WELL SOUNDERS

«DU-1».

OPERATING MANUAL

Explosion-proof design,
type of explosion protection – intrinsically safe circuit
1Ex ib IIB T3 Gb X explosion proof mark

Russia

CONTENTS

The certificate applies to “DU-1” well sounders (hereinafter referred to as the device) designed for operation at the wellhead in oil and gas fields.

The device is explosion-proof designed (intrinsically safe circuit type of protection) in accordance with the requirements of GOST 31610.0-2014 (IEC 60079-0:2011), GOST 31610.11-2014 (IEC 60079-11.), GOST 31610:2011), and have **1Ex ib IIB T3 Gb X** explosion proof mark. “DU-1” well sounder is designed for indoor and outdoor installation in hazardous areas where atmospheric explosives of IIA, IIB categories and T1, T2, T3 groups can form according to GOST R IEC 60079-20-1-2011 in the operating temperature range from -40 ºC to +50 ºC. The device design is comply with the assigned explosion proof mark, with the requirements of GOST IEC 60079-14-2013 and other regulatory documents governing the use of electrical equipment in hazardous areas.

The operating manual contains information about the design, principle of operation and specifications of the device as well as instructions necessary for proper operation, maintenance, transportation and storage of the device.

Observe the requirements of the Federal norms and regulations in the field of industrial safety "Safety rules in oil and gas industry" as well as this manual, when operating, maintaining and repairing the device.

The device may only be operated by specially trained personnel who have studied the operating documentation for the device, received the relevant safety instructions and permission to work.

1. GENERAL PRODUCT INFORMATION

1.1 Please read the operating instructions before using the DDIN-2 sensor.

1.2 The device is explosion-proof designed (intrinsically safe circuit type of protection) in accordance with the requirements of GOST 31610.0-2014 (IEC 60079-0:2011), GOST 31610.11-2014 (IEC 60079-11.), GOST 31610:2011), and have **1Ex ib IIB T3 Gb X** explosion proof mark. “DU-1” well sounder is designed for indoor and outdoor installation in hazardous areas where atmospheric explosives of IIA, IIB categories and T1, T2, T3 groups can form according to GOST R IEC 60079-20-1-2011 in the operating temperature range from -40 ºC to +50 ºC. The device design is comply with the assigned explosion proof mark, with the requirements of GOST IEC 60079-14-2013 and other regulatory documents governing the use of electrical equipment in hazardous areas.

2. DESIGNATION

The well sounder is designed for generating acoustic impulses in the annular space, as well as receiving, converting and analyzing acoustic responses (echo-signals), defining fluid level and controlling pressure at the wellhead.

The well sounder consists of:

1 - the case;
2 - thread connecting coupling;
3 - two shackles;
4 - the rotary retrievable outlet valve;
5 - the ON\OFF button;
6 - the Power LED ⏻;
7 - the Charge LED 🔋;
8 - the plug for charging the in-built accumulator.

To record an echogram, the sensor is to be installed onto the measuring connection of the tree; no connecting cables are needed. The outlet valve can be rotated around the longitudinal axis without restriction to install the discharge nozzle away from the operator.

3. BASIC SPECIFICATIONS

2.1 The device is designed for operation at the wellhead in oil and gas fields and provides:

2.1.1 Fluid level measurement in annular space in the range of (20 – 3000) m, excess pressure measurement in the range of (0 – 100) kgf/sm^2.

2.1.2 Measured data record and saving in a non-volatile storage device.

- 2.1.3 The well sounder supports control and transfer of measurement results to the terminal by means of Bluetooth radio channel (or Zig-Bee on demand) at a range of at least 35 meters.

2.2 The device maintains its operability at ambient temperatures from minus 40 C to + 50 C.

2.3 The device operates autonomously and is powered by a special internal battery type EEMB LP103450LC-PCM-LD with 3.6 V or 3.7 V voltage. The minimum operating voltage of the battery which does not lead to a loss of performance of the device is 2.7 V.

2.4 The basic specifications are given in Table 1.

Table 1

Parameter name	Norms on specifications
Explosion proof mark	1Ex ib IIB T3 X
Level control range, m	20 – 3000(6000)
Resolution capacity of the level control (at speed of sound in gas 340 m/s), % URL	0,03
Pressure measurement range, kgf/sm^2	0 – 100
Resolution capacity of pressure control, kgf/sm^2	0,1
Permissible sound speed range in annular gas, m/sec	250 – 450

Parameter name	Norms on specifications
Continuous operation time in registration mode (once a day), hour	35
Max. working power, mW	200
Weight, kg	2,3

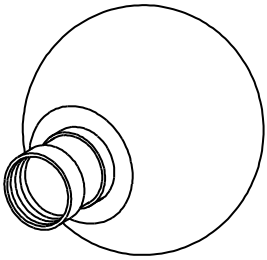
4. DELIVERY SET

The device is supplied according to the set shown in Table 2.

Table 2

Title	Q-ty
1. Well sounder «DU-1»	1
2. Certificate	1
3. Operating manual	1
4. "DB Siam 2.5" software user's guide	1
5. CD with the software	1
6. Package	1
7. Conformity certificate (copy)	1
8. Ball-type nozzle	1
9. Handle for installing Well sounder on a well	1
10. Spare parts for the valve unit: Ring 020-024-25-2-3 Cone	 1 1
11. USB cable	1
12. Network adapter	1
13. Interface cable	1

4.1. Ball-type Nozzle



The ball-type nozzle (the rubber sphere) is designed for generating an acoustic impulse when there is no excessive gas pressure in the annular space of the well. The ball-type nozzle is made up of the rubber sphere and the coupling. The ball-type nozzle is actuated by a violent blow of the hand on the sphere. An acoustic impulse, sufficient for positive control of the fluid level in wells up to 600…800 m, is formed. After the acoustic impulse is generated, the rubber sphere should be kept in the position which it took immediately after the blow until the value of the measured level pops up on the screen. The ball-type nozzle is screwed on the well sounder instead of the retrievable manual valve by using the reduction sleeve supplied with the device.

4.2 Handle for Installing Well sounder on a Well

The handle is used for convenient installation and deinstallation of the well sounder on a well. Being significantly long and strong, the handle, equipped with shackles, allows to tighten the well sounder on the measuring connection with the sufficient torque.

