
Diagnostic Rolling Element Analysis Module (DREAM)

Version 4.x

*for the “Bruel&Kjaer” Type 7107-M Sentinel software
and Type 2526 data collector*

USER'S MANUAL

OPERATOR'S MANUAL

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ABSTRACT

DREAM is the Diagnostic Rotating Element Analysis Module. It is a software that runs on the IBM PC/AT compatible personal computer and when coupled to an FFT analyzer or data collector, fitted with an envelope detector, forms a complete monitoring system for rolling element bearings.

The software is designed to be used either by nonspecialized maintenance team (mechanics not trained in diagnostics) or expert alike (high level engineer).

According to the diagnostic unit specified, the program recommends a measurement setup of the data collector. After the measurements are done, the data are downloaded to the computer and the DREAM makes analysis of the unit current condition. DREAM identifies up to 14 possible machine units' defects in three levels of danger. According to its condition DREAM determines when the next measurement should be made, or recommends what maintenance should be made, or recommends to replace the unit.

Since everything can be made in an automatic mode, the program works extremely efficient. An operator can process up to a 100 spectra an hour, and working in one shift a team of two mechanics can monitor the condition of up to ten thousand unit.

The Manual describes the operation of the application software starting from its installation and up to report generation.

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1. SPECIFICATION

1.1. WHAT THE DREAM PROGRAM DOES

- ❑ Detects and identifies the unit's defects after mounting and during operation
- ❑ Diagnoses the unit's condition by one vibration measurement
- ❑ Makes a long-term prediction of the unit's condition by one vibration measurement
- ❑ Collects and saves the data about the units' condition during their operation

1.2. DREAM FEATURES

- ❑ Automatic processing of the envelope spectrum and mean high frequency bearing housing vibration, detecting the diagnostic parameters and displaying them.
- ❑ Automatic identification of 12 types of unit defects with an indication of their levels (incipient, medium or severe).
- ❑ Automatic prediction of the unit's non-failure operation until the next measurement (the time period between measurements can be up to 20% of its MTBF)
- ❑ Practically unlimited number of units in configuration which the customer can make by himself. The configuration can be corrected or added very simply.
- ❑ Automatic determination of recommended danger defect levels and the ability to adjust them in compliance with the collected data.
- ❑ Automatic speed compensation and correction of the number of rolling elements during data processing.
- ❑ Storage of the results of intermittent vibration measurements and an unlimited number of successive measurements for each of the units.
- ❑ The simplicity of diagnostic measurements and the automatic test of the compatibility of the current spectrum and previous ones.
- ❑ Advanced search and output facilities.
- ❑ A detailed diagnostic process with the ability to display the results of different stages of the process on the screen.
- ❑ Context-sensitive helps

- Output and printing of the following data:
 - the list of the bearings' designations with their specification data
 - the list of the analyzer setup during the measurements.
 - the history of diagnostic data of the chosen unit
 - the list of the units' condition with an indication of most severe defect, its depth and recommended date of the next measurement
 - the list of recommendations on maintenance of the units
 - the list of units which conditions require diagnostic measurements on the day the operator states

1.3. SYSTEM REQUIREMENTS

Personal Computer IBM PC/AT or compatible

With the Bruel&Kjaer Type 7107-M Sentinel
software installed

10 Mb on Hard Disk or more (for the program
and the database)

Data collector Type 2526

The DREAM Application Software is supplied on floppy disks. The software is protected by an electronic key which must be attached to the parallel port. The key is supplied with the software, as well as the key driver to work with Windows (the Security software).

2. STARTING UP

DREAM for Sentinel is a Windows software that works with the Bruel&Kjaer Type 7107 Sentinel database. To install and operate DREAM, you must be familiar with the basic operation of Microsoft Windows and have installed Sentinel software of version M or higher.

2.1. INSTALLATION

The DREAM application software is supplied on distribution diskettes. It have to be installed with an automated installation program that's called 'Setup'.

The **DREAM** distribution diskettes contains:

- ❑ DREAM application software with an installation program for the **SETUP.EXE**
- ❑ Borland Database Engine software that is used to work with databases.
- ❑ Security software to install driver for the hardware protection key to work with Windows.

You should use the **SETUP** program to install DREAM software onto your computer system. This will insure that all the files that form the DREAM software would be transferred to the right place. **SETUP** will automatically create the directories and copy files from the distribution disks to your hard disk.

To install DREAM for Sentinel, follow the instructions below. To start installation:

1. Launch Microsoft Windows.
2. Insert disk “DREAM for Sentinel Setup 1” into your floppy drive.
3. From the Program Manager, go to the File menu and select *Run* command.

Note Under Windows 9x, select Run... from the Start button menu. Another way is to select Start > Settings > Control Panel and on the Control Panel displayed - Add/Remove Programs.

Fig. 2.1

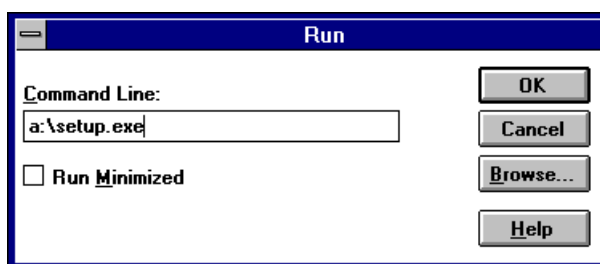
Use command Run from the File menu of Program Manager to start the installation process



4. Type "a:\setup" in the Run dialog box and press **OK** button or use the **Browse...** button to select the setup.exe file.

Fig. 2.2

Enter the setup.exe file name and click the OK button



Note If you are installing the software from floppy drive b: type in b:\setup above.

Now you will see the Welcome window of the installation program:

Fig. 2.3

Starting installation window

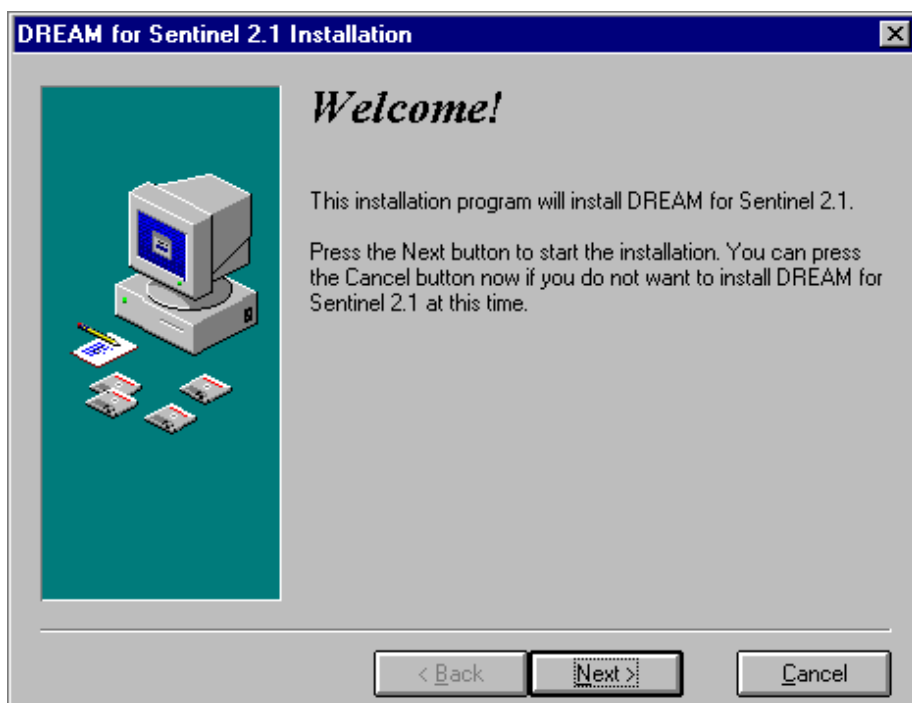
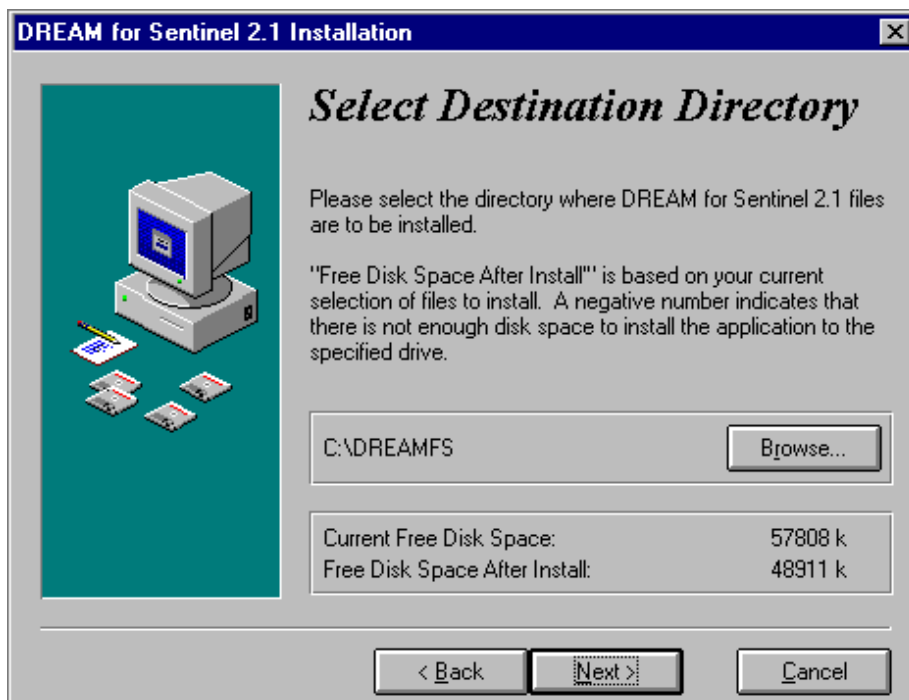


Fig. 2.4
The Select Destination
Directory dialog



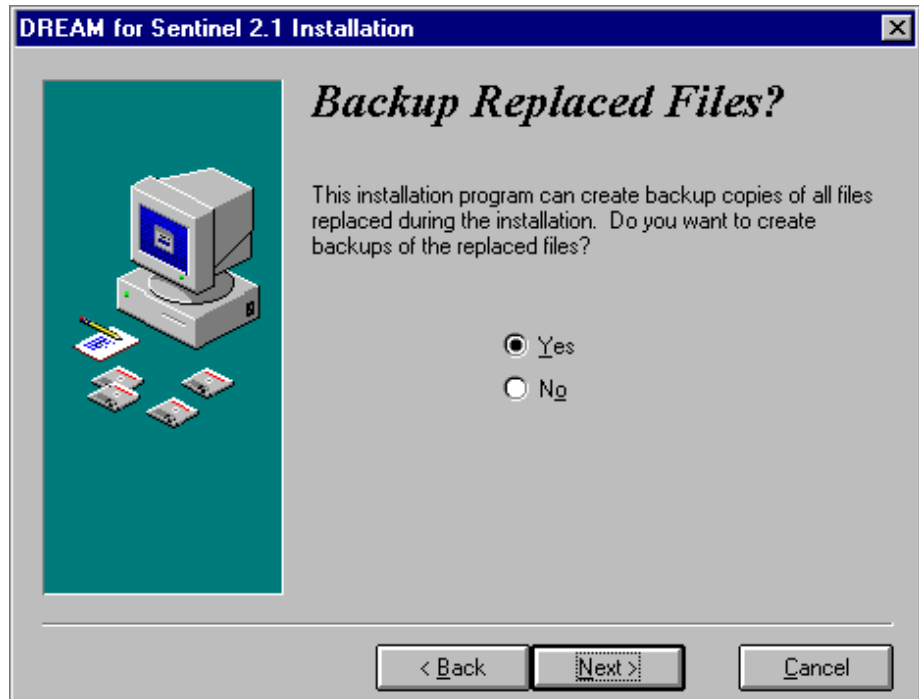
The dialog provides you with selection of a directory to copy the software files. To select another directory than the displayed, click the **Browse** button. It displays a dialog to explore your disks for path to a directory to be created.

Fig. 2.5
The Select Sentinel
Directory dialog



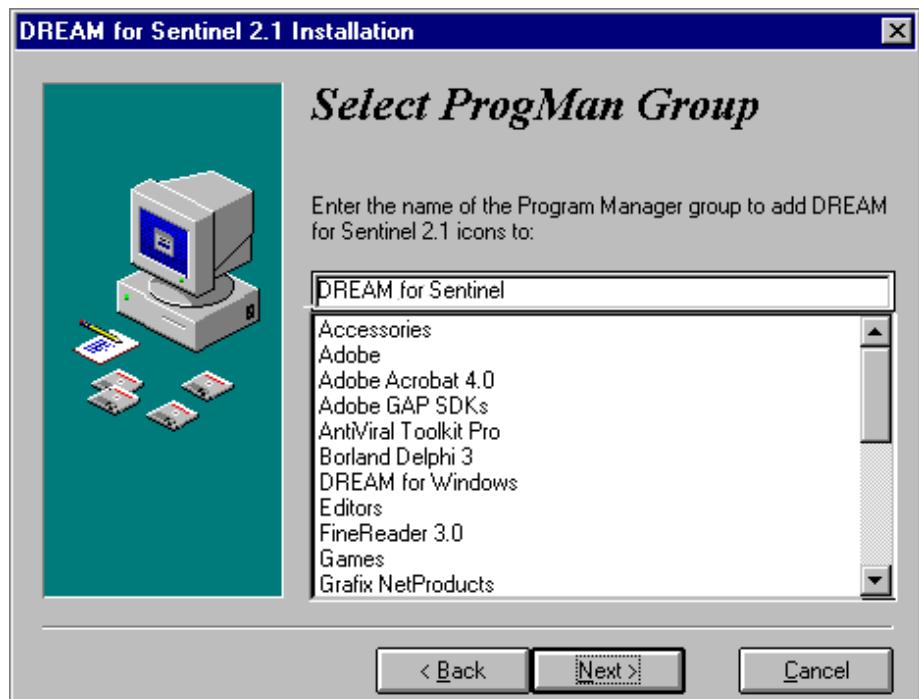
If no path to the existing Sentinel directory is displayed, select the **Browse** button and find it manually.

Fig. 2.6
The Backup Replaced
Files dialog



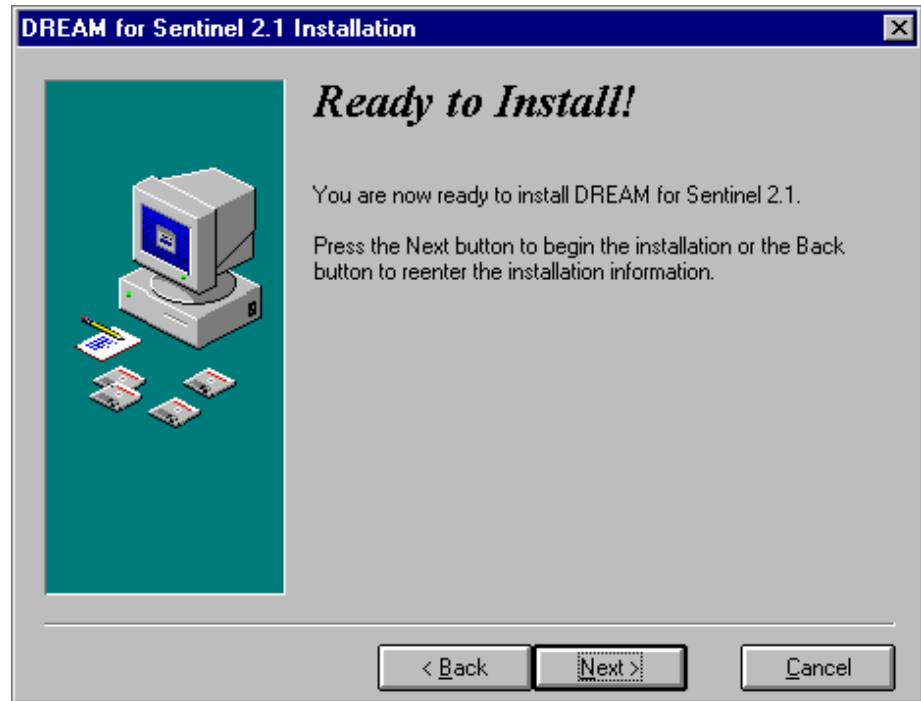
Selecting the backup option ('Yes') enables you to revert your system to the pre-installation state in the case of uninstallation. Although it may be useful only if no other programs will be installed in period between the installation and uninstallation.

Fig. 2.7
The Select Program
Manager Group
dialog



Using this dialog, you may change the name of the icon group for the software or confirm the name displayed.

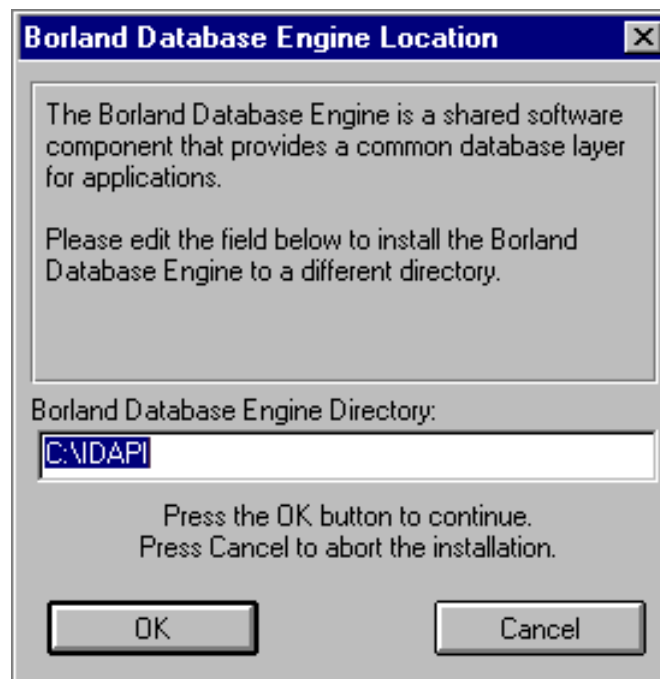
Fig. 2.8
The Ready to Install
dialog



The last dialog where you may yet change the information being entered. Click the **Back** button to do it or the **Next** to start copying process.

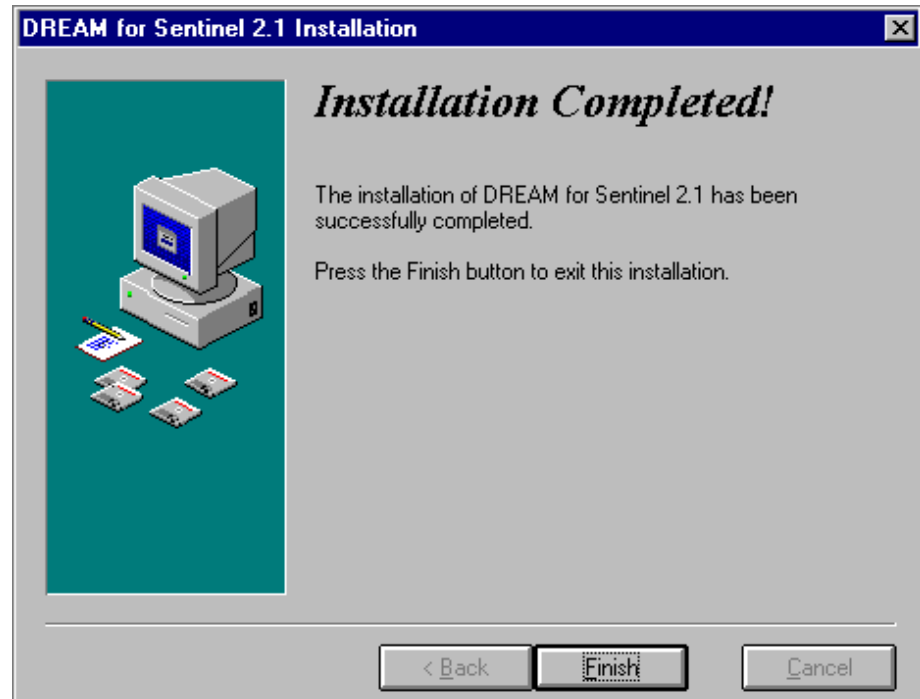
In order to work with databases, the program need the Borland Database Engine to be installed. It is the shared component which may be used by many programs. The following dialog will be displayed to select a directory for the BDE installation.

Fig. 2.9
Selecting a directory
for Borland Database
Engine



After the copying process (illustrated with the process bar) is completed, the message on it will be displayed.

Fig. 2.10
Message on installation completion



After the installation of DREAM for Sentinel, insert disk labeled Security into your floppy drive. From the Program Manager, go to the File menu and select the *Run...* Type or select by the **Browse** file *DDINSTAL.EXE*.

At the dialog box appeared, press the **Express** button:

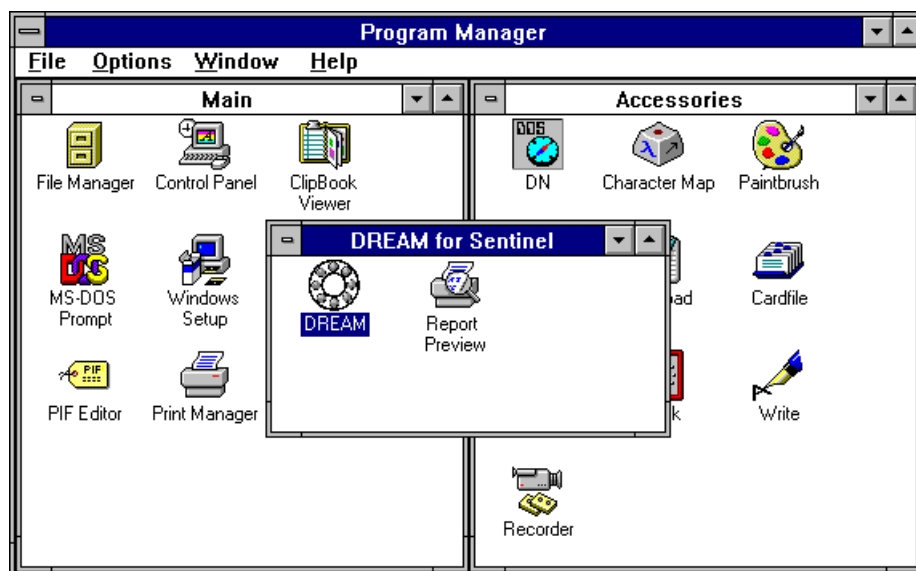
Fig. 2.11
The dialog of the Security program



The driver for the hardware protection key to work with Windows will be installed onto your computer.

After the installation of DREAM for Sentinel, the Setup program will automatically create a program group 'DREAM for Sentinel' in the Program Manager and add there two items: 'DREAM' and 'Report Preview'. You can easily drag this items with a mouse to any program group you prefer.

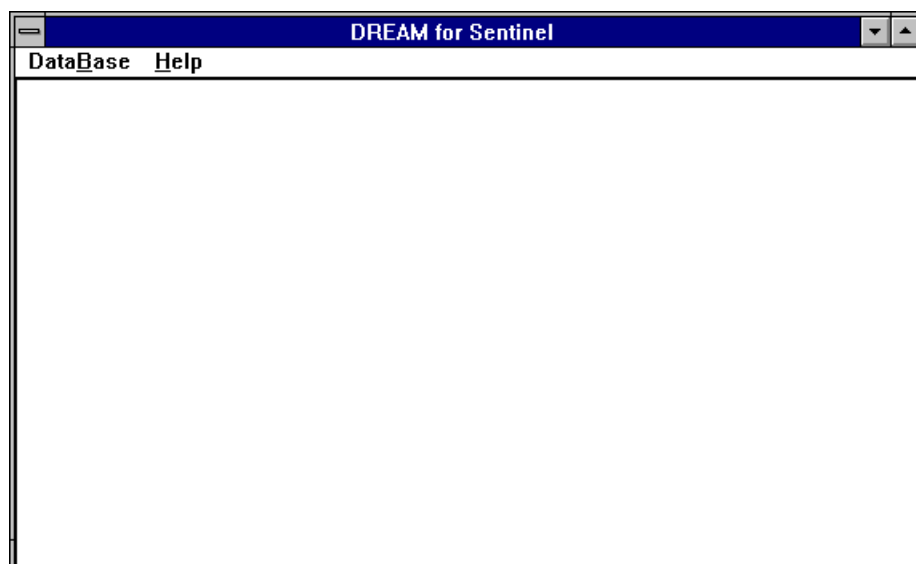
Fig. 2.12
A program group is
created by the Setup
program



To ensure that DREAM software was installed successfully, attach the electronic key to the parallel port and try to start DREAM by double-clicking its icon.

You should see the “DREAM for Sentinel” window with the menu bar.

Fig. 2.13
The main window of
the DREAM software
before opening the
database





ATTENTION! *The DREAM application software runs only when it finds the electronic protection key. The electronic key is supplied with the software and should be attached to the parallel (printer) interface. If a printer is already attached to the interface, the key should be attached to the interface first and the printer should be attached to the key. The key is transparent to the printer and does not influence printing. If the program fails to find the key, it displays a message: "The hardware protection key or security driver needs to be installed."*

2.2. TECHNICAL SUPPORT

DREAM software was developed by the VibroTek, Ltd. from St. Petersburg, Russia. If you have any questions, comments, suggestions or need help, please,

call +7 (812) 327 5563 or fax +7 (812) 324 6547

e-mail: vibro@vast.spb.su

or write:

Vibrotek Ltd.,
140, Stachek pr.,
St. Petersburg, 198207
RUSSIA



ATTENTION! *The technical support for DREAM is provided for those customers who filled and sent the registration form to the above address. When you apply for the support make sure that you know your registration number that will be sent to you after receiving the registration form.*

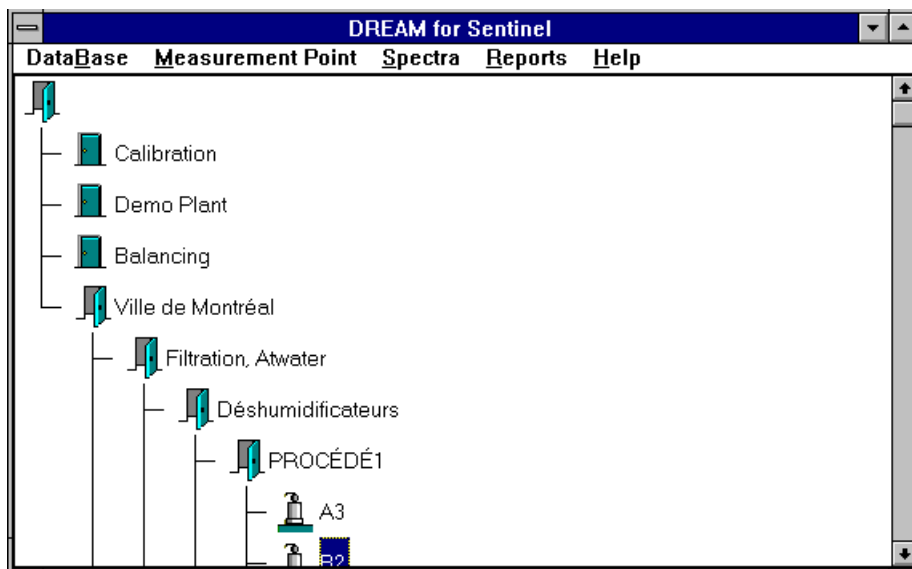
2.3. USER INTERFACE

DREAM for Sentinel is a Windows application and we assume you are familiar with the Microsoft Windows operating system. DREAM has the standard Windows interface and we will focus on the peculiarities of DREAM.

Once you started the DREAM program you see the main window (see Fig.2.14). Choose the *Open* command from the DataBase menu. The program had read the Sentinel database and shows the plant tree created with the Sentinel software, as well as all the DREAM menus.

Fig. 2.14

The main window of the DREAM software after using the Open command

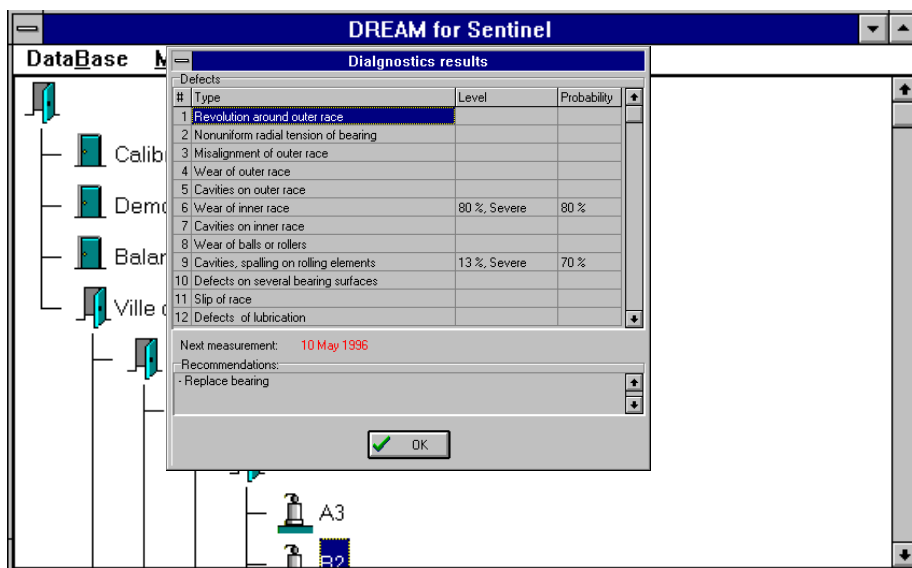


To select a node in the plant tree, click it with a left mouse button. To display the next level in the plant hierarchy, double click the closed door near a node in the plant tree. To collapse a branch in the tree, double click an opened door with the left mouse button.

The measurement points have different icons in the plant tree. To display the condition of the measurement point, double click its icon with the left mouse button.

