TABLE OF CONTENTS

1 GENERAL

1.1 isoplus - The Company

1.2 isoplus - Your Partner in Europe and Near East

1.3 isoplus - Your Plus of Safety

1 GENERAL

1.1 isoplus - The Company

1.1.1 Preface 6th Edition

The 5th edition of the **isoplus** design manual, established in April 2005, was an essential step in more than thirty-five years history of **isoplus** group of companies, in order to comply with the increased requirements of energy supply.

Within six years the total edition of approx. 10.000 pieces were sold out. Due to product developments, technical innovation and permanent change of market requirements, this new and completed 6th edition was necessary.

This 6th edition is also available under **www.isoplus.org** where it will be permanently updated and offered for download.

We want to thank everybody who helped us to create this 6th edition. All technical, informative and general important proposals for completion have been considered. The structure of chapters has been revised in general.

In this regard, we refer especially to chapter

> **>> 2 - Rigid Compound Systems**

and especially to **isoplus**-Conti-Pipe System. In this chapter you will find also the complete product range of **isoplus**-Double Pipe System, including the corresponding application and assembling instructions.

isoplus is a member of German Association of District Heating e. V., **AGFW** and of the German Federation of District Heating Pipes e. V., **BFW**.
All **isoplus** production plants are certified according to DIN EN **ISO 9001** and DIN EN **ISO 14001**, - Your **plus** of safety.

Besides of this design manual all **isoplus**-production plants, all sales partners and external sales people will be at your disposal. Furthermore you may contact directly our district heating engineers at the several design departments of our companies.

Your general management of the **isoplus** group of companies.

1.1.2 The Group

The **isoplus** group of companies consists of several legal independent production and distribution companies, who are acting all over Europe. However **isoplus** stands for more than just a name. It is the idea to offer a complete production range for our customers, that means delivery of the material incl. all required assembling and post insulation work, carried out by **isoplus** assembly-technicians.

This company-philosophy „all from one hand” in connection with **isoplus**-quality, innovative products and **isoplus** delivery-confidence leads the company **isoplus** through more than 35 years impressive success and to an important position on international markets.

As manufacturer of preinsulated pipe systems for the supply of energy and for all kind of industrial applications, we are producing in our factories in Europe with totally 1.200 employees, preinsulated pipes and fittings conventionally as well as continuously by using high technology equipment. Our additional regional offices will guarantee for an optimum of local service.

The **isoplus** group of companies is delivering approx. 3.000 km of pipes per year, world-wide, in dimensions of DN 20 up to DN 1000 mm. As a qualified group of companies, the products of our sub-suppliers as well as our finished products have to pass very strong quality control procedures by external and internal quality-engineers. Therefore our products correspond to the requirements of the European Standards as well as to all other valid technical regulations in all respects.

Preinsulated district heating pipelines with PEHD jacket pipe can be used for direct channel free buried-laying. By use of various fittings and compensating elements a perfect system comes into being which is flexible enough even in difficult conditions, i. e. in city-centres, unusual terrain or in case of subterranean passing of rivers. Traffic-interruptions can be reduced to a minimum in accordance with the construction companies, due to short assembly times.

The **isoplus**-simplex-pipe, with PEHD-jacket pipe or SPIRO-jacket pipe, has been practically proved during many years, not only by technical perfection, but mainly by economical aspects concerning purchase, assembling and maintenance.

Edition: 16.01.2012

1 GENERAL

1.1 isoplus - The Company

The most innovative and most economic variant of the preinsulated pipe-systems is the development of the **isoplus-double-pipe**. By use of a PEHD jacket pipe, essential savings can be reached concerning heat loss, constructing and assembling expenses, quantities of shrinkable couplers and expansion pads, and for leak detection.

The **isoplus-double-pipe**, energy saving marvel, unique in economy and ecology, produced in conventional and also by continuous production procedure.

All rigid simplex- or double-pipe-systems are additionally selfcontrolled by **IPS-Cu®** or **IPS-NiCr®** on every cm of the pipe-line lengths. The foamed in leak detecting control wires will indicate each moisture penetration and each wire breakage within the network.

Additionally to rigid-pipe-systems **isoplus** is producing flexible-pipe-systems as well, which are especially used for house connections. Coiled down, **isoplus-flexible-pipes** can by-pass obstacles without any problems. Carrier pipes made of steel, copper, PEX or PE are available.

For the production of **isoplus**-simplex, duplex- and flex-pipes, the excellent insulating PUR-rigid foam will be used. The absolute moisture protection due to the shock-resistant and break-proof PEHD-jacket guarantees a high degree of reliability for many years.

The different laying techniques for **isoplus** pipe systems like thermal pre-stressing, cold laying as well as tapping-branches reduce the laying costs considerably because natural compensation elements such as L-, Z- or U-bends are not necessary. The same applies for the underground working as only for couplers and expansion pads larger areas have to be provided.

Pipe line systems exposed to extremely high temperatures and pressures put high demands to material and manufacturing. The dimensioning of **isoplus-steel jacket-pipes** applies to the extreme conditions for the distribution of hot water or steam and thus guarantees a high degree of safety. The outside steel jacket pipe is a closed system, water-proof and gas-proof. A standard PE covering serves as corrosion protection. For heat insulation mineral or rock wool fibre shells are used.

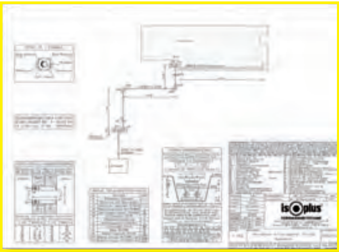
1 GENERAL

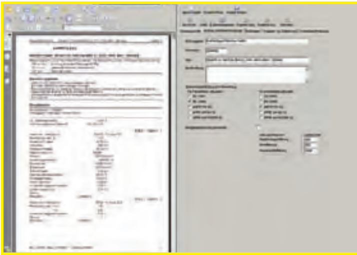
1.1 isoplus - The Company

All **isoplus**-products might be used for different applications such as heating, sanitary, steam, cooling pipes, oil, chemical and foodstuff industry etc. and temperatures at least according to EN 253. Perfect welding engineering within the steel and PE area guarantee solid products with the necessary operational reliability.

Individual design leads to optimised district heating networks and guarantees an economic and ecological solution for working and operation steps. Show us your problem, we will show you the solution.

The fabrication in our production plants as well as the quality assurance and the documentation applies to the European quality standard **DIN EN ISO 9001**. In addition to our products we offer a wide and complete range of services. A qualified consulting during all steps of your projects given by our certified chief engineers, mechanical engineers as well as by our regional sales engineers guarantee the perfect installation of **isoplus**-products.





In addition, our construction department guarantees the necessary calculations for pipe static which are documented with the delivery of the routing plan. Specifications and routing modifications are easily documented and thus assure in coordination with the fabrication smooth site works.

The international quality standard of the **isoplus** systems in combination with **isoplus** special products and the use of modern laying techniques results in economic district heating networks and helps to guarantee a trouble-free operation for many years.

The isoplus GROUP - YOUR PARTNER !

1 GENERAL

1.2 isoplus - Your Partner in Europe and Near East

1.2.1 Overview

Headoffice / Sales

GERMANY, Rosenheim

Production / Sales

GERMANY, Sondershausen
AUSTRIA, Hohenberg
HUNGARY, Budapest
CZECH REPUBLIC, Pardubice
ROMANIA, Oradea
SERBIA, Aleksinac
KUWAIT, Safat
ITALY, Villamarzana

Sales

GERMANY, Berlin
DENMARK, Middelfart
SLOVAKIA, Dunajská Streda
POLAND, Kattowitz
CROATIA, Zagreb
SERBIA, Belgrad
SWITZERLAND, Islikon
FRANCE, Grigny
NETHERLANDS, Breda

The **isoplus**-group is additionally represented in various countries.
A list of these countries and the corresponding **isoplus** branch offices you will see on following pages.

e-mail: **export@isoplus.de** or **info@isoplus.de**

1.2.2 Locations and Salespartners

isoplus Fernwärmetechnik
Vertriebsgesellschaft mbH
Aisinger Straße 12
83026 Rosenheim
GERMANY
Fon: +49 80 31 / 6 50 - 0
Fax: +49 80 31 / 6 50 - 110
e-mail: info@isoplus.de

isoplus Fernwärmetechnik
Vertriebsgesellschaft mbH
Beilsteiner Straße 118
12681 Berlin
GERMANY
Fon: +49 30 / 54 98 83 - 0
Fax: +49 30 / 54 98 83 - 33
e-mail: berlin@isoplus.de

isoplus Fernwärmetechnik
GmbH
Schachtstraße 28
99706 Sondershausen
GERMANY
Fon: +49 36 32 / 65 16 - 0
Fax: +49 36 32 / 65 16 - 99
e-mail: sondershausen@isoplus.de

isoplus Fernwärmetechnik
Ges. m. b. H.
Furthoferstraße 1a
3192 Hohenberg
AUSTRIA
Fon: +43 27 67 / 80 02 - 0
Fax: +43 27 67 / 80 02 - 80
e-mail: office@isoplus.at

isoplus Távhővezetékgyártó
Kft.
Kunigunda utca 45
1037 Budapest III.
HUNGARY
Fon: +36 1-250 / 44 40
Fax: +36 1-250 / 27 31
e-mail: isoplus@isoplus.hu

isoplus eop s.r.o.
Areál elektrárny
Opatovice nad Labem
532 13 Pardubice 2
CZECH REPUBLIC
Fon: +420 466 / 53 60 21
Fax: +420 466 / 84 36 19
e-mail: isoplus@isoplus-eop.cz

isoplus Romania S.R.L.
Conducte preizolate
Strada Uzinelor Nr. 3/H - 3/G
410605 Oradea-Județul Bihor
ROMANIA
Fon: +40 259 / 47 98 08
Fax: +40 259 / 44 65 88
e-mail: office@isoplus.ro

isoplus Fjernvarmeteknik A/S

Korsholm Alle 20
5500 Middelfart
DENMARK
Fon: +45 64 41 61 09
Fax: +45 64 41 61 59
e-mail: iso@isoplus.dk

isoplus polska Sp. z o.o.

ul. Zeliwna 43
40-559 Katowice
POLAND
Fon: +48 32 / 2 59 04 10
Fax: +48 32 / 2 59 04 11
e-mail: biuro@isoplus.pl

isoplus d.o.o.
Prodaja
Aleksandra Stamboliskog 3/b
11000 Belgrad
SERBIA
Fon: +381 11 2 66 13 24
Fax: +381 11 2 66 41 23
e-mail: isoplus@isoplus.co.rs

isoplus d.o.o.
Proizvodnja
Aleksinački rudnici bb.
18220 Aleksinac
SERBIA
Fon: +381 18 88 20 00
Fax: +381 18 88 20 01
e-mail: isoplus@isoplus.co.rs

isoplus slovakia spol. s.r.o.

Kraĉanská 40
92901 Dunajská Streda
SLOVAKIA
Fon: +421 3 15 51 - 61 72
Fax: +421 3 15 51 - 61 72
e-mail: isoplus.slovakia@stonline.sk

isoplus Zagreb d.o.o.
Predizolirane Cijevi
Vrlička 12
10000 Zagreb
CROATIA
Fon: +385 1 30 11 - 634
Fax: +385 1 30 11 - 630
e-mail: isoplus@isoplus.hr

isoplus (Schweiz) AG

Alte Landstraße 39
8546 Islikon
SWITZERLAND
Fon: +41 52 369 08 08
Fax: +41 52 369 08 09
e-mail: info@isoplus.ch

isoplus Middle East
Located at Kuwait Pipe Industries and
Oil Services Company (KPIOS),
Sulaibiya
Safat - 13035
KUWAIT
Fon: +965 66 54 08 64
e-mail: anton.tiefenthaler@isoplus.at
e-mail: office@isoplus.at

isoplus Mediterranean s.r.l.

Via Dell`Artigianato, 347
45030 Villamarzana (RO)
ITALY
Fon: +39 0425 17 18 000
Fax: +39 0425 17 18 001
e-mail: info@isoplus.it

isoplus Benelux B.V.

Van de Rejtstraat 3
4814 NE Breda
NETHERLANDS
Fon: +31 76 5 23 19 60
Fax: +31 76 5 23 19 69
e-mail: info@isoplus.nl

isoplus France SAS

19 Av de Chantelot
69520 Grigny
FRANCE
Fon: +33 4 37 60 09 93
Fax: +33 4 72 89 51 85
e-mail: contact@isoplus-france.com

The following countries are currently supported by **isoplus** (Edition 01/2012):

Country:	Support:
Austria	isoplus in Austria, Hohenberg
Belgium	isoplus in the Netherlands, Breda
Bosnia-Herzegovina	isoplus in Germany, Rosenheim
Brazil	isoplus in Austria, Hohenberg
Bulgaria	isoplus in Germany, Rosenheim
Croatia	isoplus in Croatia, Zagreb
Czech Republic	isoplus in Czech Republic, Pardubice
Denmark	isoplus in Denmark, Middelfart
Estonia	isoplus in Denmark, Middelfart
Finland	isoplus in Denmark, Middelfart
France	isoplus in France, Grigny
Germany	isoplus in Germany, Rosenheim
Great Britain	isoplus in Denmark, Middelfart
Greece	isoplus in Germany, Rosenheim
Hungary	isoplus in Hungary, Budapest
Iceland	isoplus in Denmark, Middelfart
Ireland	isoplus in Germany, Rosenheim
Italy	isoplus in Italy, Villamarzana
Kazakhstan	isoplus in Germany, Rosenheim
Latvia	isoplus in Germany, Rosenheim
Liechtenstein	isoplus in Switzerland, Islikon
Lithuania	isoplus in Poland, Kattowitz
Luxembourg	isoplus in Netherlands, Breda
Macedonia	isoplus in Germany, Rosenheim
Monaco	isoplus in France, Grigny
Netherlands	isoplus in the Netherlands, Breda
Norway	isoplus in Denmark, Middelfart
Poland	isoplus in Poland, Kattowitz
Portugal	isoplus in Germany, Rosenheim
Romania	isoplus in Romania, Oradea
Russia	isoplus in Germany, Rosenheim
San Marino	isoplus in France, Grigny
Sweden	isoplus in Denmark, Middelfart
Switzerland	isoplus in Switzerland, Islikon
Serbia	isoplus in Serbia, Belgrad
Slovakia	isoplus in Slovakia, Dunajská Streda
Slovenia	isoplus in Austria, Hohenberg
Spain	isoplus in Italy, Villamarzana
Ukraine	isoplus in Germany, Rosenheim
United Arab Emirates	isoplus in Austria, Hohenberg
Other international countries	isoplus in Germany, Rosenheim

1.3.1 Quality-Assurance, Service, Documentation

The total **isoplus**-group considers Quality Assurance as very important. A management system according to **DIN ISO 9001** is implemented in every **isoplus**-production plant, in order to assure continuously a Quality Assurance on the highest technical level. This Quality Management System includes all divisions like production and dispatch, design and project engineering, application as well as post insulation or assembly.

Condition for the realisation of this system within the **isoplus**-group is the systematically organisation of all procedures and their controlling day by day. All single divisions are spreading into each other and are in summary directly in charge of the general management. The general management will inspect periodically the effectiveness of the Quality-Assurance by internal reports, audits, technical and commercial documentation.

Production

The Quality Assurance, respectively Management-System according to DIN EN ISO 9001, implemented in all **isoplus**-production plants is the external acting frame of quality control. Furthermore even higher degree of safety are provided for all system-materials, in order to avoid any insufficiency or defective material caused by site conditions, from the very beginning.

The production of all fittings up to DN 300 mm in high quality is included therein, as well as the general use of steel-medium-pipes in seamless wall thickness up to DN 80 mm. That means that **isoplus** is not only producing according to the European standards EN 253 and EN 448 but will partly exceed it essentially.

Vendor Inspection

isoplus is checking all arriving materials very detailed according to EN 253, before they may be used for production. Small quantities will be analysed in the laboratory. Approved sub-suppliers have to be certified according to the guidelines of DIN EN ISO 9001 and they have to present all required, respectively necessary certificates (APZ).


ZERTIFIKAT

für das Managementsystem nach DIN EN ISO 9001:2008

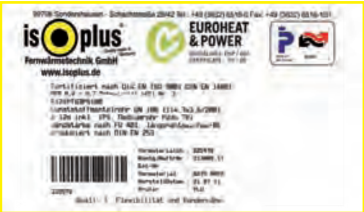
isoplus

Intermediate Inspection

Every collaborator of **isoplus** is obliged to check his work according to the valid instructions and within the sense of the company's quality politics, after the end of each working-step. Furthermore test and control procedures documented in the standards and guidelines will be carried out and documented by independent quality assurance authorities during the production procedure, as part of self-controlling.

Final Inspection

Before delivery all products have to pass a 100 % final inspection. The products will be marked optically by the corresponding collaborators, respectively by the QA engineers. Only products marked with an **isoplus**-QA-label may be dispatched.



Construction Work

As most important part of the QA-System the supervising at building site has to be considered with priority. This will be guaranteed by various local **isoplus** post-insulation centres. The quality securing measures of building site procedures are carried out directly by QA division of post insulation.

The responsible and highly educated **isoplus** engineers, technicians, supervisors and technicians are certified by AGFW and BFW. Furthermore the investigation of excavation work and pipe laying work, controlling of the conditions for sealing works before starting of works will be part of the activities of QA-assembling, as well as checking of weather conditions.

The controlling of **isoplus** assemblers and an individual documentation concerning the qualification of the corresponding assembler, as well as an optical or destroying test procedure of the executed work will finish various QA-assembling procedures. In order to identify the workers later on, each connection coupler will be marked durable by a special code number. Additionally investigation of the connection couplers may be carried out by members of external Institutes.

1.3 isoplus - Your Plus of Safety

The complete Quality Assurance from entry of material until delivery of finished product, from pipe production to post insulation will be completely guaranteed by **isoplus**-service applications. Our design engineers will prepare your project technically and economically. Very important is to reach a most possible conformity between the schedule established for the building site and the final requirements of the project owner. Therefore **isoplus** offers the following service:

Design

- Detailed first information for special project requirements
- Investigation of the trench in order to optimise pipe guidance and material
- Creating tenders, material lists and design for offers
- Using of new pipe laying technologies and materials in order to improve economy
- Investigation of the provided materials and preparing of economical alternatives like **isoplus**-flexible-pipes or **isoplus**-double-pipes

Project Work

- Investigation concerning feasibility of requirements
- Establishing of trench design and creating of the required material-list
- Comparison of design-respectively requirements, with building site and production
- Checking of pipe static and approval of pipe laying according to the standards
- Permanent correspondence with owner of the project, consultants and constructing companies

Execution

- Participation at project-discussions after request
- Co-ordinated and short delivery time in order to reach an optimal project realisation
- Building site introduction with **isoplus** collaborators in charge
- Immediate check and approval in case of modifications including new specification
- Short time of production for eventually additional required fittings and accessories

Assembling

- Post insulation work of all connection couplers
- Assembling of expansion pads at all static required areas according to drawings
- Local Polyethylene welding for special jacket pipe parts
- Installation of **IPS**-leak detecting for an optimum of safety
- Self control of all assemblers by QA department

Acceptance

- Record of tightness for connection couplers
- Checking of all expansion pads and PE-welding seams
- Checking of **IPS**-leak-detecting and establishing of measurement record
- Acceptance with project owner or/and purchaser, locally after agreement
- Guaranty for all **isoplus**-products and design works

isoplus will establish on request a technical system-documentation for all delivered materials, as well as corresponding design for pipe trenches and control wires, which may be included into the total project-documentation. Such documentation documents continuous Quality Assurance of the **isoplus**-group and secures safety of the total district heating network, without any complaints for many decades.

The documentation will be delivered in binders. Before the documentation will be established the required extension should be known, because later on it will be not possible to integrate certain chapters. In detail the **isoplus**-documentation includes the following chapters, which may be completed or cancelled as requested case by case.

- General system-, material and operating description of **isoplus**-products
- Technical data and dimensions of materials and products
- Instructions for assembling, storage, construction work and pipe laying, as well as for post-insulation work of **isoplus**-components
- Total required material certificates, works and quality certificates
- **IPS-Cu®** or **IPS-NiCr®** alarm system and operation instructions, assembling instructions, start of operation and acceptance-record
- **IPS**-measurement records according to actual data, eventually for several sections, determined according to special measurement procedures
- Design of alarm wires of alarm system **IPS-Cu®** or **IPS-NiCr®** showing all installed system-components as black/white copy or in original (by plotter) or as PLT-file
- Connection couplers records of all post insulation works carried out by **isoplus**-collaborators, certified by AGFW/BFW
- Actual design of **isoplus** pipe-trench after pipe-laying work will be finished, based on a detailed measurement design which should be provided, **no isometrics**! With all required pipe-static details for buried preinsulated jacket pipes compound systems as black/white copy or original (by plotter) or as PLT-file
- Pipe-static calculations as PC-print according to given parameters as well as separated to the pipe-trench-marks, based on pipe-static-guidelines for buried preinsulated jacket pipes

In case that several documentation will be required after a project will be finished, we will work out our performance schedule after request, as this is not included in our original offer. Also parts of technical documentation including a. m. details can be established later on after request.

1.3.2 Who is doing what?

Nr.	Project-Schedule	Project-Owner Purchase	Engineering	Works Construction	Pipe-laying	isoplus
1	Construction design, start of design procedure	X				
2	Customer, respectively user acquisition	X				
3	Calculation of required energy for users		X			
4	Hydraulic network-calculation resp. dimensioning		X			
5	First design		X			
6	Getting approvals from local authorities		X			
7	Measurement of designed trenches in lengths and heights		X			
8	Measurement of existing distributing lines		X			
9	Work out of trench design in lengths and heights		X			
10	Work out of material-list for the project		X			
11	Preparing of tender documents		X			
12	Dispatch of performance-description		X			
13	Price calculation of offer and placing of offer in time			X	X	X
14	Work out of project- time schedule	X	X			
15	Placing of order		X			
16	Visit of building site before start of works	X	X	X	X	X
17	Eventually second common measurement of trench after agreement				X	X
18	Work out of pipe-static calculation of buried pipes					X
19	Demonstration of pipe-static by presenting design for expansion pads					X
20	Material specification of **isoplus**-pipes, fittings and accessories					X
21	Equipment for building site			X	X	
22	Marking of foreign pipelines along the new trench		X	X	X	
23	Excavation of the pipeline-trench in consideration of standards and UVV			X		
24	Wall penetrations at the houses of the users			X		
25	Delivery of **isoplus** material					X
26	Unloading and weather proof storage of **isoplus** material				X	
27	Draining of pipe trench and keeping it free until refilling			X		
28	Building site instruction by **isoplus** representative, after request					X
29	Preparation of trench-bottom, placing of PU-bars, wooden bars or sand sacks			X		
30	Laying of **isoplus** pipes according to trench design in lengths and heights				X	
31	Information to **isoplus** in case of any modifications and wait for static acceptance		X		X	X
32	Visit of building site, discussion in order to find a solution in case of modification		X		X	X
33	Placing and connection of carrier pipes and fittings according to standard				X	
34	If necessary concrete fix-points and wait for setting			X		
35	Controlling of carrier pipe connections according to tender and standard				X	
36	Post insulation works at the jacket pipes connections					X
37	Fixing of required expansion pads in accordance to design					X
38	Eventual thermal pre-stressing (provide sand bridge)			X	X	
39	Insert wall sealing into wall penetration and concrete			X	X	
40	Acceptance of trench and approval for refilling by head of construction company	X	X			
41	Sand filling up to 100 mm above pipe-top and compressing by hand			X		
42	Filling and compressing of trench from top of sand bed			X		
43	Heat shrinking of end caps at house-connections					X
44	Installation of alarm wire-components					X
45	Removing of remaining material and leaving of building site			X	X	X
46	Handing-over of documentation and putting into operation of the line	X	X	X	X	X
47	Inspection by authorities	X	X			

This table should be considered as an example for a possible project-procedure and can be different, respectively completed, depending from the corresponding country.

2 RIGID COMPOUND SYSTEMS

isoplus®

2

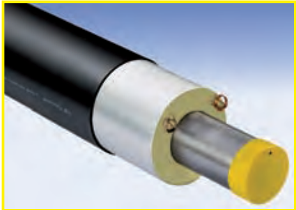
2.1 General

2.2 isoplus - Single Pipe

2.3 isoplus - Double Pipe

2.1.1 Principle

Single Pipe



isopipe®-single is mainly used as energy pipe for effective lasting transportation of district heating and district cooling. Furthermore it will be used for various applications in the production technology from food stuff industry up to the oil-industry.

The **isopipe®**-single is produced in classical and continuous method (with diffusion barrier layer).

High quality PUR-hard foam insulation - 100% free of freon, with Cyclopentan as foaming agent, processed on modern machinery equipment - guarantees a permanent excellent insulation characteristic during the duration of application. The outside PEHD-jacket pipe is covering the insulated-system, shock resistant, break-proof and water tight. All factory produced pipes and fittings can be used easily at site as a building brick system.

Data (depending on manufacturing and nominal diameter):

- DN 20 (¾“) up to DN 1000 (40“) in classical discontinuous production
- DN 25 (1") up to DN 200 (8") in continuous production
- Thermal conductivity λ_{50} Disconti = 0,027 W/(m•K) at a PUR-Density of 60 kg/m^3
- Thermal conductivity λ_{50} Conti = 0,024 W/(m•K) at a PUR-Density of 60 kg/m^3
- Standard insulation, 1x or 2x reinforced
- Operating temperature at least according to EN 253 and 25 bar pressure
- Up to 85 °C static calculation temperature infinite in length is possible
- Carrier pipe P235TR1/TR2/GH according to EN 253, DIN EN 10217-1 or -2, DIN EN 10216-2
- Available as 6, 12 or 16 m pipe bar
- **IPS-Cu®**, **IPS-NiCr®** leak detection, others available

Dimensions see **chapter 2.2.2, 2.2.3**
Technical operation data see **chapter 2.1.3, 2.2.5, 2.2.6**
Material specifications jacket pipe see **chapter 2.1.4**
Material specifications carrier pipe see **chapter 2.2.1**
Material specifications PUR hard foam see **chapter 7.1.7**

Edition: 16.01.2012

Double Pipe

isopipe®-double is an effective supplement to the single pipe and a perfect solution for the transportation of district heating and district cooling with optimized **eco**logical and **eco**nomical customer efficiency.

The **isopipe®**-double is produced in classical and continuous method (with diffusion barrier layer).

With the construction-principle of the double pipe an optimum of insulation will be reached as **one** thermal-block, with the advantage that the double pipe will reach the same insulation as a 1x reinforced single pipe. Space- and cost saving by reduced trenches will additionally lower the construction expenses essentially.

Data (depending on manufacturing and nominal diameter):

- DN 20 (¾“) up to DN 200 (8“) in classical discontinuous production
- DN 25 (1") bis DN 100 (4") in continuous production
- Thermal conductivity λ_{50} Disconti = 0,027 W/(m•K) at a PUR-Density of 60 kg/m^3
- Thermal conductivity λ_{50} Conti = 0,024 W/(m•K) at a PUR-Density of 60 kg/m^3
- Standard insulation, 1x reinforced
- Up to 90 K Spread [Δ_T] between flow- and return-line
- Up to 70 °C static average temperature infinite in length is possible
- Carrier pipe P235TR1/TR2/GH according to EN 253, DIN EN 10217-1 or -2
- Available as 6, 12 or 16 m pipe bar
- **IPS-Cu®** or **IPS-NiCr®** as leak detection

Dimensions see **chapter 2.3.2, 2.3.3**
Technical operation data see **chapter 2.1.3, 2.3.5, 2.3.6**
Material specifications jacket pipe see **chapter 2.1.4**
Material specifications carrier pipe see **chapter 2.3.1**
Material specifications PUR hard foam see **chapter 7.1.7**

Edition: 16.01.2012

2.1.2 Production Procedure / Heat-Insulation / Lambda-Value PUR

Production Procedure - Disconti

During the discontinuous production technique, the carrier pipe is prepared with spacers to which the leak detection wires are attached. The pre-assembled pipe is subsequently inserted into the casing pipe and the annular gap at the pipe ends is closed with foam covers. Afterwards, the foaming table must be set up at exactly the predetermined angle and the polyurethane foam must be sprayed into the lowest end of the pipe with an electronically controlled mixing head .

Following the development of preinsulated pipes, this procedure has become established as the most common production process and is listed as a technical standard in all the applicable specifications and guidelines. In principle, this is the only method that may be used in the production of moulded parts such as elbows, branches, etc.

Production Procedure - Conti

During the first step of the production line, the steel pipe rods will be mechanically coupled together. This string of pipes will then receive the leak detection wires, the polyurethane insulation layer, the diffusion barrier film, and the extruded polyethylene casing pipe in a continuous and CNC-controlled process.

The barrier film made of aluminum is coated with polyurethane treated with Corona (an electrochemical procedure for plastic surface modification) on both sides and prevents the diffusion of the polyurethane cell gases through the polyethylene casing pipe. The Corona treatment ensures that the minimum shear strength required in accordance with EN 253 is exceeded and that the basic or composite principle of the frictional construction method for pre-insulated pipes remains intact.

isoplus Conti-Pipes are guiding concerning their mechanical and thermal properties. The innovative production procedure guarantees a constant foam density and thickness of the PEHD-jacket pipe over the total pipe length. This will result in optimal opportunities to keep the energy efficiency of a district heating network high, respectively the heat-loss and CO_2 emission low. The positive effects for the environment as well as for the expenses for network losses during the total lifetime are considerable.

The optimal quality of the PUR-foam will result in the best possible heat insulation of non-aged pipes. The proportion of the cell gases at λ total value is approx. 60 % and is therefore the determining variable. In the case of traditionally manufactured pipes a partial exchange of the cell gases through air occurs during operation, especially with constant use temperatures ≥ 130 °C. Cyclopentan will mainly remain in the foam cells, due to it´s molecular structure. However the λ-value will get more worse because of the exchange of the CO_2 ,the so called aging procedure. In order to avoid this, a diffusion barrier-foil will be installed between PUR-foam and PEHD jacket pipe. Because of this the favorable insulation properties of the pipes will remain nearly constant during the total lifetime. This is an especially important point for smaller to middle pipe dimensions in order to keep the energy efficiency of a pipe grid at its highest level.

Conti-pipes meet all requirements of EN 253 as well as AGFW –paper FW 401- certified by EuHP. When laying pipes, work must be performed with the utmost care (only tested and certified welding personnel) while implementing the carrier pipe welds. The outgoing medium can expand faster depending on the time factor and scope of any carrier pipe leakage occurring. Because of this, it cannot be ruled out that the damage profile is more extensive than for classically manufactured pipes. Naturally, attention must also be paid to a standardized pressure test and speedy start-up of the **IPS-Cu®** or **IPS-NiCr®** leak detection.

Heat-Insulation

isoplus - Compound Systems are insulated with Polyurethane-hard-foam (PUR) in especially therefore designed prescription tested according to EN 253. Polyurethane-hard foam consists of two components Polyol (component A, bright) and Isocyanat (component B, dark). Foamed continuously in the production street classical and continuous (with diffusion barrier layer) around the carrier pipe, a high quality insulation will be reached, with excellent thermal conductivity λ_{50} = 0,024 (Conti) to max. 0,027 W/(m•K) (Disconti), at low specific weight, due to an exothermical chemical reaction.

isoplus is using generally PUR-foam which is 100 % free of chlorofluorocarbon (CFC). Cyclopentan is exclusively used as foaming agent. That means lowest possible ODP- and GWP-value at extremest heat insulation quality. ODP (ozone-reducing potential) = 0, GWP (greenhouse potential) = < 0,001 !

The EN 253 standard has been modified concerning the foam-density of preinsulated pipes. Now the density of 60 kg/m^3 is no longer strictly required. The **isoplus** Conti-Pipe-Technology offers the possibility to adjust the foam density exact and constant over the total pipe length. By reducing the foam density below 60 kg/m^3 the lambda-value (λ) can be improved. However it has to be exactly considered, that the required shearing and pressure resistance values, as well as the expected lifetime will be kept, in case of preinsulated pipes with a PUR-foam density below 60 kg/m^3.

The thermal conductivity is only marginally affected by reducing the density. However, the strength of the composite system and thus the operating life and durability of the district heating system is significantly reduced.

isoplus is convinced that it cannot be in the interest of the power utility companies or in the overall national economic interest to pay for minimal gains in thermal insulation with a reduction in the shear and compressive strength of the bonded system.

Lambda-Value PUR hard foam

The thermal conductivity (λ) of the polyurethane foam is generally to be determined in conformance with DIN EN ISO 8497 at 50 °C (λ_{50}) average temperature. Compliance with all test parameters is ensured by awarding the audit to independent external laboratories (e.g. FFI, AMPA, etc.).

In addition to these external tests, our in-house testing laboratories are constantly carrying out further investigations into the characteristics required of the polyurethane foam. The significance of the supplementary internal tests increases with repetition, using an identical scope of testing of the same product group for the same issue and submitted for the same QM audit.

Thanks to the on-going expansion of the laboratory, **isoplus** is creating the possibility of significantly extending the frequency of inspection. Amongst other things, this helps us monitoring the continuous and batch production processes in a more consistent manner and improve them still further. This ensures that our stated lambda values are based on a large number of test results, which are then published as an average, using statistical methods.

External testing continues, serving as verification of our own results. This methodology ensures that our customers receive a product that meets the declared thermal conductivity (λ_{50}).

Edition: 16.01.2012

2.1.3 Capacity / Dimension / Pressure Loss

In essence, the heat that is to be transmitted [kW] and the desired temperature difference [Δ_T] between the flow line and return line determines the pipe size. The sum of all the resistance factors [ζ] of the fittings, such as branches and elbows, should be considered. For all fittings and pipes, the pressure loss is proportional to the square of the flow velocity [w]. The entire district heating system is optimised when a specific pressure drop [Δp/l] of about 100 Pa/m, determined by cost calculations, can be maintained. Depending on the project, reserves for future users must be included here as well.

The sum [Δp] of the total friction losses within the pipe network and the static pressure loss through the geodetic height differences [H] are decisive in pump design. The calculation of friction losses is made with the pipe friction coefficient [λ], and/or the roughness coefficient [*Re*] or/and the roughness number [k] of the pipe wall.

$$\Delta p = \lambda \bullet \frac{L}{d_i} \bullet \frac{w^2 \bullet \rho}{2} + H \bullet \rho \left[\text{Pa}\right] \quad \text{in which } \rho = \frac{\gamma}{g}\left[\gamma \text{ in N/m}^3\right] \quad \Big| \quad \text{Re} = \frac{w \bullet d_i}{\nu}\left[-\right]$$

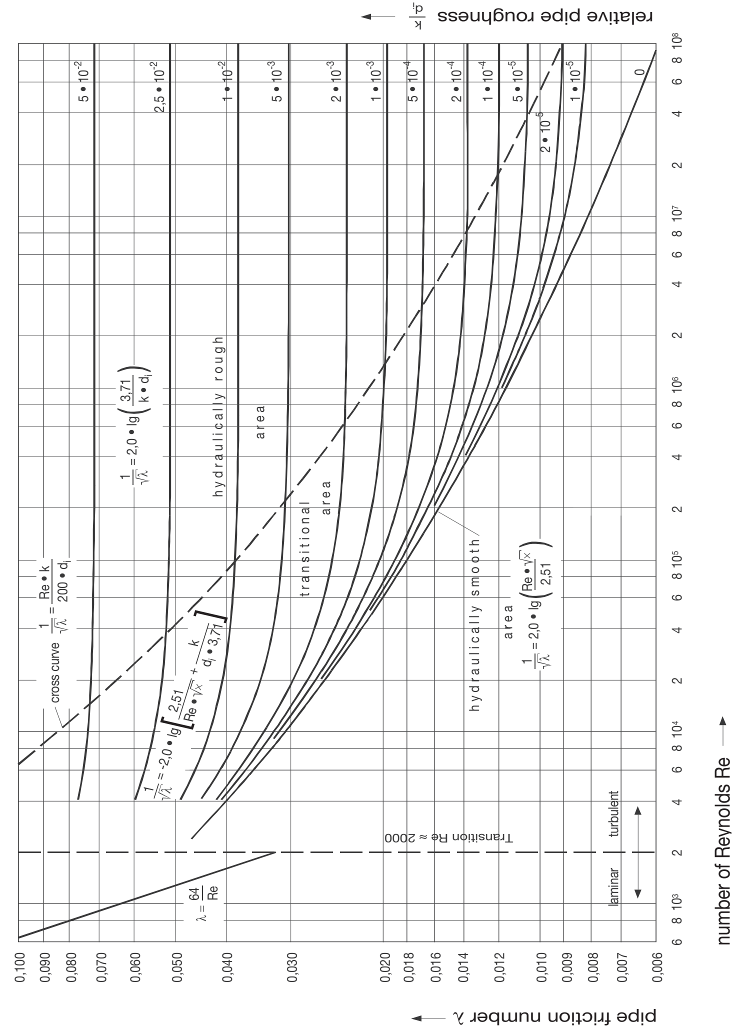
In calculating the effective pipe length [L], a specific pressure drop [Δp/l] of 60-80 Pa/m is to be expected as a result of increased losses due to the number of fittings. Lower values must be used if there are more fittings. The required flow or mass flow [Φ] follows from the calculated heat or current [$\dot{m}$] demand.

$$\Phi = \dot{m} \bullet c \bullet \left(\vartheta_{VL} - \vartheta_{RL}\right)\left[\text{kW}\right] \quad \Big| \quad \dot{m} = \frac{\Phi}{c \bullet \left(\vartheta_{VL} - \vartheta_{RL}\right)}\left[\text{t/h}\right]$$

w = Velocity of flow [m/s]
L = Effective pipe length [m]
ϑ_{VL} = Flow line temperature [°C]
d_i = Inside diameter of pipe [m]
ϑ_{RL} = Return line temperature [°C]
H = Geodetic height difference [m]
ρ = Density of the medium [kg/m³]
γ = Specific gravity of medium [N/m³]
g = Acceleration due to gravity = 9,81 m/s²
v = Kinematic viscosity of the medium [m²/s]
C = Specific heat capacity of the medium [Wh/(kg•K)]

For an approximate calculation of the pipe diameter, the **following tables** may be used to calculate the dimensions. No warranty claims will be accepted. The precise determination of the nominal sizes is usually made by the engineering or design office responsible for the plumbing and heating in the project or directly by the owner, operator or power utility company.

Diagram of Moody: friction coefficient for pipeline flows as Function by number of Reynolds Re and relative pipe roughness $\frac{k}{d_i}$



Edition: 16.01.2012

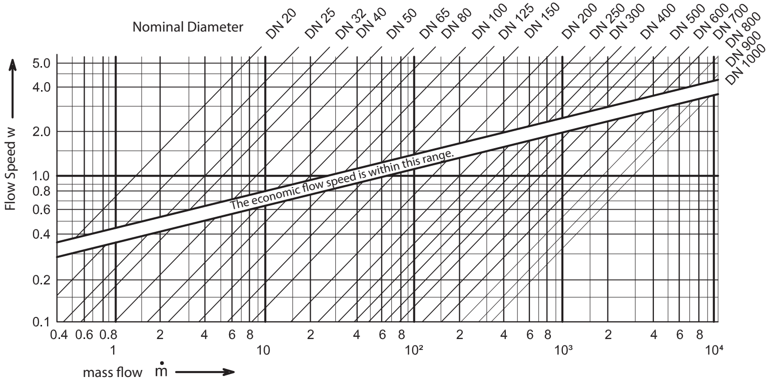
Permissible mass flows with a pressure drop of 60 -8 0 Pa/m pipe length

Dimension in	Wall-thickness **s**	Inside-Ø **d_i**	mass flow $\dot{m}$ in t/h		Dimension in	Wall-thickness **s**	Inside-Ø **d_i**	mass flow $\dot{m}$ in t/h	
DN	in mm	in mm	from	to	**DN**	in mm	in mm	from	to
20	2,6	21,7	0,4	0,5	**250**	5,0	263,0	300	348
25	3,2	27,3	0,8	1,0	**300**	5,6	312,7	472	547
32	3,2	36,0	1,7	2,0	**350**	5,6	344,4	610	7,05
40	3,2	41,9	2,5	3,0	**400**	6,3	393,8	862	1.000
50	3,2	53,9	4,7	5,5	**450**	6,3	444,6	1.180	1.370
65	3,2	69,7	9,3	11,0	**500**	6,3	495,4	1.570	1.820
80	3,2	82,5	14,5	16,5	**600**	7,1	595,8	2.520	2.920
100	3,6	107,1	28,5	33,0	**700**	8,0	695,0	3.770	4.370
125	3,6	132,5	50,0	58,0	**800**	8,8	795,4	5.390	6.240
150	4,0	160,3	82,0	95,0	**900**	10,0	894,0	7.400	9.500
200	4,5	210,1	167,0	193,0	**1000**	11,0	994,0	from 9.200	

The mass flow specifications take into account the different numbers of fittings and fixtures, with the lower values being associated with a large proportion of such parts. The flow speed [w] is derived using the table.

$$w = \frac{\dot{m}}{\left(\frac{d_i}{2}\right)^2 \cdot \pi \cdot 3600} \; [\mathrm{m/s}]$$

The relationship between the mass flow rate and the flow speed can be taken directly from the following chart.



2.1.4 Jacket Pipe

PEHD

Polyethylene High Density (PEHD) is a seamless extruded highly shock-resistant and break-proof, viscoplastic hard-polyethylene up to -50 °C. General Quality requirements acc. to DIN 8075. Corona treated for optimal compound with PUR-foam, acc. to EN 253.

Dimensions respectively wall thickness at least acc. to EN 253. Test procedure of melt flow index (MFI-Group) acc. to DIN 53 735 resp. ISO 1133. PEHD is a proved plastic-material, which is successfully used since many years for PE-jacket-pipes-systems (PJP).

Because of the resistance against nearly all chemical reactions in the soil, PEHD is excellent suitable as jacket-pipe for direct underground installation. PEHD is mentioned as the only material for jacket-pipes as PE-jacket-pipe-compound-system in all national and international standards respectively guidelines. PEHD is highly resistant against weather conditions and ultraviolet rays. isoplus only uses polyethylene materials that have been treated with light stabilisers. As required by EN 253, the polyethylene pipes are very effectively protected against ultraviolet rays by adding 2.5 ± 0.5 mass % of a special, very fine carbon black.

Due to the excellent welding characteristics of PEHD a maximum of safety and quality will be reached at the welding seams of the fittings. In case of elbow-segments these will be butt-welded by use of a butt-welding-machine. The fillet-welds of the branch-connection-piece will be carried out by use of an extruder-welding-machine.

	Technical characteristics PE 80 at 20° C	Standard	Unit	Value
specific	Raw density ρ	DIN 8074 / DIN EN ISO 1183	kg/dm^3	0,95
	Wall-Roughness k	Colebrook & White	mm	0,007
	Melt-Index, MFR-Code T	DIN EN ISO 1133	g/10 min	ca. 0,45
	Melt-Index, MFR-Code V	DIN EN ISO 1133	g/10 min	ca. 10
	MFI-Group	DIN EN ISO 1133	---	T 005
	Material Class / Behaviour in case of fire, normal flamm.	DIN 4102	---	B 2
mechanical	Yield stress (Tensile Strength) R_m	DIN EN ISO 527	N/mm^2	23
	Yield expansion	EN 253 / DIN EN ISO 527	%	10
	Elongation at tear	DIN EN ISO 527	%	> 600
	Modulus of elasticity E (Tensile test)	DIN EN ISO 527 / 178	N/mm^2	1000
	Thrust modulation	DIN EN ISO 6721 / ISO R 537	N/mm^2	500 - 600
	Ball-pressure-hardness	DIN EN ISO 2039	N/mm^2	42
thermal	Crystallite-melt-temperature	DIN EN ISO 3146	°C	ca. 130
	Vicat-distortion temperature, VST-B/50	DIN EN ISO 306	°C	ca. 72
	Stability at 200° C	EN 253	min	> 20
	Thermal conductivity λ	DIN EN 12667	W/(m•K)	0,40
	Specific thermal capacity c	DIN 4108 / IEC 1006	KJ(kg•K)	1,9
	Longitudinal expansion coefficient α	DIN 53752	K^{-1}	$1,8 \cdot 10^{-4}$
electrical	Specific volume resistance	DIN/IEC 60093	$\Omega \cdot cm$	$> 10^{16}$
	Disruptive strength	DIN/IEC 60243	kV/mm	75
	Surface resistance	DIN/IEC 60093	Ω	$> 10^{14}$

Dimensions see **chapter 2.2.2 resp. 2.3.2**

SPIRO

This casing pipe is made of a galvanized steel spiral-seam pipe acc. to DIN EN 12237 with external seams and is therefore only suitable for overhead pipework inside or outside buildings. In contrast to conventionally insulated overhead pipework, batch-produced SPIROFALZ casing pipe offers significant benefits.

The insulation thickness can be made significantly thinner due to the low thermal conductivity of the rigid polyurethane foam used in **isoplus** (λ_{50} = 0,027 W/(m•K)). This results in considerable savings in supporting structures, because the outer diameter of the pipe is reduced as well as the weight.

According to DIN 4102, the sheet-metal jacket is rated as A1 (not flammable), and the SPIROFALZ - casing pipe classified as material class B2 (flammable). Compared to the standard insulation thicknesses, differences arise when the pipes have to be insulated according to the German federal Energy Saving Regulations (EnEV). According to § 1, the EnEV only applies to service pipework within buildings and not for underground structures.

Dimensions Steel-Pipe			Delivery Length	Jacket Pipe outside diameter D_a in mm				Weight G in kg/m		
Nominal Diameter / Dimension in		Outside-Ø d_a in mm	L in m	Insulation Class				Insulation Class		
DN	**Inch**			**Standard**	**1x reinf.**	*2x reinf. **	**EnEV**	**Standard**	**1x reinf.**	*2x reinf. **
20	¾“	26,9	6	**90**	110	*125*	**90**	3,27	3,79	*4,20*
25	1"	33,7	6	**90**	110	*125*	**90**	4,10	4,61	*5,03*
32	1¼"	42,4	6	**110**	125	*140*	**110**	5,26	5,68	*6,12*
40	1½"	48,3	6	**110**	125	*140*	**110**	5,70	6,11	*6,55*
50	2"	60,3	6	125	**140**	*160*	**140**	6,99	7,43	*8,05*
65	2½"	76,1	6	140	160	***180***	**180**	8,56	9,18	*9,85*
80	3"	88,9	6	160	180	***200***	**200**	10,07	10,74	*11,45*
100	4"	114,3	6	200	225	***250***	**250**	14,23	15,18	*16,20*
125	5"	139,7	6	225	250	***280***	**280**	17,08	18,10	*19,42*
150	6"	168,3	6	250	280	***315***	**315**	21,74	23,06	*26,25*
200	8"	219,1	6	315	355	***400***	**400**	32,78	35,03	*37,78*
250	10"	273,0	6	400	**450**	*500*	**450**	45,55	48,87	*52,45*
300	12"	323,9	6	450	**500**	*560*	**500**	58,11	61,70	*66,37*
350	14"	355,6	6	**500**	*560*	*630*	**500**	64,89	69,56	*78,58*
400	16"	406,4	6	**560**	*630*	-	**560**	81,26	90,28	-
450	18"	457,0	6	**630**	-	-	**630**	95,76	-	-

ATTENTION: Italicised mentioned jacket-pipe dimensions (*) are special productions. Please check availability in case of requirement. All weights given are for steel wall thicknesses of welded pipe according to **isoplus**, material density [ρ] P235 = Ø 7,85 kg/dm³, PUR-Foam = Ø 0,07 kg/dm³, SPIRO = Ø 7,85 kg/dm³ and without water.

Edition: 16.01.2012

Heat loss comparison overhead pipework

For overhead pipework other heat loss factors apply as shown in **chapter 2.2.5** for preinsulated pipes laid in the earth. To achieve the required insulation values or thermal transmittance or U-values (k-value) in compliance with **EnEV**, the equivalent insulation thicknesses are calculated and determined for **isoplus** pipes. According to **EnEV**, the inner diameter of the pipe is the decisive factor.

Dimensions carrier pipe		EnEV λ_{50} insulation = 0,0370 W/(m•K)			**isoplus** SPIRO - Jacket Pipe λ_{50} PUR-insulation = 0,027 W/(m•K)					
Diameter in **DN**	Inside-Ø d_i in mm	insulation-layer s_D in mm	Outside-Ø D_a in mm	u-Value u_{FL} in W/(m•K)	Jacket-Pipe-Outside-diameter D_a in mm			Thermal Transm. Coefficient u_{FL} in W/(m•K)		
					Standard	**1x reinf.**	*2x reinf. **	**Standard**	**1x reinf.**	*2x reinf. **
20	21,7	20	67	0,2460	**90**	110	*125*	0,1285	0,1118	0,1033
25	27,3	30	94	0,2226	**90**	110	*125*	0,1550	0,1313	0,1197
32	36,0	36	115	0,2295	**110**	125	*140*	0,1597	0,1428	0,1306
40	41,9	42	133	0,2265	**110**	125	*140*	0,1820	0,1604	0,1452
50	53,9	54	169	0,2233	125	**140**	*160*	0,2030	0,1792	0,1575
65	69,7	70	217	0,2201	140	160	***180***	0,2376	0,2009	0,1768
80	82,5	83	255	0,2192	160	180	***200***	0,2462	0,2109	0,1870
100	107,1	107	329	0,2190	200	225	***250***	0,2587	0,2201	0,1942
125	132,5	100	340	0,2602	225	250	***280***	0,2976	0,2522	0,2166
150	160,3	100	369	0,2947	250	280	***315***	0,3487	0,2842	0,2388
200	210,1	100	420	0,3555	315	355	***400***	0,3798	0,3012	0,2496
250	263,0	100	473	0,4208	400	**450**	*500*	0,3691	0,2953	0,2505
300	312,7	100	524	0,4807	450	**500**	*560*	0,4204	0,3351	0,2750
350	344,4	100	556	0,5173	**500**	*560*	*630*	0,4108	0,3241	0,2660
400	393,8	100	607	0,5772	**560**	*630*	-	0,4351	0,3365	-
450	444,6	100	658	0,6360	**630**	-	-	0,4390	-	-

Where heat is conducted through preinsulated pipes, the heat flows through different heat-conducting materials: the carrier pipe, the insulation and the casing pipe. Each of these compounds has its own individual thermal conductivity [λ], depending on its chemical and physical properties. In compliance with applicable standards and guidelines, this calculation is to be carried out using a mean annual temperature [T_M] between the medium and ambient temperature of T_M = 50 K.

A mean heat transfer coefficient [α] of 25 W/(m²•K) is assumed in accordance with VDI Guideline 2055. For the determination of thermal transmittance [u_{FL}], the following corresponding values of thermal conductivity [λ] at T_M = 50 K were used:

⇒	carrier pipe P235	λ_{ST}	=	54,5000 W/(m•K)
⇒	insulation acc. EnEV [(1)]	$\lambda_{DÄ}$	=	0,0370 W/(m•K)
⇒	PUR-insulation acc. **isoplus**	λ_{PUR}	=	0,0270 W/(m•K)
⇒	SPIROFALZ jacket pipe	λ_{ST}	=	54,5000 W/(m•K)

[(1)] The thermal conductivity given by **EnEV**, $\lambda_{DÄ}$ = 0,035 W/(m•K), refers to a mean temperature of T_M = 20 K. At T_M = 50 K, a suitable insulating material such as mineral wool increases $\lambda_{DÄ}$ to 0,037 W/(m•K). In other words λ_{PUR} decreases at T_M = 20 K to 0,0225 W/(m•K).

Edition: 16.01.2012

2.2.1 Carrier Pipe / Connection Technology / Operating Conditions

Carrier pipe, welded

Welded, circular, unalloyed and calmed down steel, description and technical conditions acc. to EN 253, EN 10217-1 and -2.

Materials P235GH (1.0345), P235TR1 (1.0254), P235TR2 (1.0255). All pipes acc. to EN 10204 - 3.1 with acceptance certificate (APZ) approved. Starting from wall thickness > 3,0 mm with welding-seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1.

Carrier pipe, seamless

Seamless, circular, unalloyed and calmed down steel, description and technical conditions acc. to EN 253, EN 10216-2.

Materials P235GH (1.0345), with approval certificate (APZ) acc. to EN 10204 - 3.1. Starting from wall thickness > 3,0 mm with welding-seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1.

ATTENTION: Seamless carrier pipes only available in traditional production. In continuous production carrier pipes are exclusively welded !

Connection Technology

The joints between the steel pipes can be made using the following methods according to DIN ISO 857-1: manual arc welding, gas welding with oxygen-acetylene flame, tungsten inert gas (TIG) or a combination of processes. The testing and evaluation of the quality of the weld is according to AGFW Worksheet FW 446.

Operating Conditions

Maximum operating temperature T_{max} :	min. acct. to EN 253
Maximum operating pressure p_B :	25 bar
Maximum permissible axial-tension σ_{max} :	190 N/mm²
Leak detecting:	**IPS-Cu®**, **IPS-NiCr®** and others, at continuous production only **IPS-Cu®**
Possible liquids: Heating water as well as other material resistant liquids	

Technical Data P235TR1/TR2/GH at 20° C					
Property	**Unit**	**Value**	**Property**	**Unit**	**Value**
Volume weight p	kg/dm³	7,85	Elastic modulus *E*	N/mm²	211.800
Tensile stress R_m	N/mm²	360 - 500	Thermal conductivity λ	W/(m•K)	55,2
Yield stress R_e	N/mm²	235	Specific heat capacity c_m	kJ/(kg•K)	0,46
Wall roughness *k*	mm	0,02	Thermal expansion coeff. α	K^{-1}	$11,3 \cdot 10^{-6}$

Carrier pipe wall thickness see **chapter 2.2.2** resp. **chapter 2.2.3**

Edition: 16.01.2012

2.2.2 Dimensions resp. Types — straight pipe bar - Disconti

Discontinuous production - Carrier pipe, welded

Dimensions Carrier Pipe P235TR1 / TR2 / GH						Dimensions Jacket Pipe PEHD												Weight without water **G** in kg/m (**s** acc. to **isoplus**)		
Type	Nominal diameter in		Outside-Ø d_a in mm	Wall-thick. acc. to **isoplus** s in mm	Wall-thick. acc. to EN 253 s in mm	PEHD-Jacket Pipe Outside-Ø x Wall Thickness $\mathbf{D_a}$ x **s** in mm; Insulation Class / Delivery Length **L** in m												Insulation Class		
	DN	Inch				Standard	6	12	16	1x reinforced	6	12	16	2x reinf.	6	12	16	Stand.	1x reinf.	2x reinf.
DRE-20	20	¾“	26,9	2,6	2,0	90 • 3,0	√	-	-	110 • 3,0	√	-	-	*125 • 3,0*	√	-	-	2,68	3,08	*3,41*
DRE-25	25	1“	33,7	3,2	2,3	90 • 3,0	√	-	-	110 • 3,0	√	√	-	*125 • 3,0*	√	√	-	3,54	3,96	*4,30*
DRE-32	32	1¼“	42,4	3,2	2,6	110 • 3,0	√	√	-	125 • 3,0	√	√	-	*140 • 3,0*	√	√	-	4,60	4,95	*5,32*
DRE-40	40	1½“	48,3	3,2	2,6	110 • 3,0	√	√	-	125 • 3,0	√	√	-	*140 • 3,0*	√	√	-	5,04	5,38	*5,76*
DRE-50	50	2“	60,3	3,2	2,9	125 • 3,0	√	√	-	140 • 3,0	√	√	-	*160 • 3,0*	√	√	-	6,25	6,62	*7,16*
DRE-65	65	2½“	76,1	3,2	2,9	140 • 3,0	√	√	-	160 • 3,0	√	√	-	*180 • 3,0*	√	√	-	7,73	8,28	*8,87*
DRE-80	80	3“	88,9	3,2	3,2	160 • 3,0	√	√	-	180 • 3,0	√	√	-	*200 • 3,2*	√	√	-	9,15	9,75	*10,49*
DRE-100	100	4“	114,3	3,6	3,6	200 • 3,2	√	√	√	225 • 3,4	√	√	√	*250 • 3,6*	√	√	√	13,23	14,24	*15,35*
DRE-125	125	5“	139,7	3,6	3,6	225 • 3,4	√	√	√	250 • 3,6	√	√	√	*280 • 3,9*	√	√	√	16,09	17,20	*18,72*
DRE-150	150	6“	168,3	4,0	4,0	250 • 3,6	√	√	√	280 • 3,9	√	√	√	*315 • 4,1*	√	√	√	20,77	22,29	*24,15*
*DRE-175**	*175*	*7“*	*193,7*	*4,5*	-	*280 • 3,9*	√	√	√	*315 • 4,1*	√	√	√	*355 • 4,5*	√	√	√	26,22	27,91	30,22
DRE-200	200	8“	219,1	4,5	4,5	315 • 4,1	√	√	√	355 • 4,5	√	√	√	*400 • 4,8*	√	√	√	30,51	33,02	*36,05*
*DRE-225**	*225*	*9“*	*244,5*	*5,0*	-	*355 • 4,5*	√	√	√	*400 • 4,8*	√	√	√	*450 • 5,2*	√	√	√	*37,53*	*40,29*	43,77
DRE-250	250	10“	273,0	5,0	5,0	400 • 4,8	√	√	√	450 • 5,2	√	√	√	*500 • 5,6*	√	√	√	43,59	47,42	*51,66*
DRE-300	300	12“	323,9	5,6	5,6	450 • 5,2	√	√	√	500 • 5,6	√	√	√	*560 • 6,0*	√	√	√	56,40	60,65	*66,19*
DRE-350	350	14“	355,6	5,6	5,6	500 • 5,6	√	√	√	560 • 6,0	√	√	√	*630 • 6,6*	√	√	√	63,65	69,20	*76,62*
DRE-400	400	16“	406,4	6,3	6,3	560 • 6,0	√	√	√	630 • 6,6	√	√	√	*670 • 6,9*	√	√	√	80,57	88,00	*92,55*
DRE-450	450	18“	457,0	6,3	6,3	630 • 6,6	√	√	√	670 • 6,9	√	√	√	*710 • 7,2*	√	√	√	93,07	97,62	*102,44*
DRE-500	500	20“	508,0	6,3	6,3	670 • 6,9	√	√	√	710 • 7,2	√	√	√	*800 • 7,9*	√	√	√	102,40	107,22	*119,09*
*DRE-550**	*550*	*22“*	*558,8*	*6,3*	-	*710 • 7,2*	√	√	√	*800 • 7,9*	√	√	√	*900 • 8,7*	√	√	√	*110,38*	*121,16*	*134,64*
DRE-600	600	24“	610,0	7,1	7,1	800 • 7,9	√	√	√	900 • 8,7	√	√	√	*1000 • 9,4*	√	√	√	139,45	154,30	*170,59*
*DRE-650**	*650*	*26“*	*660,0*	*7,1*	-	*900 • 8,7*	√	√	√	*1000 • 9,4*	√	√	√	-	-	-	-	*156,34*	*171,09*	-
DRE-700	700	28“	711,0	8,0	8,0	900 • 8,7	√	√	√	1000 • 9,4	√	√	√	-	-	-	-	178,93	195,23	-
*DRE-750**	*750*	*30“*	*762,0*	*8,0*	-	*1000 • 9,4*	√	√	√	*1100 • 10,2*	√	√	√	-	-	-	-	*197,56*	*214,09*	-
DRE-800	800	32“	813,0	8,8	8,8	1000 • 9,4	√	√	√	1100 • 10,2	√	√	√	-	-	-	-	221,15	239,38	-
*DRE-850**	*850*	*34“*	*864,0*	*8,8*	-	*1100 • 10,2*	√	√	√	*1200 • 11,0*	√	√	√	-	-	-	-	*241,81*	*259,88*	-
DRE-900	900	36“	914,0	10,0	10,0	1100 • 10,2	√	√	√	1200 • 11,0	√	√	√	-	-	-	-	276,70	296,63	-
DRE-1000	1000	40“	1016,0	11,0	11,0	1200 • 11,0	√	√	√	1300 • 12,5	√	√	√	-	-	-	-	333,79	357,76	-

ATTENTION: Italicised mentioned dimensions (*) and jacket-pipe dimensions (*) are special productions. Please check availability in case of requirement.

For nominal diameters DN 25 to DN 65 isoplus provides only steel pipes and fittings with wall thickness of 3,2 mm! This is also to observe in comparison with competitors just as the differing standard insulation class respectively series from nominal diameter DN 250!

Length of bare steel pipe ends: 220 mm ± 10 mm. Wall thickness jacket pipe **isoplus** acc. to EN 253, Wall thickness carrier pipe **isoplus** acc. to AGFW FW 401. The mentioned steel wall thicknesses are corresponding with the standard wall thicknesses of **isoplus**, which are generally calculated against inside pressure [p] acc. to DIN 2413. The mentioned weights are valid for steel wall thicknesses acc. to **isoplus**, material density [ρ] P235 = Ø 7,85 kg/dm³, PUR-Foam = Ø 0,07 kg/dm³, PEHD = Ø 0,95 kg/dm³.

Specification carrier pipe see **chapter 2.2.1**

Discontinuous production - Carrier pipe, seamless

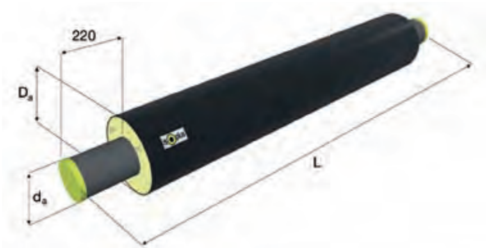
Dimensions carrier pipe P235GH						Dimensions jacket pipe PEHD															Weight without water G in kg/m (s acc. to **isoplus**)		
Type	Nominal Diameter / Dimension in		Outside-Ø d_a in mm	Wall-thickn. acc. to **isoplus** s in mm	Wall-thickn. acc. to EN 253 s in mm	PEHD-Jacket-Pipe Outside-Ø x Wallthickness D_a x **s** in mm — Insulation Class / Delivery Length **L** in m												Insulation Class		
	DN	Inch				Standard	6	12	16	1x reinforced	6	12	16	2x reinf.	6	12	16	Stand.	1x reinf.	2x reinf.
DRE-20	20	¾“	26,9	2,6	2,0	90 • 3,0	√	-	-	110 • 3,0	√	-	-	*125 • 3,0*	√	-	-	2,68	3,08	*3,41*
DRE-25	25	1“	33,7	3,2	2,3	90 • 3,0	√	-	-	110 • 3,0	√	√	-	*125 • 3,0*	√	√	-	3,54	3,96	*4,30*
DRE-32	32	1¼“	42,4	3,2	2,6	110 • 3,0	√	√	-	125 • 3,0	√	√	-	*140 • 3,0*	√	√	-	4,60	4,95	*5,32*
DRE-40	40	1½“	48,3	3,2	2,6	110 • 3,0	√	√	-	125 • 3,0	√	√	-	*140 • 3,0*	√	√	-	5,04	5,38	*5,76*
DRE-50	50	2“	60,3	3,2	2,9	125 • 3,0	√	√	-	140 • 3,0	√	√	-	*160 • 3,0*	√	√	-	6,25	6,62	*7,16*
DRE-65	65	2½“	76,1	3,2	2,9	140 • 3,0	√	√	-	160 • 3,0	√	√	-	*180 • 3,0*	√	√	-	7,73	8,28	*8,87*
DRE-80	80	3“	88,9	3,2	3,2	160 • 3,0	√	√	-	180 • 3,0	√	√	-	*200 • 3,2*	√	√	-	9,15	9,75	*10,49*
DRE-100	100	4“	114,3	3,6	3,6	200 • 3,2	√	√	-	225 • 3,4	√	√	-	*250 • 3,6*	√	√	-	13,23	14,24	*15,35*
DRE-125	125	5“	139,7	4,0	3,6	225 • 3,4	√	√	-	250 • 3,6	√	√	-	*280 • 3,9*	√	√	-	17,39	18,51	*20,03*
DRE-150	150	6“	168,3	4,5	4,0	250 • 3,6	√	√	-	280 • 3,9	√	√	-	*315 • 4,1*	√	√	-	22,74	24,26	*26,12*
DRE-200	200	8“	219,1	6,3	4,5	315 • 4,1	√	√	-	355 • 4,5	√	√	-	*400 • 4,8*	√	√	-	39,78	42,29	*45,32*
DRE-250	250	10“	273,0	6,3	5,0	400 • 4,8	√	√	-	450 • 5,2	√	√	-	*500 • 5,6*	√	√	-	52,01	55,83	*60,08*
DRE-300	300	12“	323,9	7,1	5,6	450 • 5,2	√	√	-	500 • 5,6	√	√	-	*560 • 6,0*	√	√	-	67,94	72,19	*77,74*
DRE-350	350	14“	355,6	8,0	5,6	500 • 5,6	√	√	-	560 • 6,0	√	√	-	*630 • 6,6*	√	√	-	83,95	89,49	*96,92*
DRE-400	400	16“	406,4	8,8	6,3	560 • 6,0	√	√	-	630 • 6,6	√	√	-	*670 • 6,9*	√	√	-	104,76	112,18	*116,73*
DRE-450	450	18“	457,0	10,0	6,3	630 • 6,6	√	√	-	670 • 6,9	√	√	-	*710 • 7,2*	√	√	-	133,38	137,93	*142,75*
DRE-500	500	20“	508,0	11,0	6,3	670 • 6,9	√	√	-	710 • 7,2	√	√	-	*800 • 7,9*	√	√	-	159,42	164,24	*176,11*
DRE-600	600	24“	610,0	12,5	7,1	800 • 7,9	√	√	-	900 • 8,7	√	√	-	*1000 • 9,4*	√	√	-	218,27	233,12	*249,42*

ATTENTION: Italicised mentioned dimensions (*) and jacket-pipe dimensions (*) are special productions. Please check availability in case of requirement.

For nominal diameters DN 25 to DN 65 isoplus provides only steel pipes and fittings with wall thickness of 3,2 mm! This is also to observe in comparison with competitors just as the differing standard insulation class respectively series from nominal diameter DN 250!

Length of bare steel pipe ends: 220 mm ± 10 mm. Wall thickness jacket pipe **isoplus** acc. to EN 253, Wall thickness carrier pipe **isoplus** acc. to AGFW FW 401. The mentioned steel wall thicknesses are corresponding with the standard wall thicknesses of **isoplus**, which are generally calculated against inside pressure [p] acc. to DIN 2413. The mentioned weights are valid for steel wall thickness acc. to **isoplus**, material density [ρ] P235 = Ø 7,85 kg/dm³, PUR-Foam = Ø 0,07 kg/dm³, PEHD = Ø 0,95 kg/dm³.

2.2.3 Dimensions resp. Types — straight pipe bar - Conti



Continuous production - Carrier pipe, welded

Dimensions Carrier Pipe P235TR1 / TR2 / GH						Dimensions Jacket pipe PEHD												Weight without water **G** in kg/m (**s** acc. to **isoplus**)		
Type	Nominal Diameter / Dimension in		Outside Ø d_a	Wall-thick. acc. to **isoplus** s	Wall-thick. acc. to EN 253 s	PEHD- Jacket-Pipe Outside-Ø x Wall thickness D_a x **s** in mm — Insulation Class / Delivery Length **L** in m												Insulation Class		
	DN	**Inch**	in mm	in mm	in mm	**Standard**	6	12	16	**1x reinforced**	6	12	16	**2x reinf.**	6	12	16	**Stand.**	**1x reinf.**	**2x reinf.**
KRE-25	**25**	1“	33,7	3,2	2,3	-	-	-	-	110 • 3,0	-	√	-	*125 • 3,0*	-	√	-	-	3,86	*4,19*
KRE-32	**32**	1¼“	42,4	3,2	2,6	110 • 3,0	-	√	-	125 • 3,0	-	√	-	*140 • 3,0*	-	√	-	4,49	4,83	*5,18*
KRE-40	**40**	1½“	48,3	3,2	2,6	110 • 3,0	-	√	-	125 • 3,0	-	√	-	*140 • 3,0*	-	√	-	4,91	5,24	*5,61*
KRE-50	**50**	2“	60,3	3,2	2,9	125 • 3,0	-	√	-	140 • 3,0	-	√	-	*160 • 3,0*	-	√	-	4,98	6,45	*6,97*
KRE-65	**65**	2½“	76,1	3,2	2,9	140 • 3,0	-	√	-	160 • 3,0	-	√	-	*180 • 3,0*	-	√	-	7,53	8,06	*8,63*
KRE-80	**80**	3“	88,9	3,2	3,2	160 • 3,0	-	√	-	180 • 3,0	-	√	-	*200 • 3,2*	-	√	-	8,91	9,49	*10,62*
KRE-100	**100**	4“	114,3	3,6	3,6	200 • 3,2	-	√	√	225 • 3,4	-	√	√	*250 • 3,6*	-	√	√	13,29	14,20	*15,32*
KRE-125	**125**	5“	139,7	3,6	3,6	225 • 3,4	-	√	√	250 • 3,6	-	√	√	*280 • 3,9*	-	√	√	16,00	17,13	*18,57*
KRE-150	**150**	6“	168,3	4,0	4,0	250 • 3,6	-	√	√	280 • 3,9	-	√	√	*315 • 4,1*	-	√	√	20,60	22,05	*24,14*
KRE-200	**200**	8“	219,1	4,5	4,5	315 • 4,1	-	√	√	355 • 4,5	-	√	√	-	-	-	-	30,34	33,14	-

ATTENTION: Italicised mentioned dimensions (*) and jacket-pipe dimensions (*) are special productions. Please check availability in case of requirement.