5. SAFE OPERATION GUIDELINES

5.1. General Provisions (regulatory framework)

- The design of the wellhead equipment is to be approved by the Russian Technical Surveillance Agency (RTSA).
- Preparation of the well for tests should be conducted in accordance with the requirements of the current Manual and internal guidelines for maintaining and testing wells approved by the head of the company.
- Test equipment is to be operated according to the operating instructions supplied with the equipment.
- Measures for ensuring safety are regulated by labor protection instructions for respective types of work approved by the Company's Department of Labour Protection and the Safety Regulations in Oil and Gas Industry approved by the RTSA.

5.2. Requirements to Personnel

- Well tests are to be carried out by individuals above 18 who have secondary education and who are medically cleared for work.
- Personnel are to take professional training followed by knowledge checking and have a relevant permit category in accordance with qualification requirements: not below category 5 for oil and gas production operators; not below category 4 for well test operators.
- Personnel are to be trained to work with test equipment.

5.3. Requirements to Test Objects

Pressure measurement and control of fluid level is carried out in oil and gas producing wells of different operational modes (flowing, gas lift, artificial lift, etc.), as well as in injection, intake, control and other wells.

Dynamogram control is carried out on rod pumps of all types and designs.

- Wells are to be tied and operated in accordance with the Safety Regulations in Oil and Gas Industry.

- While controlling level, a tested well is to be equipped with an offset with a valve and an elbow for connecting an echometry device. Fluid level can be determined only in the space of a well (tubular, intertubular, annular, borehole annulus) which is connected with an elbow. The elbow is not to have any abrupt tapers (chokes, hoppers and similar units).The elbow of the offset should have pipe tapered thread 60 (State Standard 633-80) and be located at the height 0.2-1.8 meters above the ground. If the height exceeds 1.8 meters, fixed or portable platforms are to be used provided they comply with the Safety Regulations in Oil and Gas Industry. The elbow which is not used is to be closed with an end cap. Along the travel path of the sound pulse, there should be no more than two 90º pipe bends at the distance of 20 meters from the elbow.

6. ENSURING EXPLOSION-PROOFNESS OF THE PRODUCT.

6.1. Explosion-proofness of the device is provided by the type of protection "intrinsically safe electric circuit" “ib” level, according to the requirements of GOST 31610.11-2014 (IEC 60079-11:2011), which is achieved by the following:

- Basic circuit diagram includes the protective component “Fib”. The protective component “Fib” is an intact spark protection unit with the short-circuit current limitation at 2.25 A (maximum), using current limiting resistors and semiconductor fuses in series. Double redundancy is used in the “Fib” protective component to ensure greater reliability. The “Fib” component is integrated into the battery compartment of the device. The design of the protective component “Fib” is met with the requirements of GOST 31610.11-2014 (IEC 60079-11:2011), including leakages and clearances. The minimum width of conductors on the PCB is 0.2 mm, copper thickness is not less than 18 μm. Thus, the electrical circuit coming out of the battery compartment of the device is intrinsically safe.

- The electrical circuit principal and applied third party components provide maximum power consumption not more than 0.45 W from the internal battery with maximum possible voltage on it 4 V. The total maximum capacity of the electrical circuit is 380 μF, maximum inductance is not more than 20 μGn. The maximum current in the circuit during normal operation is not more than 100 m.
- The well sounder uses Boston Swing 5300 battery cell.

The battery has special made contacts which exclude the possibility of its incorrect switching on (polarity reversal) and is located in the internal battery compartment of the device. The design of the battery compartment ensures that the battery does not fall out of the device. Do not replace the battery and do not charge it in the hazardous area. For this reason, in order to inform the user about special conditions of use

of the device, the identification plate of the device is marked with an "X" sign indicating special conditions of safe operation.

- The "X" symbol in the explosion proof marking indicates special conditions for safe operation:

1) Do not open the instrument cover and therefore the battery compartment cover in hazardous areas;

2) Do not replace the battery and operate the computer in hazardous areas;

3) Do not charge the battery in explosion hazard area;

4) Only the types of batteries specified in the manufacturer's technical documentation may be used as power sources;

5) Constituents and circuits ensuring intrinsically safe design shall not be repaired and in case of failure shall be replaced by new ones supplied by the manufacturer;

6) The device's operability is maintained at ambient temperature from minus 40 to plus 50ºC.

- The maximum temperature of overheating of components and connections in the circuit diagram during normal operation is 15 °C max. Thus, the surface temperature of conductors and elements during operation and at maximum operating temperature plus 50 ° C is not more than 65 ° C. Device enclosures are made with the degree of protection against external influences not lower than IP54 according to GOST 14254-2015.

6.2. Measures to ensure and keep the device explosion-proofness during the assembly, disassembly and repair of the device.

6.2.1. Measures to ensure explosion-proofness before the production process:

- The elements used in the protective component of “Fib” are subjected to an acceptance test:

- resistors are tested for their nominal resistance;

- the fuses are checked against the short-circuit current limit;
- Materials used for casting the protective component “Fib” are subjected to an acceptance test according to the certificates presented.

6.2.2. Measures to ensure explosion-proofness during production:

- The protective component “Fib” with the installed battery is subjected to an outgoing inspection:
- the short-circuit current and open circuit voltage at the output of the protective component are checked;
- visual inspection of the filling location is carried out in order to confirm the absence of any foreign inclusions, bubbles, cracks or stratification.

6.2.3. Measures to ensure explosion-proofness during operation:

- Check that the cover of the battery compartment and the compartment itself (including the threaded connection) are free from mechanical damage and corrosion. In case of corrosion or mechanical damage, do not operate the device;
- meet the requirements specified by the "X" sign in the explosion proof mark.

- 6.2.4. Measures to ensure explosion-proofness during repair:
- - the device must be repaired only by the employees of the manufacturer.
- Repair by third parties or individuals is prohibited.
- - the protective component “Fib” is not to be repaired. It is made intact and must be replaced in case of failure. Repair of the “Fib” component is not permitted.
- - after repair, the device must be tested according to the test procedure, with the “Fib” component tested for short-circuit current and open-circuit voltage (together with the battery installed).

