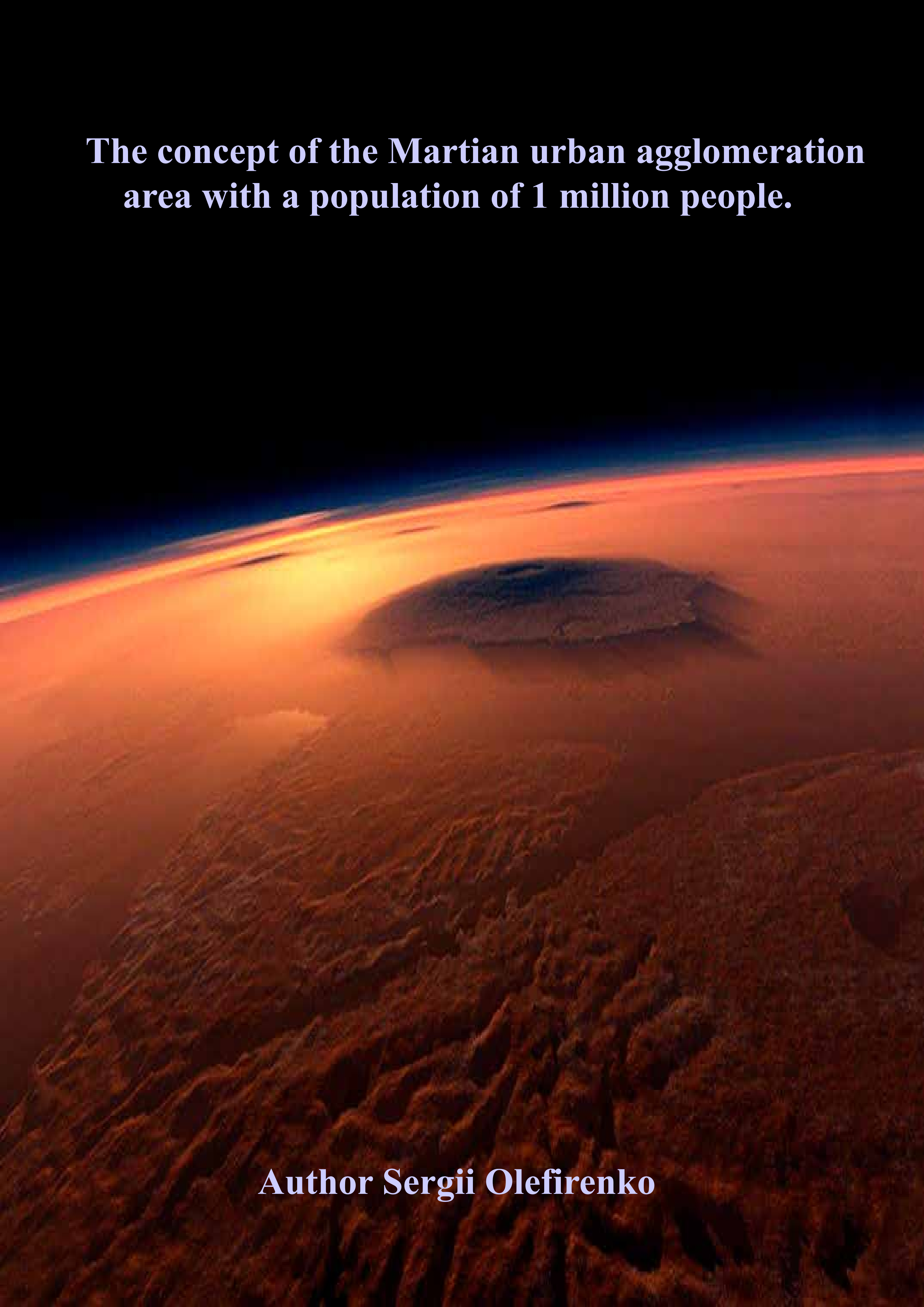
The concept of the Martian urban agglomeration area with a population of 1 million people.



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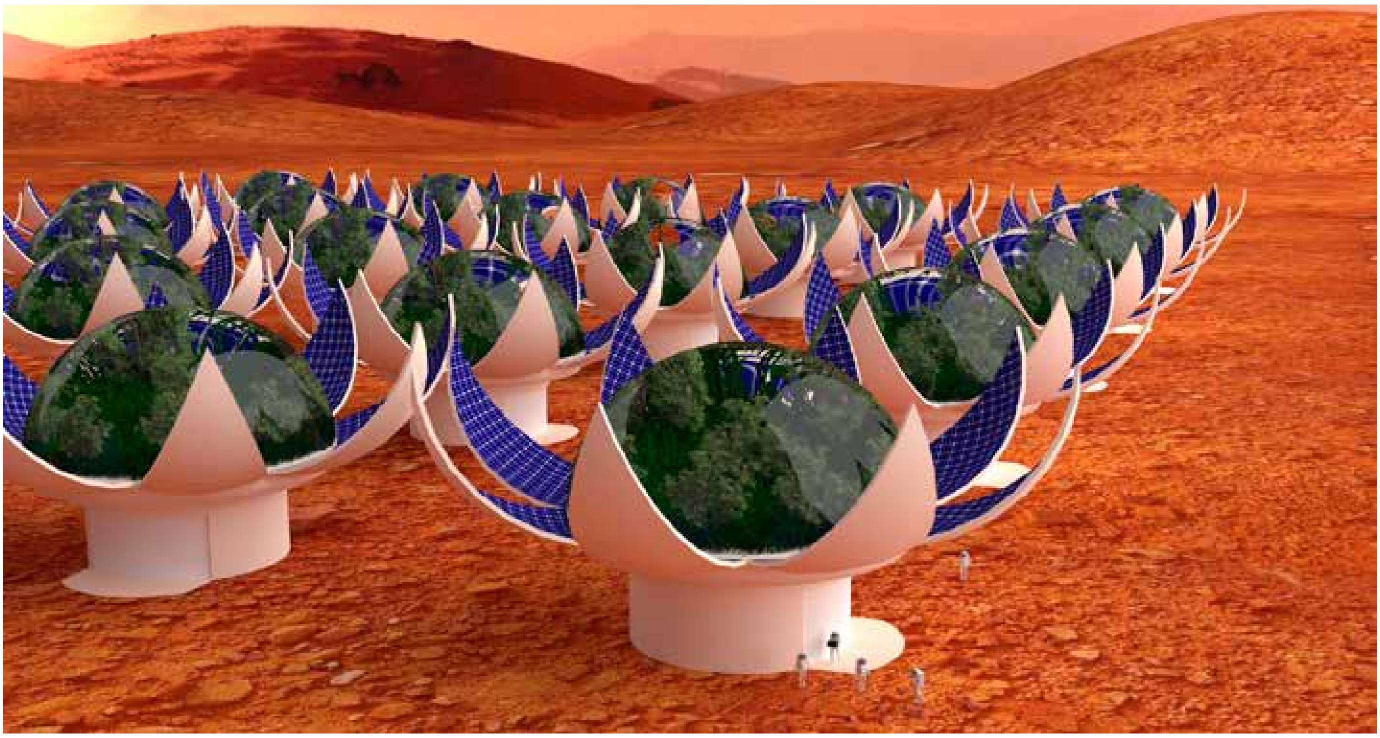
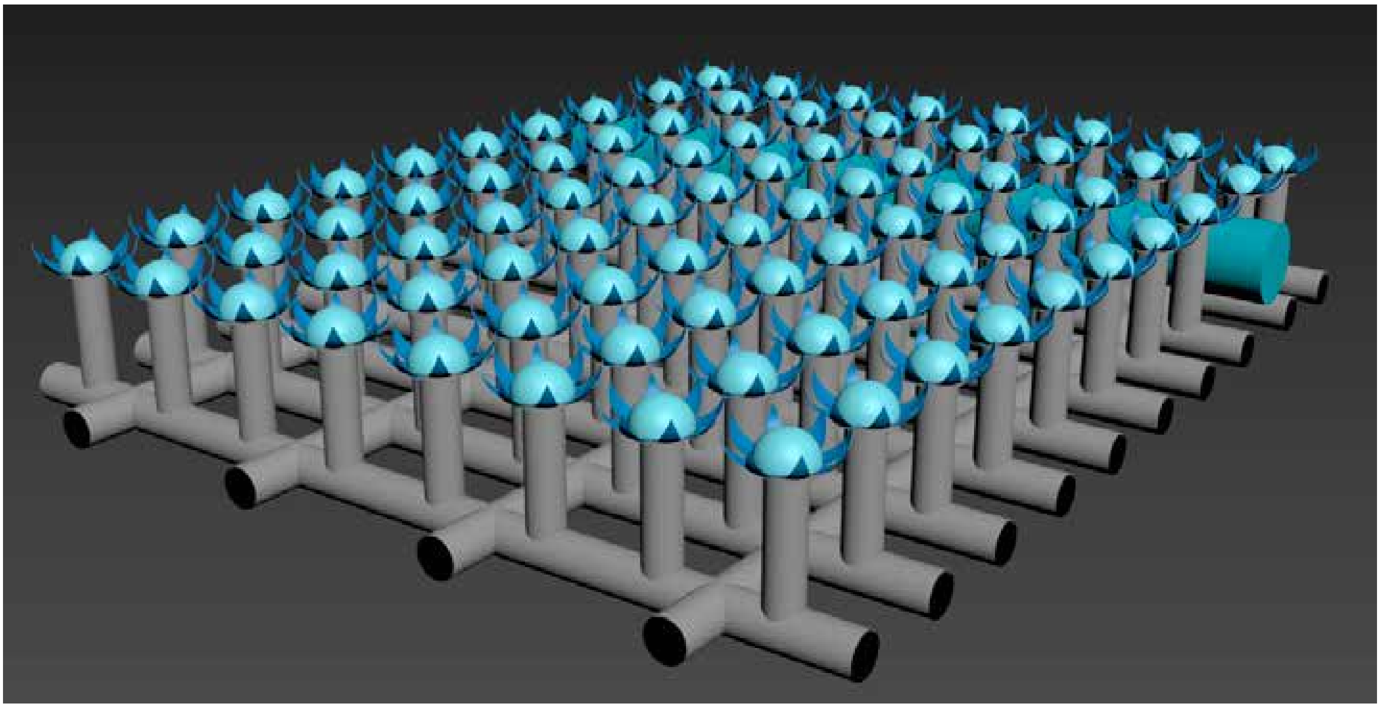


Introduction



Choosing a place for the construction of urban agglomeration

The best location for the urban agglomeration is the valley, on a sunny slope next to the cliffs. They will create shadow radiation protection from one side. In addition, under the rock on the sunny side, heating is better. In the valley, where there are high slopes that concentrate part of the solar energy and additionally heat the valley, and there are no high elevations on the opposite side, it is certainly warmer. It is also desirable to place the city over a hot reservoir hidden beneath the surface of Mars, which will allow the city to be supplied with water and electricity.

