Lungtest System

LUNGTEST

Manual

Ergospirometer START 2000

Version 22.7.13.1

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CE 1011

EN ISO 13485:2016

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Contents:

Illustration list:

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1. Introduction.

Start 2000 ergospirometer is a stationary module system for effort examination of the respiratory and circulatory systems which enables a comprehensive analysis of the conducted measurements. *Start 2000* measuring system was constructed on the basis of the pneumotachographic head patented by MES and fast analysers of carbon dioxide and oxygen which enable the measurements with the 'breath-by-breath' method and the analysis of every breathing-out stage. The system may be optionally equipped with the stirring compartment.
Thanks to the modern pneumotachographic head the measuring system does not require the inhalation-exhalation valve or other connections of the corrugated pipe type. It ensures full comfort during the test because the person examined breathes in natural conditions without the additional resistance for the air flow. In accordance with the ERS/ATS guidelines, the inbuilt spirometric examination module with unique software that provides the reliability control of the conducted examination ensures determining the FEV1, MEF 50, VC values on the basis of which the norm values of HR, VO2, VE measured in an effort examination are determined automatically.
Start 2000 enables to constantly register in time the following signals: breath volume, breath flow, O_2 and CO_2 in the exhaled gas, 1-12 ECG leads. The system always records the full course of examination so that it would be possible to re-create every exhalation. The manner of presentation of the course and the printout of the course of the measured changes and calculated values is defined by the operator.

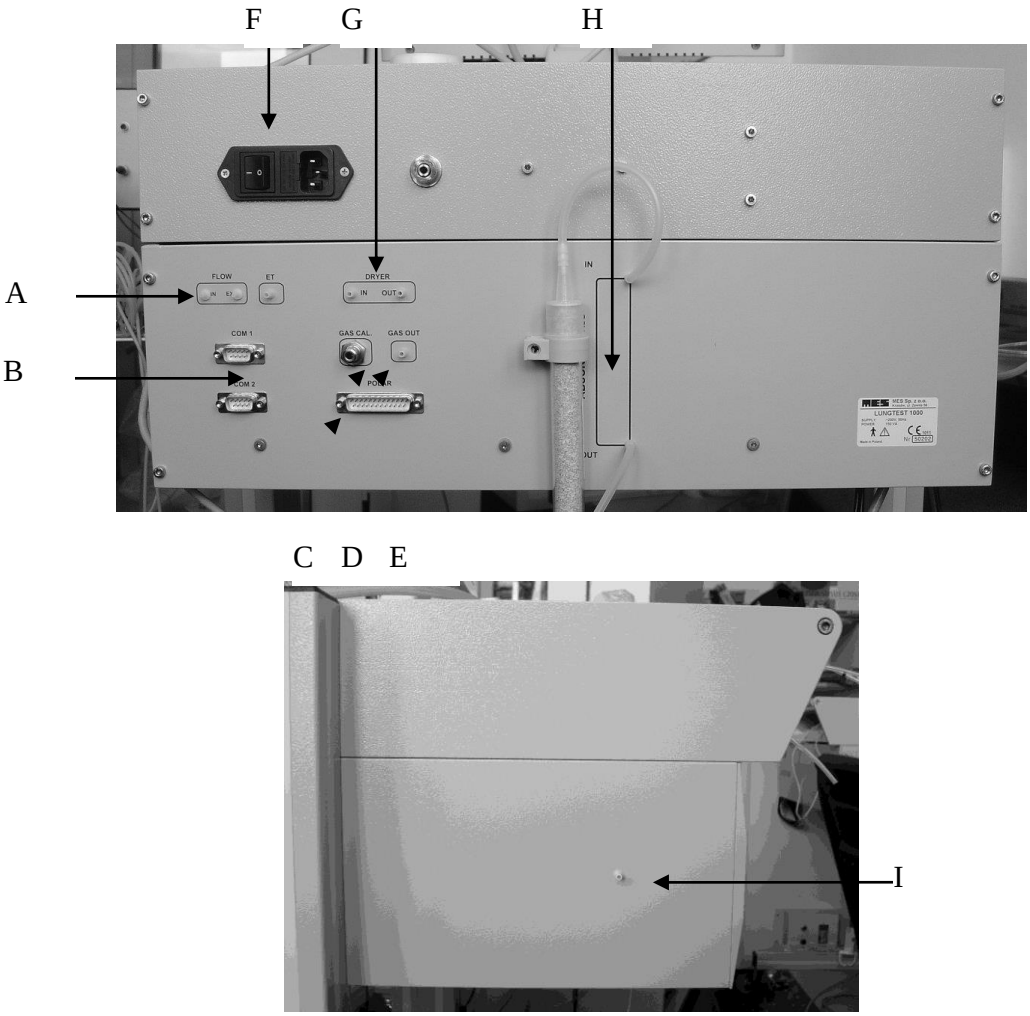
Advantages of the *Start 2000* system:

- examination with the breath-by-breath method
- light, low-resistance pneumotachographic head without moving elements
- automatic system of measuring the environment conditions
- automatic system of calibration of gas analysers
- alternative way of measuring the pulse with the wireless system or with 12 ECG leads
- automatic or manual determination of the anaerobic threshold
- possibility of VO2max calculation
- presentation of the measured items on the background norm values
- automatic steering of the moving tracks or bicycle ergometers
- possibility of editing the printout form of the examination report
- possibility of examination report transfer to the standard statistical programmes
- software compatible with Microsoft Windows
- easy transport of the system installed on a trolley
- possibility of measuring system expansion with additional options: pulsoxymetry, minute heart projection with the non-invasive method, systolic and diastolic pressure measurements.

The *Start 2000* system consists of the following elements:

1. *Start 2000* Ergospirometer (⇨ Ill. 1).
2. Pneumotachographic head.
3. Mouthpiece for the pneumotachographic head.
4. Ergospirometric mask with a cap.
5. Cylinder with calibration gas.
6. Pressure reducer.
7. Cylinder–Ergospirometer cable.
8. Cylinder rack.
9. PC computer with Windows operating system.
10. Monitor.

11. Printer.
12. Keyboard.
13. Mouse.
14. Pulse sensor of the *POLAR* type.
15. Pneumotachographic head connection cable.
16. CD-ROM with the *Start 2000* programme.



Ill. 1. *Start2000* Ergospirometer. Its view from the left and back side.

Start 2000 Ergospirometer is equipped with the following ports and elements:

1. COM 1 and COM 2 ports (⇨ Ill. 1, B), DB9 type to connect with the moving track and bicycle ergometer.
2. Mains port (⇨ Ill. 1, F) to connect power supply of 230-240V,50Hz
3. Two connection terminals: FLOW IN and FLOW EX (⇨ Ill. 1, A) for the air cables, to connect the cables from the penumotachographic head connector.
4. ET connection terminal (⇨ Ill. 1, A) for the silicone air cable to connect the gas pipe from the pneumotachographic head connector.
5. GAS CAL. connection terminal (⇨ Ill. 1, D) to connect the cylinder or bag with calibration gas.
6. GAS OUT connection terminal (⇨ Ill. 1, E) – outlet to the atmosphere.
7. IN/ OUT connection terminals (⇨ Ill. 1, H) to connect the dryer.
8. Connection terminal on the left side of device(⇨ Ill. 1, I) – outlet for calibration gas.
9. DRYER IN/ OUT connection terminals to suck in and dispose of the air to be dried.
10. Mains switch to turn on and off the device (⇨ Ill. 1, F).

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The FLOW EX connection terminal. One should there connect the cable from the pneumotachographic head marked with a black ring. One should connect the other cable to the *IN* connection terminal.

The ET connection terminal is dedicated to connect the gas cable marked with a blue ring. The GAS *EX* should be left open (outlet to the atmosphere).

During the gas calibration the GAS CAL connection terminal (quick connector) should be connected to the reducer of the sample gas cylinder.

Connection terminal on the left side of the device is used during the gas calibration (⇨ Chapter 5.2.2). During calibration one should connect the silicone cable from the pneumotachographic head connector to the connection terminal.

The *Start 2000* programme that cooperates with *Start 2000* ergospirometer enables to conduct the spirometric examination. The programme interface is presented in Ill. 2. The programme allows for determining the following parameters:

BF [1/min] ⇒ breathing frequency;
HR [1/min] ⇒ heart rate per minute;
MET = VO2/kg/3,5 ⇒ metabolism unit (1MET=3.5ml/min/kg);
VE [litre/min] ⇒ minute ventilation – air volume that the patient's lungs ventilated during 1 minute. The parameter is calculated as the product of the number of breaths (BF) multiplied by the volume of a single breath (TV) measured during the exhalation. BTPS conditions.

RER = VCO2/VO2 ⇒ respiratory equivalent;
TE [s] ⇒ exhalation time;
TI [s] ⇒ inhalation time;
TTOT [s] ⇒ total time of respiratory cycle;
TV(VT) [litr] ⇒ volume of a single breath;
VO2 [litr/min] ⇒ oxygen consumption in relation to the STPD conditions;
VCO2 [litr/min] ⇒ carbon dioxide exhalation in relation to the STPD conditions;
FeO2 [%] ⇒ average value of oxygen accumulation in the breathed-out air (value calculated like FeCO2);
FeCO2 [%] ⇒ average value of carbon dioxide accumulation in the breathed-out air. The value is calculated for every breath; in case of average determination for a given period of time, it is counted as a mean value of all the average values of full exhalations in a given period of time.
EQO2 = VE/VO2 ⇒ ventilation oxygen equivalent;
EQCO2 = VE/VCO2 ⇒ ventilation carbon dioxide equivalent;
TI/TE [%] ⇒ ratio of inhalation time to exhalation time;
TI/TTOT [%] ⇒ ratio of inhalation time to total cycle time;
VO2/HR [ml] ⇒ oxygen consumption in relation to the frequency of heart rate per minute;
VO2/Kg [ml/kg/min] ⇒ oxygen consumption in relation to 1 kg of the patient's body mass;
VO2/Kg/HR [ml/kg] ⇒ oxygen consumption in relation to 1 kg of the patient's body mass and the heart rate frequency unit;
WATT [W] ⇒ load;
PEF [l/s] ⇒ peak value of exhalation flow;
PIF [l/s] ⇒ peak value of inhalation flow;

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FETO2 [%] ⇒ maximum oxygen accumulation in the exhaled air measured in the final sample of the exhaled air;

FETCO2 [%] ⇒ maximum carbon dioxide accumulation in the exhaled air measured in the final sample of the exhaled air;

SpO2 ⇒ saturation (blood saturation with oxygen);

VD/VT ⇒ ratio of dead space to the respiratory volume;

PEO2 [mmHg] ⇒ average partial oxygen pressure in the exhaled gas;

PECO2 [mmHg] ⇒ average partial carbon dioxide pressure in the exhaled gas;

PETO2 [mmHg] ⇒ partial oxygen pressure in the final sample of the exhaled gas;

PETCO2 [mmHg] ⇒ partial carbon dioxide pressure in the final sample of the exhaled gas;

BR [%] ⇒ breathing reserve;

VET_SUM [L] ⇒ volume of the ventilated air;

TV_TE [L/s] ⇒ ratio of the TV parameter to TE;

Speed [km/h] ⇒ Moving track speed;

Slope [%] ⇒ Moving track slope;

SBP [mmHg] ⇒ value of the systolic blood pressure;

DBP [mmHg] ⇒ value of the diastolic blood pressure;

Borg ⇒ 20 point Borg scale with which the patient describes independently their own subjective perception of work exertion;

Points	Work
6	Extremely light
7	
8	Very light
9	
10	Quite light
11	
12	Quite hard
13	
14	Hard
15	
16	Very hard
17	
18	Extremely hard
19	
20	

Lactate [mmol/l] ⇒ value of lactate concentration in blood;

Values describing oxygen debt:

VE.B.SUM [L] ⇒ total volume of breaths during the test calculated with the reference phase level (tare);

VE.T.SUM [L] ⇒ total volume of breaths during the whole test;

VE.L.SUM [L] ⇒ total volume of breaths during the exertion phases;

VE.R.SUM [L] ⇒ total volume of breaths during the rest phases;

VO2.T.SUM [L] ⇒ total quantity of oxygen used during the whole test;

VO2.OD.SUM [L] ⇒ difference in the quantity of consumed oxygen during the exertion phases between the consumption quantities rounded to the level of the phase ends and the real values;

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VO2.L.SUM [L] ⇒ total quantity of the consumed oxygen during the exertion phases;
VO2.R.SUM [L] ⇒ quantity of the used oxygen in the rest phase;
VO2.A.SUM [L] ⇒ **VO2.A.SUM = VO2.OD.SUM - VO2.R.SUM;**
VO2.B.SUM [L] ⇒ quantity of oxygen used during the test calculated with the consumption level from the reference phase;

Explanation of the used abbreviations STPD, BTPS, ATP:

STPD ⇒ Standard Temperature Pressure Dry (conditions of dry gas in the temperature of 0 ^{o}C and pressure of 760 mmHg);
BTPS ⇒ Body Temperature Pressure Saturated (a man's body temperature, atmospheric pressure and humidity of air saturated with water vapour);
ATP ⇒ Ambient Temperature Pressure (conditions of temperature, humidity and pressure in the room where the test is conducted).

1.1. Technical data.

General data:

Measurements (length/width/height)	670/520/850 mm
Supply voltage	220 V (AC)
Power consumption	150 VA

Technical data of the measuring module:

Flow measurement:

Measurement head:	MES of DV40 type
Dead space:	40 ml
Flow range:	+/- 18 l/s
Consumption resolution:	+/- 10 ml/s
Volume measurement range:	0 - 10 l
Consumption resolution:	10 ml
Measurement accuracy:	< 2%

Measurement head resistance: < 0,9 cmH_2O/l/s (at the flow of 12 l/s)

Measured ventilation range:	300 l/min

Oxygen analyser:

Conductance	
Measurement range:	0 – 100 %
Response time:	t90 < 50 ms
Accuracy:	0,1 %
Resolution:	0.01 %

Carbon dioxide analyser:

NDIR infrared absorption	
Measurement range:	0 – 15%
Response time:	t 90< 90 ms
Accuracy:	0,1 %
Resolution:	0,01 %

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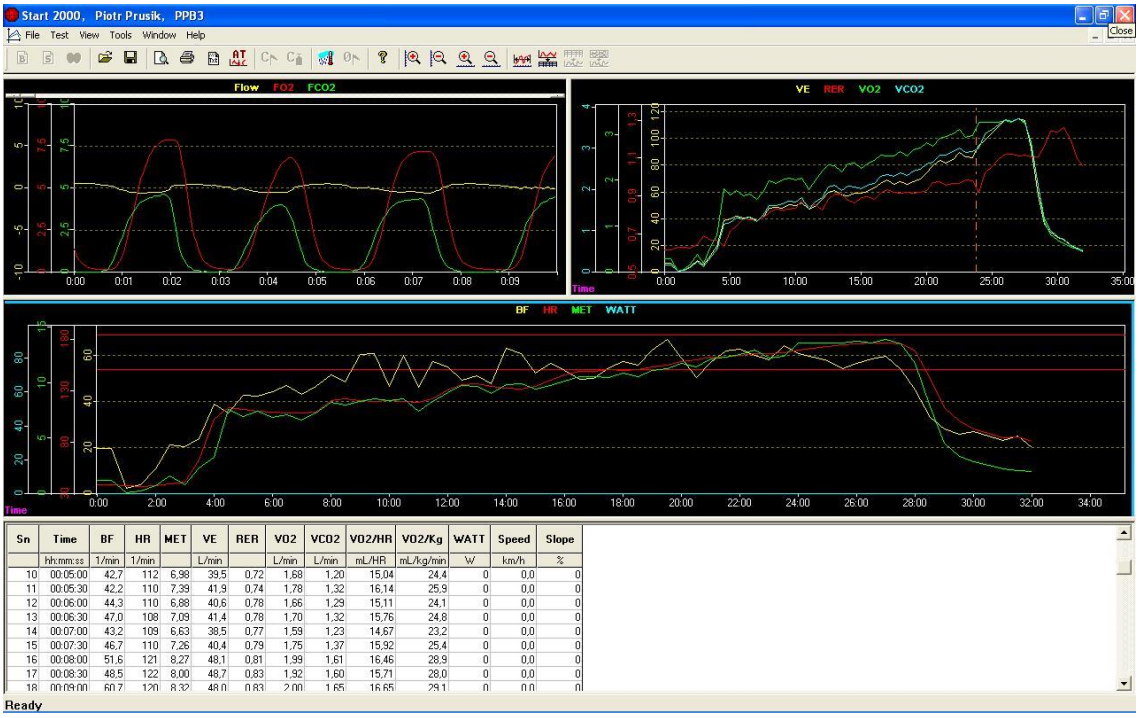
2. Installation.

To conduct the examination properly, one need to install the *Start 2000* set properly. Installation consists in the following steps:

1. From the attached CD-ROM install the *Start 2000* programme on the computer:
   - Start the *setup.exe* file in order to launch the *Start 2000* programme installer. Install the programme.
   - Reset the computer.
2. Connect the mains cable to the Z1 port of the device. The other end of the cable plug to the mains socket with 230-240 V, 50Hz.
3. Connect the cable between the device and the RS232 port of the computer.
4. Connect air tubes to connectors FLOW EX (Ill.1,A).
5. Connect *POLAR* to the POLAR socket (Ill.1,C).
6. Launch the *Start 2000* programme from Menu *Start -> Programmes* or from *Desktop*.
7. Conduct the examination according to the description from Chapter 7.
8. When there is a communication breakdown between the computer and the ergospirometer, one should check the cable connections to the ports.

3. Programme interface description.



Sn	Time	BF	HR	MET	VE	RER	VO2	VCO2	VO2/HR	VO2/Kg	WATT	Speed	Slope
	hh:mm:ss	1/min	1/min		L/min		L/min	L/min	mL/HR	mL/kg/min	W	km/h	%
10	00:05:00	42,7	112	6,98	39,5	0,72	1,68	1,20	15,04	24,4	0	0,0	0
11	00:05:30	42,2	110	7,39	41,3	0,74	1,78	1,32	16,14	25,9	0	0,0	0
12	00:06:00	44,3	110	6,88	40,6	0,78	1,66	1,29	15,11	24,1	0	0,0	0
13	00:06:30	47,0	108	7,09	41,4	0,78	1,70	1,32	15,76	24,8	0	0,0	0
14	00:07:00	43,2	109	6,63	38,5	0,77	1,59	1,23	14,67	23,2	0	0,0	0
15	00:07:30	46,7	110	7,26	40,4	0,79	1,75	1,37	15,92	25,4	0	0,0	0
16	00:08:00	51,6	121	8,27	48,1	0,81	1,99	1,61	16,46	28,9	0	0,0	0
17	00:08:30	48,5	122	8,00	48,7	0,83	1,92	1,60	15,71	28,0	0	0,0	0
18	00:09:00	60,7	120	8,32	48,0	0,83	2,00	1,65	16,65	29,1	0	0,0	0

Ill. 2. Programme interface.

The programme window is presented in Ill. 2. It basically consists of two parts divided by the so-called *splitter*. *Splitter* allows to modify the height of individual parts. In order to do this, one should:

- click on the *splitter* with the left mouse button;
- drag it to the desired position;
- drop the *splitter* by releasing the mouse button.

Additionally, interface includes menu (⇨ Chapter 10), toolbar (⇨ Chapter 11) and status line (⇨ Chapter 11.3). The window has different toolbars depending on the fact whether the programme opened a finished examination from the file, an examination for on-line test, or an examination for off-line test.

The first part includes the views of diagrams of parameters calculated during the examination and the the view of *on-line* processes. The number of both view types is set in the programme options (⇨ Chapter 5.4.1). It is possible to have maximum 4 views. They are also divided by *Splitters*. The programme offers a selection of parameters diagrams of which we would like to display in a given view (⇨ Chapter 6.5.1.2). The maximum number of diagrams in one view is four. Every diagram is in different colour. The diagram refers to the parameter whose name (at the top of the diagram) is displayed in the same colour as the diagram. Also the colour of scale on the Y axis determines the diagram it refers to.

The programme saves the data collected during the test. After the examination is finished, on the current parameter diagrams there appears *Scroll*, that is a narrow bar at the top of the diagram with a bar. By sliding the bar we may display data from any moment of the examination. The window width (the length of the time period presented in the view) is set in the view settings (Chapter 5.4.1). In the parameter diagram one can also turn off the *Scroll*. One turns it on by a mouse double-click on the view. One turns if off in the same way. The slide can also be made with the *L (left)* and *R (right)* keys. They slide the diagram left or right by a whole window. Active diagram is marked with a blue frame at the top and the right side of the view.

