AUTOMATIC SYSTEM FOR EARLY DIAGNOSTICS OF EMERGENCIES

The Automatic System for Early Diagnostics of Emergencies (ASEDE) is designed to monitor the status of an object and to generate control and annunciation signals in case of an emergency. ASEDE meets the regulatory requirements for design and construction: DBN C.1.2.-5:2007, DBN C.2.5-76:2014. The hardware used in ASEDE falls under Class II of DSTU B C.2.6-25 and can be installed in both heated and non-heated premises.

ASEDE is used to control and monitor the status of:

- buildings and structures
- roof coverings
- bridges and supports
- pipelines
- chimney pipes
- underground workings, including mine shafts
- seismic alarm and protection systems
- other objects/locations where ASEDE would be beneficial

ASEDE can be installed at nuclear and hydroelectric energy facilities and can be used to provide scientific and technical support to different objects according to regulatory requirements for design and construction DBN C 2.2-24, DBN C.1.2-14 and DBN C 1.2-5.

ASEDE consists of an Information Acquisition and Display Unit (IADU), which is designed according to technical specification UYAISH. 421451.001 TS; a power back up unit (PBU), which is designed in compliance with technical specification UYAISH. 563472.002 TS; and a set of sensors to monitor microclimate, fire, penetration, and to check the status of the automated operator's work station (AOWS).

