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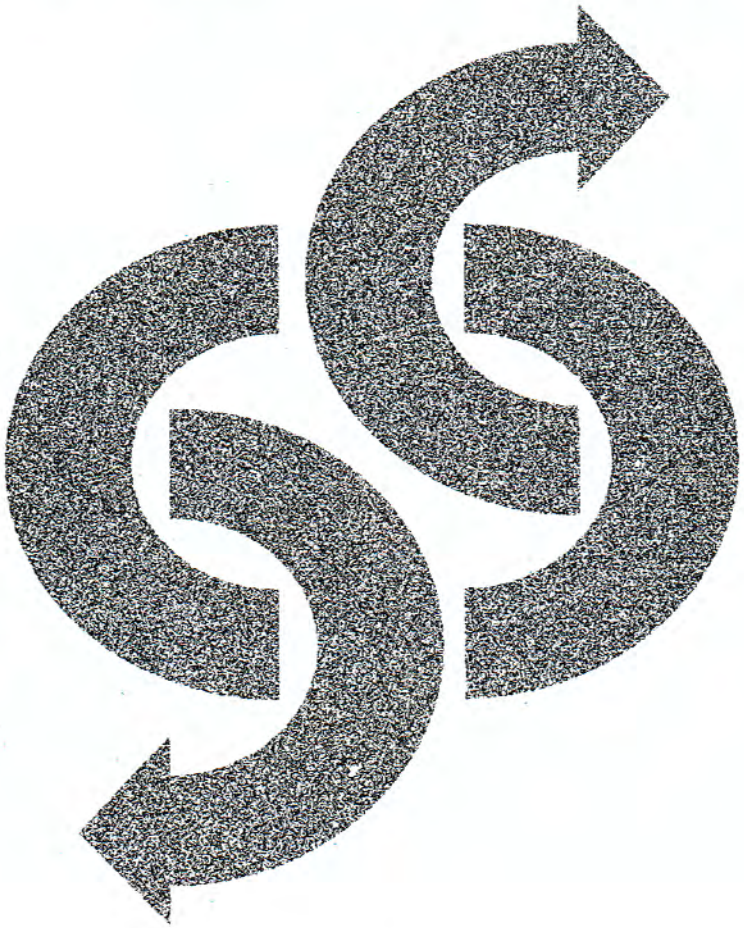

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Energy Efficiency Policy News

NEW REGULATIONS OF ENERGY SAVING IN BUILDINGS IN THE CITY OF MOSCOW

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Rationals for new building codes

Decree of the Government of the City of Moscow No.138 of February 23, 1999 enacts and puts into force new building regulations of the city of Moscow (MGSN 2.01-99) "Energy Saving in Buildings" which was elaborated by a team of authors from different institutions on NIISF initiative. The model Territorial Building Regulations (TSN) "Energy Efficiency in Buildings" developed by CENEf and NRDS as well as experience in elaborating TSN 301-23-98YaO "Thermal Insulation of Apartment and Public Buildings" for Yaroslavl Region were used to work out the aforementioned MGSN. The novelty of these new regulations resides in the fact that they help to utilize potential for enhancing energy efficiency of buildings which have not been fully used in the federal rules and regulations of construction heat engineering. The territorial regulations are not therewith contradictory to the applicable federal regulations of construction heat engineering since the former ensure the same energy saving effect as the federal regulations. The introduction of new regulations in the civil engineering practice in the city of Moscow will allow to achieve on the average a 20% energy saving effect as compared with the previous MGSN 2.01-94 and a 40% energy saving effect as compared with the regulations which were in force before 1994.

Background of the Development of Energy Saving Regulations for Buildings

The first Moscow regulations MGSN 2.01-94 "Energy Saving in Buildings. Regulations of Thermal Insulation and Heat, Water and Energy Supply" were also developed with our active involvement and were adopted in 1994. By early 1997 the city of Moscow has completely transferred to the construction of buildings in full compliance with these regulations. According to the Moscow Architectural Committee, in 1997 energy efficiency of the buildings of new designs was more than 20% higher as compared with the designs which were built on a large scale in the past: 23-24% higher as compared with the apartment buildings of P44M series; 25-26% higher as compared with the apartment buildings of P3Msh design, 18-20% — as compared with the apartment buildings of M6ECO series (monolithic), and about 20% higher as compared with the apartment buildings of Pd4 design. In other words, the target energy saving level was achieved.