For nominal diameters DN 25 to DN 65 isoplus provides only steel pipes and fittings with wall thickness of 3,2 mm! This is also to observe in comparison with competitors just as the differing standard insulation class respectively series from nominal diameter DN 250!

Length of bare steel pipe ends: 220 mm ± 10 mm. Wall thickness jacket pipe **isoplus** acc. to EN 253, Wall thickness carrier pipe **isoplus** acc. to AGFW FW 401. The mentioned steel wall thicknesses are corresponding with the standard wall thicknesses of **isoplus**, which are generally calculated against inside pressure [p] acc. to DIN 2413. The mentioned weights are valid for steel wall thickness acc. to **isoplus**, material density [ρ] P235 = Ø 7,85 kg/dm³, PUR-Foam = Ø 0,07 kg/dm³, PEHD = Ø 0,95 kg/dm³.

Specification carrier pipe see **chapter 2.2.1**

Edition: 16.01.2012

2.2.4 Dimensions resp. Types — Bowed Pipe

Discontinuous and continuous production

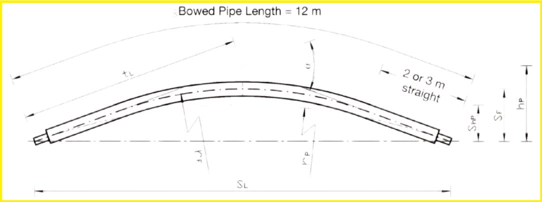
Dimensions Carrier pipe		Maximum	Minimum	Circle segment at $r_{F\ min}$ and 12,00 m		
Nominal-Diameter in **DN**	Outside-Ø d_a in mm	permissible bow-angle α_{max} in °	bending-radius $r_{F\ min}$ in m	Secant-length s_L in m	Production secant-length s_{hF} in m	Tangent-length t_L in m
100	114,3	28,0	16,78	11,78	0,97	6,07
125	139,7	28,0	16,78	11,78	0,97	6,07
150	168,3	25,0	18,80	11,83	0,87	6,06
200	219,1	22,5	20,88	11,86	0,78	6,05
250	273,0	20,0	23,49	11,89	0,70	6,04
300	323,9	18,0	26,10	11,91	0,63	6,03
350	355,6	12,0	28,65	11,96	0,42	6,01
400	406,4	6,5	52,89	11,99	0,23	6,00
450	457,0	5,0	68,75	11,99	0,17	6,00
500	508,0	4,0	85,94	12,00	0,16	6,00

Smaller dimensions available on request!

The single pipe / bowed pipe production used at the factory is only possible with a high density polyethylene jacket in 12 m lengths and only above a nominal diameter of DN 100. The values given in the table are valid regardless of the PEHD casing pipe diameter (standard, 1x or 2x reinforced). For nominal diameters DN 20 to DN 80, it is usually sufficient to compensate for pipe elbows with on-site bending (elastic distortion of a pipe length).

Due to production constraints, bowed pipes of up to PEHD casing pipe diameters $\mathbf{D_a} \leq 450$ mm have 2,0 m long straight pipe ends, while from $\mathbf{D_a} \geq 500$ these ends are approximately 3,0 m long. For this reason, the production bending radius [$\mathbf{r_F}$] is also different from the design radius [$\mathbf{r_P}$].

Bowed pipes are bent mechanically according to the route of the pipeline and the permitted production bending radius, according to local management instructions (bending angle and design radius). When ordering, the angle, design radius and bending direction, left or right (depending on the route of the network monitoring) should be given. If necessary, these parameters are determined by **isoplus**.



Context between project planning radius [r_P] and production bending radius [r_F]

General parameter			Project planning parameter			2 m pipe end straight		3 m pipe end straight	
Angle α in °	Segment s_L in m	Tangent t_L in m	Height h_P in m	Radius r_P in m	Segment s_{hP} in m	Radius r_{F2} in m	Segment s_{hF2} in m	Radius r_{F3} in m	Segment s_{hF3} in m
40	11,56	6,15	2,10	16,90	1,02	11,40	1,37	8,65	1,55
39	11,58	6,14	2,05	17,34	0,99	11,70	1,34	8,87	1,51
38	11,60	6,13	2,00	17,82	0,97	12,01	1,31	9,10	1,47
37	11,62	6,13	1,94	18,31	0,95	12,33	1,27	9,35	1,43
36	11,64	6,12	1,89	18,84	0,92	12,68	1,24	9,60	1,40
35	11,66	6,11	1,84	19,39	0,90	13,04	1,21	9,87	1,36
34	11,68	6,11	1,79	19,97	0,87	13,43	1,17	10,16	1,32
33	11,70	6,10	1,73	20,59	0,85	13,84	1,14	10,47	1,28
32	11,72	6,09	1,68	21,25	0,82	14,28	1,10	10,79	1,24
31	11,73	6,09	1,63	21,95	0,80	14,74	1,07	11,13	1,21
30	11,75	6,08	1,57	22,70	0,77	15,24	1,04	11,50	1,17
29	11,77	6,08	1,52	23,50	0,75	15,76	1,00	11,90	1,13
28	11,78	6,07	1,47	24,35	0,72	16,33	0,97	12,32	1,09
27	11,80	6,07	1,42	25,27	0,70	16,94	0,93	12,77	1,05
26	11,81	6,06	1,36	26,25	0,67	17,59	0,90	13,26	1,01
25	11,83	6,06	1,31	27,32	0,65	18,30	0,87	13,79	0,98
24	11,84	6,05	1,26	28,47	0,62	19,06	0,83	14,36	0,94
23	11,85	6,05	1,21	29,73	0,60	19,90	0,80	14,98	0,90
22,5	11,86	6,05	1,18	30,39	0,58	20,34	0,78	15,31	0,88
22	11,87	6,04	1,15	31,09	0,57	20,80	0,76	15,66	0,86
21	11,88	6,04	1,10	32,59	0,55	21,80	0,73	16,40	0,82
20	11,89	6,04	1,05	34,23	0,52	22,89	0,70	17,22	0,78
19	11,90	6,03	1,00	36,05	0,49	24,10	0,66	18,12	0,74
18	11,91	6,03	0,94	38,07	0,47	25,44	0,63	19,12	0,70
17	11,92	6,03	0,89	40,32	0,44	26,94	0,59	20,25	0,67
16	11,93	6,02	0,84	42,86	0,42	28,62	0,56	21,51	0,63
15	11,94	6,02	0,79	45,73	0,39	30,54	0,52	22,94	0,59
14	11,95	6,02	0,73	49,01	0,37	32,72	0,49	24,58	0,55
13	11,95	6,02	0,68	52,79	0,34	35,24	0,45	26,46	0,51
12	11,96	6,01	0,63	57,21	0,31	38,18	0,42	28,67	0,47
11	11,97	6,01	0,58	62,42	0,29	41,65	0,38	31,27	0,43
10	11,97	6,01	0,52	68,68	0,26	45,82	0,35	34,39	0,39
9	11,98	6,01	0,47	76,33	0,24	50,92	0,31	38,21	0,35
8	11,98	6,01	0,42	85,89	0,21	57,28	0,28	42,98	0,31
7	11,99	6,00	0,37	98,17	0,18	65,47	0,24	49,12	0,27
6,5	11,99	6,00	0,34	105,73	0,17	70,51	0,23	52,90	0,26
6	11,99	6,00	0,31	114,55	0,16	76,39	0,21	57,30	0,24
5	11,99	6,00	0,26	137,47	0,13	91,67	0,17	68,76	0,20
4	12,00	6,00	0,21	171,86	0,10	114,59	0,14	85,95	0,16

2.2.5 Energy Loss isoplus - Single Pipe Disconti

Thermal Transmission Coefficient [U_{DRE}] resp. K-Value

The mentioned values are based on an average specific thermal capacity [c_m] of the water of 4.187 J/(kg•K). A soil covering [$Ü_H$] of 0,80 m (upper edge jacket-pipe to upper edge of the terrain), a thermal conductivity of the soil [λ_E] of 1,2 W/(m•K), an average soil temperature [T_E] of 10° Cas well as on an average clearance pipe distance of 150 mm in case of single pipes, see **chapter 2.2.2** and **2.2.3.**

Average temperature:
$T_M = (T_{VL} + T_{RL}) : 2 – T_E$ [K]

Example:
T_M = (90° + 70°) : 2 – 10° = 70 K

Type	Jacket-Pipe Outside-Diameter D_a in mm			Thermal Transm. Coefficient u_{DRE} in W/(m•K)		
	Insulation Class			Insulation Class		
	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.
DRE-20	90	110	125	0,1337	0,1149	0,1056
DRE-25	90	110	125	0,1625	0,1356	0,1228
DRE-32	110	125	140	0,1661	0,1473	0,1339
DRE-40	110	125	140	0,1904	0,1661	0,1493
DRE-50	125	140	160	0,2122	0,1855	0,1617
DRE-65	140	160	180	0,2489	0,2078	0,1815
DRE-80	160	180	200	0,2566	0,2177	0,1939
DRE-100	200	225	250	0,2720	0,2285	0,2004
DRE-125	225	250	280	0,3132	0,2627	0,2239
DRE-150	250	280	315	0,3692	0,2968	0,2473
DRE-200	315	355	400	0,4017	0,3154	0,2595
DRE-250	400	450	500	0,3910	0,3092	0,2606
DRE-300	450	500	560	0,4492	0,3535	0,2876
DRE-350	500	560	630	0,4389	0,3417	0,2775
DRE-400	560	630	670	0,4674	0,3550	0,3156
DRE-450	630	670	710	0,4711	0,4041	0,3561
DRE-500	670	710	800	0,5395	0,4573	0,3481
DRE-600	800	900	1000	0,5574	0,4022	0,3221
DRE-700	900	1000	-	0,6317	0,4543	-
DRE-800	1000	1100	-	0,7088	0,5080	-
DRE-900	1100	1200	-	0,7823	0,5604	-
DRE-1000	1200	1300	-	0,8615	0,6136	-

Energy Loss [q] at T_M in W/Pipe Meter

Type	Heat Loss **q** at average temperature **T_M = 100 K** in W/m			Heat Loss **q** at average temperature **T_M = 70 K** in W/m			Heat Loss **q** at average temperature **T_M = 50 K** in W/m		
	Insulation Class			Insulation Class			Insulation Class		
	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.
DRE-20	13,367	11,493	10,559	9,357	8,045	7,391	6,683	5,746	5,279
DRE-25	16,253	13,563	12,282	11,377	9,494	8,597	8,126	6,782	6,141
DRE-32	16,614	14,731	13,393	11,630	10,312	9,375	8,307	7,365	6,697
DRE-40	19,045	16,610	14,929	13,331	11,627	10,450	9,522	8,305	7,464
DRE-50	21,221	18,552	16,169	14,855	12,986	11,318	10,611	9,276	8,084
DRE-65	24,885	20,777	18,148	17,420	14,544	12,704	12,443	10,389	9,074
DRE-80	25,664	21,768	19,386	17,965	15,238	13,571	12,832	10,884	9,693
DRE-100	27,198	22,854	20,043	19,038	15,998	14,030	13,599	11,427	10,022
DRE-125	31,321	26,272	22,388	21,925	18,391	15,672	15,661	13,136	11,194
DRE-150	36,922	29,685	24,727	25,846	20,779	17,309	18,461	14,842	12,364
DRE-200	40,173	31,540	25,948	28,121	22,078	18,164	20,086	15,770	12,974
DRE-250	39,103	30,923	26,063	27,372	21,646	18,244	19,552	15,462	13,032
DRE-300	44,922	35,348	28,758	31,446	24,743	20,131	22,461	17,674	14,379
DRE-350	43,886	34,167	27,746	30,720	23,917	19,422	21,943	17,083	13,873
DRE-400	46,735	35,498	31,556	32,715	24,849	22,089	23,368	17,749	15,778
DRE-450	47,109	40,409	35,612	32,976	28,287	24,929	23,555	20,205	17,806
DRE-500	53,949	45,726	34,810	37,764	32,008	24,367	26,975	22,863	17,405
DRE-600	55,738	40,224	32,214	39,017	28,157	22,550	27,869	20,112	16,107
DRE-700	63,173	45,431	-	44,221	31,802	-	31,587	22,716	-
DRE-800	70,876	50,798	-	49,614	35,559	-	35,438	25,399	-
DRE-900	78,228	56,042	-	54,759	39,229	-	39,114	28,021	-
DRE-1000	86,153	61,358	-	60,307	42,951	-	43,076	30,679	-

Edition: 16.01.2012

2.2.6 Energy Loss isoplus - Single Pipe Conti

Thermal Transmission Coefficient [U_{KRE}] resp. K-Value

The mentioned values are based on an average specific thermal capacity [c_m] of the water of 4.187 J/(kg•K). A soil covering [$Ü_H$] of 0,80 m (upper edge jacket-pipe to upper edge of the terrain), a thermal conductivity of the soil [λ_E] of 1,2 W/(m•K), an average soil temperature [T_E] of 10° Cas well as on an average clearance pipe distance of 150 mm in case of single pipes, see **chapter 2.2.2** and **2.2.3**.

Type	Jacket-Pipe Outside-Diameter D_a in mm			Thermal Transm. Coefficient U_{KER} in W/(m•K)		
	Insulation Class			Insulation Class		
	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.
KRE-25	-	110	125	-	0,1198	0,1086
KRE-32	110	125	140	0,1466	0,1301	0,1184
KRE-40	110	125	140	0,1679	0,1466	0,1319
KRE-50	125	140	160	0,1869	0,1636	0,1428
KRE-65	140	160	180	0,2189	0,1831	0,1602
KRE-80	160	180	200	0,2257	0,1918	0,1696
KRE-100	200	225	250	0,2329	0,1976	0,1741
KRE-125	225	250	280	0,2681	0,2265	0,1943
KRE-150	250	280	315	0,3145	0,2556	0,2137
KRE-200	315	355	-	0,3413	0,2702	-

Average Temperature:
$T_M = (T_{VL} + T_{RL}) : 2 – T_E$ [K]

Example:
TM = (90° + 70°) : 2 – 10° = 70 K

Energy Loss [q] at T_M in W/Pipe Meter

Type	Heat Loss **q** at average temperature T_M = 100 K in W/m			Heat Loss **q** at average temperature T_M = 70 K in W/m			Heat Loss **q** at average temperature T_M = 50 K in W/m		
	Insulation Class			Insulation Class			Insulation Class		
	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.
KRE-25	-	11,984	10,859	-	8,389	7,601	-	5,992	5,430
KRE-32	14,660	13,011	11,838	10,262	9,108	8,287	7,330	6,505	5,919
KRE-40	16,786	14,659	13,187	11,750	10,261	9,231	8,393	7,329	6,593
KRE-50	18,691	16,362	14,277	13,084	11,453	9,994	9,345	8,181	7,139
KRE-65	21,889	18,312	16,016	15,322	12,819	11,211	10,945	9,156	8,008
KRE-80	22,574	19,183	16,955	15,802	13,428	11,869	11,287	9,592	8,478
KRE-100	23,287	19,760	17,405	16,301	13,832	12,184	11,644	9,880	8,703
KRE-125	26,809	22,652	19,428	18,766	15,856	13,600	13,405	11,326	9,714
KRE-150	31,451	25,562	21,373	22,016	17,893	14,961	15,726	12,781	10,686
KRE-200	34,134	27,024	-	23,894	18,917	-	17,067	13,512	-

Edition: 16.01.2012

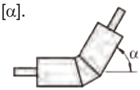
2.2.7 Elbow 90°

All carrier pipe elbows at least bent according to DIN EN 10220 in one piece or in accordance with DIN EN 10253-2 and welded pipe fittings, depending on dimension. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1.

Dimensions Carrier Pipe			Carrier Pipe Elbow		Jacket-Pipe-Outside-diameter D_a in mm			Length of Angle $L \bullet L_1$ in mm	
Nominal Diameter / Dimension in		Outside-Ø d_a in mm	Wall thickness s in mm	Radius r in mm	Insulation Class				
DN	**Inch**				**Standard**	**1x reinf.**	_2x reinf. *_		
20	¾“	26,9	2,6	110,0	90	110	_125_	1000 · 1000	
25	1“	33,7	3,2	110,0	90	110	_125_	1000 · 1000	
32	1¼“	42,4	3,2	110,0	110	125	_140_	1000 · 1000	
40	1½“	48,3	3,2	110,0	110	125	_140_	1000 · 1000	
50	2“	60,3	3,2	135,0	125	140	_160_	1000 · 1000	
65	2½“	76,1	3,2	175,0	140	160	_180_	1000 · 1000	
80	3“	88,9	3,2	205,0	160	180	_200_	1000 · 1000	
100	4“	114,3	3,6	270,0	200	225	_250_	1000 · 1000	
125	5“	139,7	3,6	330,0	225	250	_280_	1000 · 1000	1000 · 1500
150	6“	168,3	4,0	390,0	250	280	_315_	1000 · 1000	1000 · 1500
200	8“	219,1	4,5	510,0	315	355	_400_	1000 · 1000	1000 · 1500
250	10“	273,0	5,0	381,0	400	450	_500_	1000 · 1000	1000 · 1500
300	12“	323,9	5,6	457,0	450	500	_560_	1000 · 1000	1000 · 1500
350	14“	355,6	5,6	533,0	500	560	_630_	1000 · 1000	1000 · 1500
400	16“	406,4	6,3	610,0	560	630	_670_	1000 · 1000	1000 · 1500
450	18“	457,0	6,3	686,0	630	670	_710_	1100 · 1100	1100 · 1500
500	20“	508,0	6,3	762,0	670	710	_800_	1200 · 1200	1200 · 1500
600	24“	610,0	7,1	914,0	800	900	_1000_	_1250 · 1250 *_	
700	28“	711,0	8,0	1067,0	900	1000	-	_1400 · 1400 *_	
800	32“	813,0	8,8	1219,0	1000	1100	-	_1600 · 1600 *_	
900	36“	914,0	10,0	1372,0	1100	1200	-	_1900 · 1900 *_	
1000	40“	1016,0	11,0	1524,0	1200	1300	-	_2000 · 2000 *_	

ATTENTION: Italicised mentioned jacket-pipe dimensions (*) and length of angles (*) are special products resp. minimum length. Please check availability in case of requirement. This also applies to complementary angles [α] < 90°. Elbows with an angle length of 1,5 m are used in applications where preformed part is welded to preformed part and sliding up a coupler is otherwise not possible. It´s also possible to use as house entry elbow.

The mentioned steel wall thicknesses are corresponding to the minimum requirements acc. to the standard respectively to the norm wall thicknesses of **isoplus**. These are generally calculated against inside pressure [p] acc. to DIN 2413. Length of bare steel pipe ends: 220 mm ± 10 mm. Orders of special degree elbows should generally indicate the complementary angle [α].



Material specifications jacket pipe see **chapter 2.1.4**
Material specifications carrier pipe see **chapter 2.2.1**
Material specifications PUR hard foam see **chapter 7.1.7**

Edition: 16.01.2012

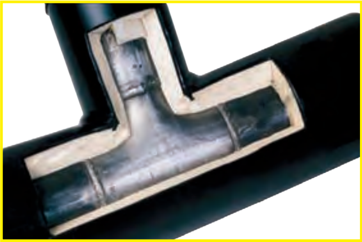
2.2.8 45°-T-Branch / Parallel-Branch / 90°-Vertical-Branch

45° T-Branch

Parallel-Branch

Vertical-Branch

T-Piece acc. to DIN EN 10253-2



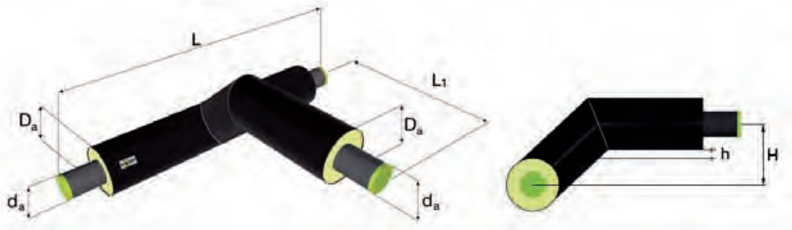
Carrier pipe inside diameter and exit with appropriate wall thickness according to the pipe bars. Pipe elbows 45°- respectively 90° at branch depending on dimension at least acc. to DIN EN 10220 bowed in one piece or with pipe elbow acc. to DIN 10253-2 and welded pipe socket. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm.

Depending on the nominal diameter, all branches are flared in the ground or with welded T-joints in compliance with DIN EN 10253-2, with appropriate wall thickness according to the pipe bars. The subsequent elbow or pipe cylinder is welded with a lap seam, which can be irradiated. Cylindrical tubes are seamless or welded steel depending on dimension.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.2.1**
Material specification PUR-hard foam see **chapter 7.1.7**

Edition: 16.01.2012

45°-T-Branch / Insulation Class Standard



Dimensions Insulation Class Standard

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		20		25		32		40		50		65		80		100		125		150	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3	
	s		2,6		3,2		3,2		3,2		3,2		3,2		3,2		3,6		4,0		4,5	
DN	D_a		90		90		110		110		125		140		160		200		225		250	
20	L	L_1	1100	695	1100	695	1100	705	1100	705	1100	710	1100	720	1100	730	1100	750	1100	760	1100	775
	h	H	70	160	70	160	70	170	70	170	70	180	70	185	70	195	70	215	70	230	70	240
25	L	L_1			1100	695	1100	705	1100	705	1100	710	1100	720	1100	730	1100	750	1100	760	1100	775
	h	H			70	160	70	170	70	170	70	180	70	185	70	195	70	215	70	230	70	240
32	L	L_1					1100	715	1100	715	1100	720	1100	730	1100	740	1100	760	1100	770	1100	785
	h	H					70	180	70	180	70	190	70	195	70	205	70	225	70	240	70	250
40	L	L_1							1100	715	1100	720	1100	730	1100	740	1100	760	1100	770	1100	785
	h	H							70	180	70	190	70	195	70	205	70	225	70	240	70	250
50	L	L_1									1100	730	1100	735	1100	745	1100	765	1100	780	1100	790
	h	H									70	195	70	205	70	215	70	235	70	245	70	260
65	L	L_1											1100	745	1100	745	1100	775	1100	785	1100	800
	h	H											70	210	70	220	70	240	70	255	70	265
80	L	L_1													1200	800	1200	800	1200	800	1200	800
	h	H													70	230	70	250	70	265	70	275
100	L	L_1															1200	800	1200	800	1200	800
	h	H															70	270	70	285	70	295
125	L	L_1																	1300	850	1300	850
	h	H																	70	295	70	310
150	L	L_1																			1300	850
	h	H																			70	320

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm
h = Clear component height in mm
H = Axle distance in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

Edition: 16.01.2012

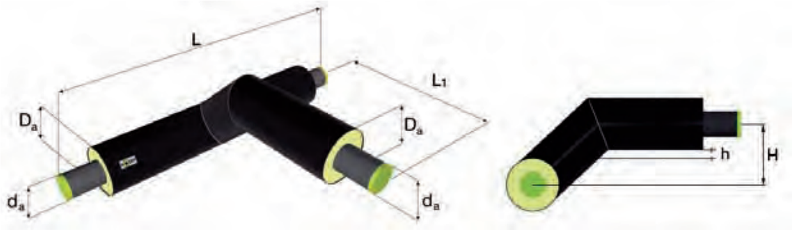
45°-T-Branch / Insulation Class Standard

Dimensions Insulation Class Standard

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		200		250		300		350		400		450		500		600		700		800	
	Inch		8“		10“		12“		14“		16“		18“		20“		24“		28“		32“	
	d_a		219,1		273,0		323,9		355,6		406,4		457,2		508,0		610,0		711,0		813,0	
	s		4,5		5,0		5,6		5,6		6,3		6,3		6,3		7,1		8,0		8,8	
DN	D_a		315		400		450		500		560		630		670		800		900		1000	
20	L	L_1	1100	805	1100	850	1100	875	1100	900	1100	930	1100	965	1100	985	1100	1050	1100	1100	1100	1150
	h	H	70	275	70	315	70	340	70	365	70	395	70	430	70	450	70	515	70	565	70	615
25	L	L_1	1100	805	1100	850	1100	875	1100	900	1100	930	1100	965	1100	985	1100	1050	1100	1100	1100	1150
	h	H	70	275	70	315	70	340	70	365	70	395	70	430	70	450	70	515	70	565	70	615
32	L	L_1	1100	815	1100	860	1100	885	1100	910	1100	940	1100	975	1100	995	1100	1060	1100	1110	1100	1160
	h	H	70	285	70	325	70	350	70	375	70	405	70	440	70	460	70	525	70	575	70	625
40	L	L_1	1100	815	1100	860	1100	885	1100	910	1100	940	1100	975	1100	995	1100	1060	1100	1110	1100	1160
	h	H	70	285	70	325	70	350	70	375	70	405	70	440	70	460	70	525	70	575	70	625
50	L	L_1	1100	825	1100	865	1100	890	1100	915	1100	945	1100	980	1100	1000	1100	1065	1100	1115	1100	1165
	h	H	70	290	70	335	70	360	70	385	70	415	70	450	70	470	70	535	70	585	70	635
65	L	L_1	1100	830	1100	875	1100	900	1100	925	1100	955	1100	990	1100	1000	1100	1075	1100	1125	1100	1175
	h	H	70	300	70	340	70	365	70	390	70	420	70	455	70	455	70	540	70	590	70	640
80	L	L_1	1200	850	1200	900	1200	900	1200	950	1200	950	1200	1000	1200	1000	1200	1050	1200	1150	1200	1150
	h	H	70	310	70	350	70	375	70	400	70	430	70	465	70	485	70	550	70	600	70	650
100	L	L_1	1200	850	1200	900	1200	950	1200	950	1200	1000	1200	1000	1200	1050	1200	1100	1200	1150	1200	1200
	h	H	70	330	70	370	70	495	70	420	70	450	70	485	70	505	70	570	70	620	70	670
125	L	L_1	1300	850	1300	900	1300	950	1300	950	1300	1000	1300	1050	1300	1050	1300	1100	1300	1150	1300	1200
	h	H	70	340	70	385	70	410	70	435	70	465	70	500	70	520	70	585	70	635	70	685
150	L	L_1	1300	900	1300	950	1300	950	1300	1000	1300	1000	1300	1050	1300	1100	1300	1150	1300	1200	1300	1200
	h	H	70	355	70	395	70	420	70	445	70	475	70	510	70	530	70	595	70	645	70	695
200	L	L_1	1400	950	1400	1000	1400	1000	1400	1050	1400	1050	1400	1100	1400	1150	1400	1200	1400	1250	1400	1250
	h	H	70	385	70	430	70	455	70	480	70	510	70	545	70	565	70	630	70	680	70	730
250	L	L_1			1500	1050	1500	1050	1500	1100	1500	1100	1500	1150	1500	1200	1500	1250	1500	1300	1500	1300
	h	H			70	470	70	495	70	520	70	550	70	585	70	605	70	670	70	720	70	770
300	L	L_1					1600	1100	1600	1150	1600	1150	1600	1200	1600	1250	1600	1300	1600	1350	1600	1340
	h	H					70	520	70	545	70	575	70	510	70	630	70	695	70	745	70	795
350	L	L_1							1700	1200	1700	1200	1700	1250	1700	1250	1700	1300	1700	1350	1700	1400
	h	H							70	570	70	600	70	635	70	655	70	720	70	770	70	820
400	L	L_1									1700	1250	1700	1300	1700	1300	1700	1350	1700	1400	1700	1450
	h	H									70	630	70	665	70	685	70	750	70	800	70	850
450	L	L_1											1800	1350	1800	1350	1800	1400	1800	1450	1800	1500
	h	H											70	700	70	720	70	785	70	835	70	885
500	L	L_1													1800	1500	1800	1600	1800	1700	1800	1700
	h	H													70	740	70	805	70	875	70	905
600	L	L_1															2000	1700	2000	1800	2000	1800
	h	H															70	870	70	920	70	970
700	L	L_1																	2100	1900	2100	1900
	h	H																	70	970	70	1020
800	L	L_1																			2200	2000
	h	H																			70	1070

Legend, information and explanation see **previous page**

45°-T-Branch / Insulation Class 1x reinforced



Dimensions Insulation Class 1x reinforced

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		20		25		32		40		50		65		80		100		125		150	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3	
	s		2,6		3,2		3,2		3,2		3,2		3,2		3,2		3,6		4,0		4,5	
DN	D_a		110		110		125		125		140		160		180		225		250		280	
20	L	L_1	1100	715	1100	715	1100	720	1100	720	1100	730	1100	740	1100	750	1100	770	1100	785	1100	800
	h	H	70	180	70	180	70	190	70	190	70	195	70	205	70	215	70	240	70	250	70	265
25	L	L_1			1100	715	1100	720	1100	720	1100	730	1100	740	1100	750	1100	770	1100	785	1100	800
	h	H			70	180	70	190	70	190	70	195	70	205	70	215	70	240	70	250	70	265
32	L	L_1					1100	730	1100	730	1100	735	1100	745	1100	755	1100	780	1100	790	1100	805
	h	H					70	195	70	195	70	205	70	215	70	225	70	245	70	260	70	275
40	L	L_1							1100	730	1100	735	1100	745	1100	755	1100	780	1100	790	1100	805
	h	H							70	195	70	205	70	215	70	225	70	245	70	260	70	275
50	L	L_1									1100	745	1100	755	1100	765	1100	785	1100	800	1100	815
	h	H									70	210	70	220	70	230	70	255	70	265	70	280
65	L	L_1											1100	765	1100	775	1100	795	1100	810	1100	825
	h	H											70	230	70	240	70	265	70	275	70	290
80	L	L_1													1200	800	1200	800	1200	800	1200	850
	h	H													70	250	70	275	70	285	70	300
100	L	L_1															1200	850	1200	850	1200	850
	h	H															70	295	70	310	70	325
125	L	L_1																	1300	850	1300	850
	h	H																	70	320	70	335
150	L	L_1																			1300	900
	h	H																			70	350

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm
h = Clear component height in mm
H = Axle distance in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

isoplus®

45°-T-Branch / Insulation Class 1x reinforced

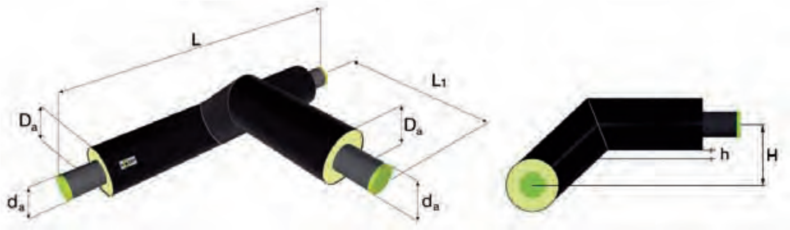
Dimensions Insulation Class 1x reinforced

Branch Exit	Transmission respectively main pipe dimensions																					
	DN		200		250		300		350		400		450		500		600		700		800	
	Inch		8“		10“		12“		14“		16“		18“		20“		24“		28“		32“	
	d_a		219,1		273,0		323,9		355,6		406,4		457,2		508,0		610,0		711,0		813,0	
	s		4,5		5,0		5,6		5,6		6,3		6,3		6,3		7,1		8,0		8,8	
DN	D_a		355		450		500		560		630		670		710		900		1000		1100	
20	L	L_1	1100	835	1100	885	1100	910	1100	940	1100	975	1100	995	1100	1015	1100	1110	1100	1160	1100	1210
	h	H	70	305	70	350	70	375	70	405	70	440	70	460	70	480	70	575	70	625	70	675
25	L	L_1	1100	835	1100	885	1100	910	1100	940	1100	975	1100	995	1100	1015	1100	1110	1100	1160	1100	1210
	h	H	70	305	70	350	70	375	70	405	70	440	70	460	70	480	70	575	70	625	70	675
32	L	L_1	1100	845	1100	890	1100	915	1100	945	1100	980	1100	1000	1100	1020	1100	1115	1100	1165	1100	1215
	h	H	70	310	70	360	70	385	70	415	70	450	70	470	70	490	70	585	70	635	70	685
40	L	L_1	1100	845	1100	890	1100	915	1100	945	1100	980	1100	1000	1100	1020	1100	1115	1100	1165	1100	1215
	h	H	70	310	70	360	70	385	70	415	70	450	70	470	70	490	70	585	70	635	70	685
50	L	L_1	1100	850	1100	900	1100	925	1100	955	1100	990	1100	1010	1100	1030	1100	1125	1100	1175	1100	1225
	h	H	70	320	70	365	70	390	70	420	70	455	70	475	70	495	70	590	70	640	70	690
65	L	L_1	1100	860	1100	910	1100	935	1100	965	1100	1000	1100	1020	1100	1040	1100	1135	1100	1185	1100	1235
	h	H	70	330	70	375	70	400	70	430	70	465	70	485	70	505	70	600	70	650	70	700
80	L	L_1	1200	850	1200	900	1200	950	1200	950	1200	1000	1200	1050	1200	1100	1200	1150	1200	1200	1200	1200
	h	H	70	340	70	385	70	410	70	440	70	475	70	495	70	515	70	610	70	660	70	710
100	L	L_1	1200	900	1200	950	1200	950	1200	1000	1200	1050	1200	1050	1200	1100	1200	1200	1200	1250	1200	1250
	h	H	70	360	70	410	70	435	70	465	70	500	70	520	70	540	70	635	70	685	70	735
125	L	L_1	1300	900	1300	950	1300	1000	1300	1000	1300	1050	1300	1050	1300	1100	1300	1200	1300	1250	1300	1250
	h	H	70	375	70	420	70	445	70	475	70	510	70	530	70	550	70	645	70	695	70	745
150	L	L_1	1300	950	1300	1000	1300	1000	1300	1050	1300	1100	1300	1100	1300	1100	1300	1250	1300	1300	1300	1300
	h	H	70	390	70	435	70	460	70	490	70	525	70	545	70	565	70	660	70	710	70	760
200	L	L_1	1400	1000	1400	1050	1400	1050	1400	1100	1400	1150	1400	1150	1400	1150	1400	1300	1400	1350	1400	1350
	h	H	70	425	70	475	70	500	70	530	70	565	70	585	70	605	70	700	70	750	70	800
250	L	L_1			1500	1100	1500	1100	1500	1150	1500	1200	1500	1200	1500	1250	1500	1350	1500	1400	1500	1400
	h	H			70	520	70	545	70	575	70	610	70	630	70	650	70	745	70	795	70	845
300	L	L_1					1600	1150	1600	1200	1600	1250	1600	1250	1600	1250	1600	1400	1600	1450	1600	1450
	h	H					70	575	70	600	70	635	70	655	70	675	70	770	70	820	70	870
350	L	L_1							1700	1250	1700	1300	1700	1300	1700	1350	1700	1450	1700	1500	1700	1500
	h	H							70	630	70	665	70	685	70	705	70	800	70	850	70	900
400	L	L_1									1700	1350	1700	1350	1700	1350	1700	1500	1700	1550	1700	1550
	h	H									70	700	70	720	70	740	70	835	70	885	70	935
450	L	L_1											1800	1400	1800	1400	1800	1500	1800	1550	1800	1550
	h	H											70	740	70	760	70	855	70	905	70	955
500	L	L_1													1800	1500	1800	1600	1800	1700	1800	1700
	h	H													70	780	70	875	70	925	70	975
600	L	L_1															2000	1700	2000	1800	2000	1800
	h	H															70	970	70	1020	70	1070
700	L	L_1																	2100	1900	2100	1900
	h	H																	70	1070	70	1120
800	L	L_1																			2200	2100
	h	H																			70	1170

Legend, information and explanation see **previous page**

Edition: 16.01.2012

45°-T-Branch / Insulation Class 2x reinforced



Dimensions Insulation Class 2x reinforced

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		20		25		32		40		50		65		80		100		125		150	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“	
	da		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3	
	s		2,6		3,2		3,2		3,2		3,2		3,2		3,2		3,6		4,0		4,5	
DN	D_a		125		125		140		140		160		180		200		250		280		315	
20	L	L_1	1100	730	1100	730	1100	735	1100	735	1100	745	1100	755	1100	765	1100	790	1100	805	1100	825
	h	H	70	195	70	195	70	205	70	205	70	215	70	225	70	235	70	260	70	275	70	290
25	L	L_1			1100	730	1100	735	1100	735	1100	745	1100	755	1100	765	1100	790	1100	805	1100	825
	h	H			70	195	70	205	70	205	70	215	70	225	70	235	70	260	70	275	70	290
32	L	L_1					1100	745	1100	745	1100	755	1100	765	1100	775	1100	800	1100	815	1100	830
	h	H					70	210	70	210	70	220	70	230	70	240	70	265	70	280	70	300
40	L	L_1							1100	745	1100	755	1100	765	1100	775	1100	800	1100	815	1100	830
	h	H							70	210	70	220	70	230	70	240	70	265	70	280	70	300
50	L	L_1									1100	765	1100	775	1100	785	1100	810	1100	825	1100	840
	h	H									70	230	70	240	70	250	70	275	70	290	70	310
65	L	L_1											1100	785	1100	795	1100	820	1100	835	1100	850
	h	H											70	250	70	260	70	285	70	300	70	320
80	L	L_1													1200	800	1200	850	1200	850	1200	850
	h	H													70	270	70	295	70	310	70	330
100	L	L_1															1200	850	1200	900	1200	900
	h	H															70	320	70	335	70	355
125	L	L_1																	1300	900	1300	950
	h	H																	70	350	70	370
150	L	L_1																			1300	950
	h	H																			70	385

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm
h = Clear component height in mm
H = Axle distance in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

Edition: 16.01.2012

45°-T-Branch / Insulation Class 2x reinforced

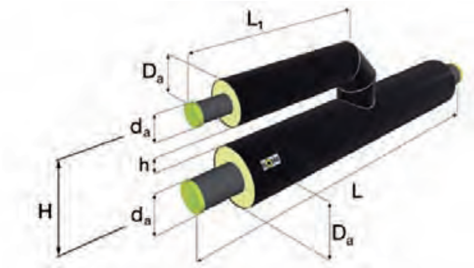
Dimensions Insulation Class 2x reinforced

Branch Exit			Transmission respectively main pipe dimensions															
	DN		200		250		300		350		400		450		500		600	
	Inch		8“		10“		12“		14“		16“		18“		20“		24“	
	d_a		219,1		273,0		323,9		355,6		406,4		457,0		508,0		610,0	
	s		4,5		5,0		5,6		5,6		6,3		6,3		6,3		7,1	
DN	D_a		400		500		560		630		670		710		800		1000	
20	L	L_1	1100	865	1100	915	1100	945	1100	980	1100	1000	1100	1020	1100	1067	1100	1118
	h	H	70	335	70	385	70	415	70	450	70	470	70	490	70	535	70	635
25	L	L_1	1100	865	1100	915	1100	945	1100	980	1100	1000	1100	1020	1100	1067	1100	1118
	h	H	70	335	70	385	70	415	70	450	70	470	70	490	70	535	70	635
32	L	L_1	1100	875	1100	925	1100	955	1100	990	1100	1010	1100	1030	1100	1075	1100	1125
	h	H	70	340	70	390	70	420	70	455	70	475	70	495	70	540	70	640
40	L	L_1	1100	875	1100	925	1100	955	1100	990	1100	1010	1100	1030	1100	1075	1100	1125
	h	H	70	340	70	390	70	420	70	455	70	475	70	495	70	540	70	640
50	L	L_1	1100	885	1100	935	1100	965	1100	1000	1100	1020	1100	1040	1100	1085	1100	1135
	h	H	70	350	70	400	70	430	70	465	70	485	70	505	70	550	70	650
65	L	L_1	1100	895	1100	945	1100	965	1100	1010	1100	1030	1100	1050	1100	1085	1100	1145
	h	H	70	360	70	410	70	440	70	475	70	495	70	515	70	560	70	660
80	L	L_1	1200	950	1200	1000	1200	1000	1200	1050	1200	1050	1200	1100	1200	1150	1200	1140
	h	H	70	370	70	420	70	450	70	485	70	505	70	525	70	570	70	670
100	L	L_1	1200	950	1200	1000	1200	1000	1200	1050	1200	1100	1200	1100	1200	1150	1200	1175
	h	H	70	395	70	445	70	475	70	510	70	530	70	550	70	595	70	695
125	L	L_1	1300	1000	1300	1050	1300	1050	1300	1100	1300	1100	1300	1150	1300	1200	1300	1178
	h	H	70	410	70	460	70	490	70	525	70	545	70	565	70	610	70	710
150	L	L_1	1300	1000	1300	1050	1300	1050	1300	1100	1300	1150	1300	1200	1300	1200	1300	1203
	h	H	70	430	70	480	70	510	70	545	70	565	70	585	70	630	70	730
200	L	L_1	1400	1050	1400	1100	1400	1150	1400	1150	1400	1200	1400	1250	1400	1300	1400	1263
	h	H	70	470	70	520	70	550	70	585	70	605	70	625	70	670	70	770
250	L	L_1			1500	1200	1500	1200	1500	1250	1500	1250	1500	1300	1500	1350	1500	1330
	h	H			70	570	70	600	70	635	70	655	70	675	70	720	70	820
300	L	L_1					1600	1250	1600	1300	1600	1300	1600	1350	1600	1400	1600	1395
	h	H					70	630	70	665	70	685	70	705	70	750	70	850
350	L	L_1							1700	1350	1700	1350	1700	1400	1700	1450	1700	1415
	h	H							70	700	70	720	70	740	70	785	70	885
400	L	L_1									1700	1400	1700	1450	1700	1500	1700	1455
	h	H									70	740	70	760	70	805	70	905
450	L	L_1											1800	1450	1800	1500	1800	1490
	h	H											70	780	70	825	70	925
500	L	L_1													1800	1600	1800	1545
	h	H													70	870	70	970
600	L	L_1															2000	1700
	h	H															70	1070

ATTENTION: Insulation class 2x reinforced are special products. Please check availability in case of request.

Legend, information and explanation see **previous page**

Parallel-Branch / Insulation Class Standard



Dimensions Insulation Class Standard

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		20		25		32		40		50		65		80		100		125		150	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3	
	s		2,6		3,2		3,2		3,2		3,2		3,2		3,2		3,6		4,0		4,5	
DN	D_a		90		90		110		110		125		140		160		200		225		250	
20	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	210	120	210	120	220	120	220	120	230	120	235	120	245	120	265	120	280	120	290
25	L	L_1			1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H			120	210	120	220	120	220	120	230	120	235	120	245	120	265	120	280	120	290
32	L	L_1					1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H					120	230	120	230	120	240	120	245	120	255	120	275	120	290	120	300
40	L	L_1							1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H							120	230	120	240	120	245	120	255	120	275	120	290	120	300
50	L	L_1									1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H									120	245	120	255	120	265	120	285	120	295	120	310
65	L	L_1											1100	600	1100	600	1100	600	1100	600	1100	600
	h	H											120	260	120	270	120	290	120	305	120	315
80	L	L_1													1200	550	1200	550	1200	550	1200	550
	h	H													130	290	120	300	120	315	120	325
100	L	L_1															1200	600	1200	600	1200	600
	h	H															120	320	120	335	120	345
125	L	L_1																	1300	600	1300	600
	h	H																	140	365	140	380
150	L	L_1																			1300	650
	h	H																			122	375

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm
h = Clear component height in mm
H = Axle distance in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

Edition: 16.01.2012

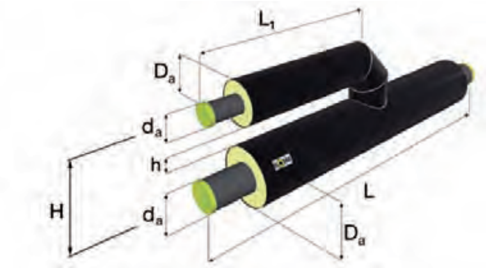
Parallel-Branch / Insulation Class Standard

Dimensions Insulation Class Standard

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		200		250		300		350		400		450		500		600		700		800	
	Inch		8“		10“		12“		14“		16“		18“		20“		24“		28“		32“	
	d_a		219,1		273,0		323,9		355,6		406,4		457,2		508,0		610,0		711,0		813,0	
	s		4,5		5,0		5,6		5,6		6,3		6,3		6,3		7,1		8,0		8,8	
DN	D_a		315		400		450		500		560		630		670		800		900		1000	
20	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	325	120	365	120	390	120	415	120	445	120	480	120	500	120	565	120	615	120	665
25	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	325	120	365	120	390	120	415	120	445	120	480	120	500	120	565	120	615	120	665
32	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	335	120	375	120	400	120	425	120	455	120	490	120	510	120	575	120	625	120	675
40	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	335	120	375	120	400	120	425	120	455	120	490	120	510	120	575	120	625	120	675
50	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	340	120	385	120	410	120	435	120	465	120	500	120	520	120	585	120	635	120	685
65	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	350	120	390	120	415	120	440	120	470	120	505	120	525	120	590	120	640	120	690
80	L	L_1	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600
	h	H	120	360	120	400	120	425	120	450	120	480	120	515	120	535	120	600	120	650	120	700
100	L	L_1	1200	550	1200	550	1200	550	1200	550	1200	550	1200	550	1200	550	1200	550	1200	550	1200	550
	h	H	120	380	120	420	120	445	120	470	120	500	120	535	120	555	120	620	120	670	120	720
125	L	L_1	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600
	h	H	120	390	120	433	120	458	120	483	120	515	120	548	120	568	120	635	120	685	120	735
150	L	L_1	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650
	h	H	114	390	140	465	140	490	140	515	140	545	140	580	140	600	140	665	140	715	140	765
200	L	L_1	1400	700	1400	700	1400	700	1400	700	1400	700	1400	700	1400	700	1400	700	1400	700	1400	750
	h	H	168	485	150	510	150	535	190	600	190	630	180	655	185	680	160	720	160	770	160	820
250	L	L_1			1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800
	h	H			197	600	197	625	188	640	184	665	174	690	230	765	220	820	180	830	180	880
300	L	L_1					1600	850	1600	850	1600	850	1600	850	1600	850	1600	850	1600	850	1600	850
	h	H					261	715	252	730	247	755	238	780	243	805	229	855	230	905	220	945
350	L	L_1							1700	900	1700	900	1700	900	1700	900	1700	900	1700	900	1700	900
	h	H							312	815	308	840	298	865	304	890	289	940	290	990	291	1045
400	L	L_1									1700	1000	1700	1000	1700	1000	1700	1000	1700	1000	1700	1000
	h	H									355	915	345	940	351	970	336	1020	337	1070	338	1120
450	L	L_1											1800	1100	1800	1100	1800	1100	1800	1100	1800	1100
	h	H											399	1030	404	1055	390	1105	391	1160	392	1210
500	L	L_1													1800	1200	1800	1200	1800	1200	1800	1200
	h	H													473	1145	459	1195	460	1245	460	1295
600	L	L_1															2000	1250	2000	1250	2000	1250
	h	H															546	1350	572	1425	573	1475
700	L	L_1																	2100	1400	2100	1400
	h	H																	688	1590	689	1640
800	L	L_1																			2200	1600
	h	H																			816	1820

Legend, information and explanation see **previous page**

Parallel-Branch / Insulation Class 1x reinforced



Dimensions Insulation Class 1x reinforced

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		20		25		32		40		50		65		80		100		125		150	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3	
	s		2,6		3,2		3,2		3,2		3,2		3,2		3,2		3,6		4,0		4,5	
DN	D_a		110		110		125		125		140		160		180		225		250		280	
20	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	230	120	230	120	240	120	240	120	245	120	255	120	265	120	290	120	300	120	315
25	L	L_1			1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H			120	230	120	240	120	240	120	245	120	255	120	265	120	290	120	300	120	315
32	L	L_1					1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H					120	245	120	245	120	255	120	265	120	275	120	295	120	310	120	325
40	L	L_1							1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H							120	245	120	255	120	265	120	275	120	295	120	310	120	325
50	L	L_1									1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H									120	260	120	270	120	280	120	305	120	315	120	330
65	L	L_1											1100	600	1100	600	1100	600	1100	600	1100	600
	h	H											120	280	120	290	120	315	120	325	120	340
80	L	L_1													1200	600	1200	600	1200	600	1200	600
	h	H													120	300	120	325	120	335	120	350
100	L	L_1															1200	600	1200	600	1200	600
	h	H															120	345	120	360	120	375
125	L	L_1																	1300	600	1300	600
	h	H																	120	370	140	405
150	L	L_1																			1300	650
	h	H																			140	420

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm
h = Clear component height in mm
H = Axle distance in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

Edition: 16.01.2012

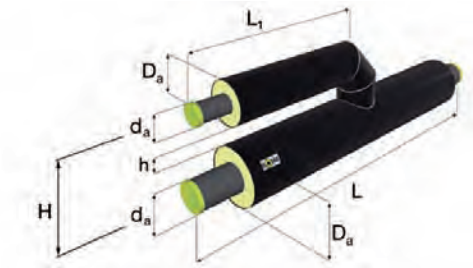
Parallel-Branch / Insulation Class 1x reinforced

Dimensions Insulation Class 1x reinforced

Branch Exit	Transmission respectively main pipe dimensions																					
	DN		200		250		300		350		400		450		500		600		700		800	
	Inch		8“		10“		12“		14“		16“		18“		20“		24“		28“		32“	
	d_a		219,1		273,0		323,9		355,6		406,4		457,2		508,0		610,0		711,0		813,0	
	s		4,5		5,0		5,6		5,6		6,3		6,3		6,3		7,1		8,0		8,8	
DN	D_a		355		450		500		560		630		670		710		900		1000		1100	
20	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	355	120	400	120	425	120	455	120	490	120	510	120	530	120	625	120	675	120	725
25	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	355	120	400	120	425	120	455	120	490	120	510	120	530	120	625	120	675	120	725
32	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	360	120	410	120	435	120	465	120	500	120	520	120	540	120	635	120	685	120	735
40	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	360	120	410	120	435	120	465	120	500	120	520	120	540	120	635	120	685	120	735
50	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	370	120	415	120	440	120	470	120	505	120	525	120	545	120	640	120	690	120	740
65	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	380	120	425	120	450	120	480	120	515	120	535	120	555	120	650	120	700	120	750
80	L	L_1	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600
	h	H	120	390	120	435	120	460	120	490	120	525	120	545	120	565	120	660	120	710	120	760
100	L	L_1	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600
	h	H	120	410	120	460	120	485	120	515	120	550	120	570	120	590	120	685	120	735	120	785
125	L	L_1	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600
	h	H	120	425	120	470	120	495	120	525	120	560	120	580	120	600	120	695	120	745	120	795
150	L	L_1	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650
	h	H	140	460	140	505	140	530	140	560	140	595	140	615	140	635	140	730	140	780	140	830
200	L	L_1	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750
	h	H	128	485	160	565	160	590	160	620	160	655	160	680	160	695	160	790	160	840	160	890
250	L	L_1			1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800
	h	H			147	600	147	625	180	685	170	710	180	740	180	760	180	855	180	905	180	955
300	L	L_1					1600	850	1600	850	1600	850	1600	850	1600	850	1600	850	1600	850	1600	850
	h	H					211	711	197	730	237	805	193	780	198	805	220	920	220	970	220	1020
350	L	L_1							1700	900	1700	900	1700	900	1700	900	1700	900	1700	900	1700	900
	h	H							252	815	243	840	248	865	254	890	260	990	260	1040	260	1090
400	L	L_1									1700	1000	1700	1000	1700	1000	1700	1000	1700	1000	1700	1000
	h	H									285	915	290	940	296	970	300	1065	300	1115	300	1165
450	L	L_1											1800	1100	1800	1100	1800	1100	1800	1100	1800	1100
	h	H											359	1030	364	1055	320	1105	321	1160	322	1210
500	L	L_1													1800	1200	1800	1200	1800	1200	1800	1200
	h	H													433	1145	389	1195	390	1245	390	1295
600	L	L_1															2000	1250	2000	1250	2000	1250
	h	H															446	1350	472	1425	473	1475
700	L	L_1																	2100	1400	2100	1400
	h	H																	588	1590	589	1640
800	L	L_1																			2200	1600
	h	H																			716	1820

Legend, information and explanation see **previous page**

Parallel-Branch / Insulation Class 2x reinforced



Dimensions Insulation Class 2x reinforced

Branch Exit			Transmission respectively main pipe dimensions																			
	DN		20		25		32		40		50		65		80		100		125		150	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3	
	s		2,6		3,2		3,2		3,2		3,2		3,2		3,2		3,6		4,0		4,5	
DN	D_a		125		125		140		140		160		180		200		250		280		315	
20	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	245	120	245	120	255	120	255	120	265	120	275	120	285	120	310	120	325	120	340
25	L	L_1			1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H			120	245	120	255	120	255	120	265	120	275	120	285	120	310	120	325	120	340
32	L	L_1					1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H					120	260	120	260	120	270	120	280	120	290	120	315	120	330	120	350
40	L	L_1							1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H							120	260	120	270	120	280	120	290	120	315	120	330	120	350
50	L	L_1									1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H									120	280	120	290	120	300	120	325	120	340	120	360
65	L	L_1											1100	600	1100	600	1100	600	1100	600	1100	600
	h	H											120	300	120	310	120	335	120	350	120	370
80	L	L_1													1200	600	1200	600	1200	600	1200	600
	h	H													120	320	120	345	120	360	120	380
100	L	L_1															1200	600	1200	600	1200	600
	h	H															120	370	120	385	120	405
125	L	L_1																	1300	600	1300	600
	h	H																	120	400	120	420
150	L	L_1																			1300	650
	h	H																			120	435

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm
h = Clear component height in mm
H = Axle distance in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

Edition: 16.01.2012

Parallel-Branch / Insulation Class 2x reinforced

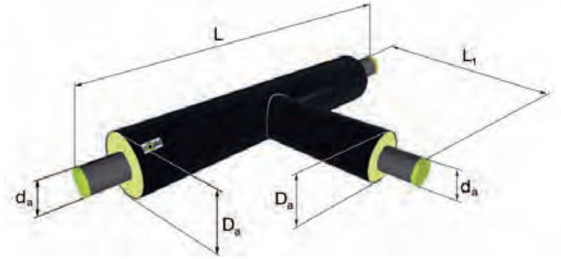
Dimensions Insulation Class 2x reinforced

Branch Exit			Transmission respectively main pipe dimensions															
	DN		200		250		300		350		400		450		500		600	
	Inch		8“		10“		12“		14“		16“		18“		20“		24“	
	d_a		219,1		273,0		323,9		355,6		406,4		457,2		508,0		610,0	
	s		4,5		5,0		5,6		5,6		6,3		6,3		6,3		7,1	
DN	D_a		400		500		560		630		670		710		800		1000	
20	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	385	120	435	120	465	120	500	120	520	120	540	120	585	120	685
25	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	385	120	435	120	465	120	500	120	520	120	540	120	585	120	685
32	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	390	120	440	120	570	120	505	120	525	120	545	120	590	120	690
40	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	390	120	440	120	470	120	505	120	525	120	545	120	590	120	690
50	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	400	120	450	120	480	120	515	120	535	120	555	120	600	120	700
65	L	L_1	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600	1100	600
	h	H	120	410	120	460	120	490	120	525	120	545	120	565	120	610	120	710
80	L	L_1	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600
	h	H	120	420	120	470	120	500	120	535	120	555	120	575	120	620	120	720
100	L	L_1	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600
	h	H	120	445	120	495	120	525	120	560	120	580	120	600	120	645	120	745
125	L	L_1	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600	1300	600
	h	H	120	460	120	510	120	540	120	575	120	595	120	615	120	660	120	760
150	L	L_1	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650	1300	650
	h	H	120	480	120	530	120	560	120	600	120	615	120	635	120	680	120	780
200	L	L_1	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750	1400	750
	h	H	140	540	120	570	120	600	120	635	120	655	120	675	120	720	120	820
250	L	L_1			1500	800	1500	800	1500	800	1500	800	1500	800	1500	800	1500	800
	h	H			150	650	142	675	130	695	130	715	135	740	120	770	130	880
300	L	L_1					1600	850	1600	850	1600	850	1600	850	1600	850	1600	850
	h	H					151	715	185	780	190	805	195	830	175	855	150	930
350	L	L_1							1700	900	1700	900	1700	900	1700	900	1700	900
	h	H							182	815	188	840	245	915	225	940	180	995
400	L	L_1									1700	1000	1700	1000	1700	1000	1700	1000
	h	H									245	915	250	940	231	970	230	1065
450	L	L_1											1800	1100	1800	1100	1800	1100
	h	H											319	1030	299	1055	250	1105
500	L	L_1													1800	1200	1800	1200
	h	H													343	1145	294	1195
600	L	L_1															2000	1250
	h	H															346	1350

ATTENTION: Insulation class 2x reinforced are special products. Please check availability in case of request.

Legend, information and explanation see **previous page**

90°-Vertical-Branch / Insulation Class Standard



Dimensions Insulation Class Standard

Branch Exit	Transmission respectively main pipe dimensions										
	DN	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**
	Inch	¾“	1“	1 ½“	1 ¼“	2“	2 ½“	3“	4“	5“	6“
	d_a	26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3
	s	2,6	3,2	3,2	3,2	3,2	3,2	3,2	3,6	3,6	4,0
DN	**D_a**	90	90	110	110	125	140	160	200	225	250
20	**L**	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	600	600	600	600	600	650	650	650	700	700
25	**L**		1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1		600	600	600	600	650	650	650	700	700
32	**L**			1100	1100	1100	1100	1100	1100	1100	1100
	L_1			600	600	600	650	650	650	700	700
40	**L**				1100	1100	1100	1100	1100	1100	1100
	L_1				600	600	650	650	650	700	700
50	**L**					1100	1100	1100	1100	1100	1100
	L_1					600	650	650	650	700	700
65	**L**						1100	1100	1100	1100	1100
	L_1						650	650	650	700	700
80	**L**							1200	1200	1200	1200
	L_1							650	650	700	700
100	**L**								1200	1200	1200
	L_1								650	700	700
125	**L**									1300	1300
	L_1									700	700
150	**L**										1300
	L_1										700

d_a = Steel pipe outside diameter in mm

s = Steel pipe wall thickness acc. to **isoplus** in mm

D_a = Jacket-pipe outside diameter in mm

L = Construction length passage in mm

L_1 = Construction axis length exit in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

isoplus

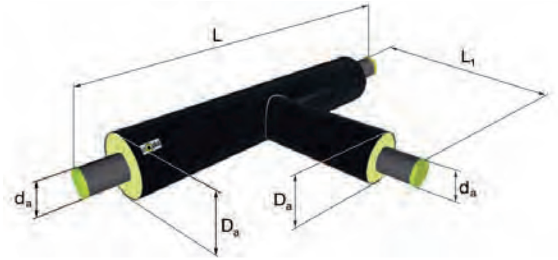
90°-Vertical-Branch / Insulation Class Standard

Dimensions Insulation Class Standard

Branch Exit		Transmission respectively main pipe dimensions									
	DN	200	250	300	350	400	450	500	600	700	800
	Inch	8“	10“	12“	14“	16“	18“	20“	24“	28“	32“
	d_a	219,1	273,0	323,9	355,6	406,4	457,2	508,0	610,0	711,0	813,0
	s	4,5	5,0	5,6	5,6	6,3	6,3	6,3	7,1	8,0	8,8
DN	D_a	315	400	450	500	560	630	670	800	900	1000
20	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
25	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
32	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
40	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
50	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
65	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
80	L	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	L_1	700	800	800	800	800	900	900	1000	1000	1100
100	L	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	L_1	700	800	800	800	800	900	900	1000	1000	1100
125	L	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
	L_1	700	800	800	800	800	900	900	1000	1000	1100
150	L	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
	L_1	700	800	800	800	800	900	900	1000	1000	1100
200	L	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
	L_1	700	800	800	800	800	900	900	1000	1000	1100
250	L		1500	1500	1500	1500	1500	1500	1500	1500	1500
	L_1		800	800	800	800	900	900	1000	1000	1100
300	L			1600	1600	1600	1600	1600	1600	1600	1600
	L_1			800	800	800	900	900	1000	1000	1100
350	L				1700	1700	1700	1700	1700	1700	1700
	L_1				800	800	900	900	1000	1000	1100
400	L					1700	1700	1700	1700	1700	1700
	L_1					800	900	900	1000	1000	1100
450	L						1800	1800	1800	1800	1800
	L_1						900	900	1000	1000	1100
500	L							1800	1800	1800	1800
	L_1							900	1000	1000	1100
600	L								2000	2000	2000
	L_1								1000	1000	1100
700	L									2100	2100
	L_1									1000	1100
800	L										2200
	L_1										1100

Legend, information and explanation see **previous page**

90°-Vertical-Branch / Insulation Class 1x reinforced



Dimensions Insulation Class 1x reinforced

Branch Exit	Transmission respectively main pipe dimensions										
	DN	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**
	Inch	¾"	1"	1 ½"	1 ¼"	2"	2 ½"	3"	4"	5"	6"
	d_a	26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3
	s	2,6	3,2	3,2	3,2	3,2	3,2	3,2	3,6	4,0	4,5
DN	**D_a**	110	110	125	125	140	160	180	225	250	280
20	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	600	600	600	600	600	650	650	650	700	700
25	L		1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1		600	600	600	600	650	650	650	700	700
32	L			1100	1100	1100	1100	1100	1100	1100	1100
	L_1			600	600	600	650	650	650	700	700
40	L				1100	1100	1100	1100	1100	1100	1100
	L_1				600	600	650	650	650	700	700
50	L					1100	1100	1100	1100	1100	1100
	L_1					600	650	650	650	700	700
65	L						1100	1100	1100	1100	1100
	L_1						650	650	650	700	700
80	L							1200	1200	1200	1200
	L_1							650	650	700	700
100	L								1200	1200	1200
	L_1								650	700	700
125	L									1300	1300
	L_1									700	700
150	L										1300
	L_1										700

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

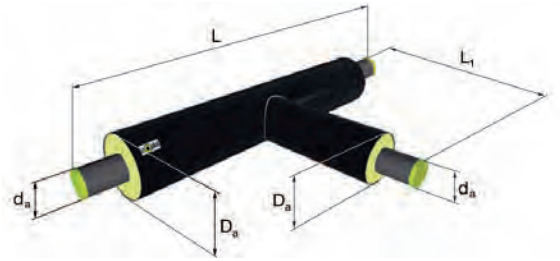
90°-Vertical-Branch / Insulation Class 1x reinforced

Dimensions Insulation Class 1x reinforced

Branch Exit		Transmission respectively main pipe dimensions									
	DN	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**	**700**	**800**
	Inch	8“	10“	12“	14“	16“	18“	20“	24“	28“	32“
	d_a	219,1	273,0	323,9	355,6	406,4	457,2	508,0	610,0	711,0	813,0
	s	4,5	5,0	5,6	5,6	6,3	6,3	6,3	7,1	8,0	8,8
DN	**D_a**	355	450	500	560	630	670	710	900	1000	1100
20	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
25	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
32	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
40	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
50	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
65	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000	1000	1100
80	L	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	L_1	700	800	800	800	800	900	900	1000	1000	1100
100	L	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	L_1	700	800	800	800	800	900	900	1000	1000	1100
125	L	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
	L_1	700	800	800	800	800	900	900	1000	1000	1100
150	L	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
	L_1	700	800	800	800	800	900	900	1000	1000	1100
200	L	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
	L_1	700	800	800	800	800	900	900	1000	1000	1100
250	L		1500	1500	1500	1500	1500	1500	1500	1500	1500
	L_1		800	800	800	800	900	900	1000	1000	1100
300	L			1600	1600	1600	1600	1600	1600	1600	1600
	L_1			800	800	800	900	900	1000	1000	1100
350	L				1700	1700	1700	1700	1700	1700	1700
	L_1				800	800	900	900	1000	1000	1100
400	L					1700	1700	1700	1700	1700	1700
	L_1					800	900	900	1000	1000	1100
450	L						1800	1800	1800	1800	1800
	L_1						900	900	1000	1000	1100
500	L							1800	1800	1800	1800
	L_1							900	1000	1000	1100
600	L								2000	2000	2000
	L_1								1000	1000	1100
700	L									2100	2100
	L_1									1000	1100
800	L										2200
	L_1										1100

Legend, information and explanation see **previous page**

90°-Vertical-Branch / Insulation Class 2x reinforced



Dimensions Insulation Class 2x reinforced

Branch Exit	Transmission respectively main pipe dimensions										
	DN	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**
	Inch	¾“	1“	1 ½“	1 ¼“	2“	2 ½“	3“	4“	5“	6“
	d_a	26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3
	s	2,6	3,2	3,2	3,2	3,2	3,2	3,2	3,6	4,0	4,5
DN	**D_a**	125	125	140	140	160	180	200	250	280	315
20	L	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	600	600	600	600	600	650	650	650	700	700
25	L		1100	1100	1100	1100	1100	1100	1100	1100	1100
	L_1		600	600	600	600	650	650	650	700	700
32	L			1100	1100	1100	1100	1100	1100	1100	1100
	L_1			600	600	600	650	650	650	700	700
40	L				1100	1100	1100	1100	1100	1100	1100
	L_1				600	600	650	650	650	700	700
50	L					1100	1100	1100	1100	1100	1100
	L_1					600	650	650	650	700	700
65	L						1100	1100	1100	1100	1100
	L_1						650	650	650	700	700
80	L							1200	1200	1200	1200
	L_1							650	650	700	700
100	L								1200	1200	1200
	L_1								650	700	700
125	L									1300	1300
	L_1									700	700
150	L										1300
	L_1										700

d_a = Steel pipe outside diameter in mm
s = Steel pipe wall thickness acc. to **isoplus** in mm
D_a = Jacket-pipe outside diameter in mm
L = Construction length passage in mm
L_1 = Construction axis length exit in mm

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. Length of bare steel pipe ends: 220 mm ± 10 mm.

For reasons of optimization and in order to follow the actual technical standard we will reserve modifications of dimensions as well as technical modifications. No obligation can be derived in case of possible dimension variations as well as in case of technical modifications.

Edition: 16.01.2012

90°-Vertical-Branch / Insulation Class 2x reinforced

Dimensions Insulation Class 2x reinforced

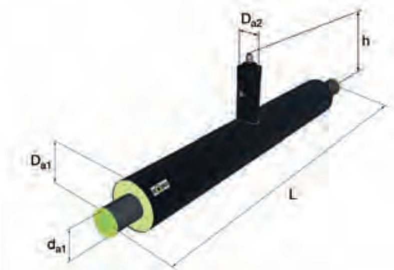
Branch Exit	Transmission respectively main pipe dimensions								
	DN	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**600**
	Inch	8“	10“	12“	14“	16“	18“	20“	24“
	d_a	219,1	273,0	323,9	355,6	406,4	457,2	508,0	610,0
	s	4,5	5,0	5,6	5,6	6,3	6,3	6,3	7,1
DN	**D_a**	400	500	450	560	670	710	800	1000
20	L	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000
25	L	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000
32	L	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000
40	L	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000
50	L	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000
65	L	1100	1100	1100	1100	1100	1100	1100	1100
	L_1	700	800	800	800	800	900	900	1000
80	L	1200	1200	1200	1200	1200	1200	1200	1200
	L_1	700	800	800	800	800	900	900	1000
100	L	1200	1200	1200	1200	1200	1200	1200	1200
	L_1	700	800	800	800	800	900	900	1000
125	L	1300	1300	1300	1300	1300	1300	1300	1300
	L_1	700	800	800	800	800	900	900	1000
150	L	1300	1300	1300	1300	1300	1300	1300	1300
	L_1	700	800	800	800	800	900	900	1000
200	L	1400	1400	1400	1400	1400	1400	1400	1400
	L_1	700	800	800	800	800	900	900	1000
250	L		1500	1500	1500	1500	1500	1500	1500
	L_1		800	800	800	800	900	900	1000
300	L			1600	1600	1600	1600	1600	1600
	L_1			800	800	800	900	900	1000
350	L				1700	1700	1700	1700	1700
	L_1				800	800	900	900	1000
400	L					1700	1700	1700	1700
	L_1					800	900	900	1000
450	L						1800	1800	1800
	L_1						900	900	1000
500	L							1800	1800
	L_1							900	1000
600	L								2000
	L_1								1000

ATTENTION: Insulation class 2x reinforced are special products. Please check availability in case of request.

