Certified by
Gosgortechnadzor of RF
(letter Nr. 12-21/668)

“SCIENTIFIC DESIGN CENTER “ENERGOSERVICE”, LLC

PASSPORT
AND OPERATION MANUAL

Ultrasonic anti-scale equipment UPA-2M
(Technical specifications TU 3444-001-78807413-2006)

Omsk city

1. Purpose

1.1. The present equipment is designated for prevention of scale formation and cleaning heating units (steam and water heating boilers, heat exchangers, boilers etc.) of scale by the means of ultrasonic method.

2. Technical data.

2.1. Power supply: 220+25 V, 50 Hz.
2.2. Common vibration frequency of transducer: 22 kHz.
2.3. Consumable power of equipment with one transducer is no more than:
Mode 1 - 3 W;
Mode 2 - 6 W;
Mode 3 - 12 W.
Equipment with two transducers consumes correspondingly 6, 12 and 24 Watt.
2.4. Number of transducers: 1 or 2.
2.5. Vibration amplitude of transducer back: 2,5 to 4 mcm.
2.6. Frequency of percussion impulses' sequence:
Mode 1 - 8 to 15 Hz,
Mode 2 - 25 to 40 Hz,
Mode 3 - 100 Hz.
Weight of equipment with one transducer and connecting cable (5 m.) is about 4 Kgs, with two transducers – 6,5 Kgs.

3. Description of equipment.

3.1. Equipment consists of two components: generator and transducer with connecting cable.
3.2. The generator generates percussive current impulses that come through the connecting cable and produce mechanical oscillations in transducer, that are transferred to heating unit and make productive effect.
3.3. Approximate number of equipment units for a heating unit depends on its power. That makes: up to 2 tons of steam per hour – 1-2 units; 6 tons of steam per hour – 3 units; 10 tons of steam p/h – 4 units; 16 tons of steam p/h – 6 units; 25 tons of steam p/h – 8 units.

4. Installation and connecting instruction.

4.1. The generator is placed in any service-convenient area, dry, with temperature no more than + 40^{o}C, range from the heating unit is defined by connecting cable length (up to 5 m.). At the installation site the power supply of 200 V nominal is arranged and the socket is installed. Voltage oscillations should be within the range between 190 and 245 V.
4.2. Metallic equipment case is earthed on earthing terminal located on the generator bottom wall (Fig. 2).
4.3. Transducer is welt at 90 degree angle on heating unit wall, and connected to the generator by connecting cable (see Fig. 1). Welding is conducted according the technology applied to the passport (see Application to Passport). Installation site for transducer is selected up to the construction of heating unit and in correspondence with applied diagrams of planting sites locations (Fig. 2, 3) or at consent of UPA-2M manufacturer or representative of dealer enterprise that conducts the installation and assembly of transducer. There should be no extra units damping ultrasonic wave (gaskets, flanges etc.) between the transducer and protected surface.

BLOCK DIAGRAM OF UPA-2M ACCEMBLY (AT HEATING UNIT)

