



C/ Apolo, 4
41700 Dos Hermanas (Sevilla) Tel.
955 674108
Ftox: 955 675 541
Email: laensa@laensa.com
www.laensa.com

TEST REPORT NO. 7035-2016

CLIENT: REVESTIMIENTOS TÉCNICOS SOSTENIBLES, S.L (RTS)

PETITIONER: Ivan Walter

ADDRESS: Polígono Industrial El Torno - C/ Alfareros 9. 41710 UTRERA (Seville)

MATERIAL TESTED:

ZERAMIC Extrem W

PURPOSE OF THE REPORT:

EXPERIMENTAL TEST TO DETERMINE THE INSULATING CAPACITY OF THE MATERIAL

TEST DATE: **04/07/2016** TEST COMPLETION DATE: **04/07/2016**

REPORT ISSUE DATE: **20/07/2016**

Testing Laboratory for the Quality Control of Construction and Public Works registered in the Register of Testing Laboratories according to Decree 67/2011 with the number AND-L-002 in the Technical Areas:
Building EA EFA, HEY EM GT PS VS. Civil Engineering: OL-A, OL-B, OL-C, OL-D

This report consists of **49 pages** and may not be reproduced without the express authorization of LAENSA, except when it is in full.

1. BACKGROUND
2. MATERIAL DESCRIPTION
3. TEST METHODOLOGY
 - 3.1. Operative
 - 3.2. Calculation
 - 3.3. Technical considerations
 - 3.4. Environmental conditions
4. INSTRUMENTATION
 - 6.1. Equipment
 - 6.2. Software
5. DESCRIPTION OF THE ANALYZED AREA
6. RESULTS
 - 6.1. Heat gains and losses
 - 6.2. Evolution of indoor temperature
7. CONCLUSIONS

ANNEXES

- A. Application routine
- B. Indoor environmental conditions
- C. Outdoor environmental conditions
- D. Thermogram sheet
- E. Technical product specifications
- F. Bibliography

1. BACKGROUND

This report is written at the request of the petitioner **REVESTIMIENTOS TÉCNICOS SOSTENIBLES, S.L (RTS),**" which requests our action to carry out an **EXPERIMENTAL TEST TO DETERMINE THE INSULATING CAPACITY OF THE ZERAMIC MATERIAL.**

Extrem W (Thermal insulation based on liquid ceramic).

The required works consist of the evaluation of the insulating capacity of the coating by calculating heat gains and losses of a treated area and another untreated (w / m^2). The surface on which the product has been applied is a sheet metal roof of an industrial warehouse located in Dos Hermanas (Seville).



2. MATERIAL DESCRIPTION

Zeramic Extrem W, is an elastic thermal insulator, of low thickness, whose application gives the support insulating properties. Zeramic Extrem W is made from hollow liquid ceramic microspheres , titanium dioxide and acrylic, elastic and photo-reticulable emulsions.

Elastic, anti-cracking, breathable and multi-stick product, for vertical and horizontal walls, for exterior or interior use.

3. TEST METHODOLOGY

3.1. Operative

With the test carried out, the average temperature of the treated and untreated surfaces from inside the building has been determined "in situ", using a thermographic equipment with the aim of studying their behavior in the face of variations in temperature and incidence of solar radiation. The determinations are made on the inner surface of the metal roof of an industrial warehouse, finding an area with the product applied and another not applied, in order to study the differential behavior. The results have been analyzed quantitatively to evaluate the effectiveness of the coating.

For our case, the test has been proposed by performing a sequence of thermograms every 5 minutes, starting the test at 9:27 h, with the incidence of the first rays of sun with the cover and prolonging until 7:06 p.m . on July 4, 2016.

A total of **117 thermograms** have been carried out.



3.2. Calculation¹

The heat that penetrates from the outside through the roof, is transferred to the interior environment in the form of two components: The radiated heat and the heat ceded by convection of the air:

$$Q_{\text{tot}} = Q_{\text{rad}} + Q_{\text{conv}} = 4s\sigma T^3 \Delta T_r \frac{\hbar}{h_c} h_c \Delta T_a$$

From the above equation, the parameters involved in the calculation of heat flows are deduced.

The following table details a brief description of the intervening variables and the origin of the data used in the calculation:

Variable	Description	Origin
ε	Wall emissivity	Empirical tables (see 3.3 technical considerations)
σ	Stefan-Boltzmann constant	Universal physical constant
T_m m	Average roof temperature (indoor)	Measurement in the test
$\Delta T_r(t)$	Variation between reflected temperature and that of the roof	Measurement in the test
$\Delta T_a(t)$	Variation of indoor ambient temperature and that of the cover	Measurement in the test
h_c	Convection coefficient	Obtained by simulation software (see Annex A, routine of application)

*An extensively detailed capture of the algorithm used in the calculations can be found for consultation in *Annex A APPLICATION ROUTINE*.

3.3. Technical considerations

- Consideration of unit area value ($1m^2$)
- Surface temperatures measured with FLIR E50bx thermographic equipment
- Air temperature measured with TESTO 174-H equipment
- Painted surface emissivity: Reference value 0,93 Source: Öhman, Claes: Emittansmätningar med AGEMA E-Box. Teknisk rapport, AGEMA 1999.

¹ These calculations correspond to the behavior of the roof under specific conditions. which, although they may be representative of the trend of the results and their order of magnitude, the thermal gains vary considerably depending on the climatic and interior conditions.

- The inner part of the roof has been considered as a flat, continuous and horizontal surface exchanging heat with the environment in stationary conditions
- Heat transfer by convection occurs by natural convection, without flow-altering drafts .
- The temperature has been measured every 5 minutes, using for calculation purposes the hourly average of these values.
- The modelling of these calculations is estimated with an accuracy of 15-20%
- The interior of the ship is not air-conditioned.

3.4. Environmental conditions

The test takes place between 09h27' and 19h06' on Monday, July 4 , 2016.

Outdoor environmental conditions

	T.ext. (°C)	H.ext. (%)	V.Vi. (km/h)	SLP (hpa)	Prec. (mm/h)
Max.	32.0	78.0	26.00	1015.25	0.0
Min.	21.0	30.0	0.0	1015.25	0.0

* See *Annex C EXTERNAL ENVIRONMENTAL CONDITIONS*.

Indoor environmental conditions

	T.int. (°C)	H.int. (%)
Max.	40.4	67.9
Min.	27.1	30.1

* See *Annex B INDOOR ENVIRONMENTAL CONDITIONS*.

4. INSTRUMENTATION

4.1. Equipment

The equipment used to carry out the measurements are as follows

Team	Brand	Model	Serial No.
Thermal imaging camera	FLIR	E50bx	64506450
Thermohydrometer	TESTO	174-H	0572 6560

Main Equipment Specifications : *FLIR E50bx Thermal Imaging Camera*

Visual field/minimum focal length	25° x 19° / 0.4 m
Spectral range	7.5–13 µm
Frame rate	60 Hz
Approach	Manual
Focal Plane Array (FPA)	Uncooled microbolometer
Thermal sensitivity	< 0.045 °C
Spatial resolution	1.82 mrad
IR Resolution	240 x 180 pixels
Temp interval. measurement	-20 °C to +120 °C
Precision	±2°C or 2% reading in temp. environment from 10°C to 35°C

4.2. Software

The computer tools that have intervened in the processing of the measurements are the following:

Software	Brand	Version
Office Excel	Microsoft	2007
Flir Tools+	FLIR	5.0.14262.1001

5. DESCRIPTION OF THE AREA

ANALYZED Material base

Material	galvanized metal (cover)
Orientation	93rd (E)
Localization	Industrial warehouse located in Two Sisters. Seville.

Coating

Application	with brush
Surface	2.00 m ²
Applied thickness	467 µm

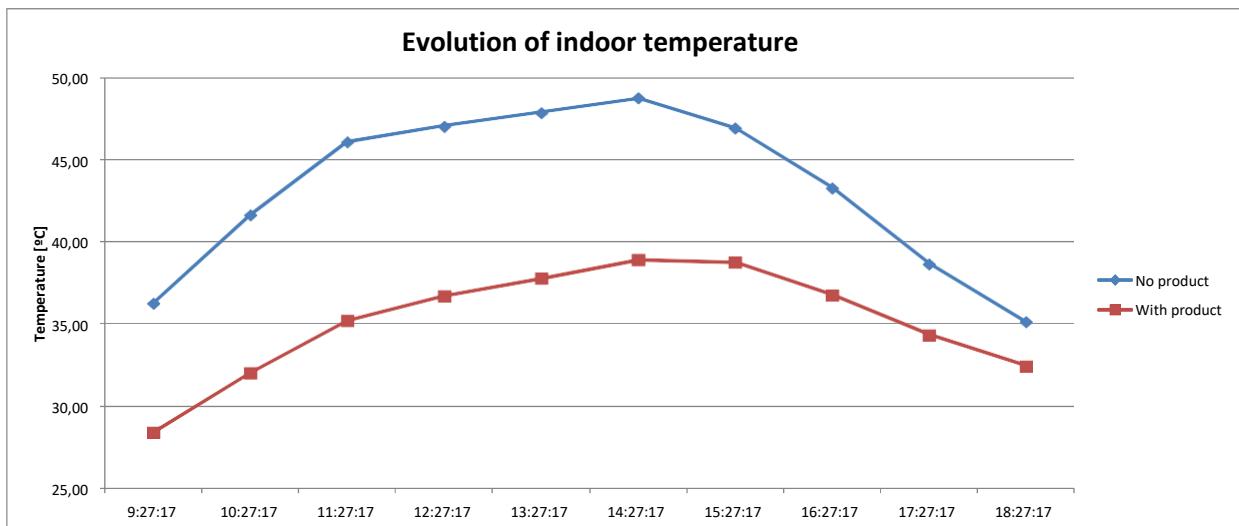


6. RESULTS

6.1. Evolution of indoor temperature

The **average temperature** has been determined on each of the surfaces (coated and uncoated with ZERAMIC Extrem W. The results obtained are shown in the attached table:

Experimental measurements						Indoor temperature [°C]	
Start time	Time [h]	Reflected T [°C]	Temperature [°C]	Humidity [%Hr]	Emissivity	No product	With product
9:27:17	1	29,93	29,23	51,64	0,93	36,26	28,43
10:27:17	2	32,08	31,57	45,83	0,93	41,62	32,04
11:27:17	3	34,17	33,68	41,41	0,93	46,05	35,21
12:27:17	4	35,44	35,20	38,00	0,93	46,99	36,71
13:27:17	5	36,61	36,53	36,27	0,93	47,82	37,78
14:27:17	6	37,80	37,83	34,05	0,93	48,72	38,91
15:27:17	7	38,71	39,92	30,83	0,93	46,89	38,75
16:27:17	8	37,72	38,70	31,83	0,93	43,25	36,76
17:27:17	9	36,32	36,87	34,42	0,93	38,64	34,33

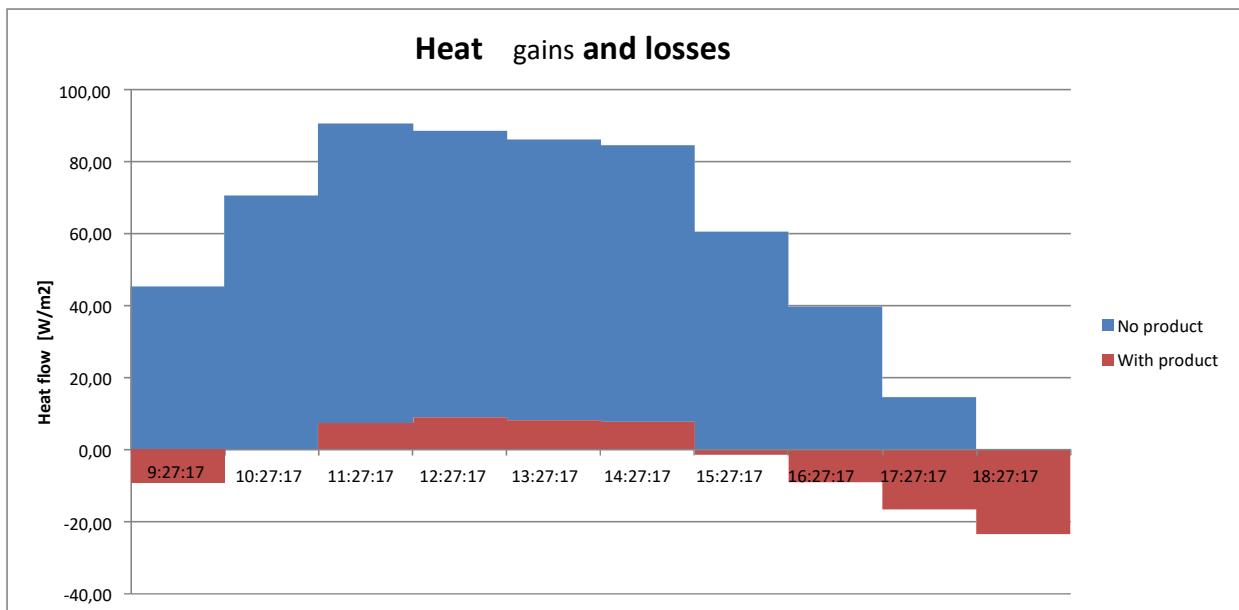


6.2. Heat gains and losses

The **average heat transfer** on each of the surfaces (coated and uncoated with ZERAMIC Extrem W. The results obtained are shown in the attached tables:

Surface without product					
Start time	Time [h]	Convection [W/m ²]	Radiation [W/m ²]	Total power [W/m ²]	
9:27:17	1	6,80	38,40	45,20	
10:27:17	2	10,60	60,00	70,60	
11:27:17	3	13,70	77,10	90,80	
12:27:17	4	12,90	75,70	88,60	
13:27:17	5	12,20	74,20	86,40	
14:27:17	6	11,70	73,00	84,70	
15:27:17	7	6,60	54,10	60,70	
16:27:17	8	3,90	36,00	39,90	
17:27:17	9	0,00	14,70	14,70	
18:27:17	10	-0,50	-1,50	-2,00	

Surface with product				
Start time	Time [h]	Convection [W/m ²]	Radiation [W/m ²]	Total power [W/m ²]
9:27:17	1	-1,00	-8,70	-9,70
10:27:17	2	0,20	-0,20	0,00
11:27:17	3	1,00	6,40	7,40
12:27:17	4	1,00	7,90	8,90
13:27:17	5	0,80	7,40	8,20
14:27:17	6	0,60	7,10	7,70
15:27:17	7	-1,60	0,30	-1,30
16:27:17	8	-3,00	-6,10	-9,10
17:27:17	9	-4,20	-12,30	-16,50
18:27:17	10	-5,60	-18,00	-23,60



7. CONCLUSIONS

Maximum, minimum and average values obtained

Indoor temperature [°C]			
	No product	With product	Difference
Max.	48,72	38,91	9,81
Min.	35,14	28,43	6,71
Average	43,14	35,14	8,00

Heat transfer [W/m ²]			
	No product	With product	Difference
Max.	90,80	8,90	81,90
Min.	-2,00	-23,60	21,60
Average	57,96	-2,80	60,76

From the experimental test carried out it is clear that for an average applied thickness of 467 µm of the product **ZERAMIC Extrem W** and the environmental conditions recorded, a reduction in the interior temperature of the roof surface of up to **8.00 °C** on average and a reduction of heat gain of up to **60.76 W/m²** on average, for a cover of these characteristics.

Dos Hermanas, July 20, 2016.

Author of the report:



Vº Bº:



Fdo.: Jaime Corraliza Solomando
Technical Architect (Coleg. No. 7633)
Responsible for Essay

Fdo.: Pablo Álvarez Troncoso
Lcdo. CC. Chemistry (Coleg. No. 3344)
Technical Director



ANNEXES



To. Routine of application



```
Public Sub ButtWattCalculate_Click()
'Added Horizontal Cylinder calculation to this subroutine.
'It's at the bottom select case true.
'This subroutine calculates the radiative and convective losses from a box or
cylinder 'including the top, bottom and sides. Length data is entered either in
English units 'or metric units on appropriate entry forms.
'The characteristic length is taken as the "depth". Be sure that is the longest
'surface dimension when entering data.
'Temperature and emissivity data are entered on this form.

'If amps current is entered, the electrical resistance in micro-ohms required to produce
'the calculated power is calculated.

'Simplified equations for air taken from Table 7-2, page 358, 8th edition, Heat Transfer,
'J.P. Holman, 1997, McGraw Hill.

'Results have been compared to James M. Bodah, Obtaining Dielectric Watt Loss and
>Contact Resistance From Thermographic Images.

'Col B=rho density in kg/m^3
'Col C=cp specific heat in kJ/kgC
'Col D= mu in kg/ms
'Col E= visc (nu) in m^2/s
'Col F= k in W/mC
'Col G= alpha m^2/s
'Col H= expan (beta) in 1/C
'Col I = Prandtl
'Nu is nusselt number, h is convective "constant"
Dim Horizontal As Boolean
Dim Nu(5), h(5), adt As Double
Dim TbackTop, TbackSide, TbackBottom As Double 'Radiative background temperatures
Dim T
Dim HiRow, LoRow, TemperatureRow As Integer
Dim Tvs, Tva, Thpt, Thpb, Thdt, Thdb, Thpa, Thda, Fraction As Double 'Surface and air temps
Dim Evs, Ehp, Ehd As Double
Dim Prandtl(5), Ray(5), expan(5), dT(5), L(5), visc(5), Qconv(5), A(5), g As Double
Dim cp(5), rho(5), mu(5), k(5), alpha(5) As Double
Dim QtotA(5), Qtot, Amps, MicroOhms As Double
Dim Tfilm(5), TTvs, TTva, TThpt, TThpb, TThdt, TThdb, TThpa, TThda As Double

'TT indicates absolute T to the fourth power times sigma
QtotA(0) = 0'Initialize total heat loss
MicroOhms = 0'Initialize resistance

g = 9.807 ' gravitational acceleration in m/sec^2
Tconst = 273.16 ' Kelvin scale conversion constant
sigma = 0.000000566961 'Stefan Boltzmann constant in Wm^-2K-4
```

```

'get the data
horizontal = false
If AreaRectFormEng.OptButHorizCylinder = True Then
    Horizontal = True
Elseif AreaRectForm.OptButHorizCylinder = True Then
    Horizontal = True
End If
Select Case Horizontal
Case False

With WattForm
    Tvs = .TxtTemperatureVS'Vertical surface temperature
    TbackTop = .TxtTbackTop'Top Radiative background temperature
    TbackBottom = .TxtTbackBottom'Bottom Radiative background
    temperature TbackSide = .TxttbackSide'Side Radiative background
    temperature
    Tva = .TxtTemperatureVA'Vertical side air temperature
    Thpt = .TxtTemperatureHPTS'Horizontal top plate temperature
    Thpb = .TxtTemperatureHPBS'Horizontal bottom plate
    temperature Thdt = .TxtTemperatureHDTs'Horizontal top disk
    temperature Thdb = .TxtTemperatureHDBS'Horizontal bottom
    disk temper ature Thpa = .TxtTemperatureHPA'Horizontal plate air
    temperature
    Thda = .TxtTemperatureHDA'Horizontal disk air
    temperature Lvs = .TxtHeight'vertical side height
    Lhp = .TxtLengthHP'horizontal plate length
    Lhd = .TxtLengthHD'horizontal disk length Evs =
    TxtEmissivityVS'emissivity vertical side
    Ehp = .TxtEmissivityHP'emissivity horizontal plate
    Ehd = .TxtEmissivityHD'emissivity horizontal disk
    A(1) = .txtareavs
    A(2) = .
    TxtAreaHP A(3) =
    . TxtAreaHP A(4)
    = . TxtAreaHD
    A(5) = .
    TxtAreaHD
    Amps = .
    TxtCurrentAmps End With
'Calculate radiative heat loss
    TTvs = sigma * (Tvs + Tconst) ^
        4
    TTva = sigma * (TbackSide + Tconst) ^ 4
    TTthpt = sigma * (Thpt + Tconst) ^ 4
    TTthpb = sigma * (Thpb + Tconst) ^ 4
    TTthdt = sigma * (Thdt + Tconst) ^ 4
    TTthdb = sigma * (Thdb + Tconst) ^ 4
    TTthpat = sigma * (TbackTop + Tconst) ^
        4 TTthdat = sigma * (TbackTop + Tconst)

```

$\wedge 4$

$TThpab = \sigma * (T_{backBottom} + T_{const})^4$

$4 TThdab = \sigma * (T_{backBottom} + T_{const})^4$

$\wedge 4 Q_{radvs} = A(1) * E_{vs} * (T_{Tvs} - T_{Tva})$



```
Qradhpt = A(2) * Eph * (TThpt - TThpat)
Qradhpb = A(3) * Eph * (TThpb - TThpab)
Qradhdt = A(4) * Ehd * (TThdt - TThdat)
Qradhdb = A(5) * Ehd * (TThdb - TThdab)
Qtot = Qradvs + Qradhpt + Qradhpb + Qradht + Qradhdb
adt1 = A(1) * (Tvs - TbackSide)
adt2 = A(2) * (Thpt - TbackTop)
adt3 = A(3) * (Thpb - TbackBottom)
adt4 = A(4) * (Thdt - TbackTop)
adt5 = A(5) * (Thdb - TbackBottom)
adt = adt1 + adt2 + adt3 + adt4 + adt5
```

'Fill in the heat loss by radiation values

With WattForm

```
. TxtWattsRadVP = Format(Qradvs, "##.0")
. TxtWattsRadHP = Format(Qradhpb + Qradhpt, "##.0")
. TxtWattsRadHD = Format(Qradhdt + Qradhdb, "##.0")
```

End With

'Calculate Rayleigh Number =g*beta*DT*L^3*Pr/nu^2

'g=gravitational acceleration m/sec^2

'beta=coefficient of thermal expansion using film temperature K^-1

'DT=delta T in K

'L^3 is cube of characteristic length in meters

'nu is kinematic viscosity of air m^2/sec

'First find values from table by interpolation

'Author used MathCad program he developed called airconstants.mcd to improve

'temperature resolution of table values from every 50 K to every 5 K

'using appropriate spline interpolation

'This allows linear interpolation in this program with improved accuracy.

'Use subscripts to speed up process. 1 is side, 2 is rect top, 3 is rect bottom, 4 is

'cylinder top, 5 is cylinder bottom.

'Air film temperature is average of surface temperature and air temperature in Kelvin.

'Col B(2)=rho density in kg/m^3

'Col C(3)=cp specific heat in kJ/kgC

'Col D(4)= mu in kg/ms

'Col E(5)= visc (nu) in m^2/s

'Col F(6)= k in W/mC

'Col G(7)= alpha m^2/s

'Col H(8)= expan (beta) in 1/C

'Col I(9) = Prandtl

```
Tfilm(1) = Tconst + Tvs / 2 + Tva / 2: Tfilm(2) = Tconst + Thpt / 2 + Thpa / 2
```

```
Tfilm(3) = Tconst + Thpb / 2 + Thpa / 2
```

```
Tfilm(4) = Tconst + Thdt / 2 + Thda / 2: Tfilm(5) = Tconst + Thdb / 2 + Thda / 2
```

```
dT(1) = Tvs - TVA: dT(2) = Thpt - Thpa: dT(3) = Thpb - Thpa
```

```
dT(4) = Thdt - Thda: dT(5) = Thdb - Thda
```



L(1) = Lvs; L(2) = Lhp; L(3) = Lhp; L(4) = Lhd; L(5) = Lhd

'L(1), vertical surface char length; L(2)and L(3) are top and bottom
'characteristic lengths respectively.
'L(4) and L(5) are characteristic lengths for top and bottom disk respectively
'for a vertical cylinder.