Legend, information and explanation see **previous page**

Edition: 16.01.2012

2.2.9 Drain / Vent - Branch



Dimensions carrier pipe				Jacket-Pipe-Outside-diameter **D_{a1}** in mm			Drain / Vent			Overall-length **L** in mm
Nominal Diameter / Dimension in		Outside-Ø **d_{a1}** in mm	Wall-thickness **s** in mm	Insulation Class			Nom. Diameter in	Jack.-P.-Ø **D_{a2}** in mm	Overall-height **h** in mm	
DN	**Inch**			**Standard**	**1x reinforced**	**2x reinforced**	**DN**	**Standard**		
25	1"	33,7	3,2	90	110	*125*	25	90	1000	1100
32	1¼"	42,4	3,2	110	125	*140*	25	90	1000	1100
40	1½"	48,3	3,2	110	125	*140*	25	90	1000	1100
50	2"	60,3	3,2	125	140	*160*	25	90	1000	1100
65	2½"	76,1	3,2	140	160	*180*	25	90	1000	1100
80	3"	88,9	3,2	160	180	*200*	50	125	1000	1100
100	4"	114,3	3,6	200	225	*250*	50	125	1000	1100
125	5"	139,7	3,6	225	250	*280*	50	125	1000	1100
150	6"	168,3	4,0	250	280	*315*	50	125	1000	1100
200	8"	219,1	4,5	315	355	*400*	50	125	1000	1100
≥ 250	10"	273,0	5,0	400	450	*500*	50	125	1000	1200

ATTENTION: Italicised mentioned jacket-pipe dimensions (*) are special productions. Please check availability in case of requirement. The ELE-/ELÜ ball-valve is made only in the mentioned sizes with standard insulation thickness. Other insulation thickness is not available!

Carrier Pipe with corresponding wall thickness like the pipe bars. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm.

Carried out as a vertical branch in accordance with **chapter 2.2.8**. At the outlet end, however, an ELE-/ELÜ ball valve (reduced bore) is fitted with a stainless steel housing and internal thread connection together with the associated plug. The factory fitted shrunk-on end cap is between the HDPE casing pipe end and the ball valve. For a detailed description of the ELE-/ELÜ- ball valve see **chapter 2.2.10**.

Assembling hint see **chapter 10.2.6**
Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.2.1**.
Material specification PUR-Hard foam see **chapter 7.1.7**

2.2.10 Drain / Vent - Pipe

As an alternative to the ELE-/ELÜ branch, it is possible to put together drainage or vents on site using a modular principle. Here the ELE-/ELÜ pipe is to be welded on to a vertical branch as in **chapter 2.2.8**. This has the advantage that the height of the ELE-/ELÜ ball valve can be exactly adapted to local conditions. The PEHD casing pipe coupler required for this is not included with the ELE-/ELÜ pipe.

Carrier Pipe with corresponding wall thickness like the pipe bars. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm.

At the end of the tube is an ELE-/ELÜ ball valve (reduced bore) mounted with a stainless steel housing and internal thread connection and the associated end cap. The factory fitted shrunk on end cap is between the PEHD casing pipe end and the ball valve.

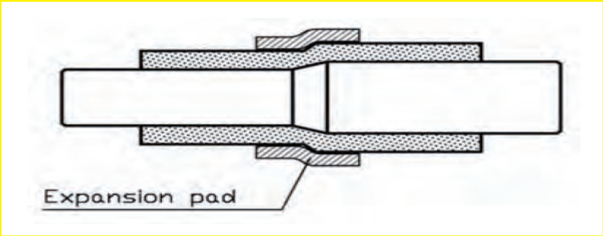
The valve housing and valve plug of the ball valve are made of stainless steel, material no. 1.4301 with a cylindrical internal or external thread conforming to DIN EN 10226-1 or DIN EN ISO 228-1. The actuation of the ball valve is with a No. 19 Allen key, the position indicator is on the housing. To fit the plug a No. 19 Allen key is required for DN 25 and No. 27 for DN 50.

Material specifications jacket pipe see **chapter 2.1.4**
Material specifications carrier pipe see **chapter 2.2.1**
Material specifications PUR hard foam see **chapter 7.1.7**

2.2.11 Reducing Piece

In order to avoid not permissible high frontal soilpressure loads due to axial expansion movements, it may be reduced maximal about two nominal diameters. At the bonding area of a thermal pre-stressed line generally only **one** dimension step will be allowed.

The reducing piece has to be padded generally at the centric jacket-pipe reduction. The expansion pad is not included in the delivery range of the reducing piece.



As carrier pipe reduction generally a conical respectively a centric steel piece acc. to DIN 10253-2 with welded pipe-socket will be used.

From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm.

Cylindrical pipe depending on size available as seamless or welded steel with corresponding wall thickness like the pipe bars.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.2.1**
Material specification PUR-Hard foam see **chapter 7.1.7**

Edition: 16.01.2012

Dimensions Reducing Piece

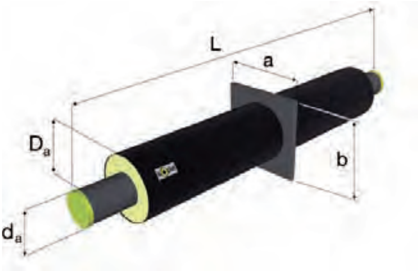
Nominal Dimension 1					Nominal Dimension 2					Overall-length
Carrier Pipe		Jacket-Pipe-Outside-Ø D_{a1} in mm			Carrier Pipe		Jacket-Pipe-Outside-Ø D_{a2} in mm			
Nominal Dimension	Outside-Ø d_{a1} in mm	Insulation Class			Nominal Dimension	Outside-Ø d_{a2} in mm	Insulation Class			L in mm
DN		**Standard**	**1x reinf.**	**2x reinf.**	**DN**		**Standard**	**1x reinf.**	**2x reinf.**	
25	33,7	90	110	*125*	**20**	26,9	90	110	*125*	1500
32	42,4	110	125	*140*	**25** **20**	33,7 26,9	90 90	110 110	*125* *125*	1500
40	48,3	110	125	*140*	**32** **25**	42,4 33,7	110 90	125 110	*140* *125*	1500
50	60,3	125	140	*160*	**40** **32**	48,3 42,4	110 110	125 125	*140* *140*	1500
65	76,1	140	160	*180*	**50** **40**	60,3 48,3	125 110	140 125	*160* *140*	1500
80	88,9	160	180	*200*	**65** **50**	76,1 60,3	140 125	160 140	*180* *160*	1500
100	114,3	200	225	*250*	**80** **65**	88,9 76,1	160 140	180 160	*200* *180*	1500
125	139,7	225	250	*280*	**100** **80**	114,3 88,9	200 160	225 180	*250* *200*	1500
150	168,3	250	280	*315*	**125** **100**	139,7 114,3	225 200	250 225	*280* *250*	1500
200	219,1	315	355	*400*	**150** **125**	168,3 139,7	250 225	280 250	*315* *280*	1500
250	273,0	400	450	*500*	**200** **150**	219,1 168,3	315 250	355 280	*400* *315*	1500
300	323,9	450	500	*560*	**250** **200**	273,0 219,1	400 315	450 355	*500* *400*	1500
350	355,6	500	560	*630*	**300** **250**	323,9 273,0	450 400	500 450	*560* *500*	1500
400	406,4	560	630	*670*	**350** **300**	355,6 323,9	500 450	560 500	*630* *560*	1500
450	457,0	630	670	*710*	**400** **350**	406,4 355,6	560 500	630 560	*670* *630*	1500
500	508,0	670	710	*800*	**450** **400**	457,0 406,4	630 560	670 630	*710* *670*	1500
600	610,0	800	900	*1000*	**500** **450**	508,0 457,0	670 630	710 670	*800* *710*	1500

ATTENTION: Italicised mentioned jacket-pipe dimensions (*) are special productions. Please check availability in case of requirement.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.2.1**.
Material specification PUR-Hard Foam see **chapter 7.1.7**.

Edition: 16.01.2012

2.2.12 Anchor



Dimensions Carrier Pipe				Jacket-Pipe Outside-Diameter D_a in mm			Minimum Dimensions Steel Flange		Overall-length
Nominal Diameter / Dimension in		Outside-Ø d_a in mm	Wall-thickness s in mm	Insulation Class			Lateral Length a • b in mm	Steel-thickness s in mm	L in mm
DN	Inch			Standard	1x reinforced	2x reinforced			
20	¾“	26,9	2,6	90	110	125	200 • 200	15	2000
25	1“	33,7	3,2	90	110	125	200 • 200	15	2000
32	1¼“	42,4	3,2	110	125	140	200 • 200	15	2000
40	1½“	48,3	3,2	110	125	140	200 • 200	15	2000
50	2“	60,3	3,2	125	140	160	250 • 250	20	2000
65	2½“	76,1	3,2	140	160	180	250 • 250	20	2000
80	3“	88,9	3,2	160	180	200	250 • 250	20	2000
100	4“	114,3	3,6	200	225	250	330 • 330	25	2000
125	5“	139,7	3,6	225	250	280	330 • 330	25	2000
150	6“	168,3	4,0	250	280	315	380 • 380	25	2000
200	8“	219,1	4,5	315	355	400	500 • 500	25	2000
250	10“	273,0	5,0	400	450	500	600 • 600	30	2000
300	12“	323,9	5,6	450	500	560	700 • 700	30	2000

ATTENTION: Anchors are special productions. Please check availability in case of requirement.

The mentioned steel pipe wall thicknesses are corresponding with the minimum requirements acc. to the standard respectively to the **isoplus** standard wall thicknesses. These have to be calculated generally against inside pressure [p] according to DIN 2413. Carrier pipe with corresponding wall thickness as the rigid pipe bars. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm.

Steel flange at anchor quadric in discoid construction, designed for max. load of $L_{max}/2$. The occurring forces will be transferred via this flange to the corresponding dimensioned concreteblock. Two kinds of construction are available:

Type A: **Standard**-construction
Type B: **Thermal- and electrical seperated** construction

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.2.1**
Material specification PUR-Hard Foam see **chapter 7.1.7**
Assembling anchor - concrete block in B 25 see **chapter 10.2.7**

2.3.1 Advantages / Carrier Pipe / Connection Technology / Operating Conditions

Advantages

⇒ essential less heat-loss, more economic production of preinstalled pipe system
⇒ 50% reduced use of connection couplers
⇒ essential reduction of expansion pads at angles and T-pieces
⇒ more fast total construction time, shorter traffic hindrance etc.
⇒ pipe-static dimensioning only for medium temperature of primary- and secondary line
⇒ no trench jumps at branches (flow- and exit on same level)
⇒ no additional fittings are required for expansion compensation
⇒ double working distance of leak detecting- and location systems
⇒ reduced excavated material and re-installation

Carrier Pipe, welded

Welded, circular, unalloyed and calmed down steel, description and technical conditions acc. to EN 253, EN 10217-1 and -2.

Materials P235GH (1.0345), P235TR1 (1.0254), P235TR2 (1.0255). All pipes acc. to EN 10204 - 3.1 with acceptance certificate (APZ) approved. From wall thickness > 3,0 mm with welding-seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1.

ATTENTION: For the production of **isopipe®**-Double exclusively welded carrier pipe is used.

Connection Technology

The joints between the steel pipes can be made using the following methods according to DIN ISO 857-1: manual arc welding, gas welding with oxygen-acetylene flame, tungsten inert gas (TIG) or a combination of processes. The testing and evaluation of the quality of the weld is according to AGFW Worksheet FW 446.

Operating Conditions

Maximum operating temperature T_{max} :	at least acc. to EN 253
Maximum permissible Spread VL / RL (ΔT) :	90 K
Maximum operating pressure p_B :	25 bar
Maximum permissible axial-tension σ_{max} :	190 N/mm²
Leak detecting:	**IPS-Cu®** and **IPS-NiCr®**, at continuous production only **IPS-Cu®**
Possible liquids: Heating water as well as other material resistant liquids	

Technical data P235TR1/TR2/GH bei 20° C					
Property	**Unit**	**Value**	**Property**	**Unit**	**Value**
Volume weight ρ	kg/dm³	7,85	Elastic modulus E	N/mm²	211.800
Tensile stress R_m	N/mm²	360 - 500	Thermal conductivity λ	W/(m•K)	55,2
Yield stress R_e	N/mm²	235	Specific heat capacity c_m	kJ/kg°C	0,46
Wall roughness k	mm	0,02	Thermal expansion coeff. α at T_{max}	K^{-1}	$11,3 \cdot 10^{-6}$

Carrier pipe wall thickness see **chapter 2.3.2** resp. **2.3.3**.

2.3.2 Dimensions resp. Types — straight pipe bar - Disconti

Discontinuous production - Carrier Pipe, welded

Type	Dimensions Steel Pipe P235TR1 / TR2 / GH					Dimensions Jacket-Pipe PEHD								Clear Pipe-distance	Weight without Water G in kg/m (s acc. to isoplus)	
	Nominal Diameter / Dimension in		Outside-Ø	Wall-thickness acc. to isoplus	Wall-thickness acc. to EN 253	PEHD - Jacket-Pipe-Outside-Ø • Wall thickness D_a • s in mm										
			d_a	s	s	Insulation Class / Del. length L in m								h_s	Insulation Class	
	DN	Inch	in mm	in mm	in mm	Standard	6	12	16	1x reinforced	6	12	16	in mm	Standard	1x reinf.
DRD-20	20	3/4“	2 • 26,9	2,6	2,0	125 • 3,0	√	√	-	140 • 3,0	√	√	-	19	4,92	5,27
DRD-25	25	1“	2 • 33,7	3,2	2,3	140 • 3,0	√	√	-	160 • 3,0	√	√	-	19	6,91	7,41
DRD-32	32	1¼“	2 • 42,4	3,2	2,6	160 • 3,0	√	√	-	180 • 3,0	√	√	-	19	8,70	9,23
DRD-40	40	1½“	2 • 48,3	3,2	2,6	160 • 3,0	√	√	-	180 • 3,0	√	√	-	19	9,58	10,11
DRD-50	50	2“	2 • 60,3	3,2	2,9	200 • 3,2	√	√	-	225 • 3,4	√	√	-	20	12,56	13,49
DRD-65	65	2½“	2 • 76,1	3,2	2,9	225 • 3,4	√	√	-	250 • 3,6	√	√	-	20	15,73	16,75
DRD-80	80	3“	2 • 88,9	3,2	3,2	250 • 3,6	√	√	-	280 • 3,9	√	√	-	25	18,54	19,93
DRD-100	100	4“	2 • 114,3	3,6	3,6	315 • 4,1	√	√	√	355 • 4,5	√	√	√	25	27,20	29,52
DRD-125	125	5“	2 • 139,7	3,6	3,6	400 • 4,8	√	√	√	450 • 5,2	√	√	√	30	36,05	39,54
DRD-150	150	6“	2 • 168,3	4,0	4,0	450 • 5,2	√	√	√	500 • 5,6	√	√	√	40	46,83	50,70
DRD-200	200	8“	2 • 219,1	4,5	4,5	560 • 6,0	√	√	√	630 • 6,6	√	√	√	45	70,61	75,56

For nominal diameters DN 25 to DN 65 isoplus provides only steel pipes and fittings with wall thickness of 3,2 mm, this is to observe in comparison with competitors.

Length of bare steel pipe ends: 220 mm ± 10 mm. Wall thickness jacket pipe **isoplus** acc. to EN 253, Wall thickness carrier pipe **isoplus** acc. to AGFW FW 401. The mentioned steel wall thicknesses are corresponding with the standard wall thicknesses of **isoplus**, which are generally calculated against inside pressure [p] acc. to DIN 2413. The mentioned weights are valid for steel wall thickness acc. to **isoplus**, material density [ρ] P235 = Ø 7,85 kg/dm^3, PUR-Foam = Ø 0,07 kg/dm^3, PEHD = Ø 0,95 kg/dm^3.

Auxiliary ridges may be located in the pipe bars. However, these have no pipe-static function. They serve only as a centering during production. In order to improve and to follow the technical development we will reserve technical modifications of the values mentioned in the table.

Specification carrier pipe see **chapter 2.3.1**

Edition: 16.01.2012

2.3.2 Dimensions resp. Types — straight pipe bar - Conti

Continuous Production - Carrier-Pipe, welded

Type	Dimensions Carrier pipe P235TR1 / TR2 / GH					Dimensions Jacket-Pipe PEHD								Clear Pipe-distance	Weight without Water **G** in kg/m (**s** acc. to **isoplus**)	
	Nominal Diameter / Dimension in		Outside-Ø d_a in mm	Wall-thickn. acc. to **isoplus** **s** in mm	Wall-thickn. acc. to EN 253 **s** in mm	PEHD - Jacket-Pipe Outside-Ø • Wall thickness D_a • **s** in mm								h_s in mm		
						Insulation Class / Del. Length **L** in m									Insulation Class	
	DN	**Inch**				**Standard**	**6**	**12**	**16**	**1x reinf.**	**6**	**12**	**16**		**Standard**	**1x reinf.**
KRD-25	**25**	1“	2 • 33,7	3,2	2,3	140 • 3,0	-	√	-	160 • 3,0	-	√	-	19	6,83	7,36
KRD-32	**32**	1¼“	2 • 42,4	3,2	2,6	160 • 3,0	-	√	-	180 • 3,0	-	√	-	19	8,61	9,18
KRD-40	**40**	1½“	2 • 48,3	3,2	2,6	160 • 3,0	-	√	-	180 • 3,0	-	√	-	19	9,46	10,03
KRD-50	**50**	2“	2 • 60,3	3,2	2,9	200 • 3,2	-	√	-	225 • 3,4	-	√	-	20	12,84	13,77
KRD-65	**65**	2½“	2 • 76,1	3,2	2,9	225 • 3,4	-	√	-	250 • 3,6	-	√	-	20	15,92	17,05
KRD-80	**80**	3“	2 • 88,9	3,2	3,2	250 • 3,6	-	√	-	280 • 3,9	-	√	-	25	18,76	20,20
KRD-100	**100**	4“	2 • 114,3	3,6	3,6	315 • 4,1	-	√	-	355 • 4,5	-	√	-	25	27,62	30,42

For nominal diameters DN 25 to DN 65 isoplus provides only steel pipes and fittings with wall thickness of 3,2 mm, this is to observe in comparison with competitors.

Length of bare steel pipe ends: 220 mm ± 10 mm. Wall thickness jacket pipe **isoplus** acc. to EN 253, Wall thickness carrier pipe **isoplus** acc. to AGFW FW 401. The mentioned steel wall thicknesses are corresponding with the standard wall thicknesses of **isoplus**, which are generally calculated against inside pressure [p] acc. to DIN 2413. The mentioned weights are valid for steel wall thickness acc. to **isoplus**, material density [ρ] P235 = Ø 7,85 kg/dm^3, PUR-Foam = Ø 0,07 kg/dm^3, PEHD = Ø 0,95 kg/dm^3.

Specification carrier pipe see **chapter 2.3.1**.

2.3.4 Dimensions resp. Types — Bowed Pipe

Discontinuous und continuous production

Dimensions carrier pipe		Max. permissible bow-angle	Minimum-bending-radius	Circle segment at r_{Fmin} and 12,00 m		
Nominal Diameter in **DN**	Outside-Ø d_a in mm	α_{max} in °	$r_{F\,min}$ in m	Secant-length s_L in m	Secant-height s_{hF} in m	Tangent-length t_L in m
50	2 • 60,3	40,0	11,75	11,56	1,28	6,15
65	2 • 76,1	36,0	13,05	11,64	1,15	6,12
80	2 • 88,9	34,0	13,82	11,68	1,09	6,11
100	2 • 114,3	28,0	16,78	11,78	0,90	6,07
125	2 • 139,7	28,0	16,78	11,78	0,90	6,07
150	2 • 168,3	25,0	18,80	11,83	0,80	6,06
200	2 • 219,1	22,5	15,30	11,86	0,83	6,05

The double pipe / bowed pipe production used at the factory is only possible with a high density polyethylene jacket in 12 m lengths and only above a nominal diameter of DN 50. The values given in the table are valid regardless of the PEHD casing pipe diameter (standard or 1x reinforced). For nominal diameters DN 20 to DN 80, it is usually sufficient to compensate for pipe elbows with on-site bending (elastic distortion of a pipe length).

Due to production constraints, bowed pipes of up to PEHD casing pipe diameters **D_a** ≤ 450 mm have 2,0 m long straight pipe ends, while from **D_a** ≥ 500 these ends are approximately 3,0 m long. For this reason, the production bending radius [r_F] is also different from the design radius [r_P], see **chapter 2.2.4**.

Bowed pipes are bent mechanically according to the route of the pipeline and the permitted production bending radius, according to local management instructions (bending angle and design radius). When ordering, the angle, design radius and bending direction, left or right (depending on the route of the network monitoring) should be given. If necessary, these parameters are determined by **isoplus**.

Edition: 16.01.2012

2.3.5 Energy Loss isoplus - Double Pipe Disconti

Type	Jacket-Pipe Outside-Diameter D_a in mm		Coefficient u_{DRD} in W/(m•K)		**q** at average temperature T_M = **100 K** in W/m		**q** at average temperature T_M = **60 K** in W/m		**q** at average temperature T_M = **50 K** in W/m	
	Insulation Class		Insulation Class		Insulation Class		Insulation Class		Insulation Class	
	Standard	1 x reinforced	Standard	1 x reinforced	Standard	1 x reinforced	Standard	1 x reinforced	Standard	1 x reinforced
DRD - 20	125	140	0,2039	0,1841	20,382	18,405	14,271	12,887	10,197	9,208
DRD - 25	140	160	0,2227	0,1954	22,269	19,539	15,592	13,680	11,141	9,775
DRD - 32	160	180	0,2424	0,2133	24,237	21,320	16,971	14,929	12,128	10,668
DRD - 40	160	180	0,2858	0,2425	28,567	24,241	20,003	16,974	14,293	12,129
DRD - 50	200	225	0,2797	0,2407	27,963	24,065	19,580	16,851	13,992	12,041
DRD - 65	225	250	0,3293	0,2775	32,917	27,746	23,049	19,427	16,470	13,882
DRD - 80	250	280	0,3710	0,2970	37,091	29,689	25,970	20,789	18,556	14,856
DRD - 100	315	355	0,3748	0,2996	37,474	29,952	26,237	20,975	18,746	14,990
DRD - 125	400	450	0,3630	0,2928	36,291	29,266	25,411	20,495	18,157	14,648
DRD - 150	450	500	0,4192	0,3301	41,911	32,991	29,343	23,104	20,965	16,513
DRD - 200	560	630	0,4754	0,3492	47,538	34,901	33,278	24,442	23,772	17,469

Energy Loss Comparison Double- to Single Pipe, T_M = 70 K, discontinuous production

Double Pipe - Standard			2x Single Pipe - Standard Insulation Class				2x Single Pipe - 1x reinf. Insulation Class			
Type	Heat Loss		PEHD-Ø D_a in mm	Heat Loss		Saving in %	PEHD-Ø D_a in mm	Heat Loss		Saving in %
	u_{DRD} in W/(m•K)	q_{DRD} in W/m		u_{DRE} in W/(m•K)	q_{DRE} in W/m			u_{DRE} in W/(m•K)	q_{DRE} in W/m	
DRD - 20	0,2039	14,271	90	0,2673	18,713	23,74	110	0,2299	16,090	11,30
DRD - 25	0,2227	15,592	90	0,3251	22,754	31,47	110	0,2713	18,989	17,89
DRD - 32	0,2424	16,971	110	0,3323	23,260	27,04	125	0,2946	20,623	17,71
DRD - 40	0,2858	20,003	110	0,3809	26,662	24,98	125	0,3322	23,254	13,98
DRD - 50	0,2797	19,580	125	0,4244	29,710	34,10	140	0,3710	25,973	24,61
DRD - 65	0,3293	23,049	140	0,4977	34,839	33,84	160	0,4155	29,088	20,76
DRD - 80	0,3710	25,970	160	0,5133	35,930	27,72	180	0,4354	30,476	14,78
DRD - 100	0,3748	26,237	200	0,5440	38,077	31,09	225	0,4571	31,995	18,00
DRD - 125	0,3630	25,411	225	0,6264	43,850	42,05	250	0,5254	36,781	30,91
DRD - 150	0,4192	29,343	250	0,7384	51,691	43,23	280	0,5937	41,558	29,39
DRD - 200	0,4754	33,278	315	0,8035	56,242	40,83	355	0,6308	44,156	24,63

Double Pipe - 1x reinforced			2x Single Pipe - 1x reinf. Insulation Class				2x Single Pipe - 2x reinf. Insulation Class			
Type	Heat Loss		PEHD-Ø D_a in mm	Heat Loss		Saving in %	PEHD-Ø D_a in mm	Heat Loss		Saving in %
	u_{DRD} in W/(m•K)	q_{DRD} in W/m		u_{DRE} in W/(m•K)	q_{DRE} in W/m			u_{DRE} in W/(m•K)	q_{DRE} in W/m	
DRD - 20	0,1841	12,887	110	0,2299	16,090	19,91	125	0,2112	14,782	12,82
DRD - 25	0,1954	13,680	110	0,2713	18,989	27,96	125	0,2456	17,194	20,44
DRD - 32	0,2133	14,929	125	0,2946	20,623	27,61	140	0,2679	18,751	20,38
DRD - 40	0,2425	16,974	125	0,3322	23,254	27,01	140	0,2986	20,901	18,79
DRD - 50	0,2407	16,851	140	0,3710	25,973	35,12	160	0,3234	22,636	25,56
DRD - 65	0,2775	19,427	160	0,4155	29,088	33,21	180	0,3630	25,407	23,54
DRD - 80	0,2970	20,789	180	0,4354	30,476	31,79	200	0,3877	27,141	23,40
DRD - 100	0,2996	20,975	225	0,4571	31,995	34,44	250	0,4009	28,061	25,25
DRD - 125	0,2928	20,495	250	0,5254	36,781	44,28	280	0,4478	31,343	34,61
DRD - 150	0,3301	23,104	280	0,5937	41,558	44,41	315	0,4945	34,618	33,26
DRD - 200	0,3492	24,442	355	0,6308	44,156	44,65	400	0,5190	36,327	32,72

The mentioned data are based on a covering height [$Ü_H$] of 0,60 m, a thermal conductivity of soil [λ_E] of 1,2 W/(m•K), a soil temperature [T_E] of 10 °C as well as a pipe distance of 150 mm at single-pipes;
$T_M = (T_{VL} + T_{RL}) : 2 - T_E \Rightarrow$ Example: (100° + 60°) : 2 - 10° = 70 K.

2.3.6 Energy Loss isoplus - Double Pipe Conti

Type	Jacket-Pipe Outside-Diameter D_a in mm		Coefficient u_{KRD} in W/(m•K)		q at average temperature T_M = 100 K in W/m		q at average temperature T_M = 70 K in W/m		q at average temperature T_M = 50 K in W/m	
	Insulation Class		Insulation Class		Insulation Class		Insulation Class		Insulation Class	
	Standard	1 x reinf.	Standard	1 x reinf.	Standard	1 x reinf.	Standard	1 x reinf.	Standard	1 x reinf.
KRD - 25	140	160	0,2004	0,1760	20,040	17,600	14,028	12,320	10,020	8,800
KRD - 32	160	180	0,2176	0,1919	21,760	19,190	15,232	13,433	10,880	9,595
KRD - 40	160	180	0,2563	0,2180	25,630	21,800	17,941	15,260	12,815	10,900
KRD - 50	200	225	0,2483	0,2148	24,830	21,480	17,381	15,036	12,415	10,740
KRD - 65	225	250	0,2920	0,2476	29,200	24,760	20,440	17,332	14,600	12,380
KRD - 80	250	280	0,3279	0,2651	32,790	26,510	22,953	18,557	16,395	13,255
KRD - 100	315	355	0,3307	0,2663	33,070	26,630	23,149	18,641	16,535	13,315

Energy Loss Comparison Double- to Single Pipe, T_M = 70 K, continuous production

Double Pipe - Standard			2x Single Pipe - Standard Insulation Class				2x Single Pipe - 1x reinf. Insulation Class			
Type	Heat Loss		PEHD-Ø	Heat Loss		Saving in %	PEHD-Ø	Heat Loss		Saving in %
	u_{KRD} in W/(m•K)	q_{KRD} in W/m	D_a in mm	u_{KRE} in W/(m•K)	q_{KRE} in W/m		D_a in mm	u_{KRE} in W/(m•K)	q_{KRE} in W/m	
KRD - 25	0,2004	14,028	-	-	-	-	110	0,2396	16,778	16,39
KRD - 32	0,2176	15,232	110	0,2932	20,524	25,78	125	0,2602	18,216	16,38
KRD - 40	0,2563	17,941	110	0,3358	23,500	23,66	125	0,2932	20,522	12,58
KRD - 50	0,2483	17,381	125	0,3738	26,168	33,58	140	0,3272	22,906	24,12
KRD - 65	0,2920	20,440	140	0,4378	30,644	33,30	160	0,3662	25,638	20,27
KRD - 80	0,3279	22,953	160	0,4514	31,604	27,37	180	0,3836	26,856	14,53
KRD - 100	0,3307	23,149	200	0,4658	32,602	29,00	225	0,3952	27,664	16,32

Double Pipe - 1x reinforced			2x Single Pipe - 1x reinf. Insulation Class				2x Single Pipe - 2x reinf. Insulation Class			
Type	Heat Loss		PEHD-Ø	Heat Loss		Saving in %	PEHD-Ø	Heat Loss		Saving in %
	u_{KRD} in W/(m•K)	q_{KRD} in W/m	D_a in mm	u_{KRE} in W/(m•K)	q_{KRE} in W/m		D_a in mm	u_{KRE} in W/(m•K)	q_{KRE} in W/m	
KRD - 25	0,1760	12,320	110	0,2396	16,778	26,57	125	0,2172	15,202	18,96
KRD - 32	0,1919	13,433	125	0,2602	18,216	26,26	140	0,2368	16,574	18,95
KRD - 40	0,2180	15,260	125	0,2932	20,522	25,64	140	0,2638	18,462	17,34
KRD - 50	0,2148	15,036	140	0,3272	22,906	34,36	160	0,2856	19,988	24,77
KRD - 65	0,2476	17,332	160	0,3662	25,638	32,40	180	0,3204	22,422	22,70
KRD - 80	0,2651	18,557	180	0,3836	26,856	30,90	200	0,3392	23,738	21,83
KRD - 100	0,2663	18,641	225	0,3952	27,664	32,62	250	0,3482	24,368	23,50

The mentioned data are based on a covering height [$Ü_H$] of 0,80 m (at KRE-100, 125, 150, 200 of 1,00 m), a thermal conductivity of soil [λ_E] of 1,0 W/(m•K), a soil temperature [T_E] of 10 °C as well as a pipe distance of 150 mm at single pipe;
$T_M = (T_{VL} + T_{RL}) : 2 - T_E$

Example: (100° + 60°) : 2 -10° = 70 K.

All values are based on a thermal conductivity of polyurethane foam λ_{50} = 0,0240 W/(m•K).

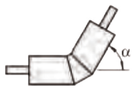
2.3.7 Elbow 90°

Elbow, horizontal

Dimensions carrier pipe			Carrier pipe elbow		Jacket-Pipe Outside-Ø D_a in mm		Length of Angle **L • L₁** in mm
Nominal Diameter / Dimension		Outside-Ø d_a in mm	Wall-thickness **s** in mm	Radius **r** in mm	Insulation Class		
DN	**Inch**				**Standard**	**1x reinforced**	
20	¾“	2 • 26,9	2,6	110,0	125	140	1000 • 1000
25	1“	2 • 33,7	3,2	110,0	140	160	1000 • 1000
32	1¼“	2 • 42,4	3,2	110,0	160	180	1000 • 1000
40	1½“	2 • 48,3	3,2	110,0	160	180	1000 • 1000
50	2“	2 • 60,3	3,2	125,0	200	225	1000 • 1000
65	2½“	2 • 76,1	3,2	140,0	225	250	1000 • 1000
80	3“	2 • 88,9	3,2	160,0	250	280	1000 • 1000
100	4“	2 • 114,3	3,6	270,0	315	355	1000 • 1000
125	5“	2 • 139,7	3,6	330,0	400	450	1000 • 1000
150	6“	2 • 168,3	4,0	390,0	450	500	1000 • 1000
200	8“	2 • 219,1	4,5	510,0	560	630	1200 • 1200

All carrier pipe elbows at least bent according to DIN EN 10220 in one piece or in accordance with DIN EN 10253-2 and welded pipe fittings, depending on dimension. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1.
Cylindrical pipe as seamless or welded steel, depending on dimension. Length of bare steel pipe ends: 220 mm ± 10 mm, clear pipe-distance (h_S) like pipe bars. Orders for special degree elbows should generally indicate the complementary angle [α]. The mentioned length of angles apply to elbows 45° and special-elbows. Other length of angles on request.
Elbows with an angle length of 1,5 m are used in applications where preformed part is welded to preformed part and sliding up a coupler is otherwise not possible. It´s possible to use as house entry elbow. For improvements and in order to follow the technical development we will reserve modifications of measures as well as technical modifications of the values mentioned in the table.
ATTENTION: When ordering elbows for height differences in levels or for house connections in advance, consider the exact mounting position and specify the location of supply and return.When in doubt, a detailed drawing is to be made.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR-hard foam see **chapter 7.1.7**



Edition: 16.01.2012

Elbow, vertical (s)

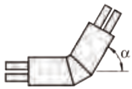
Dimensions carrier pipe			carrier pipe elbow		Jacket-Pipe Dimension-Ø **D_a** in mm		Length of Angle **$L \cdot L_1$** in mm
Nominal Diameter/ Dimension in		Outside-Ø **d_a** in mm	Wall-thickness **s** in mm	Radius **r** in mm	Insulation Class		
DN	**Inches**				**Standard**	**1x reinforced**	
20	¾“	2 • 26,9	2,6	110,0	125	140	1000 • 1000
25	1“	2 • 33,7	3,2	110,0	140	160	1000 • 1000
32	1¼“	2 • 42,4	3,2	110,0	160	180	1000 • 1000
40	1½“	2 • 48,3	3,2	110,0	160	180	1000 • 1000
50	2“	2 • 60,3	3,2	135,0	200	225	1000 • 1000
65	2½“	2 • 76,1	3,2	175,0	225	250	1000 • 1000
80	3“	2 • 88,9	3,2	205,0	250	280	1000 • 1000
100	4“	2 • 114,3	3,6	270,0	315	355	1000 • 1000
125	5“	2 • 139,7	3,6	330,0	400	450	1000 • 1000
150	6“	2 • 168,3	4,0	390,0	--	500	1000 • 1000
200	8“	2 • 219,1	4,5	510,0	--	630	1200 • 1200

All carrier pipe elbows at least bent according to DIN EN 10220 in one piece or in accordance with DIN EN 10253-2 and welded pipe fittings, depending on dimension. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1.
Cylindrical pipe as seamless or welded steel, depending on dimension. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe-distance (h_S) like pipe bars. Orders for special degree elbows should generally indicate the complementary angle [α]. The mentioned length of angles apply to elbows 45° and special-elbows. Other length of angles on request.

Elbows with an angle length of 1,5 m are used in applications where preformed part is welded to preformed part and sliding up a coupler is otherwise not possible. It´s possible to use as house entry elbow. At DN 150 and DN 200 a 1x reinforced elbow with two additionally reducing shrinkable couplers has to be used.

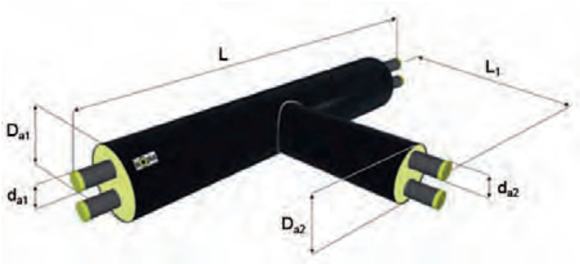
ATTENTION: Elbow for height differences in levels or for house connections see the **previous page**.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR Hard Foam see **chapter 7.1.7**



2.3.8 Branch 90° / Twin-Branch 90°

Branch 90°, straight



Carrier pipe passage and exit at least acc. to measure standard AGFW-guideline FW 401. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe-distance (h_S) like pipe bars.

All branches will be necked-out at the basic pipe or will be produced by use of weld-in T-pieces acc. to DIN EN 10253-2, depending on dimension. The following pipe cylinder will be welded by a round seam, which can be radio graphed. For improvements and in order to follow the technical development we will reserve modifications of measures as well as technical modifications of the values mentioned in the table.

The exit may be used up to the maximum admissible laying length of the corresponding dimension without expanding legs, like L-, Z- or U- elbow.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR Hard foam see **chapter 7.1.7**

Branch 90°, straight - Standard

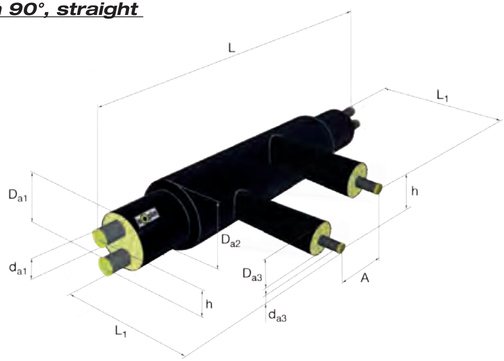
Branch Exit	Dimensions passage or main line																							
	DN		20		25		32		40		50		65		80		100		125		150		200	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“		8“	
	d_{a1}		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3		219,1	
	D_{a1}		125		140		160		160		200		225		250		315		400		450		560	
20	L	L_1	1200	550	1200	600	1200	600	1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9
25	L	L_1			1200	600	1200	600	1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}			140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7
32	L	L_1					1200	600	1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}					160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4
40	L	L_1							1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}							160	48,3	160	48,3	160	48,3	160	48,3	160	48,3	160	48,3	160	48,3	160	48,3
50	L	L_1									1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}									200	60,3	200	60,3	200	60,3	200	60,3	200	60,3	200	60,3	200	60,3
65	L	L_1											1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}											225	76,1	225	76,1	225	76,1	225	76,1	225	76,1	225	76,1
80	L	L_1													1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}													250	88,9	250	88,9	250	88,9	250	88,9	250	88,9
100	L	L_1															1300	650	1300	700	1300	700	1300	800
	D_{a2}	d_{a2}															315	114,3	315	114,3	315	114,3	315	114,3
125	L	L_1																	1300	700	1300	700	1300	800
	D_{a2}	d_{a2}																	400	139,7	400	139,7	400	139,7
150	L	L_1																			1400	700	1400	800
	D_{a2}	d_{a2}																			450	168,3	450	168,3
200	L	L_1																					1600	800
	D_{a2}	d_{a2}																					560	219,1

Branch 90°, straight - 1x reinforced

Branch Exit	Dimensions passage or main line																							
	DN		20		25		32		40		50		65		80		100		125		150		200	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“		8“	
	d_{a1}		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3		219,1	
	D_{a1}		140		160		180		180		225		250		280		355		450		500		630	
20	L	L_1	1200	550	1200	600	1200	600	1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9	125	26,9
25	L	L_1			1200	600	1200	600	1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}			140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7	140	33,7
32	L	L_1					1200	600	1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}					160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4	160	42,4
40	L	L_1							1200	600	1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}							160	48,3	160	48,3	160	48,3	160	48,3	160	48,3	160	48,3	160	48,3	160	48,3
50	L	L_1									1200	600	1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}									200	60,3	200	60,3	200	60,3	200	60,3	200	60,3	200	60,3	200	60,3
65	L	L_1											1200	650	1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}											225	76,1	225	76,1	225	76,1	225	76,1	225	76,1	225	76,1
80	L	L_1													1200	650	1200	650	1200	700	1200	700	1200	800
	D_{a2}	d_{a2}													250	88,9	250	88,9	250	88,9	250	88,9	250	88,9
100	L	L_1															1300	650	1300	700	1300	700	1300	800
	D_{a2}	d_{a2}															315	114,3	315	114,3	315	114,3	315	114,3
125	L	L_1																	1300	700	1300	700	1300	800
	D_{a2}	d_{a2}																	400	139,7	400	139,7	400	139,7
150	L	L_1																			1400	700	1400	800
	D_{a2}	d_{a2}																			450	168,3	450	168,3
200	L	L_1																					1600	800
	D_{a2}	d_{a2}																					560	219,1

Edition: 16.01.2012

Twin-Branch 90°, straight



Twin branches are used as transition from a double main pipe line to a house connection with single pipes, i. e. **isoflex** or **isopex**. Carrier pipe passage and exit at least acc. to measure standard AGFW-guideline FW 401. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe-distance (h_S) like pipe bars.

All branches will be necked-out at the basic pipe or will be produced by use of weld-in T-pieces acc. to DIN EN 10253-2, depending on dimension. The following pipe cylinder will be welded by a round seam, which can be radio graphed. For improvements and in order to follow the technical development we will reserve modifications of measures as well as technical modifications of the values mentioned in the table.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR-hard foam see **chapter 7.1.7**

Twin-Branch 90°, straight - Standard

Branch Exit			Dimensions passage or main line																					
	DN		20		25		32		40		50		65		80		100		125		150		200	
	Inch		¾"		1"		1 ½"		1 ¼"		2"		2 ½"		3"		4"		5"		6"		8"	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3		219,1	
	D_{a1}		125		140		160		160		200		225		250		315		400		450		560	
20	L	L_1	1300	500	1300	500	1300	500	1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}	47	90	54	160	62	160	68	160	80	200	96	225	114	250	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90
	A		240		490		240		240		240		240		240		240		240		240		240	
25	L	L_1			1300	500	1300	500	1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}			54	160	62	160	68	160	80	200	96	225	114	250	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}			33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90
	A				490		240		240		240		240		240		240		240		240		240	
32	L	L_1					1300	500	1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}					62	180	68	180	80	200	96	225	114	250	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}					42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110
	A						240		240		240		240		240		240		240		240		240	
40	L	L_1							1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}							68	180	80	200	96	225	114	250	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}							48,3	110	48,3	110	48,3	110	48,3	110	48,3	110	48,3	110	48,3	110	48,3	110
	A								240		240		240		240		240		240		240		240	
50	L	L_1									1300	550	1300	550	1300	600	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}									80	225	96	225	114	250	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}									60,3	125	60,3	125	60,3	125	60,3	125	60,3	125	60,3	125	60,3	125
	A										240		240		240		240		240		240		240	
65	L	L_1											1300	600	1400	600	1400	600	1400	650	1400	700	1400	750
	h	D_{a2}											96	250	114	280	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}											76,1	140	76,1	140	76,1	140	76,1	140	76,1	140	76,1	140
	A												240		300		300		300		300		300	
80	L	L_1													1400	600	1400	600	1400	650	1400	700	1400	750
	h	D_{a2}													114	280	140	315	170	400	208	450	264	560
	d_{a3}	D_{a3}													88,9	160	88,9	160	88,9	160	88,9	160	88,9	160
	A														300		300		300		300		300	
100	L	L_1															1500	650	1500	650	1500	700	1500	750
	h	D_{a2}															140	355	170	400	208	450	264	560
	d_{a3}	D_{a3}															114,3	200	114,3	200	114,3	200	114,3	200
	A																350		300		350		350	
125	L	L_1																	1500	650	1500	700	1500	750
	h	D_{a2}																	170	400	208	450	264	560
	d_{a3}	D_{a3}																	139,7	225	139,7	225	139,7	225
	A																		300		350		350	
150	L	L_1																			1600	700	1600	750
	h	D_{a2}																			208	500	264	560
	d_{a3}	D_{a3}																			168,3	250	168,3	250
	A																				350		450	
200	L	L_1																					1700	750
	h	D_{a2}																					264	560
	d_{a3}	D_{a3}																					219,1	315
	A																						450	

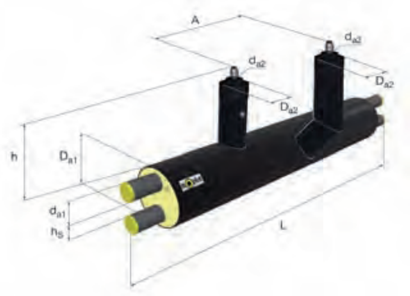
Edition: 16.01.2012

Twin-Branch 90°, straight - 1x reinforced

Branch Exit			Dimensions passage or main line																					
	DN		20		25		32		40		50		65		80		100		125		150		200	
	Inch		¾“		1“		1 ½“		1 ¼“		2“		2 ½“		3“		4“		5“		6“		8“	
	d_a		26,9		33,7		42,4		48,3		60,3		76,1		88,9		114,3		139,7		168,3		219,1	
	D_{a1}		140		160		180		180		225		250		280		355		450		500		630	
20	L	L_1	1300	500	1300	500	1300	500	1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}	47	140	54	160	62	180	68	180	80	225	96	250	114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	26,9	90	29,6	90	26,9	90	26,9	90	26,9	90
	A		240		240		240		240		240		240		240		240		240		240		240	
25	L	L_1			1300	500	1300	500	1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}			54	160	62	180	68	180	80	225	96	250	114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}			33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90	33,7	90
	A				240		240		240		240		240		240		240		240		240		240	
32	L	L_1					1300	550	1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}					62	180	68	180	80	225	96	250	114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}					42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110	42,4	110
	A						240		240		240		240		240		240		240		240		240	
40	L	L_1							1300	550	1300	550	1300	550	1300	550	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}							68	180	80	225	96	250	114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}							48,3	110	48,3	110	48,3	110	48,3	110	48,3	110	48,3	110	48,3	110	48,3	110
	A								240		240		240		240		240		240		240		240	
50	L	L_1									1300	550	1300	550	1300	600	1300	600	1300	650	1300	700	1300	750
	h	D_{a2}									80	225	96	250	114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}									60,3	125	60,3	125	60,3	125	60,3	125	60,3	125	60,3	125	60,3	125
	A										240		240		240		240		240		240		240	
65	L	L_1											1300	600	1400	600	1400	600	1400	650	1400	700	1400	750
	h	D_{a2}											96	250	114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}											76,1	140	76,1	140	76,1	140	76,1	140	76,1	140	76,1	140
	A												240		300		300		300		300		300	
80	L	L_1													1400	600	1400	600	1400	650	1400	700	1400	750
	h	D_{a2}													114	280	139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}													88,9	160	88,9	160	88,9	160	88,9	160	88,9	160
	A														300		300		300		300		300	
100	L	L_1															1500	650	1500	650	1500	700	1500	750
	h	D_{a2}															139	355	170	450	208	500	264	630
	d_{a3}	D_{a3}															114,3	200	114,3	200	114,3	200	114,3	200
	A																350		350		350		350	
125	L	L_1																	1500	650	1500	700	1500	750
	h	D_{a2}																	170	450	208	500	264	630
	d_{a3}	D_{a3}																	139,7	225	139,7	225	139,7	225
	A																		350		350		350	
150	L	L_1																			1600	700	1600	750
	h	D_{a2}																			208	500	264	630
	d_{a3}	D_{a3}																			168,3	250	168,3	250
	A																				350		450	
200	L	L_1																					1700	750
	h	D_{a2}																					264	630
	d_{a3}	D_{a3}																					219,1	315
	A																						450	

Edition: 16.01.2012

2.3.9 Drain / Vent



Dimensions Double Pipe				Length L in mm	Dimensions Drain /Vent			
Nominal Diameter/ Dimension DN	Steel-Pipe-Outside Ø d_{a1} in mm	Carrier Pipe-outside-Ø D_{a1} in mm Standard	Carrier Pipe-outside-Ø D_{a1} in mm 1x reinforced		Axes-distance A in mm	ELE Outside-Ø d_{a2} in mm	ELE Outside-Ø D_{a2} in mm	Overall-height h in mm
20	2 • 26,9	125	140	1200	150	26,9	90	500
25	2 • 33,7	140	160	1200	150	33,7	90	500
32	2 • 42,4	160	180	1200	150	33,7	90	500
40	2 • 48,3	160	180	1200	150	33,7	90	500
50	2 • 60,3	200	225	1200	150	33,7	90	500
65	2 • 76,1	225	250	1200	150	33,7	90	500
80	2 • 88,9	250	280	1200	150	33,7	90	500
100	2 • 114,3	315	355	1200	150	33,7	90	500
125	2 • 139,7	400	450	1200	150	33,7	90	500
150	2 • 168,3	450	500	1200	150	33,7	90	500
200	2 • 219,1	560	630	1200	150	33,7	90	500

Carrier pipe passage and venting at least acc. to measure standard AGFW-guideline FW 401. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe distance (h_S) double pipe like pipe bars. All venting branches may not be shortened as they include a foamed in **isoplus**-ball valve with outside located support-handle. For improvements and in order to follow the actual technical development we will reserve modifications of measures as well as technical modifications of the values mentioned in the table.

The not insulated branch-end is manufactured generally with galvanised pipe end with outside thread-connection and an end cap. For manufacturing-technical reasons venting branches will be generally insulated with standard insulation. At areas of L-, Z- or U-elbows the assembling will be not permitted, due to bending tension which will occur. In order to guarantee the operation and access to the venting, the installation should be installed in a manhole acc. to DIN 4034. The manhole has to fulfil the corresponding construction static requirements.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR-hard foam see **chapter 7.1.7**

2.3.10 Reducing Piece

Dimensions Nominal Diameter 1				Dimensions Nominal Diameter 2				Overall-length **L** in mm
Carrier pipe		Jacket-Pipe-Outside-Ø **D_{a1}** in mm		**Carrier pipe**		Jacket-Pipe-Outside-Ø **D_{a2}** in mm		
Nominal Diameter / Dimension **DN**	Outside-Ø **d_{a1}** in mm	Insulation Class		**Nominal Diameter / Dimension**	Outside-Ø **d_{a2}** in mm	Insulation Class		
		Standard	**1x reinforced**			**Standard**	**1x reinforced**	
25	2 • 33,7	140	160	**20**	2 • 26,9	125	140	1500
32	2 • 42,4	160	180	**25**	2 • 33,7	140	160	1500
				20	2 • 26,9	125	140	1500
40	2 • 48,3	160	180	**32**	2 • 42,4	160	180	1500
				25	2 • 33,7	140	160	1500
50	2 • 60,3	200	225	**40**	2 • 48,3	160	180	1500
				32	2 • 42,4	160	180	1500
65	2 • 76,1	225	250	**50**	2 • 60,3	200	225	1500
				40	2 • 48,3	160	180	1500
80	2 • 88,9	250	280	**65**	2 • 76,1	225	250	1500
				50	2 • 60,3	200	225	1500
100	2 • 114,3	315	355	**80**	2 • 88,9	250	280	1500
				65	2 • 76,1	225	250	1500
125	2 • 139,7	400	450	**100**	2 • 114,3	315	355	1500
				80	2 • 88,9	250	280	1500
150	2 • 168,3	450	500	**125**	2 • 139,7	400	450	1500
				100	2 • 114,3	315	355	1500
200	2 • 219,1	560	630	**150**	2 • 168,3	450	500	1500
				125	2 • 139,7	400	450	1500

Carrier pipe at least acc. to measure standard AGFW-guideline FW 401. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe distance (h_S) like pipe bars.
As carrier pipe reducer generally an eccentric piece of steel acc. to DIN EN 10253-2 with welded pipe socket will be used. For improvements and in order to follow the actual technical development we will reserve modifications of measures and as well technical modifications of the values mentioned in the table.

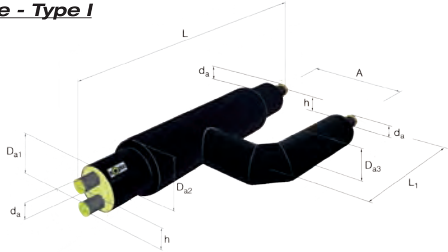
In order to avoid unacceptable high frontal soil-pressure loads, the reducing piece has to be padded in. Expansion pads are not part of the delivery range of the reducing piece.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR-hard foam see **chapter 7.1.7**

Edition: 16.01.2012

2.3.11 Bifurcated Pipe

Bifurcated Pipe - Type I



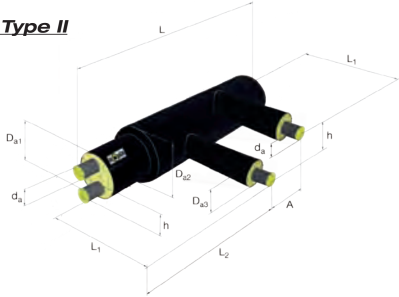
Dimensions Steel Pipe		Dimensions Double Pipe				Dimension Single Pipe	Axes-distance	Length	Length
Nominal Diameter / Dimension	Outside-Ø	Jacket-Pipe-Outside-Ø **$D_{a1/2}$** in mm							
		Insulation Class Standard		Insulation Class 1x reinf.					
DN	**d_a** in mm	**D_{a1}**	**D_{a2}**	**D_{a1}**	**D_{a2}**	**D_{a3}** in mm	**A** in mm	**L** in mm	**L_1** in mm
20	2 • 26,9	125	140	140	140	90	240	1200	600
25	2 • 33,7	140	160	160	160	90	240	1200	600
32	2 • 42,4	160	180	180	180	110	260	1200	600
40	2 • 48,3	160	180	180	180	110	260	1200	600
50	2 • 60,3	200	225	225	225	125	290	1200	600
65	2 • 76,1	225	250	250	250	140	310	1200	600
80	2 • 88,9	250	280	280	280	160	350	1200	600
100	2 • 114,3	315	355	355	355	200	375	1200	600
125	2 • 139,7	400	400	450	450	225	450	1200	600
150	2 • 168,3	450	500	500	500	250	510	1300	650
200	2 • 219,1	560	630	630	630	315	610	1400	700

Bifurcated pipes are used for transitions from two single pipes to the **isoplus**-double pipe. Carrier pipe at least acc. to measure standard AGFW-guideline FW 401. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe distance (h_S) like pipe bars. For improvements and in order to follow the actual technical development we will reserve modifications of measures as well as technical modifications of the values mentioned in the table.

ATTENTION: Orders for bifurcated pipes should clearly indicate **all** carrier and jacket-pipe diameters. During assembling the correct position of single- and double pipes resp. the installation position of the bifurcated pipe as well as the manufacturing-technical determined axis-measure **A** has to be considered. There must be the possibility of expansion compensation at the transition before the bifurcated pipe (Z- or U-elbow), because bifurcated pipes should be assembled generally at pipe-static neutral line-positions. This will be also valid in case of a system-change in an exit of a single pipe-branch. Due to manufacturing-technical reasons the single pipes will be generally insulated in standard insulation.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR-hard foam see **chapter 7.1.7**

Bifurcated Pipe - Type II



Dimensions Steel Pipe		Dimensions Double Pipe				Dimension Single Pipe	Axes-distance	Height offset	Length	Length	Length
Nominal Diameter / Dimension	Outside-Ø	Jacket-Pipe-Outside-Ø $D_{a1/2}$ in mm									
		Insulation Class Standard		Insulation Class 1x reinf.							
DN	d_a in mm	D_{a1}	D_{a2}	D_{a1}	D_{a2}	D_{a3} in mm	**A** in mm	h in mm	**L** in mm	L_1 in mm	L_2 in mm
20	2 • 26,9	125	140	140	140	90	240	47	1100	600	760
25	2 • 33,7	140	160	160	160	90	240	54	1100	600	760
32	2 • 42,4	160	180	180	180	110	260	62	1100	600	740
40	2 • 48,3	160	180	180	180	110	260	68	1100	600	740
50	2 • 60,3	200	225	225	225	125	300	80	1100	600	700
65	2 • 76,1	225	250	250	250	140	310	96	1100	600	690
80	2 • 88,9	250	280	280	280	160	360	114	1200	600	640
100	2 • 114,3	315	355	355	350	200	400	139	1300	650	750
125	2 • 139,7	400	400	450	450	225	425	170	1300	700	725
150	2 • 168,3	450	500	500	500	250	450	208	1400	700	775
200	2 • 219,1	560	630	630	630	315	615	264	1700	750	885

Bifurcated pipes are used for transitions from two single pipes to the **isoplus** double pipe. Carrier pipe at least acc. to measure standard AGFW-guidelines FW 401. From wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends 220 mm ± 10 mm, clear pipe distance (h_S) like pipe bars. For improvements and in order to follow the actual technical development we will reserve modifications of measures as well as technical modifications of the values mentioned in the table.
ATTENTION: Orders for bifurcated pipes should clearly indicate **all** carrier and jacket pipe diameters. During assembling the correct position of single- and double pipes resp. the installation position of the bifurcated pipe as well as the manufacturing-technical determined axis-measure **A** has to be considered. There must be the possibility of expansion compensation at the transition before the bifurcated pipe (Z- or U-elbow), because bifurcated pipes should be assembled generally at pipe-static neutral line-positions. This will be also valid in case of a system-change in an exit of a single pipe-branch. Due to manufacturing-technical reasons the single pipes will be generally insulated in standard insulation.

Material specification jacket pipe see **chapter 2.1.4**
Material specification carrier pipe see **chapter 2.3.1**
Material specification PUR-hard foam see **chapter 7.1.7**

3 FLEXIBLE COMPOUND SYSTEMS

Edition: 16.01.2012

3.1.1 Principle / Heat-Insulation / Jacket-Pipe

Principle

The Flexible Compound System of **isoplus** is especially suited for house connections and extension works on. It can be easily being led around obstructions such as buildings, trees or other pipeline systems. It can be also used for complete low-temperature systems in lower dimensions.

Because of the continuous production of **isoplus** flexible pipes a longitudinal water tight compound system will be reached. That means the three basic materials (carrier pipe + insulation + jacket pipe) are connected by axial force with each other. Due to very small bending radius of flexible pipes, it is possible to choose always the direct way around obstructions respectively to the area of the house connection.

Due to the big delivery lengths the pipe laying works can be carried out in a short time, the operational works can be reduced to a minimum. Also the underground construction works can be reduced essentially because of the extremly narrow trenches. For these reasons the flexible pipe system of **isoplus** represents a technically fully developed and **eco**nomically as well as **eco**logically perfect laying method for district heating systems.

Heat-Insulation

Flexible pipes will be insulated with polyurethane-hard-foam (PUR), consisting of component A = Polyol (clear) and component B = Isocyanat (dark), tested acc. to EN 15632-1. During production continuously foamed around the carrier pipe, a high quality heat insulation with an execellent thermal conductivity, λ_{50} = maximum 0,023 W/(m•K), at low specific weight will be reached, due to an exothermal chemical reaction.

isoplus is using generally Cyclopentan driven foam, 100 % free of Freon and therefore enviroment friendly. That means the very best heat insulation values will be reached at lowest possible ODP- and GWP-values, ODP (Ozone Reducing Potential) = 0, GWP (Green House Potential) = <0,001 !

In order to avoid the exchange of PUR-cell-gas, in all **isoplus** flexible pipes a diffusion barrier is included. This barrier-foil will be implemented between PUR-foam and jacket-pipe during the production procedure. The used barrier-foils are granting the flexible pipes a constant and durable low engery loss during the duration of operation.

For **isoflex** and **isocu** a 100 % diffusion tight aluminium-foil will be used as barrier. In order to keep the compound system, the foil is coated on both sides by corona treated polyethylene. **isopex**- and **isoclima**-pipes are containing a coloured and also corona (electrical surface-cross-linked) treated polyethylene foil, as a direct cell gas barrier.

Jacket-Pipe

The jacket-pipe of the flexible pipes consists of proved polyethylene with even surface. Polyethylene Low Density is a seamless, tough elastic thermo-plastic material which will be continuously extruded on to the PUR foam during the production procedure. Thermal conductivity λ_{PE} = 0,35 W/(m•K).

PE is mentioned in all national and international standards, respectively recommendations, as the only suitable material, due to the resistance against weather conditions and UV-rays, as well as against practically all chemical compounds existing in the soil.

Edition: 16.01.2012

3.2.1 Carrier Pipe / Connection Technology / Operating Conditions

Carrier Pipe

The **isoflex**-carrier pipe consists of a welded, measure rolled precision steel pipe with especial measure-exactness and plain inner surface. Measures and weights acc. to DIN EN 10220, material P195GH+N (annealed regular) No. 1.0348. Technical delivery conditions acc. to option 1 of DIN EN 10305-3, with works certificate (APZ) acc. to EN 10204-3.1.

Connection Technology

The connection of the steel pipe will be made by autogenously-welding or by Wolfram Inert Gas (WIG) welding procedure.

Operating Conditions

Permissible short-term peak temperature T_{max}: 130 °C
Maximum operating pressure p_B: 25 bar
Maximum permissible axial-tension σ_{max}: 150 N/mm²
Leak detecting: Copper wire isolated and twisted as standard
Possible liquids: Heating water as well as other material resistant liquids

Technical Data P195GH at 20 °C					
Property	**Unit**	**Value**	**Property**	**Unit**	**Value**
Volume weight p	kg/dm³	7,85	Elastic modulus E	N/mm²	211.800
Tensile stress R_m	N/mm²	320 - 440	Thermal conductivity λ	W/(m•K)	55,2
Yield stress R_e	N/mm²	195	Specific heat capacity c	kJ/(kg•K)	0,43
Wall roughness k	mm	0,01	Thermal expansion coefficient α	K^{-1}	$11,3 \cdot 10^{-6}$

3.2.2 Dimensions resp. Types / Heat Loss and Capacity

Dimensions Steel Pipe P195GH + N			Jacket-Pipe Outside-Ø D_a in mm	Delivery length in 1,00 m steps L in m	Maximum coil-outside-Ø d_R in mm	Minimum bending radius r in m	Weight without water G in kg/m
Type	Outside-Ø d_a in mm	Wall-thickness s in mm					
isoflex - 20	20,0	2,0	75	24 - 100	2220	0,8	1,57
isoflex - 28	28,0	2,0	75	24 - 100	2220	0,8	1,94
isoflex - 28 v	28,0	2,0	90	24 - 100	2300	0,9	2,15
isoflex - 28 + 28	28,0	2,0	110	24 - 100	2440	1,10	3,43

Type	**Dimensioning**						**Heat Loss**			
	Water-content v in l/m	Volume-flow V' in m³/h	Flow-speed w in m/s	Transmittable capacity **P** in kW at spread			Coefficient $u_{ER/DR}$ in W/(m•K)	**q** per **pipe meter** in W/m at average temperature T_M		
				20 K	**30 K**	**40 K**		**70 K**	**60 K**	**50 K**
isoflex - 20	0,201	0,36-0,72	0,5 - 1,0	8 - 17	13 - 25	17 - 34	0,1054	7,377	6,324	5,270
isoflex - 28	0,452	0,81-1,63	0,5 - 1,0	19 - 38	28 - 57	38 - 76	0,1397	9,777	8,380	6,983
isoflex - 28 v	0,452	0,81-1,63	0,5 - 1,0	19 - 38	28 - 57	38 - 76	0,1183	8,278	7,095	5,913
isoflex - 28+28	0,452	0,81-1,63	0,5 - 1,0	19 - 38	28 - 57	38 - 76	0,1952	13,660	11,710	9,760

The mentioned data are based on a medium specific heat capacity [c_m] of the water of 4.187 J/(kg•K), a soil covering height [$Ü_H$] of 0,60 m (Surface jacket pipe to surface of the area), a heat conductivity of soil [λ_E] of 1,2 W/(m•K), a medium temperature of soil [T_E] of 10° C as well as a carrier pipe distance of 100 mm at single pipes.

$T_M = (T_{VL} + T_{RL}) : 2 - T_E$; Example: (90° + 70°) : 2 – 10° = 70 K average temperature

3.3.1 Carrier Pipe / Connection Technology / Operating Conditions

Carrier Pipe

The **isocu**-pipe consists of a coldfinished soft, seamless drawn copper pipe acc. to EN 1057. Dimension, specification and static data and tolerances acc. to DIN 12449, material Cu-DHP/R 220, No. CW024A, in standard wall thickness, technical delivery conditions acc. to DIN 12735-2.

Connection Technology

The connection of the copper pipe will be made by capillary-soldering-fittings, acc. to DIN 1254 with the same wall thickness than the pipes, or by special suitable press fittings. It is not allowed to enlarge the copper pipes. The recommendations and/or instructions of the manufacturers of the fittings concerning soldering procedure and kind of soldering have to be considered.

Operating Conditions

Permissible short-term peak temperature T_{max}: 130 °C
Maximum operating pressure p_B: 25 bar
Maximum permissible axial-tension σ_{max}: 110 N/mm²
Leak detecting: without
Possible liquids: All potable and heating water as well as other material resistant liquids

Technical data Cu-DHP/R 220 at 20° C					
Property	**Unit**	**Value**	**Property**	**Unit**	**Value**
Volume weight p	kg/dm³	8,94	Elastic modulus E	N/mm²	132.000
Tensile stress R_m	N/mm²	220 - 260	Thermal conductivity λ	W/(m•K)	305,00
Yield stress R_e	N/mm²	65	Specific heat capacity c	kJ/(kg•K)	0,386
Wall roughness k	mm	0,0015	Thermal expansion coefficient α	K^{-1}	$16,8 \cdot 10^{-6}$

3.3.2 Dimensions resp. Types / Heat Loss and Capacity

Dimensions Copper Pipe Cu-DHP/R 220			Jacket-Pipe Outside-Ø D_a in mm	Delivery-length in 1m steps **L** in m	Maximum coil-outside-Ø d_R in mm	Minimum-bending radius **r** in m	Weight without Water **G** in kg/m
Type	Outside-Ø d_a in mm	Wall-thickness **s** in mm					
isocu - 22	22,0	1,0	65	max. 360	2200	0,8	1,14
isocu - 28	28,0	1,2	75	max. 360	2200	0,8	1,57
isocu - 22+22	2 • 22,0	1,0	90	max. 200	2300	0,9	1,80
isocu - 28+28	2 • 28,0	1,2	90	max. 200	2300	0,9	2,40

Type	**Dimensioning**						**Heat Loss**			
	Water-content **v** in l/m	Volume-flow **V'** in m³/h	Flow-speed **w** in m/s	Transmittable capacity **P** in kW at spread			Coefficient $u_{ER/DR}$ in W/(m•K)	**q** per **pipe meter** in W/m at average temperature T_M		
				20 K	**30 K**	**40 K**		**70 K**	**60 K**	**50 K**
isocu - 22	0,314	0,57-1,13	0,5 - 1,0	13 - 26	20 - 39	26 - 53	0,1282	8,974	7,692	6,410
isocu - 28	0,515	0,93-1,85	0,5 - 1,0	22 - 43	32 - 65	43 - 86	0,1397	9,777	8,381	6,984
isocu - 22+22	0,314	0,57-1,13	0,5 - 1,0	13 - 26	20 - 39	26 - 56	0,1894	13,257	11,365	9,473
isocu - 28+28	0,515	0,93-1,85	0,5 - 1,0	22 - 43	32 - 65	43 - 86	0,2537	17,757	15,222	12,688

Basis of the values see **previous page.**

3.4.1 Carrier Pipe / Connection Technology / Operating Conditions

Carrier Pipe

The **isopex**-pipe consists of cross-linked **(X) PE-Xa**, basic material **PE**, with peroxide **(a)** added during extrusion. General material requirements acc. to DIN 16892, pipe series respectively measures acc. to DIN 16893.
Resistant to aggressive chemicals and water.

Poly**E**thylene is an organic connection of carbon- and hydrogen molecules. For **P**oly**E**thylene-cross-linked (**X**) H-atoms will be removed out of the molecule chains, irreversible carbon-connections will develop, which will form a cross link between the chains. During extrusion of **PE** peroxide (**a**) will be added, the oxygen will bind the hydrogen atoms. The mechanical high resistant, but not weldable material **PE-Xa** comes into being.

Heating pipe: Pipe-range 1; series 5; SDR 11; operating pressure max. 6 bar, PN 12,5; with red coloured organic oxygen diffusion barrier of E/VAL (Ethylenvenylalcohol) acc. to DIN 4726. According to AGFW-information FW 420 „District Heating pipelines with plastic-carrier pipes (PMR)".

Sanitary pipe: Pipe-range 2; series 3,20; SDR 7,40; operating pressure max. 10 bar, PN 20; tested acc. to DVGW- documentation W 531, with DVGW- and ÖVGW-inspection mark.