Fig. 2.15

The main window of the DREAM software with the Diagnostics Results dialog box

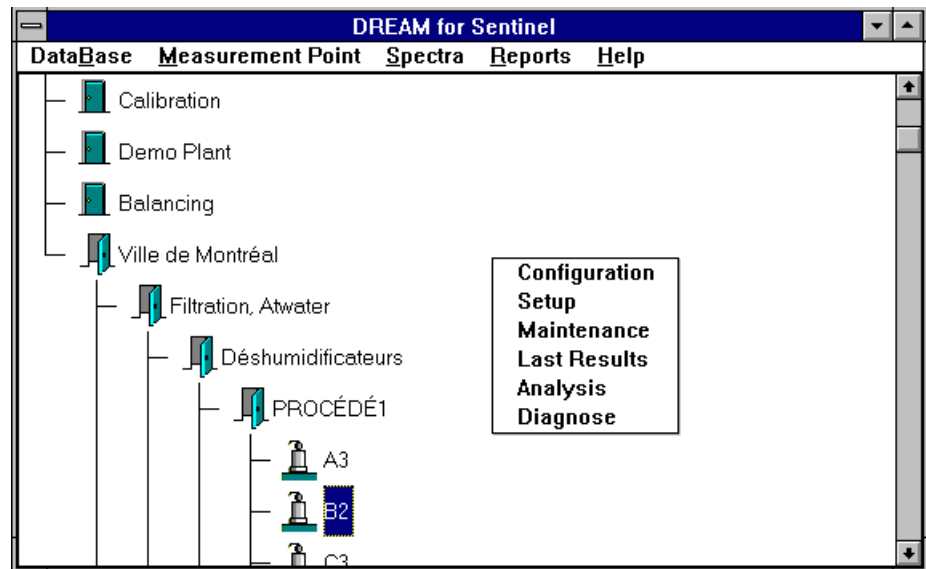


All operations in DREAM can be made with a selected node in the plant tree. For example, if you selected a node and issued a report, the report will be created for the whole branch below this node.

Besides the standard menu bar, you can access several commands by the floating menu. To access it, click with the right mouse button

anywhere in the main window. The commands from the floating menu will be executed for the selected node.

Fig. 2.16
Click the right mouse button to display the floating menu with the most common commands



To navigate through the plant tree, you can also use the arrow keys (up, down). If the expanded plant tree is large, you can go fast to the end or to the root of it by the <Home>, <End> keys.

3. OPERATING THE DREAM PROGRAM

The DREAM program is used to provide the user of Sentinel the means for automatic diagnostics and condition prediction of rotating machinery. The operation with DREAM can be divided into three main stages: preliminary configuration of DREAM and Sentinel databases, field measurements and condition diagnostics.

3.1. CONFIGURATION

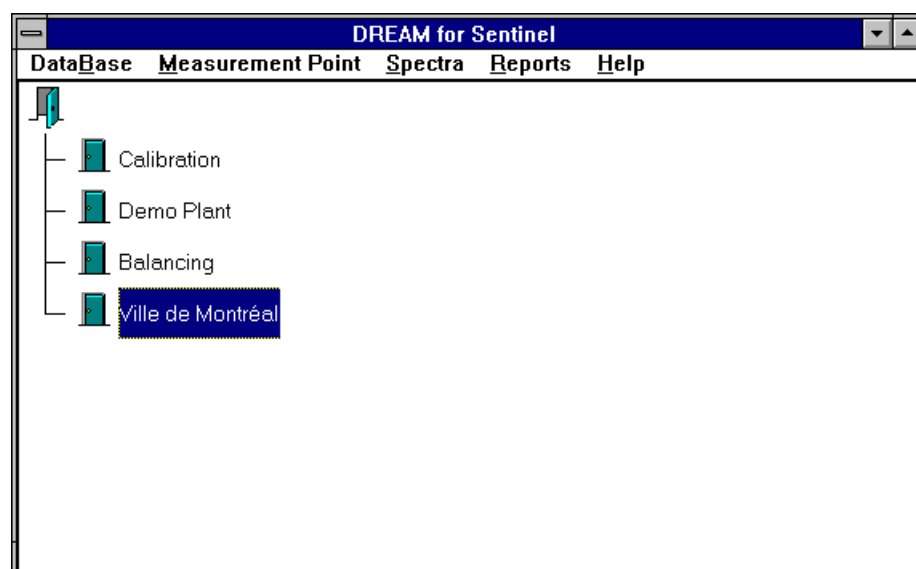
During its operation DREAM uses two databases: the one of Sentinel where the names of measurement points, their hierarchy and corresponding spectra are stored and its own database where DREAM stores additional parameters of the equipment to be diagnosed that it needs as an expert system.

The configuration process - it means to set up all the required parameters of your equipment and measurements - should be done in both Sentinel and DREAM databases.

First of all make sure that all necessary measurement points are configured in the Sentinel database. Then, before starting DREAM exit Sentinel software.

Start DREAM program, choose the *Open* command from the DataBase menu. DREAM will open the database of Sentinel and read all the plants' structure. After this DREAM will display in its main window the names of all the plants from the Sentinel database:

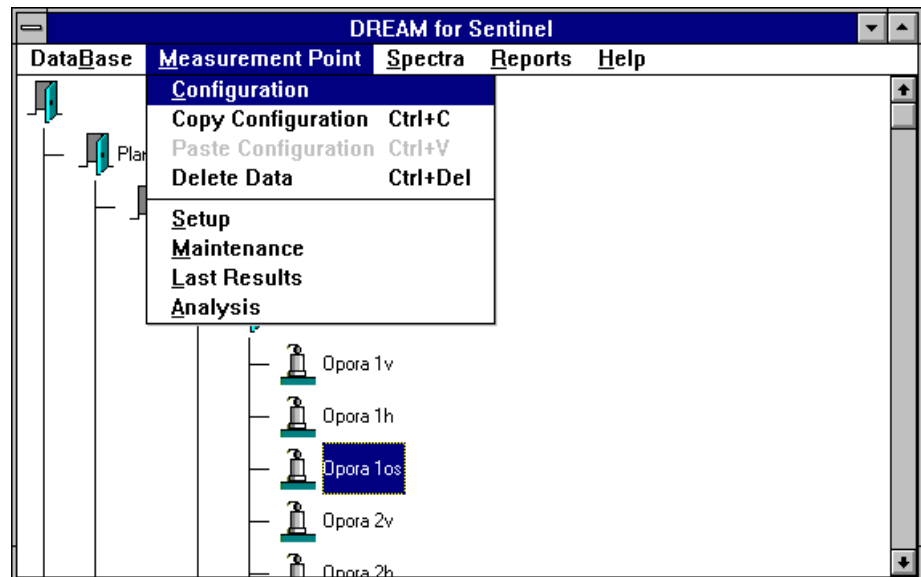
Fig. 3.1. Main window of the DREAM software with the names of the plants configured in the Sentinel database.



To display the names of the areas that belong to a plant, double-click its name. The same way you can open the units, machines and measurement points.

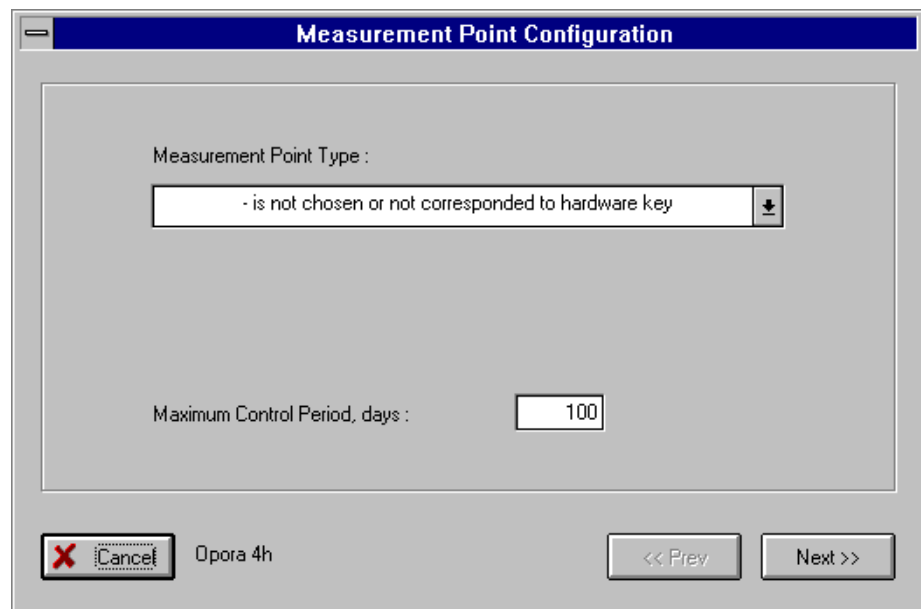
To configure a measurement point, select it in the plant tree and use the *Configuration* command from the Measurement Point menu:

Fig. 3.2. The Configuration command from the Measurement Point menu is used to configure a point in the DREAM database.



This command displays the Measurement Point Configuration dialog box.

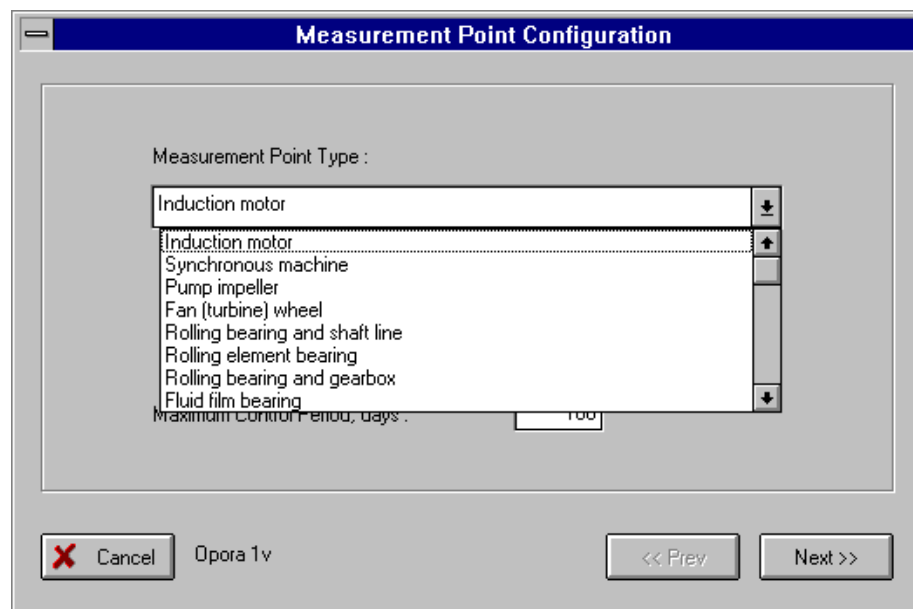
Fig. 3.3. The Measurement Point Configuration dialog box is used to set up a point in the DREAM database



This dialog box contains several pages that can be switched by **Next** and **Prev** buttons. Here you have to choose the Measurement Point Type from the corresponding drop-down list box, and set the Maximal Control Period (in days). This parameter is used to plan the measurement schedule. If there was no defect found in this measurement point, the program would suggest to measure it next time in this very number of days, if some defects will be found - this period will be decreased depending on the types and severities of the existing defects. For rolling element bearings it is recommended to state this period equal to 20% of MTBF for this very type of

bearing under these very operation conditions on this very machine.

Fig. 3.4. The drop-down list box of the Measurement Point Type dialog box



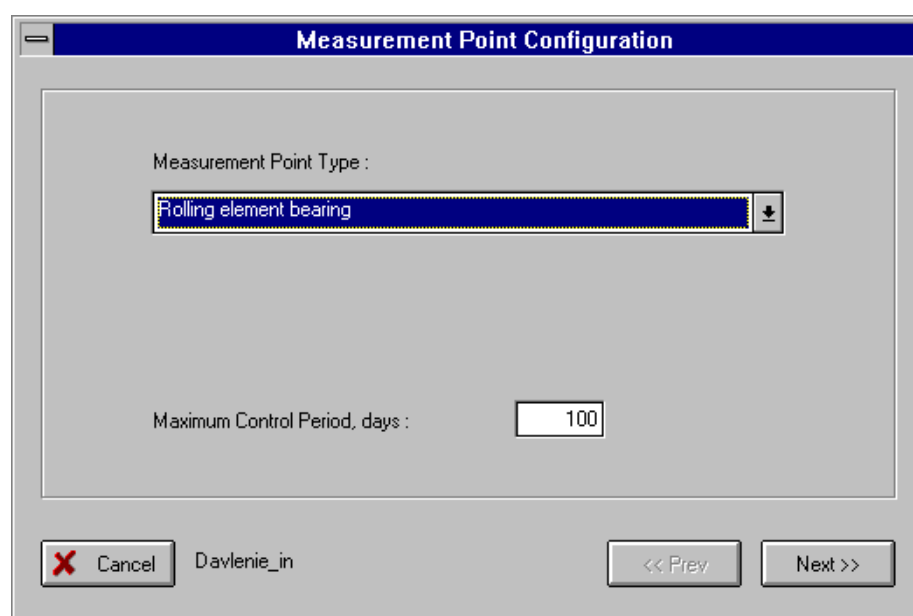
The list of the diagnosed units will be consequently enlarged by the DREAM designers.

Once you select the Measurement Point Type and type or confirm Maximum Control Period, click the **Next** button.

3.1.1. CONFIGURATION OF THE ROLLING ELEMENT BEARING

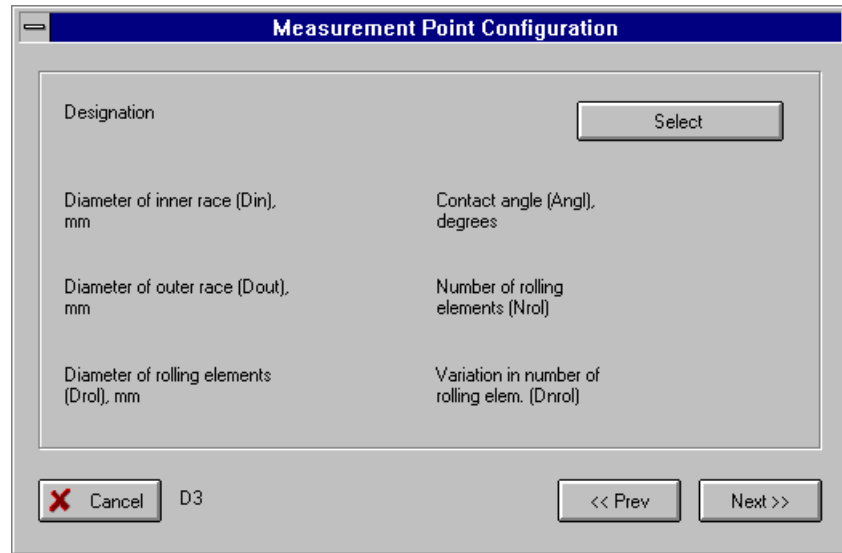
To configure a rolling element bearing, choose this type in the Measurement Point Setup dialog box.

Fig. 3.5. The Rolling Element Bearing type selected in the Measurement Point Configuration dialog box



Enter the **Maximal control period**, click the **Next** button, and the new section will appear:

Fig. 3.6. Click the Select button which is used to go to the Bearing Selection

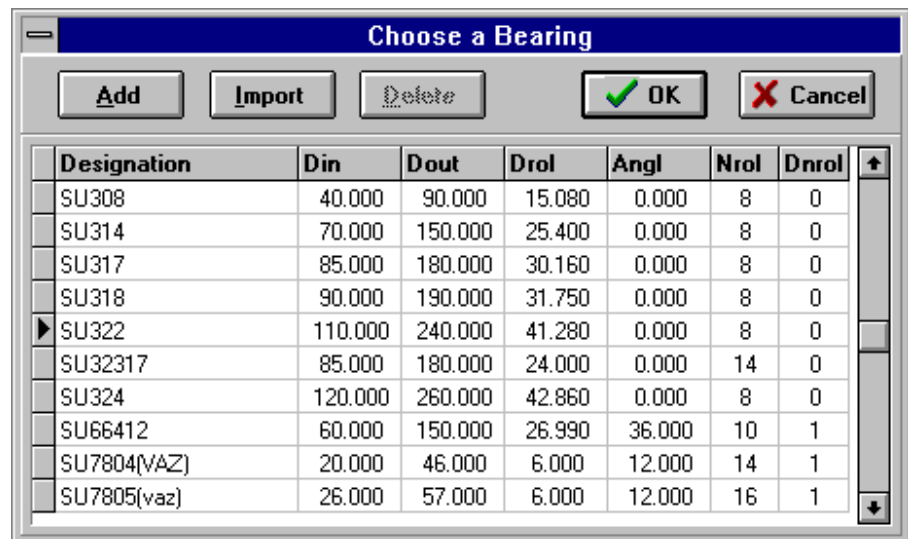


The dialog box titled "Measurement Point Configuration" contains several input fields and buttons. At the top right is a "Select" button. Below it are two columns of input fields: "Diameter of inner race (Din), mm" and "Contact angle (Angl), degrees" on the left, and "Diameter of outer race (Dout), mm" and "Number of rolling elements (Nrol)" on the right. Below these are "Diameter of rolling elements (Drol), mm" and "Variation in number of rolling elem. (Dnrol)". At the bottom left are "Cancel" and "D3" buttons. At the bottom right are "<< Prev" and "Next >>" buttons.

This dialog box is used to display the bearing designation (bearing type) and the bearing dimensions.

Click the **Select** button and the Bearing Selection dialog box will appear:

Fig. 3.7. The Bearing Selection dialog box with designations from the DREAM database



The dialog box titled "Choose a Bearing" features buttons for "Add", "Import", "Delete", "OK", and "Cancel". Below these is a table with the following data:

	Designation	Din	Dout	Drol	Angl	Nrol	Dnrol	
	SU308	40.000	90.000	15.080	0.000	8	0	
	SU314	70.000	150.000	25.400	0.000	8	0	
	SU317	85.000	180.000	30.160	0.000	8	0	
	SU318	90.000	190.000	31.750	0.000	8	0	
▶	SU322	110.000	240.000	41.280	0.000	8	0	
	SU32317	85.000	180.000	24.000	0.000	14	0	
	SU324	120.000	260.000	42.860	0.000	8	0	
	SU66412	60.000	150.000	26.990	36.000	10	1	
	SU7804(VAZ)	20.000	46.000	6.000	12.000	14	1	
	SU7805(vaz)	26.000	57.000	6.000	12.000	16	1	

In this dialog box you have to choose the designation (the identifier under which the bearings are listed in the specification documents of the manufacturer where all the technical data of the bearings are specified) that is installed in this measurement point.

There are variants. You can choose the designation from the list box where all the bearings that have been entered once in any measurement point are listed, or import one from the bearing library that is supplied together with the software and contains data of about 5000 bearings, or create a new designation.

To choose the designation from the database - the bearings that were entered once in a measurement point - click the desired designation name from the list - the designation will be highlighted and marked by triangle, and click the **OK** button.

To choose a bearing from the external bearing library that contains 4000-5000 bearings of mainly Soviet and SKF production, click the **Import** button. The following dialog box will appear:

Fig. 3.8. The Bearing Import dialog box lists several thousands of bearing's designations.

	Designation	Din	Dout	Drol	Angl	Nrol	Dnrol
▶	SKF1/2X351571	380.00	810.00	90.00	90.00	15	0
	SKF1052117	17.00	40.00	5.00	32.00	14	0
	SKF1066145E	9.00	25.00	4.50	45.00	12	0
	SKF1200	10.00	30.00	4.76	12.22	9	0
	SKF1200E	10.00	30.00	4.76	12.21	9	0
	SKF1201	12.00	32.00	4.76	12.70	10	0
	SKF1201E	12.00	32.00	5.00	12.64	10	0
	SKF1202	15.00	35.00	5.56	12.54	10	0
	SKF1202E	15.00	35.00	5.56	12.54	10	0
	SKF1203	17.00	40.00	5.56	11.61	12	0
	SKF1203E	17.00	40.00	6.00	11.81	11	0
	SKF1204	20.00	47.00	6.35	10.37	12	0
	SKF1204E	20.00	47.00	7.14	11.15	12	0
	SKF1205	25.00	52.00	7.14	10.31	12	0

Use the Mask text box to find the desired designation. When you enter the first symbols of the designation, the list advances to the corresponding names.

You can choose one of the bearings by its designation and verify its dimensions. Once you click the **OK** button, this bearing designation will be included in the DREAM database and will appear in the list of designations in the Bearing Selection dialog box.

To create a new designation, click the **Add** button. A blank line will appear in the list of bearings. Type the parameters of the bearing: designation ID in the designation column and all other parameters in corresponding columns:

Din - the diameter of the inner race (or the inner raceway).

Dout - the diameter of the outer race (or the outer raceway, if **Din** was the diameter of the inner raceway).

Note: if you do not know the diameters of races you can put in the cage diameter as a diameter of both inner and outer race. The program actually needs only the cage diameter that is calculated as a mean value of inner and outer race diameters. It is also recommended to enter the cage diameter for the thrust bearings.

Angle - the contact angle in degrees between the rolling elements and the race.

Drol - the diameter of rolling elements.

Nrol - the number of rolling elements in the bearing.

dNrol - the acceptable variations in the number of rolling elements set by the operator. During the analysis of the envelope spectrum the program will correct the number of rolling elements in the limits $Nrol + dNrol$, if there is a mistake in the input data. If the variations in the number of rolling elements exceed $+dNrol$ the program is not able to identify the type of defect.

Note: Our experience shows that it is rather typical for the bearing manufacturers to vary the cage design and thus the number of rollers in the same type of bearing.

After the bearing designation had been selected and confirmed by the **OK** button, click the **Next** button and enter the following parameters:

Fig. 3.9. The second section of the Measurement Point Configuration dialog. Type the Rotation Speed and its Variations from measurement to measurement for this machine.

Rotation Speed - the rotation speed of the bearing can be entered in Hz.

Variation - possible variations in rotation frequency (fr) from measurement to measurement.

From the point of the program, the variations could be normal (set by the operator, for example, $Rotation\ Speed + Variations$) or maximal.

The more variations and maximal variations values the less certainty (the probability of the exact type of the defect that is displayed by the program), and it takes more time to make diagnostics.

If the actual rotation speed is not within variations, but within max variations, the program identifies the type of the defect but gives a warning that the data have variations and while processing, the program has revised them to identify the defect. The program generates the same warning if there is a mistake in the number of rolling elements in the limits $\pm dN_{rol}$.

Max. Variations - the maximum value of variations in the input data for Rotation Speed (%) at which the program will still identify the type of the defect but will give a warning signal to the operator.

If the variations exceed the Max. Variations value, the program will detect the defect and its depth but will not identify the type of the defect. In this case, the type of the defect will be defined as a Not Identified Defect (NID). If there is such information it is recommended:

- ☐ To check whether the processed spectrum belongs to the chosen measurement point
- ☐ To check the data in the measurement point
- ☐ To check the data in the bearing's designation
- ☐ To make a new measurement.

Note: it is recommended to put in the Variations of about 2-3% and maximum variations not more than 10%.

By the above data the DREAM program automatically calculates the severe defect levels. You can view or edit them according to your own experience. To do it, click the **Next** button. The following dialog box will be displayed:

Fig. 3.10. In this dialog box operator can either confirm levels calculated automatically by DREAM or change them according to his experience

#	Defect Type	Level		Default		
		%	Db	%	Db	
1	Revolution around outer race	23	17			
2	Nonuniform radial tension of bearing	8	11			
3	Misalignment of outer race	13	17			
4	Wear of outer race	13	17			
5	Cavities on outer race	13	17			
6	Wear of inner race	8	11			
7	Cavities on inner race	8	11			

Revolution around outer race % <-17 All Default

Db %

 D3 << Prev Finish

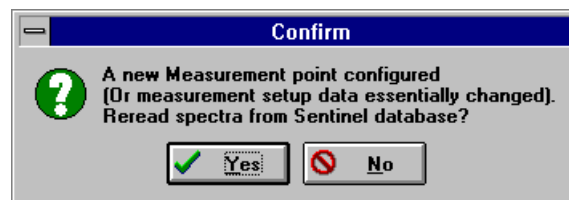
Here are listed all types of defects with actual and default levels. The defect levels are presented in the percentage of modulation. And the level for the defect of lubrication is in dB. To change values select the type of defect and type a new value in the input line under the list. This way you can edit all the defect levels.

To restore the default values for all defects, click the **All default** button; to set a default lever for a certain defect type, select the defect in the list and click the button next to the level input line with the default value.

You can also change all defect levels by a certain factor. To do this, type the change factor in percentage in the input box below **All Default** button and click this button. For example, to increase all defect levels in two times, enter 200% and click **All Default** button.

Click the **Finish** button to complete configuration. Now DREAM is ready to receive spectra for diagnostics, but it has to get spectra from the Sentinel database. After a new measurement point was configured or a setup for an old measurement point was significantly changed, DREAM displays the following dialog box:

Fig. 3.11. To read spectra for a newly configured measurement point, DREAM needs to reread Sentinel's database

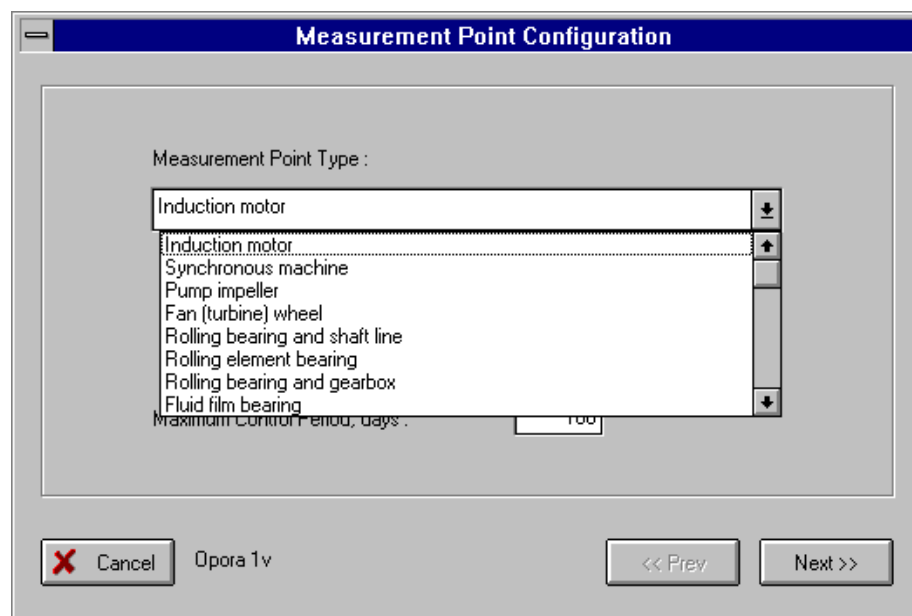


Click **Yes** button to reread new spectra from the Sentinel database or click **No** to proceed with configuration. If you click **No**, the new spectra will be accessible by DREAM when you will close and open database next time.

3.1.2. CONFIGURATION OF THE ROLLING ELEMENT BEARING AND GEARBOX

If you have to configure a rolling element bearing of gearbox, choose this option in the Measurement Point Configuration dialog box and confirm it by the **Next** button.

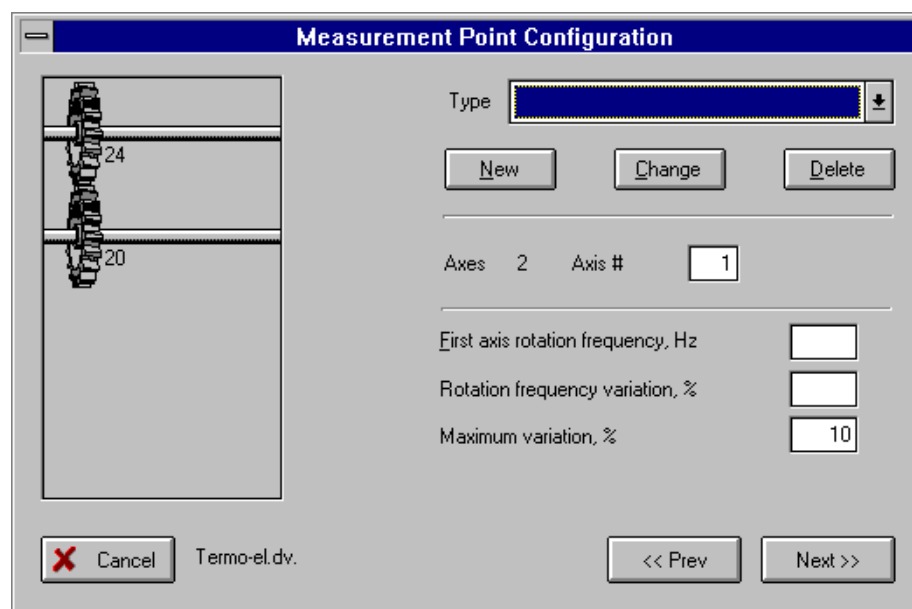
Fig. 3.12. The starting window of the Configuration dialog for choosing the Measurement Point Type



After clicking the **Select** button at the intermediate window (which is appeared) and choosing a bearing designation at the Bearing Selection window (more detailed description of these operations you can get in previous section 3.1.1. Configuration of Rolling Element Bearing), which one you confirm by clicking the **OK** button, the intermediate window appears again with inputted parameters of the chosen bearing.

Click the **Next** button, and the gearbox configuration window should be present.

Fig. 3.13. The Measurement Point Configuration dialog box in which there is the drop-down list box of gearbox types yet configured.



If there are no gearbox types configured by you, the list is empty and the gearbox scheme is absent. You must choose the Gearbox Specification via clicking the **New** button.

Fig. 3.14. The Gearbox Specification dialog box

Axis	#	Teeth
1	Z12	
2	Z21	
2	Z23	
3	Z32	

Moving through input boxes in turn by striking the Tab key or mouse-button-clicking, you must name the gearbox type that you are setting at the Type box, type axes number in the Axes box and teeth number in the Teeth boxes column. Each gear has its own combined number. The first figure indicates the number of the axis on which the gear is placed, the second figure indicates the number of the axis on which the connecting gear is placed. For example, Z12 is the gear placed on the first axis (input shaft) and connecting to a gear placed on the second axis.

To complete the gearbox specification, click the **OK** button.

You will be back to the gearbox configuration window. To change or delete the gearbox type, use relative buttons (**Change**, **Delete**).

Note: If the certain gearbox type used yet for the several measurement points, you can not delete that type at once. First, you have to know all the measurement point with that type configured, by means of the Statistics command from the Report menu. Then you have to delete all data from them by the Delete Data command from the Measurement Point menu. Only after that you can delete an improper type in the gearbox configuration window.

Here you have to put in all the frequency parameters: "First axis rotation frequency", "Rotation frequency variation" and may be "Maximum Variation" (more detailed description of these param-

eters you can get in the previous section 3.1.1. Configuration of the Rolling Element Bearing). Click the **Next** button to confirm all the inputted data.

The last section of the Measurement Point Configuration, the defect levels window, should appear. The last configuration step is the same as for the rolling element bearing. Refer to it.

This way you can configure the DREAM database for all the measurement points that were created in the Sentinel software.

