summary of ENMAS Boiler.....	33
8	TG #2	34
8.1	Turbine Surface Area:	34
8.2	HP Steam Lines and header:	34
8.3	MP Steam Lines and header:	34
8.4	Graphical Representation of Losses in TG #2:	34
8.5	Summary of TG #2:.....	35
9	TG #4	36
9.1	Turbine Surface Area:	36
9.2	HP Steam Lines and header:	36
9.3	MP Steam Lines and header:	36

9.4	LP Steam Lines and header:	36
9.5	No Cladding Area:	36
9.6	Graphical Representation of Losses in TG #4:	37
9.7	Summary of TG #4:.....	37
10	HP Steam lines and Headers	38
11	Summary of Potential Savings	39

Executive Summary

- 1.0 This section presents a brief summary of the results of the thermal insulation audit conducted at Paper Plant in 2016.
- 2.0 A team of three specialist engineers were involved in the thermal insulation audit. The audit was mainly targeted at identifying the heat loss occurring in the Boilers, Steam Lines and Turbines due to bare and weak insulation.
- 3.0 The audit involved using sophisticated portable thermal imaging camera and anemometer; to identify the bare and weak area, to measure the accurate temperature and to measure the wind speed to facilitate in complex analysis to estimate the heat loss and corresponding steam loss due to bare and weak insulation.
- 4.0 The identified annual heat loss due to bare and weak insulation is **5540.02 million kCal/Annum** and the equivalent steam loss is **6942.63 Tonnes/Annum**. The identified steam loss works out to **20%** of the total steam loss occurring due to temperature drop in the steam lines. The total identified cost saving potential by insulating the bare and weak areas is **Rs.72.89 lakh** and the total cost of implementation is estimated to be **Rs.28.59 lakhs**. The summary of identified total hot spots, heat loss, steam loss, monetary loss, investment required for rectification and payback period are given in below table;

Description	Total Hot Spots			Total Heat Loss, kcal/Annum	Total Steam Loss Tonne/Annu m	Total Money Loss Rs/Annum	Total area to be insulated, m ²
	Bare	Weak	Total				
FBC #3	09	17	26	1212.39Million	1519.35	15,95,320	127.9
FBC #4	06	20	26	338.69 Million	424.44	4,45,670	62.23
BHEL Recovery Boiler	25	7	32	448.23184 Million	561.71515	5,89,800.9	44.17
Enmas Boiler	40	6	46	2905.1474 Million	3640.67245	38,22,706	86.94
TG #2	06	10	16	465.68384 Million	583.58564	6,12,764.9	24.7
TG #4	08	11	19	169.8764 Million	212.88569	2,23,529.9	11.52
TOTAL	94	72	165	5540.0194 Million	6942.6356	72,89,789	357.46
Equivalent Steam Loss, tonnes per annum						6942.6356	
Equivalent Monetary Loss, Rs per annum						72,89,789	
Approximate Investment Cost (Considering Rs. 8000/sq.m)						28,59,680	
Payback Period, years						0.392	

1 Introduction

PAPER PLANT

2 Methodology and Approach

The audit involved carrying out thermography scanning of boiler, steam line and turbines to realistically assess heat loss and potential for energy savings.

- Using FLIR E60 Thermal Imager, the surveyor scanned the Steam Pipelines, Boiler and Turbine surfaces to assess the condition of the existing insulation for identifying bare/weak insulation contributing to excessive heat loss.
- The surveyor captured Infrared image and Normal image simultaneously for easy identification of hotspots.
- The images are segregated based on bare insulation, weak insulation and cladding missing areas.
- Heat Losses due to bare and weak insulation is calculated as per **IS14164.2008 standards** and recommendation of insulation material, economic insulation thickness, approximate cost of investment , payback period analysis is provided in the report. IS 14164,2008 standards

2.1 Approach

Thorough thermal scanning of the following areas are carried out;

- FBC 3, FBC 4, BHEL Boiler and Enmas Boiler top to bottom, respective Feed water tank, Feed water pump suction and discharge line till boiler drum
- Boiler ID, FD, PA, SA and TA fan ducts.
- HP discharge line from boiler to HP header and HP header to Turbine.
- TG 3 and TG 4.
- MP and LP line from TG to MP and LP header.

