RADIATYM Sp. z o.o.
20 Przewozowa str.
44-100 Gliwice

INSTRUCTION XVII

REV. 0.0. DATED 03.02.2020

THE TRANSPORT, STORAGE, ASSEMBLY AND USE INSTRUCTION OF INSULATING JOINTS MANUFACTURED BY RADIATYM Sp. z o.o.

Gliwice, 2020.

1. The instruction subject.

The scope of this instruction are the main rules of handling, installing and maintaining of Monolithic Isolation Joints manufactured by RADIATYM, Gliwice, Poland. The Joints are designed to secure a breakage in the electrical conductivity of a pipeline in lengthwise direction in order to keep just properties at the point of cathodic protection.

An isolating joint is an isolating metallic integral factory pre-assembled device supporting an optional electrical breakage (*internal or replaceable external*) along a pipeline into which it is applied. The joints are designed to be used in any pressure pipeline networks supplying gas, liquid fuels or water media. They are usually applied in front of or behind reduction stations, pumping stations as well as in oil or gas plants and gas holders or oil reservoirs, oil pipelines and water pipelines.
The joints are designed for aboveground or underground installation in vertical or horizontal position.

2. Basic parameters of insulating joints' acceptance and operation.

Basic parameters of insulating joints' acceptance and operation:

- maximum operation pressure (*MOP [bar]*),
- resistance test pressure (*standard MOPx1.5*) and it's duration (*standard 30[min]*),
- possibility of special acceptance tests at the Manufacturer's factory (*hydraulic fatigue test; bending test+p; torsional test; tension test+p*),
- lowest/highest operating temperature allowable(*TS [°C]*),
- minimum required resistance of insulating joint with DC voltage (*R [MΩ]*) (*standard: min 1.0 [GΩ]/500[V] in dry condition*),
- DC voltage for insulating joint external coating leaktightness measurement (*voltage level depends on coating type and it's thickness*),
- AC voltage for alternating voltage electric test and it's duration (*standard: 5,0[kV]/50[Hz] during 1[min]*).

Prior to the installation on pipeline (*installation*) an authorised inspector shall measure check:

- electrical resistance R of insulating joint at U-DC voltage established at the stage of order *in dry condition*; the result must be at least the same as R resistance level established [MΩ]/U[V],
- leaktightness of insulating joint external coating at Us-DC voltage established with Purchaser *in dry condition* (*Us voltage is matched depending on the coating type and it's thickness*).

3. Conditions of insulating joints' transportation.

During transport, insulating joints must be protected from the mechanical damages. The loading surface of the transport mean should be flat (*even*) and free from sharp or protruding edges. Insulating joints should be put closely one next to the other (*separated by dividers protecting the joints from the external coating damage*) and protected from the movements on the f.e. pallet during transportation.

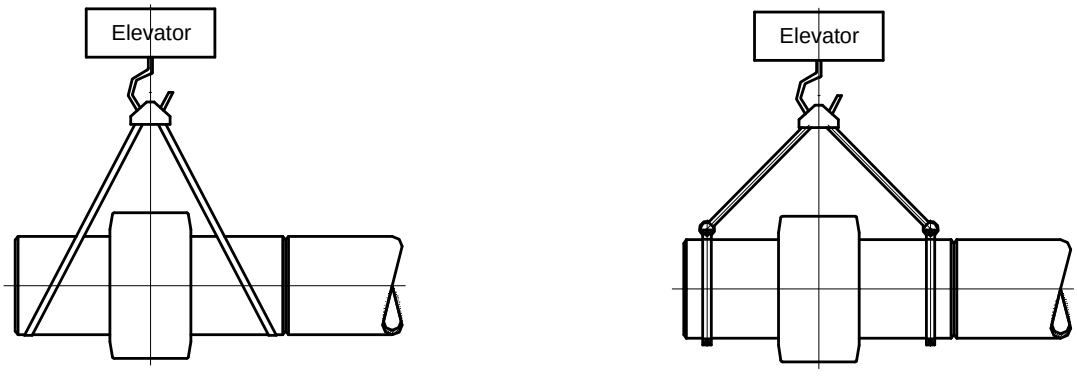
4. Conditions of insulating joints' storage.

Insulating joint, which are not intended directly for assembly should be stored in conditions that assuring:

- protection against solar radiation UV,
- protection against atmospheric precipitation (*rain, snow*),
- protection against eventual mechanical damage and dustiness (*proper packaging*).

