APPENDIX 2

THERMAL CALCULATION
Based on the building thermal imaging results, dated 24 January 2014.

Introduction

1. Any inquiries, related to this thermal calculation, shall be forwarded to OOO Teplozashchita, telephone (844) 331-39-50, www.teploza.ru, teploza@mail.ru.

2. **Region** *Sergiyev Posad, prospect Krasnoi Armii, 234, building 3, Moscow Oblast.*

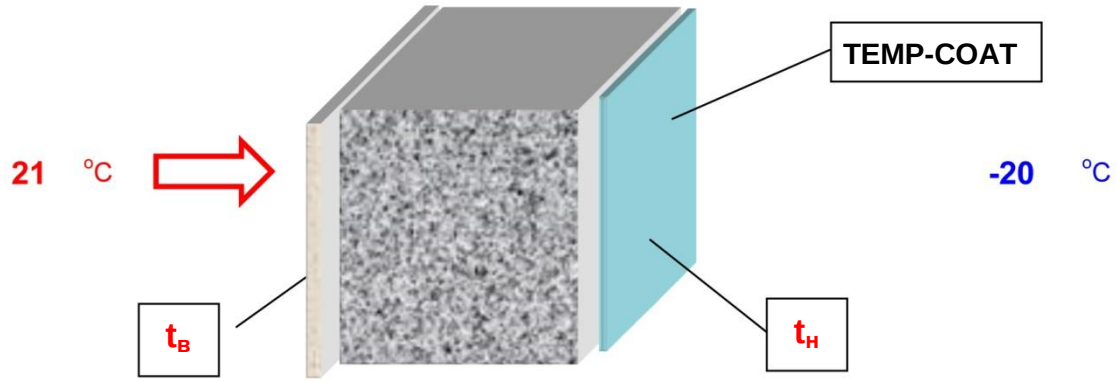
3. **Object**

Residential apartment block thermal insulation.
Phase 2 – building thermal imagining after thermal insulation application.

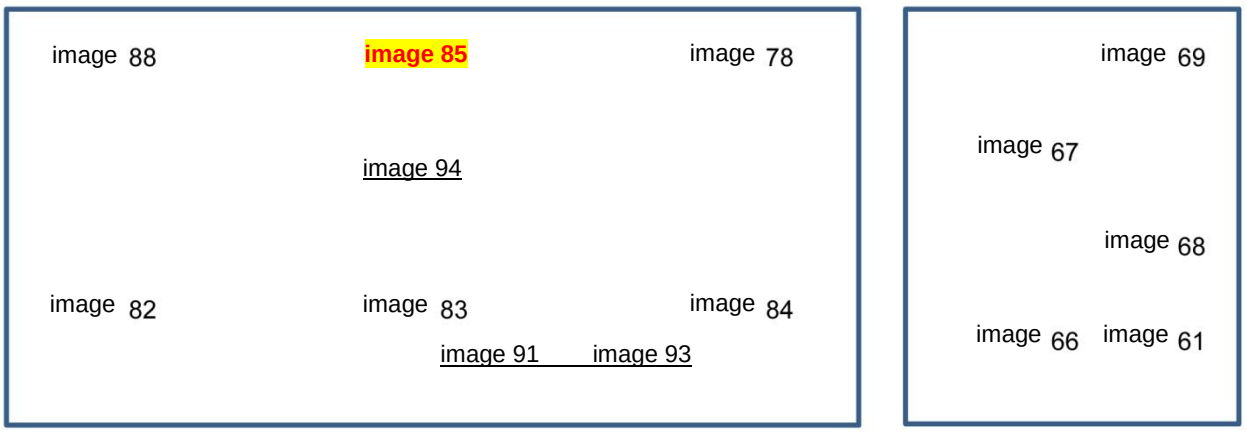
4. **Input data**

$t_в$	Rated indoor air temperature	21°C
$t_{оп}$	Average temperature of the heating period (SNiP 23-01-99, table 1)	minus 3.1 °C
$t_н$	Average temperature of the coldest five-day period (SNiP 23-01-99, table 1)	minus 27 °C
$t_н$	Ambient air temperature at time of thermal imaging	**minus 20 °C**

Enclosing structure design.