For J = 1 to 5

 InterpFactor (Tfilm(J)) 'Find fraction of temperature between table values

 With Worksheets("Convection")

 Fraction = . Range("A32"). Value'InterpFactor puts fraction in

 spreadsheet 'Convection in cell A32

 LoRow = . Range("A34"). Value'puts start (low) row in A34

 HiRow = LoRow + 1

 End With

 With Worksheets("AirTable") 'Use above fraction to linear interpolate table data

 rho(J) = . Cells(LoRow, 2). Value + Fraction * (. Cells(HiRow, 2). Value - . Cells(LoRow, 2). Value)

 cp(J) = . Cells(LoRow, 3). Value + Fraction * (. Cells(HiRow, 3). Value - . Cells(LoRow, 3). Value)

 mu(J) = . Cells(LoRow, 4). Value + Fraction * (. Cells(HiRow, 4). Value - . Cells(LoRow, 4). Value)

 visc(J) = . Cells(LoRow, 5). Value + Fraction * (. Cells(HiRow, 5). Value - . Cells(LoRow, 5). Value)

 k(J) = . Cells(LoRow, 6). Value + Fraction * (. Cells(HiRow, 6). Value - . Cells(LoRow, 6). Value)

 alpha(J) = . Cells(LoRow, 7). Value + Fraction * (. Cells(HiRow, 7). Value - . Cells(LoRow, 7). Value)

 Value) expan(J) = . Cells(LoRow, 8). Value + Fraction * (. Cells(HiRow, 8). Value - . Cells(LoRow,

 8). Value) Prandtl(J) = . Cells(LoRow, 9). Value + Fraction * (. Cells(HiRow, 9). Value - .

 Cells(LoRow, 9). Value)

'calculate Rayleigh Number

 Ray(J) = g * expan(J) * dT(J) * L(J) ^ 3 * Prandtl(J) / visc(J) ^ 2

 Worksheets("Convection"). Cells(30 + J, 2) = Ray(J) 'store in cells B31-35 to check

If Ray(J) <= 1000000000# Then'Rayleigh < 10^9,

 laminate flow Select Case J

Case 1

 If L(1) <> 0 Then

 h(1) = 1.42 * (Abs(dT(1)) / L(1)) ^ (1 / 4) 'Laminar flow for air, vertical surfaces

 End If

Case 2

 If L(2) <> 0 Then

 If dT(2) >= 0 Then

 h(2) = 1.32 * (dT(2) / L(2)) ^ (1 / 4) 'Laminar flow for air, horizontal hot top plate

 Else

 h(2) = 0.59 * (-dT(2) / L(2)) ^ (1 / 4) 'Laminar flow, horiz top plate, cold

 End If

 End If

Case 3

 If L(3) <> 0 Then

 If dT(3) >= 0 Then

 h(3) = 0.59 * (dT(3) / L(2)) ^ (1 / 4) 'Laminar flow, horiz bottom plate, warm

 Else

 h(3) = 1.32 * (-dT(3) / L(2)) ^ (1 / 4) 'Laminar flow, horiz bottom plate, cold

 End If

```

End If
Case 4
If L(4) <> 0 Then
  If dT(4) >= 0 Then
    h(4) = 1.32 * (dT(4) / L(4)) ^ (1 / 4) 'Laminar flow for air, horizontal hot top disk
  Else
    h(4) = 0.59 * (-dT(4) / L(4)) ^ (1 / 4) 'Laminar flow, horiz top disk, cold
  End If
End If
Case 5
If L(5) <> 0 Then
  If dT(5) >= 0 Then
    h(5) = 0.59 * (dT(5) / L(5)) ^ (1 / 4) 'Laminar flow, horiz bottom disk, warm
  Else
    h(5) = 1.32 * (-dT(5) / L(5)) ^ (1 / 4) 'Laminar flow, horiz bottom disk, cold
  End If
End If
End Select
If L(J) = 0 Then
  h(J) = 0
End If

Else

Select Case J
Case 1
If L(1) <> 0 Then
  h(1) = 1.31 * (dT(1)) ^ (1 / 3) 'Turbulent flow for air, vertical surfaces
End If
Case 2
If L(2) <> 0           Then 'Avoid divide
  by zero If dT(2) >= 0 Then
    h(2) = 1.52 * (dT(2)) ^ (1 / 3) 'Turbulent flow for air, horizontal hot top plate
  Else
    h(2) = 0.59 * (-dT(2) / L(2)) ^ (1 / 4) 'Turbulent flow, horiz top plate, cold
  End If
End If
Case 3
If L(3) <> 0 Then
  If dT(3) >= 0 Then
    h(3) = 0.59 * (dT(3) / L(2)) ^ (1 / 4) 'Turbulent flow, horiz bottom plate, warm
  Else
    h(3) = 1.52 * (-dT(3)) ^ (1 / 3) 'Turbulent flow, horiz bottom plate, cold
  End If
End If
Case 4

```



```
If L(4) <> 0 Then
    If dT(4) >= 0 Then
        h(4) = 1.52 * (dT(4)) ^ (1 / 3) 'Turbulent flow for air, horizontal hot top disk
    Else
        h(4) = 0.59 * (-dT(4) / L(4)) ^ (1 / 4) 'Turbulent flow, horiz top disk, cold
    End If
End If

Case 5
If L(5) <> 0 Then
    If dT(5) >= 0 Then
        h(5) = 0.59 * (dT(5) / L(5)) ^ (1 / 4) 'Turbulent flow, horiz bottom disk, warm
    Else
        h(5) = 1.52 * (-dT(5)) ^ (1 / 3) 'Turbulent flow, horiz bottom disk, cold
    End If
End If
End Select

End If

Qconv(J) = h(J) * A(J) * dT(J)      'Calculate convective heat flow in Watts

End With

With Worksheets("Convection") 'Output Data
    . Cells(30 + J, 2) = Ray(J)
    . Cells(30 + J, 3) = h(J)
    . Cells(30 + J, 4) =
Qconv(J) End With

QtotA(J) = Qconv(J) + QtotA(J - 1)      'Sum up convective heat flow in
watts. Next J

Qtot = QtotA(5) + Qradvs + Qradhpb + Qradhpt + Qradhdt + Qradhdb 'Calc total heat flow
If Amps = "" Then
    MicroOhms = 0
ElseIf Amps = 0 Then
    MicroOhms = 0
Else
    DataCheck (MicroOhms)
    MicroOhms = Qtot * 1000000# / Amps ^ 2

End If
```

```
With WattForm
    . TxtWattsConvVP = Format(Qconv(1), "#.0")
    . TxtWattsConvHP = Format(Qconv(2) + Qconv(3), "#.0")
    . TxtWattsConvHD = Format(Qconv(4) + Qconv(5), "#.0")
    . TxtWattsTotalVP = Format(Qconv(1) + Qradvs, "#.0")
```



```
. TxtWattsTotalHP = Format(Qconv(2) + Qconv(3) + Qradhp + Qradhpt, "##.0")
. TxtWattsTotalHD = Format(Qconv(4) + Qconv(5) + Qradhdt + Qradhdb, "##.0")
. TxtWattsTotal = Format(Qtot, "##,##0.0")
. TxtResistanceMicroOhms = Format(MicroOhms, "##,##0")
. TxtAreaDeltaT = Format(adt, "##,##0.00")
```

End With

Case True

```
'Horizontal cylinder calculation '
redefines areas for horizontal
cylinder
A(2) = Worksheets("convection"). Range("C26"). Value 'cylinder
area A(1) = Worksheets("convection"). Range("M26"). Value 'end
area A(3) = A(1)
With WattFormHoriz
    Tle = . LETemp'left      end temperature in celsius
    Thc = . HorizCylTemp'cylinder           body
    temperature in celsius Tre = . RETemp'right   end
    temperature in celsius
    Ele = . LEE            miss'left end emissivity
    Ehc = . HorizCylEmiss'cylinder
    body emissivity Ere = . REEmiss'right  end
    emissivity
    Tla = . LEAmb'left      end ambient temperature in celsius
    Tha = . HorizCylAmb'cylinder           body ambient
    temperature in celsius Tra = . REAmb'right   end ambient
    temperature in celsius
    Tlb = . LEBkg'left      end background temperature in celsius
    Thb = . HorizCylBkg'cylinder           body background temperature in
    celsius Trb = . REBkg'right   end background temperature in celsius
```

```
'calculate radiative heat loss
TTle = sigma * (Tle + Tconst) ^      4'sigma
T^4 TThc = sigma * (Thc + Tconst) ^ 4
TTre = sigma * (Tre + Tconst) ^ 4
TTlb = sigma * (Tlb + Tconst) ^ 4
TThb = sigma * (Thb + Tconst) ^
4 TTrb = sigma * (Trb + Tconst) ^
4
```

```
Qradle = A(1) * Ele * (TTle - TTlb) 'left end radiation in watts
Qradhc = A(2) * Ehc * (TThc - TThb) 'cylinder body radiation in watts
Qradre = A(3) * Ere * (TTre - TTrb) 'right end radiation in watts
```

QtotRad = Qradle + Qradhc + Qradre ' total watt loss

```
adt1 = A(1) * (Tle - Tlb)      'Left end area*deltaT in m^2*C
adt2 = A(2) * (Thc - Thb)      'cylinder body area*deltaT in
m^2*C adt3 = A(3) * (Tre - Trb)      'right end area*deltaT in
```

m^2*C

adt = adt1 + adt2 + adt3'Total area*deltaT



```
'***** 'Calculate the
convective heat loss
Tfilm(1) = Tconst + Tle / 2 + Tla / 2: Tfilm(2) = Tconst + Thc / 2 + Tha / 2: Tfilm(3) = Tconst + Tre / 2 + Tra / 2 '
air film temperatures for left (1), middle (2) and right (3)
dT(1) = Tle - Tla: dT(2) = Thc - Tha: dT(3) = Tre - Tra
'surface to ambient delta temperature for left, middle and right
HCDia = Worksheets("convection"). Range("K24"). Value
HCLength = Worksheets("convection"). Range("E24"). Value
L(1) = HCDia: L(2) = HCDia: L(3) = HCDia
'characteristic lengths
For J = 1 To 3
    InterpFactor (Tfilm(J)) 'Find fraction of temperature between table values
    With Worksheets("Convection")
        Fraction = . Range("A32"). Value'InterpFactor puts fraction in
        spreadsheet 'Convection in cell A32
        LoRow = . Range("A34"). Value'puts start (low) row in A34
        HiRow = LoRow + 1
    End With
    With Worksheets("AirTable") 'Use above fraction to linear interpolate table data
        rho(J) = . Cells(LoRow, 2). Value + Fraction * (. Cells(HiRow, 2). Value - . Cells(LoRow, 2). Value)
        cp(J) = . Cells(LoRow, 3). Value + Fraction * (. Cells(HiRow, 3). Value - . Cells(LoRow, 3). Value)
        mu(J) = . Cells(LoRow, 4). Value + Fraction * (. Cells(HiRow, 4). Value - . Cells(LoRow, 4). Value)
        visc(J) = . Cells(LoRow, 5). Value + Fraction * (. Cells(HiRow, 5). Value - . Cells(LoRow, 5). Value)
        k(J) = . Cells(LoRow, 6). Value + Fraction * (. Cells(HiRow, 6). Value - . Cells(LoRow, 6). Value)
        alpha(J) = . Cells(LoRow, 7). Value + Fraction * (. Cells(HiRow, 7). Value - . Cells(LoRow, 7). Value)
        Value) expan(J) = . Cells(LoRow, 8). Value + Fraction * (. Cells(HiRow, 8). Value - . Cells(LoRow,
        8). Value) Prandtl(J) = . Cells(LoRow, 9). Value + Fraction * (. Cells(HiRow, 9). Value - .
        Cells(LoRow, 9). Value)
    'calculate Rayleigh Number
    Ray(J) = g * expan(J) * dT(J) * L(J) ^ 3 * Prandtl(J) / visc(J) ^ 2
    Worksheets("Convection"). Cells(30 + J, 2) = Ray(J) 'store in cells B31-35 to check
    If Ray(J) <= 1000000000# Then'Rayleigh < 10^9,
        laminate flow Select Case J
        Case 1
            If L(1) <> 0 Then
                h(1) = 1.42 * (Abs(dT(1)) / L(1)) ^ (1 / 4) 'Laminar flow for air, vertical surfaces
            End If
        Case 2
            If L(2) <> 0 Then
                h(2) = 1.32 * (Abs(dT(2)) / L(2)) ^ (1 / 4)
            End If
        Case 3
            If L(3) <> 0 Then
                h(3) = 1.42 * (Abs(dT(3)) / L(3)) ^ (1 / 4)
            End If
        End Select
        If L(J) = 0 Then
```

```

h(J) = 0
End If

Else

Select Case J
Case 1
If L(1) <> 0 Then
    h(1) = 1.31 * (dT(1)) ^ (1 / 3) 'Turbulent flow for air, vertical surfaces
End If

Case 2
If L(2) <> 0           Then'Avoid divide
    by zero h(2) = 1.24 * (dT(2)) ^ (1 / 3)
End If

Case 3
If L(3) <> 0 Then
    h(3) = 1.31 * (dT(3)) ^ (1 / 3)
End If

End Select

End If

Qconv(J) = h(J) * A(J) * dT(J)      'Calculate convective heat flow in Watts

End With

With Worksheets("Convection") 'Output Data
    . Cells(30 + J, 2) = Ray(J)
    . Cells(30 + J, 3) = h(J)
    . Cells(30 + J, 4) =
Qconv(J) End With

QtotA(J) = Qconv(J) + QtotA(J - 1)      'Sum up convective heat flow in
watts. Next J

Qtot = QtotA(3) + QtotRad
    . TxtADT.BackColor = &H80000005
    . TxtHCCConv.BackColor = &H80000005
    . TxtHCRad.BackColor = &H80000005
    . TxtLEConv.BackColor = &H80000005
    . TxtLERad.BackColor = &H80000005
    . TxtREConv.BackColor = &H80000005
    . TxtRERad.BackColor = &H80000005
    . TxtTotalWattLoss.BackColor = &H80000005
    . TxtLERad = Format(Qradle, "##,##0") 'left end radiation to form
    . TxtHCRad = Format(Qradhc, "##,##0") 'cylinder body radiation to form

