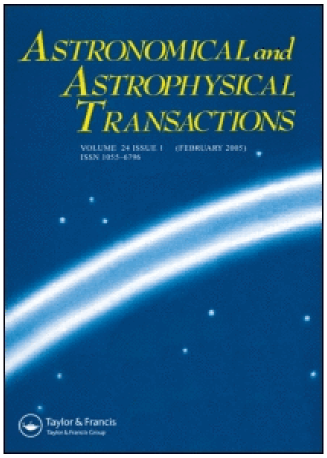


Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

The conception of creation of the International Antarctic Astronomical Station

M. Yu. Baranov [a]; Yu. V. Baranov [a]; V. A. Khripkov [a]; I. A. Jastrebtsov [a]; V. V. Malozemov [a]; V. S. Pichulin [a]; A. N. Zhovinsky [a]
[a] Euroasian Astronomical Society,

Online Publication Date: 01 November 1996
To cite this Article: Baranov, M. Yu., Baranov, Yu. V., Khripkov, V. A., Jastrebtsov, I. A., Malozemov, V. V., Pichulin, V. S. and Zhovinsky, A. N. (1996) 'The conception of creation of the International Antarctic Astronomical Station', Astronomical & Astrophysical Transactions, 11:1, 81 - 93
To link to this article: DOI: 10.1080/10556799608205457
URL: http://dx.doi.org/10.1080/10556799608205457

Astronomical and Astrophysical Transactions, 1996,
Vol. 11, pp. 81–93
Reprints available directly from the publisher
Photocopying permitted by license only

THE CONCEPTION OF CREATION OF THE INTERNATIONAL ANTARCTIC ASTRONOMICAL STATION

M. Yu. BARANOV, Yu. V. BARANOV, V. A. KHRIPKOV,
I. A. JASTREBTSOV, V. V. MALOZEMOV, V. S. PICHULIN,
and A. N. ZHOVINSKY

Euroasian Astronomical Society

(Received December 20, 1994)

The conception of creation of the International Antarctic Astronomical Station is presented. The main characteristics are presented both for the housing and laboratory building and for its parts. The questions of transportation the parts of the station and its mounting are considered.

KEY WORDS Antarctic Astronomical Observatory

This paper has been prepared by the working group of the Euroasian Astronomical Society for the followng purposes:

- to determine the list of problems which it is necessary to solve while creating the Antarctic observatory;
- to determine the composition of the observatory;
- to determine the list of requirements both to the observatory and to its parts;
- to formulate specific requirements both to the observatory and to its parts.

The station will be used to carry out astronomical observations in the broad wave-length range of electromagnetic radiation, from ultraviolet to millimeter wavelengths. The observations are supposed to be conducted continuously all year long. The observatory should be of maximum ecological purity and its functioning should introduce minimal errors into the results of observations.

The composition of the complete set of scientific equipment is one of the main factors forming the structure of the observatory. The observatory is supposed to have 5–7 telescopes with the diameters from 0.5 m to 4 m, very informative receivers will be placed at two telescopes and less informative receivers will be placed at the rest of the telescopes. These suppositions permit to evaluate the electric consumption and the amount of information to be processed and transmitted.

Another important factor forming the structure of the observatory is the geographic position and the corresponding climatic conditions. One of the best places for the observatory is Dome A with the approximate coordinates: 82° southern latitude and 72° eastern longitude. The altitude above the sea level is 4200 m. The barometric altitude is about 4700 m. The temperature range of ambient air is from $-90°$ in winter up to $-14°$C in summer. The average wind speed is approximately 3 m/s. The wind speed at wind rush does not exceed 35 m/s. The relative air humidity is 60...90%. The observatory is supposed to work both during the polar day and during the polar night.

Because of the station being very remote and because of extreme climatic conditions, the visits to the station in order to change and to service the equipment, to supply materials and to change the crew (service personnel) are possible during only 2 months in the year. Thus the future station is something average between an ordinary ground-based observatory and a space station.

One can imagine 3 principal possibilities of the station's operation:

(a) completely automatic station,

(b) served automatic station,

(c) scientific center.

More preferable, in our opinion, is the conception of the served automatic station, which means reliable functioning of the station by means of a little crew. Thus the following functions of the station are executed: receiving information, preliminary (primary) processing, and its transmitted to astronomical scientific centers. Complete processing of information, formulating new scientific tasks and working programs are done at astronomical centers. The exchange of information between the station and scientific centers is accomplished by means of a widepass satellite radio system.