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The second part includes a table with the values of the selected parameters from the consecutive moments of examination. Which parameters and moments are displayed can be set in the table view settings (⇨ Chapter 6.5.4). If the window size exceeds the available screen area, there appear in this window scrolls with bars on the right side and at the bottom of the window. They allow to slide the window vertically and horizontally so that the desired fragment would be displayed.

4. Patient's data

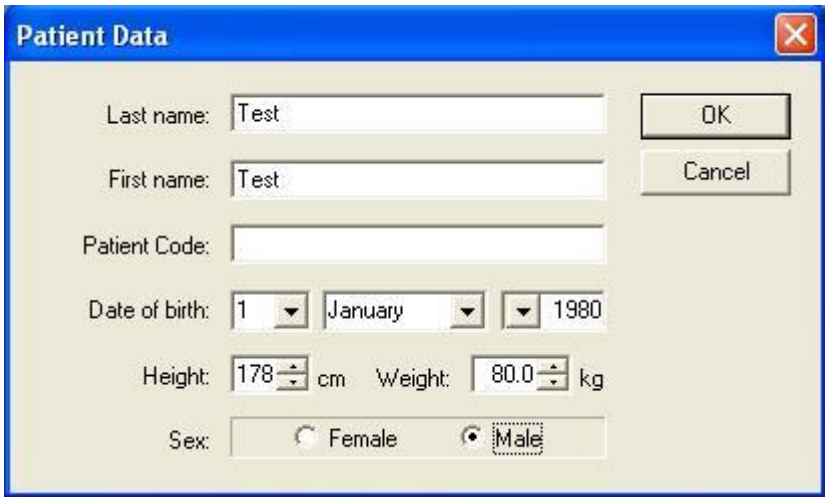
The patient's data is a set of information required for the patient's identification. Without this information no examination can be conducted. The patient's data can be entered in two ways:

1. Entering new patient's data (⇨ Chapter 4.1).
2. Opening the file with the results of examination previously conducted on a patient (⇨ Chapter 7.4).

After entering the patient's data, the examination will be conducted for this patient. In order to examine another patient, first one needs to enter their data.

4.1. New data

Patient's new data is entered by means of the dialogue window: *Patient's data* (⇨ Ill. 3) available after selecting the *Patient's data* command (menu *File*). The window opens a set of fields where one should enter information according to the labels next to each field.



Ill. 3 Dialogue window: *Patient's data*.

4.2. Modification

The patient's data modification can be done only before the examination beginning. After the examination beginning, the modification of the incorrectly entered and accepted data requires shutting down of this examination and launching a new one. One should then enter the correct data in accordance with the procedure of entering a new patient (⇨ Chapter 4.1). The dialogue window: *Patient's data* includes patient's data from the last opened examination in the programme (regardless of the fact whether the examination was opened from the file or it was a new examination).

The patient's data modification before the beginning of the examination can be done by means of the dialogue window: *Patient's data* (⇨ Ill. 3) selecting the *Patient's data* command (menu *File*). The data modification is possible only after its previous entering (⇨ Chapter 4). All patient's data can be modified.

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4.3. Data survey

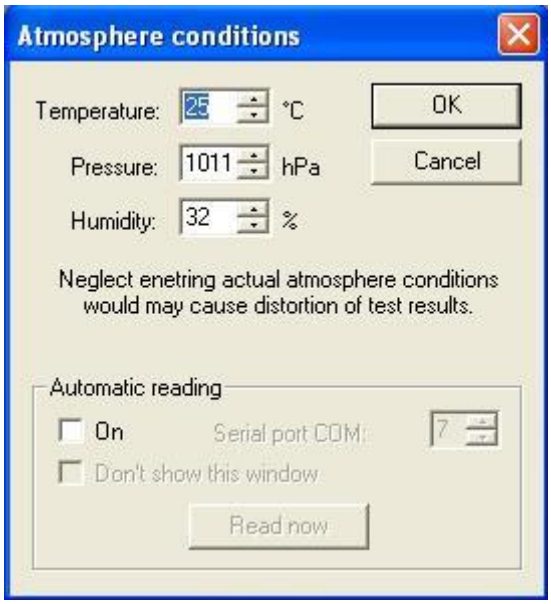
The patient's data survey, that is the survey of its content on the day of performance of the open examination, is conducted after selecting the *Patient's data* command (menu *File*). Before the examination starts, it is possible to modify this data (⇨ Chapter 4.2), and after its start or reading the examination from the file, it can only be surveyed.

5. Programme options

Programme options include information necessary for the proper conduction of the examination. They refer to the parameters of data transfer between the ergospirometer and the computer, and to the examination parameters. The examination options are available in the menu *Tools*.

5.1. Environment conditions

Upon selecting the *Environment conditions* command, there appears a dialogue window referring to the external conditions during the examination (⇨ Ill. 4).



Ill. 4. Atmospheric conditions.

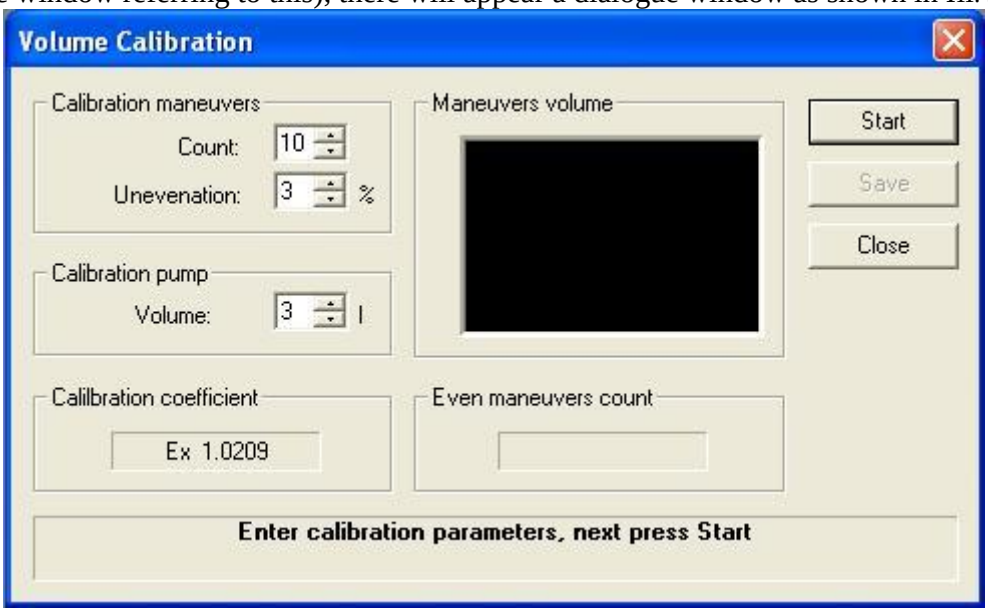
Not giving or giving the wrong parameter values about the temperature, humidity and pressure may lead to the distortion of the examination results. Those values can be entered manually reading them from the external appliances (thermometer, barometer, hygrometer) or by means of automatic reading. In order to do this, one needs to connect to the computer a special add-on device for reading the weather conditions, and then (after launching the *Start 2000* programme) mark the field *Turn on* in the *Automatic reading* group. A *Series port COM* window will become activated where one should select the number of port to which the add-on device has been connected. By clicking the *Read now* button, the reading of the current atmospheric conditions will be made and the values will be entered into the dialogue window. This data can be updated both before and after the selection of the examination type (⇨ Chapter 7.2). It is valid for 4 hours. It means that for 4 hours from entering the data the programme will not require the weather conditions update, regardless of the fact whether the programme was launched once or several times during this period of time.

5.2. Calibration

After the selection of the *Calibration* command one needs also determine whether the calibration refers to gas or to volume. If the programme is launched without current atmospheric conditions, there will appear a dialogue window for their updating (⇨ Chapter 5.1). One should enter the current values of temperature, pressure and humidity or select the automatic reading of those values (if we have at our disposal the add-on device for the automatic reading of those conditions). Gas and volume calibration is valid for 24 hours. Calibration should be made in the ATP conditions.

5.2.1. Volume calibration

After selecting the *Volume calibration* command from the submenu *Calibration* in the menu *Tools* and possible updating of the current atmospheric conditions (if there appears a dialogue window referring to this), there will appear a dialogue window as shown in Ill. 5.



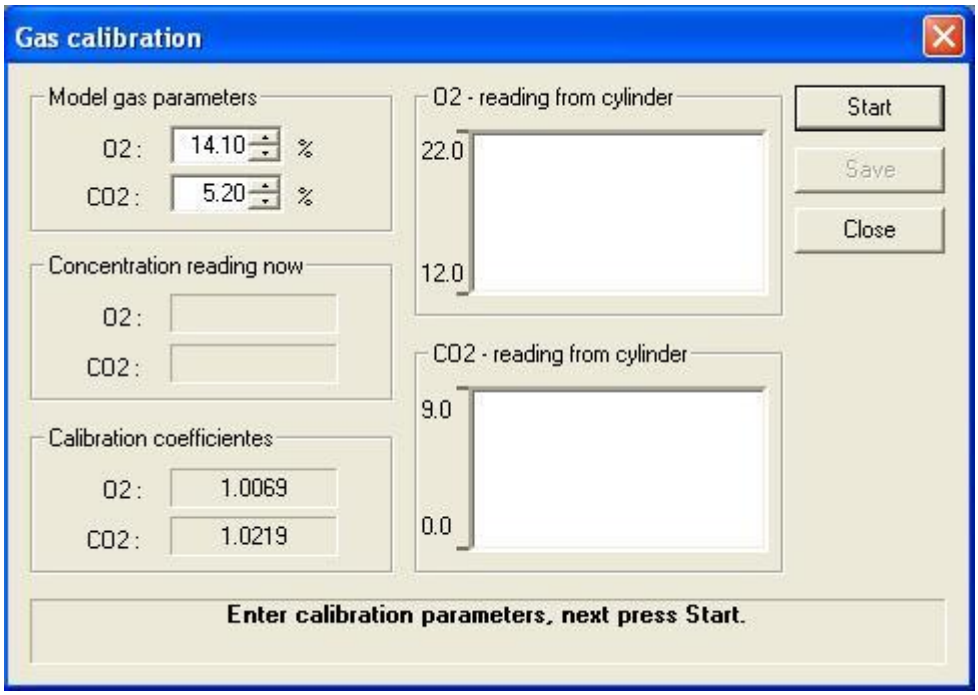
Ill. 5. Volume calibration.

In the *Calibration manoeuvre* group in the *Number* field one should enter the number of correct movements of the calibration pump piston which finish the calibration. In the *Irregularity* field we enter the irregularity percentage of the pomp piston movement. Exceeding it causes that the programme rejects the manoeuvre whose irregularity exceeded the set percentage. This percentage is calculated from the average volume of all previous movements. Therefore, it is possible to reject the manoeuvre that was previously accepted. In the *Calibration pump* group in the *Capacity* field we give the volume of the used calibration pump. Before one starts calibration, one obviously has to connect the calibration pump to the spirometric head which is properly attached to the air cable connector. Calibration is started by clicking the *Start* button and there is a steady movement of the calibration pump piston. In the *Calibration factor* field there is displayed the last correct calibration factor, and in the *Number of steady manoeuvres* field there is the number of movements accepted by the programme. In the *Manoeuvre volume* window there are displayed columns whose height indicates the volume of the performed manoeuvre. The number of columns corresponds to the number displayed in the *Number of steady manoeuvres* field. At the bottom of the window there is a field where the 'prompting messages' are displayed which facilitate the process of calibration. When in this field

appears information that the calibration has been completed successfully, the process of volume calibration is finished.

5.2.2. Gas calibration.

The dialogue window for gas calibration (⇨ Ill. **6**) will appear after selecting the *Gases* command from the submenu *Calibration* in the menu *Tools.*



Ill. 6. Gas calibration.

This calibration may be summarised in the following points to be performed in a strictly determined order:

In the *Sample gas parameters* group one should enter the *O2* and *CO2* concentration percentage in the sample gas (description on the calibration gas cylinder). Changes can be made only after connecting a new sample gas cylinder.

1. After clicking the *Start* button there appears information that 'zero' will be read from the atmosphere. One should make sure that the end of the silicone gas cable (by the head connector) is 'let out' to the atmosphere. Then we confirm this with the *OK* button.
2. For the next 30 seconds 'zero' will be read from the atmosphere.
3. After reading 'zero', the programme will inform that the sample gas calibration will be conducted. Then one needs to connect the bag or cylinder with calibration gas (if it is not already connected) to the socket CalGas(Ill.1,D)of the device. The end of the gas cable (the one 'let out' in point 2 to the atmosphere) should be connected to the socked showed on the Ill.1,I(outlet of the calibration gas).
4. The connection is confirmed with the *OK* button. The proper calibration process lasts also around 30 seconds. During the process the following information are displayed in the window:

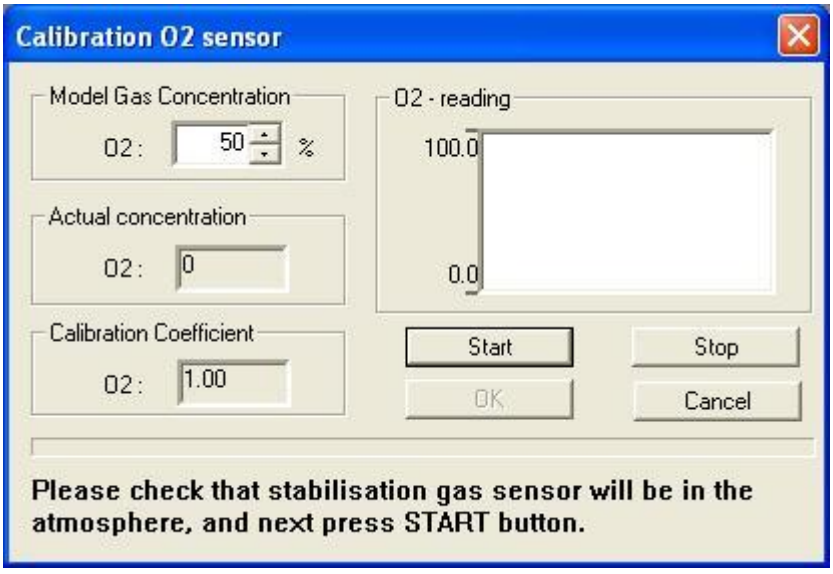
a) In the *Currently read concentration* group there are displayed the currently read concentrations of the proper gases.
b) In the *O2 – cylinder reading* and *CO2 – cylinder reading* columns are drawn whose height corresponds to the values from the *Currently read concentration* windows.
c) At the bottom there is a field where the 'prompting messages' are displayed that facilitate the process of calibration. When in this field appears information that the calibration has been completed successfully, the process of gas calibration is finished.
d) In the *Calibration Factors* field the calculated calibration factors are displayed.

5.2.3. Gas calibration (high O2) – OPTION.

This type of calibration is used for examination with stabilisation. It is similar to the standard gas calibration; the difference lies in the fact that the oxygen concentration in the examined gas is much higher than in the standard calibration (around 50 %). What is more, carbon dioxide (CO2) is not included in the calibration. The calibration process itself is conducted in the same way as the standard gas calibration; at the end of calibration the calibration factor for oxygen is calculated and it may be saved.

5.2.4. Oxygen sensor calibration (additional oxygen sensor – OPTION).

This calibration concerns the oxygen sensor located on the bag with inhalation gas during the examination with oxygen stabilisation. Dialogue for calibration is presented in Ill. 7.



Ill. 7. Oxygen sensor calibration.

At the bottom of the window there are prompts that facilitate the calibration process. One should follow these instructions;

In the *Sample gas concentration* field we enter the known concentration of the examined gas. The oxygen sensor is put in the atmosphere, then we press the *Start* button – reading 'zero' from the atmosphere starts. During this and other stages at the bottom of the window

there is displayed a progress bar informing about the duration of the given stage. Additionally, in the prompting field there is displayed information about the current stage of calibration. After reading zero from the atmosphere one needs to put the gas bag on the sensor, and then click the *Start* button one more time. Then there is a stage of reading sample gas when in the *O2 – reading* columns are drawn whose height corresponds to the read concentration. After its completion the calibration factor will be calculated automatically, and the user will be informed whether the calibration has been completed successfully or not (it is successfully completed when the factor fits into the range of 0.8 to 1.2). After the calibration has been completed successfully, the *OK* button is activated which causes saving the calculated calibration factor and closing the window. In order to perform another calibration, one needs to press the *Next calibration* button (earlier it is the *Stop* button). Calibration may be stopped in any moment with the use of the *Stop* button. In order to close the window, press the *Cancel* button.

5.3. Equipment configuration.

After selecting the *Equipment configuration* command from the *Tools* menu, there appears a dialogue window with three pages. The first one, *Ergometer*, concerns the examination options related to the ergometer; the second one, *Communication*, includes the parameters related to the ergometer communication and other devices with the computer; the third one, *General*, determines the directory path for saving the examinations and the manner of power calculation on the basis of slope and speed of the moving track. All parameters set in here are saved in the programme. It means that after closing and opening the programme again the previously set parameter values will be still valid.

5.3.1. Ergometer.

The *Ergometr* page is presented in Ill. 8.

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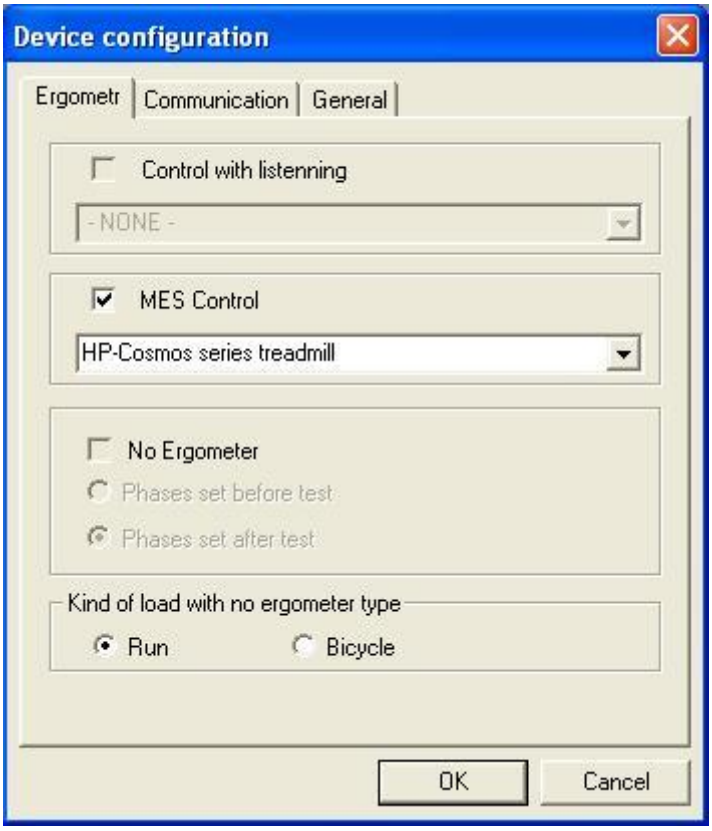


Ill. 8. *Ergometer* dialogue window.

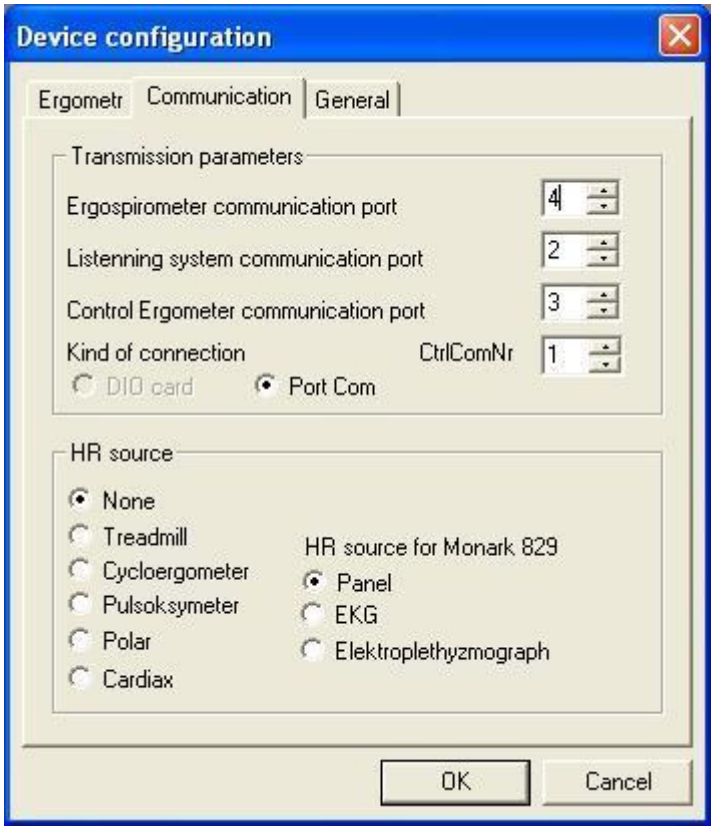
In this window we determine the type of ergometer we work with during the examination. In one moment there may be only one or none of the fields marked. Marking any of them causes blocking all the others. By de-marking the field, we have the possibility of marking any field. Available fields are: *Tapped control*, *MES control* and *No ergometer*. By marking the *Tapped control* field and selecting the tapped device type we select the option of downloading the current load to the programme by reading it off the ergometer. The *MES control* field is dedicated for the selection of ergometer which we intend to control during the examination. Using this option one needs to set the examination phases before its start. In the *No ergometer* field we determine whether (if there is no ergometer) the phases should be set before or after the examination. If we decide that the phases should be set before the examination, the programme will not allow starting the examination when there are no phases designed and will remind us of this. If we select the option of setting the phases after the examination, upon finishing the examination there will automatically appear a dialogue window about the examination phases. If we do not mark any of the fields, we select the examination type which does not require any ergometer and we do not have to give the load. During such examination the load value in the WATT column will amount to '0'.