Following the example of the city of Moscow, in 1995 the State Committee for Construction of Russia introduced certain changes in the federal rules and regulations of construction heat engineering which allowed to improve significantly the level of thermal insulation of buildings and to establish two stages of upgrading: the first stage is in force since 1996, the second one will start in the year 2000. The requirements of the second stage are comparable with the applicable regulatory requirements of foreign countries which have achieved a notable energy saving effect within the last decade.

For instance, if the required heat transfer resistance of the walls in Russia ranges from 2.1 to 4.9 m^2 ^{0}C/W (from 2000 to 10000 ^{0}C day), in Sweden this indicator ranges from 2.9 to 3.5 m^2 ^{0}C/W, in Denmark — from 3.3 to 4 m^2 ^{0}C/W, (at 2900 ^{0}C day), in Finland — from 2.9 to 3.5 m^2 ^{0}C/W, in Canada — from 3 to 4.1 m^2 ^{0}C/W for single-family buildings up to 3 stories high and from 2 to 3.1 m^2 ^{0}C/W for apartment buildings, in Germany — from 2 m^2 ^{0}C/W (at 3500 ^{0}C day). At present, the Russian regions have practically completed the first stage. New advanced energy saving technologies were actively introduced therewith, e.g. the technology of energy efficient glazing which uses glass with heat reflecting coatings in the PVC frames, walls of two-layer structure with mineral wool warmth-keeping jacket in-between, etc.

New Moscow Regulations of Energy Saving in Buildings

The Federal Law of the Russian Federation "On Energy Conservation" (No.28-F3 of April 3, 1996) requires to include the indicators of energy efficiency of materials and structures into relevant standards, which indicators are subject to certification tests. As regards consumption of energy carriers, the indicators of their efficient utilization as well as indicators of energy consumption for heating, ventilation and hot water supply shall be included in relevant regulations and technical documentation. The Law requires that design, production of building materials, items and structures as well as construction, certification and operation of buildings should be subject to mandatory state metrological control and supervision in terms of energy saving. In particular, the Law stipulates the conduct of energy peer review of design building documentation. Since such requirements were not envisaged in the previous Moscow regulations, which had been developed before the enactment of this law, it became necessary to elaborate new MGSN.

How important are new MGSN for different participants in the construction process in the city of Moscow?

As regards designers who develop designs of new buildings or designs of their retrofitting, new MGSN provide higher flexibility in design, possibility to take into consideration additional factors and to use computer technologies in design since the previous regulatory approach limited their creative potentialities too much. Consequently, new architectural forms can be wider used in building designs as well as new energy efficient building technologies and materials, new engineering equipment which produces a positive impact on efficient use of energy.

As to the management of the city building industry and construction companies, new MGSN set forth new criteria which the development of efficient building technologies and construction industry shall be oriented at.

For the land lords and house operators new MGSN are a document which requires that newly built and reconstructed apartment buildings and other buildings, which are municipal property, should use energy efficiently. Consequently, in a long-term future these buildings will lead to lower energy expenditures ensuring therewith better heat comfort and lower heating expenses.

For the population of Moscow energy efficiency means lower expenses, more efficient economy, saving of valuable non-renewable energy resources for future generations, and significant improvement of environmental conditions due to reduction of emissions of carbon dioxide, sulfur and other harmful substances into the atmosphere.

For other regions of Russia new MGSN will be a good example of testing and implementing new ideas and can become a model for developing regional regulations.

The basic difference between the previous MGSN and new ones

The purpose of new MGSN is to stimulate design of buildings with lower energy consumption. The major differences reside in the following:

- in a new structure of the document and transition to a new principle of regulation;
- in a systematic approach to buildings when each building is viewed as a united energy system;
- in the introduction of new indicators related to quantitative consumption of energy;
- in more stringent requirements which lead to better thermal insulation and reduction of energy consumption;
- in the use of additional energy indicators which are used to determine energy consumption in a building and which have not been taken into account before;
- in a necessity of more qualitative design and in the introduction of a new section "Energy Efficiency" in the design documentation;
- in the introduction of "energy passport" which confirms the compliance of the design with new regulatory requirements.

The new principle of regulation is applied to the requirements which are placed to the whole building as a system (which requirements include a new from energy point of view indicator related to the amount of energy consumed for heating), rather then to the requirements which are placed to individual parts of the building (walls, ceilings, windows, etc) which govern the heat balance of the building. Amount of consumed energy depends on heat insulation of a building, its architectural, volumetric and layout features, heating and ventilation system, additional heat inputs, climatic parameters and inner conditions.