```



```
. TxtRERad = Format(Qradre, "##,##0") 'right end radiation to form  
. TxtTotalWattLoss = Format(Qtotal, "##,##0") 'Total watt loss to form  
. TxtLEConv = Format(Qconv(1), "##0")  
. TxtREConv = Format(Qconv(3), "##0")  
. TxtHCConv = Format(Qconv(2), "##0")  
. TxtADT = Format(adt, "##0")
```

End With

End Select

End Sub



B. Indoor environmental conditions

Instrument Name : Equipo_1					
Start time: 04/07/2016 9:02:00		Minimal	Maximum	Average	Limit values
End time: 04/07/2016 19:22:00	Temperature [°C]	27,10	40,40	35,198	-10,0/70,0
Measuring channels : 2	Humidity [%Hr]	30,10	67,90	38,937	0,0/100,0
temperature and humidity					
				AVERAGES	
Id	Date-Time	Temperature[°C]	Humidity[%Hr]	Temperature[°C]	Humidity[%Hr]
1	04/07/2016 9:02:00	27,10	67,90		
2	04/07/2016 9:07:00	27,50	55,50		
3	04/07/2016 9:12:00	27,70	55,40		
4	04/07/2016 9:17:00	27,80	55,40		
5	04/07/2016 9:22:00	27,90	55,00		
6	04/07/2016 9:27:00	28,10	54,40	29,23	51,64
7	04/07/2016 9:32:00	28,30	54,00		
8	04/07/2016 9:37:00	28,40	53,70		
9	04/07/2016 9:42:00	28,70	53,10		
10	04/07/2016 9:47:00	29,00	52,40		
11	04/07/2016 9:52:00	29,20	51,60		
12	04/07/2016 9:57:00	29,40	51,00		
13	04/07/2016 10:02:00	29,50	50,80		
14	04/07/2016 10:07:00	29,70	50,50		
15	04/07/2016 10:12:00	29,90	49,90		
16	04/07/2016 10:17:00	30,10	49,40	31,57	45,83
17	04/07/2016 10:22:00	30,40	48,90		
18	04/07/2016 10:27:00	30,40	48,80		
19	04/07/2016 10:32:00	30,60	48,20		
20	04/07/2016 10:37:00	30,90	47,50		



21	04/07/2016 10:42:00	31,00	47,10		
22	04/07/2016 10:47:00	31,30	46,40		
23	04/07/2016 10:52:00	31,50	45,90		
24	04/07/2016 10:57:00	31,70	45,30		
25	04/07/2016 11:02:00	32,00	44,60		
26	04/07/2016 11:07:00	32,10	44,60		
27	04/07/2016 11:12:00	32,30	44,10		
28	04/07/2016 11:17:00	32,40	43,90		
29	04/07/2016 11:22:00	32,60	43,50		
30	04/07/2016 11:27:00	32,70	43,40		
31	04/07/2016 11:32:00	32,90	43,00		
32	04/07/2016 11:37:00	33,30	42,20		
33	04/07/2016 11:42:00	33,40	42,10		
34	04/07/2016 11:47:00	33,50	42,10		
35	04/07/2016 11:52:00	33,60	41,70		
36	04/07/2016 11:57:00	33,70	41,40		
37	04/07/2016 12:02:00	33,90	40,90		
38	04/07/2016 12:07:00	34,10	40,60		
39	04/07/2016 12:12:00	34,20	40,10		
40	04/07/2016 12:17:00	34,40	39,90		
41	04/07/2016 12:22:00	34,50	39,50		
42	04/07/2016 12:27:00	34,60	39,20		
43	04/07/2016 12:32:00	34,90	38,80		
44	04/07/2016 12:37:00	35,10	38,30		
45	04/07/2016 12:42:00	35,10	38,20		
46	04/07/2016 12:47:00	35,20	37,80		
47	04/07/2016 12:52:00	35,10	38,10		
48	04/07/2016 12:57:00	35,20	37,90		

33,68 41,41

35,20 38,00



49	04/07/2016 13:02:00	35,20	37,80		
50	04/07/2016 13:07:00	35,40	37,60		
51	04/07/2016 13:12:00	35,50	37,40		
52	04/07/2016 13:17:00	35,50	37,50		
53	04/07/2016 13:22:00	35,60	37,40		
54	04/07/2016 13:27:00	35,90	37,00		
55	04/07/2016 13:32:00	36,10	36,60		
56	04/07/2016 13:37:00	36,30	36,40		
57	04/07/2016 13:42:00	36,40	36,30		
58	04/07/2016 13:47:00	36,40	36,50		
59	04/07/2016 13:52:00	36,50	36,50		
60	04/07/2016 13:57:00	36,70	36,20		
61	04/07/2016 14:02:00	36,80	36,10		
62	04/07/2016 14:07:00	36,70	36,10		
63	04/07/2016 14:12:00	36,70	36,10		
64	04/07/2016 14:17:00	36,80	35,80		
65	04/07/2016 14:22:00	37,00	35,60		
66	04/07/2016 14:27:00	37,10	35,30		
67	04/07/2016 14:32:00	37,20	35,10		
68	04/07/2016 14:37:00	37,40	34,60		
69	04/07/2016 14:42:00	37,50	34,50		
70	04/07/2016 14:47:00	37,70	34,00		
71	04/07/2016 14:52:00	37,80	34,20		
72	04/07/2016 14:57:00	37,80	34,10		
73	04/07/2016 15:02:00	37,80	34,20		
74	04/07/2016 15:07:00	37,90	34,00		
75	04/07/2016 15:12:00	38,30	33,30		
76	04/07/2016 15:17:00	38,60	32,90		



77	04/07/2016 15:22:00	38,90	32,40		
78	04/07/2016 15:27:00	39,10	31,90		
79	04/07/2016 15:32:00	39,30	31,60		
80	04/07/2016 15:37:00	39,60	31,30		
81	04/07/2016 15:42:00	39,70	31,10		
82	04/07/2016 15:47:00	39,80	31,00		
83	04/07/2016 15:52:00	39,90	30,80	39,92	30,83
84	04/07/2016 15:57:00	40,00	30,70		
85	04/07/2016 16:02:00	40,20	30,50		
86	04/07/2016 16:07:00	40,30	30,30		
87	04/07/2016 16:12:00	40,30	30,30		
88	04/07/2016 16:17:00	40,40	30,20		
89	04/07/2016 16:22:00	40,40	30,20		
90	04/07/2016 16:27:00	40,10	30,10		
91	04/07/2016 16:32:00	39,80	30,60		
92	04/07/2016 16:37:00	39,50	30,90		
93	04/07/2016 16:42:00	39,30	31,20		
94	04/07/2016 16:47:00	39,10	31,60		
95	04/07/2016 16:52:00	38,80	31,70	38,70	31,83
96	04/07/2016 16:57:00	38,40	32,20		
97	04/07/2016 17:02:00	38,20	32,30		
98	04/07/2016 17:07:00	38,00	32,50		
99	04/07/2016 17:12:00	37,90	32,70		
100	04/07/2016 17:17:00	37,80	32,90		
101	04/07/2016 17:22:00	37,50	33,20		
102	04/07/2016 17:27:00	37,40	33,70		
103	04/07/2016 17:32:00	37,40	33,40	36,87	34,42
104	04/07/2016 17:37:00	37,40	33,50		



105	04/07/2016 17:42:00	37,20	33,70		
106	04/07/2016 17:47:00	37,10	34,00		
107	04/07/2016 17:52:00	36,90	34,40		
108	04/07/2016 17:57:00	36,80	34,50		
109	04/07/2016 18:02:00	36,70	34,90		
110	04/07/2016 18:07:00	36,50	34,90		
111	04/07/2016 18:12:00	36,50	35,00		
112	04/07/2016 18:17:00	36,40	35,20		
113	04/07/2016 18:22:00	36,10	35,80		
114	04/07/2016 18:27:00	36,00	36,00		
115	04/07/2016 18:32:00	36,10	35,80		
116	04/07/2016 18:37:00	36,20	35,70		
117	04/07/2016 18:42:00	36,40	35,40		
118	04/07/2016 18:47:00	36,40	35,50		
119	04/07/2016 18:52:00	36,40	35,60		
120	04/07/2016 18:57:00	36,30	35,70		
121	04/07/2016 19:02:00	36,20	35,90		
122	04/07/2016 19:07:00	36,20	36,20		
123	04/07/2016 19:12:00	35,40	37,00		
124	04/07/2016 19:17:00	34,00	47,80		
125	04/07/2016 19:22:00	32,00	40,20		

35,63

37,23



C. External environmental conditions

HoraCEST	TemperatureC	Humidity	Wind Direction	Wind speedKm/h	Conditions
12:00 AM	28	35	BEAR	11.1	
12:00 AM	28.0	45	BEAR	11.1	Clear
12:30 AM	27.0	58	NO	13.0	Clear
1:00 AM	27	46	ONO	20.4	
1:00 AM	27.0	54	ONO	18.5	Clear
2:00 AM	26	47	West	16.7	Scattered clouds
3:00 AM			Calm	Calm	
3:30 AM	25.0	61	NO	14.8	Clear
4:00 AM	25	50	ONO	14.8	
4:00 AM	24.0	61	ONO	13.0	Clear
4:30 AM	24.0	61	West	13.0	Clear
5:00 AM	24	52	ONO	13.0	Clear
5:00 AM	24.0	61	ONO	13.0	Clear
5:30 AM	23.0	65	NO	9.3	Clear
6:00 AM	22	59	West	5.6	
6:00 AM	22.0	69	West	5.6	Clear
6:30 AM	22.0	69	Variable	3.7	Clear
7:00 AM	22	65	NNW	5.6	
7:00 AM	22.0	69	NNW	5.6	Clear
7:30 AM	21.0	78	Calm	Calm	Clear
8:00 AM	23	64	ONO	11.1	Scattered clouds
8:00 AM	22.0	73	ONO	9.3	Partly cloudy
8:30 AM	23.0	73	ONO	13.0	Partly cloudy
9:00 AM	24	63	West	11.1	
9:00 AM	23.0	73	ONO	11.1	Partly cloudy
9:30 AM	24.0	69	West	11.1	Partly cloudy
10:00 AM	25	56	BEAR	5.6	
10:00 AM	25.0	65	BEAR	3.7	Partly cloudy
10:30 AM	25.0	65	Variable	3.7	Partly cloudy
11:00 AM	27	48	UNDER	11.1	Scattered clouds
11:00 AM	26.0	61	BEAR	7.4	Partly cloudy
11:30 AM	27.0	58	UNDER	9.3	Clear
12:00 PM	26.0	61	SSO	13.0	Clear
12:30 PM	27.0	58	BEAR	9.3	Clear
1:00 PM	29	42	UNDER	18.5	
1:00 PM	28.0	58	BEAR	16.7	Clear
1:30 PM	28.0	54	BEAR	20.4	Clear
2:00 PM	29	43	UNDER	18.5	Clear