2.2 Tagging

Different colour tags are used to highlight the condition of insulation based on the severity of damage. The different colour tags and the respective condition of insulation is given in table 2.1

Tag Type	CLASSIFICATION
RED	BARE, WEAK
BLUE	No CLADDING

2.3 Instruments

The audit study made use of various portable instruments, for carrying out various measurements and analysis. The specialized instruments used during the audit are given below;

- Thermal Imager –FLIR- E-60



FLIR E60
For electrical/industrial applications

E-Series InfraRed Camera (320 x 240 IR Resolution)
With on Board Visual Camera, Picture-in-Picture, Thermal Fusion and Bright LED Light

- 0.05°C @ 0.01 Thermal Sensitivity
- Bright LED Light
- Adjustable Tripod with Noisec
- Picture-in-Picture (PIP) (Optional)
- Thermal Fusion

- 3.5" Touch-Screen LCD Display
- 4K Continuous Zoom
- Area Min/Max with Auto Hot/Cold Spot Marker
- Delta T - Differential Temperature



Thermal Fusion



Ball-Laser Pointer



Bright LED Light



Differential Temperature

FLIR E60 Features

- **High Resolution IR Images** - 75,000 pixels (320 x 240) infrared resolution
- **Visible Light Digital Camera** - 3MP resolution with flash provides sharp images regardless of lighting conditions
- **Thermal Fusion** - Blending of thermal and digital images in real-time
- **Scalable Picture-in-Picture (PIP)** - Displays thermal image superimposed over a digital image and is scalable to make the thermal image
- **Bright LED Light** - Allows the visual camera to be used in poorly lit environments
- **Wide Temperature Range** - From -50° to +650°C targeting electrical and industrial applications
- **± 2% Accuracy** - reliable temperature measurement
- **Touchscreen Image Gallery** - Allows quick access of stored images
- **Li-Ion Rechargeable Battery** - lasts when continuously use, replaceable
- **Copy to USB** - Easy upload of images from camera to USB memory stick
- **Laser Locator™ Pointer** - Points a laser reference spot with a laser
- **Laser Marker** - Marks the point on the IR image to show where the Laser pointer is targeting
- **IR Window Correction** - Software settings allow you to account for transmission loss through IR windows
- **Area (Min/Max) Mode** - Shows the Minimum or the Maximum Temperature reading within the selected area
- **Auto Hot/Cold Spot Marker** - Marks the area that automatically finds the hottest or coldest spot within the lens
- **Voice Comment Recording and Text** - on images & can be integrated into report
- **Wireless Communication** - Bluetooth™ transmitter with METERLINK™
- **Includes** - Hard transport case, Infrared camera with lens, Battery, Calibration certificate, Camera lens cap, FLIR Tools software CD-ROM, Manuals, Memory card, Power supply, Incl. multi-page Printed Getting Started Guide, Printed Important Information Guide, USB cable, User documentation CD-ROM, Video cable, Warranty extension card & Registration card



Applications







- Anemometer – For Measurement of Wind Velocity



2.4 Calibration of Instruments



TransCal

Measurement to Perfection...



Main Bld. Premises : Centenary Building (G. Flr), Door No. At : 100, W. Park Rd.,
Between Sampighe Road And Margosa Rd., 10th Crs., Malleswaram, Bangalore City, Pin- 560003

NABL Accredited Calibration Lab as per ISO/IEC 17025 : 2005

CALIBRATION CERTIFICATE

Customer Name & Address : M/s.

Permaweld Pvt Ltd.

#227, Akarsh Plaza, 1st Stage, 5th Phase, West Of Chord Road, 60ft Main Road, Shivanagar. Bangalore Karnataka IND 560010

Customer's Reference :

SRF No. : TSC/16-17/5337

Dated : 07 Nov 2016

Calibration Certificate Number	Calibrated On	Recommended Calibration Due	Page Number
TSC/16-17/5337-1	10 Nov 2016	10 Nov 2017	1 of 2

Details of device under calibration		Transcal ID	
Nomenclature	: Thermal Imager	No. of Pages	: 2
Make	: Flir	Cal Procedure No.	: TSC/CAL/511
Model/Range	: E60	DUC Received	: 07 Nov 2016
SI No.	: 49030962	DUC Condition on Receipt	: Satisfactory
ID No.	: --	Cal At	: Thermal Lab

Environmental Conditions : Temperature in °C : 26

Humidity in RH % : 65


Standards used :

SI No.	Nomenclature	Make	Model	SI No./ID.No.	Certificate No.	Validity
1	Handy calibrator	Yokogawa	CA 71	TIFC016	TSC/15-16/INH-TCAL-13	10 Dec 2016
2	Black Body	Tempens	Calsys1200 BB	BB 004	Used As Source	21 Feb 2017
3	RTD Class A	YEP	PT100	11020778	TSC/15-16/INH-TCAL-45	01 Mar 2017
4	Thermocouple	-----	N Type	TSC/N-011	TSC/15-16/INH-TCAL-70A	25 Dec 2016

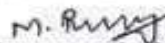
Note :

