ADVANCES IN ENERGY CODES IN RUSSIA AND KAZAKHSTAN. HARMONIZATION OF CODES WITH EUROPEAN STANDARDS

Yuri Matrosov Cand. Sc. (Bld). [1]
Corresponding Member of Municipal Academy

[1] Research Institute for Building Physics (NIISF) of the Russian Academy of Architect and Building science, 21, Lokomotivny pr., Moscow 127238, Russia, yuri_matrosov@mtu-net.ru.

David B. Goldstein Dr. Ph. [2]
[2] Natural Resources Defense Council (NRDC), 111 Sutter St., 20 th Fl., San Francisco, CA 94104, USA, dgoldstein@nrdc.org.

Keywords: building's energy codes, thermal performance, energy efficiency, harmonization

Summary

A ten-year struggle in Russia over a new generation of building energy codes has recently culminated in the passage of a sweeping new federal energy code. This federal code employs the approaches and locks in the energy-performance targets of innovative regional codes adopted since the late 1990s, based on a model code developed by the author of this paper. These new codes are causing a major shift in the Russian building sector — a transformation without parallel in Russia's other industrial sectors — toward increased energy efficiency. The Russian market has undergone fundamental transformation toward production, sale, and use of energy-efficient building materials and products, and the use of new energy-efficient technologies. Kazakhstan has also started down the path blazed by Russia regarding energy codes.

The proposed article will discuss important recent developments in Russian and Kazakhstani building energy codes, including setting of energy-efficiency criteria and targets for buildings development of rating systems, and new federal and regional codes embodying these targets. We also discuss oversight over the quality of design and construction, and monitoring of energy performance of buildings during operation. We close by discussing next steps in code development and implementation in both countries, and opportunities for further increasing energy efficiency.

1. Introduction

Over the past 10 years we have informed readers of the development, step by step, of a new generation of codes and standards in Russia for energy-efficient buildings (see WEB www.cenef.ru/home-pg/hp-1r_fr.htm, then follow links to publications). A new generation system of codes has been **created and implemented successfully** at federal and regional levels. The system of codes includes

at the regional level:

codes in 50 regions of the Russian Federation, implemented between 1995 and 2004; and

at the federal level:

the new code “Thermal Performance of Buildings” (SNiP 23-02 [1],[1] adopted late 2003);
the new code of practice “Design of Thermal Performance of Buildings” (SP 23-101 [2]);
the standard for indoor climate (GOST 30494 [3]);
two new standards on building energy audits (GOST 31167 [4], GOST 31168 [5]);
a standard on the detection of concealed defects of building thermal insulation (GOST 26629 [6]); and

[1] Throughout this paper, we will refer to Russian federal building codes and standards by their commonly used initials – SNiP means *Stroitelnye Normy i Pravila*, or Construction Codes and Regulations, and GOST means *Gosudarstvennye Standart*, or State standard. SNiP documents generally contain normative prescriptive and performance requirements while GOST documents contain test protocols for measuring and reporting performance.

sections entitled “Energy Conservation” and “Sanitary-Epidemiological Requirements” in two new residential codes (SNiP 31-01 [7] and SNiP 31-02 [8]).

All the documents mentioned above have been officially adopted by the relevant authorizing agencies, have entered into force, and are mandatory. In accordance with the new Russian Federation law “On Technical Regulation,” all GOSTs and SNiPs adopted before the passage of this law will carry mandatory force up to year 2010, after which they will become recommended. Regional codes will be in force beyond that time as mandatory documents.

2. Energy Savings and Market Changes to Date

Surveys of actual building designs and the availability of efficient building components and materials show that they are being implemented. Under new regional and federal codes, energy consumption for heating in newly constructed and renovated buildings has been reduced by 35 to 45 percent, depending on building type. There has been a transition from universal use of single-layer and three-layer wall-panel construction to monolithic frame construction with external insulation and light thermal insulation materials. Building designs with increased wide (up to 22-25 meters, in comparison with 12 meters previously) have become widely used. Types of light porous concrete have also been in use. Factories that produce concrete wall panels have made the transition to producing a great variety of products. Buildings made of these components do not differ in outward appearance from monolithic-frame buildings. At the same time, windows with sealed glass units with low-emissivity glazing and composite wood or plastic frames have begun to be used as well.