It is common knowledge that architectural, volumetric and layout (different combinations of multistory sections) features of buildings produce a significant impact on energy consumption. For example, widened buildings consume 15-18% of energy less than buildings of normal width; buildings of P44 series, which consist of four sections with two corner sections, consume energy by 25-30% more as compared with a building consisting of four regular and end sections. Correct accounting of heat losses due to infiltration allows to use engineering solutions which reduce their negative effect. Household heat releases and solar radiation can be accounted for energy saving purpose, given automatic control of the heating system. Lack of automatic control or its improper operation increases heat consumption for heating by 20-25%.

The main criterion in the new Moscow regulations is specific energy consumption for heating one sq. meter of useful area during a heating season, which parameter is measured at the locations where the building is connected to the heat supply systems or other energy sources, e.g. individual gas-fired boilers. This indicator is the main one for heat engineering design and is measured in kWh/m^2. Required values of specific energy consumption are established in compliance with the regulations which will be in force at the second stage of introduction of the federal rules and regulations of construction heat engineering. Table 1 presents required values of specific heat consumption by the heating system of a building (q_h^{req}) in compliance with new MGSN. For the purpose of comparison, the table also gives the requirements of the previous regulations MGSN 2.01-94. It follows from the table that new MGSN will allow to reduce specific heat consumption for heating buildings by more than 20% as compared with the previous MGSN version.

In this case there is no necessity in a rigorous element-by-element regulation of heat transfer

Table 1. Required Specific Heat Consumption by the Heating System of a Building (q_h^{req}) During a Heating Season, kWh/m²

Type of building	Number of Stories							
	1-3		4-5		6-9		>10	
	MGSN 2.01-94	MGSN 2.01-99	MGSN 2.01-94	MGSN 2.01-99	MGSN 2.01-94	MGSN 2.01-99	MGSN 2.01-94	MGSN 2.01-99
Apartment	200	160	160	130	140	110	115	95
General education and medical institutions, polyclinics	205	175	195	165	185	155	-	-
Preschool institutions	280	245	-	-	-	-	-	-

resistance of filler structures as stipulated in the federal rules and regulations of construction heat engineering P-3-79* — only their lower limit is established in compliance with the level of the achieved (first) stage of effectuation of the above-mentioned building code.

On the other hand, comfortable living condition shall be ensured for the inhabitants which is also a consumer requirement. Thus, the establishment of comfortable living conditions in a building at pre-assigned energy consumption sufficient to maintain such conditions is the main objective from consumer's viewpoint. And, at last, the sanitary-hygienic aspect of heat engineering design resulted in a requirement that prohibits formation of condensate on inner surfaces of filler structures.

It should be noted that this new principle of specific energy consumption regulation is used in Germany (since 1995), certain states in the USA, Denmark (since 1995), Netherlands (since 1996) and partially in Canada (since 1998).

Energy Passport of a building is another specific feature of new MGSN, which passport is intended to be used for controlling quality of building design, construction and operation. The Energy Passport is supposed to be used in the development of building design and in verification of compliance of the design with the requirements of the territorial regulations. In addition, it provides specific information on energy efficiency of the building to potential buyers and residents. Preference can be given to more energy efficient buildings as compared to less energy efficient buildings in which one will have to pay more for energy if the actual energy consumption does not comply with the regulatory requirements. Consequently, the Energy Passport is a substantiating document for economic stimulation of energy conservation (concessional taxation, soft credits, subsidies, etc) and for objective evaluation of its cost on the housing market.

Impact of Moscow Regulations on Federal Regulation Process

After the evaluation test of new MGSN in the city of Moscow the State Committee for Construction of Russia also took a decision on the appropriateness of transfer to the above-mentioned principle of regulation at the federal level. At the present time, a new version of the federal rules and regulations of heat insulation of buildings is drafted. This building code contains requirements to heat insulation of buildings and limitations of specific energy consumption for their heating during a heating season. This document is based on the following philosophy.

Heat insulation of buildings shall be designed in compliance with required values of heat transfer resistance of its individual elements which are in force at the second stage of implementation of the federal rules and regulations of construction heat engineering. In this context the compliance of the design level of specific energy consumption for heating apartment and public buildings during a heating season with the rate established for a particular type of buildings shall be verified using a standardized calculation method. If the calculated specific energy consumption for heating the building is lower than the regulated value, heat transfer resistance of certain thermal insulation elements can be reduced, as compared with the required resistance (but not lower than the values which ensure sanitary-hygienic conditions and condensate non-formation), down to the values when the calculated specific energy consumption achieves the required level.

Table 2 presents the required values of specific energy consumption for heating different types of buildings during a heating season in kJ/(m²·°C·day) and in kJ/(m³·°C·day). These values are given in relation to degrees-days in order to ensure independence from climate parameters.

