



THERMIBEL

LABORATORY

Calibration & other scientific services



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INTRODUCTION

THERMIBEL has been a leading manufacturer of temperature sensors since 1984 and has unrivalled experience in the field of temperature measurement.

Its BELAC-accredited temperature laboratory performs on-site and laboratory calibration work. Accreditation was obtained in 2001, in recognition of the **personnel skills** and the **validity of equipment** and **methods** used.

We are also able to make calibrations according to the «Aerospace Material Specifications **AMS 2750**».

COOPERATION WITH THE CLIENT

Cooperation between the laboratory and the client includes the possibility of the client being present during the calibration work carried out for him. This type of cooperation builds up a climate of trust between the client and the Thermibel calibration laboratory.

Access to the laboratory is permitted on the condition that it does not interfere with calibration operations. In the interests of the confidentiality of calibration work, the client may only be present when **his own sensors, or Thermibel demonstration devices**, are being calibrated: he is asked to leave the laboratory if any other calibrations are in progress. The client may also be present during the preparations for calibration and the packing and shipment of calibrated sensors.

Cooperation with the client is a major consideration in the definition of calibration requirements: laboratory personnel pay particular attention to defining the client's true needs.

COOPERATION WITH BELAC

The calibration laboratory provides BELAC and its representatives with the cooperation required to confirm that the requirements in the present procedures are respected. Cooperation includes:

- access to the calibration laboratory for one or more representatives,
- all reasonable inspections to allow BELAC to confirm the laboratory's ability to verify calibrations,
- participation in any calibration programme that BELAC may reasonably consider necessary,
- permission for BELAC to examine the results of internal audits.

COOPERATION WITH OTHER LABORATORIES

If required, the laboratory is able to contribute to the following:

- the definition of national, European or international standards in the area of calibration,
- the inter-laboratory testing, providing results to the leading laboratory in the shortest possible time,
- the information sharing with other laboratories undertaking thermometric calibration work.

LABORATORY SERVICES UNDER BELAC ACCREDITATION

THERMIBEL Accreditation No. 139-Cal : Calibration of resistance thermometers and thermocouples.

The advantages of calibration under BELAC accreditation are:

- calibrations are appropriate to the instruments concerned,
- measurement uncertainties are guaranteed by experts from the accreditation commissions,
- traceability to national standards is proven,
- requirements of the NF EN ISO/CEI 17025 Standard are respected.



CALIBRATION BY FIXED POINTS

THERMIBEL possesses a cell which is capable of calibration at the triple point of water (0.01°C).

Calibrating a sensor by the fixed point method consists in placing it in an enclosure in which a uniform constant temperature is defined by the thermodynamic equilibrium between different phases of a pure body.

CALIBRATION BY COMPARISON

THERMIBEL owns calibration baths and ovens covering the temperature range -100°C to + 1300°C.

Calibrating a sensor by comparison consists of placing it in an enclosure of which the uniform constant temperature is measured by a standard sensor taken as a reference.

DOCUMENTS DELIVERED

THERMIBEL issues a BELAC Calibration Certificate (see appendixes A1 & A2) containing the following mandatory information:

- the calibration method,
- the traceability of calibration resources used,
- the table of results including the uncertainties linked to the means of calibration,
- the environmental conditions.



SERVICES WITH TRACEABILITY TO NATIONAL STANDARDS (NOT BELAC-ACCREDITED)

The advantage of “Factory” calibration under ISO 9001 is the reduced cost.

CALIBRATION BY COMPARISON

This type of calibration uses the same principle as calibration by comparison under accreditation, but with greater calibration uncertainties and less sophisticated equipment.



CALIBRATION BY ELECTRICAL SIMULATION

Calibration with connection to national standards is carried out at the request of a customer or when the characteristics of the elements to be calibrated are not compatible with the equipment under accreditation. This calibration is based on the same principle as calibration by comparison under accreditation.

TESTING AND CHARACTERISATION

Thermibel carries out characterisation of thermal and climatic chambers, ovens, furnaces, etc. in accordance with the standards in force. The purpose of an enclosure characterisation is to determine and/or periodically verify the true performance of the enclosure. It determines the characteristics which are covered by the specifications i.e.:

- measurement of temperature rise times,
- measurement, of stability and uniformity of the enclosure at different temperature set points,
- calibration of the sensor associated with the enclosure regulator.

