

**Preinsulated pipes to be used
in buried water district heating utilities**

ZPU Międzyrzecz Sp. z o.o. System

DX JOINTS ELECTRICALLY WELDED

[MANUAL]

Zakład Produkcyjno Usługowy

Międzyrzecz

POLSKIE RURY PREIZOLOWANE

Sp. z o.o.

66-300 Międzyrzecz, ul. Zakaszewskiego 4

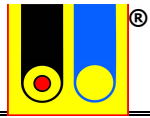
Tel.: (0-95) 741-25-26, 742-33-00, 742-00-93

Fax (0-95) 742-33-01, 742-33-02

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1 Introduction

- 1.1 A new technology of electrical welding of joints means increased quality and durability of pre-insulated pipe joints.

This is particularly important in:

- pipelines laid down in unfavourable field conditions as electrically welded joints provide higher leak-tightness and durability compared to traditionally formed joints (slip-on sleeves, heat shrinkable sleeves sealed with glue);
- large diameter preinsulated pipelines where electrically welded joints can handle greater pressure loads as regards friction and shearing forces in buried pipe.

Electrical welding consists in making use of heat generated by the flow of electrical current through a copper strip applied to the external DX joint surface. This makes the sections to be joined heat up above the polyethylene melt state point (internal joint surface and external case pipe surface), and, ultimately, to be joined through pressure applied externally by means of pressure bands.

The heating process is effected by a microchip controlled welder, which automatically analyses the data input by the operator.

- 1.2 DX joints can only be made by qualified personnel trained and certified by Zakład Produkcyjno Usługowy Międzyrzecz POLSKIE RURY PREIZOLOWANE Sp. z o.o., ul. Zakaszewskiego 4, Międzyrzecz.

- 1.3 The manual "OHSA, Technical and Performance Requirements to Be Met in Constructing Electrically Welded (DX Type) Joints on Preinsulated Pipe Systems" specifies safety conditions to be observed while works are being carried on DX joints. It is a supplementary manual for training seminars written by ZPU Międzyrzecz Sp. z o.o.

- 1.4 It is suggested that DX joints be assembled by a team of 4 assemblers and 1 electrician.

- 1.5 A list of tools required to complete a DX joint successfully:

- an HG-2 microchip controlled welder to weld case pipe – 1 set;
- an electric jig saw – 1 set;
- an electric belt grinder – 1 set;
- a battery operated (recommended) or electric drill – 1 set;
- a set of DX join supports and clamps – 3 sets;
- pedal pump – 1 set;
- a drill to make inflow holes of the diameter of a flat drill – 1 set.

- 1.6 Additional materials:

- felt;
- acetone;
- sand paper.

2 Conditions for DX Joint Assembly

- 2.1 Weather conditions, temperature.

DX joints can be electrically welded under the following conditions:

- the ambient temperature higher than +3°C and not exceeding +35°C;
- surfaces to be welded must be dry;
- it is windless – optimal conditions.

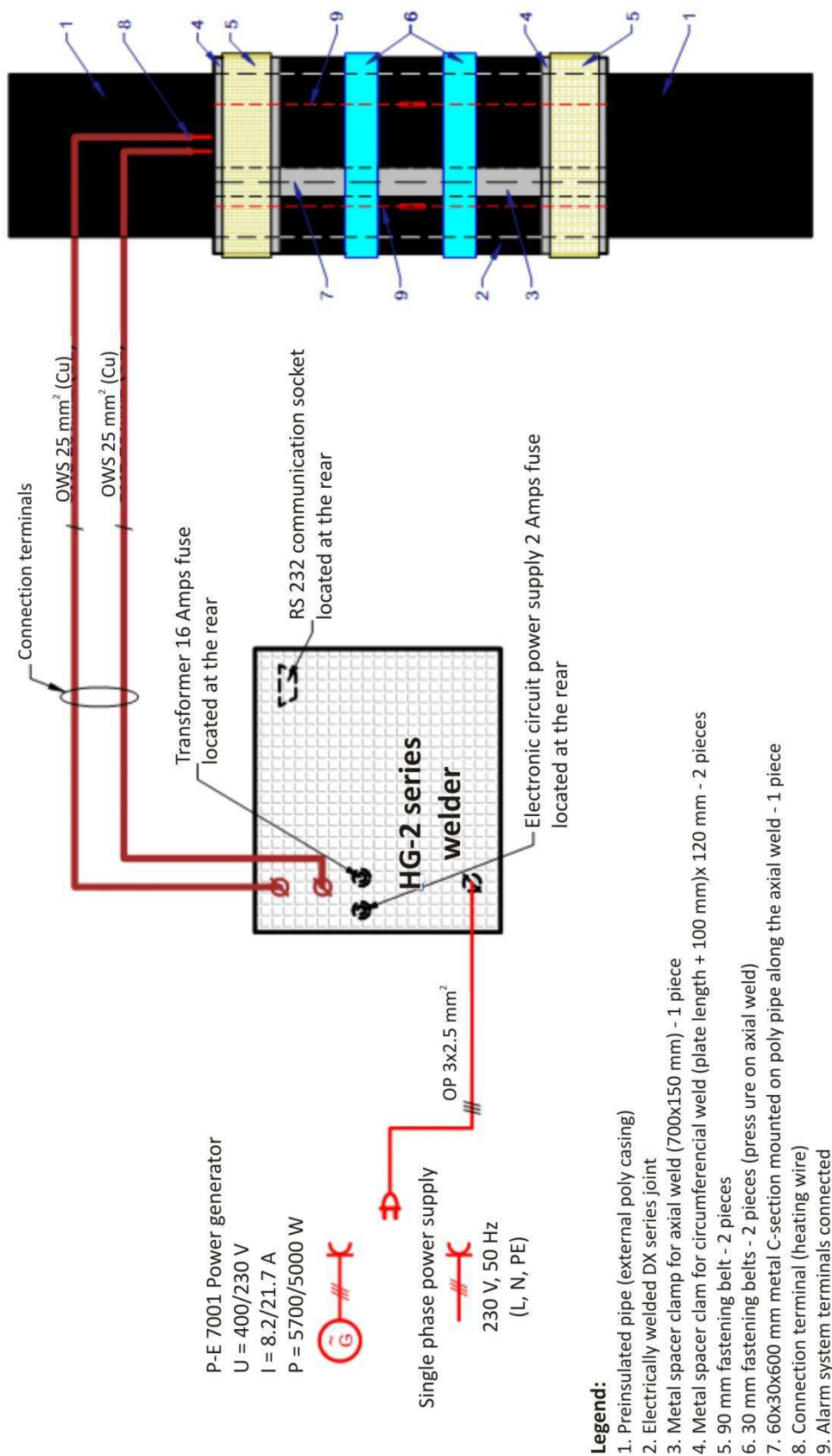
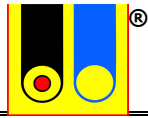