7. EQUIPMENT INSTALLATION AND DEINSTALLATION ORDER

7.1. Preparation of Test Objects for Echometry

- Make sure that the valve of the offset and the control manometer function properly.
- Check if the pressure in the tested space corresponds to the maximum admissible pressure value for the device.
- Remove the plug from the elbow. Clean the thread part from dirt, oil, sand, etc. Make sure that the thread meets the above requirements. If the thread type does not meet the specifications or is worn out, or significantly corroded, testing is prohibited.
- Clean the inner side of the elbow from paraffin, hydrates, ice, etc.

7.2. Well sounder Installation

- Clean and check the thread part of the connecting coupling of the sensor. If the thread segment is worn out or significantly corroded or damaged, well sounder installation is prohibited.
- Open the valve on the offset for a short period of time (1-2 seconds) for purging (cleaning from possible condensate, ice, mud and pother plugs).
- Install the well sounder by threading it firmly on the elbow and tightening it thoroughly to avoid its displacement under pressure. The minimal tightening torque shall be 200±30 newton meters (20±3 kilogram-force-meters). For tightening the thread use the clamps on the threaded connecting coupling and the handle.
- Warning! No impact drivers shall be used for tightening.
- Turn the valve cap so that the vent hole is in the Push position.
- Check the tightness of the nut of the gage outlet valve; tighten it if it gets loose.
- Warning! The valve is to be rotated only if there is no pressure in the work volume of the gage.

- Gradually, avoiding a pneumatic or hydraulic shock open the valve until the gas starts entering the gage. Stop opening the valve until the pressure in the well and in the work volume of the gage levels off; afterwards, open the valve fully. Control the process of pressure equalization on the terminal indicator.
- In order to avoid leaks in thread connections, use P-402 dope (ТУ 38.101.330-73) or ФУМ 0.1х20 sealing band (ТУ6-05-1388-86).

7.3. Well sounder Removal

- Switch off the device.
- Close the valve of the offset.
- Open the outlet valve of the well sounder and bleed off the excessive pressure from the work volume.
- Unscrew the gage and remove it from the elbow. Drain off condensate from the gage work volume, clean the thread segment and put the gage into the bag provided.
- Close the elbow with an end cap.

8. BATTERY CHARGE

The well sounder has the same type of built-in Li-Ion - battery. The battery is charged at a temperature not lower than 0 ° C. Charging is allowed at temperatures down to -20°C. To charge the battery, connect the device via an appropriate cable to a network or car adapter or USB port of your computer. The charging time of a fully discharged battery is approximately 7 hours.

The voltage of a fully charged battery is 4.1 - 4.2V. Rated voltage is 3.7 - 3.8V. At temperatures below -30°C, the battery voltage may drop to 2.7V.

When the sensor is connected to the adapter, the "Power" and "Charging" LEDs will light up orange. After charging is complete, the "Charge" LED lights up green.

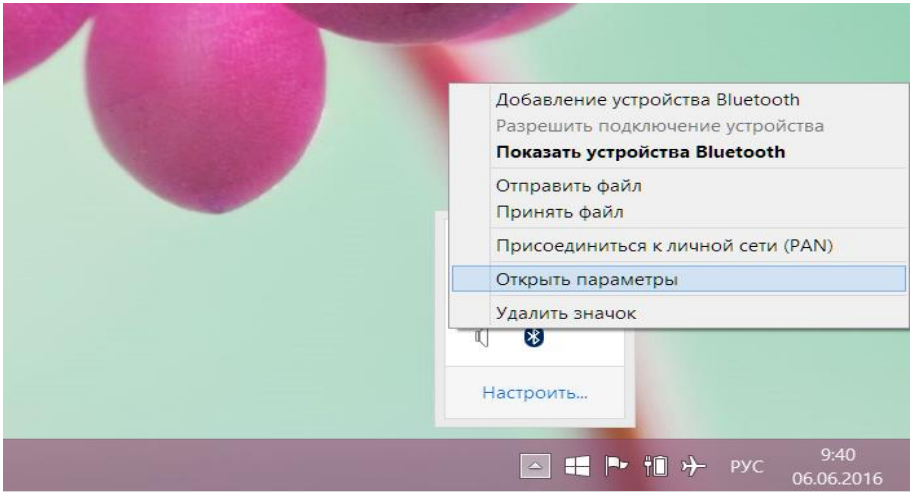
9. DEVICE OPERATION IN THE “DB SIAM” SOFTWARE

9.1 Connecting the device to a computer

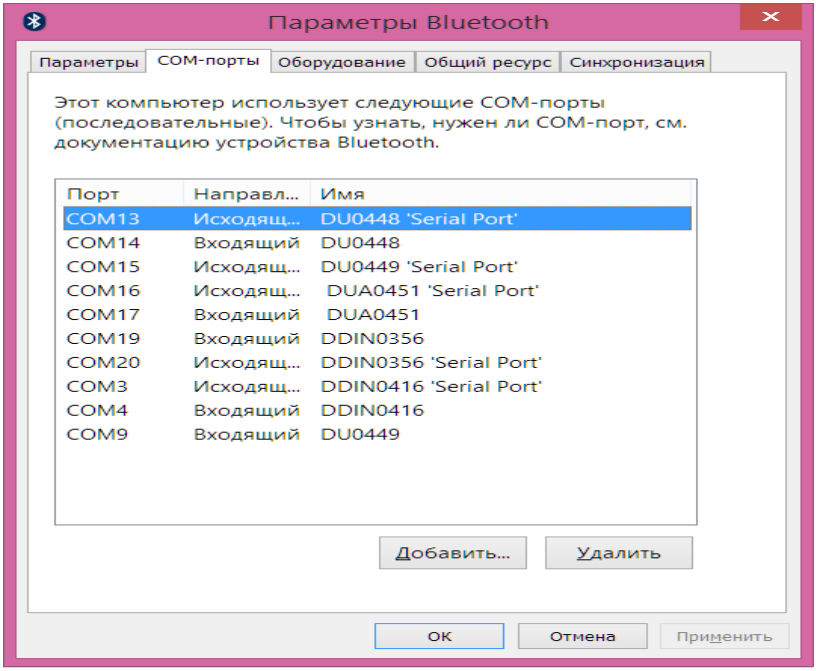
The Bluetooth module must be activated on the computer/tablet from which the wireless devices will be operated. The first time you use each device with this computer, you must connect the sensor using Windows - "Add Bluetooth device". The procedure for connecting may vary depending on the OS version.