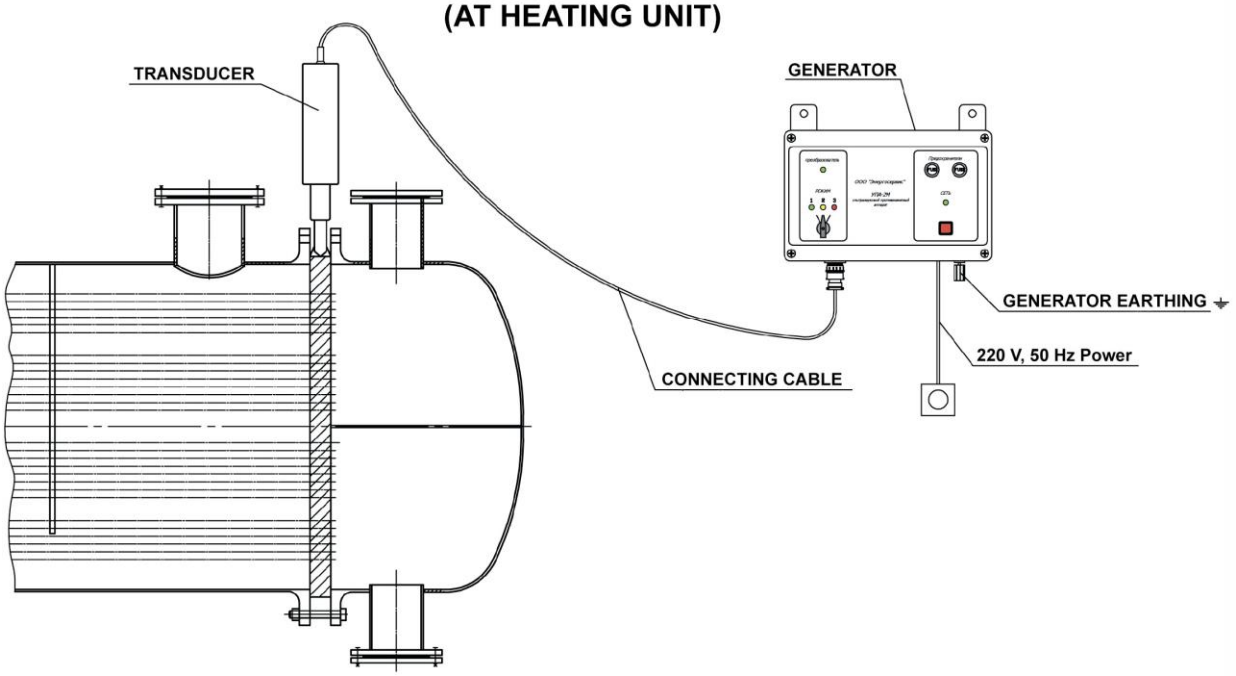


Fig. 1

GENERATOR UPA-2M

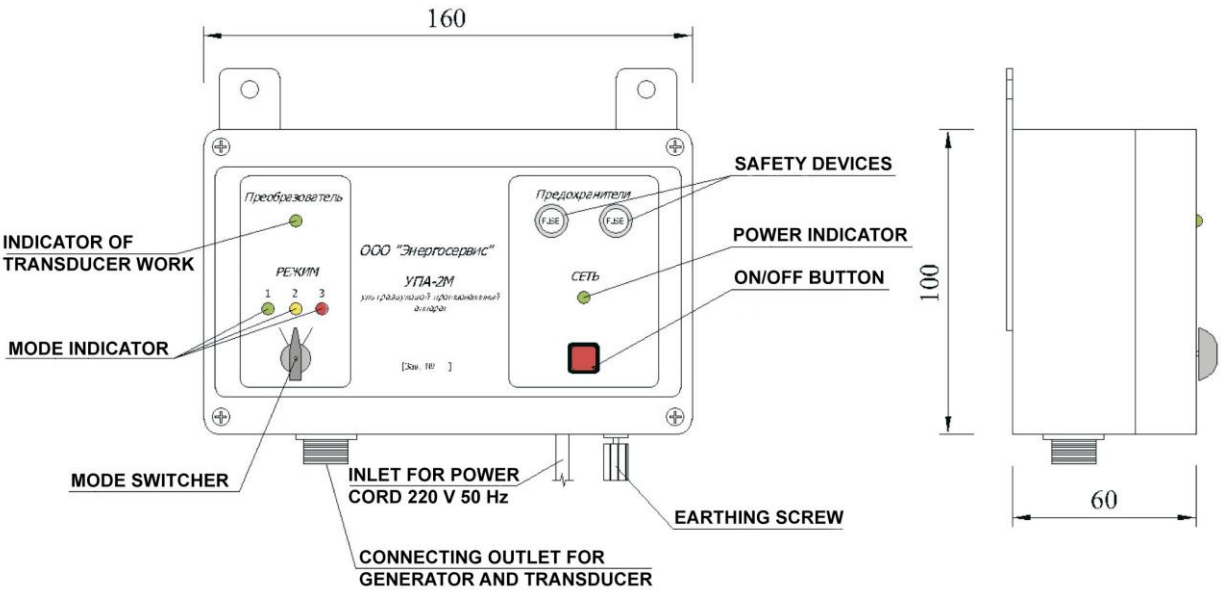
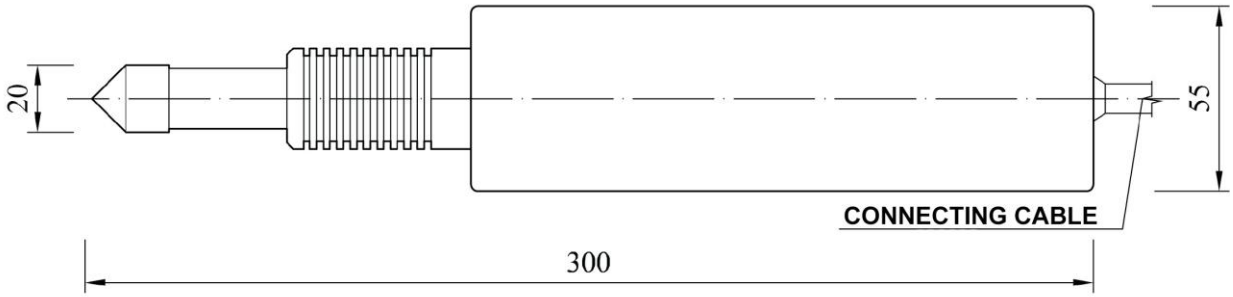