Connection Technology

The connection of **PE-Xa**-pipes is made in buried sections preferably with press resp. clamp connections- and connection pieces, see **chapter 3.6.5**. Inside of buildings as well as for sanitary installations also screwed connections may be used. Electric welded connections are available on request.

Operating Conditions

Maximum permanent operating temp. $T_{B\,max}$: 80 °C
Maximum operating temperature T_{max}: 95 °C
Maximum operating pressure p_B: 6/10 bar
Leak detecting: without
Possible liquids: potable and heating water, chemicals as well as other material resistant liquids

Technical data PE-Xa at 20° C					
Property	**Unit**	**Value**	**Property**	**Unit**	**Value**
Volume weight ρ	kg/dm³	0,938	Elastic modulus E	N/mm²	600
Tensile stress R_m	N/mm²	≥ 20	Thermal conductivity λ	W/(m•K)	0,38
Yield stress R_e	N/mm²	17	Specific heat capacity c	kJ/(kg•K)	2,3
Wall roughness k	mm	0,007	Thermal expansion coefficient α	K^{-1}	$15{,}0 \cdot 10^{-5}$

Due to the production principle of **isopex**-pipes a longitudinal water tight compound system comes into being, that means the three materials (**PE-Xa**, PUR-foam, PELD) are connected by axial force with each other. At increasing temperature the E-modulus of the carrier pipe is getting smaller and will cause only very slight tension. Because of soil-embedding the tension will be additionally reduced and in case of a compound system like **isopex**, the axial heat extension will be nearly totally suppressed.

That means, **isopex**-pipes may be designed without expansion components and at building entries without anchors, due to the compound.

Edition: 16.01.2012

3.4.2 Dimensions resp. Types

Single Pipe Heating - 6 bar

Dimensions PE-Xa-Pipe			Jacket-Pipe Outside-Ø	Delivery-length in 1,00 m steps	Maximum coil-outside-Ø	Minimum-bending radius	Weight without water
Type	Outside-Ø d_a in mm	Wall-thickness s in mm	D_a in mm	L in m	d_R in mm	r in m	G in kg/m
H - 25 / H - 25 v	25,0	2,3	75 / 90	≤ 360 / 250	2530	0,7 / 0,8	0,82 / 1,03
H - 32 / H - 32 v	32,0	2,9	75 / 90	≤ 360 / 250	2530	0,8 / 0,8	0,90 / 1,10
H - 40 / H - 40 v	40,0	3,7	90 / 110	≤ 250 / 200	2530	0,8 / 0,9	1,22 / 1,62
H - 50 / H - 50 v	50,0	4,6	110 / 125	≤ 250 / 170	2530 / 2550	0,9 / 1,0	1,79 / 2,06
H - 63 / H - 63 v	63,0	5,8	125 / 140	≤ 170 / 150	2550 / 2690	1,0 / 1,1	2,35 / 2,82
H - 75 / H - 75 v	75,0	6,8	140 / 160	≤ 170 / 120	2690 / 2700	1,1 / 1,2	3,14 / 3,58
H - 90 / H - 90 v	90,0	8,2	160 / 180	≤ 120 / 85	2700 / 2800	1,2 / 1,4	4,07 / 4,65
H - 110	110,0	10,0	180	max. 85	2700	1,4	5,43
H - 125	125,0	11,4	180	max. 85	2700	1,4	6,14
H - 125 Stg.	125,0	11,4	225	only as pipe bar		2,2	7,85
H - 160 Stg.	160,0	14,6	250	in 12 m available		3,0	10,78

Double Pipe Heating - 6 bar

Dimensions PE-Xa-Pipe			Jacket-Pipe Outside-Ø	Delivery-length in 1,00 m steps	Maximum coil-outside-Ø	Minimum-bending radius	Weight without water
Type	Outside-Ø d_a in mm	Wall-thickness s in mm	D_a in mm	L in m	d_R in mm	r in m	G in kg/m
H - 20 + 20	2 • 20,0	2,0	75	max. 360	2500	0,9	0,71
H - 25 + 25 / H - 25 + 25 v	2 • 25,0	2,3	90 / 110	250 / 200	2500 / 2530	0,9 / 0,9	0,92 / 1,19
H - 32 + 32 / H - 32 + 32 v	2 • 32,0	2,9	110 / 125	200 / 150	2500 / 2550	0,9 / 1,0	1,34 / 1,50
H - 40 + 40 / H - 40 + 40 v	2 • 40,0	3,7	125 / 140	150 / 120	2500 / 2700	1,0 / 1,1	1,74 / 2,10
H - 50 + 50 / H - 50 + 50 v	2 • 50,0	4,6	160 / 180	120 / 85	2800 / 2800	1,2 / 1,4	2,71 / 3,08
H - 63 + 63	2 • 63,0	5,8	180	max. 85	2800	1,4	3,67

Single Pipe Sanitary - 10 bar

Dimensions PE-Xa-Pipe			Jacket-Pipe Outside-Ø	Delivery-length in 1,00 m steps	Maximum coil-outside-Ø	Minimum-bending radius	Weight without water
Type	Outside-Ø d_a in mm	Wall-thickness s in mm	D_a in mm	L in m	d_R in mm	r in m	G in kg/m
S - 25	25,0	3,5	75	24 - 360	2530	0,7	0,89
S - 32	32,0	4,4	75	24 - 360	2530	0,8	1,01
S - 40	40,0	5,5	90	24 - 250	2530	0,8	1,39
S - 50	50,0	6,9	110	24 - 200	2530	0,9	2,05
S - 63	63,0	8,7	125	24 - 150	2550	1,0	2,77

Single pipe heating - 6 bar may be used for dimensions **> S - 63**, providing that operation pressure will be maximum 6 bar. Admissible operating pressure p_B see **chapter 3.4.3**.

Double Pipe Sanitary - 10 bar

Dimensions PE-Xa-Pipe			Jacket-Pipe Outside-Ø	Delivery-length in 1,00 m steps	Maximum coil-outside-Ø	Minimum-bending radius	Weight without water
Type	Outside-Ø d_a in mm	Wall-thickness s in mm	D_a in mm	L in m	d_R in mm	r in m	G in kg/m
S - 25 + 20	25,0 / 20,0	3,5 / 2,8	90	24 - 250	2530	0,9	0,98
S - 32 + 20	32,0 / 20,0	4,4 / 2,8	110	24 - 200	2530	0,9	1,37
S - 40 + 25	40,0 / 25,0	5,5 / 3,5	125	24 - 150	2550	1,0	1,78
S - 50 + 32	50,0 / 32,0	6,9 / 4,4	140	24 - 140	2690	1,1	2,53
S - 63 + 32	63,0 / 32,0	8,7 / 4,4	160	24 - 120	2700	1,2	3,23

3.4.3 Heat Loss and Capacity (Dimensions)

Single Pipe Heating - 6 bar

Type	Dimensioning						Heat Loss			
	Water-content v in l/m	Volume-flow V' in m³/h	Flow-speed w in m/s	Transmittable capacity P in kW at spread			Coefficient u_{ER} in W/(m•K)	q per pipe meter in W/m at average temperature T_M		
				20 K	30 K	40 K		70 K	60 K	50 K
H - 25	0,327	0,59 - 1,18	0,5 - 1,0	14 - 27	21 - 41	27 - 55	0,1246	8,719	7,473	6,228
H - 32	0,539	1,17 - 2,33	0,6 - 1,2	27 - 54	41 - 81	54 - 108	0,1582	11,077	9,495	7,912
H - 40	0,835	1,80 - 3,61	0,6 - 1,2	42 - 84	63 - 126	84 - 168	0,1646	11,525	9,879	8,232
H - 50	1,307	3,30 - 6,59	0,7 - 1,4	77 - 153	115 - 230	153 - 307	0,1693	11,854	10,160	8,467
H - 63	2,075	5,23 - 10,5	0,7 - 1,4	122 - 243	182 - 365	243 - 487	0,1921	13,449	11,528	9,607
H - 75	2,961	8,53 - 17,1	0,8 - 1,6	198 - 397	298 - 595	397 - 793	0,2109	14,764	12,655	10,546
H - 90	4,254	12,3 - 24,5	0,8 - 1,6	285 - 570	428 - 855	570 - 1140	0,2264	15,851	13,587	11,322
H - 110	6,362	20,6 - 41,2	0,9 - 1,8	479 - 959	719 - 1438	959 - 1918	0,2608	18,257	15,649	13,041
H - 125	8,203	26,6 - 53,2	0,9 - 1,8	618 - 1237	927 - 1855	1237 - 2473	0,3390	23,730	20,340	16,950
H - 125 Stg.	8,203	26,6 - 53,2	0,9 - 1,8	618 - 1237	927 - 1855	1237 - 2473	0,2245	15,717	13,472	11,226
H - 160 Stg.	13,437	48,4 - 96,7	1,0 - 2,0	1125 - 2250	1688 - 3376	2250 - 4501	0,2883	20,179	17,296	14,413
H - 25 v	0,327	0,59 - 1,18	0,5 - 1,0	14 - 27	21 - 41	27 - 55	0,1072	7,506	6,434	5,362
H - 32 v	0,539	1,17 - 2,33	0,6 - 1,2	27 - 54	41 - 81	54 - 108	0,1313	9,191	7,878	6,565
H - 40 v	0,835	1,80 - 3,61	0,6 - 1,2	42 - 84	63 - 126	84 - 168	0,1342	9,396	8,054	6,711
H - 50 v	1,307	3,30 - 6,59	0,7 - 1,4	77 - 153	115 - 230	153 - 307	0,1470	10,288	8,819	7,349
H - 63 v	2,075	5,23 - 10,5	0,7 - 1,4	122 - 243	182 - 365	243 - 487	0,1681	11,766	10,085	8,404
H - 75 v	2,961	8,53 - 17,1	0,8 - 1,6	198 - 397	298 - 595	397 - 793	0,1761	12,330	10,568	8,807
H - 90 v	4,254	12,3 - 24,5	0,8 - 1,6	285 - 570	428 - 855	570 - 1140	0,1915	13,402	11,488	9,573

Double Pipe Heating - 6 bar

Type	Dimensioning						Heat Loss			
	Water-content v in l/m	Volume-Flow V' in m³/h	Flow-speed w in m/s	Transmittable Capacity P in kW at spread			Coefficient u_{DR} in W/(m•K)	q per Pipe Meter in W/m at average Temperature T_M		
				20 K	30 K	40 K		70 K	60 K	50 K
H - 20 + 20	0,201	0,36 - 0,72	0,5 - 1,0	8 - 17	13 - 25	17 - 34	0,2107	14,743	12,639	10,535
H - 25 + 25	0,327	0,59 - 1,18	0,5 - 1,0	14 - 27	21 - 41	27 - 55	0,2148	15,033	12,887	10,742
H - 32 + 32	0,539	1,17 - 2,33	0,6 - 1,2	27 - 54	41 - 81	54 - 108	0,2346	16,419	14,076	11,732
H - 40 + 40	0,835	1,80 - 3,61	0,6 - 1,2	42 - 84	63 - 126	84 - 168	0,2638	18,462	15,827	13,192
H - 50 + 50	1,307	3,30 - 6,59	0,7 - 1,4	77 - 153	115 - 230	153 - 307	0,2464	17,243	14,783	12,322
H - 63 + 63	2,075	5,23 - 10,5	0,7 - 1,4	122 - 243	182 - 365	243 - 487	0,2935	20,542	17,610	14,678
H - 25 + 25 v	0,327	0,59 - 1,18	0,5 - 1,0	14 - 27	21 - 41	27 - 55	0,1744	12,206	10,464	8,721
H - 32 + 32 v	0,539	1,17 - 2,33	0,6 - 1,2	27 - 54	41 - 81	54 - 108	0,1975	13,823	11,850	9,877
H - 40 + 40 v	0,835	1,80 - 3,61	0,6 - 1,2	42 - 84	63 - 126	84 - 168	0,2223	15,557	13,337	11,116
H - 50 + 50 v	1,307	3,30 - 6,59	0,7 - 1,4	77 - 153	115 - 230	153 - 307	0,2103	14,717	12,617	10,517

Admissible Operating Pressure p_B in bar

Duration	Permanent Operating Temperature T_B in °C									
	10°	20°	30°	40°	50°	60°	70°	80°	90°	95°
1 year	17,9	15,8	14,0	12,5	11,1	9,9	8,9	8,0	7,2	6,8
5 years	17,5	15,5	13,8	12,2	10,9	9,7	8,7	7,8	7,0	6,6
10 years	17,4	15,4	13,7	12,1	10,8	9,7	8,6	7,7	6,9	---
25 years	17,2	15,2	13,5	12,0	10,7	9,5	8,5	7,6	---	---
50 years	17,1	15,1	13,4	11,9	10,6	9,5	8,5	---	---	---

The mentioned data are corresponding to DIN 16893 for flow medium water with a safety factor of S_D = 1,25.

Edition: 16.01.2012

Single Pipe Sanitary - 10 bar

Type	Dimensioning							Heat Loss			
	Water-content v in l/m	Volume-Flow V' in m³/h	Flow-Speed w in m/s	Volume-Flow V' in m³/h	Flow-Speed w in m/s	Volume-Flow V' in m³/h	Flow-Speed w in m/s	Coefficient u_{ER} in W/(m•K)	q per Pipe Meter in W/m at averageTemperature T_M		
									60 K	50 K	40 K
S - 25	0,254	1,099	1,2	1,191	1,3	1,283	1,4	0,1237	7,425	6,187	4,950
S - 32	0,423	1,826	1,2	1,978	1,3	2,131	1,4	0,1570	9,419	7,849	6,279
S - 40	0,661	2,853	1,2	3,091	1,3	3,329	1,4	0,1633	9,780	8,166	6,533
S - 50	1,029	4,446	1,2	4,817	1,3	5,187	1,4	0,1679	10,075	8,396	6,717
S - 63	1,633	7,055	1,2	7,643	1,3	8,231	1,4	0,1903	11,418	9,515	7,612

Double Pipe Sanitary - 10 bar

Type	Dimensioning							Heat Loss			
	Water-content v in l/m	Volume-Flow V' in m³/h	Flow-Speed w in m/s	Volume-Flow V' in m³/h	Flow-Speed w in m/s	Volume-Flow V' in m³/h	Flow-Speed w in m/s	Coefficient u_{DR} in W/(m•K)	q per Pipe Meter in W/m at average Temperature T_M		
									60 K	50 K	40 K
S-25+20	0,254	1,374	1,5	1,466	1,6	1,557	1,7	0,1930	11,578	9,674	7,769
S-32+20	0,423	2,283	1,5	2,435	1,6	2,587	1,7	0,1893	11,356	9,510	7,664
S-40+25	0,661	3,567	1,5	3,805	1,6	4,042	1,7	0,2053	12,319	10,319	8,319
S-50+32	1,029	5,558	1,5	5,928	1,6	6,299	1,7	0,2348	14,086	11,800	9,514
S-63+32	1,633	8,819	1,5	9,407	1,6	9,995	1,7	0,2765	16,588	13,928	11,267

The mentioned data are based on a medium specific thermal capacity [c_m] of the water of 4187 J/(kg•K), a soil covering height [$Ü_H$] of 0,60 m, a thermal conductivity of the soil [λ_E] of 1,2 W/(m•K), a medium soil temperature [T_E] of 10 °C and for single pipes on a carrier pipe distance of 100 mm. The flow speed [w] has to be determined specifically.

$T_M = (T_{VL} + T_{RL}) : 2 - T_E$; Example: (80° + 60°) : 2 – 10° = 60 K average temperature.

Admissible Operating Pressure p_B in bar - Sanitary

Duration	Permanent Operating Temperature T_B in °C									
	10°	20°	30°	40°	50°	60°	70°	80°	90°	95°
1 year	28,3	25,1	22,3	19,8	17,7	15,8	14,1	12,7	11,4	10,8
5 years	27,8	24,6	21,9	19,4	17,3	15,5	13,8	12,4	11,1	---
10 years	27,6	24,4	21,7	19,3	17,2	15,3	13,7	12,3	11,0	---
25 years	27,3	24,2	21,4	19,1	17,0	15,2	13,6	12,1	---	---
50 years	27,1	24,0	21,3	18,9	16,8	15,0	13,4	---	---	---

The mentioned data are corresponding to DIN 16893 for flow medium water with a safety factor of S_D = 1,25.

3.5.1 Carrier Pipe / Connection Technology / Operating Conditions

Carrier Pipe

The **isoclima** pipe consists of a seamless extruded, impact- and shatter-resistant, ductile and stable high-density polyurethane known as polyethylene 100. General quality requirements, pipe series, and measurements according to DIN 8075, DIN 8074 / DIN EN 12201-2. Polyethylene 100 pipes are tested for drinking water suitability and tested in accordance with DVGW Directive W270.

Connection Technology

The connection of the **isoclima** pipe occurs in underground sections, preferably using weldable PE-HD joints; butt welds and screw-type connections are also options. A wide range of connection components is available.

Operating Conditions

Maximum operating temperature T_{max}:	+30 °C
Minimum operating temperature T_{max}:	-20 °C
Maximum operating pressure p_B:	16 bar
Leak detecting:	without

3.5.2 Dimensions resp. Types / Energy Loss and Capacity

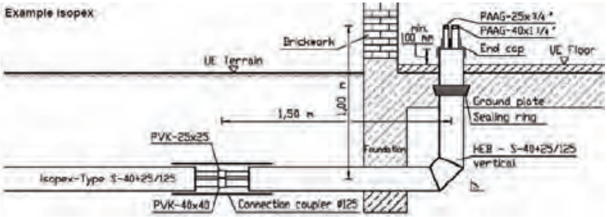
Series 1								
Dimensions PE100-Pipe								
Type	Outside-∅ d_a in mm	Wall-thickness s in mm	PEHD-Outside-∅ D_a in mm	Maximum Delivery length L in m	Maximum coil-outside-∅ d_R in mm	Minimum-bending radius r in m	Weight without Water G in kg/m	Heat-Loss coefficient u-Value in W/(m•K)
isoclima-20	20,0	2,0	65	250	2500	0,8	0,66	0,1115
isoclima-25	25,0	2,3	75	250	2500	0,8	0,82	0,1188
isoclima-32	32,0	2,9	75	250	2500	0,9	0,90	0,1511
isoclima-40	40,0	3,7	90	200	2500	0,9	1,23	0,1573
isoclima-50	50,0	4,6	110	200	2500	1,0	1,80	0,1617
isoclima-63	63,0	5,8	125	150	2500	1,1	2,37	0,1836
isoclima-75	75,0	6,8	140	140	2700	1,2	3,15	0,2017
isoclima-90	90,0	8,2	160	120	2700	1,4	4,10	0,2166
isoclima-110	110,0	10,0	160	85	2700	1,4	4,89	0,3173
isoclima-110	110,0	10,0	180	85	2700	1,4	5,47	0,2498

Edition: 16.01.2012

3.6.1 General

Depending on the application form parts such as elbows, branches will be delivered on request as well as custom molded parts from the PJP program if required.

3.6.2 House Entry Elbow 90°



House-entry-elbows are useful for connecting buildings without cellars by passing the concrete ground-plate of the house. They will be produced generally in standard lengths of 1,00 x 1,50 m. Depending from kind of flexible pipe with steel, copper, PE-Xa or PE100-carrier pipe. For post insulation of the connection spot in the soil a jacket pipe connecting coupler will be required, see Design-Manual, **chapter 6**.

In case of **isopex**-pipes the connection with the continuing pipe will be made inside of the building by using connection couplers with welding ends or outside threads, see **chapter 3.6.5**.

Orders of house-entry-elbows should clearly indicate all carrier- and jacket pipe dimensions respectively -type and operating pressure. In case of double pipes additionally the position of the bend, vertical (s), horizontal (w) or falling (f) should be mentioned. In case of different carrier pipe diameters, the position of the smaller carrier pipe diameter will be generally in 12:00 o'clock position.

Example of order:

House-Entry-Elbow (HEB) isoflex:

Single: **HEB - 28 / 75**
for **isoflex** - Standard

House-Entry-Elbow (HEB) isocu:

Double: **HEB-s - 2 x 28 / 90**
for **isocu** - Double 28 + 28

House-Entry-Elbow isopex-Heating:

Single: **HEB - 40 / 90**, 6 bar
for **isopex**-Heating **Type H-40**

Double: **HEB-s - 63 + 63 / 180**, 6 bar
for **isopex**-Heating **Type H-63+63**

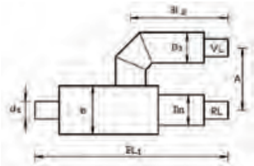
House-Entry-Elbow isopex-Sanitary:

Single: **HEB - 32 / 75**, 10 bar
for **isopex**-Sanitary **Type S-32**

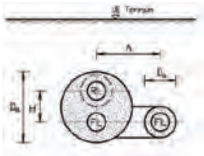
Double: **HEB-s - 50 + 32 / 140**, 10 bar
for **isopex**-Sanitary Type **S-50+32**

Carrier- and jacket-pipe dimensions **isoflex** see **chapter 3.2.2**, **isocu** see **chapter 3.3.2** and **isopex** see **chapter 3.4.2**. All connection couplings, protection- and end caps as well as jacket-pipe couplers are not included within the delivery of the elbow. **isoclima**-preformed parts available on request.

3.6.3 Bifurcated Pipe



Top View



Front View

Bifurcated pipes are used for transition of two single pipes to one double pipe and are produced generally with the same dimensions. For **isoflex**-applications, bifurcated pipes will consist of steel carrier pipe, for **isopex**-Heating and **isopex**-Sanitary of crosslinked PE-Xa. In relation with **isocu** they will consist of copper pipes according to DIN 1754/17671.

For post insulation of the connection spots in the soil, corresponding connection couplers will be required, according to the jacket-pipe dimensions, see Design-Manual, **chapter 6**. The connection has to be ensued to the requirements of the advanced systems.
Orders of bifurcated pipes should clearly indicate **all** carrier- and jacket-pipe dimensions respectively kind and operating pressure. In case of double pipes the position of the smaller dimension will be generally in 12:00- o'clock position.

Example of order:

Bifurcated Pipe (HR-I) isoflex:

HR-I for **isoflex**, 2 x Single 28 / 75
to 1 x Double **28 + 28 / 110**

Bifurcated Pipe (HR-I) isocu:

HR-I for **isocu**, 2 x Single 22 / 65
to 1 x Double **22 + 22 / 90**

Bifurcated Pipe (HR-I) isopex-Heating:

HR-I for **isopex**-Heating, 6 bar
2 x Single **H - 63 / 125**
to 1 x Double **H - 63 + 63 / 180**

Bifurcated Pipe (HR-I) isopex-Sanitary:

HR-I for **isopex**-Sanitary, 10 bar
2 x Single **S - 50 / 110** and **S - 32/75**
to 1 x Double **S - 50 + 32 / 140**

Carrier- and jacket-pipe dimensions **isoflex** see **chapter 3.2.2**, **isocu** see **chapter 3.3.2** and **isopex chapter 3.4.2**. All connection couplings as well as jacket-pipe couplers are not included within the delivery of a bifurcated pipe. Due to manufacturing reasons the jacket-pipe dimensions may differ partly from the PELD-dimensions of the flexible pipes. Available dimensions and measures on request.

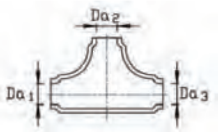
During assembling the correct position of single- and double pipes, respectively the position of the bifurcated pipe as well as the axial measures A and H has to be considered. The condition for expansion compensation (L-, Z, or U-elbow) has to be provided at the transitions of the single-pipe system before the bifurcated pipe, because bifurcated pipes have to be installed generally at pipe-static neutral pipeline spots. In case of changing of the system within an exit-pipe of a branch, between branch and bifurcated pipe a rigid fitting part of at least 2,50 m lengths has to be installed for compensation of lateral expansion.

Edition: 16.01.2012

3.6.4 GFK-Assembling Fittings

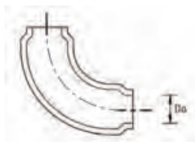
GFK-Assembling-Branch 90°

Passage in mm		Branch resp. Exit D_{a2} in mm							
D_{a1}	D_{a3}	65	75	90	110	125	140	160	180
65	65	✓							
75	65	✓	✓						
75	75	✓	✓						
90	65	✓	✓	✓					
90	75	✓	✓	✓					
90	90	✓	✓	✓					
110	65	✓	✓	✓	✓				
110	75	✓	✓	✓	✓				
110	90	✓	✓	✓	✓				
110	110	✓	✓	✓	✓				
125	75	✓	✓	✓	✓	✓			
125	90	✓	✓	✓	✓	✓			
125	110	✓	✓	✓	✓	✓			
125	125	✓	✓	✓	✓	✓			
140	90	✓	✓	✓	✓	✓	✓		
140	110	✓	✓	✓	✓	✓	✓		
140	125	✓	✓	✓	✓	✓	✓		
140	140	✓	✓	✓	✓	✓	✓		
160	110	--	✓	✓	✓	✓	✓	✓	
160	125	--	✓	✓	✓	✓	✓	✓	
160	140	--	✓	✓	✓	✓	✓	✓	
160	160	--	✓	✓	✓	✓	✓	✓	
180	125	--	--	✓	✓	✓	✓	✓	✓
180	140	--	--	✓	✓	✓	✓	✓	✓
180	160	--	--	✓	✓	✓	✓	✓	✓
180	180	--	--	✓	✓	✓	✓	✓	✓



GFK-Assembling-Elbow 90°

D_a in mm	Elbow
65	--
75	✓
90	✓
110	✓
125	✓
140	✓
160	✓
180	✓



Edition: 16.01.2012

GFK-Assembling-Branch 90° / GFK-Assembling-Elbow 90°

Orders for GFK-fittings should clearly indicate the corresponding jacket pipe dimensions [D_a] or/and the flexible pipe types. All half shells consist of a break proof fibre glass polyester (GFK). The delivery includes the two shells and the required quantity of stainless-hexagon-screws M8 x 40, sealing stripes made of butyl-rubber, eventually required reducing rings, brass threaded-valve including closing cap for the PUR-foam filling-hole, as well as the corresponding quantity of ready-made foam portion.

Example of order:

GFK-Assembling-Branch, passage x branch x passage (D_{a1} x D_{a2} x D_{a3}):

isopex: **GFK-T - 140 x 110 x 125**
for **isopex**, Type **H-75** to **H-50** to **H-63**

isocu: **GFK-T - 75 x 65 x 75**
for **isocu**, Type **28** to **22** to **28**

GFK-Assembling-Elbow:

isopex: **GFK-B - 180**
for **isopex**, Type **H-63+63**

isoflex: **GFK-B - 90**
for **isoflex**, Type **28 v**

Further information see **chapter 11.3.11**.

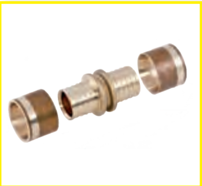
Edition: 16.01.2012

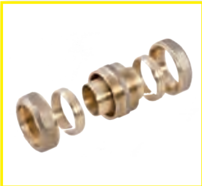
3.6.5 Components Carrier Pipe isopex

Connecting- and Elbow-Coupling

Dimensions	Heating - 6 bar						Sanitary - 10 bar					
	Press		Screw		Clamp		Press		Screw		Clamp	
	Conn.	Elbow	Conn.	Elbow	Conn.	Elbow	Conn.	Elbow	Conn.	Elbow	Conn.	Elbow
PE-Xa-Pipe	PVK	PBK	SVK	SBK	KVK	KBK	PVK	PBK	SVK	SBK	KVK	KBK
20 x 20	--	--	--	--	✓	✓	✓	✓	✓	✓	✓	✓
25 x 25	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
32 x 32	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40 x 40	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
50 x 50	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
63 x 63	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
75 x 75	✓	✓	✓	✓	--	--	--	--	--	--	--	--
90 x 90	✓	✓	✓	✓	--	--	--	--	--	--	--	--
110 x 110	✓	✓	✓	✓	--	--	--	--	--	--	--	--
125 x 125	✓	✓	✓	✓	--	--	--	--	--	--	--	--
160 x 160	✓	✓	✓	✓	--	--	--	--	--	--	--	--

Conn. = Connecting-Coupling Elbow = Elbow-Coupling





Orders for connecting- or/and elbow-couplings (90° bends) should bear the exact description, operating pressure and kind of connection to the **isopex**-pipe ends, for which press fittings, screwable or clampable connections can be used.

For buried sections as well as for heating installations (6 bar) generally press fittings or clamp fittings should be used. Inside of buildings in manholes as well as for sanitary applications (10 bar) also screwed connections can be used.

Example of order:

Press-Connection-Coupling (PVK):

Heating: **PVK - 110 x 110**, 6 bar,
with press fittings
for **isopex**-Heating Type **H-110**

Sanitary: **PVK - 25 x 25**, 10 bar,
with press fittings
for **isopex**-Sanitary Type **S-25**

Press-Elbow-Coupling (PBK):

Heating: **PBK - 90 x 90**, 6 bar,
with press fittings
for **isopex**-Heating Type **H-90**

Sanitary: **PBK - 63 x 63**, 10 bar,
with press fittings
for **isopex**-Sanitary Type **S-63**

Screw-Connection-Coupling (SVK):

Heating: **SVK - 32 x 32**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-32**

Sanitary: **SVK - 50 x 50**, 10 bar,
with screw fittings
for **isopex**-Sanitary Type **S-50**

Screw-Elbow-Coupling (SBK):

Heating: **SBK - 75 x 75**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-75**

Sanitary: **SBK - 40 x 40,** 10 bar,
with screw fittings
for **isopex**-Sanitary Type **S-40**

Clamp-Connection-Coupling (KVK):

Heating: **KVK - 63 x 63**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-63**

Sanitary: **KVK - 25 x 25**, 10 bar,
with clamp fittings
for **isopex**-Sanitary Type **S-25**

Clamp-Elbow-Coupling (KBK):

Heating: **KBK - 50 x 50**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-50**

Sanitary: **KBK - 40 x 40**, 10 bar,
with clamp fittings
for **isopex**-Sanitary Type **S-40**

According to type and dimension, press-connection-couplings and clamp-connection-couplings determined from **isoplus**, may consist of steel 435 GH or dezincification resistant brass MS58/M560 or red cast iron RG 7. Screw-connection-couplings generally acc. to DIN 8076 in heavy brass quality.

Edition: 16.01.2012

Reducing-Coupling

Dimensions PE-Xa-Pipe	Heating - 6 bar			Sanitary - 10 bar		
	Press Reduction PRK	Screw Reduction SRK	Clamp Reduction KRK	Press Reduction PRK	Screw Reduction SRK	Clamp Reduction KRK
25 x 20	✓	✓	✓	✓	✓	✓
32 x 20	✓	✓	✓	✓	✓	✓
32 x 25	✓	✓	✓	✓	✓	✓
40 x 25	✓	✓	✓	✓	✓	✓
40 x 32	✓	✓	✓	✓	✓	✓
50 x 32	✓	✓	✓	✓	✓	✓
50 x 40	✓	✓	✓	✓	✓	✓
63 x 40	✓	✓	✓	✓	✓	✓
63 x 50	✓	✓	✓	✓	✓	✓
75 x 50	✓	✓	✓	--	--	--
75 x 63	✓	✓	✓	--	--	--
90 x 63	✓	✓	✓	--	--	--
90 x 75	✓	✓	✓	--	--	--
110 x 75	✓	✓	✓	--	--	--
110 x 90	✓	✓	✓	--	--	--
125 x 90	✓	--	✓	--	--	--
125 x 110	✓	--	✓	--	--	--
160 x 110	✓	--	✓	--	--	--
160 x 125	✓	--	✓	--	--	--

Orders for reducing-couplings should bear the exact description, operating pressure and kind of connection to **isopex**-pipe ends, for which press fittings, screwable or clampable connections can be used.

For buried sections as well as for heating installations (6 bar) generally press fittings or clamp fittings should be used. Inside of buildings in manholes as well as for sanitary applications (10 bar) also screwable connections can be used.

Example of order:

Press-Reducing-Coupling (PRK):

Heating: **PRK - 110 x 75**, 6 bar,
with press fittings
for **isopex**-Heating Type **H-110** to **H-75**

Sanitary: **PRK - 25 x 20**, 10 bar,
with press fittings
for **isopex**-Sanitary Type **S-25** to **S-20**

Screw-Reducing-Coupling (SRK):

Heating: **SRK - 32 x 25**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-32** to **H-25**

Sanitary: **SRK - 50 x 32**, 10 bar,
with screw fittings
for **isopex**-Sanitary Type **S-50** to **S-32**

Clamp-Reducing-Coupling (KRK):

Heating: **KRK - 40 x 32**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-40** to **H-32**

Sanitary: **KRK - 25 x 20**, 10 bar,
with clamp fittings
for **isopex**-Sanitary Type **S-25** to **S-20**

According to type and dimension, press-reducing-couplings and clamp-reducing-couplings determined from **isoplus**, may consist of steel 435 GH or dezincification resistant brass MS58/M560 or red cast iron RG 7. Screw-reducing-couplings generally acc. to DIN 8076 in heavy brass quality.

Edition: 16.01.2012

Alignment-Coupling inside of building with Welding-End or Outside-Thread

Dimensions	Heating - 6 bar						Sanitary - 10 bar					
	Press		Screw		Clamp		Press		Screw		Clamp	
PE-Xa-Pipe	SE	AG	SE	AG	SE	AG	SE	AG	SE	AG	SE	AG
	PASE	PAAG	SASE	SAAG	KASE	KAAG	PASE	PAAG	SASE	SAAG	KASE	KAAG
20 x ½“	--	--	--	--	--	--	--	✓	--	✓	--	✓
25 x ¾“	✓	✓	✓	✓	✓	✓	--	✓	--	✓	--	✓
32 x 1“	✓	✓	✓	✓	✓	✓	--	✓	--	✓	--	✓
40 x 1 ¼“	✓	✓	✓	✓	✓	✓	--	✓	--	✓	--	✓
50 x 1 ½“	✓	✓	✓	✓	✓	✓	--	✓	--	✓	--	✓
63 x 2“	✓	✓	✓	✓	✓	✓	--	✓	--	✓	--	✓
75 x 2 ½“	✓	✓	✓	✓	✓	✓	--	--	--	--	--	--
90 x 3“	✓	✓	✓	✓	✓	✓	--	--	--	--	--	--
110 x 4“	✓	✓	✓	✓	✓	✓	--	--	--	--	--	--
125 x 5“	✓	✓	✓	✓	✓	✓	--	--	--	--	--	--
160 x 6“	✓	✓	✓	✓	✓	✓	--	--	--	--	--	--

SE = Welding-End AG = Outside-Thread

All alignment-couplings with outside-thread (AG) acc. to DIN EN 10226 for connection of the following pipe line. The corresponding thread coupler acc. to DIN EN 10241 should be provided at site.






Orders for alignment-couplings should bear the exact description, operating pressure and kind of connection to **isopex**-pipe ends, for which press fittings, screwable or clampable connections can be used.

For buried sections as well as for heating installations (6 bar) generally press fittings or clamp fittings should be used. Inside of buildings in manholes as well as for sanitary applications (10 bar) also screwable connections can be used.

Example of Order:

Press-Alignment with Welding-End (PASE):

Heating: **PASE - 110 x 4"**, 6 bar,
with press fittings
for **isopex**-Heating Type **H-110**

Press-Alignment with Outside-Thread (PAAG):

Heating: **PAAG - 90 x 3"**, 6 bar,
with press fittings
for **isopex**-Heating Type **H-90**

Sanitary: **PAAG - 40 x 1"**, 10 bar,
with press fitting
for **isopex**-Sanitary Type **S-40**

Screw-Alignment with Welding-End (SASE):

Heating: **SASE - 32 x 1"**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-32**

Screw-Alignment with Outside-Thread (SAAG):

Heating: **SAAG - 25 x 3/4"**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-75**

Sanitary: **SAAG - 63 x 2",** 10 bar,
with screw fittings
for **isopex**-Sanitary Type **S-63**

Clamp-Alignment with Welding-End (KASE):

Heating: **KASE - 63 x 2"**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-63**

Clamp-Alignment with Outside-Thread (KAAG):

Heating: **KASE - 32 x 1"**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-32**

Sanitary: **KASE - 63 x 2"**, 10 bar,
with clamp fittings
for **isopex**-Sanitary Type **S-63**

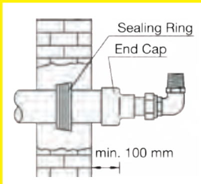
According to type and dimension, press-alignments and clamp-alignments determined from **isoplus**, may consist of steel 435 GH or dezincification resistant brass MS58/M560 or red cast iron RG 7. Screw-alignments generally acc. to DIN 8076 in heavy brass quality.

Edition: 16.01.2012

Alignment-Angle 90° inside of building with one Outside-Thread

Dimensions PE-Xa-Pipe	Heating - 6 bar		Sanitary - 10 bar	
	Screw-Angle with Outside-Thread SWAG	Clamp-Angle with Outside-Thread KWAG	Screw-Angle with Outside-Thread SWAG	Clamp-Angle with Outside-Thread KWAG
20 x ½“	--	✓	✓	✓
25 x ¾“	✓	✓	✓	✓
32 x 1“	✓	✓	✓	✓
40 x 1 ¼“	✓	✓	✓	✓
50 x 1 ½“	✓	✓	✓	✓
63 x 2“	✓	✓	✓	✓
75 x 2 ½“	✓	--	--	--
90 x 3“	✓	--	--	--
110 x 4“	✓	--	--	--
125 x 5“	✓	--	--	--
160 x 6“	✓	--	--	--

All 90°-alignment-angles with outside thread (AG) acc. to DIN 10226 for connection with the following pipe line. The corresponding thread coupler acc. to DIN 10241 should be provided at site.



Orders for alignment-angles should bear the exact description and operating pressure. The connection to the **isopex** pipe end is carried out as a screw or clamp connection, whereby the screw connections are only used at accessible material transitions in buildings or shafts.

Example of order:

Screw-Angle with Outside-Thread (SWAG):

Heating: **SWAG - 90 x 3“**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-90**

Sanitary: **SWAG - 63 x 2“**, 10 bar,
with screw fittings
for **isopex**-Sanitary Type **S-63**

Clamp-Angle with Outside-Thread (KWAG):

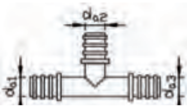
Heating: **KWAG - 32 x 1“**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-32**

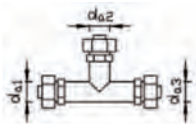
Sanitary: **KASE - 63 x 2“**, 10 bar,
with clamped fittings
for **isopex**-Sanitary Type **S-63**

According to type and dimension, alignments-angles determined from **isoplus**, may consist of steel 435 GH or dezincification resistant brass MS58/M560 or red cast iron RG 7. Screw-angles generally acc. to DIN 8076 in heavy brass quality.

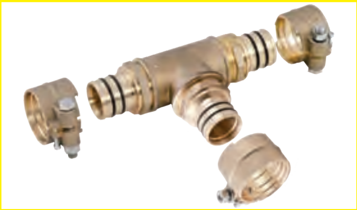
T-Piece – Heating, 6 bar

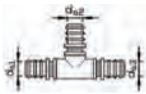
Passage		Press-T-Piece (PT)										Screw-T-Piece (ST)									
		Branch resp. soil pipe d_{a2}										Branch resp. soil pipe d_{a2}									
d_{a1}	d_{a3}	25	32	40	50	63	75	90	110	125	160	25	32	40	50	63	75	90	110	125	160
25	25	✓										✓									
32	25	✓	✓									✓	✓								
32	32	✓	✓									✓	✓								
40	25	✓	✓	✓								✓	✓	✓							
40	32	✓	✓	✓								✓	✓	✓							
40	40	✓	✓	✓								✓	✓	✓							
50	25	✓	✓	--	✓							✓	✓	✓	✓						
50	32	--	✓	✓	✓							✓	✓	✓	✓						
50	40	✓	✓	✓	--							✓	✓	✓	✓						
50	50	✓	✓	✓	✓							✓	✓	✓	✓						
63	32	--	--	--	--	✓						✓	✓	✓	✓	✓					
63	40	--	--	✓	✓	--						✓	✓	✓	✓	✓					
63	50	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓					
63	63	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓					
75	40	--	--	--	--	--	--					✓	✓	✓	✓	✓	✓				
75	50	--	--	--	--	✓	✓					✓	✓	✓	✓	✓	✓				
75	63	✓	✓	✓	✓	✓	--					✓	✓	✓	✓	✓	✓				
75	75	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓				
90	50	--	--	--	--	--	--	✓				✓	✓	✓	✓	✓	✓	✓			
90	63	--	--	--	--	✓	✓	--				✓	✓	✓	✓	✓	✓	✓			
90	75	--	✓	✓	✓	--	✓	✓				✓	✓	✓	✓	✓	✓	✓			
90	90	--	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓			
110	75	--	--	--	✓	--	--	--	--			✓	✓	✓	✓	✓	✓	✓	✓		
110	90	--	--	--	--	✓	--	--	--			✓	✓	✓	✓	✓	✓	✓	✓		
110	110	--	--	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		
125	90	on request										--	--	--	--	--	--	--	--	--	
125	110	on request										--	--	--	--	--	--	--	--	--	
125	125	on request										--	--	--	--	--	--	--	--	--	
160	110	on request										--	--	--	--	--	--	--	--	--	--
160	125	on request										--	--	--	--	--	--	--	--	--	--
160	160	on request										--	--	--	--	--	--	--	--	--	--





Edition: 16.01.2012



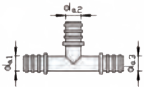
Passage		Clamp-T-piece (KT)				
		Branch resp. soil pipe d_{a2}				
d_{a1}	d_{a3}	25	32	40	50	63
25	25	✓				
32	25	✓	✓			
32	32	✓	✓			
40	25	✓	✓	✓		
40	32	✓	✓	✓		
40	40	✓	✓	✓		
50	25	✓	✓	✓	✓	
50	32	✓	✓	✓	✓	
50	40	✓	✓	✓	✓	
50	50	✓	✓	✓	✓	
63	32	✓	✓	✓	✓	✓
63	40	✓	✓	✓	✓	✓
63	50	✓	✓	✓	✓	✓
63	63	✓	✓	✓	✓	✓

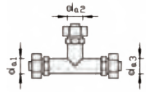
Orders for T-pieces should bear the three dimensions of the t-piece [$d_{a1\text{-}3}$], operating pressure and kind of connection to **isopex**-pipe ends, for which press fittings, screwable or clampable connections can be used.

For buried sections as well as for heating installations (6 bar) generally press fittings or clamp fittings should be used. Inside of buildings in manholes as well as for sanitary applications (10 bar) also screwed connections can be used. Other dimensions on request.

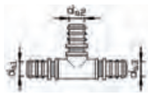
T-Piece – Sanitary, 10 bar

Passage		Press-T-Piece (PT)						Screw-T-Piece (ST)					
		Branch resp. soil pipe d_{a2}						Branch resp. soil pipe d_{a2}					
d_{a1}	d_{a3}	20	25	32	40	50	63	20	25	32	40	50	63
20	20	✓						✓					
25	20	✓	✓					✓	✓				
25	25	✓	✓					✓	✓				
32	20	✓	✓	✓				✓	✓	✓			
32	25	✓	✓	✓				✓	✓	✓			
32	32	✓	✓	✓				✓	✓	✓			
40	20	--	--	--	--			✓	✓	✓	✓		
40	25	--	--	--	--			✓	✓	✓	✓		
40	32	--	--	✓	--			✓	✓	✓	✓		
40	40	--	✓	✓	✓			✓	✓	✓	✓		
50	25	--	--	--	--	--		✓	✓	✓	✓	✓	
50	32	--	--	--	--	--		✓	✓	✓	✓	✓	
50	40	--	--	✓	--	--		✓	✓	✓	✓	✓	
50	50	--	--	✓	--	✓		✓	✓	✓	✓	✓	
63	32	--	--	--	--	--	--	✓	✓	✓	✓	✓	✓
63	40	--	--	--	--	--	--	✓	✓	✓	✓	✓	✓
63	50	--	--	✓	--	--	--	✓	✓	✓	✓	✓	✓
63	63	--	--	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓





Passage		Clamp-T-Piecce (KT)					
		Branch resp. soil pipe d_{a2}					
d_{a1}	d_{a3}	20	25	32	40	50	63
20	20	✓					
25	20	✓	✓				
25	25	✓	✓				
32	20	✓	✓	✓			
32	25	✓	✓	✓			
32	32	✓	✓	✓			
40	20	✓	✓	✓	✓		
40	25	✓	✓	✓	✓		
40	32	✓	✓	✓	✓		
40	40	✓	✓	✓	✓		
50	25	✓	✓	✓	✓	✓	
50	32	✓	✓	✓	✓	✓	
50	40	✓	✓	✓	✓	✓	
50	50	✓	✓	✓	✓	✓	
63	32	✓	✓	✓	✓	✓	✓
63	40	✓	✓	✓	✓	✓	✓
63	50	✓	✓	✓	✓	✓	✓
63	63	✓	✓	✓	✓	✓	✓



Orders for T-pieces should bear the three dimensions of the t-piece [d_{a1-3}], operating pressure and kind of connection to **isopex**-pipe ends, for which press fittings, screwable or clampable connections can be used.

For buried sections as well as for heating installations (6 bar) generally press fittings or clamp fittings should be used. Inside of buildings in manholes as well as for sanitary applications (10 bar) also screwable connections can be used. Other dimensions on request.

Example of order: passage x branch x passage (da_1 x da_2 x da_3):

Press-T-Piece (PT):

Heating: **PT - 110 x 50 x 75**, 6 bar,
with press fittings
for **isopex**-Heating Type **H-110** to **H-50** to **H-75**

Sanitary: **PT - 40 x 32 x 32**, 10 bar,
with press fittings
for **isopex**-Sanitary Type **S-25** to **S-32** to **S-32**

Screw-T-Piece (ST):

Heating: **ST - 63 x 40 x 50**, 6 bar,
with screw fittings
for **isopex**-Heating Type **H-32** to **H-40** to **H-50**

Sanitary: **ST - 50 x 32 x 40**, 10 bar,
screw fittings
for **isopex**-Sanitary Type **S-50** auf **S-32** auf **S-40**

Clamp-T-Piece (KT):

Heating: **KT - 40 x 32 x 40**, 6 bar,
with clamp fittings
for **isopex**-Heating Type **H-40** to **H-32** to **H-40**

Sanitary: **KT - 25 x 20 x 20**, 10 bar,
with clamp fittings
for **isopex**-Sanitary Type **S-25** to **S-20** to **S-20**

According to type and dimension, Press-T-Pieces and Clamp-T-Pieces determined from **isoplus**, may consist of steel 435 GH or dezincification resistant brass MS58/M560 or red cast iron RG 7. Screw-T-Pieces generally acc. to DIN 8076 in heavy brass quality.

4 INDUSTRIAL PIPE / SPECIAL PIPE

4.1 General

4 INDUSTRIAL PIPE / SPECIAL PIPE

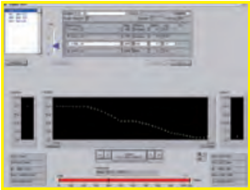
4.1 General

4.1.1 Principle / Heat Insulation / Jacket-Pipe

The prefabricated and preinsulated respectively produced **isoplus industrial-pipes** are based on an experience of 35 years of the **isoplus**-group in the energy sector of district heat supply. In order to reach the highest degree of efficiency and most effective information, the industrial requirements will be arranged exclusively by a central business unit **isoplus-industry** (e-mail: industrie@isoplus.de) located in Germany.

Due to the variety of the available pipe qualities it will be possible to construct the suitable prefabricated and preinsulated pipe system, for nearly every kind of application respectively for every medium. The range of application includes sewage-, climate- and ventilation equipment, as well as district cooling, biomass equipment, oil- and district gas supply, ship- and oil-platform constructions up to aggressive solvents and acids containing, chemical laboratory liquids.

isoplus industrial-pipes consist of three components **carrier pipe + insulation + jacket-pipe**. This simple unit construction system will guarantee an unlimited variety of combinations. **isoplus** is constructing prefabricated insulated rigid and flexible jacket-pipes, rigid sheet metal- and steel-jacket pipes with PEHD- or SPIRO-jacket-pipe.



Of course it will be possible to integrate a leak detecting system like **IPS-Cu®** or **IPS-NiCr®** or/and a fully automatical control and detecting-technology **IPS-Digital®** into the industrial pipes. At all steel pipes a profile pipe can be provided for connection free assembling and in order to install an attending trace later on. This may be used as heat tracing, for constant temperature system or for frost-protection. Alternatively it will be possible to fix a heat tracing directly at the carrier pipe.

4.1.2 Advantages of preinsulated Industrial Pipes

The essential advantages of preinsulated industrial pipes

⇒ reduced weight of pipe
⇒ no corrosion from outside
⇒ long term corrosion protection
⇒ effectively avoided environment emissions
⇒ space saving small jacket-pipe dimensions
⇒ no moisture penetration at the pipe clamps
⇒ no cold- or heat transition at the pipe clamps
⇒ definite improved energy loss due to PUR-foam
⇒ high sound protection respectively sound values
⇒ pipe clamps will be required only at the jacket-pipe
⇒ frames are only required at the seams of the pipes
⇒ minimum life-time of 30 years, according to EN 253
⇒ complete product range incl. accessories and fittings
⇒ essential reduced conductivity of the insulation material
⇒ easy cleaning by use of high pressure steam aggregate
⇒ pressure resistant PE-jacket, spiro-jacket or steel-jacket
⇒ most various thermal resistance of – 30° up to + 400° C
⇒ 100 % water tight PE-jacket-pipes and connection couplers
⇒ certified Quality Management according to DIN EN ISO 9001
⇒ practically no maintenance intervals, low expenditure of maintenance
⇒ resistant jacket-pipe against chemicals-, UV-, salt and exhaust fumes
⇒ mechanical extremely stable and therefore passable pipe construction
⇒ reduced insulation thickness, i.e. compared to heat equipment prescription
⇒ very short assembling periods due to installation and insulation in one working step

The right pipeline for every application

PEHD-jacket-pipe rigid
Single pipe DN 20 to DN 1000
Double pipe DN 20 to DN 200
Temperatures min. acc. to EN 253
Pressure stages up to PN 25

PELD-jacket-pipe flexible
Single pipe DN 20 to DN 125
Double pipe DN 20 to DN 50
Temperatures -20 °C to
+95 °C / +130 °C
Pressure stages up to PN 25

Spirofalz-jacket-pipe
DN 20 to DN 1000
Temperatures min. acc. to EN 253
Pressure stages up to PN 25

Steel-jacket-pipe
DN 25 to DN 1200
temperature -30 °C to +400 °C
Pressure stages up to PN 64

Edition: 16.01.2012

4.1.3 Application areas / References

isoplus industrial-pipes will be used among others for the following applications:

- ⇒ Acid containing
- ⇒ Acids
- ⇒ Gas pipelines
- ⇒ Air condition technology
- ⇒ Air-technology
- ⇒ Alcoholic Industry
- ⇒ Ballast water
- ⇒ Bath- finishing-equipment
- ⇒ Beer
- ⇒ Bio-gas
- ⇒ Biomass heat equipment
- ⇒ Canalisation
- ⇒ Chemical industry
- ⇒ Chemicals
- ⇒ Chilled water
- ⇒ Chocolate
- ⇒ Circulation
- ⇒ Cleaning equipment
- ⇒ Cold methods
- ⇒ Coldness
- ⇒ Combined heat power plants
- ⇒ Combustion exhaust fumes
- ⇒ condense
- ⇒ Cooking plant
- ⇒ Cooling
- ⇒ District cooling
- ⇒ District gas
- ⇒ District heating
- ⇒ Dump-drainage
- ⇒ Exhaust fumes
- ⇒ Faeces
- ⇒ Fertiliser
- ⇒ Fire-fighting equipment
- ⇒ Flammable liquids
- ⇒ Fodder
- ⇒ Food stuff industry
- ⇒ Fuel
- ⇒ Regeneration equipment
- ⇒ Geothermal
- ⇒ Glycol
- ⇒ Heat-carrier-oil
- ⇒ Heating equipment
- ⇒ Heavy oil-/thermal oil
- ⇒ High pressure steam
- ⇒ Hot air
- ⇒ Hot water
- ⇒ Hydrochloride acid
- ⇒ Ice-water
- ⇒ Industrial cold water
- ⇒ Industrial water
- ⇒ Kerosene
- ⇒ Laboratory liquids
- ⇒ Lawn heating
- ⇒ Liquid food stuff
- ⇒ Low pressure steam
- ⇒ Mash i.e. mustard
- ⇒ Mineral water
- ⇒ Mining
- ⇒ Natural gas
- ⇒ Offshore-platform
- ⇒ Oil-transport
- ⇒ Paper industry
- ⇒ Patrol
- ⇒ Petroleum
- ⇒ Potable water
- ⇒ Power plant water
- ⇒ Pressure air
- ⇒ Printing industry
- ⇒ Pure gas
- ⇒ Rain water
- ⇒ Refinery
- ⇒ Air condition cold water
- ⇒ Roof-drainage
- ⇒ Run-way-heating
- ⇒ Sanitary equipment
- ⇒ Sea-water
- ⇒ Sea-water desalination
- ⇒ Seep-water
- ⇒ Sewage
- ⇒ Sewage plant
- ⇒ Ship-building
- ⇒ Smoke-gas cleaning
- ⇒ Solar systems
- ⇒ Solar-collectors
- ⇒ Solvents
- ⇒ Soot water
- ⇒ Staining equipment
- ⇒ Steam
- ⇒ Storage water
- ⇒ Sugar industry
- ⇒ Sulphuric acid
- ⇒ Synthetic fibre industry
- ⇒ Textile-industry
- ⇒ Thermal water
- ⇒ Treacle
- ⇒ Underwater pipeline
- ⇒ Ventilation
- ⇒ Warm water
- ⇒ Washing equipment
- ⇒ Waste air
- ⇒ Waster treatment
- ⇒ Water
- ⇒ Wet-oil
- ⇒ .... and so on

In case that your special application should not be mentioned above, please call us or send an e-mail to **industrie@isoplus.de**.
Or fill in the following lines and send this page to Fax-No.: +49 (0) 36 32 / 65 16 - 16.

Name / Company: (stamp)		Contact person:	
		Street:	
		Post code / City:	
		Telephone:	
e-mail:		Facsimile:	
internet:		Date:	
remark resp. Application:			

Edition: 16.01.2012

References (Extract from ≥ 300 m; ∑ = 52 km)

Project / City / Remark	Country	Application	Pipe Material			Dimension from / to in	Length in
			IR	Dä	MR	DN	km
AMD Dresden; incl. Epoxy resin-coating	GER	Chilled water	St	PUR	ALF	600	0,42
Barracks Amberg	GER	Potable water	Es1	PUR	PEH	80 - 40	0,50
BASF airport Munich	GER	Pipe-bridge	St	PUR	SPF	250	0,50
Basin Leuna	GER	Condense	Es2	PUR	ALF	400	1,30
Bayer AG Antwerpen; incl. corrosion protection	B	Process water	St	PUR	ALF	80	0,76
Cityhall Potsdam	GER	Sanitary	Cuh	PUR	PEH	15 - 32	0,70
Congress-Centre Hannover	GER	Coldness	St	PUR	SPF	100 - 200	0,40
Dairy Erfurt	GER	Steam	St	MW	St	200	1,50
Degussa AG Wesseling	GER	Acid	Es2	PUR	ALF	40 - 50	0,50
Deusa International GmbH Kehmstedt	GER	Salt water	St	PUR	SPF	100 - 300	1,58
Dueker construction Rhine Harbour Karlsruhe	GER	District heating	St	PUR	PEH	500	0,30
Federal Armed Forces Königsbrück	GER	Heating	PVC	PUR	PEH	25 - 100	0,80
Flower hyper-market Straelen	GER	Coldness	Es1	PUR	PEH	50 - 300	1,50
Flower market Heerenveen	NED	Coldness	Es1	PUR	PEH	300	1,60
Greppin; incl. 2 pipe inserts high grade steel	GER	Ground water	St	PUR	SPF	125	0,60
GSF Neuherberg	GER	Coldness	PEH	PUR	PEH	100 - 250	0,80
Haag	AUT	Sewage	GFK	PUR	PEH	25 - 100	2,90
High way tunnel Allach; SPF = stainless steel	GER	Fire exting water	PEH	PUR	SPF	80 - 200	6,30
High way tunnel Thuringia	GER	Fire exting water	Cast St.	PUR	PEH	150	2,75
IBM Mainz; incl. pipe insert; SPF = stainless st.	GER	Process water	St	PUR	SPF	200	0,30
Invest Timisoara	RO	Bio-gas	St	PUR	SPF	100	1,20
Local heat supply Straubing	GER	Thermal water	PEH	PUR	PEH	50 - 200	2,48
Malt factory Erfurt	GER	Steam	St	MW	St	200	1,00
Meat production Eberswalde; incl. Epoxy resin-c.	GER	Coldness	St	PUR	SPF	20 - 125	0,62
Metalica Oradea	RO	Water	St	PUR	SPF	200	0,50
Mineral water Staffelstein	GER	Brine water	PP	PUR	PEH	40	0,30
New exhibition Friedrichshafen	GER	Potable water	PEH	PUR	PEH	40 - 100	1,00
Northwest-Circle Zurich; MR = SPF + PEH	SUI	Sewage	Cast	PUR	SPF	200	3,00
Orga Flintbek	GER	District cooling	PEH	PUR	PEH	250 - 350	0,42
Philip Morris Kasachstan	KAZ	Oil	St	PUR	PEH	200	3,20
Pipeline at Motorway 4 Bautzen	GER	District heating	St	MW	St	400	2,50
Rennsteig-Tunnel Zella-Mehlis	GER	Fire exting water	Cast	PUR	PEH	150	2,80
Reutlingen	GER	Cooling water	St	PUR	SPF	100 - 250	0,41
RWE-Power plant Hürth	GER	Transportation	St	PUR	SPF	200	0,70
Speed-course VW Wolfsburg; Dä = PUR + MW	GER	Heat 180°	St	MW	PEH	65 - 80	0,30
Tar disposal Rositz	GER	Tar	St	PUR	SPF	150	1,00
Tar-mud treatment Rositz	GER	Tar-mud	Es2	PUR	St	150	0,30
Telecommunication school Feldafing	GER	Heating	Es1	PUR	PEH	20 - 65	2,60
Wagon construction Görlitz	GER	District heating	St	MW	St	250	1,00
Wesseling; incl. surface treatment	GER	Acid	St	PUR	ALF	40 - 50	0,51

IR = Inside- resp. medium pipe
Dä = Insulation material
MR = Jacket- resp. outside-pipe
St = Steel black, i. e. P235GH
Cuh = Copper Pipe, hard R 290
Es1 = Stainless steel pipe, material 1.4301 (V2A)
Es2 = Stainless steel pipe, material 1.4571 (V4A)

GFK = Reinforced fibre glass plastic
PEH = Polyethylene High Density, PEHD
PP = Polypropylene
MW = Mineral-wool-fibre-shell
PUR = Polyurethane-hard foam
SPF = Galvanised Spiro-pipe
ALF = Aluminium-fold-pipe

5 SHUT-OFF VALVES

5.1.1 Principle / Heat-Insulation / Jacket-Pipe

Principle

isoplus shut-off valves assembling will be made at open valve position and will be not permitted at the area of L-, Z- or U-elbows due to bending tension which will occur. After flushing of the line the first closing procedure can be carried out. Position in between should be avoided. Do not over wind the stop position. Using of inexpert prolongation is not permitted.

Heat-Insulation

Shut-off valves will be insulated with Polyurethane-hard-foam (PUR) according to EN 253. Polyurethane-hard-foam consists of two components Polyol (component A, bright) and Isocyanat (component B, dark). **isoplus** is using generally PUR-foam which is 100 % free of chlorofluorocarbon (CFC). Cyclopentan is exclusively used as foaming agent. That means lowest possible ODP- and GWP-value at extremest heat insulation quality. ODP (ozone-reducing potential) = 0, GWP (greenhouse potential) = < 0,001 !

Jacket-Pipe

PEHD - Polyethylene High Density is a seamless extruded, shock- and break proof, viscoplastic hard polyethylene up to -50° C. General quality requirements according to DIN 8075. Corona treated for optimum compound with PUR-hard-foam according to EN 253.

Dimensions and wall thickness must be at least in accordance with EN 253. Testing of the melting index (MFI Group) is carried out in accordance with DIN 53735 and ISO 1133. PEHD is a proven plastic that has been used successfully for many years in the plastic jacket pipe system.

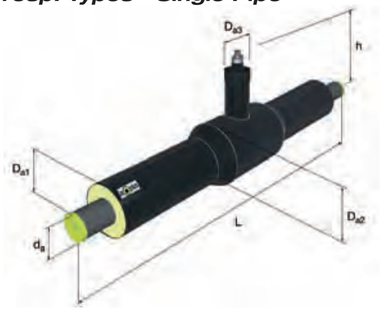
PEHD is resistant against weather conditions and UV-rays in a high extent as well as practically against all chemical reactions which may develop in the soil.Therefore PE is declared in all national and international standards as the only suitable material for direct buried pipe-laying.

isoplus exclusively uses polyurethane materials equipped with light stabilizers. As required by EN 253, the polyurethane pipes are effectively protected against UV-rays by adding special, very fine carbon blacks with 2.5 ± 0.5 percent by mass.

Due to the excellent welding properties of PEHD, the welding seams of the moulded parts have a high degree of safety and quality. PEHD bend segments are brought together with a mirror welding machine and butt welded. The fillet welds at branch connections are carried out with an extruder welding machine.

Accessories see **chapter 5.4**
Assembly information shut-off valves see **chapter 10.2.5**
Material specification jacket-pipe see **chapter 2.1.4**
Material specification PUR-hard-foam see **chapter 7.1.7**

5.2.1 Dimensions resp. Types - Single Pipe



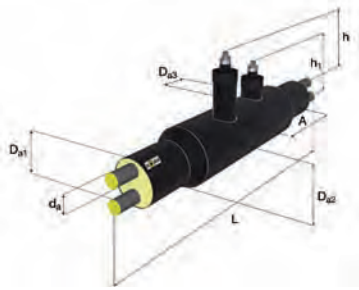
Dimensions Steel Pipe				Jacket-Pipe Outside-Ø D_{a1} / D_{a2} in mm			Dimensions Dome		Overall-length **L** in mm
Nominal Diameter / Dimension in		Outside-Ø d_a in mm	Wall-thickness **s** in mm	Insulation Class			Jacket-Pipe-Outside-Ø D_{a3} in mm	Overall resp. axes height **h** in mm	
DN	**Inches**			**Standard**	**1x reinforced**	**2x reinforced**			
25	**1“**	33,7	3,2	90 / 110	110 / 110	125 / 125	110	480	1500
32	**1¼“**	42,4	3,2	110 / 125	125 / 125	140 / 140	110	485	1500
40	**1½“**	48,3	3,2	110 / 125	125 / 125	140 / 140	110	495	1500
50	**2“**	60,3	3,2	125 / 140	140 / 140	160 / 160	110	500	1500
65	**2½“**	76,1	3,2	140 / 160	160 / 160	180 / 180	110	505	1500
80	**3“**	88,9	3,2	160 / 180	180 / 180	200 / 200	110	515	1500
100	**4“**	114,3	3,6	200 / 225	225 / 225	250 / 250	125	525	1500
125	**5“**	139,7	3,6	225 / 250	250 / 250	280 / 280	140	545	1500
150	**6“**	168,3	4,0	250 / 280	280 / 280	315 / 315	140	565	1500
200	**8“**	219,1	4,5	315 / 355	355 / 355	400 / 400	140	585	1500
250	**10“**	273,0	5,0	400 / 450	450 / 450	500 / 500	180	625	1500
300	**12“**	323,9	5,6	450 / 500	500 / 500	560 / 560	180	665	1800

Carrier pipe at least acc. to EN 488, from wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm. **ATTENTION:** The mentioned construction measures are only valid for the standard product used by **isoplus**, other available type's resp. dimensions on request. In some available types of ball valves is a conical square cover included. Up to nominal diameter DN 125 the **isoplus**-spindle prolongation can be used, which can be operated with any standard T-key. Starting from DN 150 this accoutrement should preferable be used by a gear, spindle prolongation or other accessories from the ball valves producers. Orders should indicate exactly type and kind of operation, T-key or slip-on gear.
A T-key, a spindle prolongation or a slip-on gear can be put on this adapter. All standard types with reduced flow are also available in full bore. Fully bored fittings are available as special components. The h and L dimensions may differ slightly due to the fabrication. Slip-on protection pipe are available in various versions. slip-on protection pipes are not include in delivery range of shut-off valves and it´s seperatly to order.

Accessories see **chapter 5.4**
Assembling information shut-off valve see **chapter 10.2.5**
Material specification jacket-pipe see **chapter 2.1.4**
Material specification PUR-hard-foam see **chapter 7.1.7**

Edition: 16.01.2012

5.2.2 Dimensions resp. Types - Double Pipe



Dimensions Steel Pipe				Jacket-Pipe-Ø D_{a1} / D_{a2} in mm		Dimensions Dome				Overall-length
Nominal Diameter / Dimension in		Outside Ø d_a	Wall-thickn. s	Insulation Class		Jacket-Pipe-Outside-Ø D_{a3}	Overall resp. axes height h	Overall resp. axes height h_1	Axes-distance dome A	L
DN	Inches	in mm	in mm	Standard	1x reinforced	in mm	in mm	in mm	in mm	in mm
2 • 25	1“	33,7	3,2	140 / 200	160 / 225	110	480	480	250	2200
2 • 32	1¼“	42,4	3,2	160 / 225	180 / 250	110	485	485	250	2200
2 • 40	1½“	48,3	3,2	160 / 225	180 / 250	110	495	495	250	2200
2 • 50	2“	60,3	3,2	200 / 280	225 / 315	110	500	500	250	2200
2 • 65	2½“	76,1	3,2	225 / 315	250 / 355	110	505	505	250	2200
2 • 80	3“	88,9	3,2	250 / 355	280 / 400	110	515	515	250	2200
2 • 100	4“	114,3	3,6	315 / 450	355 / 500	140	525	525	250	2200
2 • 125	5“	139,7	3,6	400 / 560	450 / 560	140	545	545	300	2400
2 • 150	6“	168,3	4,0	450 / 630	500 / 630	140	565	565	300	2600
2 • 200	8“	219,1	4,5	560 / 800	630 / 800	140	585	850	400	2800

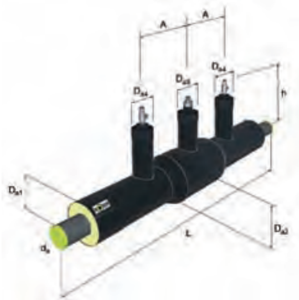
Carrier pipe at least acc. to EN 488, from wall thickness > 3,0 mm with weld seam preparation by 30° bevelled ends acc. to DIN EN ISO 9692-1. Length of bare steel pipe ends: 220 mm ± 10 mm. Clear pipe-distance (h_S) like pipe bars, see **chapter 2.3.2**.

ATTENTION: The mentioned construction measures are only valid for the standard product used by **isoplus**, other available type's resp. dimensions on request.
A 1,50 m long PEHD slip-on protection pipe which can be shortened will be part of the delivered product as well as a conical square cover. A T-key, a spindle prolongation or a slip-on gear can be put on this adapter.
Starting from DN 150 this accoutrement should preferable be used by a gear.
Orders should indicate exactly type and kind of operation, T-key or slip-on gear. All standard types with reduced flow are also available in full bore. Fully bored fittings are available as special components. The h and L dimensions may differ slightly due to the fabrication.

