



# ПромСервис

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ИНН 7302005960, ОКОНХ 95300, ОКПО 12560879, КПП 730201001

## Diagnostic expert system

# DIES

Diagnostic expert system of rotary equipment (compressors, pumps, fans, turbines, locomotive wheel pairs etc.) is designated to determine the technical condition of the objects to be diagnosed by customer's specialists with the help of the equipment and methods delivered by ZAO "Promservis".

**This system performs diagnostics in automatic mode.** It allows the user to detect disbalance and shaft misalignment, defects of rolling and plain bearings, gears and couplings, unit looseness etc. High-qualified specialists in the field of vibrodiagnostics are not required to operate this system.

The proper use of this diagnostics system allows **avoiding unreasonable repairs**, to repair the equipment promptly, to purchase the required spare parts beforehand, to reduce considerably or even avoid unplanned downtime in case of a sudden failure.

**The most significant users are:** in metallurgical industry (Altaisky chemical - recovery coal carbonization works, Navoi, Magnitogorsky and Starooskolsky integrated iron- and- steel works), in machine building ("AvtoVAZ"), oil-producing industry ("Sibneft Noyabrskneftegas", "IBUR"), atomic power stations (Kalininskaya APS, Research Institute of Atomic Reactors), chemical industry ("UralKaliy", "OmskTechUglerod"), in energetics, in water-supply canals (Ulyanovsk, Vladimir and Togliatti) and others.



In general **the states under definition** are determined from the diagnostic object design, are agreed with the customer's technical requirements and usually include the following: Rotating mass unbalance, discentring or misalignment of the joint shafts, rolling and plain bearings defects, defects of skew and worm gearing touching, units are not fastened on the foundation, muffs defects.

### Delivery minimal set:

- a portable analyzer of vibro-acoustic signal spectrum PR200EX. (Devices of several companies can be used, such as DIAMEH,

ORGTECHDIAGNOSTIKA, INCOTES etc.), the devices of the other companies can be used after carrying out changes of the software;

- two vibro-acceleration transducers (piezoaccelerometers);
- a photosensor (for balancing);
- diagnostics program and methods developed by ZAO "Promservis";
- Developed and prepared for operation database of customer's equipment (the equipment quantity is practically unlimited).

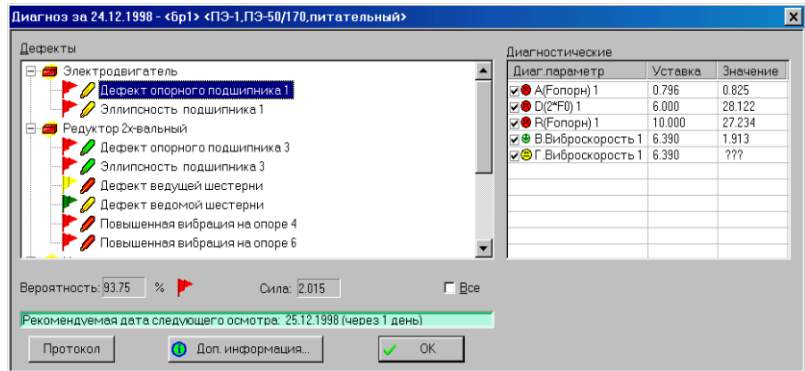
A delivery set, a list of the equipment to be diagnosed and its malfunctions as well as the outcoming document forms are agreed upon with a customer. Personnel training are carried out during the system trial operation on the customer's or manufacturer's equipment for choice.

The database structure is the same as the actual enterprise structure and includes all the customer's equipment to be diagnosed. The DB is completely set up and ready to operate. It is possible to get

summary reports about the equipment condition of the enterprise, to make prognoses for its condition, to give out summary repair and inspection orders. This program allows to create any paperwork forms.

During **diagnostics procedure** each assembly is considered as an integral structure. On the grounds of the decision about the availability or no availability of defects on separate units (bearing, gear, shaft etc.) a conclusion is drawn about the assembly performance upon the whole.

