

Portable rail profilometer (PRP) is designed for non contact registration of cross-section of the railhead acting face (including flaws 44 – head side wear; 11.1-2 – metal spalling on the side work head fillet).

The profilometer is used at the road economy for the estimation of the railhead cross-section state with the purpose of planning the profile grind work volume as well as for the control of the quality of rail-grinding trains and rail-grinding equipment functioning.

1. MAIN FUNCTIONS

The profilograph uses the non-contact way of profile registration with the help of laser sensor and the scanning means.

The main functions of PRP are:

- obtaining the information on the cross-section profile of the working railhead surface with the current road coordinate mark at the place of registration;
- processing the information on the parameters of cross-section profile of the working railhead (conformation, ranging, filtration, alteration and correction);
- visualization of the combined graphical images of actual and new cross-section railhead profiles on the display of system unit;
- documentation of the registered profile parameters on the magnetic medium;
- printing out the information of the cross-section railhead profile.

2. BASIC TECHNICAL CHARACTERISTICS

2.1 *Controlled parameters*

- railhead vertical wear (h_B);
- side wear (h_{δ}), that is measured 13 mm lower the top of railhead or side wear ($h_{\delta L 45^\circ}$), that is measured at 45 degrees relative to the rail symmetry axes at the point that passes through the center of lateral working fillet;
- reduced head wear, that is determined as vertical one + the half of lateral wear, namely $:h_{np} = h_B + 0,5h_{\delta}$ or $h_{np} = h_B + 0,5h_{\delta L 45^\circ}$.

2.2 *Control range and inaccuracy*

Railhead vertical wear, mm	-2,0...+12
Lateral railhead wear, mm	-5...+18,0
Reduced railhead wear, mm	Less than 12
Scanning angle inside the rail track, degrees	80±2
Scanning angle outside the rail track, degrees	55±2
Inaccuracy, not more than, mm	±0.1