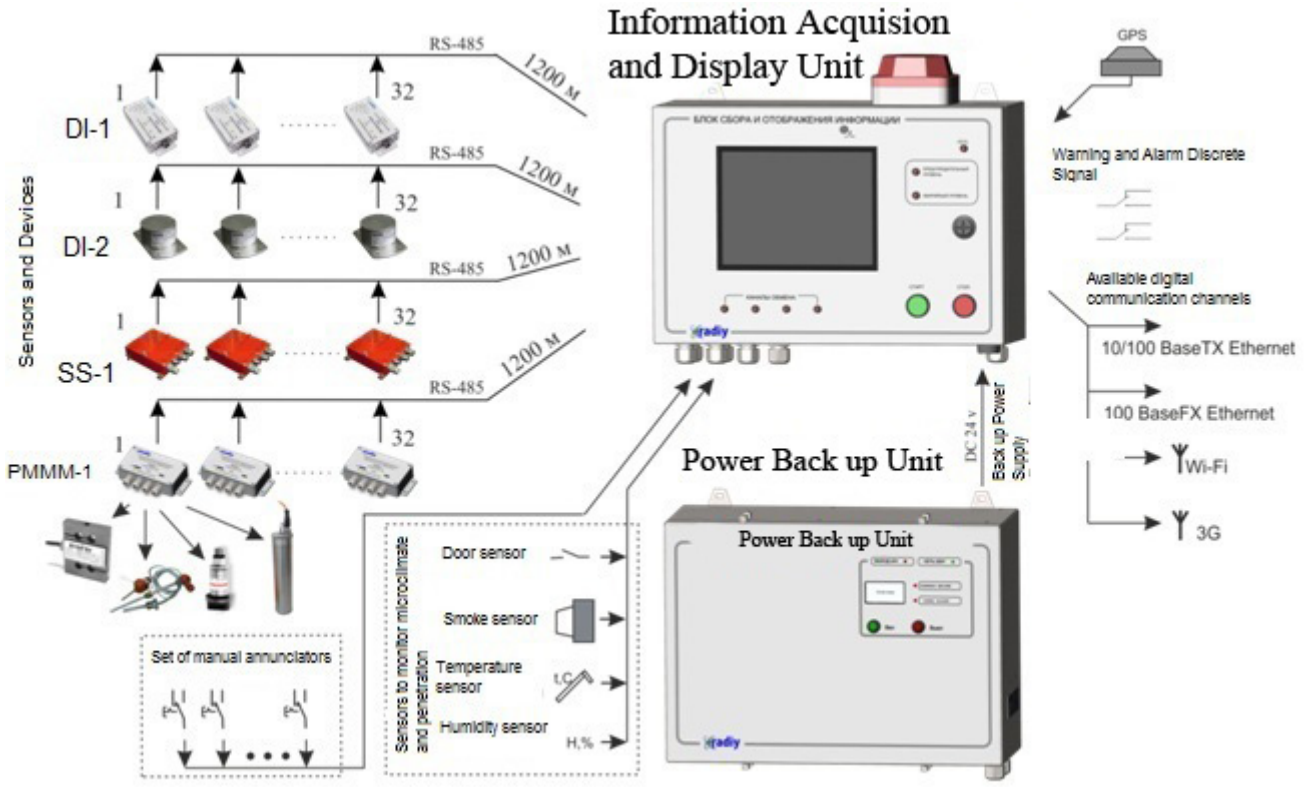

Fig. 1 Part of ASEDE block diagram

The IADU receives measuring data from primary sensors that are installed on or in the object to be monitored. Collected data and the event development scenario are then shown on the graphic display. In the event of an emergency, the IADU also generates warning and alarm signals.

The PBU provides a continuous power supply to the IADU and to all sensors that are part of the system. If there is a loss of power, the PBU will allow the ASEDE to fully function for 24 hours.

The application of open protocol digital interface RS 485 as a communication channel allows the ASEDE to be a unique system that can work with a wide range of sensors. The ASEDE block diagram (Fig. 1) illustrates that the ASEDE works simultaneously with inclinometer and seismic sensors using external converters. The figure shows precise measurement multifunctional module PMMM-1, a three-channel analog to digital converter with a 24-bit converter. The module can handle inputs from load cells, pressure, temperature, and research seismic sensors and other sensors with a standard analog interface.

For the allocated control system, when it is necessary to control several objects or when the places for control are distantly located, the ASEDE design can be based on the principle of one-rank segments. In this case, each segment of the system can act as a self-sufficient ASEDE with its own set of controlled parameters. The block diagram of the ASEDE as a group of one-rank segments is provided in Figure 2.