The *Type of load with no ergometer type selected* field is dedicated to determine what type of load we are dealing with if there is no ergometer type selected. This information is necessary to calculate the VO2 norm.

5.3.2. Communication.

The *Communication* page is presented in Ill. 9.

.

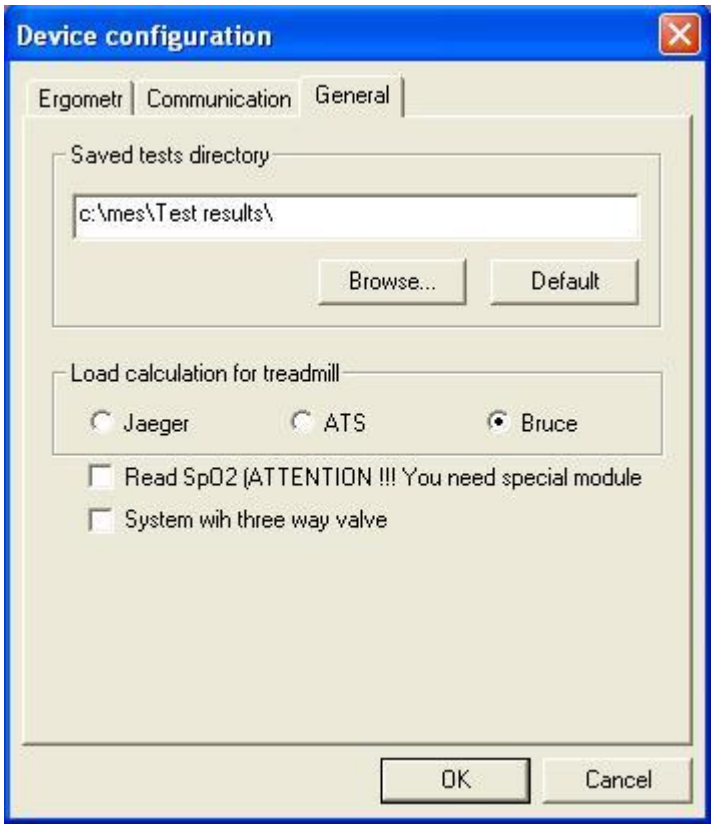


Ill. 9. *Communication* dialogue window.

In this window we determine the port numbers to which the tapped ergometer and control ergometer are connected. If there is no communication with any of these devices, one should check first of all whether the set numbers correspond to reality. While closing the window we confirm all the changes with the *OK* button. In the *HR Source* field we determine the type of device from which we read the HR value. If we choose *Pulsoxymeter* at the examination start, the *OksyTest 1000* programme is launched which transmits the HR value to the programme. Similarly, if we select the *Polar* and *Cardiax* options, the *Polar* and *CRX* with *Cardiax* programmes will be launched respectively. Additionally, the selection of the *Cardiax* option is necessary if we want to read other cardiographic parameters. The detailed description of the cooperation with *Cardiax* can be found in Chapter 6.11. If during the test we use the Monark 829 bicycle as an ergometer, we have a choice of HR signal from the bicycle. Up to the 1.6.0.0 version the HR from bicycle or moving track was read only after the control phase. From the 1.6.0.0 version this parameter is read also during the control phase. The necessary condition for reading the HR parameter from the bicycle or moving track is the choice of the proper source in the menu and the choice of controlled ergometer in the *Ergometer* tab for the right bicycle or running machines (which transmit the HR parameter, e.g. Monark 829, 839, h/p/cosmos).

5.3.3. General.

The page *General* is presented in Ill. 10.



Ill. 10. The *General* dialogue window.

On this page in the *Directory with saved examinations* field we give the access path to the directory where we wish to save the examinations. This path may be entered manually or created automatically. Automatic path creation occurs in two cases. The first one is when the default path is set. We do this by clicking on the *Default* button. Default path is: *c:\mes\Wyniki badań\ (c:\mes\Examination results\)*. In the second case the path is created in the directory selected in the dialogue window that appears after the *Browse* button. This window is presented in Ill. 11.

Ill. 11. Dialogue window: *Browsing in search of the directory*.

After marking the selected directory and confirming this with the *OK* button, in the editing window there is displayed the path to the selected directory.

In the *Manner of power calculation for the moving track* field we determine which formula to use in order to calculate the power on the basis of the moving track's speed and slope. It is used in the examination with the controlled ergometer if it is a moving track. We have the following formulae to choose from:

- JAEGER:
  - ✓ for running:
    W [Watt] = (V * BW * (2.11 + G * 0.25) + 2.2 * BW - 151) / 10.5
  - ✓ for walking:
    W [Watt]= (V * BW * (2.05 + G * 0.29) + 0.6 * BW - 151) / 10.5
- ATS:
  G = 100 * tan α
  W [Watt] = BW * V * sin α * 100 / 36.4
- BRUCE:
  tan $\alpha \cong$ sin α for small α
  W [Watt] = BW * V * G / 36

Abbreviations used in the above formulae stand for:
BW – patient's body weight [kg]
V – moving track's velocity [km / h]
G – slope [%]
W – load [Watt]

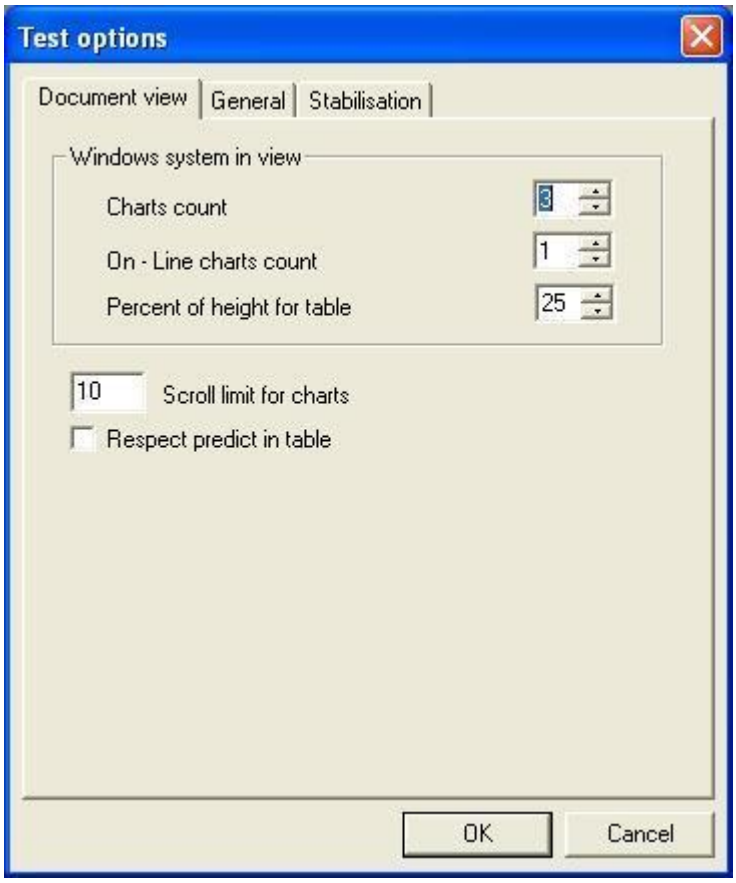
When we mark the *Read SpO2* field upon starting the examination, the *OksyTest 1000* programme is launched which transmits the parameter value to the programme. The suitable module is necessary for this purpose.
The *System with three-way valve* field should be marked if the three-way valve is used in the examination.

5.4. Examination option.

5.4.1. Document layout.

The *Document layout* page is presented in Ill. 12.

.



Ill. 12. Dialogue window: *Document layout*.

In the *Window layout in the view* group we determine the number of all views in the part dedicated to diagrams (⇨ Chapter 3). The minimum number is one, maximum – four. How many of those views will be the *on-line* type views is determined in *Number of On-Line Diagrams.* In the *Height percentage for the table* field we determine the percentage of the whole window interface to be covered by the table. The *Scroll range for diagrams* determines the period of time in seconds that will be visible on views with the *scroll* turned on. If we mark the *Include the due in Table* field, in the table of the values of parameters which are due, they will be displayed in the colour dependent on the value and due relation. If the parameter value ranges between the minimal and maximal due value, then the cell has the sea-green colour. Sample fragment of the table including the dues is presented in Ill. 13.

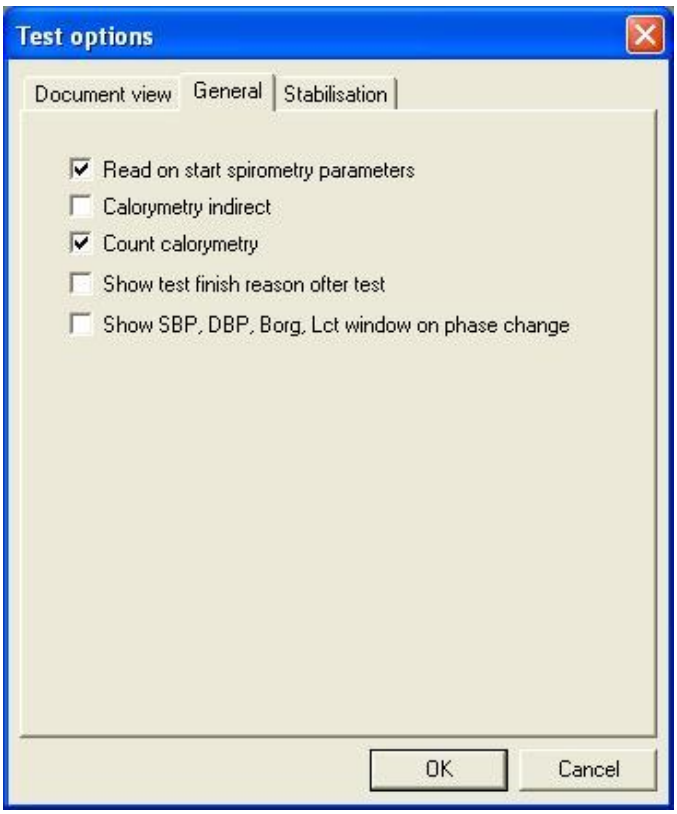
.

Sn	Time	BF	HR	MET	VE	RER	VO2	VCO2
	hh:mm:ss	1/min	1/min		L/min		L/min	L/min
45	00:22:30	60.1	166	12.93	89.3	0.97	3.11	3.0
46	00:23:00	58.4	166	12.20	86.4	0.99	2.93	2.8
47	00:23:30	64.3	168	12.37	85.4	0.98	2.97	2.9
48	00:24:00	60.7	169	13.54	94.5	0.92	3.26	3.0
49	00:24:30	59.5	171	13.58	99.1	1.02	3.27	3.3
50	00:25:00	58.0	173	13.60	103.9	1.05	3.27	3.4
51	00:25:30	54.4	175	13.55	108.9	1.09	3.26	3.5
52	00:26:00	56.8	176	13.70	114.1	1.12	3.30	3.6
53	00:26:30	58.6	177	13.56	112.4	1.12	3.26	3.6
54	00:27:00	59.8	176	13.86	114.5	1.11	3.33	3.7
55	00:27:30	53.9	175	13.49	113.2	1.12	3.24	3.6
56	00:28:00	45.1	168	11.77	93.2	1.11	2.83	3.1
57	00:28:30	33.2	142	7.80	58.0	1.11	1.88	2.0
58	00:29:00	28.3	114	4.59	35.8	1.16	1.10	1.2
59	00:29:30	26.0	101	3.38	29.7	1.24	0.81	1.0
60	00:30:00	27.0	93	2.87	25.9	1.24	0.69	0.8
61	00:30:30	24.9	88	2.55	24.4	1.26	0.61	0.7
62	00:31:00	23.0	85	2.22	20.3	1.20	0.53	0.6
63	00:31:30	25.0	85	2.12	17.8	1.10	0.51	0.5

Ill. 13. Table including dues.

5.4.2. General.

The *General with Examination Options* page is presented in Ill. 12.



Ill. 14. Dialogue window: *General with Examination Options.*

With the *Read spirometric parameters at start* field marked, at the examination start the programme tries to read the patient's spirometric parameters. If there are any, they will be read and the parameter creation date will be checked. If they were created more than a month before, the user will be informed which parameters are concerned and when they were created. If there are no spirometric parameters of the patient, the user will also be informed about it.

If the *Indirect calorimetry* field is marked, the energy consumption will be calculated with the indirect calorimetry method, otherwise the calorimetry will be calculated from the minute ventilation.

Marking the *Calculate calorimetry* option enables to calculate the energy consumption during the examination. If this option is de-marked, the consumption will not be calculated despite the occurrence of examination conditions for the calculation.

The *Display the cause of test ending dialogue after examination* option causes that after the examination there will be automatically displayed a window where we can give the cause of ending the test.

Marked *Show SBP/ DBP/ Borg/ Lct window with phase change* introduces the automatic display of dialogue dedicated for entering the values of these parameters for examination. The window can also be opened with the *SBP, DBP, Borg, Lct Entry* command from the *Tools* menu or with the use of this icon: 

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5.4.3. Stabilisation (OPTION).

The template is dedicated to determine the parameters of examination with stabilisation.

In the *Stabilisation method* field one should select the type of stabilisation that one would like to exploit during the examination. The *Oxygen stabilisation* field determines the set oxygen concentration in the breathed-out gas during the stabilisation. In the *Air stabilisation* field we set the temperature in which the inhalation gas should be kept. Below we set the flow values from the air reducer and from the oxygen reducer. One should give those values accurately, because it significantly influences the quality of keeping the set oxygen concentration. In order to set those flows accurately, one should use the *Open* buttons. They open the electro-valves from air and from oxygen, which enables to set both flows and enter their values. Then there is a place for entering the gas volume for preparation. It is the amount of gas that would fill the gas bag before the examination start. Obviously, this amount should be smaller or at least equal to our bag's capacity. At the end we determine the port numbers that are used to read the sample gas parameters and to control the stabilisation device.

5.5. User and Service.

The *User* command produces a dialogue window with queries about the User's *Login* and *Password* (⇨. 15).

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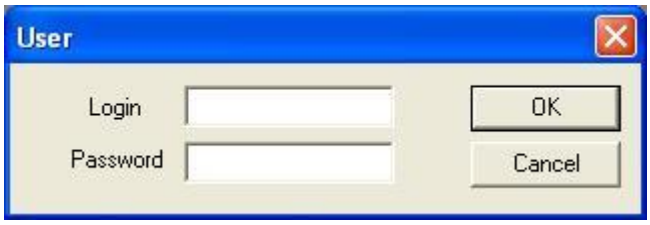

Ill. 15. The *User* dialogue window.

After entering the right key words, the User has access to certain options of the programme which are normally unavailable. **It is used by the programme's service men.**

The *Service* order is available for an average user. It is also used by the programme's service men.

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6. Conducted examination options.

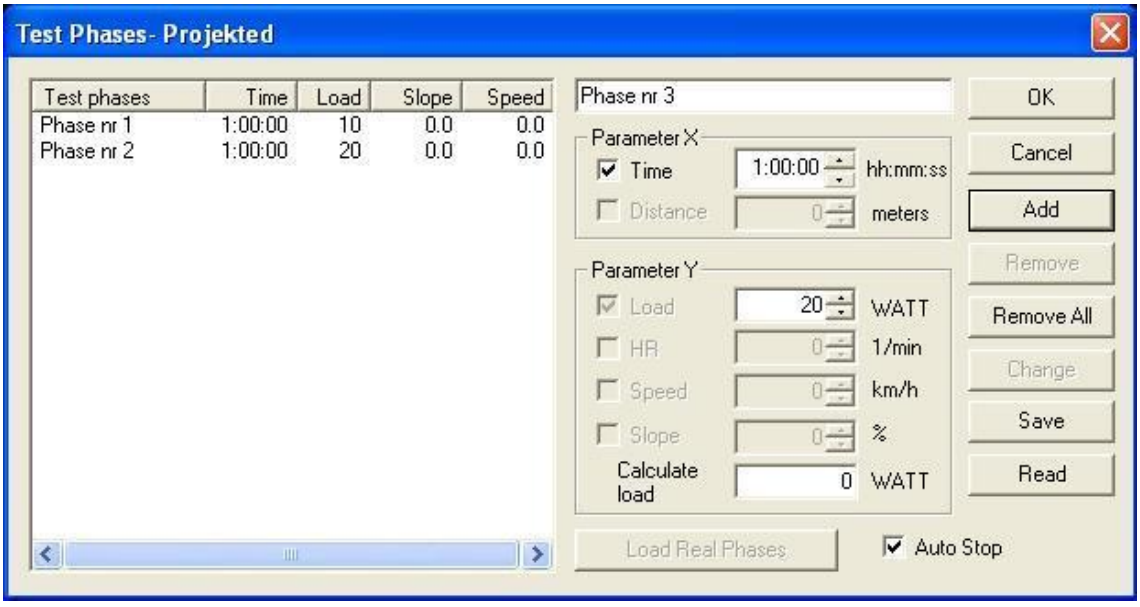
6.1. Examination stages.

Every examination consists of two stages: control stage and examination stage. During the control stage there are actions performed to prepare the ergospirometer for work. It includes resetting its memory and ventilation of the measurement system. When those actions are completed, the programme enters the analysis state in the control stage whose values are not saved. One should then check if the programme operates properly and if the parameter rows are added to the bottom table. During the examination stage we perform the proper examination which is divided into three parts: reference (resting), exertion and rest (restitution). During both stages the successive parameter values appear both on the diagram and in the table at time intervals determined with the *Averaging* parameter (*Examination options -> Document view* – Chapter 6.6).

NOTE !!!
1). The control stage is crucial for the correct performance and receiving reliable results in the proper examination stage, because in this stage the processes of ventilation and resetting the measurement system are conducted. During this process the pneumotachographic head connection cable must be as far as possible from the mouths of the patient and the operating personnel, because the great sensitivity of measuring systems of ventilation and exhalation gas concentration may lead to reading and saving the false zero of the module of ventilation and CO2/O2 gas analysers.
2). In the control phase of the stage when the programme launches the analysis system, the three-way air connection cable must be connected to the pneumotachographic head installed to the measurement mask previously put on by the patient. The third cable of the three-way air cable, marked in blue, must be connected to the connection terminal installed in the mask connector.

6.2. Examination phases.

The dialogue window referring to the examination phases is produced by the *Examination phases* command from the *Examination* menu. This command is available only for the open document (new examination or examination opened from the file). This window is presented in Ill. 16.



Ill. 16. Examination phases.

Examination phases include information about the test parameters for the whole time of examination. The information are: phase name, its duration, load received by the patient, and speed and slope of the moving track (if it is used for the examination). The examination may consist in any number of phases.

The window basically consists of three parts. The first one includes the list of all phases and their parameters. The second part includes fields to enter the data. The third part includes buttons used to edit the phases. While entering a new phase, one needs to determine both the X and Y parameters. The phase name is set by default as *Phase no. x* where *x* stands for the successive number of phase. But this name may be changed to any name. The X parameter is the phase duration time. In the Y parameter field we may enter the load, or the speed and slope of moving track during the given phase. Which field is active depends on the settings in *Examination options* on the *Ergometer* page (⇨ Chapter 5.3.1). If we select the option of tapped ergometer, none of the fields will be active because the load is read from the ergometer. The same situation takes places if no field is marked. If the examination uses the ergometer control, then in case of a bicycle the active field will be *Load* and in case of a moving track the active fields will be *Speed* and *Slope*. By marking the *Phases with no ergometer* field one may enter the *Load*. If one enters to the phases the speed and slope of the moving track, then in the *Calculated load* there is displayed load calculated according to the formula set in *Examination options* on the *General* page (⇨ Chapter 5.3.3). The load is entered to the phase while adding the phase.