There are powerful dust storms on Mars. During a dust storm, it overcooling of the planet's surface occurs. Due to the fact that a lot of dust rises into the atmosphere, the colony modules must be compactly located and have everything necessary for people to live for a long time within a limited space. Strong winds blowing on the plains are carrying a lot of dust and create a wind load and cool the construction, therefore, the preservation of heat in inhabited constructions will become one of the most important problems of future colonists, in addition to oxygen, water, and food.

On the surface of Mars, a sufficiently high level of radiation is therefore required for radiation protection of residential premises. Although it is lower than in space, a long stay without special protection will lead to the accumulation of radiation, therefore, constructions should provide maximum absorption of radioactive particles.

Certain difficulties will be connected with protection against ultrahigh-energy particles. Complete absorption of radiation to a background level close to the Earth’s level is possible only at great depths below the surface of Mars. The most effective radiation shield is a three-layer composite using boron carbide. It is also possible to apply protective coatings of boron-containing material and nickel directly to the surface of the module. In the facilities of the colony, life-support systems for a closed cycle for oxygen and water should be created. They should provide normal pressure and air composition, as well as have a room heating system. For access to the surface, the city modules are equipped with lock chambers and have appropriate thermal insulation for effectively retain heat with minimal energy consumption. Fibrous materials for thermal insulation, under the conditions of Mars, can be obtained from basalt.

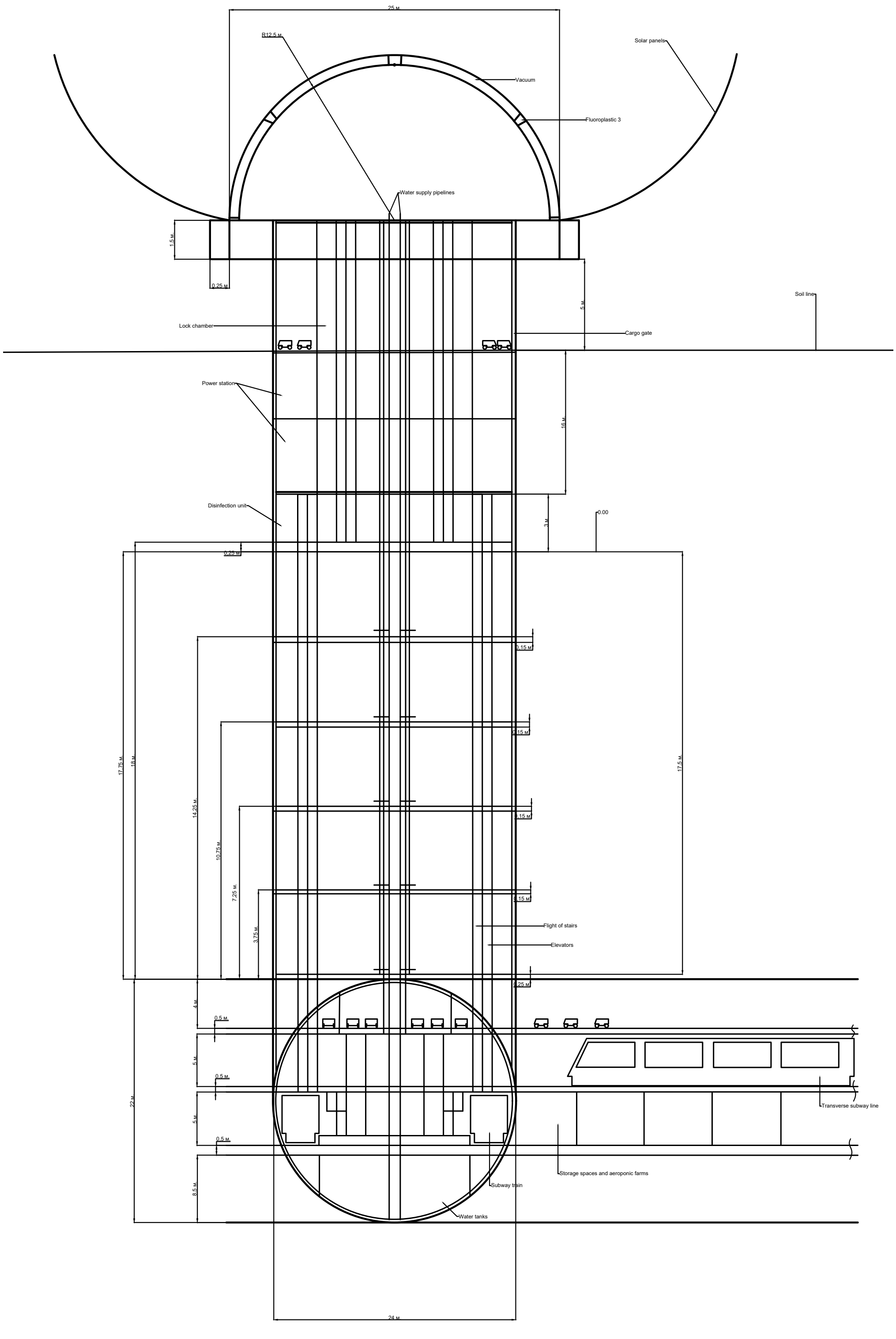
1. The infrastructure of urban agglomeration.

City infrastructure is a system of tubular modules interconnected by a transport system. The total number of modules is 26720 pcs. and are designed for 1000000 inhabitants. Of them:
- 25000 modules are residential and have an external of the dome size 25 m.
- 1000 modules are the infrastructure of recreation and entertainment. They are represented by shops, cafes, hotels, and restaurants, located in the center of the city agglomeration, in the amount of 100 pcs. for every 10 transverse subway lines. The diameter of the external dome is 75 m. They include entertainment centers, cafes, science and echnology centers, SPA complexes, beauty salons, educational centers, cultural and art centers, cinemas, cycle tracks, and slides for skateboarders. These modules do not have their own power plants, and power is supplied from a common network.
- 120 modules are located on the periphery of the city, on the transverse ring lines of the subway, 60 modules on each side of the city agglomeration, for the possibility of observing the Martian landscape. There are no power plants in these modules, but they are equipped with freight elevators for the possibility of moving bulky goods and equipment from the surface into the transport infrastructure of the city agglomeration and vice versa. At the top of these modules are hotels, restaurants, cafes, stadiums, pools, cinemas, and the conditions of various climatic zones of the earth with their flora are created. Fauna, at the first time, can be represented by marine life, bred from eggs, due to the difficulty in transporting animals that may not transfer a long journey from Earth to Mars.
- 200 modules located on the longitudinal lines of the subway, 100 modules on each side of the city - are industrial facilities and represent enterprises that shape the city’s economy, they are represented by the main plants and factories.
- 400 modules moved outside the main transport infrastructure, along the longitudinal line of the subway. The chemical, and metallurgical industries, as well as machine-building enterprises, are located in it. The mining industry is implemented by automatic robotic complexes for work on the surface, as well as mining in the mine way.

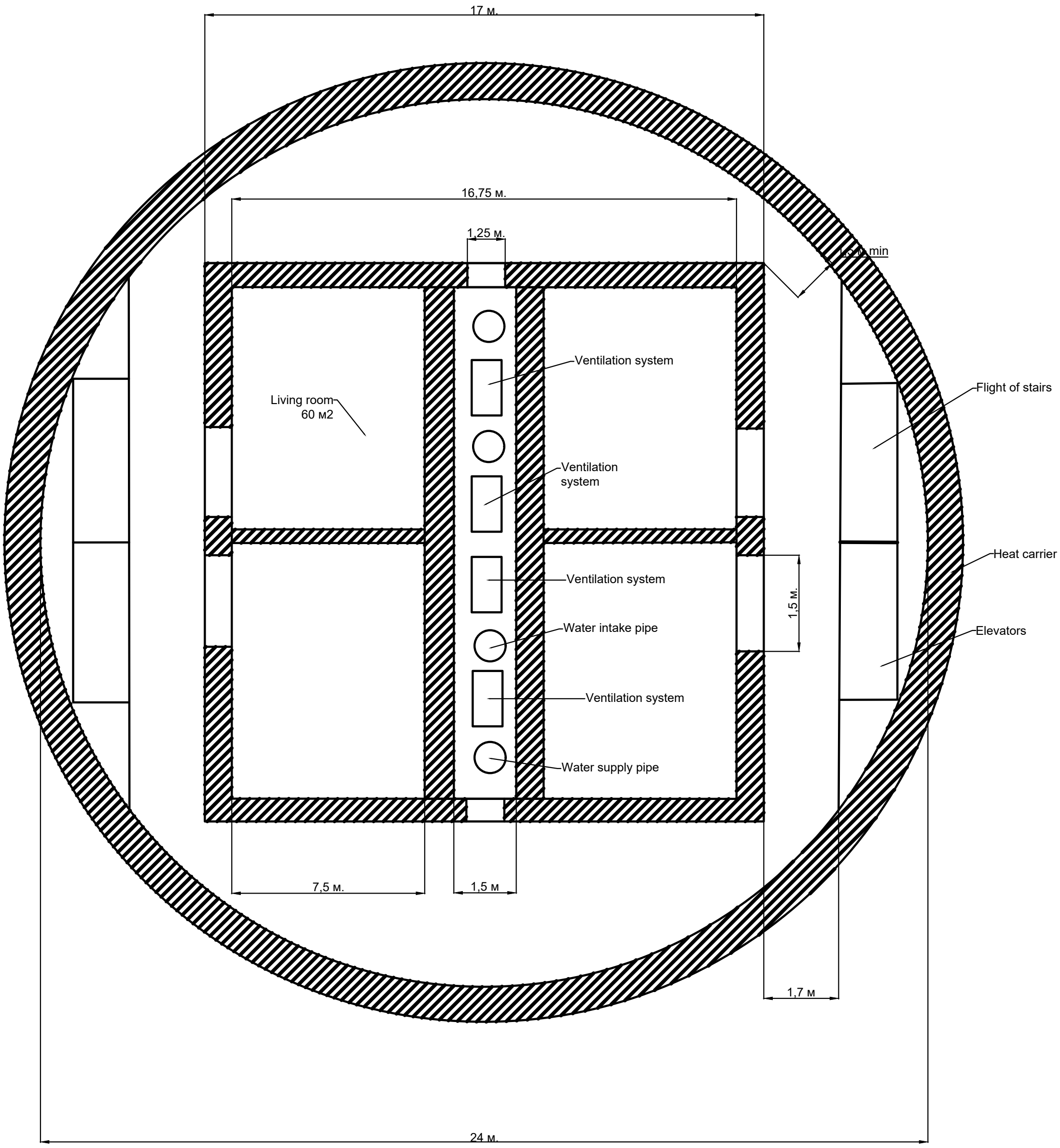
A standard residential module consists of:
1. Dome system of hydroponic farms. The highest point is at +19 m above ground level. The hemisphere radius of the dome is 12,5 m.
2. At +6.5 m above the ground, there is a system of compensating devices and pneumatic actuators for opening/closing protective petals with installed solar panels.