The sensor must be turned on and ready for connection. The sign of readiness is the green color of the LED "Power". As a result of the connection, a COM port is created through which the SIAM Database software establishes a connection to the device.

To see which COM port has been created for a specific sensor, proceed as follows:



- point the mouse cursor over the Bluetooth icon in the right part of the taskbar, click the right mouse button;
- in the appeared context menu select item "Open parameters" (see Figure 1);
- in the appeared Bluetooth Options window on the COM Ports tab, see which outgoing port is assigned to the connected device (see Figure 2).

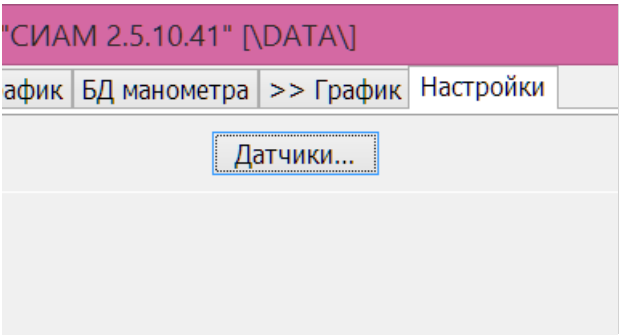


In figure 2, the outgoing port COM20 is assigned to well sounder No. 448.

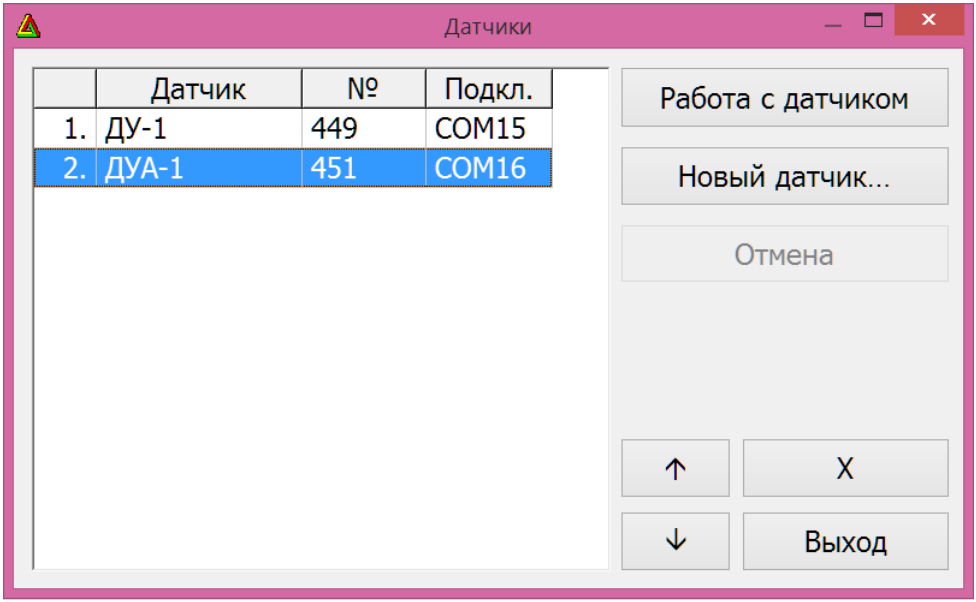
Working with devices in “DB SIAM”

To work with devices in the “DB SIAM” software:

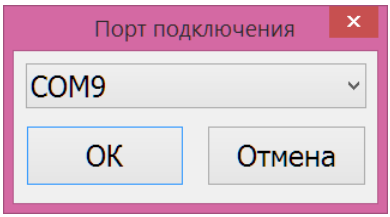
- start the program;
- switch to the “Settings” tab;
- press the “Sensors” button (see Fig.3);



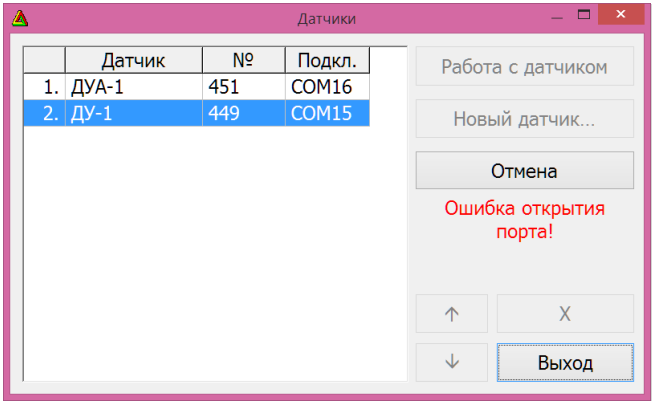
- the “Sensors” dialog box will appear (see Fig.4):



If no devices is listed or if for some reason the connection port of this device does not correspond to the one assigned in "Bluetooth parameters" (see above), then register the sensor in the program.