The *Add* button is dedicated to enter the set phase. *Delete* deletes the phase marked in the phase list. We mark it by clicking the left mouse button on the name of the selected phase. *Delete all* deletes all phases from the list. *Change* allows us to change the selected phase's parameters. The *Save* button saves the set of phases from the list in a file of the given name. The standard file extension is **.phs*. The *Read* button is dedicated to load the phases from the file. In order to confirm the entered data we use the *OK* button. During the programme installation on the computer in the *C:/Mes/Phases* directory the files with the most popular examination programmes are saved. They are:

1) Weber;
2) Repty;
3) Naughton Modified;
4) Cornell;

5) Bruce Modified;
6) Bruce;
7) Acip Modified;
8) Acip;

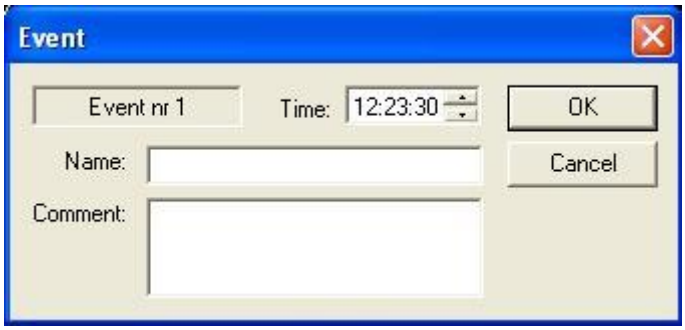
The programme often requires for examinations setting the phases before the examination starts. This requirement concerns examinations using controlled ergometer and in case of the selection of the *Phases set before examination* option from the *Phases with no ergometer* field (*Examination options -> Ergometer* – Chapter 5.3.1). When we choose the *Phases set after examination* option, the programme will require entering the examination phases right after the examination ends and automatically display the window related to examination phases.

The *Load real phases* button is dedicated to loading the real phases created automatically during the examination on the moving track. After pressing, the button name changes into *Load project phases.* It is dedicated to loading the project phases. If there are no real phases in the examination, then the phase field will be empty. While saving the examination, both real and project phases are saved.

Marking the *Auto Stop* option causes the automatic ending of the examination when all the project phases are completed.

6.3. Events.

An event is a blue vertical line which marks the examination characteristic moment. The event is entered with the *Enter event* command from the *Examination* menu. The relevant dialogue window is presented in Ill. 17.



Ill. 17. *Event* dialogue window.

The event is entered when the examination is conducted. In the *Name* field one should enter the name of the event, and in the *Commentary* field – the description of the situation that occurred. In the *time* field there is displayed the moment of examination when the event was entered. We confirm this entry withe the *OK* button. The dialogue window presented in Ill.. 18 is used for event editing.

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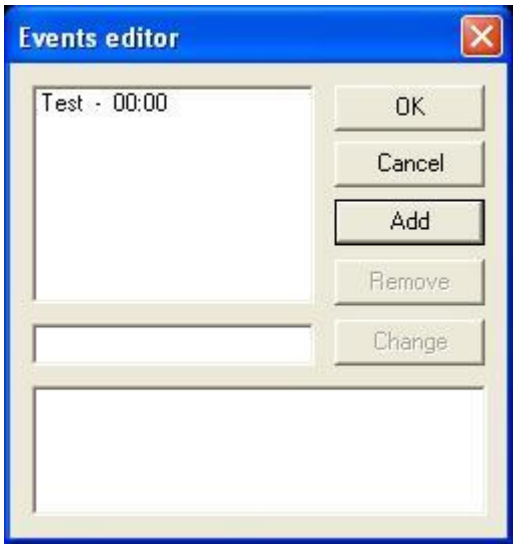


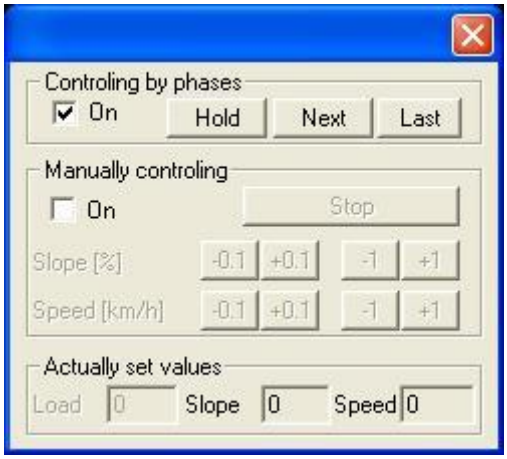
Ill. 18. *Event editor* dialogue window.

It is possible there to change and delete events entered during the examination. The editing concerns the event marked on the event list (top dialogue window). Marking and de-marking is done with the left mouse button. The *OK* button is used for confimation. From the 1.5.0.0 programme version the events are displayed also on the on-line diagrams.

An event may also be entered after the examination. If we have a row marked in the table, then after giving the *Enter Event* command the above dialogue will be displayed with the set time from the marked row. Additionally, oen may enter the event from the *Event editor* dialogue and from the diagram menu.

6.4. Remote control to the ergometer.

This remote control enables us to control the ergometer. The remote control is presented in Ill. 19.



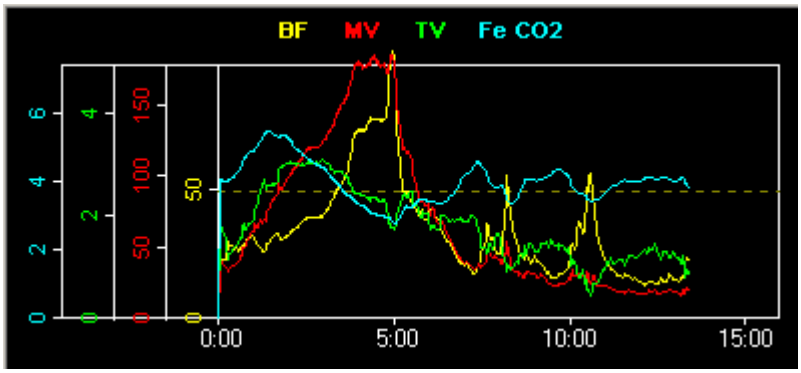
Ill. 19. Remote control to the ergometer.

We may control it manually or with the help of phases. If we control the ergometer with the help of phases, it is possible to skip one phase and move to the next one. We do this by clicking the *Next phase* button. If we move beyond the last phase, the controlled device is

stopped. The *Last* button id dedicated to moving to the beginning of the last phase. In order to lengthen the duration time of the currently operated phase, one should use the *Hold* button. Moving to the next phases will be blocked then until the button is released. During the blocking the button changes its name to *Release*. Unblocking the phase moves us to the phase that is after the blocked one. If we select manual control, there is a possibility of changing the speed and slope. There are buttons that change these parameters by the value displayed on the given button. The parameters cannot be reduced to the value below zero. Additionally, the manual control offers the possibility of stopping the moving track. In order to do this, press the *Stop* button. After that the button name changes into *Start*. Another click causes the start of the moving track with the last set values of speed and slope. The button name changes again into *Stop*. At the bottom part of the remote control there are fields that have the current values of speed and slope. When the moving track is is stopped with the *Stop* button, they include the last set values. When the control is changed from manual to phase control, the values of speed and slope are changed to those that are set for the phase conducted during at the time of change. In case of manual control the time determining the phase to be conducted is constantly running. If we go back to control with the help of phases, there will be activated the phase that corresponds to the change time. If the last phase is completed, the moving track is stopped. If the control is changed from automatic to manual, the current values of speed and slope are the last values set by phases.

6.5. Diagram view.

The programme offers two types of diagram views. They are views of parameter diagrams and the course *on-line* views. Sample diagram view is presented in Ill. 20.



Ill. 20. Diagram view.

The sample view includes the diagrams of four parameters. It presents the maximum number of parameters in one view. Which parameters should be displayed in the view is set in the reference menu in the diagram view (⇨ Chapter 6.5.1). Every diagram is drawn in another colour. Which Y axis corresponds to which diagram is determined by the Y axis colour. Similarly, the diagram in a given colour is the diagrma of the parameter whose name is displayed in the same colour as the diagram. In case of *on-line* views the X axis is the time axis and is common for all diagrams. In the parameter diagram the X axis parameter may be any parameter. Additionally, the active diagram is marked with a blue frame at the top and right side of the view. It will affected by the commands of stretching/ narrowing the scale of the vertical and horizontal axis and synchronisation of the table and other parameters. The diagram is activated by clicking on the selected diagram with the left mouse button.

6.5.1. Reference menu of the diagram view.

One may set here options referring to the diagram display in the given view. It appears after clicking with the right mouse button on the selected view. The menu is presented in Ill. 21.

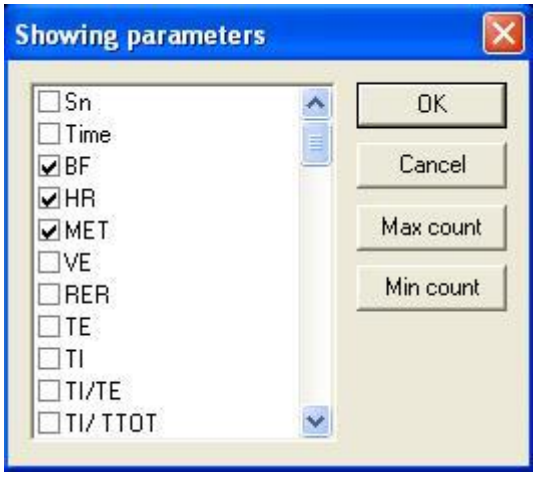
Ill. 21. *Diagram view options* menu.

6.5.1.1. Show events.

Marking the *Show events* field (so-called 'tick') means that this option is activated. It displays the events entered during the examination (⇨ Chapter 6.3). Marking and de-marking this option is done by selecting this command.

6.5.1.2. Parameters.

In order to determine which parameters should be displayed in a given view, one should select the *Parameters* command from the menu in Ill. 21. There will appear a window as presented in Ill. 22. If the selected view is of the *on-line* type, then the window will have different parameter list.



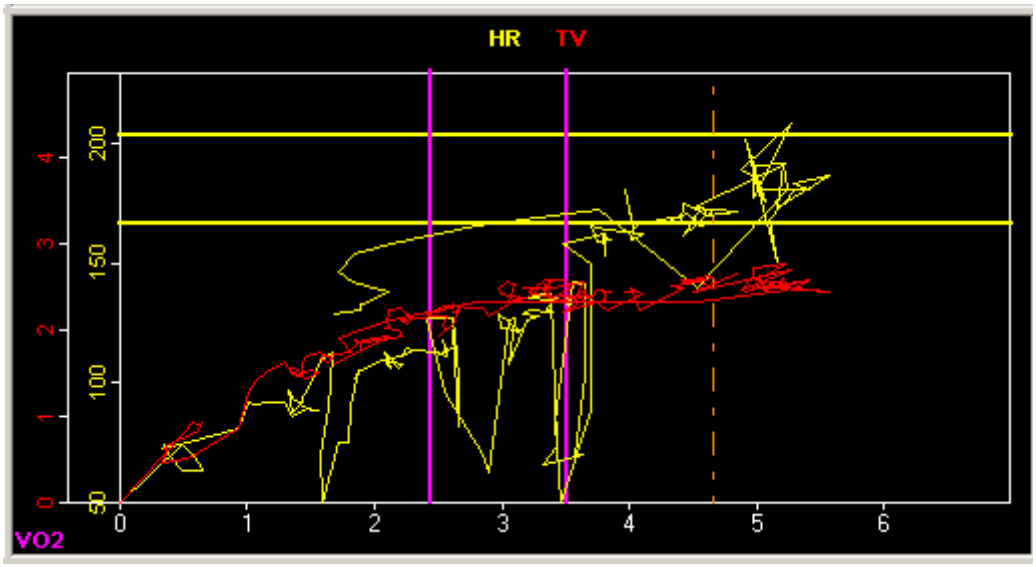
Ill. 22. Dialogue window for selecting the parameters for the diagram view.

One may select the maximum of four parameters for each view. If we try to select more than four parameters, the programme informs about exceeding the allowed number and does

not allow marking another one. In order to mark another parameter, one should de-mark one of the already marked parameters. The parameters are marked and de-marked by clicking on the selected parameter with the left mouse butoon (in the field on the left of the parameter name). The *Min. number* button is dedicated to mark the minimal number of parameters (one parameter). De-marking is also done from the top of the list until only the minimal number of parameters is marked. The selection of parameters is confirmed with the *OK* button.

6.5.1.3. Predicted values.

Marking this option causes that in the given view there are displayed due values of the parameters. There are displayed due values of parameters that have such due values. Due values take the shape of two lines which mark their bottom and top limit. Those lines are drawn in the same colour as the parameter diagram. Displaying the dues concerns both the Y and X axis parameters. The sample view with the due values is presented in Ill. 23.



Ill. 23. View with marked due values and anaerobic threshold.

6.5.1.4. Type of diagram.

This command allows us to choose between the line and point diagram type in the given view.

6.5.1.5. Print the diagram.

Selecting this command results in printing the given diagram view.

6.5.1.6. Enter AT threshold.

It consists in manual placing the indicator (Chapter 6.5.1.9) in the place where we think that the anaerobic threshold is. In the selection field there appears an orange vertical

line that marks this threshold. The programme looks for the breath that is closest to this place during the load phase. In the table the anaerobic threshold is marked with larger bold and underlined font (only in case of averaging *by breath*). This option is available only if the examination is completed and the number of phases in the examination is bigger than one.

6.5.1.7. Show AT threshold.

It results in displaying in the given view the anaerobic threshold (if it has been determined). The view with the threshold displayed is presented in Ill. 23.

6.5.1.8. Background colour.

This option allows us to change the background colour of the given diagram.

6.5.1.9. Indicator.

Marking this option results in displaying on the diagram a thin vertical line that is the indicator. It is used to select the place where we would like to place the Event or the anaerobic threshold. While surveying the diagram content with the indicator in the programme status line we receive information on the phase conditions of the examination (which phase was conducted, how much time was left to its completion, how much time was left to the examination completion). Obviously, information about the phases if displayed only if there are any phases in the examination. The information refers to the real phases.

6.5.1.10. Enter event.

This command results in entering the Event into the examination in the place where there currently is the indicator.

6.5.2. Diagram options.

6.5.2.1. Change of axis scale.

In order to change the axis scale use the command from the *View* menu: *Streching the X scale, Narrowing the X scale, Stretching the Y scale, Narrowing the Y scale*. Thos commands are repeated in the toolbar buttons with the (+/-) magnifiers with the right scale marked  . Stretching the Y scale is possible for all the diagrams, while stretching the X scale is possible only for the diagrams with *Scroll* (on-line diagrams and parameter diagrams with activated *Scroll*). Those operations affect the active diagram. The smallest possible X axis scale is restricted to 10 seconds.

6.5.2.2. Synchronisation of the table with the diagram.

This command (*View* menu) is dedicated to set the table in the time place (its *Scroll*) in which the diagram is active. This option refers to diagrams with *Scroll*. The command is repeated in the toolbar  .

6.5.2.3. Synchronisation of diagrams with the diagram.

This command (*View* menu) is dedicated to set the other diagrams with *Scroll* in the time place in which the diagram is active. This option refers to diagrams with *Scroll*. The command is repeated in the toolbar  .

6.5.2.4. Default X scale range.

This command (*View* menu) is dedicated to setting in all diagrams with *Scroll* the same scroll range (set previously in the options – Chapter 5.4.1). The command is repeated in the toolbar  .

6.5.3. Table.

Sample table is presented in Ill. 24.

Sn	Time	BF	HR	MET	VE	RER	VO2	VCO2	VO2/HR	VO2/Kg	WATT
	hh:mm:ss	1/min	1/min		L/min		L/min	L/min	mL/HR	mL/kg/min	W
46	00:23:00	58.4	166	12.20	86.4	0.99	2.93	2.89	17.62	42.7	0
47	00:23:30	64.3	168	12.37	85.4	0.98	2.97	2.92	17.75	43.3	0
48	00:24:00	60.7	169	13.54	94.5	0.92	3.26	3.00	19.22	47.4	0
49	00:24:30	59.5	171	13.58	99.1	1.02	3.27	3.34	19.05	47.5	0
50	00:25:00	58.0	173	13.60	103.9	1.05	3.27	3.45	18.92	47.6	0
51	00:25:30	54.4	175	13.55	108.9	1.09	3.26	3.56	18.67	47.4	0
52	00:26:00	56.8	176	13.70	114.1	1.12	3.30	3.69	18.71	48.0	0
53	00:26:30	58.6	177	13.56	112.4	1.12	3.26	3.65	18.42	47.5	0
54	00:27:00	59.8	176	13.86	114.5	1.11	3.33	3.71	18.89	48.5	0
55	00:27:30	53.9	175	13.49	113.2	1.12	3.24	3.63	18.49	47.2	0
56	00:28:00	45.1	168	11.77	93.2	1.11	2.83	3.14	16.81	41.2	0
57	00:28:30	33.2	142	7.80	58.0	1.11	1.88	2.08	13.21	27.3	0
58	00:29:00	28.3	114	4.59	35.8	1.16	1.10	1.28	9.71	16.1	0
59	00:29:30	26.0	101	3.38	29.7	1.24	0.81	1.01	8.03	11.8	0
60	00:30:00	27.0	93	2.87	25.9	1.24	0.69	0.86	7.43	10.0	0
61	00:30:30	24.9	88	2.55	24.4	1.26	0.61	0.77	6.93	8.9	0

Ill. 24. Parameter table.

The table presents the values of the selected parameters at the given moments of the examination. When the size of the table exceeds the available screen area, there appear scrolls with bars at the bottom and on the right which enable to display any fragment of the

table. If we mark the *Include dues in the Table* field one the *View* page in *Examination options* (Chapter 5.4.1) in the value table of parameters that have dues, they will be displayed in the colour depending on the value and due relation. If the parameter value lies within the range of minimal and maximal due value, then the cell will be sea-green (normal value). In other cases, it is white. If the HR parameter is incorrect, four horizontal dashes are displayed there.

6.5.4. Table view options.

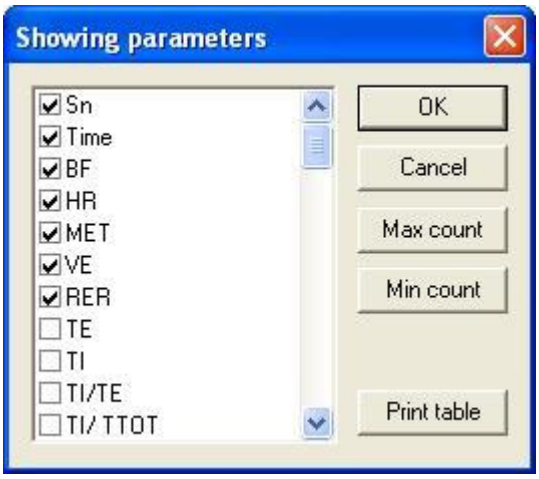
Table view options are available in the context menu that appears after clicking on the table view with the right mouse button (Ill. 25).

Ill. 25. Table view menu.

If we mark the table row (with the left mouse button) while surveying the table content, we receive in the programme status line the information about the phase conditions of the examination (which phase was conducted, how much time was left to its completion, how much time was left to the examination completion). Obviously, this information is displayed if there are any phases in the examination. The information refers to the real phases.

6.5.4.1. Parameters.

The parameters displayed in the table are selected from the dialogue window which appears after choosing the *Parameters displayed in the Table* command from the *View* menu. The window can also be opened by clicking on the *Parameters* command in the table menu. The window is presented in Ill. 26.



Ill. 26. Dialogue window for the selection of parameters in the table.

In the window with the parameter names we select those that we would like to display in the table. Marking and de-marking is done by clicking on the selected parameter with the left

mouse button (in the field on the left side of the name). One may switch the parameters' place (they will be displayed in the table in this order). In order to do this we click on the selected parameter with the left mouse button and drag it to the desired position.
The *Max. number* button is used to mark the maximal number of the available parameters (in the present version it is 20). Marking is completed from the top of the list until the maximal number of marked parameters is reached. The *Min. number* button is used to mark the minimal number of parameter (2 parameters). De-marking is also done from the top of the list until there is only the minimal number of parameters marked. The selection is confirmed with the *OK* button. *Print* results in printing the table with the printer.
The parameters from which examination moments appear in the table is determined by the selected averaging (⇨ Chapter 6.6).