3. On the ground line is the outer part of the residential module, which is a transport block, lock chambers, and a condenser system of a power plant.
4. At the mark of -16 m. is located power station «FGR» (Fast Gas Reactor)
5. There is a disinfection unit at the level of -19 m. Next are the residential blocks.
6. At marks from -19 to – 36,5 are located the residential premises.
7. At the point of -58,5 there is a transport infrastructure that includes the subway and a transport system located at different levels and interconnected by a system of elevators and stairwells, as well as a communications system, storage facilities, aeroponic farms, etc., in accordance with module shown on the drawing section.
8. Each module is designed for autonomous provision of 40 people.
9. The residential block has an area of 452,38 m2 and consists of 4 apartments with an area of 60 m2 each, designed for a family of 2 people. The rest is the transport infrastructure and life support systems.

The location of the transport system and residential modules can be changed in accordance with the technical capabilities of the implementation.



Section of the residential module. Conditional designation. (not to scale)



Section of the residential block

1.1. Transport system.

The transport system of the subway serving 1000000 people, at the rate of 40 people per module and the number of modules 26320 pcs.

1.2.1. The number of modules per subway line:

Longitudinal line - 1 line for 200 modules. A total quantity of 132 lines. Passenger flow - 8,000 people at the rate of 200 residential blocks of 40 people.

Transverse line - 1 line for 10 modules. A total quantity of 20 lines. Passenger flow - 5,000 people at the rate of 125 residential blocks of 40 people. The total number of lines, including circle ones - 156 pcs.

The total number of subway trains is 65

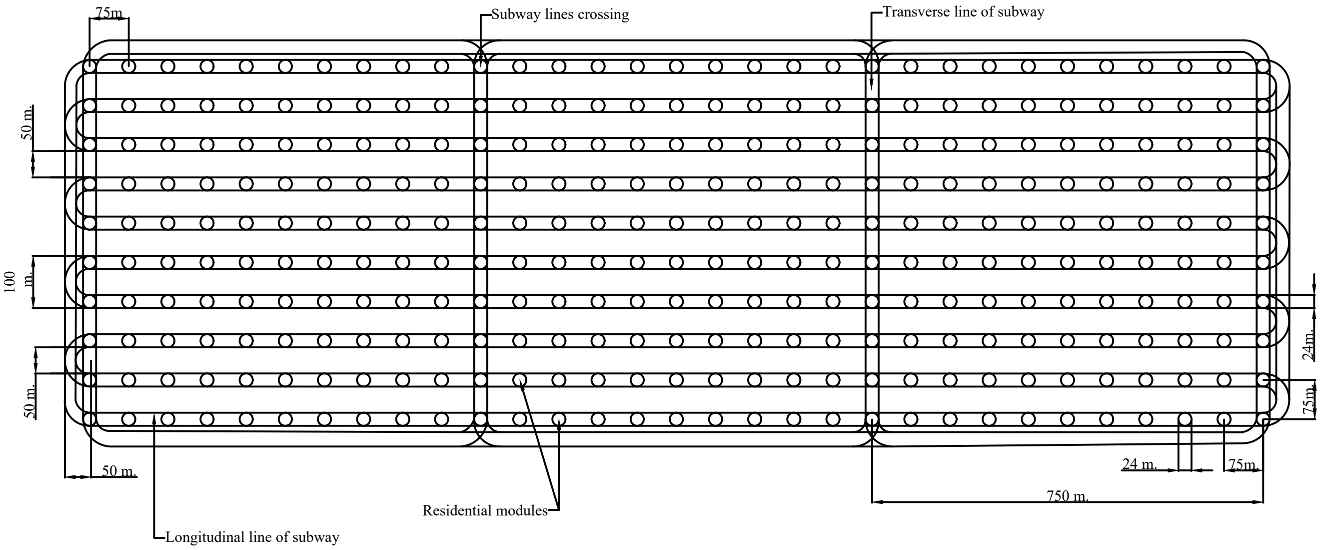
The length of the longitudinal line is 15150 m. The number of trains is 40

The length of the transverse line is 10675 m. The number of trains is 25

1.2.2. Calculation of passenger capacity and length of the metro.

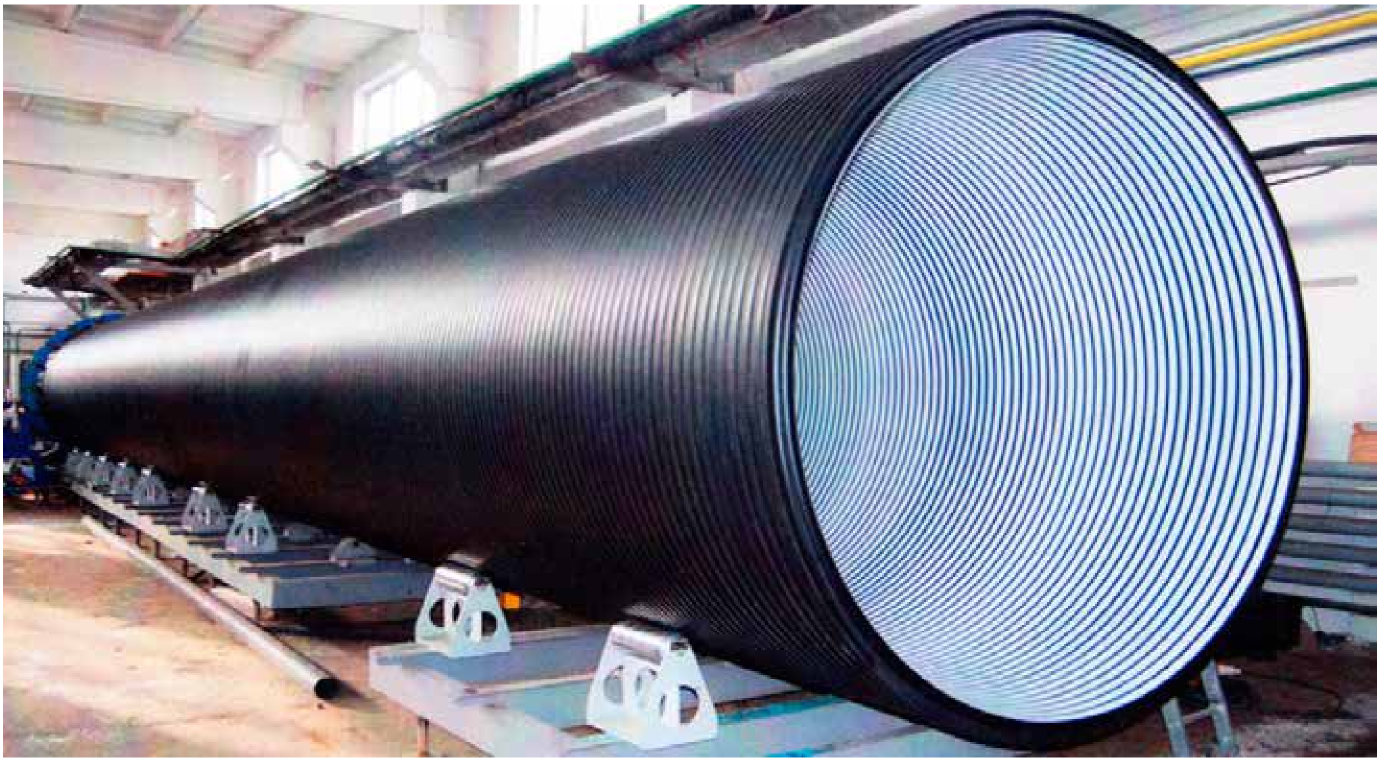
Each transport capsule accommodates 40 people., 20 people on each side of the capsule. The total length of the capsule from the calculation is 0.5 m per person, plus 2 doors of 1.5 m each, plus 2 m to the space between the seats and the capsule wall. The total length is 15 meters. Each train consists of 5 capsules, two of which are traction, and taking into account the coupling devices is 80 meters. The drive is implemented by the linear electric motors.

The subway infrastructure is powered by power plants located at the top of the modules and is supplied both from a common network and from each individual power station in case of an emergency. In the event that any of the power plants is disconnected from the general network, the operation of the subway and the infrastructure as a whole will not be affected. The area of the city agglomeration is - 15650 * 10025/1000 = 161726,25 km2



An approximate scheme of the Martian subway

The tubular system is a plastic pipe of a certain section, welded in a spiral, the section of which is a hollow wall that acts as stiffeners and allows the transfer of coolant or compensates for the difference in internal and external pressures. The choice of a solution in favor of the tubular system is justified in terms of strength, practicality, on-site production speed, and maximum efficiency at minimum cost.



2. Engineering systems

2.1 The external part of the module (hydroponic farms)

The external, above-ground, part of the module consists of a double-walled dome of hydroponic/aeroponic farms, separated by stiffeners of the hexagonal honeycomb type made of material - fluoroplastic 3 and is a technological complex, with installed mechanisms and sensors. It functions constantly and gives a harvest round the year. The rarefaction between the walls of the outer and inner part of the dome is aimed at reducing heat loss by the farm itself, and fluoroplastic 3, due to low thermal conductivity, acts as a temperature bridge.

The degree of rarefaction is determined by the calculation method and technological capabilities of obtaining. Perhaps the use of turbomolecular pumps (if necessary). The base of the dome is also made of a material with low thermal conductivity (ftoroplast 3 or ftoroplast 4 (teflon)). Dome protection is made in the form of petals that are closed with pneumatic cylinders in case of dust storms, as well as at night, to reduce heat loss. In the daytime, the petals open, allowing access to sunlight. The solar panels are made on the inner part of the petals for the possibility of obtaining additional energy directed to domestic needs. At night and when closed, the hydroponic farm is illuminated by LED lamps.

The opening of the petals is possible up to 90 degrees with a rotation around its axis by 15 degrees in each direction. The rotation and regulation of each petal occurs individually using pneumatics (hydraulics will be difficult to implement in the conditions of Mars). A side that is less lit can be completely or partially covered by petals to maintain optimal temperature. Petals, it is desirable to make from a material with low thermal conductivity like fluoroplast 3 and aluminum base. These petals can be assembled from segments of the Lego or Puzzles type and connected by locks, possibly using welding, on the place. When closing, all the petals are set in the same position and then closed. The same thing happens during disclosure. The opening/closing drive is a pneumatic cylinder system. The rotation mechanism is implemented by a valve or plunger system of pneumatic distribution of the flow of the working substance to a dual-flow impeller, the axis of which is connected to the petal. Fluoroplast 4 (Teflon) is being considered as a coating material for sliding bearings.

The regulatory system is implemented in two ways:

1. Software, collecting data from temperature and lighting sensors;
2. Manually, in case of software malfunctions, either when sensors fail, or during scheduled maintenance, repair, etc.

