EVALUATION OF THE ENERGY PERFORMANCE OF PUBLIC UTILITY

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INTRODUCTION

Romania is located in an area characterized by a severe continental moderate climate, the temperature of the air during the winter frequently dropping below - 20°C; precipitations are frequent and the wind blows with high intensities.

The good operation of the heating plant aims goal the realization of the conditions of thermic comfort in the buildings where human activities are developed (dwelling buildings, commercial buildings, sport halls, treatment facilities etc).

The calculation of the sources of energy (which operate continuously or intermittently using liquid, solid or gas fuel and having average or high output) depends on several parameters, such as:

- site of the building;
- conditions of comfort imposed by functions;
- performances of the envelope of the building and its working conditions;
- performances of the thermal agent and source of energy distribution network;
- quality of the fuel.

1. HYGROTHERMIC COMFORT CRITERIA AND LEVELS OF PERFORMANCE

The main criteria and the appropriate levels of the hydrothermal comfort of the buildings are:

- the temperature of the air inside, T_i =18…22°C;
- the average temperature of the air inside, T_{ai} or, the average radiant temperature T_{rs} = 18...20 °C (taking into account the standard instruments of the various countries);
- the humidity of the interior air φ_i = 50…60%;
- the difference of temperature between the interior air and the interior surface of the fastening elements ΔT_{si} = 4…6°C;
- the air velocity $v \le 0.1$ m/s.

2. HYGROTHERMIC COMFORT IN THE BUILDINGS OF PUBLIC UTILITY

The comfort depends on the type of the building and the category of occupation (table 1).

TABLE 1

	Buildings which function continuously	Buildings which function intermittently
1	Hospitals, nurseries, polyclinics	Polyclinics, nurseries and medical centres
2	Education and sport buildings	Education and sport buildings
3	Hotels, commercial and office buildings	Hotels, commercial and office buildings
4	Other buildings (industrial buildings)	Other buildings (industrial buildings)

Standards and the Romanian Codes do not specify the criteria and the levels of performance for the two categories of buildings, or the diurnal duration of occupation and the working duration of the heating plant. It is to be desired that the designing or building plant engineer who will evaluate these elements. The Romanian Standards should foresee these parameters.

3. CONDITIONS OF LOCATION

Romanian Standard normalizes only the climatic zone and, unfortunately, this parameter is erroneously presented. The C107/2

Standard report to three climatic zones but, in the zonal chart there are four of them, corresponding to the following outside temperatures:

- zone I:……...T_e = -12°C;
- zone II:……. T_e = -15°C;
- zone III:…… T_e = -18°C;
- zone IV: …...T_e = -21°C.

A building located in the fourth climatic zone has an almost double consumption of energy compared to that of a building located in the first climatic zone.

One does not take into account the location conditions which facilitate the losses of heat because of the additional phenomenon of convection, in the case of constructions without protection or located in zones exposed to very strong drafts. Moreover, most of the C107/2 Standard treats solar gains, though in Romania, during the cold season, the sunny period is negligible. The calculation of the solar gains which positively influence the energy level of performance of the envelope of the building, is carried out in the same way as does the French Standard in the following cases:

- for the buildings where the glazed surface exceeds 50% of the surface of the external walls;
- for sport, schools and others purpose buildings;
- for the buildings with low, medium, high or any thermic inertia;
- one does not take into account the location of the building, the solar exposure or the degree of sky overcoat.

4. EVALUATION OF THE ENERGY PRFORMANCE OF PUBLIC UTILITY

To evaluate the energy performance of buildings, as criterion of performance one uses the effective global coefficient of thermic insulation G_1 and the corresponding level of performance is the global coefficient of reference $G_{1\,ref}$:

$$G_1 = \frac{1}{V}\left[\frac{\sum_i (A_i\theta_i)}{R_{my}}\right], \qquad (1)$$

$$G_{1ref} = \frac{1}{V}\left[\frac{A_1}{a} + \frac{A_2}{b} + \frac{A_3}{c} + d\cdot P + \frac{A4}{e}\right] \qquad (2)$$

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where: V is the overheated volume of the building or part of the building concerned, calculated taking into account the outside dimensions of the building;

A_i - the surface of the fastening elements (subjected to the thermic transfers) calculated taking into account the interior dimensions of the overheated volume;

$\theta_i = \tau_i$ - the factor of correction;

$$\theta_i = \tau_i = \frac{T_i - T_u}{T_i - T_e}$$

T_i - the temperature of the air of overheated volume, °C;

T_u - the temperature of adjacent volume, °C;