Accessories see **chapter 5.4**
Assembling information see **chapter 10.2.5**
Material specification jacket-pipe see **chapter 2.1.4**
Material specification PUR-hard foam see **chapter 7.1.7**

Edition: 16.01.2012

5.3.1 Dimensions resp. Types - Single Pipe



Dimensions Nominal Passage						Drain / Vent			Dome-Ø	Axes-distance	Overall-length
Steel Pipe			Jacket-Pipe-Outside-Ø D_{a1} / D_{a2} in mm			Nom. Diam.	Jacket-Pipe-Outside-Ø	Overall resp. axes height		ELE/ELÜ to dome	
Nominal Diameter in **DN**	Outside-Ø d_a in mm	Wall-thickness **s** in mm	Insulation Class			in **DN**	D_{a4} in mm	**h** in mm	D_{a3} in mm	**A** in mm	**L** in mm
			Standard	1x reinforced	2x reinforced						
25	33,7	3,2	90 / 110	110 / 110	125 / 125	25	110	480	110	300	2000
32	42,4	3,2	110 / 125	125 / 125	140 / 140	25	110	485	110	300	2000
40	48,3	3,2	110 / 125	125 / 125	140 / 140	25	110	495	110	300	2000
50	60,3	3,2	125 / 140	140 / 140	160 / 160	25	110	500	110	300	2000
65	76,1	3,2	140 / 160	160 / 160	180 / 180	25	110	505	110	300	2000
80	88,9	3,2	160 / 180	180 / 180	200 / 200	50	125	515	110	300	2000
100	114,3	3,6	200 / 225	225 / 225	250 / 250	50	125	525	140	350	2000
125	139,7	3,6	225 / 250	250 / 250	280 / 280	50	125	545	140	350	2000
150	168,3	3,6	250 / 280	280 / 280	315 / 315	50	125	565	140	350	2000
200	219,1	4,0	315 / 355	355 / 355	400 / 400	50	125	585	140	500	2000
250	273,0	4,5	400 / 450	450 / 450	500 / 500	50	125	625	160	500	2000
300	323,9	5,0	450 / 500	500 / 500	560 / 560	50	125	665	180	500	2200

Carrier pipe, execution and operating-dome like shut-off valves, **chapter 5.2.1**, however pre-fabricated as complete drain- or/and venting unit, which will be preferable installed in a manhole. An **isoplus** ball-valve with outside operating handle is factory-foamed in at the vertical exits for drain and/or vent, therefore they may not be shortened. The not insulated exit ends will be supplied with end caps and are produced generally with a galvanized pipe end with outside thread-connection. All standard types with reduced transition.

Available types as well as other dimensions on request. Valves with full bore as well as drain or/and vent with insulation class 1x reinforced or 2x reinforced available as special construction respectively as special manufactured product also on request, please check availability. Orders should clearly indicate kind of construction, type of accoutrement, operation (T-key or slip-on gear) as well as drain or/and vent.
Alternatively this shut-off valve combination will be available without foamed-in drain-/vent-ball valve. The h, A and L dimensions may differ slightly due to the fabrication.

Edition: 16.01.2012

5.4.1 Protection Pipe / Spindle-prolongation / Operation Equipment

PEHD-Slip-on protection pipe

This standard protection pipe with a protection cap as well as inside fixed laminate as centring aid is part of the delivery range of a shut-off valve. The protection pipe will be delivered generally in a length of 1,50 m and will be adjusted directly to the covering height at site.

Protecting pipes are mostly ending in a DIN-street-cap or a manhole. Depending from application and nominal diameter different types will be required. Dimensions and special types, i. e. with screw-cap-cover on request.

Spindle-prolongation

In case that shut-off valves will be installed very deep, prolongation should be additionally used. A conical square-nut for putting on the standard dome, respectively a square cover will be part of the delivery range of a shut-off valve.

The prolongation will end again with a square-cover. Depending from dimension and manufacturer of shut-off valve different spindle-prolongation are available in standard length of 0,50 m, 1,00 m or 1,50 m. Possible types on request.

T-Key / Slip-on gear

Depending from dimension of the shut-off valve the operation will be made by use of a T-key. Starting from DN 150 a gear should respectively can be used.

The T-key will be delivered generally in a length of 1,00 m with a conical square-nut. For operation of the shut-off valve inexpert prolongation of the lever arm is not permitted.

The gear has to put vertical on the shut-off valve. Depending from types of shut-off valves different types of gears are available which will eventually need additional accessories like slip-on flange.

Use of torque increasing units which are not corresponding with the type are not allowed. Available slip-on- and planet-gears as well as electrical-gears on request.

6 CONNECTION TECHNOLOGY JACKET-PIPE

isoplus®

Edition: 16.01.2012

6.1.1 Explanation / Sleeves / Coupler Test Procedure

Explanation

There are several coupler constructions available for the different technical requirements. All PEHD-connection couplers are used in order to reach a non-positive safety, gas- and watertight jacket-pipe connection. The pipe layer will be responsible for slipping on the coupler before starting the welding works. All couplers consist of a PEHD-socket pipe with material properties as described in **chapter 2.1.4**. It will be generally possible to deliver all couplers in special length, i. e. for post-insulation of the welding seams of an uninsulated one-time-ball-valve, an one-time-compensator or a fitting piece. Insulation and sealing of all kind of couplers, except of **isocompact®**, will be carried out generally by **isoplus**-works-educated assembling specialists, tested by AGFW- and BFW.

Sleeves

The manual usable shrink-sleeves which are part of the different kind of couplers consist of a heat shrinkable, molecular cross-linked and modified polyolefin with a sealing adhesive system consisting of an elastic-viscous sealing area. This kind of sleeve is resistant against thermal ageing, weather conditions and chemical influence as well as UV-rays and alkaline-earth.

Coupler Test Procedure

In co-operation with accepted test institutes, like i. e. **FFI** in Hanover (District Heating Research Institute e.V.) **isoplus** offers extensive analysis of PUR-local foam and sleeves respectively of complete couplers. The test procedures include all quality guidelines of EN 253 and EN 489 standard. Depending from requirements the quality control includes i. e.:

⇒ Visual expertise of storage, quality and processing of the material

⇒ Preparing of a test sample in a test box, for local used foam with expertise concerning starting time, rise- as well as foaming behaviour

⇒ Taking out of a 30 mm drill-cone from the PUR-foam of a coupler followed by a visual check concerning colouring, homogeneity and cell-structure

⇒ Testing of the foam sample in the laboratory concerning cell-structure, closed cells, foam density, pressure resistance and water absorption during boiling test

All taken samples will be recorded with the relevant parameters like date, time project and-section, constructing company and installer, weather conditions, temperature, dimension, kind of coupler and -number, local foam (mechanical or manual) and trench conditions, and transferred to the corresponding test institute. After writing of the certificate it will be given to the buyer for documentation. The content of the test procedure as well as the determination of the samples has to be decided by agreement between the purchasers or by an authorized third party and the coupler-assembling company, respectively with **isoplus**. As executing company of the test procedure **isoplus** has to be informed concerning this decision. Parallel to this the procedure after completion of the test report has to be determined before starting of the quality test procedure. Please contact **isoplus**-quality-engineering specialists in case of additional questions.

6.1.2 Survey Basic Material & Properties

	Coupler construction / -type	PEHD Shrinkable	isojoint X®-Shrinkable	isojoint III®	Electro-Welding®	isocompact®	Spiro
Socket-pipe	Uncross-linked PEHD-pipe	√	-	-	√	-	-
	Cross-linked PEHD-pipe	-	√	√	-	√	-
	Heat shrinking	√	√	√	√	√	-
	Extruder weldable and to shorten	√	-	-	√	-	-
	Steel-spiral-pipe (Spiro), separated	-	-	-	-	-	√
Accessories	two shrinkable sleeves	√	-	-	-	-	-
	two PE-weldable plugs	√	√	-	√	-	-
	PE-hole-lockers	2	2	-	2	-	1
	Butyl-rubber-sealing tape	√	√	√	√	√	√
	two single copper-heat conductors	-	-	-	√	-	-
	Shrinking foil + sealing compound	-	-	√	-	√	alternative
	Sealing sheet metal	-	-	-	-	-	√
	Blind riveting	-	-	-	-	-	√
	Silicon sealing	-	-	-	-	-	eventual
Insulation	Polyurethane-local foam (PUR)	√	√	√	√	-	√
	PUR-insulation shells	-	-	alternative	-	√	alternative
Characteristic	................sealing	double	double	double	electric	double	single
	Gas- and water tight	√	√	√	√	√	-
	Splash proof	√	√	√	√	√	√
	Air pressure test 0,2 bar	√	√	-	√	-	-
	Test certificate acc. to						
	EN 489 - 100 Cycles	√	√	√	√	√	-
	DVS-guideline 2207-part 5	-	-	-	√	-	-
	suitable for:						
	Flexible Compound Systems - Single pipe	√	√	√	-	√	-
	Rigid Compound Systems - Single pipe	√	√	√	√	√	-
	Rigid Compound Systems - Double pipe	√	√	√	√	√	-
	Steel-spiral-pipe (Spiro) - Jacket-pipe	-	-	-	-	-	√
	Application	2	2	3	3	1	4

1 = suitable for all pipe net works with standard operating- and soil conditions
2 = suitable for all pipe net works with increased operating- and soil conditions, like ground- and pressing water
3 = like 2, however especially for big pipe sizes
4 = suitable for all pipe net works layed inside of buildings or in the open

Edition: 16.01.2012

6.2 PEHD - Shrinkable Coupler

6.2.1 Delivery Range

Heat-shrinkable PEHD-pipe	two shrink-sleeves	Butyl-rubber-sealing tape	two PE-venting and weldable plugs each	two heat-shrinkable PE-hole-lockers

6.2.2 Description

The uncross-linked, PE-weldable coupler is a double-sealing system which consists of a PEHD-socket-pipe in one piece with heat shrinkable properties, two shrink-sleeves for sealing of the coupler at the transitions to the jacket-pipe as well as of two PE-welding plugs and two PE-hole-lockers. During assembling the coupler will be shrinked down to the original diameter by use of soft gas-flame; the so called memory-effect. A sealing tape made of butyl-rubber will be placed between jacket- and socket-pipe before the first shrinking procedure, which will result in a first sealing.

The cross-linked shrinking joint will be subjected to an air pressure test of 0,2 bar before foaming and will be tested using an appropriate indicator liquid. After foaming the second sealing by use of shrink-sleeves will follow. The foam filling-in- and venting opening will be sealed by PE-plugs and additionally with PE-hole-lockers.

Application:	Suitable for all pipe-networks with high operating- and soil conditions, like ground- and pressing water. According to **EN 489** in sand box sliding test approved with 100 cycles
Available as:	Connecting coupler, long coupler, reduction coupler, Double-reduction coupler, end coupler
Diameter:	from $\mathbf{D_a \geq 65}$ **mm** up to maximum $\mathbf{D_a = 800}$ **mm**
Delivery length:	Standard = **700 mm**

Assembling sequence see **chapter 11.3.1**

6.3.1 Delivery Range

Heat-shrinkable cross-linked PEHD-pipe

Butyl-rubber-sealing tape

two PE-venting and weldable plugs each

6.3.2 Description

The cross-linked, self-sealing **isojoint X**® –shrinkable coupler is a system consisting of an undivided PEHD pipe with heat-shrinking characteristics in addition to two polyurethane welding plugs. After extrusion, the joint body will be cross-linked. The radiation cross-linking gives technical plastics the mechanical, thermal, and chemical qualities of high-performance plastics.

Stretched while warm during production, the socket is shrunk back to its original diameter using a soft gas flame. This shape memory is also called the Memory Effect. Before the shrinking process, a sealing strip of butyl rubber is inserted between the casing pipe and the joint, so that a very high ring key strength is achieved due to the shrinking and the seal, which means that no additional collars are required.

The cross-linked shrinking joint will be subjected to an air pressure test of 0,2 bar before foaming and will be tested using an appropriate indicator liquid. After foaming, the foam filling and the ventilation openings will be sealed with polyethylene stoppers. In order to enable welding of the polyethylene plugs, the area of the welding plugs will not be cross-linked and therefore will be weldable.

Application:	Suitable for all pipe-networks with high operating- and soil conditions, like ground- and pressing water. According to **EN 489:2009** (D)
Diameter:	from **D_a ≥ 90 mm** up to maximum **D_a = 560 mm**
Delivery length:	Standard = 700 mm

Assembling sequence see **chapter 11.3.2**

6.4.1 Delivery Range

Heat-shrinkable cross-linked PEHD-pipe

PE-X-shrinking foil with sealing compound

Butyl-rubber-sealing tape, extra wide

6.4.2 Description

The two-fold sealed joint system, **isojoint III®**, consists of a PE-X casing joint, shrinkable along its entire length, a PE shrinking foil with mastic melt adhesive, and a special, semi-crystalline melt adhesive.

The basic material of the **isojoint III®** is a molecularly cross-linked carrier material made of modified PEHD. In combination with the polyethylene pre-insulation of the joint cavity, the PE-X shrinking foil and an exceptionally peel- and shear-resistant adhesive, a high-quality, economically processable and permanently sealed joint system is created.

Bored holes, foam holes and ventilation holes are no longer required since the joint cavity in the **isojoint III®** joint system is foamed before sealing the joint using polyethylene foam and a foam mold. This enables to non-destructively test the flawless quality of the foam.

Application:	Suitable for all pipe-networks with high operating- and soil conditions, like ground- and pressing water. According to **EN 489:2009** (D)
Available as:	Connecting coupler
Diameter:	from **D_a ≥ 315 mm** up to maximum **D_a = 1400 mm**
Delivery length:	Standard = **730 mm**

Assembling sequence see **chapter 11.3.3**

6.5.1 Delivery Range

Heat-shrinkable PEHD-pipe

two processor controlled copper-heat conductors

two PE-venting and weldable plugs each

two heat-shrinkable PE-hole-lockers

6.5.2 Description

The patented electro-welding coupler® **without** axial-welding seam consists of a closed, uncross-linked, PE-weldable shrinkable coupler, two loose copper-heat conducting wires which will be put in shortly before assembling as well as of two PE-welding plugs each with PE-hole lockers. The separated delivery of heat conductor and coupler will guarantee a maximum of cleanness as well as an ideal overcoming of measure tolerances and ovality at the jacket-pipe ends. By using a microprocessor controlled welding transformer for a 400 V/15 A three-phase- respectively power current connection the electrical welding procedure will run off self controlling and fully automatically. Starting with the heating up period the transformer is determining the procedure under considering all other secondary conditions.

The Electro-welding coupler© can be tested before foaming by air-pressure of 0,2 bar and soaped in. The results as well as the data of the welding procedure have to be recorded. After foaming the foam filling-in- and venting opening will be sealed by PE-plugs and additionally with PE-hole lockers.

Application:	Suitable for all pipe-networks with high operating- and soil conditions, like ground- and pressing water, especially in case of bigger pipe dimensions. According to **EN 489** in sand box sliding test approved with 100 cycles, PE-welding wire acc. to DVS-guideline 2207 - part 5, approved with time-fracure test
Available as:	Connecting coupler and long coupler
Diameter:	from $\mathbf{D_a \geq 90}$ **mm** up to maximum $\mathbf{D_a = 800}$ **mm**
Delivery length:	Standard = **700 mm**, and in 100 mm steps up to maximal 1500 mm

Assembling sequence see **chapter 11.3.4**

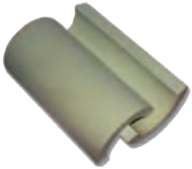
6 CONNECTION TECHNOLOGY JACKET-PIPE

6.6 isocompact®- Coupler

6.6.1 Delivery Range

Heat-shrinkable cross-linked PEHD-pipe

Butyl-rubber-sealing tape, extra wide



a two-parted insulation shell made of PUR-hard-foam

PE-shrinking foil with sealing compound

6.6.2 Description

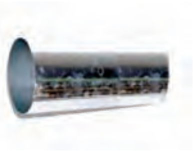
With the **isocompact®**-coupler the pipe layer can carry out the post insulation independently at the connection spots of **isoplus**-pipes, except of double pipe-systems. It consists of a two-parted PUR-insulation-shell, a shrink-foil coated with sealing compound, the corresponding quantity of sealing tape as well as of a closed, totally cross-linked, not weldable shrinkable coupler. For the shrinking foil and -coupler PE with heat shrinkable properties will be used, both will be shrinked during assembling by use of a soft gas-flame.

Between shrinking foil and socket-pipe the sealing adhesive will be placed after the first shrink-procedure, in order to reach a high circular conclusive strength during and after the shrink procedure. The coupler length of 780 mm will guarantee an insulation of maximum 220 mm long steel pipe ends respectively a maximum length of 440 mm not insulated area. **isocompact®**-coupler is not available as reducing- or end coupler.

Application:	Suitable for all pipe-networks with normal operating- and soil conditions. According to **EN 489** in sand box sliding test approved with 1000 cycles
Available as:	Connecting coupler
Diameter:	from **D_a ≥ 65 mm** up to maximum **D_a = 560 mm**
Delivery length:	Standard = **780 mm** (Long coupler not possible)

Assembling sequence see **chapter 11.3.5**

6.7.1 Delivery Range



separated
sheet metal-pipe

Butyl-rubber-
sealing tape

one sealing sheet metal
and venting-plug each

blind- resp.
machine rivets

6.7.2 Description

Spiro-couplers are used for actuated jacket-pipe connections for industrial, open line constructions or building lines. Inner folded spiro-jacket or outside folded spiro-jacket can be concerned. The delivery range includes a longitudinal separated jacket-pipe husk and a sealing sheet metal for closing the foam opening.

Depending from jacket-pipe diameter the corresponding quantity of blind resp. machine rivets for fixing of the longitudinal seam and the sealing sheet metal, as well as a sealing tape made of Butyl-rubber which will be placed at the radial material overlappings, are belonging additionally to the delivery range of a coupler. On request all material edges may be covered additionally by a silicon layer after foaming.

Application:	Suitable for all open line or pipe-networks inside of buildings with standard operating conditions
Avialable as:	Connecting coupler and long coupler
Diameter:	from **$D_a \geq$ 65 mm** up to maximum **D_a = 1200 mm**
Delivery length:	Standard = **700 mm**

Assembling sequence see **chapter 11.3.6**

Edition: 16.01.2012

6.8.1 Delivery Range

Heat-shrinkable PEHD-pipe with 1x jacket-pipe-reduction

two shrinkable sleeves

Butyl-rubber-sealing tape

two PE-venting and weldable plugs each

two heat-shrinkable PE-hole-lockers

6.8.2 Description

Reduction-shrinkable couplers will be used at the spot where a medium pipe will be reduced, as transition of different jacket-pipe diameter. The corresponding reducing ring is in the middle of the socket-pipe. Reducing of the carrier pipe is part of the work executed by the pipe line constructing company.

In order to avoid not permitted high frontal soil pressure loads in case of hot-operating and buried PE-jacket-pipes, reducing should be made only about maximum two dimensions. At the bonding area of a thermal pre-stressed line only one dimension step will be admissible.

The coupler has to be generally padded at the reducing ring in circumference direction. Expansion pad is not part of the delivery range of a reduction coupler.

Application:	Analog **chapter 6.2**
Available as:	Uncross-linked PEHD-Shrinkable Coupler
Diameter:	from $\mathbf{D_a \geq 75}$ **mm** up to maximum $\mathbf{D_a = 800}$ **mm**
Delivery length:	Standard = **1000 mm, 1400 or 1500 mm**
Kind of Delivery:	centrical

Assembling sequence see **chapter 11.3.7**

6.9.1 Delivery Range

Heat-shrinkable PEHD-pipe with 2x jacket-pipe-reduction

two shrinkable sleeves

Butyl-rubber-sealing tape

two PE-venting and weldable plugs each

two heat-shrinkable PE-hole-lockers

6.9.2 Description

Double reduction-shrinkable couplers are used for post insulation of not insulated components with an outside diameter which is bigger than the carrier pipe. The coupler will be enlarged in the middle with two reducing rings. Due to this the required insulation thickness will be guaranteed in case of special components, i. e. one-time compensators. Parallel the metallic contact (short circuit) of the leak detecting wires with the mounting part will be avoided.

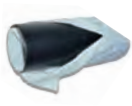
In order to avoid not permitted high frontal soil pressure loads in case of hot-operating and buried PE-jacket-pipes, reducing should be made only about maximum two dimensions. At the bonding area of a thermal pre-stressed line only one dimension step will be admissible. The coupler has to be padded at the reducing rings in circumference direction. Expansion pad is not part of the delivery range of a double-reduction coupler. In case of one-time compensators the expansion pad is not necessary, because one-time compensators will be generally within the bonding area of a line.

Application:	Analog **chapter 6.2**
Available as:	Uncross-linked PEHD-Shrinkable Coupler
Diameter:	from **D_a ≥ 75 mm** up to maximum **D_a = 800 mm**
Delivery length:	Standard = **1000 mm**
Kind of Delivery:	centrical

Assembling sequence see **chapter 11.3.8**

Edition: 16.01.2012

6.10.1 Delivery Range



Heat-shrinkable PEHD-pipe with 1x blind cover

one shrinkable sleeve

Butyl-rubber-sealing tape

two PE-venting and weldable plugs each

two heat-shrinkable PE-hole-lockers

6.10.2 Description

Shrinkable end couplers are used for temporary closing of blind ending pipes. Therefore the coupler end is closed with a blind cover. The carrier pipe end has to be closed tight before foaming, with a torospherical head, a pipe cap or similar. The pipe caps respectively torospherical heads are part of the performance of the pipe construction company.

In order to avoid high frontal not permitted axial expansion movements in case of hot-operating and buried PE-jacket-pipes, the blind cover generally has to be padded. The expansion pad is not part of the delivery range of an end-coupler.

Only one shrinking-sleeve is part of the delivery range of a shrinkable coupler.

Application:	Analog **chapter 6.2**
Available as:	Uncross-linked PEHD-Shrinkable Coupler
Diameter:	from **$D_a \geq$ 65 mm** up to maximum **D_a = 800 mm**
Delivery length:	Standard = **700 mm**
Kind of delivery:	Plug-execution

Assembling sequence see **chapter 11.3.9**

Assembly parts should GENERALLY BE AVOIDED FOR QUALITY AND WARRANTY REASONS !

Assembling components should be generally used ONLY EXCEPTIONALLY (!!!) i. e. spud-tapping-branch. Production will be made ONLY AFTER WRITTEN REQUEST of the purchaser.

Assembly joints/assembly fittings do NOT meet the requirements and regulations of EN 253 !

6.11.1 Delivery Range - Spud-Tapping-Branch

Transition coupler with outlet nozzle	PEHD-Assembling elbow	four shrinkable sleeves	Butyl-rubber-sealing tape	three PE-venting and weldable plugs	three heat-shrinkable PE-hole-lockers

6.11.2 Description

If connections to buildings are subsequently required, in very exceptional cases branch fittings may be used. This requires making a carrier pipe branch, by tapping. The PEHD branch is split apart in the axial direction, folded over the carrier pipe and then welded using the PEHD extruder process. Branch fittings with a diameter of ≥ 280 mm should be avoided.

A special coupling is included with an outlet nozzle. The main pipe consists of a long shrunk-on coupling similar to **chapter 6.2.1**, where the outlet nozzle of not shrinkable PEHD casing pipe is welded in at the factory. The shrinkable PEHD elbow, reduced on one side, is mounted on this piece.

The diameter of the outlet nozzle and the installation elbow depends on the tapping procedure used. To ensure the necessary insulation thickness is maintained, it may be necessary for the assembly elbows to be supplied in a diameter that is several times greater. It is therefore imperative that **isoplus** is notified prior to tapping, with a scale drawing giving the following details:

Tapping procedure or system, nominal inlet and outlet diameter, inlet and outlet casing pipe diameter, type of outlet, axis height and spacing of carrier pipe, inlet to outlet, outlet form (45°, parallel or 90° vertical tiers), non-insulated or peeled length (max. 400 mm) and outlet (max. 250 mm).

Without these parameters, PEHD branch fittings will not be delivered or made!

7 ACCESSORIES

7.1 Rigid and Flexible Compound Systems

7.2 Special Accessories Flexible Compound Systems

Edition: 16.01.2012

7.1.1 One-Time-Compensator

EKO (One-time-compensator) - system will be used for thermal pre-stressing of **isoplus**-pipelines in case of already refilled pipe-trenches. The distances of the pipelines between the one-time-compensators have to be filled, only the required assembling hollow at the EKO will remain open. Normally the thermal pre-stressing will be carried out by using the operating medium, however mobile heating units may be used as well.

EKO is a component which will be welded into the PJP-pipeline. During the heating period alterations of the pipe length will occur, which will be reliably compensated by this system. Due to the welding of the EKO-guiding pipes, the prestressing of the pipeline will be fixed after the expansion compensation will be completed.

One-time-compensators will be used in case where the maximum pipe laying length **[**L_{max}**]** cannot be kept or/and natural expansion elements will be not possible due to lack of space. However a natural expansion side-leg (L-, Z- or U-elbow) should be provided at the beginning and at the end of an EKO-section, respectively an anchor may be provided at one side.

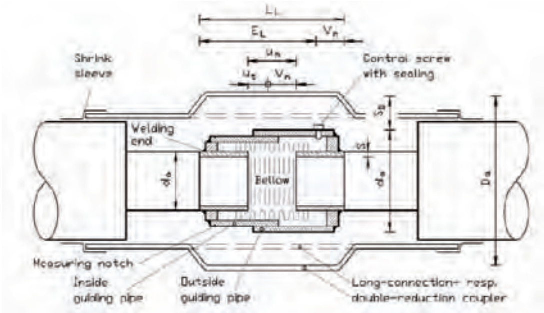
At the beginning or at the end of a section one-time-compensators cannot be used instead of L-, Z- or U-elbows for compensation of expansion. In order to reach the pre-stressing respectively the limitation of the axial tension at refilled pipe trenches, the EKO should be at the detention area. In case of trench sections smaller than the maximum permitted pipe-laying length an one-time-compensator will be ineffective. In case of designed mixed systems, i. e. EKO ⇒ cold-laying can pipe-statically not determined.

Delivery length **[**L_L**]** has to be shortened before installation of EKO´s about the mechanical pre-stressing measure **[**V_m**]** In that way the real expansion expected from the pipeline **[**u_t**]** will be adjusted. For that the EKO has to be pressed together mechanical by use of a suitable gripping tool. On request EKO´s can be pre-stressed in the factory, starting from dimension DN 350 this will be made generally due to the high strengths.

Material: Bellow/inside pipe made of chromium-nickel-steel, material-No. 1.4541; welding ends, outside pipe and the like made of P235GH, material-No. 1.0345; delivery incl. inside-hexagon-screw with sealing; nominal pressure PN 25.

Dimensions EKO see **following page**
Assembling steps EKO see **chapter 10.2.9**

Edition: 16.01.2012



d_a	=	Steel pipe outside diameter PJP		u_m	=	maximum expansion compens.
s	=	Wall thickness welding end EKO		F	=	Spring rate axial
d_a‘	=	EKO-outside diameter		A	=	effective bellow cross-section
D_a	=	Minimum-coupling diameter at EKO		G	=	Weight EKO
s_D	=	Insulation thickness at EKO		u_t	=	actual expansion compensation
M	=	Minimum length connecting coupler		V_m	=	mechanical pre-stressing meas.
L_L	=	Delivery length EKO		E_L	=	Installation length EKO

DIMENSIONS - TYPE TC - PN 25

DN	Type	d_a [mm]	s [mm]	d_a´ [mm]	D_a [mm]	s_D [mm]	M [mm]	L_L [mm]	u_m [mm]	F [N/mm]	A [cm^2]	G [kg]
20	EKO-25/25/50 (*)	26,9	3,2	56,0	125	34,5	1000	275	50	176	9,7	1,3
25	EKO-25/25/50	33,7	3,2	56,0	125	34,5	1000	275	50	176	9,7	1,3
32	EKO-25/32/50	42,4	2,6	73,0	140	33,5	1000	275	50	204	15,1	1,7
40	EKO-25/40/50	48,3	2,6	73,0	140	33,5	1000	275	50	177	16,3	1,8
50	EKO-25/50/50	60,3	2,9	86,0	160	37,0	1000	275	50	224	25,9	2,4
65	EKO-25/65/70	76,1	2,9	106,0	180	37,0	1000	335	70	219	42,1	3,8
80	EKO-25/80/70	88,9	3,2	122,0	180	29,0	1000	345	70	180	67,8	5,5
100	EKO-25/100/80	114,3	3,6	139,7	225	42,6	1200	390	80	212	109,9	9,8
125	EKO-25/125/80	139,7	3,6	168,3	250	40,8	1200	400	80	226	159,9	12,5
150	EKO-25/150/100	168,3	4,0	193,7	280	43,1	1200	475	100	261	230,5	14,5
200	EKO-25/200/120	219,1	4,5	268,0	355	43,5	1200	515	120	361	383,9	27,5
250	EKO-25/250/120	273,0	5,0	323,9	400	38,0	1200	515	120	362	594,0	35,0
300	EKO-25/300/140	323,9	5,6	355,6	450	47,2	1400	660	140	353	834,2	57,5
350	EKO-25/350/140	355,6	5,6	406,4	500	46,8	1400	650	140	617	1004,3	60,0
400	EKO-25/400/140	406,4	6,3	457,2	560	51,4	1400	650	140	505	1310,0	75,5
450	EKO-25/450/150	457,2	6,3	508,0	630	61,0	1400	660	150	528	1656,1	86,0
500	EKO-25/500/150	508,0	6,3	560,0	670	55,0	1400	660	150	537	2042,8	93,0
600	EKO-25/600/150	610,0	7,1	675,0	800	62,5	1500	690	150	864	2937,8	162,0

(*) = pipe reducing from DN 25 to DN 20 has to be carried out at site.
Other dimensions and types on request.

Edition: 16.01.2012

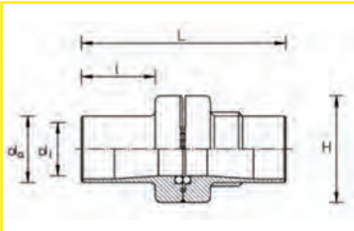
7.1.2 Tapping-Branch

A tapping-branch will be used to produce a pipe-branch at a **isoplus**-pipeline which is in operation. Preparation as well as execution of the tapping according to AGFW-guideline FW 432. Between nominal main- and branch size at least two dimension differences have to be kept, according to AGFW FW 401.

Due to the tapping procedure considerable expenses will be saved by simple, economical working steps, as well as by fast and safe assembling without operating interruptions. Temperature and pressure should be reduced before assembling.

Tapping-Branch - ASP - Type T

DN	d_a [mm]	H [mm]	d_i [mm]	l [mm]	L [mm]	D_a [mm]
20/25	26,9/33,7	68	27,3	47	130	125
32	42,4	76	36,0	47	130	125
40	48,3	78	39,0	47	130	140
50	60,3	88	46,0	52	135	140
65	76,1	105	60,0	55	145	160
80	88,9	117	71,0	63	155	200
100	114,3	148	100,0	73	175	250
125	139,7	260	121,0	90	204	315
150	168,3	292	140,0	105	243	355
200	219,1	386	182,0	120	287	450



Material: S355J2G4 (tai AISI 316), sealing made of EPDM, delivery incl. lock-disc. For assembling of tapping locks DN 125 to DN 200 a 24 h tapping service will be available on request. They will carry out even tappings at bigger pipes up to DN 400, after corresponding inspection.

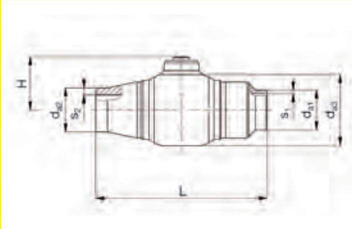
For branches up to maximum DN 100 a safety-tapping-lock-unit will be available as accessory.

The complete delivery includes all adapters of the tapping branches DN 25 to DN 100, hole saws made of thin-walled Bi-metal of these nominal sizes, a 475 mm long tapping-spindle, centralization-drill made of hard-metal with catch device, all required keys, handle for lock-discs and gear-unit.

Assembling information see **chapter 6.11.1** and **10.2.10**

Edition: 16.01.2012

Tapping-Branches - AKH - Type J



DN	d_{a1} [mm]	s_1 [mm]	d_{a2} [mm]	s_2 [mm]	H [mm]	d_{a3} [mm]	L [mm]	D_a [mm]
20	24,0	2,6	24,0	3,9	34	42,4	125	125
25	33,7	2,9	37,0	5,8	46	60,3	145	140
32	42,4	2,9	37,0	5,8	46	60,3	145	140
40	48,3	2,9	54,0	6,7	57	88,9	200	160
50	60,3	3,2	54,0	6,7	57	88,9	200	160
65	76,1	3,2	63,0	7,0	70	114,3	260	180
80	88,9	3,2	82,0	8,0	80	133,0	265	225
100	114,3	3,6	100,0	9,0	90	159,0	275	280

Material: Casing and welding ends made of P235, adjusted ring and sealing made of PTFE, ball and gear-shaft made of high grade steel. The operation of DN 20 is carried out with a screwdriver, DN 25 to DN 50 with a hexagon socket wrench 10 mm and 14 mm beyond.

The tapping procedure occurs in this system by a user supplied device.

Edition: 16.01.2012

7.1.3 One-Time-Ball-Valve

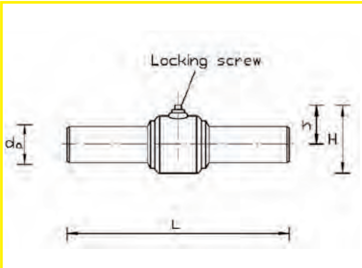
One-time- respectively connection ball valves will be used for the end of a construction-section, which will be continued later on. As the end-piece will be welded at the pipe end, the existing **isoplus**-pipeline may be continued at any time, without draining the pipes and without interruption of pipeline operation.

One-time-ball-valves will be welded in closed position into the pipeline, like a piece of pipe. In case of double pipes it has to be considered that the assembling of the ball valves should be made clockwise and longitudinal transposed.

For protection reasons and in order to avoid that PUR-foam will enter into the open end of the ball valve, the assembling of a torospherical head respectively a pipe cap acc. to DIN EN 10253-2 will be prescribed. Post insulation will be carried out by use of an end-coupler.

One-Time-Ball-Valves - Maximum dimensions of available types

DN	d_a [mm]	H [mm]	h [mm]	L [mm]	D_a Single pipe [mm]	D_a Double Pipe [mm]
20	26,9	57,2	36,0	230	110	140
25	33,7	75,2	45,0	235	125	180
32	42,4	91,5	56,5	260	140	200
40	48,3	100,1	62,0	260	160	225
50	60,3	121,0	76,5	300	180	280
65	76,1	144,7	87,5	360	200	315
80	88,9	171,4	101,5	370	225	355
100	114,3	210,9	122,0	390	280	450
125	139,7	236,9	140,0	325	315	500
150	168,3	269,6	160,0	350	355	560
200	219,1	321,5	185,0	390	400	670



Material: Casing and welding ends made of P235, adjusted ring and sealing made of PTFE, ball and gear-shaft made of high grade steel.
If the continuing section will be installed, assembled and welded on to the one-time-ball-valve, the line will be put in operation. For that the locking-screw of the one-time-ball-valve will be moved by use of a screw driver respectively an inside-hexagon-key and will be welded afterwards. The post insulation ensues with a double reducing joint.

7.1.4 End Cap

Simplex-End Cap

Duplex-End Cap

Zipper-End Cap

End caps are suitable for gable-end protection against water in order to avoid moisture penetration into the PUR-foam at the pipe ends, in buildings or constructions. Inside of manholes the end caps have to be secured against flooding with heating water.

Additionally end caps will protect against diffusion of PUR-foam-cell-gas which will occur at the open pipe ends. According to the result of long term investigations, cell-gas diffusions at not protected pipe ends respectively gable-ends, will influence the life time of PEHD jacket-pipes in a negative way. Therefore installation of pipe ends without end cap will be generally not permitted.

The pipe-layer will be responsible for putting on the end caps before connection to the continuing conventional pipe lines, inside of the building. End caps may be not cut open and have to be protected against heat and burnings in case of welding works. In order to guarantee a correct shrinking of the end caps, a minimum overlapping distance of the PEHD-jacket-pipe has to be considered inside of the building.

In case of medium temperatures > 120 °C end caps have to be fixed additionally at carrier pipe and jacket pipe by use of anti corrosion gripping tapes. End caps are available in all carrier-/jacket-pipe combinations. For double pipes so called Duplex-end caps are available and zipper-end caps for already welded pipes. If Simplex end caps are used for **isoplus** double pipes, an aging-resistant EDPM fill block to bridge the clear distance between the carrier pipes is included in delivery. This will be pressed into the gap before assembly.

All end caps consist of a heat shrinking, molecular cross linked, modified and therefore nonweldable Polyolefin, and are coated by a special temperature resistant sealing adhesive at both ends. Resistant against weather conditions- and chemical influence as well as UV-radiation and alkaline soil.

Assembling steps see **chapter 10.2.12**
Carrier-/Jacket-pipe combinations see **chapter 2.2.2, 2.2.3, 2.3.2, 2.3.3, 3.2, 3.3, 3.4, 3.5**

7.1.5 Wall duct

Sealing Ring Standard

Sealing Insert with Pipe Liner

Sealing rings resp. -inserts are used in order to avoid water entry at wall ducts inside of buildings or manholes. The pipe-layer will be responsible for putting on the sealing rings and for centering the inserts at the wall ducts before the connection to the pipeline of the building.

The wall ducts have to be installed rectangular to the wall. Radial loads due to subsidences at building- or manhole entry as well as lateral dislocations will cause leakages. This can be avoided by careful compression of the soil at the area of the entry. Installation of **isoplus**-pipes without sealing rings is not permitted. Inside of the building a minimum overlapping of the PE-jacket-pipe has to be considered.

Sealing Ring - Standard

Standard sealing ring consists of special profiled, non ageing neoprene rubber ring and is suitable for sealing against non pressing and none damming up water acc. to DIN 18195-4. The ring-breadth is 50 mm independing from nominal diameter, the strength resp. thickness of the conical ring is 12 mm up to 22 mm. The ring will be pushed to the middle of the wall duct and will be imbedded in concrete afterwards by a constructing company. At standard sealing rings axial expansions up to 10 mm are permissible.

Sealing Insert - C 40

In case of pressing and damming up water acc. to DIN 18195-6 gas- and compressed water a tight sealing insert, which can be restreched from inside has to be used. This consists of a double-sealing insert with two steel-pressure-disks, as well as each of two 40 mm, black EPDM-solid-rubber sealings (Ethylen-Propylen-Rubber), shore-hardness = 35 ShA. All metal parts are electrogalvanized, yellow-chromated and sealed. The special for KMR constructed sealing areas will guarantee a constant distribution of compression on the PEHD-jacket-pipe and will avoid any imprints or necks.

It will be installed into a pipe liner or core drilling. Drilling resp. imbedding in concrete of the pipe liner will be carried out by a construction company. The length of the pipe liner is depending from the wall thickness. The retention moments of the screws have to be considered strictly, in order to avoid any damages of the jacket-pipe during assembling. At sealing inserts axial expansions up to 20 mm are permissible in case of creeping expansion, that means no temperature-impacts which will occur i. e. at steam.

Assembling steps see **chapter 10.2.13** and **chapter 10.2.14**
Carrier- /Jacket-pipe combinations see **chapter 2.2.2, 2.2.3, 2.3.2, 2.3.3, 3.2, 3.3, 3.4, 3.5**

Edition: 16.01.2012

7.1.6 Expansion Pads

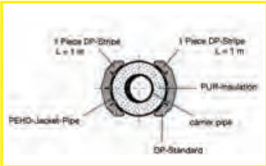
Expansion pads (DP) are compensating movements of **isoplus**-pipelines at L-, Z- and U-elbows, at branches, at reduction- and end-couplers, at shut-off-valves as well as at high- and lowest points. The pipe-layer is responsible to keep the increased minimum distances between the jacket-pipes and the trench side-walls at the expansion pad areas, see **chapter 9.2.4**.

Only because of that a regular DP-assembling according to the pipe-static requirements will be guaranteed. As standard DP with a thickness of 40 mm and a length of 1000 mm will be produced. If a thickness of > 40 mm will be required, two or more pads should be glued upon another by flaming up. Assembling will be made exclusively by approved and **isoplus**-educated installers.

Kind of execution

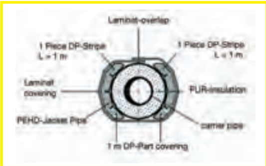
DP - Standard

One meter of DP-standard includes two pieces of stripes for lateral assembling at 3.00 o'clock and 9.00 o'clock-position. Hereby a heat accumulation will arise at the pipe-peak.



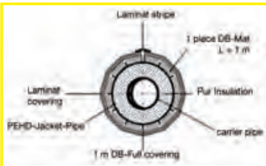
DP - Part-Covering

Like DP-standard, but with an additional factory backed outside, solid edge-area of laminate for complete covering of the PEHD-jacket-pipe in closed horizontal-oval execution. Hereby no heat accumulation will arise and penetration of sand between jacket-pipe and pad will be avoided.



DP - Full-Covering

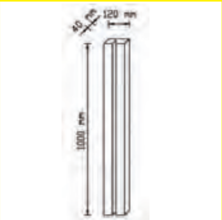
Like DP-part-covering, but not in stripe-execution, however as DP-mats, which will cover the circumference of the PE-jacket-pipes totally. Longitudinal and lateral abutting ends will be glued by flaming up of laminate. One meter DP-full covering consists of a piece of mat of 1000 mm length and a breadth depending from dimension. This alternative can be used only conditionally, resp. the DP-thickness has to be reduced to max. 80 mm, due to the high heat accumulation, especially at the pipe-peak.



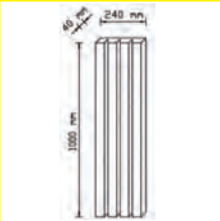
Technical Parameter 20° C		Standard	Unit	Value - DP	Value - Laminate
Raw Density ρ		DIN EN ISO 845	kg/m³	32 ± 4	45 ± 4
Tensile Strength σ_B		DIN EN ISO 1798	N/mm²	0,16	0,59
Breaking Elongation ε_R		DIN EN ISO 1798	%	55	109
Rebound Resilience R		DIN 53 512	%	45	---
Compressive Strain σ_D at de-formation (spring characteristic)	25 %	DIN EN ISO 3386	N/mm²	0,045	0,023
	50 %			0,110	0,050
Deformation by compression after 24 h relief DVR	25%	DIN EN ISO 1856	%	6	18
	50%			22	---
Thermal Conductivity λ		DIN 52 612	W/(m•K)	0,042	0,039
Water Absorption after 24 h		DIN 53 428	vol.%	2	3
Water-Steam Absorption after 24 h (d = thickness)		DIN EN ISO 12572	g/m² • d	d = 60 mm 0,15	d = 10 mm 0,65
Material Class		DIN 4102	---	B 2	B 3
Material		Closed celled, cross linked, not corroded, rodent-protected and chemical resistant white Polyethylene-foam-laminate			

Measures DP-Stripes

Size I (1 nick)



Size II (3 nicks)

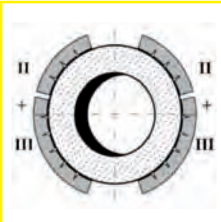


Size III (5 nicks)

Application

Jacket-Pipe- Ø in mm	Size	Combination
65 - 160	I	---
180 - 280	II	---
315 - 355	III	---
400 - 500	IV	II + II
560	V	II + III
630 - 670	VI	III + III
710	VII	III + II + II
800	VIII	III + III + II
900	IX	III + III + III
1000	X	III + III + II + II
1100	XI	III + III + III + II
1200	XII	III + III + III + III
1300	XIII	III + III + III + II+ II

Example of Combination Size V



7.1.7 PUR-Foam

Polyurethane-hard foam consists of two components Polyol (component A, bright) and Isocyanat (component B, dark). As blowing agent environmental friendly C-Pentane will be used, whose characteristics will neither impair the ozonosphere nor will increase the greenhouse effect. In the factory Polyurethane-hard foam (PUR) will be manufactured by use of high sophisticated high pressure equipment.

At site **isoplus** installers are using manual mixed can-foam which will be mixed by use of a turbo-mixer, or machined foam, which will be portioned acc. to corresponding requirements in pre-heated containers from a mobile foaming equipment.

Because of an exothermal chemical reaction a high-quality insulation material comes into being with excellent insulation characteristics and a low specific gravity. PUR-foam is reaching a high pressure resistance at thermal load as well as a long life-time. The temperature-dependent field of application of the current stage of development extends far beyond the required values according to EN 253.

Studies from officially approved material-test-authorities (AMPA) certify a lifetime of at least 30 years as well as a thermal conductivity [λ] of maximum **0,027 W/(m•K)** at **discontinuous** production. In the **continuous** production of pipe bars the thermal conductivity is maximum **0,024 W/(m•K)**, at flexible pipes max. **0,023 W/(m•K)**.

Due to an optimal adhesive force of the PUR-foam, a very high shearing strength will be reached between jacket-pipe and foam as well as between foam and carrier pipe. Because of that the reached compound can compensate the frictional force which will occur due to the thermal stress between sand-bed and jacket-pipe, as well as the occurring shearing- and pressure tension.

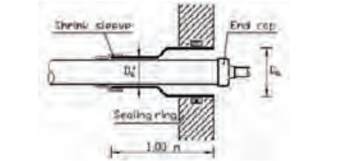
Technical Characteristics PUR-Hard-Foam	Unit	Minimum value acc. to EN 253
Raw density free foamed ρ	kg/m³	50
Radial compression strength σ_{Druck} at 10% deformation	N/mm²	0,40
Closed cells	%	90
Size of cells in radial direction	mm	< 0,5
Water absorption after 90 minutes boiling-test	vol.%	5
Maximum continuous operating temperature T_{max}	°C	161
Lifetime L	a	≥ 30
Thermal Conductivity λ at 50 °C average temperature	W/(m•K)	≤ 0,027
Specific Heat Capacity c_m	kJ/(kg•K)	1,4
Material Class (highly flammable)	DIN 4102	B 3
Fire Resistance Class (fire-retardant)	DIN 4102	< F 30
Ozone Depletion Potenzial ODP	---	0
Global Warming Potential GWP	---	< 0,001

Foam used at site has to be stored acc. to EN 489 at +15° up to +25° C, and can be used at surface temperatures between min. 15° and max. 45° C. Maximum storing period is 3 months. Depending from quantity delivery will be in 1 ltr., 5 ltr. or in 10 ltr. units, incl. the corresponding required multiple mixing-cans.

Edition: 16.01.2012

7.1.8 Joining Pipe / Assembling Supports / Warning Tape

isoplus-pipes often have to be connected to existing channel net-works. In case of lateral duct through the channel wall a lateral movement will normally occur. By use of a joining pipe this movement can be compensated.



Delivery length of the PEHD-fitting will be 1,00 m. It consists of a central placed PEHD-jacket-pipe- and socket pipe. Delivery includes a shrink seal for the socket pipe-end for sealing of the joining pipe to the PEHD-jacket of the corresponding PEHD-jacket pipe.

Sealing of the joining pipe will be made with the technically required wall-duct, see **chapter 7.1.5**, this will be not included in the delivery.

Technical caracteristics PEHD see **chapter 2.1.4**

D_a' = Joint-pipe diameter
D_a = Jacket-pipe diameter
Δl_{Lat} = Maximum permissible expansion compensation, lateral resp. transverse

D_a' [mm]	D_a [mm]	Δl_{Lat} [mm]	D_a' [mm]	D_a [mm]	Δl_{Lat} [mm]
65	110	19	315	450	60
75	125	22	355	500	64
90	140	22	400	560	71
110	160	22	450	630	80
125	180	24	500	710	93
140	200	26	560	800	107
160	225	28	630	900	122
180	250	30	670	900	102
200	280	35	710	1000	131
225	315	40	800	1100	136
250	355	46	900	1200	135
280	400	53	1000	1300	135

Assembling Supports

Pipe supports are used as auxiliary bearing support for **isoplus**-pipelines up to a jacket-pipe diameter of max. 315 mm. Contrary to squared timber, they have not to be removed and should therefore preferably used. Pipe supports consist of extruded hard-foam free of fluorine hydrogen. Three point of support, resp. pieces of supports are required per 6,00 m pipeline.

Warning Tape

Warning tapes are used for marking **isoplus**-pipelines above the finished sand-bed and the first filling layer of 200 mm in 12.00 o'clock position of primary and secondary pipeline. The warning tapes will be delivered in coils of 250 m length and a breadth of 40 mm, with black inscription on yellow background "Attention District Heating Pipeline".

Edition: 16.01.2012

7.2.1 Press Tool / Bending Tool

Press Tool

For the pressing procedure three types of tools are available:

⇒ Mechanical press tool
for **isopex**-pipes up to dimension of 40 mm

⇒ Hydraulically press tool
for **isopex**-pipes up to dimension of 40 mm

⇒ Hydraulically press tool
for **isopex**-pipes starting from 50 mm

All tools incl. all required accessories like press-pincers, -blocks and -ridges, expansion pincer and -heads as well as the corresponding small accessories are completed in a stable metal suitcase.

Depending from requirements they can be used for some days or weeks against payment. During this time the user of the tools will be exclusively responsible for correct function, cleaning and complete return of the equipment.

Bending Tool

For the procedure of bending of **isoflex** or/and **isocu** the hydraulically **isoplus**-bending tool incl. pump and pressure hoses will be available. Bending will be made in three to four steps. Depending from kind of flexible pipe different minimum bending radius should be considered. See **chapter 3.2.2** and **chapter 3.3.2**

The use of a not suitable bending equipment is not allowed. In order to avoid damages of the flexible pipes bending around edges like foreign pipe-lines, squared timber, buildings- or wall-corners are not permitted.

Depending from requirement the equipment may be used for days or weeks. During this period the user will be exclusively responsible for correct function, cleaning and the complete return of all parts.

For bending of **isopex**-pipes the use of a tool will be not possible, due to the high self-elasticity of the carrier pipe.

7.2.2 Protection Cap / Distributing Manhole

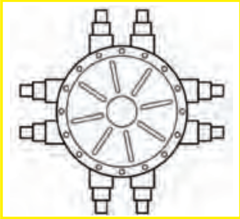
Protection Cap

In order to protect the PUR foam against moisture by means of condense, inside of buildings (drying-rooms) protection caps should be used. These are consisting of age-resistant neoprene-rubber and will be used as simplex- or duplex-cap, depending from kind of flexible pipe-type.

The pipe laying company will be responsible to put on the protection cap before connecting with the building line. These caps have to be protected from fire, may not be cutted and may not be used for post installation. The installation of the pipe ends without protection cap is not permitted.

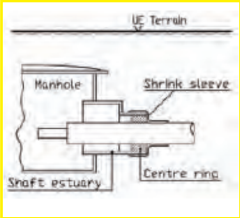
Available PE-jacket-pipe dimensions see **chapter 3.2.2, 3.3.2, 3.4.2, 3.5.2**

Distributing Manhole



A distributing manhole will be used for checking of installations like branches within a **isopex**-pipeline. This inspection manhole incl. cover-plate consists of polyethylene (PE) and will be delivered in dimension of 800 mm and an installation height respectively depth of approx. 700 mm.

The universal and water-tight construction allows the connection of up to eight pipes with jacket-pipe dimensions of 65 to 180 mm.



Before the flexible pipe will be installed, the pipe layer should install the corresponding sealing set. This consists of a closed heat shrinkable sleeve as well as of a centre ring in accordance with the jacket-pipe dimension. The sealing sets are not part of the delivery of the distributing manhole.

At a pipe covering height of 0,4 m the maximum admissible load of the cover will be 50 kN/m². In case that higher coverings will be reached, a well ring respectively a soak-hole concrete ring should be installed above the PE-manhole.

7.2.3 Twin-Accoutrement

This fitting unit, consisting of two ball-valves, may be used for all **isoplus**-flexible pipes for heating installations. It should be installed at the wall in closed position with the included mounting-plate.

Casing and welding ends are made of P235GH , (Material-Number 1.0345), ball of stainless steel (Material-Number 1.4301) and gear-shaft of stainless steel (Material-Number 1.4404), ring and sealing of PTFE (Teflon), available for carrier pipe dimensions of ¾" to maximum 2".

For **isopex** type **H-25** to **H-63** additionally two connection couplings with welding ends are required, see **chapter 3.6.5.**

8 LEAK DETECTING

8.1.1 Explanation to Leak Detecting

Even slight leaks may cause essential damages. The result could be heat loss, corrosion at pipelines and interruptions of operation. Therefore **isoplus** offers two leak detection systems and monitoring systems, which will guarantee a continuous monitoring of the complete pipeline concerning moisture and pipeline damages, because of two foamed in copper- or resistance wires and due to different kind of measuring units, suitable for the correspondent application.

The monitoring includes not only the coupler area, but also each meter of the pipeline. Even very slight moisture of the PUR-hard foam caused by leaking weld seams or building-moisture will be indicated, also at high-impedance range. Damages of the PEHD-jacket-pipe, i. e. caused by civil underground engineering or planting as well as wire break, will also lead to a fault indication.

Within the coupler connections and T-branches no sensible fully or half-active electronic components will be used, which will eventually lead to an early wearing of the alarm system. The measuring units with the electronic components are outside of the building, manholes or corresponding pale-distributors.

In case of **IPS-Cu®** (Copper) two bare copper wires will be foamed into the pipe bars and into all fittings, as detecting or monitoring wires. In case of **IPS-NiCr®** (nickel-chrome) the two detecting wires consist of an isolated resistance- (sensor-wire) an a copper wire (loop-wire).

The isolation of the NiCr-sensor-wire is perforated in cyclic defined distances. All wires are wearing free, corrosion- and temperature resistant.

For optical characteristics feature the detecting wires are coloured coded. **IPS-Cu®** by a bare and a tinned copper wire, **IPS-NiCr®** by a yellow and a black isolated wire. Therefore any confusion will be excluded. The wires will be connected before foaming the couplers, by use of a press-connection which will be additionally soldered in case of **IPS-Cu®** , and in case of **IPS-NiCr®** shrinked.

All branch pipelines as well as later pipeline extensions, cann be integrated into the leak detecting system without any problem. The assembling of the leak detecting will be carried out parallel with the insulation and sealing works, by AGFW-/BFW- approved and **isoplus**-factory educated specialists. The wires of each coupler connection will be wired and again tested after the foaming procedure, concerning correct transmission. At the final assembling of all accessories and required equipments, an additional recorded acceptance will be carried out.

8.2.1 Description

The **IPS-Cu®** - system is especially suitable for network monitoring of pipelines. An effective safety could be reached due to a simple construction and a consequent further development. Lasting for decades of experience and developments will enable a compatible and manufacturer predominant wire system of the "Nordic Monitoring Technology".

This standard and the popularity of **IPS-Cu®** allow an economic useful production and installation. A standard assembling in the pipe and in the coupler connection will allow a optimum product and function control and will secure the quality requirement. The resulting minimization of the assembling failures will increase the expected life time of the complete pipeline.

Because of its architecture the **IPS-Cu®** is already offering a very high degree of failure security. An interrupted loop will i. e. not limit the function because the excavation of the located failure position can be avoided for the time being, due to a simple change over in the wire. Therefore an extreme economical operation of the equipment will be possible during the complete life time.

The special characteristic of **IPS-Cu®** are the both bare copper wires. Both wires are available with their complete surface for failure determination in the total pipeline. This will be an essential advantage for an early recognition of a tendency change. The **IPS-Cu®** - system offers the optimum solution for various problems, due to a permanent further developing equipment technology, which offers an early and safe recognition and detection.

Two bare copper wires with a standardized 1,5 mm^2 profile will be factory foamed into the compound jacket-pipe. For visual distinctive features one wire is galvanic tinned. Required wire connections within the jacket-pipe couplers will be carried out with squeeze-husks and additional soldering with soft solder.

The wire distance holders will fix the wire position within the coupler area. Both wires are short circuited at the end points of the pipeline, in order to create finally a measuring loop. Branch pipelines will be included directly in consideration to the wiring guidelines. The detecting unit will be installed at the starting point of the measuring loop, i. e. in the heating station.

An additional wiring design will be not necessary, due to the **isoplus**-presentation of the required hard-ware components which have to be installed and the standardized course of the detecting wires. Because of the complete documentation on one view, the unfavourable comparison between wiring and pipeline course as well as the double recording will be a matter of the past.

Edition: 16.01.2012

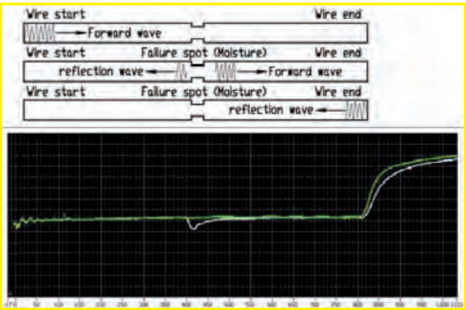
8.2.2 Function

The monitoring in case of **IPS-Cu®** will be carried out via the ohm-resistance measurement between the pair of wires and the electric conducting carrier pipe. Because PUR-foam is like an electrical isolator, a high isolation resistance will occur between wire and carrier pipe in case of an intact compound jacket-pipe.

Additionally a wire loop measurement will be carried out for in-house monitoring. A location of determined failures will be made by use of impulse-reflector-measurement, therefore a wire loop will be required.

The impulse-reflector-technology is using the high frequency electrical characteristics of pipelines. Due to the geometrical location of the foamed in bare Cu-wires and the carrier pipe as well as the electrical characteristics of the PUR foam technology, a wave impedance will occur which will be almost constant along the total length.

Electrical impulse of low energy will spread undisturbed with approximate light velocity. The wave impedance in the PUR-foam will change in case of a moisture penetration which has not to be electrical conducting. The spread of the impulse will be disturbed and a reflection of the impulse will occur within this area (echo). The position of the fault will be calculated from the time between transmitted pulse and reflection.



isoplus offers for this purpose the digital leak detecting hardware **IPS-Digital®**. The advantage is the impulse feeding via the sample-and-hold procedure. The wire system will be sampled in regular periods (sample) and the signals will be pre-recorded (hold).

At a certain time eventual returning reflections will be recorded. Due to the different time of recording it will be possible to check certain sections of the pipeline in detail concerning echo (reflections). With a total number of 6000 impulses **IPS-Digital®** will reach with **IPS-Cu®** a definition of at least 0,5 m, the locating exactness will be 0,2 %.

In case of high frequent fault indication the number of impulse will be increased. Also in such a case measurements will be unlimited possible, by use of secondary filters and mathematical algorithm. Also **multiple faults** within a measuring section can be definitely determined and located.

8.3.1 Description

The **IPS-NiCr®** - System will be suitable like **IPS-Cu®** especially for the monitoring of pipeline networks of all sizes. For extension of an existing NiCr-detection or for application for a steel jacket-pipe system **IPS-NiCr®** can be also used. Our experience and development will enable a compatible and manufacture extending monitoring system in the resistance reference technology.

Due to a simple construction, avoiding of active components within the pipeline as well as a standard assembling in the pipe and coupler connection, a high processing safety will be guaranteed. The **IPS-NiCr®** stands for a continuous detecting of the pipe and coupler area with parallel high sensitivity.

The special characteristic of the **IPS-NiCr®** is the perforated NiCr-wire as sensor technology. This NiCr-wire will be available with its perforation in the total pipeline network. Therefore individual moistures can be exactly detected. In connection with the permanent further developing **IPS**-equipment technology a high degree of safety concerning detecting and monitoring will be guaranteed.

During production of pre-insulated jacket-pipes the two wires will be foamed in. Through the yellow, perforated NiCr-wire the moisture will be detected. The PTFE-isolation (Polytetrafluorethylen resp. Teflon®) which is covering the 0,5 mm^2 NiCr-wire (NiCr 8020) is resistant up to 260° C and is perforated in regular distances. Due to a special alloying the wire has a constant longitudinal resistance of 5,7 Ω/m.

The black Cu-wire with a profile of 0,8 mm^2 will be used for loops and has no detection purpose. The isolation resistance up to 205° C consists of FEP (Fluorinatedethylenepropylene). Required connections of NiCr- and Cu-wires within jacket-pipe couplers will be made by use of squeeze-husks. Water tight and up to 150° C temperature resistant shrink-hoses made of PO-Xc (Polyolefin, cross-linked by irradiation) are additionally assembled over the squeeze-husks, in order to protect them against direct moisture contact.

Wire distance holders have to be used, in order to guarantee a defined wire position in the coupler area. The measuring loop with the NiCr- and Cu-wire at the end points of the pipeline, will be connected with the monitoring unit at the determined starting point.

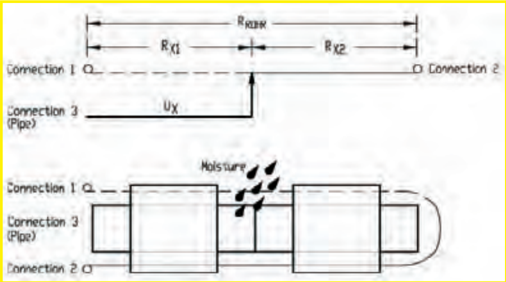
An additional wiring design will be not necessary, due to the **isoplus**-presentation of the required hard-ware components which have to be installed and the standardized course of the detecting wires. Because of the complete documentation on one view, the unfavourable comparison between wiring and pipeline course as well as the double recording will be a matter of the past.

Edition: 16.01.2012

8.3.2 Function

The monitoring will be carried out like at **IPS-Cu®** via the ohm-resistance measurement between the pair of wires and the electric conducting carrier pipe. Because the PUR-foam is like an electrical isolator, a high isolation resistance will occur between wire and carrier pipe in case of an intact compound jacket-pipe. Additionally a wire loop measurement will be carried out for in-house monitoring.

The geometric position of carrier pipe as well as the measure- and loop wire is a system with four unknown factors. These are the both part-resistance R_{X1} and R_{X2}, with the resistance of the pipeline $[R_{Rohr}] = R_{X1} + R_{X2}$, the isolation resistance of the PUR-insulation $[R_{ISO}]$ as well as the tension element $[U_X]$. The total resistance R_Σ will be determined by the NiCr-resistance wire. The both part-resistance R_{X1} and R_{X2} are depending from the location of moisture.



In case of failure the conducting moisture will transfer a tension-part-value, which is depending from location, on the carrier pipe, which takes the function of the measuring wire, seen from the electrical point of view. The connection "pipe" can be compared with a loop of a potentiometer. The loop preparation will represent the location of the fault.

As shown on the replacement wiring diagram, the tension-part-value - from R_{X1} and R_{X2} - will be not available as direct measurable factor at connection 3, because practically several fault factors will affect. Additionally the isolation resistance $[R_{ISO}]$ and a chemical tension element $[U_X]$, which will occur due to the different metals of resistance wire, have to be considered.

Especially the chemical tension element will adulterate the real loop preparation at connection 3. This circumstance can be recognized practically due to the fact that the measurement of the isolation resistance $[R_{ISO}]$ by use of conventional measuring units, depending from polarity and degree of measuring tension, will lead to different results. Even the presentation of negative resistance, which will of course not occur, will be possible.

The inner resistance of the tension element $[U_X]$ and therefore also the isolation resistance between wire and carrier pipe, are depending from the degree of moisture and chemical structure of the penetrating medium, i. e. water. Both will of course influence essentially the measuring result for determination of the leak location (loop-preparation) and the isolation resistance $[R_{ISO}]$.

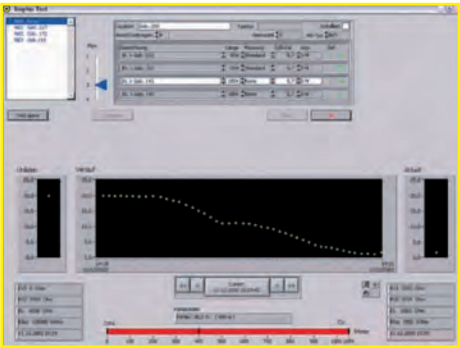
Therefore the isolation resistance [R_{ISO}] is an essential indicator for the evaluation of the pipeline condition. Conventional measuring system will ignore the tension element [U_X], which can lead to essential measuring failures.

The **IPS-NiCr®** - system determines all electrical components of wire-/pipe arrangement with a high degree of exactness and a new digital procedure. Several distribution conditions will be set up to the shown connections 1 to 3, **see previous page**, and the occurring tension- and current values will be measured. After digitalisation the measured values will be transmitted to a central computer.

A mathematical algorithm (to the patent announced) will calculate the location of the moisture and the unknown factors of the part-resistances R_{X1} and R_{X2}, with the resistance of the pipeline [R_{Rohr}], the isolation resistance of the PUR-insulation [R_{ISO}] as well as the tension element [U_X]. Due to the physical principle of the "unloaded tension distributor" only single moisture-failures can be exactly located in all **NiCr**-systems.

Several moisture failures cannot definitely locate in contrary to the nordic systems like **IPS-Cu®**. Additionally it has to be considered, that in case of **NiCr**-systems only one moisture failure or one wire-pipe contact (short circuit) can be exactly located via the resistance reference-measuring procedure. All other possible failures like i. e. a wire break have to be determined and located manually by use of other measurement technologies. **isoplus** is using the impulse reflector technology like at the **IPS-Cu®** - system.

By use of the digital monitoring hardware **IPS-Digital®**, **IPS-NiCr®** indicates isolation resistance [R_{ISO}] in the range of 10 kΩ to 20 MΩ. From < 10 MΩ a first detection will be carried out for information of the user. The indicator barrier of the alarm indication will be < 5 MΩ. Therefore the user will have the possibility of self-determination of his range of activity.



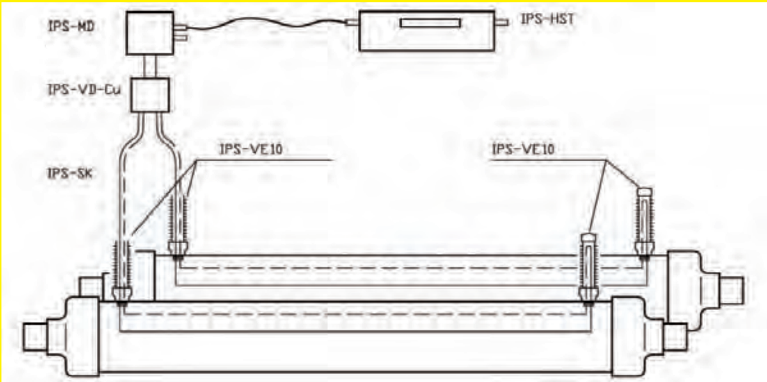
With a recommended limited **NiCr**-wire length of 1.300 m the **IPS-Digital®** will reach with **IPS-NiCr®** a detection exactness of 0,2 %. The failure detection may be on the total length without restriction of marginal areas. The indication of the failure position will be shown in "meter" and "percent".

Edition: 16.01.2012

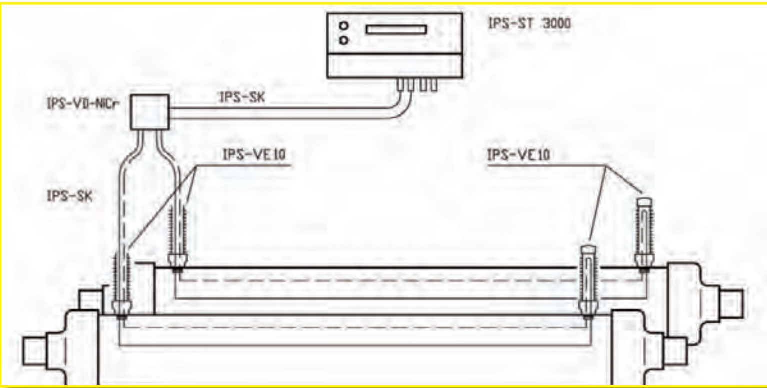
8.4.1 Analog / Monitoring Equipment

The group of monitoring equipment consists of the portable manual system tester **IPS-HST**, the stationary unit **IPS-ST 3000** as well as the combination of, the all-round unit **IPS-MSG**, which will be suitable for smaller to medium pipeline networks. These are offering an automatic monitoring and can be used for **IPS-Cu®** and **IPS-NiCr®** as well as for technical comparable systems. The **IPS-ST 3000** can be additionally used for hierarchical constructed pipe-network-detecting systems.

IPS-Pipe-Network-Detecting with IPS-HST



IPS-Pipe-Network-Detecting with IPS-ST 3000



Portable Manual System Tester IPS-HST

The manual system tester **IPS-HST** is a simple operating all round measuring unit for **IPS-Cu®** and **IPS-NiCr®** as well as for technical comparable monitoring systems.

The unit will be suitable for:

⇒ Inspection measurements
⇒ Quality control during assembling
⇒ Rotational, manual monitoring of smaller pipeline networks

All measurements will be carried out automatically, program-controlled, for that further adjustments will be necessary. For NiCr-systems different longitudinal resistance values can be selected. The indication of the measuring results, there will be differentiate between isolation and loop, will be shown by a 2 x 16 sign LCD-display as ohm value. In case of lowering the adjusted admissible values, an visual and acoustical signal will be indicated.

The **IPS-HST** is equipped with a connection cable respectively -plug for a safe connection to a measuring box **IPS-MD**, see **Chapter 8.5.3**. It can be also connected directly to leak detecting wires by use of alligator clips respectively tapping clips which are included in the delivery.

Technical parameter see data sheet, **chapter 8.6.1**

Edition: 16.01.2012

Stationary Leak Detecting Unit IPS-ST 3000 with 1- to 4- Channel Technology

The monitoring unit **IPS-ST 3000** is the optimum monitoring technology for a clear pipeline network of medium size. It monitors fully automatically the connected pipelines concerning moisture, sensor wire-pipe contact and sensor wire break. It will be suitable for copper wire- and resistance wire systems like **IPS-Cu®** and **IPS-NiCr®** as well as for technical comparable systems.