Fig. 3.15. In this dialog box operator can either confirm levels calculated automatically by DREAM or change them according to his experience

#	Defect Type	Level		Default	
		%	Db	%	Db
1	Coupling shaft wobbling	25	20	25	20
2	Small gear wheel defects	25	20	25	20
3	Large gear wheel defects	25	20	25	20
4	Small gearing defects	25	20	25	20
5	Large gearing defects	25	20	25	20
6	Defects on another axis	25	20	25	20
7	Wear of outer race	25	25		

Coupling shaft wobbling % <-25 All Default

Db <-20 100 %

D3 << Prev Finish

3.1.3. CONFIGURATION OF THE ROLLING ELEMENT BEARING AND SHAFT LINE

Configure this measurement point type the same way as the rolling element bearing. Choose only the Rolling element bearing and Shaft Line on the first stage of configuration (Fig. 3.4).

There are differences in the defect list on the last stage of configuration in regard to the shaft coupling.

This measurement point type is required not only the envelope spectra (as for the rolling element bearing) but autospectra as well.

3.1.4. CONFIGURATION OF THE FLUID FILM BEARING

Configuration of the fluid film bearing is done the same way as for the rolling element bearing excluding the bearing selection which is absent. The list of the defects that can be indicated differs, certainly.

So, refer to Configuration of the Rolling Element Bearing section.

For configuration of the fluid film bearing, the following windows are used: the bearing type selection window (Fig. 3.4), the frequency parameters window (Fig. 3.9), the defect levels window (Fig. 3.10).

3.1.5. CONFIGURATION OF THE FLUID FILM BEARING AND GEARBOX

In addition to the Fluid Film configuration you must specify the gearbox.

To configure a point of this type -

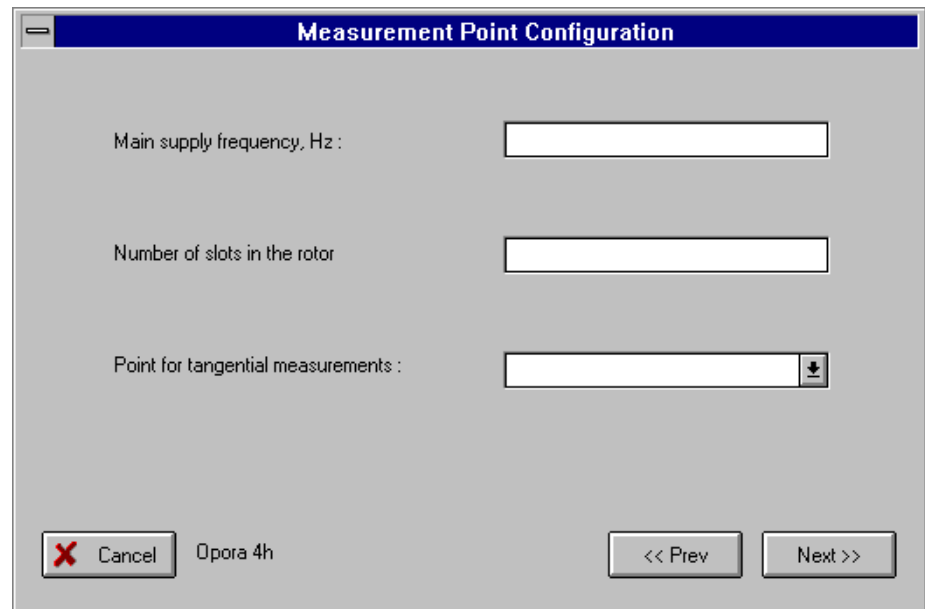
1. Select the Fluid Film and Gearbox in the first section of the configuration dialog (Fig. 3.4).
2. Select or specify the gearbox type as well as frequency parameters (Fig. 3.13, 3.14).
3. Set up or confirm defect levels (Fig. 3.10).

3.1.6. CONFIGURATION OF AN ELECTRIC MACHINE (INDUCTION MOTOR, SYNCHRONOUS MACHINE)

At the Configuration dialog box (Fig. 3.4), choose the Measurement Point Type - Induction Motor or Synchronous Machine, and click the **Next** button.

At the Frequency parameters window (Fig. 3.9), put in the Rotation Speed, Variation and Max. Variation and click the **Next** button. The Electric Machine Setup section appears:

Fig. 3.16. The Electric Machine section of configuration.



Put in Mains Power Supply in Hz and

Number of slots Number of slots in the rotor (for induction motor) - number of bars (rods) for the squirrel cage type rotors or the number of slots for the phase type rotors. Number of slots in the stator (for synchronous machine).

Note: If you do not know the actual number of slots, in the majority cases you can define this number by the analysis of autospectrum of electric machine body vibration. To do this look for the slot passing frequency and divide it by the rotation speed.

Point for Tangential Measurements Choose a measurement point in which you will store the tangential measurements results. In this case the current machine should contain additional point not configured in DREAM. Choose a point for tangential measurements from the list box. If there are no additional points configured in DREAM for the current machine, DREAM will present an error message and the electric machine would not be configured.

Click the **Next** button.

At the Defect levels window (Fig. 3. 10), either confirm levels (calculated automatically by DREAM) or change them, and click the **Finish** button to complete the configuration.

3.1.7. CONFIGURATION OF A BLADED MACHINE (PUMP, TURBINE)

The pumps are considered to be a machine that works with liquids.

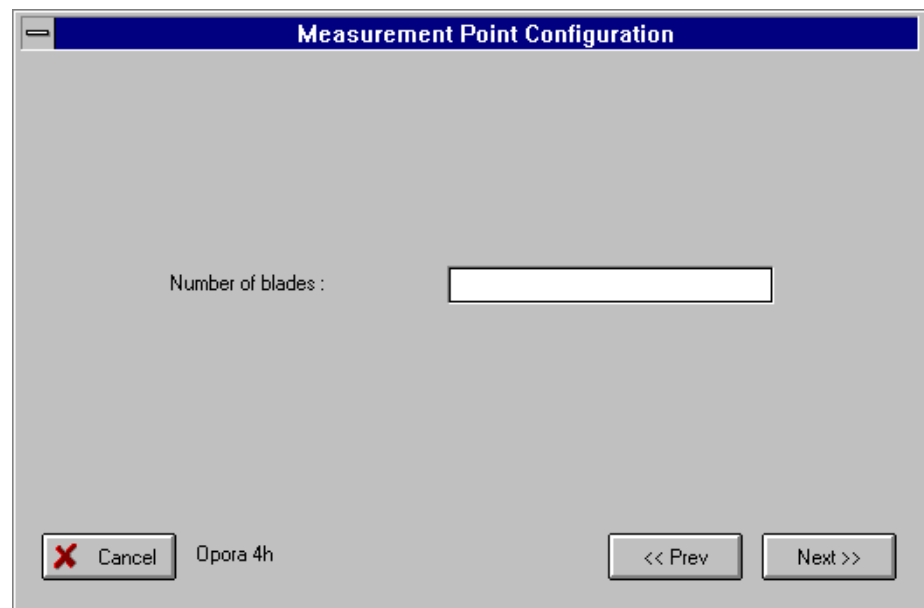
Fans and turbines are the machines that operate with gas.

Pumps can have a cavitation defect that can be detected by DREAM software.

To configure a bladed machine:

At the Configuration dialog box (Fig. 3.4), choose the Measurement Point Type - Pump Impeller or Fan (turbine) wheel, and click the **Next** button. The Bladed machine setup dialog appears:

Fig. 3.17. The specialized dialog box for the bladed machine.



The image shows a software dialog box titled "Measurement Point Configuration". It has a blue header bar with the title in white. The main area is light gray. In the center, there is a label "Number of blades :" followed by a white rectangular input field. At the bottom, there are three buttons: a "Cancel" button with a red 'X' icon, a small text label "Opora 4h", and a "Next >>" button. To the left of the "Next >>" button is a "<< Prev" button.

Type the number of blades on the working wheel and click the **Next** button.

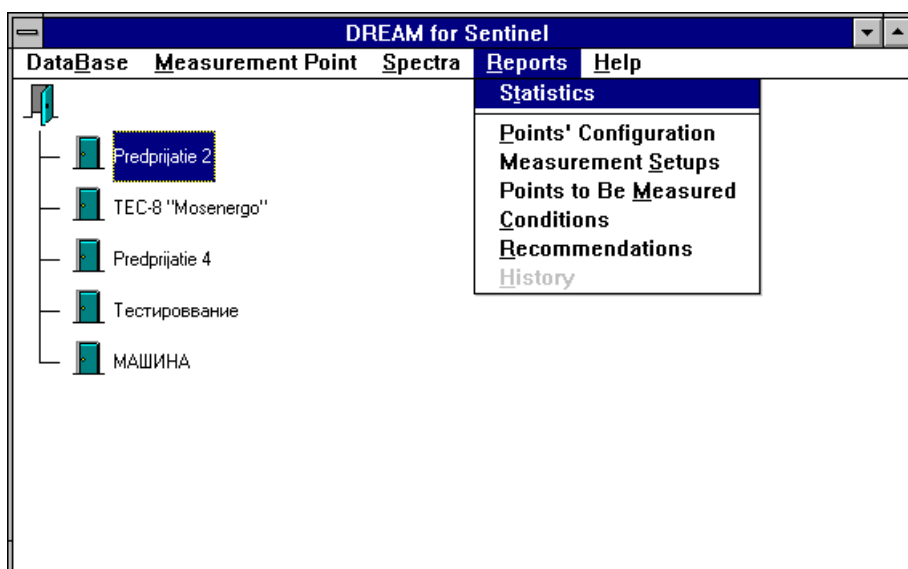
At the Frequency parameters window (Fig. 3.9), put in the Rotation Speed, Variation and Max. Variation and click the **Next** button.

At the Defect levels window (Fig. 3. 10), either confirm levels (calculated automatically by DREAM) or change them, and click the **Finish** button to complete the configuration.

3.2. SETTING UP MEASUREMENTS

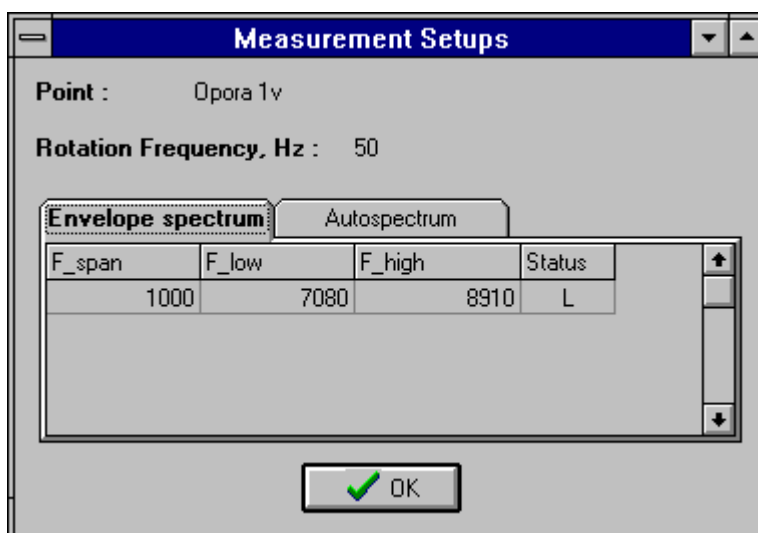
According to the configuration data of measurement points DREAM will require to set up the measurements in the appropriate way. This should be done in the Sentinel database. Preliminarily, you can issue a list of the measurement setups required for DREAM diagnostics on all measurement points, have a look at them and set up measurements for the points in Sentinel according to this list. For that purpose, select in the DREAM software a machine or a unit to which the measurement points to be configured belong and use the *Measurement Setups* command from the Reports menu:

Fig. 3.18. The Measurement Setups command from the Reports menu is used to issue the list of settings to set up measurements in the Sentinel database



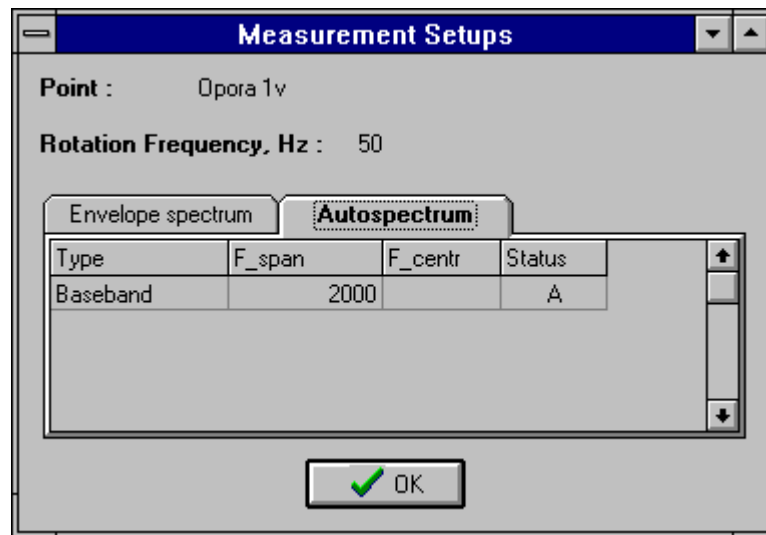
There is also the *Setup* command in the Measurement Point menu (and in the floating menu as well). This command presents the Measurement Setup information box (for a single measurement point only):

Fig. 3.19. The Setup command from the floating menu presents the Measurement Setup information box (for a single measurement point only)



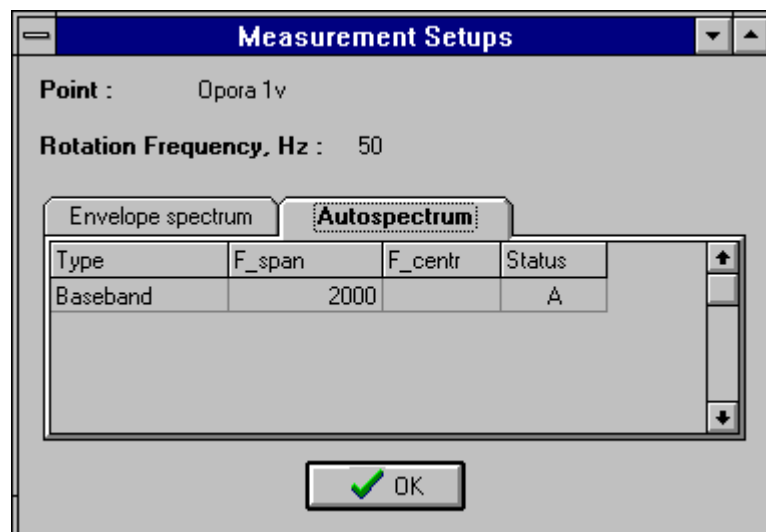
In this dialog box there can be one or the two sections - for envelope and auto- spectrum. Click the title of a section to see it.

Fig. 3.20. The Measurement Setup with the selected Autospectrum section.



The **Status** column may contain the letters: **L**, **R**, **A**.
L - leading spectrum that is presented in reports,
R - required spectrum,
A - additional spectrum.

Fig. 3.21. The Measurement Setup information box with the Autospectrum section visible.



Type can be Baseband or Zoom to be set in the Sentinel measurement setup.

Note: Due to the fact that Type 2526 data collector can measure only 400 lines resolution spectra in some cases DREAM will require to measure two spectra with different settings for diagnostics (for example a bearing with a number of balls more than a hundred). For DREAM these two spectra are both one measurement and it will identify this measurement by a time of the leading spectrum. So, for diagnostics DREAM needs leading and required spectra to be measured, additional spectra may be used to refine some types of defects, but not required. Leading

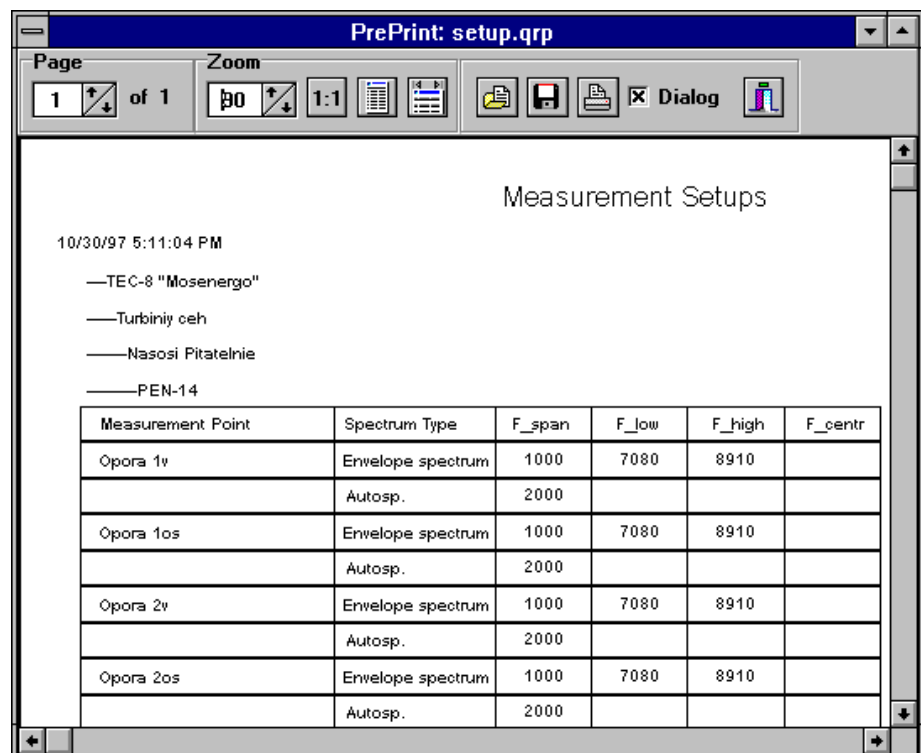
spectra are used to identify the measurement and only the date of leading spectrum is presented in all reports and lists.

The button **OK** lets you come back to the DREAM main window.

The other parameters contains also in the report.

We return to the **Measurement Setups** command from the Reports menu. The program automatically issues the list that contains required setup parameters for all measurement points in the chosen machine or unit.

Fig. 3.22. The Measurement Setups report



The report can be printed or saved by clicking the corresponding buttons. Click the **Exit** button to close the report window.

Now start Sentinel.

The task is to change the setup for all measurement points that will be used for diagnostics by DREAM. To do it, choose machine in the plant tree of Sentinel software and enter the Measurement Setup. We will discuss indetailes the Envelope Spectrum dialog box for envelope spectrum measurement of the corresponding point. The settings for autospectra are similar.

Fig. 3.23. Measurement Setup: Envelope Spectrum dialog box is used to setup envelope spectrum measurement in the Sentinel database

Here set for each measurement point:

Averages - Number of averages should be in the range 16-30. The more averages you select the more reliable results in diagnostics you receive, but the measurements will take more time.

Averaging Mode - Set to Spectrum.

Weighting Mode - Set to Hanging.

Trigger - Set to Free Run.

Detector - Set to RMS.

Integrations - Set to None.

Frequency Mode - Set to Absolute.

Frequency Span - Set as required by DREAM in the Fs column in the Measurement Setup list for this measurement point.

Lower Frequency - Set as recommended by DREAM in the Flow column in the Measurement Setup list for this measurement point.

Upper Frequency - Set as recommended by DREAM in the F_high column in the Measurement Setup list for this measurement point.

All other parameters are not essential for DREAM but, of course, you should set a proper gain factor.

The choice of Lower and Upper frequency (thus the bandpass filter for envelope detector) is a very important factor. The DREAM only recommends a 1/3 octave band, but the choice of the actual band should be done after the analysis of the autospectrum in this point. The detailed description of how to choose that frequency band for the envelope analysis can be found in the third part of this manual, but the basic rule says: look at the shape of the autospectrum in the region of the recommended bandpass filter. If there are some

resonances or strong harmonic components, it is recommended to set the bandpass filter to the nearest flat region of the autospectrum.

This way you have to configure all points for DREAM in the Sentinel database.

3.3. GETTING ROUTE MAPS

Once measurement points are configured, DREAM can form a list of bearings to be measured. To do it, select a node on the plant tree in DREAM and choose the *Points To Be Measured* command from the Reports menu.

Fig. 3.24. The Points
To Be Measured
report

PrePrint: meas.qrp

Page 1 of 1 Zoom 70 1:1

Points to be measured by 30 Oct 1997

10/00/97 5:14:19 PM
TEC 8' Mosenergo'
Turbine ceh
Nasos I Plateleke
PEN 14

Measurement Point	Measurement Date	Spectrum Type	F_span	F_low	F_high	F_centr
Opora 1v	07 Feb 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 1os	19 Jan 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 2v	19 Jan 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 2os	07 Feb 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 3v	07 Feb 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 3os	07 Feb 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 4v	07 Feb 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			
Opora 4os	07 Feb 1997	Envelope spectrum	1000	7080	8910	
		Autosp.	2000			

When DREAM will diagnose some spectra, it will give either a recommendation on some corrective actions to be done for the unit or give a non failure operation period prediction. Then DREAM will automatically follow up the conditions of your equipment and include in the list only the measurement points for which the condition prediction is expired according to the day you chosen. In the Meas. Date column you can see the expiry date of the condition prediction. If this point have not been measured previously, "Not determined" will be presented in this column.

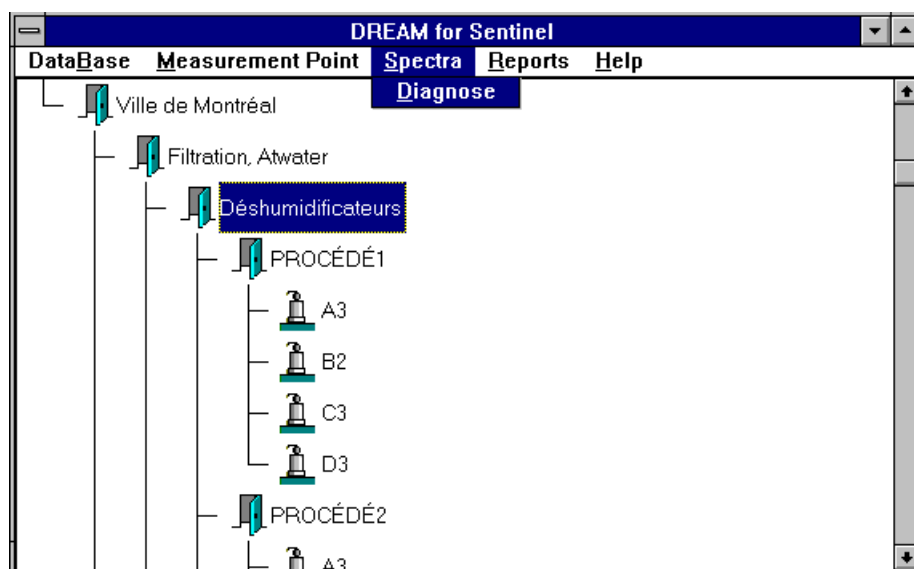
Once you've got the list of measurement points to be measured, you can go to Sentinel and form a corresponding route and download it to the Type 2526 data collector.

3.4. COLLECTING AND PROCESSING DATA

The vibration data are collected by the Type 2526 data collector according to the routes formed and loaded through the Sentinel software. After measurements, unload the routes from the data collector into the Sentinel database.

To process data by DREAM, exit Sentinel and start DREAM. In the plant tree choose unit, machine or point for data processing and select the *Diagnose* command from the Spectra menu:

Fig. 3.25. The Diagnose command from the Spectra menu

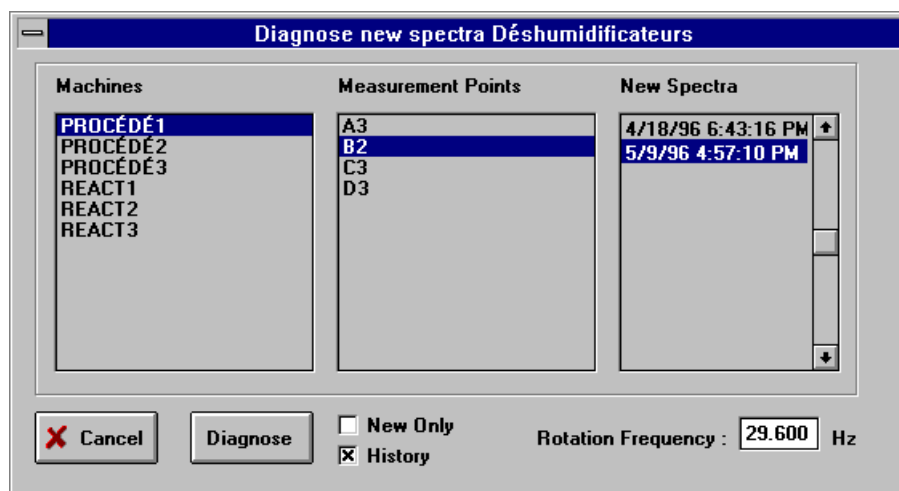


The command is used to diagnose spectra and store results of diagnostics in the DREAM database.

Note: the higher level you choose the more measurement points you can diagnose (but not higher than the machine group).

By this command the Diagnose New Spectra dialog box is displayed:

Fig. 3.26. In the Diagnose New Spectra dialog box you can choose a spectrum from the Sentinel database for processing with DREAM



If in the plant tree you have chosen a machine group node, you can choose a machine from the list of machines for diagnostics. If you have chosen a machine or a measurement point, you can choose only a measurement point and a spectrum.

In this dialog box you can choose one by one all the spectra for the points below the selected node and process them in turn.

Choose Machine if possible, Measurement point, Spectrum. Enter or confirm Rotation Speed.

Only new spectra from the Sentinel database, that have not been processed by DREAM, are included in the list of spectra when the New Only box is checked. In another way you can process the old spectra. To diagnose all previous spectra to see the defect development from measurement to measurement, check the History check box. In the last case much more time may be needed to process all the spectra.

Click the **Diagnose** button. The spectrum will be processed automatically and the results of diagnostics displayed in the Detailed Diagnostics dialog box (see the next section Detailed Diagnostic). Use scroll bar to check all the defects in the list.

Click **Done** button, and the diagnostic results will be saved in the DREAM database for future reporting. This way you can process all new spectra from the Sentinel database.

3.5. DETAILED DIAGNOSTICS

This mode is an optional utility that displays you the diagnostic process and explains why the DREAM says that this type of defect is found in the measurement point and why this or that recommendation is given. In other words, it provides an operator with all available data to make a correct decision about the condition of the unit.

The starting point for this mode is the Detailed Diagnostics dialog box that appears on the screen as the result of diagnostics for any spectrum (see Fig. 3.25).

The dialog box contains three fields: a list of defects, date of the next measurement (prediction of the non-failure operation period) and a list of recommendations.

Fig. 3.27. The Detailed Diagnostic dialog box with the list of defects and recommendations

Defect	Severity	Modulation Index	Probability
☐ Revolution around outer race			
☐ Nonuniform radial tension of bearing			
☐ Misalignment of outer race			
☐ Wear of outer race	80 %	(80%)	
☐ Cavities on outer race	12 %	(50%)	
☐ Wear of inner race			
☐ Cavities on inner race			
☐ Wear of balls or rollers			
☐ Cavities, spalling on rolling elements	14 %	(70%)	
☐ Defects on several bearing surfaces			
☐ Slip of race			
☐ Defects of lubrication			
☐ Notidentified changes in vibration	80 %	(0%)	

Next Measurement: 10/05/96

Recommendations:

- ☐ Refine the defect type
- ☐ Replace bearing

The severity of the defects is represented by a color (green - incipient, yellow - medium, red - severe). Besides, for each defect found the program presents its severity in modulation index and probability for a defect to be of this particular type (in the parentheses). Please, refer to the 4th part of this manual for the table of probabilities.

Warning A defect may be not seen. Use the scroll bar to view the whole list of defects.

Each defect or recommendation of the list has a check box. If you check a box near a recommendation, the program will check the boxes near the defects that were the reasons for this very recommendation.

Fig. 3.28. Check a check box of the recommendation to see the reason for this very recommendation

Defect	Severity	Modulation Index	Probability
☐ Revolution around outer race			
☐ Nonuniform radial tension of bearing			
☐ Misalignment of outer race			
☒ Wear of outer race	80 %	(80%)	
☐ Cavities on outer race	12 %	(50%)	
☐ Wear of inner race			
☐ Cavities on inner race			
☐ Wear of balls or rollers			
☒ Cavities, spalling on rolling elements	14 %	(70%)	
☐ Defects on several bearing surfaces			
☐ Slip of race			
☐ Defects of lubrication			
☐ Notidentified changes in vibration	80 %	(0%)	

Next Measurement: 10/05/96

Recommendations:

- ☐ Refine the defect type
- ☒ Replace bearing

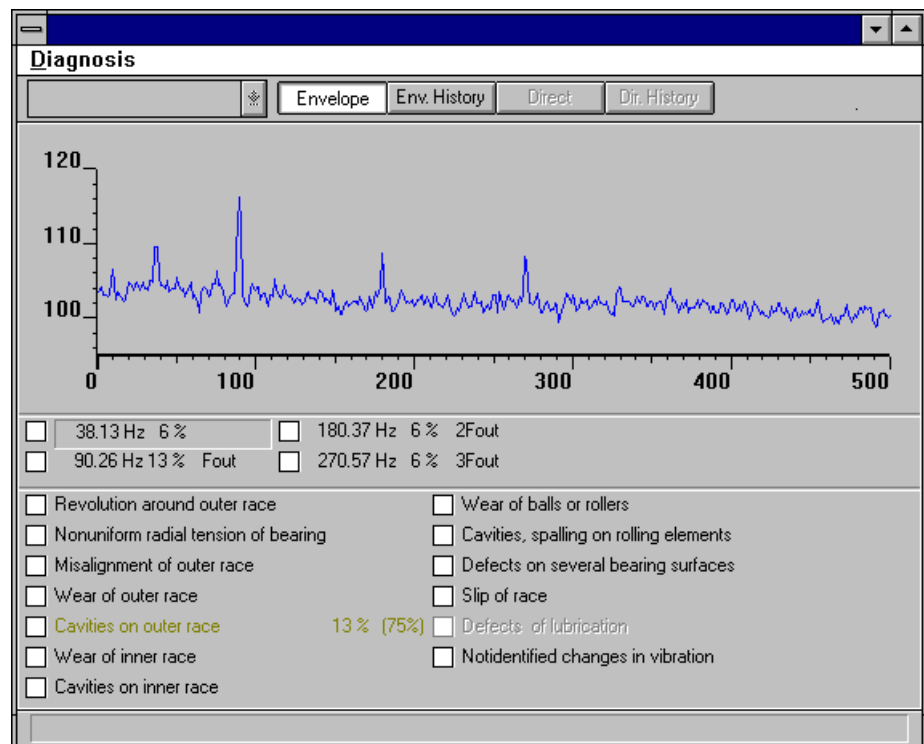
In the right part of this dialog box there are three buttons (which function is described more detailed in the next sections):

- Done** Saves the results of diagnostics in the database and closes Detailed Diagnostics dialog box.
- Details** Displays you the spectrum with all lines and the defects found. In this mode DREAM can display you the diagnostic symptoms for each defect or recommendation.
- Expertise** Displays the expertise of the spectrum including all recommendations with reasons for them, all the defects with their reasons, all warnings or comments in the text form.