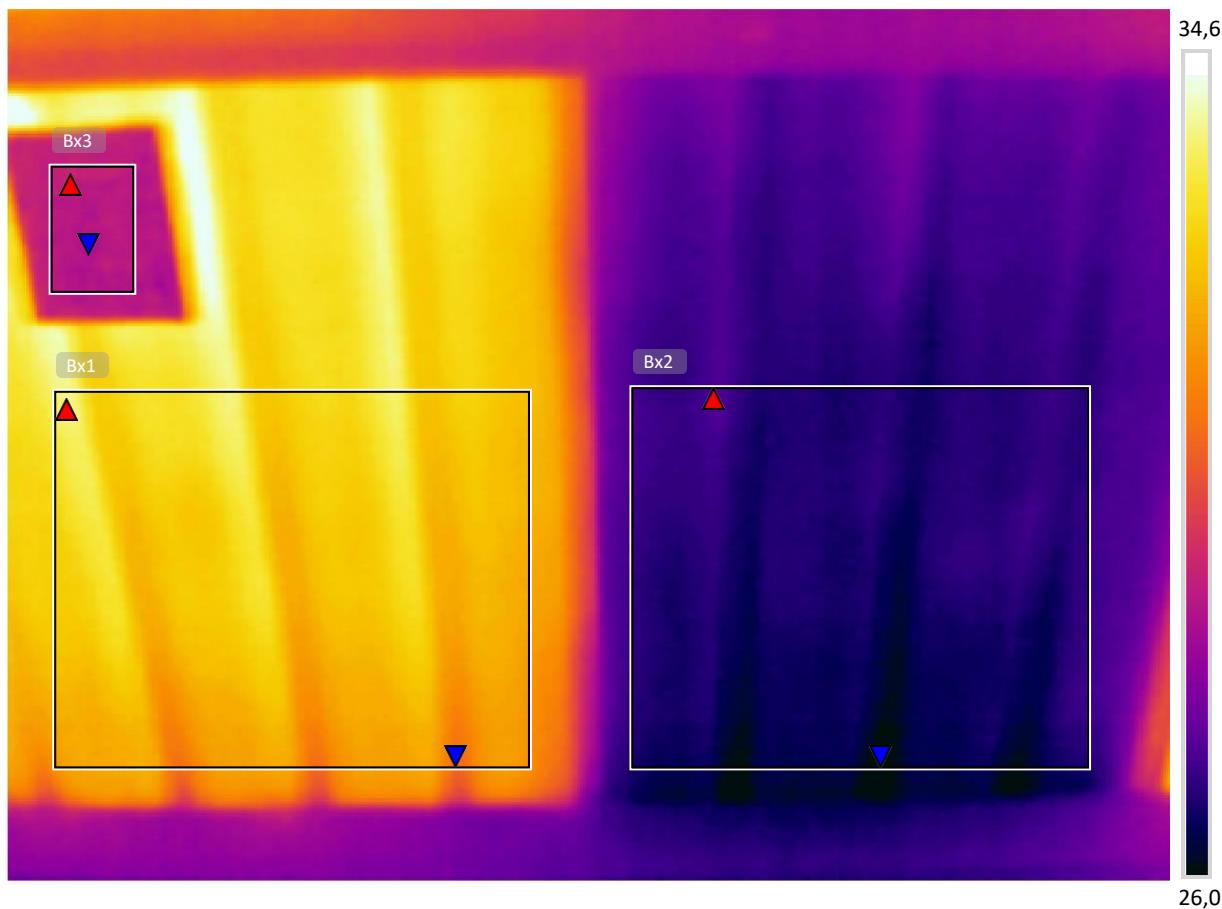


2:00 PM	29.0	55	BEAR	18.5	Clear
2:30 PM	29.0	55	SSO	14.8	Clear
3:00 PM	31	35	UNDER	16.7	
3:00 PM	30.0	45	UNDER	14.8	Clear
3:30 PM	31.0	43	UNDER	18.5	Clear
4:00 PM	32	31	UNDER	18.5	
4:00 PM	31.0	43	UNDER	14.8	Clear
4:30 PM	31.0	43	BEAR	16.7	Clear
5:00 PM	32	31	UNDER	18.5	Clear
5:00 PM	32.0	40	UNDER	18.5	Clear
5:30 PM	32.0	43	UNDER	20.4	Clear
6:00 PM	32	30	UNDER	24.1	
6:00 PM	31.0	43	UNDER	22.2	Clear
6:30 PM	31.0	43	UNDER	25.9	Clear
7:00 PM			Calm	Calm	
7:00 PM	30.0	48	UNDER	25.9	Clear
7:30 PM	30.0	48	UNDER	22.2	Clear
8:00 PM	30	36	UNDER	24.1	Clear
8:00 PM	30.0	48	UNDER	20.4	Clear
8:30 PM	29.0	51	UNDER	18.5	Clear
9:00 PM	29	42	UNDER	18.5	
9:00 PM	29.0	51	UNDER	18.5	Clear
9:30 PM	28.0	54	UNDER	18.5	Clear
10:00 PM	28	46	UNDER	18.5	
10:00 PM	27.0	58	UNDER	18.5	Clear
10:30 PM	26.0	61	UNDER	14.8	Clear
11:00 PM	26	53	UNDER	14.8	Clear
11:00 PM	26.0	61	UNDER	13.0	Clear
11:30 PM	26.0	61	UNDER	13.0	Clear



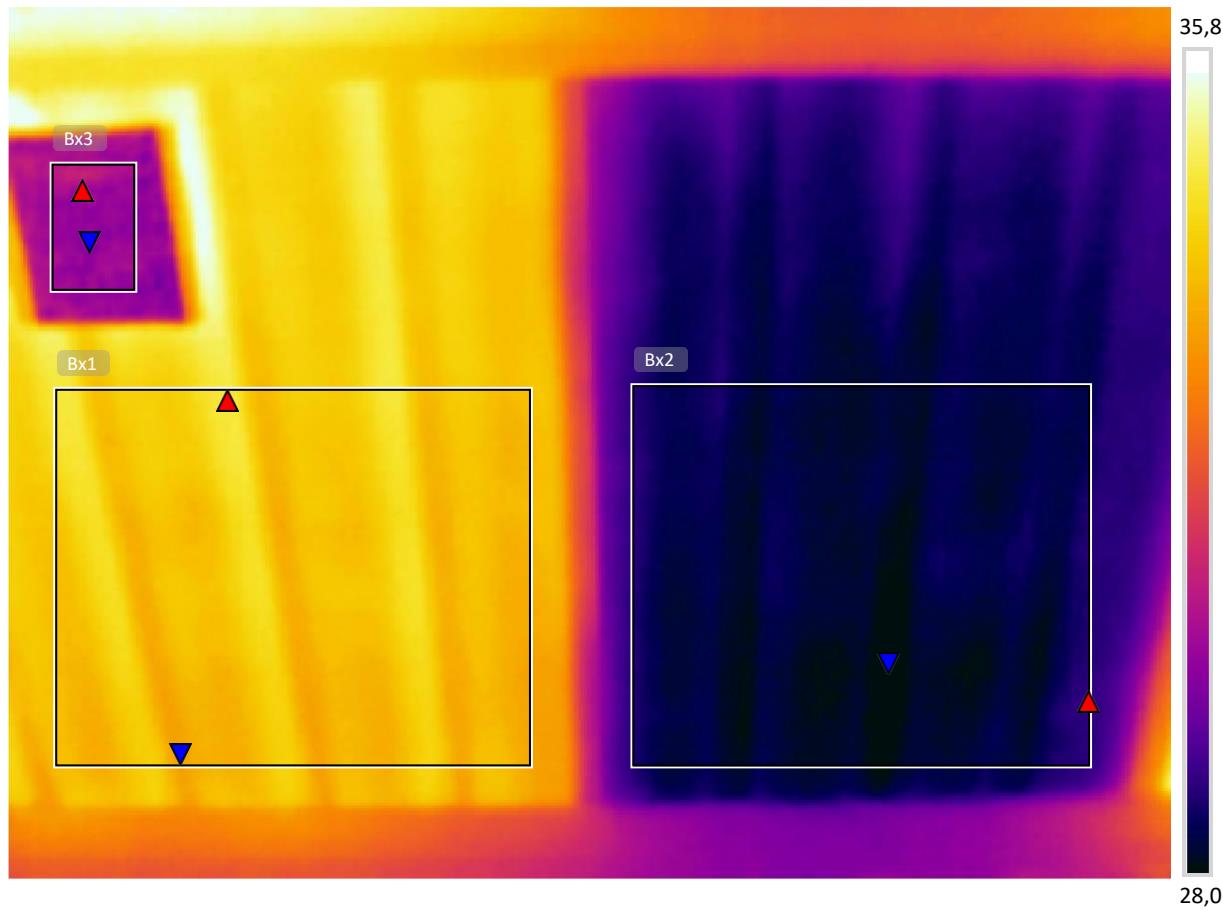
Report of Practice Number 7035-

D . Thermogram sheet



Measures		°C
Bx1	Max	34,1
	Min	30,8
	Average	32,6
Bx2	Max	27,4
	Min	25,8
	Average	26,8
Bx3	Max	29,5
	Min	28,7
	Average	29,0

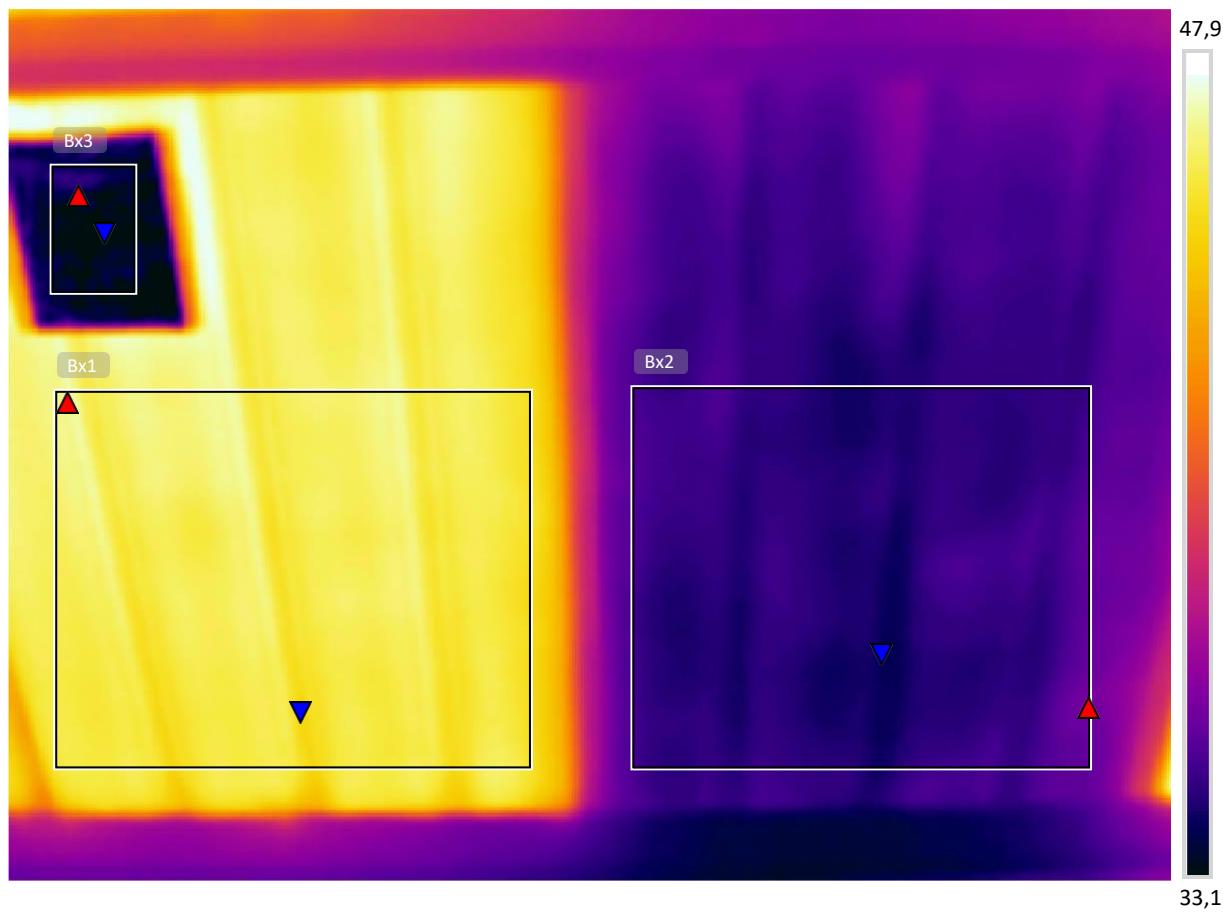
Parameters	
Emissivity	0.93
Temp. refl.	29.9 °C
Distance	4 m
Temp. atmospheric	29.2 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	51.6 %