The supposed number of permanent station personnel is 6 people. The distribution of duties in the crew may be the following:

1. Commander — radio operator — electronic engineer.
2. Doctor — cook.
3. Operator — astronomer.
4. Operator — medical assistant.
5. Operator — electronic engineer.
6. Mechanic.

All this determines both the composition and the appearance of the observatory. The station will consist of (Figure 1):

(1) energy supply system;

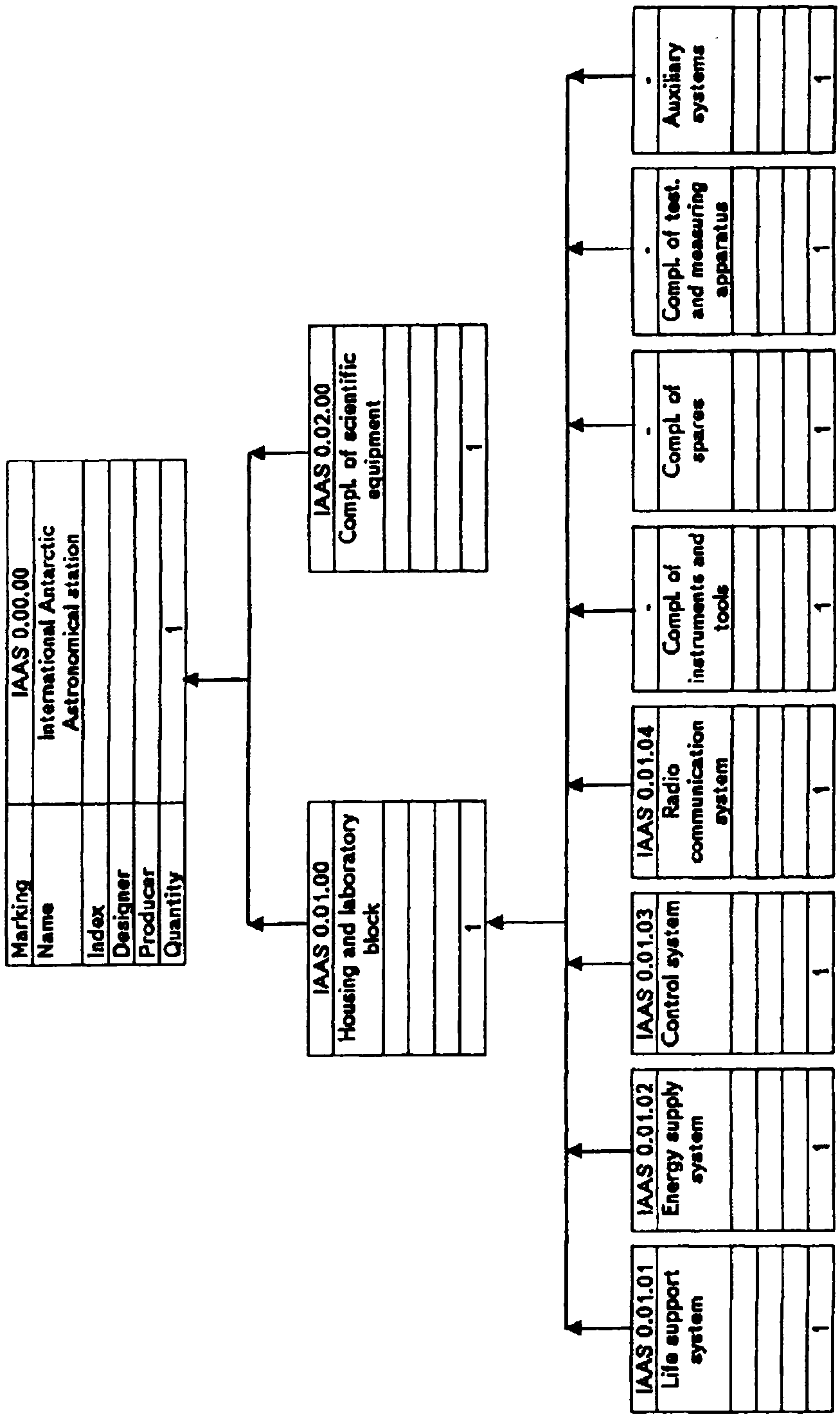


Figure 1 A scheme of devisions of the International Antarctic astronomical station.