6.5.4.2. Remove / Restore.

The programme offers the possibility of removing the rows from the table if we suspect that there was some interference. The remove and restore option is possible only if the rows are averaged by breath. In order to remove a given row, one needs to highlight it with the left mouse button and then select the *Remove/ Restore* command from the table menu. Then the highlighted row turns grey and the parameter values of this row change into the average value from the previous and next rows. On the printout the removed row is marked in bold italics. In order to restore the original row, we act in the same way as with removing (highlighting the removed row). While saving the examination, the original and removed rows are recorded, so it is possible to restore the original rows in the examination saved with removed rows. It is possible to remove or restore several rows at a time. One should highlight several rows with the use of the *Shift* key and the left mouse button and then select the *Remove/ Restore* button. Within the highlighted area the removed rows will be restored, and those that are not removed will be removed.

6.5.4.3. Enter event.

This command allows to enter an event in the time represented by the highlighted row. In order to do this, one needs to highlight the row in the table with the left mouse button and then select the *Enter event* command from the table menu. There will appear a dialogue window for entering the Event with the set time of the highlighted row.

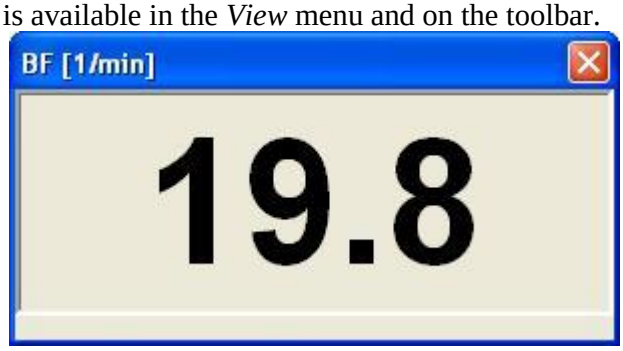
6.5.4.4. HR editing.

This command allows to edit the HR parameter in the highlighted row. It is available only with averaging by breath. In order to edit the HR parameter, one need to highlight the row and select the *HR editing* command from the table menu. There will appear the dialogue window that contains the old parameter value. One should modify the value and confirm this with the *OK* button. (Ill. 27).

Ill. 27. *HR editing* dialogue window.

6.5.4.5. Pop-Up window.

It is the window where the given parameter is displayed during the examination. The parameter is displayed in a very large font, which enables the observation of its value from afar. We select the parameter by clicking the left mouse button on the window area which presents us with the parameter selection menu. We may select only one parameter (i.e. in order to mark the selected one, one should de-mark the one previously marked). It is not possible to select the time and ordinal number parameters. The command for displaying the Pop-Up window is available in the *View* menu and on the toolbar.



Ill. 28. Pop-Up window.

6.5.4.6. Synchronisation of diagrams with the table.

This command (available in the *View* menu) results in setting all the diagams with *Scroll* in the time place where the highlighted table row is. The table row is highlighted by clicking on it with the left mouse button.

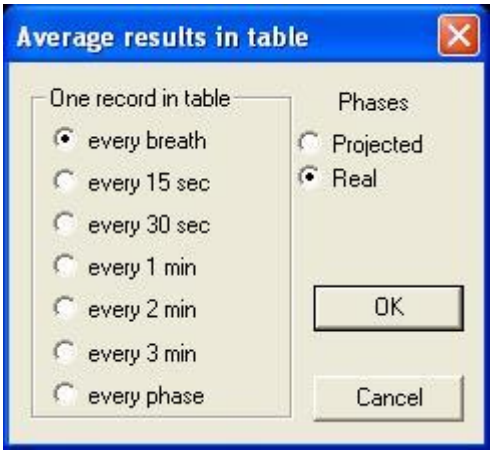
6.5.4.7. Table printout.

By selecting the *Print Table* command from the *View* menu or pressing the *Print* button in the parameter dialogue window (Chapter 6.5.4.1) we print only the table with the printer.

6.6. Averaging.

If we select the *Data averaging* command from the *View* menu there appears a window as presented in Ill. 29.

.



Ill. 29. Dialogue window: *Averaging the results in the table*.

Here we select the averaging method the data read during the examination. The programme saves the data after the patient's each breath, so it is possible to change the averaging method for the examination opened from the file. If we select *by breath* method the parameter value will be the value for the given patient's breath. If we select any of the times, then the parameter value is the average of its values from the selected time period. With the change of the averaging method there also changes the number of samples that are displayed in the table and in the diagram, because their number depends on the period of time from which their average value is calculated (from *by breath* to *every 5 min.*). Therefore, the averaging method change changes the outlook of the displayed diagrams and tables. If we select the *by phase* method, the averaging will be made according to the periods of time of the individual phases. On the right we determine the phases according to which the averaging is made. If we select averaging according to the real phases and there are no real phases, the programme will notify about this fact and average the data according to the project data. If there are no phrases set, then the option of averaging according to phases is inactive.

6.7. Zeroing the flow and gases.

To operate properly the measurement systems have to be zeroed before every examination. Zeroing is conducted automatically in the starting moment of a new examination. It can also be launched from the menu with the *Flow zeroing* and *Gas zeroing* commands.

6.8. Export to the statistical programmes.

This command orders the programme to convert the open document into a text file with the format that enables its reading and processing in the *Microsoft Excel* spreadsheet. Since it is a text file, it can be even modified with the simplest word processor (e.g. *Notepad* from the *Windows' Accessories*). The converted file is saved in the directory from which the document was opened and has the **.txt* extension. The file name is identical with the name of the examination that we want to convert.

.

6.9. Last parameters LT.

This command is used to display the last spirometric parameters for the given patient (not the ones saved with the examination). If there are no parameters, the programme informs the user about this fact.

6.10. Show predicted values.

Selection of this position from the *Tools* menu displays the available predicted values for the given patient. If there are no predicted values, the user is informed about this fact.

6.11. ECG parameters.

The programme enables reading the HR parameter during the examination. It is necessary to have the ECG signal source, e.g. *Cardiax, POLAR or other* device.
The programme reads the HR parameter while operating if one of the sources is marked in the *HR source* group in the *Communication* tab in *Examination options.*

The ECG Cardiax system is an independent device (look: Cardiax manual), but it can also operate together with the ergospirometer.

6.12. Predicted values.

The programme calculates the predicted values for four parameters. They are: VO2, HR, MV_{MAX}, BR. In order to cacultate the norm for the last two, the spirometric parameter MEF50 is necessary. One can obtain it from the spirometric examination (Chapter 7.2.3). Those norms are calculated according to the Wasserman standards. Calculated values may be:

- displayed (Chapter 0) ;
- included in the diagram (Chapter 6.5.1.3);
- included in the table (Chapter 5.4.1)

6.13. Find the AT threshold.

This command is located in the *Tools* menu (during the open examination). It is dedicated to automatically find the examination moment that is closest to the anaerobic threshold criterion. If such moment cannot be found in the examination, the programme informs the user about this fact.

6.14. Remove the AT threshold.

This command is located in the *Tools* menu (during the open examination with the AT threshold marked). It removes the previously marked or found threshold from the examination.

6.15. Indirect calorimetry. BMR norm configuration.

In order to calculate the energy consumption, one should mark the *Calculate calorimetry* option in the *General* tab in *Examination options.* The energy consumption determined during rest or exertion is calculated with two methods: direct or indirect. The direct calorimetry method is the most accurate and requires expensive instruments, therefore few institutes use it. The indirect calorimetry method consists in calculating the energy consumption with the help of the analysis of oxygen consumption during the exertion which should last minimum 5-6 minutes because in such a period of time the functional equilibrium is achieved. Total energy consumption consists of three elements:

- basic metabolism necessary to provide basic living functions which depends on the body surface of the examined person and the non-fat body weight – 60 ÷ 75 %;
- specific dynamic food actions – 10 ÷ 15 %;
- energy consumption during motor activity related to everyday actions – 15 ÷ 30 %.

In order to conduct the BMR norm configuration, click on the *BMR norm configuration* command in the *View* menu. A dialogue window (Ill. 30) will appear where one should mark the selected norm author:

Ill. 30. BMR norm configuration.

Formulae for the BMR values:

Harris Benedict:
Men: [kcal/day] = 66 + 13.75 * weight + 5.0 * height – 6.76 * age
Women: [kcal/day] = 65.5 + 9.56 * weight + 1.85 * height – 4.68 * age

Owen:
Men: [kcal/day] = 879 + 10.2 * weight
Women: [kcal/day] = 795 + 7.2 * weight

Miffin:
Men: [kcal/day] = 5 + 10 * weight + 6.25 * height – 5 * age
Women: [kcal/day] = - 161 + 10 * weight + 6.25 * height – 5 * age

where:

.

weight [kg];
height [cm];
age [years].

6.16. Calorimetry based on the minute ventilation.

It is not always possible to determine the energy consumption on the operating place with the help of the classic indirect calorimetry method. In the practice of industrial examination there is often used a method based on the results of the lung ventilation measurement. There is a high correlation coefficient and almost linear relation between the oxygen consumption during exertion and the minute ventilation value. The approximate value of the energy consumption may be calculated with the use of **Datta-Ramanathana** equation:

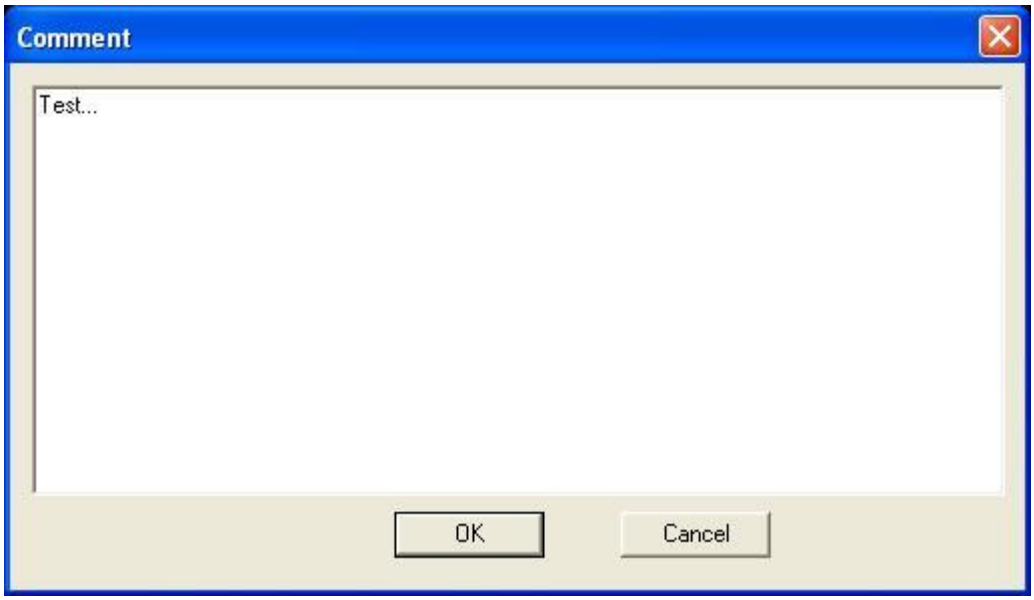
REE(EE) = 0.21 x VE(STPD) [kcal/min]

where VE(STPD) – lung ventilation in L/min in the STPD conditions (volume of dry gas in the temperature of 0^{o}C and the atmospheric pressure of 760 mmHg).
In order to calculate the calorimetry with this method one should mark the *Indirect calorimetry* in *Examination options -> General.* In order to convert the value from one method to another, one needs to mark and de-mark the above-mentioned field and issue the *Convert calorimetry* command from the *View* menu.

6.17. Commentary.

To the examination we may add the commentary that would characterise it. In order to add commentary one should select the *Commentary* command from the *Examination* menu. There will appear a dialogue window to enter the commentary (Ill. 31).

.



Ill. 31. Window to enter commentary.

The information entered should be confirmed with the *OK* button. The commentary is saved with the examination. In order to read the saved commentary, one needs to select the *Commentary* option from the *Examination* menu.

.

7. Conducting the examination.

7.1. Preparation for work.

1. Check if the ergospirometer is connected to the DIO card port or RS 232 port in the computer.
2. Check if the pneumotachographic head is properly connected to the device (⇨ Chapter 1).
3. If the examination is conducted with the use of controlled ergometer, connect it to the proper computer port (⇨ Chapter 5.3.2).
4. Connect the mouthpiec to the pneumotachographic head or the pneumotachographic to the mask .
5. Launch the ergospirometer with the W1 mains switch.
6. Start the *Start 2000* programme.
7. Set the programme options (⇨ Chapter 5).
8. Conduct the examination according to the description from Chapter 7.2.

7.2. Conducting the examination.

The necessary condition for the test start is checking if all the measurement elements of the device function properly. The check is possible thanks to the procedure of calibration of the gas analysers and the ventilation measurement system (Chapter 5.2). It is recommended to calibrate the device before conducting a series of examinations on a given day.

During the examination the only command available is the one ending the examination (the *Stop* command from the *Examination* menu). It prevents all incorrect methods of ending the work with the programme (e.g. closing the programme during the examination). The whole examination may summarised in the following points:

1. Control the device for safety from electric shock checking visually the condition of the electric cables.
2. Perform the everyday device service according to the guideline from Chapter: Maintenance and everyday service.
3. Turn the device on with the use of the mains switch at the back of the device (W1 switch in Ill. 1).
4. Leave the device on for at least 30 minutes so that the measurement elements would gain the thermal stability.
5. Start the *Start 2000* programme.
6. Enter the patient's data (⇨ Chapter 4).
7. Match the proper size of the measurement mask for the patient so as to ensure the tightness on the contact point with the skin of the face.

   NOTE!
   A/ It is recommended to connect the pneumotachographic head to the mask before putting it on;
   B/ One should remember not to connect the pneumotachographic head connection cable before the automatic zeroing procedure of the measurement system is completed;
8. Set the examination options (⇨ Chapter 5.3).
9. Start the examination by clicking the *B* icon (⇨ Chapter 7.2.1).

10. Conduct the examination according to the description of this type of examination.
11. Finish the examination with the *Stop* button (button with the red circle). Save the examination (⇨ Chapter 7.3).
12. In order to conduct another examination, one should close the open examination (the *Close* command in the *File* menu). Further procedure goes as described above starting from point 3. The patient's data refer to the last patient. When the examination is conducted on another patient, the data should be modified (⇨ Chapter 4.2).

7.2.1. The *Test for Start 2000* examination.

This examination is started by clicking the *B* button or selecting the *Test for Start 2000* command from the *Examination* menu. Obviously, one has to enter the patient's data first (⇨ Chapter 4) and set the programme options (⇨ Chapter 5). If the programme's calibration is invalid, it will require the calibration of gases and volumes. Such calibration is valid for 24 hours. The same is true for the environment conditions. The measurement system is ventilated automatically – 'Ventilation of the measurement system' presented with the help of progress bar. After the ventilation is finished, the system asks whether it should zero, then after pressing OK, there is the zeroing conducted – also presented with the help of progress bar.

NOTE.
a/The pneumotachographic head connection cable cannot be connected to the pneumotachographic head attached to the mask;
b/It is required to move the pneumotachographic head connection cable as far away as possible from the mouth of the examined person or the person operating the ergospirometer!
c/After the zeroing is completed, the measurement system is in the control phase and then the pneumotachographic head connection cable should be connected to the head and the connection terminal in the mask;

If the last update took place more then 4 hours before the attempt to start the test, the programme will remind about the data update (⇨ Chapter 5.1). When this type of examination is selected, the programme menu and toolbar changes. The toolbar is presented in Ill. 32.

Ill. 32. Toolbar for the *Test for Start 2000* examination.

The test is started wen the *Start* command from the *Examination* menu. Depending on the examination option settings, the programme goes to the control stage of the examination (⇨ Chapter 6.1) or requires entering the examination phases (⇨ Chapter 6.2). After entering the phases, the examination should be started once again. If the programme operated correctly in the control stage, we may go to the examination stage by clicking the *GO* icon or selecting the *Start test* command from the *Examination* menu. The control stage for the 1.6.0.0 version could last maximum of 5 minutes. From the 1.6.0.0 version it is unrestricted, but every 5 minutes a reminder is displayed that we are in the control stage. In this time is exceeded, the programme informs about this fact and recommends starting the examination from the beginning. In the examination stage the diagram views and tables with parameters are zeroed. If the examination is conducted with the use of a controlled ergometer, the control is initiated. Ergometer control can be done on the basis of the

examination project phases or with the help of remote control. The remote control is launched with the *Ergometer control* command from the *Examination* menu or by clicking on the remote control icon in the toolbar. Operating the remote control is described in Chapter 6.4. During the examination the ergospirometer pumps are working. Should the need arise they can be turned on and off with the *Pumps On/ Off* command (*Examination* menu) or with the pump button on the toolbar.

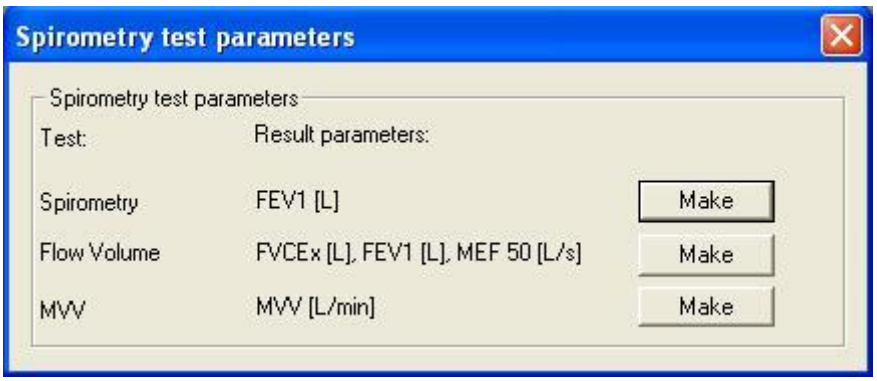
During the examination in the diagram views there are drawn the *on-line* courses and diagrams of parameters selected in the reference menu of the diagram view (⇨ Chapter 6.5.1.2). The values of individual parameters are entered to the table in *Examination options -> Document view* (⇨ Chapter 5.4.1). One may also set there the number of diagram views. During the examination with the set phases and controlled ergometer, in the status line there is entered information about the number of all the phases, the number of the current phase and the time left to the phase completion, and the time left to the test completion. The examination is stopped with the *Stop* command from the *Examination* menu. One should then save the conducted examination to file (⇨ Chapter 7.3). The programme saves the diagrams and table columns for all parameters, irrespective of which and how many parameters we have selected to be drawn on the diagram and in the table. It means that after opening the examination from the file, we have access to all diagrams and values of all parameters from every moment of the examination.

7.2.2. Spirometric examination.

Selectin the *Spirometric examination* command from the *Examination* menu launches the *LungTest 1000* programme with the previously entered patient data. The *LungTest 1000* programme is described in a similar manual.

7.2.3. Download parameters LT.

After the selection of this command, a dialogue window appears as presented in Ill. 33.



Ill. 33. Spirometric examination parameters.

In the left column there are names of examinations to be conducted to obtain the parameters from the middle column. In order to conduct a given examination, one should press the *Conduct* button. The *LungTest 1000* programme is then launched in the mode suitable for

the given examination. One should conduct the examination and the desired parameters will be transferred to the programme.

7.2.4. Examination with stabilisation (OPTION).

During this examination we stabilise the parameters of the inhaled gas. Depending on the fact whether we select oxygen stabilisation or air stabilisation in the options, the stabilised parameter will be the oxygen concentration in the inhaled gas or the temperature and humidity of the inhaled gas. Both the gas concentration and temperature are set in the examination options (Chapter 5.4.3), while the humidity should be kept at the level of 40 – 50 %. In order to start the examinations, the system requires valida calibrations. They are valid for 24 hours. It refers to the calibration of the oxygen and carbon dioxide sensor for the gas analysis from the head, and the oxygen sensor for the analysis of inhaled gas (from the bag). One should pay attention to the fact that the examination with oxygen stabilisation uses another oxygen sensor for gas from the head than the standard examination. Its calibration is conducted with the *Gas calibration (high O2)* command (Chapter 5.2.3). Calibration coefficient for carbon dioxide calibration is the same for both types of examination. Please, mark the ***System with three-way valve*** option in the *General* tab in the *Examination options* for the examination with stabilisation, because the breaths go through this valve.

The examination starts with entering the patient's data and selecting the *Start* command from the *Examination* menu. There appears information that 'zero' will be read from the atmosphere for the oxygen sensor in the bag and the request for taking the bag off the device. After acceptance, 'zero' is read from the atmosphere (it is the reference level for the oxygen sensor). Then the system informs about the intention of filling the bag with the gas mixture and requests for the bag to be attached to the device. After pressing *Yes* there is the preliminary filling of the bag with the gas mixture. Depending on the fact whether the examination is conducted with the oxygen stabilisation or the air stabilisation, the system fills the bag either with the mixture of oxygen and air of set concentration or with air of set temperature and humidity lower than 50 %. The filling time depends on the flows set in the examination options and on the volume of the initial mixture which is also set in the options. During the filling the information progress bar moves and the total time of filling is given.