Fig. 1. Schematic diagram of electrical welding of DX series joints



If joints are to be welded in unfavourable weather conditions like rain falls, thick fog or strong wind, protective shelter should be put up, and at low temperatures the ends of the pipes to be joined have to be heated with for instance hot air.

The differential between the highest and lowest temperatures at the joint point should not exceed 15°C, while the case pipe temperature should be maintained below 35°C.

2.2 Welding process parameters.

Of decisive importance to the strength and quality of polyethylene joints are:

- clean places to be joined;
- dryness (the surfaces to be joined cannot be wet);
- adequate welding temperature;
- welding time;
- adequate pressure applied to the welded surfaces (fastening belts);
- time of natural cooling down.

If the above specified conditions (process parameters) are met, the durability and the quality of the welded joint is close to the strength of the case pipe.

3 Preparation of Surfaces to Be Joined

3.1 To achieve an adequately executed joint the following have to be carried out:

- case pipe ends, which are to be welded during daytime have to be protected against direct sunlight with aluminium foil. This has to be done prior to sunlight falling onto it on the day the DX joints are planned for welding;
- surface to be joined have to be cleaned, and then checked with a marking-off template for unevenness.
Any uneven surface has to be flattened. Deviations such as bends, non-axial positions have to be set off adequately.
- PUR foam has to be removed from the head faces of the sections to be welded over a distance of 15 cm.

3.2 With the template and a marker (see Fig. 2) mark the position of:

- holes and cuts to hold the C-section;
- outer edges of the joint plate;
- if pipes are to be laid at an angle, determine the bend angle (permissible angle should not exceed 3°);
- to have the lines as defined above properly marked, the top edge of the template should be aligned with the top outline of the case pipe.

The position where the C-section is to be mounted should be between 10 and 2 on the clock face, while the very C-section support should not get into way with the alarm system wiring (a minimal set off distance is 25 mm).

3.3 Drill Ø 10 mm holes to mount the C-section.

3.4 Make cut-outs to accommodate the C-section support beginning with the hole minding the other hole walls. Slit width 2 mm.

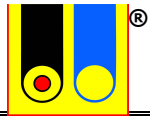
3.5 Scrap about 0.1÷0.25 mm of the case pipe surface over a distance of 250 mm where the joint is to be made.

This has to be done on both pipe ends prepared to be joined with a DX joint.

Scraping has to be done by means of an hand-held electric belt grinder, grain grade 50÷70.

3.6 Connect the alarm system wires (copper tin plated and copper) as specified in ZPU Międzyrzecz Sp. z o.o. Manual:

- the tin plated wire should be on the right seen from the heat source;



- the wires should be connected with clamps, and then soldered each time checking the quality of the connection (continuity of wires and PUR foam resistance between the wires and the steel carrier pipe).

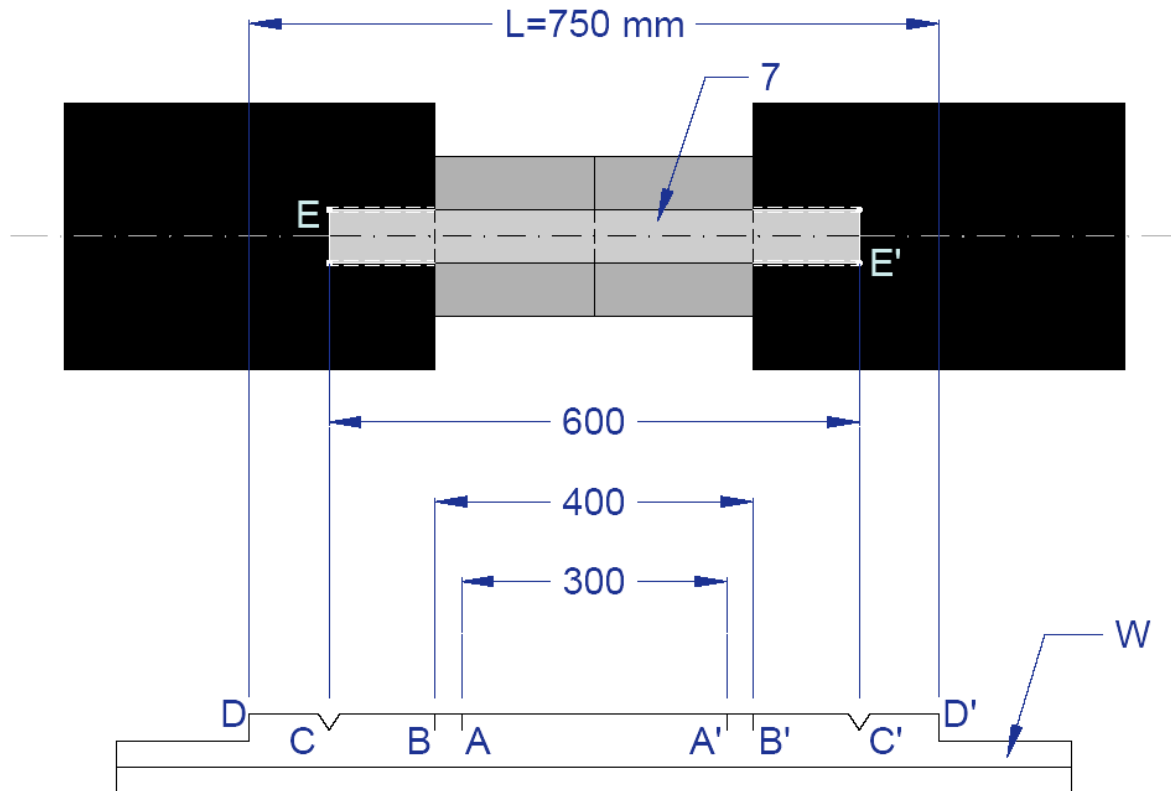
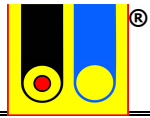