Measures		°C
Bx1	Max	34,9
	Min	33,3
	Average	34,0
Bx2	Max	28,9
	Min	27,8
	Average	28,3
Bx3	Max	31,1
	Min	29,8
	Average	30,3

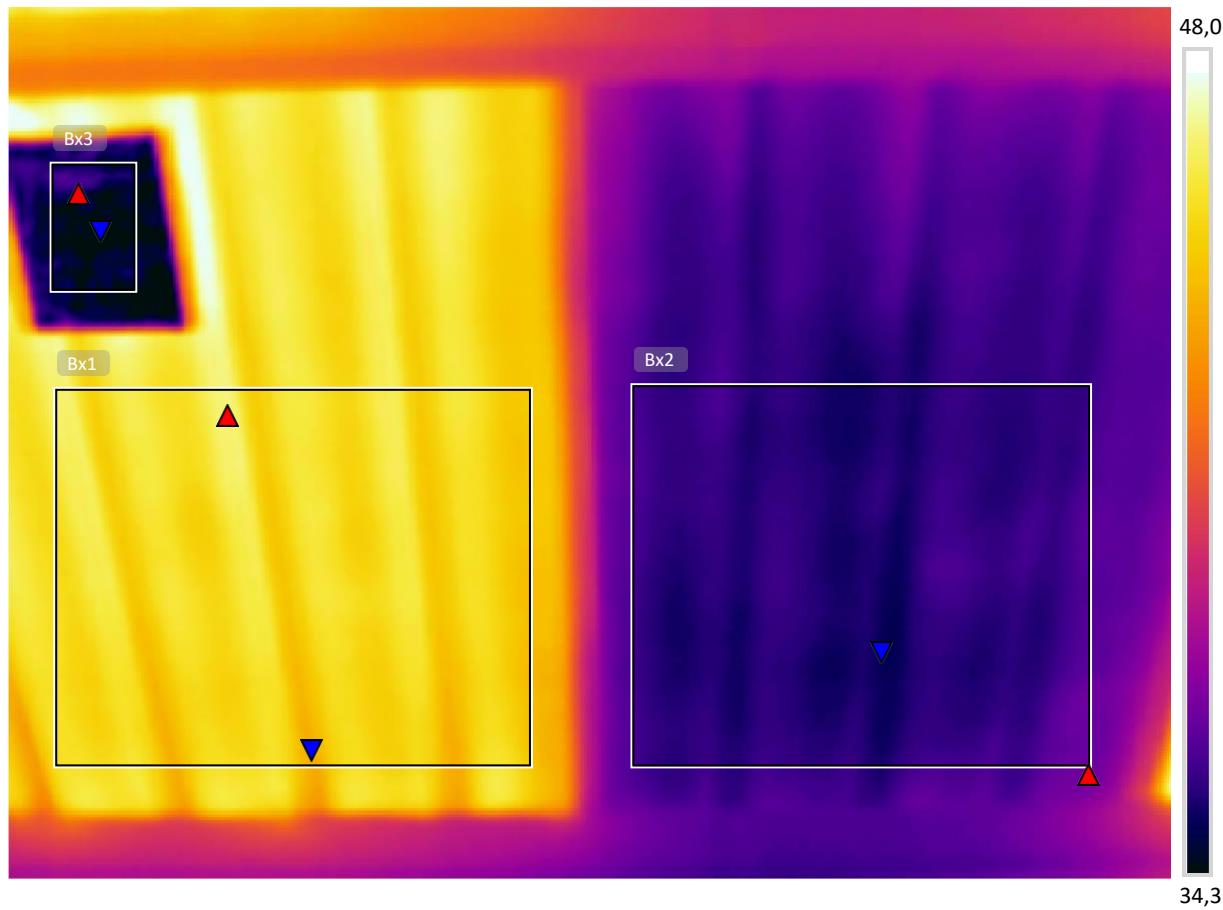
Parameters

Emissivity	0.93
Temp. refl.	32.1 °C
Distance	4 m
Temp. atmospheric	31.6 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	45.8 %



Measures		°C
Bx1	Max	47,3
	Min	45,1
	Average	46,3
Bx2	Max	36,4
	Min	33,9
	Average	34,8
Bx3	Max	34,9
	Min	32,5
	Average	33,5

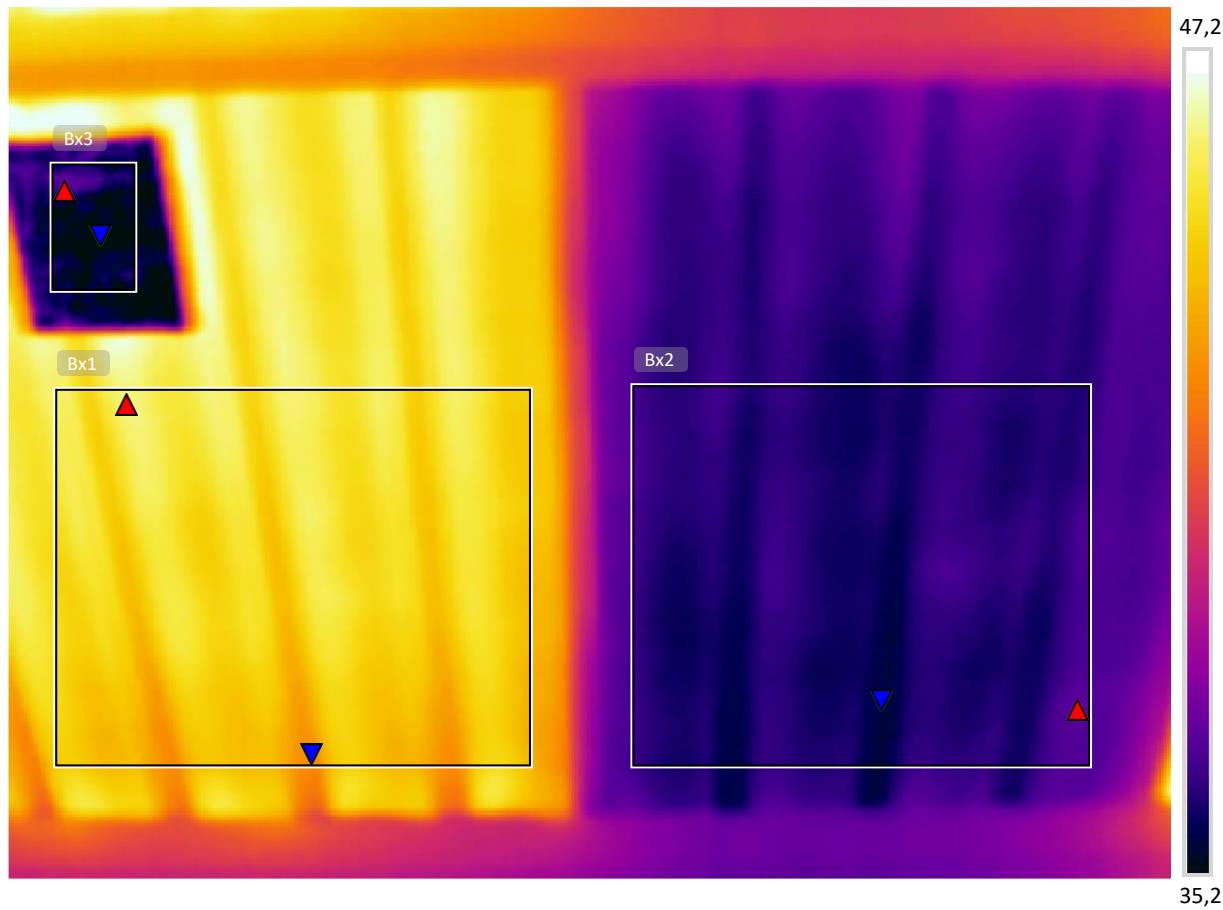
Parameters	
Emissivity	0.93
Temp. refl.	34.2 °C
Distance	4 m
Temp. atmospheric	33.7 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	41.4 %



Measures		°C
Bx1	Max	47,0
	Min	44,0
	Average	45,6
Bx2	Max	37,2
	Min	35,1
	Average	35,8
Bx3	Max	36,6
	Min	33,5
	Average	34,8

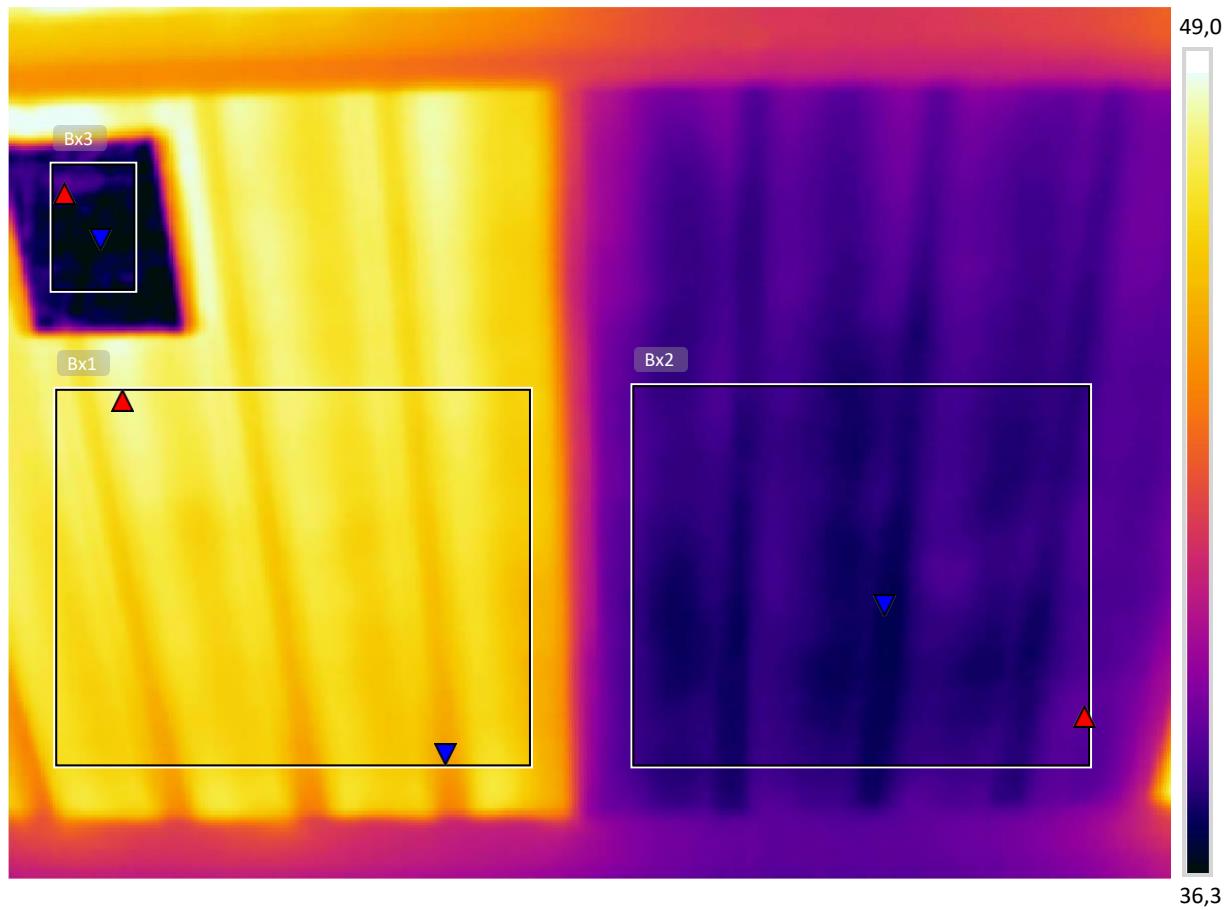
Parameters

Emissivity	0.93
Temp. refl.	35.4 °C
Distance	4 m
Temp. atmospheric	35.2 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	38 %