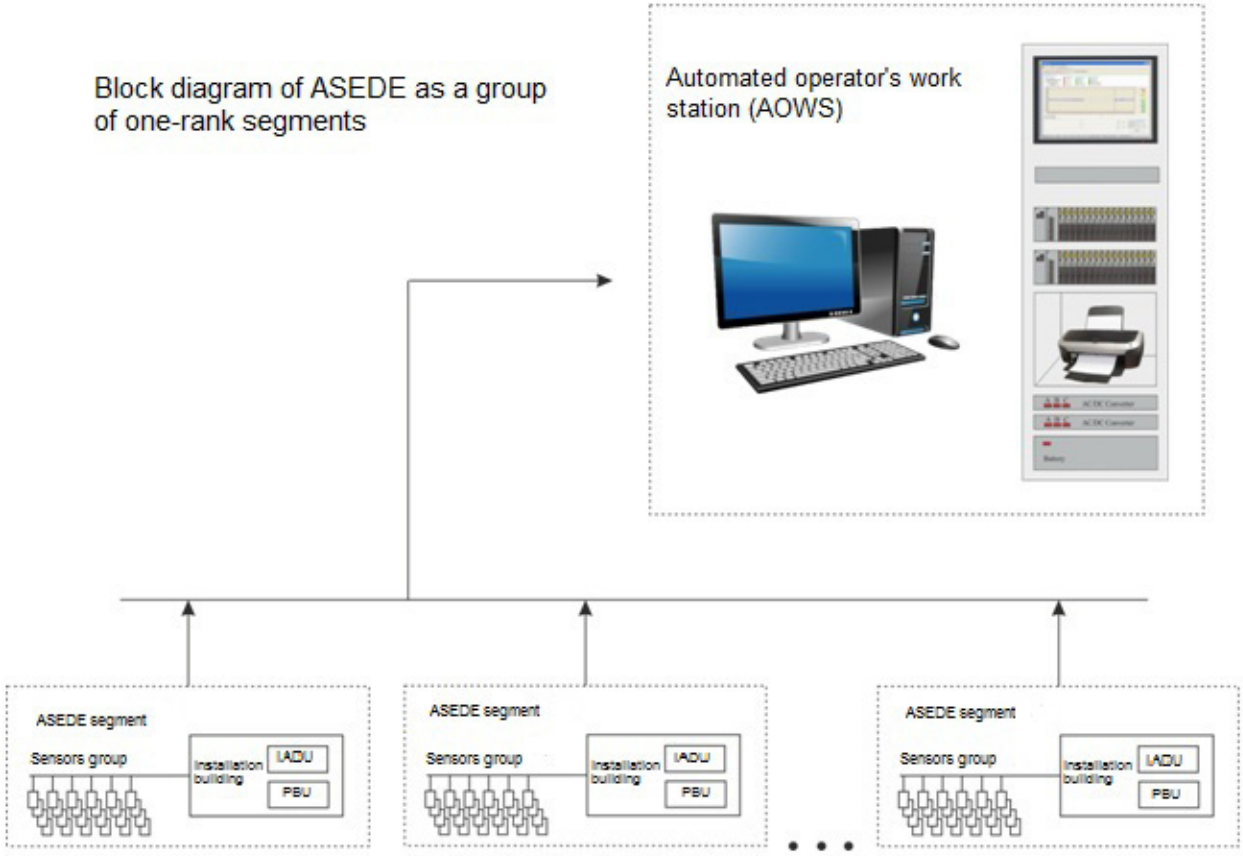

Fig. 2 Block diagram of ASEDE as a group of one-rank segments

The connection between system segments and with the automated operator's work station (AOWS) can be arranged by using any of the available communication channels at any part of the system design. The following communication channels are available:

- 10/100 Base TX Ethernet (copper twisted pair);
- 100 Base FX Ethernet (fiber optic);
- IEEE 802.11 (Wi-Fi);
- UMTS/WCDMA (3G).

These communication channels are used to exchange data with upper level hardware (ULH) which can be the central status system of annunciation (according to regulatory requirements DBN C.1.2.-5).

The main part of the ASEDE segment is the IADU. The block diagram of the IADU, sensors for controlled parameters, and microclimate sensors are provided in Figure 3.