Fig. 2. Marking off with a template

Key:

A – A'	distance between case pipe ends (from \varnothing 110 up to \varnothing 315)
B – B'	distance between case pipe ends (from \varnothing 400 up to \varnothing 1200)
C – C'	\varnothing 10 hole centre and centre of cut-out to fix the C-section support
D – D'	DX joint length ($L = \text{const} = 750 \text{ mm}$)
E – E'	cut-out to fix the C-section support
7	C-section support 60x30 mm, 600 mm long
W	template



4 Assembly of DX Sleeve Plate

4.1 Preparing a sleeve plate:

Directly prior to use a DX plate has to be removed from its foil wrap which protects it against dirt and damage.

Remove the protective adhesive tape from the connection terminals and check the condition of the plate.

Check the condition of the temperature probe socket mounted on the external side of the plate.

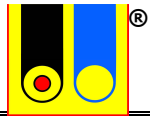
Should any of the following be noticed on the plate surface:

- bends, scratches or creases, etc;
- heating strip of terminals are damaged (bent, crushed, no electrical connection);
- the temperature probe socket found to be missing on the external side of the plate (opposite the heating strip);
- in some places the heating strip does not adhere to the plate
then the plate should be returned unconditionally to the manufacturer.

No repair is permitted on the site.

4.2 Assembly of DX plate on the joint.

- 1) Case pipe ends and the area of the heating strip on the plate have to be cleaned thoroughly with felt soaked with acetone or ethanol (or any other cleaning agent neutral to polyethylene).
- 2) Set up the C-section support.
- 3) Place the connecting plate around the case pipe ends, and then with a fastening belt applied to the middle of the plate form the plate provisionally (in such a manner so that the axial weld line can still be available for cleaning).
Once cleaned, the plate has to be fastened downright, set down correctly and fix permanently.
- 4) The metal spacer clam (3) has to be slipped under the fastening belt and its centre set up accordingly (so that it is beyond the axial weld line centre), while its edges should be aligned with the edges of the plate to be welded.
- 5) Wrap the metal pressure circumferential spacer (4) around the joint with a 10 mm distance from the edge and tighten it provisionally with the belt, set up the spacers (4) and the fastening belts.
The metal pressure circumferential distance pieces (4) should always be placed onto the metal axial distance piece (3), the belt centred on the metal circumferential belt, while the rolls of the tightening device on the centre of the distance piece overlap.
All the fastening belts should be tightened up manually.
- 6) To press the axial weld two fastening belts (6) 30 mm wide should be applied apart from the belts wrapped round the circumferential welds.
Should pressure be not applied in a uniform manner (skewed joints, lack of alignment, etc) extra fastening belts might be required.
- 7) Check the accuracy of the position of the DX plate and the fastening belts.
- 8) The DX joint ready to be welded has to be connected to the welding machine as indicated in Fig. 1.



5 HG-2 Welding Machine

5.1 Description of the welding machine.

The welding machine is used to weld polyethylene pipe DX joints on preinsulated pipe of the diameter up to $\varnothing 1200$ mm by ZPU Międzyrzecz Sp. z o.o. Welding is automatic, while temperature, welding current and time are controlled by a microchip.

The HG-2 welding machine control panel is shown in Fig. 3.

The HG-2 rear wall is shown in Fig. 4.