(2) life support system;

(3) control system;

(4) radio communication system;

(5) complete set of scientific equipment, corresponding to the set of scientific tasks accomplished by the station.

Moreover, there should be auxiliary systems for:

- meteorological observations;
- geodetic reference;
- navigation;
- communication between personnel inside and outside the station buildings;
- outside illumination and TV observation for outside equipment and for situation around the station.

The supposed outlook of the station is presented in Figure 2. The main house of the station is the housing and laboratory building (Figure 3) with the electric power station. The telescopes are disposed to the main wind direction. About the station there is a runway with the site to unload and load the airplanes.

The housing and laboratory building includes (Figure 4):

- common room;
- personal state-rooms;
- medical room;
- workshop;
- kitchen;
- laundry;
- toilets and shower-bath;
- cold and warm storages;
- a little greenhouse in the commomroom;
- life support system's apparatus;
- emergency fuel tank.

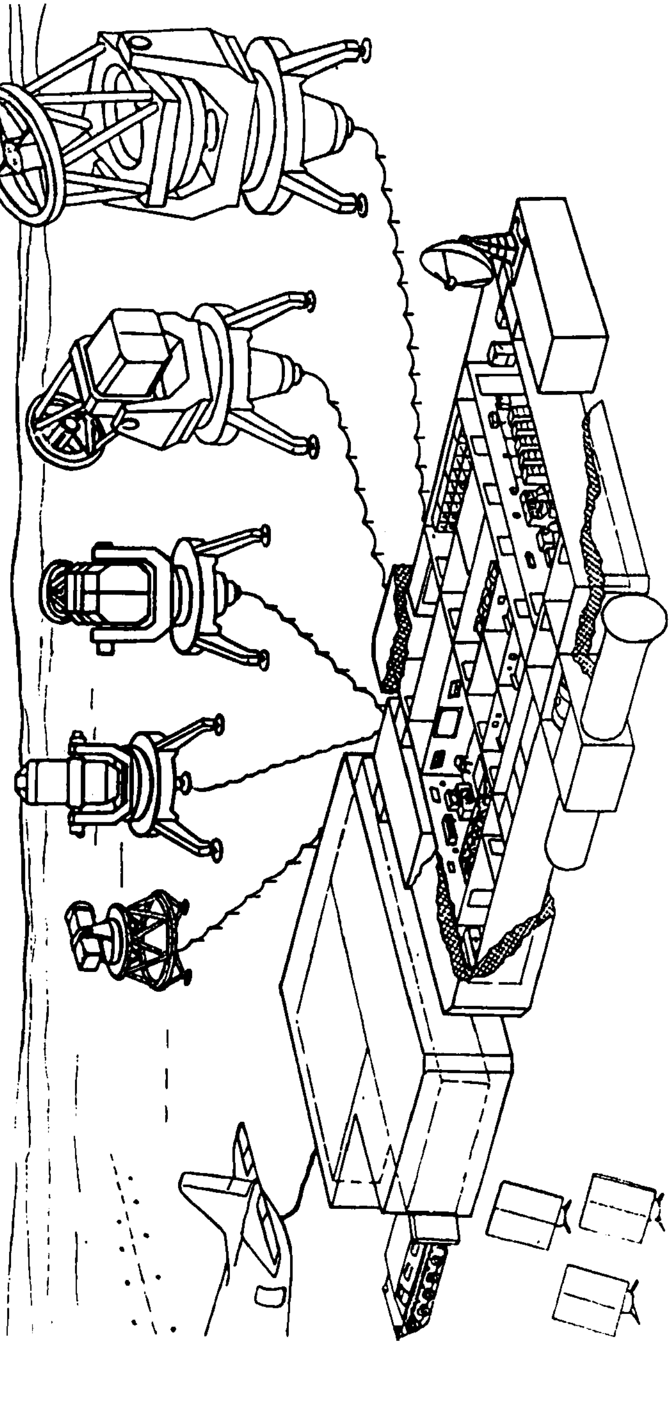


Figure 2 The Antarctic astronomical station.

