ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 7, Issue 6 , June 2020

Engineering Solutions for High-Rise Residential Complexes

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ABSTRACT: This article highlights the main key points of the design and operation of high-rise complexes, which are reflected in the published book "Engineering equipment of high-rise buildings"

KEYWORDS: ventilation, design, air conditioning, heating, water supply, high-rise buildings, water disposal, climate, engineering equipment

I.INTRODUCTION

The introduction of the article is devoted to a review of topics of high-rise construction as a new human environment. Tall buildings represent a natural new stage of the development of urban construction and are cost-effective elements of the urban economy. According to modern architects, most of storeys of buildings or a high density of urban population, in which housing, work and social institutions and activities are located close to each other, automatically lead to a higher quality of life. Since the advent of the first tall buildings the question of whether their construction is discussed in heated discussions between the architects, engineers, sociologists, psychologists, environmentalists, medical and security professionals. Without diminishing the importance of architectural and design issues when designing tall buildings, we note the following, not less serious problems that occur in the design of heating, ventilation, air conditioning:

– design of heating, ventilation, air-conditioning high-rise buildings is fundamentally different from designing the same systems for high-rise buildings, because tall buildings the influence of external climatic influences and the magnitude of the gradients of the flows of mass and energy inside the building were of extreme importance;

– every high-rise building is a unique work of architectural and engineering, and applied solutions cannot be replicated in other projects without serious rethinking and deeper additional research, including methods of physical and mathematical modeling.The architectural and engineering design of the building, taking into account the directed action of the external climate, makes it possible to increase the building's energy efficiency, microclimate quality and solve the problem of preserving the natural environment without additional costs.

To reduce the cost of energy, as well as reduce the harmful effects on the environment in high-rise buildings, autonomous sources of heat and energy are used. “Traditional” autonomous sources of heat and energy supply are characterized by higher efficiency and reduced emissions of harmful emissions. “Non-traditional” (renewable) sources of heat and energy supply include fuel cells, photovoltaic panels (solar panels), systems for using low-grade heat of the earth.

Section 1 focuses on the estimated parameters of the external climate

Adopted at the present time in Russia methodology of design of thermal protection of enclosing structures, heating, ventilation and air conditioning system is mainly based on three distinctive climatic periods:

• indicators of the external climate the coldest five days;
• indicators of the external climate heating period;
• indicators of ambient climate most of the month.

When calculating thermal protection and systems of climate control high-rise buildings these parameters may greatly differ from those accepted for the traditional multi-storey buildings. First, it refers to the change (selection) of wind speed. The most important indicator of high-rise buildings – their aerodynamics.

Considering that, every high-rise building is a major energy consumer, the choice of optimal technical and economic indicators (parameters) of thermal performance of buildings and systems of climate control should be

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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determined on the basis of operating costs, the main component of which are the costs to heat, cold and electricity. In addition, on the basis of these indicators should be the optimal form of the building envelope.In cold and warm periods of the year the outside air temperature falls approximately 1 °C every 150 metres of altitude, atmospheric pressure decreases about 1 hPa every 8 meters height and the wind speed increases [2].

The Chapter provides calculated values of the outdoor temperature, and outdoor barometric pressure at the earth's surface, modified by altitude ambient air temperature and barometric pressure, the intensity of total solar radiation, the methodology of calculating flows, the total solar radiation that arrives during the heating period on horizontal and vertical surfaces. Discusses the aerodynamics of buildings for ventilation design of buildings and calculation of air flows inside the building, assessing the impact of buildings on the aerodynamic mode of the adjoining territory, a choice of envelopes with the necessary breathability.

Section 2 addresses the issues of heating and energy supply of heating, hot water, ventilation and air conditioning

Heat supply of heating, hot water, ventilation and air conditioning systems (hereinafter the systems of internal heat supply) should mainly carry out thermal networks of systems of the centralized heat supply. The accession of the systems of internal heat supply to centralized system may be provided to ensure uninterrupted supply of heat in the amount of not less than the flow required for heating the building. Providing 100% reservation of heat supply for the building's internal heat supply systems is established by the design task. One of the solutions for redundancy can be the installation of autonomous heat and power supply systems for high-rise buildings based on gas turbine or gas reciprocating plants that simultaneously generate both of these energies. Modern means of protection against noise and vibration allow you to place them directly in the building, including on the upper floors. As a rule, the capacity of these units does not exceed 30–40% of the maximum required capacity of the facility, and in normal mode these units operate, supplementing the centralized power supply systems. With a large capacity of cogeneration plants, problems arise in transferring excesses of one or another energy carrier to the network.

