

INTERCONNECTING METHODS OF NONDESTRUCTIVE TESTING WELDED TUBES IN THE STREAM OF MANUFACTURE

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Perfection of metallurgical manufacture longitudinal welded tubes of the big diameter is provided with faultless performance of sequence of all technological operations of manufacture. The major place in maintenance of quality of manufacture makes interconnecting non-destructive testing (NDT) which in necessary places of a chain of manufacture as obligatory are built - in technology and provide duly detection of defects in crucial zones of a tube. It first of all a longitudinal welded seam and zone, adjoining to a welded seam, and also the ends of a tube forming a zone of a ring welded seam already during construction of pipelines.

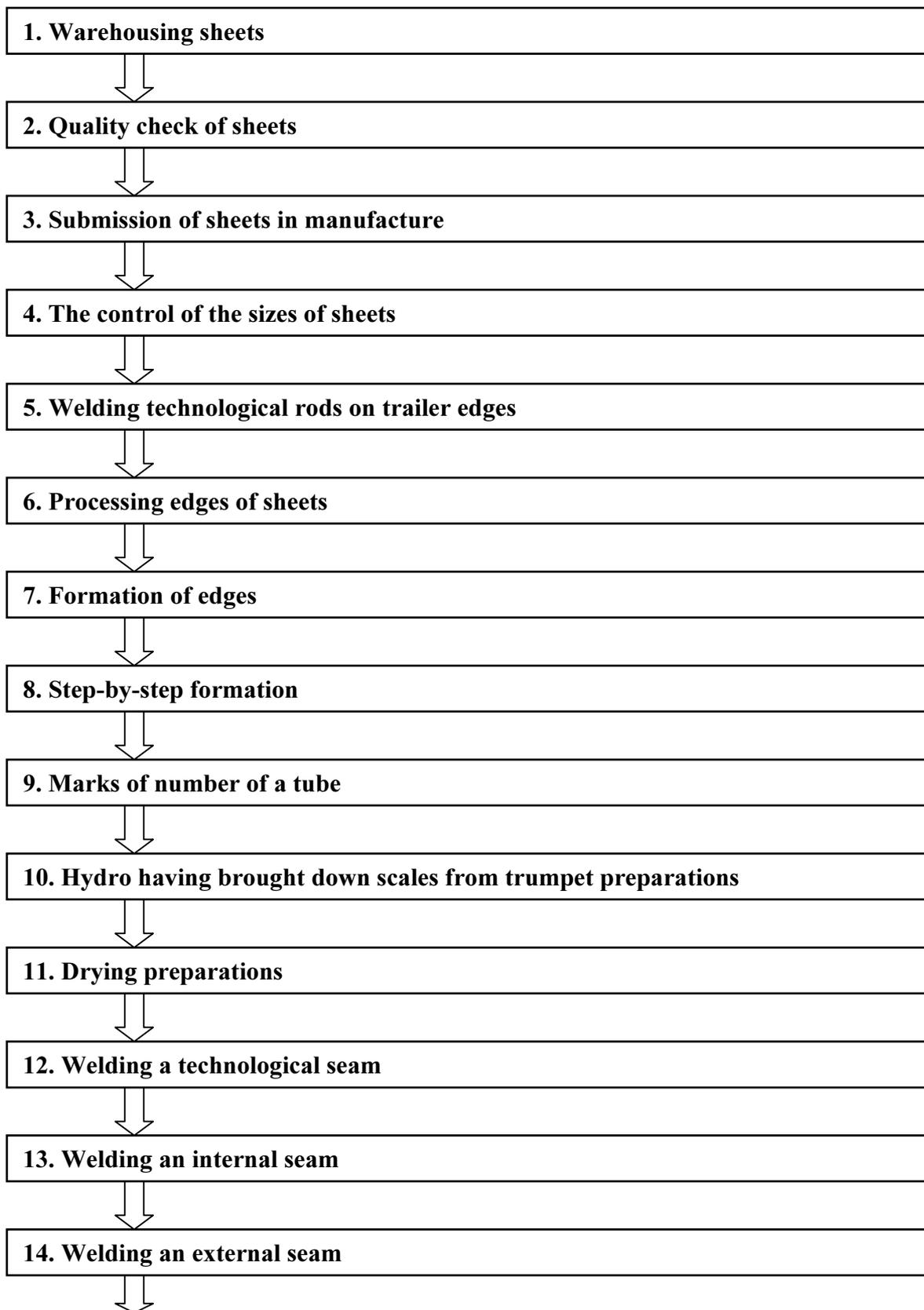
In technological operations of manufacture of tubes distinguish two stages of control operations: technological and delivery. At a technological stage interconnecting the following methods NDT: automated ultrasonic testing (AUST) of welded seams, radioscopic testing (RT) of the marked defective sites of a welded seam, manual ultrasonic testing (MUST) of the sites marked AUST, but not confirmed RT, RT the repaired sites of a welded seam, MUST the repaired sites of a welded seam. At a delivery stage the complex of the following methods is used: AUST welded seams, AUST the ends of tubes, RT the ends of welded seams, visual survey and repair of defective sites of tubes, rechecking MUST a welded seam and MUST the ends of tubes. If as a result of indication of defects, a scrap of the end of a tube it is impossible, the tube is rejected, if scrap is possible - the end of a tube is cutting-off, and it comes back to a position of the beginning of the control of the end of a tube. If all elements of a tube are recognized suitable, the tube is translated in a position of magneto-luminescent testing (MLT) of a facet of tubes. In case of successful passage of the given operation, final acceptance is made and on each tube the passport is formed. In case of revealing defects of a facet, it is made a piece of the end of a tube, and it comes back to the repeated delivery control of the ends, or is rejected. The block diagram of a technological line of manufacture of tubes of the big diameter is resulted on figs 1. Interconnecting the listed methods of not destroying control we shall consider by the example of manufacture of welded tubes of the big diameter in JSC "VSW" at which the following systems and the equipment are used.