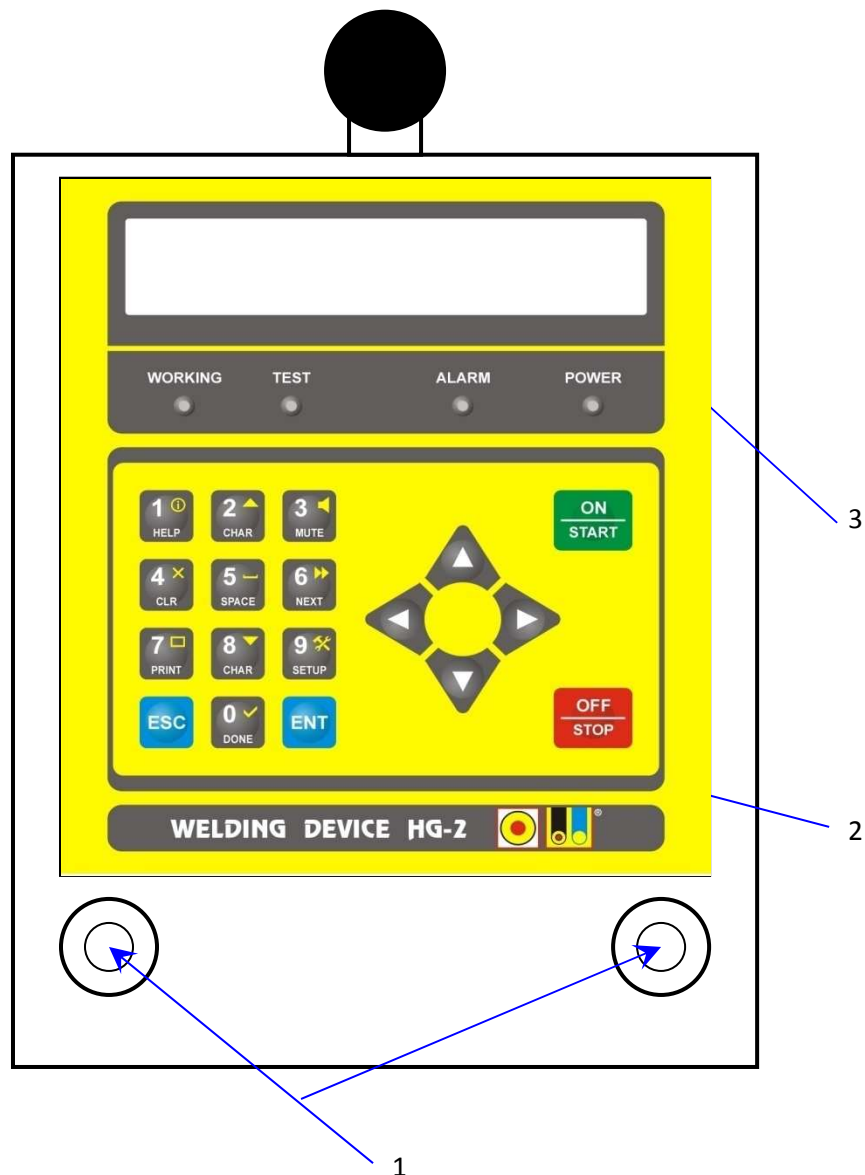
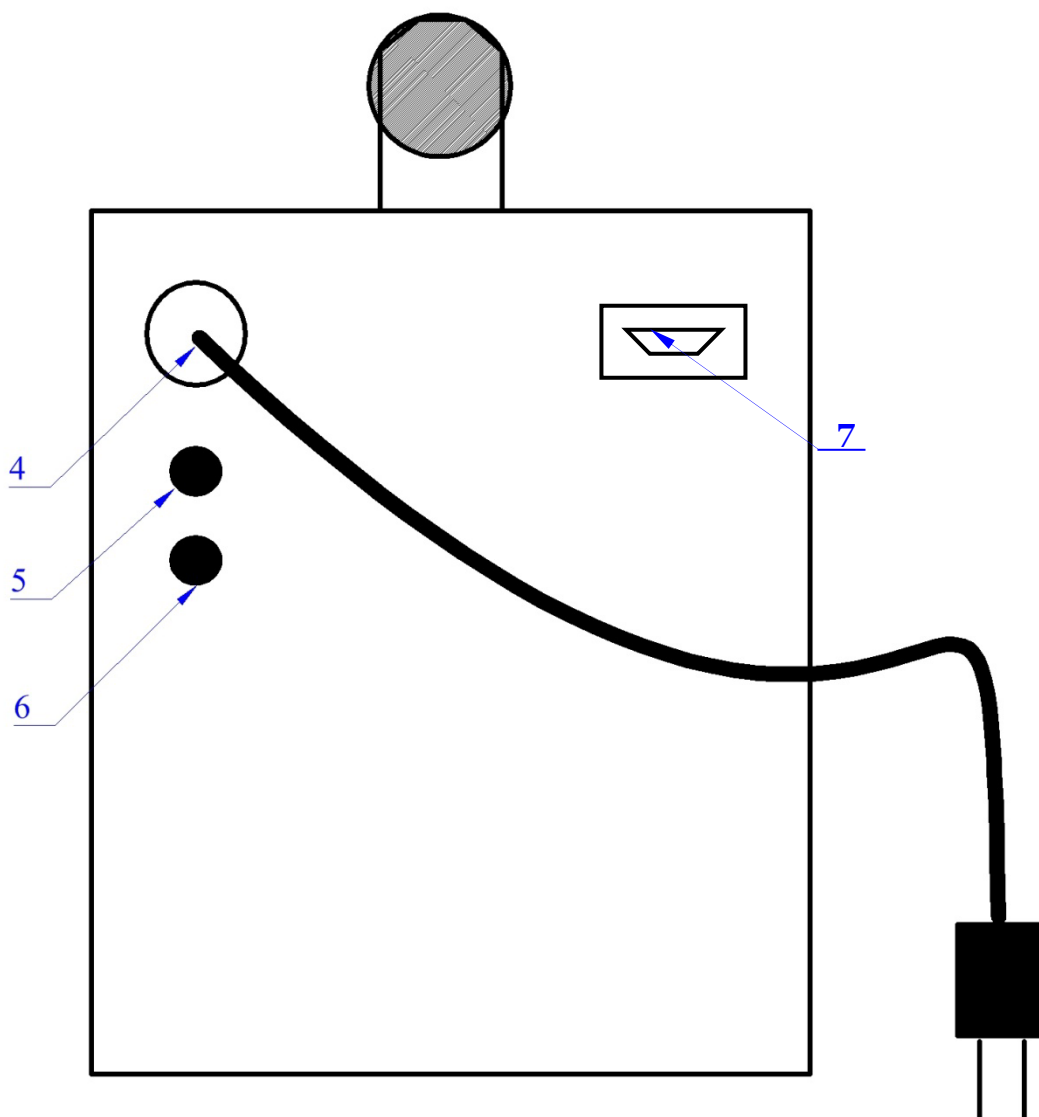






Fig. 3. HG-2 control panel



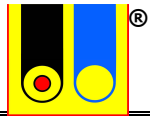
Front panel outlay:

- 1 – Outlets („power”)
- 2 – Keyboard
- 3 – LCD display
- 4 – Power supply cord
- 5 – High power fuse
- 6 – Low power fuse

Press button function:

ON / OFF	Device On/off
0 ... 9	Data input
ESC	Function cancelled
ENT	choice acceptance
	scrolling menu - choice
	
	scrolling menu – enter/exit
	

7 – RS 232 Serial port connecting the PC and a 40 character width printer



Operating functions:

- the welding machine can be powered from a single phase mains 230V, 50Hz or by a generator;
- the outlet is short circuit protected;
- small size;
- complete wiring included;
- simple operation;
- a large easy to read LCD.

5.2 Technical data:

Power supply:

Voltage	230 V (+5% -10%)
Power consumed	< 2500 VA (max)
Power supply frequency	50 Hz, maximal deviation +0.2 -0.5 Hz
Power supply mains type	Neutral point grounded
Protection class	IP 40

Climatic data:

Operating temperature	5...50°C
Storage temperature	-10...70°C
Air relative humidity	25...95%
	(without humidity condensation)

Other data:

Onboard memory capacity	255 welds
Weight (without wiring)	Ca 25 kg
PC communication	RS 232 serial port (HG communicator)

5.3 Preparing the machine for operation:

Warning!