In many cases, mini-CHP plants based on reciprocating motor generators are used as autonomous energy centers of high-rise buildings. The implementation of large-scale investment projects in many regions is constrained by the lack of free capacities of the country's unified energy system. Long-term plans for the commissioning of new large energy sources do not satisfy the construction needs due to long lead times. The period of excess power sources above the level of energy consumption ends earlier than expected by the energy sector.

Recent policies to stimulate consumption growth (if there are reserves of a commodity – it is necessary to implement them and to sell) have its downside. Dramatically increased the irrational use of electricity for direct transformation into heat – electric boilers, air curtains, electric heaters ventilation systems. To return to the mainstream of energy saving is very difficult.

A possible solution to the problem of energy supply of new buildings, including high-rise, is the design and construction of mini-CHP.

CHP providing energy high-rise buildings, can be a reasonable Supplement of the unified energy system and can work in parallel.

The complexity of this problem is that at a very early stage of design it is necessary all the basic features of CHP to harmonize with the system modes of energy consumption.

Unfortunately, in Russia there is no regulatory and methodological base of designing the CHP, and the practical experience of a small number of organizations, designing Autonomous energy centers is clearly insufficient. In the end, due to unskilled approach to the problem, there has been a trend to discredit the progressive trend of low power. Under optimal annual the download of the installation, given its autonomy and the minimum length of energokommunikatsij, the cost of production of electricity, heat and cold calculation is 1.5–2 times lower than current tariffs Central grid.

For maximum loading of cars could be excessive electrical energy be spent on compensation of losses of heat for heating water in hot water system, installing heating elements in tanks-accumulators. In this case, the system would be reduced heat supply for heating the hot water in the as received electrical energy for the same purpose, until the complete disconnection of heat for hot water needs. Selection of power of the installed piston machines are based on the load on the heating, but not the maximum time and the average for two of the coldest days of the usually choose the estimated five days. In summer, excess heat energy vyrabatyvaet simultaneously with the production of electric energy, can be used in heat absorption refrigerating machine for obtaining the cold necessary in air conditioning systems.

With a deficit of only thermal energy to the object as the source of heat may be adopted an Autonomous source of heat (AIT) in the form of a boiler with hot water boilers.

Can be used attached or detached boilers, opportunity and placement which should be linked with the whole complex of environmental impact, including residential high-rise building. Detached AIT is recommended to use two

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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or more closely spaced high-rise residential buildings. The chimney attached and detached AIT should be run above the roof level of the building, and its height is determined by calculation on the dispersion of combustion products.

Heat capacity of AIT choose the design load for heating buildings, for heating water supply systems, heat shields and average hourly load of hot water. In AIT, it is recommended to use hot-water boilers with water heating temperature to 115 °C. as a fuel for AIT used is natural gas. The pipeline should provide alloy steel with a gas pressure of 0.1–0.3 MPa. The thermal capacity of each boiler AIT and recommended amount to take into account providing one of the boilers fulfil the conditions ensure uninterrupted supply of heat in amounts not less than the flow required for heating the building.

All systems of high-rise multifunctional complexes must have 100% redundancy for heat exchangers and pumps. This allows in case of large frosts, when the heat supply organization does not comply with the temperature schedule and the temperature does not have enough heating area, to include backup heat exchangers in parallel operation and thereby ensure a normal temperature schedule for a given outdoor temperature.

If it is not possible to design 100% redundancy of the central heating equipment, it is necessary to provide a backup heat exchanger only for the ventilation system or at least one heat exchanger for maximum power, which, first of all, is connected directly to the heat exchanger of the ventilation system in the shortest circuit first.

The chapter also summarizes the experience of designing and operating a hot water system with one heat exchanger. As shown by operating experience, this system is efficient and very reliable.

Section 3 is devoted to the problems of device heating systems of tall buildings

Section 3 summarizes the experience of the design and operation of heating systems. On the basis of operational experience once again shows the advantage of door-to-door (horizontal) heating systems.

The use of door-to-door horizontal two-pipe heating systems with wiring in the floor allows you to:

– disable only one apartment or room, for example, in the event of an accident or, if necessary, repair or replacement of heating devices;

– adjust the heating system of one apartment or room independent of the other apartments or premises;

– to avoid problems arising from the unauthorized conversion of heating systems within the apartments (replacement of devices and thermostats);

– to carry out an individual heating system for each apartment depending on the wishes of the owner;

– install individual heat meters and go to pay for actually consumed heat energy according to the testimony of heat meters data.