T_e - the temperature of the surrounding air during the cold season, °C;

R_{my} – the corrected average thermic resistance of the fastening element of overall construction, taking into account the influence of the thermal bridges, m^2K/W;

A_1 - the surface of the external walls, calculated between the tracing axes, m^2 ;

A_2 - the surface of the higher floor, calculated between the tracing axes, m^2;

A3 - the surface of the lower floor, m^2;

A4 - the surface of the exterior joinery, calculated on nominal dimensions of the gap in the wall, m^2;

P - the external perimeter of the overheated room in contact with the ground or buried (m);

a, b, c, d, e - coefficients of control which depend on the type of the building, the climatic zone and the category of the building.

The coefficients of control represent some thermic resistances (m^2K/W or mK/W), where:

a) corresponds to the capacity of average thermic insulation of the external walls;

b) corresponds to the capacity of average thermic insulation of the roof;

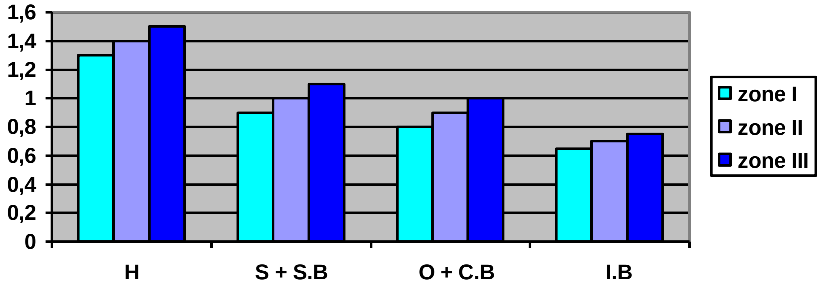
c) corresponds to the capacity of average thermic insulation of the lower floor;

d) corresponds to the capacity of average thermic insulation of the thermic bridge on outside contour of the building to the contact with soil;

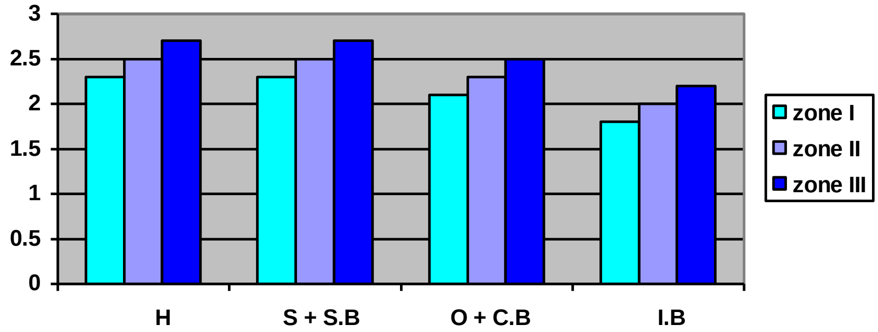
e) corresponds to the capacity of average thermic insulation of joinery.

The values of these two coefficients are very different for these two categories of constructions (fig. 1 and fig. 2). It is noted that the average values of the thermic insulation degree (fig. 3) are lower in the case of the discontinuous occupation buildings. The interruption of the heating and the absence of thermic inertia lead to a significant consumption of energy

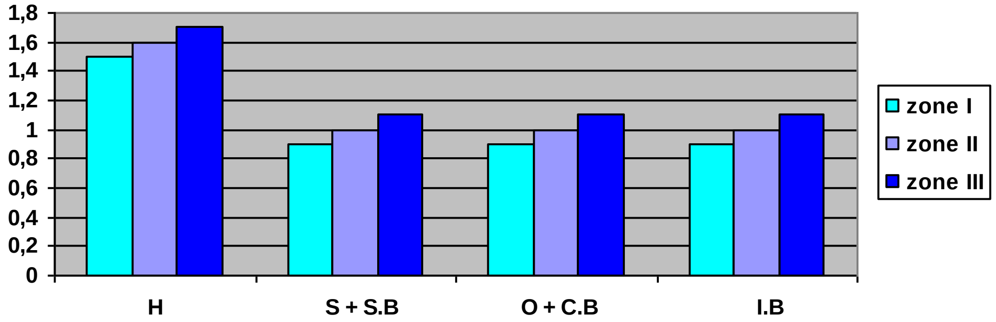
a [m^{2}K/W]



b [m^{2}K/W]



c [m^{2}K/W]



e [m^{2}K/W]