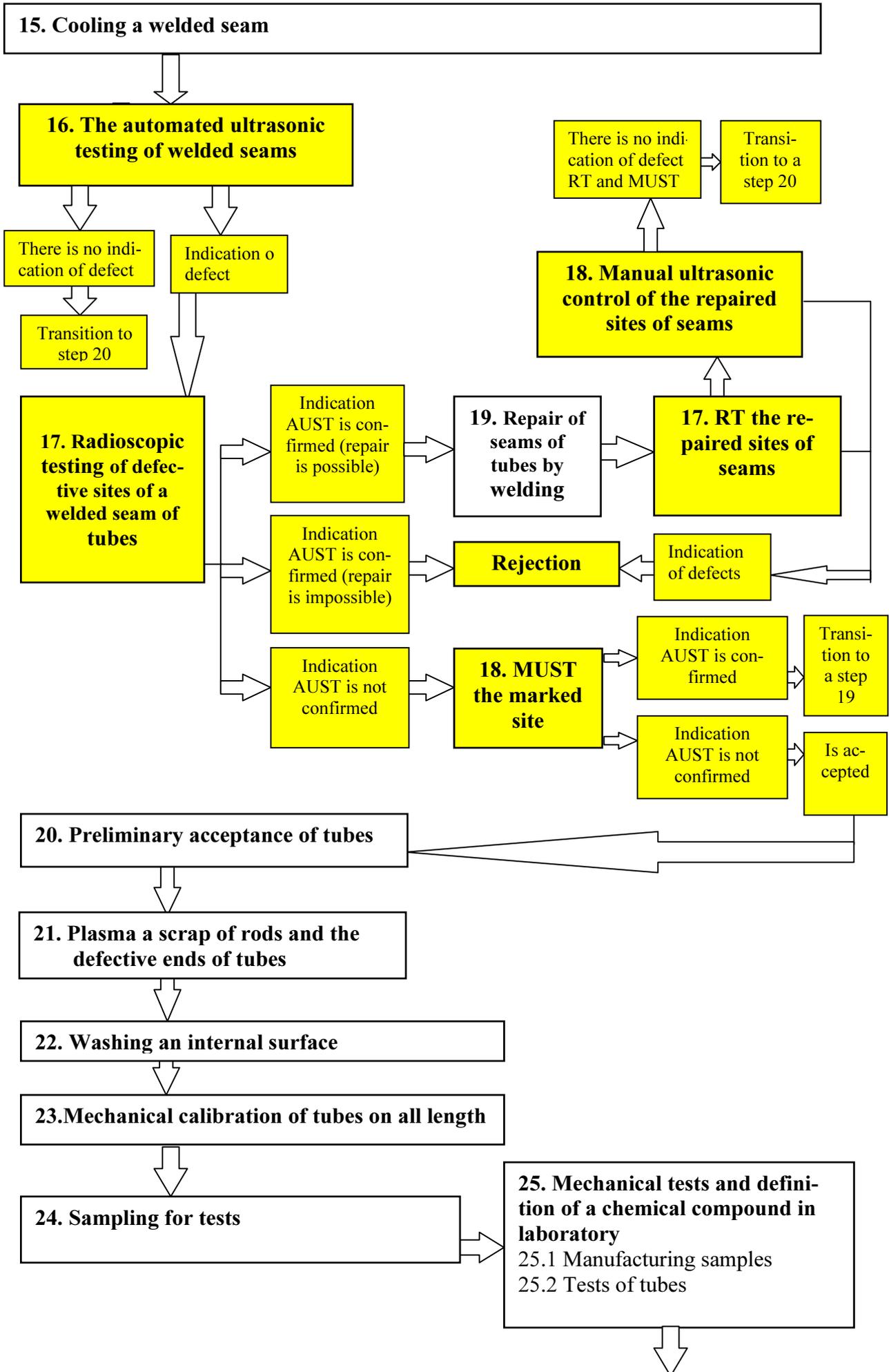
Technological AUST a welded seam in a stream of manufacture of a tube before hydrotests (№16 in the block diagram) it is carried out by installations HK360 and HK361, the created experts of the Scientific research institute of NDT (NIINK JSC "INTROSCOP") of Kishinau and Institute of electric welding E.O.Patona of Kiev with participation of laboratory NDT JSC "VSW". Installations AUST are intended for revealing various defects of longitudinal and cross-section orientation and equipped with the automatic sound and light signal system, paintmarker for a mark of defective sites and sites of deterioration of acoustic contact, laser systems of tracking a welded seam with accuracy ± 1 mm.