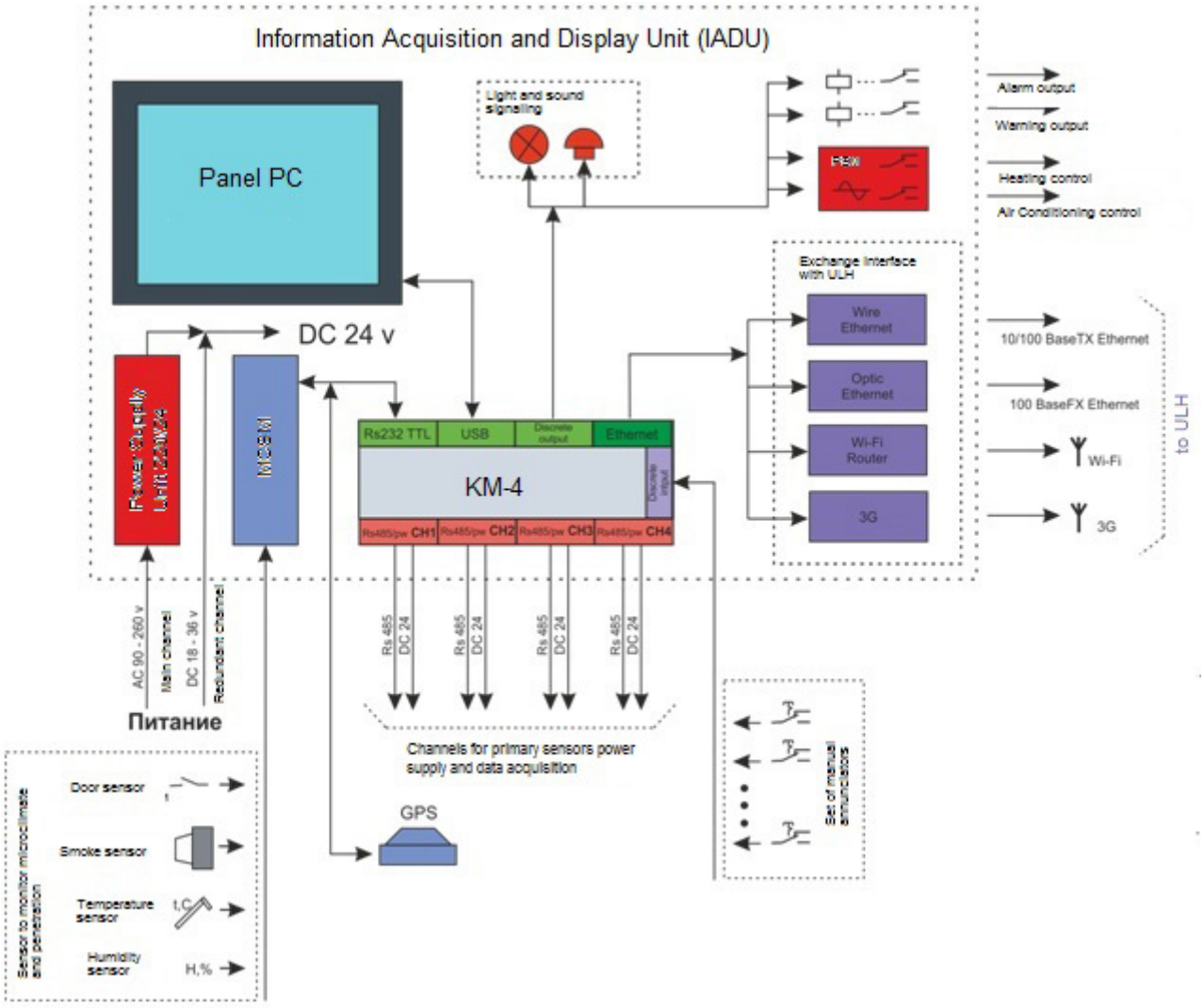

Fig.3 Block diagram of IADU and periphery interaction

The IADU consists of:

- power supply unit 220V – 24V to supply power for the IADU internal circuit;
- command module (KM-4), which processes primary data from sensors, generates control signals, supports data exchange with the panel PC, and generates data packages to communicate with ULH;
- panel PC to allow for input of parameter settings and to display data, schedules, emergency scenarios, and primary data archive;
- microclimate and security module (MCSM), which processes signals from microclimate sensors and sends them to the command module (KM-4);
- light and sound signaling for zone annunciation;
- exchange interface with ULH, which provides information exchange with the AOWS via selected communication channel;
- power switching module (PSM) that can control supplemental heating or air conditioning;
- switching relays of discrete alarm and warning signals output.

ASEDE FUNCTIONAL CHARACTERISTICS

Each ASEDE segment performs the following functions:

1) Receives data from sensors and devices via four digital interfaces of RS 485 standard;
2) Event time synchronization on GPS;
3) Receives signals from manual alarm annunciators;
4) Local display of the received information, electronic accident map development, and emergency development scenario visualization on its own monitor;
5) Input data analysis, local archiving, and information output using protocol SOS Access V3 to the AOWS or ULH;
6) Zone sound or light annunciation, and discrete alarm and warning signals output to control plant data processes and to control upper level annunciation devices;
7) Power supply monitoring and control of four long-distance power supplies for sensors;
8) Storage battery (SB) status control and automatic SB charging/discharging;
9) Power and current control of ASEDE long-distance power input.

The ASEDE self-diagnostic functions are as follows:

1) Status control of data exchange digital lines;
2) Operational control of primary data acquisition sensors;
3) Sensor data bus for voltage and current;
4) Voltage and current control of power supply main input.

In addition to the main technological functions, the ASEDE has a set of supplementary functions to control and monitor its own operation.