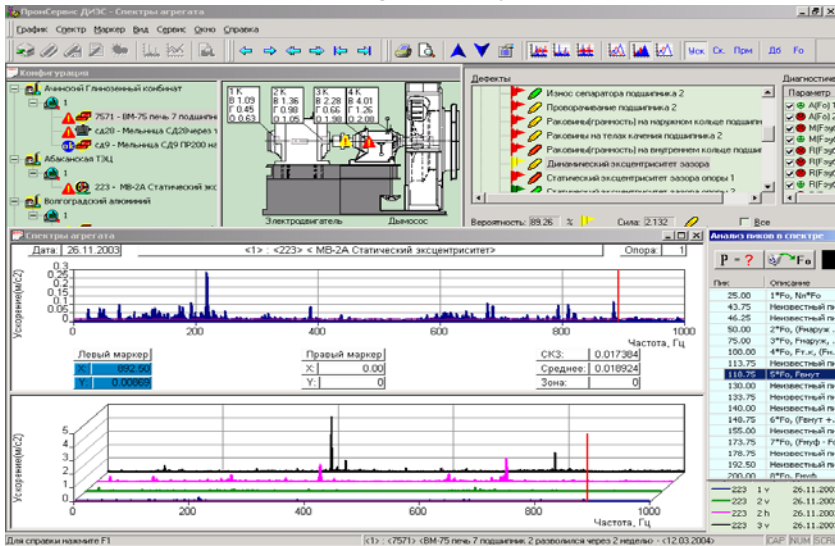
The diagnostics results are stored in archives, which allow viewing the assembly condition for any date and can be used in the enterprise information system.



Diagnostics protocol includes a list of detected malfunctions, values of vibration velocity on the supports and a recommended date of the next inspection, as well as a list of the required repair work.

The program includes a **multifunctional spectroanalyser**, which performs the following functions:

- automatic calculation of characteristic frequency of defect occurrence
- combined survey and analysis of acoustic functions
- complete harmonious signal analysis



The program allows viewing, analyzing and printing out vibration trends on the supports, defect progress trends and parameter change trends.

The system predicts the condition of the equipment to be diagnosed for a certain period of time, for example, up to the next planned preventive repair (PPR), determines the next inspection date, traces the assembly defect progress. There is a possibility to perform balancing of shafts in their own bearing.

**Diagnostics reliability 89%!**

The company performs servicing of the delivered software version, carries out changes according to the customer's requirements. Any time you can get a qualified consultation about vibrodiagnostics and program functioning developed by ZAO "Promservis" free of charge.

For the users, who have experience in vibrodiagnostics, the program "DIES" gives the opportunity to realize their own methods of malfunction detection.

Considerable economic effect of using this system is achieved owing to:

- earlier malfunction detection and timely taking measures to prevent their progress;
- refusal of performing scheduled work on serviceable equipment;
- proper repair planning of the equipment being diagnosed during PPR;
- prevention of sudden failures and break downs on the objects to be diagnosed;
- extension of service life of the objects to be diagnosed.

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Diagnostic systems, elaborated by stock company "PromServis" and adopted by atomic, oil-refining, machine building, metallurgical and other branches of industry, are destined to determine the technical state of pumps, compressors, fans, turbines, rolling mills drivers as well as separate (not in set) pumps, bearings, set-up gears and so on.

**Systems under elaboration are intended for:**

- periodical or permanent controlling of the equipment state;
- automatic diagnostic of the equipment indicating the defective unit and the kind of the defect;
- making prognoses for the equipment during operation and giving the information about time and volume of the repair.

**The aim of the elaboration of such systems is:**

- shortening of the defects detecting time;
- the increase of the defects definition truth;
- the decrease of the amount of the stuff fault solutions during the defect definition;
- the increase of objectivity when diagnostic.



When diagnostic, every unit is considered as an indivisible design, consisting of a drive (electric motor, turbine), a reduction gear, muffs, pump (compressor, electric generator and so on), fixed on a foundation. On the base of the conclusion about presence or absence of defects in separate assemblies (bearing, gearing, shaft and so on) one can come to recognize that the unit as a whole is serviceable. **This system performs diagnostics in automatic mode.** It allows the user to detect disbalance and shaft misalignment, defects of rolling and plain bearings, gears and couplings, unit looseness etc. High qualified specialists in the field of vibrodiagnostics are not required to operate this system.

The objects diagnostic is made according specially developed methods. They were realized in a program product according to the State standard ГOCT 20911-85 and ГOCT 2518-87.