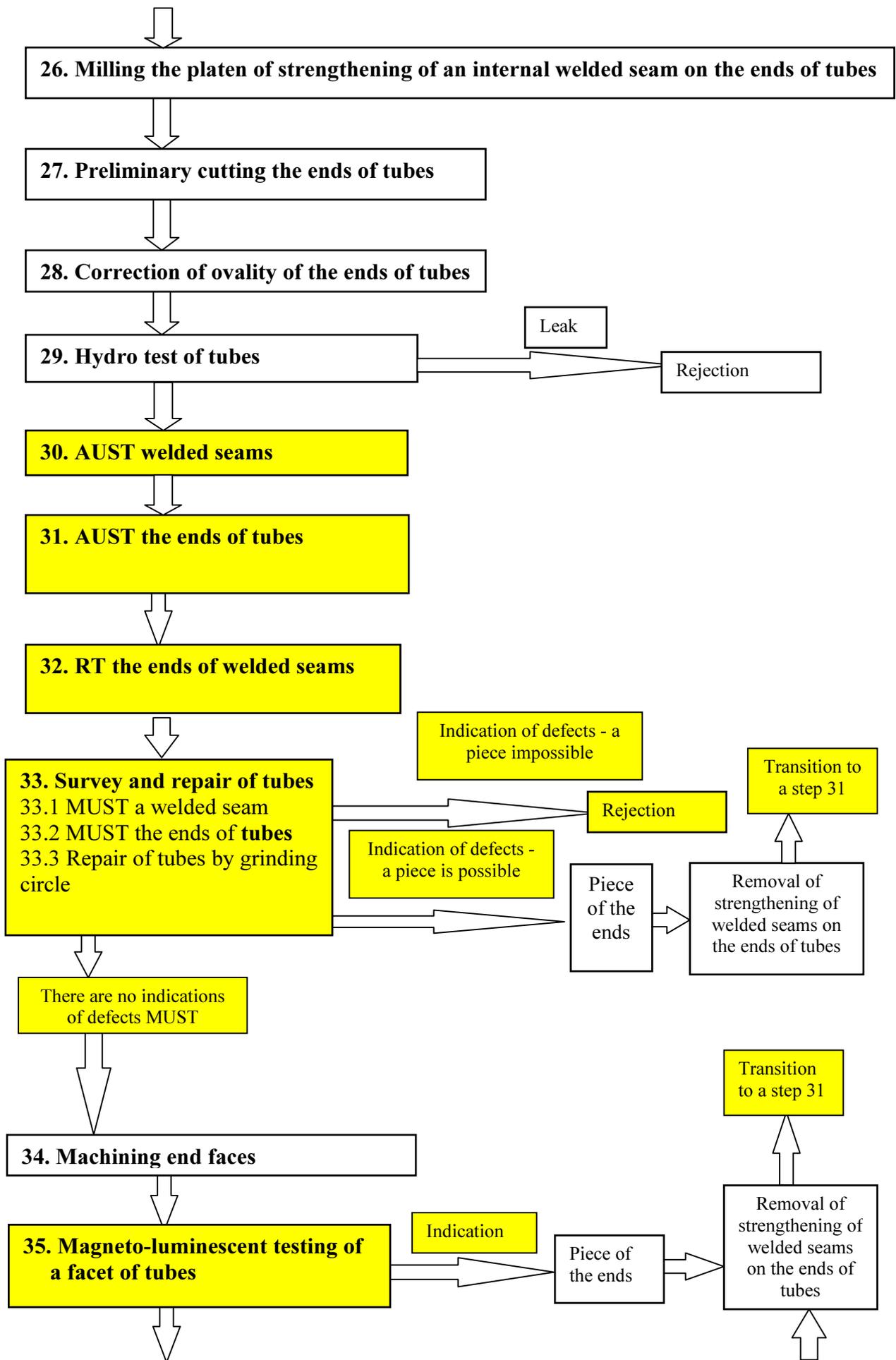
The acoustic system of installation (figs 2) will consist of two acoustic blocks BA1 and BA2. Structure BA1 includes two pairs inclined combined piezoelectric probes (probe) 0 - 1 and 2 - 3, axes of which diagrams of an orientation, are focused perpendicularly axes of a controllable longitudinal seam of a tube, corners of input of ultrasound and distances up to a seam are chosen so, that pair probes 0 - 1 sounds the bottom zone of a welded seam, and pair probes 2 - 3 sounds the top zone of a seam. Besides structure BA1 includes two pair's probes 4 - 5 and 6 - 7, consisting of generating and reception probe included under the circuit "tandem" and located in pairs from two sides of a seam. The pair 4 - 5 is adjusted on revealing of longitudinal and volumetric defects of the seam located in a zone from the middle up to a root part of a seam. The pair 6 - 7 is adjusted on revealing of longitudinal and volumetric defects of the seam located in a zone from the middle up to the top part of a seam.

