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NEW SYSTEM FOR THE SEISMIC PROTECTION OF NPP SSZ -1M TYPE

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ABSTRACT

Continuous operation of industrial anti-seismic system of protection of S1AZ-2 type in Nuclear power plant of the former USSR and the countries of Eastern Europe revealed some shortages of this system. Connected with this on a technical task of concern "Rosenergoatom", Russian-Armenian joint venture "Atomoseismoizyskaniye" worked out a new system for seismic protection SSZ-1M type, which is a modification of S1AZ-2 industrial aseismic protection and implements the functions, foreseen for this system. Besides, its engineering, operational and functional capabilities are improved.

INTRODUCTION

The system of seismic protection of NPP SSZ -1M type is foreseen for the protection of industrial entities (in particular NPP) from the secondary effect (fires, explosions, flow of radiation, etc.) during strong and destructive earthquakes. It can be used for running seismic emergency protection of powerful machines in the enterprises, for stopping railway transportation, closing petroleum and gas mains, etc., in case of strong earthquakes.

The system carries out continuous control and recording of the ground oscillation magnitude, caused by earthquakes as well as automatically turns on the corresponding means of protection in case of surpasses with a definite acceleration level (threshold).

TECHNICAL DESCRIPTION OF THE SYSTEM

SSZ -1M system consists of three separate identical blocks of seismic sensors set around the protected object (SSB), a block of signal processing (SPB), three blocks of continuous power supply (PSB) and a laser printer.

In SSB block on a poured aluminum basis three accelerometer are set of OCn -2M type for measuring the three constituent vectors of accelerating the oscillation of the ground with its booster -trans formers. The basis is closed with a steel cover, which protects the block from mechanical influences and electromagnetic fields.

The block of signals processing structurally is a metal box of a table shape, in front of which there is a industrial computer of AWS-8430 type, and inside it at the back there are three similar modules of signal processing.

Each block of seismic sensors converts the mechanical energy of ground oscillation in three perpendicular directions - x, y, z - into proportional electric signals, which are then transferred to the block of signal processing. Here the signals are processed in the following way, the summary vectors are calculated $W=(x^2+y^2+z^2)^{0\ 5}$ and the exit signals are heard from each block separately. These signals are remembered (registered) by the computer, and the final signal for the emergency protection system of the object, in case of surpassing the advanced threshold of exploitation, is formed according to a logical principal "two of three"'.

SSZ -1M system is a modernization of industrial system of anti-seismic protection of SIAZ - 2. with which the power stations of the former USSR and some countries of Eastern Europe are equipped.

Continuous operation of CIAZ -2 system revealed a number of shortages, the main of which is the short period of its exploitation (10 years, and for some setting goods less - 5-6 years). Connected to this, according to technical task of "Rosenergoatom" concern, Russian-Armenian Joint venture " Atomseismoizyskaniye" worked out a new system of seismic protection of SSZ- 1M type.

The main purpose of modernization and creation of new generation of SSZ -1M system is the improvement of technical and exploitation indices of the existing systems. The system has the following functions, which SIAZ - 2 does not have:

- links of seismic events with the real time;
- automatic control over efficiency of the device and audible and light signals input while revealing disorder;
- long-term storage of accumulated seism-information and its printing in shape of tables and graphics on any printer, cooperated with IBM;
- link with the local computing net (LCN) NPP.

The comparative evaluation of the technical features and functional capacities of SIAZ -2 and SSZ -1M systems is presented in a Table.

Table 1. Comparison of Technical Features and Functional Capacities of SIAZ-2 and SSZ-1 M

Technical features	SIAZ-2	SSZ-1M
The range of the controlled accelerations of the ground oscillation	0.05-4.0 m/s^2	0.05-4.0 m/s^2
The range of the frequencies of the controlled accelerations of the ground	0.5-30 Hz	0.4-50 Hz
The range of the acceleration within which the threshold of emergency alarm is defined	0,25-4.0 m/s^2	0.25-4.0 m/s^2
The range of the acceleration within which the threshold of recording start-time is defined	0.05-0.25 m/s^2	0.05-0.25 m/s^2
The main error of producing the emergency alarm while surpassing the threshold	10%	±5%
Exploitation period	10 years	30 years
Automatic checking of the efficiency	No	Yes
Audible alarm in case of seismic event	No	Yes
Continuous control over accuracy of the device, diagnostics of disorder and the massage on place and time o!'the defect	No	Yes
Audible alarm in case of disorders	No	Yes
Automatic blocking of outgoing signals in case of the device disorder	No	Yes
Recording of the revealed disorders, pointing the data, time and type of the defect	No	Yes
Recording and storing the information (including the actions of the operator)	No	Yes
Recording duration of each seismic event	30s	100 s., 3 s. of which - before the seismic event
Recording time of the seismic event	No	Yes