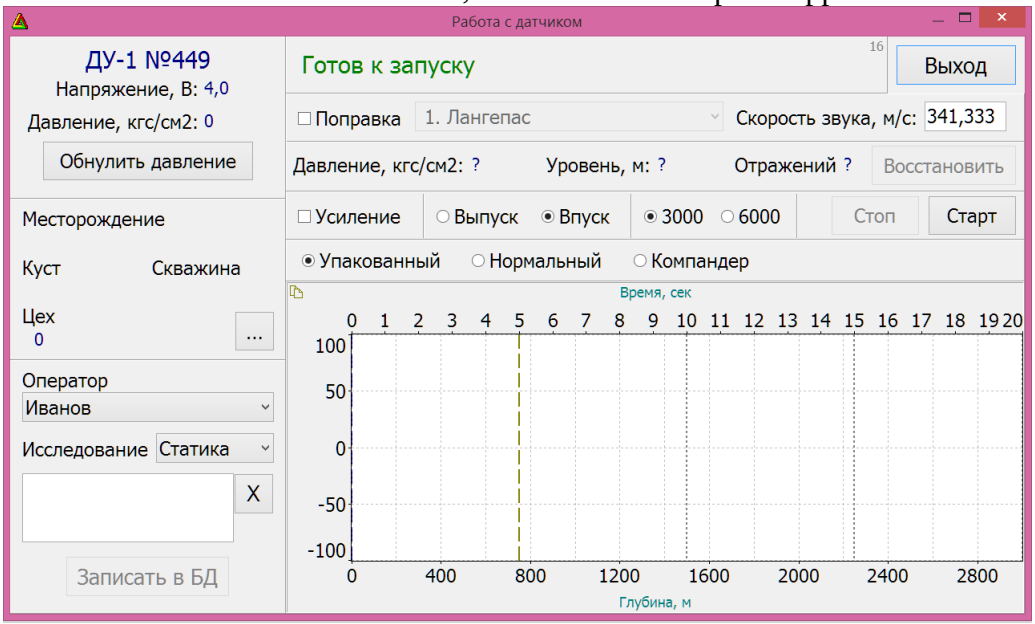


In this window you have to select the corresponding sensor COM port. In case of connection problems, a corresponding warning message appears:



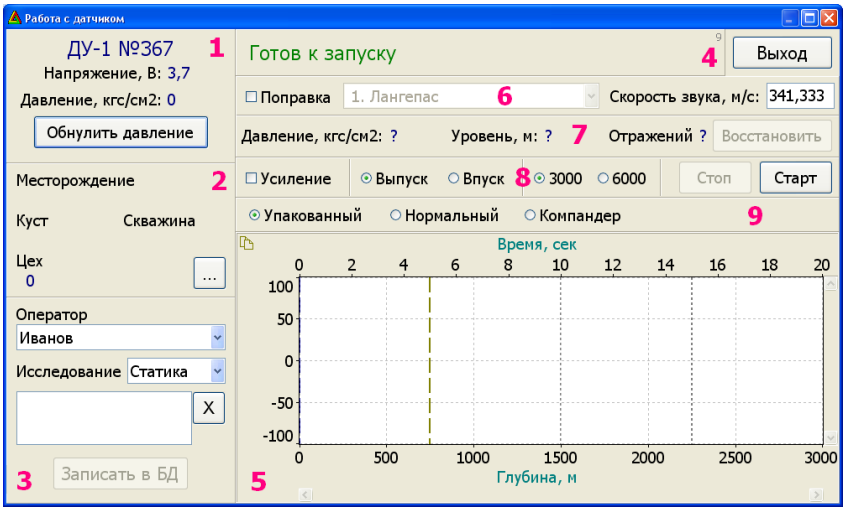
This happens if the COM port is incorrectly specified or in case of the sensor is switched off. If the error occurs because the sensor has been switched off, switch the sensor on and the connection will take place after some time. If, however, an error occurs on the incorrectly specified COM port, the connection must be interrupted by clicking to "Cancel" and the connection must be repeated by clicking to "New sensor...", checking which COM port is assigned to the sensor.

If the connection is successful, the sensor control panel appears:



For each sensor type, the control panel will have a different look.

Well sounder



Panel 1: The name and sensor number, the current battery voltage, temperature, load and acceleration readings are displayed here;

Panel 2: the well details (field, cluster, well, shop floor) are displayed (if specified) here; after pressing the "..." button it is possible to specify or change the details of the well where the measurement is made.

Panel 3: allows you to specify the well survey operator, the type of survey, add explanations to the survey in the text form. The button "Write to Database" becomes available after receiving the echogram from the sensor and allows the operator to save the study into the database at the moment when he is sure that he has correctly specified the well details and other study parameters. If the operator has not saved the study by pressing the button "Save to Database", it will be saved automatically before the next one or when closing this window of work with the sensor.

Panel 4: serves to display the status of the sensor and the connectedness; in the upper right corner is a counter received from the sensor data packets. If communication with the sensor is normal, this counter will continuously increase at intervals of 1-2 seconds.

Panel 5: serves for displaying the echogram. You can select an area on the echogram by swiping your finger from top to bottom and from left to right,

framing the desired area, after releasing your finger the selected area will be enlarged - stretched over the entire area of the chart. In this case, scroll bars will be available to access the areas of the echogram that are outside the chart zone. In order to return to the initial scale, you should drag your finger anywhere in the chart in the opposite direction - from bottom to top and from right to left. The markers also can be dragged corresponding to the level on the echogram to correct the value of the level defined by the device.

Panel 6: is used to specify what sound speed to use for level detection. You can use one of the tables of correction (tables of dependence of sound speed in annular space on pressure in annular space) or set the value of sound speed directly.

Panel 7: shows the results - the pressure in the annulus, the level of the fluid and the number of echo signal reflections from the fluid level. At a small fluid level, the number of reflections indirectly indicates the validity of the fluid level determination. The "Restore" button becomes available after manual correction of the level value by dragging markers on the echogram and allows to return to the level value automatically determined by the well sounder.

Pane 8: allows specify the options for starting the research and start the research.

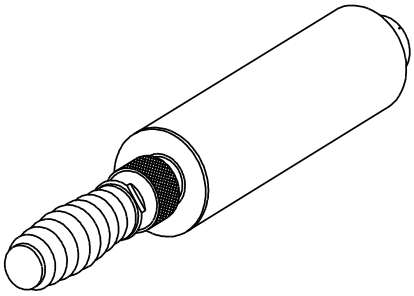
Panel 9: controls the echogram output mode on the screen. Switching the modes in combination with the echogram section enlargement can make it easier to find the mark from the level on the echogram manually.

Study procedure:

1. Check and, if necessary, change the details of the well.
2. Specify the operator, select the type of survey and enter the explanations.
3. Select correction or specify the value of sound speed directly
4. Specify the launch options (if it is known that the level in the well is below 2500 m, select the option 6000).
5. Make sure that the sensor is in the "Ready to start" state and press the "Start" button.
6. The “Waiting for burst...” state would succeed the state " Noise Measurement …".
7. Run the burst.
8. The device will switch to the state of recording the echogram, the screen will begin to show the progress.
9. After registration of the echogram the device will successively pass the state "Measurement completed", "Reading the echogram..." and will switch to the state "Ready to start". The just measured echogram will be displayed on the screen.
10. Check the correctness of the fluid level determination by the well sounder, correct it if necessary.
11. Save the result to the database by pressing the button "Save to database".
12. If necessary, repeat the study.
13. Finish the work with the sensor by clicking the "Exit" button located in the upper right corner of the window.