Regulation of the building industry throught the introduction of new codes has stimulated the emergence of new production facilities and companies, such as the URSA plant in St. Petersburg (Russian-German), the Rockwool Russia plant near Moscow (Russian-Danish), and the Pobeda-Knauf plant near St. Petersburg (Russia-German).

Once an energy efficient building is constructed, it saves energy for many years. The federal code and a large proportion of regional codes have been in force, starting from the year 2000. In 2000, building design according to the new codes was carried out, and in 2001, these buildings entered into operation. The energy-saving effect has calculated as the difference in energy consumption for heating for the volume of new construction starting in 2002 and up to the end 2004 in compliance with the new generation of codes.

Russia introduced about 111 million square meters of new residential floor area over the period 2002-2004. The calculated energy-saving effect cumulatively for heating these buildings amounted to 70 PJ. It is assumed that heat supply systems are 50 % efficient on average in Russia. This means that only one-half of primary fuel, converted at thermal stations or boilers reaches the building for the purpose of heating. The energy-savings effect in terms of primary fuel cumulatively is calculated at almost 140 PJ. An average domestic heat price from thermal stations or boilers of RF on Dec.2004 is 4.24 US dollars per GJ. The cost of the energy savings effect of primary fuel use is calculated about 594 million dollars or about 840 million dollars, if it is taking account 6 dollars per GJ - the whole sale gas price from US pipelines.

It should be noted that with the growth of residential building stock, there has been an inevitable growth in energy consumption for heating. The concurrent development of a new generation of energy-efficient codes and their entry into force has put the brakes on this growth. Expenditure of primary fuel for the generation of heat energy for the heat-supply system, up to the end of 2004, has grow only by 108 PJ compared with 181 PJ, if these codes had not been adopted. The reduction in grow of energy demand up to the end of 2004 also led to a reduction of CO_2 emissions into the atmosphere of 9.5 million tonnes this year.

Annual figures grow cumulatively over a 10-year period (2000-2010) up to 1.3 EJ assuming a 10 % growth a year in residential construction volume, which is highly realistic, and a stable fuel price. Then the dollar savings grow up to 7.8 billion. Reduction of CO_2 over this period will grow to about 88 million tonnes cumulatively.

3. The New Russian Federal SNiP

The new federal code adopted in 2003 locks in energy savings embodied in regional codes, implements innovations from these regional codes, sets forth additional new elements, and of course, dramatically expands geographic coverage of codes from selected regions to the whole country. Gosstroy of Russia adopted this code by executive order №113 in June 2003, and the code [1] entered into force on October 1, 2003. The new code replaces the previous federal SNiP "Thermal Engineering for Buildings," which despite major modifications between 1995 and 1998, still had a variety of deficiencies, in content as well as form.

The new SNiP "Thermal Performance of Buildings" seeks to address these deficiencies by:

establishing numerical values for required performance targets, corresponding to world levels;
classifying new and existing buildings according to their energy efficiency;
encouraging buildings that are more efficient than required by code;
creating a mechanism for identifying low-performing existing buildings and mandating necessary upgrades;
developing design guidelines for both prescriptive and performance-based compliance paths; and
developing methods for oversight and enforcement of compliance in terms of thermal performance and energy efficiency (energy passports), during design, construction, and prospective operation phases.

In its general principles, the new SNiP is a completely new document in terms of structure, applicability, criteria, oversight and enforcement, computer-compatibility, linkages with energy audits for operating buildings, harmonization with European standards, and in light of all these factors, its very name. Still, the new document maintains continuity with the code it replaced, and provides for equivalent levels of energy efficiency, while offering wider technical options for compliance. Below we summarize the general principles of the new federal code.

3.1 Criteria

The code establishes two means for achieving compliance:

a) a prescriptive path, with required thermal resistance values for individual building envelope elements; these values have been defined so as to be consistent with whole-building specific energy consumption requirements, and have been retained from the former SNiP for continuity;
b) a performance path, with required specific energy consumption levels for heating the whole building, allowing for tradeoffs in the energy performance of individual envelope elements (except the buildings for industry), taking account of heating controls and heat-supply system efficiency. The performance path includes precise instructions on how to calculate the specific energy consumption for a building.

The choice of which of these options to use is left to the owner and/or designer. Methods and paths for achieving these requirements are chosen during the design process.