The use of door-to-door (horizontal) heating systems, compared to the vertical, leads to a reduction in the length of the main pipes, which always have the largest diameter (most expensive), to reduce heat losses to unheated areas where pipelines are laid, the simplification of the floor and section of building input in operation.

The peculiarities of application of pipes made of heat-resistant polymeric materials.

Heating systems with pipes made of polymeric materials applicable regulations have the following requirements:

• Systems door-to-door (horizontal) heating in buildings should be designed with two-pipe, while allowing installation of devices of regulation, control and metering of heat for each apartment.

• Pipelines of heating systems should be designed from steel, copper, brass pipes, heat resistant pipes made of polymeric materials (including metal and fiberglass), permitted for use in construction. Complete with plastic pipes should be used fittings and the products corresponding to applied type of pipes.

• The coolant parameters (temperature, pressure) in heating systems with pipes of heat-resistant polymeric materials should not exceed the permissible values specified in the normative documentation on their production, but not more than 90 °C and 1.0 MPa.

Noted that the timing and the complexity of installation and the number of employees at the same time people are much lower than when using steel pipes, the system is very easy to work with and their installation does not require the specialists of such high qualification as welders.

Lifetime PEX-pipes depends on the temperature of the coolant – the lower the temperature, the greater the service life of the pipe. Manufacturers specify the lifetime of the pipes, depending on the temperature from 25 to 50 years. This is the minimum period of service.

The internal surface of pipes from the sewed polyethylene are always clean, unlike steel, where there is no accumulation of rust, scale, etc. ageing of the material of such tubes occurs only as a result of exposure to ultraviolet radiation. As mentioned in this Chapter buildings all pipes are protected from the sun – laid in ripple, the screed floor, in the space of a suspended ceiling, in Strabag – aging and destruction of these pipes does not occur. The heating devices are connected either through a special outlet installed in the wall or through a standardized metal liner on the bottom.

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Section 4 is devoted to the issues of ventilation and air-conditioning

This Section discusses the features of design of systems of ventilation and air conditioning high-rise multifunctional residential complexes

In residential and public parts of the high-rise multifunctional residential complexes usually applied mechanical supply and exhaust ventilation. The air conditioning system used in residential and public parts, but the systems vary depending on the destination premises. Public zones usually used Central air conditioning; in a residential area – local (piping) installation (such as split and multi-split systems).

For proper operation of the ventilation system hood, natural or mechanical, kompensiruet flow. If you use mechanical supply ventilation, no problems. In the case of natural flow, the use of sealed Windows disrupts the operation of the ventilation system. The simplest way of organizing the flow in this case is the installation of inlet valves on a window or external wall or use the "slotted ventilation". You can use other solutions. For example, in separate apartments to secure the flow you can install a small duct air handling units with the electric capacity of 3-6 kW, however, such a solution is possible only if the electric capacity can be provided.

The use of supply and exhaust mechanical ventilation has little effect on the cost of apartments, but it may be filed the required air flow regardless of external weather conditions.

When the economic rationale for the use at the facility mechanical centralized ventilation should bear in mind that when you use the natural flow through openable Windows for supply air heating is carried out by heating. Therefore, when designing the heating system needs to take this fact into account and, accordingly, to increase the surface of heating devices.

As noted above, for air conditioning of apartments can be used either local or Central air conditioning system. In the first case, in designated areas on the facade of the set outdoor units, from which one or more indoor units are summarized in the Freon line. In the case of using the Central systems of refrigeration machines installed, in most cases, in lower-her part of the building or on the roof, and the apartment is served chilled water.

In the design process the question often arises: what is more advantageous for cooling apartments – local multi-zone systems or Central systems with chillers and fan coils?

There is no simple answer. The decision on the appropriateness of an option shall be determined after examination of each project.

When choosing a cooling system of a residential area (local or Central) takes into account not only technical aspects but also economic considerations. In particular, the installation of local air-conditioning system for all costs for design, installation and maintenance of equipment is attributed to the customer who is the owner of the apartment (with a service manual, they specify only the location of outdoor units). When used for building air conditioning Central air conditioning system installation costs of equipment are costs of the investor, who then return the invested funds, increasing the cost of apartments.