The supply of carbon dioxide necessary for plant life occurs from the outside, after preliminary cleaning and heating by cooling the working substance of turbine condensers, using CO_2 as the working substance, which is carried to the outer, above-ground, part of the housing of the residential module. CO_2 is supplied for cooling forcibly. The laser is used for cleaning the glass of domes of hydroponic farms from dust. It is also possible to use an electrostatic field to protect against cosmic rays and the use of absorbing materials. At the time of construction, the use of inflatable greenhouses and residential modules is possible.

To maintain the pressure inside the dome of hydroponic farms, at the minimum necessary level, due to the increase in pressure with the increasing temperature inside the dome during the daytime, a system of pneumatic or hydraulic accumulators is located on the periphery of the dome and is provided in an amount equal to the number of petals. When depressurizing/equalizing the pressure in the pneumatic/hydraulic accumulators, the useful energy is used to close/open the petals, thus minimizing energy consumption.

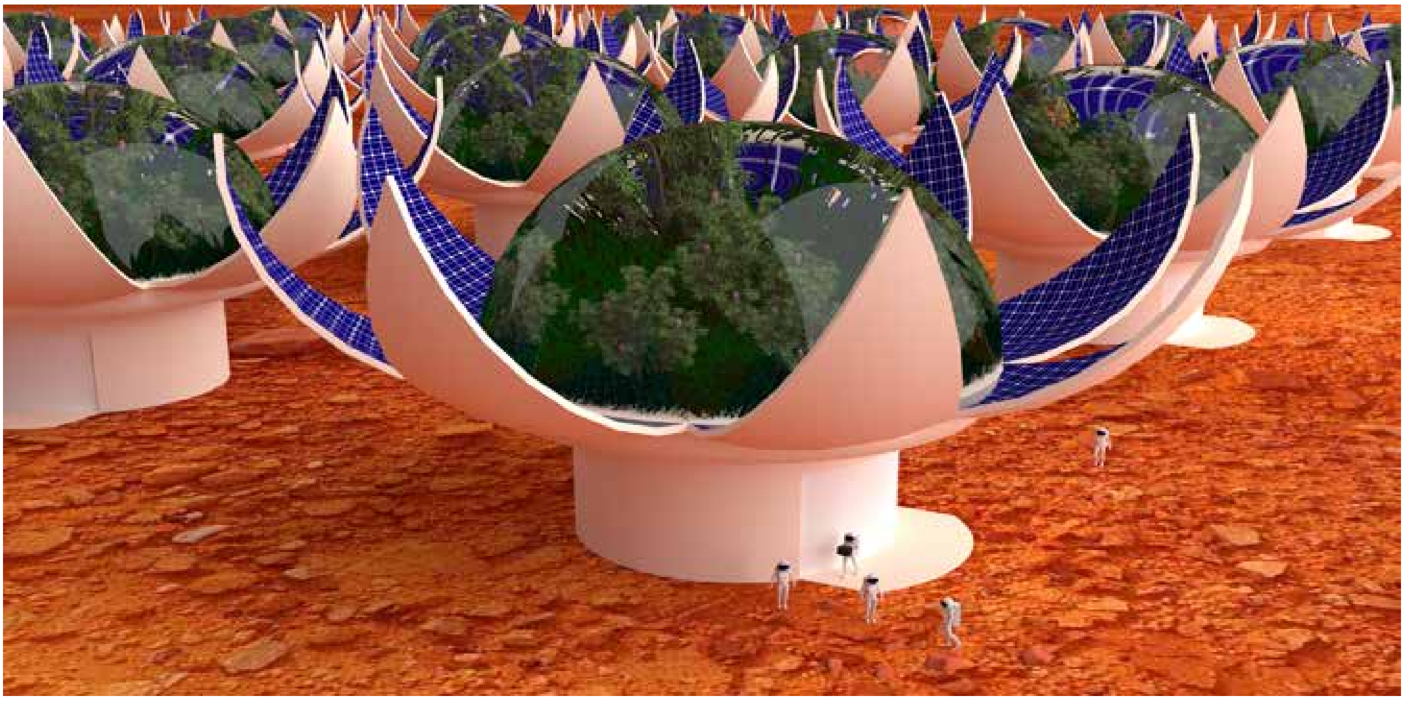
2.2. Structural strength.

For compensate of the pressure on the dome from the inside, the mass of the structure must compensate the air pressure inside the structure by the mass of overlap, otherwise, the air pressure can destroy the structure. At the same time, the air pressure force supports all structure. The loads are evenly applied to the spherical structure, so the main problem point will be the conjugation between the hemisphere and the base. It must be reinforced, engage with the base, and have a greater thickness at the base. The dome itself must work in tension and have a solid structure. A dome made of translucent plastic conforms to this condition. In such a dome, the internal air pressure is balanced by the forces of elasticity or the forces of molecular attraction of the dome material. The main danger here is that damage to the dome can lead to the fall of all structure. To prevent this, the dome must have a margin of safety and in the absence of internal pressure, the structure must be stable. Thus, inside the dome, in addition to the spherical structure itself, support elements with compensators working in tension, compression, and shear can be located. Also can consider the design of two-layer, translucent elements of a hexagonal shape such as honeycombs, with compensators along the periphery of the honeycomb, assembled together using lock joints, the layers of which are made vacuum. The shape of the lock of the honeycombs is such that the higher cells press on the lower ones, fastening the entire structure, and the lower ones do not allow the higher cells to fall, fixing their position. In the presence of internal overpressure, such a design will be effective if the weight of the dome is much greater than the internal pressure force. The outer dome can be further strengthened with an aluminum structure of a hexagonal shape, such as honeycombs, connected at the periphery to the base and shielded with precision nanocomposite coatings. A multilayer system transparent to visible light is formed on the glass, which adheres firmly to the surface and maximally dissipates the impact energy of the incident particle.

2.3. Residential Modules.

The housing of the module is made of plastic pipes with an internal section up to 100 mm., welded together. This technology allows producing on-site hull parts of different cross-sections, including residential modules and hull parts of the transport infrastructure. In this case, the pipe walls act as stiffeners, since the module is made of a twisted pipe welded in a spiral. The heat carrier passes through the internal, inter-wall section of the pipe, the kind of which is determined by the calculation method and technological capabilities. It can be water, air, or carbon dioxide.

Also, filling the inter-wall space with a heat carrier compensates for the difference between internal and external pressure. The inter-wall space of the internal part of the module, located above the soil line, can be performed using screen-vacuum insulation. The same applies to the base of the dome. The outer part of the housing module, protruding above the surface, is a hull, 3/4 of which is surrounded by a tubular heat exchange system of the turbine condenser and 1/4 is the space of the cargo gate. Cargo gates do not have lock chambers. The pressure inside the cargo compartment is similar to external pressure, or slightly higher. The lock chambers are located inside the outer part of the module and are located around the circumference of the inside of the outside of the module. They are not interconnected and are not directly related to the transport system of the module. Residential blocks are located at the level of -19 m. (zero level). And lower, to the level of -36.5 m. from the ground level. Next is the transport system to the level of -58,75 m. Power supply for each module is provided both from its own power plant installed in each individual module and from the common network in case of an emergency. In the event of a shutdown of any of the power plants, the module will be powered from a common network and it will not affect the operation of life support systems. Each module is equipped with a vacuum product delivery and waste disposal system.



2.4. Energetics.

From the soil line to a point of -16 m., is located the FGR power station (fast gas-cooled nuclear reactor), operating on the Rankine carbon dioxide cycle, auxiliary equipment, and communications. At a point - 18,75 m from the soil line, a disinfection unit is located. The power station can also be carried out in a separate module, depending on the required power. It includes a high-temperature reactor, a turbine, three regenerators connected in series, a condenser, a pump, and a compressor connected in parallel with it, as well as main pipelines of high and low pressure, a storage and filling system for the coolant. The use of carbon dioxide as a working substance is justified under the conditions of Mars and makes it possible to carry out the Rankine cycle with condensation and compression of the working substance in the liquid phase, which can drastically reduce the power consumption of compression power. However, a simple Rankine cycle with CO2 compression only in the liquid phase does not allow to obtain high efficiency due to the fact that the heat capacity of high-pressure carbon dioxide in front of the turbine is almost 2 times greater than its heat capacity at the outlet of the turbine. As a result of this is the relatively low temperature at the inlet to the reactor and, accordingly, low efficiency is obtained. In a combined compression scheme, only 65% of the carbon dioxide flow is sending to the condenser and then to the pump, and 35% of the flow is compressed by a compressor working parallel to thepump. The first regenerator after the pump has a high-pressure carbon dioxide consumption of about 65% of the consumption through the reactor, and 100% of the flow rate flows on the high-pressure side of the regenerator.
A scheme with combined compression of carbon dioxide by a pump and compressor significantly increases the temperature at the inlet to the reactor, which leads to an increase in efficiency. After heating in the first regenerator, high-pressure carbon dioxide is mixed with carbon dioxide compressed by the compressor. The parameters of the regenerator are selected so that these flows have the same temperature with carbon dioxide at the compressor outlet. Then the mixed stream enters the second regenerator, in which the consumption of substance on the high and low-pressure sides is the same. In the second regenerator, high-pressure carbon dioxide is heated to a temperature of 370 ° C. Such parameters of the second regenerator are selected to have carbon dioxide in the cycle with a temperature acceptable for cooling the reactor vessel and the housing of the third high-temperature regenerator. In the third regenerator, high-pressure carbon dioxide is heated to a temperature of 640 ° C.

At this temperature, carbon dioxide is sending into the reactor. In the first and second regenerators, the tube plates are made of low carbon steel, and the tube plates of the third regenerator are made of heat-resistant austenitic steel. The design of the reactor used double pipelines with thermal insulation and detachable joints. To protect the case, radiation and thermal protection with slaked lime Ca (OH) 2, which is placed in steel tubes, is used. The power supply of the city agglomeration is carried out both from the general network, and from each individual power station, in case of an emergency. In the case of the disconnection of any of the power plants from the general network, the operation of the infrastructure as a whole will not be affected.

2.5. Water supply system. Under the transport system are water reservoirs. This location assumes maximum protection, the possibility of drainage, and the recycling of water resources.
The water supply system can be interconnected by the general water supply system of the city, and also it can be separated, in case of emergency, in order to avoid pollution. Separation is carried out by overlapping gateways on both sides of the same module.
Water supply from the point -58.75 m is carried out through pipelines located in the central part of the module in two ways:
1. With using a pump system (main water supply)
2. By using electro-hydraulic elevators (reserve water supply) and water supply to hydroponic farms. If appropriate.
2.1. The principle of operation is based on creating a vacuum in the pipeline when lifting the elevator, in which, with the water supply valve open, it rises through the pipeline with section «a» and is fed into the pipeline with section «b», through the non-return valve, during the descent of the elevator. The valves are made spherical, according to the principle of pumping-compressors tubes. In this case, the water column acts as a hydraulic brake, preventing the breakage (falling) of the elevator in the event of a power outage or an emergency of a counterbalance system.
2.2. The pneumatic or hydraulic accumulator acts as a compensating device that allows you to compensate for the power consumption for lifting the counterweight mechanism, and also has an external heat exchange circuit for heating the working fluid used in the turbine of the power plant by cooling the working substance of the pneumatic/hydraulic cylinder at increasing temperature, due to increased pressure under compression.