5. Conditions of insulating joints' assembly.

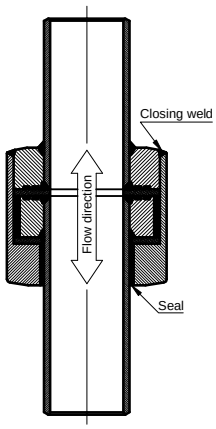
During the transportation and handling a particular care must be taken to prevent any mechanical damage or permanent deformations. Transport to the site should be carried out with rope slings put so as not to damage the joint nor its external coating. A recommended way of transportation is present in the figure below. Diagrammatically shown option with use of webbing and second option with ordered earlier metal bands (*there is no possibility to move webbing*).



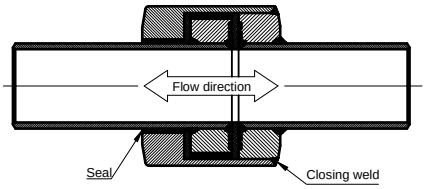
A particular care must be taken not to damage the external or internal coating. If so happens a repair procedure supplied or approved by the manufacturer must be used (*after submitting the demand*).

In case of insulating joint assembly, no guidelines for the factor flow direction are used. If the insulating joint is to be assembled in vertical position, it is recommended to place it with the closure weld upright.

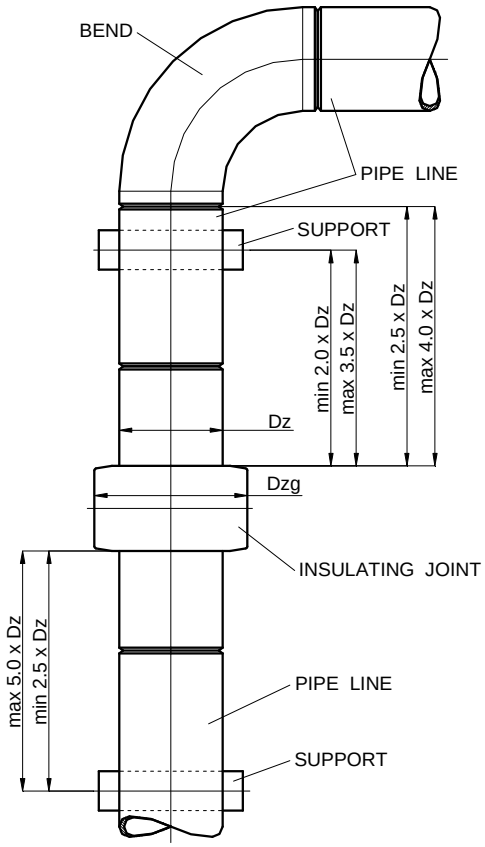
Vertical development of insulating joint



Horizontal development of insulating joint

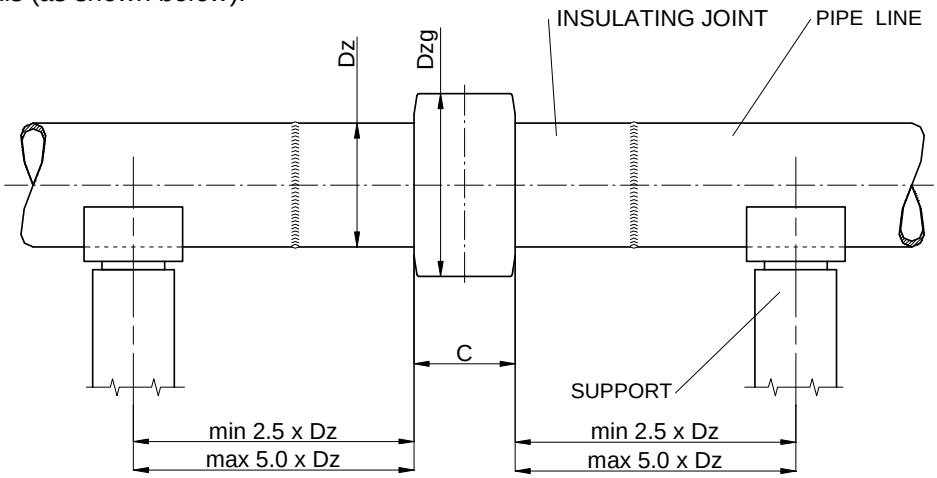


For connection of insulating joint with Elbow the RADIATYM Company proposes to keep distance at least 2,5 x Dz, from beginning of elbow component to headwall and supports spacing around the insulating joint as shown below:



Final distance parameters stipulates design office on the basis of calculations related to type of pipeline (*above or below ground*), established external loads, the supports spacing,the soil type, assumed shape of pipeline, etc.