PRESSURE CALIBRATION **NEW**

From now on, Thermibel can calibrate pressure instruments on a range of :

- -1 to 20 bar relative and absolute pressure
- 0 to 400 bar relative pressure

DOCUMENTS DELIVERED

THERMIBEL issues a calibration certificate with traceability to national standards containing the following information:

- the calibration method,
- the traceability of calibration resources used,
- the table of results including the uncertainties linked to the means of calibration,
- the environmental conditions.



SERVICES WITH TRACEABILITY TO NATIONAL STANDARDS PERFORMED ON-SITE

THERMIBEL is able to calibrate temperature sensors on your site. We are also able to make calibrations according to the «Aerospace Material Specifications **AMS 2750**».

These are the advantages of on-site services:

- methods which take account of installation conditions (such as thermal constraints),
- reduction of unwanted shutdowns,
- verification of non-removable sensors.



CALIBRATION BY COMPARISON

You have a choice of three methods:

Method 1:

- removing the sensor to be calibrated from the process,
- use of a portable oven/bath and a reference standard,
- calibration by comparison at one or more points between -25°C and $+1200^{\circ}\text{C}$.

Method 2:

- installation of a reference standard in the process, in the vicinity of the sensor to be calibrated,
- calibration is possible up to $+1200^{\circ}\text{C}$.

Method 3:

- calibration by simulation of a temperature signal (Volts, mA, etc.).

CLIMATE (TEST) CHAMBERS

The purpose of a climatic chamber characterisation is to determine and/or periodically verify the true performance of the enclosure. It determines the characteristics which are covered by the specifications i.e. (time of rise, accuracy, stability, homogeneity, etc.).

PRESSURE CALIBRATION **NEW**

From now on, Thermibel can calibrate pressure instruments on a range of :

- -1 to 20 bar relative and absolute pressure
- 0 to 400 bar relative pressure

DOCUMENTS DELIVERED

THERMIBEL issues a calibration certificate with traceability to national standards containing the following information:

- the calibration method,
- the traceability of calibration resources used,
- the table of results including the uncertainties linked to the means of calibration,
- the environmental conditions.

OTHER SERVICES

OPINIONS AND INTERPRETATIONS

Our Calibration Certificates include remarks and notes concerning the interpretation of our findings relating to title definitions, reference values, expression of uncertainties, etc...

Based on expressly-formulated requests, we can issue an opinion on a declaration of the conformity/non-conformity with regard to expected specification stipulations, within the acceptable limits for our declared uncertainties. Communications of this type can only be conveyed through a Calibration Certificate.

AMS 2750

We are also able to make calibrations according to the «Aerospace Material Specifications AMS 2750»

TRAINING

Our laboratory technical team offers its experience and qualifications for metrology training courses. Theoretical and practical courses are specifically oriented towards practice concerning measurement uncertainties, tolerances, temperature sensor calibration and enclosure characterisation procedures, as well vibration calculations for thermowells immersed in a fluid (see also our web site: <http://www.thermibel.be>).



SALE OF CALIBRATION EQUIPMENT

THERMIBEL can supply all the equipment required for calibration work:

- calibrated probes and thermocouples,
- portable calibration ovens and baths,
- standards,
- temperature measurement systems,
- indicators, calibrators, etc...

BEST LABORATORY UNCERTAINTIES

The following table summarises the minimum measurement uncertainties which the laboratory can achieve with the equipment and methods at its disposal. The uncertainties correspond to 2 standard deviations, calculated by taking account of the different influencing factors (standards, resources, etc.).

The uncertainties indicated in the Calibration Certificate can never be smaller than those given in the table and will be generally increased depending on the type of apparatus being calibrated and the resources deployed in performing the calibration.