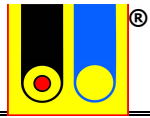
Before the machine is put into operation, check the condition of the connecting wires. Under no circumstances should the welding machine be operated if the wires are damaged (e.g. insulation torn, broken plug or socket)!!!

Position the welding machine on a stable and dry surface. Connect the supply wires to the welding machine and the heating plate terminals.

Then connect the temperature probe already mounted on the plate (the black wire of the temperature probe to the black terminal on the probe socket). The welding machine is put into operation once the supply cord has been inserted into 220 V, 50 Hz mains or a power generator.

To start welding follow the sequence of operations presented in the Fig. "Structure of Program of Welding Machine Operations".

A list of errors possible to occur during operations.



Message	Description
MEMORY FULL!!!	Weld registration memory full. The EEprom chip memory has to be erased
SHORT-CIRCUIT!!!	The heating circuit shorted. Check the heating circuit and the condition of clamps supplying power
OPEN-CIRCUIT!!!	The heating circuit broken. Check it and the connection of clamps supplying power. Disconnect the power supply cord for about 5 seconds. If the error recurs, contact service.
RESISTANCE OVERSIZE!!!	The heating circuit resistance too high. Heating process should be done section by section.
RESISTANCE TOO SMALL!!!	The heating circuit resistance too low.
CHECK FUSE 16 A	Internal error. Contact service

NOTE:

In the event of the welding machine powered by a generator, first start the generator and then connect the welding machine.

If the power source is at a distance from the welding position and extension cables are used, keep their length:

- 50 metres for OW (OP) wires 3×2.5 mm²;
- 80 metres for OW (OP) wires 3×4 mm²;

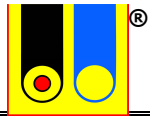
5.4 Maintenance and repairs

Keep the machine in a clean condition, seeing to that the terminals are clean and the wires are in good repair.

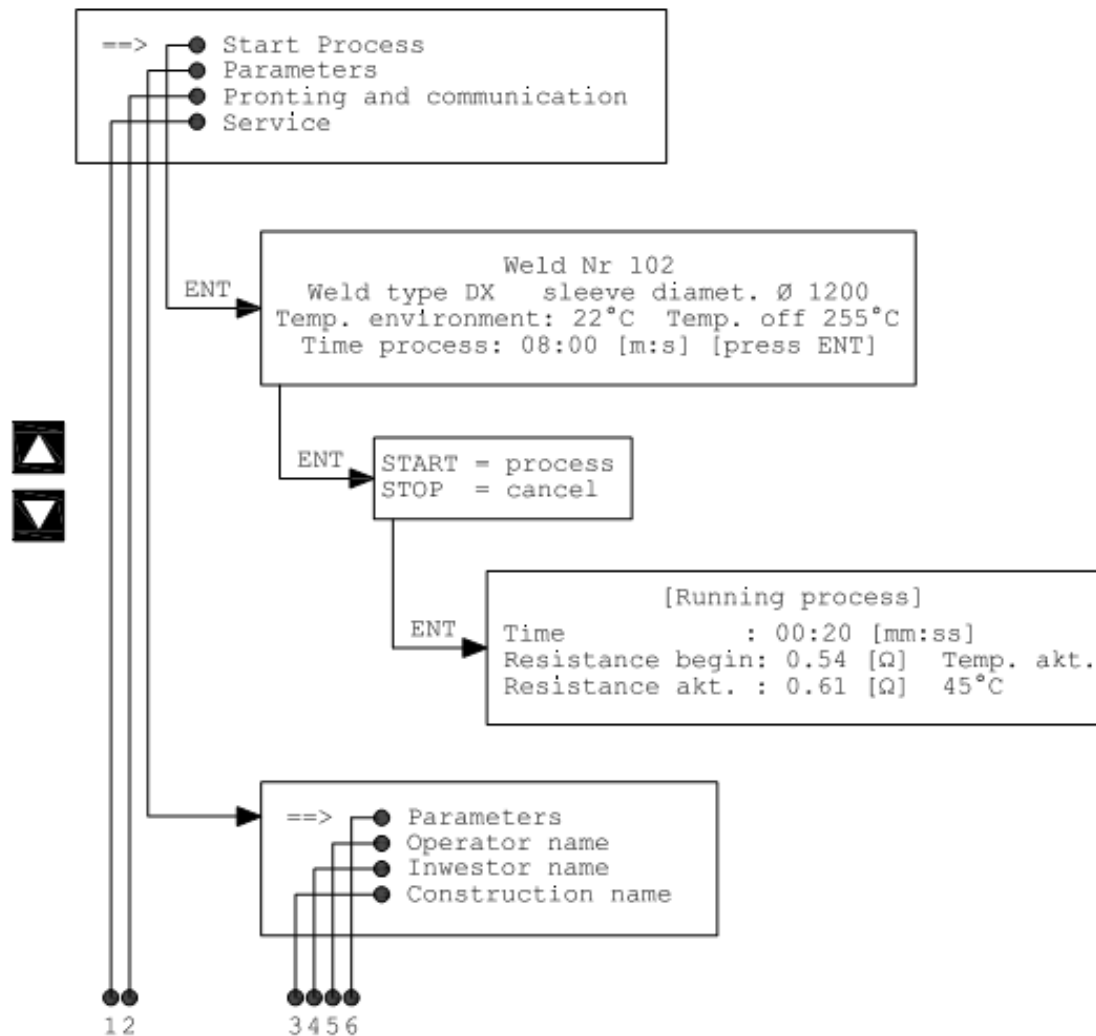
In the case of a fault, repair only with an authorised service centre.