The ASEDE supplementary functions are as follows:

1) Monitor temperature in the room where IADU and PBU are installed;
2) Monitor humidity;
3) Monitor flooding;
4) Monitor 2 channels from the fire alarm sensors;
5) Monitor 2 channels from penetration and motion sensors;
6) Monitor 1 channel of heating control;
7) Monitor 1 channel of air conditioning control.

All data on technological function and microclimate control and monitoring can be accessed from the AOWS. Parameters that specify system operation, microclimate control, and sensor channel power supply are set locally from IADU monitors and remotely from the AOWS.

ASEDE TECHNICAL CHARACTERISTICS

General characteristics:

Power supply voltage	90.. 260 V, 50 Hz
Storage battery capacity (for PBU)	24 V 28 A/h
IADU consumption capacity (with no power supply for sensors)	not more than 20 W
PBU consumption capacity (no power for sensors and no charges to storage battery)	not more than 16 W
Overall dimensions of IADU	452x302x158 мм
IADU weight	not more than 16,0 Kg
Overall dimensions of PBU	452x322x176 мм
PBU weight	not more than 32,0 Kg

Technological features:

The number of sensors connected to one segment of ASEDE	1..128 шт.
The number of RS485 channels to connect sensors	4
The number of sensors connected to one channel	1..32
Exchange speed range	19200, 38400,57600
	115200, 230400
	460800 Baud
Maximum length of each channel line (at the speed of 115,2 KBaud)	1200 м
Supply voltage for each channel of sensor connection	DC 24V, 1,5 A
Each channel power supply commutation	Yes
Internal sound and light alarm for exceedance	Yes
The number of discrete information output signals	2
Switching power of discrete information signals	200 watt
Data archive storage capacity	16 Gb
Output interface type to integrate with other devices	10/100 Base TX Ethernet
	100 Base FX Ethernet
	IEEE 802.11, WCDMA

Microclimate support features:

Microclimate temperature range	from -50 to +85ºC
Microclimate relative humidity range	- from 25 to 100%
Flooding identification	Yes
The number of fire alarm discrete inputs	2
The number of input discrete signals of interference alarm	2
The number of discrete signals to monitor microclimate	2
Switching power of discrete signals to monitor microclimate (no interference electronic commutation)	- 2000 Watt

ASEDE SPECIFIC FEATURES

The main benefit of the ASEDE is that it can be used in any monitoring and control system.

Other specific features include:

- sensor power supply and ASEDE components power supply in case of emergencies, such as loss of external power. Independent power supply guarantees full operational capability of sensors and components;
- ability to measure certain parameters, monitor microclimate, and detect and alarm flood, fire, and physical penetration alarms;
- high level of resistance to exposure factors;
- self-diagnostic functions to monitor status of sensor information exchange, power supply, the status of entrance power channel, and the status of the SB;
- ability to mobilize and respond to an emergency.

EXAMPLES OF ASEDE DESIGN

INCLINOMETER MONITORING SYSTEM (IMS)

The IMS is designed to register slowly changing position angles that are measured by inclinometers installed on/ in the object. When the threshold angle values are exceeded, sound and light alarm discrete signals are generated.