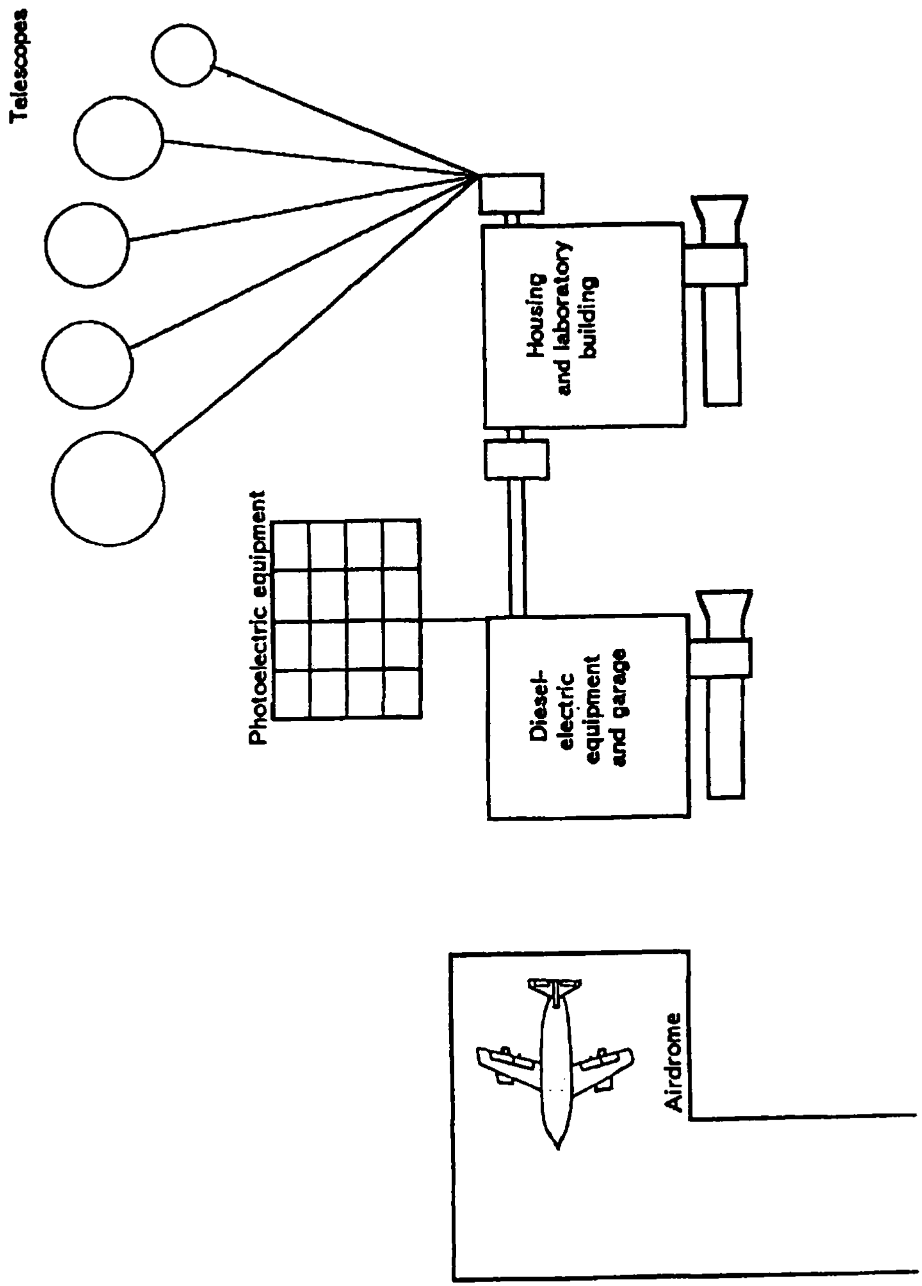


Figure 3 The general plan of the IAAS.