In general the states under definition are determined from the diagnostic object design, are agreed with the custom's technical requirements and usually include the following:

1. Standard state (no significant deviations of the analyzed parameters and characteristics from the given values, taken as normal, were find out).
2. Rotating mass unbalance, caused by non qualitative treatment of the bearing rotor necks, rotor wheels offcentre fit, rotor bending and other defects leading to the rotor mass center displacement.
3. Discentring or disalignment of the joint shafts of the pump pressure regulator drive (and so on).
4. Plain bearings defects:
  - 4.1. The journal of the plain bearing is ellipse
  - 4.2. Oil wedge vibration caused by the discrepancy of the rotor dynamic qualities and lubricate property of the plain bearing
  - 4.3. Plain bearings shells wrong installation
  - 4.4. Plain bearings shells wear

- 4.5. Shaft touching the babbit in plain bearings
5. Rolling bearings defects .
  - 5.1. Outer bearing race wear.
  - 5.2. Outer bearing race defect (cracks, cavities).
  - 5.3. Inner bearing race wear.
  - 5.4. Inner bearing race defect.
  - 5.5. Separator wear.
  - 5.6. Rolling bodies wear.
  - 5.7. Defects on the rolling bodies.
  - 5.8. Irregular radial tension.
  - 5.9. Lubricant stiffening or insufficiency.
  - 5.10. Outer bearing race spinning.
  - 5.11. Outer bearing race skewness.
6. Defects of skew and worm gearing touching.
7. Defects of reductor assembly.
8. Units are not fastened on the foundation.
9. Non - qualitative assembly (got looses) of the unit.
10. Muffs defects.
11. Defects of electric system.
12. Defects of electromagnetic system
13. Rotor - support system resonance.
14. Contact of rolling and stationary rotor parts.

The diagnostic systems are fabricated in two modifications: transportable and stationary.

The states from 1 to 12 can be determined by both modifications of the diagnostic systems but the states 13 and 14 only by the stationary one.

The fundamental peculiarity of the systems elaborated by stock company "Promservis" consists in determining the state of all parts of the unit in complex, i.e. taking into account the effect of their behavior on each other. That permits not only to determine the available defects and to predict their development but to determine the initial cause at further analysis. Such information permits to plan correctly and to make the repairing, to eliminate the source of the defect appearance up to the design defects. The above listed defects are rather typical for the rotor type equipment. They reveal themselves in spectrum typical changes of the vibroacoustic signals of the units taken from the support. Besides that some signals' statistical characteristics and processing control parameters are used to carry out the analysis.

In the process of elaboration the list of the detected states may be changed and filled up and the design peculiarities of the diagnostic object.

The proper use of this diagnostics systems allows to avoid groundless repairs, to repair the equipment in good time, to purchase the required spare parts beforehand, to reduce considerably or even avoid unplanned downtime in case of a sudden failure.

**Considerable economic effect** of using systems by "Promservis" is achieved owing to:

- earlier malfunction detection and timely taking measures to prevent their progress;
- refusal of performing scheduled work on serviceable equipment;
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## The transportable diagnostic expert system "DIES"

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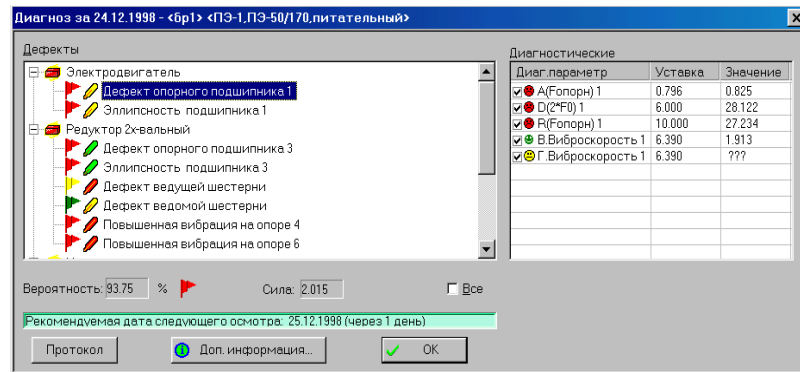
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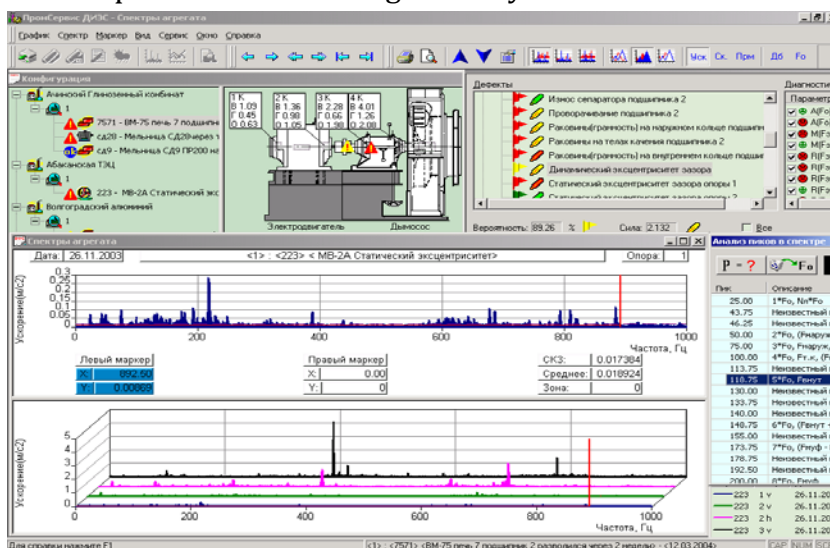