Potential buyers in this case agrees to pay for additional services that improve consumer quality of the building and increase the commercial attractiveness of housing. But for the equipment of buildings with Central air conditioning required considerable capital investments. An investor often seeks to reduce the cost of the project, leading to the abandonment of a Central air conditioning system in favor of local systems.When using central air conditioners, chilled water is supplied to the apartment heat exchangers, such a system has more flexibility: if necessary, it is quite easy to change the configuration of the mains, with sufficient bandwidth it is possible to connect new consumers. To limit hydrostatic pressure, these systems are zoned, intermediate heat exchangers are installed on intermediate technical floors, etc.

In the head of a large place is given to the peculiarities of ventilation and air conditioning high-rise public multifunctional complex "Federation", namely the choice of design parameters of outside air, which was determined based on the conditions that cold and warm periods of the year the outside air temperature falls approximately 1 °C every 150 m height, and wind speed increases.In the warm period of the year, as a result of solar radiation, the outdoor walling there is a strong convective flow with a higher temperature than away from the building, so the accepted parameters of outdoor air differ from standard in both warm and cold periods of the year, given the higher security systems and the impact of the building height.

Design parameters of indoor air given the high-class building of the complex "Federation" are accepted, for example, in offices, in the warm period of 22-24 °C in the cold period of 20-22 °C and in the rooms at 22-24 °C year-round. During the cold period in most of the rooms provided for maintaining the relative humidity in the range of 30-40 %.

The choice of the air conditioning system of the complex "Federation".

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When designing a public high-rise multifunctional complex were considered two options of air conditioning system: floor-by-floor decentralized system and scheme of technical floors.

In a decentralized scheme, on each working floor provides for a small engineering center with an area of 60-70 m2 with a fence of external air directly from the front and the air exhaust is also on the facade in the normalized distance. In this center there is Central air conditioning, serving only your floor, handling unit, VRV external units or water-cooled chiller condenser, cooling towers, heat exchangers, pumps, electrical panels and other accessories.

In the variant with the technical floors are installed the same set of more powerful hardware, in particular, one technical floor, 6 air conditioners capacity 44 000 m3/h each, which supply air 12 floors up or down on the three vertical shafts separately for each facade (the building plan is in the shape of a triangle).

Technical and economic calculations and a thorough analysis showed that the preferred solution is a decentralized solution with a floor layout system. Its main advantages are the following:

– the smaller total area occupied by the equipment and mines;

a very high degree of zoning, as one system serving only one floor, i.e. approximately 1 700 m2;

– higher security, because failure leaves without conditioning supply air is only one floor of the building;

– lower operating costs because work is just a mini-engineering center corresponds exactly to the mode of operation of the offices of the serviced floor;

– the minimum cross section of air ducts and their length, the lack of flame-retardant valves, and some other elements of the network;

– exceptional ease of maintenance of the equipment having small dimensions and mass and, very importantly, a significant decrease in initial costs, since the purchase and installation of such equipment can lead as the delivery of premises in rent.

The drawbacks include only three factors:

higher unit cost of equipment, less power (for different types of equipment from 10% to 30%);

– lower specific energy parameters;

– significantly (several times) greater number of serviced equipment that scares the service manual.

Regarding the first two factors, they completely overlap with the above mentioned advantages.

In assessing the third disadvantage is necessary to consider that the process of operation, and, if necessary, and repair of small equipment, is much easier and cheaper, since you can quickly carry out the replacement of equipment and subsequent repair is already in stationary conditions the Studio, not on the technical floor. Layout option with technical floors for this particular object has almost no benefits, as technical floors be advantageous when deciding on the number and traffic patterns of elevators, and to place the power supply equipment.

For high-rise multi-functional buildings mainly used Central air conditioners with a minimum flow of outside air and the fan coil as local door closers-coolers or heaters. If teplopostupleniya in areas far exceed the heat loss in the cold period, in the scheme include dry cooler with a glycol circuit.

However, for areas that require a significant amount of outdoor air or are there local hoods, for example, restaurants, canteens, gyms, meeting rooms, etc., is more appropriate scheme, when the flow of outside air to accept of the conditions of assimilation of excess heat in cold period of the year. This solution allows to abandon the dry coolers, plate heat exchangers and ethylene glycol.

Section 5 considers the issues of fire safety facilities, including fire prevention in engineering systems

Development activities must ensure the safety of people in case of fire in accordance with the requirements of GOST 12.1.004–91 "Fire safety. General requirements". Limits of fire resistance of other structural elements of the building height more than 75 m and 100 m should be provided in accordance with statutory requirements for buildings of the first degree of fire resistance, and in buildings taller than 100 m, a special degree of fire resistance. According to MGSN 4.04–94, thermal insulation of external walls should be used, as a rule, non-flammable (NG) materials.