Per channel maximum 2.500 m sensor wire at **IPS-Cu®** and 1.300 m at **IPS-NiCr®** can be monitored. 10.000 m of nordic Cu-wire respectively 5.200 m NiCr-wire can be monitored with the final level, the four-channel unit **IPS-ST 3000-4**. The kind of connected sensor wire will be recognized automatically.

With the multiple-channel variants it will be possible to allocate every single channel to a different sensor. Therefore it will be especially suitable for mixed pipeline networks with only one central monitoring unit, the **IPS-ST 3000-1, -2, -3** or **-4**. The following measuring data and alarm- respectively failure signals will be shown separately for every channel on the 4 x 20 sign LCD-Display:

⇒ Alarm barrier value
⇒ Isolation resistance
⇒ Failure status resp. -type
⇒ Longitudinal resistance at NiCr- resp. sensor-wire-type at Cu-systems

The isolation values as well as the longitudinal resistances will be indicated in “Ohm”, therefore the comparison with other measuring units will be possible at any time. Additionally to the visual indication it offers a potential-free exit for relaying of signals respectively measuring data. The **IPS-ST 3000** is prepared for the connection with an external detecting unit and will be therefore a favourable detecting position. The very simple control will be made by a pressure-button.

Technical parameter see data sheet, **chapter 8.6.1**

Independent Leak-Monitoring-Modul IPS ST3000 - AUTARK

ST3000 – AUTARK is the first analog isoplus-leak-monitoring-modul which is fully integrated into the **„isoplus-digital** family“. It will be used locally and totally **AUTARK** – that means no current supply by conduction wires and no fix data-line (copper-bus or LWL) will be required. The product is equipped with a GSM-unit for data transmission via mobile phone network and with a powerful lithium battery (Li-$SoCl_2$) with guaranteed lifetime up to 5 years (*).
ST 3000 – AUTARK is able to monitor up to four Cu-wires of 2.500 mtr. each as well as four NiCr-wires of 1.300 mtr. each and to low point sensors, depending from kind of type. All data will be evaluated and displayed with our proved **isoplus-Digital** software.

(*) One measurement per day and one transmission per week to central unit

Furthermore ST3000 - AUTARK offers:

⇒ Failure evaluation via **isoplus**-digital-software (without locating!)
- Moisture / contact / loop interference
- Man-hole monitoring
- Battery status
- Indication of location
- configured for operational control rooms

⇒ Suitable for all known copper- and NiCr-wire-systems

⇒ Variable configurations:
- 230V operation with power unit
- Network usable with COM-Server
- 2/4 measurement channels, 1-2 man-hole monitoring

⇒ Multiple usable:
- Central monitoring of remotelines (so called “outside-lines”)
- Central monitoring of not reachable lines (i. e. in man-holes, private houses)
- Central site-monitoring (nocturnal control measurement)

The **ST3000 - AUTARK / SÜ** Module is for pure monitoring man-holes with two digital inputs for water level detectors or other signal transmitters (hourly measurement control).

Technical parameter see data sheet, **chapter 8.6.1**

Mobile Stationary Unit IPS-MSG 500 / 1000

This all-round unit should be used for simple monitoring, combined with automatic detecting of small pipelines with **IPS-NiCr®** wire sensor technology as well as for technical comparable systems. The **IPS-MSG** can be used for many applications, by single combination of a stationary monitoring unit with the mobility of a manual measure unit. Monitoring up to 500 m sensor-wire will be possible with **IPS-MSG 500**, and up to 1.300 m with **IPS-MSG 1000**.

The special characteristic is the automatic detection of the centre of moisture. In case of failure checks from additional points of connection can be carried out rapid, due to the flexibility. The **IPS-MSG** can be used equally for:

⇒ Detection measurements
⇒ Inspection measurements
⇒ Quality control during assembling
⇒ Rotational, manual monitoring and detecting of smaller pipeline networks

All measurements will be carried out automatically, program-controlled, without any additional adjustment. The outline of the measured results (differential between isolation and loop) will be shown as ohm-value, via a 2 x 16 sign LCD-display. In case of undershooting of the admissible limiting value, an optical and acoustical alarm will be released.

The detected results will be determined based on the longitudinal resistance of the NiCr-wire of 5,7 Ω/m, for other wire systems an additional indication as per cent value will be possible. The relaying of the failure indication will be possible via the integrated potential relay output.

The **IPS-MSG** is equipped with a connection cable respectively -plug for a safe connection to a measuring box **IPS-MD**, see **chapter 8.5.3**. Additionally it can be connected directly to the power supply by using an Euro-plug power-unit. A direct connection to the monitoring wires will be possible, by using tapping or alligator clips, which are included in the delivery.

Technical parameter see data sheet, **chapter 8.6.1**

8.4.2 Digital / Detecting Units with Monitoring

The **IPS-Digital®** - system is the optimal complete solution for a fully automatic monitoring and parallel permanent detection. **IPS-Digital®** will be suitable for copper wire- and resistance wire systems **IPS-Cu®** and **IPS-NiCr®** as well as for technical comparable systems. **IPS-Digital®** offers a central leak detecting management for medium- up to big respectively branched pipeline networks.

The modular structure will assist the economical construction of a corresponding adapted monitoring installation. With **IPS-Digital®** several specific wire characteristics may be chosen free of any restrictions. Due to this an essential and unique safety at the central recording and evaluation of different sensor-wire-systems can be reached.

Due to the software based control and evaluation of the complete system, a simple up-date and configuration to the project-typical factors will be possible. The automatic recognition of the kind of measuring unit, i. e. **IPS-Cu®** or **IPS-NiCr®**, the friendly operation as well as an optimum of safety in monitoring and detecting, are additional essential advantages of **IPS-Digital®**.

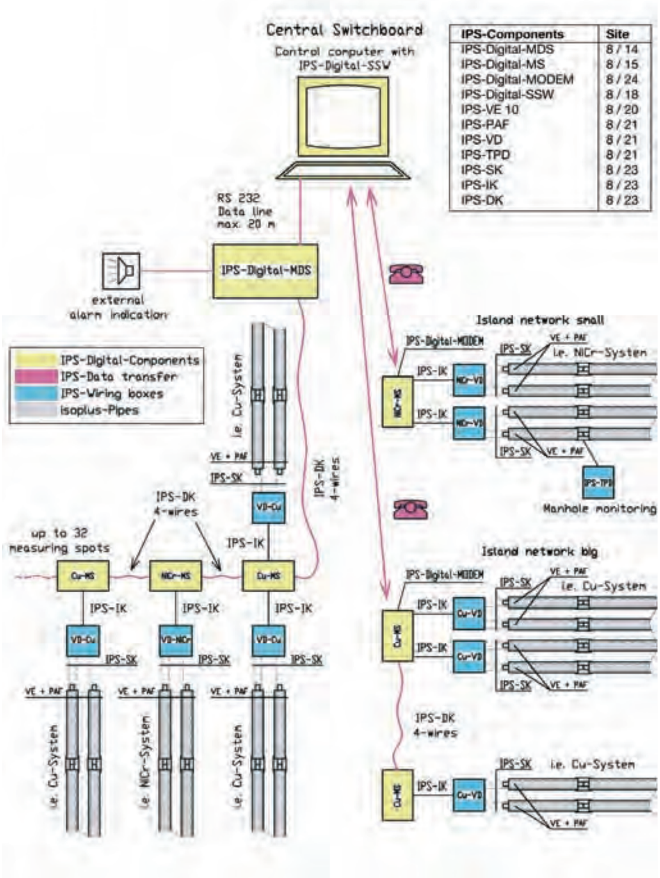
Depending from application the following **IPS-Digital®** - components will be available:

Units for an expandable monitoring network IPS-Digital®		Site
⇒ IPS-Digital-MDS	Central measuring data acquisition	8 / 14
⇒ IPS-Digital-Cu-MS	Measuring spot for Cu-systems	8 / 15
⇒ IPS-Digital-NiCr-MS	Measuring spot for NiCr-systems	8 / 15
⇒ IPS-Digital-TV	Data T-distributor	8 / 24
⇒ IPS-Digital-MODEM	Modem extension for IPS-MS	8 / 24
⇒ IPS-Digital-PFA	Alarm-reporting-module	8 / 24
⇒ IPS-Digital-FSV	Distant voltage supply	8 / 24
Single units for smaller monitoring networks without extension		
⇒ IPS-Digital-Cu-KMS	Compact measuring spot for Cu-systems	8 / 16
⇒ IPS-Digital-NiCr-KMS	Compact measuring spot for NiCr-systems	8 / 16
Portable units for application at site as well as for unstructured networks		
⇒ IPS-Digital-Cu-MBS	Mobile unit for Cu-systems	8 / 17
⇒ IPS-Digital-NiCr-MBS	Mobile unit for NiCr-systems	8 / 17
⇒ IPS-Digital-UNI-MBS	Mobile unit for Cu- and/or NiCr-systems	8 / 17
Software modules for control, extension and adaptation		
⇒ IPS-Digital-SSW / AUTARK	Control software for IPS-Digital® and AUTARK	8 / 18
⇒ IPS-Digital-VISUAL	Failure visualisation with design presentation	8 / 19

Technical parameter see data sheet, **chapter 8.6.2**

Edition: 16.01.2012

Construction of a IPS-Digital® - Pipe Network Monitoring



Measuring Data Acquisition Station IPS-Digital-MDS

The central measuring data acquisition station **MDS** is an essential part of the control central of an **IPS-Digital**® - network. Together with an usual desktop computer or notebook (PC) and the control software **SSW** the total monitoring network will be central controlled. The **MDS** is the interface between central-control respectively PC and monitoring network, respectively pipeline.

There will be an adaptation from the PC-interface RS 232 to the RS 485 interface of the measuring spot/s **MS**. By use of a data transfer based on interface RS 485 a data intensification respectively a data-refresh will be not necessary.

The **MDS** represents additionally a galvanic separation between external (in direction measuring spot/s) and internal (in direction PC) data network. Because of this a high effective protection against interference- and over-voltage will be required. In case of interference the control software **SSW** will activate a potential-free relay-exit which is integrated in the **MDS**, and which will be available for transmission to a process-control-system.

Technical parameter see data sheet, **chapter 8.6.2**

Edition: 16.01.2012

Measuring Spot IPS-Digital-MS with 2- or 4- Channel Technology

The measuring spot MS is the basic hardware within an **IPS-Digital**® - network and is placed at the corresponding end point of a monitoring section, directly at the pipe end. Depending from requirement measuring spots will be used with 2- or 4- channel technology, **MS-2** or **MS-4**. Their control will be made via the measuring data acquisition station **MDS** respectively via the control software **SSW**.

All recorded data will be digitized and send via the RS 485 interface to **MDS**. Each **MS** is equipped with a data input and -output as well as with two respectively four pipeline- respectively measuring connections, depending from grouping of cables. The data connections are galvanic separated against the measuring spots. Several **MS**, which are working parallel like a data-refresh, will be connected interrelated in cascade form.

Because of this the maximum possible data transmission length will be available at each of the 16-fold addressable **MS**. For an alternative adaptation and extension each MS can be extended by the data transfer per **MODEM**.

IPS-Digital-Cu-MS 2 / 4

One Cu-MS will supervise and detect changes of impedance on maximum 2.500 m sensor wire per channel. For that the impulse-running-period-measurement will be used. Additional constant- and alternating voltage as well as the ohmic resistance will be determined.

IPS-Digital-NiCr-MS 2 / 4

One NiCr-MS will supervise and detect changes of resistance on maximum 1.300 m sensor wire per channel. For that the constant-voltage-resistance-measurement will be used. The detection of failures will be made via the resistance-detecting measurement procedure.

Technical parameter see data sheet, **chapter 8.6.2**

Compact Measuring Spot IPS-Digital-KMS with 2- or 4-Channel Technology

The compact measuring spot **KMS** is the basic hardware within an **IPS-Digital**® - network and is placed directly at the starting point of the monitoring section at the location of the control computer (desktop or notebook). The **KMS** consists of a measuring spot assembled at the end of the pipeline, and of a standard PC with software **SSW**, which should be installed within a distance of maximum 20 m.

Depending from requirement compact measuring spots will be used with 2- or 4- channel technology, **KMS-2** or **KMS-4**, which cannot be interlaced with each other. All recorded data will be digitized and transmitted to the control software **SSW** respectively to the control computer.

The data connections are galvanic separated opposing of the measure-ports. For an optional adaptation and extension each **KMS** can be extended by data transfer per **MODEM**. Each **KMS** has a potential-free contact for transmission to an operating control system.

IPS-Digital-Cu-KMS 2 / 4

One **Cu-KMS** will supervise and detect changes of impedance on maximum 2.500 m sensor wire per channel. For that the impulse-running-period-measurement will be used. Additional constant- and alternating voltage as well as the ohmic resistance will be determined.

IPS-Digital-NiCr-KMS 2 / 4

One **NiCr-KMS** will supervise and detect changes of resistance on maximum 1.300 m sensor wire per channel. For that the constant-voltage-resistance-measurement will be used. The detection of failures will be made via the resistance-detecting measurement procedure.

Technical parameter see data sheet, **chapter 8.6.2**

Edition: 16.01.2012

Portable IPS-Digital®- Pipe Network Monitoring

This complete measuring system is suitable for manual monitoring and detection of unstructured networks as well as for site application. Depending from requirement the following system variants, completed in a stable measuring suitcase, will be different:

⇒ **IPS-Digital-Cu-MBS** - Mobile unit for Cu-Systems
- Impulse-running period measurement (i. e. **IPS-Cu®** or comparable)

⇒ **IPS-Digital-NiCr-MBS** - Mobile unit for NiCr-Systems
- Resistance measurement (i. e. **IPS-NiCr®** or comparable)

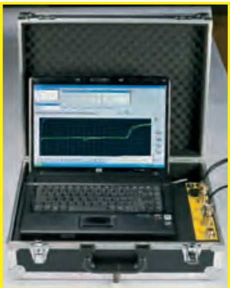
⇒ **IPS-Digital-UNI-MBS** - Mobile combined unit for Cu- and NiCr-Systems

The handling of the mobile station **MBS** is very simple, and due to an integrated accumulator the measuring suitcase can be used also independent from network. The control of all manual or automatic measurements will be made via the included notebook and installed control software **SSW**. For that the notebook will be purchased directly or placed at disposal. Due to the unique flexibility an **MBS** will be especially suitable for:

⇒ Acceptance control with direct protocol print out
⇒ Failure detection with picture print out of impulse-running period
⇒ Automatic monitoring and detection in free defined pipeline sections
⇒ Continuous supervising of construction without additional equipment

All collectable data will be determined by software control, visualised evaluated and archived. An eventually required failure detection will be also made fully automatically. Therefore the **MBS** is an independent measuring equipment. A long term monitoring of one or several pipeline sections will be also possible.

The single sections have to be defined exactly, because each **MBS** will be addressable up to 100-fold. A required data-exchange will be made via the standard interfaces of the notebook. An **MBS** can be of course extended additionally with all available software modules.



Technical parameter see data sheet, **chapter 8.6.2**

8.4.3 Digital / Software

Control Software IPS-Digital-SSW / AUTARK

One single software will be sufficient for the control of the complete **IPS-Digital**® - network. All units of the **IPS-Digital**® - hardware are using this software. The following basic logic functions will be carried out:

⇒ Measured value- and failure evaluation
⇒ Adjustment of the response levels
⇒ Print out of all measuring data and failures
⇒ Acoustical and visual alarm or forwarding to **PFA**
⇒ Calibration of different kind of sensors, that means kind of wire
⇒ Automatic, software-based detection of failure spots
⇒ Central, menu-driven operation and control of the complete equipment
⇒ Direct evaluation of data and plain text announcement of the pipeline condition
⇒ Automatic recognition of kind of measuring station in mixed equipment
⇒ Archive of measuring data and failures incl. date and time (time-stamp)
⇒ Passing-on alert for IPS-Man-hole water sensor (**ST3000 - AUTARK**)

Optional extension with **VISUAL** will be possible. In order to guarantee an optimal operation, the central and standard desktop computer or notebook should fulfil the following minimum configurations:

Operating system:	Windows® NT, XP, 2000 and more actual
Processor:	> 400 MHz preferable
Working memory:	≥ 64 MB RAM
Free hard disk:	ca. 150 MB, incl. Archive
Graphics:	≥ 800 x 600 Pixel / 256 colours
Drive:	CD-Rom / CD-burner
COM-Port:	1 x RS 232 or USB 1.1/2.0
Sound card:	yes, in case that acoustic signal will be required
Printer:	Printout via commercial printers

Edition: 16.01.2012

Fault Visualisation IPS-Digital-VISUAL

This extension module will be used for presentation of the detected failure spots in the pipeline design. Because of this an enormous simplification concerning the determination of failure spots in expanded pipeline networks will be reached. The module, which will get the required data for presentation from the control software **SSW**, is working on the basis of Bitmap-data (BMP/Tiff).

By simple scanning it will be possible to use also older drawings, which have been not established by CAD. **VISUAL** can be also used with other detecting systems, because a manual input of determined detection data will be possible. The following basic functions will be carried out by **VISUAL**:

⇒ Lens function
⇒ Indication of failure spot
⇒ Mouse controlled menu-guidance
⇒ Coloured codification of single channels
⇒ Automatic data transfer **SSW**
⇒ Manual failure detection input in case of foreign systems
⇒ In mixed systems with **IPS-Cu**® and **IPS-NiCr**® usable
⇒ Indication of the failure spot and the neighbouring digitizing spots
⇒ Indication of drawings with maximum 2036 x 1442 pixels at 256 grey grades

In order to guarantee an optimal operation, the central and standard desktop computer or notebook should fulfil the following minimum configurations:

Operating system:	Windows® NT, XP, 2000 and more actual
Processor:	> 400 MHz preferable
Working memory:	≥ 64 MB RAM
Free hard disk:	ca. 150 MB, incl. Archive
Graphics:	≥ 1024 x 768 Pixel / 256 colours
Drive:	CD-Rom / CD-Burner
COM-Port:	1 x RS 232 or USB 1.1/2.0
Sound card:	yes, in case that acoustic signal will be required
Printer:	Printout via commercial printers

8.5.1 IPS-VE10 / IPS-PAF / IPS-KAF / IPS-MSP

Wire End Piece IPS-VE 10

House- resp. wiring-end-point for installation of the continuous sensor-loop at calibration spots, respectively in buildings, or as connection with signal wires to all other IPS-system components. One piece per pipeline end, installed at PEHD-jacket-pipe.

Potential Connection Sensor IPS-PAF

For a safe and permanent welded earth connection to the carrier pipe. One piece per pipeline end at location of the IPS-units.

Cable Exit IPS-KAF

As loop-wire separation in pressure water tight and strain-relieved execution for welding in the PEHD-socket-pipe of weldable couplers, consisting of a PEHD-pipe Ø 63 mm, PN 10, 150 mm long. An annulus sealing, a shrinkable end cap as well as an expansion pad plate 240 x 240 x 80 mm for protection against axial movement will be included in the delivery.

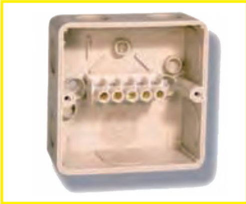
Measuring Point Post IPS-MSP

For installation of a surface- and connection point outside of buildings, consisting of a yellow, powder-coated 10.000 V disruptive strength aluminium pipe (ALMgSi). Outside diameter 100 mm, delivery length = 2,00 m, with end cap and spread anchor for site fastening, approx. 70 cm depth, in soil or foundation. Delivery incl. of a triangular crank-key and a fixing plate for a DIN-identification sign.

Edition: 16.01.2012

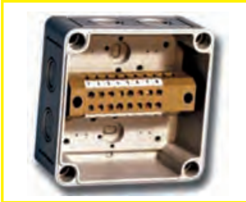
8.5.2 IPS-VD-Cu / IPS-VD-NiCr / IPS-TPD

Wiring Box IPS-VD-Cu



For jumping and distributing of measure and sensor wires at **IPS-Cu**® or technical comparable systems. Polycarbonate box in moisture-proof execution with 5-pole block binder, 1 piece per pipeline pair.
Protection class: IP 65

Wiring Box IPS-VD-NiCr / Digital



For jumping and distributing of measure and sensor wires at **IPS-NiCr**® or technical comparable systems. Polycarbonate box in moisture-proof execution with numbered 8-pole block binder, 1 piece per pipeline pair.
Protection class: IP 65

Bottom Point Sensor Box IPS-TPD

For connection of the sensor wire as bottom point monitoring, respectively flooding indicator in buildings, manholes or channels. Switchable as close open contact, consisting of a single wiring box with integrated float switch. One piece per pipeline pair.

8.5.3 IPS-MD / IPS-MPD / IPS-ID-Cu

Measure Box IPS-MD

For installation of a measuring point at **IPS-Cu**® as well as **IPS-NiCr**® oder or technical comparable systems. Connection with the several pole-plug of an **HST** or with other pin-compatible measuring units for manual check of the pipeline will be possible. In moisture-proof execution, preferable one piece per pipeline.
Protection class: IP 65

Measure Point Box IPS-MPD

For installation of one or several measure points within a sensor circle at **IPS-Cu**® as well as **IPS-NiCr**® or technical comparable systems. For direct connection of a mobile-station **MBS** or other measuring units with 4 mm split plugs. Polycarbonate box in moisture-proof execution, preferable one piece per pipeline.
Protection class: IP 65

Impedance Wiring Box IPS-ID-Cu

For jumping and distributing of several impedance connection wires at **IPS-Cu®** or technical comparable systems. Polycarbonate box in moisture-proof execution. One piece per pipeline pair.
Protection class: IP 65

8.5.4 IPS-SK / IPS-IK / IPS-DK / IPS-EK

Sensor Connection Cable IPS-SK

For wiring of sensor wires with wiring boxes and monitoring units inside of buildings or manholes, type NYM 3 x 1,5 mm^2.

Only suitable for **IPS-NiCr®** within an **IPS-Digital®** - network. At **IPS-Cu®** the impedance connection cable **IPS-IK** has to be used.

Impedance Connection Cable IPS-IK

For correct impedance wiring of the sensor wires with wiring boxes and monitoring units inside of buildings and manholes, type 300 ohm (Ω).

Only suitable for **IPS-Cu®** within an **IPS-Digital®** - network. At **IPS-NiCr®** the sensor connection cable **IPS-SK** has to be used.

Data Transmitting Cable IPS-DK

For data connection of the measuring data acquisition station **IPS-MDS** with the individual measuring points **IPS-MS** within an **IPS-Digital®** - network, type J-Y (ST)Y ≥ 2 x 2 x 0,8 mm^2 or similar.

Earth Connection Cable IPS-EK

For buried wiring of the sensor wires at connection couplers with cable exit **IPS-KAF** and for relaying i. e. to a measuring point post **IPS-MSP**, type NYY 7 x 1,5 mm^2.

8.5.5 TV / MODEM / PFA / FSV

Data T-Distributor IPS Digital TV

With the **TV**, which simultaneously serves as a galvanized separator as well as data refresh, T- and star-shaped data grid structures can build up. Depending on demand, up to a maximum of six outputs can be switched. The option with one outlet is used as a pure power enhancer in very long data strings.

In case of a direct, star-shaped distribution from the main office, the **TV** can also be integrated directly into a measured data acquisition system **MDS** with up to a maximum of three outputs.

Modem Extension IPS-Digital-MODEM

As an expansion module for the **MS** measuring points, the **MODEM** enables data transmission to the **MDS** via an analog or digital (ISDN) telephone dial-up connection. During this process, fixed data lines are dropped and individual **MS** or whole groups of **MS** must be controlled by an individual **MODEM**.
Supply islands distant from the monitoring control center with fixed data transmission can also be connected via the **MODEM** and centrally recorded.
The **MODEM** is available as an extra device to retrofit existing systems. For new systems, this expansion can optionally be directly integrated into the **MS**.

Alarm Module IPS-Digital-PFA

Expansion module with integrated, potential-free output.

Distant Voltage Supply IPS-Digital-FSV

The **FSV** serves to supply individual **MS** via the data line or other appropriate cables. One or multiple separate wires will be connected together independently of the line cross-section and the distance between the **FSV** and **MS**. Parallel operation in a data cable without significant impairment of functionality is possible if DC voltage of max. 30 V is used.

Technical parameter see data sheet, **chapter 8.6.2**

8.6.1 Analog

isoplus - Device Type IPS-	**HST**	**ST 3000**	**ST 3000 - AUTARK**	**MSG 500**	**MSG 1000**
Page	8.4.1	8.4.1	8.4.1	8.4.1	8.4.1
Monitoring manually / automatically	√ / -	- / √	√ / √	√ / √	√ / √
Detection Cu / NiCr	-	-	-	- / √	- / √
Measurement (L x B x H) in mm	230 x 85 x 35	215 x 245 x 115	150 x 300 x 80	230 x 85 x 35	230 x 85 x 35
Weight in kg	0,5	2,0	3,0	0,5	0,5
Casing	Aluminium diecasting	Polycarbonate	Steel plate	Aluminium diecasting	Aluminium diecasting
Powder coated and dip-impregnated	-	-	√	-	-
Operating temperature	0 °C to + 40 °C	+ 5 °C to + 40 °C	- 20° C to + 50° C	0 °C to + 40 °C	0 °C to + 40 °C
Temperature for guaranteed exactness	+ 20 °C ± 8 °C	+ 20 °C ± 8 °C	+ 20° C ± 8° C	+ 20 °C ± 8 °C	+ 20 °C ± 8 °C
Store- resp. ambient temperature	- 10 °C to + 50 °C	- 10 °C to + 50 °C	- 10° C to + 50° C	- 10 °C to + 50 °C	- 10 °C to + 50 °C
Humidity until + 31° C	max. 80 %	max. 80 %	max. 80 %	max. 80 %	max. 80 %
Akku- / Battery Voltage	9 V	-	3,6 V / 12 Ah	9 V	9 V
Akku- / Battery type	6LR61 (9V Block)	-	$Li-SoCl_2$	6LR61 (9V Block)	6LR61 (9V Block)
230 V ± 10 % / 50 Hz net voltage	-	√	- / √	√	√
Euro-plug connection	-	√	- / √	√ / Plug-power-pack	√ / Plug-power-pack
Fuse	-	250 V / T 315 AL	250 V / T 100 mA	-	-
Power consumption operation / standby	35 mA / -	8 VA / -	4,5 VA / 2 VA	35 mA / -	35 mA / -
Consump. per year at 1 measurement per day	-	30 kWh	17 kWh	-	-
Protection Class	III	I	I	III	III
Kind of protection	-	IP 54	IP 66	-	-
Measuring category	I	I	I	I	I
Potential Free Relay Contact	-	Opener / Turnkey	-	Opener	Opener
Contact carrying capacity	-	30 V / 1 A	-	30 V / 1 A	30 V / 1 A
RS 485 - Interface Input / Output	-	-	-	-	-
Voltage level maximum	-	-	0 / 10 V	-	-
Data cable length maximum to MS / MDS	-	-	-	-	-
Data rate 2400 - 38400 baud	-	-	9600 baud	-	-
Automatic selection	-	-	-	-	-
Half duplex transmission at 2-wire RS 485	-	-	-	-	-
Full duplex transmission at 4-wire RS 485	-	-	-	-	-
RS 232 - Interface Input	-	-	-	-	-
Voltage level maximum	-	-	-	-	-
Data cable length maximum to PC	-	-	-	-	-
Data rate 2400 - 38400 baud	-	-	-	-	-
Measure Entries / -Channels	1	1, 2, 3 or 4	2 / 4	1	1
Voltage strength of entries	1.000 Veff	1.000 Veff	-	1.000 Veff	1.000 Veff
Maximum Cu-sensor wire per channel	2.500 m	2.500 m	2.500 m	-	-
Recommended max. Cu-wire lengths / channel	2.500 m	2.500 m	1.000 m	-	-
Maximum NiCr-sensor wire per channel	1.400 m	1.400 m	600 / 1.200 m	500 m	1.300 m
Recomm. max. NiCr-wire lengths per channel	1.200 m	1.200 m	500 / 1.000 m	500 m	1.300 m
Isolation Resistance Measurement	√	√	√	√	√
Measuring range	10 kΩ to 40 MΩ	10 kΩ to 2,5 MΩ	20 kΩ to 20 MΩ	10 kΩ to 10 MΩ	10 kΩ to 10 MΩ
Dissolution	1 kΩ / 10 kΩ / 100 kΩ	10 kΩ / 100 kΩ	10 kΩ	1 kΩ / 10 kΩ / 100 kΩ	1 kΩ / 10 kΩ / 100 kΩ
Measuring voltage maximum	12 V	12 V	10 V	12 V	12 V
Measuring current maximum	3 mA	1 mA	10 mA	3 mA	3 mA
Exactness	± 3 % ± 1 Digit	± 3 % ± 1 Digit	± 3%	± 3 % ± 1 Digit	± 3 % ± 1 Digit
Alarm threshold value "Isolation" adjustable	√	√	am Gerät	√	√
Alarm threshold value from / to in steps	10 kΩ to 39,9 MΩ	20 kΩ to 2,5 MΩ	20 kΩ to 2,5 MΩ	200 kΩ to 10 MΩ	200 kΩ to 10 MΩ
Loop Resistance Measurement	√	√	√	√	√
Measuring range	0 Ω to 8 kΩ	0 Ω to 8 kΩ	0 Ω to 7 kΩ	0 Ω to 2,85 kΩ	0 Ω to 7,40 kΩ
Dissolution	1 Ω	100 kΩ	1 Ω	1 Ω	1 Ω
Voltage level maximum	12 V	12 V	10 V	12 V	12 V
Measuring current maximum	5 mA	1 mA	10 mA	5 mA	5 mA
Exactness	± 0,5 % ± 1 Digit	± 0,5 % ± 1 Digit	1%	± 0,2 % ± 1 Digit	± 0,2 % ± 1 Digit
Alarm threshold value "Loop" adjustable	8 kΩ solid	8 kΩ solid	-	8 kΩ solid	8 kΩ solid
Impulse Running Period Measurement	-	-	-	-	-
Dissolution / Exactness	-	-	-	-	-
Voltage level maximum	-	-	-	-	-
Pulse wave shape	-	-	-	-	-
Impulse running period adjustable from / to (V/2)	-	-	-	-	-
Direct Voltage Measurement (DC)	-	-	-	√	√
Measuring range	-	-	-	± 2 V	± 2 V
Exactness	-	-	-	0,01 V	0,01 V
Dissolution	-	-	-	± 0,6 %	± 0,6 %
Alternating Voltage Measurement (AC)	-	-	-	-	-
Measuring range	-	-	-	-	-
Exactness	-	-	-	-	-
Dissolution	-	-	-	-	-
USB-Interface	-	-	-	-	-
Power distant supply voltage maximum	-	-	-	-	-
Working range power distant supply	-	-	-	-	-
Addressability standard / extended	-	-	-	-	-
Radio interface / GSM	-	-	√	-	-
TC / IP - Ethernet interface	-	-	-	-	-
isoplus - Device Type IPS-	**HST**	**ST 3000**	**ST 3000 - AUTARK**	**MSG 500**	**MSG 1000**

8.6.2 Digital

isoplus - Device Type IPS-	Digital-MDS	Digital-Cu-MS	Digital-NiCr-MS	Digital-Cu-MBS	Digital-NiCr-MBS	Digital-UNI-MBS
Page	8.4.2	8.4.2	8.4.2	8.4.2	8.4.2	8.4.2
Monitoring manually / automatically	- / √ [1]	- / √ [2]	- / √ [2]	√ / √	√ / √	√ / √
Detection Cu / NiCr	-	√ / -	- / √	√ / -	- / √	√ / √
Measurement (L x B x H) in mm	150 x 150 x 80	150 x 300 x 80	150 x 300 x 80	410 x 490 x 180	410 x 490 x 180	410 x 490 x 180
Weight in kg	2,0	3,0	3,0	4,0 without PC	4,0 without PC	4,0 without PC
Casing	Steel plate	Steel plate	Steel plate	Plastic suitcase	Plastic suitcase	Plastic suitcase
Powder coated and dip-impregnated	√	√	√	-	-	-
Operating temperature	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C
Temperature for guaranteed exactness	-	+ 20° C ± 8° C	+ 20° C ± 8° C	+ 20° C ± 8° C	+ 20° C ± 8° C	+ 20° C ± 8° C
Store- resp. ambient temperature	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C
Humidity until + 31° C	max. 80 %	max. 80 %	max. 80 %	max. 80 %	max. 80 %	max. 80 %
Akku- / Battery Voltage	-	-	-	8,4 V / 1,7 Ah	8,4 V / 1,7 Ah	8,4 V / 1,7 Ah
Akku- / Battery type	-	-	-	NiCd	NiCd	NiCd
230 V ± 10 % / 50 Hz net voltage	√	√	√	√	√	√
Euro-plug connection	√	√	√	√	√	√
Fuse	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA
Power consumption operation / standby	2,5 VA / -	4,5 VA / 2 VA	8 VA / 2 VA	9 VA / -	9 VA / -	9 VA / -
Consump. per year at 1 measurement per day	21 kWh	17 kWh	17 kWh	17 kWh	17 kWh	17 kWh
Protection Class	I	I	I	I	I	I
Kind of protection	IP 66	IP 66	IP 66	-	-	-
Measuring category	-	I	I	I	I	I
Potential Free Relay Contact	Turnkey	-	-	-	-	-
Contact carrying capacity	48 V / 1 A	-	-	-	-	-
RS 485 - Interface Input / Output	0 / 1	1 / 1	1 / 1	-	-	-
Voltage level maximum	0 / 5 V	0 / 5 V	0 / 5 V	-	-	-
Data cable length maximum to MS / MDS	3.000 m	3.000 m	3.000 m	-	-	-
Data rate 2400 - 38400 baud	√	√	√	-	-	-
Automatic selection	√	√	√	-	-	-
Half duplex transmission at 2-wire RS 485	√	√	√	-	-	-
Full duplex transmission at 4-wire RS 485	√	√	√	-	-	-
RS 232 - Interface Input	1	-	-	1	1	1
Voltage level maximum	± 10 V	-	-	± 10 V	± 10 V	± 10 V
Data cable length maximum to PC	15 m	-	-	15 m	15 m	15 m
Data rate 2400 - 38400 baud	√	-	-	√	√	√
Measure Entries / -Channels	-	2 or 4	2 or 4	4	4	2 Cu + 2 NiCr
Voltage strength of entries	-	-	-	-	-	-
Maximum Cu-sensor wire per channel	-	2.500 m	-	2.500 m	-	2.500 m
Recommended max. Cu-wire lengths / channel	-	2.500 m	-	2.500 m	-	2.500 m
Maximum NiCr-sensor wire per channel	-	-	1.400 m	-	1.400 m	1.400 m
Recomm. max. NiCr-wire lengths per channel	-	-	1.200 m	-	1.200 m	1.200 m
Isolation Resistance Measurement	-	√	√	√	√	√
Measuring range	-	200 kΩ to 20 MΩ	1 kΩ to 20 MΩ	200 kΩ to 20 MΩ	1 kΩ to 20 MΩ	1 kΩ to 20 MΩ
Dissolution	-	1 kΩ / 100 kΩ	1 kΩ	1 kΩ / 100 kΩ	1 kΩ	1 kΩ
Measuring voltage maximum	-	5 V	10 V	5 V	10 V	10 V
Measuring current maximum	-	20 mA	20 mA	20 mA	20 mA	20 mA
Exactness	-	± 3 %	± 0,01 %	± 3 %	± 0,01 %	± 0,01 %
Alarm threshold value "Isolation" adjustable	-	-	via control software	-	via control software	via control software
Alarm threshold value from / to in steps	-	-	1 MΩ to 10 MΩ	-	1 MΩ to 10 MΩ	1 MΩ to 10 MΩ
Loop Resistance Measurement	-	-	√	-	√	√
Measuring range	-	-	0 Ω to 8 kΩ	-	0 Ω bis 8 kΩ	0 Ω bis 8 kΩ
Dissolution	-	-	1 Ω	-	1 Ω	1 Ω
Voltage level maximum	-	-	10 V	-	10 V	10 V
Measuring current maximum	-	-	20 mA	-	20 mA	20 mA
Exactness	-	-	± 0,02%	-	± 0,02%	± 0,02%
Alarm threshold value "Loop" adjustable	-	-	automatic	-	automatic	automatic
Impulse Running Period Measurement	-	√	-	√	-	√
Dissolution / Exactness	-	0,5 m / 0,2 %	-	0,5 m / 0,2 %	-	0,5 m / 0,2 %
Voltage level maximum	-	0 / 5 V to 270 Ω	-	0 / 5 V to 270 Ω	-	0 / 5 V to 270 Ω
Pulse wave shape	-		-		-	
Impulse running period adjustable from / to (V/2)	-	90 to150 m/μs	-	90 to 150 m/μs	-	90 to 150 m/μs
Direct Voltage Measurement (DC)	-	√	√	√	√	√
Measuring range	-	± 2 V	± 2 V	± 2 V	± 2 V	± 2 V
Exactness	-	0,01 V	0,01 V	0,01 V	0,01 V	0,01 V
Dissolution	-	± 3 %	± 0,2 %	± 3,0 %	± 0,2 %	± 0,2 %
Alternating Voltage Measurement (AC)	-	√	√	√	√	√
Measuring range	-	2 Vss	2 Vss	2 Vss	2 Vss	2 Vss
Exactness	-	± 3 %	± 0,2 %	± 3,0 %	± 0,2 %	± 0,2 %
Dissolution	-	0,01 V	0,01 V	0,01 V	0,01 V	0,01 V
USB - Interface	√ / via adapter	-	-	√ / via adapter	√ / via adapter	√ / via adapter
Power distant supply voltage maximum	-	-	-	-	-	-
Working range power distant supply	-	-	-	-	-	-
Addressability standard / extended	-	16- / 32-fold	16- / 32-fold	16-fold	16-fold	16-fold
Radio interface / GSM	-	-	-	-	-	-
TC / IP - Ethernet interface	-	possible	possible	-	-	-
isoplus - Device Type IPS-	**Digital-MDS**	**Digital-Cu-MS**	**Digital-NiCr-MS**	**Digital-Cu-MBS**	**Digital-NiCr-MBS**	**Digital-UNI-MBS**

(1) only in connection with **IPS-Digital®-Cu-MS** and / or **IPS-Digital®-NiCr-MS**

(2) only in connection with **IPS-Digital®-MDS**

isoplus - Device Type IPS-	Digital-Cu-KMS	Digital-NiCr-KMS	Digital-TV	Digital-MODEM	Digital-PFA	Digital-FSV
Page	8.4.2	8.4.2	8.5.5	8.5.5	8.5.5	8.5.5
Monitoring manually / automatically	- / √	- / √	-	-	- / √ (1)	-
Detection Cu / NiCr	√ / -	- / √	-	-	-	-
Measurement (L x B x H) in mm	150 x 300 x 80	150 x 300 x 80	150 x 150 / 300 x 80	150 x 150 x 80	150 x 150 x 80	150 x 150 x 80
Weight in kg	3,0	3,0	2,0 / 3,0	2,0	2,0	2,0
Casing	Steel plate	Steel plate	Steel plate	Steel plate	Steel plate	Steel plate
Powder coated and dip-impregnated	√	√	√	√	√	√
Operating temperature	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C	- 20° C to + 50° C
Temperature for guaranteed exactness	+ 20° C ± 8° C	+ 20° C ± 8° C	-	-	-	-
Store- resp. ambient temperature	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C	- 10° C to + 50° C
Humidity until + 31° C	max. 80 %	max. 80 %	max. 80 %	max. 80 %	max. 80 %	max. 80 %
Akku- / Battery Voltage	-	-	-	-	-	-
Akku- / Battery type	-	-	-	-	-	-
230 V ± 10 % / 50 Hz net voltage	√	√	√	√	√	√
Euro-plug connection	√	√	√	√	√	√
Fuse	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA	250 V / T 100 mA
Power consumption operation / standby	4,5 VA / 2 VA	8 VA / 2 VA	2,5 VA / -	4 VA / -	2,5 VA / -	10 VA / -
Consump. per year at 1 measurement per day	17 kWh	17 kWh	21 kWh	15 kWh	17 kWh	30 kWh
Protection Class	I	I	I	I	I	I
Kind of protection	IP 66	IP 66	IP 66	IP 66	IP 66	IP 66
Measuring category	I	I	-	-	-	-
Potential Free Relay Contact	Turnkey	Turnkey	-	-	Turnkey	-
Contact carrying capacity	48 V / 1 A	48 V / 1 A	-	-	48 V / 1 A	-
RS 485 - Interface Input / Output	-	-	1 / 1 bis 6	0 / 1	0 / 1	-
Voltage level maximum	-	-	0 / 5 V	0 / 5 V	0 / 5 V	-
Data cable length maximum to MS / MDS	-	-	3.000 m	3.000 m	3.000 m	-
Data rate 2400 - 38400 baud	-	-	√	√	√	-
Automatic selection	-	-	√	√	√	-
Half duplex transmission at 2-wire RS 485	-	-	√	√	√	-
Full duplex transmission at 4-wire RS 485	-	-	√	√	√	-
RS 232 - Interface Input	1	1	-	-	1	-
Voltage level maximum	± 10 V	± 10 V	-	-	± 10 V	-
Data cable length maximum to PC	15 m	15 m	-	-	15 m	-
Data rate 2400 - 38400 baud	√	√	-	-	√	-
Measure Entries / -Channels	2 or 4	2 or 4	-	-	-	-
Voltage strength of entries	-	-	-	-	-	-
Maximum Cu-sensor wire per channel	2.500 m	-	-	-	-	-
Recommended max. Cu-wire lengths / channel	2.500 m	-	-	-	-	-
Maximum NiCr-sensor wire per channel	-	1.400 m	-	-	-	-
Recomm. max. NiCr-wire lengths per channel	-	1.200 m	-	-	-	-
Isolation Resistance Measurement	√	√	-	-	-	-
Measuring range	200 KΩ to 20 MΩ	1 kΩ to 20 MΩ	-	-	-	-
Dissolution	1 kΩ / 100 kΩ	1 kΩ	-	-	-	-
Measuring voltage maximum	5 V	10 V	-	-	-	-
Measuring current maximum	20 mA	20 mA	-	-	-	-
Exactness	± 3 %	± 0,01 %	-	-	-	-
Alarm threshold value "Isolation" adjustable	-	via control software	-	-	-	-
Alarm threshold value from / to in steps	-	1 MΩ to 10 MΩ	-	-	-	-
Loop Resistance Measurement	-	√	-	-	-	-
Measuring range	-	0 Ω to 8 kΩ	-	-	-	-
Dissolution	-	1 Ω	-	-	-	-
Voltage level maximum	-	10 V	-	-	-	-
Measuring current maximum	-	20 mA	-	-	-	-
Exactness	-	± 0,02%	-	-	-	-
Alarm threshold value "Loop" adjustable	-	automatic	-	-	-	-
Impulse Running Period Measurement	√	-	-	-	-	-
Dissolution / Exactness	0,5 m / 0,2 %	-	-	-	-	-
Voltage level maximum	0 / 5 V to 270 Ω	-	-	-	-	-
Pulse wave shape		-	-	-	-	-
Impulse running period adjustable from / to (V/2)	90 to 150 m/µs	-	-	-	-	-
Direct Voltage Measurement (DC)	√	√	-	-	-	-
Measuring range	± 2 V	± 2 V	-	-	-	-
Exactness	0,01 V	0,01 V	-	-	-	-
Dissolution	± 3 %	± 0,2 %	-	-	-	-
Alternating Voltage Measurement (AC)	√	√	-	-	-	-
Measuring range	2 Vss	2 Vss	-	-	-	-
Exactness	± 3 %	± 0,2 %	-	-	-	-
Dissolution	0,01 V	0,01 V	-	-	-	-
USB - Interface	√ / via adapter	√ / via adapter	-	-	-	-
Power distant supply voltage maximum	-	-	-	-	-	30 V
Working range power distant supply	-	-	-	-	-	ca. 1.800 m
Addressability standard / extended	16- / 32-fold	16- / 32-fold	-	-	-	-
Radio interface / GSM	-	-	-	-	-	-
TC / IP - Ethernet interface	-	-	-	-	-	-
isoplus - Device Type IPS-	**Digital-Cu-KMS**	**Digital-NiCr-KMS**	**Digital-TV**	**Digital-MODEM**	**Digital-PFA**	**Digital-FSV**

Edition: 16.01.2012

9 HANDLING UNDERGROUND WORK

Edition: 16.01.2012

9.1.1 Explanation to Underground Work

Excavation works have to be carried out corresponding to the general valid guidelines and standards for civil underground engineering. Parallel the communal different additional conditions as well as the AGFW-guidelines of the FW 401 regulations - part 12 have to be considered.

The pipe trenches have to be excavated by a competent civil underground engineering company acc. to DIN 18300, DIN EN 805, DIN EN 1610 and DIN 4124 and re-filled again acc. to section 3.09 and 3.11 of standard DIN 18300. Concerning the width of the trench section 5.2 of DIN 4124 has to be considered.

Whether pipe trenches should be scarped and at which depth they have to be constructed is also mentioned in standard DIN 4124 section 4.1 to 4.3, as well as the scarping angles for the different soil characteristics.

The laying depth respectively pipe-crown-covering height according to the projecting work and pipe-static has strictly to be meet. Section DIN EN 1610 will describe the structure of trench-sole. The total length of the sole has to be carried out stable and stone-free.

In order to secure the quality of the total system, the pipe layer will be responsible for draining the pipe trenches and to keep them free until all insulation works at the welding spots will be finished, according to DIN EN 1610.

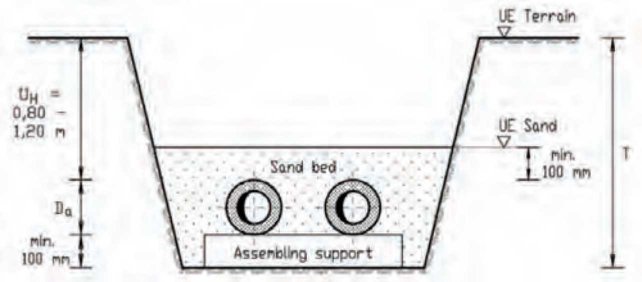
Contracted pipe trenches have to be shovelled free manually. The quality of all works and the expected life time of a district heating line are depending in a high degree from the excavation of the trenches in accordance to the DIN standard.

The measures of length of the **isoplus**-pipeline design are valid as axis measure for the trench excavation. The following described civil underground information has been especially proved practically, without claim for completeness. In case of special situations we ask you to contact the **isoplus**-assembling- respectively design engineers, who will work out special problem-solutions.

Edition: 16.01.2012

9.2.1 Trench Depth Main Line

The soil-depth [T] of the pipe trench will be calculated from the given covering height [$Ü_H$], the PEHD-jacket-pipe diameter [D_a] and the height of the pipe support respectively the sand bed. The standard covering height for pipe construction is 0,80 m (= frost-depth) up to 1,20 m.



Jacket-pipe-Ø **D_a** in mm	65	75	90	110	125	140	160	180	200	225	250	280	315	355
Covering height **$Ü_H$** in m	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80
Soil-depth **T** in m	0,97	0,98	0,99	1,01	1,03	1,04	1,06	1,08	1,10	1,13	1,15	1,18	1,22	1,26

Jacket-pipe-Ø **D_a** in mm	400	450	500	560	630	670	710	800	900	1000	1100	1200	1300	
Covering height **$Ü_H$** in m	0,80	0,80	0,80	0,80	0,90	0,90	1,00	1,00	1,20	1,20	1,20	1,20	1,20	isoplus
Soil-depth **T** in m	1,30	1,35	1,40	1,46	1,63	1,67	1,81	1,90	2,20	2,30	2,40	2,50	2,60	

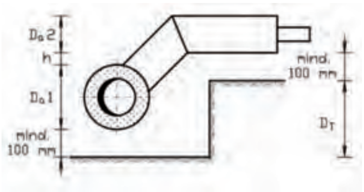
The value mentioned in the table are valid for the given covering heights and an assembling support of 0,10 m. In case of other covering heights the difference value of the mentioned covering height [$Ü_H$] has to be added or subtracted from the depth [T].

9.2.2 Trench Depth Branch Line

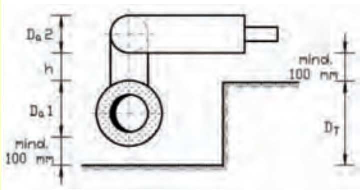
Due to manufacturing technical construction heights [h] at 45° T-branches and at parallel-branches the soil-depth [T] will change at the branch lines in correspondence with the difference measure [D_T]. Depending from installation position of the branch, topside or bottom side the measure D_T has to be added or subtracted from the main line depth [T].

The exact measure [h] can be seen from **chapter 2.2.8**.

45° T-Branch



Parallel-Branch

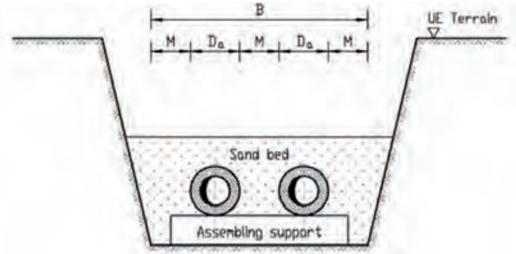


The difference measure [D_T] will be calculated acc. to the following formula:

Exit topside	⇒	$D_T = D_a1 + h$	[m]
Exit downside	⇒	$D_T = D_a2 + h$	[m]

9.2.3 Trench Width Standard

The soil-width [B] will be calculated in trench sections without expansion pads and without additional foreign lines like i. e. a parallel water line, the PEHD-jacket-pipe diameter [D_a] and the minimum assembling distance [M] depending from dimensions.



Jacket-pipe-Ø **D_a** in mm	65	75	90	110	125	140	160	180	200	225	250	280	315	355
Min. assembl. distance **M** in mm	100	100	150	150	150	150	200	200	200	200	200	300	300	300
Soil-width **B** in m	0,43	0,45	0,63	0,67	0,70	0,73	0,92	0,96	1,00	1,05	1,10	1,46	1,53	1,61

Jacket-pipe-Ø **D_a** in mm	400	450	500	560	630	670	710	800	900	1000	1100	1200	1300	isoplus
Min. assembl. distance **M** in mm	400	400	400	500	500	600	600	700	700	800	800	900	900	
Soil-width **B** in m	2,00	2,10	2,20	2,62	2,76	3,14	3,22	3,70	3,90	4,40	4,60	5,10	5,30	

The mentioned width [B] in the table is valid for two pipes of the same PEHD-jacket-pipe diameter. Because of this a sufficient assembling width for post insulation at the connection couplers as well as for the sand bed will be guaranteed. At the areas of the expansion pads the values according to **chapter 9.2.4** will be relevant.

In case that coupler-constructions like i. e. fitted electrical couplers will be installed, which are not included in the **isoplus**-performance range, the conditions of the corresponding supplier will be valid. For other applications, like i. e. in case of several pipes [x] the sole width [B] will be calculated according to the following formula:

$$B = x \bullet D_a + (x + 1) \bullet M \qquad [m]$$

9.2.4 Trench Width Expansion Pads Area

At the area of expansion pads at L-, Z- or U-elbows as well as at 45° T- and Parallel-branches the sole width [B] and the minimum distance [M] has to be enlarged. The widening is depending from the thickness of the expansion pads [DP_s] mentioned in the **isoplus**-trench-designs. The length of the enlargement is depending from the length of the given expansion pads [DP_L].

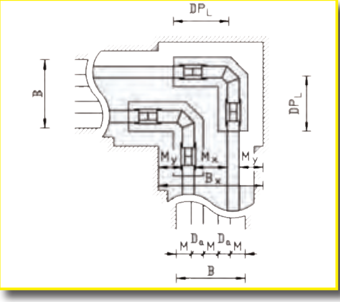
DP_L = Expansion pad length acc. to trench-design [m]

M_x = Minimum distance [M] + 2 • Expansion pad thickness [DP_s] acc. to trench design [mm]

M_y = Minimum distance [M] + 1 • Expansion Pad thickness [DP_s] acc. to trench design [mm]

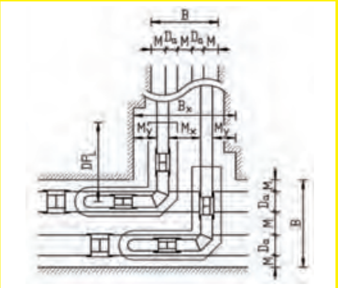
B_X = Total soil-width [m]

L-Elbow



B_X = $2 \bullet (D_a + M_y) + M_x$ [mm]

Parallel-Branch

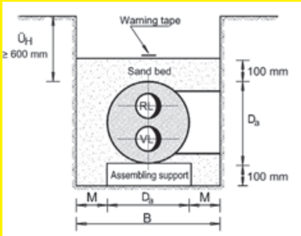


Edition: 16.01.2012

9.3.1 Trench Depth / Trench Width

Trench Depth

The soil-depth [T] of the pipe trench will be calculated from the given covering height [$Ü_H$], the PEHD-jacket-pipe diameter [D_a] and the height of the pipe support respectively the sand bed.



D_a in mm	125	140	160	180	200	225	250	280	315	355	400	450	500	560	630
Soil-depth **T** in m	0,825	0,840	0,860	0,880	0,900	0,925	0,950	0,980	1,015	1,055	1,100	1,150	1,200	1,260	1,330

The value mentioned in the table are valid for the given covering heights of 0,60 m and an assembling support of 0,10 m. In case of another covering height the difference-value to $Ü_H$ = 0,60 m has to be added or to subtract from the depth [T].

Trench Width

The soil-width [B] will be calculated from PEHD-jacket-pipe width [D_a] and the minimum assembling distance [M], depending from dimension.

D_a in mm	125	140	160	180	200	225	250	280	315	355	400	450	500	560	630
Min. assembl. dist. **M** in mm	150	150	150	150	150	200	200	200	200	200	200	300	300	300	300
Soil-width **B** in m	0,425	0,440	0,460	0,480	0,500	0,625	0,650	0,680	0,715	0,755	0,800	1,050	1,100	1,160	1,230

Due to the minimum values a sufficient assembling-width for post insulation at the connection couplers as well as for preparing the sand-bed will be guaranteed. In case that expansion pads will be required at branches or at direction-changes, the soil-width [B] has to be enlarged about 80 mm at a padding thickness of 40 mm as well as about 160 mm at a padding thickness of 80 mm. The values of the table are valid for an **isoplus**-double pipe. In case that more pipes [x] will be laid, the soil-width [B] will be calculated according to the following formula:

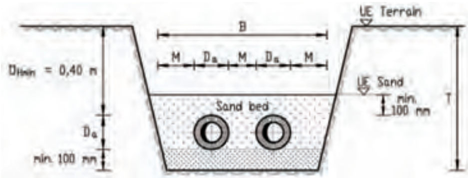
$B = x \bullet D_a + (x+1) \bullet M$ [m]

Edition: 16.01.2012

9.4.1 Trench Depth / Trench Width

Trench Depth

The soil-depth [T] of the pipe trench will be calculated from the given covering height [$Ü_H$], the PEHD-jacket-pipe diameter [D_a] and the height of the pipe support respectively the sand bed. The standard covering height for **isoplus** flex pipes is 0,40 m. The frost depth in Central Europe is 0,80 m.



D_a in mm	65	75	90	110	125	140	160	180	225	250
Soil-width **T** in m	0,565	0,575	0,590	0,610	0,625	0,640	0,660	0,680	0,725	0,750

The values mentioned in the table are valid for the given covering heights and a sand-bed respectively assembling support of 0,10 m. In case of other covering heights the difference value of the mentioned covering height $Ü_H$ = 0,40 m has to be added or subtracted from the depth [T].

Trench Width

The soil-width [B] will be calculated in trench sections without expansion pads and without additional foreign lines like i. e. a parallel water line, the PEHD-jacket-pipe diameter [D_a] and the minimum assembling distance [M] depending from dimensions. In case that expansion pads will be required for **isoflex** or **isocu** at alterations of direction or at branches, the distance [M] has to be enlarged about 80 mm.

D_a in mm	65	75	90	110	125	140	160	180	225	250
Min. assembl. dist. **M** in mm	100	100	100	100	100	100	100	100	150	150
Soil-width **B** in m	0,430	0,450	0,480	0,520	0,550	0,580	0,620	0,660	0,900	0,950

The mentioned width [B] in the table is valid for two pipes of the same PEHD-jacket-pipe diameter. For the pipe laying of double pipes this value will be calculated as follows:

$B_{\text{Double pipe}} = D_a + 2 \bullet M$ [m]

For other applications, like i. e. in case of several pipes [x] the sole width [B] will be calculated according to the following formula:

$B = x \bullet D_a + (x+1) \bullet M$ [m]

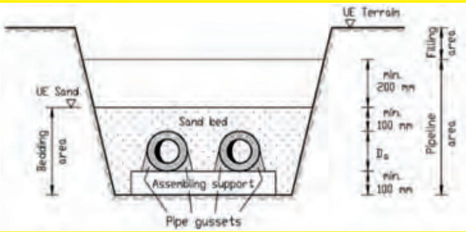
9.5.1 Sand Bed / Sand Structure / Limit of Grading Curve / Grain Size Distribution

Sand Bed

After the insulation and sealing works as well as after assembling of expansion pads, all kind of test procedures which are belonging to the performance range have to be carried out. Especially the following points have to be considered:

⇒ The pipeline guidance corresponds with the **isoplus**-trench-design
⇒ The static calculated covering heights have been strictly considered
⇒ Contracted soil, stones or/and foreign particles have to be removed from the area of the sand-bed respectively from the pipe area
⇒ The expansion pads are assembled in the given length and thickness and against soil an pressure
⇒ All couplers are foamed and recorded, the ducts to the buildings and houses are closed
⇒ In case of a thermal prestressing the given expansion movements and the corresponding temperatures have been reached and recorded
⇒ The monitoring system has been functionally tested and recorded

Before the sand-bed will be established, the trench has to be inspected and approved concerning the mentioned points by a responsible site-manager.



Thereafter the preinsulated jacket-pipe PJP, have to be re-filled carefully with at least 10 cm sand layers with a grain size of 0 - 4 mm (class NS 0/2), **see following page**. After that the sand should be compressed manually. The areas between the pipes and also at the pipe gussets should be especially considered, in order to avoid hollow spaces. These spaces have to be compressed and sealed especially in order to avoid not admissible settlements or movements later on. During these works eventually used supports have to be removed, in case that it will be no sand-sacks, which have to be cut-off, or hard foam supports.

In case that a washing away of the bedded sand cannot be excluded during the underground construction works, due to unfavourable conditions like heavy rain, the bedding area has to be covered by use of geo-textiles. This should be generally considered at locations on a slope respectively at precipitous inclines because of the draining effect of the trench profile. Because of the water quantity the water content of the sand will be above the optimum value of the proctor-curve, and will not fulfill the compressing degree, $D_{Pr} \geq 97$ %.

Edition: 16.01.2012

Here, the grain sizes are separated so that the target friction values at PJP are not achievable and the so-called „tunnel effect“ kicks in. For this reason, among other things, slurrying the sand is not classified as state-of-the-art in accordance with AGFW FW 401 - Part 12.

In the pipe zone, special requirements are placed on the friction between PEHD material and the quality of the sand. The resulting permanent friction conditions form the decisive basis for verification of the static and dynamic use of the PJP.

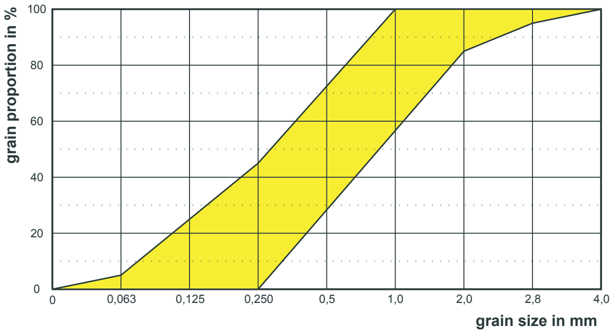
Should flowable bedding materials, such as self-stabilizing sand mixtures, SSM, or soil mortar be used, note that no long-term experience is available in terms of removing these with a simple device. There are no permanent and safeguarded test results available in practice for mechanical characteristics such as long-term friction behavior. General approval of these filling materials as road construction material has not yet been obtained through the German Forschungsgesellschaft für Straßen- und Verkehrswesen, FGSV (Resebend Association for Roads and Transportation). These have not been taken into account in the pipe static basics in accordance with AGFW FW 401 - Parts 10 + 11.

Replacement materials such as foam glass granules, crushed sand, recycled material, etc. are fundamentally not permitted in the pipe zone as bedding material or sand bed material.

Sand Structure in the Bedding Area

Sand bed height	⇒	all sides at least 100 mm
Kind of sand	⇒	Not binding medium up to rough sand
Grainsize	⇒	0 - 4 mm
Kind of Grain	⇒	round edged
Classification	⇒	Nature sand, NS 0/2
Norm	⇒	DIN 12620 resp. TL Min-StB (Technical delivery conditions for mineral materials in the road building)

Limit of Grading Curve acc. DIN EN 12620 of grain class 0/2



Grain Size Distribution acc. to DIN EN 12620

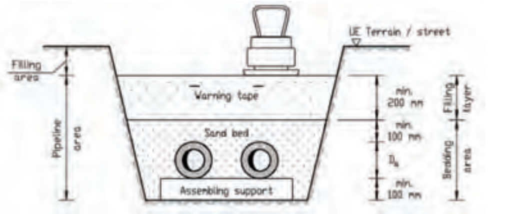
Rate of passage to 0,063 mm	⇒	± 5 %	Rate of passage to 1,0 mm	⇒	± 20 %
Rate of passage to 0,250 mm	⇒	± 25 %	Rate of passage to 2,0 mm	⇒	± 5 %

Edition: 16.01.2012

9.6.1 Re-Filling

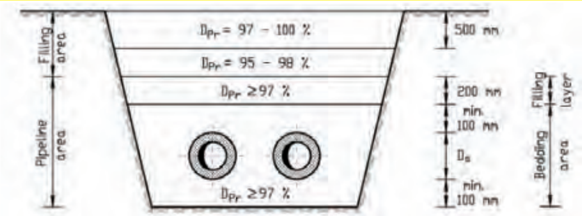
After finishing of the sand bed the trench can be filled with excavation material. The compressing should be carried out in layers. Rough and peaked stones should be removed. According to ZTV E - StB rough-graining soils up to a grain size of 20 mm have to be used as filling soil outside of the line area. Generally re-filling material according to DIN 18196, compressing class V 1 has to be used.

According to ZTV A - StB **in**sensitive soils against water and weather conditions have to be used for the trench filling of the filling area and the 20 cm filling-layer. In connection to this the ZTV E - StB allows also industrial recycling and recycling components, providing that the defined requirements like i.e. environment compatibility regarding water resources policy, compatibility with other building materials etc. as well as the requirements concerning compressing will be meet.



Filling and compressing of the trench has to be carried out simultaneously on both sides of the pipes. After filling of the 20 cm filling layer compressing machines like i. e. a surface compressor or an explosionram (weight up to 100 kg) may be used. The allowed area load is 40 N/cm^2 respectively 4 kg/cm^2 at a cold pipeline. In case that the pipeline should be already in operation, the area load will reduce to maximum 20 N/cm^2 respectively 2 kg/cm^2.

Further layers of 20 - 30 cm will be put on the first layer and a covering layer will finish the filling procedure. The requirements of the “Additional technical contract conditions and guidelines for excavations and soil-works of road constructions”, ZTV A and ZTV E, should additional used. The following degrees of compressing [D_{Pr}] should be reached in correspondence to ZTV E - StB.



Edition: 16.01.2012

9.6.2 Minimum Covering Height / Bridge Class

The influence of traffic loads on preinsulated jacket-pipes will increase in correspondence with the reducing of the covering height. Therefore the minimum covering heights in dependence of the bridge-classes and dimensions have been investigated and defined by independent material-test-institutes. Theoretically only extreme slight results could be proved.

In case of a secured superstructure at road construction the wheel load will spread over a larger area, as the wheel load will not effect directly on the filled soil, that means the preinsulated jacket-pipe will be less stressed.

The covering heights mentioned in the table have to be meet due to the danger of beaming and buckling of the preinsulated jacket-pipes, the spade-safety, sucking of vehicles in case of not secured surfaces as well as to the possible exceeding of the admissible ring-bending stress.

Bridge class	Single pipe Nominal Diameter in DN										
	20 - 125	150	200	250	300	350	400	450	500	550	600 - 1000
SLW 12	0,40	0,40	0,40	0,40	0,40	0,50	0,50	0,50	0,60	0,80	1,00
SLW 30	0,40	0,40	0,40	0,40	0,50	0,50	0,50	0,60	0,70	0,90	1,10
SLW 60	0,40	0,50	0,50	0,60	0,60	0,50	0,70	0,80	0,90	1,00	1,20

Bridge Class	Double pipe Nominal Diameter resp. type					All flex pipe types and dimensions
	to Dr-80	Dr-100	Dr-125	Dr-150	Dr-200	
SLW 12	0,40	0,40	0,40	0,40	0,40	0,40
SLW 30	0,40	0,40	0,40	0,40	0,50	0,40
SLW 60	0,40	0,50	0,50	0,60	0,60	0,40

Covering height in meter [m]

For big dimensions additional soil mechanical demonstrations respectively underground engineering static calculations are required. This includes the calculation of the circumference-bending-tension for pipes > DN 500 at heavy load traffic SLW 60, for pipes > DN 350 at railway and at road construction works with covering heights < 0,80 m. Calculation will be made according to ATV-working regulation A 127.

Bridge Class acc. to DIN 1072

Heavy-load traffic	Contract breadth the wheel	Wheel-load		Radius load-area	resulting load-area	calculated pressure [p] of load-area		resulting aquivalent surface load	
	in cm	in kN	in to	in cm	in cm^2	in N/cm^2	in kg/cm^2	in kN/m^2	to/m^2
SLW 12	30	40	4,08	18	1.017,88	39,30	4,01	6,70	0,68
SLW 30	40	50	5,10	20	1.256,64	39,79	4,06	16,70	1,70
SLW 60	60	100	10,19	30	2.827,43	35,37	3,61	33,30	3,39

Edition: 16.01.2012

9.6.3 Maximum Covering Height

The soil-load respectively soil pressure on the preinsulated jacket-pipes will increase in dependence with the increasing pipe-laying depth. Due to the admissible shearing strain respectively transverse stress [τ_{PUR}] between PEHD-jacket and PUR-hard foam respectively carrier pipe and foam, the covering height has to be limited, independent from operating temperature and the medium.