3.5.1. DETAILS

Click the **Details** button in the Detailed Diagnostics dialog box to get this mode. Before you can check on the defect or recommendation you are interested in from the corresponding list. The following window will be displayed:

Fig. 3.29. The results of diagnostics are presented in this window together with the spectrum, frequencies and modulation indexes of lines found in the envelope spectrum and their identification



The Diagnosis dialog box contains three fields. You can change the size and shape of each window by dragging field separators. The first window presented a spectrum. In the second window all lines found in the spectrum are presented and classified by their origin. For example, **Frot** is the rotation speed, **Fout** and **Fin** are the ball passing frequencies on outer and inner races, etc. In the third window you can see all the defects found in the bearing.

When you check on any check boxes for frequencies in the second field, the corresponding lines are marked in the spectrum by red lines.

If you check on any check box near the defect, you will see reasons for diagnosis: in the first window you will see the lines by which the defect had been found, the lines will be marked by red lines; in the second window these lines will be checked on.

Fig. 3.30. To find a line in the spectrum, check on the check boxes of the corresponding frequency.

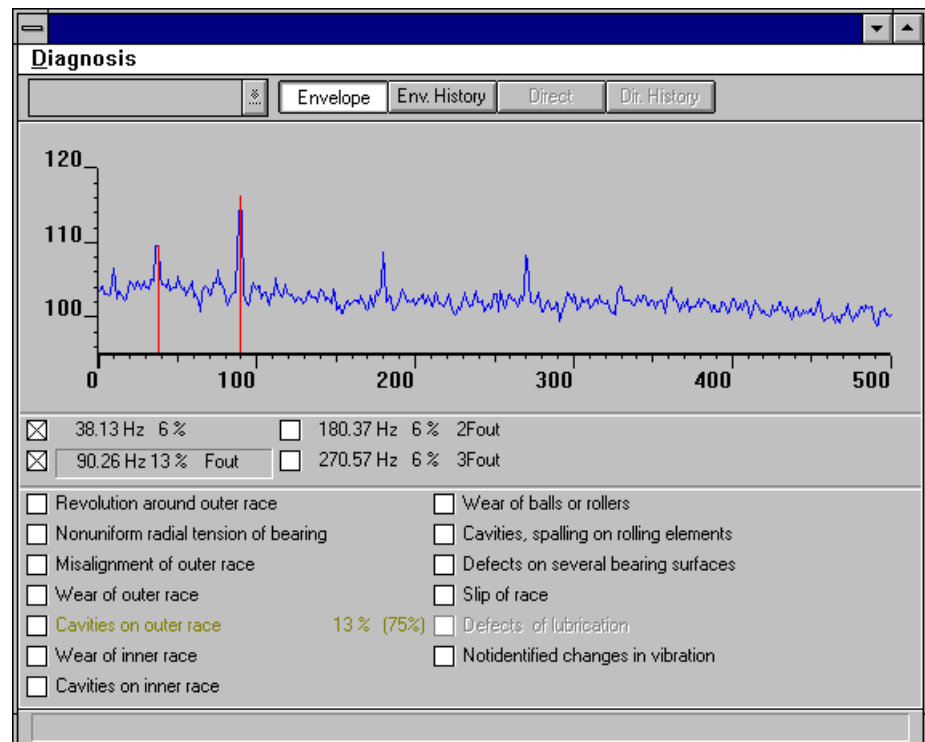
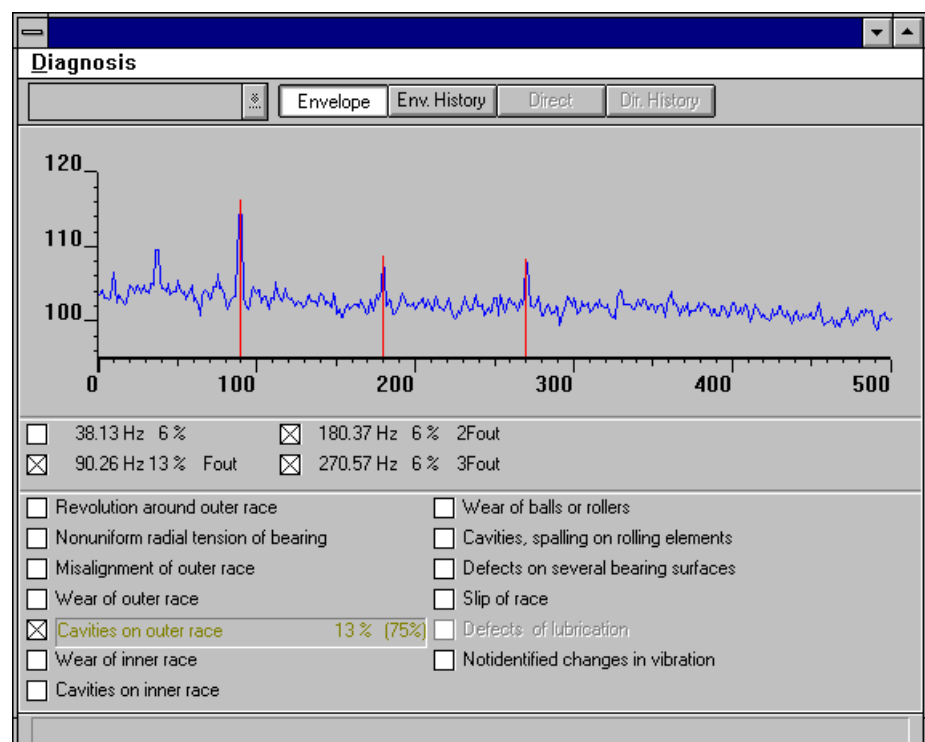


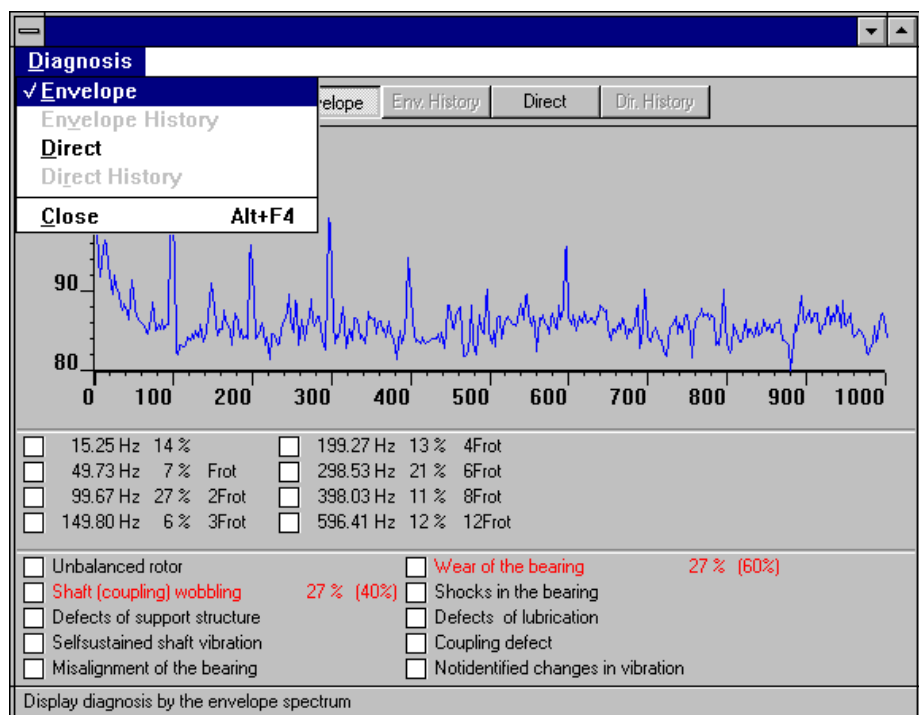
Fig. 3.31. To display all the lines symptoms for a certain defect, check on the defect check boxes.



The menu of the Details window contains the following commands:

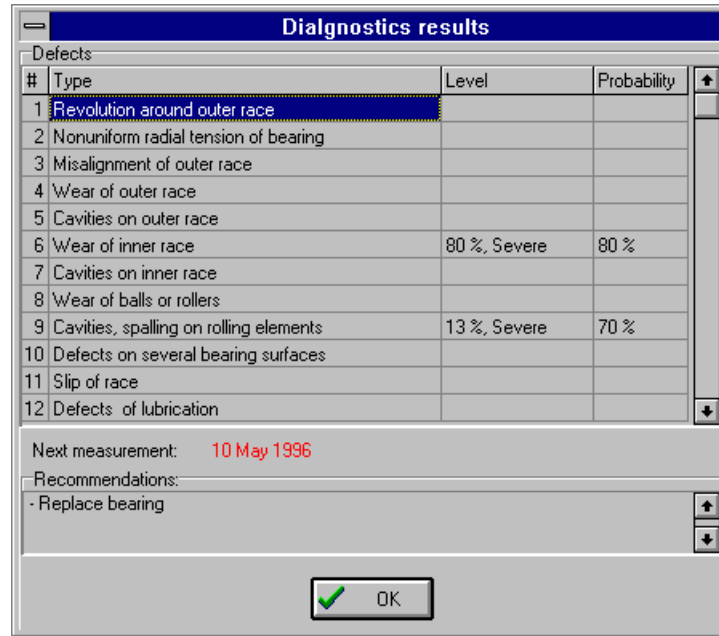
- Envelope** Displays diagnosis by the envelope spectrum. This command equals to the **Envelope** button from the speed bar.
- Envelope History** Displays diagnosis by the envelope spectrum history. This command equals to the **Env. History** button from the speed bar. It would be disabled if you measured only one spectrum for this measurement point or checked off the History check box in the Diagnose New Spectra dialog box. The command allows you to display a diagnosis for the previous spectra, compare two spectra and see how the defect has developed (do it by clicking the **Envelope** and **Env. History** buttons in turn).
- Direct** Displays diagnosis by the autospectrum. This command equals to the **Direct** button in the speed bar. This command is disabled for the measurement points that do not require autospectra for diagnostics, e.g. for rolling element bearings.
- Direct History** Displays diagnosis by the autospectra history. This command equals to the **Dir. History** button in the speed bar. This command is disabled for the measurement points that do not require autospectra for diagnostics, e.g. for the rolling element bearings.
- Close** Closes this window.

Fig. 3.32. The Diagnosis menu with the pop-up line at the bottom of the dialog box



Results of diagnostic you can easily require in the main window of DREAM. To do it, select the measurement point and double-click it with the left mouse button.

Fig. 3.33. The Diagnostics results box with the list of defects

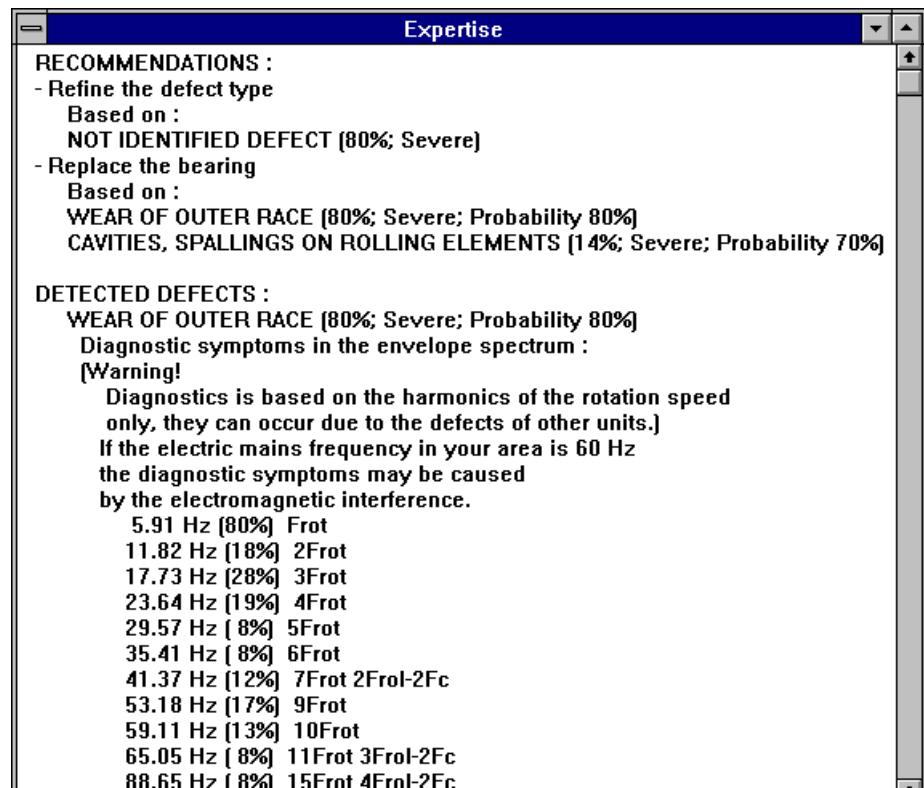


You can get this box also by the *Last Results* command from the Measurement Point menu.

3.5.2. EXPERTISE

Click the **Expertise** button in the Detailed Diagnostics dialog box to get the expert estimation of the spectrum, recommendations and all defects and their symptoms together with the warnings and comments. By this command the following window will be displayed:

Fig. 3.34. The expert estimation of the spectrum includes recommendations with the reasons for them, all defects and their symptoms together with the possible warnings and comments

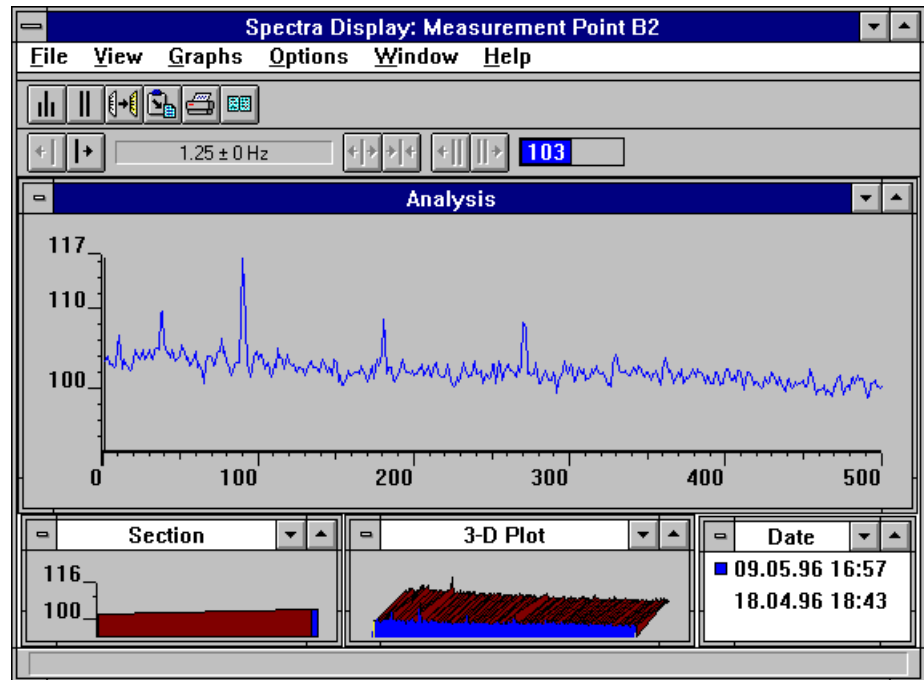


3.6. ANALYSIS

Besides data processing in automatic mode described above DREAM has detailed analysis mode for all spectra stored in the database. To access it, choose point in the plant tree in DREAM and choose the *Analysis* command from the Measurement Point menu.

By this command the Spectra Display window is displayed :

Fig. 3.35. The main window of PLOT program that is used for the analysis and diagnostics of spectra within DREAM software



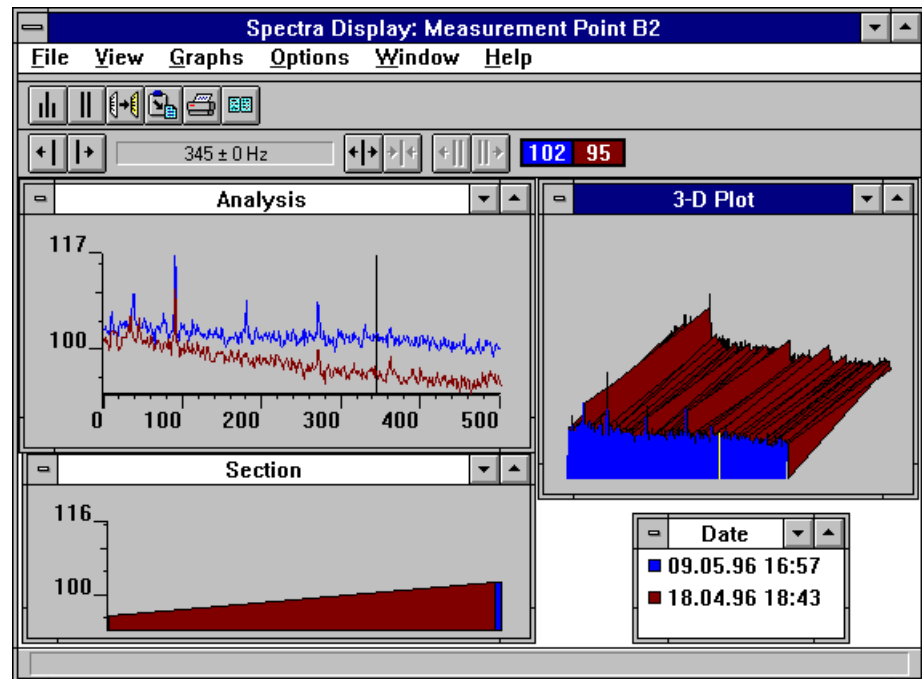
The window of the plot program contains the Analysis window where the spectra are displayed, the Date that allows you to choose spectra for displaying and analysis, the Section that displays the history of certain spectra component's development from measurement to measurement, and 3-D Plot that displays the 3-d surface representation of the spectra development in period from measurement to measurement.

The choice of spectra for displaying can be done in the Date window. Click the certain date to toggle display/hide for a corresponding spectrum. You can trend spectra by displaying them all together at the Analysis window.

The cursor can be placed anywhere in the Analysis window by clicking the mouse button in the desired location or it can be moved by cursor keys or by pressing the buttons in the speed bar. The position of the cursor and its amplitude readouts are displayed in the speed bar of the main window. The color of the spectrum coincides with the color square near the date and color of the cursor readout.

Synchronous to the movement of the cursor in the Analysis window, the section in the Section window changes (the horizontal axis here represents the intervals between spectra measurements and the vertical axis - amplitude of the spectra at the position of the cursor in the Analysis window) and the cursor moves in the 3-D Plot window.

Fig. 3.36. The cursor is controlled in the Analysis window, synchronously it moves in the 3D-Plot window, in the Section window you can see trends on the spectra components at the cursor position.



Besides the normal cursor you can display two harmonic cursors. One is called Harmonics and can contain both harmonics and sidebands, another is called Harmonic Row and can contain only harmonics. The number of harmonics in these cursors and number of side bands and modulation frequency for the Harmonics cursor are controlled by the *Harmonics* command from the Options menu.

To display harmonic cursors, use corresponding commands from the View menu, or click the following buttons on the speed bar:

-  to display Harmonics cursor;
-  to display Harmonic Row.
-  Buttons are used to move Harmonic cursor.
- Alt +**  buttons are used to move Harmonic Row cursor .

Fig. 3.37. The Harmonics cursor can be used to find sidebands for certain spectrum components

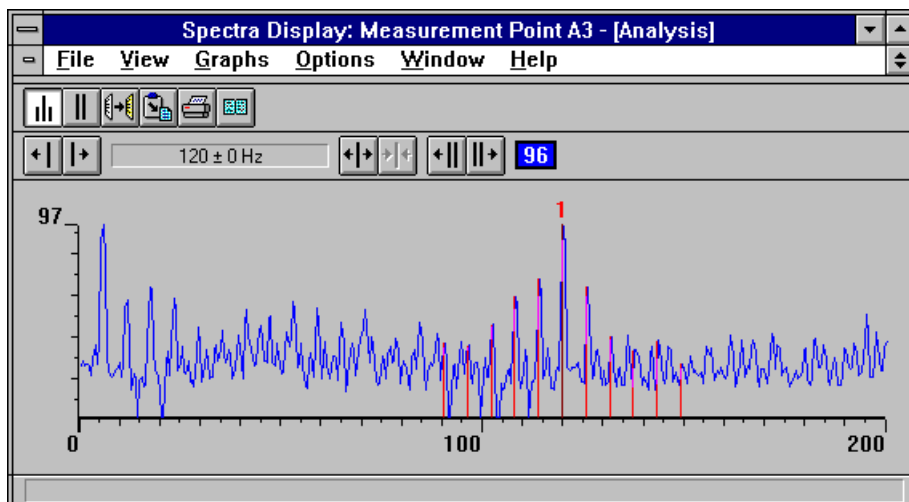
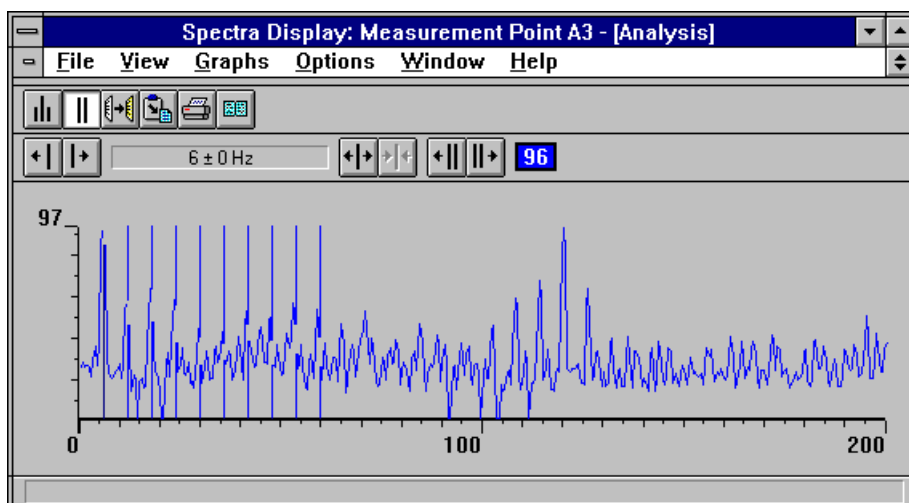
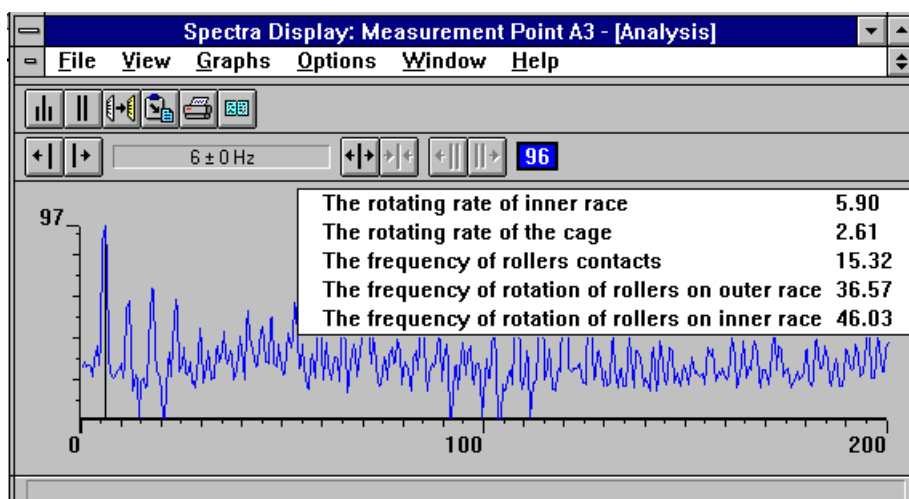


Fig. 3.38. Harmonic Row cursor can be used to find harmonic rows in the spectrum



You can display the window with all the bearing frequencies. To do so use the *right* mouse button. Click it in the Analysis window and the list box of bearing frequencies will be displayed.

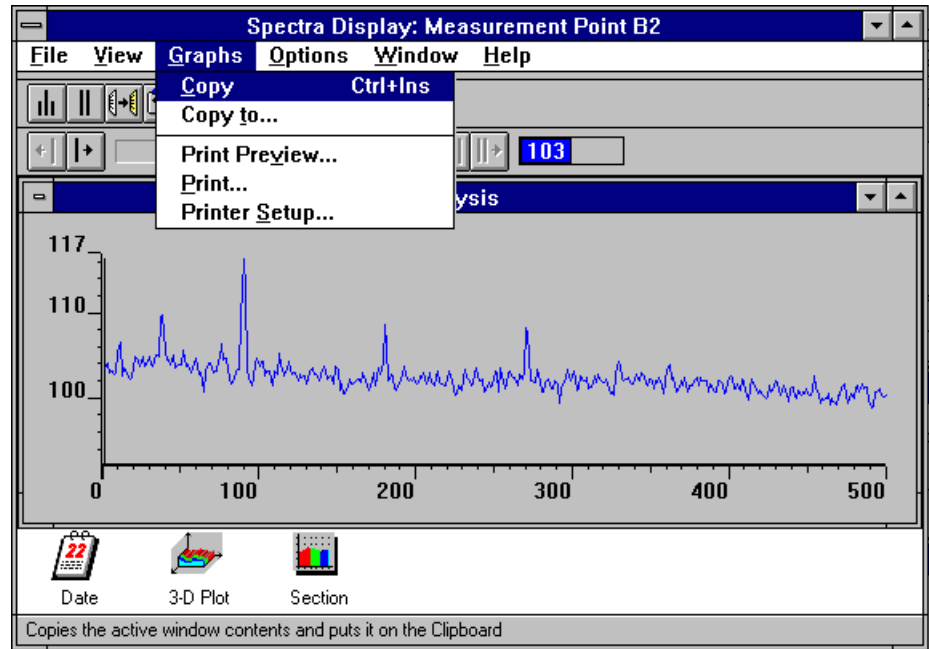
Fig. 3.39. The list box presents all the characteristic frequencies of a bearing.



To move cursor to the frequency position in the Analysis window, click the frequency you are interested in.

To create a report in a standard text editor with any pictures from the Spectra Display window, you can copy into clipboard contents of any window. Two commands from the Graphs menu can be used to do it. These are *Copy* and *Copy to...* commands.

Fig. 3.40. The Graphs menu for printing and copying graphics.



Besides, you can immediately print the contents of the active window using the *Print* or *Print Preview* commands. The graph will be stretched to the paper size and orientation of the default printer. To change these parameters use the *Printer Setup* command.

Attention! *If you try to run more than one Spectra Display, you will fail. You must find Spectra Display yet opened, close it, and run again for the new selected node.*

3.7. REPORTING

After diagnostics all the results are stored in the DREAM database and can be retrieved in several types of reports:

The commands of the Report menu issue reports for the selected node in the plant tree. There are only two exceptions. The first is the List of Bearings (by the *Statistics* command) that is made for all plants and does not depend on the selected node. The second is History that can be made only for a selected measurement point. When you select a node and issue a report all measurement points that are below this node in the tree hierarchy are included in the report.

List of Bearings This report presents all designations and specifications of the bearings included in the bearing database. These are the bearings that you have on your plant at any measurement point. This report is issued for all the equipment. Its contents are not depending on the node or bearing designation you have selected. This report is created with the command *Statistics*.

For each node of the plant tree there can be generated the following reports:

Points' Configuration Contains information on the type of measurement points configured in the DREAM database, the designation of the installed units, the rotation speed.

Measurement Setups Contains information on the type and setups of measurements required by DREAM for the diagnostics of all measurement points. These setups depend on the type of the unit to be diagnosed, the parameters of the unit and the rotation speed.

Points To Be Measured Very important report that is used to plan measurements. All configured in DREAM measurement points that have not been measured or condition of which should be refined by a certain date are included in the list together with the measurement setup for each point.

Conditions This report presents the information about the condition of your equipment. The report contains information when were done the measurements last time for each measurement point, when should be measured it next time, on the maximum defect level found in the equipment, and lists the recommendations for corrective actions to be done.

Recommendations This report is a subset of the previous report in which there are included only the measurement points that have some recommendations. When you create this report, the program asks you which

of recommendations to include in the list. The possible recommendations are:

Refine the defect type - it means that a defect is found but the type of it can not be determined, actually it may be not the defect of a bearing, for example, but an interference from other units;

Check the lubrication quality - the defect of lubrication was detected that usually results in the increase of the high frequency vibration level.

Replace the bearing - dangerous combination of defects occur. This recommendation is given when the system considers that in the next 1% of MTBF 10% of the bearings in such a condition may fail.

Correct misalignment - it means that the mounting defect of the bearing was found - the misalignment of inner and outer races. This is not a very dangerous defect that leads to the immediate failure of the bearing, but it significantly decreases the service life of the bearing.

Correct nonuniform radial tension - it means that the mounting defect of the bearing was found - the nonuniform clearances. This is not a very dangerous defect that normally does not lead to immediate failure of the bearing, but it may significantly decrease the service life of the bearing.

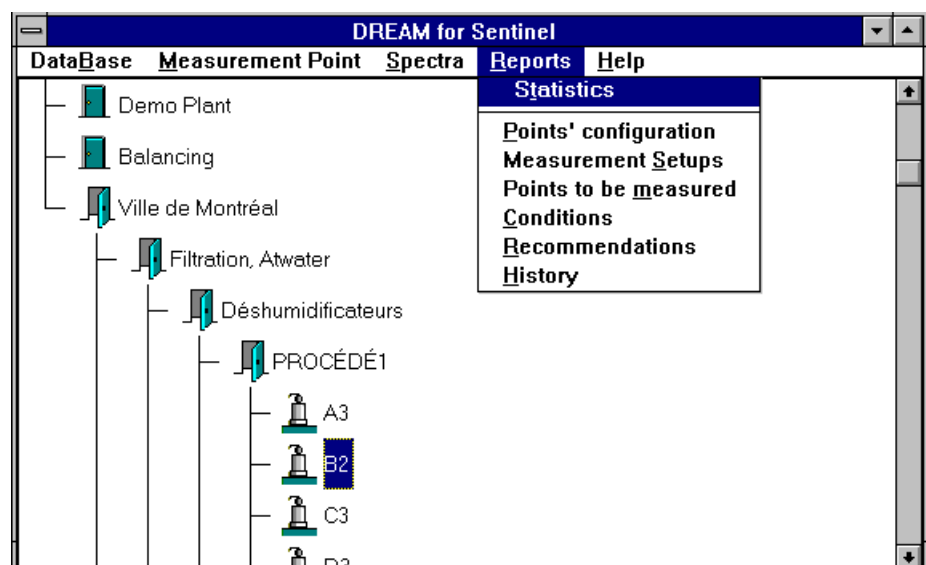
For each measurement point there can be shown the

History

Contains information of all measurements and the results of diagnostics that were made for this measurement point.