For the supports spacing (*the line section of a pipeline*) around an insulating joint, RADIATYM recommends to keep the min. distance of 2,5xDz up to max. 5.0xDz from the head's headwall to the support axis (*as shown below*):



The final distance parameters are established by the design office on the basis of calculations made depending on: the pipeline type (*aboveground, underground*), external loadings assumed, supports spacing, soil type, the pipeline shape assumed.

FINAL REMARKS:

It is assumed that the assembly internal loadings will not exceed the allowable levels (*that results mainly from non-axial supports spacing,which requires the "stretching" of line pipe in order to connect it with an insulating joint; the support falling in the soil during the pipeline operation, etc.*).
Big values of assembly loadings together with max.operation loadings assumed *(internal pressure, forces of the pipeline thermal dilatability and reciprocal force interaction of pipeline sections slope one to another at angles, subsoil movements, lack of support for an insulating joint at one side and weighting this section with " hanging" mass of pipeline installation fragment under which the soil may displace*); may, in some situations, lead to the mechanical damage of insulating joints.

5.1. Threaded joints.

Based on „Regulation of The Economy Minister of 2013-04-26 on technical conditions, the gas grids should fulfill and their location for maximum operating pressure (*MOP*) to 5 [bar] inclusive, the threaded joints with the following diameters are allowed:

- to DN25 inclusive with the leaktightness achieved on a thread,
- from DN25 to DN50 inclusive without the leaktightness achieved on a thread (*sealing agents are used to seal*).

to connect the insulating joint with the other pipeline elements.
Threaded joints should have the inner rolled thread compliant with PN-ISO 228-1 or PN-ISO 7-1 and the outer conical thread compliant with PN-ISO 7-1. When using threaded joints the suitable sealing materials need to be used, which is: anaerobe sealing compounds compliant with PN-EN 751-1, non-hardening sealing compounds compliant with PN-EN 751-2 or non-caking tapes PTFE compliant with PN-EN 751-3.

5.2. Flange joints.

In practice, flanged joints are used in order to connect insulating joints with the other aboveground and underground pipeline elements in case the use of different methods of connection is difficult or even impossible. Flanges should be manufactured in compliance with PN-EN 1092-1:2010, screws and nuts in compliance with PN-EN 1515-1:2002, PN-EN 1515-2:2005, gaskets in compliance with PN-EN 1514-1÷4:2001, PN-12560-1÷5:2002. Flange joints gaskets need to be matched to the flange type used and should be made of material resistant to the transported fluid reaction. Gaskets should not contain asbestos.

5.3. Welding and Welded joints.

Note:
The external coating must be protected from welding chips during welding operation.
It is forbidden to strike the electric arc on the outside surface of roll line pipe.

To connect insulating joints with steel linepipes, the welded joints are used most frequently. Such technology, as well as additional materials used should assure the joints strength equal to the strength of basic materials. The connection process should be carried out using one of the electrical welding methods only, compliant with PN-EN ISO 4063:2011, which are:

- covered electrode arc welding – 111
- activated-type tungsten electrode arc welding (*TIG*) - 141
- activated gas consumable electrode arc welding (*MAG*) – 135, 136, 138.