Thermal imaging survey layout.



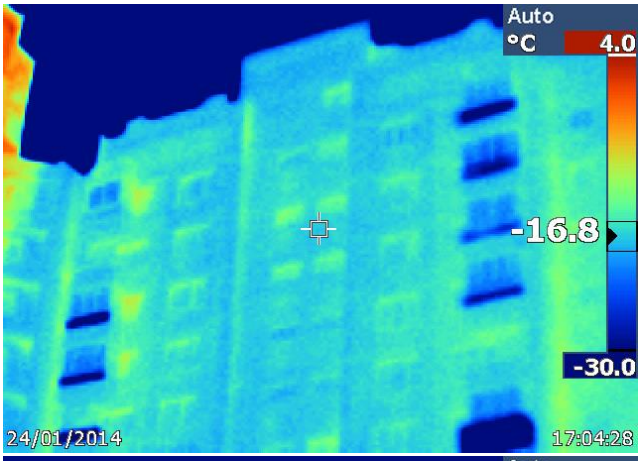


Image 88

Surface temperature in the measurement point: **minus 16.8** °C.

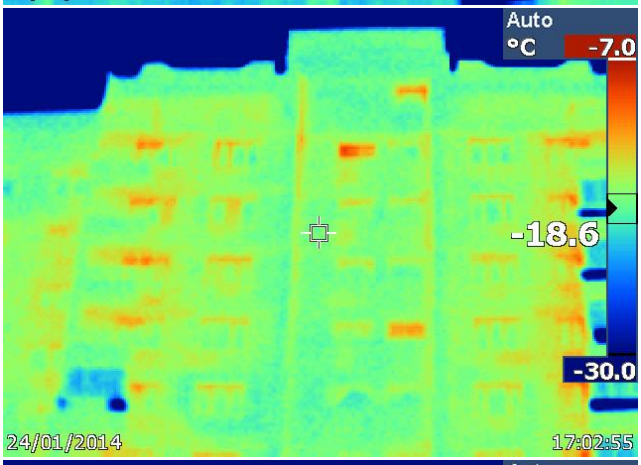


Image 85

Surface temperature in the measurement point: **minus 18.6 °C**.

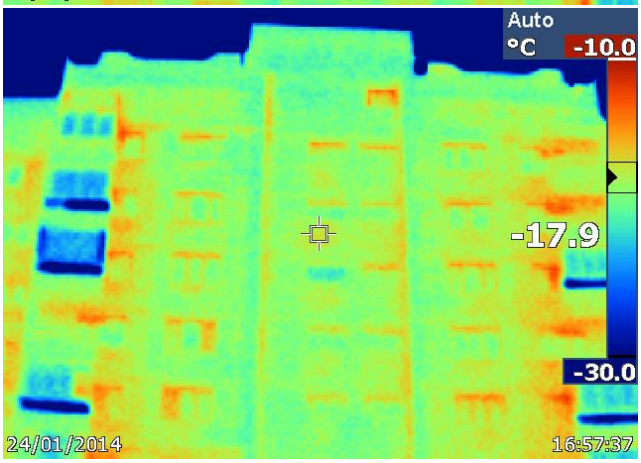


Image 78

Surface temperature in the measurement point: **minus 17.9** °C.