Fig. 2

TRANSDUCER



5. Operation instruction.

5.1. The equipment is switched on with "Power" button. At this, indicator light "Power", indicator light "Transducer" and light, corresponding to selected mode, are active. The transducer starts producing characteristic sound of knocking.

5.2. Positions "1", "2", "3" of the switch correspond to the modes of equipment work that differ by their power. Mode "1" is for minimum power, mode "3" is for maximum. Necessary work mode is selected according to actual work conditions of heating unit (initial pollution, feed water quality, scale compound etc.). Low power mode is recommended for desired effect attaining, it also reduces the energy consumption.

Attention! **a). Installing the equipment for contaminated working boiler consider that scaling slurry can jam the tubes, so Mode "1" is recommended as initial. Using this mode decreases but not eliminates the possibility of such tube jamming.**

b). Installing the equipment for contaminated water heating boiler (VK-21, for instance), it's recommended to peel the slurry particles in liquid form with water spray to avoid them from drying and jamming mid-tube areas of heating unit.

5.3. Usually the equipment should work continuously in the period of heating unit work. At switching the heating unit off, the equipment isn't switched off until water temperature falls below 50^{o}C, otherwise secondary slurry scaling is possible. Work mode recommended for continuous work is "2".

5.4. The equipment may be applied to clean the heating unit of scale in "cold" mode. To effect this, the heating unit is filled with water, and equipment is set working in maximum mode three for 10 days. At this provide please the water circulation for urgent removal of peeling slurry particles.

5.5. Working effect of equipment is in this: scale inside the heating unit is crashed, removed from the walls and then from the tubes. Wet scale is better deleted from the opened heating unit. If the equipment works constantly, scale doesn't form at the walls; it is dropped as scales at the bottom of heating unit or removed by flush.

5.6. There are no extra ominous effects of equipment on welt joints and milled joints of heating units; that is certified by the letter Nr. f.1702 of 29.10.2003 from "Boiler Plant of Biysk" OJSC.

5.7. Regular flush is necessary at equipment operation.

5.8. It is prohibited to power-on the equipment with non-connected connecting cable of transducer.

5.9. After installation of equipment one employee of boiler servicemen is set in charge of their maintenance.

6. Possible malfunctions

6.1. Equipment powered, indicators active, no vibration of transducer. Origin: connection of generator to transducer is violated. Solution: fix the socket tightly, "ring-out" the cable if necessary, fix the cord rupture.
6.2. Equipment operation unstable, transducer vibration doesn't correspond to the selected mode. Origin: power voltage is below 195 V. Solution: apply the automated transformer or voltage stabilizer.
6.3. Safety device constantly fusing. Origin: power voltage is over 245 V. Solution: apply the automated transformer or voltage stabilizer, replace the safety. Note: the safety device used in the equipment should be 150-250 mA one.
6.4. If the enumerated measures have no effect, consult the vendor.