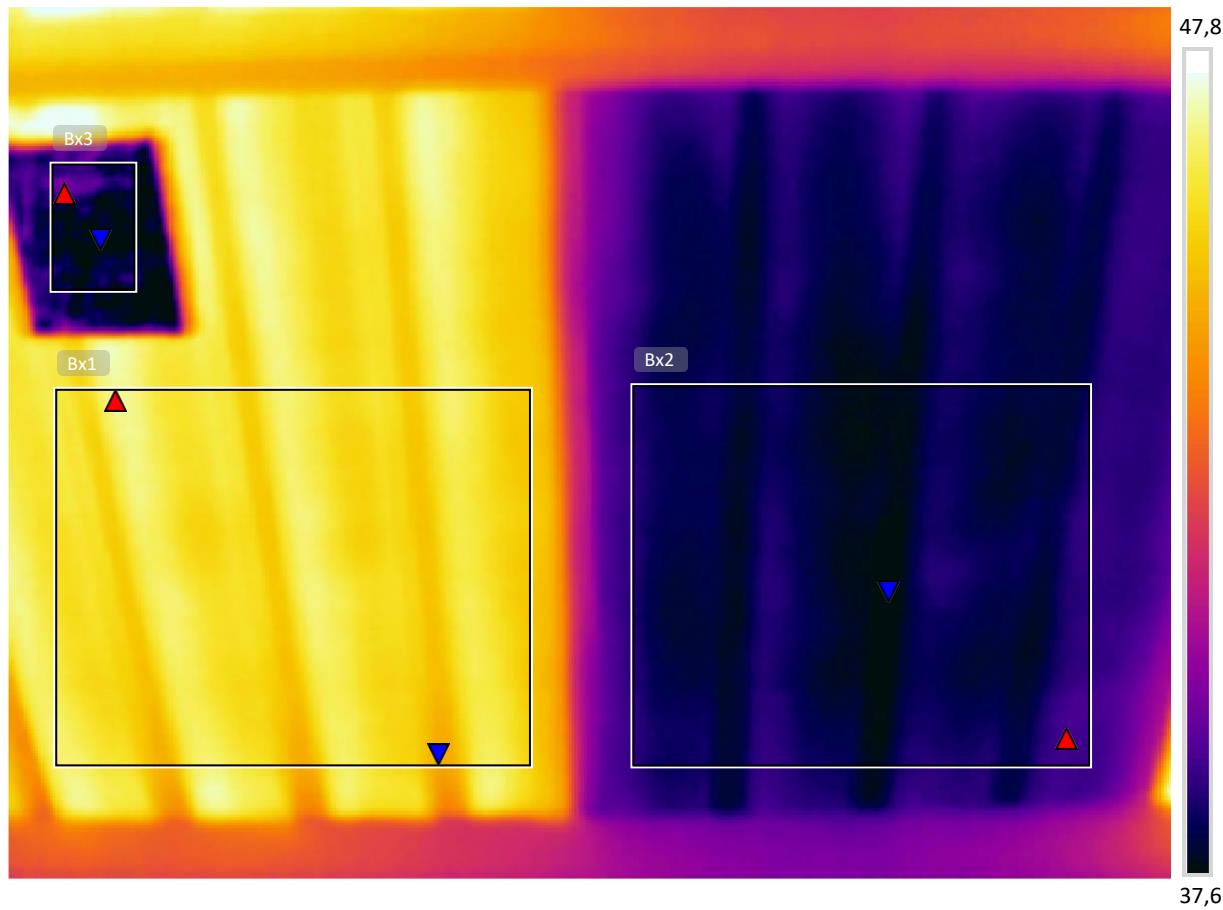
Measures		°C
Bx1	Max	46,3
	Min	42,7
	Average	45,0
Bx2	Max	37,3
	Min	35,6
	Average	36,3
Bx3	Max	37,5
	Min	34,4
	Average	35,6

Parameters	
Emissivity	0.93
Temp. refl.	36.6 °C
Distance	4 m
Temp. atmospheric	36.5 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	36.3 %



Measures		°C
Bx1	Max	48,3
	Min	44,8
	Average	46,8
Bx2	Max	38,6
	Min	36,9
	Average	37,6
Bx3	Max	38,6
	Min	35,5
	Average	36,8

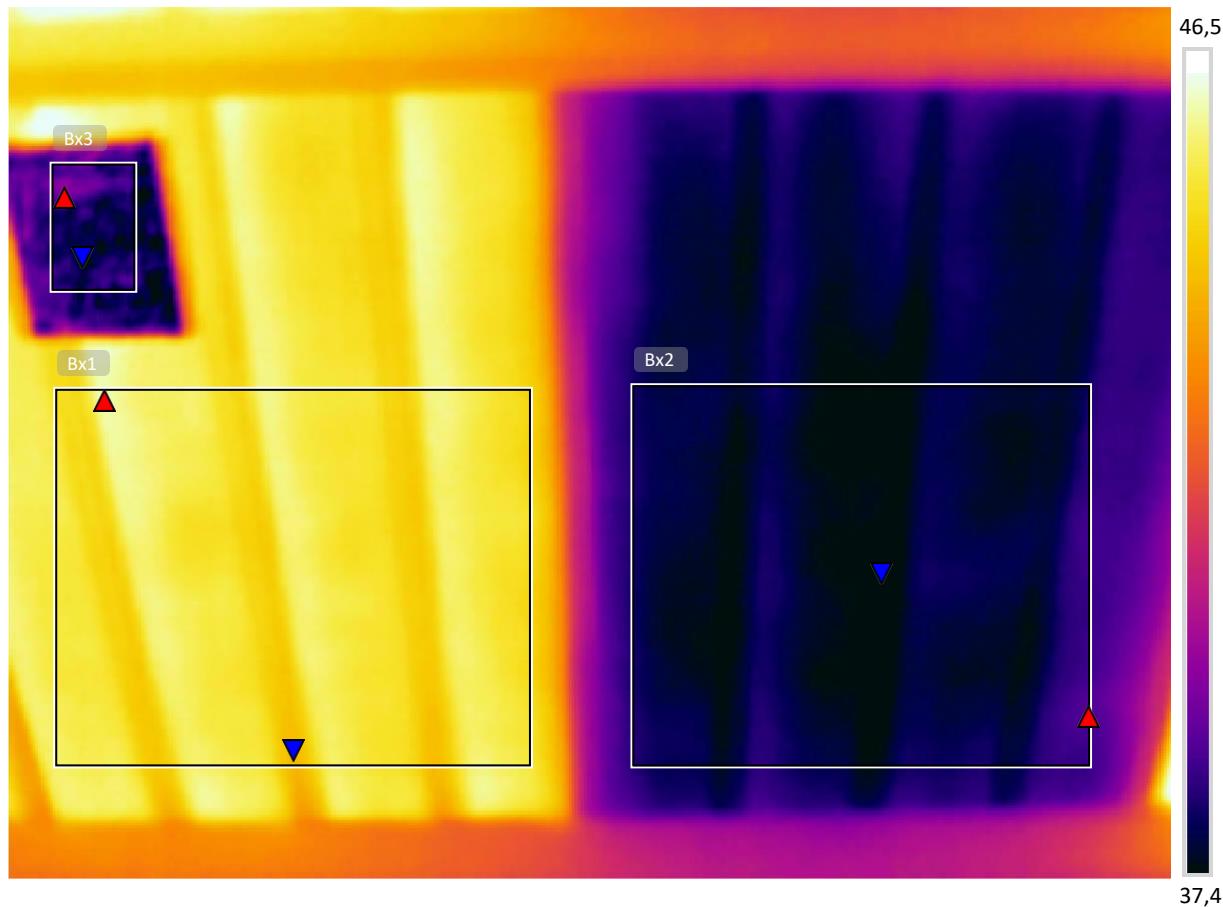
Parameters	
Emissivity	0.93
Temp. refl.	37.8 °C
Distance	4 m
Temp. atmospheric	37.8 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	34 %



Measures		°C
Bx1	Max	47,3
	Min	44,7
	Average	46,2
Bx2	Max	39,1
	Min	37,4
	Average	38,1
Bx3	Max	39,9
	Min	36,8
	Average	38,1

Parameters

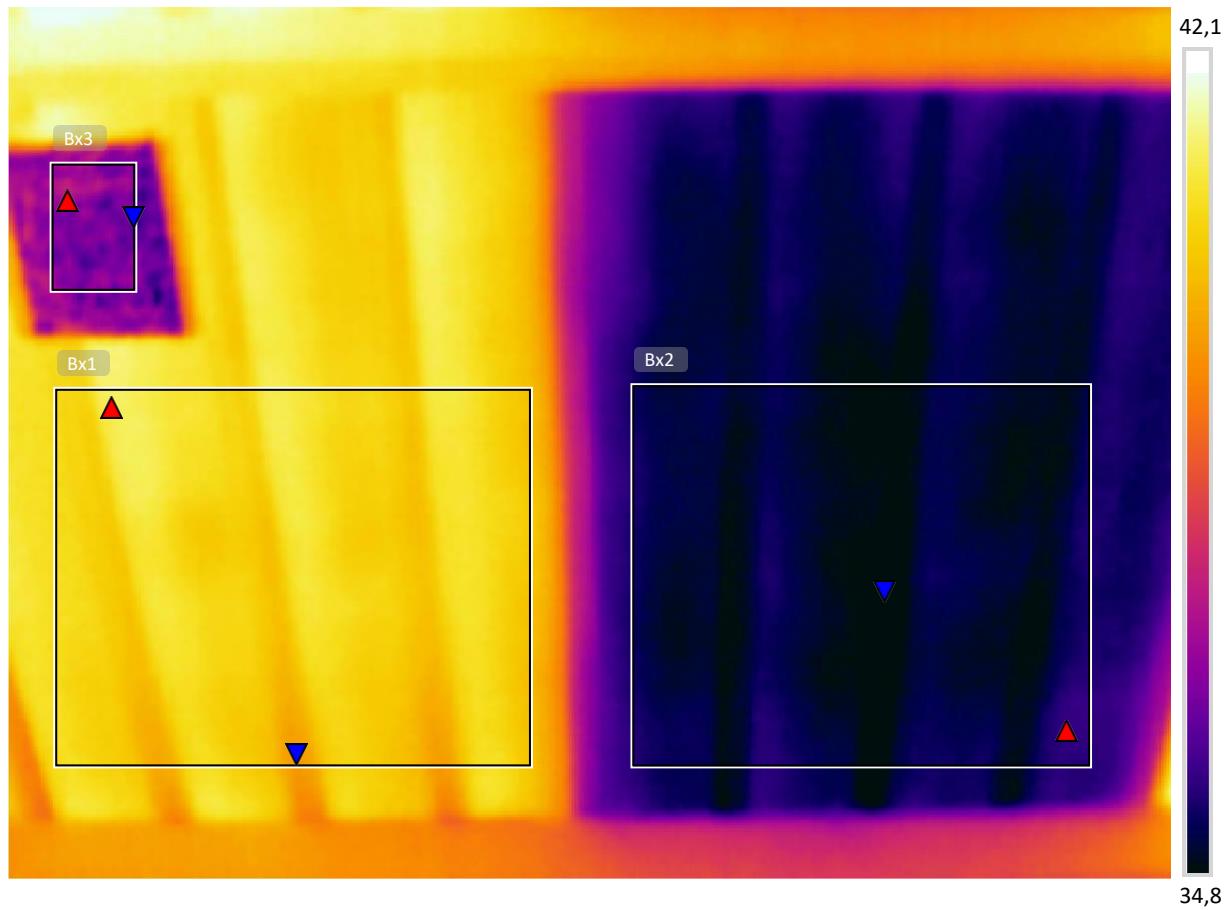
Emissivity	0.93
Temp. refl.	38.7 °C
Distance	4 m
Temp. atmospheric	39.9 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	30.8 %