When the bag is full, the starting procedure for the examination is the same as for the *Test for Start 2000* examination. There is a question about the measurement system zeroing, ventilation, system zeroing, checking the zero and examination start.

In the examination with stabilisation we have at our disposal three more parameters in the table. They are: O2 concentration, temperature and inhalation gas humidity. They allow to assess the stabilisation quality. During the examination the bag is filled automatically with the inhalation gas. In order to turn the filling system off for any reason, one should de-mark the *Filling system* field in the *Tools* menu or press the  button on the toolbar. Additionally, after the examination is properly completed, we have a printed report summing up the examination. It includes information about the stabilisation type, and in case of oxygen stabilisation also the date and calibration coefficient for the oxygen sensor in the bag. The report also includes the parameters set for stabilisation and the obtained parameters +/- standard deviation. One should pay attention to the fact that for the examination with oxygen stabilisation the coefficient and date of O2 calibration refers to calibration with high oxygen.

7.3. Saving the examination to file.

In order to save the examination results, select the *Save examination* command from the *File* menu. There appears a dialogue window with the question about the name of the file where we would like to save the examination. Standard extension of these files is **.egs*. The programme creates automatically a subdirectory with the patient's personal data in the proper directory set in *Examination options* (⇨ Chapter 5.3.3). The file name consists of the date and time of conducting the examination. We may obviously change the name of the file and the directory where we want to save it. The file is saved upon closing the *Save* dialogue window with the *OK* button. If we try to close the programme without saving, the programme will remind us of the fact that the examination is not saved and enable us to save the examination before closing the programme.

7.4. Opening examination from the file.

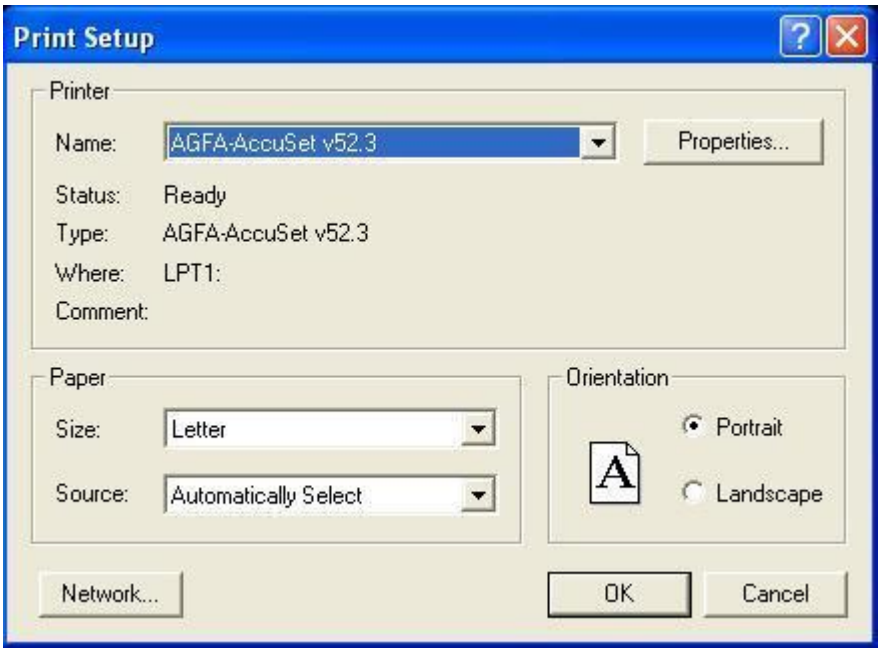
The programme opens one type of files with the **.egs* extension which include the saved examination. The examination saving process is described in chapter 7.3. In order to open the desired file, one should select the *Open* command from the *File* menu. When the dialogue window appears, select the file that we want to read.
Upon opening the programme displays the diagram views and table with the parameters for the individual moments of examination. The number of views is set in *Examination options -> Document view* (⇨ Chapter 5.4.1). The parameters displayed in the table are determined in the table view options (⇨ Chapter 6.5.4). Because the values of all parameters from every moment of the examination are saved to the file, we may put any parameter in the table or on the diagram. In this way we have access to the diagram of every parameter and to its values at any moment of the examination.

7.5. Printing the examination report.

We may print the examination results after the examination completion or after opening the examination from file (⇨ Chapter 7.4). In order to print a report, one should select the *Print* command from the *File* menu or click on the printer icon in the toolbar. In order to survey the report layout, one should select the *Printout preview* command from the *File* menu. The printout may be set with the *Print settings* command from the *File* menu. The parameters of report layout may be set in *Printout configuration.* Its description can be found in chapter 7.5.2.

7.5.1. Print settings.

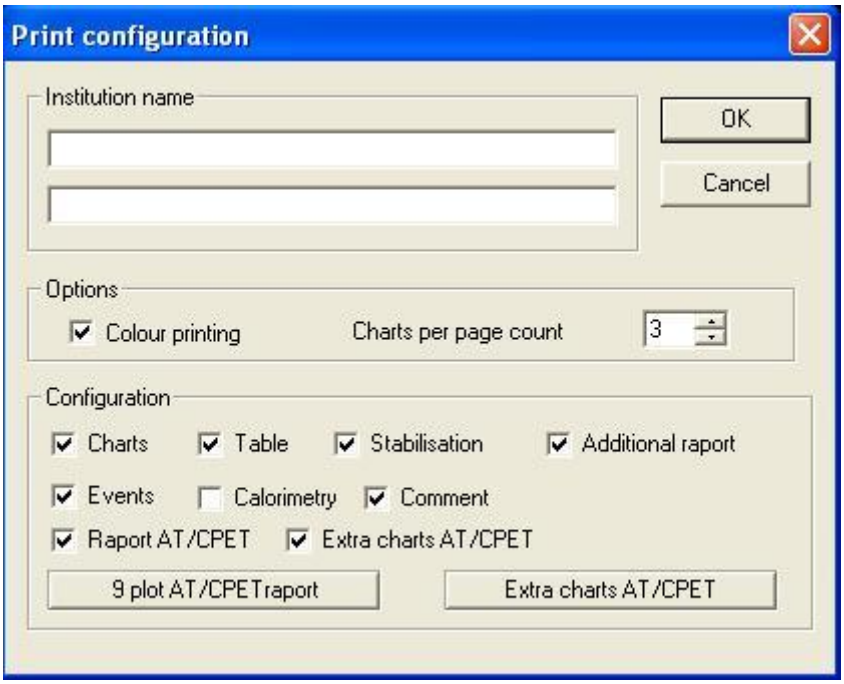
The *Print settings* command from the *File* menu launches the menu where we set the printout parameters. Here those parameters include: type of the printer with which we want to print the report, size and source of paper, page orientation. This window is presented in Ill. 34.



Ill. 34. *Print settings* dialogue window.

7.5.2. Printout configuration.

The layout options of the examination report are set in the window that appears after selection of the *Printout configuration* command from the *Examination* menu. It is presented in Ill. 35.



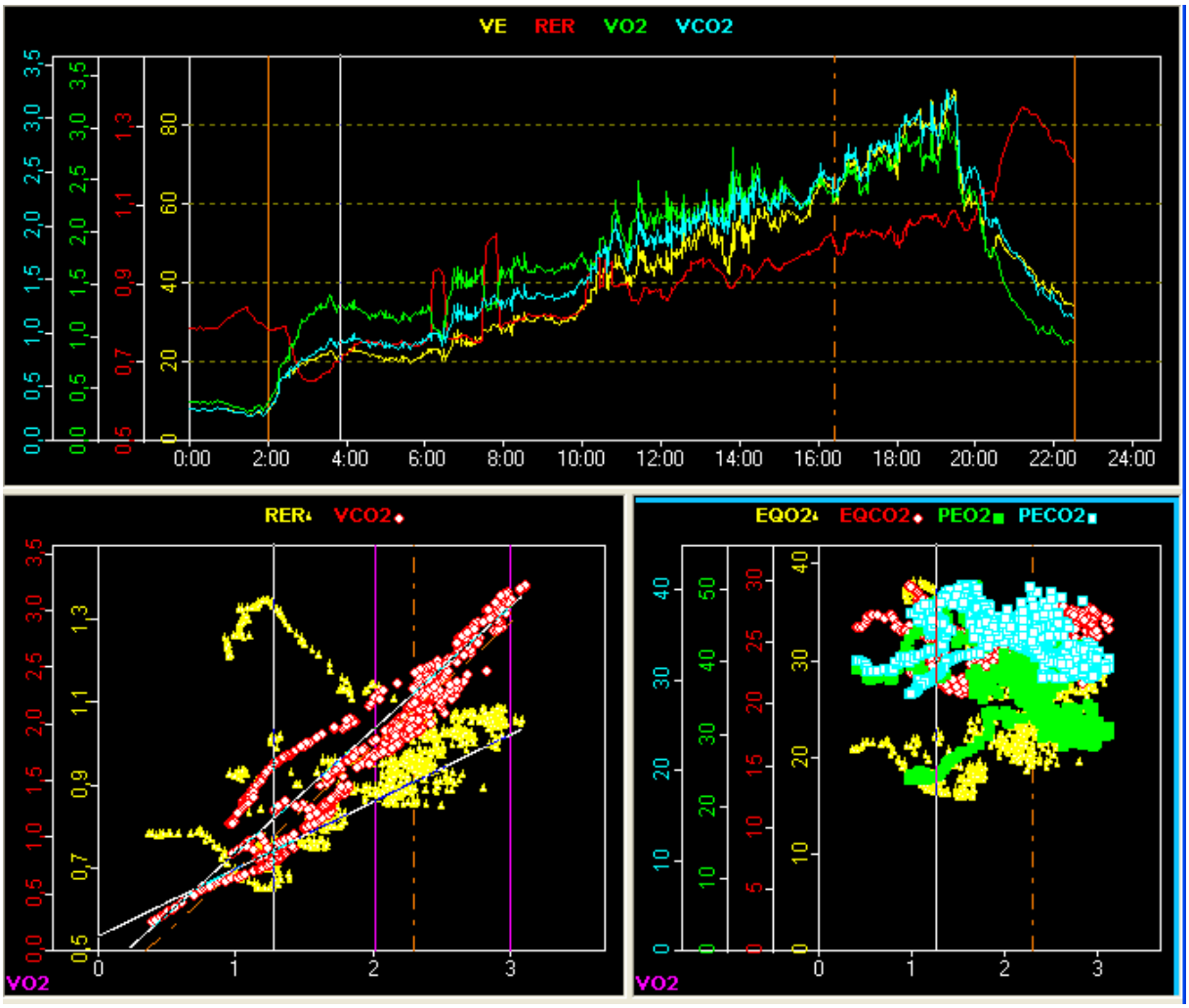
Ill. 35. *Printout configuration* dialogue window.

In the *Name of institution* fields we enter the name of institution that conducted the examination. The name will appear under the heading on the first page of the report (⇨ Chapter 9). By marking the *Colour printout* field we inform the programme whether the printing will be in colour or not. If we do not mark this field, the programme will treat it as

printing in the grey scale. In such case every view with more than one diagram will be divided into so many separate diagrams as there was parameters determined in this view. Every selected parameter will be printed on a separate diagram. In the *Number of diagrams on page* field we determine how many diagrams should there be on one printout page. We confirm the set parameters with the *OK* button.
In the *Configuration* field we select the printout elements. The maked modules will appear on the final printout. The buttons: *9 landscape report AT/CPET* and *Additional diagrams AT/CPET* are used for the AT/CPET report configuration (Chapter 9) .

8. Mode of searching the AT threshold.

In order to go to the *mode of searching the AT threshold* one should select the *AT search* command from the *Tools* menu or select the  from the toolbar. As a result the system displays three windows.



Ill. 36. View of the mode of searching AT.

They display the value data of the examination parameters from the exertion phase (except for the first window which displays the data from the whole examination and the exertion area is marked with two orange vertical lines). The first window includes the diagram of maximum of four parameters in time. Those parameters may be selected freely in the same way as in the case of ordinary diagrams (the *Parameters* command from the diagram menu). The second window is the diagram of the relation of VCO2 and RER to VO2 parameters. The third window displays one of the prepared parameter sets which is selected from the diagram menu (*Parameters* command). There is also a table displayed which, contrary to an ordinary table, has an orange heading. Upon selecting the *AR search* command the system automatically starts to search for the point closest to the AT threshold. In order to do this the programme uses the MES algorithm. If the threshold is determined, it will be marked on the diagrams and in the table. If the algorithm fails to determine the point corresponding to the AT threshold, the user will be informed about this fact.

.

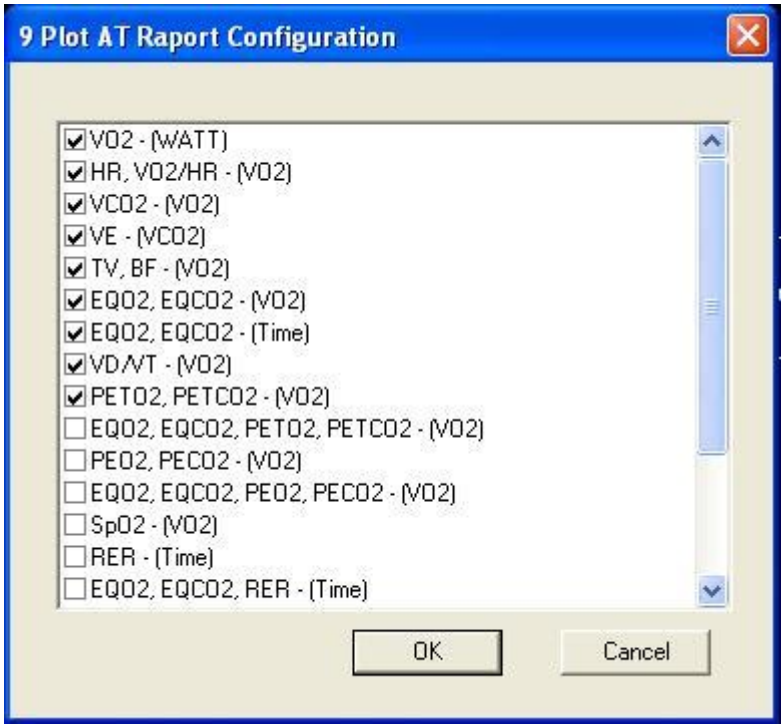
If we want to determine the AT threshold on own own, the mode of searching the AT threshold offers us a lot of facilities. On the first diagram we have at our disposal an indicator (a vertical line) which we can move horizontally (along the time axis) with the mouse cursor (the indicator 'sticks' to the mouse cursor when the cursor moves onto the area of the first window). Moving the indicator within the exertion phases' area (two orange vertical line – only when the grid is displayed) on the second diagram the two regression straight line change their positions. They refer to the two data areas. Those areas are created by splitting all the data with a point marked with the indicator in the first window. The regression lines facilitate finding the maximum inflection point of the VCO2 in relation to VO2 diagram (point suspected of being the AT). Apart from the regression lines in the second window there is also an indicator (vertical line) drawn that determines the point corresponding to the place indicated in the first window. Such indicator is also drawn in the third window. Additionally, while moving the indicator, in the table there is marked in light orange a row corresponding to the indicated place. Also the table scroll is moved automatically so that the indicated row is displayed in the visible fragment of the table. In order to identify the place in the first window more accurately we can turn on the scroll. We do this as with the ordinary diagrams through double click on the area. We can turn the scroll off in the same way. With the indicator's movements there is integrated information about the phases displayed in the status bar. Hence we know in which phase the indicator is, how long it lasted and what the exertion was then.

Both the first and third view can undergo configuration. For the first one we select the parameters like for the ordinary diagrams (the *Parameters* command from the view menu). For the third one the call is also made with the *Parameters* command, but here there will be displayed a window with parameter sets (like for the configuration, e.g. 9 landscape AT/CPET report). From this list we select one set of parameters.

In order to mark in the chosen place the AT point, we select from the menu of the first view the *Insert AT threshold* command. The place is marked with an orange dashed line on every diagram and in the table the row is highlighted in orange. Additionally, on the second diagram the regression line of the first data area (data are split by the AT threshold) is drawn with this orange dashed line. The determined AT threshold is also marked in the table by highlighting the row in orange.

After determining the AT threshold, we may print the report referring to this determination. In order to do this we mark the *AT/CPET report* option in the printout configuration. In order to print additional report diagrams one should also mark the *Additional AT/CPET report diagrams* button. The window is identical as for the 9 landscape AT/CPET report (Ill. 37). We select there two to four parameter sets. The sets for the 9 landscape report are selected after launching the window with the *9 landscape AT/CPET report* window. During the 9 landscape report one needs to select nine sets.

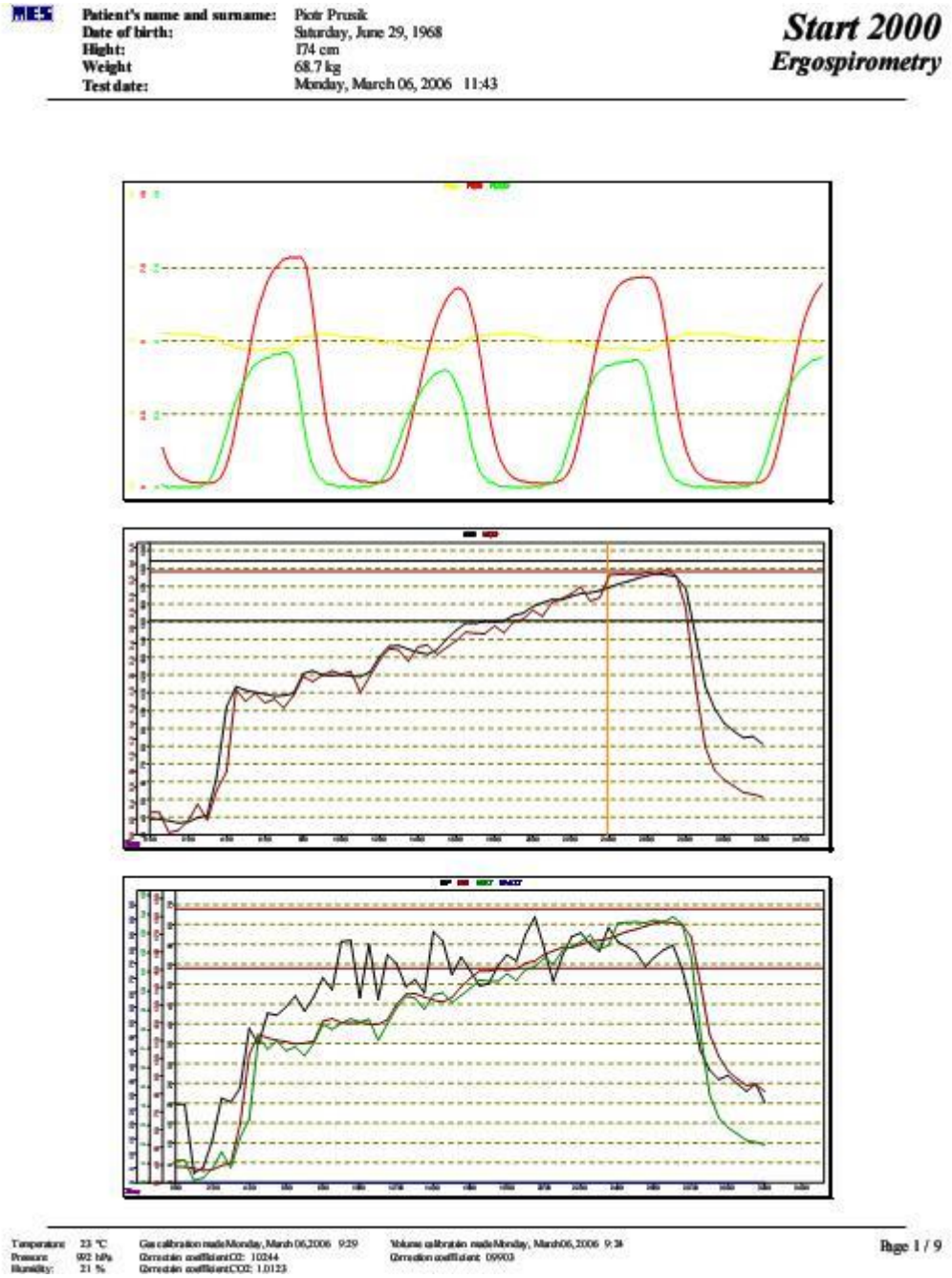
.