Printing as records, tables and graphics on any printer compatible with IBM	only graphics on oscillograph HO44	Yes
Possibility of quick changes of exploitation thresholds (without calibration on vibrostand)	No	Yes
Possibility of replacing the device junctions out of order without additional calibration on vibrostand	No	Yes
Possibility of exiting to external LCN	No	Yes

Main ways of meeting the above-mentioned goals were:

- using the methods of digital data processing;
- using modern computer technologies;
- using modern program provision;
- improving the primary transformers and the system's metrological provision;
- improving the algorithms of the processing and information provision from the seismic oscillation of the ground;
- diagnostics of technical and metrological condition of the equipment.

The open architecture of the SSZ -1M system and storing a great number of information allows tc enlarge the functional capacities of the system and run a statistic data processing:

- spectral analysis;
- calculation of the direction of blaster wave;
- defining the force of the blaster wave in the given direction etc.

The system satisfies the following technical features:

- acceleration range, where the control of seismic oscillation of the ground is carried out with 0.05 m/s^2 up to 4.0 m/s^2;
- the frequency range of the controlled oscillation from 0.4 Hz up to 50 Hz;
- the acceleration range, within the limits of which the threshold of the recording start-time of the seismic event is established from 0.05 m/s^2 up to 0.25 m/s^2.

While processing the threshold recording of the seismic event starts-lime, audible alarm turns on and a message appears on the screen of the computer. The alarm is turned off by the service staff.

- acceleration range, within the limits of which the threshold of emergency alarm is defined - from 0.25 m/s^2 up to 4.0 m/s^2 with a step of 0.25 m/s^2.

While putting the threshold into execution the emergency protection signals are produced and audible alarm turns on. A message about emergency defense signals appears on the screen of the computer, mentioning the data and the time.

- the main relative error of the emergency signals - not more than ±5% of the defined threshold of putting it into execution.

The system provides the implementation of the following functions:

- the system consists of three independent channels, producing the signals into the system of NPP for organizing the logics of "two of three";
- producing the emergency alarm and the recording takes place according a full vector of ground acceleration, surpassing the established thresholds:
- each channel of the system records and stores up to 5 seismic events after which the later are transferred to the computer for a long-term storage;
- the duration of the recording of each seismic event - not more than 100 s, 3 s of

which - before the first seismic wave;

- the data and the time of the event start-time are also recorded with each recording in the system of the common time of NPP. The absolute time is recorded within exactly Is. The note on seismogram is implemented with a step of 0.05, 0.1 and Is selectively;
- the program-technical means have imbedded device-program accuracy self-control tools of the equipment in the process of its functioning, with the alarm in case of breakdowns;
- the equipment is reeved with audible and light alarm. The system includes means of checking the efficiency of the whole system and the constituent parts. In case of malfunctions the signal of disorder of the given channel is hazard in the system emergency protection the signals of this channel are blocked;
- diagnostic operative procedures are put into execution automatically. The procedures inform the operator about the existing disorders, pointing the location of the defect and the peculiarities of the problem.

The channels of the system are connected to the common net of the alternating current with 220V and the frequency of 50 Hz through the block of continuity of service, which, being a net filter at the same time, provides the work of the channel in case of the lack of the voltage in the common net for 15 minutes.

The system preserves its efficiency in the following terms:

- the air temperature from -5°C up to +35°C;
- the relative air humidity up to 90% with the temperature of 20°C.

The system preserves the technical features in case of seismic impacts with the strength of 9 balls on the level of the ground for SSB and on a mark of 24.6 for SPB.

The system can be kept in a transport container without any damage with a temperature of -50°C up to +50°C, as well as it can sustain transportation jolting with an acceleration of 30 m/s^2 and a frequency of 10 up to 120 blasters a minute.

The average time of the system exploitation is not less than 30 years.