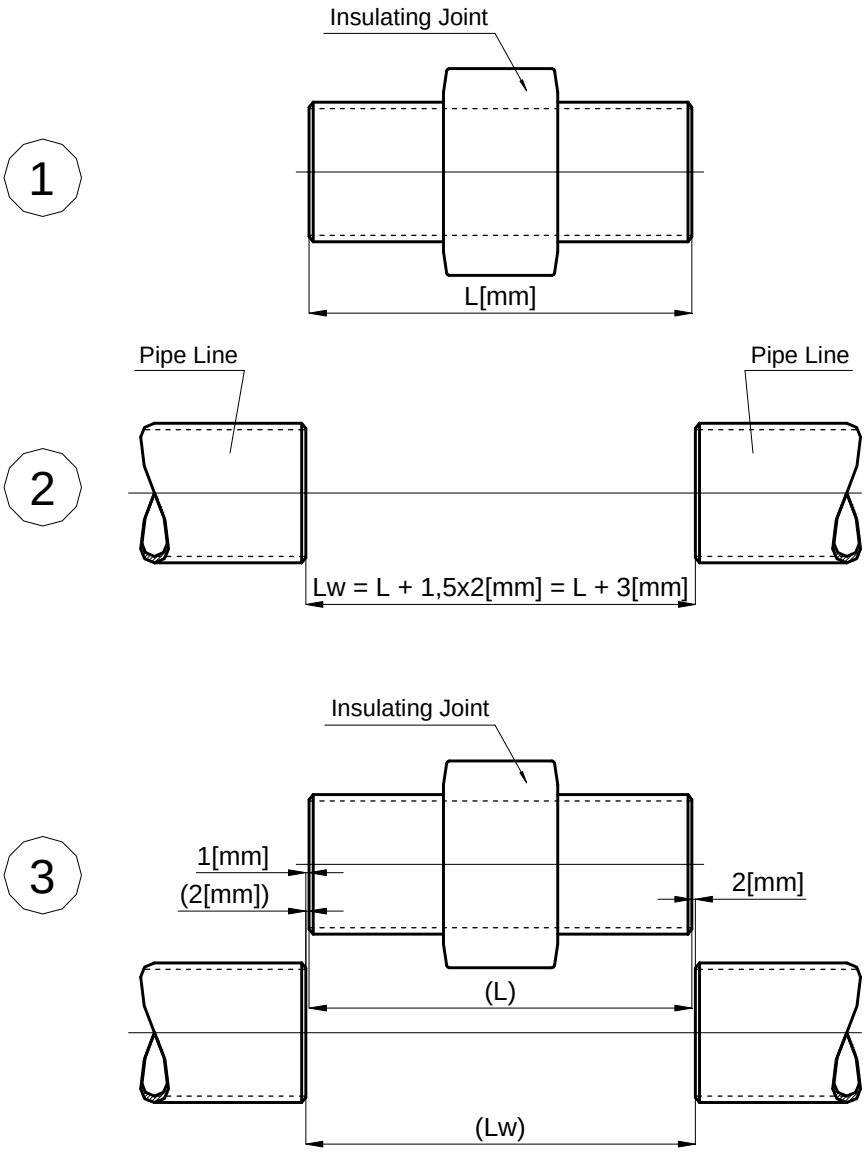
All welding works need to be carried out based on the recognized welding technological instruction (*WPS*).

To centre and support pipes during the welding process of the first two layers it is recommended to use either mechanical, hydraulic or pneumatic centring device. The equal space between the bevelled pipes' edges as well as the pipes' reciprocal radial shift needs to be kept.

Welders carrying out the welding joint must be qualified in accordance with EN 287-1:2011. Master hand welders qualified in accordance with PN-EN ISO 14731:2006 are authorized to supervise the welding works on site. Working space should make possible the suitable access to the working area in order to secure the surroundings and to render possible the correct execution and tests of welded joint. If not agreed differently, joints should be connected using the butt joints. The joints'

edges should be prepared in accordance with PN-EN 1708-1:2010. The joint's shape selection should depend on the welding method, welding position and the joint's accessibility. The weld's space should be sufficient enough to ensure the joint's electrical integrity.

In connection with welding shrinkage effect appearance, special attention must be paid in order to eliminate any additional stresses that may affect an insulating joint after welding is finished. Such effect may appear in case monolithic joint is welded (*f.e. after replacing it*) to existing pipeline. To minimize the size of such stresses it is necessary to make an accurate "neck" in the pipeline (*length Lw*) , taking into consideration an actual (*measured*) length of monolithic joint (*L*) and increased about ~1,5 of welding space 2.0[mm] big assumed (*from one side 2.0[mm], 1.0[mm] from another*). After carrying out one weld with welding gap 2.0[mm] (*wait until it is cooled down*)it is necessary to widen the second welding gap to the assumed size 2.0[mm] (*f.e. use the hack-saw 2[mm] wide*). Make second weld. Observe the behavior of gaps between the implementation of successive layers of welds in order to reduce their temperature. All welding works must be carried out based on the recognized technological instruction of welding (*WPS*) for pipeline.