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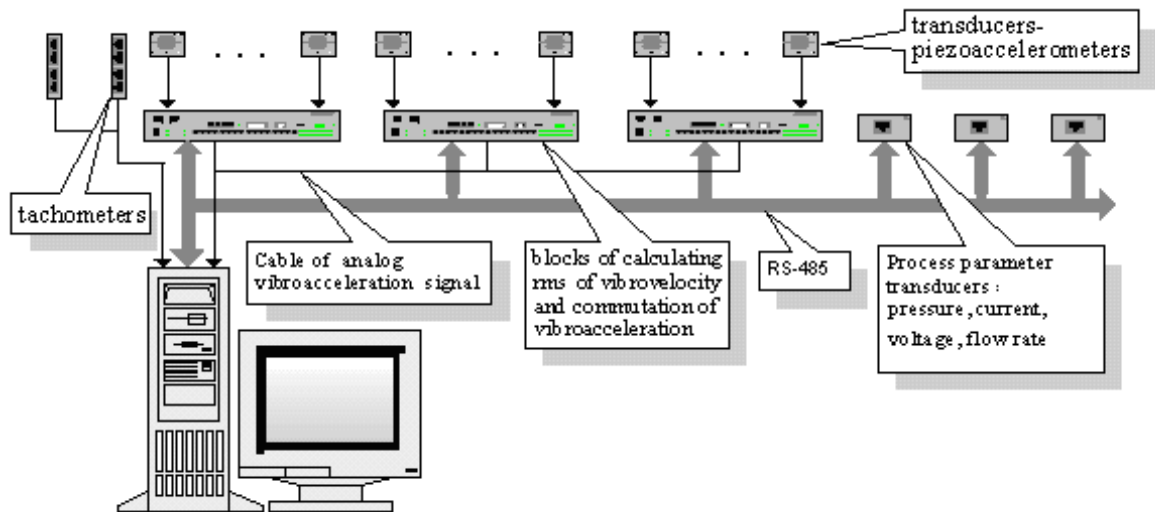
- earlier malfunction detection and timely taking measures to prevent their progress;
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### **Stationary system of automatic diagnostics and monitoring of the equipment ("SADKO" -"САДКО")**

Stationary system of automatic diagnostics and monitoring of the equipment ("SADKO") is designated for twenty-four-hour monitoring and tracing of the industrial equipment condition on the grounds of vibroacoustic noise and technological parameter analysis.

This system (Fig.1) allows to solve the following main tasks:

- performance of process monitoring;
- detection of equipment faults and timely notification of the personnel;
- performance of automatic diagnostics and location of a fault source during the early fault progress stage as well as the reasons of its occurrence;
- help in making decisions to eliminate dangerous situations;
- keeping archives of the equipment measuring parameters.