10. ADDITIONAL ACCESSORIES

10.1. GAI-1 Acoustic Pulse Generator



GAI-1 acoustic impulse generator is supplied separately and is designed for generating an acoustic impulse when there is no excessive gas pressure in the annular space of the well. GAI-1 can be used at low annular pressure for controlling fluid level up to 1800… 2500 m.

GAI-1 is a unit which combines a container for accumulating excessive air pressure, a manual pump, a shipping lock pin and a valve for quick bleeding off.

The handle has spare rubber gaskets for GAI-1.

GAI-1 is to be installed on the well sounder instead of the removable manual valve using the reduction sleeve in the gage package.

10.2. Multi-purpose Valve

The multi-purpose valve is supplied separately and is to be used in SUDOS well sounders and SIAM-manufactured well sounders for generating an acoustic impulse by injecting gas into the well or bleeding the well down.

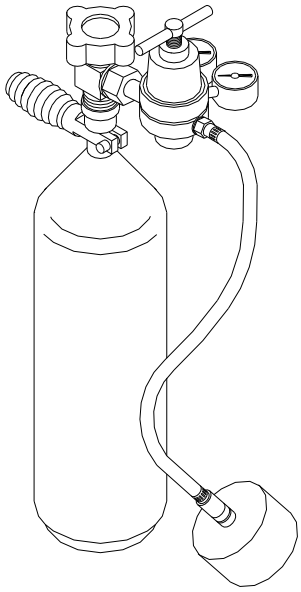
The valve is to be installed instead of the removable manual valve. If there is excessive annular pressure, the valve is used as an ordinary manual valve for generating an acoustic impulse by releasing some portion of gas into the atmosphere. At low values of excessive pressure and in vacuum, the valve can be used for forming an acoustic message by injecting the portion of high pressure gas into the annular space. In this case, GBO-2 conversion kit filled with nitrogen is used as an excessive pressure source. While venting gas from the annular space by the multi-purpose valve, the receiver from GBO-2 conversion kit might be used to

change the form of the acoustic message. In this case the conversion kit is not connected.

10.3. GBO-2 Conversion Kit

GBO-2 conversion kit is supplied separately and is to be used in SUDOS well sounders and SIAM-manufactured well sounders for controlling the level when there is no or low excessive pressure in the annular space of the well.

GBO-2 consists of the vessel filled with nitrogen, the reducer, the receiver and the connecting hose. The hose has a connector that allows to connect the conversion kit to the well sounder receiver.



The cylindrical receiver from GBO-2 kit is screwed on the outlet of the automatic valve unit or on the specialized manual valve of the well sounder. Gas from the BTs container is supplied through BK94 tap, БК-50-4 reducer (reduces pressure up to 15 atm) and through the hose to the storage receiver. While opening the well sounder valve, the portion of gas accumulated in the receiver gets into the annular space of the well, thus forming an acoustic impulse for controlling the level of fluid in the well. A filled container (the pressure in the container is 150 atm) is sufficient for taking up to 250 level measurements.

11. MAINTENANCE

11.1. Order of Well sounder Maintenance

Type of works	Maintenance 1 (every week)	Maintenance 2 (every month)	Maintenance 3 (every 6 months)	Maintenance 4 (every 12 months)
Cleaning of the tapered connecting thread, the acoustic sensor, the well sounder and the case	+	+	+	+
Maintenance of the exhaust valve	-	+	+	+
Cleaning of accumulator charging socket	-	+	+	+
Performance monitoring [1)]	-	-	+	+
Pressure tests [1)]	-	-	+	+
Replacement of the valve sealing ring	-	-	-	+

11.2. Procedure of Well sounder Maintenance

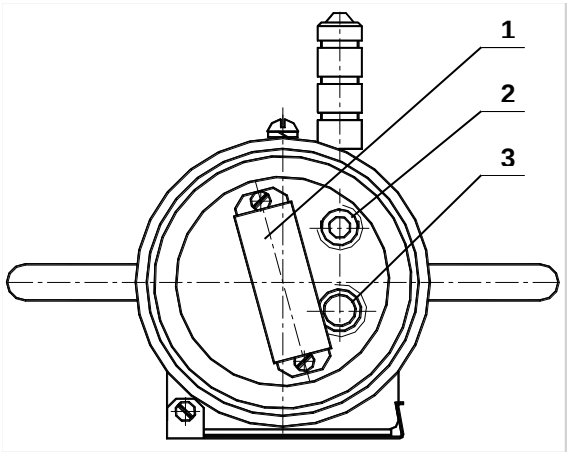
11.2.1. Cleaning Tapered Connecting Thread, Acoustic Sensor, Well sounder and Sensor Case

Arrangement of the elements inside the threaded coupling cavity is given in the figure of the level indicator:

1 - acoustic sensor;

2 - pressure sensor;

3 - fitting.



Cleaning is done using pure gasoline, a brush and a cleaning rag. It is allowed to pour a small amount (50…100ml) of gasoline inside the threaded coupling cavity while cleaning. However, do not immerge the well sounder housing in the cleaning liquid, and do not let its ingress in the connector. When cleaning a very dirty thread, application of metal tools (an awl, a screwdriver, etc.) is allowed, but do not apply an excessive force not to damage the thread.

It is strictly forbidden to use a metal tool for cleaning the acoustic and pressure sensors. Moreover, be careful not to apply much force during cleaning. Acoustic sensor housing is covered with a protective varnish, do not damage it! It is forbidden to insert foreign objects in the pressure sensor hole!