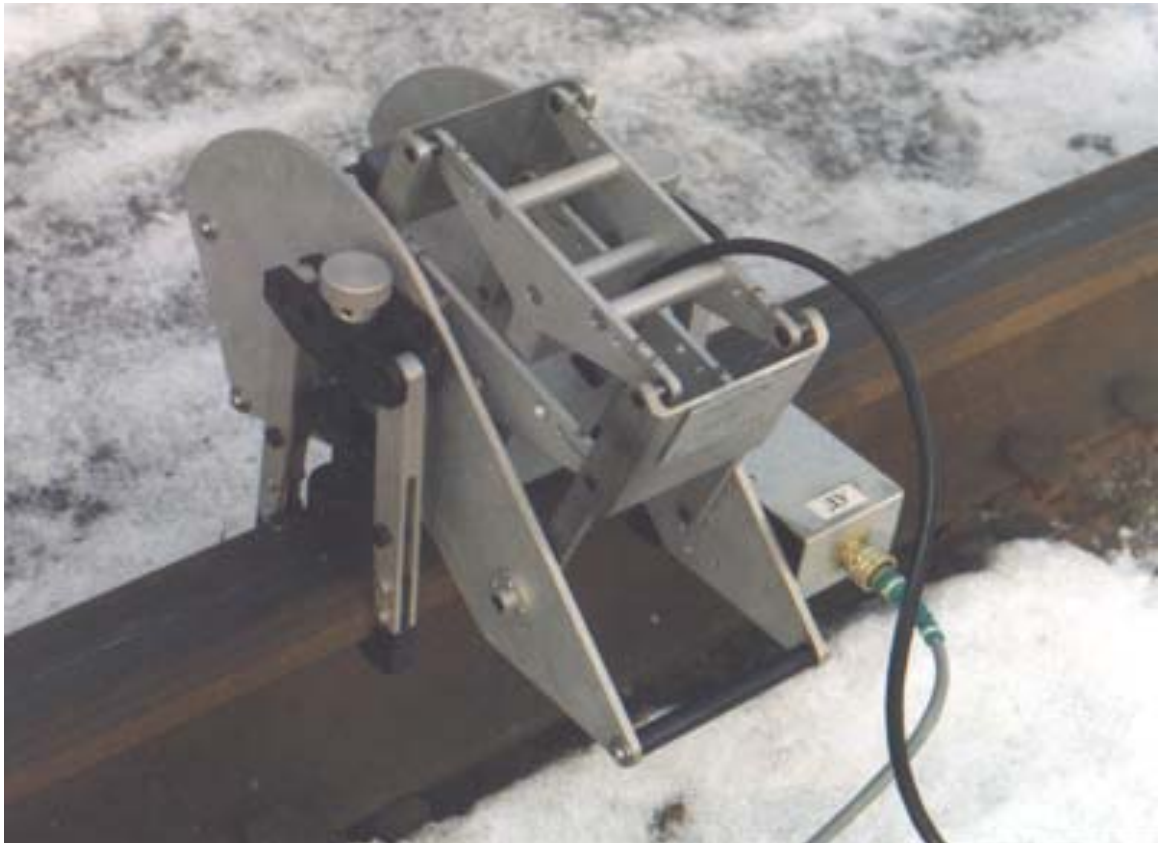
2.3 *Constructive attributes*

Scanning means dimensions, mm	230x450x230
System unit dimensions, mm	220x170x120
Continuous functioning period,	14
Working temperature range, °C	-10...+50

3. STRUCTURE AND FUNCTIONING

3.1 *Scanning means*

Scanning means PRP is designed for establishing the predetermined motion trajectory of optical censor around the railhead in the working range of angles about 80 degrees inside and 55 degrees outside the rail track (determined at the device alignment)



Scanning means is based on the con-rod crank engine. This device is disposed between two webs connected with bushings that constitute the bearing structure of the scanning means. Con-rod crank engine working stroke from its initial position, at which it fully bears on the bush disposed inside the rail track, to its final position, at which the engine thrusts to the analogous bush disposed outside the track, is performed manually by the handhold. The working stroke provides the motion of the optical sensor along the predetermined path around the railhead

Smooth manual displacement of con-rod crank engine from its initial position to the final one provides operated friction brake that creates the necessary braking torque. Optical censor angle position at any moment of working stroke is registered by means of transmitter of rotation angle.

There are spring self-lock mechanisms on the outer sides of webs that are meant for the scanning means capture and fixation. To open these mechanisms it is necessary to grip the handholds manually. A removable blind is mounted on the laser censor as a protection from bright sun light.

3.2 System computing unit

3.2.1 SCU structure

The system computing unit is designed for performing the functions meant in part 1 (except printing out) of the description.

SCU consists of the following devices:

- controller;
- memory device (MD);
- rechargeable battery;
- voltage changer block of the primary power supply;
- timer with the independent power supply;
- control and indication board
- the frame with the output connectors;
- the set of connecting cables.

Prior to beginning of the work operator performs initial data setting and some preparation. As a result, data file for the particular work cycle is created in the MD that contains all the necessary initial information.

MD contains the data on:

- railway designation;
- codes for operators allowed to work with PRP;
- PRP serial number.

At the operating mode the signals from laser sensor (LS) and rotary sensor (RS) of the scanning means enter the controller board. Outcome code from the LS is stored in MD as well as the position mark of the scanning means from RS that forms data file. With operation completed, the data files in the form of railhead profiles shapes that are placed in MD can be outputted at the monitor screen at the data view mode and rewritten to external PC for the detailed analysis and storing.

3.2.2 SCU operation

At SCU power supply turning on, its internal testing is performed. The testing consists of computing system functioning check, voltage measuring on the accumulator battery and free space of MD determination. On completion of the internal testing, the monitor screen shows its results and the *MAIN MENU*:

Mode choice is performed by means of buttons with up and down arrows on the control board and the subsequent pressing "Ent" button. Any mode except "Measurement" can be chosen at that moment. In order to enter the "Measurement" mode one should have performed "Preparation" mode operations.

SCU test is completed successfully Profilograph number: 1 005 profiles have been registered Choose operating mode: Preparation Measurement

Transference Records scan

3.2.2.1 “PREPARATION” mode

This mode includes initial data setting with the following window at the monitor screen:

► Day of entry: 17:04:01 Time of entry: 16:30 Operator code: Ivanov Railway designation: Moscow Permanent way division: ПЧ-01 Track number: 3 Track plan: straight (right curve, left curve) Rail type: P65 left (right) Track coordinate: 00910.021 Store and quit

The necessary string choice is made by means of control buttons with “up” and “down” arrows and by "Ent" button pressings. On transferring in the string of the message it necessary to use “left” and “right” buttons to pass from one category to another. The chosen category starts blinking.