7. Supply setting

- **generator – 1 unit,**
- **transducer with cable – 1 unit,**
- **transducer with cable – 2 pcs.,**
- **safety device – 2 pcs.,**
- **passport and operation manual – 1 piece.**

8. Safety measures and warranties.

8.1. Safety measures are realized according to requirements of PTE and PTB for electric devices below 1000 V.
8.2. Manufacturer's warranty of equipment working with free repair is till _____
8.3. All questions of equipment work address to: ""Scientific Design Center "Energoservice", LLC. Address: 644043, Omsk, Volochaevskaya St., 11/1. Phone/Fax: (3812) 999-522, (3812) 215-00. E-mail: ooo_energoservis@inbox.ru

Acceptance certificate.

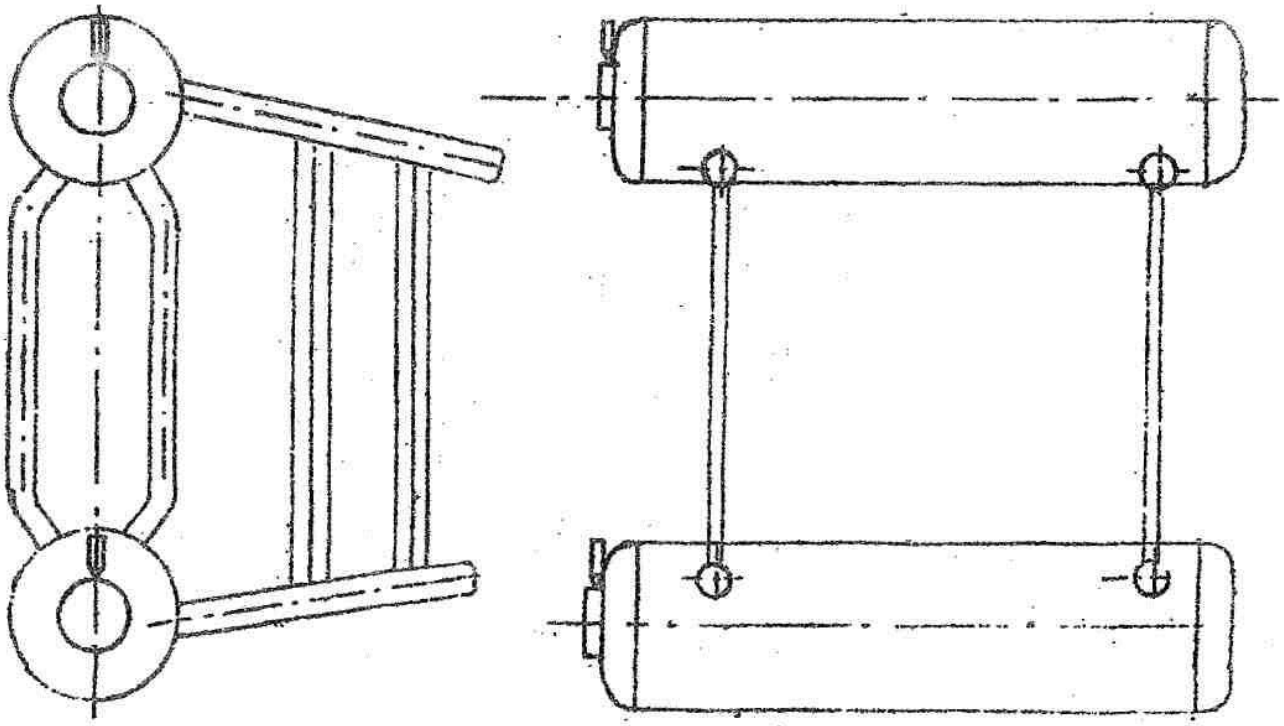
Equipment UPA-2M Nr. _____ meets technical requirements of the present Passport and Technical specifications TU 3444-001-78807413-2006, and was accepted as fit for use.