In calculations of design whole-building energy performance, indoor air temperatures are set at the lower limits of optimal ranges. A new standard, GOST 30494 [3], has been developed in order to define these temperature input data. In accordance with this standard, design indoor air temperature is set at 20 ^{o}C instead of the previous 18 ^{o}C.

3.2 Classification and rating buildings on the basis of energy performance

The new federal code, in contrast to previous codes, applies not only to new and renovated buildings, but also to existing buildings already in operation, with instructions for evaluating and monitoring thermal-performance and energy parameters during both design and operation.

Table 1 show a set of rating categories based on the degree to which design or normalized measured parameters for specific energy consumption deviate from required values from the new code. This classification applies both to newly construct and renovated buildings designed according to the new code, as well as to operating buildings built according to previous codes, even those from before 1995.

Buildings whose designs have been developed according to the new code can be assigned to classes ***A***, ***B***, and ***C***. In the process of real operation, the energy efficiency of such buildings may deviate from design data into better classes (***A*** or ***B***) within the limits shown in Table 1. Where classes ***A*** and ***B*** are earned, the use of economic incentive measures by local government agencies or investors is recommended.

Classes ***D*** and ***E*** apply to operating buildings, built under codes in force at the time of construction. Class ***D*** corresponds to code-compliant levels from before 1995. These classes give information to local government agencies or building owners on the necessity of immediate or less immediate measures for increasing energy efficiency. Thus, for example, for buildings falling into class ***E***, energy-efficiency renovation is urgently required.

Specific actions regarding the rating of existing buildings, awarding of incentives, requiring upgrades, and levying sanctions are left to regional and municipal agencies, which are responsible for enforcing the federal code.

Table 1 Classes of Energy Efficiency for Buildings

Letter grade and graphical representation	Name of the class	Deviation of design or normalized measured specific energy consumption from code-stipulated level, %	Recommended measures
For new and renovated buildings			
A	*Very high*	less than –51	economic incentives
B	High	From -10 to -50	as above
C	**Normal**	from +5 to –9	-
For existing buildings			
D	Low	from +6 to +75	Renovation desirable
E	*Very low*	greater than +76	Upgrades urgently required

3.3 Quality control and energy audits

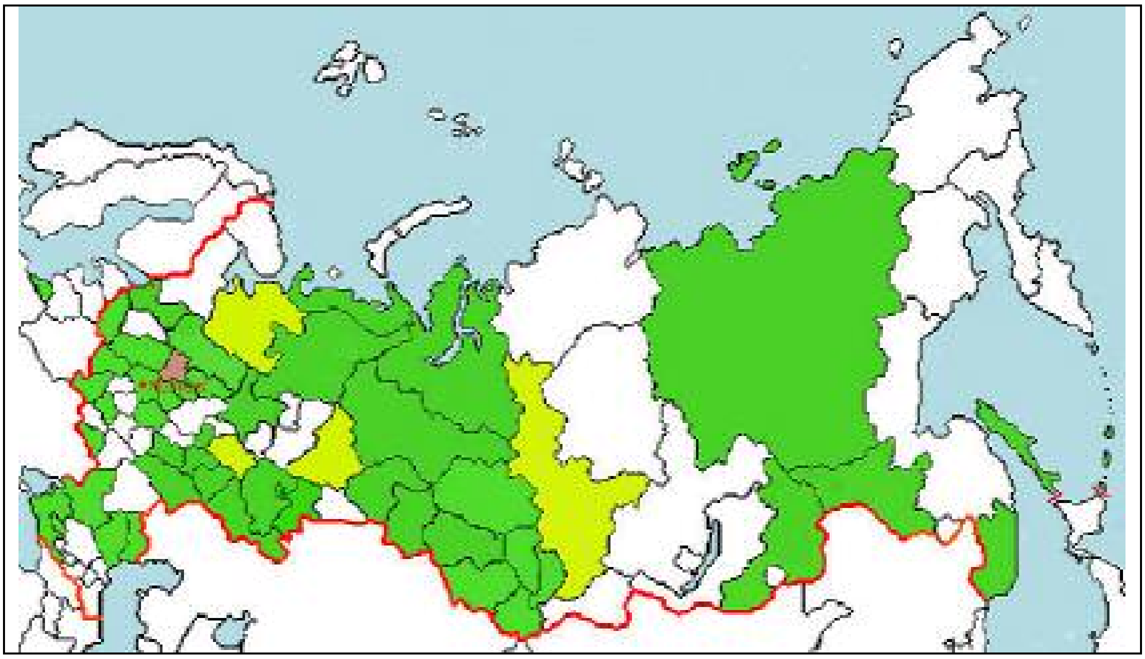
The new SNiP also requires the performance of quality control for the thermal insulation in every building by means of thermo graphic testing, in accordance with GOST 26629 [6] upon the building's entry into operation. Such oversight helps to reveal hidden defects and means to remedy them before the departure of the construction crew from the site. The new SNiP also requires selective monitoring of air permeability of the inhabited areas of buildings entering into operation, in accordance with the new GOST 31167 [4].