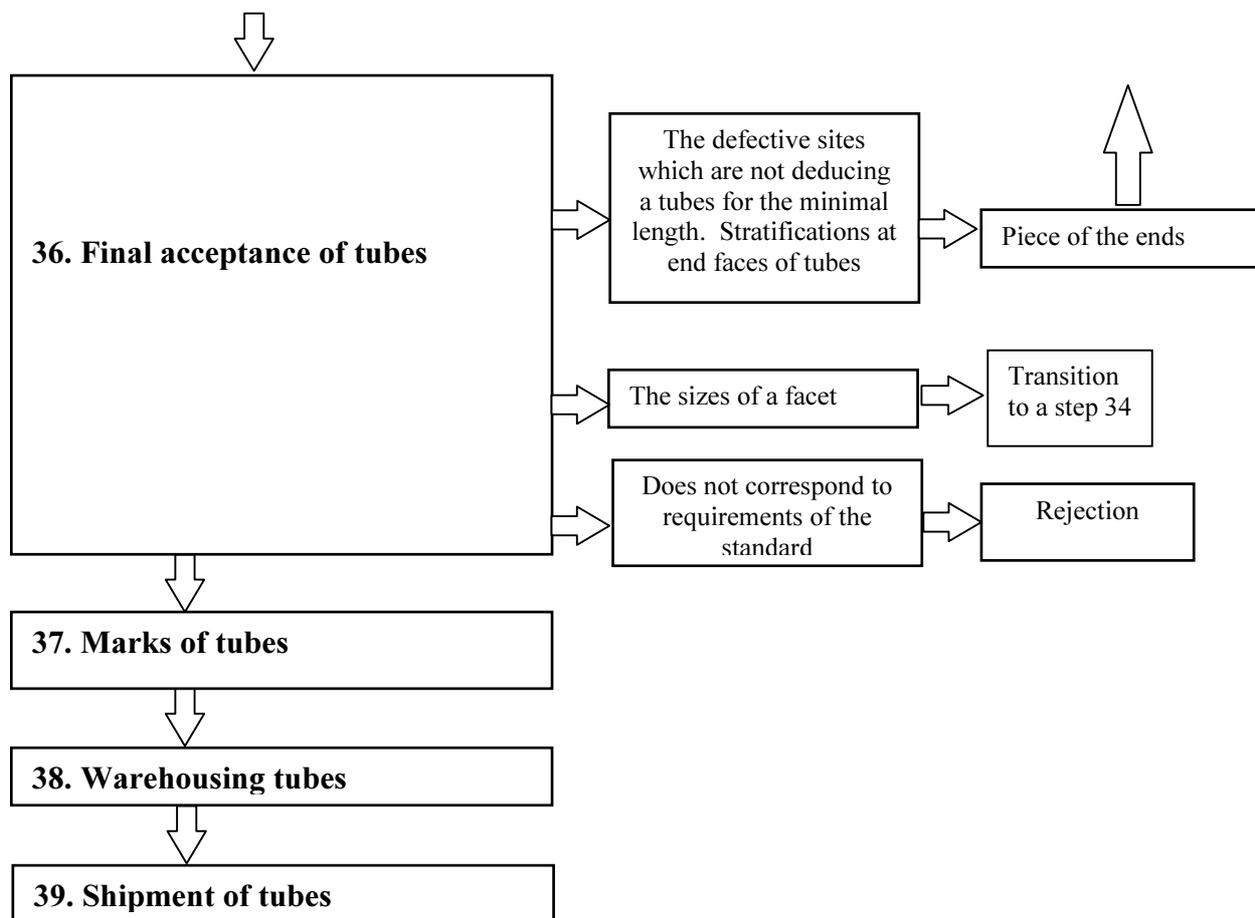
Structure BA2 includes pair probes 0-5, included under the circuit the "tandem", adjusted on revealing of longitudinal and volumetric defects of a seam, in the central zone of a welded seam. Besides in BA2 enters 4 probes 1, 2, 3, 4, included under the X-circuit, the cross-section on

revealing cross-section and volumetric defects. The variant of the circuit when probes 1, 2, 3, 4 acoustic blocks BA2 are grouped in pairs (on figs 2 is not shown), settle down above a welded seam, through a thick layer of water provide input of ultrasonic fluctuations directly in a body of a seam under a corner of 45 degrees, providing detection of cross-section and volumetric defects.







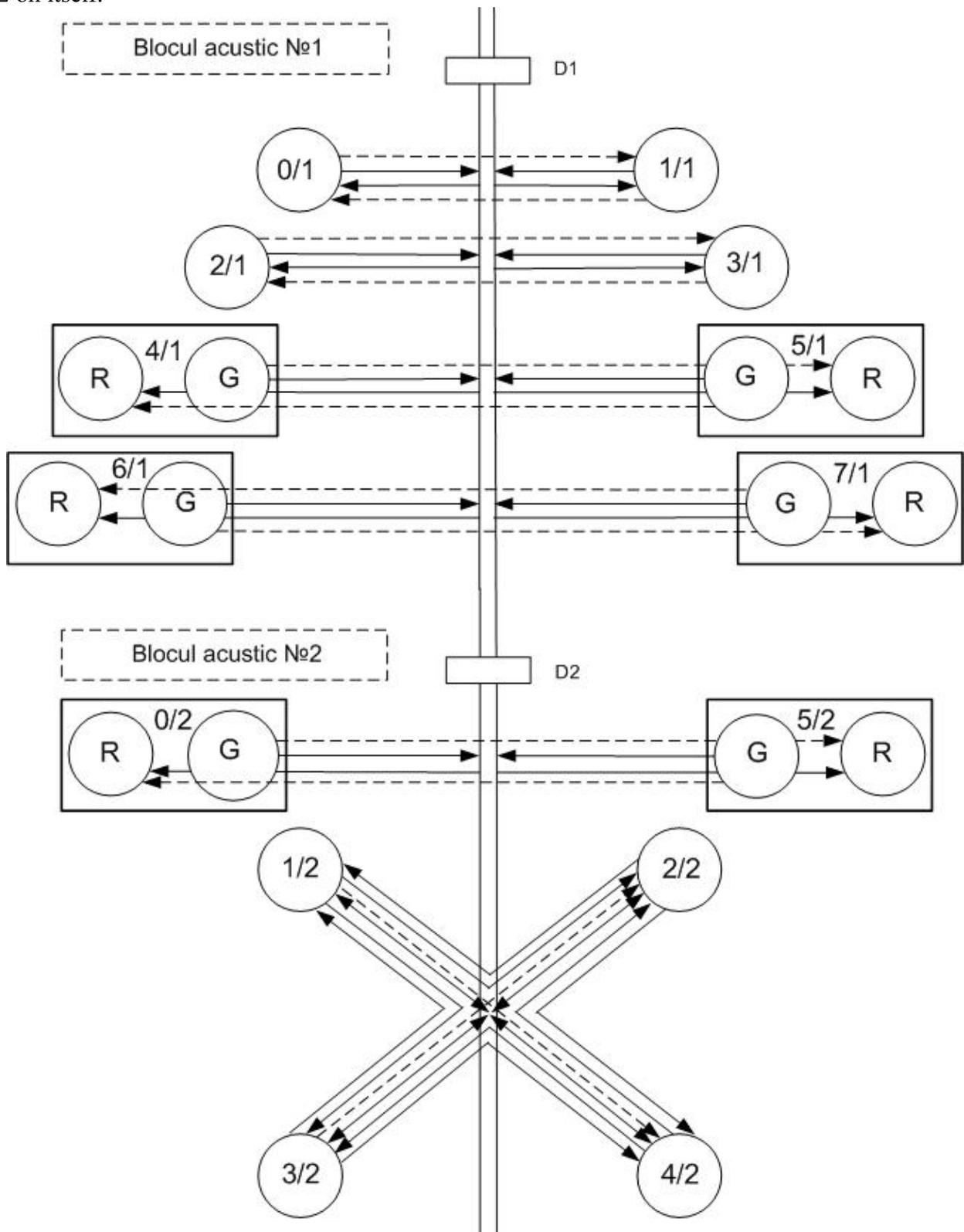


Figs 1. The block diagram of a technological line of manufacture longitudinal welded tubes of the big diameter