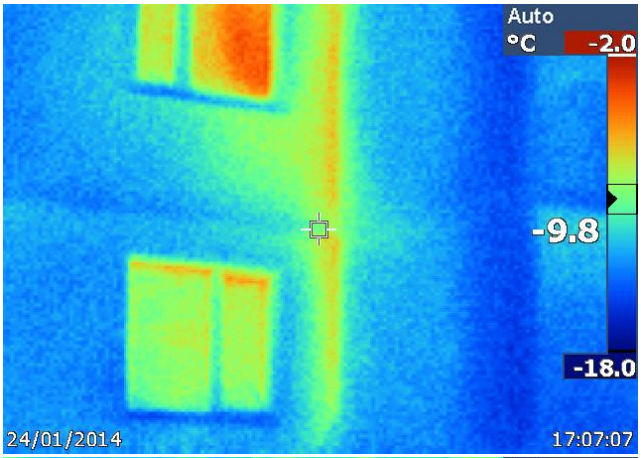


Image 94

Surface temperature in the measurement point: **minus 9.8** °C

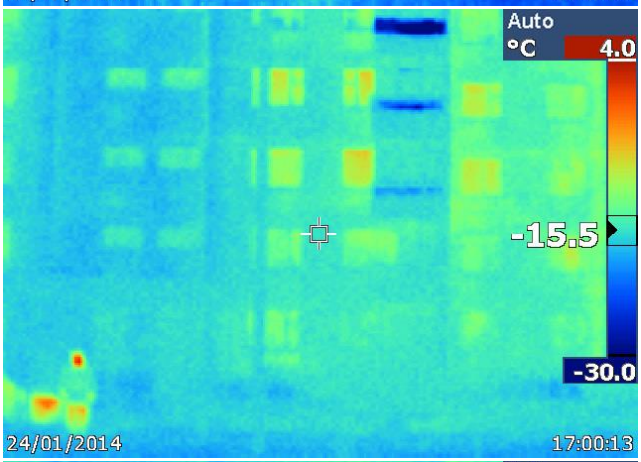


Image 82

Surface temperature in the measurement point: **minus 15.5** °C.

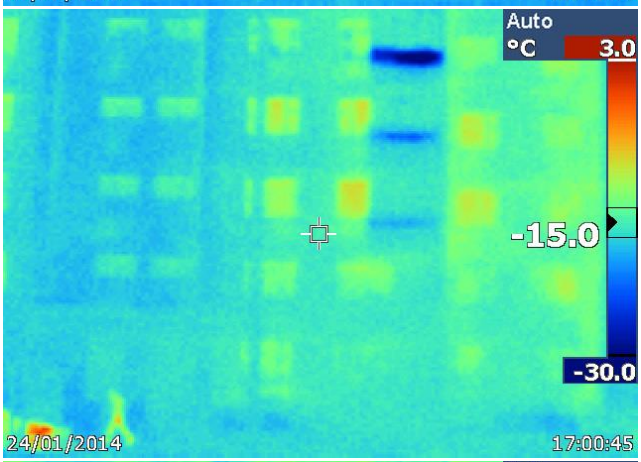


Image 83

Surface temperature in the measurement point: **minus 15** °C.

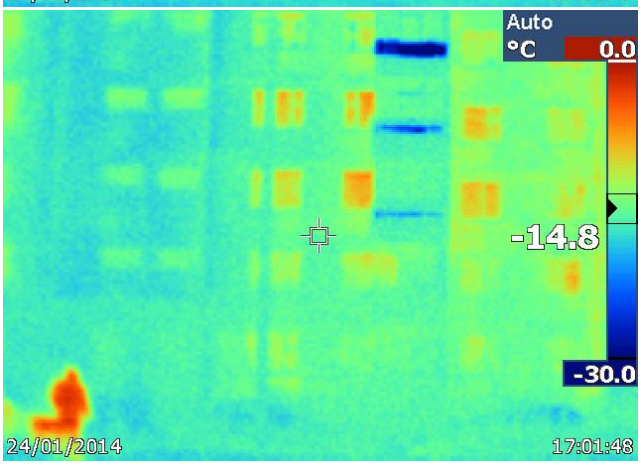


Image 84

Surface temperature in the measurement point: **minus 14.8** °C.