Pipelines of engineering systems (Sewerage, drainage, heating, hot and cold water, garbage disposal) should be taken from non-combustible materials. Pipelines of heating and water supply within the apartment (except risers) are allowed to perform from combustible materials groups G1 and G2.

The possibility of using pipelines of the sewage system of the combustible materials of the groups G1 and G2 must be demonstrated by test. Mine utilities (including garbage chutes) residential and non-residential part of the building should be separate.

Currently in the world there is a trend towards using a single integrated system of automatic control of engineering systems (smart buildings). In domestic practice of PPA, as a rule, ring-fenced from other systems of automation and dispatching. This is due to the fact that the creation of intelligent buildings, smart homes initially involves the use of expensive basic equipment. Developers are usually not willing to go on such costs. In addition, the

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more complex the instrument, the more systems it needs to serve, the higher the probability of it (or part of it) down.The automation of the fire protection systems of a high-rise building should ensure the full operability of many internal engineering systems of the facility, therefore, further complicating it, combining it with the automation of general ventilation systems, central heating, elevators, etc., is impractical. Due to the combination of these factors, reliability and cost, under the current conditions it is justified to separate fire-prevention automation into a separate system, which is isolated from other building automation and control systems and has a connection with the same general ventilation system no more than at the level of “dry” contacts. As you know, at the initial stage it is much easier to put out any fire. Even if it is not possible to completely eliminate the source of ignition, further extinguishing the fire can be simplified by localizing it and preventing the spread of fire throughout the building.

For these reasons, the operating companies a high rise multipurpose complexes often create their departmental (site) fire departments who are trained to respond quickly to the fact of occurrence of fire, and whose task is the localization of the place of fire prior to the arrival of paramilitary fire departments of State fire service of EMERCOM of Russia.

In high-rise buildings it is advisable to apply the scheme nezadymlyaemye stairwells 3 (N3), i.e., stairwells, shielded from the smoke by creating an air overpressure in case of fire in lobbies-locks. This scheme was tested in the Institute of fire prevention on the "fragment of a floor of high-rise buildings" and confirmed its effectiveness. In this scheme, the air in the air locks is served on a special channel. Parameters of the ventilator pressurization in the channel is calculated similarly to the parameters of the fan pressurization in Elevator shafts and stairwells.

Section 6 is devoted to the issues of water supply and sanitation

Unfortunately, the existing regulations for the design and operation of water supply systems the requirements for water supply systems of high-rise buildings were not full, scattered in numerous documents and do not contain requirements on resource. The reliability requirements are formulated in General terms and do not allow to assess the reliability of water supply to individual consumers and small consumer groups. Increasing the hydraulic reliability of systems of economic and drinking water supply is provided by zoning them according to the height of the building. Zone height is taken from the conditions of maximum allowable pressure in front of the intake fittings. All pumps and other equipment must have automation systems, dispatching and control with manual and remote control. Preferably these systems to integrate into an automated building management system.

The water distribution network take the ring. A great influence on the reliability of having the material of the pipelines, clogging or corrosion which leads to a deterioration of the hydraulic characteristics, to accidents and disruptions in the supply of water to consumers. The correct choice of pipeline material, the use of copper and plastic pipes, little subject to corrosion and clogging, significantly increases the reliability and durability of systems. Water tanks, providing temporary backup, create a regulatory and emergency water supply in the building and stabilize the water pressure in the system.

To reduce hydraulic instability of the internal networks, when the water temperature changes drastically when you turn on the faucets at the neighbors or in the next room, it is advisable to use a collecting housing layout, where each mixer is connected by separate tubing to a common manifold attached to the riser. The risers, control valves, control and measuring devices (water meters) it is desirable to make the outside of the premises so that the service operation in emergency situations could quickly disable the emergency stations placed in apartments and premises .Based on these considerations, in the exclusive commercial and high-rise buildings towers water supply system laid in the niche of ladder-leftoverall, providing you enter the apartment piping hot and cold water. The system is equipped with meters for hot and cold water, together with filters and pressure regulators installed in the distribution cabinets in the stairway and Elevator lobby. The calculation for actual consumption of resources is conducted according to indications of counters. This solution allows, if necessary, to cut off one of the consumers to check the pressure, adjust consumers. Localization of the damaged area helps to minimize the damage from the accident, the water supply of the neighboring apartments not terminated.