To issue a report, choose a node in the plant tree and use the corresponding command from the Reports menu.

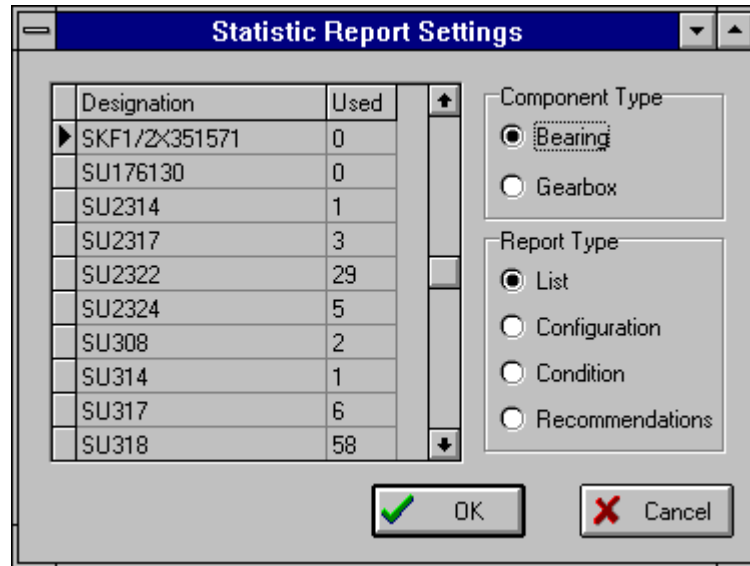
Fig. 3.41. The Reports menu



Besides the reports on the selected node you can get the statistics reports on the selected bearing designation or gearbox type. They are List of Bearings, Measurement Points, Conditions, Recommendations.

To issue a statistic report, select the *Statistics* command from the Report menu. It calls the Statistic Report Settings dialog box.

Fig. 3.42. The dialog to choose a bearing designation or gearbox type for reporting



By this dialog box you can choose the component type (bearing or gearbox) you want to issue a report, and type of report as well.

You can see in this dialog box the list of the bearings (gearboxes) used, and how many times they are used. It can be useful, for example, if you want to know whether you need the bearing of this type. Or, if you configured an improper bearing, and that caused wrong diagnostics, you need to know in which points it is used, delete the data and reconfigure these points. Only then you can delete the improper bearing.

Note: When to find points with the improper configured bearing, you use the Measurement Configuration report, select the highest level. Only then you find all the similar points. In another way you can get program message "The report is empty".

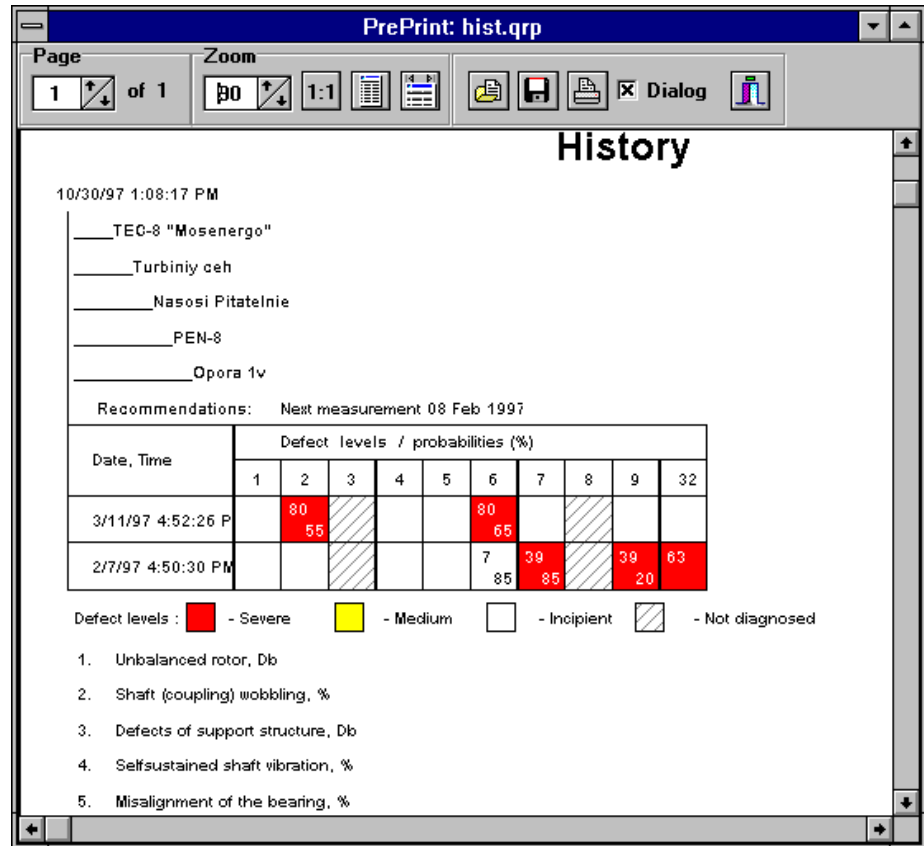
Here -

1. Select a component type (bearing or gearbox).
2. Select from the list the bearing/gearbox type you are interested in.
3. Select a type of the statistic report.

Confirm your choice by the **OK** button or escape this dialog by the **Cancel** button.

Each report is shown in the special PrePrint program. The number of the report open is limited only by the resources of your computer.

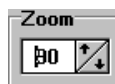
Fig. 3.43. A PrePrint window with a History report for a measurement point.



The following controls are used in this window:



The Page input box to set the page number for display. You can use arrows to scroll through a report.



The Zoom input box is used to setup displaying. You can use the arrows advance this control. By the arrows you can change zooming in 10% intervals.



Click this button to set zoom to 100%.



Click this button to fit the whole page in the window.



Scales the editing view to see the width of the page.



The **Load** button is used to open your previously saved report to view or print it. The standard extension for the report files is QRP. The program normally saves only one last report of each kind on disk.



The **Save** button is used to save a report on disk. The standard extension for the report files is QRP. The program normally saves only one last report of each kind on disk, so to be able to open and print reports later you have to save them manually.



Click this button to print a report on the default printer.



When this check box is checked on, the Print dialog box is displayed before setting the report to printer. In this dialog box you can setup your printer, set the print range, the number of copies, etc.



The **Exit** button is used to close this window.

3.8. RECOMMENDED MODE OF PROGRAM OPERATION

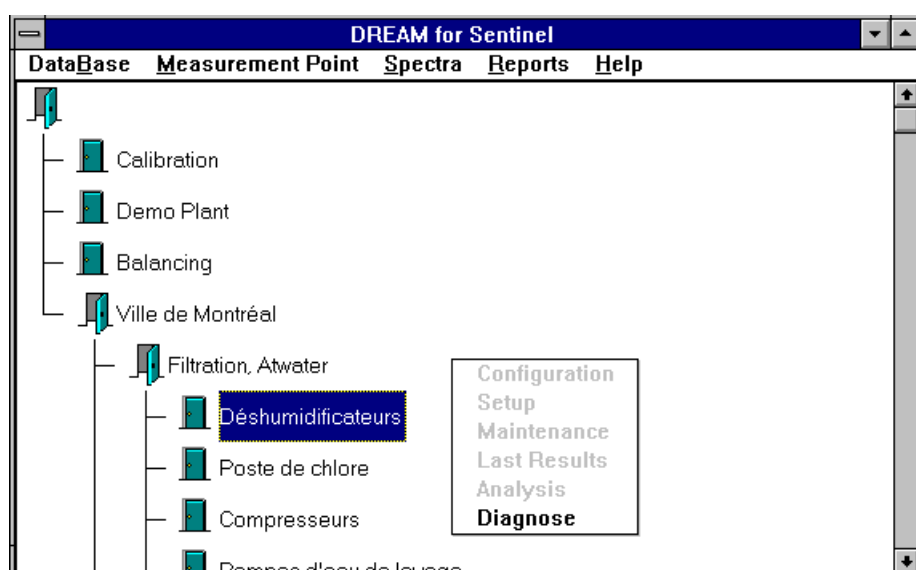
Here we will discuss an optimum way of DREAM operation once you have configured your database and how use the system as a condition monitoring and predictive maintenance tool.

First of all when you come to your office, you can issue the Points To Be Measured report for the whole equipment for today or for any later time, e.g. by the next Monday if you are not going to work on weekend. You can analyze the amount of work to be done during this period.

Next you set up the corresponding route in the Sentinel software, load it into the 2526 data collector, make measurements and unload them into Sentinel. Then exit Sentinel and start DREAM.

In DREAM select one by one all the units from which the measurement points were measured. Once you selected a unit click the right mouse button to display the floating menu and select the *Diagnose* command from it.

Fig. 3.44. The floating menu is the most convenient way to work with the plant tree. It is simply accessed by the right mouse button



In the DREAM main window you can get an additional menu which contains the main commands. To do it select any element of the plant tree and click the *right* mouse button.

The Diagnose New Spectra dialog box will be displayed. Check on the New Only check box, select one by one all machines and measurement points from the lists and diagnose all the new spectra. In case of doubts in diagnostics you can use the Details and Expertise modes to confirm the diagnosis.

After you finished with one unit, select another one in the plant tree and process all spectra.

When you have processed all new spectra it is worth creating new reports: *Condition* to print the updated report on condition of your equipment with the dates of the next measurements, it can help you to optimize orders for the spare parts, so that you minimize the stock and have enough time to order only the needed ones in advance; and *Recommendation* to plan the maintenance works. You can print separate reports for "Bearings To Be Replaced" by including only this recommendation in the list, "Bearings To Check the Lubrication" or "Bearings With Mounting Defects" by including in the list only some of recommendations. This can be rather helpful when different persons are responsible for certain corrective actions.

Sometimes it may be worth printing the Bearing History reports to make a decision whether to replace a bearing or not. Usually, DREAM recommends to make only 5-7 measurements during the bearing service life, and you can see how the defects change and develop within a bearing. Typical situation is when first a small wear of, say the outer race, develops, then in half a year it transforms in medium cavities on the same race, then in 1-3 months it changes up to severe cavities and medium wear of the same race and some medium defects on another one, and in this case you have to be more careful and measure more often. As soon as another severe defect develops - cavities on the inner race or rolling elements (this usually happens after another 2 weeks - 2 months) DREAM recommends to replace the bearing.

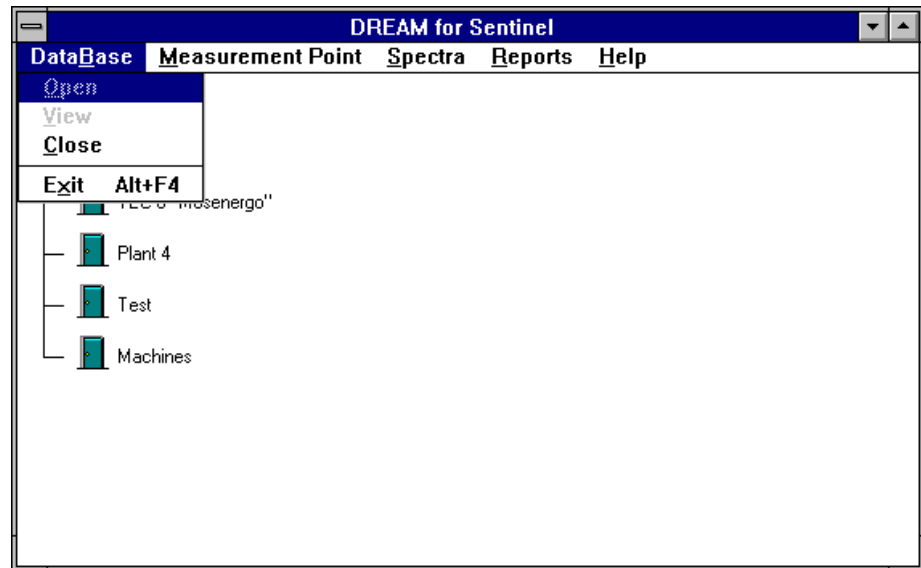
4. MENU DESCRIPTION

This chapter of the manual will describes all the commands and features of the DREAM software.

4.2. THE DATABASE MENU

This menu is used to work with database.

Fig. 4.1
Menu Database of
the DREAM software



The following commands are included in the menu:

Open Opens the database of Sentinel and reads all plants' structure and spectra that can be used by DREAM for diagnostics.

Note: To start DREAM and open the database of Sentinel, you should exit Sentinel. Otherwise this command will be disabled. When DREAM reads all the spectra it closes the Sentinel database and you can work simultaneously with Sentinel and DREAM.

View This command can be executed independent on the database of Sentinel being opened. By this command DREAM -

1. Opens its database in the same state as it was closed last time. In this case new spectra from the Sentinel database can not be used.
2. Displays in the DREAM plant tree only the measurement points configured in DREAM. The tree branches that do not contain such points are not present at all.
3. The measurement points configuration command is disabled, but all other commands including reports, diagnostics, analysis work as in normal mode.

The View mode is recommended when you do not need to diagnose new spectra or configure measurement points.

Close Closes the database. The command is disabled when the database is not opened.

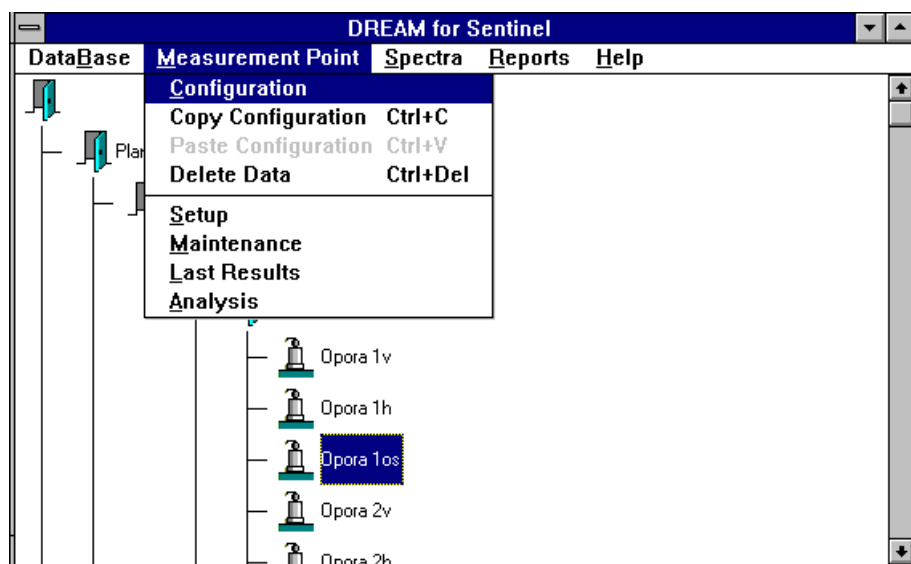
Exit Closes the database and quits the application.

4.3.

THE MEASUREMENT POINT MENU

This menu contains several commands to work with measurement points - to configure measurement points (and edit configuration data: delete, copy, paste) , enter and retrieve information about the setup, condition of measurement points and last maintenance date; also it enable you to make manual diagnostics (the *Analysis* command).

Fig. 4.2
The Measurement
Point menu of the
DREAM software



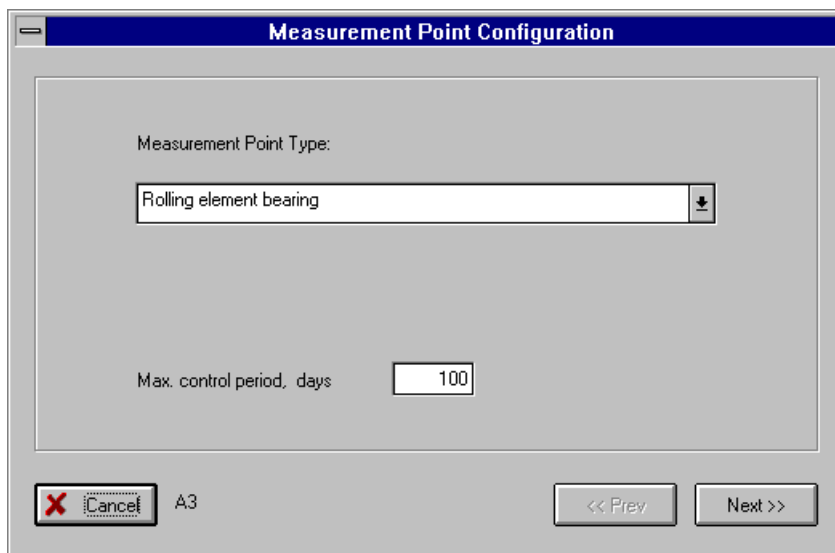
Below you can see a detailed description of each command from this menu.

4.3.1. CONFIGURATION

The *Configuration* command from the Measurement Point menu is used to configure (set up) a point in the DREAM database.

This command displays the Measurement Point Configuration dialog box:

Fig. 4.3
Measurement Point
Configuration dialog
box is used to set up
a point in the DREAM
database

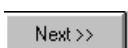


This dialog box contains three sections that can be switched by the **Next** and **Prev** buttons. The first section have the following controls:

- Measurement Point Type** A list box where you have to choose one of the measurement point types from the list. Click the button to open the list.
- Maximal Control Period** An input box. Enter the period in days that will be an interval between measurements for a measurement point that has no defects according to the last diagnostic results. For rolling element bearings we recommend to enter 20% of MTBF.



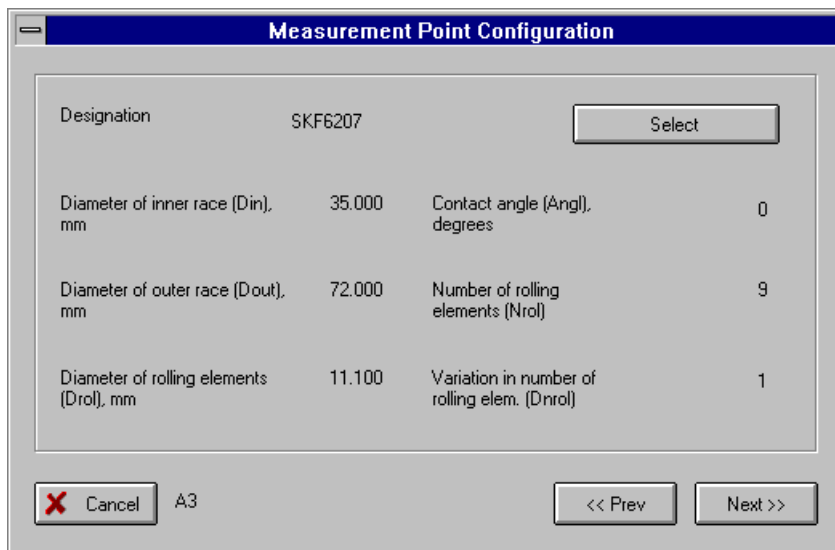
Click this button to disable changes and close this dialog box



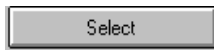
Click this button to apply changes and advance to the next section of the dialog box

The following, for example, is the rolling element bearing configuration. Click the **Next** button to advance to the next section:

Fig. 4.4
The second section
of the Measurement
Point Configuration
dialog is used to
select a bearing
designation



The second section displays information about the bearing designation and has the following controls:



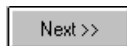
Click this button to choose a designation from the database or enter a new one



Click this button to disable changes and close this dialog box



Click this button to apply changes and go to the previous section of this dialog



Click this button to apply changes and advance to the next section of this dialog box

When you click the **Select** button the Choose a Bearing dialog box will be displayed on the screen:

Fig. 4.5
Bearing Selection
dialog box is used to
work with the data-
base of bearings'
designations

	Designation	Din	Dout	Drol	Angl	Nrol	Dnrol
	SU308	40.000	90.000	15.080	0.000	8	0
	SU314	70.000	150.000	25.400	0.000	8	0
	SU317	85.000	180.000	30.160	0.000	8	0
	SU318	90.000	190.000	31.750	0.000	8	0
▶	SU322	110.000	240.000	41.280	0.000	8	0
	SU32317	85.000	180.000	24.000	0.000	14	0
	SU324	120.000	260.000	42.860	0.000	8	0
	SU66412	60.000	150.000	26.990	36.000	10	1
	SU7804(VAZ)	20.000	46.000	6.000	12.000	14	1
	SU7805(vaz)	26.000	57.000	6.000	12.000	16	1

This dialog box lists all the bearings' designations that were used for any measurement points previously. To select a bearing, click a desired row. To change a bearing parameters, simply click a parameter to be changes and enter the new value.

The following abbreviations are used in the list:

Din - the diameter of the inner race (or the inner raceway).

Dout - the diameter of the outer race (or the outer raceway, if **Din** was the diameter of the inner raceway).

Note: if you do not know the diameters of races you can enter the cage diameter as a diameter of both inner and outer race. The program actually needs only the cage diameter that is calculated as a mean value of inner and outer race diameters.

Angle - the contact angle in degrees between the rolling elements and the race.

Drol - the diameter of rolling elements.

Nrol - the number of rolling elements in the bearing.

dNrol - the acceptable variations in the number of rolling elements set by the operator. When analyzing the envelope spectrum, the program will correct the number of rolling elements in the limits **Nrol+dNrol** if there is a mistake in the input data. If the variations in the number of rolling elements exceed **+dNrol**, the program is not able to identify the type of defect.

Note: Our experience shows that it is rather typical for the bearing manufacturers to vary the cage design and thus the number of rollers in the same type of bearing.

This dialog box has the following controls:



Click this button to add a blank line to the list where you can fill in the designation and dimensions of the new bearing



Click this button to access the bearing library that is supplied with the DREAM software and contains 4000-5000 bearing designations from different manufacturers



Click this button to delete a selected bearing from the database



Click this button to choose a selected designation for the measurement point and close this dialog



Click this button to disable your selection and close this dialog

When you click the **Import** button, the Import a Bearing dialog box will be displayed.

Fig. 4.6
Import a Bearing
dialog box is used to
work with the external
library of bearings'
designations

Designation	Din	Dout	Drol	Angl	Nrol	Dnrol
SKF1/2X351571	380.00	810.00	90.00	90.00	15	0
SKF1052117	17.00	40.00	5.00	32.00	14	0
SKF1066145E	9.00	25.00	4.50	45.00	12	0
SKF1200	10.00	30.00	4.76	12.22	9	0
SKF1200E	10.00	30.00	4.76	12.21	9	0
SKF1201	12.00	32.00	4.76	12.70	10	0
SKF1201E	12.00	32.00	5.00	12.64	10	0
SKF1202	15.00	35.00	5.56	12.54	10	0
SKF1202E	15.00	35.00	5.56	12.54	10	0
SKF1203	17.00	40.00	5.56	11.61	12	0
SKF1203E	17.00	40.00	6.00	11.81	11	0
SKF1204	20.00	47.00	6.35	10.37	12	0
SKF1204E	20.00	47.00	7.14	11.15	12	0
SKF1205	25.00	52.00	7.14	10.31	12	0

This dialog box lists bearings' designations from the external bearing library. To make a choice, select the desired bearing and click the **OK** button.

This dialog box has the following controls:



A text box that is used to find the desired designation. When you enter the first symbols of the designation, the list advances to the corresponding names.



Click this button to accept choice and add the selected designation to the DREAM database and close the dialog box.



Click this button to disable your choice and close the dialog box.

Once you click the **Next** button at the second section of the Measurement Point Configuration dialog box, you advance to the next section:

Fig. 4.7
The third section of the Measurement Point Configuration dialog box is used to enter the parameters of the rotation speed

 A screenshot of the 'Measurement Point Configuration' dialog box. The title bar is blue with white text. The main area is light gray and contains three rows of controls: 'Rotation Speed' with an input box containing '23' and 'Hz' to its right; 'Variation, %' with an input box containing '2'; and 'Max. variation, %' with an input box containing '4'. At the bottom, there is a 'Cancel' button with a red 'X' icon, a label 'D3', and two buttons: '<< Prev' and 'Next >>'.

The third section has the following controls:

Rotation Speed

An input box to enter the rotation speed of the machine in Hz.

Variation

An input box to enter possible variations in rotation frequency from measurement to measurement.

From the point of the program the variations could be normal (set by the operator, for example, Rotation Speed+Variations) or **Max Variation**.

The more Variations and Max Variations are, the less the certainty (the probability of the exact type of the defect that is displayed by the program) and it takes more time to make the diagnostics.

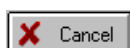
If the actual rotation speed is not within Variations, but within Max Variations, the program identifies the type of the defect but gives

the warning that the data have variations, and during processing the program has revised them to identify the defect. The program generates the same warning if there is a mistake in the number of rolling elements in the limits +dNrol.

Max. Variations

An input box to enter the maximum value of variations in the input data for the Rotation Speed (in %) at which the program will still identify the type of the defect but will give a warning signal to the operator.

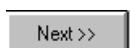
If the variations exceed the Max. Variations value, the program will detect the defect and its depth but will not identify the type of the defect. In this case, the type of the defect will be defined as a "Not identified defect" (NID). When such information, it is recommended to enter the Variations of about 2-3% and maximum variations not more than 10%.



Click this button to disable changes and close this dialog



Click this button to apply changes and go to the previous section of this dialog



Click this button to apply changes and advance to the next section of this dialog

Enter the above values and click the **Next** button. The program will automatically calculate the levels for severe defects and advance to the next section:

Fig. 4.8
The last section of
the Measurement
Point Configuration
dialog box is used to
set or confirm defect
levels

#	Defect Type	Level		Default	
		%	Db	%	Db
1	Revolution around outer race	23	17		
2	Nonuniform radial tension of bearing	8	11		
3	Misalignment of outer race	13	17		
4	Wear of outer race	13	17		
5	Cavities on outer race	13	17		
6	Wear of inner race	8	11		
7	Cavities on inner race	8	11		

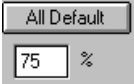
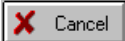
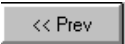
Revolution around outer race % <-17 All Default

Db %

Buttons: Cancel, D3, << Prev, Finish

The last section displays information on the default (calculated by the program) and actual levels for severe defects. The actual levels are presented in the Level column and the default in the Default

column. To change level for a particular defect, select it and use the following controls:

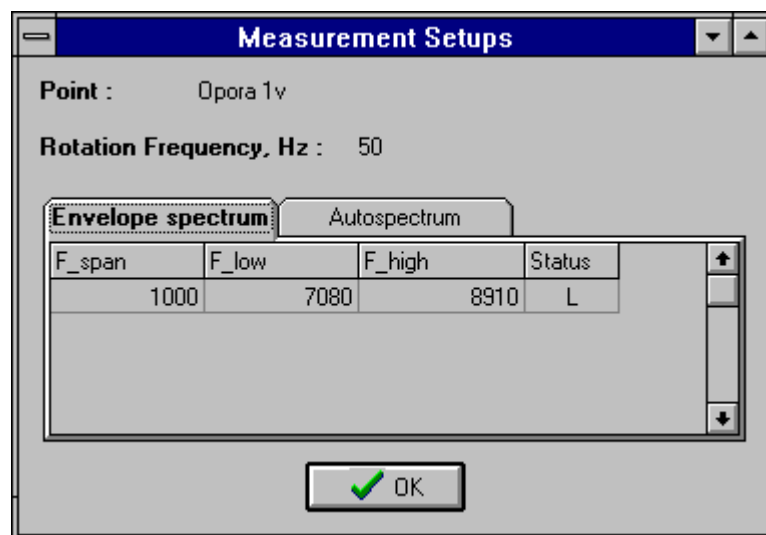
-  Type a new level in this input box.
-  Click this button to restore the default level for the selected defect.
-  Click this button to set default levels multiplied by the below percentage to all defect types in the list.
-  Click this button to disable changes and close this dialog box.
-  Click this button to apply changes and go to the previous section of this dialog.
-  Click this button to apply changes and close this dialog box.

For the different types of the measurement point the program calls the different configuration dialog boxes on the second stage of configuration. On the other stages of configuration the dialog boxes will be the same as for the example above on the rolling element bearing.

4.3.2. SETUP

This command is used to display the information on the measurement setup that is required by DREAM to process diagnostics for the particular measurement point. By this command the Measurement Setup information box is displayed:

Fig. 4.9
The Measurement Setup information box with the Envelope spectrum section visible.



There may be the one of or the two sections if necessary for measurements: Envelope Spectrum, Autospectrum.

Here:

F_span is the Frequency Span to be set in the Sentinel measurement setup.

F_low is the Lower Frequency to be set in the Sentinel measurement setup.

F_high is the Upper Frequency to be set in the Sentinel measurement setup.

The **Status** column may contain letters L, R, A that mean:

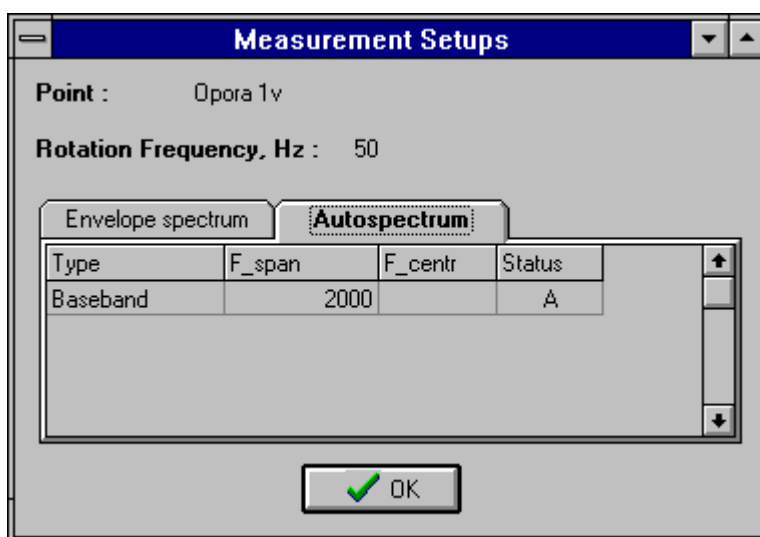
L - leading spectrum that is presented in reports,

R - required spectrum,

A - additional spectrum.