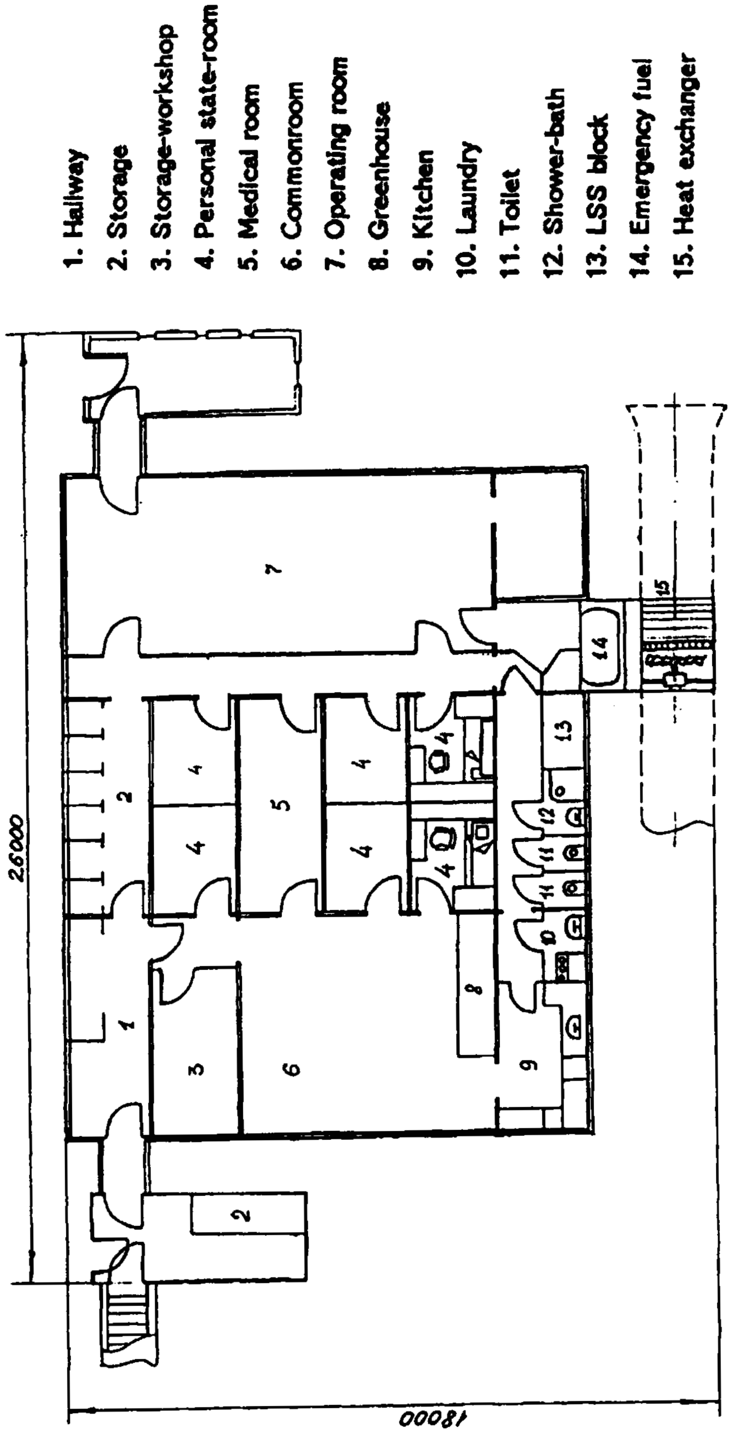


Figure 4 The housing and laboratory building.

The main unit of the housing and laboratory building is a completely equipped container with dimensions 6 m by 2.4 m by 2.4 m. Assembling the station consists of joining containers together and connecting instrumentation placed in the containers. Joined containers are covered with heat-proof isolation.

The main part of the energy supply system is diesel-electric equipment, placed in the containers too. The number of diesel-electric engines (from 3 to 5) will be determined during more detailed elaboration. About 215 t of diesel fuel are necessary for making 100 kW of electric power per year. The consumption of fuel is 245 g/kW h.

Photoelectric equipment is supposed to be auxiliary (and even main) power source in summer time. About 700 m^2 of silicon photoelements are necessary for making 100 kW of electric power. Such photoelectric convertors are usually used in space equipment.

It is necessary to study the possibility of using wind power under conditions of little average wind speed at the Antarctic centre. The scheme of the energy supply system is presented in Figure 5.

The composition and main characteristics of the life support system (LSS) of the Antarctic observatory are presented in Figure 6.

The LSS includes:

- thermal control system;
- atmospheric control system;
- food storage and cooking facility;
- sanitary system;
- water supply system;
- individual warming suit with a pack of oxygen equipment.

The LSS is partially closed. LSS features are enhanced oxygen pressure in the station's rooms and the fully closed system of drink water and sanitary water supply for the crew.

In the standard regime, the main heat source is running equipment. Superfluous heat should be extracted from the building to the atmosphere through heat exchanger. The question of utilization and accumulation of superfluous heat can be considered, for example, for heating up diesel fuel.