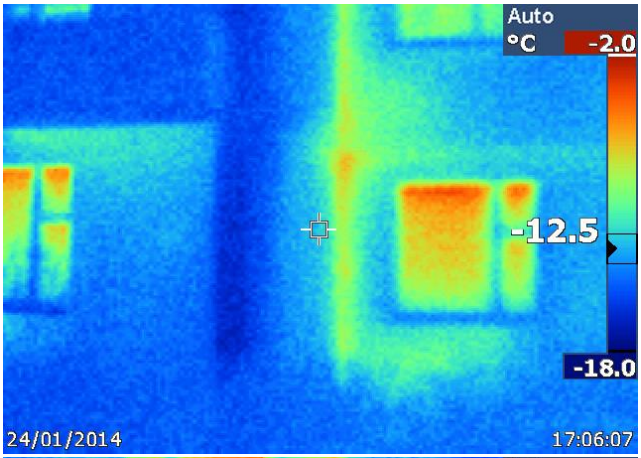


Image 91

Surface temperature in the measurement point: **minus 12.5** °C.

Image 93

Surface temperature in the measurement point: **minus 8.5** °C.

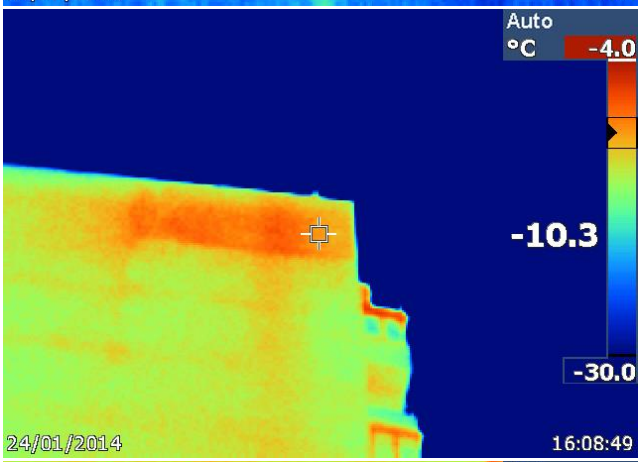


Image 69

Surface temperature in the measurement point: **minus 10.3** °C.

Image 67

Surface temperature in the measurement point: **minus 13** °C.

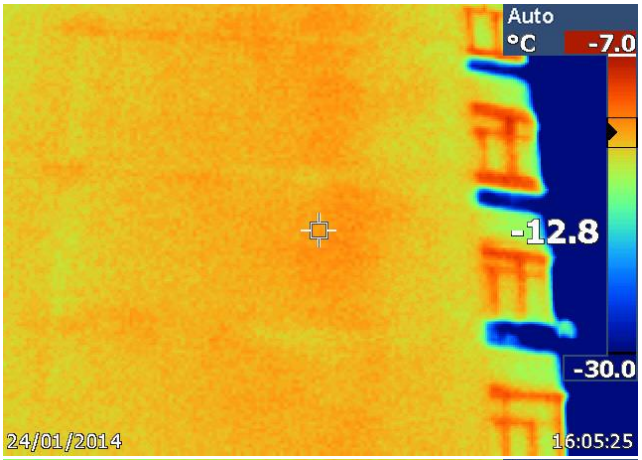


Image 68

Surface temperature in the measurement point: **minus 12.8** °C.

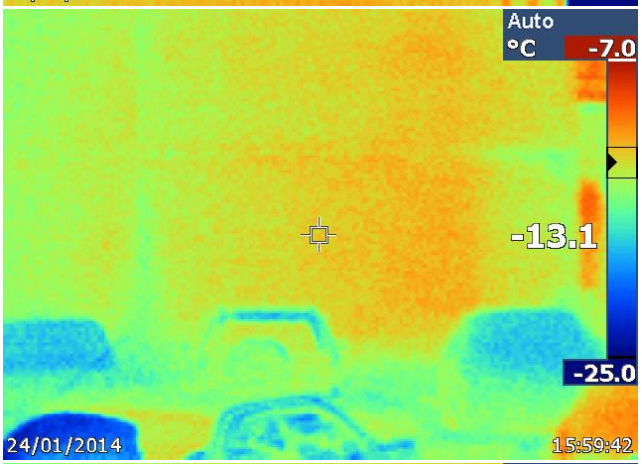


Image 66

Surface temperature in the measurement point: **minus 14.8** °C.