Detection of defects, data processing of the control, registration of results of calibration of installation are provided with multi-channel ultrasonic system INTROSCOP-02 with managing computer complex on the basis of an industrial computer with the advanced structure of an exchange with systems of installation. In multi-channel system the choice and input of zones of the control of metal of a welded seam and zones of quality assurance of acoustic contact is carried out by time strobes - pulses installed at a program level. At the control of welded seams of tubes over alignment of sensitivity the equal defects located on different distance from probe, and for exception of the overestimated rejection of tubes in INTROSCOP-02 the system of time adjustment of sensitivity is used. Supervision over process of the control and adjustment, display of results of the control in INTROSCOP-02 is carried out with the help 19-ти the inch monitor on which screen all necessary signals are distinctly looked through, displayed A-scan (figs 3) and B-scan (figs 4.) B-scan allows estimating work of all multi-channel system (the channel of detection of defect, its position, relative amplitude, presence of acoustic contact). Computer complex INTROSCOP-02 allows making processing of the received information on defect by various rejection criteria - amplitude, extent, quantity of defects for the set extent of a welded seam.

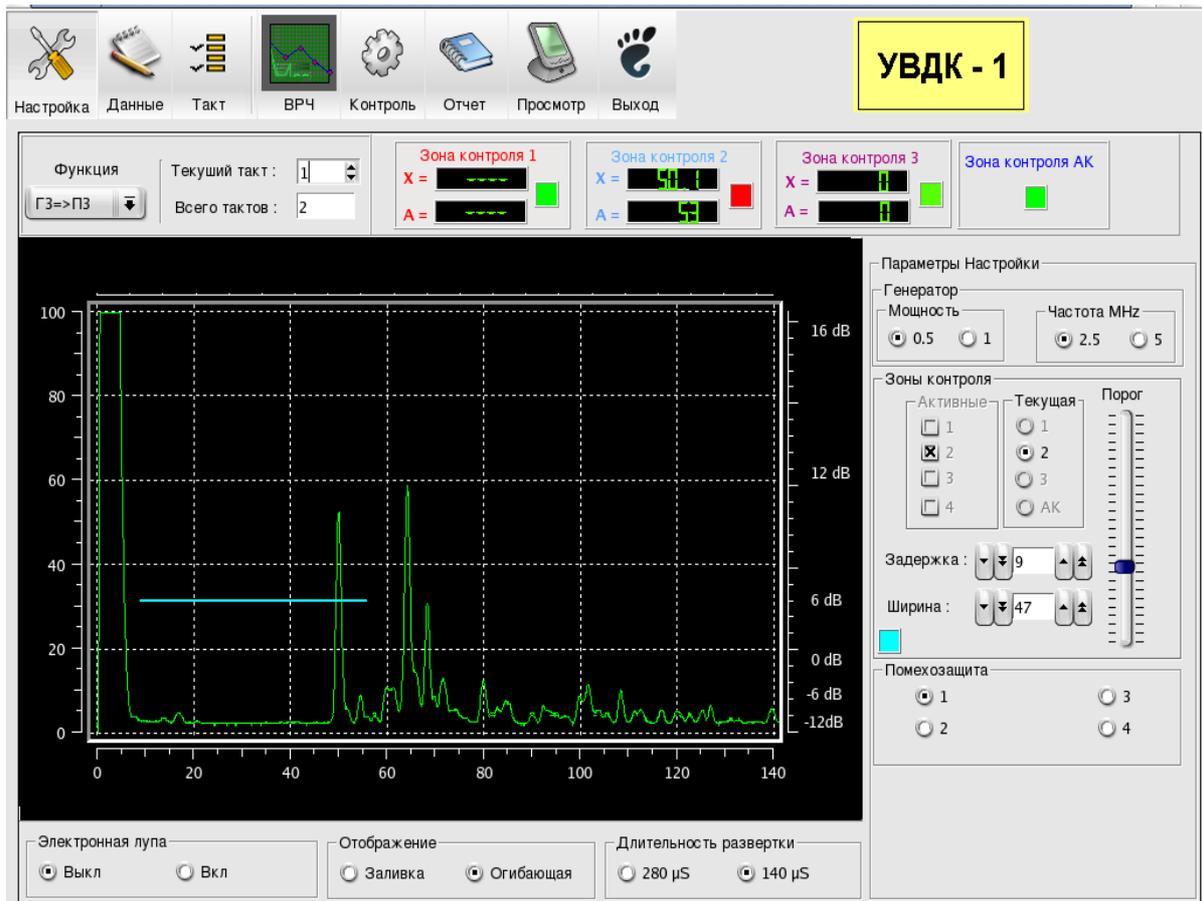
Result AUST is the file of defects placed in database INTROSCOP-02, and the report of the control (figs 5) which, if necessary, can be directed on a seal. There is an interface for information interchange with the automated control system of technological processes of shop. For connection with systems of automatics of the equipment of a site structure INTROSCOP-02 includes the block of management which, on availability for service of a mechanical part of a complex, accepts signals of management of the beginning of the control, pulses of gauges of moving of a tube concerning acoustic blocks and transfers signals of management to executive mechanisms of installation (about presence of defect, the end of the control, the termination of scanning). The special attention is given to convenience of service of installation by the serviceman and efficiency of adjustment - recustomizing for other diameter of a tube. For this purpose the portable monitor with "mouse" and

the keyboard is stipulated, allowing making adjustment, being directly at acoustic blocks of installation. The monitor is established at the adjusted acoustic block and takes management INTROSCOP-02 on itself.