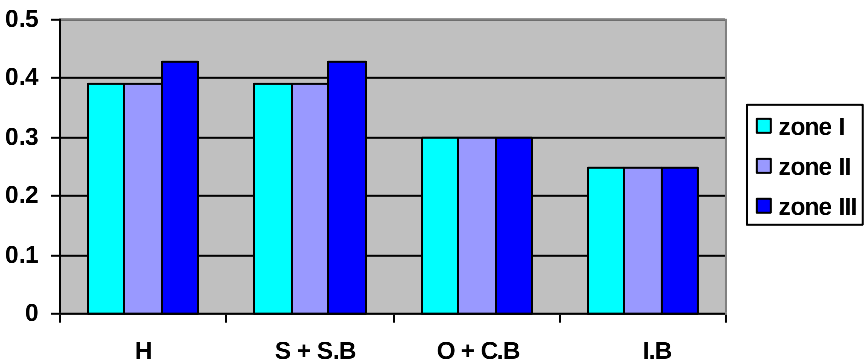
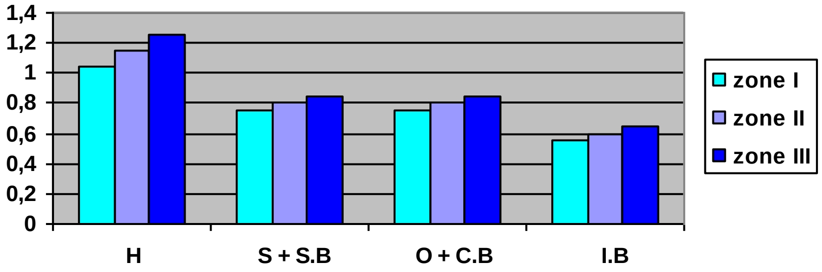
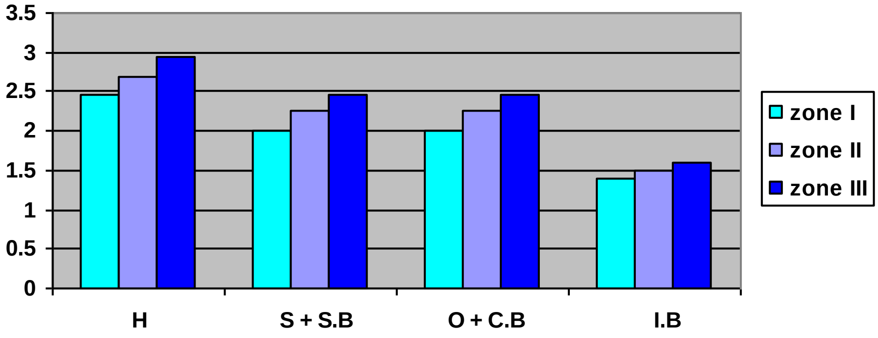


Figure 1. Control coefficients for permanent occupation buildings (d=1.3mK/W)

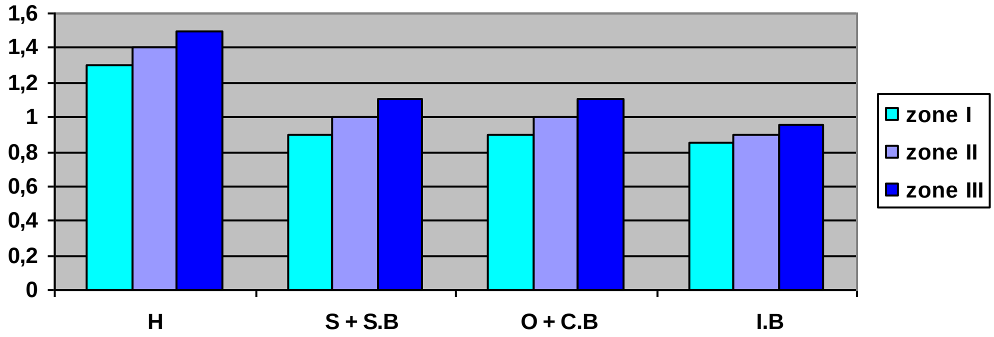
a [m^{2}K/W]



b [m^{2}K/W]



c [m^{2}K/W]



e [m^{2}K/W]