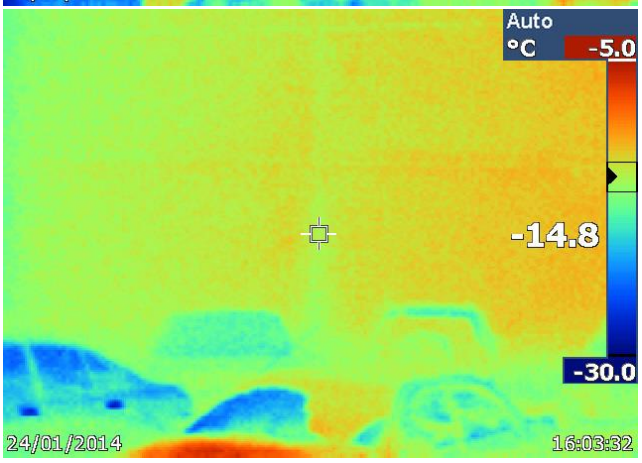


Image 61

Surface temperature in the measurement point: **minus 13.1** °C.

Enclosing structure heat transfer resistance value determination

Region	***The city Sergiyev Posad***		
Structure	***Plastering with cement – sand grout***	δ_1	***0.02*** m
		λ_1	***0.93*** W/m °C
	Haydite concrete slab ´Y=800 kg/m^3	δ_2	***0.32*** m
		λ_2	***0.24*** W/m °C
	Thermal insulation coating TEMP-COAT	δ_4	***0.001*** m
		λ_4	***0.001*** W/m °C
	NA	δ_4	***0.00*** m
		λ_4	***1.00*** W/m °C
	NA	δ_5	***0.00*** m
		λ_5	***1.00*** W/m °C
	NA	δ_6	***0.00*** m
		λ_6	***1.00*** W/m °C

1. **Rated heat transfer resistance of this wall**

$$R_o = 1/\alpha_B + \delta_1/\lambda_1 + \delta_2/\lambda_2 + \delta_3/\lambda_3 + \delta_4/\lambda_4 + \delta_5/\lambda_5 + \delta_6/\lambda_6 + 1/a_H$$

Where

R_o	Heat transfer resistance	**2.51** m^2 °C/W
α_B	Wall heat absorption coefficient SNiP II – 3- 79* table 4.	8.70 W/ m^2 °C
δ_1	Cement – sand grout plastering	0.02 m
λ_1	Heat conductivity coefficient	0.93 W/ m^2 °C
δ_2	Haydite concrete slab ***´Y=800 kg/m^3***	0.32 m
λ_2	Heat conductivity coefficient	0.24 W/ m^2 °C
δ_3	Thermal insulation coating TEMP-COAT	0.001 m
λ_3	Heat conductivity coefficient	0.001 W/ m^2 °C
δ_4	NA	0.00 m
λ_4	Heat conductivity coefficient	1.00 W/ m^2 °C
δ_5	NA	0.00 m
λ_5	Heat conductivity coefficient	1.00 W/ m^2 °C
δ_6	NA	0.00 m
λ_6	Heat conductivity coefficient	1.00 W/ m^2 °C
α_H	Wall heat transfer coefficient SNiP II-3-79* table 6*	23 W/ m^2 °C

2. Estimation of heating season degree – day (HSDD).
HSDD = $(t_B - t_{ОП})\, Z_{ОП}$

Where

HSDD	Heating season degree - day	**5157** °C day
t_B	Rated indoor air temperature	21 °C
$t_{ОП}$	Average heating season temperature SNiP 23-01-99 table 1	minus 3.1 °C
$Z_{ОП}$	Heating season period SNiP 23-01-99 table 1	214 days