OTK _____ " " _____ 201__

TECHNOLOGY

for welding the transducer shift of
ultrasonic anti-scale equipment

CONTENT



Planting sites for transducers
on boilers of E - 1/9 type

Fig 3

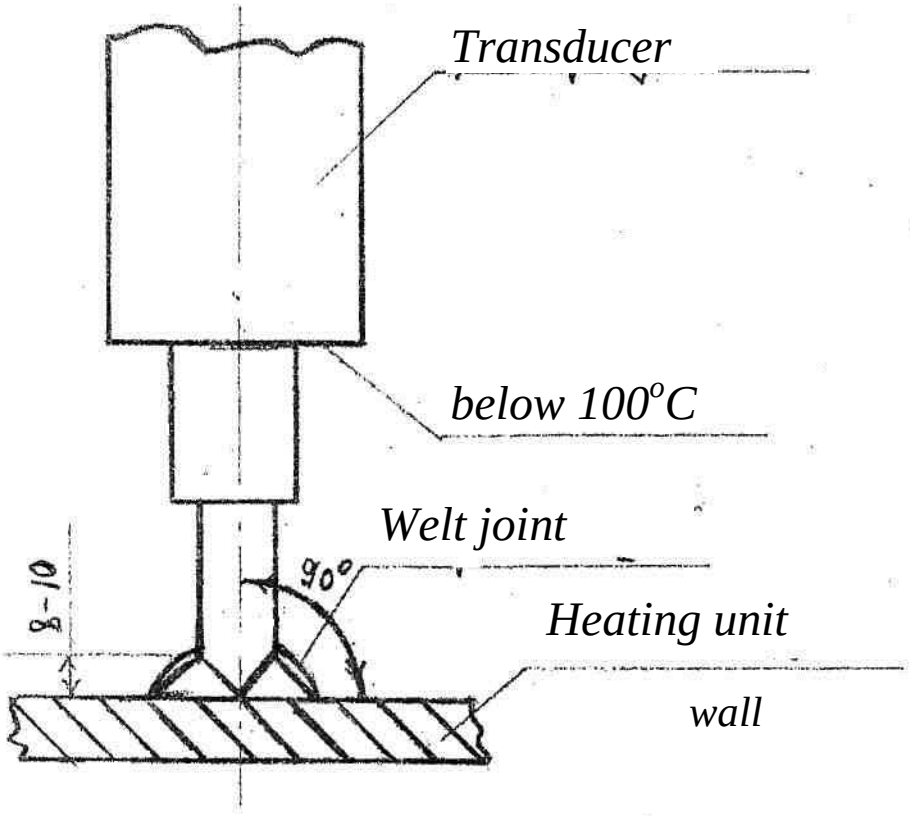
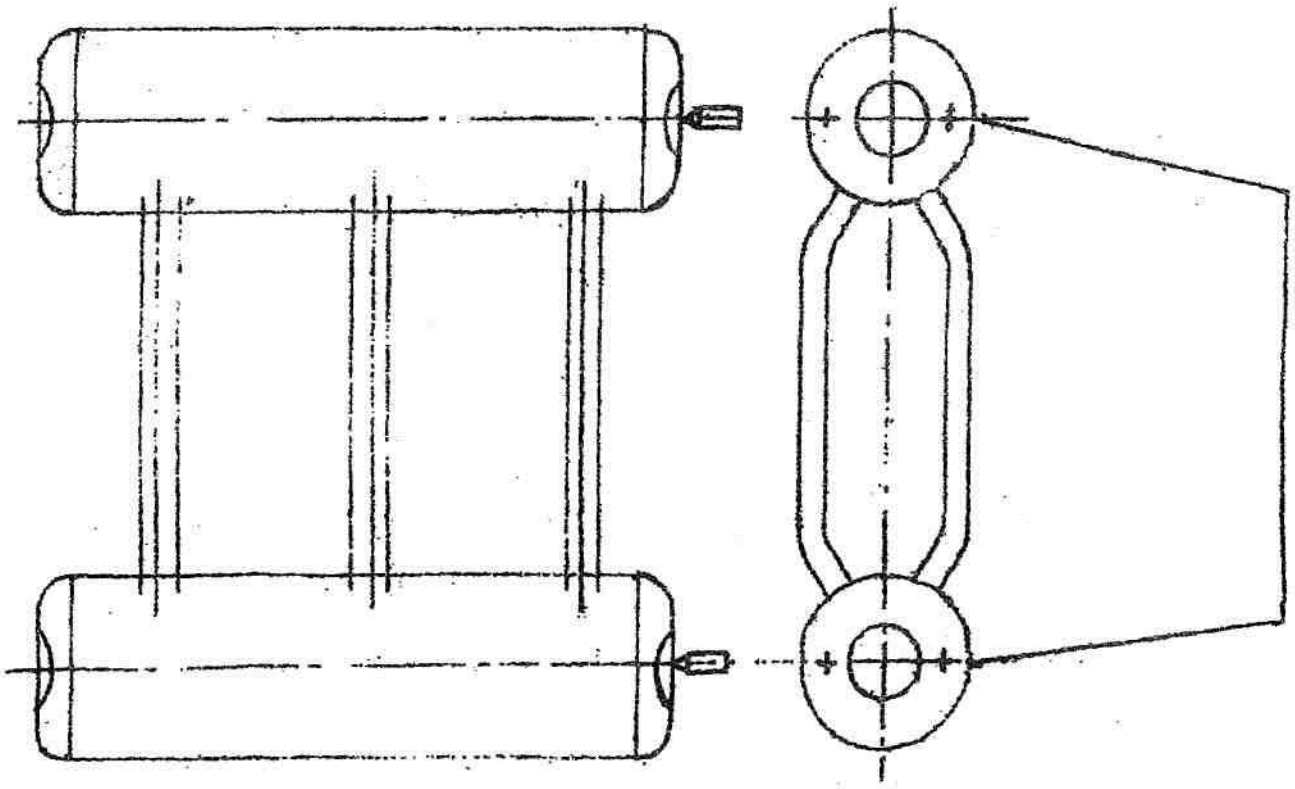