Wiring to apartments and the apartment is performed, as heating system from PEX-pipes, placed, as a rule, of the suspended ceiling (or the floor). Since the wiring from the disconnect to the water valves is performed without breaks, "one pipe", this scheme features high reliability, resistance to leaks. In turn, the smooth inner surface of pipe cross-linked polyethylene avoids the overgrowing of the pipe even in the case of very hard water. The water system is also divided into zones according to altitude, and in the described systems risers systems are laid in parallel in recesses of the stair-Elevator site, have convenient access for maintenance and repair. By analogy with heating systems all hot water risers equipped with compensators and fixed supports. The estimated circulation is exposed with control and balancing valves. The use of modern controllers allows the use of individual calorific point one group of heat exchangers hot water for 2-3 zones. The building in the first place must be installed with fire fighting water. Let this

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International Journal of AdvancedResearch in Science, Engineering and Technology
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system is in "dry" mode, but should be able at any moment to submit to it and to repay, for example, combustion of household waste on any floor.

Temporary water supply projects under construction must ensure the fire water consumption. Such water can be put temporary fire booster pump that can be turned on manually in case of fire to provide the fire. Currently, all new buildings are widely used non-flared cast iron pipe. These tubes do not burn in contrast to PVC pipes. In addition, they are soundproof, which is important for luxury buildings. When you fire a PVC pipe is lit, passes the fire to adjacent floors and secretes toxic substances. One of the main advantages of this system is the quick dismantling of individual sections of beds on the tehetazha to remove cement-sand and colorful adhesive deposits, which grows to 3/4 section of sunbeds for two weeks. For quality of cleaning the sunbeds machine "Cobra" with the simultaneous flushing of the system is used with the device of cleaning of two polwatta in order to open the funnel was above the main pipe.Special attention should be given to releases of high-rise buildings. Since buildings have a considerable drawdown, releases in exterior walls not sealed deaf, and uses a special damping device, which does not allow the pipe to release be reversed. This also applies to all other networks.

Another problem is the drainage of water in case of fire. If there is sprinkleron apartments, must not be about 100% waterproofing apartments (and not just the areas of the bathroom) because of a leak on the lower floors will lead to the need for reparations. For interroom halls is necessary to make the slope of the floor to the receiving holes (trap in this case is not suitable because it has a small bandwidth) and output pipes at floor level interroom hall (with discharge in drainage network).

For the rest of the Sections will focus only on content.

Section 7. Disposal of rubbish, Bulgarovo

Discusses the devices of waste disposal systems and saleprovides.

Section 8. Automation

Examines the questions:

– Work offline and work in a collaborative mode. The choice of Protocol.

– Intellectualization of the building.

– Peculiarities of automation of some types of HVAC systems.

– Regulation "on the reverse air".

System with zonal control.

– Systems with variable air flow (VAV).

System with group control.

– Pair of automation systems with security systems.

Pairing with the power supply system.

– Engineering and operation.

An example of the use of system automation and control in high-rise residential complexes.

– Automation system of ventilation and air thermal veils.

Automation systems Central heating unit.

– Fire alarm system and automation.

The access control system and burglar alarm.

System for video surveillance and digital recording of video.

Section 9 describes the built of existing high-rise complexes

In the annexes to the book the questions of aerodynamics of high-rise buildings:

– Change the height of temperature, wind speed and barometric pressure.

Convective air flow from the outside of a building.

– Wind pressure, aerodynamic coefficients.

– An example of the results of mathematical modeling of aerodynamics of a tall building.

– Approximate method of determination of local aerodynamic effects on high-rise building with application of computer technologies simulation of turbulent flow around the facades of a complex configuration.

– The choice of the model surface boundary layer. Approximate methods of calculating wind loads.

– Average component of the wind speed.

– Mindful of the speed of wind gusts.

– Two mechanisms of unsteady wind loading on facades of high buildings.

– Technique of differentiation factors in maintaining an unsteady wind.

– Numerical simulation of the unsteady two-dimensional flow profile of the building.

Mathematical model, computational domain, the technology of computing.

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– Methods of processing results.

The results of numerical simulation.

– Calculation of wind loads via the hybrid method.

The book, undoubtedly, will cause interest of specialists.

We are grateful to all, who will find the opportunity to Express their comments or suggestions to the contents of the book. Your comments and suggestions will be incorporated into subsequent editions.

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