5.5 Structure of Program of Welding Machine Operations

Below is the program structure



Welding device HG-2 Nr 2
Date: 20.07.2007 Time: 10:34:59
ZPU Międzyrzecz Sp. z o.o. ver: 4.0h DX
Copyright (c) 2007 by Arkadiusz Marszałek



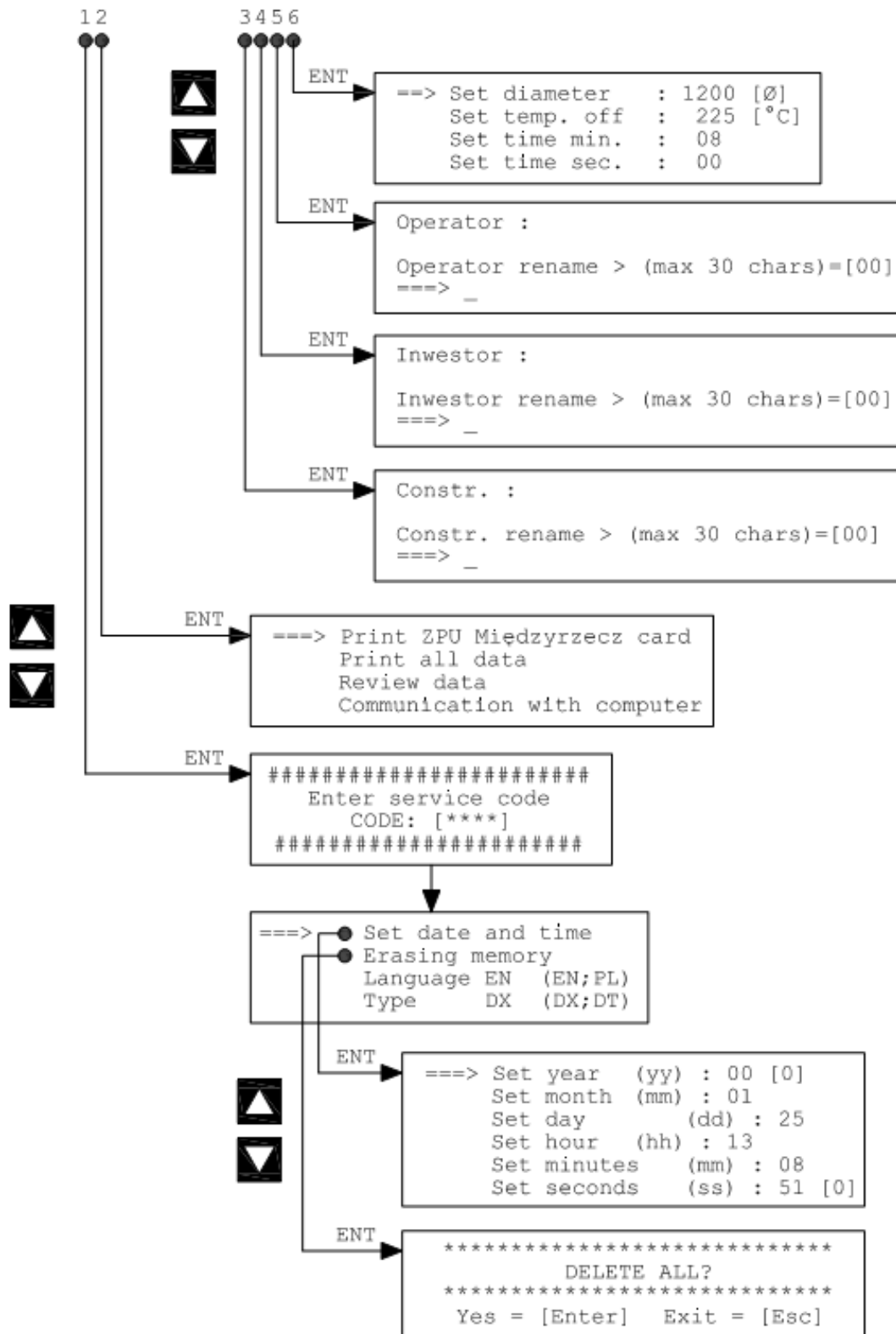
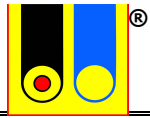
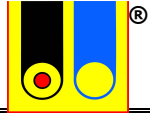


Fig. 5. Structure of Program of HG-2 Welding Machine Operations



6 Electrical Welding of a DX Joint

A pictorial presentation of electrical welding of DX joints is presented in Fig. 1.

- 6.1 Connect the HG-2 welding machine to a single phase power supply source of the nominal voltage of $U_f \approx 230V +5\% - 10\%$; 50 Hz, a maximal deviation of + 0.2 Hz, - 0.5 Hz, protected with a fuse $I_b = 40 A$ or a power generator.
- 6.2 Connect a DX joint to the welding machine. A single section DX plate is shown in Fig. 6. Plates (multisectional) fitted with more than two terminals are presented in Fig. 7.