2.6. Air conditioning and ventilation systems. The ventilation system is located in the central part of each module. Residential blocks have their own ventilation and gas purification system with heat recovery. The air conditioning system works in conjunction with heat pumps and a common life support system. In case of emergency, each module is equipped with a backup ventilation system, which is common to the entire city agglomeration.

2.7. Life support systems.

2.7.1. Oxygen production. The production of oxygen should provide oxygen supply to the atmosphere of the residential unit in the amount of 0.9 kg/day per person and maintain a partial oxygen pressure in the range of 18-32 kPa.
2.7.1.1. Using of Na_2O_2 imported from Earth by reaction: $2Na_2O_2 + 2CO_2 = 2Na_2CO_3 + O_2$
The resulting sodium carbonate - alkali is necessary for carrying out metal leaching reactions, as well as in the production of glass, to reduce the melting point of SiO_2
Further, at heating, possibly in reflective furnaces: $Na_2CO_3+Q1000°C = Na_2O + CO_2$
Further, at heating: $2Na_2O + 3Co_2+Q500°C = 2Na_2Co_3 + O_2$
2.7.1.2. Perchlorates. Perchlorates are strong oxidizing agents that can decompose with the release of oxygen when heated.

Name	Chemical formula	Decomposition temperature °C
Aluminum perchlorate	$Al(ClO_4)_3$	147-427
Ammonium perchlorate	NH_4ClO_4	200-270
Boron perchlorate	$B(ClO_4)_3$	20
Bromine Perchlorate	$BrClO_4$	-20
Gallium perchlorate	$Ga(ClO_4)_3$	175
Potassium perchlorate	$KClO_4$	610
Calcium perchlorate	$Ca(ClO_4)_2$	300
Cobalt perchlorate	$Co(ClO_4)_2$	450
Lithium perchlorate	$LiClO_4$	400
Magnesium perchlorate	$Mg(ClO_4)_2$	251
Copper perchlorate	$Cu(ClO_4)_2$	230
Sodium perchlorate	$NaClO_4$	482
Nickel Perchlorate	$Ni(ClO_4)_2$	400

2.7.1.3. Separation of carbon dioxide into oxygen and CO is possible using low-temperature plasma (ionized gas), the charged particles of which can both separate individual ions from a carbon dioxide molecule and indirectly contribute to their separation, providing additional energy to individual atoms in the molecule and increasing the amplitude of molecular vibrations. On Mars, where the average temperature is minus 60 degrees Celsius and the pressure is 6 mbar, the re-oxidation reaction will occur slowly, which will give time to separate oxygen and CO
2.7.1.4. Cyanobacteria and photosynthesis of hydroponic farm plants.

2.8. Atmospheric cleaning system. The gas purification system should ensure the collection and removal of carbon dioxide from the atmosphere in an amount of 1.0 kg/day, maintain its partial pressure at a level of no more than 1 kPa, and also ensure that the atmosphere is cleaned of harmful micro-impurities emitted by humans and equipment. One solution may be the use of aluminosilicates (molecular sieves) with a cell diameter of 0.3-0.31 nm, sufficient for the separation of oxygen molecules with a diameter of 0.3 nm. The second solution, on an industrial scale, can be the expansion of the cleaned air, in which, when expanding on the turbine, compressed in the compressor of the air mixture, and its sharp cooling - part of the CO_2 goes into solid-state and is removed. To compensate for energy consumption, the turbine is connected to a generator.

2.9. Water supply system. The water supply system should provide the colony staff with drinking water in an amount of at least 2.5 kg/person per day. The presence of perchlorates on Mars can facilitate chemical reactions to produce hydrochloric acid and the subsequent production of water and oxygen: $4NaO_2 + 4HCl = 4NaCl + 2H_2O + 3O_2$
Thermal decomposition of ammonium perchlorate: $4NH_4ClO_4+Q200°C = 2Cl_2+3O_2+8H_2O+2N_2O$

To purify water, in the presence of perchlorates in it, you can use terrestrial bacteria that restore perchlorates to chlorides and receive the energy they need for life. Also, for a population of 1,000,000, an average of 20 million m^3 of water per year will be needed, including the water for industrial and domestic needs. Part of this water can be used for the production of deuterium if necessary, as well as for the operation of the chemical industry.
2.10. Temperature and humidity control system. The temperature and humidity control system of the atmosphere, together with the general thermal control system, removes from the compartment of heat generated by humans about 145 W/person. carry out the removal from the atmosphere of water vapor released by man, about 1200 g/person per day, and also maintain a temperature of 18-22 ° C, with a relative humidity of 30-70% and air circulation of 0.1-0.4 m / s. Water vapors are disposed of and sent to the hydroponic system, and also, after cleaning, to maintain the relative humidity of the colony atmosphere.

2.11. Waste disposal system. The waste disposal system provides for the collection and removal of liquid and solid waste products from the atmosphere.

2.12. Disposal and recycling of waste. To eliminate the spread of bacteria, odors, etc. residential blocks and premises of the staff are equipped with electric dry closets connected to the common and internal power supply of each module. There is the separation of liquid and solid waste and redistribution in different tanks in this. The liquid is removed through pipes into the drainage, solid waste is dried and compressed. Further, solid waste is sending to biogas reactors, along with food waste, and liquid waste is sent to the first stage of purification - freezing.

2.13. Freezing water from waste. One of the methods is CO_2 expansion (expansion on a turbine of turboexpander) with feeding into a hollow, rotating auger driven by the same turbine when pressure is released, through a gearbox, or from an electric motor, if the power produced by the expander turbine is used by the generator. In this case, the guiding apparatus in the turbine part must be adjustable, in order to avoid CO_2 sublimation and ice formation on the internal sections of the guiding apparatus, auger, and pipelines. The working substance that worked out in the cycle is sent to the forced cooling system of the condenser of the FGR of the power plant, and then it is released into the atmosphere of Mars. The water contained in the waste products, upon contact with the highly cooled surface of the auger, crystallizes with the formation of ice, which is removed from the auger by a scraper mechanism and send through a system of chopping knives and holes into the water ice collection chamber, which, in turn, is equipped with a heat exchanger, in which the working substance moves, cooling the expander's compressor (supercharger) and increasing the temperature of ice, and also into drainage system connected to the second screw in a cycle in which the process is repeated with the only difference that freezing of water occurs on the second auger with minimum salt content.
The outer parts of the augers are immersed in brine on 1/2 of diameter. Further, the obtained water is sending either to household needs - a cooling system, or to the household - hydroponics, or, after appropriate post-processing, for consumer needs. The brine is removed from frozen ice in various ways - by natural drainage, vacuum filtration, centrifugation, pressing, and the ice itself, when melted, forms fresh water. The processing of industrial water used for domestic needs is carried out in the same way. Also, after mechanical purification of water and removal of impurities from it by a powerful stream of air specially grown bacteria are introduced. Microorganisms eat up the remains of waste products, then the water is filtered through special membranes. Also, the resulting water may be subjected to

2.14. Waste recycling. Waste of life-activity after processing in biogas reactors and biogas production are used as fertilizers. After extracting water from waste products, urea located in brine is the basis for the production of plastics and nitrogen-containing fertilizers. evaporation heat treatment. Also, from liquid waste can be extracted: nitrogen, phosphorus, magnesium, and ammonium phosphates. The chemical reaction of liquid waste with calcium hydroxide can increase the pH to 12, which guarantees the destruction of any microbes and sterilization of liquid waste with the release of phosphorus in the form of calcium phosphate and gaseous ammonia, which, when reacted with sulfuric acid, forms ammonium sulfate. Ammonium sulfate is common nitrogen fertilizer. Calcium phosphate is a phosphate fertilizer required when growing plants.

Using electric dry closets, with the separation of waste products, increases the nitrogen content in raw materials. Products containing calcium, magnesium, potassium, and sodium carbonates also increase the pH value of pH, stopping the chemical process that converts urea to ammonia and stabilizes the nitrogen content in urea. After this, the liquid waste products can be evaporated or frozen out without nitrogen loss, which can then be collected and used as fertilizer.

2.15. Gas separation and gas purification. Gas separation and gas purification can be carried out through hydraulic lockin gas holders, using technical water of the first stage of purification, after freezing, through a hydration cycle followed by dehydration and separation of components: N2, CH4, CO2, H2S through a step-change in pressure and temperature.

2.16. Pressure control system. The pressure control system maintains a total atmospheric pressure of 77-107 kPa, monitors the integrity of the module, and compensates for air leaks.

2.16.1. Key parameters and pressure standards.

Parameter	Value			
	Minimum		Maximum	
	Pa	Mm. of the mercury column	Pa	Mm. of the mercury column
Total pressure	33,3	250	107	800
Oxygen partial pressure	16	120	40	300
Nitrogen partial pressure	9,3	70	80	600
Carbon dioxide partial pressure	0	0	1,0	7,6

2.16.2. The main parameters of the atmosphere and physiological standards.

Parameter	Value	
	Minimum	Maximum
Air temperature, °C	16	24
Relative humidity, %	30	70
The temperature of the walls of the residential block, °C	18	26
Heat dissipation of the population, mJ/person per day	10,5	14,7
Oxygen consumption, g/person per day	760	990
The emission of carbon dioxide, g/person per day	870	1215
Water and food consumption, g/person per day	1500	6400
Urine excretion, g/person per day	1100	2000
Excretion, g/person per day	90	200
Metabolic water, g/person per day	250	350
Hygienic water, g/person per day	680	2630

2.17. The nutrition system. The nutrition system is aimed at providing staff with good nutrition, with a diet containing proteins, fats, and carbohydrates in a mass ratio of about 1: 1: 4 and with a total calorie content of up to 12500 kJ/person per day.

3. The economy of urban agglomeration.

The city economy is a system of organizational and economic relations that are expressed in the specialization of production, typical forms of labor cooperation, and a combination of products. Industrial facilities of the city agglomeration are located on the periphery of the city, outside the city agglomeration, closer to the sources of raw materials, which minimizes logistics costs and eliminates the harmful effects in case of emergency. The water supply system of industrial facilities is a closed system that is not connected with the rest of the city infrastructure. The power supply system is the location of power plants in each individual industrial module. Industrial modules are interconnected by an external and internal transport system, and communications.
Large industrial facilities, such as chemical enterprises, metallurgical and machine-building plants, as well as food industry enterprises aimed at obtaining vegetable fats, are moved outside the city agglomeration or located on the peripheral lines of the transport system.