Fig. 1



Planting sites for transducers
on boilers of D, E type

Fig. 2

INTRODUCTION

In this technology we present the directions for welding the transducer shaft of ultrasonic anti-scale equipment to boilers of DKVR, KE and DE type with productivity of 1 to 25 tons of steam per hour.

The technology is actual together with “Regulations of assembly and safe maintenance of steam and water heating boilers”, certified by Gosgortechnadzor of Russia, GOSTs, “Directive technical materials on welding, heat treatment and control of tubing systems of boilers and pipelines at installation and repair of thermal energy stations equipment”-RTM-IC-93 and Directive documents “Steam and water heating boilers, steam and hot water pipelines. Welt joints.” RD 2730.940.102-92, RD 2730, -940.103-92. General requirements and quality control.

Management at welding works on boilers and elements should be done by engineering technical specialists, certified according to the “Regulations of welders and welding specialists’ certification, approved by Gosgortechnadzor of Russia on 30.10.98” and regulations and instructions of safety.

Works of welding and acceptance of welt boiler to the owner should be conducted by specialized organization, having such activity specified in the Charter, and having necessary equipment and materials, welding constitutive documents and quality control. Welding-conducting organization should be certified (licensed) for conducting such works by Gosgortechnadzor organ in specified order.

Mechanics, conducting assembly works, should be qualified no less than rank 4 and have practical skills of boiler repair.

1. Technology for welding the transducer shaft of ultrasonic anti-scale equipment

1.1. Before commencing the welding works the boiler should be set offline.
1.2. Welt area in 30-40 mm. radius is set free of setting and cleansed of cinder, rust, dirt to clean metal surface.
1.3. Transducer is posed perpendicularly to the surface and tacked at one side with full penetration and further cleaning the tack of skim and melt metal drops.
1.4. Welt face of transducer is a shaft of 20 mm. diameter, ending with 45^{o} cone, made of Steel 10 or Steel 20 (see Fig.1).
1.5. Welding is effected in 5-6 passings to fill the technological cone with metal.
After welding each passing it is necessary to clean the joint of skim and melt metal drops.
Welt joint should cover the cone breaking for no more than 2 mm.
Attention: full penetration tack of heating unit wall is non-admissible.
1.6. At welding it is principal to observe the transducer case at maximum diameter not to overheat above 100^{o}C. Transducer shouldn't be connected to generator, and cable should be swerved to prevent electrode contact.
1.7. After welding and cooling of welt joint, cleaning the skim, flattening and visual control are conducted. Lacks of penetration, pores, hollows and cracks are non-admissible.
1.8. Welding should be conducted with electrodes UONI 13/55 mm. ø 3 mm.
Welding mode should correspond to requirements specified in the electrodes' passport.
1.9. During installation and welding of transducer it is necessary to make controls of work quality and correspondence to this technology's requirements.
1.10. Number and allocation places for transducers installed at boilers are defined up to the type and power of the boiler (see Fig. 2, Fig. 3).
1.11. At deinstallation of welt transducer, the cut is made directly before the welt joint. At this arc-jet welding can be applied as well as gas welding or mechanical instruments.
1.12. Cut area of transducer is subject to visual control and should meet the requirements of clause 3.6 and clause 3.7 of present technology.