The new code also has a section on building energy audits, which are defined as a sequence of activities intended to determine the energy efficiency of the building and to assess measures for increasing energy efficiency and energy conservation. The results of energy audits by the new GOST 31168 [5] are used for general classification and certification of buildings according to energy efficiency. Providing a uniform and consistent methodology for calculating energy consumption is a critical step in making audits work and getting their results accepted in the market.

These standards have also been adopted in the Republic of Kazakhstan.

4. Regional Energy Codes

At present, 50 regional codes, entitled "Energy Efficiency in Buildings," have been adopted and confirmed by Gosstroy RF, and 3 more are in the stage of final editing. See Figure 1. Regional codes are mandatory for all Russian and foreign entities involved with construction in the given region, even in isolated cases where federal codes do not apply. All regional codes are developed according to criteria described above – they may be consistent with federal codes, or more stringent. Regional codes also contain detailed climate parameters not contained in the federal code, including heating-season degree days and solar radiation under real cloud conditions. In a few regions, climate data are provided on a district-by-district basis.



Note: Regions with dark shading have their own codes. Regions with light shading have codes in the final stages of editing.

Figure 1 Regional Codes in Russia, 2004

5. Energy Passports

The new federal SNiP and regional codes require the completion of an «Energy Passport» for the building, a document intended to verify energy performance in design, construction, and operation. Energy Passports also give potential buyers and resident's information on what they can expect regarding the building's energy efficiency and real costs, helping to stimulate market preferences for high-performance buildings.

For existing buildings, the new federal code and regional codes require selective inspection and review to determine compliance with relevant codes, or to assess the need for renovation. The results of this review must reflect technical, energy-related, and thermal aspects, as well as technical and economic analysis of options for renovation.

To help ensure quality in energy-related aspects of building design, the new federal code and regional codes also require the preparation of a special section of the building design, entitled "Energy Efficiency." This section must include summary parameters for energy performance for various parts of the building design. These parameters are presented side-by-side with code-required values.

6. Computer tools

To facilitate and standardize calculations, a PC version of the Energy Passport has been developed. This version enables quick calculations, iterative assessment of design variants, and comparison with code values at all stages of design, construction, and operation. It is available upon request to interested organizations.

Three other programs for PC are available, intended to facilitate thermal-engineering calculations in the design of building envelopes. The first program enables the user to carry out complex calculations of envelope performance under conditions of steady-state linear heat transfer, as described in the federal supplemental guidance manual, and helps to verify compliance with code-required values for thermal resistance, thermal stability, air permeability, vapor permeability, and thermal assimilation of floors. The second and third programs define the overall thermal resistance of heterogeneous elements with two- and three-dimensional temperature fields, under conditions of steady-state heat transfer.

7. Harmonization of codes with European standards

The new federal SNiP and regional codes are consistent with international levels and in particular, with the requirements of EU Directive (law) №93/76 SAVE [9], with the new German executive order EnEV 2002 [10], and with the new EU Directive [11] on energy-efficiency indices for buildings. In terms of approach, the Russian codes even go beyond those of EU countries.

It is interesting to compare the code-required energy performance targets of Germany and Russia; German codes stipulate targets that fall between 40 and 96 kWh/(m^2·yr) for baseline heat-supply systems. Values from Russian regional codes and the new federal SNiP, adjusted to Germany's climate conditions fall between 55 and 105 kWh/(m^2·yr). See Figure 2. The German codes are clearly more stringent - by 20 to 27 percent for multifamily residential buildings, and 9 to 10 percent for single-family homes, but this higher efficiency level is entirely the result of the pre-existing heating system's being much more efficient in Germany than the low 50% level prevalent in Russia. For a new Russian building hooking up the existing district heating system, the building itself must achieve comparable or greater savings in Russia than in Germany.