The radio communication system should provide communication with international scientific centers

- to receive scientific tasks and working programs for the station;
- to transmit scientific results, to transmit scientific data and data concerning technological condition of the equipment, to transmit medical data about the health of the station's crew to international astronomical centers.

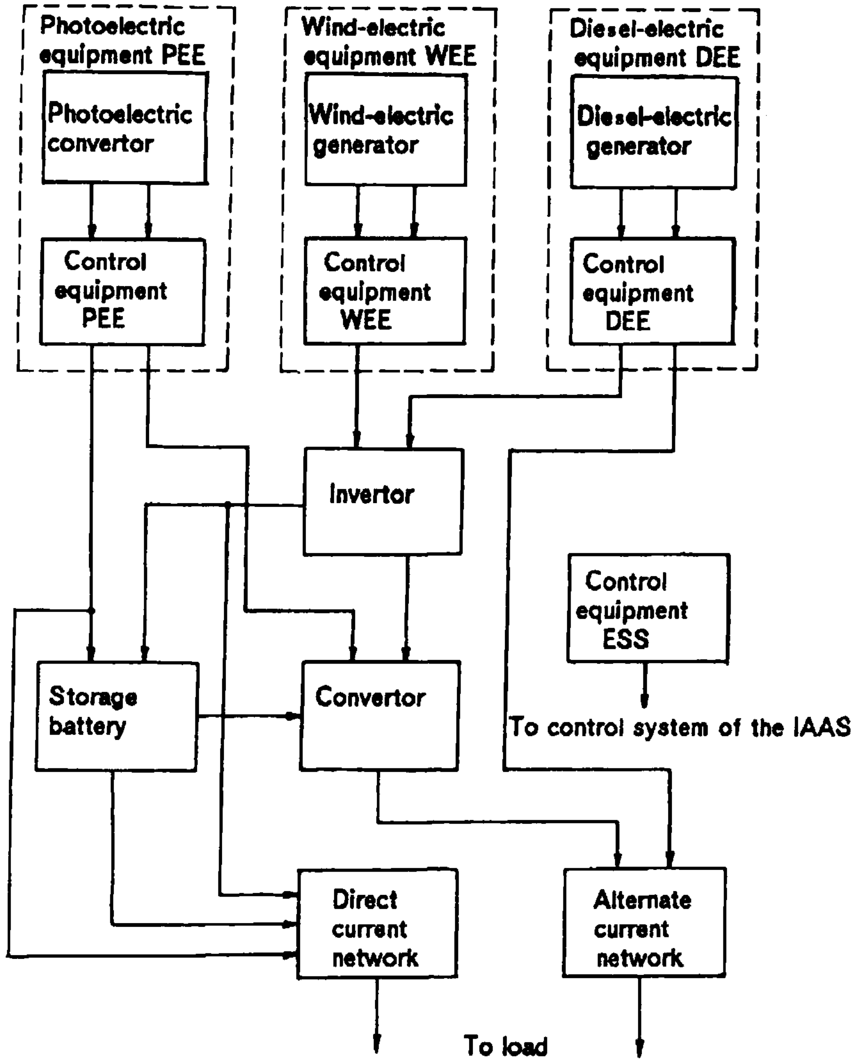
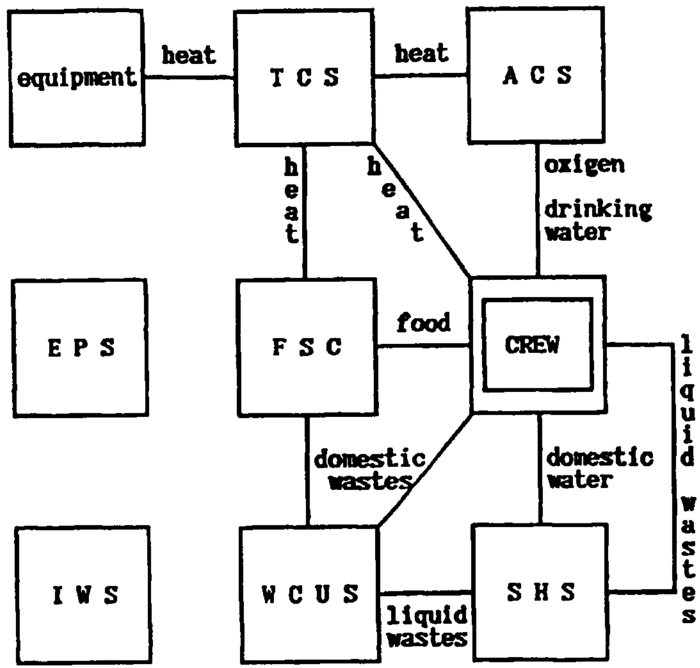


Figure 5 The energy supply system.