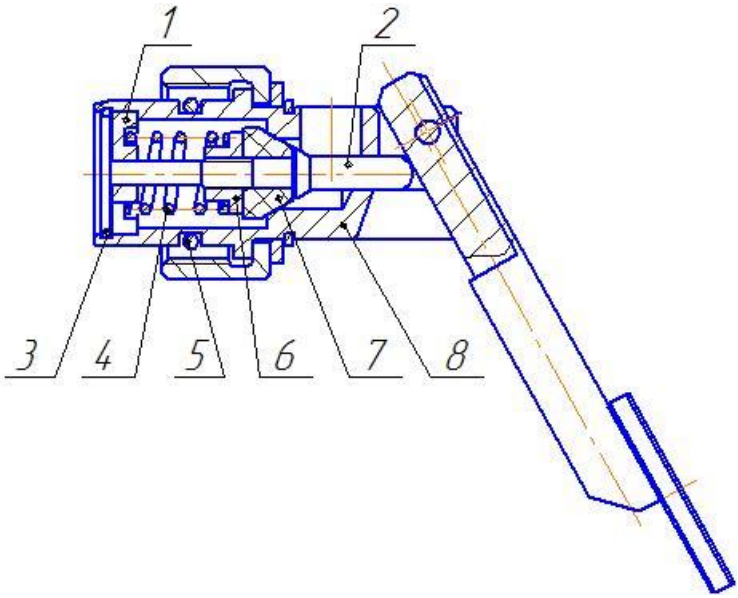
Wipe the surfaces with a rag after washing. Cleaning should result in a metallic lustre on the coupling surfaces, connecting thread, acoustic sensor, and clean holes of pressure sensor and fitting.

The outer surfaces of pressure sensor are wiped with a clean rag, wetted in a small amount of gasoline, and then wiped dry.

11.2.2. Exhaust Valve Maintenance

Exhaust valve components are given in the Figure:

:



1 - guide bush;
2 - tappet;
3 - retaining ring;
4 - spring;
5 - sealing ring;
6 - nut;
7 - cone;
8 - housing.

Washing is done with diesel fuel or kerosene, using a brush and a rag. Before washing, remove the valve from well sounder, put it into a clean container and pour a small amount of washing liquid. Press the handle several times without taking the valve out of a container. Clean the

outer surfaces with a brush. Do not leave the valve in the washing liquid for a long time. After washing you should wipe the valve dry with a clean rag. Before installing it back in the well sounder, apply a small amount of lubricant, according to standard CIATIM GOST 6267-80, on the rubber sealing ring surface (5).

After mounting the valve on the well sounder, install the latter on the Inspection bench for well sounders SKU-1 IZM 4.137.003 (SIAM Company) and purge the valve at pressure of 5…8 atm, using clean air. Test for pressure integrity with a soap solution. A slight “seepage” is allowed with small bubbles in the discharge hole area. In case of a high "seepage", repeat the valve washing process.

If high “seepage” continues, then replace the cone (7) of ball seats. In order to do that, press the retaining ring (3) and pull it out of valve housing. Take out the guide bush (1), spring (4), tappet (2) in combination with cone (7) and nut (6) from valve housing (8). Then, replace the cone (7) by unscrewing the nut (6). When necessary, clean the contact chamfer of the valve ball-and-seat in the housing (8) with a rag.

Assemble it in the reverse sequence.

11.2.3. Cleaning of Accumulator Charging Socket

Cleaning is done with a pure ethyl alcohol or alcohol-gasoline blend (1 part of ethyl alcohol, 1 part of rubber solvent or oil solvent gasoline, the other kind of gasoline is not allowed), using a brush. Alcohol consumption – 30g per month of operation. Apply a small amount of CIATIM GOST 6267-80 lubricant on the connector surface after cleanup.

11.2.4. Performance Monitoring

Well sounder performance control is done at the SIAM service center or by SIAM certified specialists, according to design documentation under the testing program.

11.2.5. Pressure Testing

Well sounder pressure testing is done at the SIAM service center or by SIAM certified specialists on the Hydraulic testing bench SGI-1 IZM

4.137.002, using oil, at the excessive pressure of 150 atm during 10 minutes. Oil leakage from well sounder is not acceptable during testing.

11.2.6. Replacement of the Valve Sealing Ring

In order to replace the sealing ring, the latter should be demounted from the well sounder with a sharp tool. Take the ring out of the groove, clean the groove from dirt with a rag, wetted in gasoline, then wipe the groove dry and insert a new ring in the groove. Before installation the ring should be lubricated with CIATIM GOST 6267-80 lubricant. Then the valve should be put in place.

After a final assembly of the well sounder, it is necessary to carry out the integrity and strength tests. First, install the well sounder on the Inspection bench SKU-1 IZM 4.137.003 and test for pressure integrity with a soap solution at the pressure of 5…8 atm. A slight “seepage” is allowed with small bubbles in the discharge hole area. "Seepage" in the area of flexible joint coupling-body is not allowed. Then carry out the pressure testing of the well sounder, according to Clause 8.2.5. hereof.

Well sounder is permitted for operation if integrity requirements are met. If not, the sensor shall be sent to manufacturer for defects elimination.

12. DEVICE STORAGE AND TRANSPORTATION

The device should be stored in a standard bag in dry heated premises, at the temperatures from -10 to +40 °C and moisture less than 80%.

Product transportation is allowed in a standard bag by any type of transport at the temperature from -50 to +50 °C.

Severe shock and vibration are to be avoided during transportation.

When storing the device, a monthly check of installed accumulator voltage shall be done at least monthly and charged when needed. Charging shall only be done at positive temperatures!

APPENDIX 1. Control of Well Fluid Level in Complicated Conditions

In some situations a steady identification of echo signal, reflected from fluid level, and, accordingly, an accurate automatic sensing of level is complicated. Some of the causes, recommended methods and modes of measuring, results analysis methods are described in this Appendix.

Factors which complicate the automatic identification of level:

High level of fluid (less than 30 m from wellhead), when response time is less than acoustic dispatch time.	Response signal comes at the background of the original signal and usually difficult to read.
In the annular space a level of interference is very high, what is caused by an excessive vibration of the tubing hanger and casing, ESP vibration, valve leakage and other causes.	Response signal has a lower amplitude than noise level.
High level of foam in the annular space.	Acoustic signal is absorbed by the foam and returns to the wellhead significantly weakened.
Incomplete opening of the valve or narrowed space between tubing and casing due to hydrate or paraffin plugs.	Response acoustic signal is scattered in multiple variation of clearance.
A very small (less than 0.5 kgf/cm^2) or zero excess pressure in the annular space of low level (over 1000 m).	Acoustic signal is generated and returns of a very low amplitude.