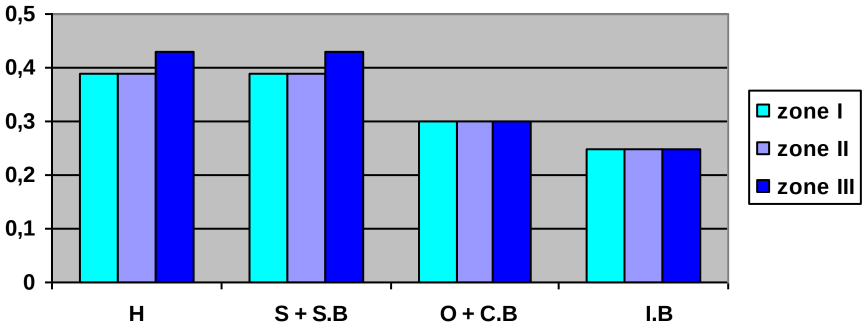


Figure 2. Control coefficients for the intermittent occupation buildings (d=1.4mK/W)

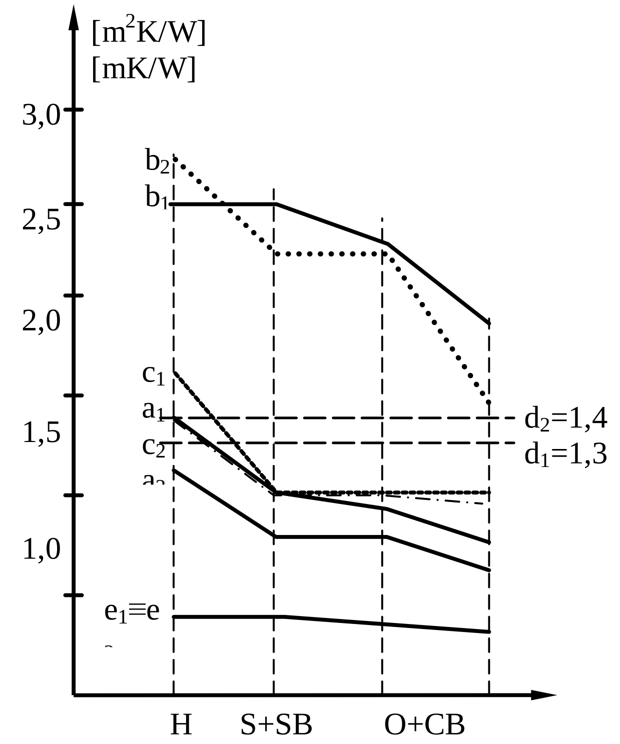


Fig.3. Variation of control coefficients for buildings : I - permanent occupation (a_1, b_1; c_1; d_1; e_1); II – intermittent occupation (a_2; b_2; c_2; d_2; e_2)

5. ENERGY DEPENDENCE. CONSUMPTION AND CURRENCY AVAILABILITIES

Regarding the energy, Romania depends on the fossiliferous fuel resources coming from other countries. During winter, a large part of big consumers of energy diminish their activity to ensure the thermic agent necessary to the good working of the schools, hospitals, dwelling buildings etc.

In the conditions where the degree of thermic insulation of the dwelling buildings is showing a deficit, the consumption of energy increases to about 300 kWh/m^2 per year.

If one imposes a higher level of thermic insulation for all the elements of the envelope, the consumption of energy drops below 100KWh/m^2 per year, having significant effects which relate to the deficit in currency of the country, the conditions of comfort of the inhabitants as well as the expenses utilities of the population.

In this case, the energy performance increases, the losses of heat decrease and the environmental quality improves because of the diminution of the quantity of the harmful exhaust gases produced by the combustion of fuels. Pollutants resulted by the production of one 1 Kcal (table 2):

Table 2.

POLLUTANT (10^{-4}G/KCAL)	FUEL			
	Liquid	Coal	Wood	Gas
Dust	1.19	16.208	40.714	0.374
SO_x (SO_2)	4.297…34.38	87.29	4.857	-
CO_x	0.594	145.87	3.243	0.397
Unburned HC	0.350	4.052	3.243	0.159
NO_X (NO_2)	1.195	4.855	16.214	1.587
Aldehydes	0.249	-	-	-

6. CONCLUSIONS

The evaluation of the energy performance elaborated according to the provisions of the C107/2-1997 Standard for public utility buildings is very simple. Standards of European Union countries (for example, Germany) introduced objective criteria of performance expressed by indicators of annual consumption of thermic energy (KWh/m^2). These parameters can become very interesting for recipients and the users from the point of view of the energy performance and energy saving.

In the case of the envelope, the elements which facilitate important losses of energy (external walls and joinery) will be insulated without disregarding the minimum volume of oxygen strictly necessary to the breathing (0.7…1 volume/hour).

Legend
H – hospitals
S +S.B – Schools +Sport Buildings
O + C.B – Office + Commercial Buildings

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