Ill. 37. Configuration of the 9 landscape AT/CPET report.

Detailed description of the report from determining the AT threshold can be found in the next chapter: Examination report (Chapter 9).

9. Examination report.



Ill. 38. Examination report.

The user can decide the range of the printed report. According to chapter 7.5.2 and dialogue window in ill. 35, there is a possibility of report standard configuration for the user's purposes.

The first page of the sample examination report is presented in Ill. 38. Under the heading with the MES company logo as well as the ergospirometer name and the conducted examination, there is the name of institution that conducted the examination (if it was entered in the *Printout configuration* – Chapter 7.5.2). Underneath there are data of the examined patient and the examination date. Then there are printed all the diagrams displayed in the diagram views. In case of black-and-white printout the views with more than one diagram are divided so that one view included only one diagram. After the

diagrams there is the table drawn. If it exceeds the available width of the printout, on the pages dedicated to the table there is a message: *Too little space to print the table.* Then one should reduce the number of parameters in the table (⇨ Chapter). **Before starting to print, it is recommended to check the printout preview (the *Printout preview* command from the *File* menu).** In the report's footnote there are the parameters referring to the atmospheric conditions during the examination and information about the last gas and volume calibrations before the examination. (⇨ Chapter 5.2).

After the diagrams the table may be printed (Ill. 39). It looks the same as in the programme window.

MES

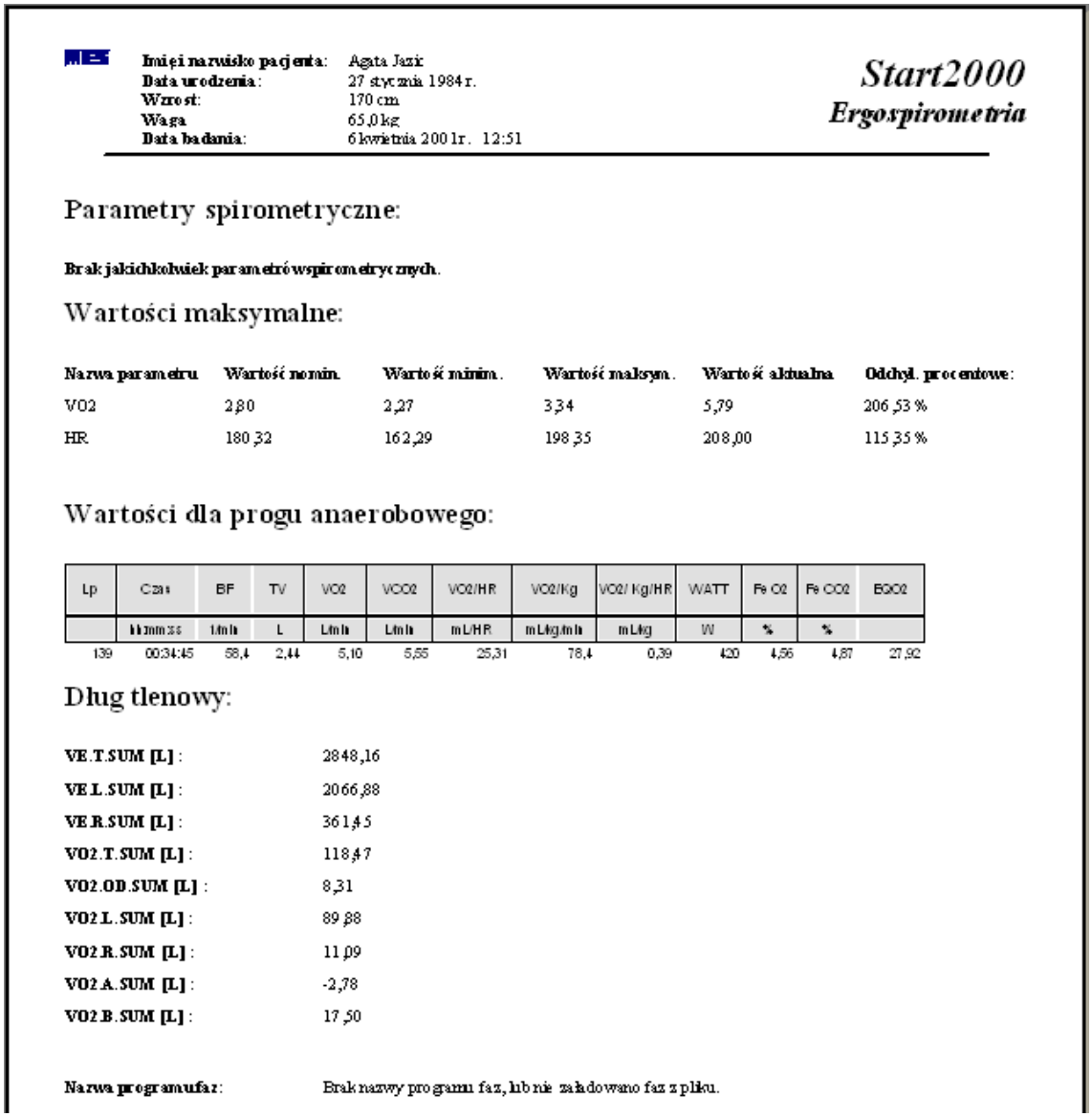
Patient's name and surname: Piotr Prusik
Date of birth: Saturday, June 29, 1968
Hight: 174 cm
Weight 68.7 kg
Test date: Monday, March 06, 2006 11:43

Start 2000
Ergospirometry

Sn	Time	BF	HR	MET	VE	RER	VO2	VCO2	VO2/HR	VO2/Kg	WATT	Speed	Slope
	hh:mm:ss	1/min	1/min		L/min		L/min	L/min	mL/HR	mL/kg/min	W	km/h	%
1	00:00:30	19.7	39	1.17	6.7	0.62	0.28	0.17	7.20	4.1	0	0.0	0
2	00:01:00	2.4	38	0.12	0.7	0.63	0.03	0.02	0.73	0.4	0	0.0	0
3	00:01:30	3.9	37	0.26	1.5	0.63	0.06	0.04	1.68	0.9	0	0.0	0
4	00:02:00	10.8	37	0.73	3.9	0.63	0.18	0.11	4.71	2.6	0	0.0	0
5	00:02:30	21.3	40	1.62	8.6	0.65	0.39	0.25	9.79	5.7	0	0.0	0
6	00:03:00	20.3	41	0.79	5.3	0.69	0.19	0.13	4.61	2.8	0	0.0	0
7	00:03:30	23.8	63	2.34	12.9	0.67	0.56	0.38	8.94	8.2	0	0.0	0
8	00:04:00	38.9	102	3.29	19.0	0.67	0.79	0.53	7.75	11.5	0	0.0	0
9	00:04:30	34.9	114	7.58	38.5	0.64	1.82	1.16	16.06	26.5	0	0.0	0
10	00:05:00	42.7	112	6.98	39.5	0.72	1.68	1.20	15.04	24.4	0	0.0	0
11	00:05:30	42.2	110	7.39	41.9	0.74	1.78	1.32	16.14	25.9	0	0.0	0
12	00:06:00	44.3	110	6.88	40.6	0.78	1.66	1.29	15.11	24.1	0	0.0	0
13	00:06:30	47.0	108	7.09	41.4	0.78	1.70	1.32	15.76	24.8	0	0.0	0
14	00:07:00	43.2	109	6.63	38.5	0.77	1.59	1.23	14.67	23.2	0	0.0	0
15	00:07:30	46.7	110	7.26	40.4	0.79	1.75	1.37	15.92	25.4	0	0.0	0
16	00:08:00	51.6	121	8.27	48.1	0.81	1.99	1.61	16.46	28.9	0	0.0	0
17	00:08:30	48.5	122	8.00	48.7	0.83	1.92	1.60	15.71	28.0	0	0.0	0
18	00:09:00	50.7	120	8.32	48.0	0.83	2.00	1.65	16.65	29.1	0	0.0	0
19	00:09:30	51.1	120	8.55	50.2	0.83	2.06	1.71	17.18	29.9	0	0.0	0
20	00:10:00	46.6	120	8.38	49.4	0.84	2.02	1.69	16.76	29.3	0	0.0	0
21	00:10:30	50.0	119	8.52	51.7	0.88	2.05	1.80	17.15	29.8	0	0.0	0
22	00:11:00	46.2	119	7.44	47.4	0.85	1.79	1.51	15.00	26.0	0	0.0	0
23	00:11:30	57.5	122	8.29	48.9	0.86	1.99	1.71	16.35	29.0	0	0.0	0
24	00:12:00	55.2	130	9.12	54.2	0.83	2.19	1.82	16.81	31.9	0	0.0	0
25	00:12:30	49.3	136	9.72	60.0	0.88	2.34	2.06	17.17	34.0	0	0.0	0
26	00:13:00	51.2	137	9.64	61.2	0.91	2.32	2.11	16.98	33.8	0	0.0	0
27	00:13:30	47.8	135	9.05	58.0	0.91	2.18	1.98	16.15	31.7	0	0.0	0
28	00:14:00	53.3	133	9.81	57.0	0.88	2.36	2.07	17.74	34.3	0	0.0	0
29	00:14:30	50.9	132	9.90	59.3	0.86	2.38	2.06	18.08	34.7	0	0.0	0
30	00:15:00	52.5	134	9.41	58.7	0.89	2.26	2.01	16.86	32.9	0	0.0	0

Ill. 39. Table on the printout.

After the table there may be an additional report on the printout (Ill. 40).



Imię i nazwisko pacjenta: Agata Jazic
Data urodzenia: 27 stycznia 1984 r.
Wzrost: 170 cm
Waga 65,0 kg
Data badania: 6 kwietnia 2001 r. 12:51

Start2000
Ergospirometria

Parametry spirometryczne:

Brak jakichkolwiek parametrów spirometrycznych.

Wartości maksymalne:

Nazwa parametru	Wartość nomin.	Wartość minim.	Wartość maksym.	Wartość aktualna	Oddzyl. procentowe:
VO2	2,80	2,27	3,34	5,79	206,53 %
HR	180,32	162,29	198,35	208,00	115,35 %

Wartości dla progu anaerobowego:

Lp	Czas	BF	TV	VO2	VCO2	VO2/HR	VO2/Kg	VO2/ Kg/HR	WATT	Fe O2	Fe CO2	EQO2
	hh:mm:ss	l/min	L	L/min	L/min	mL/HR	mL/kg/min	mL/kg	W	%	%	
139	00:34:45	58,4	2,44	5,10	5,55	25,31	78,4	0,39	420	4,56	4,87	27,92

Dług tlenowy:

VE.T.SUM [L] : 2848,16
VE.L.SUM [L] : 2066,88
VE.R.SUM [L] : 361,45
VO2.T.SUM [L] : 118,47
VO2.OD.SUM [L] : 8,31
VO2.L.SUM [L] : 89,88
VO2.R.SUM [L] : 11,09
VO2.A.SUM [L] : -2,78
VO2.B.SUM [L] : 17,50

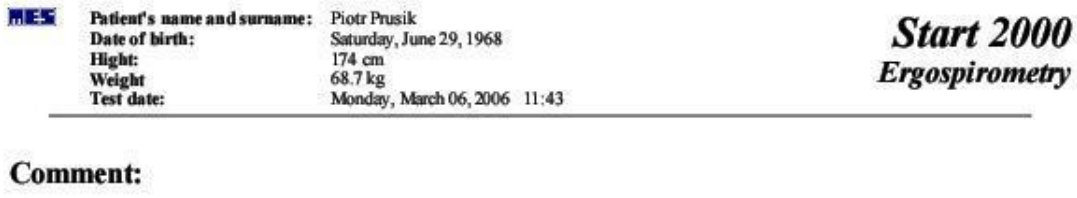
Nazwa programu faz: Brak nazwy programu faz, lub nie załadowano faz z pliku.

Ill. 40. Additional report(PL).

Additional report includes the spirometric parameters valid for the given patient on the examination day, the maximum values for which norms apply (together with the norm values and percentage of deviation), the parameter values in the anaerobic threshold point, parameters of the oxygen debt and the name of programme phases if they were loaded from the file and not entered manually. If there are no spirometric parameters, suitable information will be placed there instead of them. Similarly in case of the oxygen debt if it is not calculated, there will be information displayed about the likely cause for this state of affairs. Usually, it is the lack of any phases in the examination. The parameters for which the maximum value norms apply are VO2, HR, BR, VE.

Then there may be a metabolism report. The detailed description of it can be found in chapters **.**(Chapter 6.15) and **.**(Chapter 6.16).

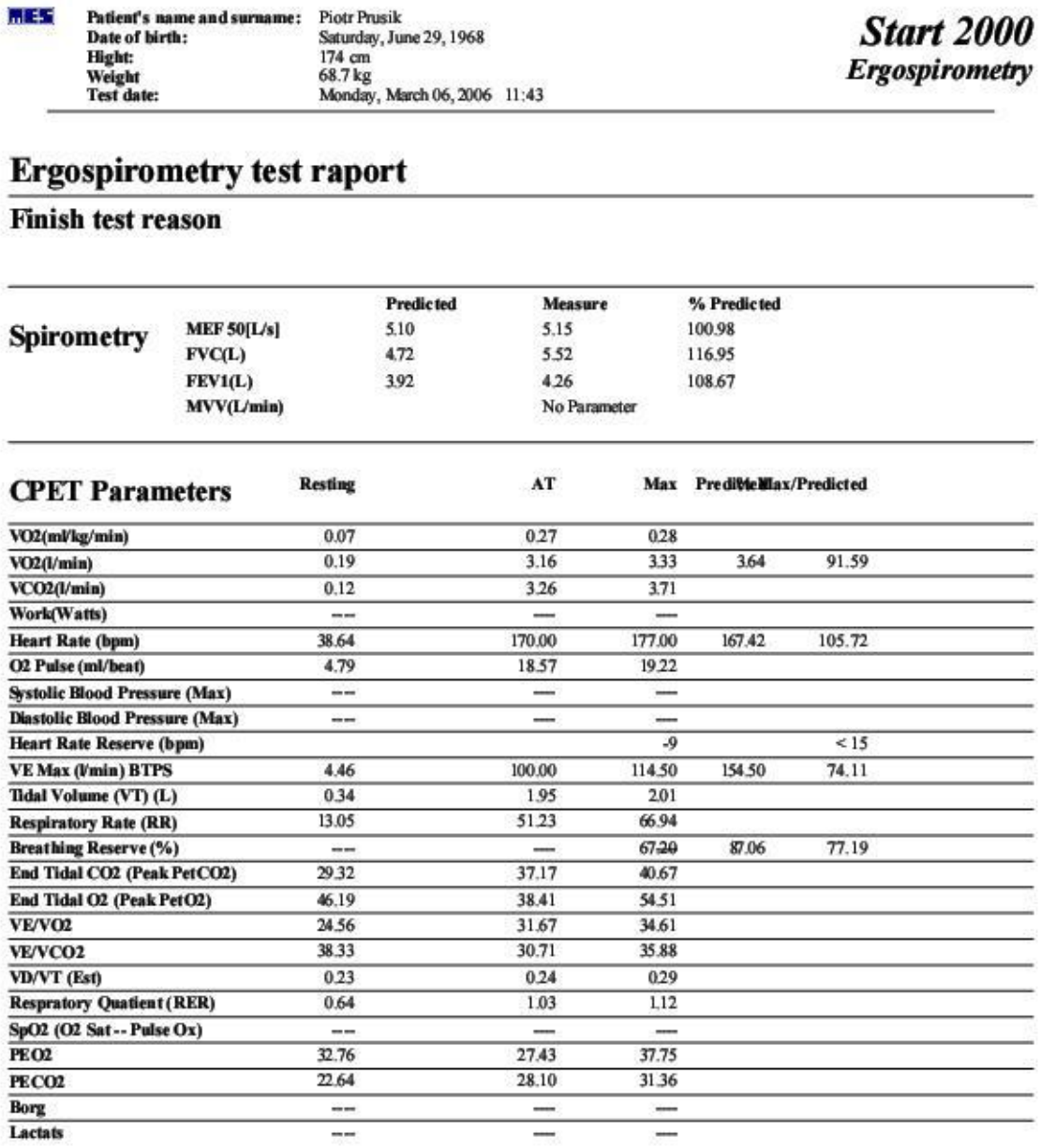
Then there may be a commentary to the examination (Ill. 41) and chapter **.**(6.17).



Ill. 41. Commentary on the printout.

The next pages are the printout related to the AT threshold determination. Below there is the first page presented.

.



Patient's name and surname:	Piotr Prusik
Date of birth:	Saturday, June 29, 1968
Hight:	174 cm
Weight	68.7 kg
Test date:	Monday, March 06, 2006 11:43

Start 2000
Ergospirometry

Ergospirometry test raport

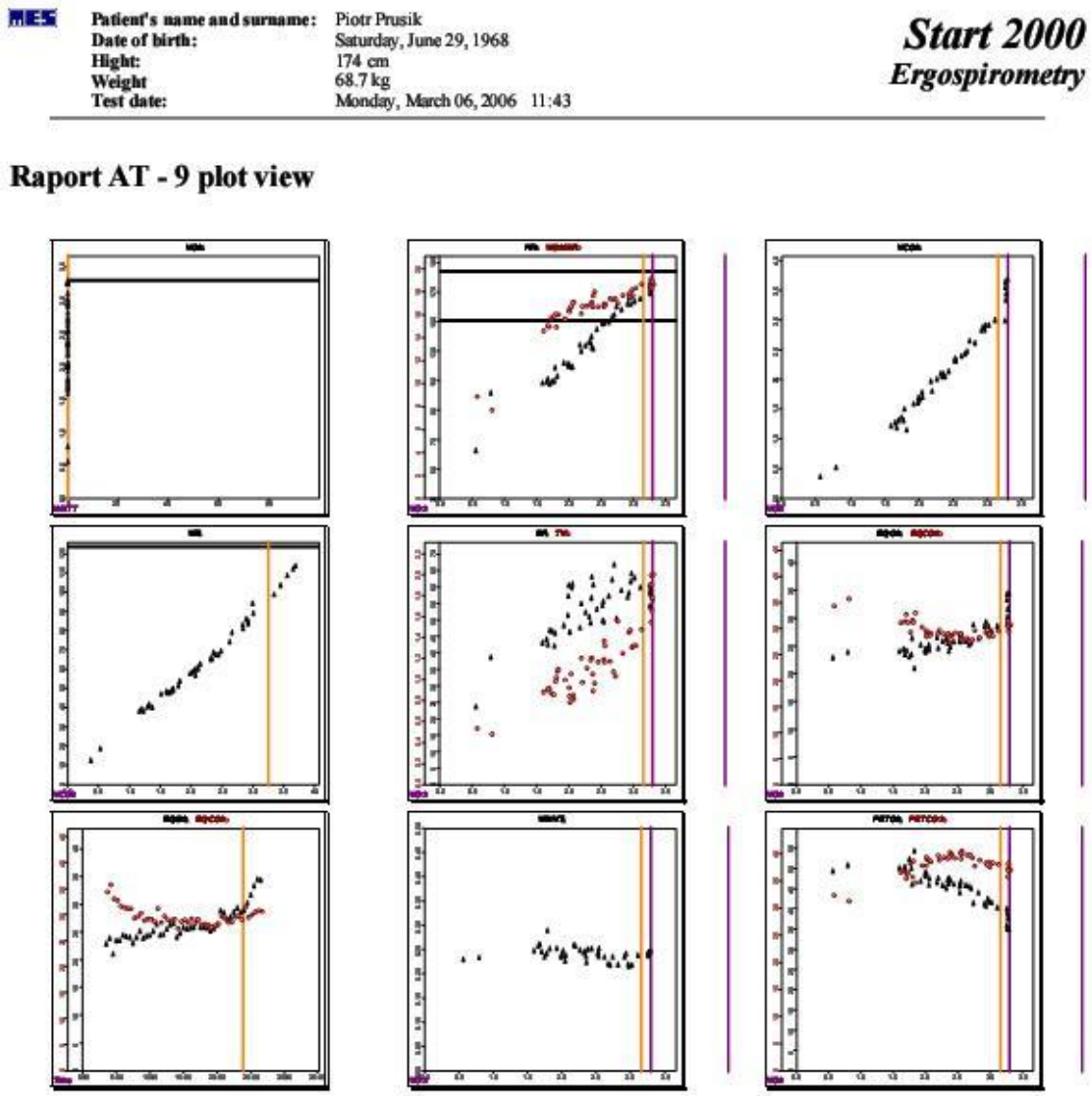
Finish test reason

Spirometry		Predicted	Measure	% Predicted
	MEF 50[L/s]	5.10	5.15	100.98
	FVC(L)	4.72	5.52	116.95
	FEV1(L)	3.92	4.26	108.67
	MVV(L/min)		No Parameter	

CPET Parameters	Resting	AT	Max	Predicted Max	Max/Predicted
VO2(ml/kg/min)	0.07	0.27	0.28		
VO2(l/min)	0.19	3.16	3.33	3.64	91.59
VCO2(l/min)	0.12	3.26	3.71		
Work(Watts)	---	---	---		
Heart Rate (bpm)	38.64	170.00	177.00	167.42	105.72
O2 Pulse (ml/beat)	4.79	18.57	19.22		
Systolic Blood Pressure (Max)	---	---	---		
Diastolic Blood Pressure (Max)	---	---	---		
Heart Rate Reserve (bpm)			-9		< 15
VE Max (l/min) BTPS	4.46	100.00	114.50	154.50	74.11
Tidal Volume (VT) (L)	0.34	1.95	2.01		
Respiratory Rate (RR)	13.05	51.23	66.94		
Breathing Reserve (%)	---	---	67.20	87.06	77.19
End Tidal CO2 (Peak PetCO2)	29.32	37.17	40.67		
End Tidal O2 (Peak PetO2)	46.19	38.41	54.51		
VE/VO2	24.56	31.67	34.61		
VE/VCO2	38.33	30.71	35.88		
VD/VT (Est)	0.23	0.24	0.29		
Respratory Quatient (RER)	0.64	1.03	1.12		
SpO2 (O2 Sat -- Pulse Ox)	---	---	---		
PEO2	32.76	27.43	37.75		
PECO2	22.64	28.10	31.36		
Borg	---	---	---		
Lactats	---	---	---		

Ill. 42. First page of the AT/CPET report.

