Air-fractionating plants (AFP) are in wide use in metallurgical, chemical, and other industries. A major component of expenditures on energy affecting the cost of air-fractionation products is electric power consumption for air compression. In AFP operation, unit power consumption is influenced by factors like loss of air and fractionation products on commutation of heat exchangers, expander flow rate required to cover cold loss, oxygen loss with waste nitrogen, thermal head in condensers, etc. [1, 2].

The essential requirements of an AFP management system are dictated by the fact that a wide range of issues need to be settled at the stages of adjustment and functioning of the plant. These requirements are met by currently used monitoring and control systems (MCS) built by the joint-stock company Krigoenmash (Cryogenic Machinery). They monitor the process, signal deviations in process parameters, interlock and protect the process units, executive programmed-logical control and automatic adjustment of the key process parameters.

Traditional monitoring and measuring instruments and automatic equipment (MMIAE) panels of oxygen plants designed until recently are equipped, in addition to electronic—mechanical monitoring and recording instruments, with microprocessor regulating instruments PROTAR, multichannel microprocessor measuring transducers Sh711, and regulating and logical microprocessor controllers REMICONT and LOMICONT. Figure 1 shows the control room of the oxygen plant at the Jinan Metallurgical Plant in China for control of the air-fractionating plant KAAR-15M, the argon purification plant ART-0.75, the storage system SKh-210, and the air compressor K1500 commissioned in 1993.

In recent years both in our country and elsewhere vigorous efforts are on to improve monitoring and control systems (MCS) of process plants, which consists in increasingly wider use of latest computer hardware—software systems and introduction of more sophisticated systems for monitoring and measurement of process parameters [3, 4].

The efficiency of the process presupposes a high level of automation. Ease of process control, guaranteeing reliability, authenticity of information on the process — these are far from being a complete list of demands made by modern technology on automation systems. The automation systems must perfectly interface with the operator and provide for practicable and comprehensive process control and an advanced process reporting system.

In developing the monitoring and control system (CMS) of an AFP, the primary demand made on the choice of the hardware—software system is its openness which allows customized grouping of systems of the required configurations, including decentralized control and processing.

Realization of MCS functions reduces to the accomplishment of the following basic tasks:

- to decide, based on the executed functional or topological decentralization of the object being controlled, the number of controllers and PCs in the system, their configurations, and the need for change-over to a standby facility (duplicating);
- to work out the forms of presentation of information on the technological object for display on videoterminal screens, the forms of information storage, and to develop panels and windows for control of manipulating devices and processes which ensure convenient interface for the technical operator;
- to develop algorithms and programs for automatic equipment protection, signaling, adjustment and control, including algorithms for optimal process control;
- to test the hardware—software systems of the MCS of the AFP, using programmable simulators of the technological object.
The developer of the AFP monitoring and control system must also take decision on a number of issues associated with the choice of the monitoring and manipulating devices, techniques of installing them on the object, metrological measurement procedures, etc.

The AFP monitoring and control system building process at the Kriognemash joint-stock company also includes development and construction of a set of instrumentation and electrical equipment consisting of devices having transducers, instruments, and electrical apparatuses that ensure linking of the controllable object with the hardware—software system. This set of instrumentation and electrical equipment includes:

- devices with primary pressure, flow rate, resistance, and level measuring transducers;
- devices with transducers and electronic gas analysis instruments;
- devices with secondary transducers for reading liquid levels in the apparatuses of the plant;
- stands with converters of electric into pneumatic signals that control the degree of opening of the regulating members having pneumatic drives;
- stands with pneumatic distributors for controlling two-position valves for commutating heat exchangers and two-position cutoff valves;
- electrical devices with units for controlling electrically driven regulating members;
- electrical devices for power distribution and protection of electric circuits from short-circuiting and overloading;
- electrical devices with units for controlling electric heaters, and liquid oxygen, nitrogen and argon pumps;
- electrical devices for controlling turboexpander and compressor units;
- local desks for monitoring and controlling units of the AFP.

During 1991-1994 Kriogenmash, in collaboration with experts from the GNIKI SKU (State Scientific Research Cryogenics Institute for Monitoring and Control Systems) "Sistema" (St. Petersburg), carried out a host of operations to create the top level of the AFP monitoring and control system using modern hardware-software systems of the A845 type.

Four air-fractionating plants equipped with such systems were supplied in 1994-1995 to the metallurgical plants in the Dunhua (AKAr-13/6), Kunming (AKAr-15M4), Wuxi (AKAr-13/6-1), and Tangshan (AKAr-15M5) cities of China.

The technical structure of the top level of the MCS of the AFP based on the A845 system is shown in Fig. 2. Two functional parts are distinguishable in the system, viz., systems console station (SCS) and local technological station (LTS). The SCS consists of two IBM AT-386 PCs and a reconfiguration control desk (RCD), which is designed for remote turning of the equipment of the system on and off as well as for controlling switching of the standby controllers. The RCD is connected to each A382-14 control unit by two IRPS-type sequential information channels and channels for exchange of auxiliary signals with all constituent parts of the system.

Two personal computers included in the SCS duplicate the functions of each other ("hot" standby). From the keyboard of either computer the operator can give control command and display the desired information on the monitor. Each computer exchanges information through the IRPS-type sequential channels with both the master and the standby controller of each A382-14 control unit. The LTS is an assembly of technical facilities designed to monitor and control one of the technological