Measurement instrument	Measurement range	Uncertainty in determination of calibration temperature	Remarks
Resistance temperature sensor	-100°C to 20°C	0,07°C	By comparison with a reference standard (Pt100) in a liquid bath
	0°C	0.05°C	Calibration at the melting point of ice
	0.01°C	0,03°C	Calibration in the water triple point cell
	20 to 150°C 150°C to 200°C	0,10°C 0,13°C	By comparison with a reference standard (Pt25) in a liquid bath
	200°C to 400°C 400°C to 650°C	0,18°C 0,31°C	By comparison with a reference standard (Pt25) in a dry oven
Thermocouple	-100°C to 20°C	0,08°C	By comparison with a reference standard (Pt100) in a liquid bath
	0°C	0.06°C	Calibration at the melting point of ice
	20 to 150°C 150°C to 200°C	0,10°C 0,13°C	By comparison with a reference standard (Pt25) in a liquid bath
	200°C to 400°C 400°C to 650°C	0,19°C 0,31°C	By comparison with a reference standard (Pt25) in a dry oven
	650°C to 750°C 750°C to 1000°C 1000°C to 1100°C 1100°C to 1300°C	1,14°C 1,4°C 2.7°C 3.0°C	By comparison with a reference standard (TC) in a dry oven
Measurement loop	-100°C to 20°C	0,07°C	By comparison with a reference standard (Pt100) in a liquid bath
	0°C	0.05°C	Calibration at the melting point of ice
	20 to 150°C 150°C to 200°C	0,10°C 0,13°C	By comparison with a reference standard (Pt25) in a liquid bath
	200°C to 400°C 400°C to 650°C	0,18°C 0,31°C	By comparison with a reference standard (Pt25) in a dry oven
	650°C to 750°C 750°C to 1000°C 1000°C to 1100°C 1100°C to 1300°C	1,14°C 1,4°C 2.7°C 3.0°C	By comparison with a reference standard (TC) in a dry oven

REMARKS:

- according to the International Temperature Scale 1990 (ITS-90).



ESSENTIAL CONDITIONS TO BE MET BEFORE LABORATORY CALIBRATION

DIMENSIONAL CONDITIONS

Our calibration devices impose certain dimensional conditions on the sensors to be calibrated. These conditions are shown in the summary table on the next page.

CLEANLINESS AND DECONTAMINATION

Each sensor to be calibrated must be clean (no grease, tar, mud, etc. which is likely to pollute the comparison medium and invalidate the results).

Sensors must be straightened and, if required, long sensors with mineral insulation must be re-wound. Our manufacturing facility can carry out this type of work!

If applicable, sensors must be sent to us with a decontamination certificate.

SUPPLY OF ACCESSORIES

All accessories required for correct sensor or equipment operation must be provided.

This includes instructions, battery chargers, power supplies, etc.

INSULATION VALUE

The insulation resistance of sensors to be calibrated must undergo mandatory verification by our quality control department before calibration.

The acceptable limiting values at ambient temperature are as follows:

		Test voltage	Insulation value
Sheath thermocouples (mineral insulation)	$\varnothing \leq 1,5 \text{ mm}$	75 ± 25 Vdc	> 1000 MΩ
	$\varnothing \geq 1,5 \text{ mm}$	500 ± 50 Vdc	> 1000 MΩ
Thermocouples (beaded or wired)		500 ± 50 Vdc	> 500 MΩ
RTD sensors (Pt50, Pt100, Pt1000, etc.)		100 Vdc	> 100 MΩ
Thermistors (NTC, PTC,...)		50 Vdc	> 100 MΩ