Fig. 4.10

The Measurement Setup information box with the Autospectrum section visible.



Type can be Baseband or Zoom to be set in the Sentinel measurement setup.

Note: Due to the fact that Type 2526 data collector can measure only 400 lines resolution spectra in some cases DREAM will require to measure two spectra with different settings for diagnostics (for example a bearing with a number of balls more than a hundred). For DREAM these two spectra are as one measurement and it will identify this measurement by the date of the leading spectrum. So, for diagnostics DREAM needs leading and required spectra to be measured, additional spectra may be used to refine some types of defects, but not required. Leading spectra are used to identify the measurement, and only the date of leading spectrum is presented in all reports and lists.



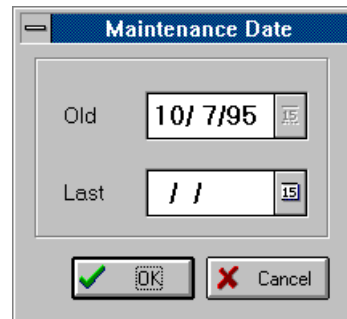
Click this button to close the window.

4.3.3. MAINTENANCE

This command is used to display the information about the maintenance and repair works that have been done for this very measurement point and enables the operator to enter new dates of maintenance. This information can be vital if you would like to

compare spectra from different dates. The thing is that sometimes during maintenance the vibration pattern on the machine may change and the spectra measured before and after maintenance may be not compatible. By this command the Maintenance Date dialog box is displayed:

Fig 4.11. The Maintenance Date dialog box



Here:

Old The last previously entered maintenance date.

Last An input line where you can enter the last maintenance date. If you enter a maintenance date in this line, next time you call this command this date will be displayed in the Old text box.

The following controls are used to operate this dialog box:



Click this button to call the calendar for choosing the date of maintenance.



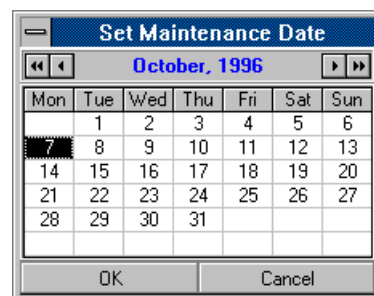
Click this button to apply changes and close this dialog box.



Click this button to disable changes and close this dialog box.

Once you clicked the  button the Set Maintenance Date dialog box will be displayed:

Fig. 4.12
The Set Maintenance Date dialog box



Here to select a date within current month, just click it with the right mouse button. To change the month and the year, use the following controls:



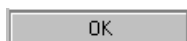
Click this button to advance one year forward.



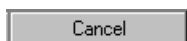
Click this button to advance one month forward.

 Click this button to advance one month backward.

 Click this button to advance one year backward.



Click this button to apply changes and close this dialog box.

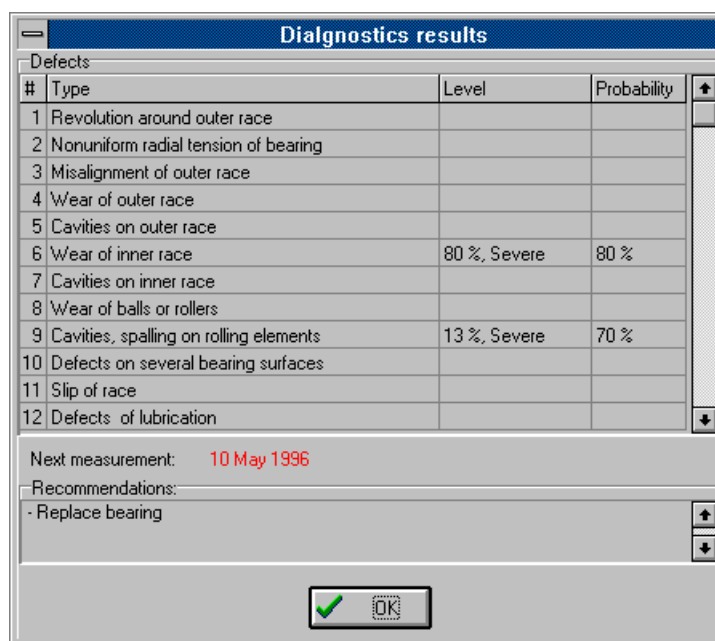


Click this button to disable changes and close this dialog box.

4.3.4. LAST RESULTS

This command is used to display the information about the current condition of the measurement point or the results of the last diagnostics. This command can also be accessed through just double-clicking the measurement point node in the main window of the DREAM software. This command calls the Diagnostics Results dialog box:

Fig. 4.13
The Diagnostics
Results dialog box
with the list of defects



Here all the defects, their severities and probabilities are listed together with the recommendations on maintenance and date of the next measurements. The following fields are displayed in this dialog box:

Defects This table contains all the defects that can be found by the DREAM software for this type of measurement point. The defects that have been found have the severity and probability on to be the defect of this very type.

**Date of the Next
Measurement**

The condition prediction or the non failure operation time for this measurement point. If this date have passed, it is painted with the

red color. It means that the system is unsure about the current condition of the unit and you should check its condition by new measurements and diagnostics.

Recommendations Recommendations for corrective actions to be made for this measurement point. Possible recommendations are:

Refine the defect type - it means that a defect is found but the type of it can not be determined, actually it may be not a defect of a bearing, for example, but an interference from other units;

Check the lubrication quality - defect of lubrication was detected that usually results in the increase of high frequency vibration level.

Replace the bearing - dangerous combination of defects occurs. This recommendation is given when the system considers that in the next 1% of MTBF 10% of the bearings in such a condition may fail.

Correct misalignment - it means that a mounting defect of the bearing was found - a misalignment of inner and outer races. This is not a very dangerous defect that leads to immediate failure of the bearing, but it significantly decreases the service life of the bearing.

Correct nonuniform radial tension - it means that a mounting defect of the bearing was found - a nonuniform clearances. This is not a very dangerous defect that normally does not lead to immediate failure of the bearing, but it may significantly decrease the service life of the bearing.

Note: Be sure to scroll the lists of defects and recommendations to view all the defects and recommendations issued by the program.

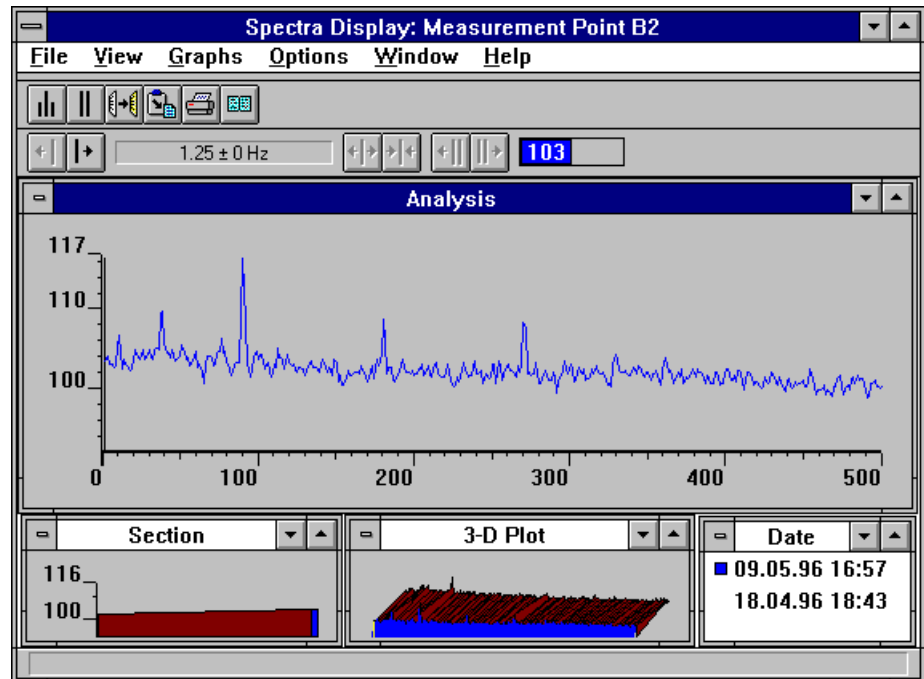


Click this button to close the window

4.3.5. ANALYSIS

This command is used to enter the manual mode of diagnostics. Despite DREAM is thought to be an automatic systems for diagnostics of different types of rotating equipment it has an advanced tools for an expert to deal with spectra. A special Plot application is started by this command that provides an experienced operator with graphic interface for diagnostics. By this command the Spectra Display window appears:

Fig. 4.14
The main window of PLOT program that is used for analysis and diagnostics of spectra within DREAM software



Here are presented dates of all envelope spectra measurements that are stored in the database of Sentinel and can be used for the diagnostics of the chosen (in DREAM) point.

The main window of the plot program contains the Analysis window where the spectra are displayed, the Date that allows you to choose spectra for display and analysis, the Section that displays the history of certain spectra component's development from measurement to measurement and 3-D Plot that displays the 3-d surface representation of the spectra development in the period from measurement to measurement.

Under the menu bar there is a speed bar with control buttons for controlling the cursors and operating the active window contents (copying, printing). Their uses are as follows:



to display/hide the Harmonics cursor. The button correspond to the *Harmonics* command from the View menu.



To display/hide the Harmonic Row. The button correspond to the Harmonic Row command from the View menu.



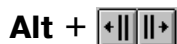
Buttons are used to move the standard cursor. It can be moved by the arrow keys too.



Buttons are used to change the cursor width.



Buttons are used to move the Harmonic cursor. It can be moved also by the <Ctrl> + arrow keys.



buttons are used to move the Harmonic Row cursor. It can be moved also by the <Ctrl> + <Alt> + arrow keys.



Click this button to copy the active window contents and put it on the clipboard. This button correspond with the *Copy* command from the Graphs menu.



Click this button to copy the active window contents into file. This button correspond with the *Copy to...* command from the Graphs menu.



Click this button to print the active window. This button correspond with the *Print...* command from the Graphs menu.



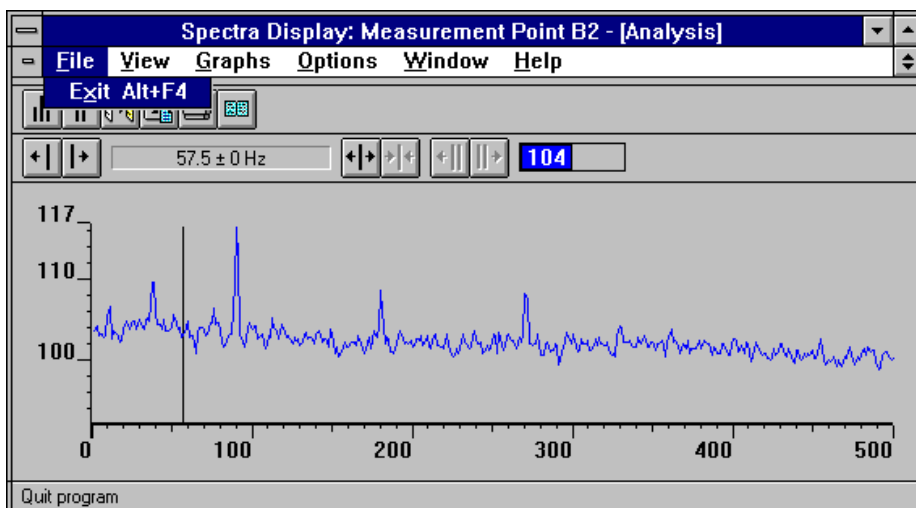
Click this button to view the page layout for printing. This button correspond with the *Print Preview...* command from the Graphs menu.

The window menu bar lists five menu names: File, View, Graphs, Window and Help.

The File menu

This menu contains the single command: *Exit*.

Fig. 4.15
The File menu

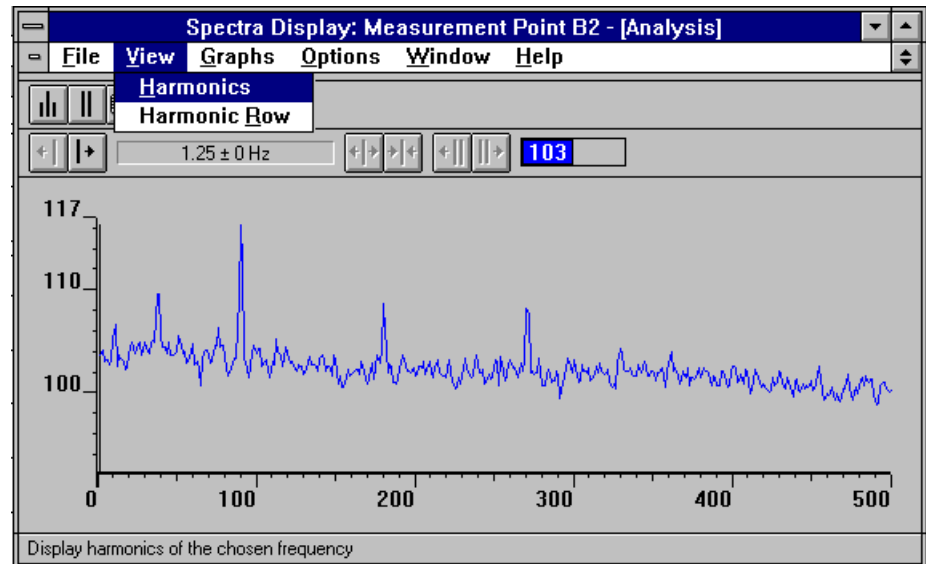


Exit Closes the Spectra Display window .

The View menu

This menu contains view options by which you can display two types of cursors or hide them.

Fig. 4.16
The View menu



When an option is selected, it is marked with a check mark.

The harmonic cursors appear at the position of the normal cursor. The cursor can be placed anywhere in the Analysis window by clicking a mouse in the desired location or it can be moved by cursor keys or by pressing the arrow buttons in the speed bar. The position and readouts of a cursor are displayed in the speed bar of the main window. If you display a number of spectra the readouts are displayed for all spectra with corresponding colors.

Harmonics Check on this option to display the harmonic cursor. The corresponding button  will be pressed automatically indicating the chosen option. Or you can simply press the button instead of checking the command. To hide the cursor, check this option one more time.

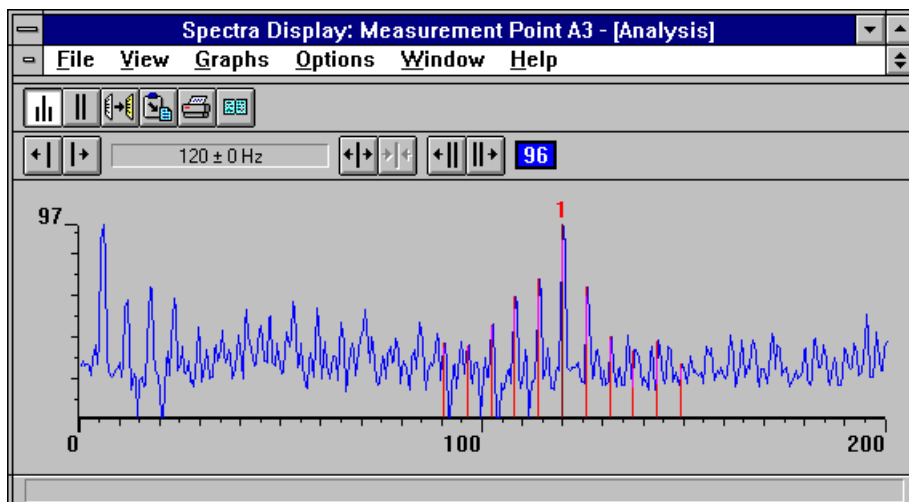
Harmonic Row Check on this option to display the harmonic row corresponding to the current cursor position. The corresponding button  will be pressed automatically indicating the chosen option. Or you can simply press the button instead of check on the command.

Harmonics cursor can contain any number of harmonics and side bands.

Harmonic Row cursor can contain only harmonics, not bands.

Fig. 4.17

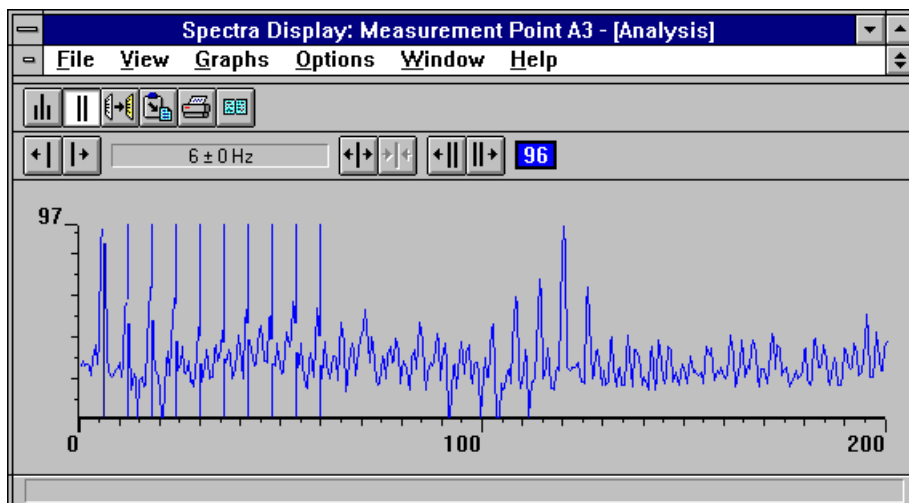
The Harmonics command is marked (and the button is pressed) and harmonics of the chosen frequency are displayed



The harmonics cursor can be used to find sidebands for certain spectrum components (see fig. 4.16.).

Fig. 4.18

The Harmonics Row command is marked (and the button is pressed)



The Harmonic Row cursor can be used to find harmonic rows in the spectrum.

The harmonics cursors appear at the position of the standard cursor and can be moved:

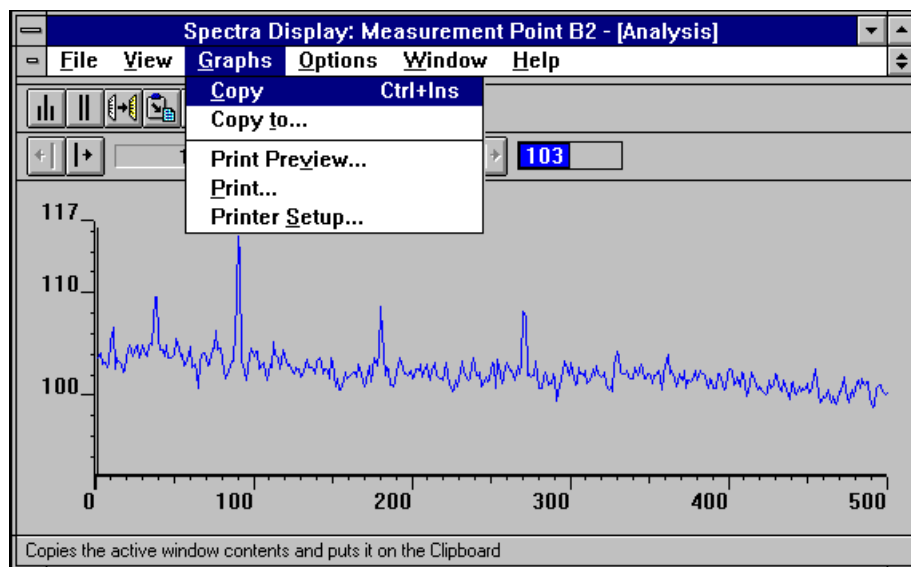
The Harmonics cursor - by the <Ctrl> + arrow keys or by  buttons in the speed bar.

The Harmonic Row - by the <Alt>+<Ctrl>+arrow keys or by <Alt> +  buttons in the speed bar.

The Graphs menu

This menu allow you to copy contents of any window in clipboard to paste in any other application, e.g. text editor or saved as a file in the Windows bit map format or printed. This menu also enables you to print the contents of all windows directly by your printer from the DREAM program.

Fig. 4.19
The Graphs menu for
printing and copying
commands

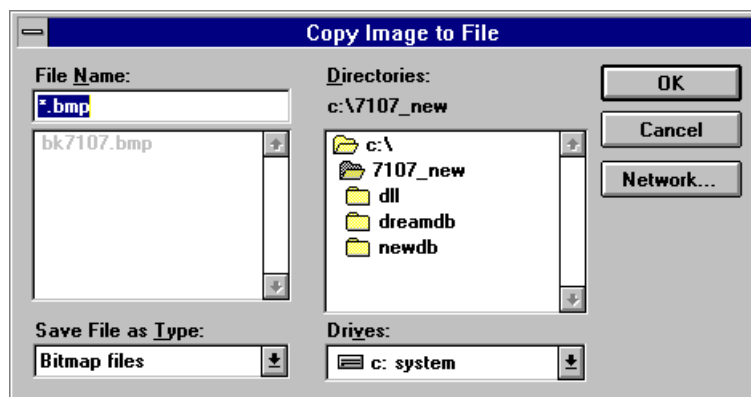


Copy Copies the active window contents and puts it on the Clipboard. The corresponding button in the speed bar is . Afterwards, you can paste the contents of the clipboard to any application, e.g. MS Word text editor, include it in the documents and print.

Copy to... Copies active window contents into file. The corresponding button in the speed bar is . The file is saved in the Windows Bitmap format and can be edited and printed by graphic editors (e.g. Paintbrush) or imported to the most text editors.

By the *Copy to...* command the Copy Image to File dialog box is displayed:

Fig. 4.20
The Copy Image to
File dialog box

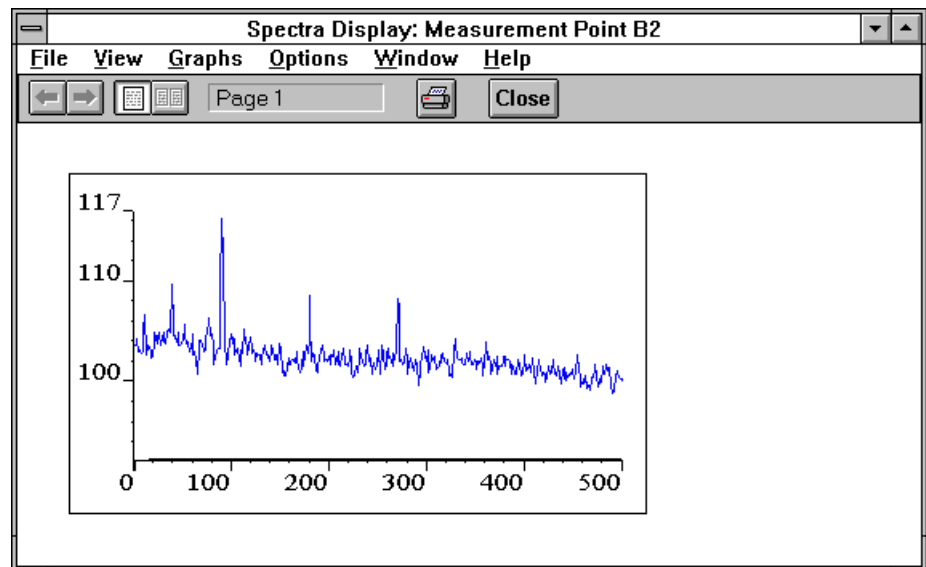


In this dialog box you can choose the directory and file name for copying a picture.

Print Preview... Displays the page layout for printing. The corresponding button in the speed bar is .

By the *Print Preview...* command from the Graphs menu the corresponding window is displayed:

Fig. 4.21
The window of the
page layout.



Here you can see how the page will be printed.

This window has the following controls:



Click these buttons to go from one page to another.



Click these buttons to display one or facing pages.



Click this button to display the Print dialog box and print the page.



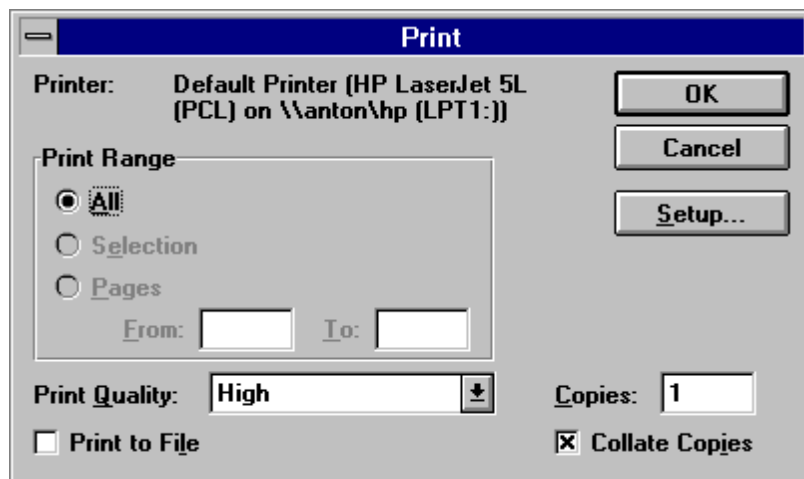
Click this button to close the page layout window.

Note: The program will automatically fit your picture to the full size of the default paper size of the default printer in Windows. To get better results you can use the Printer Setup command to adjust the paper size for better outlook. It is also recommended to use the "Wide" or "Landscape" paper orientation.

Print... Displays the Print dialog box for printing the active window. The corresponding button in the speed bar is .

By the *Print...* command from the Graphs menu the Print dialog box appears:

Fig. 4.22
The Print dialog box

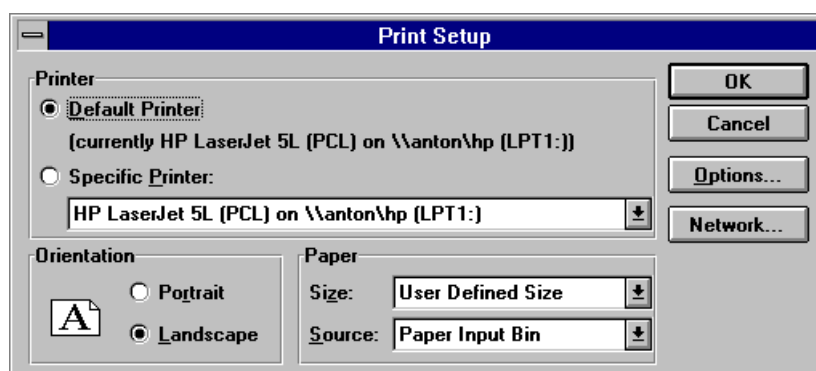


In this dialog box you can set up your printer, set the print range, the number of copies, etc. Click the OK button to start printing.

Printer Setup Displays the Print Setup dialog box.

Once you click the *Printer Setup* command in the Graphs' menu the Print Setup dialog box appears:

Fig. 4.23
The Print Setup dialog box.



This is a standard dialog box of Windows for setting up the default printer. Here you can set up your printer, paper size, etc.

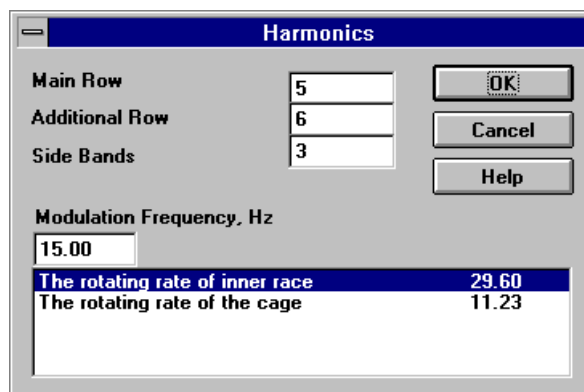
The Options menu

This menu contains the *Harmonics* command only. The command allows you to set the number of harmonics in the Harmonics and Harmonic Row cursors and number of side bands and modulation frequency for the Harmonics cursor.

Harmonics

This command is used to set options for two types of harmonic cursors. By this command the Harmonics dialog box is displayed:

Fig. 4.24
The Harmonics dialog
box



Here:

Main Rows is the number of harmonics in the main Harmonics cursor

Additional Row is the number of harmonics in the Harmonic Row cursor.

Side Bands is the number of the sidebands for each of harmonics in the Harmonics cursor. Note that if you have more than one harmonic in this type of cursor, not all the side bands may be displayed. Only those side bands are displayed that fit in the closest half of the interval between nearby harmonics, others are hidden.

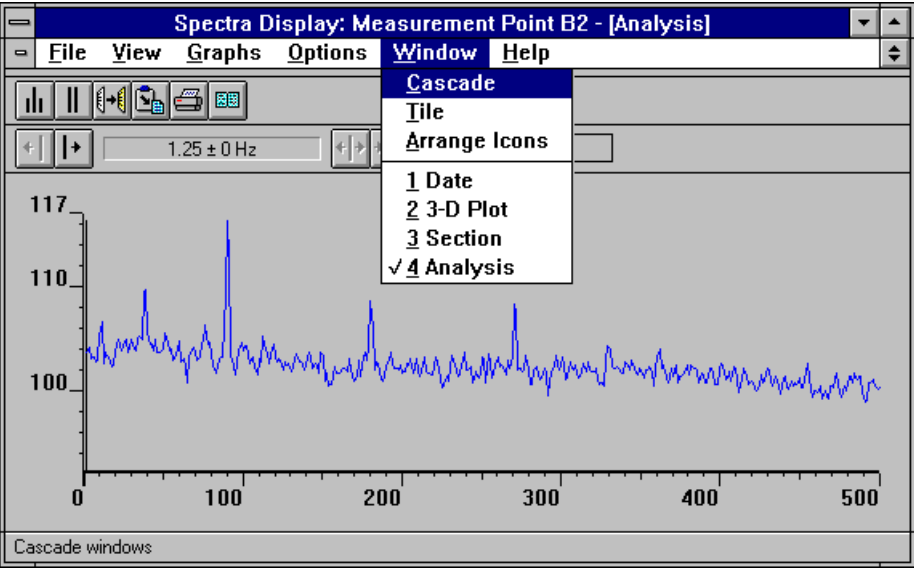
Modulation Frequency the distance between sidebands in the Harmonics cursor. You can enter it or select one of the most typical frequencies from the list box.

Click the **OK** button to apply changes and close this dialog or **Cancel** button to disable changes.

The Window menu

The Window menu includes the commands for windows' management.