The value of the chosen category can be changed with the help of buttons with “up” (more) and “down”(less) arrows.

The work under the mode of strings choosing is performed by means of "Ent" or "Esc" buttons.

Two last digits in the *Track Coordinate* string show the number of the profile being measured.

Store and quit string is meant for storing the data in the MD and leaving to the *MAIN MENU* after the "Ent" button pressing.

3.2.2.2 “MEASUREMENT” mode

On passing to the “Measurement” mode from the *MAIN MENU* of the program the monitor screen shows the following window:

Move the scanner handle from inside of the track to its outer side The measurement period is not less than 4 sec- onds

Scanning period is to be within the limits of 3-4 seconds. Jerking is unacceptable during the scanning. This condition is connected with the finite period of one point measurement that equals approximately 12 millisecond (total quantity of measurement points is 190)

If the quantity of fixed measurement points during scanning is insufficient, press Esc button to pass to the next mode. The following information window will appear:

Repeat measurement please!
Not enough quantity of readings
View profile
Store result in memory
Repeat measurement
Quit without storing

If the move of the scanner handle from its initial position to outer track side up to the stop was correct by speed, the following information window will appear:

Measurements are made
 $h_B = 10,0$ mm
 $h_{\sigma \angle 45} = 12$ mm
 $h_{np \angle 45} = 16$ mm
View profile
Store result in memory
Repeat measurement
Quit without storing

One should use “up” and “down” buttons to choose the necessary mode that will be indicated by horizontal cursor on the screen.

At choosing “**View profile**” mode the monitor screen shows the measured (actual) and new (not worn) cross-section profiles of the railhead. If necessary it is possible to delete a new one from the monitor by pressing "Ent" button, the same button pressing will add the profile back.

At choosing “**Store result in memory**” mode and pressing Ent button the measured cross-section profiles is put into the MD.

To repeat measurement it is necessary to choose “**Repeat measurement**” mode and press "Ent" button.

“**Quit without saving**” mode will reset the cross-section profile measurement result without storing it in the MD.

3.2.2.3 “TRANSFERENCE” mode

At transferring in this string of the main menu the following message appear:

Transference mode
Connect IBM PC
Press Esc to quit

At that moment the control is transferred to the external PC. The work with PC in the modes of rewriting the files from SCU, clearing MD of the computational unit, viewing and analyzing the rewritten from SCU files, adjusting and inputting operators codes and railway designation into PS of SCU are performed with the help of special PRP control program.

3.2.2.4 “RECORDS SCAN” mode

At transferring in this string the following message will appear:

Input profile number 005 Esc – to quit

At Esc button pressing the following window will appear:

$h_B = 10,0$ mm $h_{\delta \angle 45} = 12$ mm $h_{np \angle 45} = 16$ mm Ent – to scan the profile
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The visualization of the chosen profile will appear after “Ent” button pressing.

3.3 SCU control software from external PC

3.3.1 Program installation and removal

To install the program it is necessary to create directory on the hard disc of your computer and copy *PRP.EXE* and *Datafiles* to it from the floppy disc.

To delete the program it is enough to remove this directory with its content.

3.3.2 Working with the program

Main window

The main window of the program consists of the following elements:

- “*Main menu*” is meant for managing files and SCU.
- “*Files and SCU control panel*”
- “*Screen and parameters of rail profile deviation*”, in which actual and new rail profiles are displayed with the standard deviation parameters.
- “*Panel of profiles and current marks values visualization*”
- “*File parameters panel*” with the parameters of the opened file.

Program main menu

Main menu contains the following commands:

“*File/Open*” – opens the dialog window for file choice

“*File/impose*” – opens the dialog window to choose the second file to be imposed

“*File/print*”- prints out the information.

“*File/Table*” – shows table data of the measured profile.

“*File/Exit*” – closes the program.

“*SCU/edit ROM*” – opens dialog window of operators codes and railway designation setting, they are placed in MD of SCU.

“*SCU/read data*” – opens dialog window of reading the files from the MD of SCU.

“*SCU/Clear memory*” – deletes all the files from SCU, clearing its main storage device MD.

“*SCU/Connection*” – opens and closes connection with SCU parameters adjustment window.

“**Help/About**” - shows the dialog window with the information on the program. This command is not available in the current version.

Files and SCU control panel contains buttons that duplicate Main Menu commands.