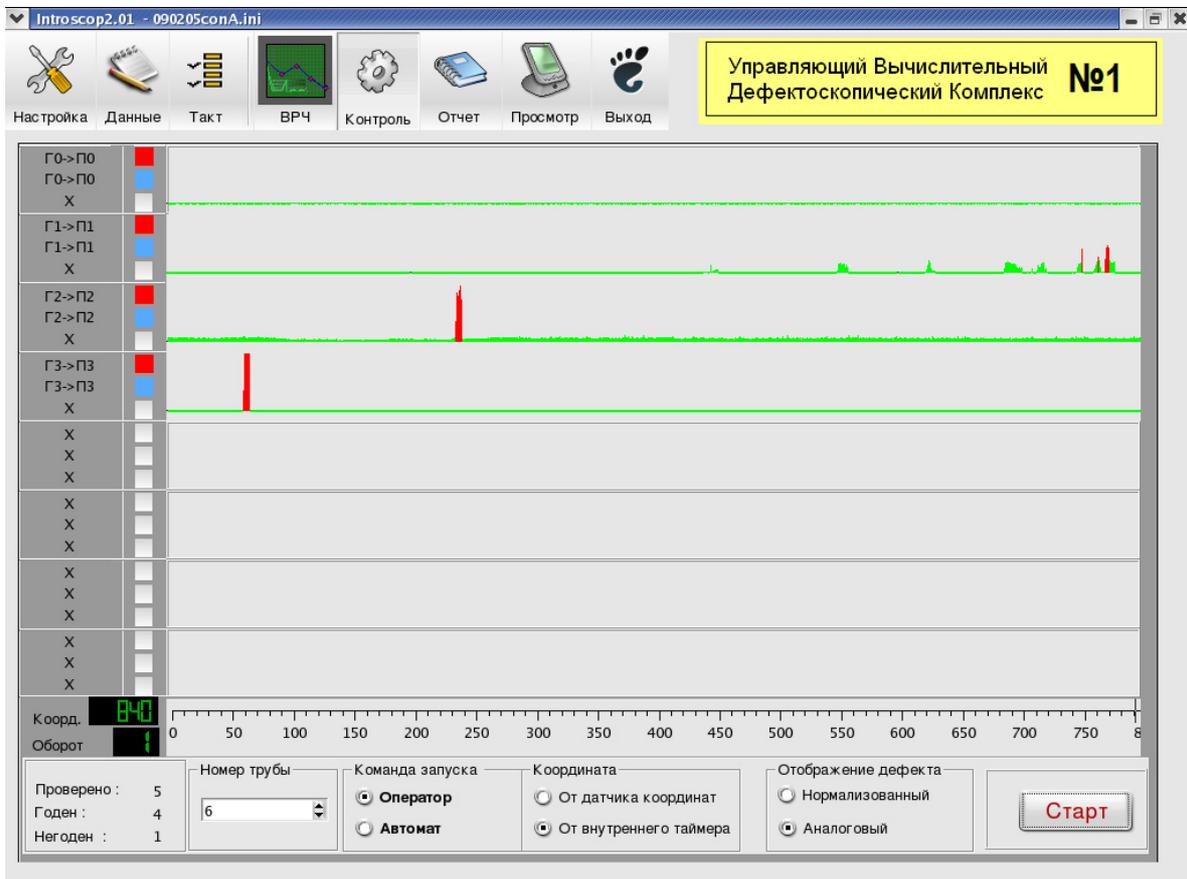


Figs. 2. Acoustic system of installation HK361

Adjusting parameters can be remembered and the operator at any moment can establish the necessary adjustment which is stored in memory of a computer. It allows realizing various variants of research of a welded seam. While translating lines of welding of a pipe for other diameter input of new modes INTROSCOP-02 occupies no more than minutes.



Figs 3. Image A-scan on the screen of the monitor multi-channel system INTROSCOP-02



Figs 4. Image B-scan on the screen of the monitor multi-channel system INTROSCOP-02

ПРОТОКОЛ УЗ-КОНТРОЛЯ

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 Имя УЗ файла : 1220-34.6.vis
 Имя PAR файла: 1220-34.6.Par

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 Header Text 6
 Header Text 7
 Header Text 8
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 Header Text 10
 Header Text 11
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 Header Text 13
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 Header Text 15
 Header Text 16

Вид дефекта	Начало [мм]	Конец [мм]	Длина [мм]	Амплитуда [%LSH]	Толщина стенки [мм]	
T1 8->5	190	220	30	2		AF
TII 5->8	190	220	30	2		AF
LII 10->11	170	190	20	3		AF
LIV 19->17	160	180	20	2		AF
LIV 18->20	160	180	20	3		AF
TIII 21->21	410	420	10	57		
TIII 22->21	11820	11830	10	28		AF
TIII 22->21	11890	11920	30	26		AF
TIII 22->21	11940	11950	10	24		AF
TIII 21->22	11820	11830	10	24		AF
TIII 21->22	11890	11900	10	25		AF
TIII 21->22	11930	11960	30	20		AF
TIV 26->25	110	180	70	102		
TIV 25->26	110	200	90	102		

 Дефектоскопист-оператор

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Figs 5. The form of the report of results AUST

Sensitivity of system is sufficient for automatic detection of defects of a welded seam, the amplitude echo-signals from which is equal or exceeds echo-signals from artificial reflectors as a rectangular groove in width of 1 mm in the extent of 50 mm and depth of 5 % from thickness of a wall of tubes, a through aperture in a seam in diameter of 1,6 mm, the rectangular groove executed across a seam, depth of 5 % from thickness of a wall of tubes. Time instability of installation on each channel does not exceed 1dB for 8 hours of continuous work.