The radio communication system should transmit urgent information in the case of emergency situation at the station.

Because the station is to be placed near the pole, it becomes problematic to use the system of geostationary satellites for radio communication. (The satellite system may be finally chosen after fixing the station's coordinates). It is supposed to use the "Pilot-E" system with highly-elliptic orbit and with apogee in the southern hemisphere for transmitting of large volumes of information. The possibility of using quasigeostationary orbit satellites may be investigated.



TCS - Thermal Control System
ACS - Atmospheric Control System
FSC - Food Storage and Cooking
SHS - Sanitary System
WCUS - Waste Collection and Utilisation System
EPS - Emergency Power Source
IWS - Individual Warming Suit with pack of oxigen equipment

Main Characteristics.

1. Constant personnel	6 persons.
2. Guest personnel	10 persons.
3. Time of autonomous existence	12 months.
4. Existence time in emergency conditions	3 months.
5. Atmospheric parameters inside the station :	
5.1.Temperature	22...27 C,
5.2.Relative air humidity	30...70 %.
5.3.Pressure:	
full	53...59 kPa,
oxygen	16 kPa,
carbon dioxide	0.06 kPa.
6. Electric power consumption:	
6.1.In routine conditions:	
average	5.5 kW,
maximal	10 kW.
6.2.In emergency conditions:	
average	4.2 kW,
maximal	5.5 kW.
7. Average domestic water consumption:	
In routine conditions	75 kg p.d.,
in emergency conditions	40 kg p.d..
8. Drinking water consumption:	15 kg p.d..
9. Food supply per year	4400 kg.
10. Absorbents supply per year	200 kg.

Figure 6 LSS block diagram.

As an auxiliary system it is suggested to use the "Gonets" system which can work both as a retranslator and as an electronic mail facility.

"Cospas" system should be placed at the station for emergency signals transmission. The main characteristics of the radio communication system are presented in Figure 7.

The control system of the station is supposed to be rather traditional (Figure 8). The control system is designed for the controls of information streams inside the station and between the station and the channel of outer communication, which connects the station with the control center. The control system should provide storage of large amounts of information which should be transmitted to the control center during the interval between communication sessions.

As mentioned earlier, the construction of the observatory consists, in general, in mating the ready-made blocks together. The delivery of big weights to the center of Antarctics is a principal question. The following weights should be delivered:

- about 38 containers with equipment;
- about 250 t of fuel;
- solar batteries;
- about 1200 m^3 of heat isolation;
- telescopes.

The basic ways of transportation at the last Antarctic section of the journey may be:

- air transport;
- sledge-tractor trains.

The rated distance of transportation through Antarctics is about 2000 km. The C-130 (Hercules) airplane, which has very good references in Antarctic conditions, may be suggested as the basic aircraft. The main characteristics of the C-130 airplane at the sea level are:

- load-lifting capacity, 19.6 t;
- measures of cargo compartment, 12.6 m by 3.1 m by 2.8 m;
- volume of cargo compartment, 109 m^3;
- speed, 555 km/h;
- run way, 1575 m;
- brake way, 1510 m.