According to SNiP II-3-79*, tables 1a and 1b. enclosing structure full heat transfer resistance shall be as follows:

Sanitary – hygienic specification:	R_o^{TP}=	1.38 m^2 ˚C /W
Energy efficiency specification, phase 1	R_o^{TP}=	1.83 m^2 ˚C /W
Energy efficiency specification, phase 2	R_o^{TP}=	3.20 m^2 ˚C /W

3. Rated heat loss

$$q = \frac{t_B - t_H}{R_o}$$

Where

		Winter	Theoretical	
q	Heat loss	**10**	**16**	W/m^2
t_B	Indoor air temperature	21	21	°C
t_H	Outdoor air temperature	minus 3.1	minus 20	°C
R_o	Heat transfer resistance, calculation 1, item 2	2.51	2.51	m^2 °C/W

4. Enclosing structure exterior surface temperature

$$T_B = t_B - n(t_H - t_B)/R_o\,\alpha_B$$

Where

		Winter	Theoretical value	Actual value (image 85) minus 18.6	
T_B	Surface temperature	minus 2	minus 18.1	minus 18.6	°C
t_H	Outdoor air temperature	minus 3.1	minus 20	minus 20	°C
n	Coefficient SNiP II – 3-79* table 3*	1	1	1	
t_B	Indoor air temperature	21	21	21	°C
R_o	Heat transfer resistance (calculation 1)	2.51	2.51	3.40	m^2 °C/W
a_B	Coefficient of heat transfer to the ambient air	8.7	8.7	8.7	W/m^2 °C

5. Enclosing structure inner surface temperature

$$\boldsymbol{T_B = t_B - n(t_B - t_H)/R_o\,\alpha_B}$$

Where

		Winter	**Theoretical value**	**Actual value 20.0**	
$\boldsymbol{T_B}$	Inner surface temperature	**21**	**20**	20	°C
$\boldsymbol{t_B}$	Indoor air temperature (as measured in apartment 280)	21.9	21.9	21.9	°C
n	Coefficient SNiP II – 3-79* table 3*	1	1	1	
$\boldsymbol{t_H}$	Outdoor air temperature	minus 3.1	minus 20	minus 20	°C

R_o	Heat transfer resistance (calculation 1)	2.51	2.51	2.51	m^2 °C/W
a_B	Coefficient of enclosing structure heat absorption (SNiP II – 3-79* table 4*)	8.70	8.70	8.70	W/m^2 °C

SUMMARY

Wall exterior surface averaged temperature was applied as input for the surveyed residential apartment block enclosing structure heat transfer resistance calculation.

The measurements were made using thermal imaging survey.

Ambient air temperature was minus **20 ^{O}C** at time of the thermal imaging survey.

Wall exterior surface average temperature was minus **17 °C.**

1. Surveyed building enclosing structure design heat transfer resistance: **2,51 m^2 °C /W.**
2. Surveyed building enclosing structure actual heat transfer resistance: **2.51 m^2 °C /W**
3. Surveyed building enclosing structure heat transfer resistance as required by the sanitary norms: **1.38 m^2 °C /W**
4. Surveyed building enclosing structure heat transfer resistance as required by energy efficiency norms: **1,83 m^2 °C /W.**

The surveyed building complies with the sanitary and energy efficiency norms, applied to the first phase of buildings refurbishment.

List of references .

SNiP 23 - 01 – 99. Construction Climatology.

SNiP 23 - 02 – 2003. Thermal Protection of Buildings.

SNiP II - 3 - 79*. Construction Heat Engineering.

Reference Book. Thermal Insulation. STROIIZDAT - 1976.

TU -5768-001-62595647-2009. Super-thing thermal insulation coating TEMP-COAT®.