- This Calibration Certificate relates only to the above DUC & Reported results are valid at the time of and under the stated conditions of measurements.
- Partial Publication/ reproduction of this Certificate in any form is not permitted without the written consent of Transcal.
- Errors if any, in this Certificate shall be brought to notice within 45 days from the date of this Certificate
- Measurement Uncertainty reported is at approximately 95 % confidence level with k=2; Units of Measurement results & Measurement Uncertainty are same as that of range selected - Unless otherwise indicated.
- Calibration of the DUC are traceable to National/International Standards
- Corrections/erasing, invalidate the Calibration Certificate- exception to the 'Final Page or Part' of this Report- provided for incorporation of additional data(To be filed by customer authorized signatory and not under calibration laboratory control).
- In Result Sheets, 'Pass' indicates measured readings are within specification limit, 'Fail' indicates measured readings are out of specification limit & '-' indicates no specification limit furnished.
- Consider Model or Range whichever is applicable.
- Nabl-133 guidelines are adopted for use of NABL symbol.

Calibrated By



Maheshwara Reddy K M
(Calibration Engineer)

Checked By


Ramamoorthy M
(Calibration Engineer)



Authorised By


V Shashidhar
(Lab Incharge)



CAL CERT. NO : TSC/16-17/5337-1

Page : 2 of 2

Range: -35 to 650°C

Resolution: 0.1 °C

Accuracy: $\pm 2^\circ\text{C}$

Results:

Temperature Measurement

Sl. No.	DUC Reading (°C)	Std. Reading (°C)	Deviation Observed (°C)	Measurement Uncertainty \pm (°C)	Remarks
1	50.2	49.9	0.3	4.36	Pass
2	200.3	199.9	0.4	4.36	Pass
3	400.2	399.8	0.4	4.36	Pass
4	500.2	500	0.4	5.02	Pass
5	650.3	650	0.4	5.02	Pass

Conclusion Remarks:

- 1 Measurement Uncertainty reported is at 95% confidence level.
- 2 Temperature Scale : International Temperature Scale, 1990 (ITS-90).
- 3 Calibration done as per customer request

Calibrated By


Maheshwara Reddy K M
(Calibration Engineer)

Checked By


Ramamoorthy M
(Calibration Engineer)



Authorised By


V Shashidhar
(Lab Incharge)



Kalibrier-Protokoll

Certificate of conformity • Protocole d'étalonnage
Protocollo di collaudo • Informe de calibración

Gerät / Module type /

Modèle / Modelo:

testo 410-1

Messbereich / Measuring range /

Etendue de mesure / Rango de medición:

Vane: 0.4...20m/s

Temperature : -10...50°C

Serien-Nr. / Serial no. /

N° de série / Número de serie:

38453140/604

Segmenttest / Display test /

Test d'affichage / Test del visualizador:

OK

Messwerte / Measured values / Valeurs mesurées / Valores medidos:		
Sollwert / Reference / Référence / Referencia:	Zulässige Toleranz / Permissible tolerance / Tolérance admise / Tolerancia permitida:	Istwert / Actual Value / Valeur réelle / Valor medido:
Vane:		
12.0m/s	±0.4m/s	12.0m/s
Temperature:		
24.0°C	±0.5°C	23.9°C

J. Yeung

Prüfer / Inspector /
Responsable / Verificador



Kalibrier-Protokoll

Certificate of conformity • Protocole d'étalonnage
Protocollo di collaudo • Informe de calibración

Wir bestätigen, dass dieses Testo-Produkt unter Beachtung eines zertifizierten Qualitätssicherungssystems (nach **DIN EN ISO 9001:2008**) abgeprüft wurde.

Die dafür verwendeten Messrichtungen werden regelmäßig kalibriert und sind rückführbar auf die nationalen Normale der Physikalisch-Technischen Bundesanstalt (PTB) Deutschlands oder auf andere nationale Normale. Wo keine nationalen Normale existieren, entspricht das Messverfahren den derzeit gültigen technischen Regeln und Normen.

Dieses Kalibrier-Protokoll belegt die Einhaltung der von uns zugesagten Toleranzen.

Sehr gerne informieren wir Sie über **Kalibrier-Zertifikate**, die die Toleranzen **des gesamten Messsystems** (Messgerät und Fühler) beinhalten.

Dieses Zertifikat benötigen Sie, wenn das Messsystem in qualitäts-relevanten Prozessen innerhalb eines nach **DIN EN ISO 9001:2008** zertifizierten Unternehmens eingesetzt wird.

Unsere Kalibrationslabors für Temperatur, Druck, Feuchte, Strömung und elektrische Messgrößen sind vom Deutschen Kalibrierdienst (DKD) akkreditierte Kalibrationslabors.