3. 1. The industry of the Martian urban agglomeration. The entire industry of the Martian city agglomeration, except for light and food industries, is taken out of the city agglomeration. The maintenance personnel of industrial production occupies modules located on the periphery of the city agglomeration.

3.1.1. Food industry. The food industry is expressed:
- Plants for processing vegetables and fruits, as well as processing protein foods, can be located directly under residential modules, above the underground line along the longitudinal lines.
- Oilseed processing plants can be located on extreme, transverse lines.
- Grain processing plants can be located along the longitudinal lines.

Food production is carried out mainly from products grown on hydroponic farms located in the upper part of the module above the soil line, where plants will be grown on a substrate - a substitute for soil delivered from the Earth, and aeroponic farms located at the level of the transport system, and also in laboratories for growing protein foods. Also, as reserves, canned or lyophilized food and concentrates from the Earth will be exported. At the same time, there remain problems in providing plants with enough light and protecting them from radiation. The radiation background of Mars averages 8 rad per year but can reach 2 rad a day during solar flares. To ensure proper lighting and maintenance of hydroponic and aeroponic farms, each module is equipped with its own power station.

3.1.1.1. The quality and type of food produced. With the high physical and mental activity to which the inhabitants of the city agglomeration will be exposed, the value of the basal metabolism will be approximately 1.5 kcal/1 kg. of body weight per hour, despite the fact that the energy expenditure for the assimilation of food is approximately 10-15% of the total energy expenditure. Important is not only the amount of food but also the composition of the diet, therefore, it is necessary to match the chemical composition of the human diet to its physiological needs for chemicals. The main nutrients in the diet are proteins, fats, carbohydrates, and minerals. Imbalance in energy balance can lead to health problems and reduce life expectancy.

Proteins are the main building material for cells. All hormones, antibodies, enzymes are protein in nature and are essential nutrients. The body receives full-fledged protein only with food. The usefulness of a protein depends on its amino acid composition. Basically, high-grade protein is of animal origin: meat, fish, poultry or chicken, eggs, dairy products. Of the plant proteins, soy proteins are closest to high-grade ones, followed by legumes, nuts, and mushrooms. Every day, a healthy person needs at least 1.1-1.2 grams of protein for every kilogram of body weight. Based on this, the first basic set of crops grown is determined: soybeans, legumes, mushrooms, nuts.

Fats are a strategic supply and source of energy. The body needs 1-1.2 grams per kilogram of body weight. On average, fats should not make up more than 30% of the total calorie intake. When 1 gram of fat is oxidized, 9 kcal of energy is released. Fats are an integral part of many hormones and with their help vitamins A, D, E, K are absorbed. Fats also supply the body with fatty acids, phosphatides, and choline. Based on this, the second main set of crops is determined - oilseeds: sunflower, soybean, flax, sesame seeds, black cumin, mustard, etc.

Carbohydrates. Provide gastrointestinal tract health and are the main food for the microflora of the human body. Optimal for an adult is the consumption of carbohydrates in the amount of 55-60% of the daily calorie intake, from about 300 to 500 grams per day. At the same time, at least 80-90% of this amount should be accounted for by complex carbohydrates contained in cereal products, vegetables, and fruits. Based on this, the third main set of crops is determined - cereals: wheat, rye, rice, oats, barley, corn, buckwheat, amaranth. And also potatoes, tomatoes and fruit trees, as well as possibly coffee trees. Dairy products can be produced in laboratories using bioengineering. This will require yeast that sugar-fed, vitamins, minerals, and proteins, such as calcium caseinate, which can be created in the laboratory and has the formula $C_{81}H_{125}N_{22}O_{39}P$. Fermentation-causing bacteria will also be needed. Many industrial processes are based on the fermenting action of bacteria. Based on this, bacteria are another major import item from Earth.

3.1.1.2. Growing plants. Soil for growing plants is useless without the organisms inhabiting it, providing plants with nutrients. Plants cannot live without bacteria connecting nitrogen with other elements. Bacteria causing rotting of dead plants are also needed. But, in addition to benefits, bacteria can be dangerous. Dangers worth paying attention to are bacteria that multiply in the soil and turn oxygen into carbon dioxide. Also, when growing fruit trees, it is necessary to take into consideration that in the absence of resistance to wind, tree trunks become thin and brittle, and do not withstand their own weight, therefore, it is necessary to provide for the possibility of air circulation in the enclosed space of the dome and the necessary access to sunlight, the lack of which will lead to yellowing and falling leaves, as well as an increase in the level of $CO2$ in the confined space of the dome. In the case of organizing hydroponic or aeroponic farms at the lower levels of the transport infrastructure - plants, due to the lack of sunlight, stop synthesizing oxygen, which must be taken into consideration when designing. For hydroponic farms, it will be necessary to import a substrate replacing the soil from the Earth.

3.1.2. Mining and processing industry.
1. Mining and processing of ore concentrates containing rare earth metals for export.
2. Extraction and processing of iron, nickel, and copper ores.
3. Mining for the chemical industry.
4. Extraction and processing of magnetic ores.

3.1.3. Chemical industry. The chemical industry of the Martian city agglomeration is expressed:

1. The production of oxygen and water.
2. Processing of waste products with the concomitant production of glass, plastics, and fabrics.
3. The processing of methane obtained in biogas reactors, as well as other chemical methods, for example, from clathrates, by catalytic and thermal methods to produce hydrogen, acetylene, formaldehyde, and water.
4. The production of acetylene by the thermal decomposition of methane with the following production of various products from it, including acetic acid, which is necessary for the production of plastics, dyes, artificial silk, rubber, acrylonitrile and polyacrylonitrile (orlon), with the following processing for the manufacture of artificial wool, vinyl chloride and acrylates used for the production of synthetic fibers, and fabrics, explosives, for blasting during tunneling.
5. The production of synthetic resins and plastics from formaldehyde obtained by the oxidation of methane.
6. Leaching of rare materials in an ultrasonic reactor, for the processing of various concentrates containing rare elements with the regulation of the size of the working space of the reactor.

3.1.4. Metallurgical industry. It is represented by the following types of production:
1. Induction smelting of semi-finished rare-earth metals with heat recovery for the production of electricity and methane, as well as the production and storage of hydrogen.
2. Steel and cast iron smelting in induction furnaces and reflective furnaces.
3. Smelting of copper and its alloys in induction furnaces.
4. Production of aluminum and alloys based on it with aluminum perchlorates.
5. Composite materials production and powder metallurgy.

3.1.5. Mechanical engineering. Developments in the field of robotics. Production of basic machines and mechanisms such as:
1. The rolling stock of the subway.
2. Electric motors, including linear ones.
3. Electric transport.
4. Robotics.
5. Automatic mining machines and sinking machines.
6. Production of magnets.
7. Aviation industry (airships) and electric helicopters.

3.1.6. Building sector. The building sector provides tunneling, the manufacture and installation of residential modules, and the construction of factories.

3.1.7. Pharmaceutical industry. Represented by research, development, and production of medicines.

3.1.8. Light industry. The light industry of the Martian city agglomeration is expressed by the production of fabrics from fibers obtained in chemical industries, materials for the production of balloons (airships), materials for inflatable modules, and greenhouses, as well as the production of personal protective equipment and personal hygiene.

3.1.9. Martian Research Institute.

1. Geology and geological research and development.
2. Physics, chemistry, biotechnologies, bioengineering, nanotechnologies.
3. Research and development in space and space technology
3.2. Necessary import and useful export.

The Martian city agglomeration is economically dependent due to imports from Earth, so one of the conditions of independence will be a useful export. The main import items:
1. Na2O2 (sodium dioxide). Until the start of the production of oxygen from perchlorates or any of the above methods.
2. Medical equipment and equipment for 3-D printing. For the future Martian colony, people will need numerous machines, mechanisms, and equipment, the details of which, if worn out, can be printed on 3D printers. For the Martian colony, you will need a wide range of 3D printers, from industrial to the household. And will also need heavy-duty, resistant to radiation and extreme temperatures materials.
3. Bacteria, microorganisms, and chemicals.
4. Hydrogen. Until the start of its own production.
5. Food. Until the start own production.
6. Electronic devices and equipment.
7. Personal hygiene items and protective equipment until the start own production.
8. Laser installations for soil destruction and tunnel production.

3.2. Useful export and payback of urban agglomeration.

Due to the need for the chemical production of oxygen and water, the chemical industry is the basis of the Martian economy. To compensate for the costs of logistics and critical imports, the production of expensive and necessary products for the Earth is necessary. Such products are rare metals.

The main cost in the delivery of useful cargo from Earth to Mars will be logistics. Since it is not possible to calculate all the actual costs that will be incurred during the construction of the Martian colony, before the start of construction will assume that the average cost of building one module, including a power plant and the distributed cost of transport infrastructure, taking into consideration the delivery of equipment for tunneling, is 100 million dollars, and industrial import is 10 thousand dollars per person per year.

Based on this we have:
1. Total construction costs are $ 2,672 trillion.
2. The import volume is 10 billion dollars a year.

With these costs, the total cost per person will be $ 2.682 million in the first year after the construction of the city agglomeration. That is, the cost of the product produced by each person in the city should be at least $ 2,682 million in order to recoup the costs, and given that about 800000 people living in the colony will be involved in servicing the colony itself, the provision of external debt will be: 1000000/200,000 * 2,682 = 13,41 million dollars per person.

If the payback of the Martian program is calculated for 50 years, then we have the following indicators:
50*0.01 + 2,672 = 3,172 trillion dollars or 3,172 / 50 = 63,44 billion dollars a year.
In this case, external debt servicing will be: 63440000000/200,000 = $ 317,200 per person per year.
On this basis, the city agglomeration will not be able to service this amount of external debt only through the export of intellectual property, the sale of rights to television, make films, and the organization of the tourism industry.
In order to service external debt and pay for useful imports, it is necessary to export high-value products such as rare metals.

3.2.1. Main export items.

The main rare-earth metals of sufficient value for export from the Martian colony are Californium-252, Osmium-187, and Rhodium.

The required production volume of Californium-252 for the ability to service external debt, at a cost of $ 10 million per 1 gram, is:
63440000000/10000000/1000 = 6,344 kg. in year. What is not feasible due to the specifics of production.

The required production volume of Osmium-187 for the ability to service external debt, at a cost of 10 thousand dollars per 1 gram, is:63 440 000 000/10 000/1000 = 6344 кг. What is more realistic to implement in the conditions of the Martian city agglomeration.

The cost of logistics 6344 kilograms of Osmium-187 at a price of $ 6620/kg. = 6344 * 6620 = 2099864 dollars, which additionally is 4.2 kilograms of the substance.

The necessary production volume of Rhodium for the ability to service external debt, at a cost of 257,21 dollars per 1 gram, is:
63440000000/ 257,21/1000 = 246647,71 kg. This is difficult because it requires a minimum of 18 cargo ships with a useful cargo capacity of 13,6 tons.