Screen management

After the command “**File/Open**” that opens the file, there performed automatic computation and displaying the cross-section railhead profile deterioration values: vertical, lateral (lateral at 45 degrees) and reduced one. At that the screen visualizes the actually measured profile and new one as well as standard parameters of deviation of actually measured profile from the new one. Furthermore, the area of the given part of new profile S_H and measured profiles (the main S_1 and imposed one S_2) and areas differences (S_H-S_1 , S_H-S_2 , S_1-S_2) are calculated.

At pressing “**Hide (Show) actual profile**” and “**Hide (Show) new profile**” the visualization of the corresponding profiles on the screen is stopped (refreshed).

On moving the mouse pointer with “**SHIFT**” button pressed it possible to move the mark on the screen. In the extreme left and center elements of “**Panel of profiles and current marks values visualization**” the intersection of the mark with actual and new rail profiles graphs are shown respectively. In the extreme right element of “**Panel of profiles and current marks values visualization**” the current slope angle value of the mark to the horizontal axis that corresponds to current mark position is shown.

SCU control

To control the system computation unit (SCU) by means of external PC it is necessary to turn them off and then connect one with another by special cable that is included in delivery set of PRP, and then choose “**Transmittance**” mode of SCU.

To set up connection between the computer and SCU it is necessary to open “**SCU**” in the main window and choose “**SCU/Connection**” command. The SCU connection setup window will be opened.

This window contains the list of available computer ports. One should choose from the list the port SCU is connected to.

To set up operator's codes and railways designations in the main storage of the device it is necessary to choose “**SCU/ ROM setup**” command or press “**SCU**” button. At that moment the dialog window of main storage of SCU will appear.

This window is described in details in the part “**Operators lists and railways designations setup**”. To read the files from SCU it is necessary to choose “**SCU/Scan data**” command or press “**SCU**” button. At that moment the dialog window of files scan from SCU will be opened.

To delete all the files from the device one should choose “**SCU/Clear memory**” command or press “**SCU**” button. After that, the program will ask two times for a confirmation of deleting. After the confirmation was received, the program performs deleting.

Operators lists and railways designations setup

The dialog window is meant for changing the SCU operators list and that of railways designations that are stored in ROM of SCU.

The dialog window “ROM parameters changing” is called from the program main window by means of “**SCU**” button. At opening, the information is read from ROM of SCU automatically. One more reading from SCU can be done by pressing “**Scan SCU**” button. The SCU operators codes list is shown on the left, the list of railway designations is on the right.

A new SCU operator code can be chosen in the “**Name inputted**” window over the codes list. To add it to the codes list it is necessary to press “**Add name**” button or just press <Enter> button.

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“**Remove name**” button is used to delete the code, selected from the list. If the removed code was the only one in the list, there appears the message “**No name**”.

If to press mouse left button twice on one of the codes from the list, the window will appear in which it is possible to change the code. If to delete the code in this window, it will be removed from the list.

By the same way one can input, remove or edit the railways designations list.

At “**Restore**” button pressing all the changes that have been done during the current work period are cancelled and initial PS content is read once again.

At completion of the work with "ROM parameters changing", it is necessary to press “**OK**” button and all the information inputted is be stored in ROM of SCU.

“ROM” parameters changing” window is closed without changes saving if the “**Cancel**” button was pressed.

Reading SCU files.

This window is used to scan the list of files that are stored in MD of SCU and to copy them on some magnetic medium (floppy or hard disk) of PC.

The call of “**Reading SCU files**” dialog window is done from the program main window by “**SCU**” button pressing or from “**SCU**” window.

On opening the “**Reading SCU files**” dialog window the information from MD of SCU and the list of files stored in SCU is read. This list is shown in the opened window. File names contain the distance number and PRP, track number, track coordinate, entry data and its record number.

To copy on PC all the files without allotting one should press “**Read All**” button. To copy only some needed files they should be selected by mouse, if necessary <**Ctrl**> and <**Shift**> button can be used. After that, the selected files are copied at pressing “**Read**” button.

Single files are copied at double pressing of mouse left button after the cursor was placed on the necessary file name in the list.

The files on PC are stored in “**Data files**” subdirectory that is stored in the directory with the executable program file.

If while copying the program finds the dupe of the file (the file with the same name as the copied one) the question “**Overwrite file?**” appears. The possible answers are: “**Yes**”, “**No**”, “**All**”.