SUMMARY OF CALIBRATION SERVICES

DIMENSIONAL DETAILS AND CONDITIONS

TYPES OF SERVICE	DESCRIPTION / DETAIL	MEDIUM	RANGE	CONDITIONS			TYPE OF CERTIFICATE THAT CAN BE ISSUED	
				Ø max. (mm)	L. min. (mm)	L. max. (right) (mm)	With traceability to national standards	ISO 17025 (BELAC)
Temperature calibration by comparison	All types of thermocouples (precious and base metals); Platinum resistance thermometers with 2, 3 or 4-wire connection; Temperature measurement loop with temperature read-out	LIQUID	-196°C	20	200	1100	✓	✓
		LIQUID	-100...200°C	12	200	1100	✓	✓
		DRY	50...200°C	8,5	250	1100	✓	✓
		DRY	200...1200°C	8	200	1100	✓	✓
		DRY	200...1300°C	12	600	1100	✓	✓
		LIQUID	0°C	20	100	1100	✓	✓
Triple point of water (0.01 °C), fixed point ITS90	Same as above	LIQUID	0,01°C	12	420	1100	✓	✓
TYPES OF SERVICE	DESCRIPTION / DETAIL	GENERATOR	RANGE	CONDITIONS			TYPE OF CERTIFICATE THAT CAN BE ISSUED	
Pressure calibration by comparison	Pressure gauges and indicators	Pneumatic hand pump	-1...20 bar(g)	Straight and conical fittings (max Ø: 18mm)			✓	✓
Pressure calibration by comparison	Pressure gauges and indicators	Hydraulic hand pump	0...160 bar(g)	Straight and conical fittings (max Ø: 18mm)			✓	✓
Calibration by electrical simulation	Temperature and electrical indicator and generator	"Voltage Resistance Current"	-10...10V 0...4kΩ 0...55mA	n/a			✓	✓

It is possible however to calibrate certain sensors which do not meet these criteria (please send your request to info@thermibel.be).

INTERPOLATION TABLES & CURVES

A Calibration Certificate gives the sensor error at the specified calibration temperatures. Determining the error between these temperatures is known as **interpolation** and is performed by calculation. The results of the calculation are gathered in an **interpolation table**.

The only condition required for the table to be generated is the presence of **at least four calibration points**.

INTERPOLATION TABLE FOR SENSOR NO. T54490/1/1.1

Page no. 1: from R = 73.000 Ohm to R = 84.931 Ohm

Calibration Certificate no. 090711 – Table from R = 73 Ohm to R = 119 Ohm – 4 pages

R of sensor no. T54490/1.1	Temperature of sensor no. T54490/1.1 in accordance with the IEC751:2008 Standard	Interpolated temperature	Correction	Interpolation uncertainty	Slope
Ohm	°C	°C	°C	±°C	Ohm/°C
73.000	-68.34	-68.30	0.04	0.06	0.3998
73.400	-67.34	-67.30	0.04	0.06	0.3997
73.800	-66.34	-66.30	0.04	0.06	0.3995
74.199	-65.34	-65.30	0.04	0.06	0.3394
74.598	-64.34	-64.30	0.04	0.06	0.3992

Extract from an interpolation table for a Pt100

Each interpolation table is supplied with an introductory page which explains the method of calculation and gives an interpretation example.

In addition to the table, Thermibel supplies a graphic covering the following (see appendix B):

- the measurement points,
- the curve representing the interpolation model,
- the curve of the Standard.



CALCULATING THERMOWELL VIBRATIONS

When a fluid flows around a Thermowell (TW), the change in the momentum of the fluid creates a series of turbulent eddies downstream of the TW. The eddies develop alternately on either side of the TW, **creating vibrations which cause the TW to oscillate** at a certain frequency. If the vibrations approach the natural frequency of the TW, it may resonate with a sufficiently large amplitude of vibration to cause its destruction.

To protect against this risk, the ASME-PTC :2010 Standard recommends certain calculations to allow the TW to be sized and its environmental parameters to be evaluated so as to avoid approaching the resonant frequency.

To take this further, Thermibel specialists and the University of Louvain-la-Neuve jointly developed a **computation program** which not only meets the ASME-PTC :2010 Standard but also performs additional calculations concerning bending, the maximum static pressure permissible for the TW and the maximum length of the latter. Coupled with a database of the most common materials (stainless steel, Inconel, nickel, titanium, etc.), the program produces, on completing the calculations, a report as shown in appendix B.



APPENDIX A1: EXAMPLE OF CALIBRATION CERTIFICATE



N.V. **THERMIBEL** S.A.