In addition, there is no guarantee of a drop in the value of this metal when deliveries are made in such a volume. Based on this, we determine the main direction of export - production of Osmium-187

The following export articles:

1. New materials, including composite and rare-earth-based nanomaterials: Osmium 187, Rhodium, Iridium, Ruthenium, Platinum, Palladium, Gold, Scandium, Yttrium, Lanthanum, Lanthanides in the total amount of at least 20% of the amount of external debt.
2. Intelligent products such as software - 5% of the amount of external debt.
3. Technologies in the field of space exploration and the creation of spacecraft - 10% of the amount of external debt.
4. Biotechnologies and nanotechnologies - 5% of the amount of external debt.
5. Technologies and developments in the field of physics and chemistry - 5% of the amount of external debt.
6. Technologies in the field of medicine, pharmaceuticals, microbiology - 10% of the amount of external debt.
7. Export of medicines – 1%;
8. Jewelry export – 10%
9. Tourism with appropriate infrastructure - 1% of the amount of external debt.
10. Export of materials for the film industry and the film industry with the possibility of in-kind filming - 1% of the amount of external debt.
11. Sale of exclusive rights to conduct television programs on the life of the Martian colony - 0.1% of the amount of external debt.

Total import items - 68.1% of the amount of external debt per year. The remaining 31.9% is the export of semi-finished rare metals.

3.2.2. Export at a decrease in imports. With a decrease in critical imports to $ 1 billion per year, compensation for the cost of imported products and logistics is possible due to the export of semi-finished rare metals:

Payback on imports and logistics for platinum exports: 1000000000/ 25.78/1000 = 38789.76 kg.
The weight of platinum for logistics, with the cost of logistics 6620 dollars/kg. - 13,402.33 kg. Total - 52,292.092 kg.

Payback on imports and logistics for gold exports:1000000000/56,65/1000 = 17652,25 kg.
The weight of gold for logistics, with the cost of logistics 6620 dollars/kg. - 2335,75 kg. Total - 19988 kg.

Payback on imports and logistics at export of osmium: 1000000000/12,86/1000 = 77760,5 kg.
Osmium weight for logistics, at a cost of logistics of $ 6620/kg. - 82496 kg. Total: 160256,5 kg.

Payback on imports and logistics for the export of iridium:1000000000/52,73/1000 = 18964,54 kg.
The weight of iridium for logistics, with a logistics cost of $ 6620/kg. - 2713,73 kg. Total: 21678,27 kg.

Payback on imports and logistics for palladium exports: 1000000000/59,35/1000 = 16849,2 kg.
The weight of palladium on logistics, with the cost of logistics 6620 dollars/kg. - 2115,34 kg. Total: 18,964.54 kg.

Payback on imports and logistics for export of ruthenium: 1000000000/ 8.68/1000 = 115207,37 kg.
The weight of ruthenium for logistics, with a logistics cost of $ 6,620/kg. - 370229,51 kg. Total: 485436,88 kg.

4. Martian society.

The main social group of Martian society is technical specialists. The social component is a complex of social phenomena and processes and is characterized by the size and structural composition of the population, educational level, lifestyle, habits, traditions and work ethic. Due to the fact that initially, for the survival and development of the colony, Martian society will be expressed by specialists with a high level of education, mainly technical specialists - the social and cultural components will be closely intersected. The values shared by people will be very similar. The attitude of people towards work and the quality of life will be approximately the same, as will the influence on the choice of goals and the means to achieve them. In economic terms, this will lead to the main emphasis on technology with its subsequent export to Earth.

Most likely, the concept of a creative economy or a creative industry will emerge, based on the established cultural principles and the development of areas of productive activity in which culture or creativity will be the main asset, based on all kinds of technologies and technological achievements. Based on this, the cultural policy of the Martian society will be formed.

4.1. Population.

The population of the Martian city agglomeration, comprising 1 000000 people, should be composed of people of various specialties to ensure the full functioning of the city's infrastructure. The concept of «infrastructure» means a complex of interactions, of a person, mechanisms, and objects of urban agglomeration. To ensure the full life of Martian society, it is necessary to ensure the following:
1. Residents of the Martian colony must be heterosexual and comprise 500,000 families.
2. For 500,000 families, for a comfortable stay, a minimum of 1,500,000 m2 of the total area is required, excluding infrastructure.

4.2. Number of staff.

4.2.1 Medical staff.
1. For 1000000 people, given that the percentage of people who apply to the medical help can be up to 10% per day, based on the doctor's 8-hour work schedule and 0.5 hours per patient, 6250 medical specialists are needed, as well as another 6250 medical staffs, who will make up the service sector from highly qualified specialists to service personnel. Total - 12500 medical staffs.
2. The number of medical modules: 1000000/12500 = 80. Due to the difficulty in organizing a large number of medical modules, we reduce their number to 18, in accordance with the transverse metro lines minus the sidelines, increasing the number of staff to 700 people for each medical module.
3. Location of medical modules. The medical module can be located separately or be part of the transport infrastructure, which is much easier to implement.
4. The attendants of one medical module are residents of 61 residential modules located above it and each responsible for their own direction. In this way, convenience in moving personnel is realized, due to the presence of common transport infrastructure and speed of response - due to direct residence near the place of main work.
5. The area of the medical module. Each module has 5 residential blocks of 4 apartments, in which 40 people live at the rate of 8 people per block. One medical module serves: 1000000/ 40/18 = 1389 residential units. The required area of the medical module is 15m2/ person plus 4 m2/ person at 10% load. Total: 83340 + 22224 = 105564 m2.
6. The length of the medical module along the transverse line: 105564/(24-1) = 4590 m.

4.2.2. The number of service personnel employed in the food industry.

For providing the population with food, based on the daily consumption of water and food at least 2 kg. per day per person, based on the area of the hydroponic farm of the residential module 490 m2., Given that 1 m2 of the area should provide 60 kilograms of ready-to-eat products per person per year, based on: 2*40* 365/490 = 59,6 kg. or 164 gr./ day, which is feasible with a given technical task, the required number of staff should be 125000 people.

When production processes are automated, it will take 5 people to service one hydroponic farm, based on 98 m2 of area per 1 person, which is: 5*25000 = 125000 people. Also, in the food processing industry, the number of personnel equal to the number of personnel serving hydroponic farms will be involved. Total - 250000 people involved in the food industry and providing food to a population of 1000000 people. To optimize, the upper floors of residential blocks adjacent to hydroponic farms will be occupied by personnel serving these farms and maintenance personnel of the power plant. Families of staff should consist of people with similar specialties or specialties that allow minimizing the movement of people to remote places of work.

4.2.3 The number of personnel serving the transport infrastructure is 520 people.
4.2.4. The number of personnel serving the power plant is 78000 people.
4.2.5. The number of personnel involved in the utility sector is 150000 people.
4.2.6. The number of personnel involved in the education system is 2000 people.
4.2.7. The number of personnel employed in the service sector is 144000 people.
4.2.8. The number of personnel involved in the field of waste management and recycling – 150000 people.

4.3. Health protection

Colonists will wear bracelets that will, in real-time, monitor human health indicators, monitor blood pressure, take a blood test, inhaled air, measure radiation, measure ambient temperature, dust, vibration, control body position in space, and also send the necessary signals and give recommendations when detecting abnormalities in the heart rate that can develop into a heart attack, and other problems. Any fall of a person or an emergency situation with a member of the city agglomeration is registered by a system that alerts emergency personnel and medical services.

4.4. Medicine.

The city modular infrastructure includes medical modules, which are a single whole with the transport infrastructure and residential modules located above them. In the medical modules is implemented the possibility of remote diagnostics. Robotic surgeons are used to performing complex operations, and artificial intelligence is used to diagnose diseases. In the laboratories of medical modules, viable organs are grown from cells, and 3D printing of tissues similar in quality to the tissues of the human body is carried out. An important direction for the Martian colony is the production of drugs in zero gravity or with low gravity.

4.5. The education system and the types of schools.

Learning online while giving lectures from the Earth is technically difficult. Due to the distance between Mars and the Earth, which is not constant, and the speed of data exchange is limited by the speed of light, it is difficult to achieve rapid data exchange. The minimum distance from Mars to the Earth is 55.75 million km. When the Earth is exactly between the Sun and Mars, and the maximum is about 401 million km. The signal transmission, in this case, will go from approximately 186 to 1337 seconds or from 3 to 22 minutes. Perhaps, in the future, hosting will be provided, providing synchronization of servers on different planets. Due to therotation of the planets, laser data transmitters are needed in the satellite network in the nearest orbit, which should be constantly turned towards Mars. To ensure continuous synchronization, high power orbital lasers can be installed. When the Sun is located between the planets, communication can be provided by interplanetary switches. To ensure the fastest possible synchronization of data, it is advisable to place data satellites in the orbits of the planets, providing the same data transmission distance between the planets.

Education can be obtained online at conditions subject to lectures by teachers located directly in the Martian city. It is also possible to organize schools directly in blocks that are a continuation of medical modules. In this case, the children will always be under the supervision of medical staff and will be able to receive prompt medical attention, if necessary. Schools and institutes can also be organized in modules that perform the functions of the leisure industry, from the fifth to the first floors of these modules. Moreover, the education system in such schools should be multidisciplinary, due to the difficulty in organizing specialized schools, due to the peculiarities of the infrastructure.

Lectures conducted by a virtual teacher, as well as training in recorded lectures, will not lead to anything without a living teacher since it requires self-discipline and self-organization, which requires instilling these criteria by parents and society, and in the early stages of the formation of the Martian society, this will be difficult to achieve, due to the multitasking that the colonists will face.

4.6. The cultural component. The concept of culture includes everything that was created by mankind during its historical spiritual development and that will continue during the formation of the Martian colony by the first colonists, based on cultural elements, which include: language, values, norms, manners, etiquette, rituals, customs, traditions.

Of the types of arts in Martian society, the following can be distinguished:

1. Art and 3D graphics;
2. Music;
3. Growing decorative plants.

Due to weak gravity, the sport will have a special place in the life of the colonists as it will be necessary to maintain a good physically fit. Therefore, athletics and heavy-duty will be developed, and of aesthetic sports - choreography. Perhaps in the future, the development of the kind of sports such as figure skating and hockey.

4.6.1. Language. Most likely, the so-called ethnic language will be formed, a concrete, real existing sign system used in a particular society, at a specific time and space.

Due to the fact that the Martian society will be completely isolated and will be forced, first, to fight for their own survival, and then for development and prosperity, the language of the colony will change taking into account many factors that are unique to the ecosystem developing in the extreme conditions of the Martian environment. The terminology and speed of decision-making, and, accordingly, the presence of abbreviations and new phrasal expressions, can change any language beyond recognition. Also, habits will influence language change, established patterns and stereotypes of behavior in certain situations that arise on the basis of skills and are reinforced as a result of repeated repetition, as well as manners - external forms of human behavior that receive a positive or negative assessment of others and are based on habits that make up the elements culture, in a complex called etiquette.