Fig. 4 Example of IMS data displayed at IADU

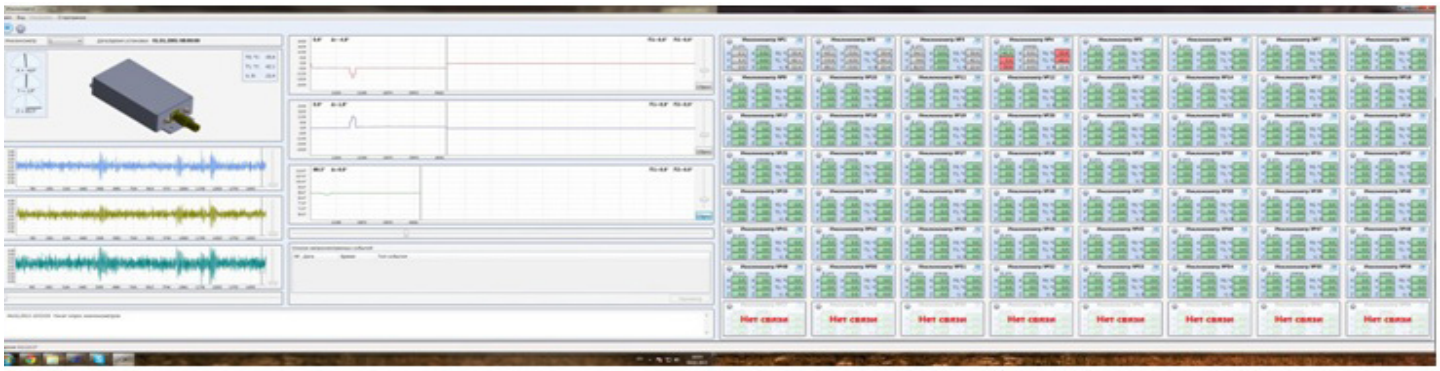

Fig. 5 Example of IMS data displayed at AOWS

SEISMIC MONITORING AND PROTECTION EARLY WARNING SYSTEM (SMP EWS)

The system is designed to provide continuous remote control and monitoring of seismic impact at different observation points installed in different geographical locations. The system also transfers data to the object in a secure location . If designed seismic levels are exceeded, the system will generate and send emergency discrete signals.