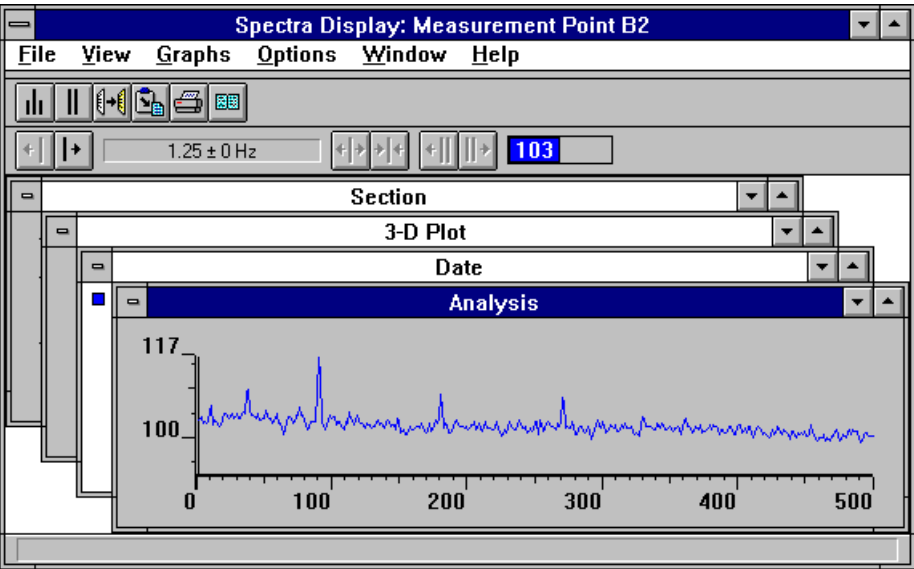
Fig. 4.25
The Window menu



The first part of this menu contains three commands:

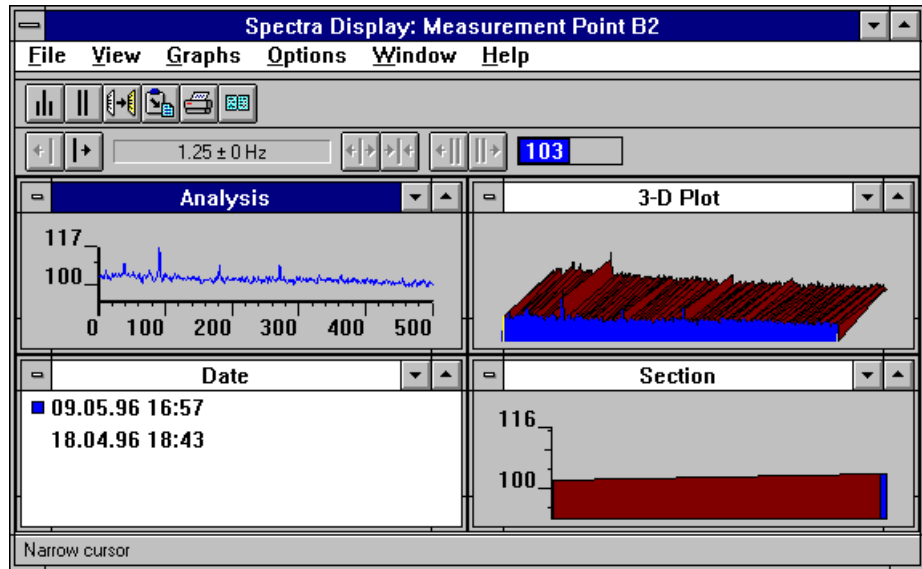
Cascade This command arranges open windows so that they overlap each other, with the title bar of each window remaining visible.

Fig. 4.26
The windows arranged in cascade



Tile This command arranges open windows so that no windows overlap and all windows are visible.

Fig. 4.27
The windows are arranged in tile.



Arrange Icons

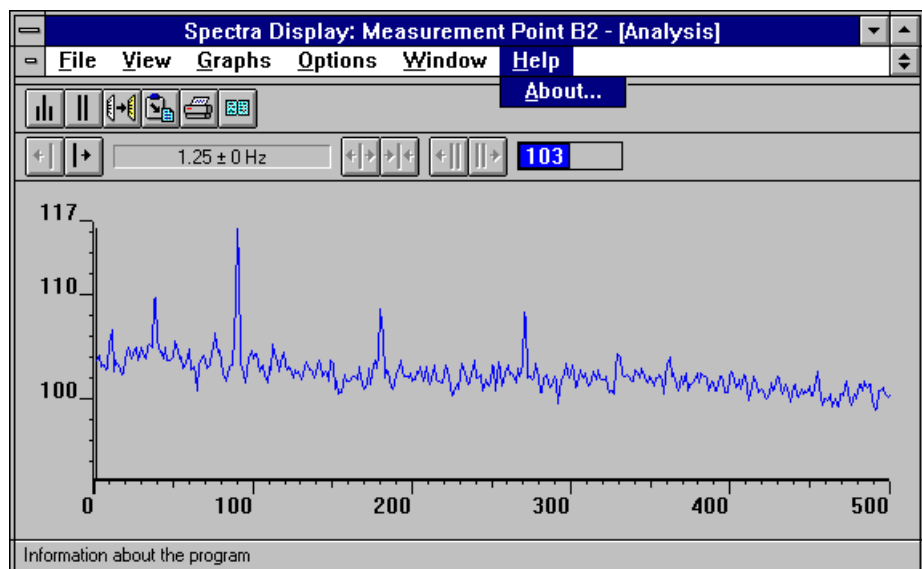
This places all in one line at the bottom of the desktop.

All the icons and windows are listed in the second part of the Window menu. There are Date, 3-d Plot, Section, Analysis. If you select the window from the list of this menu, it will become active.

The Help menu

This menu contains the single item **About..**

Fig. 4.28
The Help menu



About..

Displays the copyright and version information.

Fig. 4.29
The About information box

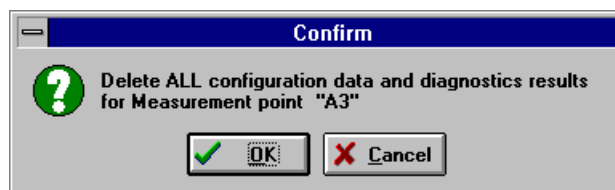


4.3.6. DELETE DATA

This command deletes the configuration data for the selected measurement point. Then you can configure the measurement point once again and all the spectra stored in the Sentinel database may be proceeded by DREAM as new ones.

The command requires the confirmation and displays the corresponding dialog box:

Fig. 4.3
The dialog box for the
confirmation of the
Delete Data com-
mand

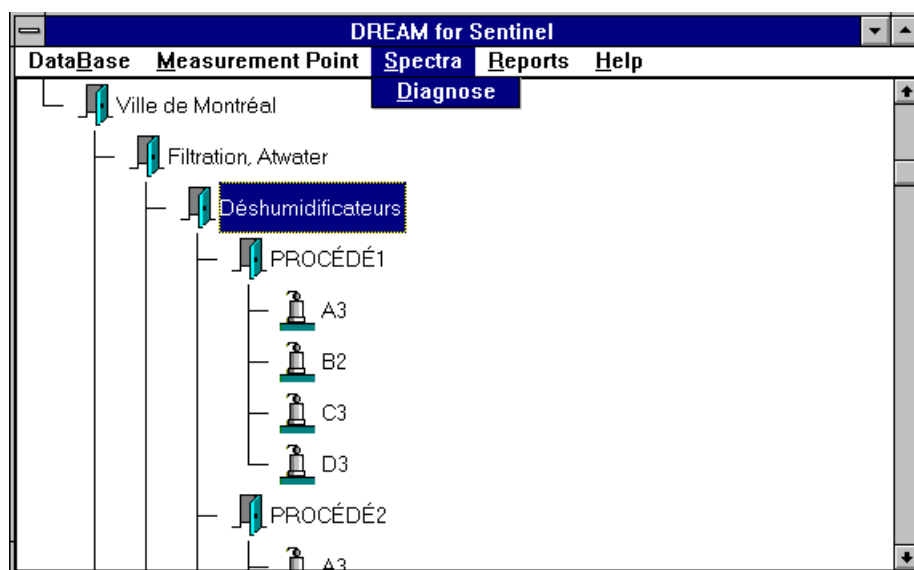


Click the **OK** button to delete data or the **Cancel** button to disable changes.

4.4. THE SPECTRA MENU

This menu contains the **Diagnose** command only.

Fig. 4.31. The Spec-
tra menu

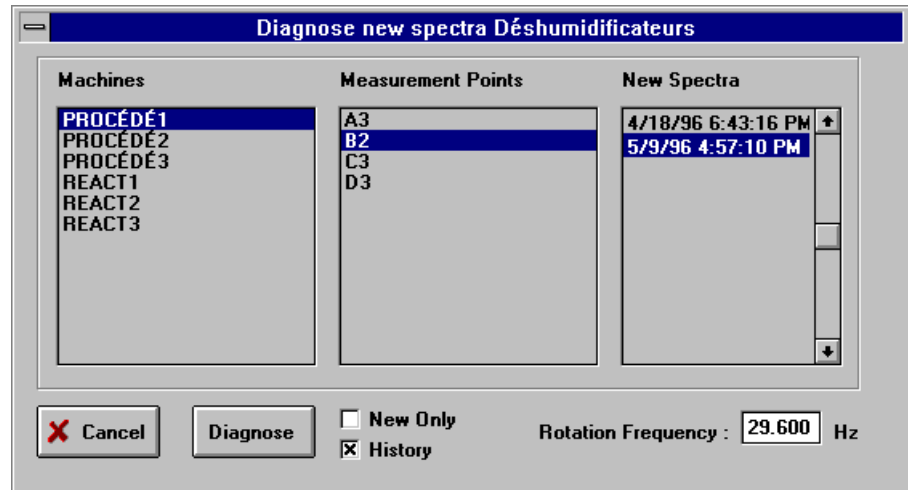


Diagnose

The command is used to diagnose spectra for the selected measurement point and store results of diagnostics in the DREAM database.

By this command the Diagnose New Spectra dialog box is displayed:

Fig.4.32. In the Diagnose New Spectra dialog box you can choose spectrum from the Sentinel database for processing with DREAM



In this dialog box you can choose spectrum from the Sentinel database for processing with DREAM.

It contains three lists: Machine, Measurement point and Spectrum. Dependent on what node you selected in the plant tree you can select the machine measurement point from this machine and corresponding spectra. If you selected a unit you can make choice in all lists, if you had selected a measurement point, the first two lists are disabled. The spectra are listed by the time and date of measurement (the time and date of the leading spectrum are presented).

☐ New Only

Select this option to display only new spectra from the Sentinel database, that have not been processed by DREAM, in the third list. Another way you can process the all spectra stored in the Sentinel database and suitable for DREAM.

☒ History

Select this option to diagnose all previous spectra together with the selected one. This can be valuable to review the defect development from measurement to measurement. In this case much more time may be needed to process all the spectra.

In the Rotation Frequency input box enter the actual rotation frequency during measurements.

At the bottom of the dialog box there are two buttons:

Diagnose

Click this button and the spectrum will be processed automatically and the results of diagnostics displayed in the Detailed Diagnostics dialog box.

Cancel

Click this button to close this dialog box.

When you click the **Diagnose** button the spectrum will be processed:

Fig. 4.33. The Detailed Diagnostic dialog box with a list of defects and recommendations

Defect	Modulation Index	Probability
☐ Revolution around outer race		
☐ Nonuniform radial tension of bearing		
☐ Misalignment of outer race		
☐ Wear of outer race	80 %	(80%)
☐ Cavities on outer race	12 %	(50%)
☐ Wear of inner race		
☐ Cavities on inner race		
☐ Wear of balls or rollers		
☐ Cavities, spalling on rolling elements	14 %	(70%)
☐ Defects on several bearing surfaces		
☐ Slip of race		
☐ Defects of lubrication		
☐ Notidentified changes in vibration	80 %	(0%)

Next Measurement: 10/05/96

Recommendations:

- ☐ Refine the defect type
- ☐ Replace bearing

The dialog box contains three fields: a list of defects, date of the next measurement (prediction of the non failure operation period) and a list of recommendations.

The severity of the defects is represented by a color (green - incipient, yellow - medium, red - severe). Besides, for each defect found the program presents its severity in modulation index and probability for a defect to be of this particular type (in the parentheses).

Each defect or recommendation of the list has a check box. If you check a box corresponding to a recommendation the program will check the boxes near the defects that were the reasons for this very recommendation.

The following buttons are used in this dialog box:



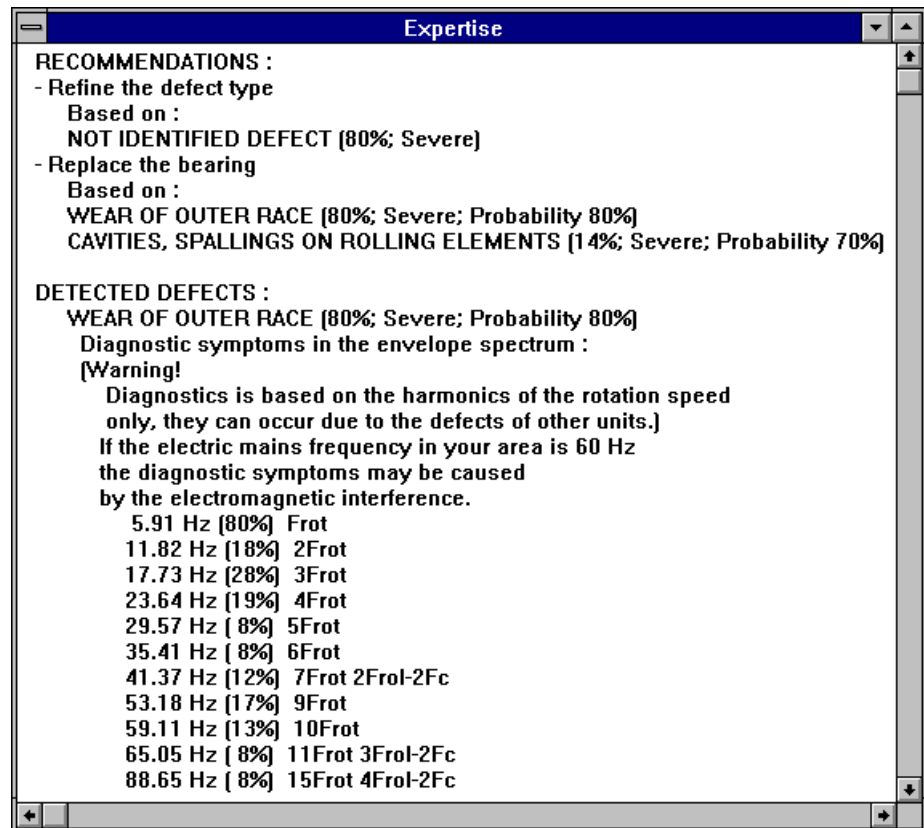
Saves the results of diagnostics in the database and closes Detailed Diagnostics dialog box.



Displays the spectrum with all lines and the defects found. In this mode DREAM can display you the diagnostic symptoms for each defect or recommendation.

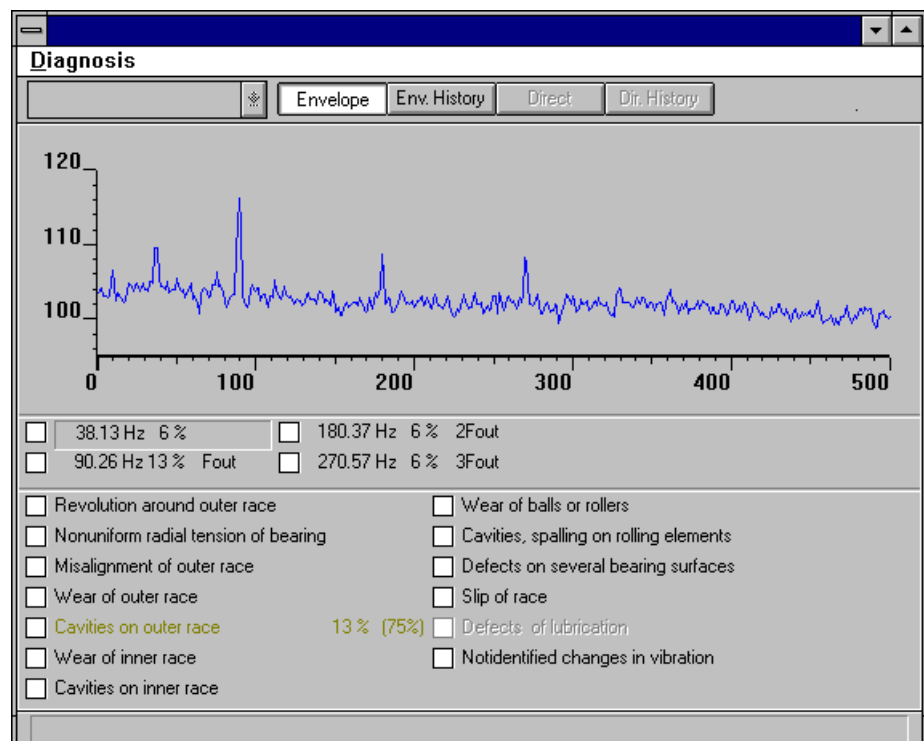
Displays the expertise of the spectrum including all recommendations with reasons for them, all the defects with their reasons, all warnings or comments in the text form.

Fig. 4.34. The Expertise information box



Once you click the **Details** button (before it you can check on the defect or recommendation in which you are interested in the corresponding list) the following window will be displayed:

Fig. 4.35. The Diagnosis dialog box



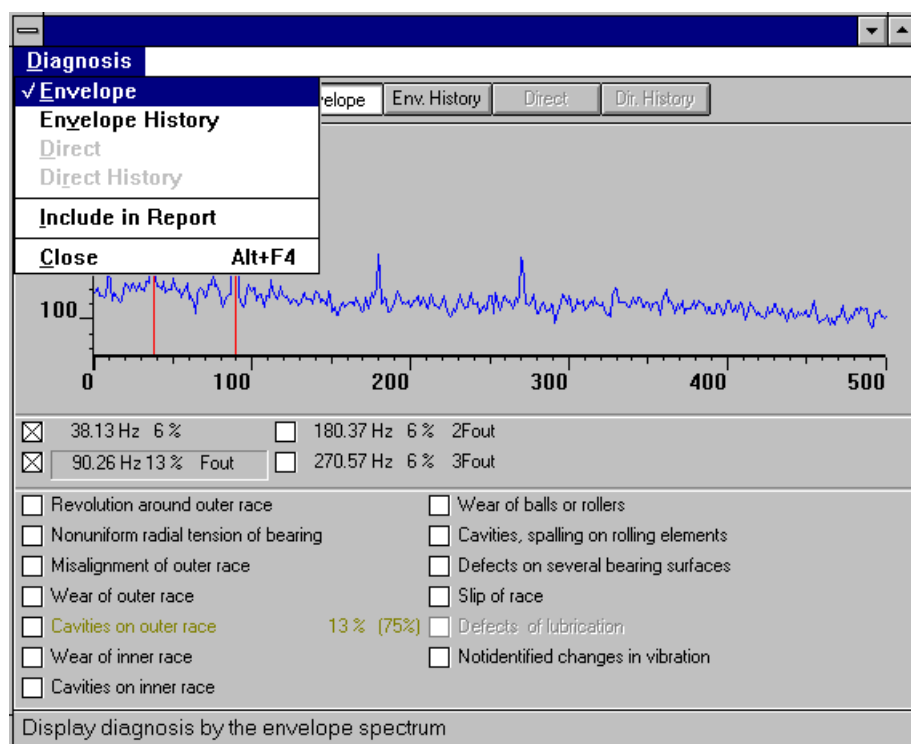
The results of diagnostics are presented in this window together with the spectrum, frequencies and modulation indexes of lines found in the envelope spectrum and their identification.

The Diagnosis dialog box contains three fields. You can change the size of each window by dragging field separators. The first window presented a spectrum. In the second window all lines found in the spectrum are presented and classified by their origin. For example, **Frot** is the rotation speed, **Fout** and **Fin** are the ball passing frequencies on outer and inner races, etc. In the third window you can see all the defects found in the bearing.

When you check on any check boxes for frequencies in the second field, the corresponding lines are marked in the spectrum by red lines.

If you check on the any check box near the defect, you will see reasons of defect diagnosis: in the first window you will see the lines by which the defect had been found, the lines will be marked by red lines; in the second window these lines will be checked on.

Fig. 4.36. The Diagnosis menu with the pop-up line at the bottom of the dialog box



The menu of the Details window contains the following commands:

Envelope Displays diagnosis by the envelope spectrum. This command equals to the **Envelope** button in the speed bar.

- Envelope History** Displays diagnosis by the envelope spectrum history. This command equals to the **Env. History** button in the speed bar. It will be disabled if you measured only one spectrum for this measurement point or checked off the History check box in the Diagnose New Spectra dialog box. The command allows you to display diagnoses for the previous spectra, compare two spectra and see how the defect has developed (do it by clicking the **Envelope** and **Env. History** buttons in turn).
- Direct** Displays diagnosis by the autospectrum. This command equals to the **Direct** button in the speed bar. This command is disabled for the measurement points that do not require autospectra for diagnostics, e.g. for rolling element bearings.
- Direct History** Displays diagnosis by the autospectra history. This command equals to the **Dir. History** button in the speed bar. This command is disabled for the measurement points that do not require autospectra for diagnostics, e.g. for the rolling element bearings.
- Close** Closes this window.

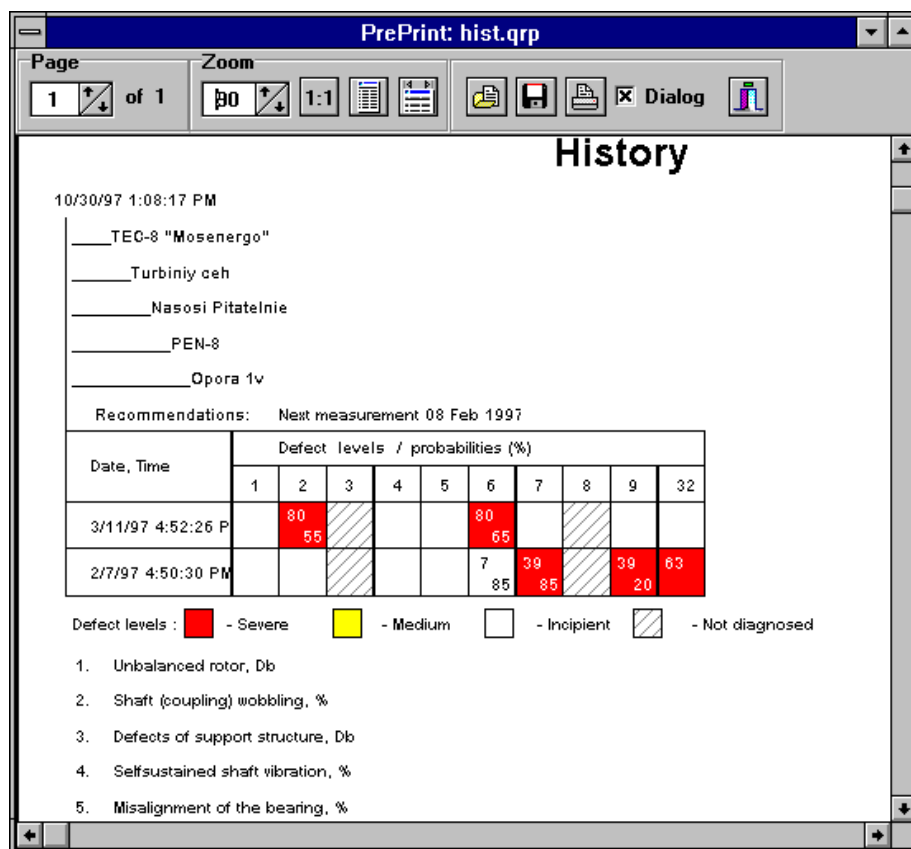
4.5. THE REPORTS MENU

After diagnostics all the results are stored in the DREAM database and can be retrieved in several types of reports:

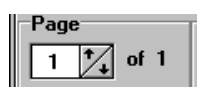
The commands of the Report menu issue reports for the selected node in the plant tree. There are only two exceptions. The first is the List of Bearings (by the *Statistics* command) that is made for all plants and does not depend on the selected node. The second is History that can be made only for a selected measurement point. When you select a node and issue a report all measurement points that are below this node in the tree hierarchy are included in the report.

Each report is shown with a special PrePrint program. The number of the report open is limited only by the resources of your computer.

Fig. 4.37. A PrePrint window with a History report for a measurement point.



The following controls are used in this window:



The Page input box to set the page number for display. You can use arrows to scroll through a report.

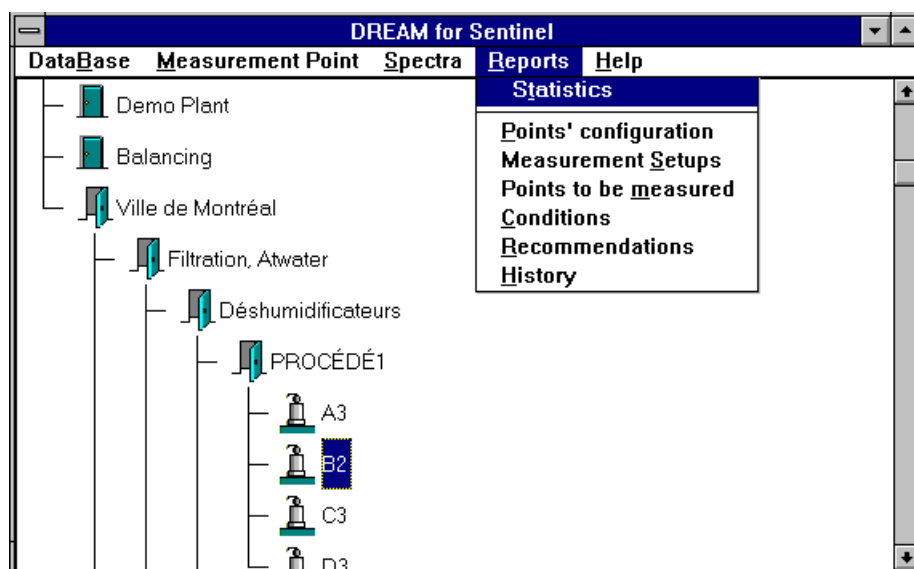


The Zoom input box is used to setup displaying. You can use the arrows advance this control. By the arrows you can change zooming in 10% intervals.

-  Click this button to set zoom to 100%.
-  Click this button to fit the whole page in the window.
-  Scales the editing view to see the width of the page.
-  The **Load** button is used to open your previously saved report to view or print it. The standard extension for the report files is QRP. The program normally saves only one last report of each kind on disk.
-  The **Save** button is used to save a report on disk. The standard extension for the report files is QRP. The program normally saves only one last report of each kind on disk, so to be able to open and print reports later you have to save them manually.
-  Click this button to print a report on the default printer.
-  When this check box is checked on, the Print dialog box is displayed before setting the report to printer. In this dialog box you can setup your printer, set the print range, the number of copies, etc.
-  The **Exit** button is used to close this window.

To issue a report, choose a node in the plant tree and use the corresponding command from the Reports menu.

Fig. 4.38. The Reports menu

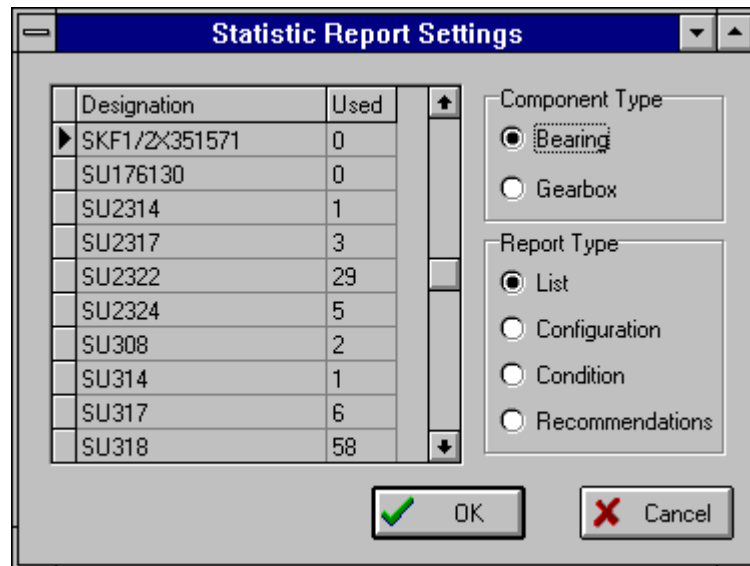


4.5.1. THE STATISTICS COMMAND

Besides the reports on the selected node you can get the statistics reports on the selected bearing designation or gearbox type. They are List (of Types), Measurement Points, Conditions, Recommendations.

To issue a statistic report, select the *Statistics* command from the Report menu. It calls the Statistic Report Settings dialog box.

Fig. 4.39. The dialog to choose a bearing designation or gearbox type for reporting



By this dialog box you can choose the component type (bearing or gearbox) on which you want to issue a report, and type of report as well.

You can see in this dialog box the list of the bearings (gearboxes) configured in the database, and how many times they are used in measurement points configuration. It can be useful, for example, if you want to know whether you need the bearing of this type. Or, if you configured an improper bearing, and that caused wrong diagnostics, you need to know in which points it is used, delete the data and re-configure these points. Only then you can delete the improper bearing.

Note: When to find points with the improper configured bearing, you use the Measurement Configuration report, select the highest level. Only then you find all the similar points. In another way you can get program message "The report is empty".

To issue a statistics report:

1. Select a component type (bearing or gearbox).
2. Select from the list a bearing/gearbox the type you are interested in.

3. Select a type of the statistic report.

Confirm your choice by the **OK** button or escape this dialog by the **Cancel** button.

The report will be issued on the selected bearing designation or gearbox type. The form of the statistic reports (Measurement Points, Conditions, Recommendations) is the same as the non-statistic's ones that are described below.

The List of Bearings you can get only by the Statistics command. It is independent report: its contents are not depend on your selections. It tells about all the plant tree's bearings.

The report contains the designations of all the bearings which had been configured in the program:

Fig. 4.40. The List of Bearings report.

10/10/96 12:40:40 PM

Designations	Din (mm)	Dout (mm)	Drol (mm)	Angle (deg)	Nrol	dNrol
Many Balls	200.00	220.00	5.00	0.00	100	0
SKF1/2X351571	380.00	810.00	90.00	90.00	15	0
SKF1201	12.00	32.00	4.76	12.70	10	0
SKF29422E	110.00	230.00	32.30	52.90	14	0
SKF6021	105.00	160.00	16.70	0.00	15	0
SKF6030	150.00	225.00	22.20	0.00	16	0
SKF6203	17.00	40.00	6.80	0.00	8	1
skf6206	30.00	62.00	9.50	0.00	9	0
SKF6207	35.00	72.00	11.10	0.00	9	1
SKF6208	40.00	80.00	12.30	0.00	9	0
SKF6309	45.00	100.00	17.50	0.00	8	0
SKF6322	110.00	240.00	41.30	0.00	8	0
SKFYAR2091112F	48.80	81.15	12.30	0.00	10	0

This report presents all designations and specifications of the bearings included in the bearing database. These are the bearings that you have on your plant in any measurement points.