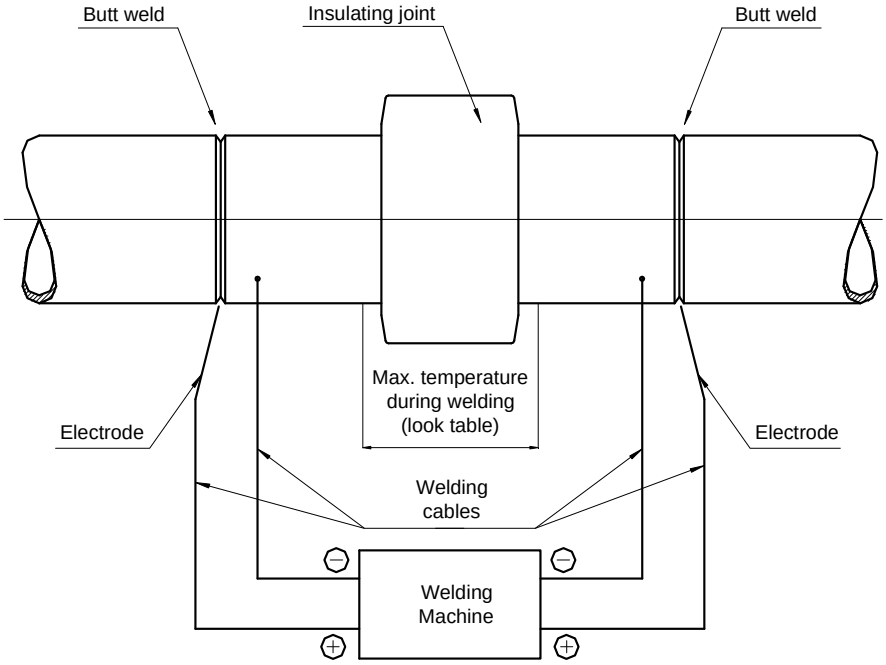
In case an insulating joint is connected to the pipes with different wall thicknesses, special precautions must be applied in order to avoid the stress concentration and welding discrepancies. It is recommended to consider the examples given in Annex C of the PN-EN 12732:2004 standard.

Welding the joint to the linepiepes should be carried out in such a way, the heat generated during the welding process does not damage the isolation materials of monolithic joint and the temperature in it's central part – the head does not acceptable level (*see the table*) inside the head the tightening elements susceptible to high temperatures are present. In order not to exceed this temperature level, it is necessary to wrap the head with wet fabrics either the compressed air stream needs to be directed to the head zone. Temperature on the monolithic joint's line pipes in the place where manufacturing insulation begins cannot exceed the acceptable level (*see the table*) – in order to do that, the surface needs to be cooled down with compressed air directed to the high temperature zone, either fabrics soaked up with water and wrapped around this zone. The linepipes' ends that are to be welded to the monolithic joint must be free from oils, lubricants and other impurities as well as external and internal isolation at min 50÷100 [mm] length form the edges (*depending on the line pipe's wall thickness or PWHT operation requirements – see subsection 5.4*) as it has a crucial influence on the quality of welds made.

In case the preliminary heat is applied, it needs to be carried out in a way the monolithic joint's coatings remain without damages . Temperature on the monolithic joint's line pipes in the place where manufacturing insulation begins cannot exceed the acceptable level (*see the table*). In case acetylene-oxygen burners are used for preliminary heat, the fire source mustn't be directed on the coating directly which causes the damage of a coating. During the welding operation, the temperature needs to be maintained on an acceptable level (*see the table*) in the place the manufacturing insulation begins (*compressed air or fabrics soaked with water will be used to cool down the surface*). Monolithic joint's coating needs to be protected from welding chips during the welding operation otherwise gets destroyed.

Pipes to be welded to an insulating joint are electrically isolated with respect to one another. For this reason the current source "earthing" must be placed on the same side of the pipeline as the welded pipe (*see the drawing below*). Otherwise, the joint's isolation damage may occur due to the current applied for welding.

The correct welding process (*for right and left side*) should be carried out in accordance with the drawing shown below.



Note: Maximum temperature during welding – see below table (*on the drawing exemplary shown 80[℃] as for Epoxy coating*)

The quality of welding must be ensured by the welds' control which is possible due to the non-destructive examination (*NDT*). The tests' results should be substantiated. Non-destructive examination need to be carried out based on the recognized procedures. The control shall include the welding process check-up and the final visual and non-destructive examination.

Table with allowable temperatures during welding and during PWHT.

No.	Type of External Coating	Allowable Head's Temperature [°C]	Allowable temperature of line pipe in place where fabrical isolation starts [°C]
1.	**Poliethylene coating**	**max 40**	**max 60**
2.	**Poliurethane coating**	**max 60**	**max 80**
3.	**Epoxy Coating**	**max 80**	**max 100**
4.			
5.			