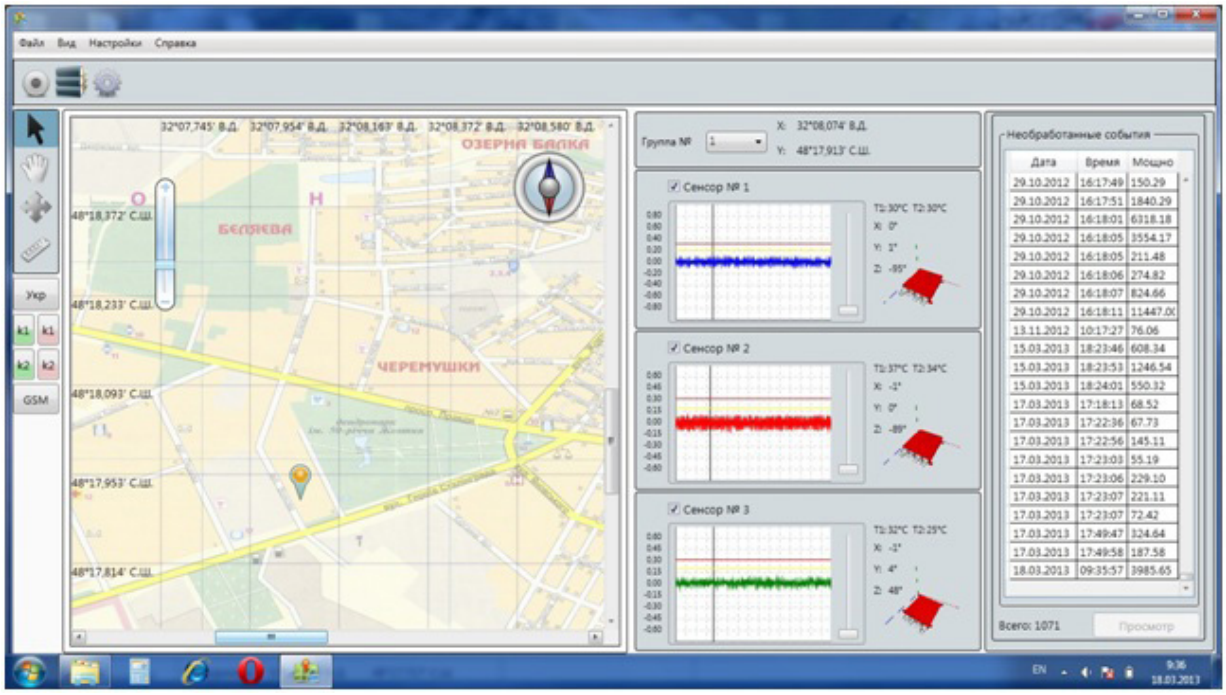

Fig. 6 A sample of the main window display

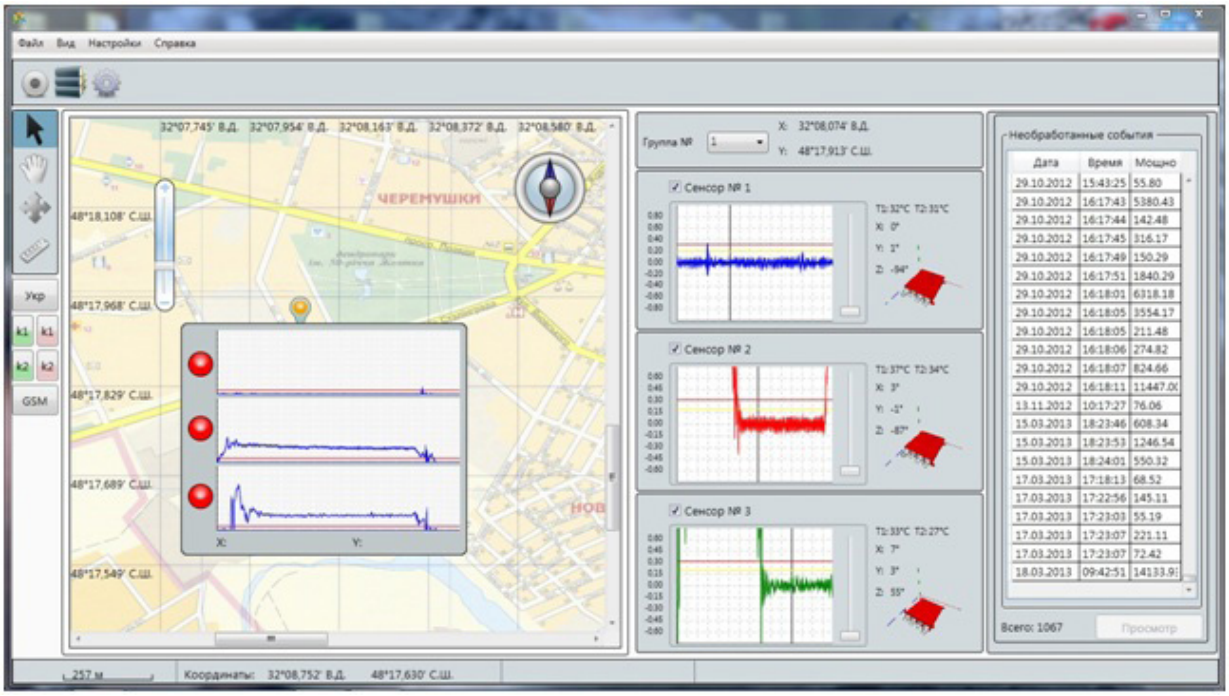

Fig. 7 A sample of the registered event display

OTHER WAYS TO IMPLEMENT ASEDE

ASEDE can be used to monitor and control the status of different objects

Fig. 8 ASEDE application to monitor emergency state of building and other constructions

Fig. 9 Monitoring mine working emergency conditions

Fig. 10 Monitoring bridges and supports emergency conditions

Design Solutions of Physical Process Analysis Design Bureau

Physical Process Analysis Design Bureau of PC "RPC Radiy" is set up for development of seismic protection systems, calibration equipment and qualification of product data at NPP. The bureau designs and implements the Seismic Sensor that is the source of seismic data for the seismic protection equipment. Other successfully designed and implemented product is the vibration measuring system for periodic calibration of seismic sensors in semi-automatic mode. Besides nuclear products the design bureau has developed the Information Acquisition and Display Unit that is the basic item in any monitoring system design including the Automatic System for Early Diagnostics of Emergencies. Additionally, the design bureau develops the angel precision gages for the wide scope of measurement.