The report can be issued for any selected node of the plant tree in the same form.

Here are:

Din - diameter of the inner race (or the inner raceway).

Dout - diameter of the outer race (or the outer raceway, if **Din** was the diameter of the inner raceway).

Angle - contact angle in degrees between the rolling elements and the race.

Drol - diameter of rolling elements.

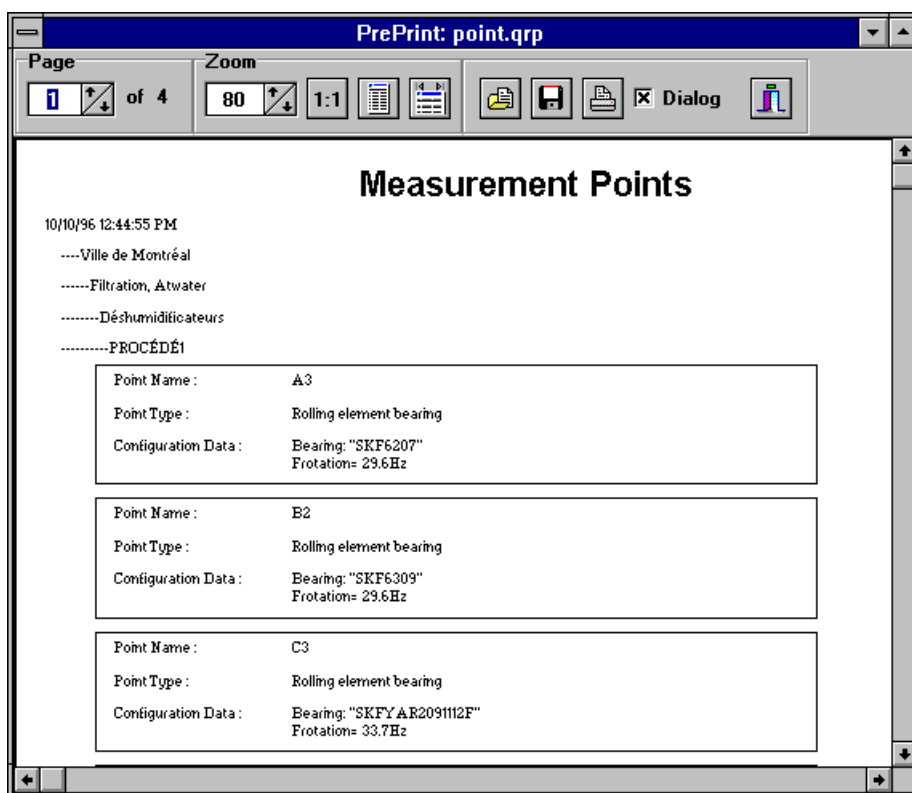
Nrol - number of rolling elements in the bearing.

dNrol - acceptable variations in the number of rolling elements set by the operator. During the analysis of the envelope spectrum the program will correct the number of rolling elements in the limits $Nrol + dNrol$ if there is a mistake in the input data. If the variations in the number of rolling elements exceed $+dNrol$ the program is not able to identify the type of defect.

4.5.2. POINTS' CONFIGURATION

This command displays the Measurement Points report:

Fig. 4.41. The Measurement Points report.

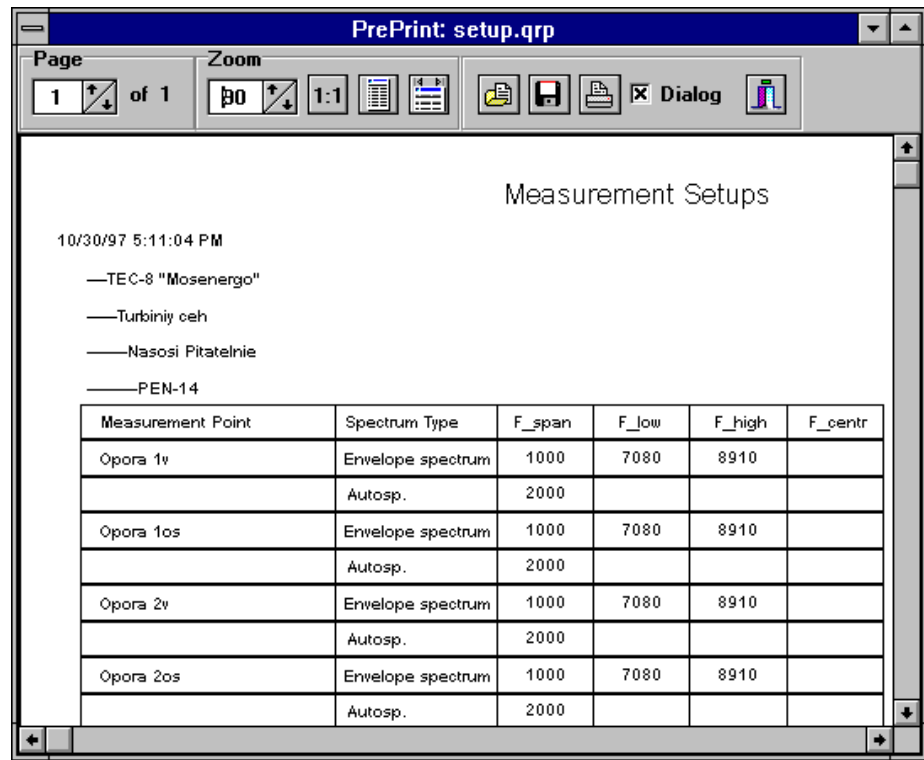


The report contains information on the type of measurement points configured in the DREAM database, the designation of the installed bearings, the rotation speed.

4.5.3. MEASUREMENT SETUPS

This command displays the Measurement Setups report:

Fig. 4.42. The Measurement Setups report.



The report contains information on the type and setups of measurements required by DREAM for the diagnostics of all measurement points. These setups depend on the type of the unit to be diagnosed, the parameters of the unit and the rotation speed.

Here are:

Measurement Point contains the name of the measurement point.

Measurement Type may be either Envelope or Auto- spectrum.

F_span is the Frequency Span to be set in the Sentinel measurement setup. It is the span of the analysis.

F_low is the Lower Frequency to be set in the Sentinel measurement setup for the envelope spectra.

F_high is the Upper Frequency to be set in the Sentinel measurement setup for the envelope spectra.

F_centr is the Center Frequency to be set in the Sentinel measurement setup for the zoomed autospectra.

F_low and F_high form the bandpass filter for envelope detector.

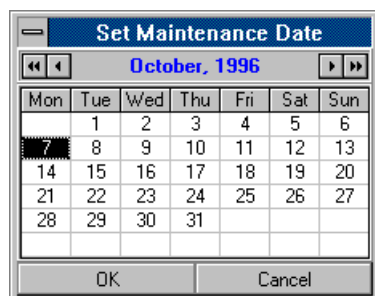
The report is used to look at the measurement parameters, required for DREAM diagnostics, you need to set up in the Sentinel.

4.5.4. POINTS TO BE MEASURED

By this command DREAM will automatically check the diagnosed conditions of your equipment and include in the list only the measurement points for which the condition prediction is expired by the stated day.

This command displays the Select Measurement Date dialog box:

Fig. 4.43. Select Measurement Date dialog box:



In this dialog box you can select a date for which the report will be issued.

To select a date within current month just click it with the left mouse button. To change a month and a year use the following controls:

- » advances one year.
- » Advances one month.
- « Goes one month backward.
- « Goes one year backward.
- OK Applies changes and close this dialog box.
- Cancel Disables changes and close this dialog box.

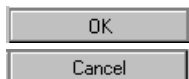


Fig. 4.44. The Points To Be Measured report

PrePrint: meas.qrp

Page 1 of 1 Zoom 90 1:1

Points to be measured by 10 Oct 1996

10/10/96 2:59:39 PM

----Ville de Montréal

-----Filtration, Atwater

-----Déshumidificateurs

-----PROCÉDÉ1

Measurement Point	Meas. Date	Meas. Type	F_s	F_low	F_high
A3	10 May 1996	ES	500	7080	8910
B2	28 Jun 1996	ES	500	7080	8910
C3	17 Aug 1996	ES	500	7080	8910
D3	Not determined	ES	500	7080	8910

In the Meas. Date column you can see the expiry date of the condition prediction. If this point have not been measured previously a Not determined note will be presented in this column.

It is very important report that is used to plan measurements. All configured in DREAM measurement points that have not been measured or condition of which should be refined by a certain date are included in the list together with the measurement setup for each point.

4.5.5. CONDITIONS

This command displays the Measurement Point Conditions report:

Fig. 4.45. The Measurement Point Conditions report:

10/10/96 3:16:21 PM
 ----Ville de Montréal
 -----Filtration, Atwater
 -----Déshumidificateurs
 -----PROCÉDÉ1

Point	Last measurement	Next measurement	Max. defect level	Recommendation
A3	5/9/96 4:55:22 PM	10 May 1996	22 %, Severe	
B2	5/9/96 4:57:10 PM	28 Jun 1996	13 %, Medium	
C3	5/9/96 4:59:26 PM	17 Aug 1996	7 %, Incipient	

-----REACT1

Point	Last measurement	Next measurement	Max. defect level	Recommendation
A3	5/9/96 5:04:44 PM	28 Jun 1996	15 %, Medium	
B3	5/9/96 5:07:22 PM	10 May 1996	41 %, Severe	7

Recommendations :
 7 - Replace bearing

This report presents the information about the condition of your equipment. It is the information when were done the measurements last time for each measurement point, when should be measured it next time, on the maximum defect level found in the equipment, and lists the recommendations for corrective actions to be done.

4.5.6. RECOMMENDATIONS

The command displays the Select Recommendations dialog box.

Fig. 4.46. The Select Recommendations dialog box.



As a default all recommendations are selected (each contains an asterisk in the first column). To deselect a recommendation click with a mouse on the asterisk. To select it again repeat this action. So, you can select the needed recommendations.

Select the desired recommendations and click the OK button. The Measurement Point Recommendations report will be displayed.

Fig. 4.47. The Measurement Point Recommendations report.

10/10/96 4:31:50 PM

-----Ville de Montréal

-----Filtration, Atwater

-----Déshumidificateurs

-----REACT1

Point	Last measurement	Next measurement	Max. defect level	Recommendations
B3	5/9/96 5:07:22 PM	10 May 1996	41 %, Severe	?

-----GMP Baseline Precision

-----W1

Point	Last measurement	Next measurement	Max. defect level	Recommendations
A3	5/9/96 5:17:42 PM	10 May 1996	80 %, Severe	1 ?
A3+	5/9/96 5:19:48 PM	10 May 1996	80 %, Severe	1 ?
B3	5/9/96 5:22:46 PM	10 May 1996	80 %, Severe	?

-----W4

Point	Last measurement	Next measurement	Max. defect level	Recommendations
A3	5/9/96 5:36:28 PM	10 May 1996	46 Db, Severe	1
B3	5/9/96 5:40:58 PM	10 May 1996	80 %, Severe	?

Selected recommendations :

1 - Refine the defect type

7 - Replace bearing

This report is a subset of the Measurement Points' Conditions report in which there are included only the measurement points that have some recommendations. Possible recommendations are:

Refine the defect type - it means that a defect is found but the type of it can not be determined, actually it

may be not the defect of a bearing, for example, but an interference from other units;

Check the lubrication quality - the defect of lubrication was detected that usually results in the increase of the high frequency vibration level.

Replace the bearing - dangerous combination of defects occur. This recommendation is given when the system considers that in the next 1% of MTBF 10% of the bearings in such a condition may fail.

Correct misalignment - it means that the mounting defect of the bearing was found - the misalignment of inner and outer races. This is not a very dangerous defect that leads to the immediate failure of the bearing, but it significantly decreases the service life of the bearing.

Correct nonuniform radial tension - it means that the mounting defect of the bearing was found - the nonuniform clearances. This is not a very dangerous defect that normally does not lead to immediate failure of the bearing, but it may significantly decrease the service life of the bearing.

The recommendations are included in the report in the form of numbers. Their meaning is described at the bottom of the report.

If there are no recommendations, then a message appears:

Fig 4.48. The Error information box.

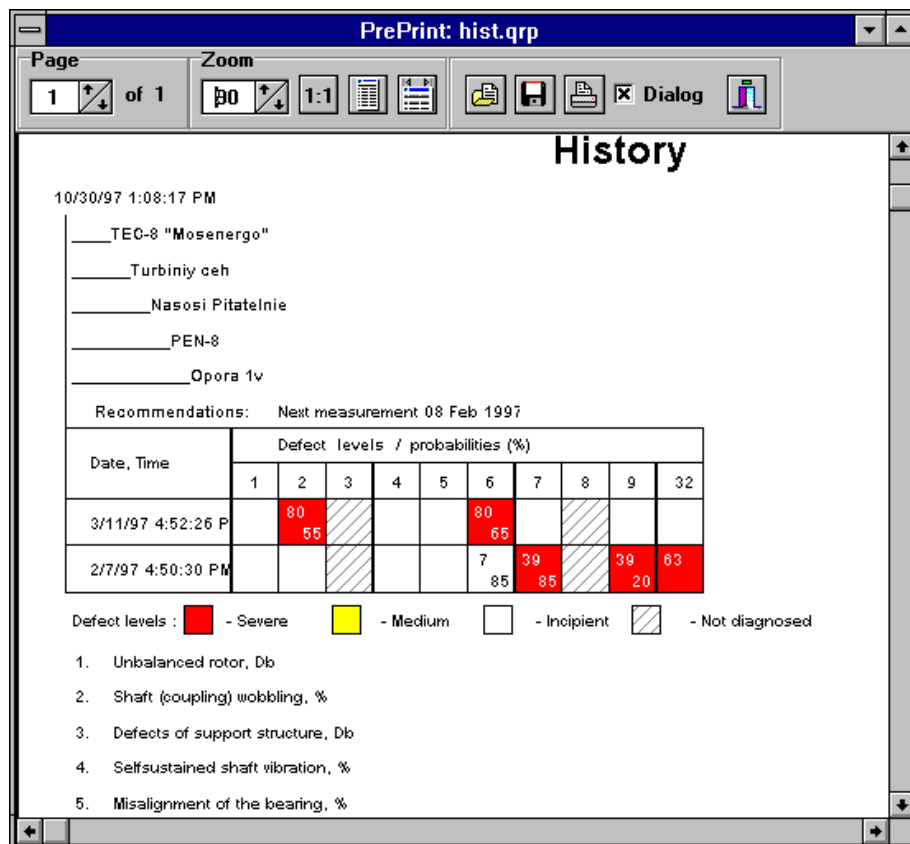


4.5.7. HISTORY

This command displays the History report.

This report contains information about all measurements and the results of diagnostics that were made for this measurement point.

Fig. 4.49
The History report.



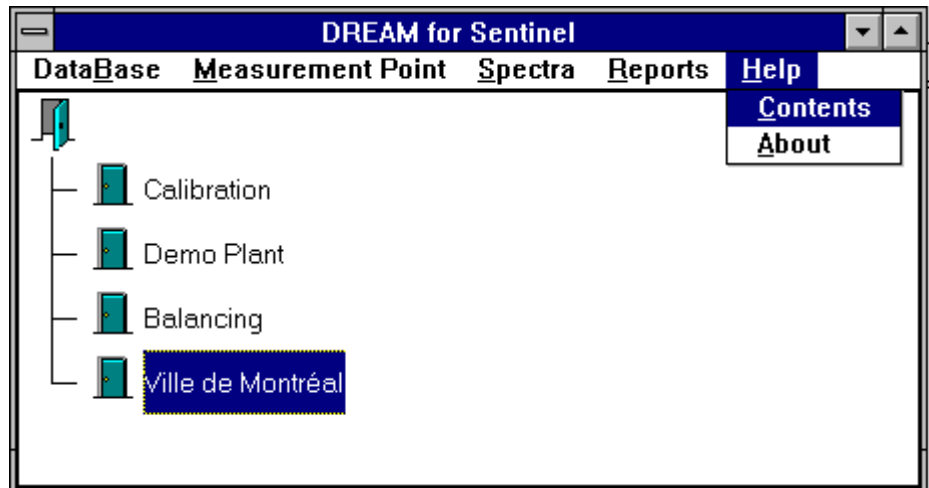
The defect severity is presented in the percentage of modulation (figures) and three degrees of severity: severe, medium, incipient (letters) and marked by different colors.

It contains also the list of enumerated defects that depend on the measurement point type.

4.6. THE HELP MENU

This menu enable you to display the information about application's features by means of the standard Windows Help.

Fig. 4.50
The Help menu



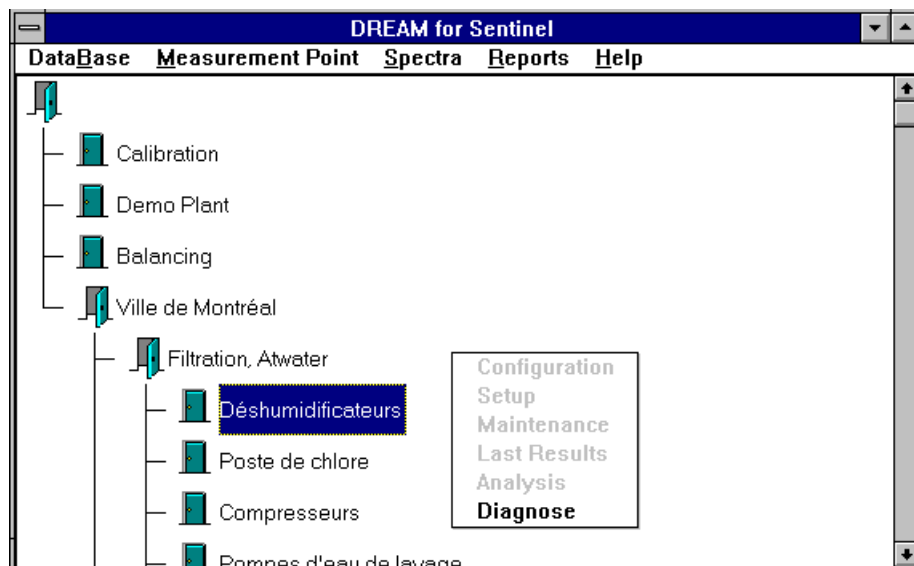
This menu contains two command:

- | | |
|-----------------|--|
| Contents | Starts the Help system and displays the Help table of contents. |
| About | When you choose the About command, the dialog box appears with copyright and version information. |

4.7. FLOATING MENU

In the DREAM main window you can access the additional menu which contains the main commands needed for operation. It is called by the *right* mouse button.

Fig. 4.51
The DREAM main window with the additional menu which supplies you the main commands



The floating menu is the most convenient way to work with the plant tree.

This menu contains commands from other two menus: Measurement Point and Spectra.

The commands from this menu are applied to the selected node in the plant tree.

Select the desired node with the left mouse button and press the right mouse button anywhere on the desk top.

APPENDIX 1. THE FILES OF THE DREAM FOR SENTINEL SOFTWARE

The following files are located on the Sentinel directory

dream_fs.exe The main executable of DREAM for Sentinel
preprint.exe Report Preview main executable

Additional modules required by DREAM for Sentinel

<i>com16.dll</i>	<i>bc453rtl.dll</i>
<i>bids47.dll</i>	<i>plot.exe</i>
<i>edd.dll</i>	<i>plotlib.dll</i>
<i>oriondb.dll</i>	<i>owl253.dll</i>
<i>rdm330.dll</i>	<i>dream.hlp</i>
<i>detaildl.dll</i>	

Files located in the DLL subdirectory

omdllrdm.dll library required by DREAM for Sentinel

Database of DREAM for Sentinel is located in the DREAMDB subdirectory and consists of the following files

<i>bearns.db</i>	<i>mpoints.db</i>	<i>rtyp_10.val</i>
<i>bearns.px</i>	<i>mpoints.mb</i>	<i>rtyp_10.x02</i>
<i>bearns.val</i>	<i>mpoints.px</i>	<i>rtyp_10.y02</i>
<i>bearns.x02</i>	<i>mpoints.val</i>	<i>rtyp_4.db</i>
<i>bearns.y02</i>	<i>mpoints.x03</i>	<i>rtyp_4.px</i>
<i>defects.db</i>	<i>mpoints.x04</i>	<i>rtyp_4.val</i>
<i>defects.px</i>	<i>mpoints.y03</i>	<i>rtyp_4.x02</i>
<i>defects.val</i>	<i>mpoints.y04</i>	<i>rtyp_4.y02</i>
<i>defects.x05</i>	<i>mptypes.db</i>	<i>rtyp_6.db</i>
<i>defects.y05</i>	<i>mptypes.mb</i>	<i>rtyp_6.px</i>
<i>dirparam.db</i>	<i>mptypes.px</i>	<i>rtyp_6.val</i>
<i>dirparam.px</i>	<i>mptypes.val</i>	<i>rtyp_6.x02</i>
<i>dirparam.val</i>	<i>mptypes.x06</i>	<i>rtyp_6.x03</i>
<i>elmach.db</i>	<i>mptypes.xg0</i>	<i>rtyp_6.y02</i>
<i>elmach.px</i>	<i>mptypes.y06</i>	<i>rtyp_6.y03</i>
<i>elmach.val</i>	<i>mptypes.yg0</i>	<i>spectra.db</i>
<i>elmach.x02</i>	<i>otree.db</i>	<i>spectra.mb</i>
<i>elmach.y02</i>	<i>otree.px</i>	<i>spectra.px</i>
<i>envparam.db</i>	<i>results.db</i>	<i>spectra.val</i>
<i>envparam.px</i>	<i>results.mb</i>	<i>strings.db</i>
<i>envparam.val</i>	<i>results.px</i>	<i>strings.px</i>
<i>gearbox.db</i>	<i>results.val</i>	<i>strings.val</i>
<i>gearbox.px</i>	<i>roll.db</i>	<i>turbin.db</i>
<i>gearbox.val</i>	<i>roll.px</i>	<i>turbin.px</i>
<i>gearbox.x02</i>	<i>rtyp_10.db</i>	<i>turbin.val</i>
<i>gearbox.y02</i>	<i>rtyp_10.px</i>	

GLOSSARY

Angle The contact angle in degrees between the rolling elements and the race.

Data Variations (DV) During machine operation some variations can appear in process parameters, for example, in rotation frequency (fr). There can also be some mistakes in data, such as in the number of rolling elements (Nrol) or in the dimensions of bearing elements.

Defect Level The danger of a defect depends on the stage of its development.

Each defect, according to the stage of its development, can be considered as an **incipient**, a **medium** or **severe** defect.

The **incipient level** means that the defect is detected and identified, but in normal operating conditions it cannot lead to a failure in a predictable period, which is considered to be about 20% of its specified service life.

The **severe level** means that the defect is in such a state of development that there is no possibility to ensure its work for a long period without failure. The bearing must be either replaced or, if its operation is prolonged, the period between measurements must be reduced to 1 - 5% of its specified service life. Under these conditions, the operation of the bearing can be prolonged up to the moment of appearance of an automatic indication on danger to fail.

Defect type

The following types of defects are identified for the rolling element bearing:

1. Revolution around outer race
2. Nonuniform radial tension of bearing
3. Misalignment of outer race
4. Wear of outer race
5. Cavities on outer race
6. Wear of inner race
7. Cavities on inner race
8. Wear of balls, rollers or cage
9. Cavities, spillings on balls and rollers
10. Complex defect (on two or more roll surfaces)
11. Slip of race
12. Defects of lubrication

Each type of defect is rated into four levels, according to the stage of its development:

1. No defects
2. Incipient defect
3. Medium defect
4. Severe defect.

The exceptions are made for defect types such as “Revolution around outer race” and “Slip of race”, which are united into one group. “Defects of lubrication” is divided into two levels - medium and severe.

The program generates an automatic indication of failure danger only after setting up the levels for severe defects. The levels are set up for each type of defect by the customer himself according to the recommendations in the software instructions and the experience in the program operation.

Revolution around the outer race

The revolution around the outer race is characterized by appearance of dynamic forces applied to the outer race by the rotor or shaft. These forces revolve around the outer race synchronously with the rotor or shaft rotation. So, it is not a defect of the bearing itself, but, in many mechanisms, the forces increase in the bearing, which decrease its service life. Such a situation is abnormal and it should be identified during diagnostics. The revolution can be a result of rotor imbalance, misalignment of half-coupling, connecting the rotors of different machines, self-excited rotor oscillations and so on.

Nonuniform radial tension of bearing

Nonuniform radial tension is the bearing's state when the radial load on the friction surface is significantly dependent on the angle of the inner (rotating) race position. It is the bearing unit's defect which influences its service life. It can, for example, lead to seizure of the bearing, slip of the races in the housing and even the cage or race breaks.

Usually, such a state is caused by the defects in a bearing's housing production or high axial loads and is detected during quality control after housing production, maintenance of the machine or in the beginning of machine operation.

Misalignment of the outer race

The misalignment of the outer race is the bearing's state when the maximum load applied to the races is concentrated in two

opposite points of the outer race. It is a result of a maintenance defect of the bearing unit and can lead to rapid wear of races in the points of the maximum load. The situation is detected during quality control of the bearing unit (the replacement of the bearing) or in the beginning of the machine operation.

Wear of the outer race

This bearing defect appears during machine operation and results in pitting of a part of the outer race. When the rolling elements roll through this wear zones the friction coefficient increases but the shock pulses do not occur on the outer race. This defect, as a rule, appears as one of the first in the bearings with a fixed outer race and develops relatively slowly.

Cavities on the outer race

This bearing defect is the result of the race wear, the appearance of cracks, the impact loads during maintenance, transportation and so on. It is characterized by the appearance of shock pulses from the rolling elements impacts on the outer race in the defect zone and by the quick development of the defect level. The defect can appear in any stage of bearing operation and significantly decreases its service life.

Wear of the inner race

This bearing defect appears during machine operation resulting in pitting of a part of the inner race. When the rolling elements roll through this wear zones, the friction coefficient increases but the shock pulses do not occur on the inner race. The defect develops relatively slowly.

Cavities on the inner race

This bearing defect is the result of the race wear, the appearance of cracks, the impact loads during maintenance, transportation and so on. It is characterized by the appearance of shock pulses from the rolling elements impacts on the inner race in the defect zone and by the quick development of the defect level. The defect can appear in any stage of bearing operation and significantly decreases its service life.

Wear of balls, rollers or cage

This bearing defect appears during machine operation resulting in pitting of a part of one or a group of rolling elements. It is characterized by a periodic increase in the friction coefficient during cage rotation reaching maximum when the maximum load is applied to the defective element.

Cavities, spallings on balls and rollers

This bearing defect is the result of wear or shock impacts on rolling elements. There is a possibility of the appearance of this defect as a result of rolling elements production - facing. It is characterized by the appearance of rolling elements' impacts on races. The defect leads to rapid wear of rolling element surfaces and the cage, which results in a significant decrease of service life.

Complex defect (on two or more roll surfaces)

This bearing defect consists of two or more defects of different roll surfaces. It appears in the final development stage of the single surface defects and represents a danger for future operation because of the possible appearance of dynamic loads applied to the cage. This can lead to cage break.

Slip of race

This bearing defect is the result of slackening one of the race fit in the mounting seat. The defect can appear in any stage of machine mounting and operation. The bearing's operation with such a defect is undesirable. Such a bearing must be replaced as soon as possible.

Defects of the lubrication

This bearing defect is characterized by an increase in the friction forces with the absence of any other types of developed defects. The defect can be a result of the lack or excess of lubrication in the bearing, destruction of lubrication structure or impurities in lubrication. The defect can appear in any stage of a bearing's operation and significantly decreases its service life. The defect must be corrected as soon as possible.

Designation A name under which the bearings are listed in the manufacturer's specification documents, where all the technical data of the bearings are given. The program has only one file with such data and takes all its specification data from this file. You do not need to put in these data every time you describe the bearing - the program will take these data by itself from the database. There is a designation library in the program that contains almost all the Soviet-made bearings and the designations of the bearings of the most common western manufacturers.

Din The diameter of the bearing's inner race or inner raceway. In the latter case, **Dout** must be the diameter of the outer raceway.

dNrol The acceptable variations in the number of rolling elements set by the operator. During the analysis of the envelope spectrum the program will correct the number of rolling elements in the limits $\pm dNrol$ if there is a mistake in the input data. If the variations in the number of rolling elements exceed $\pm dNrol$, the program will not be able to identify the type of defect.

Dout The diameter of the bearing's outer race or outer raceway. In the latter case **Din** must be the diameter of the inner raceway.

Drol The diameter of the bearing's rolling elements.

Failure Danger The bearing failure danger indication is generated when a slip of the race in the housing, or a severe defect of lubrication, a severe wear of balls, rollers or cage, or two and more severe defects of different roll surfaces appear.

Fin The ball-passing frequency inner race.

F_high The high cut off frequency of the band pass filter of the envelope detector that should be set in the Sentinel software for each measurement according to the recommendations of the DREAM software.

F_low The lower cut off frequency of the band pass filter of the envelope detector that should be set in the Sentinel software for each measurement according to the recommendations of the DREAM software.

Fr The rotation speed of the bearing (the shaft).

Fout The ball-passing frequency outer race.

Frol The rotation frequency of the rolling elements.

Frot (Hz) The rotation speed of the bearing.

Fs Full Frequency Scale frequency that should be set for each measurement in the Sentinel software according to the recommendations of the program.

History A report file where all diagnostics results are presented. The recommendations are given as a result of the last diagnostic measurement. The file is printed on the screen and you can browse it in the file viewer.

Max The maximum value of variations in the input data for **Frot** (%) with which the program will still identify the defect type, but will give a **Warning signal** to the operator.

Not identified defect (unidentified defect) A defect that differs from the 12 types that the program can identify. In this case the program will give only its depth and the recommendation to replace the bearing.

The operator can

1. Check whether the processed spectrum belongs to the chosen measurement point
2. Check the data in the measurement point
3. Check the data in the bearing's designation
4. Make a new measurement.

Nrol The number of rolling elements in the bearing.

Service life The period in months during which the bearing is intended to work without replacement (mean time before failure).