2. Requirements to welders and welding materials

2.1. Requirements to welder qualification.
2.1.1. Only the welders, certified in accordance with "Welders' certification regulations" approved by Gosgortechnadzor of Russia, and having licenses in the established standard form, can be allowed to conduction of welding works.
2.1.2. Welders can be allowed only to the work types specified in the license.
2.1.3. Before commencing the welding work, a welder should tack the reference welt joint of 16GS steel of 13 mm. thickness and dimensions of 210 x 400 mm. according to GOST 5520-69 with the same rim processing and the same work mode as at boiler repair.
2.2. Requirements of welding electrodes.
2.2.1. For hand arc-jet welding apply the electrodes meeting the requirements of GOST 9466-75 and 9467-75, and RD 2730.940.102-292.
2.2.2. Quality and specifications of welding electrodes should be certified by manufacturer plants.
2.2.3. Technical features of electrodes in each batch should be checked before applying them with no regard of certificates.

2.2.4. Check of electrodes' technical features should be conducted by qualified welder.
2.2.5. Before welding industrial joints and conducting tests, the electrodes should be decrepitated at following modes: for UONI 13/55 electrodes – 350^{o} for one hour.
2.2.6. Technical features of electrodes should be checked during electrode melting at welding in overhead position of one-sided T-joint in one layer of 150 mm. length according to Fig. 4.

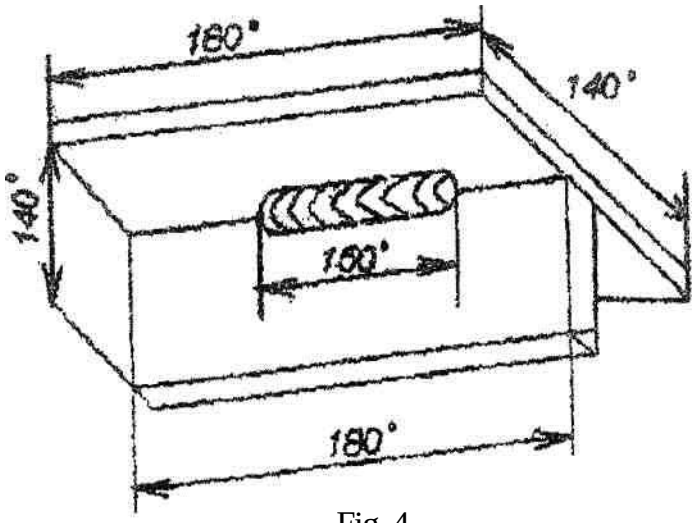


Fig. 4

2.2.7. Thickness of bar and welt leg at T-joint welding are defined up to diameter of electrode shaft:

Electrode diameter, mm	Over 3 up to 4 mm. inclusively
Bar thickness, mm	10-16
Welt leg, mm	6-8

2.2.8. Bars for checking the technical features of electrodes UONI 13/55 should be made of 16GS steel.
2.2.9. Uniformity of seam metal is checked by sample fracture. To simplify the sample fraction, it is admissible to make a cut in the middle of joint, from the reinforcement side at depth of below 20% of welt bar thickness.
2.2.10. Uniformity of seam metal checked by sample fracture should meet the requirements specified in the paragraph "Quality control";
2.2.11. Technical features of electrodes should meet the following requirements:
1) Arc is easily actuated and stably burning;
2) Surface is melting uniformly without excessive sputtering, peeling particles and baffle forming, that prevents the normal electrode melting;
3) Welding skim enables right joint forming and easily removed after cooling;
4) Joint metal and surface metal have no cracks, impurities rate doesn't exceed the norms for quality control of welt joints.
2.2.12. The results of checking technical features of electrodes should be reflected in the act of electrodes' technical tests.
2.2.13. Welding electrodes should be stored in a dry heated compartment at +15^{o}C temperature and relative air humidity of below 50%.