Table 2. Required Specific Energy Consumption for Heating a Building (q_h^{req}) kJ/(m²·°C·day)[kJ/(m³·°C·day)] during a heating season

Types of buildings	Number of stories			
	1-3	4-5	6-9	>10
Apartment	115	95	80	70
Institutions of general education and offices	36[33]	33[27]	30[23]	[20]
Policlinics and medical establishments, boarding schools	36	33	30	-
Pre-school institutions	44	-	-	-
Note: Values q_h^{req}, kJ/(m³·°C·day) in parentheses are related to offices.				

The calculated value of specific energy consumption for building heating can be decreased at the expense of:

a) alteration of volumetric-layout solutions which ensure the lowest area of external filler structures, reduction of the number of external angles, widening of the building as well as use of orientation and rational arrangement of multisectional buildings;

b) reduction of the area of window openings down to the minimal values required in compliance with natural illumination standards;

c) utilization of efficient thermal insulating materials and their rational location filler structures which will ensure a higher heat engineering homogenity and operating reliability of envelopes as well as improvement of quality of sealing joints and of the opening elements of external walls;

d) enhancement of conditioning systems self-control efficiency, application of efficient types of heating hardware and more rational arrangement of such equipment;

e) recovery and utilization of heat of removed internal air and incoming solar radiation.

In conclusion it should note that the development and enactment of new regulations gives the following advantages for the city of Moscow:

- new principle of regulation facilitates the transfer to the second stage of introduction of the rules and regulations of construction heat engineering SNiP II-3-79* and ensures energy efficiency enhancement effect envisaged in the federal regulations;
- conditions are created for introducing new energy efficient technologies and building materials as well as energy efficient ventilation and heating equipment and relevant control systems;
- there is a possibility now to achieve preset energy saving effect at the design stage due to different combinations of individual thermal insulation elements and conditioning systems inside the premises, i.e. finally due to improvement of the quality of design;
- transfer to consumer's principle stimulates the architects and designers to create architectural image of a building using energy efficient layouts of buildings.

MAIN WAYS TO ENHANCE ENERGY AND ECOLOGICAL EFFICIENCY OF COAL-FIRED BOILER HOUSES OF SMALL CAPACITY

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There is a huge number of small coal-fired boiler houses in Eastern Siberia, which boiler houses feature low efficiency of fuel combustion and high releases of hazardous substances into environment. These boiler houses are commonly equipped with boilers with manual loading of fuel for multi-layered filling. The main specific feature of such boilers resides in periodic loading of fuel and, naturally, in significant variation of combustion parameters and releases of harmful substances into environment (Fig.1) with time. There are three stages of combustion in such boilers: (1) heating and ignition of fuel, (2) intensive combustion, and (3) after-burning of residual coke. The duration of each stage and its conditions (temperature, concentration of oxidant) govern to a great extent the quantitative indicators: releases of harmful substances into environment and heat source efficiency.

The authors used domestic and foreign instruments to study the specific features of coal combustion in this kind of boilers in great detail. The experiments were carried out at an NRS-type boiler of 0.4 Gcal/h capacity. Five types of coal from Eastern Siberia were burned therewith: (bituminous coal — from Cheremkhovsk and Tugnuisk deposits; lignite — from Azeisk, Mugunsk and Borodino deposits), which coals differed in the content of small fractions. In addition, energy audit was carried out at about 20 coal-fired boiler houses of different capacity. The obtained experimental data allowed to establish basic problems and to generate recommendations which could help to enhance significantly the energy efficiency of coal-fired boilers of small capacity and to reduce releases of harmful substances into atmosphere many times.

1. Indicators of Boiler Heat Efficiency

The results of thermophysical measurements allowed to determine heat efficiency indicators of coal-fired boilers of small capacity. The spread in values of these indicators was very high for the examined boilers. The obtained results were compared with the rated values (Table 1). The guidelines "Heat Design of Boiler Units (Regulatory Method)" (M-L, GEI, 1957) were used to estimate regulated values of the coefficient of excess-air in the furnace, air suction in the gas circuit of the boiler, temperature of exit gases, temperature of removed slag, etc.

Table 1. Components of Heat Losses in Coal-Fired Boilers of Small Capacity, % of fuel heat

	Components of Losses actual	Losses rated
Due to exit gases	30-50	8-10
Due incomplete combustion	1.5-3.6	1-2
Due to unburned coal	4-14	6-7
Due to external cooling	3-7	4
Due to sensible heat of slag	0.5-0.8	0.5
Boiler efficiency (gross)	32-60	76-80