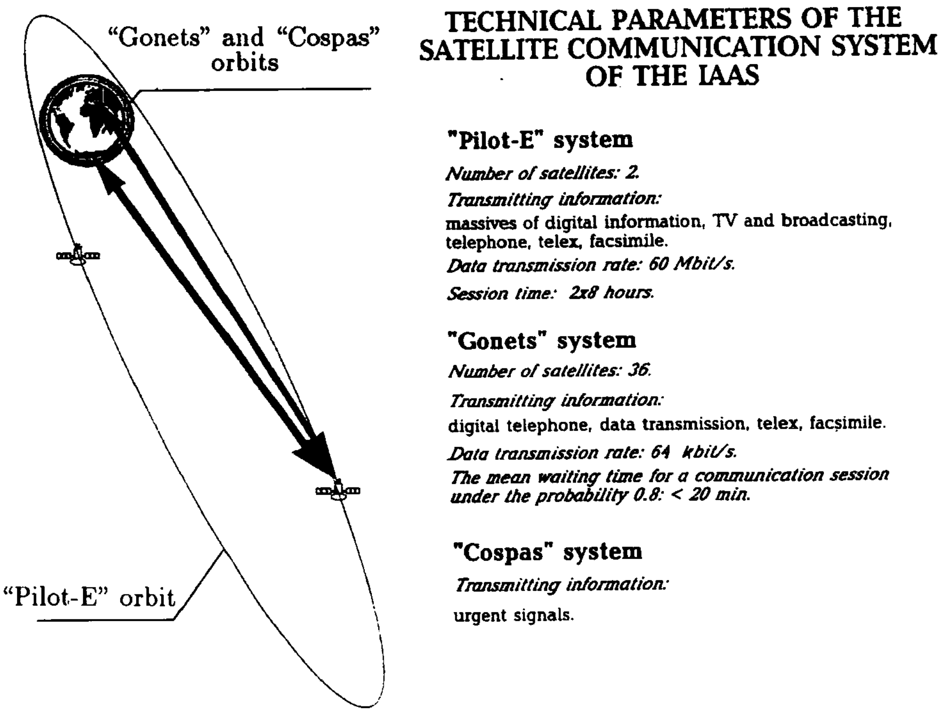


Figure 7 The satellite communication system of the IAAS.

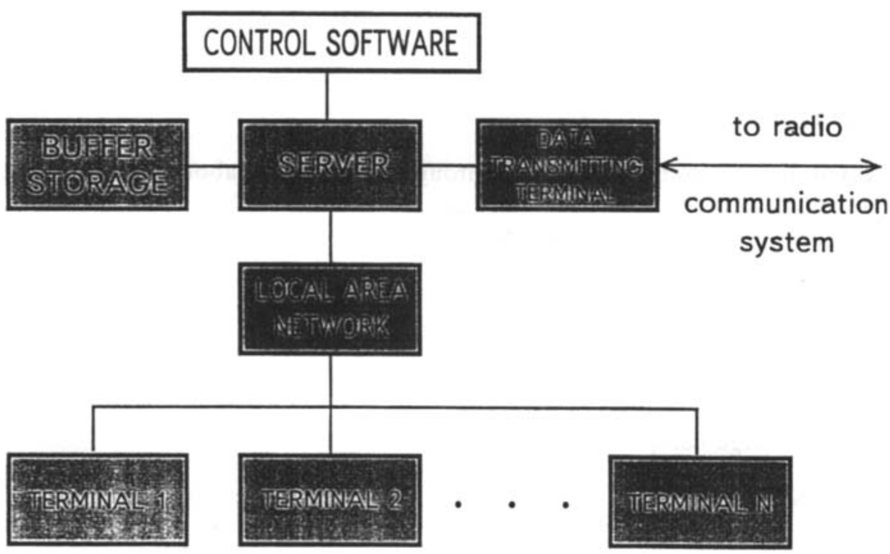


Figure 8 The control system of the IAAS.

The flight plus load-unload time is about 10 hours. If the transportation of the telescopes is not considered, about 40–45 flights will be necessary. The whole transportation will take 400–450 hours. The transportation of heavy diesel fuel may be combined with the transportation of light but bulky heat isolation.

Thus one airplane can carry the whole observatory (without telescope) in about 18 days, or 3 airplanes (6 shifting crews), in a week. The necessity of servicing the airplanes makes the carrying time almost twice longer. As the observatory mounting is supposed to be conducted parallel to the transportation, the whole observatory infrastructure can be mounted in 15–20 days.

The following rough characteristics of the sledge-tractor train may be taken for calculation:

- the number of tractors, 10;
- total number of sledges, 18;
- the number of sledges for train's service, 5;
- sledge measures, 8 m by 4 m;
- load-carrying capacity of sledge, 30 t;
- velocity (for "Kharkivchanka" tractor), 8 km/h;
- consumption of fuel for trip, 63 t;
- trip time from the shore to Dome A and back, about 21 days.

The accomplished work allows to determine in the first approximation the station's composition, requirements to the station and to its components. The final document of this stage of work is the block of projects of technical requests for elaboration of the station and its components. We hope that these documents will be the basis of the next stage of work: discussion and more accurate definition of requirements for the elaboration and choice of the designers and producers of the Antarctic observatory.