3. Quality control of welt joints.

3.1. During welding of transducer shaft, systematical control of conducting welding works and accordance to the requirements of the present specifications, preliminary control and post-operation control of ready welt joints should be conducted.
3.2. At preliminary control the checked features are: welders' qualification, welding materials' quality and equipment conditions, and certificates for main and applied materials.
3.3. At post-operation control the checked features are:
- welt article preparation quality;
- pre-welding assembly quality;
- at welding: welding mode, order of welt seams application, form and sizes of them, skim cleaning, occurrence of pores, cracks etc. external deficiencies of joints.

3.4. Ready welt joints regulated by Gosgortechnadzor of Russia are subject to:
- external inspection and measurement;
- hydraulic tests.

3.5. Before visual check, welt joints and adjoining surface of metal in about 20 mm. diameter should be cleaned of skim, sputter, cinder and other contaminations.
3.6. External inspection is conducted by eyesight or with looking glass of 5-7 times amplification with compulsory application of portable lighting, patterns and measurement instrument.
3.7. Up to external inspection results, welt joint quality is confessed satisfying if the requirements of seam size and shape are met, and no cracks, surface pores, burn-throughs and poor-weld craters are detected.
3.8. Metallographic inspection of welt joint should be conducted on a sample produced of reference welt joint.
3.9. Cutting samples of blanks should be effected with cutting or abrasive equipment. Gas torch cutting is admissible if at following mechanical processing zones with structural alterations of metal are excluded.
3.10. Metallographic inspection should be conducted by checking the polished section surface, cut across the welt seam. Controlled surface should include the joint pattern with thermal influence area and adjoining areas of main metal.

3.11. Following deficiencies are inadmissible for reference welt joints:
- deviations of specified dimensions;
- cracks of all types and directions in seam metal or adjoining area;
- poor welds;
- pores of continuous grill pattern;
- lappings;
- poor-weld craters;
- skim and non-metallic impurities.

CONTENTS

INSTRUCTION FOR CONDUCTING OPERATION TESTS OF EQUIPMENT UPA-2M.

1. To conduct the tests, heating units with contaminated working surface are selected. Contamination should be of salt residue nature. Contaminations are fixed: photographed, measured etc.
2. Equipment installation is effected. Equipment installation means hooking the generator up and welding the transducers to heating unit (according to operation manual). **For Boster Boiler steam boiler, the transducer is installed on lower ring collector vertically or horizontally close to separator tube between the flange and boiler case (marked with red arrow at the diagram).**

   According to the common installation rule, the transducer is located in the place in acoustic contact with protected surface. For example, at water inlets and outlets. Contamination isn't removed from the surface without contact with water. Intermediate connections – flanges etc. – are undesirable. Number of transducers for a unit is defined in connection with its power. At heating unit of about 1 MW power 1 transducer is installed, for 3 MW unit – 2 transducers etc.

   At economizer the transducer is installed at outlet pipe (also marked with red arrow at the diagram).
3. After equipment installation, the boiler is filled with water, and its circulation is arranged. The circulation is necessary for flushing of peeled scale by water flow. Otherwise the contamination of pipes and collectors is possible. Equipment is switched on in the following order. For the first 4 days they work at Mode 1 of generator power, then 4 days in Mode 2 and 4 days in Mode 3. Such a sequence with gradual power increase also allows preventing the jamming of the pipes with peeled scale particles.
4. After test operation the heating unit is stopped, and after its cooling the equipment is switched off. Heating unit is uncovered and inspected.
5. At regular operation of cleaned or new boiler, the equipment is **constantly** working in Mode 2.