Dimensions carrier pipe			Single pipe						Double pipe			
			Jacket-Pipe Outside-Diameter D_a in mm			Maximum admissible Covering Height $Ü_H$ in m			Jacket-Pipe Outs.-Diameter-Ø D_a in mm		Max. admissible Covering Height $Ü_H$ in m	
Nominal Diameter in **DN**	Outside-Ø d_a in mm	W. thick. **s** in mm **isoplus**	Insulation Thickness			Insulation Thickness			Insulation Thickness		Insulation Thickness	
			Standard	**1x reinf.**	**2x reinf.**	**Standard**	**1x reinf.**	**2x reinf.**	**Standard**	**1x reinf.**	**Standard**	**1x reinf.**
20	26,9	2,6	90	110	125	2,10	1,70	1,45	125	140	1,70	1,50
25	33,7	3,2	90	110	125	2,65	2,15	1,85	140	160	1,90	1,65
32	42,4	3,2	110	125	140	2,70	2,35	2,10	160	180	2,10	1,85
40	48,3	3,2	110	125	140	3,10	2,70	2,40	160	180	2,40	2,15
50	60,3	3,2	125	140	160	3,40	3,00	2,60	200	225	2,40	2,10
65	76,1	3,2	140	160	180	3,85	3,35	2,95	225	250	2,60	2,40
80	88,9	3,2	160	180	200	3,90	3,45	3,10	250	280	2,70	2,40
100	114,3	3,6	200	225	250	4,00	3,50	3,15	315	355	2,75	2,40
125	139,7	3,6	225	250	280	4,35	3,90	3,45	400	450	2,60	2,30
150	168,3	4,0	250	280	315	4,70	4,15	3,65	450	500	2,70	2,40
200	219,1	4,5	315	355	400	4,80	4,25	3,70	560	630	2,75	2,40
250	273,0	5,0	400	450	500	4,65	4,10	3,65	---	---	---	---
300	323,9	5,6	450	500	560	4,90	4,35	3,85	---	---	---	---
350	355,6	5,6	500	560	630	4,80	4,25	3,70	---	---	---	---
400	406,4	6,3	560	630	670	4,90	4,25	3,95	---	---	---	---
450	457,2	6,3	630	670	710	4,85	4,50	4,20	---	---	---	---
500	508,0	6,3	670	710	800	5,05	4,70	4,10	---	---	---	---
600	610,0	7,1	800	900	1000	5,00	4,35	3,80	---	---	---	---
700	711,0	8,0	900	1000	---	5,10	4,50	---	---	---	---	---
800	813,0	8,8	1000	1100	---	5,20	4,65	---	---	---	---	---
900	914,0	10,0	1100	1200	---	5,25	4,75	---	---	---	---	---
1000	1016,0	11,0	1200	1300	---	5,30	4,80	---	---	---	---	---
isoflex	20	2,0	75	---	---	1,85	---	---	---	---	---	---
isoflex	28	2,0	75	90	---	2,65	2,20	---	110	---	1,50	---
isocu	22	1,0	65	---	---	2,40	---	---	90	---	2,00	---
isocu	28	1,2	75	---	---	2,65	---	---	90	---	2,50	---
isopex and isoclima	20	2,0	---	---	---	---	---	---	75	---	2,20	---
	25	2,3	75	90	---	2,35	1,95	---	90	110	2,25	1,85
	32	2,9	75	90	---	3,05	2,50	---	110	125	2,40	2,10
	40	3,7	90	110	---	3,15	2,55	---	125	140	2,55	2,35
	50	4,6	110	125	---	3,20	2,80	---	160	180	2,50	2,25
	63	5,8	125	140	---	3,55	3,15	---	180	---	2,75	---
	75	6,8	140	160	---	3,80	3,30	---	---	---	---	---
	90	8,2	160	180	---	3,95	3,50	---	---	---	---	---
	110	10,0	180	---	---	4,30	---	---	---	---	---	---
	125	11,4	180	225	---	4,90	3,90	---	---	---	---	---
	160	14,6	250	---	---	4,65	---	---	---	---	---	---

ATTENTION: The values mentioned in the table are valid for soils with a specific weight of 19 kN/m^3, an inner soil-friction angle [φ] of 32,5° and for steel wall thickness according to **isoplus**, see **chapter 2.2 and 2.3**. Outside of the expansion pad areas respectively expansion branches, according AGFW FW 401, part 10 and EN 253, admissible shearing strain τ_{PUR} = ≤ **0,04** N/mm^2.

Edition: 16.01.2012

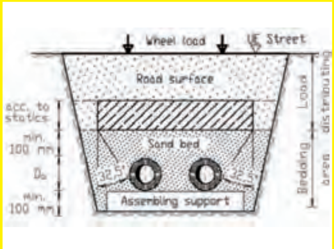
9.6.4 Load Distributing Plate

In case of lowering the minimum covering height respectively exceeding of the maximum covering height, civil underground technical safety measures have to be considered. These should be suitable to secure the preinsulated jacket-pipes against not admissible overloads of the crown-pressure, maximum 20 N/cm² respectively 2 kg/cm².

As possible load-distributors steel plates which have to be protected against corrosion, or steel-concrete-plates, concrete class B25 can be installed. Both kinds should be at least 100 cm longer as the area of the PJP pipeline which has to be protected. A construction static-engineer has to determine the exact thickness, the reinforcement and the eventual required foundations. Before the execution the approval from the **isoplus**-design engineers will be required.

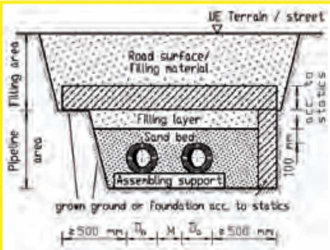
Distributing Plate

These are used for separating of high lumped loads (traffic loads) in case of lowering of the minimum covering height.
Distributing plates should be wide enough to reach with their load-distributing-angle of 32,5° the area outside of the preinsulated jacket-pipe.



Recover Plate

Recovering plates will be suitable for separating of high area-loads (traffic- and soil-loads) in case of exceeding of the maximum covering height. These should bear solid at both sides, that means along the trench length on grown ground. In case that this cannot be guaranteed, additional continuous- or point-footing have to be established. The plate should be at least 50 cm wider than the area which has to be covered.



Edition: 16.01.2012

9.7.1 Building Site - Quality Assurance

For building site it will be necessary to provide a guideline for a quality performance of the single working steps, in order to reach an optimization of the installing situation for preinsulated jacket pipes. This guideline will be valid in the same manner for civil underground engineering, pipe layer and pipe manufacturer. The most important test parameters are listed chronologically in the following table in accordance with the construction progress:

Working step	Execution and result
Functional check and co-ordination of the tools for the relevant working steps	- Professional work can be only reached with suitable tools
Checking of trench measures: Trench width and trench depth according to pipe dimensions	- Creating of optimal working conditions for pipe layer and coupler assemblers; working clearance at the areas of elbows, expansion pads and coupler connections
Check of trench execution	- Creating of a stone-free and plain laying bottom, with lateral trench security and water and mud-free assembling areas, during the total construction period
Trench filling - Sand filling	- Stone free covering with sand, at least 10 cm thick around of the preinsulated PEHD-jacket-pipe, squared timber have to be removed before filling, Sand grain 0 - 4 mm (class NS 0/2), consider particle-size curve exactly
Trench filling - Filling material	- Stone free not binding compressing suitable material will be filled in layers

See **isoplus**-Assembly-Term - **chapter 11.5.2**

10 HANDLING PIPE CONSTRUCTION

10.1.1 Transport / Unloading / Storage

Transport

isoplus-pipes and components as well as accessories will be delivered by truck to building site respectively to the material storage. The traffic route has to be suitable for heavy-load-traffic as well as for trucks with 12 m respectively 16 m loading area.

Before delivery the pipe ends will be closed with yellow caps for protection reasons. These protection caps should remain on the pipe ends until the assembling. Also in case of unloading of the **isoplus**-pipes, the caps may not be removed. Additionally it should be considered that the pipes will be loaded longitudinal and even.

The loading area of the trucks has to be checked concerning any rigid- and bearing out parts. If necessary such parts have to be removed in order to avoid damages of the pipes and especially of the PEHD-jacket pipe.

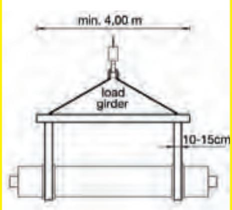
All couplers and shrinkable material as well as all accessories like end caps, sealing rings etc. will be delivered in protecting envelopes or/and cardboards. Also these cardboards may not be removed or damaged before beginning of the assembling works.

Unloading

Unloading of trucks will be carried out by the pipe layer or by third parties. During this the safety regulations of all relevant regulations for preventing of accidents have to be considered. All **isoplus**-pipes, components and accessories have to be unloaded correctly and material-friendly, and may not thrown from the loading area.

At arrival of the material it has to be checked concerning any external damages. The completeness of the delivery has to be checked and recorded. Any damages have to be marked resp. registered clearly on the delivery papers.

Smaller dimensions and accessories should be preferable unload manually. In case of bigger dimensions the unloading will be carried out by use of a crane which should be provided. For that two textile- or nylon belts 10-15 cm wide, with a load-beam of at least 4 m length or a truck with reacher should be used, for 12 m and 16 m pipe bars generally.



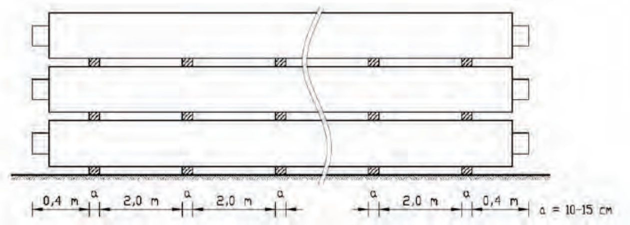
Because of this a not admissible bending and damage of the pipes, as well as a possible break of integrated systems, like leak detecting wires will be avoided.

Pulling and rolling on the ground as well as the use of steel ropes or chains is not permitted. Rough and uneven ground will cause scrapes and pressure marks at the jacket-pipe.

Edition: 16.01.2012

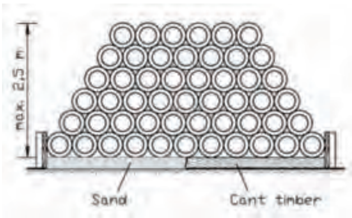
Storage

isoplus-pipe bars and components have to be stored on stone-free and dry areas, separated by dimensions. Water stemming soils and groundwater endangered soils should be avoided. Sand sacks or timber-squares will be used as support for the pipe bars. Depending from dimension these should be between 10 and 15 cm wide and should be placed in a distance of approx. 2,00 m each. Crown pressure at jacket should not exceed 40 N/cm^2 respectively 4 kg/cm^2.

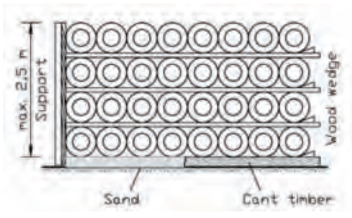


For safety reasons the height of pile should be limited to maximum 2,50 m. Conical or squared pipe-piles may be used. The pipes have to be generally protected against lateral slipping, by use of supports, pegs or wooden wedges.

Conical form



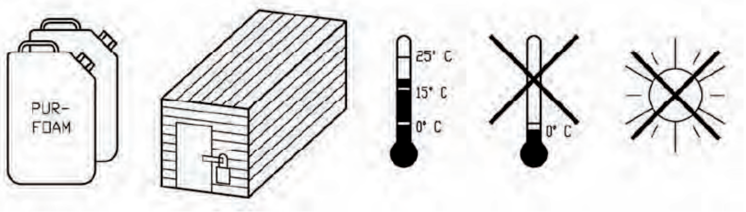
Cuboid form



In case that the storage should last for a longer period, corresponding protection measures against all kind of weather conditions have to be provided. During a frost period the **isoplus**-pipes, -components and -accessories have to be protected against inexpert handling like stroke- and shock effect, bending etc.

Edition: 16.01.2012

Accessories and incidentals like couplers, shrinkable sleeves, end caps, expansion pads etc. have to be as well stored sorted, dry, frost-protected and protected from direct sun-rays. The PUR-local foam components have, the already mentioned accessories should be stored in a closed room or container with anti-theft device, at a temperature between + 15° C and + 25° C.



The PUR-local foam will be delivered separated in component A, Polyol - bright, and component B, Isocyanat - dark, in 1 l, 5 l or 10 l cans. These cans may be opened just before using it. At temperatures below 0 °C the PUR-foam will crystallize. Frozen respectively crystallized foam may not be used for post insulation.

For the correct storage of all **isoplus**-system components the pipe-layer, respectively a third party will be exclusively responsible. He has to confirm the completeness of material and to supervise the material distribution during the construction period. The assembling material which will be required for post insulation has to be given to the AGFW-/BFW-approved **isoplus**-factory-engineers at the execution term.

10.1.2 Special Features Flexible Compound Systems

Transport

isoplus-flexible pipes will be delivered in coils (Diameter ≥ 2,00 m) per truck to the building site respectively to the material stock. In order to protect the carrier pipe the pipe ends are closed with yellow caps, which should be removed not before the connection of the pipes.

In case of a further transportation of the pipes the loading area of the truck should be checked concerning rigid stick out parts. The pipes should lay plain and symmetrically on the loading area.

Unloading

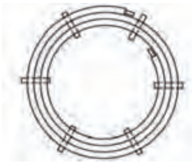
Unloading will be made properly and carefully by the pipe-layer or third parties. In case of unloading by use of a crane, belt with a width of at least 10 cm should be used. Fork-ends of fork-lifts have to be covered with protecting pipes.

Pulling and rolling of flexible pipes on the ground as well as the use of steel ropes or chains is not allowed because of scratches and pressure-spots at the jacket-pipe, caused by uneven grounds.

Storage

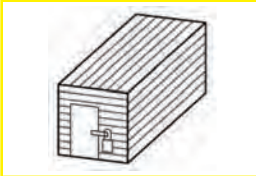
Flexible pipes have to be stored on even and dry surfaces, free of stones. Ground water endangered and water stowed soils should be avoid. Sand banks respectively -sacks or squared timber in star-constellation may be used as support.

In case that the pipes will be stored for a longer time, suitable protection measures against all weather conditions have to be provided. During a period of frost the jacket-pipe as well as the **isoplus** carrier pipe and the **isopex** carrier pipe has to be protected against strikes and shocks.



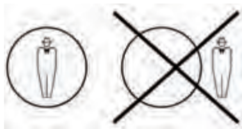
Edition: 16.01.2012

10.1 Delivery



Accessories for flexible pipes have to be stored within a lockable room or container. The pipe-layer respectively a third party will be exclusively responsible for the correct storage of all system components. He will confirm the receipt of the complete material and will control the distribution of the material during the construction period.

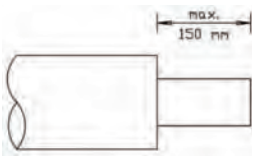
Cut Off



Flexible pipe-coils have to be opened from inside, due to the remaining tension.

ATTENTION: Danger of injuring !

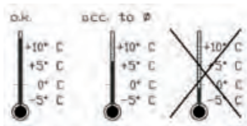
For assembling the **isoplus**-flexible pipes will be uncoiled and cutted to the corresponding lengths. The coils should be also turned accordingly. Additionally it should be considered, that the coil will be not pulled on an uneven respectively stone containing ground.



After the right-angled cutting of the flexible pipe, the jacket-pipe and the PUR-foam should be cutted in a distance of max. 150 mm from the cut. Then the jacket will be peeled by use of a suitable tool and the foam, as well as the remaining foam will be removed.

ATTENTION: The red E/VAL-diffusion barrier of the **isopex**-pipe, 6 bar - heating, may be not destroyed!

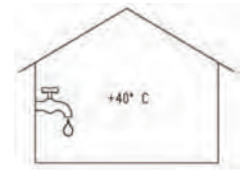
Processing



Pipe laying and processing of **isoplus**-flexible pipes will be generally possible up to an outside temperature of +10 °C. At temperatures below 10 °C eventually suitable precautions should be provided, depending from dimensions. Up to PELD jacket-pipe dimension of 90 mm the assembling of flexible pipes will be also possible at ≥ 0 °C.

In case of lower temperatures PUR-foam and jacket pipes can break. The risk will generally exist in case of jacket pipes > 90 mm and in case of **isopex**-double pipes at temperatures below 10 °C.

In case that **isoplus**-flexible pipes should nevertheless laid at such low outside temperatures the suitable processing temperature has to be reached by storing the pipes inside of a heated room or by filling them with warm water and/or by heat supply (max. 40 °C on to the PELD-jacket) by use of a suitable equipment. Water filled pipes may not be stored during a longer period of frost.

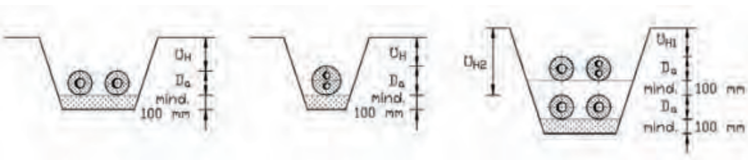


In case that the pre-heating will be carried out by use of a gas-burner, a burner-head of minimum Ø 50 mm has to be used. Preheating should be made with yellow flame in pendulum movements over a longer distance. Selective heating of the jacket-pipe will lead to damages of the flexible compound system.

Pipe-Laying

Assembling of flexible pipes will be normally on a 10 cm sand bed. Eventually required manholes should be provided as working area. Due to the long delivery lengths this requirement will occur only exceptionally. Supports have to be provided in a distance of 2,00 m.

Flexible pipes may be laid side by side or on top of each other into the trenches. Pipe-laying by use of a special horizontal flush-drilling procedure will be also possible. The instruction of the executing company has to be strictly considered.

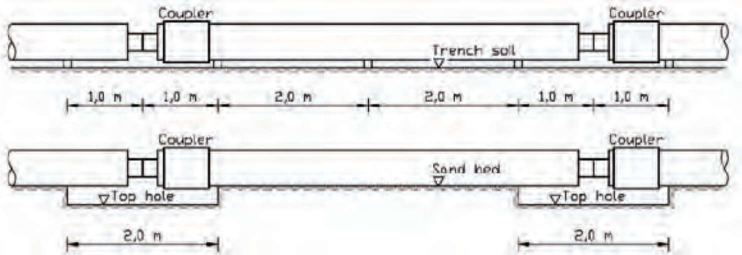


Edition: 16.01.2012

10.2.1 Assembling Supports / Top-Holes / Foreign Lines

Assembling Supports / Top-Holes

The assembling of the pipeline will be made on timber squares, hard-foam bars, sand sacks or directly on a 10 cm sand layer. In case of direct laying on a sand bed top-holes will be required as working space at the connection points. Supports will be placed in a distance of 2 m that means in case of 6 m pipe bars three and in case of 12 m pipe bars six supports will be necessary. In order to reach a correct coupler assembling, the first support should be placed at least 1 m from the pipe end respectively from the weld seam.



If squared timber will be used, these have to be removed before the sand filling of the trench. This will avoid not admissible pressure loads on the PEHD-jacket-pipe. Sand sacks have to be slit before refilling.

Foreign Lines

Essential hindrance concerning the line guidance have to be considered in case of district heating lines which will be constructed for the public traffic, due to existing lines and facilities like i. e. for gas, water, sewage, electricity or post. Therefore the location of these obstacles has to be clarified with the corresponding authorities by means of estate layouts and sectional drawings, before the beginning of the construction works. The result has to be determined in written. The following distances have to be meet in accordance with the AGFW, providing that no other local regulations should be valid:

Foreign Line - Type	**Minimum Distance**	
	at crossing or parallel laying up to 5 m	in case of parallel laying above 5 m
Gas- and water pipelines	20 - 30 cm	40 cm
1 kV - signal- or measure cable	30 cm	30 cm
10 kV cable or a 30 kV cable	60 cm	70 cm
several 30 kV cable or cable of more than 60 kV	100 cm	150 cm

10.2.2 Connection Technology / Weld-Seam-Test

Connection Technology

Before welding the pipes and components, the appropriate casing joints with the associated shrink joints must be inserted onto the casing pipe next to the weld. If adverse weather conditions are present, a protective tent must be erected over the joint area for preparation and implementation. While welding, the front sides of the pipe ends must be protected from welding sparks and burns using damp cloths, flame-retardant mats, or front covers.

The joints of the black steel pipes can be implemented in accordance with DIN ISO 857-1 using the following procedures: manual bend welding, gas welding with an oxygen-acetylene flame, tungsten inert gas welding (TIG), or a combination of processes. AGFW worksheet FW 446 applies to the quality of the weld, its inspection and its evaluation.

Companies carrying out welding work must meet the welding technical requirements in accordance with EN ISO 3834 and must be certified in accordance with AGFW Worksheet FW 601. Welding work may only be carried out by welders who are in possession of a valid test certificate in accordance with DIN EN 287-1. In addition, the corresponding qualification in accordance with DVGW GW 350 must be documented under construction site conditions.

The welding procedure to be used must be appropriate for construction site welding. DIN 2559-2 and 3 as well as DIN EN ISO 9692-1 based on DIN EN 448 are decisive for weld preparation, the joint form on the steel, and the distance between the pipe ends.

The additional weld materials must be matched to and approved with the basic materials; they must be selected by weld procedure in accordance with DIN EN 12536, DIN EN ISO 2560 or DIN EN ISO 636 and must be clearly marked. The completed welds must meet the requirements of evaluation groups B and C in accordance with DIN EN ISO 5817 in accordance with AGFW Worksheet FW 601; only evaluation group B is required in accordance with DIN EN 489.

Weld-Seam-Test

After the welding works are finished the welding seams have to be tested according to the agreed extent between purchaser and supplier. Obvious damages are classified in DIN EN ISO 17637. After this, the non-destructive weld test must be carried out in an environment to be determined. If a radiographic test is used, test class B of DIN EN 1435 is desirable.

A penetration test must be carried out in accordance with DIN EN 571-1, the ultrasound test in accordance with EN 1714, a magnet particle test in accordance with DIN EN ISO 17638, and an eddy current test in accordance with DIN 54141. After the non-destructive test, the leakage and/or sealtightness test must be carried out in accordance with AGFW Information Sheet FW 602.

The visual inspection method using air is recommended compared with that using water in a control test; during the test the welds are coated with a foaming agent. If no froth bubbles form within at least 1 minute, its state of sealtightness is considered proven. For the method using internal air overpressure the test pressure is 0,2 to 0,5 bar, with external air underpressure (vacuum glasses) an absolute maximum of 0,6 bar.

A cold water pressure test must be carried out on the vented route in accordance with the DVGW Worksheet G 469, Procedure A1. The test pressure is 1,3 x the operating pressure at its highest point and must be maintained for 3 hours.

10.2.3 Fitting Pieces

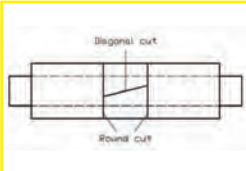
Due to individual pipeline guidance it will be necessary to shorten standard pipe bars into smaller fitting pieces. Due to this any pipe line length can be realised. The following working steps will be necessary for the production of a fitting piece:

The length of the fitting piece will be measured at a pipe bar and marked. At the left and the right from this mark the 2 • 200 mm wide respectively long area of dismantling will be marked.

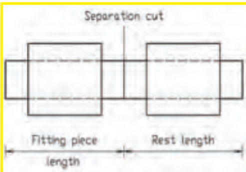
Cut the PEHD-jacket at the marks and connect both round cuts with a diagonal cut.

ATTENTION: At temperatures of < 10 °C the jacket pipe has to be heated before cutting, due to danger of cracks.

ATTENTION: The alarm wires of the monitoring system may not be cut when the round cuts will be made. Thereafter the jacket-pipe has to be lifted off by use of a suitable tool, i. e. mortise chisel.



The PUR-foam has to be removed by use of a hammer and a mortise chisel. Thereafter the alarm wires will be cut central. Remaining foam on the steel pipe has to be removed by use of an emery linen. Finally the steel- respectively the carrier pipe has to be cut at the middle of the dismantling area.

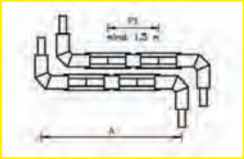


Edition: 16.01.2012

10.2.4 Z-Leaps / U-Elbow / Parallel-Branch

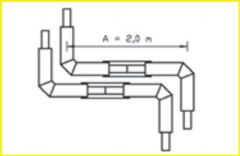
Z-Leaps with Fitting Piece

The length of Z-elbow [P1] will be in correspondence with the static requirements. The cross-angle [A] can be seen from the **isoplus**-trench-design. Theses leaps will be assembled with two insulated elbows, normally 90°, and a fitting piece. The fitting piece [P1] should be at least 1,50 m long in order to put the connection couplers on.



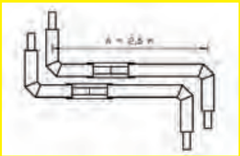
Z-Leaps without Fitting Piece up to DN 100

A transverse leg [A] of 2,00 m is usually sufficient from a static point of view in the smaller nominal size range up to DN 100. No fitting piece will be necessary in case that 4 long-elbows 1,0 • 1,0 m will be used. Slipping over on the 1 m long angle of the elbows will be possible.



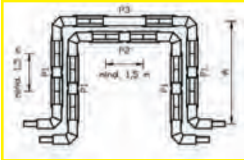
Z-Leaps without Fitting Piece from DN 125

A transverse leg [A] of 2,50 m is usually sufficient from a static point of view in the medium nominal size range up to DN 125. To achieve this, 2 bend pieces with bars 1,0 • 1,0 m long and 2 bend pieces with bars 1,0 • 1,5 m long must be used. During this process, inserting the joint is also possible on the long bars of the bend.
As of approx. DN 400, detailed static calculations are required.



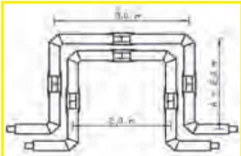
U-Elbow with Fitting Piece

The length of the U-elbow [P1] will be in correspondence with the static requirements. The total bearing out [A] can be seen from the **isoplus**-trench-design. The fitting pieces [P2] + [P3] at U-elbow head are different in length, whereas the inner one [P2] should be at least 1,50 m long. This will allow to put on both couplers.



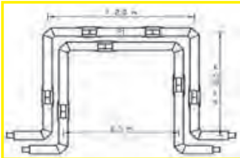
U-Elbow without Fitting Piece up to DN 100

In the smaller nominal size range up to DN 100, from a static point of view, a projection [A] of 2,00 m is usually sufficient. When using 6 bend pieces with leg lengths of 1,0 • 1,0 m and 2 bend pieces with legs 1,0 • 1,5 m long, fitting pieces are not usually required. During this process, inserting the joint is also possible on the long legs of the bend.



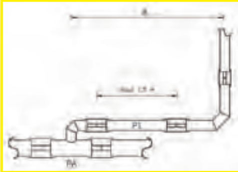
U-Elbow with Fitting Piece from DN 125

A projection [A] of 2,50 m is usually sufficient from a static point of view in the medium nominal size range up to DN 125. When using 3 bend pieces with legs 1,0 • 1,0 m long and 5 bend pieces with legs 1,0 • 1,5 m long, only one fitting piece [P1] on the external U-bend head, whose length is determined by the dimension and the pipe distance, is required. During this process, inserting the joint is also possible on the long legs of the bend. Detailed static calculations are required above DN 400.



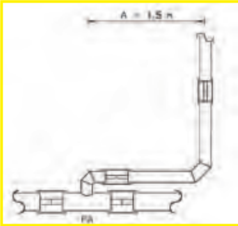
Parallel-Branch with Fitting Piece

In a parallel branch, the length of the fitting piece [P1] is dependent on the static requirements. The transverse leg [A] is given in the **isoplus** route plan. These offsets are assembled from a finished bend, in general 90°, and a fitting piece. The fitting piece [P1] must be at least 1,50 m long in order to insert the casing joints onto it.



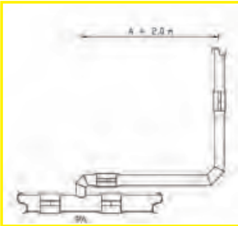
Parallel-Branch without Fitting Piece up to DN 100

A transverse leg [A] of 1,50 m is usually sufficient from a static point of view in the smaller nominal size range up to DN 100. When using bends with legs 1,0 • 1,0 m long, no fitting piece is required. During this process, inserting the joint is also possible on the long legs of the bend.



Parallel-Branch without Fitting Piece from DN 125

A transverse leg [A] 2,00 m long is usually sufficient from a static point of view in the nominal size range from DN 125 to approx. DN 250. When using bends with legs 1,0 • 1,5 m long, no fitting piece is required. During this process, inserting the joint is also possible on the long legs of the bend. possible on the long legs of the bend. Detailed static calculations are required above DN 400.

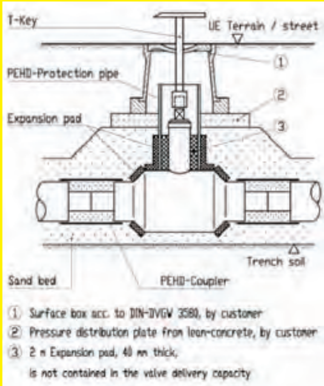


Edition: 16.01.2012

10.2.5 Shut-Off Valve

Shut-Off Valve

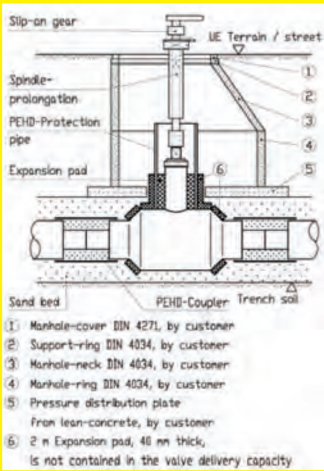
Shut-off valves will be welded into the line like a straight piece of pipe. The welding works have to be carried out in passage-position that means with open ball, in order to avoid a damage of the sealing. Installation within the area of angles of L-, Z- or U-elbows will be not admissible because of occurring bending tensions.



The PEHD-protection pipe, with inside centering support, which is not part of the delivery, will be shortened according to the covering height. It will be put over the operational dome and will end in a street-cap or pit-ring. Operating will be made by use of a T-key or by a portable plug-on-gear, which should be generally used starting from dimension DN 150.

Please consider during installation that there will be enough space for movement, due to possible axial expansion. The prolongation will be put vertical on the conical square of the valve-dome. The prolongation will end also with a conical square, on which now the T-key or/and the plug-on-gear can be put.

After the assembling will be finished, the first closing procedure should be carried out after flushing the pipeline, in order to remove rigid particles in the pipes, which may cause damages of the sealings. The shut-off valves are right hand closing or clockwise up to a 90°- stop, the opening will be contrary. The stops should not be over winded by force. Opening and closing should be carried out slowly, in order to avoid pressure shocks in the pipe system.

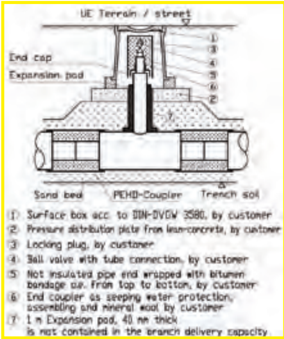


In between or adjusted positions are not allowed, due to possible damages of the sealings. The use of not suitable torque moment-duplicators, or inexpert prolongation of the T-key are not allowed and will lead to an exclusion of warranty.

10.2.6 Drain / Vent

Drain / Vent

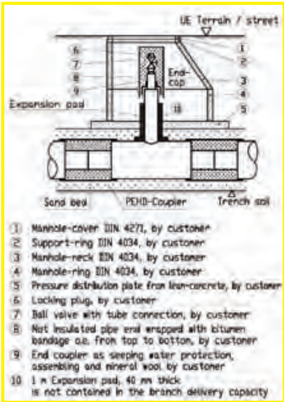
At top and low points, which will especially occur at constant covering heights of pipelines, draining or/and venting (ELE/ELÜ) have to be provided, according to the regulations of the local management of works. ELE/ ELÜ branches with a vertical exit will be welded into the pipeline like a straight piece of pipe, see **chapter 2.2.8.** Installation at the area of L-, or Z- angle or U-elbows will be not allowed, due to occurring of bending tensions.



After adjusting of the exit height an end cap, see **chapter 10.2.12**, has to be assembled. Thereafter the assembling of a draining- respectively venting valve will be carried out at site. At the outside-thread of the ball valve, the suction tube can be connected.

The still visible not insulated steel pipe has to be wrapped with a bitumen bandage. Please consider that the direction of the wrapping should be made from top to bottom. Finally a PEHD-blind-cover will be put over the complete ELE/ELÜ- construction, for protection against percolating water. This blind-cover has to be equipped with a suitable insulation material.

For protection against axial movements expansion pads have to be assembled at the exit, in accordance with the **isoplus**-trench-design. The mentioned end cap, the PEHD-blind-cover and the expansion pads are not part of the delivery range of the ELE- or/and ELÜ-branches.



Alternatively to the vertical-branches also pre-fabricated draining/venting, acc. to **chapter 2.2.9,** can be used. At the exit of these a corresponding ball valve is integrated respectively foamed in.

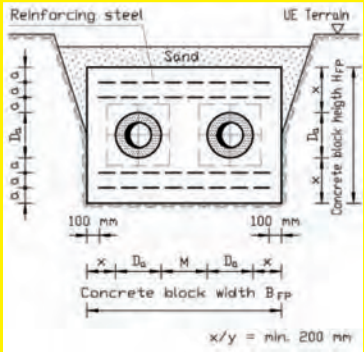
Edition: 16.01.2012

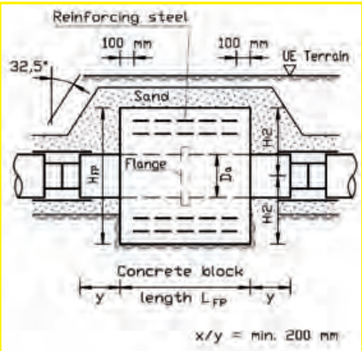
10.2.7 Anchor - Concrete Block

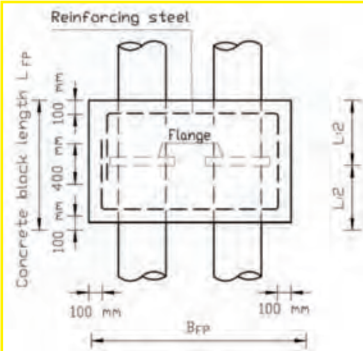
Concrete blocks have to be installed into grown soils. The required excavation has to be made before pipe laying. In case that an anchor will be located before a construction building or a house, a clearance of at least 2,00 m should strictly considered between the brickwork and the anchor. A suitable drainage has to be provided in case that stemming groundwater cannot be excluded at the concrete-block.

The execution of the water tight block has to be made by use of blast furnace cement with concrete quality C 20/25 F2 acc. to DIN 1045-2 and DIN EN 206-1 incl. the required armouring of B500B acc. to DIN 488-1. The irons have to be bended acc. to the standard and can be welded at the overlapping. Before the pipeline will be put into operation the pipe trench and the concrete block has to be filled completely. The binding of the concrete should be totally completed. First after 28 days the given-consistency will be reached. The specific block-size as well as the corresponding reinforcing steel can be seen from **isoplus**-pipeline design, see **chapter 2.2.12**.

Dimension Steel Pipe		Reinforcing Steel	
Norminal Diameter in DN	Outside-Ø d_a in mm	Number resp. piece	Diameter Ø in mm
20	26,9	2	8
25	33,7	2	8
32	42,4	2	8
40	48,3	2	8
50	60,3	2	8
65	76,1	2	8
80	88,9	2	8
100	114,3	4	8
125	139,7	4	8
150	168,3	4	8
200	219,1	6	10
250	273,0	6	10
300	323,9	6	10







10.2.8 Connection Couplers

Several coupler constructions are available for the different technical requirements. All PEHD-connection couplers are used for non-positive gas- and water tight jacket-pipe connections. The assembling information for all kind of couplers have been integrated into the **chapter 6** for simple use and handling of the available **isoplus**-Design Manual.

Before welding of the carrier pipes all kind of couplers as well as the shrinkable sleeves should be slipped over pipe bars. Only the pipe-layer or a qualified third party will be responsible for that.

Thereafter and after recording of the agreed test procedures, the welding seams will be insulated and sealed with couplers and PUR-foam. Because of warranty reasons these works, except in case of **isocompact®**-couplers, should be carried out by AGFW-/BFW-approved assembling specialists educated by **isoplus**-factory assembling personnel.

An identification mark will be fixed on all coupler connections carried out by **isoplus.**

This will allow an exact identification of the corresponding assembling engineer and will increase the quality requirement. In case that the post-insulation should be made by third parties, their qualification has to be proved by presenting of the AGFW-/BFW-test certificate, before beginning of the post insulation works.

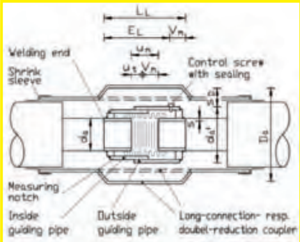
isoplus has to be informed concerning this exceptional case before beginning of the works. The general valid **isoplus**-assembling guidelines, see **chapter 11.5.2** have to be generally considered.

Edition: 16.01.2012

10.2.9 One-Time-Compensator

Preparation Works

The length- and measure values mentioned in this chapter, like $[L_L]$, $[u_m]$ etc. can be seen in data sheet **chapter 7.1.1**, and the **isoplus**-trench-design. The one-time-compensator (EKO) will be delivered with fully extended bellow, which means with the maximum possible expansion absorption $[u_m]$. The measure $[u_m]$ corresponds exactly with the distance between the edge of the outer guiding pipe and the rotating notch at the inner guiding pipe.



ATTENTION: The factory made welding spots are only used for transportation security and should therefore be removed before any further works.

Delivery length $[L_L]$ has to be cut about the mechanical prestressing measure $[V_m]$. Because of this the real from the pipeline expected expansion $[u_t]$ will be adjusted. This will be decisive for the correct thermal prestressing of the EKO-system. For that the EKO has to be pressed together mechanically about the measure $[V_m]$ by use of a suitable gripping tool. The required force [F] can be seen from data sheet, **chapter 7.1.1**. On request EKO´s can be pre-stressed. This will be generally the case starting from dimension DN 350, due to high forces.

The distance between the edge of the outer pipe and the notch of the inner pipe is now in accordance with the real expansion absorption $[u_t]$, and the lengths of the EKO´s with the real installation length $[E_L]$.At this status the both guiding pipes of the EKO´s will be connected with 2 - 3 welding points. This will fix the expansion length $[u_t]$ adjusted for the installation. For the later pressure test of the pipeline no modification of the EKO length will be allowed. The measure $[u_t]$ has to be adjusted identical for primary and secondary-EKO, because the circulating pre-heating- respectively starting medium in the primary and secondary line has to indicate the same thermal values.

Installation

Before EKO´s will be welded in, the long-connection- respectively long-double-reduction couplers have to slipped over the pipe bars. Due to reasons of Quality Safety of the total system, in consideration to sufficient insulation thickness and monitoring of the net-work, so called long-double-reduction couplers will be necessary for EKO´s up to the dimension of DN 200.

The EKO will be welded in exactly at the spots mentioned in the pipeline design, with the fixed status, like a piece of pipe. During this it has to be considered that no rough impurities will come into the inside located chrome-nickel-steel-bellow. Furthermore the control-screw for the tightness-test of the EKO should be at the upper area, between 11:00 and 13:00 o'clock. The same requirements as for all other steel-welding connections in the system, will be also relevant concerning the welding quality of both round-seams at the welding ends of the EKO´s.

The given distance measures between an expansion angle and an EKO, respectively between two EKO´s has to be guaranteed. EKO´s have to be installed generally between two, at least 6 m long straight pipe bars. The installation between bowed pipes or in elastic bowed sections, which means a bending load for the EKO´s, will be not admissible.

Furthermore it will be not allowed to cut the EKO, to use it for changing the direction respectively as compensation support in case of axis-bevelling and length-differences. Bevelling cuts are not allowed at the both welding seams. After welding in of the EKO´s the connecting points at the fillet seam may be **not** removed.

Weld-Seam-Test of Pipeline with installed EKO

After the welding works will be finished the welding seams have to be tested. During pressure test it should be considered, that the hydraulic restoring forces will be reliable compensated. Otherwise the adjusted expansion length [u_t] at the EKO´s may change in an unacceptable way, which could lead to a damage of the EKO´s.

Fixing of a restoring force-security directly at the EKO will be not allowed. In case that the EKO should be factory pre-stressed, the fixing will be just a security during transportation and during assembling. The fixing will be not suitable for transmission of restoring forces. Restoring forces [F] will be calculated as follows:

$$F = A \bullet p_p \quad [N]$$

A = effective bellow cross section in cm^2, see **chapter 7.1.1**
p_p = test pressure in bar

Edition: 16.01.2012

Insulation-, Sealing- and Earth Works

After the test procedures are finished and recorded, the welding seams have to be insulated by the AGFW-/BFW-approved and **isoplus**-educated assembling engineers, by use of the connection couplers which have been slipped on to the pipes before, however without the long-connection couplers at the welded EKO´s. Thereafter the expansion pads will be installed at all expansion angle and other corresponding longitudinal and thickness data as per **isoplus**-trench-design.

Thereafter the 10 cm sand-bed with a 0 - 4 mm grain (class NS 0/2 acc. to DIN 12620) has to be prepared and compressed manually at the complete pipeline, except of the EKO-areas. Now also the pipe trench, **except** of the EKO´s has to be re-filled and compressed manually with excavation material acc. to DIN 18196, see **chapter 9.5** and **9.6**.

The assembling pit at the EKO´s has to be big enough in order to carry out the final welding and insulation works without any problems. However it has to be considered that the length of the pit will not exceed the effective required space. This will guarantee that the pipes will not buckle horizontal or/and vertical during start of operation.

Start of Operation resp. Prestressing of the Pipeline

Before starting the operation of the pipeline, the stitch-spots at the fillet weld of the EKO´s **have to be detached**, in order to allow the compensation of expansion in the compensator-bellow. The heating of the pipes has to be carried out slowly and parallel, in order to avoid any temperature shocks.

If the pre-stress temperature of 80 °C has been reached, the adjusted and calculated expansion compensation **[**u_t**]** has to be checked. In case that the outside guidance pipe will appear at the circulating notch of the inner guidance pipe, the final position of the EKO has not yet reached and the heating temperature has to be increased.

ATTENTION: The final position of the EKO´s has to be reached!

Final Works resp. Final Assembling

If the final position of the EKO´s has been reached, the medium temperature has to be kept as long until the both guidance pipes will be welded with a fillet seam. Due to this a non-positive- and material connection has been carried out and the EKO will be considered just as a rigid piece of steel. The pipeline is now prestressed.

The fillet seam of the EKO has to be tested by an air-pressure test. Therefore a valve has to be screwed into the test drill at the upper third of the EKO. As test pressure 0,2 to 0,5 bar air will be sufficient. After testing the valve will be removed and the test drill will be tightly closed and welded by use of the also delivered screw.

Now the EKO will be insulated by the assembling engineers by using long connection couplers which have been slipped on to the pipes before. Finally only the sand-bed in the EKO-pit has to be prepared and compressed.

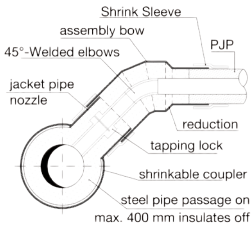
Edition: 16.01.2012

10.2.10 Tapping Branch

Preparation and execution of the tapping has to be made acc. to the guidelines of AGFW. That means a difference of nominal dimension of at least two dimensions, or i. e.: DN 150 has to be tapped with max. DN 100.

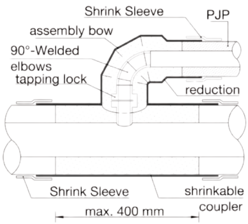
The tapping of a coupler connection is not allowed. Tapping locks have to be stored at temperature of – 5 °C to + 30 °C and a relative humidity of < 70 %. Thread and sealing areas may not be damaged.

According to the passage pipe dimension the end of the lock without thread has to be adjusted without to shorten it. The tapping-lock will be welded electrically to the main pipe, by use of a 45°-exit with 45°-angle and in case of a parallel branch with 90°-angle. The lock-disc will be fixed at the handle and lubricated. The correct assembling of the lock can be checked by easy putting in and out of the disc.



It will be possible to check the weld seam before the tapping. The appropriate compass saw will be assembled at the tapping tool and the unit will be fixed at the tapping-lock. The drill spindle will be lowered until the grip-drill with gripping device will touch the passage pipe. Now the gear-unit will be fixed at the tapping unit and the tapping will be carried out under pressure with adjustable speed, depending from dimension.

After drilling the compass saw with spindle will be pushed slowly to the “off” position. Thereafter the lock-disc will be pushed into the slot of the tapping-lock. Now the gear and the tapping unit will be dismantled and the branch pipe will be welded to the tapping-lock. A pressure test against the tapping-lock will demonstrate the tightness of the connection.



The lock-disc can be removed now slowly from the tapping-lock, in order to avoid any pressure shock, and the slot of the tapping-lock can be welded electrically. Finally the exit will be post insulated by **isoplus**-factory educated assembling engineers, by use of a PEHD-assembling branch, see **chapter 6.11.1**. Detailed assembling information will be available on request.

Edition: 16.01.2012

10.2.11 One-Time-Valve

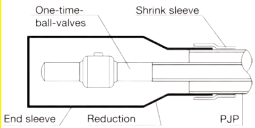
Single-use and on-demand connection ball valves can be used to close off a construction section which will be continued at a later date. The available **isoplus** route can be continued at any time without requiring the pipeline to be emptied and taken out of operation if welded in as an end piece.

Single-use ball valves will be welded into the route in a closed position like a piece of pipe. In connection with double pipes, make sure that the assembly of the ball valve occurs clockwise and relocated along the longitudinal axis.

To prevent contamination and to prevent the polyethylene foam from penetrating into the open end of the ball valve, assembly of a dished bottom and a pipe cap in accordance with DIN EN 10253-2 is required. For use up to temperatures at least in accordance with EN 253 operating temperature and 25 bar operating pressure.

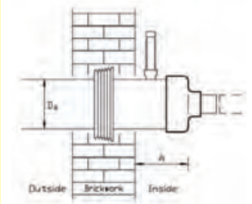
Post-insulation is made using an end joint. It is necessary that this end joint is being delivered with a widened or enlarged diameter in order to ensure the necessary insulation thickness, like **chapter 7.1.3**.

Once the continuing section has been installed, assembled, and welded to the single-use ball valve, commissioning may take place. For this purpose, the closing screw of the single-use ball valve will be operated using a screwdriver or a hexagon Allen key and then welded.



10.2.12 End Cap

The pipe layer will be responsible for putting the end caps on to the pipes in the buildings or in manholes, before connection to the conventional continuing pipelines. Fixing in the PJP-ends in a wall without end cap is not allowed. The alarm wires have to be kept free until to the final assembling, they may not be fixed in a wall and not pulled off. End caps may not cut open and have to be protected from heat and combustion during welding works. Cut up end caps are excluded from assembling.



Before shrinking of an end cap, the PEHD-jacket-pipe end has to be degreased by use of a PE-cleaner. Thereafter the jacket-pipe and the steel pipe has to be roughen with an emery linen on a width of approx. 100 mm. Remove PE- and steel particles.

The shrinking of the end cap will be continued with a soft propane gas flame of at least 60 °C in circumference direction. Thereafter let it cool down. Now the shrinking procedure will be continued at the annular gap and at the steel pipe. The shrinking procedure will be finished as soon as the sealing adhesive will expose at the edges.

Due to warranty reasons the shrinking of the end caps should be carried out by the AGFW-/BFW-approved and **isoplus**-factory educated assembling engineers.

At medium temperatures > 120 °C the end caps have to be fixed additionally with stainless-strap retainers, as well at carrier- as also at jacket-pipe.

Minimum-Excess **[**A**]**:

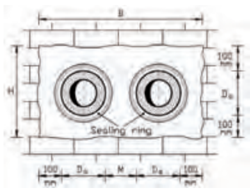
PEHD-Jacket-Pipe Diameter D_a in mm	from	65	250	450	710	1000
	to	225	400	670	900	1300
PEHD-Jacket-Pipe Excess A in mm		100	125	150	200	250

Edition: 16.01.2012

10.2.13 Wall Duct - Sealing Standard

The dimension of the wall duct respectively the core drill is depending from the PEHD-jacket-pipe, the number of pipes and from the kind of sealing.

Sealing Ring - Standard

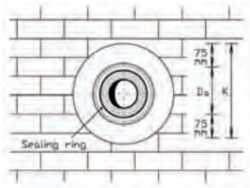


The neoprene ring has to be slipped on in the middle of the brickwork and should not lie on. The mentioned passing through size will allow a correct concrete-pouring. At dimensions ≥ DN 400 it will be recommended to slip on two sealing rings per pipe and to wrap the space in between with a grease-band. The admissible angle of the pipe to the wall will be max. 30°.

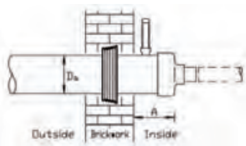
The mentioned minimum measures have to be kept strictly. The total size will be calculated as follows:

$$B = x \bullet D_a + M \bullet (x - 1) + 200 \ \text{[mm]}$$

$$H = D_a + 200 \ \text{[mm]}$$



x = Number of pipelines
D_a = Jacket-Pipe Outside-Diameter in mm
M = clear distance between Jacket-Pipes, acc. to **chapter 9.2.3**



At the pipe duct through a concrete wall also a core drill [K] can be provided. At installation of the standard sealing ring the drill should be at least 150 mm bigger than the PEHD-jacket-pipe diameter.

$$\varnothing K = D_a + 150 \ \text{[mm]}$$

Minimum-Excess [A]:

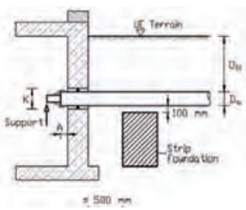
PEHD-Jacket-Pipe-Diameter D_a in mm	from	65	250	450	710	1000
	to	225	400	670	900	1300
PEHD-Jacket-Pipe Excess A in mm		100	125	150	200	250

10.2.14 Wall Duct - Sealing Insert

The press-water tight insert will be installed into a pipe liner or a core drill [K]. The mentioned drill diameters should be strictly kept, because the width of the C 40 - insert will match the ring-space gap. The sealing will end with the outside of the wall and can be re-stretched from inside of the building respectively inside of the manhole. The admissible angle to the wall will be max. 8°. For the jacket-pipe excess [A] analogous the table in **chapter 10.2.13** will be valid. The mentioned core drillings are valid only for type C 40. **isoplus** will not guarantee for the correctness of the diameters in case of using any other type!

The pipeline has to be tightened carefully at the building entry in case that sealing inserts will be used, in order to avoid settlements. Additional the pipeline should be supported in the building or in the house. The special sealings can compensate only slight axial movements up to 20 mm.

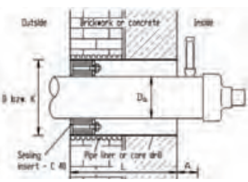
ATTENTION: Radial loads or soil-settlements at the building or manhole entry will cause leaks. This should be avoided by efficient compressing of the soil and by support constructions in the manhole or in the building. A discharge of pressure can be reached by a stripe-foundation before the building edge.



Jacket-Pipe-Ø D_a in mm	65	75	90	110	125	140	160	180	200	225	250	280	315	355
Diameter Core Drill K in mm	125	125	150	200	200	200	250	250	300	300	350	350	400	450

Jacket-Pipe-Ø D_a in mm	400	450	500	560	630	670	710	800	900	1000	1100	1200	1300	isoplus
Diameter Core Drill K in mm	500	600	700	700	800	800	800	900	1000	1100	1200	1300	1400	

The pipe-liner made of special synthetic fibre cement (SFC) acc. to DIN 19800 consists of a pressure pipe PN 6, outside grooved, corrosion resistant and not electrically conducting. It has to be already fixed and positioned during the construction works. The inner diameter [D] is correspondent with the diameter of the core drill [K]. The length of the pipe-liner [L] is depending from the thickness of the wall. It will be available in standard length 200, 240, 250, 300, 365, 400, 500, 650 and 1000 mm.



Edition: 16.01.2012

10.2.15 Leak Detecing

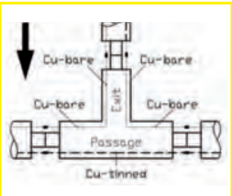
IPS-Cu®* & *IPS-NiCr®

The leak detecting wires foamed in into the pipe bars and components will be connected during the postinsulation works by approved assembling engineers. All wires are different in colour, in order to avoid wire connection failures.

During pipe assembling the wires have to be aligned to 11:00 o'clock respectively 13:00 o'clock. Do never change the wire codification. Due to warranty reasons the final wiring, that means the assembling of all **IPS-Cu**® and **IPS-NiCr**® accessories as well as units, will be carried out exclusively by the approved and **isoplus**-factory educated assembling engineers. After completion of these works a measure- respectively acceptance report has to be prepared.

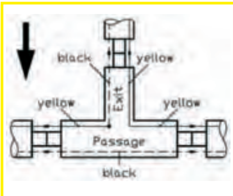
IPS-Cu®	IPS-NiCr®
Wire Connection: Decoil bare Cu-wire ends, stretch carefully and cut to abut, degrease and draw bright by use of sandpaper. Thereafter press right colours with squeeze husks and solder additionally, which will avoid high transition resistances. Fix two wire-distanceholders at pipe and fix the wires on it. Check measurement on each coupler and in both directions.	**Wire Connection:** Decoil wire ends, stretch carefully, strip the insulation of yellow NiCr-wire with 10 mm overlengths, cut black wire to abut, cut and strip the insulation. Pull shrink-hose approx. 70 mm over both wires. Connect black wires to abut, yellow wires overlapping with squeezing husks, 2 x squeezed. Shrink shrinking-hose above the husks. Fix two wire distance holder at the pipe and fix the wires on it. Check measurement on each coupler to the left and to the right.
Branch wire connection resp. rule: The bare copper wire has to be connected always to the right to the main pipeline on the bare copper wire, the tinned copper wire always to the left on the bare copper wire, seen from the branchpipeline to **direction of arrow**, without consideration whether the branch has been installed outgoing topside or at the bottom. The tinned copper wire of the passage has to be wired straight through the branch. Eventually the course of the foamed in Cu-wires in the preinsulated branch has to be checked by an ohmmeter.	**Branch wire connection resp. rule:** The black wire of the passage has to be wired straight through the branch. Eventually the course of the foamed in NiCr-wires in the branch has to be checked by an ohmmeter. **Branch upward:** Connect the yellow wire to the left to the main pipeline on yellow, the black wire to the right on yellow, seen from the branch-pipeline to direction of arrow. **Branch downward:** Connect the yellow wire to the right to the main pipeline on yellow, the black wire to the left on yellow, seen from the branch-pipeline to direction of arrow.

IPS-Cu®



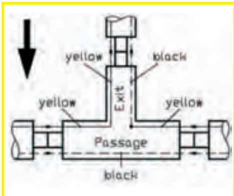
Branch

IPS-NiCr®



Branch **upward**

IPS-NiCr®



Branch **downward**

10.2.16 Thermal Prestressing

Pipe Laying and Weld-Seam-Test

The PJP-pipeline will be assembled according to the **isoplus**-laying guidelines on assembling supports or directly on the sand-bed. Before the welding of the pipes and components, the corresponding connection couplers with the shrinking sleeves have to be slipped on the jacket-pipe beside of the welding spot.

After completion of the welding works, the welding seams have to be checked in accordance to the agreed extend between buyer and supplier. Obvious damages are classified in DIN EN ISO 17637. Subsequently, the non-destructive weld test must be carried out in an environment to be determined. In case of a radiographic test, test class B of DIN EN 1435 is desirable. After the non-destructive test, the leakage and/or sealtightness test must be carried out in accordance with AGFW Information Sheet FW 602.

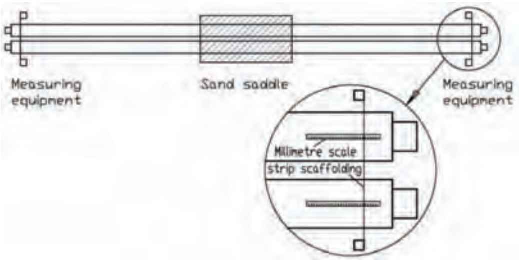
The visual inspection method using air is recommended compared with that using water in a control test; during the test the welds are coated with a foaming agent. If no froth bubbles form within at least 1 minute, its state of sealtightness is considered proven. For the method using internal air overpressure the test pressure is 0,2 to 0,5 bar, with external air underpressure (vacuum glasses) an absolute maximum of 0,6 bar.

A cold water pressure test must be carried out on the vented route in accordance with the DVGW Worksheet G 469, Procedure A1. The test pressure is 1,3 x the operating pressure at its highest point and must be maintained for 3 hours.

Insulation- and Sealing Works

After the test procedure will be completed and recorded, the welding spots will be insulated by the AGFW-/BFW-approved and **isoplus**-factory educated assembling engineers, by use of the connection couplers which have been slipped over the pipes before, but without the long-connection couplers at eventually necessary fitting pieces respectively measuring systems.

Thereafter the expansion pads will be assembled at the expansion angle like L-, Z- and U-elbows as well as at all other required spots in correspondence to the length- and thickness data of the **isoplus**-trench-design.



Edition: 16.01.2012

Preparation Works

After the insulation works the prestressing section **has to be** checked concerning obstacles like roots etc. which will eventually obstruct the expected unimpeded extension, and whether they can be removed.

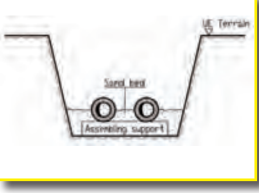
Branch pipelines should be excluded from the prestressing procedure in case that they are part of the prestressing section. T-branches can be used as intermediate measuring spots. However if branch pipelines have to be included into the prestressing, it should be also considered that the unimpeded extension of the pipeline will not be blocked.

In case that the prestressing section will run parallel to a front of houses or other buildings in a distance of ≤ 5 m, the corresponding wall ducts should be fixed respectively covered with concrete first after completion of the thermal prestressing. Without considering this, the damage of the sealing rings and the preinsulated jacket-pipes will be pre-programmed. This will lead to a warranty exclusion.

For an exact recording of the prestressing, the measuring installations mentioned in the **isoplus**-trench-design have to be installed as a fix profile. For that it will be helpful to fix a weather resistance millimetre scale on the jacket-pipe.

Thereafter the prestressing section up to the pipe axis, that means up to 3:00 respectively 9:00 o'clock position, has to be filled orderly with sand in layers, grain 0 - 4 mm (class NS 0/2 acc. DIN EN 12620) which has to be compressed manually.

The assembling space between the pipes should especially be considered. The fitting pieces and the measuring installation will not be filled with sand.



Thereafter the sand-saddle respectively the supporting fix-point has to be filled and compressed to the upper edge of the soil- respectively street, in accordance to the concept. The saddle has to be provided at road crossings or eventual existing bowed pipes. As an advantage these areas may then be sanded and filled completely with excavation material.

The bowed pipes **have to be** supported lateral in case that the sand-saddle cannot be placed. Additionally the sand-bed has to be completed **only** on the complete length of the bowed pipes up to 10 cm above the pipe crown. These two measurements will guarantee that the axial pipe extension will move over the bowed pipes during the prestressing, and that these will not buckle horizontal or vertically.

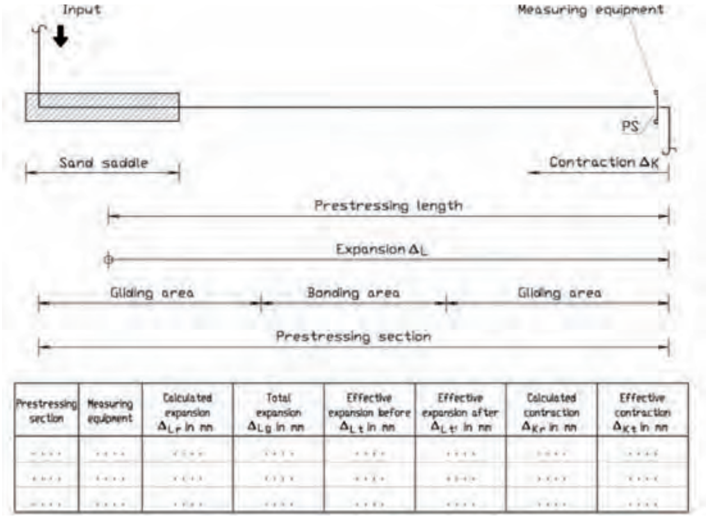
If the free expansion should be provided one-sided, i. e. in case of a prestressing with the operating medium from the heating plant, the sand-saddle has to be filled at the end of the opposite side of the measuring spot. This end at the sand-saddle has to be supported additionally lateral, in order to guarantee an one-sided unimpeded expansion movement. In case of a prestressing with the existing medium the sand-saddle can be placed just at one end of the prestressing section, and has not to be placed in the middle.

Execution and Recording

The length- and measuring data described in this section, like [ΔL_r], [M_L] etc., can be seen from the **isoplus**-trench-design and from the prestressing concept. Heating of the pipes has to be carried out slowly and parallel, in order to avoid any temperature shocks.

As soon as the prestressing temperature [V_T] has been reached, it has to be kept constant. The calculated unimpeded modification of length [ΔL_r] will be checked at the measure installations and recorded. The effective result [ΔL_t] will be recorded in the concept.

ATTENTION: The prestressing temperature [V_T] has to be kept, the effective expansion movement [ΔL_t] may slightly differ from the calculated value [ΔL_r]. In case of bigger differences the responsible design and construction manager or/and engineer has to be informed!



Thereafter the 10 cm sand-bed (class NS 0/2) has to be established and compressed manually all over the total prestressing section, except of the measure installations. Now the pipe trench **has to be** refilled and compressed with excavation material, except of the already mentioned spots, according to DIN 18196, ZTV A - StB just as ZTV E StB.

The prestressing temperature has further to be kept.

Edition: 16.01.2012

If the re-filling of the total prestressing section cannot be made in one procedure, the minimum filling length [M_L] on both sides have to be **strictly** kept. It will be not admissible to distribute the required soil on to the total section length. The remaining length [R_L] should be filled thereafter, however the trench at this area may be also filled later on.

The change of length [ΔL_r] will be checked again at the measuring equipment and the read off result [ΔL_t] will be also mentioned in the protocol. Thereafter the prestressing unit can be switched off. However the measuring equipment will still remain in order to check the calculated length contraction [ΔK_r] after the cooling period and in order to secure the measured result [ΔK_t] in the protocol.

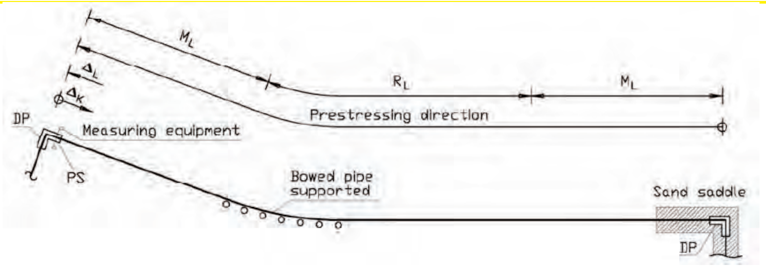
At prestressing of several sections following after each other, the contraction [ΔK] has to be added to the unimpeded expansion [ΔL] , in order to reach the total change [ΔL_g]. Additional has to be considered that the sliding areas have to be defined again after every section at the stage- respectively step-back prestressing procedure.

For registering of all Δ-values it will be strictly necessary that the client will determine a responsible chief construction manager, who will also supervise the prestressing procedure and who will confirm with his signature the effective data in the protocol respectively in the concept.

Final Works resp. Final Assembling

At the completion of the prestressing, recorded in the concept and in the report, the measuring equipment has to be removed and the pre-heated fitting pieces (PS) should be welded in. Fitting pieces should be as short as possible. This can be reached under consideration that the assembling gap for a fitting piece may correspondent maximum to the 1,5-fold of the unimpeded expansion movement [ΔL].

Thereafter the fitting piece will be insulated by use of the long-connection coupler slipped over before, the expansion pad (DP) will be assembled at these areas and the sanding and re-filling of the remaining pipeline will be carried out.



PROCESS REPORT THERMAL PRESTRESSING

Working Step	
	Customer: ____ **Project:** ____ **Street:** ____ **PC / City:** ____ **Prestressing Section:** ____ **Project-No.:** ____
1	Responsible operating personnel: ____ Delivery from: ____ date ____ from ____ ◷ at ____ km Arrival in: ____ date ____ at ____ ◷ at ____ km
2	Current supply existing: yes ❑ no ❑ Fitting piece gaps available: yes ❑ no ❑ Section acc. to drawing: yes ❑ no ❑ Measuring system available: yes ❑ no ❑
3	Aggregate installation: date ____ from ____ ◷ to ____ ◷
4	Sand-saddle acc. to drawing: yes ❑ no ❑ Guiding sand-bed existing: yes ❑ no ❑ Branches re-filled: yes ❑ no ❑ Bowed pipes supported: yes ❑ no ❑
5	Steel pipe temperature before: ____ °C Ambient temperature: ____ °C Weather conditions: ____
6	Aggregate employed: date ____ at ____ ◷ Heat up phase: from ____ ◷ ____ to ____ ◷ Prestressing temperature reached: date ____ at ____ ◷ Steel pipe temperature at protocol of ΔL_i - values: ____ °C
7	Sand-bed in order: yes ❑ no ❑ Minimum filling lengths kept: yes ❑ no ❑
8	Aggregate stopped: date ____ at ____ ◷ Heat down phase: from ____ ◷ ____ to ____ ◷ Prestressing completed: date ____ at ____ ◷ Steel pipe temperature at protocol of ΔK_i - values: ____ °C
9	Aggregate dismounting: date ____ from ____ ◷ to ____ ◷
10	Overtime total: ____ hrs. Night work total: ____ hrs. Sunday work total: ____ hrs. Holiday work total: ____ hrs.
11	Removal from: ____ date ____ from ____ ◷ at ____ km Arrival at the next project: date ____ at ____ ◷ at ____ km Entire driven kilometer: ____ km
12	Comment/Explanation: ____
13	____ Date ____ Signature + Name Responsible engineer ____ Signature + Name Operating personnel

Prestressing of Expansion-Angle resp. -Pad

The length reductions of L-, Z- or U-elbows as well as those of the expansion pads thickness by thermal prestressing, is a well known and in the pipeline construction accepted technology, which will be mainly used for bigger dimensions and especially in the accepted “Operational Self Prestressing” technology. It will be used wherever essential change of length have to be compensated or if the normal calculated length cannot be reached by use of an expansion branch, due to local regulations.

Practically this minimisation can be reached by using the thermal prestressing procedure. This will be made by subsequent sanding and filling of the expansion pads. The first expansion of the pipes has not been compensated by the pads, only the remaining movement will be compensated by the pads. The static calculations will be made not with the effective pre-heating temperature [V_T], but with a hypothetical pre-heating temperature [V_{Tf}], in order to simulate the occurring friction forces [F'_R].

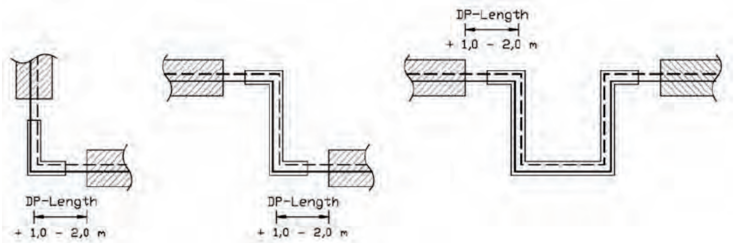
$$V_{Tf} = T_E + \frac{T_B - T_E}{3} \quad [°C] \qquad \text{i. e.:} \qquad V_{Tf} = 10 + \frac{130 - 10}{3} = 50\ °C$$

Because of this calculated necessary step, the first expansion of the pipeline will be no longer statically considered.

In contrary to the thermal prestressing at open pipe trench, no protocol will be required at the expansion branch- respectively expansion pad- prestressing. The working procedure can be carried out analogous to point **1.** and **2.** of the already described process. Fitting pieces will be not required. Thereafter the following working steps will be carried out:

1. Expansion pads will be assembled at L-, Z- or U-elbows in tension free position at cold pipeline. In contrary to the mechanical prestressing these areas will be **not** sanded and filled or compressed.

2. Now the complete PJP-pipeline will be sanded, filled and compressed up to approx. 1 - 2 m before the expansion pads, according to the standard and to the guidelines. The open areas can be seen from the **isoplus**-trench- respectively from the pre-heating design.

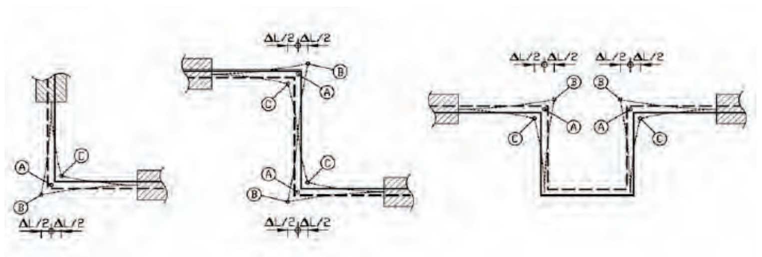


3. Thereafter the net will be put in operation or heated up to the effective prestressing temperature [V_T] of i. e. 70 °C (T_B = 130 °C), by use of a mobile prestressing unit.

4. As soon as V_T will be reached the sand-bed will be carried out at the still open padding areas in order to fill and to compress these pits thereafter. The prestressing temperature **has to be** kept constant. The expansion branches are now free of tension.

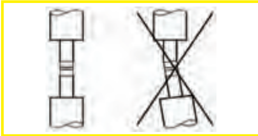
5. Therefore the first expansion will be not be compensated by the expansion pads and the branch will be pre-stressed about 50 %.

6. During heating to the maximum operating temperature [T_B] of i. e. 130 °C point ***A*** will move to ***B*** about $\Delta L/2$ respectively to ***C*** when cooling down to 10 °C also about only $\Delta L/2$.