At work of installations HK 360 and HK 361 are stipulated:

- Drawing marks of different color on a surface of the pipe, determining type and a site of defects, and also sites with unsatisfactory acoustic contact.
- Delivery of the report of the control over each tube, including at least number of a tube, amplitude echo-signals the found out defects with the indication of their coordinates, extents, numbers of the channel which is finding out defect;
- Calibration of installation on standard samples of the enterprise - simulators of defects as in static and a dynamic mode at speed of moving on standard samples of the enterprise close by the speed of moving of tubes during the control. Results of calibration also are recorded;
- Registration of B-scan on each channel with an opportunity of viewing or a seal of the information on all or a part of channels on the paper carrier;
- A possibility of transfer of the information on results of the control over system of the automated control system of technological processes of shop by means of local network Ethernet.

RT defective sites of a welded seam of tubes (№17 in the block diagram) it is carried out by the equipment of firm "YXLON", "SEIFERT" and "ACK-ПЕНГЕН". RT sites of welded seams of the pipes having marks of the automated ultrasonic control over presence of defects and sites of

seams after repair by welding are exposed. Fixing of results of the control of pipes is made in memory of computer complex RT, with the subsequent record on CD carriers and transfers to archive.

MUST welded seams (№18 in the block diagram) it is carried out by installations on the basis of ultrasonic flaw detector УД2-12, УДЦ-201П and СКРУЧ. Installation of the manual ultrasonic control is intended for check and estimations of deficiency of sites of the welded seams defective by installations AUST, but no validated by installations RT, and also for the control of sites of the seams repaired by removal of defects with the subsequent tea leaves and polishing.

Delivery AUST welded seams and the ends of pipes (№30 in the block diagram) it is carried out after hydrotests of tubes by installations of firm Krautkramer SNUP-LO/OFF-L-REP with the automatic sound, light signal system and paintmarker for a mark of defective sites and sites of deterioration of acoustic contact, to registration of the report of the control.

Delivery AUST the ends of tubes (№31 in the block diagram) it is carried out by installations HK-362 created experts of NIINK JSC "INTROSCOP" and Institute of electric welding E.O.Patona with participation of laboratory NDT JSC "VSW", intended for revealing defects such as longitudinal cracks and stratifications in the basic metal on all perimeter of trailer sites of tubes, in a technological stream of shop after hydrotests. HK-362 with the automatic sound, light signal system and paintmarker for a mark of defective sites and sites of deterioration of acoustic contact, to registration of the report of the control. For the control of pipes it is used four acoustic blocks, on two each end, carrying out scanning of both ends of a tube simultaneously with volume of the control over 150 mm. Each acoustic block will consist of two wide piezoelectric probes, one of which separately - combined, one is used for detection of defects such as stratifications, and inclined probe for detection of longitudinal defects.

At RT the ends of welded seams (№32 in the block diagram) trailer sites of welded seams at length not less than 300 mm are exposed to the control. Sensitivity RT is determined on wire to standards. For definition of scale of the image and a visual estimation the operator of the sizes of defects uses a sample representing a plate from steel by thickness of 3-5 mm with apertures in diameters $4\pm 0,1$ mm; $3\pm 0,1$ mm; $2\pm 0,1$ mm; $1\pm 0,1$ mm and distances between their centers $10\pm 0,2$ mm. Fixing of results of the control of tubes is made in memory of computer complex RT, with the subsequent record on CD carriers and transfers to archive.

MUST welded seams and the ends of tubes on perimeter (№33.1 and 33.2 in the block diagram) it is intended for the control of trailer sites of a welded seam over length not less than 250 mm (on both ends of a tube), not tested AUST, and sites of a welded seam with marks AUST, as the control of trailer sites of tubes over perimeter with marks AUST of the ends of tubes.

Magneto-luminescent testing facets of tubes (№35 in the block diagram) than 300 mm from both ends of a tube and a facet from both ends of a tube are carried out by equipment УМЖК-10 and МАГНИСКОП КТ/Б on trailer sites of external and internal zones of a welded seam at length not less. Revealed defects - defects such as stratifications, bowls, cracks of any orientation leaving on a surface of an end face of a tube and a welded seam on distance not less than 300 mm from an end face. A used display material – magneto-luminescent suspension. The site of a seam can be polished or cut off before removal of defect and MLT is made repeatedly.

Interconnecting not destroying quality monitoring providing release of welded tubes, it is based on more than 30-ти standards and the normative documents resulted in tab. 1 and regulating application of set of those or other methods NDT at various stages of manufacture of tubes depending on area of their application.