High level of fluid. It is recommended to generate an acoustic impulse of short length.

High interference, high foam level, a significant narrowing of annular clearance, low gas pressure in the annular space. It is recommended to generate an acoustic impulse of increased length.

Quite often, especially in wells equipped with ESP, sources of high interference are acoustic noises on the part of flowline. In this case, it is recommended to shut a casing valve of the flowline tree during measurement, if it is not in conflict with the safety regulations and production process. A shut valve should be provided with a warning sign, telling it's closed.

Upon measurement completion, the casing valve is required to be brought to initial state. The valve should be opened in several steps to level the pressure slowly and avoid pump supply failure. After opening the valve, the sign should be removed.

APPENDIX 2. Setting Sound Speed Work Sheet

When controlling a level, the operator has an opportunity to select and install a worksheet of speeds, according to which the device detects the acoustic wave speed, depending on measured pressure in the annular. Here can be selected both the sheets from device's memory and user sheets from computer database.

Attention! Sound speed in wells even within one field can vary greatly. Therefore, we strongly suggest to use your own (for your region) sheet of corrections for a specific field or a pattern of wells within one field range. The device will show the level, based on the preset sound speed!

General use sheets are recorded in the read-only memory of the device, obtained from averaged data for respective regions. These sheets can only be used for a rough estimation of level. They are denoted by the following conventional codes and names:

Sheet 1 – "Langepas" (for Siberia region);

Sheet 2 – "Tatarstan" (for Tatneft fields).

Besides the mentioned general sheets, user sheets can be recorded in the device memory, accepted for specific conditions of O&G Production Divisions, fields, etc. Numbers of user sheets can be from 3 to 99.

Working with a database, including questions on creation and use of user sheets, is described in the document "Database DB SIAM v2.5. User Manual", included in the package.

APPENDIX 3. Dependence of Sound Speed on Annular

Pressure

Sheet 1 - "Langepas" (averaged data for Siberia)

Pressure, kgf/cm^2	Sound speed, m/s	Pressure, kgf/cm 2	Sound speed, m/s	Pressure, kgf/cm^2	Sound speed, m/s	Pressure, kgf/cm^2	Sound speed, m/s
0	320	2,0	337	4,7	354	8,7	371
0,1	321	2,1	338	4,9	355	8,9	372
0,2	322	2,2	339	5,1	356	9,2	373
0,3	323	2,3	340	5,3	357	9,5	374
0,4	324	2,4	341	5,5	358	9,9	375
0,5	325	2,6	342	5,7	359	10,2	376
0,6	326	2,7	343	5,9	360	10,6	377
0,7	327	2,8	344	6,1	361	10,9	378
0,8	328	3,0	345	6,3	362	11,2	379
1,0	329	3,1	346	6,6	363	11,5	380
1,1	330	3,3	347	6,9	364	11,9	381
1,2	331	3,5	348	7,1	365	12,3	382
1,3	332	3,7	349	7,5	366	12,8	383
1,5	333	3,9	350	7,7	367	13,5	384
1,6	334	4,1	351	8,0	368	≥14,6	385
1,7	335	4,3	352	8,2	369		
1,8	336	4,5	353	8,4	370		

Tatarstan" (for Tatneft fields)

Pressure, kgf/cm2	Sound speed, m/s	Pressure, kgf/cm2	Sound speed, m/s	Pressure, kgf/cm2	Sound speed, m/s	Pressure, kgf/cm2	Sound speed, m/s
0	300	2,0	322	4,7	336	9,2	346
0,1	302	2,1	323	4,9	336	9,5	347
0,2	303	2,2	324	5,1	337	9,9	347
0,3	305	2,3	324	5,3	338	10,5	348
0,4	306	2,4	325	5,5	339	11,2	349
0,5	307	2,6	326	5,9	339	11,9	349
0,6	309	2,7	326	6,1	340	12,3	350

Pressure, kgf/cm2	Sound speed, m/s	Pressure, kgf/cm2	Sound speed, m/s	Pressure, kgf/cm2	Sound speed, m/s	Pressure, kgf/cm2	Sound speed, m/s
0,7	310	2,8	327	6,3	340	13,5	351
0,8	311	3,0	329	6,6	341	14,0	352
1,0	313	3,1	329	6,9	341	15,0	353
1,1	314	3,3	330	7,1	342	17,0	354
1,2	315	3,5	331	7,5	343	20,0	356
1,3	316	3,7	332	7,7	343	26,0	358
1,5	318	3,9	332	8,0	344	34,0	360
1,6	319	4,1	333	8,4	344	48,0	362
1,7	320	4,3	334	8,7	345	60,0	363
1,8	321	4,5	335	8,9	345	≥81,0	364

CLAIMS

If the “DU-1” well sounder malfunctions during the warranty period, the consumer must draw up an act indicating the signs of faults. Act indicating the exact address of the consumer should be sent to the manufacturer.

КОМПАНИЯ СИАМ

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For repair and maintenance of products manufactured by TSIIC “SIAM” LLC contact the service centers of the company:

1. Service center in Neftejugansk, Tyumen region
   106 Microrayon 11B,
   Neftejugansk, 628305, Tyumen region, Russian Federation;
   tel.: (34632) 3-44-69; +7912-812-95-73.
2. Service center in Otradny, Samara region
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3. Service center in Almetyevsk, Tatarstan Republic
   7a Bazovaya Str,
   Almetyevsk, 423450, Tatarstan Republic, Russian Federation;
   tel.: (3822) 65-58-80; 45-021.

4. Service center in Tomsk
   3 Belaya Str.,
   Tomsk, 634003, Russian Federation.
   tel.: (3822) 90-00-08; 20-02.

REVISION RECORD SHEET

Revi-sion	Numbers of sheets (pages)				Total sheets (pages) of document	Ref # of docu-ment.	Incoming # of supporting document	Signa-ture	Date
	Revised	Replaced	New	Annulled					