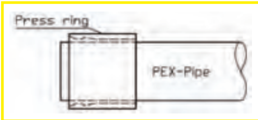
Edition: 16.01.2012

10.2.17 Assembling Connection Coupler isopex

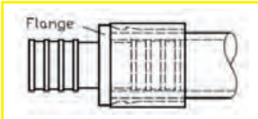


The **isopex**-pipe will be cutted rectangular, and insulated to a maximum lengths of 150 mm. Both pipe ends should touch straight respectively absolutely plain against each other, as this system allows generally no crease or angles.

After cutting and removing of insulation the pipes should be ridged by use of a suitable tool.



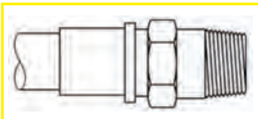
ATTENTION: The red diffusion barrier of the heating pipe may not be damaged. Thereafter the pressring has to be put on to the **isopex**-pipe and the PEX-ends should be enlarged two times by using a expanding pincer, for a period of 5 seconds and shifted by 30°.



The connection part should be put into the **isopex**-pipe end up to the stop position of the flange. Thereafter the press ring should be pressed to theflange of the connecting part; eventually a rubberor wooden-hammer may be used.

The press-pincer (can be bought or rented, see **chapter 7.2.1** will now put in position and pressing will be carried out in a way that the blocks of the pincer, respectively the rings will touch each other at the flange.

Before the pressing procedure all materials have to be cleaned. Lubricating of the pipe will be helpful. At assembling temperatures about ± 0 °C the carrier pipe should be warmed up carefully to ≈ 20 °C by using a hot air-blow

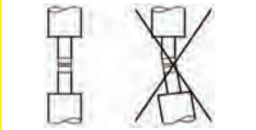


Fitting couplings will be assembled with the pipes to the outside thread or to the welding end. In case that a fitting coupling with press fitting and welding end will be used as end piece in the soil, the following has to be considered:

Before the fitting coupling will be pressed, a piece of steel pipe with a minimum length of 200 mm has to be closed with a torospherical head. This piece of steel pipe will be welded autogenously or electrically to the welding end. Thereafter the prepared component will be pressed on to the **isopex**-pipe. Post insulation will be made by use of a long-end coupler.

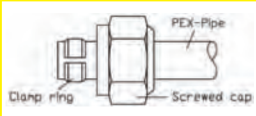
The next step of assembling will be to cut off the coupler and the torospherical head and the next fitting coupling will be welded. The previous pressing has to be cooled in order to avoid that it will get loose. Thereafter again the fitting coupling will be assembled on to the **isopex** pipe. Post insulation will be made by use of long-connection coupler. Possible kind of couplers see **capter 6.**

The **isopex**-pipe will be cutted rectangular, and insulated to a maximum lengths of 150 mm. Both pipe ends should touch straight respectively absolutely plain against each other, as this system allows generally no crease or angles.

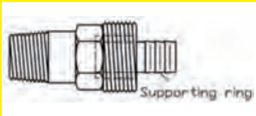


After cutting and removing of insulation the pipes should be ridged by use of a suitable tool.

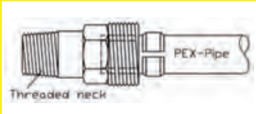
ATTTENTION: The red diffusion barrier of the heating pipe may not be damaged. Thereafter the screwed-caps should be pushed with the clampring on to the **isopex**-pipe.



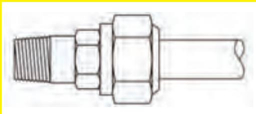
For pipe dimensions 90 and 110 mm the supporting ring should be pressed manually into the pipe, by using a rubber-hammer. Any damages of the support-ring and the pipe end should be avoided.



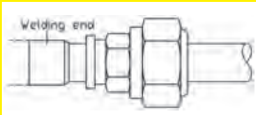
Now the **isopex**-pipe end should be pressed into the cylindrical-threaded-neck until to the stop position.



Thereafter the screwed-cap should be fixed sufficiently. Screwed connections for **isopex**-pipes with a minimum temperature of approx. 60 °C - 80 °C should be fixed again as soon as they have reached the operating temperature. For post insulation with PUR-foam at the connection spots, the temperature should be drop down to 45 °C.



In case of fitting couplings the assembling of the continuing pipe will be made to the outside thread or to the welding end.



10.3.1 General / Method of Pipe-Laying / Transition Free- to Buried Laying

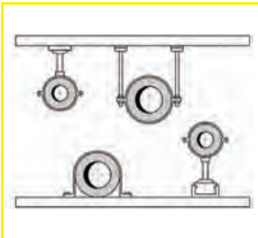
General

In case of spiro-fold jacket-pipes for open line constructions inside or outside of buildings, as well as in case of preinsulated PEHD-jacket-pipes inside of buildings, the pipe layer has to provide and to install the additional required assembling scaffolds, until the pipe laying and post-insulation works will be completed. Also a third party will be responsible for the procurement of the required support- and supporting structure, in pendulous construction, or sliding bearing.

The relevant regulations for prevention of accidents as well as the required combustion-, cold-, sonic-, heat-, or/and civil defence have to be kept. The pipe clamps respectively -bearings have to be fixed only at the jacket-pipe of all **isoplus**-pipes. This will effective avoid that any moisture-, cold-, or/and heat-bridges will occur.

Method of Pipe-Laying

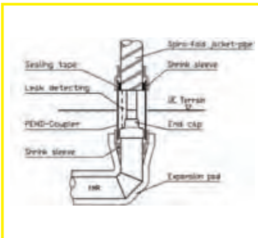
The pipe-laying can be made as high-, socle- or/and support line as well as on a pipe-bridge in spandrel-braced or hanging version. All methods of pipe-laying have to guarantee a sliding respectively pendulous bearing, due to the eventually occurring change of pipe length. It has to differentiate between compound and sliding system.



In case of a compound pipe the three frictional connected components (carrier pipe + insulation + jacket-pipe) will constantly expand in axial direction. At the sliding system only the carrier pipe will expand, because of the missing frictional connection to the insulation respectively to the jacket-pipe.

Transition Free- to Buried Laying

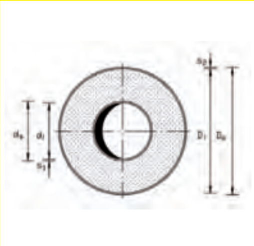
Providing that a static approval will be available, direct transitions from buried preinsulated pipes to open line layed spiro-fold jacket-pipes may be assembled without any restrictions. However it has to be considered that the last metal coupler should be installed 100 % outside of the soil-area.



Within this metal coupler an end cap has to be installed additionally as system-separation, according **chapter 10.2.12.** The upward PJP-elbow in the soil-area has to be equipped with expansion pads in accordance to the **isoplus**-trench-design.

10.3.2 Bearing Distance

Bearing Distance



In order to determine the possible respectively maximum admissible bearing distance [L_S] of a pipeline, the following parameter should be known:

⇒ Admissible pipe bowing [f] in mm
⇒ Moment of inertia of the pipe [I] in cm^4
⇒ Own pipe weight [F'_G] in kg/cm

The pipe bowing [f] in the middle of the field should be between 2 mm and maximum 4 mm.

For better interpretation the following formula are mentioned parallel with an example. For this will be valid: DN 150 (d_a = 168,3 mm; s_1 = 4,0 mm; d_i = 160,3 mm) with PUR-insulation and PEHD-jacket-pipe (D_a = 250,0 mm; s_2 = 4,5 mm; D_i = 241,0 mm). As carrier pipe a black steel (P235GH) filled with water has been considered.

The moment of inertia [I] will be calculated as follows:

$$I = \frac{\pi}{64} \bullet (d_a^4 - d_i^4) \; [cm^4] \quad \Rightarrow \quad I = \frac{3{,}1416}{64} \bullet (16{,}83^4 - 16{,}03^4) \; [cm^4]$$

Result: $I = 697{,}09 \; cm^4$

π	=	3,1416	[-]	d_a	=	Outside diameter jacket-pipe	[cm]
64	=	Constant	[-]	d_i	=	Inside diameter medium-pipe	[cm]

For the pipe weight force [F'_G] will be valid:

$$F'_G = G_{IR} + G_{DÄ} + G_{AR} + G_{MF} \; [kg/m] \quad \Rightarrow \quad F'_G = 16{,}25 + 1{,}87 + 3{,}30 + 20{,}18 \; [kg/m]$$

Result: F'_G = 41,60 kg/m or: F'_G = 0,416 kg/cm or: F'_G = 41,60 • 9,81 = 408,10 N/m

The single weight [G_{xy}] will be calculated as follows:

G_{IR} = Weight inside resp. carrier pipe $G_{IR} = (d_a - s_1) \bullet \pi \bullet s_1 \bullet l \bullet \rho_{IR}$ [kg/m] $G_{IR} = (1{,}683 - 0{,}04) \bullet 3{,}1416 \bullet 0{,}04 \bullet 10 \bullet 7{,}87$ Result: G_{IR} = 16,25 kg/m	$G_{DÄ}$ = Weight insulation $G_{DÄ} = [(D_i : 2)^2 - (d_a : 2)^2] \bullet \pi \bullet l \bullet \rho_{DÄ}$ [kg/m] $G_{DÄ} = [(2{,}41 : 2)^2 - (1{,}683 : 2)^2] \bullet 3{,}1416 \bullet 10 \bullet 0{,}08$ Result: $G_{DÄ}$ = 1,87 kg/m
G_{AR} = Weight outside resp. jacket-pipe $G_{AR} = (D_a - s_2) \bullet \pi \bullet s_2 \bullet l \bullet \rho_{AR}$ [kg/m] $G_{AR} = (2{,}5 - 0{,}045) \bullet 3{,}1416 \bullet 0{,}045 \bullet 10 \bullet 0{,}95$ Result: G_{AR} = 3,30 kg/m	G_{MF} = Weight filling of carrier pipe $G_{MF} = (d_i : 2)^2 \bullet \pi \bullet l \bullet \rho_{MF}$ [kg/m] $G_{MF} = (1{,}603 : 2)^2 \bullet 3{,}1416 \bullet 10 \bullet 1{,}0$ Result: G_{MF} = 20,18 kg/m

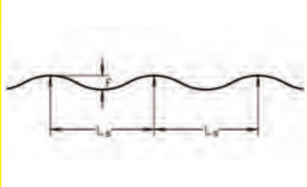
ρ_{xy}	=	Material apparent density			l	=	10	dm	
ρ_{IR}	=	7,87	kg/dm³	(Steel)	$\rho_{DÄ}$	=	0,08	kg/dm³	(PUR)
ρ_{AR}	=	0,95	kg/dm³	(PEHD)	ρ_{MF}	=	1,00	kg/dm³	(Water)

d_a	=	Outside diameter carrier pipe	[dm]	D_a	=	Outside diameter jacket-pipe	[dm]
d_i	=	Inside diameter carrier pipe	[dm]	D_i	=	Inside diameter jacket-pipe	[dm]
s_1	=	Wall thickness carrier pipe	[dm]	s_2	=	Wall thickness jacket-pipe	[dm]

For determining the bearing distance [L_S] for pipes on three bearings will be valid:

$$L_S = \sqrt[4]{\frac{f \bullet I}{F'_G \bullet 2{,}48}} \quad [m]$$

$$L_S = \sqrt[4]{\frac{4 \bullet 697{,}09}{0{,}416 \bullet 2{,}48}} \quad [m]$$



Result (PEHD-MR): L_S = 7,21 m

f	=	Admissible bowing	[mm]
I	=	Moment of inertia	[cm^4]
F'_G	=	pipe weight force	[kg/cm]
2,48	=	Constant	[-]

d_a = Outside diameter carrier pipe

s = Wall thickness carrier pipe acc. to **isoplus**

D_a = Outside diameter jacket-pipe

G = Weight pipe incl. water

f = Admissible pipe bowing

L_S = Bearing distance f. bearing to bearing

B_{SCH} = Required bearing- resp. clamp width

Dimensions carrier pipe				Jacket-pipe (MR) standard					
Norminal Diameter		Outside-Ø	Wall-thickn.	Outside-Ø	Weight	f = 2 mm		f = 4 mm	
DN	**Inches**	**D_a** in mm	**s** in mm	**D_a** in mm	**G** in kg/m	**L_S** in m	**B_{Sch}** in mm	**L_S** in m	**B_{Sch}** in mm
20	¾“	26,9	2,3	90	0,036	2,35	10	2,80	10
25	1“	33,7	3,6	90	0,044	2,75	20	3,27	20
32	1 ¼“	42,4	3,6	110	0,059	3,07	20	3,65	20
40	1 ½“	48,3	3,6	110	0,066	3,30	20	3,93	20
50	2“	60,3	3,6	125	0,090	3,73	30	4,43	30
65	2 ½“	76,1	3,6	140	0,120	4,16	30	4,95	40
80	3“	88,9	3,6	160	0,156	4,50	40	5,35	40
100	4“	114,3	3,6	200	0,235	5,07	50	6,03	60
125	5“	139,7	3,6	225	0,312	5,51	60	6,56	70
150	6“	168,3	4,0	250	0,422	6,04	80	7,18	100
200	8“	219,1	4,5	315	0,679	6,75	110	8,03	130
250	10“	273,0	5,0	400	1,006	7,42	140	8,82	170
300	12“	323,9	5,6	450	1,358	8,06	190	9,58	220
350	14“	355,6	5,6	500	1,592	8,31	200	9,89	240
400	16“	406,4	6,3	560	2,044	8,89	250	10,58	290
450	18“	457,2	6,3	630	2,527	9,22	280	10,97	330

Diameter in DN	Jacket-pipe (MR) 1x reinforced						Jacket-pipe (MR) 2x reinforced					
	Outside-Ø	Weight	f = 2 mm		f = 4 mm		Outside-Ø	Weight	f = 2 mm		f = 4 mm	
	D_a in mm	**G** in kg/m	**L_S** in m	**B_{Sch}** in mm	**L_S** in m	**B_{Sch}** in mm	**D_a** in mm	**G** in kg/m	**L_S** in m	**B_{Sch}** in mm	**L_S** in m	**B_{Sch}** in mm
20	110	0,041	2,27	10	2,70	10	125	0,046	2,21	10	2,63	10
25	110	0,049	2,67	10	3,17	20	125	0,054	2,61	10	3,10	20
32	125	0,063	3,01	20	3,58	20	140	0,068	2,96	20	3,52	20
40	125	0,071	3,25	20	3,87	20	140	0,075	3,20	20	3,80	20
50	140	0,095	3,68	20	4,38	30	160	0,102	3,62	20	4,30	30
65	160	0,127	4,10	30	4,88	30	180	0,134	4,05	30	4,81	30
80	180	0,163	4,45	40	5,29	40	200	0,171	4,40	30	5,23	40
100	225	0,245	5,01	50	5,96	50	250	0,256	4,96	40	5,90	50
125	250	0,323	5,46	60	6,50	70	280	0,337	5,40	50	6,43	60
150	280	0,437	5,99	80	7,12	90	315	0,470	5,88	70	6,99	80
200	355	0,704	6,69	100	7,95	120	400	0,734	6,62	100	7,87	110
250	450	1,043	7,35	130	8,74	160	500	1,083	7,28	120	8,66	150
300	500	1,398	8,00	170	9,51	200	560	1,449	7,93	160	9,43	190
350	560	1,643	8,25	190	9,81	220	630	1,740	8,13	170	9,67	210
400	630	2,141	8,79	230	10,45	270	670	2,183	8,75	220	10,40	260
450	670	2,569	9,19	270	10,92	320	710	2,614	9,15	260	10,88	310

All weight data are valid for carrier pipes acc. to **isoplus** with SPIRO-jacket-pipe **incl.** water content.

Edition: 16.01.2012

10.3.3 Pipe Clamps

Concerning the construction of pipe clamps we have also to differentiate between compound- and sliding system. At compound pipes the clamps may not obstruct the expected expansion movement, that means they have to include a sliding insert or they have to be fixed on axial-, and near to the expansion elbows also on lateral flexible pipe bearings.

In case of sliding systems the pipe clamps may be fixed directly at the jacket pipes, as this will move only slightly. In connection with thermoplastic jacket-pipes it will be possible, that changing of environment- respectively air-temperatures may cause a change of length. Therefore the bearing of the pipe clamps should be also flexible for sliding systems.

The pipe clamps has to be wide enough resp. should be equipped with a long enough bearing in order to avoid that the maximum admissible pressure load [σ_p] of the compound pipe will exceed. For PEHD- and Spiro-jacket-pipes as compound- and sliding system will be valid $\Rightarrow \sigma_p = \leq 0,15$ N/mm² !

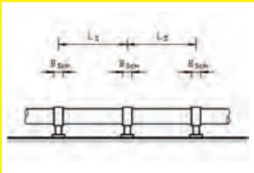
In circumference direction the clamp will be effective as a pipe bearing only to a third of the circumference length. From this the effective clamp length in circumference direction [U_L] will result:

U_L = $D_a \bullet \pi : 3$ [mm]

U_L = $250 \bullet 3,1416 : 3$ [mm]

Result: U_L = 261,8 mm

From the calculated bearing width [L_S] in m, weight force [F'_G] in N/m and circumference length [U_L] the following clamp width [B_{Sch}] will result under consideration of σ_p length direction of pipe:



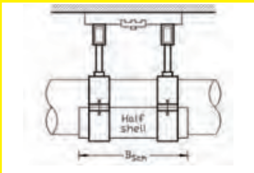
B_{Sch} = $L_S \bullet F'_G : \sigma_p : U_L \bullet S_D$ [mm]

B_{Sch} = $7,21 \bullet 408,1 : 0,15 : 261,8 \bullet 1,2$ [mm]

Result: $B_{Sch} = \approx 90$ mm

S_D = Safety correction value [-]

For bigger pipe dimensions a required clamp width > 200 mm can be possible. Because these clamps will be mostly not available, the required width can be distributed to a double clamp. A pipe half-shell should be put on this double clamp in order to distribute the weight. First then the **isoplus**-pipe will be layed in.



In case that the pipeline will be hanged by use of galvanized strap retainers at two spots instead of the double clamp, the installation of the half-shell will be strictly necessary. Strap retainers without pipe half-shells will damage the jacket-pipe.

Edition: 16.01.2012

10.3.4 Support Construction

Supports can be in pendulous-hanging or sliding spandrel-braced construction. The weight- load resulting from the support distance to the pipe-shell, which will effect as tensile stress in case of hanging construction and as compressive strain in case of spandrel-braced construction, has to be considered concerning the support variations. Of course may several pipes placed over- or under each other, the load will increase accordingly.

For fixing the supports at the construction substance (concrete ceiling, trapezoidal corrugations, steel-traverse etc.) sliding carriages will be used, which are moving in sliding rails. This construction allows the compensation of the axial expansion movement of the pipeline. Complete sliding sets will be used for the area of the expansion elbows, where also the lateral expansion has to be considered. The sliding sets have to be installed at the sliding carrier, turned about 90° to the rail.

If fixed bearings- respectively fix-points should be required in consideration with the project work, it will be sufficient to fix them frictional at the jacket-pipe, in case of the compound system. Fix-points for the sliding system "high temperature pipe" have to be installed at the carrier pipe. As fixed bearings also pre-fabricated fittings, see **chapter 2.2** and **2.3,** may be used. The axial force [F_{FL}] resulting from the straight section and compensated from the fixed bearing, will be calculated per pipeline as follows:

$$F_{FL} = F'_G \bullet \mu \bullet L_X \quad [N]$$

$$F_{FL} = 408{,}1 \bullet 0{,}1 \bullet 20{,}0 \quad [N]$$

Result: $F_{FL} = 816{,}2$ N

F'_G = pipe weight force [N/m]

μ = Friction number jacket pipe to support resp. clamp
⇒ Steel / Steel = 0,5 [-]
⇒ Polyethylene / Steel = 0,1 [-]

L_X = Pipeline length from fixed bearing to the next compensation spot [m]

Edition: 16.01.2012

10.4.1 Building Site - Quality Assurance

For building site it will be necessary to provide a guideline for a quality performance of the single working steps, in order to reach an optimization of the installing situation for preinsulated jacket pipes. This guideline will be valid in the same manner for civil underground engineering, pipe layer and pipe manufacturer.

Working Step	Execution and result
Pipe-bars - storage outside of the trench	- Piling of pipe bars on sand-bed or wide squared timber, which will avoid a pressing of the insulation; lateral security of pile in accordance to height
Storage of fittings	- Stored horizontal on stone-free ground and ordered to dimensions
Accessories - storage of sealing rings, couplers, expansion pads etc.	- Storage in container, or protected against weather conditions
Storage of PUR-foam and shrinking material	- Stored in ambient temperature without direct sun irradiation
Functional check and co-ordination of the tools for the relevant working steps	- Professional work can be only reached with suitable tools
Putting in place of PJP-pipes and components	- Correct transport into the trench by use of textile belts Storage on squared timber, sand sacks or PUR-foam supports; ground clearance of at least 10 cm between pipe and trench bottom or sand-bedding with head-holes.
Alignment of pipes and fittings in the trench	- Positioning of the leak detecting wires in accordance to the suppliers guideline. - Slip over the coupler at the area of the welding spot
Welding of pipes and fittings	- Considering of the instructions of the detailed estimate and the technical requirements for the later operating conditions - Mitre cuts max. 3° at sliding area and 5° at bonding area. - Weld seam test and release
Creating of working space for coupler assembling	- Bearings should be at least in a distance of 1 m from the welding seam; head-holes has to be carried out in a way that a unimpeded working procedure according to the supplier guidelines will be possible
Providing of fitting length	- Correct remove of insulation at the pipe ends of at least 150 mm without damage of the alarm wires Do not leave cold water filling in the carrier pipe.
Checking of pipeline before coupler assembling	- Temperature of carrier pipe max. 45 °C, at least more than 15 °C. - Do not cut fittings and fitting pieces too much, in order to guarantee the required coupler support. - Consider space requirement and technical practicability for the assembling fittings which will be carried out by the coupler assembler

See **isoplus**-assembling term - **chapter 11.5.2**

11 HANDLING POST INSULATION

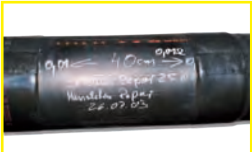
11 HANDLING POST INSULATION

11.1 General

11.1.1 Description

All carrier pipe connections have to be insulated and sealed with connection couplers and PUR-foam after recording of the agreed pressure tests. For warranty reasons these works, except of **isocompact**®-coupler, should be carried out by **isoplus**-educated assembling specialists, approved by AGFW- and BFW institute. The **isocompact**®-coupler may be used by the pipe laying company for independent post-insulation at the connection spots, except of double pipes.

All coupler connections made by **isoplus** will be clearly and durable marked by the installer, this includes:



⇒ Date of foaming
⇒ Length of coupler (hollow space)
⇒ Assembling date of sleeves
⇒ Name of installer
⇒ Resistance values **IPS-Cu**® or **IPS-NiCr**®

This mark will allow a detailed identification of the executing installer and will increase the quality safety with their requirements. In case that the post-insulation should be nevertheless carried out by a third party, their ability has to be checked by presenting the AGFW-/BFW-test certificate before starting the assembling work. **isoplus** has to be informed about this in advance.

Current assembly-instructions of all **isoplus** connection-couplers are available in our download-section at www.isoplus.org .
Detailed information on wiring the leak detection and the differing wiring regulations for branching, as well as tables for the foam quantities to be used for the differing casing joint types, are also available in this section.

The preparing working steps 1. to 11. are valid concerning all coupler constructions delivered by **isoplus**. Additionally the **isoplus**-assembling conditions, see **chapter 11.5.2** have generally to be considered.

ATTENTION: Assembling works have to be carried out always with working overall and if necessary with gloves and protection glasses as well as in accordance with the general regulations for preventing accidents (UVV) requested protection clothes.

11.2.1 Survey

#	Coupler construction / -type	PEHD Shrinkable	isojoint X®	isojoint III®	Electro-Welding®	isocompact®	Spiro
1	Pressure set with pump and manometer	✓	✓		✓		
2	Workman's overall	✓	✓	✓	✓	✓	✓
3	Working gloves	✓	✓	✓	✓	✓	✓
4	Binding wire	✓	✓		✓		✓
5	Drilling set, ø = 4, 6 and 10 mm	✓	✓		✓		✓
6	Drilling machine (Akku or 230 V)	✓	✓		✓		✓
7	Triangular scraper	✓	✓		✓		✓
8	High-grade-steel strap retainer				✓		
9	Gas-burner set	✓	✓	✓	✓	✓	eventual
10	Hammer, ca. 150 gramme	✓	✓	✓	✓	✓	✓
11	Hand-broom	✓	✓	✓	✓	✓	✓
12	Wood-driller with stopper	✓	✓		✓		
13	Insulation adhesive tape, 40 mm, if required	✓	✓	✓	✓	✓	✓
14	Cable drum, if required	✓	✓		✓		✓
15	Cartouche-press, if required						✓
16	Marker, white + black (water resistant)	✓	✓	✓	✓	✓	✓
17	Measuring tape and meter stick	✓	✓	✓	✓	✓	✓
18	Tongs for rivets						✓
19	PE-burr-remover resp. -scraper	✓	✓		✓		
20	PE-cleaner resp. fat solvent	✓	✓	✓	✓	✓	✓
21	Propane-liquid gas bottle	✓	✓	✓	✓	✓	eventual
22	Cleaning rag, fluffy free	✓	✓	✓	✓	✓	✓
23	Umbrella if required	✓	✓	✓	✓	✓	✓
24	Stirring set for drilling machine	✓	✓		✓		✓
25	Hand-saw	eventual		✓		✓	eventual
26	Peel-driller, conical, size M 3	✓	✓		✓		
27	Foaming machine, starting from Da ≥ 315 mm	✓	✓		✓		✓
28	Scissors	✓	✓	✓	✓	✓	
29	Emery linen, 50 mm, grain 60	✓	✓	✓	✓	✓	
30	Set of screwdrivers, kirve and cross	✓	✓		✓		✓
31	Protecting glasses	✓	✓	✓	✓	✓	✓
32	Welding transformer / -machine (400 V)				✓		
33	Welding pincers				✓		
34	Stretch band, at least 2 pieces	eventual					✓
35	Sprayer with soap-water	✓	✓		✓		
36	Steel brush	✓	✓	✓	✓	✓	✓
37	Mortise chisel	✓	✓		✓		✓
38	Compass saw	eventual					
39	Plug-welding machine(230 V)	✓	✓		✓		
40	Current aggregate, if required	✓	✓		✓		✓
41	Tapestry roller	✓	✓		✓		
42	Temperature probe	✓	✓	✓	✓	✓	eventual
43	Carpet knife	✓	✓	✓	✓	✓	

#	Type of leak detecting	IPS-Cu®	IPS-NiCr®
45	Wire distance holder, per coupler 2 pieces	✓	✓
46	Electro pincer set (strip the insulation, press, cutter, kombi)	✓	✓
47	**isoplus**-hand-system tester, type IPS-HST	✓	✓
48	Soldering burner	✓	✓
49	Soldering tin	✓	
50	Pinch husks	✓	✓
51	Shrinking tube		✓

#	Assembling fitting	Coupler	Elbow	Branch
52	Extruder welding unit (220 V), starting from D_a = 225 mm	✓	✓	✓
53	Hot-air welding unit (220 V), up to D_a = 200 mm	✓	✓	✓
54	PE-welding wire	✓	✓	✓
34	Stretch bands	✓	✓	✓

Edition: 16.01.2012

11 HANDLING POST INSULATION

11.2 Assembling Tools

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

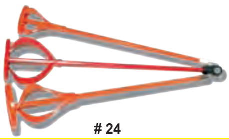
21

22

23

25

27



24

26

28

29

32

34

30

31

33

35

36

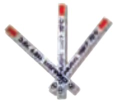
37

38

39

40

41



42

43

45

47

50

46

48

49

51

52

53

54

Edition: 16.01.2012

11.3.1 PEHD - Shrinkable Coupler

Heat-shrinkable PEHD-pipe

two shrink-sleeves

Butyl-rubber-sealing tape

two PE-venting- and weldable plugs each

two heat shrinkable PE-hole-lockers

Working Procedure

Technical description see **chapter 6.2.2**

Current assembly-instructions of the PEHD-Shrinkable Coupler are available in our download-section at www.isoplus.org .

11.3.2 isojoint X® - Shrinkable Coupler

Heat-shrinkable
cross linked
PEHD-pipe

Butyl-rubber-
sealing tape

two PE-venting- and
weldable plugs each

Working Procedure

Technical description see **chapter 6.3.2**

Current assembly-instructions of the isojoint X-Shrinkable coupler are available in our download-section at www.isoplus.org .

11.3.3 isojoint III® - Shrinkable Coupler

Heat-shrinkable
cross linked
PEHD-pipe

PE-X-shrinking foil
with sealing compound

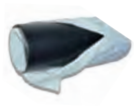
Butyl-rubber-
sealing tape,
extra wide

Working Procedure

Technical description see **chapter 6.4.2**

Current assembly-instructions of the isojoint III - Shrinkable coupler are available in our download-section at www.isoplus.org **.**

11.3.4 Electro - Welding Coupler©



Heat-shrinkable PEHD-pipe

two processor controlled copper-heat conductors

two PE- venting- and weldable plugs each

two heat shrinkable PE-hole-lockers

Working procedure

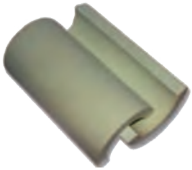
Technical description see **chapter 6.5.2**

Current assembly-instructions of the Electro - Welding coupler are available in our download-section at **www.isoplus.org** **.**

11.3.5 isocompact® - Coupler

Heat-shrinkable totally cross linked PEHD-pipe

Butyl-rubber-sealing tape, extra wide



a two-parted insulation shell made of PUR-hard foam

PE-shrinking foil with sealing compound

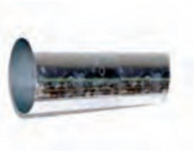
Working Procedure

Technical description see **chapter 6.6.2**

Current assembly-instructions of the isocompact - coupler are available in our download-section at www.isoplus.org .

Edition: 16.01.2012

11.3.6 Spiro-Coupler



separated sheet metal-socket-pipe

Butyl-rubber-sealing tape

one sheet metal and venting plug each

blind- resp. machine-rivets

Working procedure

Technical description see **chapter 6.7.2**

Current assembly-instructions of the Spiro - coupler are available in our download-section at **www.isoplus.org** .

11.3.7 Reduction - Shrinkable Coupler

Delivery range and technical description see **chapter 6.8.1** and **6.8.2**

11.3.8 Double Reduction - Shrinkable Coupler

Delivery range and technical description see **chapter 6.9.1** and **6.9.2**

11.3.9 Shrinkable End Coupler

Delivery range and technical description see **chapter 6.10.1** and **6.10.2**

Assembly instruction for reduction coupler, double reduction coupler and shrinkable end coupler are the same like PEHD shrinkable coupler.

They are available in our download-section at **www.isoplus.org**.

Edition: 16.01.2012

11.3.10 Assembling Connection Coupler / Assembling Parts

Assembly shrinking joints, bends, branch fittings, and short circuits must be separated in an axial direction during assembly, folded over the carrier pipe connection, and subsequently welded in accordance with the HDPE hot air or extrusion process.

Assembly parts should GENERALLY BE AVOIDED FOR QUALITY and WARRANTY REASONS !

Usage of these components is therefore restricted to absolute EXCEPTIONS (!!!); manufacturing may only take place at the EXPRESS WRITTEN request of the client and at the client‘s own risk.

Assembly joints/assembly fittings do NOT meet the requirements and regulations of EN 253 !

Edition: 16.01.2012

11.3.11 Assembling Half-Shells

Two half shells as elbow 90° or branch 90°	Nirosta-6-edge-screws M8x40	Butyl-rubber-sealing tape	Reducing rings (eventually)	Stroke plug with sealing cap	prefabricated PUR-Foam package

Working procedure

Technical description see **chapter 3.6**

Current assembly-instructions of the Assembling Half-Shells are available in our download-section at www.isoplus.org .

11.4.1 Foam-Table

Tables for the quantity of components A (polyol) and B (isocyanate) to be used for the different joint constructions are available in our download section at www.isoplus.org

The liter quantities [ltr] given in the tables are valid for a standard weight of the joint foam of 80 kg/m^3 as well as for a length [L] of 440 mm of the non-insulated pipe section (carrier pipe). For other lengths [L] in mm, the required foam quantity [V] is calculated on the basis of the given quantities [v'] (= A, B or ∑) using the following simple rule of three:

$$V = v' \bullet L / 440 \quad [\text{ltr}]$$

The stated liters apply to a processing or air temperature of ≥ + 20 °C. At lower temperatures, these quantities must be multiplied by the correction factor of 1,3.

11.5.1 for Building Site - Quality Assurance

For building site it will be necessary to provide a guideline for a quality performance of the single working steps, in order to reach an optimization of the installing situation for preinsulated jacket pipes. This guideline will be valid in the same manner for civil underground engineering, pipe layer and pipe manufacturer. The most important test parameters are listed chronologically in the following table in accordance with the construction progress.

Working step	Execution and result
Considering of the working information from the corresponding system manufacturer	- The correct function of the total system is depending essentially from the consideration of all execution guidelines.
Consideration of the wiring	- Wiring regulations and building site execution have to be congruent for a later fault location
Measuring of the pipeline in sections	- Recording of the measuring values in sections Receipt of an individual standard value for the pipeline in order to evaluate modifications later on Correct electrical transmission on the complete system
Pricking out of the frontal PUR-foam of the factory produced pipes and fittings	- Avoiding of construction moisture in the couplers
Checking of reaction and validity of the PUR-foam components	- Testing of required reaction and quality of foam by providing of test-foam before the real local foaming procedure
Keeping of the temperature conditions for foaming	- Outside temperature at least 15° C, steel pipe not warmer than 45° C, in case of variation; providing of special measurements; foaming works may be not carried out at air temperatures below + 5° C and at a relative humidity above 90 %; works in the open should be avoided during rain - In case that these requirements cannot be kept, additional special measurements, i. e. weather protection, pre-heating of the pipelines, have been provided by the buyer

See **isoplus**-Assembling Conditions **chapter 11.5.2**

Working Steps	Execution and result
Destroying test of single couplers by taking drill-cones of 30 mm diameter or testing of the total coupler-foam	- Consideration of the quality guidelines of EN 253 and EN 489 for apparent density, cell size, water absorption, pressure resistance of the PUR-foam produced at building site
Preparing of a rough surface at the area of the shrinkable sleeves at the jacket- and socket-pipe, free from lubrication	- Creating of optimal compound conditions of the sleeves on the PEHD-surface
Heating of the coupler- and jacket-pipe for improving of the compound and heating of the sleeve	- Correct flow of the melt adhesive and lateral penetration as sign for a complete heating of the area
Thumb test	- Wrinkling should immediately disappear when moving the sleeve with the thumb, due to swimming on the melt-adhesive
Ring-liquefied strength	- Tight position and correct sealing at the sleeve edges
Proportional support on coupler- and jacket-pipe	- Sleeve should be positioned constant on coupler- and jacket-pipe
Destroying test	- Check of compound strength on the underground. Removing of the sleeve in cold condition The sleeve should be removable only in small pieces and not totally in one piece
Pressure test with 0,2 bar with foam producing agent	- Demonstration of the tightness of all functional sealing areas and seams
Obvious check and inner pressure test of the seams (PEHD)	- Keeping of a constant heated and correct filled welding seam
Installing of side-pads in stripes	- Strong sticking of the expansion pad stripes on the PEHD-jacket-pipe, later filling may not loosen the pad
Installing of stripe pads with laminate covering or expansion pad complete covering	- Expansion pads should cover the pipe completely and should also tighten frontal, in order that no sand may penetrate; good push-type overlapping will be required
Leak detecting: Check of the total system after filling of the trench	- A final measurement of the pipelines in operation will result in final data which may be used for later comparisons

See **isoplus**-Assembling Conditions **chapter 11.5.2**

11.5.2 isoplus - Assembling Conditions

for executing of insulation- and sealing works at district heating compound systems by AGFW-/BFW-approved and isoplus- factory educated assembling engineers

1. In order to assure a qualitative optimal and exact terminated post insulation, an announcement in advance of at least five working days and during the months July, August, September and October even eight working days have to be considered. The execution of the insulation and sealing works will last approximately as long as the time for the pipe laying- and welding works.

2. The exact terminated completion of the works will depend from the detailed information about the extent of the works. **isoplus** will be not responsible for exceeding of the agreed date of completion, due to not sufficient information.

3. The pipe layer will be exclusively responsible for providing of all required system accessories for post insulation works (PUR-foam, shrinkable sleeves, expansion pads etc.) as well as for a dry, frost-free and protected against direct sun irradiation storing in a lockable room or container. PUR-foam has to be stored at temperatures between + 15° C and + 25° C. The maximum storing period is 3 month.

4. In case of building ducts the delivered end- respectively shrinkable caps have to put on without any damage before the later welding works. During the welding works these parts have to be protected against heat and combustion. In case that this cannot be guaranteed, so called zip-end caps should be ordered and assembled. Standard end caps may not be cut off.

5. The completeness of all delivered accessories has to be checked and confirmed by the pipe layer at receipt of the material. Complaints will be accepted only within three days. Only the pipe layer will be responsible for any material which will disappear during the construction period.

6. The pipe layer will be generally responsible to drain the pipe trenches and to keep them free until the post insulation works will be completed, according to DIN 4033, section 5.3. The trenches have to be constructed according to the regulations of the Employer's Liability Insurance Association. The **isoplus**-laying guidelines have to be considered additionally.

The assembling progress as well as the quality of all required works, and therefore the expected lifetime of a district heating pipeline will essentially depend from a trench construction which will fulfill all regulations and guidelines.

7. PEHD-assembling fittings should be used only exceptionally, due to assembling technology reasons. These parts have to be checked and approved before using, by our technical departments concerning pipe-static. A production will be made only on written request. Sufficient construction space as well as a both side support should be available in order to produce assembling fittings at site.

8. For open line constructions the pipe layer has to install and to hold the required assembling scaffolds acc. to DIN 4420 free of charge, until completion of all laying- and post insulation works. The Employer's Liability Insurance Association regulations for prevention of accidents have to be considered.

Edition: 16.01.2012

9. Post insulation in manholes, buildings or channels will be only carried out if a sufficient ventilation and aeration can be granted at site. If this will be not the case, the shrinking works cannot be carried out.

10. Foaming works may not be carried out at air temperatures below + 5° C and at a relative humidity of more than 90 % as well as during rain. In case that this will be not possible, additional measurements, i. e. weather protection or pre-heating, has to be provided by the purchaser. The temperature of the system components, the PEHD-jacket-pipe and the carrier pipe should be at least + 15° C, however may not exceed + 45° C. As executing party of the insulation and sealing works, **isoplus** will have the right to stop or to postpone the post insulation works in case of unfavourable weather conditions.

11. The disposal of all waste resulting from the insulation and sealing works will be on charge of the pipe-layer. The **isoplus**-assemblers will pack the waste in waste-sacks and will deposit it at the agreed collection place. The disposal of PUR-waste will be made via a house-waste-garbage, according to the kind of waste catalogue of the German Environment Department, according to waste-key-number 57110 for hardened PUR-foam. The liquified Polyol- and Isocyanat-components have to be deposit at a special-waste-garbage according to the waste-key-number 57202.

12. During installation of the final components of the leak detection the pipe-layer has to assure that all buildings, manholes etc. will be accessible and not closed.

13. Additional works which will be not to **isoplus** charge, will be generally invoiced separately. This will include:

⇒ Additional approach and additional departure as well as overnight stay due to not sufficient information respectively not sufficient preparations.

⇒ Not considering of the **isoplus**-laying guidelines, especially concerning sufficient assembling space at the areas of the couplers, assembling fittings and expansion pads.

⇒ Cleaning works at the accessories and the welding spots, which are caused by not correct storage and not according to DIN prepared trenches.

⇒ Repairing of complaints at system components, caused by a third party.

⇒ Fees for waste disposal which has been charged to us.

⇒ Additional approaches to building site in case of less than eight couplers for post insulation.

14. The purchaser will be obliged to confirm the assembling reports after completion of the insulation and sealing works.

15. For all kind of documentation which will be required during assembling but which has been not agreed, respectively which was not included in the offer, **isoplus** will invoice according to the occurred additional extra works and the actual **isoplus**-rate per hour. This will be also valid for eventual required technical documents, like master drawings, static calculations, wiring drawings etc.

Edition: 16.01.2012

12 PROJECT WORK

12.1 Rigid Compound Systems

12.2 Flexible Compound Systems

12.1.1 General / Compound System / Laying Technology

General

The preinsulated jacket-pipe (PJP) is proved practically since decades. In comparison with other conventional laying systems it offers essential advantages concerning **eco**nomical, **eco**logical and technical aspects.

An exact knowledge of the functional properties of the PJP-system will be necessary in order to use these advantages, because extensive special knowledge will be required for the project work.

Corresponding technical working resources have to be provided for the designing engineer, in order to develop economical useful and efficient district heating net works. In the following sections an introduction into the static knowledge will be given. This will however not cover the total extent of all projection work situations.

Therefore the **isoplus**-design engineers will be additionally available at each phase of construction, from tender up to execution and documentation, in order to work out all kind of information and required calculations for any individual problem.

The **eco**nomical situation of the district heating requires to check the limits of pipe static calculations as well as the part-safety correction values [γ_M] of the used materials to a large extent. Therefore the design criteria have to be considered with high attention. This will be guaranteed only by using the latest EDV computing programs.

Compound System

Carrier- and PEHD-jacket-pipe are non-positive connected with each other via the PUR-hard foam as a compound (compound system). Therefore this pipe system respectively laying technology will differentiate essentially compared to conventional procedures.

These special characteristics have to be considered during design and also during pipe laying, in order to guarantee a safe operation and a long lifetime of the PJP-pipeline.

Further information to project work is available in our download area **www.isoplus.org**

In case of thermal load all three components carrier pipe, PUR-foam and PEHD-jacket-pipe will expand axial constant, in the opposite to other pipe systems. Therefore all occurring external forces from soil and traffic loads as well as friction between jacket-pipe and surrounding soil (sand bed), will be transmitted on the carrier pipe. Due to the combined effect of these external as well as internal forces, caused by thermal expansion, several tensions will occur, which have to be taken from the compound system.

Because of this limiting values will occur, which have to be considered at design and assembling. The **isoplus**-PJP-systems may be used up to temperatures at minimum acc. to EN 253. On request a corresponding test certificate from an official material test authority (AMPA) can be seen.

Detailed and extensive static calculations will be required at higher temperatures as in EN 253 because this temperatures will cause enormous axial expansions and forces. Therefore the type of burden has to be checked exactly before beginning of the design, because admissible material parameter may reach their limit.

Laying Technology

Pipe laying procedures will be differentiated essentially between Cold Laying and Hot Laying. These two main groups will be characterised again by five different technologies. According to the local regulations respectively restrictions of the pipeline which has to be designed as buried pipeline, among the following five laying procedures can be chosen:

Cold Laying

1) Cold Laying
   without limitation of admissible laying length
   but with limitation of temperature to maximum 85 °C

2) Conventional Laying
   with limitation of admissible laying length
   and temperature according EN 253

3) Operative Self Prestressing
   without limitation of admissible laying length
   but with limitation of temperature to maximum 130 °C

Hot Laying

4) Thermal Prestressing
   without limitation of admissible laying length
   but with prestressing in **not** filled pipe trench and limitation of
   temperature according EN 253 (preheating temperature = average temperature)

5) One-Time-Compensator-System
   without limitation of admissible laying length
   but with prestressing in filled pipe trench with limitation of temperature
   according to EN 253 (preheating temperature according to static calculation)

Edition: 16.01.2012

12.1.2 Survey Ad- and Disadvantages

Laying Technology		Advantage	Disadvantage
Cold Laying	1) Cold laying	- Slight axial tension from heat extension - Pipe trench may be filled immediately	- Maximum admissible operating temperature ≤ 85 °C
Cold Laying	2) Conventional laying	- The maximum admissible axial tension will not exceed - Pipe trench may be filled immediately	- The maximum admissible laying length has to be kept by placing of the required expansion sides (L, Z, U)
Cold Laying	3) Operative Self Prestressing	- Pipe trench may be filled immediately - Saving of expansion sides - also possible in the gliding area	- Extremely axial expansion movements - Danger of buckling - Axial tension exceeding the yield point of steel - Tapping branches will be not possible later on
Hot laying	4) Thermal Prestressing	- Limitation of axial tension - any desired laying length - Low axial expansion - Saving of expansion sides	- Pipe trench has to be kept open until prestressing will be finished - Depending from method an adjustable operational medium or a 380 V supply connection will be necessary
Hot laying	5) One-Time-Compensator-System	- Pipe trench may be filled immediately, except of the one-time-compensators - Saving of expansion sides	- The higher the temperature, the more compensators will be required - The assembling pits have to be kept open until preheating

12.1.3 Admissible Laying Length L_{max} Single Pipe at convent. Laying

Dimensions Carrier Pipe				Jacket-Pipe Outside-Ø D_a in mm			L_{max} at a covering height [$Ü_H$] from upper edge, upper-edge-Jacket pipe (JP) up to upper-edge-terrain								
Nominal Diameter in		Outside-Ø d_a in mm	Wall-thickness acc. to **isoplus** in mm				$Ü_H$ = 0,80 m			$Ü_H$ = 1,20 m			$Ü_H$ = 1,60 m		
				Insulation Class			Insulation Class			Insulation Class			Insulation Class		
DN	Inches			Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.	Standard	1x reinf.	2x reinf.
20	¾“	26,9	2,6	90	110	125	56	45	40	38	31	27	29	23	20
25	1“	33,7	3,2	90	110	125	87	70	61	59	48	42	45	36	32
32	1¼“	42,4	3,2	110	125	140	90	79	70	61	54	48	47	41	36
40	1½“	48,3	3,2	110	125	140	104	90	80	71	62	55	54	47	42
50	2“	60,3	3,2	125	140	160	114	101	88	78	69	60	59	53	46
65	2½“	76,1	3,2	140	160	180	129	111	98	89	77	68	67	59	52
80	3“	88,9	3,2	160	180	200	131	115	102	90	80	71	69	61	54
100	4“	114,3	3,6	200	225	250	148	130	115	103	91	81	79	70	62
125	5“	139,7	3,6	225	250	280	159	141	124	111	99	88	86	76	68
150	6“	168,3	4,0	250	280	315	187	165	145	132	117	103	102	91	80
200	8“	219,1	4,5	315	355	400	210	183	159	150	131	115	116	102	90
250	10“	273,0	5,0	400	450	500	218	190	167	158	138	123	124	109	97
300	12“	323,9	5,6	450	500	560	249	220	192	182	162	142	144	128	112
350	14“	355,6	5,6	500	560	630	240	210	181	177	155	135	140	123	108
400	16“	406,4	6,3	560	630	670	266	231	214	198	173	160	157	138	128
450	18“	457,2	6,3	630	670	710	257	238	222	193	179	168	154	144	135
500	20“	508,0	6,3	670	710	800	262	244	210	198	185	160	159	149	130
600	24“	610,0	7,1	800	900	1000	278	240	209	214	185	163	173	151	133
700	28“	711,0	8,0	900	1000	-	309	270	-	240	211	-	196	173	-
800	32“	813,0	8,8	1000	1100	-	332	294	-	261	232	-	215	192	-
900	36“	914,0	10,0	1100	1200	-	368	329	-	292	262	-	242	218	-
1000	40“	1016,0	11,0	1200	1300	-	359	324	-	287	260	-	239	217	-

The values given in the table are based on the AGFW guideline FW 401 Part 10 and apply to soils with a specific weight of 19 kN/m³, a maximum permitted shear stress [τ_{PUR}] of ≤ 0.04 N/mm² and an angle of internal friction [φ] of 32.5°, and for black carrier pipes, material P235GH (welded or seamless), No. 1.0345, wall thickness in accordance with **chapter 2.2.2** or **2.2.3**.

Maximum permitted axial stress [σ_{zul}] in a straight pipe = 190 N/mm², with a maximum operating temperature [T_B] of 130° C and a nominal pressure of PN 25. Depending on the T_B and depth of cover [$Ü_H$] a laid length of ≥ 120m can cause an axial elongation [ΔL] of >80 mm. This ΔL causes an expansion pad thickness [DP_s] of > 120 mm.
The PEHD casing pipe temperature is limited to a maximum of 60° C according to AGFW FW 401, which in turn means a maximum permissible DP_s of 120 mm. If there is then an ΔL von > 80 mm, the expansion leg or pad should be pre-tensioned.

Further information to project work is available in our download area **www.isoplus.org**

Edition: 16.01.2012

12.1.4 Admissible Laying Length L_{max} Double Pipe at convent. Laying

Dimensions Carrier Pipe				Jacket-Pipe-Ø D_a in mm		Spread [K]	L_{max} at covering height [$Ü_H$] from upper edge upper-edge-Jacket Pipe (JP) up to upper edge-terrain					
Double Pipe Type		Outside-Ø d_a in mm	Wall-thickness **isoplus** in mm	Insulation Class			$Ü_H$ = 0,80 m		$Ü_H$ = 1,20 m		$Ü_H$ = 1,60 m	
							Insulation Class		Insulation Class		Insulation Class	
DN	Inches			Standard	1x reinf.		Standard	1x reinf.	Standard	1x reinf.	Standard	1x reinf.
20	3/4“	26,9	2,6	125	140		63	57	43	39	33	30
25	1“	33,7	3,2	140	160		78	69	54	48	41	36
32	1¼“	42,4	3,2	160	180		86	77	60	54	46	41
40	1½“	48,3	3,2	160	180		97	87	68	61	52	47
50	2“	60,3	3,2	200	225		96	86	68	61	52	47
65	2½“	76,1	3,2	225	250	20 K	106	95	75	68	58	53
80	3“	88,9	3,2	250	280		108	97	77	69	60	54
100	4“	114,3	3,6	315	355		119	106	86	77	68	60
125	5“	139,7	3,6	400	450		108	96	80	71	63	56
150	6“	168,3	4,0	450	500		123	111	92	83	73	66
200	8“	219,1	4,5	560	630		134	119	102	91	82	73

Type	Spread [K]	$Ü_H$ = 0,80 m		$Ü_H$ = 1,20 m		$Ü_H$ = 1,60 m	
		Insulation Class		Insulation Class		Insulation Class	
		Standard	1x reinf.	Standard	1x reinf.	Standard	1x reinf.
20		58	52	40	36	30	27
25		72	63	50	44	38	33
32		79	71	55	49	42	38
40		89	80	62	56	48	43
50		88	79	62	56	48	43
65	30 K	97	88	69	62	53	48
80		99	89	71	64	55	50
100		110	97	79	71	62	56
125		100	88	73	65	58	52
150		114	102	84	76	67	61
200		124	109	94	83	76	67

Type	Spread [K]	$Ü_H$ = 0,80 m		$Ü_H$ = 1,20 m		$Ü_H$ = 1,60 m	
		Insulation Class		Insulation Class		Insulation Class	
		Standard	1x reinf.	Standard	1x reinf.	Standard	1x reinf.
20		53	48	37	33	28	25
25		66	58	45	40	35	31
32		72	65	50	45	39	35
40		82	73	57	51	44	39
50		81	72	57	51	44	39
65	40 K	89	80	63	57	49	44
80		91	81	65	58	50	45
100		100	89	73	65	57	51
125		91	81	67	60	53	47
150		104	93	77	70	62	56
200		113	100	86	76	69	62

Type	Spread [K]	$Ü_H$ = 0,80 m		$Ü_H$ = 1,20 m		$Ü_H$ = 1,60 m	
		Insulation Class		Insulation Class		Insulation Class	
		Standard	1x reinf.	Standard	1x reinf.	Standard	1x reinf.
20		48	43	33	30	25	23
25		59	52	41	36	31	28
32		65	58	46	41	35	31
40		74	66	52	46	40	36
50		73	65	52	46	40	36
65	50 K	81	73	57	52	44	40
80		82	74	59	53	46	41
100		91	81	66	59	52	46
125		83	73	61	54	48	43
150		94	84	70	63	56	50
200		103	91	78	69	63	56

Type	Spread [K]	$Ü_H$ = 0,80 m		$Ü_H$ = 1,20 m		$Ü_H$ = 1,60 m	
		Insulation Class		Insulation Class		Insulation Class	
		Standard	1x reinf.	Standard	1x reinf.	Standard	1x reinf.
20		43	39	30	27	23	20
25		53	47	37	32	28	25
32		59	52	41	37	31	28
40		66	59	46	41	35	32
50		66	59	46	41	36	32
65	60 K	72	65	51	46	40	36
80		74	66	53	47	41	37
100		81	72	59	53	46	41
125		74	65	54	48	43	38
150		84	76	63	56	50	45
200		92	81	70	62	56	50

If the double-pipe is being thermal stressed, the three components carrier pipes, PUR foam and PEHD jacket pipe, in contrast to others pipe systems, stretch axially on the effective average temperature between forward and reverse.
For the **isoplus** double pipe the maximum laying length [L_{max}] is depending on the depth of cover [$Ü_H$] and spread [K].

The values given in the table are based on the AGFW guideline FW 401 Part 10 and apply to soils with a specific weight of 19 kN/m³, a maximum permitted shear stress [τ_{PUR}] of ≤ 0.04 N/mm² and an angle of internal friction [φ] of 32.5°, and for black carrier pipes, material P235GH (welded or seamless), No. 1.0345, wall thickness in accordance with **chapter 2.3.2** or **2.3.3**.
Maximum permitted axial stress [σ_{zul}] in a straight pipe = 190 N/mm², with a maximum operating temperature [T_B] of 130° C and a nominal pressure of PN 25.

Further information to project work is available in our download area **www.isoplus.org**

Edition: 16.01.2012

12.2.1 General / Admissible Laying Length

For flexible pipe systems as well as for rigid PJP-compound systems a high degree of conversion of special know-how will be required. The following examples will show proved pipe laying technology of **isoplus**-flexible pipes.

Flex Pipe		**isoflex**						**isocu**							
Type		**20**	**28**	**28 v**	**28+28**			**22**	**28**	**22+22**			**28+28**		
Dimensions		20x2,0/75	28x2,0/75	28x2,0/90	2 • (28x2,0)/110			22x1,0/65	28x1,2/75	2 • (22x1,0)/90			2 • (28x1,2)/90		
spread in **K**		- -	- -	- -	**20**	**30**	**40**	- -	- -	**20**	**30**	**40**	**20**	**30**	**40**
depth of cover [$Ü_H$]	0,40 m	47	67	56	74	67	59	29	38	27	23	20	40	35	30
	0,60 m	31	45	38	53	47	42	20	26	19	16	14	28	24	21
	0,80 m	24	34	28	41	37	32	15	20	14	13	11	21	19	16
	1,00 m	19	27	23	33	30	26	12	16	12	10	9	17	15	13

Spread [K] = Difference of temperature between flow and return line.
At operating temperatures < 60° C no effect on **isocu**-pipe laying lengths.
At operating temperatures < 85° C no effect on **isoflex**-pipe laying lengths.

The Values mentioned in the table are for soils with a specific weight of 19 kN/m^3 as well as a friction angle of 32,5°. Parameters which will differ from that will lead to other lengths, which will be calculated from **isoplus**-design engineers on request. For bridges class SLW 60 (33,3 kN/m^2 surface load; 100 kN wheel load) a minimum covering height of 0,40 m will be sufficient for all **isoplus**-flexible pipes.

isoflex: Maximum permissible axial tension [σ_{zul}] in straight pipe = 150 N/mm^2
isocu: Maximum permissible axial tension [σ_{zul}] in straight pipe = 110 N/mm^2

In case of pipe laying lengths > L_{max} **isoflex**- and **isocu**-pipelines should be thermal pre-stressed, or one of the following described first three application-technology (Loop-Technology, U-Compensation or Wave-Technology) has to be used. The axial expansion which will occur at every kind of technology has to be compensated by use of corresponding long expansion side legs and pads.

isopex-pipes are self compensating and may therefore be laid without limitation of laying lengths and without expansion pads. Due to the remaining tension and -bending after uncoiling, **isopex**-pipes may and will be laid similar like wave-technology.
isoclima-pipes will be installed generally without limitation of laying length and without expansion pads because of the maximum operating temperature of 30 °C.

12.2.2 Application isoflex and isocu

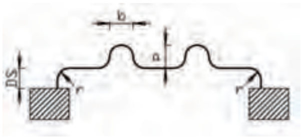
Loop-Technology

Flexible pipes will be laid from building to building resp. from house connection area to house connection area, L_{max} has to be considered. In front of the building additionally an expansion side leg [DS], of at least 1,00 m, or a minimum bending radius [r] has generally to be considered.

Edition: 16.01.2012

U-Compensation

In case of pipe laying lengths longer than L_{max} U-compensation may be used. From U-elbow to U-elbow the corresponding maximum pipe laying length L_{max} has to be kept. The length [a] and the width [b] of the U-elbows should be at least the double of the minimum bending radius [r].



Wave-Technology

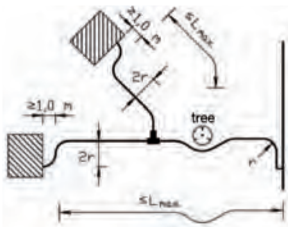
Pipe laying in wavy lines may be also used in case that L_{max} will be exceeded. The flexible pipes will be laid in wavy lines with a cross-measure [q] of at least 2,00 m.

At the beginning and at the end of such a section a 90° angle with a corresponding minimum bending radius [r] has to be provided. Branches can be not installed in this kind of technology.

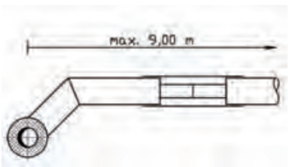
Branch-Technology

The connection of **isoflex**- resp. **isocu**-pipes will be made by use of pre-fabricated 45°- or parallel-branches.
It will be generally possible, to produce all kinds of branches, as described in **chapter 2.2** and **2.3**..

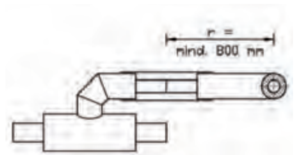
The connecting branch-pipe to the main pipe will be made by use of **isoflex** or **isocu**, depending from requirement, that means no additional carrier pipe and jacket-pipe reduction will be necessary.



45° T-Branch



Parallel-Branch



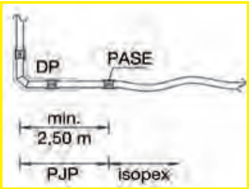
Edition: 16.01.2012

12.2.3 Application isopex

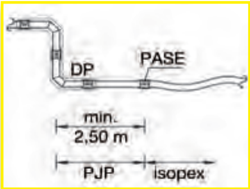
Transition PJP

Before connection of **isopex** on a axial or/and lateral expanding pipe system like **isoplus**-jacket-pipe (PJP), the expansion has to be compensated. That means, that before the transition of the PJP-pipe an L-, Z- or U-elbow has to be projected, or an anchor (FP) has to be provided.

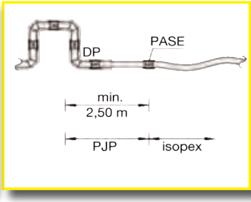
L-Elbow



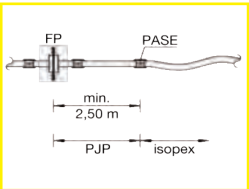
Z-Elbow



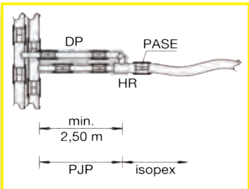
U-Elbow



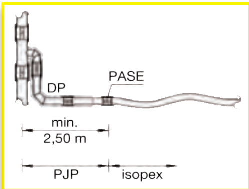
Anchor



45° T-Branch



Parallel-Branch



PASE = Press-Coupling with Welding-End **HR** = Bifurcated pipe

In case of a system-change within a PJP-branch-pipe, a rigid PJP-piece of pipe of at least 2,50 m lengths has to be provided between branch and transition for compensation of lateral expansion.

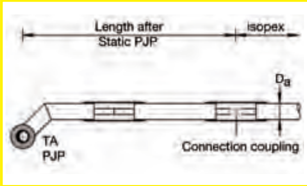
Expansion side legs of PJP-systems have to be provided with expansion pads (EP), according to the **isoplus** line-drawing.

Branch isopex

Alternatively it will be possible to carry out branches from several pipe systems with different kinds of connections and branches. The following **isopex**-branch technologies (possibilities A-D), see **following pages**, show the practically most used possibilities. In case of transitions to expanding pipe systems like i. e. **isoplus**-PJP (A-C), the pipe static has to be considered, see above.
In case of other applications please contact **isoplus**-application engineers.

12.2.4 Possibilities / Examples

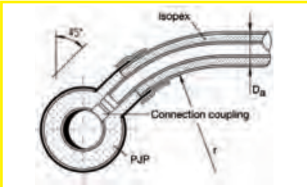
isoplus-PJP - isopex
Possibility A

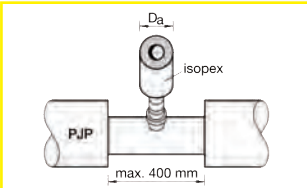


At the factory pre-insulated branch, according to the Design Manual, **chapter 2.2 and 2.3**, an **isopex**-connection coupling with unilateral welding end of steel will be welded to the corresponding branch-steel pipe of the prefabricated insulated branch, see **chapter 3.6.5**, and **10.2.17**.

The post-insulation at this spot will be made by use of a connection coupler or reducing coupler, according to Design Manual, **chapter 6** - Connection Technology Jacket-Pipe. Reducing couplers are only necessary if the outside diameter, [D_a] of the jacket pipe will be not the same as outside diameter of the **isopex**-pipe.

isopex - isopex
Possibility B





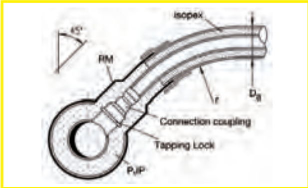
In case that house connections have to be installed later on into a pipeline which is still not in operation, the installation will be also made by use of a **isopex**-connection coupling with unilateral welding end of steel.

The insulation of the main pipe will be removed for a length of maximum 400 mm. The branch diameter of the carrier pipe will be tapped or burned out. Thereafter the connection coupling will be welded electrically or autogenously to the rigid **isoplus**-PJP-system, preferable in 45° angle. Connection coupling see **chapter 3.6.5**, assembling see **chapter 10.2.17.**

Post-insulation at this spot will be carried out by using half-shells, see **chapter 3.6.4**, or using an assembly branch. Informations concerning PEHD-assembly branches, see Design Manual, **chapter 6** - Connection Technology Jacket-Pipe!

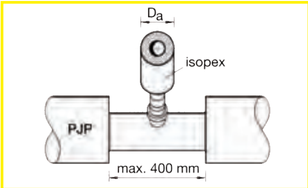
isoplus-PJP - isopex
Possibility C

In case that the rigid PEHD-jacket-pipeline will be already in operation, the connection has to be carried out by tapping procedure and by use of **isopex**-connection coupler with unilateral welding end made of steel.



The insulation of the main pipe will be removed for a length of maximum 400 mm. Thereafter the corresponding dimensioned tapping lock will be welded electrically to the rigid **isoplus**-PJP-system, preferable with an angle of 45°. Available tapping locks see Design Manual, **chapter 7.1.2**.

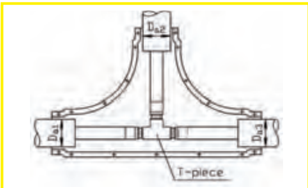
After the tapping has been carried out in accordance to Design Manual **chapter 10.2.11** also the connection coupling has to be welded electrically to the tapping lock. Connection coupling see **chapter 3.6.5,** assembling see **chapter 10.2.17**.



Post-insulation at this spot will be carried out by use of PEHD-assembling branch, see Design Manual, **chapter 6** - Connection Technology jacket-pipe. Due to the bigger nominal diameter of the tapping lock eventually an reinforced insulation thickness will be required at the branch, respectively a reducing coupler has to be provided.

isopex - isopex
Possibility D

Branches within the **isopex**-system will be carried out with **isopex**-T-pieces which should be preferable assembled with a branch-angle of 45°.

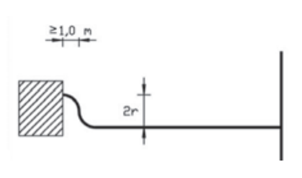


The flexible pipes will be cut right-angled and the insulation will be removed at all three ends to a length of maximum 150 mm. Thereafter the T-piece has to be fixed at the pipe ends, as described on **chapter 10.2.17**. Post-insulation of this branches will be carried out with GFK-assembly branches, see **chapter 3.6.4**.

Edition: 16.01.2012

House Connection

with 45° T-Branch

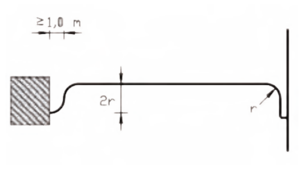


Buildings can be connected directly up to a distance of 9,00 m with **isoflex** and **isocu**, by using a 45°-branch.

Before the house-entry an expansion side-leg of a length corresponding to the double of the minimum bending radius [r] has to be provided. This will guarantee that inside of the building no expansion and no other strength have to be compensated.

In case of **isopex** and **isoclima** a limitation of length will be not necessary.

with Parallel-Branch



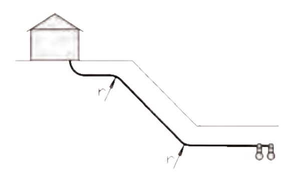
In case of parallel connections an expansion side-leg with a length according to the minimum bending radius [r] has to be provided for the exit pipe of the branch.

From this side-leg to the building the max. permissible pipe laying length [L_{max}], has to be considered in case of **isoflex** and **isocu** see **chapter 12.2.1**, or longer length one of the described pipe laying possibilities should be used, **chapter 12.2.2**.

In front of the house-entry a side-leg, preferable with the double length of the minimum bending radius [r] has to be provided, for the same reasons as at 45°-connection.

A limitation of the length is not necessary in case of **isopex** and **isoclima**.

at Sloping Terrain

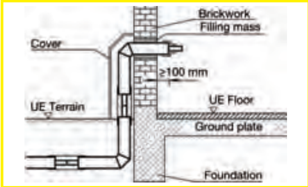


In case that big height-differences i. e. terrain-embankments have to be overcome, **isoplus**-flexible pipes will be particularly suitable.

The connection to the main pipeline will be made as already described with 45°- or parallel-branch.

House Connection without Cellar

with Elbow - Outside

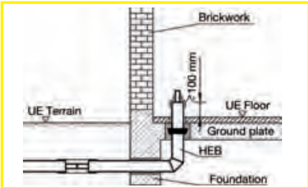


According to requirement PJP-elbows with standard side-legs or 1,00 • 1,00 m or 1,00 • 1,50 m length will be used, see Design Manual, **chapter 2.2.7** and **2.3.7** and **3.6.2**.

In connection with **isopex** connection couplers with one-side welding end will be required, see **chapter 3.6.5**, assembling see **chapter 10.2.17**.

Post-insulation of the connection spots will be made by use of corresponding connection couplers, see Design Manual, **chapter 6** - Connection Technology Jacket-Pipe.

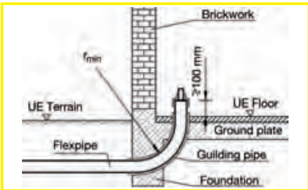
with Elbow - Inside



House-entry-elbows (HEB) with a standard delivery length of 1,00 • 1,50 m will be also used for houses without cellar, see **chapter 3.6.2**.

This solution will guarantee that there will be no connection coupler in the foundation and in the area of the ground-plate of the house. Post-insulation of the connection spots will be made by use of a connection coupler.

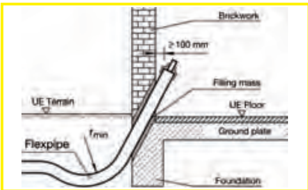
with Guiding Pipe



During construction of the house a suitable and flexible guiding pipe has to be installed into the foundation and into the ground-plate. The diameter of the protecting pipe should be at least 30 mm bigger than the PELD-jacket-pipe dimension of the flexible pipe.

ATTENTION: Minimum bending radius [r] of the used flexible pipe has to be kept absolutely.

Special



Special constructions for house connections of houses without cellar may be installed only after agreement and approval by **isoplus** design-engineers.

Edition: 16.01.2012

13 SPECIFICATIONS

Edition: 16.01.2012

13 SPECIFICATIONS

We offer the specifications and the tender text in different formats to download at **www.isoplus.org**

For inquiry regarding this issue please send an e-mail to **ausschreibung@isoplus.de** or call our headquarter in Germany/Rosenheim on 0049 8031 650-0.

AGFW

BFW

TÜV CERT DIN EN ISO 9001 DIN EN ISO 14001

14 SUPPLEMENT / NOTES

Edition: 16.01.2012

Edition: 16.01.2012

Edition: 16.01.2012