The first page of the report includes the cause the test termination, the spirometric parameters and average values of some parameters from the rest phase, maximum values from the exertion phases and values of the AT threshold. The window with the cause of test termination appears at the end of the examination if the proper option was marked in the *Examination options*. Additionally, this window may be displayed with the *Cause of test termination* command from the *Tools* menu. The cause of test termination is saved with the examination. Additionally, the table includes the SBP, DBP, Borg and lactate (Lct) parameters. The window to enter those values appears automatically during the examination when there is a phase change if the proper option was marked in the *Examination options.* One may call the window individually with the *Enter SBP/ DBP/ Borg* command from the *Examination* menu or clicking on the icon:  .

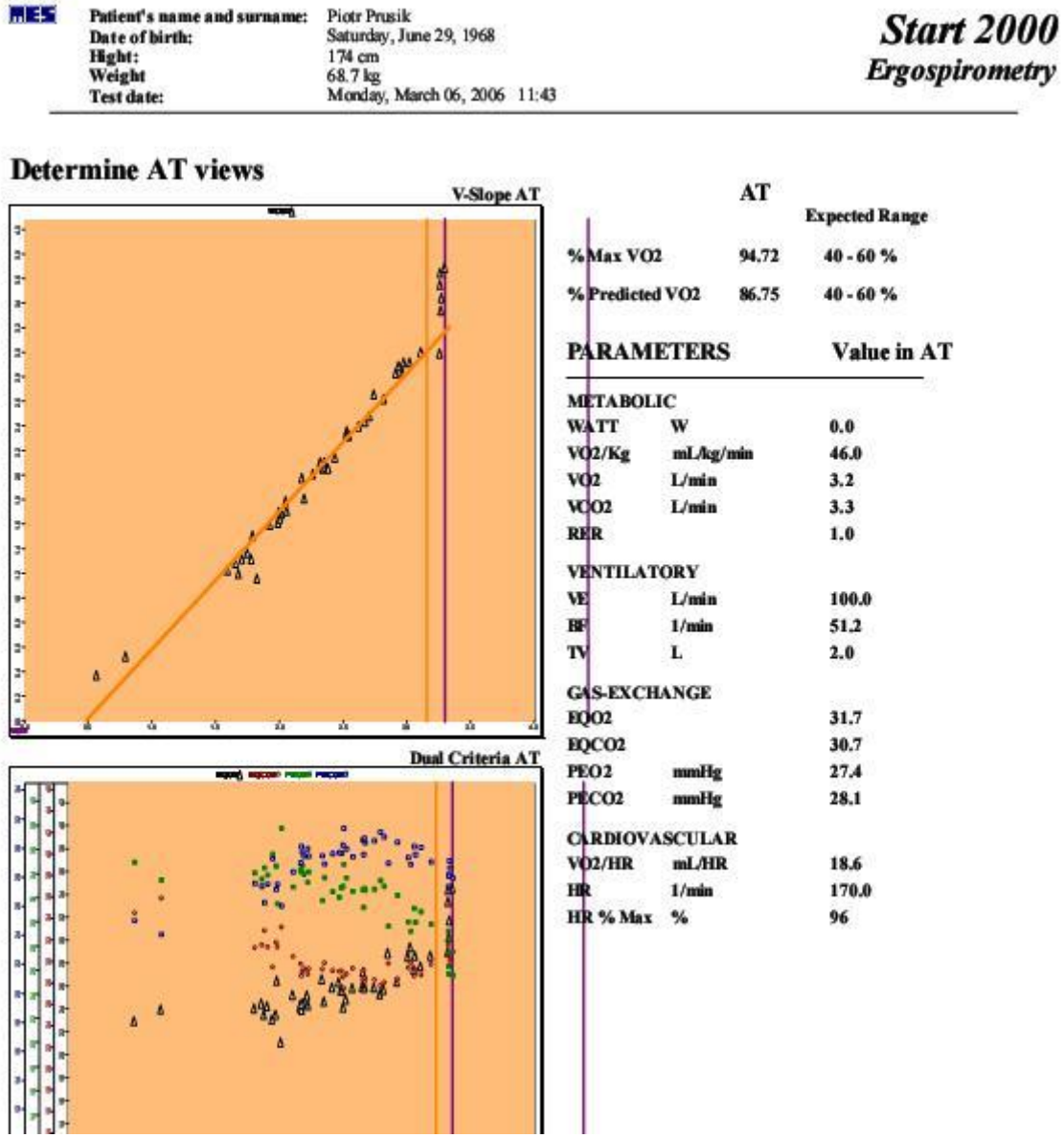


Ill. 43. AT report – 9 diagram view

The second page may include nine diagrams selected from among twenty/ seventeen. The selection is made in the *Printout configuration* menu by clicking the *Configuration of 9 view AT report* button. From the displayed menu we mark 9 selected diagrams.

On the third page of the report there are two views: *V-Slope AT*

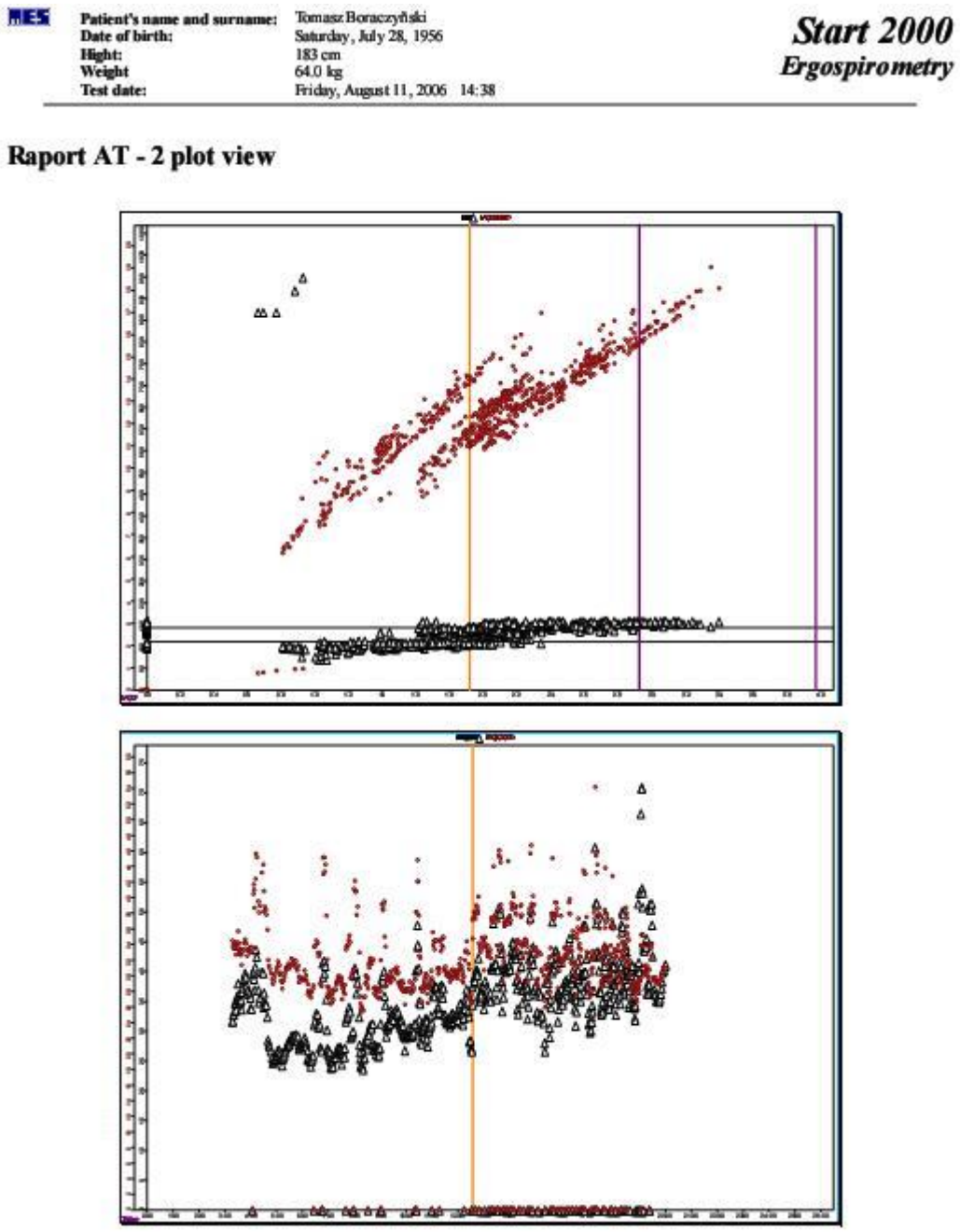
and *Dual Criteria AT*. The first one presents the diagram of VCO2 in relation to VO2.



Ill. 44. Third page of the AT/CPET report.

It is the same diagram as the second diagram of the *mode of searching AT*, but here we do not have the RER parameter. The second view is the diagram of the parameters: EqO2, EqCO2, PeO2 and PeCO2 in relation to VO2. In those views there are additional columns with the expected range (light orange), the AT threshold is marked with an orange vertical line and the VO2 maximum value norms are displayed. On this page there are laso tables. The first one includes the percentage values of the VO2 parameters in the AT point in relation to the VO2 maximum value from the exertion phases and in relation to the VO2 due. The second table is split to groups: metabolism, ventilation and gas exchange, parameter values in the AT points. If the AT threshold was not selected, the table will not appear and the *Determined AT threshold* caption will change into *No determined AT threshold*. On the next pages there may be additional diagrams selected in the printout configuration.

.



Ill. 45. Additional diagrams of mode of searching the AT.

We may print individual views in *Mode of searching the AT.* In order to do this, one should select the *Print diagram* command from the menu of the selected diagram view.

10. Menu commands.

10.1. *File* menu

Patient's data	⇨ Chapter 4
Open...	⇨ Chapter 7.4
Close	Closes the opened examination.
Save	⇨ Chapter 7.3
Save as ..	Saves the examination result under the set name.
Print...	⇨ Chapter 7.5
Printout preview	⇨ Chapter 7.5
Printout settings...	⇨ Chapter 7.5.1
Printout configuration...	⇨ Chapter 7.5.2
List of the recently opened files	Includes the list of the recently opened files.
Finish	Ends the work with the programme

10.2. *View* menu.

Toolbars	Shows or hides the toolbar.
Status line	Shows or hides the status line (⇨ Chapter 11.3).
Data averaging...	⇨ Chapter 6.6
Parameters displayed in the table.	⇨ Chapter 6.5.4
ECG parameters	⇨ Chapter 0
Configuration of BMR norms	⇨ Chapter 6.15
Calculate calorimetry	⇨ Chapter 6.16
Stretching the Y diagram	⇨ Chapter 6.5.2.1
Narrowing the Y diagram	⇨ Chapter 6.5.2.1
Stretching the X diagram	⇨ Chapter 6.5.2.1
Narrowing the X diagram	⇨ Chapter 6.5.2.1
Default range of X scale	⇨ Chapter 6.5.2.4
Synchronisation of diagram with the table	⇨ Chapter 6.5.4.6
Synchronisation of table with the diagram	⇨ Chapter 6.5.2.2
Synchronisation of diagrams with the diagram	⇨ Chapter 6.5.2.3
Pop-Up window	⇨ Chapter 6.5.4.5

10.3. *Examination* menu.

Test for Start 2000	⇨ Chapter 7.2.1
Test with Stabilisation	⇨ Chapter 7.2.4
Spirometric examination	⇨ Chapter 7.2.2
Start	Starts the examination (⇨ Chapter 7.2).
Stop	Ends the examination (⇨ Chapter 7.2).

Start the test	Starts the examination stage (⇨ Chapter 7.2).
Enter event	Enters event 6.3
Edit event	⇨ Chapter 6.3
Examination phases...	⇨ Chapter 6.2
Ergometer control	Launches the remote control to control the ergometer (⇨ Chapter 6.4).
Commentary	⇨ Chapter 6.17
Enter SBP, DBP, Borg, Lct	⇨ Chapter 8

10.4. *Tools* menu.

Gas calibration	⇨ Chapter 5.2.2
Volume calibration	⇨ Chapter 5.2.1
Flow zeroing	⇨ Chapter 6.7
Gas zeroing	⇨ Chapter 6.7
Environment conditions	⇨ Chapter 5.1
Equipment configuration	⇨ Chapter 5.3
Examination options	⇨ Chapter 5.4
Export to text file	⇨ Chapter 6.8
Last parameters LT	⇨ Chapter 6.9
Show dues	⇨ Chapter 6.10
Print table	⇨ Chapter 6.5.4.7
Determine AT threshold	⇨ Chapter 6.13
Remove AT threshold	⇨ Chapter 6.14
Cause of test termination	⇨ Chapter 5.4.2

10.5. *Help* menu.

About the programme	Displays information about the programme: version number, copyright, etc.

11. Toolbar.

11.1. Standard toolbar.

Ill. 49. Toolbar

This toolbar includes the following buttons:

	*Test for Start 2000*	Starts new examination (⇨ Chapter 7.2.1)
	*Examination with Stabilisation*	Starts examination with stabilisation (⇨ Chapter 7.2.4)
	*Spirometric examination*	⇨ Chapter 7.2.2
	*Open*	⇨ Chapter 7.4
	*Save*	⇨ Chapter 7.3
	*Printout preview*	⇨ Chapter 7.5
	*Print*	⇨ Chapter 7.5
	*Export to statistical programmes*	⇨ Chapter 6.8
	*Volume calibration*	⇨ Chapter 5.2.1
	*Gas calibration*	⇨ Chapter 5.2.2
	*Atmospheric conditions*	⇨ Chapter 5.1
	*Flow zeroing*	⇨ Chapter 6.7
	*About the programme*	Displays information about the programme: version number, copyright, etc.
	*Stretching the Y diagram*	⇨ Chapter 6.5.2.1
	*Narrowing the Y diagram*	⇨ Chapter 6.5.2.1
	*Stretching the X diagram*	⇨ Chapter 6.5.2.1
	*Narrowing the X diagram*	⇨ Chapter 6.5.2.1
	*Default range of X scale*	⇨ Chapter 6.5.2.4
	*Synchronisation of diagram with the table*	⇨ Chapter 6.5.4.6
	*Synchronisation of table with the diagram*	⇨ Chapter 6.5.2.2
	*Synchronisation of diagrams with the diagram*	⇨ Chapter 6.5.2.3

11.2. Toolbar of the *Test for Start 2000* examination.

Ill. 46. Toolbar of the *Test for Start 2000* examination.

This toolbar includes the following buttons:

	*Open*	⇨ Chapter 7.4
	*Save*	⇨ Chapter 7.3
	*Print*	⇨ Chapter 7.5
	*Export to statistical programmes*	⇨ Chapter 6.8
	*Start*	Starts the control stage (⇨ Chapter 7.2)
	*Start test*	Starts the examination stage (⇨ Chapter 7.2)
	*Stop*	Terminates the examination (⇨ Chapter. 7.2)
	*Enter event*	Enters event (⇨ Chapter 6.3)
	*Ergometer control*	Launches the remote control (⇨ Chapter 6.4)
	*Move to the last phase*	⇨ Chapter 6.4
	*Turn on/ off the pumps*	Turns the pumps on and off
	*Atmospheric conditions*	⇨ Chapter 5.2.2
	*Flow zeroing*	⇨ Chapter 6.7
	*Gas zeroing*	⇨ Chapter 6.7
	*About the programme*	Displays information about the programme: version number, copyright, etc.
	*Filling system*	⇨ Chapter 7.2.4
	*Stretching the Y diagram*	⇨ Chapter 6.5.2.1
	*Narrowing the Y diagram*	⇨ Chapter 6.5.2.1
	*Stretching the X diagram*	⇨ Chapter 6.5.2.1
	*Narrowing the X diagram*	⇨ Chapter 6.5.2.1
	*Defaulf range of X scale*	⇨ Chapter 6.5.2.4
	*Synchronisation of diagram with the table*	⇨ Chapter 6.5.4.6
	*Synchronisation of table with the diagram*	⇨ Chapter 6.5.2.2
	*Synchronisation of diagrams with the diagram*	⇨ Chapter 6.5.2.3
	*Pop-Up window*	⇨ Chapter 6.5.4.5
	*Mode of searching AT*	⇨ Chapter 8
	*Enter SBP, DBP, Borg, Lct*	⇨ Chapter 8

11.3. Status line.

The status line is at the bottom edge of the main application window (⇨ Ill. 47). Its position cannot be changed, however, the line may be hidden with the help of the *Status line* command (*View* menu).

The status line displays explanations of menu commands and elements in the toolbars. In order to obtain the explanation, one place the mouse cursor upon the given element.

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During the examination with the use of ergometer control the line displays information about the number of all phases, the number of the current phase, phase duration time, time left to the end of the phase and time left to the end of examination.

On the right of the status line there are three fields informing about the status of the following keys: *CapsLock*, *NumLock* and *ScrollLock*.

Ill. 47. Status line.

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12. Maintenance and everyday service.

1. Replace the content of the humidity absorber in the back part of the device after every hour of the device's work.
2. After the finished work, remove the content of the tank from the humidity absorber.
3. Before starting the examination and device calibration fill the tank of the humidity absorber.
4. As the humidity absorber use the globule agent of the silicon gel. If the gel contains the colourful indicator, it should be blue before the humidity absorption and pink afterwards.
5. Check the system of sponges at the outlets of the connection terminals of the humidity tank – they should be clean. The sponges can be cleaned in water and dried.
6. Sponges in the humidity absorber tank should be always placed at the outlets of the connection terminals.
7. The devices cannot be started without the sponges in the absorber tank.
8. The masks always have to be clean, and the mask's channel – connected with the air cable – must be patent.
9. The masks and the pneumotachographic heads should be changed after each examination so that the patient would receive sterile mask and head.
10. The mask and mouthpiece sterilisation can be done in the gas steriliser or in liquids (CIDEX or ALDESAN).
11. Sterilisation in liquids should be done through dipping the masks for 2 hours and then carefully washing them with distilled water and drying. The drying temperature cannot exceed 65°C.
12. After sterilisation in liquids and drying, the masks and heads should be checked in terms of the patency of the air channels.
13. **Grounding and potential levelling connections:** Start 2000 is a device with the B2 anti-shock protection class. The device's grounding is not necessary, but it may be helpful in removing the interferences from the mains supply. The supply cable is equipped with the neutralising cable (the central pin in the port and plug of the supply cable). If the supply mains neutralisation is uncertain, then it is possible to connect the device to grounding in compliance with the IEC norm with the help of the grounding cable. The grounding cable should be connected to the device with the help of the grounding port on the back board of the device. **Note. The grounding cables are not the potential levelling cables.**
14. **Fuse replacement.** Fuse of 1A 220V 50Hz is placed in the drawer port of the supply switch on the back board of the device. In order to replace the fuse, one should unplug the supply cable and then take out the fuse drawer. **Note. One should only use fuses with parameters as given in the manual.**

NOTE!!!

The above recommendations should be strictly followed!

Non-observance of the above recommendations may damage the device, lead to erroneous results of the conducted tests and to infect the examined person.