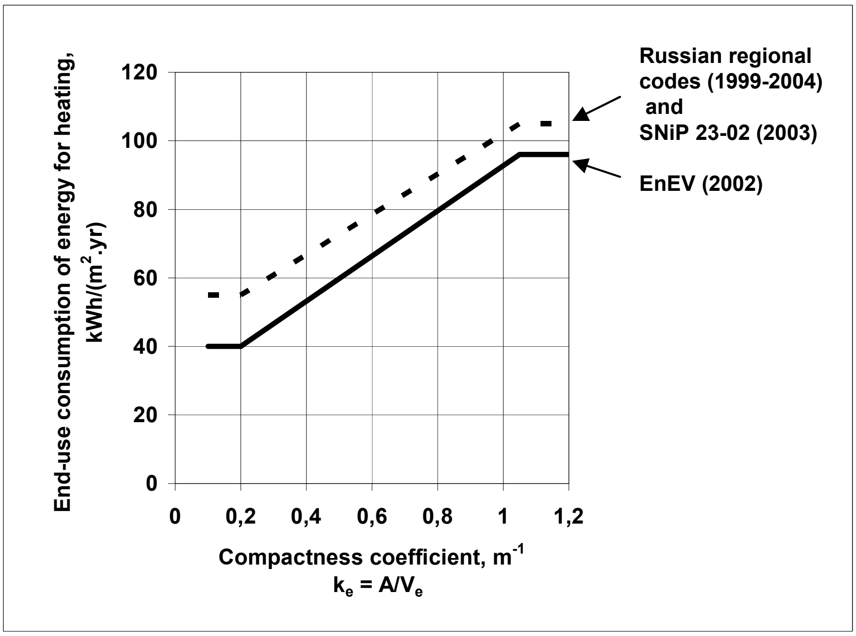


Figure 2 Comparison of Required Energy-Performance Levels of Russian Regional and Federal Codes, and Germany's EnEV-2002

The Codes are take account according to EU directive [11] on the energy-performance of buildings:

- a system approach to the buildings and the total energy use for heating;
- an energy declaration / energy passport for the energy certification;
- measures in both new and renovated buildings;
- a general principle of methodology for calculation to obtain the overall energy performance of a building including energy for ventilation, internal heat gain and solar radiation;
- the efficiency of the heat supply system;
- thermal comfort.

The Codes are not taking account (except Code for Moscow) of:

- domestic hot water supply;

- artificial lighting.

However, for residential buildings, it is difficult to mandate significantly higher efficiency in the hot water system, and the potential for artificial lighting savings in buildings is small compared to either heating energy or to lighting savings in commercial buildings.

8. Codes of the Republic of Kazakhstan

New codes have also been developed (SN RK 2.04-21 [12], adopted on May, 2004) in the Republic of Kazakhstan (RK) — one of the most successfully developing central Asian republics of the post-Soviet sphere. Thanks to economic reforms and liberal laws, foreign investment in this republic has grown without cease, especially from western countries. The building sector is also growing mightily. But the RK has practically no base of codes of its own for the building sector. Buildings are being built in accordance with the expertise of construction companies hired by the future owner or investor, often according to the codes of the country where hired companies are based, or according to Russian codes. In this light, the government of the RK has set forth a goal of creating its own code for energy efficiency in the building sector and of including in these new code performance targets for civilian buildings that correspond to world levels, as well as methods for oversight and enforcement.

We have been developing this code in close collaboration with the Department of Technical Codes and New Construction Technologies of the Committee for Construction Affairs of the RK, under the support of the U.S. Environmental Protection Agency.

9. What Next?

Reduction of energy consumption in the building sector is a complex problem, the most important element of which is designing and verifying thermal performance. Over the next ten years, further significant improvements in wall or ceiling thermal performance will probably not be readily achievable; instead, further savings will come from more efficient ventilation systems (systems that deliver air on demand, heat recovery from exhaust air, and so on), from improved control systems, including nighttime automated temperature setback, and from improved low-emissivity coatings on windows. Additional energy efficiency gains can be achieved either by upgrading existing district heating systems or by using on-site boilers instead of district heat.