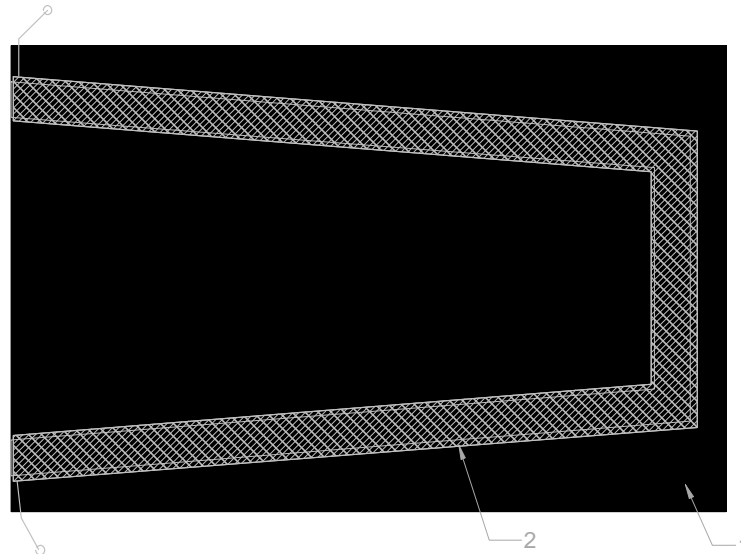


Fig. 6. A DX plate placed on a joint
1. Polyethylene plate
2. Heating strip

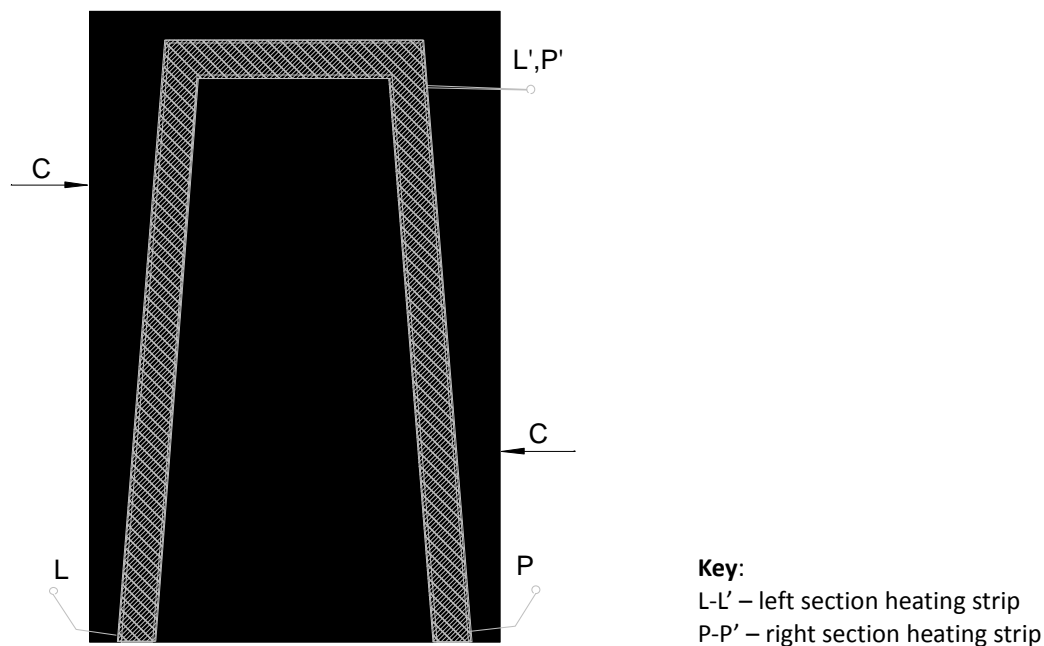
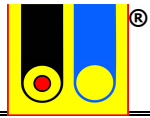
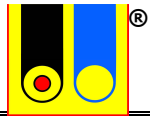


Fig. 7. A double-section DX plate placed on a joint

- 6.3 Singular welding sections and temperature probe sockets are indicated with the same letters (see markings in Fig. 7).
- 6.4 Heating strip clamp terminals and probe compensating terminals cannot hang loosely on their wires or be moved around while the joint is being welded. They should be protected against such unwanted events.
- 6.5 Weld as described in the HG-2 Welding Machine Operating Manual.
- 6.6 Fill in the welding form entering the program number, operator and other data that the program contains.
- 6.7 Upon natural cooling down of the welded joint to $50 \pm 60^\circ\text{C}$ the fastening belts and metal distance pieces are removed.



7 Checking DX joint tightness

The quality of a DX joint depends on all the factors affecting the joint during the welding process (i.e. cleanliness, dryness, proper force applied, welding time, welding temperature, and cooling down time).

DX joint tightness can be tested only by an experienced and trained fitter who will inspect the joint visually and carry out a pressure test.

- 7.1 Inspect visually and palpably the external surface of the whole DX joint.
Pay attention to such features like:

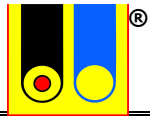
- narrowing within the weld line area;
- a dull or partly gray surface tarnish on the joint

are natural effects resulting from the thermal processes and do not mean inferior quality or durability of the joint.

- 7.2 Drill a 25 mm hole in the joint with a spade drill taking care not to injure the alarm wiring. The hole should be placed in the 12 o'clock position 100 mm away from the joint centre.
- 7.3 Set up a test gauge with a venting plug.
- 7.4 Fill the joint with air or a neutral gas (N_2 or CO_2) creating a pressure of 2.5 m of column of water (0.25bar).
- 7.5 The tightness of welded joints in a DX joint has to be checked with a water soap solution (that is a solution of deionised water with a 3% content of detergent). First, the joint should be filled with air or another neutral gas (N_2 or CO_2) up to a positive pressure of 2.5 m of H_2O (0.25 bar). Unless pressure gauge readout drops by one interval within two minutes the condition has been met. Then, the prepared solution has to be applied with a brush or a sprayer on areas adjacent to the weld seam, edges and fillet over their whole lengths at the same time making the solution stable bubbly with brush strokes. The joint tightness has to be checked visually – the joint is tight if neither soap bubbles are formed on the sprayed areas nor the foam volume increases. Once the tightness check has proved positive, the joint is ready for operation.

8 Final Touches

- 8.1 On DX joint tightness test yielding a positive result:
- remove the temperature probe from the socket;
 - cut off the terminals next to the joint edge seeing to that the case pipe surface or welded joint are not damaged
- 8.2 A polyethylene flash which might build up excessively during welding is to be removed.
- 8.3 The DX joint should now be thermally insulated by pouring in the A and B components of polyurethane foam, as described in the manual of thermal insulation of heat shrinkable joints in the ZPU Międzyrzecz Sp. z o.o. system.
- 8.4 Check if the PUR foam does not pour out from between the internal joint surface and the external case pipe. Any such signs would mean that the joint has lost its tightness.
- 8.5 Plugs inserted into the joint housing should be heated electrically until the combine with the housing.



9 DX Joint Re-welding

Should the DX joint fail to yield positive results, the joint has to be welded again. However, it has to be borne in mind that prolonged heating is detrimental to plastics, polyethylene including.

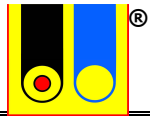
Therefore, any additional welding works on a DX joint should be minimised. Such a repeated welding is allowed providing:

- the welding process was disturbed and stopped due to a break in the electric circuit, power supply failure;
- the welded joint is not tight;
- the DX welded joint has not been re-welded yet.