**Fig.1 Flow chart of a stationary system**

System structure consists of the following main blocks:

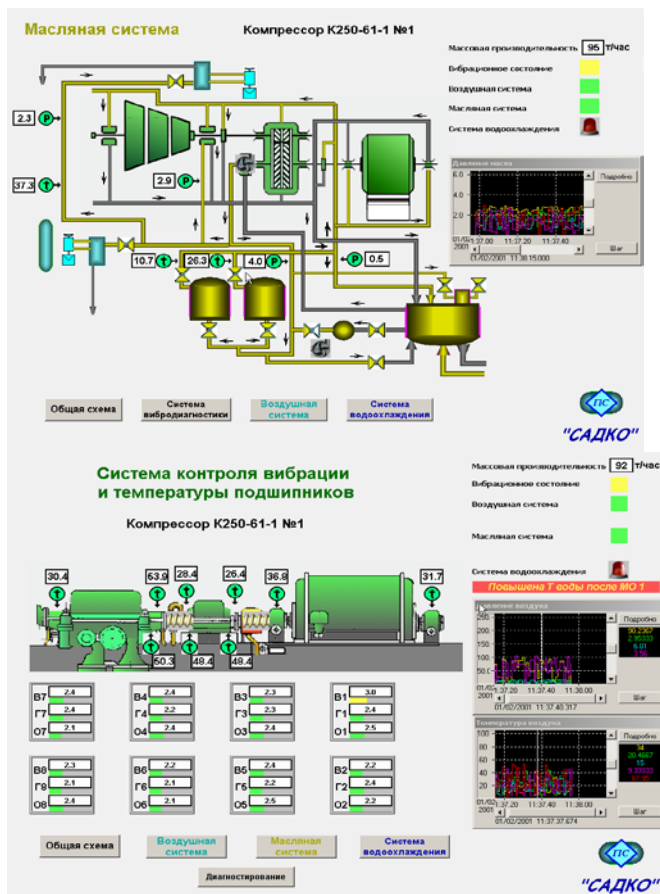
- transducers-piezoaccelerometers;
- blocks of calculating rms values of vibrovelocity and commutation of vibroacceleration signals;
- process parameter transducers;
- tachometers for measuring frequencies and variations of shaft rotation;
- computer with installed special software and multichannel measuring board.

The system "SADKO" performs the following main functions:

- detection and conversion of analog signals into digital ones from transducers of vibration and process monitoring: temperature, pressure, flow rate;
- detection and generation of digital signals onto the process control devices;
- equipment starting and transient mode monitoring;
- comparison of the current parameters with settings of prealarm and alarm conditions;
- detection of mechanical assembly unit faults of the equipment according to the methods developed by ZAO "PromServis";
- generation of light and audible signals;
- report creation;
- defect progress prediction;
- generation of operation sequence lists under off-optimum situation.

The system is based on real time monitor TRACE MODE (or WinCC etc.). Graphic interface is widely used in this system (Fig.2). Multiport structure allows to trace general condition of the whole listed equipment with indication of main and additional technical parameters of each assembly unit. The whole operation data are displayed in a digital form, in the form of a semaphore and function graphs on the unit mimic panels or their separate subsystems.





**Fig.2 Indication of the whole operation data in various forms**

If a parameter value is not within the setting, the corresponding sensor on the mimic panel changes its color into yellow or red and a warning is displayed. A process or armature condition is shown in the form of an animation diagram.

In spite of the fact that the system is local, all reports and archives are accessible for viewing in the local net.

Thanks to the continuous processing of the whole data concerning the object under monitoring, "SADKO" allows to perform a perfect diagnostics of all main mechanical assembly units and detect such failure as: rolling and plain bearing defects, disbalance and misalignment of joint shafts, incorrect gear engagement and gear defects, absence of support rigidity, coupling defects, cavitation phenomena, touching between rotary and stationary parts, occurrence of self-excited oscillations and resonances etc.

Analyzing the tendencies of process parameter changes in the cause of time, "SADKO" is able to predict failure progress and evaluate technical condition of mechanisms in future.

This system is of a special importance at the assembly switching on and off. In automatic mode the system generates an operator activity sequence and guaranties its performance as it checks the correspondence of the operator's activities with the available recommendations. The operator's activities are shown on the diagram in the form of correspondingly colored pictures of valves and measuring devices. After switching into a desirable mode the system maintains the operation condition informing the operator about deviations which take place.

Introduction of "SADKO" allows considerably to increase equipment reliability and reduce costs owing to prevention of emergency situations, as well as trace defect progress and eliminate the reasons of their occurrence. Besides, the work of such systems is favorable to reveal and to eliminate the design defects of the diagnostic objects.

These systems introduction experience shows that the input recoupment period is from 1 month till 1 year. Experts estimations of the diagnostic effectiveness of the atomic industry objects are showing that their return is 10-15 dollars for one spent dollar.