4.6.2. Etiquette. For Martian society, this will be a system of rules of conduct that make up a single whole and include manners, norms, and rules that govern people's behavior in accordance with cultural values determined by the situation in which the colonists are turned up, ceremonies, and rituals.

4.6.3. System of values. Initially, beliefs about the goals that a person should strive for will be approximately the same for all members of the Martian society, and they will form the basis of moral principles. This will continue until people feel safe and Martian society begins to develop. From this moment, cardinal changes are possible in the value system. Customs and traditions will change, as the habitual environment of people will change.

4.7. Other activities in the Martian city agglomeration:

1. Engineering, physics, chemistry.
2. Chemical industry;
3. Growing food crops;
4. Genetic engineering, biology, biochemistry, microbiology, biotechnology, and bioengineering;
5. Metallurgy and nanotechnology, the production of composite materials;
6. Engineering and energy;
7. Light industry;
8. Software development;
9. Geology;
10. Jewelry manufacturing.

4.8. Can life on Mars be better than life on Earth if you start all over again?

If it starts all over again, life on Mars can be done better than life on Earth if the Martian society completely directs itself to development. When the priorities of the society will be higher than their own priorities, and the physical and legal protection of each individual member of the colony will become the dominant factor for society.

4.9. The political component.

Martian society must be technocratic. The political system is technocracy.

4.10. The city-state management system.

4.10.1 Organizational structure:

1. Department of strategic planning. This is the central authority that consists of a network of departments, each of which represents a separate area of activity and consists of specialists in this field, interacting between themselves, and departments of other areas of activity and the analytical department. It also initiates the development and adoption of laws and regulations governing economic, political, and social processes. It establishes the rights and obligations of departments and individuals that determine the rules of business relationships, determines the rights of all members of the Martian city agglomeration, and is the main employer. At the same time, it does not prohibit the development and conduct of its own business, with the establishment of restrictions on certain types of activities that pose a threat to the security of the colony.
2. Analytical department. It processes information received from the strategic planning department. It interacts with the strategic planning department, the infrastructure department, and industry departments.
3. Department of infrastructure. It interacts with the analytical department and industry departments. Its functions include the organization of a full cycle of interaction between structural units.
4. Industry departments: Their functions include the organization of a full production cycle. They interacts with the analytical department and the infrastructure department.

4.10.2. Tax system and judicial system. There is only one type of tax - a tax on expenses in the amount of 10%. It is a cascading taxation method. The system excludes any reporting and control. The tax is written off in the form of an automatic transaction to municipal accounts when is transferring funds or paying for goods and services. In this case, tax is charged on the amount of the transfer or payment, regardless of the amount of the transaction. Any received income is not taxed until the funds aren't transferred and the goods and services aren't paid. In the event of a return of goods or a refund for dishonestly performed services, there is a concept of "return tax payment", in which the guilty person reimburses the amount of taxes paid. There is a possibility of compensation for this tax.
The judicial system is arranged on the Earth principle.

4.11. Private business in Martian society. Private business is possible both on the basis of the rights to carry out work by order of the municipality of a city-state by private individuals or by an organization of persons engaged in organized business activities, as well as the implementation of foreign economic activity. Private business should have as its goal the development of the Martian society in all fields of activity, especially in the technical and technological aspects. Due to the fact that the ban on private activity will provoke a shortage of ideas, innovations, and technologies, this direction should be encouraged in every way. At the same time, a private business operating within the city-state, without conducting foreign economic activity, should interact with industry departments, the infrastructure department, and the analytical department. Regardless of whether a private person works for a government authority or carries out commercial activities for the benefit of the colony, the municipality of the Martian city agglomeration provides this person with a social package that allows them to ensure proper living conditions.

4.12. Labour payment system. Each member of the Martian society has a social package necessary for a full life, regardless of gender, age and type of activity, with the exception of people who refused to perform work, commercial or municipal, without a valid reason: injury, illness, health condition, age. The social package is basic for all members of the Martian society. Further, payment is carried out depending on the level of complexity of the work performing.

The maximum labor payment for the staff of research laboratories, medical personnel, and personnel employed in the food, mining, and chemical industries, as well as personnel serving the public infrastructural facilities, transport infrastructure, and energy.

5. Aesthetics.

A modern Martian city agglomeration is digital and creative, which means it is convenient to use and involving in its space. In the Martian city agglomeration, the following is implemented:

5.1. Creative spaces. Unite communities of professionals. In addition to the common space for creativity, professionals get the opportunity to collaborate in terms of ideas and projects. These spaces are also the place in which various interesting events are organized. So, this place becomes a keyspace where ideas useful for the city are born and implemented. They are designed in such a way that they have working places, offices, conference rooms, photoshops, bars, shops, libraries, gyms, and pools.

5.2. Diversity. When planning the arrangement of space, all categories of people visiting these spaces are taken into account: their gender, age, occupation, nationality, and attractive directions are created that cause a variety of feelings and impressions.

5.3. Own style and attractive design. Infrastructure can be used around the year. Many modules have cycle tracks and slides for skateboarders. In view of the subjects of various climatic zones of the Earth, snowboarding is implemented in the peripheral modules, water activities are represented by water slides, diving boards and waterfalls, electric motorcycle safaris and other entertainment, gyms, and creative spaces.

5.4. Comfort and conveniences. The abundance of seats gives people the opportunity to sit down wherever they want, and the murmuring of water, pleasant lighting, and calm music creates comfort. Park zones located in the domes of 200 modules allow you to relax and contemplate the night sky of Mars lying on the grass or view the starry sky through telescopes installed in the parks. Also can stay in one of the automatic cells if the path to own module takes a long time, and the time is later. Many meeting places are available to everyone. A lot number of various stores.
Each module is equipped with a vacuum product delivery and waste disposal system.

5.5. Public transport. Automatic public transport is constantly moving.

Any public transport, automatic metro train or electric car can be called individually, in the case of late time, when the frequency of trains decreases, simply entering the data of own residential module at one of the station's terminals and passing identification by scanning with a fingerprint.

In this case, artificial intelligence will determine the location of the nearest train, in the case of a trip by subway, calculate the maximum possible speed of the train and its route in order to exclude emergency situations with trains located on other lines. The system of payments for services rendered or work performed involves a simple fingerprint scan. Each resident has an electronic card to which funds can be transferred by scanning a fingerprint directly with a card scanner. Moreover, the basic package of products and services is provided to each resident of the city agglomeration free of charge, regardless of the type of activity.

5.6. Management and control. Regulation of all processes in the city is carried out by an organized management system.

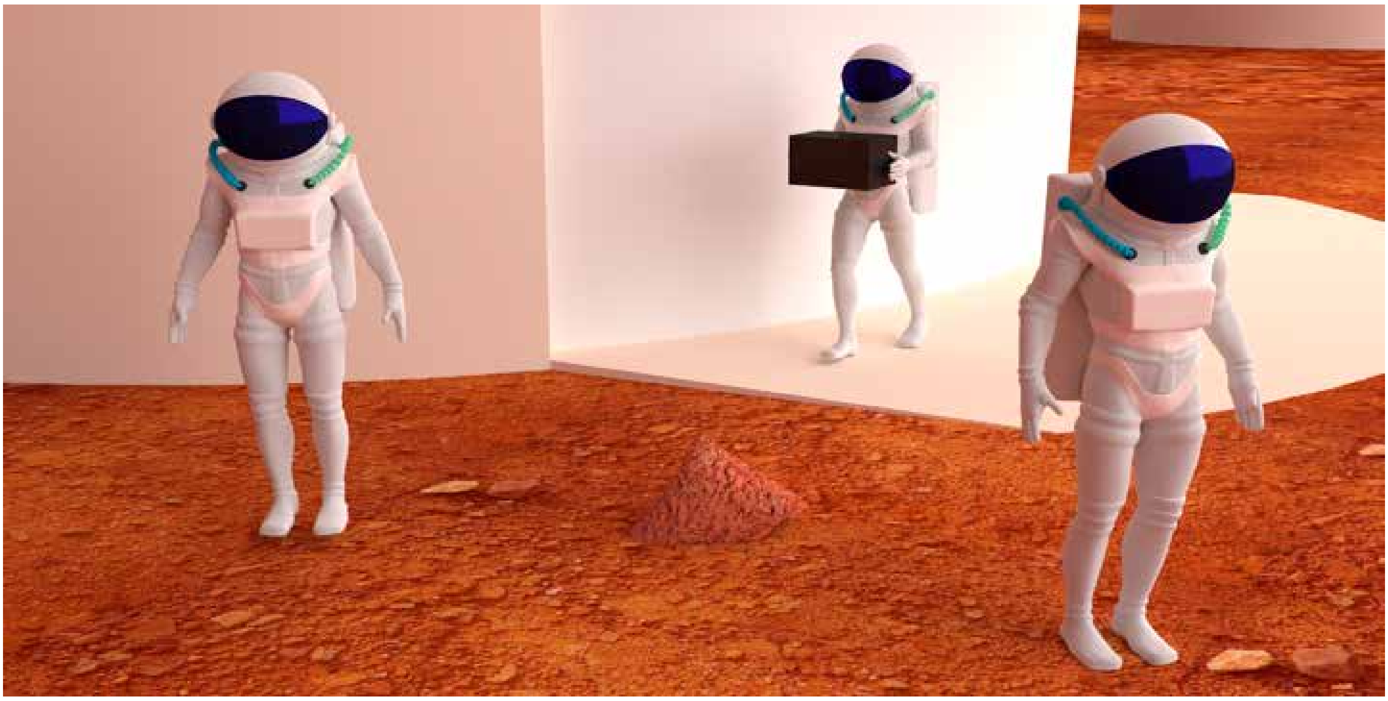
5.7. Traffic and pedestrians. The city has the opportunity to easily ride and stroll unhindered. There are accessible bicycle parking lots, convenient public spaces for pedestrians, the ability to move on foot and by bicycle. Convenient transitions from shopping centers to residential modules.

5.8. Seasonal strategies. Holding seasonal festivals, organizing holidays, and various weekend activities depending on the season. Festivals are very popular events that, depending on the subject, can attract the attention of a wide range of people. The main idea is that the festival can be based on any topic attractive to the public. Moreover, such an event favorably affects the life of the city in which it is organized, as it creates a positive attitude among the population and stimulates participants to generate creative ideas. Organization of exhibitions of personal art.

5.9. A special urban design, in the creation of which everyone can participate. The city becomes something special due to the fact that beauty is combined with usefulness and, in order to make the city look special, everyone can submit their project ideas through electronic communication with the authorities of the municipality.

5.10. Extraordinary cafes. The cafe is not only a place where you can have a cup of coffee but also where, in addition to basic services, an atmosphere is created that gains the sympathy of the visitor.

Over time, a subculture of its own will emerge in Martian society.



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