A DX joint can be welded again on DX joint that have been naturally cooled down below 35°C with the fastening belts as under 4.2.

10 Important Additional Information

- 10.1 This Manual does not present all important and necessary information about the assembly of DX type welded joints, and, moreover, it does not mean to substitute training that might be held on the premises of ZPU Międzyrzecz Sp. z o.o. as regards their assembly, neither does it relieve from completing such training.
- 10.2 Those who will assemble electrically welded DX type joints must acquire proper qualifications and be properly knowledgeable in the assembly of DX joints, and will be held responsible for correct assembly of DX welded joints.



Annex No 1

MANUAL

Safety, technical and performance requirements to be observed in assembling heat shrinkable electrically welded DX joints in preinsulated thermal utilities

(Auxiliary training materials)

I. HG-2 welding machine

1. Power supply parameters:
 - single phase mains, 3 wires (L + N + P)
 - $U = 230 \text{ V}$, 50 Hz , $P_{\max} = 3 \text{ kVA}$
 - fuse $I_b = 16 \text{ A}$.

Note: The welding machine should be provided with a PE protective wire!

2. Output parameters:
 - $U_{\max} = 48 \text{ V}$, 50 Hz , $I_{\max} = 50 \text{ A}$
3. Other data:
 - dimensions $34 \times 27 \times 44 \text{ cm}$
 - weight ca 25 kg .

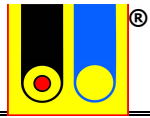
II. Work safety rules to be observed while DX joints are assembled

During assembly works carried out on DX joints certain factors may affect labour safety and hygiene. These are among others:

- a risk of electric shock during welding works;
- burns if works are carried out on hot pipelines or on heating elements and heat shrinkable sleeves.

Therefore, the following cautionary measures have to be undertaken:

1. When welding devices are in operation, regulations contained in respective operating manuals supplied by manufacturers have to be strictly observed.
2. Cables connecting the welding machine with a 230 V power supply must be of OW or OP type and meet respective standards. The cross section of copper wires supplying power to the welding machine cannot be smaller than 2.5 mm^2 .
The welding machine should be connected to the mains with OW or OP $3 \times 2.5 \text{ mm}^2$ flexible cords with a plug furnished with a PE protective pin.
For safety reasons a PE protective wire (grounding) has to be connected to the welding machine in order to avoid a risk of electrical shock.
The PE wire should be marked with green-yellow colour strip insulation to make it possible to distinguish it from other cables.
3. If the power supply source is placed at a distance or extension cables are used the cross section of these cables should be at least one grade higher (e.g. $3 \times 4 \text{ mm}^2$).
4. If the welding machine is to be powered by a generator it can only be used if capable of supplying undisturbed sine voltage.
The power generator must be thoroughly grounded and operated as indicated in its Operating Manual.
5. The lengths and cross sections of cables attached to the welding machine should meet nominal welding currents and secure lowest electrical losses.
6. Wires through which the welding machine is to be powered should be protected against mechanical damage (suspended, protected with proper guards, etc.)
7. The welding machine should preferably be situated as close as possible to the welding station.



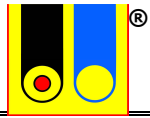
8. Welding machine operations should be stopped immediately should the operator's safety be endangered or a risk to the environment becomes imminent or if faults are found, especially if:
 - the machine becomes excessively hot;
 - signs of smoke, fire, and a smell of burning insulation can be detected;
 - excessive vibrations and noise levels;
 - damaged controls and automatic voltage and current controls.
9. The welding machine and its equipment should be kept in good repair by being periodically maintained, fixed and repaired.
10. Results of performed revisions and scopes of maintenance and repair operations have to be recorded in the respective documentation.
11. External visual inspections as required by the manufacturer have to be carried out while the machine is working and idle, no less than once a month.
12. Inspections: as specified by the manufacturer but at least once in 6 months.
13. Anti shock protection should meet the requirements set out in respective regulations on electrical shock protection for power equipment, and additional requirements set out by the manufacturer and the actual conditions under which the machine is operated.
14. Workers performing DX joint assembly should be provided with personal protection gear like: clothes, gloves, head gear and protective shoes.

III. Excavations

1. Excavations deeper than 1 metre should be shuttered (boarding) or graded at safe angles.
Moreover, they should be provided with safe entrance (exits) for workers.
The distance between successive service entries (exits) should not exceed 20 m.
2. Each time works are to be commenced the walls of the excavations or scarps have to be inspected.
3. Neither material nor equipment can be stored:
 - closer than 1 metre to the excavation edge if its walls are shuttered;
 - within the limits of the soil wedge if the walls are not protected.
4. Excavations in places where DX joints are to be assembled should be suitable widened and deepened.
HG-2 welding machine operators should be provided with sufficient area (a niche), that is the distance between the poly casing pipe and the excavation bottom should be at least 60 cm. The niche length should not be shorter than 190 cm.
5. Pipelines on which DX joints are to be assembled have to be stored dry in the designated places, and cannot come into contact with ground waters.
6. DX joints are suggested to be assembled in favourable weather conditions.
In case of rainfall the assembly places should be protected by covers, e.g. foil tents.
7. Workers in excavations should pay attention to the uncovered utilities there (power cables, telecommunication lines, gas pipe, etc.)
They should not be touched unnecessarily.
The gas pipe uncovered in excavations should be tested as regards their tightness with gas detectors.

IV. Central heating chambers, manholes and conduits

1. Prior to entry into chambers, manholes and central heating conduits gas concentrations there and sufficient supply of air oxygen should be checked.
2. Workers carrying out works in central heating conduits, manholes and closed chambers should be equipped with gas detectors and alarm sounders.



3. In works carried out inside central heating chambers at least one person should be on the look out to secure those at work.

V. General remarks

1. Work places and equipment should be cared for.
2. Do not expose yourself or your colleagues to unnecessary risks.
3. In cases of doubt as regards safety of work the worker has the right to cease operations performed and address his superior to clarify the situation.