Performance-based code-compliance methodologies for the buildings of industry are needed, though heat losses through the envelopes of these buildings is relatively small compared with the inefficiencies of their HVAC systems.

The other part of the heretofore unresolved problem is determining the level of thermal performance for buildings with mechanical cooling. The algorithm for calculating energy consumption will need to account for cooling as well as heating. Future code methodologies will also be developed in this area. In this case, the level of thermal performance required from the point of view of energy efficiency may be higher than the level determined based on heating alone. This means that for northern and central regions of Russia, code requirements may be based on heating considerations alone, but in southern regions and for commercial buildings, requirements may be driven as much (or more) by cooling as for heating.

It will evidently be worthwhile too to create integrated code requirements for energy consumption for domestic hot water, electricity consumption for lighting and other needs, and also for gas – thus leading to a code that is based truly on whole-building energy performance.

Conclusion

- A new generation of codes has led to real results in the design and construction of efficient buildings, and accompanying standards have helped clearly define key parameters for code-compliance inputs and assessment of energy performance of operating buildings. New code methodologies were first approved and implemented in great numbers at the regional level in Russia. The experience gained from regional codes has confirmed the applicability of these new approaches, and has made possible the development of codes with similar innovative elements at the federal level in Russia and in Kazakhstan. The principal methodological basis of the new codes and their basic requirements are consistent with advanced international levels, and these codes are harmonized with European codes and standards. There is no precedent for such change in codes in Russia, Kazakhstan, or the former USSR.

- New codes have made a wider range of compliance options available to designers, including building geometry as well as selection of materials, components, and heating systems, thus leading to improved overall building design quality. But taking advantage of these options requires more effort and expertise. To simplify the use of the performance approach, the Energy Passport was developed. Designers have greeted this documentation system and its computer version with enthusiasm, and in general, complaints about the complexity of new codes dissipate after demonstration of automated compliance calculations.
- Russian codes and standards for energy efficiency, despite pessimistic predictions, have created conditions for market transformation for new construction technology, have made possible a construction boom, have increased employment, have led to real energy savings, and have increased indoor comfort.

References

[1] СНиП 23-02-2003 Тепловая защита зданий (Thermal Performance of Buildings), M., 2004, 26 p.;

[2] СП 23-101-2004 Проектирование тепловой защиты зданий (Design of Thermal Performance of Buildings), M., 2004, 140 p;

[3] ГОСТ 30494-96 Здания жилые и общественные. Параметры микроклимата в помещениях (Residential and public buildings. Microclimate parameters for indoor enclosures), M., Госстрой РФ 1999, 14 p.;

[4] ГОСТ 31167-2003 Здания и сооружения. Методы определения воздухопроницаемости ограждающих конструкций в натурных условиях (Buildings and structures. Methods for determination of air permeability of building envelopes in field conditions), M., Госстрой РФ 2003, 22 p.;

[5] ГОСТ 31168-2003 Здания жилые. Метод определения удельного потребления тепловой энергии на отопление (Houses. Method for determination of specific heat consumption for building heating), M., Госстрой РФ 2003, 26 p.;

[6] ГОСТ 26629-85 Здания и сооружения. Метод тепловизионного контроля качества теплоизоляции ограждающих конструкций (Buildings and structures. Method of thermo vision control of enclosing structures thermal insulation quality), M., Издательство стандартов, 1986, 14 p.;

[7] СНиП 31-01-2003 Здания жилые многоквартирные (Multicompartment residential buildings), M., 2004, 20 p.;

[8] СНиП 31-02-2001 Дома жилые одноквартирные (Single-family houses), M., 2001, 12 p.;

[9] Council Directive 93/76/EEC of 13 September 1993 to Limit Carbon Dioxide Emissions by Improving Energy Efficiency (SAVE), Official Journal L 237, 22.09.1993, pp.28-30.;

[10] Verordnung über energiesparenden Wärmeschutz und energiesparende Anlagentechnik bei Gebäuden (Energieeinsparverordnung – EnEV), vom 16. November 2001;

[11] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the Energy Performance of Buildings. Official Journal, 4.1.2003, pp. 65-70;

[12] СН РК 2.04-21-2004 Энергопотребление и тепловая защита гражданских зданий (Energy consumption and thermal performance of civil buildings), Астана, 2004 (in progress).