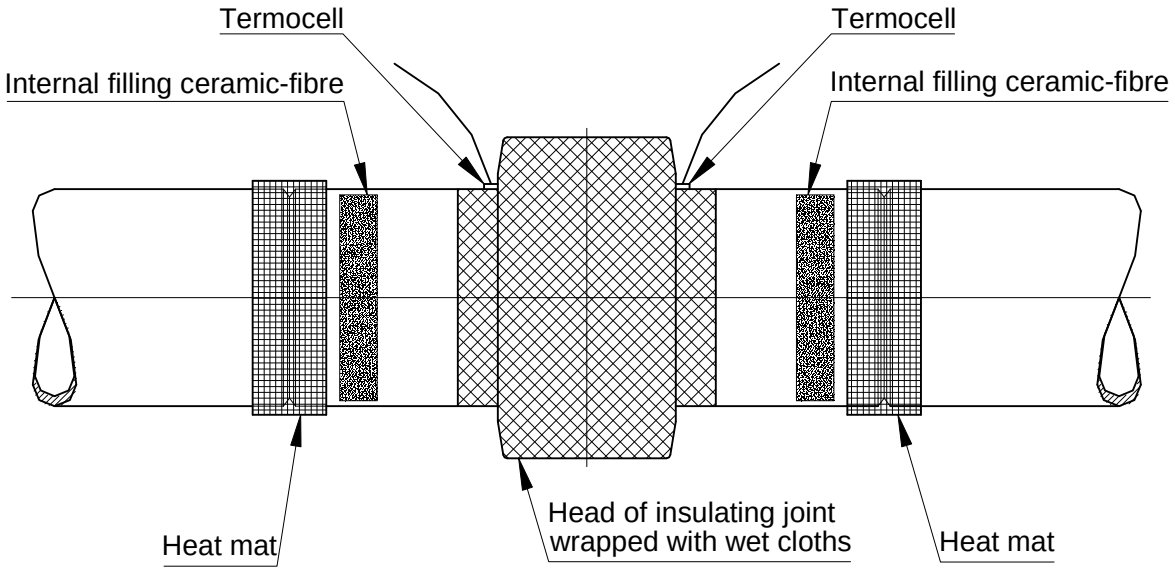
5.4 Post Weld Heat Treatment (*PWHT*).

Note:

Insulating joint for this operations shall not have External Spark Gap installed (*in this case external spark gap can be installed after PWHT is completed*).

If PWHT is required it is necessary to protect the joint's head against overheating. The internal bore of the joint must be filed up with a refractory material next to the place to be heat treated. Additionally a proper cooling method shall be applied; for example moisture cloth wrapped over or compressed air blow direction to the joint head. The head's temperature must be carefully controlled during the PWHT process and should not exceed (*see table in Chapter 5.3*) on the external surface. Temperature on Line Pipes of insulating joint in place of beginning of factory's isolation should not exceed allowable level (*see table in chapter 5.3*) – for this purpose to cool down surface compressed air directed onto high temperature zone should be used or material soaked up with water wrapped around this zone.

Ends of Line Pipes of insulating joint shall be free from external and internal isolation on a minima distance 170÷200[mm] from edges (*this distance is selected depending on width of heating mates and eventual another requirements for this process*).



In case of insulating joint's damage due to heat generated during welding process or PWHT, insulating joint shall be replaced by New one. Damaged insulating joint, due to overheating, can be identified in two ways:

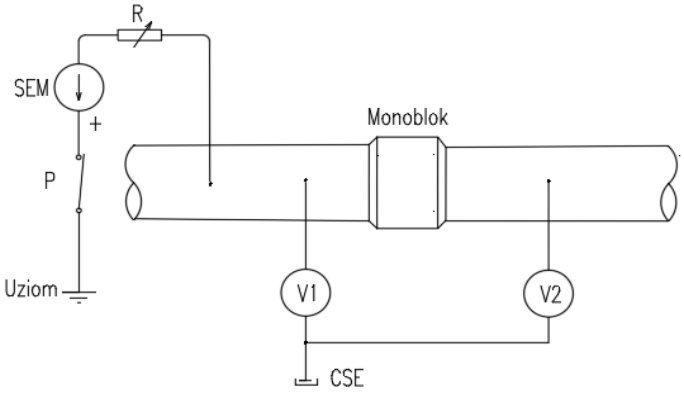
- in case of damage of its isolating properties (*dielectric*) using simple resistance measurement (R < 10[Ω]) or through measurement of electrical integrity (*see chapter 5.5*),
- in case of damage of sealing system, **damage can be detected during hydrostatic test only**.