Zoning Industriel - Pavé du Roelux - B7110 Strépy-Bracquegnies
Tél. +32(0)64 671500 - Fax +32(0)64 671512
Email : info@thermibel.be



Calibration certificate n° **A221110/1**

THERMIBEL

445, Pavé du Roelux

7110 - Strépy-Bracquegnies - Belgium

Calibration made from : 14/11/2022 to: 15/11/2022
Certificate made on : 15/11/2022
Number of pages : 2
Date of rec. of probes : -
Our references ID : *INTERNE - LABO*
Your references ID : -

Probe number : *LET416*

Type of probe : *Pt 100 4 fils*

Presence of transducer : *No*

Presence of a display : *No*

Physical parameter measured : *Resistance*

Connexion type : *Plug Dostmann*

Conversion scale : *IEC-60751:2008*

Average ambient temperature & humidity: *23±3°C / 45±20%RH*

Notes : *CAL OP1: 2727 0107*

This calibration certificate is delivered in conformity with BELAC and guarantees traceability to international standards. It can only be reproduced in its entirety, except written authorization for partial reproduction given by the laboratory.

Calibration supervised by :

XXX

Operator :

XXX



APPENDIX B: EXAMPLE OF VIBRATION CALCULATION SHEET

NATURAL FREQUENCY OF THERMOWELLS Calculations using ASME PTC 19.3 TW-2010 by THERMIBEL S.A.						
			1/1			
CUSTOMER						
TAG NR :	XXXXX	CONTACT :				
INPUT DATA			25/10/2017			
Fluid properties :						
P =	2.340	bar (g)	Operating Gauge Pressure			
T =	160	°C	Operating temperature			
V =	61.2	m/s	Operating flow velocity			
ρ =	1.908	kg/m ³	Fluid density			
μ =	2.200E-02	cP	Dynamic Fluid Viscosity			
D =	991.0	mm	Pipe Inside Diameter			
F =	324.4	T/h	Flow rate			
Type of thermowell is :	<table border="1" style="margin: auto;"> <tr><td style="text-align: center;">Tapered</td></tr> <tr><td style="text-align: center;">Flanged</td></tr> <tr><td style="text-align: center;">No</td></tr> </table>			Tapered	Flanged	No
Tapered						
Flanged						
No						
Type of fixing is :						
Presence of a shield ?						
Geometry of the thermowell :						
A =	36	mm	Thermowell outer diameter at the root of the thermowell shank or at the support plane			
B =	33	mm	Thermowell diameter at the tip			
d =	7	mm	Bore diameter			
L =	220	mm	Length of the thermowell from the tip to the support plane ("unsupported length")			
Material of the thermowell :						
Type :	316 Stainless Steel	-				
E =	1.92E+05	Mpa	Elastic modulus at the operating temperature			
ρ =	8031	kg/m ³	Mass density of material at operating temperature			
S =	1.17E+02	MPa	Max Allowable working stress			
RESULTS OF COMPUTATIONS						
D _a =	34.5	mm	Average outer diameter			
I =	6.942E-08	m ⁴	Second moment of inertia			
m =	7.199	kg/m	Mass per unit length of the thermowell			
f _a =	497.784	Hz	Approximate natural frequency of the thermowell			
N _{sc} =	19.838	-	Scruton number			
Re =	1.75E+05	-	Reynolds number			
N _s =	0.192	-	Strouhal number			
P _c =	595	bar	Maximum external pressure			
Cyclic stress conditions						
S _a =	0.243	MPa				
S _r =	0.234	MPa				
S _t =	0.252	MPa				
SD =	0.901	MPa				
S _{max} =	1.144	MPa				
VMC :	0.901	Von Mises criteria	OK			
f _n ^c =	475	Hz	Natural frequency of the mounted thermowell			
f _s =	357	Hz	Vortex shedding frequency			
Criteria coeff. :	0.8	-				
f _s / f _n ^c =	0.751	-	The thermowell passes the most stringent frequency limit Steady-state conditions met (§6-8,4 ASME PTC 19.3 TW-2010)			
Cyclic stress computation						
R=	2.129635507 -					
a(R)=	0.02362748 -					
VIR=	41.65789755 m/s					
GSP=	179.890468 -					
SoMax=	0.166201456 MPa					
Thermowells attachment methods are beyond the scope of the Standard. Specification of a thermowell and the materials of construction are the sole responsibility of the designer of the system, that incorporates the thermowell. Sole responsibility for ensuring compatibility or the process fluid with the system rests with the end user.						

**Pavé du Rœulx 445 - Zoning Industriel -
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cert. n°139 - CAL)