DKD-Kalibrierzertifikate werden für Messungen gefordert, bei denen die Genauigkeit eine entscheidende Rolle spielt.

We confirm that this Testo product was calibrated under the observation of a **DIN EN ISO 9001:2008** certified quality assurance system.

The measuring installations used for this calibration are calibrated regularly and can be traced back to the national standards of the German Federal Physical and Technical Institution (PTB) or to other national standards. Should no national standards exist, the measuring procedure corresponds with the currently valid technical regulations and standards.

This calibration protocol is proof of adherence to the tolerances as confirmed by us.

We would be delighted to inform you about **certificates of conformities** which cover the tolerances for the **complete measuring system** (measuring instrument and probe).

This certificate is required only if the measuring system is to be used in processes relevant to quality in a company certified to **DIN EN ISO 9001:2008**.

Our calibration laboratories for temperature, pressure, humidity, velocity and electrical parameters are calibration laboratories accredited by the German Calibration Service (DKD).

DKD calibration certificates are required for measurements where accuracy plays a decisive role.

Nous confirmons par la présente que ce produit Testo a été étalonné sous la surveillance d'un système d'assurance qualité selon la norme **DIN EN ISO 9001:2008**.

Les installations de mesure utilisées pour cet étalonnage sont étalonnées de façon régulière et s'appuient aux normes nationales de l'Institut Fédéral de Techniques Physiques d'Allemagne (PTB) ou aux autres normes nationales. S'il n'existe aucune norme nationale, le processus de mesure est conforme aux règles et normes techniques actuellement en vigueur.

Ce protocole d'étalonnage vous indique que cet appareil respecte bien les tolérances constructeur annoncées dans nos documentations.

Un **certificat d'étalonnage** est nécessaire pour la

vérification de la **chaîne complète** (appareil et sonde). N'hésitez pas à nous contacter pour de plus amples renseignements.

Ce certificat vous sera utile si vous vous trouvez être certifié ou en cours de certification **DIN EN ISO 9001:2008**.

Notre laboratoire d'étalonnage en température, pression, humidité, vitesse d'air et paramètres électriques a été accrédité par le DKD - équivalent ENM/COFRAC -, Bureau de Métrologie Allemand.

Les certificats d'étalonnage DKD/COFRAC sont indispensables lorsque les mesures effectuées doivent être précises.

Vi confermiamo che questo prodotto è stato collaudato seguendo il sistema di certificazione di qualità **DIN EN ISO 9001:2008**.

Gli strumenti di misura elettronici utilizzati per la calibratura sono a loro volta regolarmente verificati e possono essere ricondotti agli standard nazionali del PTB (Physikalisch-Technische Bundesanstalt), l'istituto ufficiale tedesco per la determinazione degli standard tecnici.

Questo protocollo di collaudo documenta l'osservanza delle tolleranze da noi indicate.

Siamo a Vostra disposizione per fornire informazioni sui **Certificati di Taratura** che comprendono le tolleranze del sistema di misura completo (strumento e sonda).

Questo documento Vi sarà utile se già siete certificati o siete in corso di certificazione **DIN EN ISO 9001:2008**.

I nostri laboratori di taratura per temperatura, pressione, umidità, velocità dell'aria e parametri elettrici sono stati accreditati dal PTB e sono in grado di rilasciare certificati ufficiali DKD indispensabili quando la misura effettuata dev'essere precisa e ripetibile.

Queste regole, riconosciute in tutta Europa, sono equivalenti a quelle SIR italiane ed alle procedure tecniche standard utilizzate in tutto il mondo.

Confirmamos que este producto Testo se calibró de acuerdo con el sistema de garantía de calidad **DIN EN ISO 9001:2008**.

Las instalaciones de medición utilizadas para esta calibración se calibrán con regularidad y pueden rastrearse a los estándares nacionales del Instituto Federal de Técnicas Físicas Alemán (PTB), o a otros estándares nacionales. Si no existe una norma nacional, el procedimiento de medición corresponde con las regulaciones técnicas y normas válidas en la actualidad.

Este informe de calibración es una prueba de las tolerancias que nosotros confirmamos.

Estamos encantados en informales sobre **certificados de calibración** que cubran las tolerancias para el **sistema de medición completo** (instrumento de medición y sonda).

Nuestros laboratorios de calibración para temperatura, presión, humedad, velocidad y parámetros eléctricos son laboratorios de calibración acreditados por el Servicio de Calibración Alemán (DKD).

Los certificados de calibración DKD son necesarios para las mediciones donde la precisión sea muy importante.