If the answer is:

“**Yes**” - the program overwrites the old file with a new one;

“**No**” – file will not be copied “**All**” –all the dupes are overwritten without additional questions;

To stop the work with “**Reading SCU files**” window one should press “**Close**” button.

Printing files out

Only files copied from SCU to PC can be printed out. To print the necessary file one should open it with the help of “**File/Open**” command of the main menu. The window for choosing the file is opened. It is necessary to choose the needed file and press “**Open**” button. The file is shown on the PC screen after that.

To print out the file it is necessary to press “**File/Print**” button.

At the bottom of each file printout (page) there are file data (railway designation, division and track numbers, rail type and position (left, right), profilograph number and entry date).

3.4 Power supply

The power supply (PSP) of PRP is destined to provide continuity of SCU service at free running mode. The PSP consists of:

- primary power supply
- charger (C)

The primary power supply of the PRP system is a waterproof storage battery with the operating supply voltage +12V that is included in the SCU kit. Regular storage battery recharge is performed by means of automatic charger (C), which is included in the delivery set.

4. MAKEREADY

4.1 Scanning means installation

- Take the scanning means from the packing bag.
***Caution!** It is prohibited to carry the device by buckles or con-rod crank engine handles, it can damage the scanning means. The device can be carried by webs buckles or by picker mechanism handles.*
- Wipe the glass of optic sensor with dry soft fabric (flannel).
- Set the scanning means onto the railhead. First unclench the pickers by pressing on the handles, and then vertically press on the lateral buckles of the protecting webs up to pickers fixation by the spring mechanism.
***Note:** It is recommended to perform cross section railhead profile registration in one rail cut starting from the left rail according to the main direction of trains operation.*
- To take the scanning means off the railhead it is necessary to press on the picker's handles.
- To register cross section head profile of right rail in one rail cut, one should take the scanning means off the left rail, to turn it on 180 degrees and set it on as it was described before.

4.2 SCU connection

- Take SCU from the packing bag and put it inside the rail track (approximately in the center).
- Connect the following from the scanning means to SCU:
 - cord from optical displacement transducer to the connector RS-232 on the SCU frame;
 - rotary sensor to the connector on the SCU frame.

4.3 Power supply and charger (C)

To prepare the profilograph power supply to work it is necessary to check the charge level of storage battery with the operating supply voltage +12V, placed in the SCU frame. To check this level it is necessary to:

- connect the charger to SCU through the connector on its frame with the 3Y mark,
- connect the charger to the industrial power system 100...240V.

***Note:** The charge level of the accumulator battery is indicated by control light of automatic charger that is on only when the battery is fully charged. The charge operating rules are given in the enclosed log book.*

- Recharge (if necessary) the accumulator battery up to the full charge before working on the line.
- Turn the charger off and disconnect the cord, connecting with SCU.

After setting the scanning means on the railhead, connecting SCU and charging the accumulator battery the profilograph is ready to work.

5. WORKING ORDER

- To fix the profilograph scanning means on the railhead at the place of cross-section profile registration.
- Move the con-rod crank engine of the scanning means into the initial position (inside the track).
- Turn the SCU power on by moving the tumbler switch “OFF” to the “SUP” state. After that full inside SCU scanning is performed.
- After inside testing of SCU was done successfully with the entrance to “Main Menu” on the screen as the result, it is necessary to set “**Preparation**” mode.
- Set all the initial data necessary for the file (rail profile) in “**Preparation**” mode.
- Put the cursor opposite the “**Store and quit**” string and press “**Ent**” button to quit to *MAIN MENU* By means of control buttons put the cursor opposite the “**Measurement**” string and perform the actions that are necessary in this mode.
- If there is a need for repeated registration of railhead profile, set mode and perform all the actions of the previous item.
- To register cross section head profile of right rail in one rail cut, take the scanning means off the left rail, to turn it on 180 degrees and set it on the right railhead in the necessary place and repeat operations.

Working in the “**Transmittance**” mode it is necessary to perform the following steps:

- Place SCU near PC and connect them by cord through **PC** connector on the SCU with the connector of the available port (**COM1, COM2**) on the computer.
- turn the SCU on, after that turn PC on; Enter the **Main Menu** of SCU and choose the “**Transmittance**” mode.
- open **prp.exe** program on the computer. The “**Program Main Window**” will appear on the monitor screen and connection will be established with, the control will be given to PC.