Measures		°C
Bx1	Max	46,1
	Min	44,1
	Average	45,2
Bx2	Max	38,9
	Min	37,1
	Average	37,8
Bx3	Max	39,9
	Min	37,1
	Average	38,3

Parameters

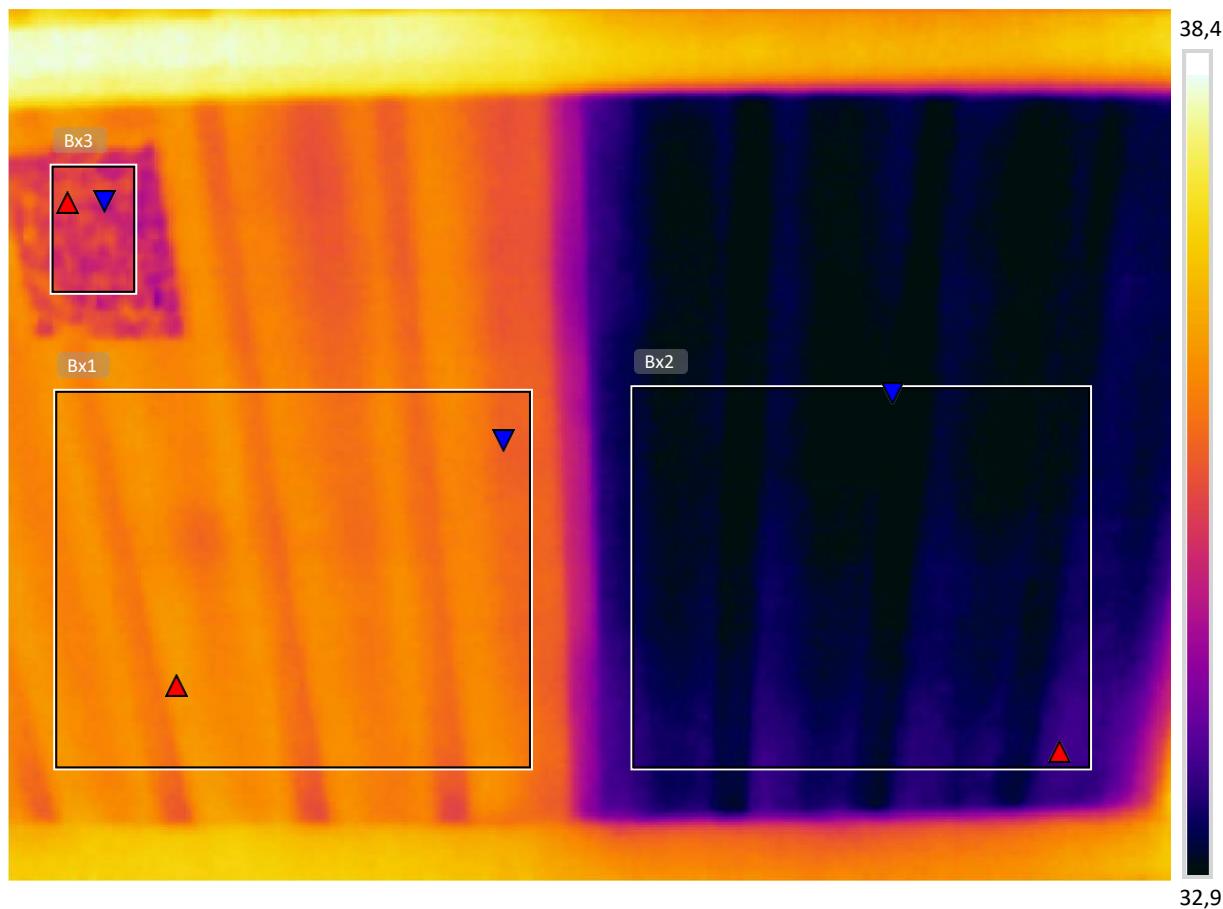
Emissivity	0.93
Temp. refl.	37.7 °C
Distance	4 m
Temp. atmospheric	38.7 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	31.8 %



Measures		°C
Bx1	Max	41,4
	Min	39,6
	Average	40,7
Bx2	Max	35,7
	Min	34,5
	Average	35,0
Bx3	Max	37,5
	Min	35,8
	Average	36,6

Parameters

Emissivity	0.93
Temp. refl.	36.3 °C
Distance	4 m
Temp. atmospheric	36.9 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	34.4 %



Measures		°C
Bx1	Max	36,6
	Min	35,8
	Average	36,3
Bx2	Max	33,7
	Min	32,7
	Average	33,1
Bx3	Max	35,8
	Min	34,6
	Average	35,3

Parameters

Emissivity	0.93
Temp. refl.	35.4 °C
Distance	4 m
Temp. atmospheric	35.6 °C
Temp. optics ext.	20 °C
Trans. optics ext.	1
Relative humidity	37.2 %



And. Technical product specifications



Finishes Technical Sustainable Sl.

Zeramic Extrem W

Insulating Thermal in base ceramics Liquid

TECHNICAL DATA

THERMO-ELASTIC COATING FOR VERTICAL AND HORIZONTAL SUPPORTS

DESCRIPTION

Zeramic Extrem W, is an elastic thermal insulator, of low thickness, whose application gives the support insulating properties, Climatic effect. **Zeramic Extrem W** is made from hollow liquid ceramic microspheres , titanium dioxide and acrylic, elastic and photo-reticulable emulsions.

Elastic, anti-cracking, breathable and multi-stick product, for vertical and horizontal walls, for exterior or interior use.

Once applied, we will have a continuous surface, without joints, waterproof, breathable and prepared to thermally insulate the surfaces, either from cold or heat.

Its application can be brush , roller or airless.

The **Zeramic Extrem W** product line is based on the technology developed by NASA, to cover space shuttles, back in the 80s, to ensure that they could withstand extreme temperatures when going out into space.

PROPERTIES

-**ECOLOGICAL:** Low VOC content.

-**REACCION TO FIRE:** M-1, does not spread fire

-**THERMAL INSULATION:** Thermally isolated, both from the cold in winter, and from the heat in summer. It also reflects the sun's rays by 95%, avoiding the oven effect.

-**ANTICONDENSACION:** Eliminates the thermal bridge.

-**WATERPROOFING:** 100% waterproof, highly breathable and elastic product (190%)

-**MULTIADHERENT:** Its application can be, on any type of constructive support, including metal, galvanized sheet, aluminum ...

-**ACOUSTIC:** Corrects the echo and reverberation.

-**SAVE €:** Considerably reduces heating and cooling costs, by not having thermal losses. Both for indoor and outdoor applications .

Revestimientos Técnicos Sostenibles S.L.

Polygon Ind. El torno C/Alfareros nº9 41710 Utrera (Sevilla)Tf. 955 27 01 07 - 639 68 68 87
www.rts-spain.com / info@rts-spain.com



Finishes Technical Sustainable Sl.

Zeramic Extrem W

Insulating Thermal in base ceramics Liquid

PROPERTIES

-ANTIBACTERIAL: Product in aqueous dispersion of silver ion particles coated with titanium dioxide. It eliminates 99% of bacteria, within 24 hours of being applied. (Effective for a duration of 5 years)

-PHOTOCATALYTIC : Accelerates photocatalysis and produces negative ions, beneficial for health.

TECHNICAL FEATURES

Finish: Smooth matte.

Color : Zeramic Extrem colors chart or NOVA, NCS or RAL cards on request.

Specific weight: 0.77 kg./l.

Solid volume: 72 ±2%

Solvent: Water

Drying at 23°C: To the touch 4 hours, total drying 72 hours.

Mix Life : No

Dilution: 5-10% diluted with water **Yield:** 0.350

grs. X m² (according to absorptions) **Thermal**

conductivity : K=0.05 W/m°K **Insulating capacity:**

R=0.0038 m² K/W **Processing:** U=263.16 W/m²K

CONTAINERS

ZERAMIC Extrem W comes in packs of 15L., and 4L

Revestimientos Técnicos Sostenibles S.L.

Polygon Ind. El torno C/Alfareros nº9 41710 Utrera (Sevilla) Tf. 955 27 01 07 - 639 68 68 87
www.rts-spain.com / info@rts-spain.com



Finishes Technical Sustainable Sl.

Zeramic Extrem W

Insulating Thermal in base ceramics Liquid

APPLICATIONS

ZERAMIC Extrem W is a coating, with qualities out of the ordinary. It is composed of liquid ceramic microspheres, which once dry allows to have uniform, continuous surfaces without joints. Among other applications we can highlight:

* Rehabilitation of facades, to improve the envelope of the building. As well as an ultraviolet protection and a protection against climatological agents, sea breezes ...

* Rehabilitation of roofs, to improve temperature and waterproofing .

*Elastic, anti-crack .

*Self-cleaning

* It heats the interiors of the houses, to reduce between 30-35% the energy costs for cooling or heating.

*Avoids the effect of cold feet and hot head, by achieving a more homogeneous distribution of heat

*Recommended, for allergic or asthmatic people, as they do not release any chemical substance or migrations.

*Decorative product, any color can be manufactured

*Low cost and easy maintenance

*High durability, warranty of up to 10 years (always by technical or optional prescription)

HOW TO USE

SURFACE PREPARATION

*In supports of a new nature or supports painted in good condition, the walls must be cleaned or dripped to eliminate any residue of dust, pollution or other anomaly. Alone

if the walls are made of concrete, they must be fixed with a fine particle acrylic fixative called **Fixative-100**.

If there are pathologies such as fissures or chipping, these will be covered with a fibered putty for exteriors if possible multi-adherent called **Reve-Elast Fiber**.

Once the support is sanitized, **zeramic Extrem W** will be applied, until the necessary thickness is achieved. Minimum 3 hands of product.

Revestimientos Técnicos Sostenibles S.L.

Polygon Ind. El torno C/Alfareros nº9 41710 Utrera (Sevilla) Tf. 955 27 01 07 - 639 68 68 87
www.rts-spain.com / info@rts-spain.com



Finishes Technical Sustainable S.L.

Zeramic Extrem W

Insulating Thermal in base ceramics Liquid

HOW TO USE

*In defective or very deteriorated supports, the support must be dripped with pressurized water (150 bars), once the support is dry it will be repaired with structural mortars type **Reparatec R4** or **Reparatec R2** or with a multi-stick external multi-stick exterior putty type **Reve-Elast Fibra**.

Once the support has been sanitized, a solvent-based fixative called **Fixative-250** will be applied.

Then we will proceed to the application of **ZERAMIC Extrem W**, until the necessary thickness is achieved. Minimum 3 hands of product.

In both cases the drying times will be respected

GUARANTEES

ZERAMIC Extrem W is guaranteed for a maximum period of 10 years depending on support and geographical location.

The guarantee of **ZERAMIC Extrem W** is always of the product, so the application will have to be guaranteed by the applicator company.

In order to request a product warranty, it will be necessary to make a prescription.

PRECAUTIONS

ZERAMIC EXTREM W should not be stored for a period of more than 1 year, provided that it has been treated correctly, avoiding direct exposures of the sun, frost, humidity ...

Empty containers must be deposited in the clean points or prepared for it. Must respect European environmental regulations.

Revestimientos Técnicos Sostenibles S.L.

Polygon Ind. El torno C/Alfareros nº9 41710 Utrera (Sevilla) Tf. 955 27 01 07 - 639 68 68 87
www.rts-spain.com / info@rts-spain.com

F. Bibliography

- Infrared thermography: fundamentals, research and applications / Michael Vollmer, Klaus-Peter Möllmann 2013, ASHRAE Handbook - Fundamentals
- Heat transfer, J.P. Holman. Mc Graw Hill. 10th edition