Table 1

The normative document	Scope of tubes
ТУ 14-3-1573-96	For construction of gas mains, oil pipelines and oil pipelines in northern and usual performance on working pressure 5,4-9,8 MPa
ТУ 39-0147016-123-2000	For a construction of gas mains, oil pipelines, the technological and trade pipelines conducting oil and mineral oil. containing hydrogen sulphide up to 6 volumetric % of Hvdro-

	gen's and also intended for drawing an external and internal anticorrosive covering. Tubes of the increased corrosion resistance and cold resistance on working pressure up to 7,4 MPa.
TY 39-0147016-103-2000	For a construction of gas mains, oil pipelines, the technological and trade pipelines conducting oil and mineral oil, containing hydrogen sulphide up to 6 volumetric % of hydrogen's, and also intended for drawing an external and internal covering. Pipes of the increased corrosion resistance and cold resistance on working pressure up to 7,4 MPa for Open Society " Surgutneftegaz ".
TY 14-3P-21-96	For transportation of natural gas working pressure 5,5 - 12,5 MPa with the low and average contents of hydrogen sulphide on gas mains inside the gas enterprises up to the large consumers located outside of regions of the Far North.
TY 14-3P-28-99	For construction of the main oil pipelines, gas mains and oil pipelines on working pressure up to 9,8 MPa. Tubes of the increased cold resistance.
TY 14-3P-45-2001	For construction main, including elevated, gas mains pressure 5,4 MPa with temperature of operation up to - 60°C.
TY 1380-219-0147016-02	Tubes steel electrowelded longitudinal welded petrogas-supplying increased reliability at operation for deposits at enterprises "Kogalimneftegaz".
ГОСТ P 52079-2003	For construction and repair of the main gas mains, oil pipelines and the oil pipelines conducting not corrosion active products (natural gas, oil and mineral oil at superfluous working pressure up to 9,8 MPa and temperature of operation from +50°C up to - 60°C.
TY 14-3P-70-2003	For construction and repair of pipelines of thermal networks.
TY 1383-011-48124013-2003	For a construction of gas mains, oil pipelines of technological and trade pipelines on working pressure up to 7,4 MPa conducting oil and the mineral oil, containing hydrogen sulphide up to 6 volumetric % of hydrogen's. And also intended for drawing an external and internal anticorrosive covering.
TY 1303-09-593377520-2003	For a construction of gas mains, oil pipelines, technological and trade pipelines, with temperature of operation up to - 60°C on working pressure up to 7,4 MPa, conducting oil and mineral oil. Containing hydrogen sulphide up to 6 volumetric % of hydrogen's, and also intended for drawing an external and internal anticorrosive covering.
TY 1303-006.2-593377520-2003	For a construction of the trade pipelines conducting oil, mineral oil, fresh{stale} and commercial water on working pressure up to 7,4 MPa, increased operational reliability, increased corrosion resistance and cold-resistant.
TY 1381-007-05757848-2005	For construction, repair and reconstruction of a linear part, transitions and ground objects of the main oil pipelines and oil pipelines on working pressure up to 9,8 MPa.
TY 14-1-5491-2004	For a construction of petromodular networks (conducting corrosion active gas, oil and layers of water), maintained both in usual climatic conditions, and in regions of Siberia and Far North.
TY 1381-012-05757848-2005	For a construction of the main pipelines on working pressure up to 9,8 MPa for transportation not corrosion active gas.
TY 1381-013-05757848-2005	For construction and repair of the gas mains conducting natural gas, containing hydrogen sulphide.
TY 1381-014-05757848-2005	For pipelines pair and hot water with pressure no more than 2,5 MPa and temperature no more 300°C for steel of mark Ст3сп, no more 350°C for steel of marks 20, 09Г2С and no more 425°C for steel of marks 17Г1С and 17Г1С-У.
TY 1381-018-05757848-2005	For construction, repair and reconstruction of a linear part, transitions and ground objects of the main oil pipeline «Eastern Siberia - Pacific Ocean» on sites with the worker pressure 9,8 - 14,0 MPa with seismicity up to 8 points inclusive and on sites with working pressure up to 14,0 MPa inclusive and seismicity more than 8 points.
TY 1381-020-05757848-2005	For manufacturing protective cases (casings) of the main oil pipelines.

ГОСТ 20295-85	For a construction of the main gas mains, oil pipelines, oil pipelines, technological and trade pipelines.
ГОСТ 10704-91 ГОСТ 10706-76	For pipelines and designs of different purpose.
ТН 14-3P-01-93	For a construction of the main gas mains of oil pipelines and oil pipelines with working pressure 7,4 MPa.
API Spec 5L (PSL 1, PSL 2)	For construction of pipelines for transportation of gas, water and oil, both in oil, and in the gas industry.
ISO 3183(ч.1, 2 и 3)	For the pipelines conducting oil and gas.
1-EN-PIE-SPE-000-0000001 (1-GE-MAW-SPE-000-001 release B)	The specification for the main pipelines.
1-EN-PIE-SPE-000-ADD001OM	Addition to the specification for the main pipelines.
DNV-OS F101	Underwater pipeline systems.
ISO 9764 ISO 9765	Tubes steel pressure head, received by arc welding under a flux. The ultrasonic control of a welded seam over detection of longitudinal and cross-section defects.
ISO 12096	Tubes steel, received by arc welding under a flux, for work under pressure. The radiographic control of defects of a welded seam.
ASTM A 578/ A 577 M	Steel thicksheet not alloyed and plated special purpose. UT a direct bunch{beam}. Specifications.
ASTM E 709	Manual on magneto-powder testing.
ISO 12094	Tubes steel welded pressure head. The ultrasonic control over detection of layered imperfections in the strip / sheet material used for manufacturing of welded tubes.
ISO 13664	Tubes steel pressure head seamless and welded. The control of the ends of tubes magneto-powder a method for detection of layered imperfections.

CONCLUSIONS: Interconnecting methods of non-destructive testing used in a stream of manufacture of welded pipes, made on the resulted specifications and standards, promotes high quality maintenance and reliability of erected important economic objects, such as the main pipelines, including underwater, power constructions, etc.

Due to a high level of the organizational - technical measures undertaken on JSC "VSW" Vyksa Russia has allowed to make pipes for such projects as Sakhalin - 1, Sakhalin - 2, the gas main "Nord Stream", Djugba-Sochi, the gas main Uzbekistan-China, etc.