5.5 Measurement of electrical integrity after welding of insulating joint into pipeline.

After the insulating joint is installed, an authorised Inspector shall measure the electrical integrity of welded joint with a pipeline (*one of two exemplary methods given below may be used).*

METHOD 1

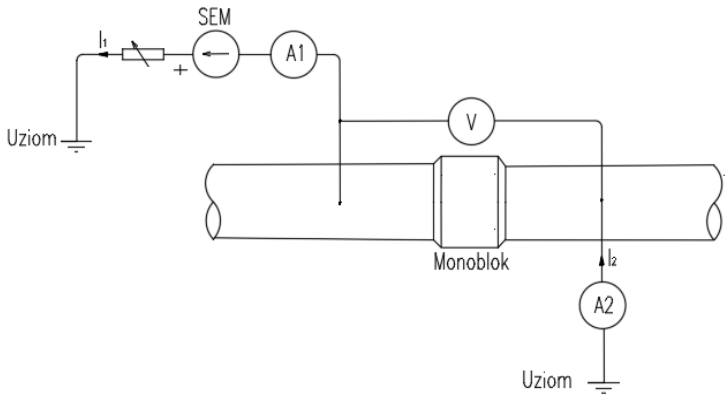
Efficiency of the joint may be tested by using the electro resistance method.



As a source of electricity, generator of 12 Voltage can be used. Attach electric breaker in the circuit. Set the source of electricity by using potentiometer R to the point where value on the polarized side is about -2V to the measuring electrode Cu/Cu SO4nas (CSE). Switch a breaker to intermittent mode in cycle 1S turn on/ 5s turn off. Potential change caused by electric source timing on the polarized side (voltometer V1) shall not cause potential change on the other side of the insulting joint (voltometer V2).

METHOD 2

Technical method



Earth electrodes should possibly have low resistance.
According to above drawing, adjust electricity in the circuit to maximal level of the source.
Measure current I1, I2 and voltage on insulting joint.

- if a joint is efficient- indicated voltage should be close to the voltage source.
- if a joint is damaged- measured voltage by the voltmeter shall be close to zero and current should be approximately equal to current I1.

WARNING:
Please remember, current is a sum of a current that flows through an insulating joint and flows through earthed resistance of buried parts of a pipelines on both sides of the joint.
Also, electric measurement flows through a voltmeter, that is why using measuring voltmeter ≥ 10 MΩ should have input resistance.

6. Conditions of exploitation and maintenance of insulating joint.

Insulating joint can be used on existing objects as well as on construction sites, on transmission pipelines, distributive underground and aboveground pipelines, before and after reduction stations in aboveground and underground gas storage mines installations, petroleum, on fuel gas and liquid fuel installations and tanks and on waterpipes.

No maintenance for such a construction Insulating joints is required for such a construction guarantees an absolute tightness of assembly during operation and their life is no less than any other element of the pipeline.

In the event of the need to comply with abrasive- stream machining on installed insulating joint, be sure to protect the dielectric gap (around filling epoxy). This area is easy to recognize as it's localized on the opposite side of closure weld. The abrasive-stream machining needs to be performed to achieve Sa 2 ½ level and height of roughnss 50÷70 [μm] acc. Standard PN ISO 8501-1.

The dielectric (*isolation*) properties can be damaged due to the atmospheric discharge, high-voltage breakdown caused by improper working conditions of adjacent and mating electrical devices, alternating current induced from the adjacent cables. It is recommended (*depending on assembly place*) to protect insulating joints optionally with surge arrestors (*external and internal*), condensers, polarized cells, etc. Protective devices should be matched and housed in a way to avoid their dirties and soaking that could result in the external discharges at a relatively low voltages.

Damaged insulating joint, due to overheating, can be identified in two ways:

- in case of damage of its isolating properties (*dielectric*) using simple resistance measurement (R < 10[Ω]) or through measurement of electrical integrity (*see chapter 5.5*),
- in case of damage of sealing system, damage **can be detected during hydrostatic test only**.

7. Provisions and stripulations.

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8. Regulations and standards.

8.1 Regulations:

- Technical inspection act of December the 21, 2000 r. (*Dz. U. Nr 122, poz. 1321 ze zm. z 2002 r. Nr 74, poz. 676*),
- 97/23/WE Instruction implemented with the decree of Economy, Work and Social Politics Minister of August the 8th, 2003 r. Regarding the basic requirements for pressure vessels and pressure vessel units (*Dz. U. Nr 99, poz. 912*),
- Conditions of Technical Inspection Office:
  - WUDT-UC-WO-T : Introduction, definitions and arrangements,
  - WUDT-UC-WO-W : Production,
  - WUDT-UC-WO-M : Materials,
  - WUDT-UC-WO-O : Strengthening calculations,
  - WUDT-UC-RT : Technological pipelines.

8.2 Standards:

PN-EN 10028-2:2010	Wyroby płaskie ze stali na urządzenia ciśnieniowe. Część 2: Stale niestopowe i stopowe o określonych własnościach w podwyższonych temperaturach.
PN-EN 10025-1:2005	Wyroby walcowane na gorąco ze stali konstrukcyjnych. Część 1: Ogólne warunki techniczne dostawy.
PN-EN 10208-2:2011	Rury stalowe przewodowe dla mediów palnych. Warunki techniczne dostawy. Rury o klasie wymagań B.
PN-EN 287-1:2005	Egzamin kwalifikacyjny spawaczy. Spawanie. Część 1: Stale.
PN-EN 288-8:1999	Wymagania dotyczące technologii spawania metali i jej uznawanie. Uznawanie na podstawie badania przedprodukcyjnego spawania.
PN-EN ISO 14175:2008	Spawalnictwo. Materiały dodatkowe do spawania. Gazy osłonowe do łukowego spawania i cięcia.
PN-EN ISO 14341:2008	Spawalnictwo. Materiały dodatkowe do spawania. Druty elektrodowe i stopiwo do spawania łukowego elektrodą topliwą w osłonie gazów stali niestopowych i drobnoziarnistych. Oznaczenie.
PN-EN 571-1:1999	Badania nieniszczące. Badania penetracyjne. Zasady ogólne.
PN-EN ISO 14731:2006	Spawalnictwo. Nadzór spawalniczy. Zadania i odpowiedzialność
PN-EN ISO 3834-1:2006	Spawalnictwo. Spawanie metali. Wytyczne doboru wymagań dotyczących jakości i stosowania.
PN-EN ISO 3834-2:2006	Spawalnictwo. Spawanie metali. Pełne wymagania dotyczące jakości w spawalnictwie.
PN-EN ISO 3834-3:2006	Spawalnictwo. Spawanie metali. Standardowe wymagania dotyczące jakości w spawalnictwie.
PN-EN ISO 3834-4:2006	Spawalnictwo. Spawanie metali. Podstawowe wymagania dotyczące jakości w spawalnictwie.

PN-EN ISO 17637:2011	Spawalnictwo. Badania nieniszczące złączy spawanych. Badania wizualne.
PN-EN 1708-1:2010	Spawanie. Podstawowe rozwiązania stalowych połączeń spawanych. Część 1: Elementy ciśnieniowe.
PN-EN 13480-1:2005	Rurociągi przemysłowe metalowe. Część 1: Postanowienia ogólne.
PN-EN 13480-2:2002	Rurociągi przemysłowe metalowe. Część 2: Materiały.
PN-EN 13480-3:2002	Rurociągi przemysłowe metalowe. Część 3: Projektowanie i obliczenia.
PN-EN 13480-4:2005	Rurociągi przemysłowe metalowe. Część 4: Wykonanie i instalowanie.
PN-EN 13480-5:2005	Rurociągi przemysłowe metalowe. Część 5: Kontrola i badania.
PN-EN 13480-6:2005	Rurociągi przemysłowe metalowe. Część 6: Wymagania dodatkowe dla rurociągów podziemnych.
PN-EN 1594:2011	Systemy dostawy gazu. Gazociągi o maksymalnym ciśnieniu roboczym wyższym niż 16 bar. Wymagania funkcjonalne.
PN-EN 12732:2004	Systemy dostawy gazu. Spawanie stalowych układów rurowych. Wymagania funkcjonalne.
ISO 3183:2007	Petroleum and natural gas industries – Steel pipe for pipeline transportation systems.

Date of last modification of dokument (ver4a - *en*): 13 January, 2017 Franciszek Sech (*polish version*), Translated: Klaudia Tymkiewicz, Monika Moroń (*2014-06-03*), Beata Jabłońska (*2017-01-13*).