nupi INDUSTRIE ITALIANE

TECHNICAL MANUAL

HDPE PIPE AND FITTING SYSTEM

SMARTFLEX™

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1 • NUPI INDUSTRIE ITALIANE AND SMARTFLEX

NUPI Industrie Italiane has over 50 years experience in the design and manufacture of the most modern polymeric materials culminating in the development of 20 complete product ranges for Water, Gas, Industry Applications, Plumbing and Heating fields marketed all over the world.

Every year more than 25.000 km of pipes and 20 million fittings are installed worldwide.

NUPI Industrie Italiane has always dedicated considerable investments to Research & Development activities, technological trainings and quality control.

This technological commitment allowed NUPI Industrie Italiane to place itself among the first companies in its market segment worldwide.

MANAGEMENT QUALITY
Designed, manufactured and supplied under an ISO 9001 accredited Quality Management System, NUPI Industrie Italiane products comply with relevant national, European and international product Standards to ensure complete peace of mind for our customers.

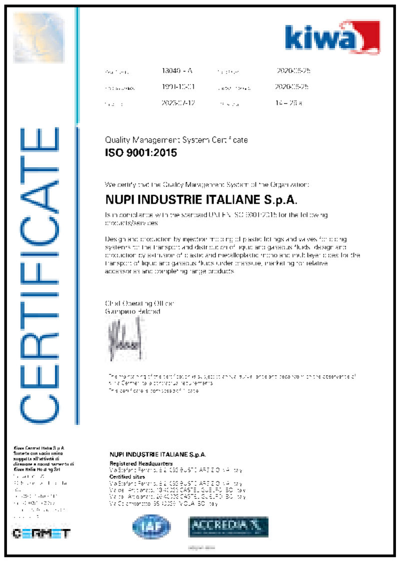
ENVIRONMENT QUALITY
Committed to sustainable manufacture and systems, NUPI Industrie Italiane operates and maintains an environmental policy fully accredited to ISO 14001.

HEALTH&SAFETY MANAGEMENT
The continuous improvement of health and safety at work is a priority of NUPI Industrie Italiane S.p.A. and an essential part of its activities that become strategic commitment within the company goals.

NUPI Industrie Italiane S.p.A. is committed to acting responsibly, in accordance with the law in force and voluntarily chooses to implement a managing system for health and safety at work in accordance with Standard ISO 45001.

SMARTFLEX was developed by NUPI Industrial Group for the conveyance of petroleum products, alcohols, alcohol-gasoline mixtures and biofuels.

The SMARTFLEX system shall be installed by qualified installers only. Installers shall follow the manufacturer's installation and assembly instructions and all the regulations and local laws in force.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Quality Management System Certificate
ISO 9001:2015
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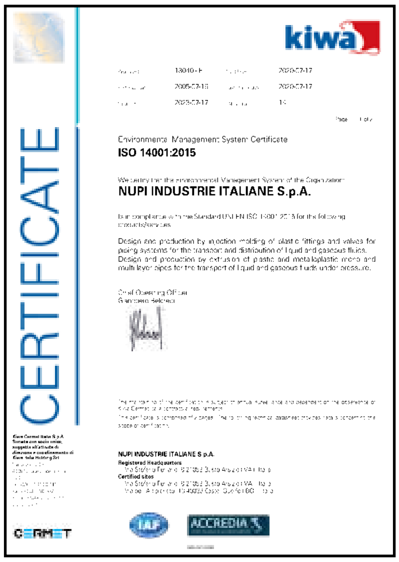
CERMET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1.1 WHAT IS THE SMARTFLEX SYSTEM

The SMARTFLEX system comprises a Composite multilayer piping system, Electrofusion fittings and Tools suitable for the conveyance of petroleum products, alcohols, alcohol-gasoline mixtures and biofuels.

The SMARTFLEX range is available both in SINGLE WALL and DOUBLE WALL systems.

SMARTFLEX is manufactured using the latest technopolymers that are biocompatible and 100% recyclable.

The quality of the materials used and the strict quality controls in its manufacture allows NUPI Industrie Italiane to provide a product warranty of 30 years.

1.2 MAIN CHARACTERISTICS OF THE SMARTFLEX SYSTEM

FULL DOUBLE WALL RANGE

Range Primary ø32 - Secondary ø40
Primary ø50 - Secondary ø63
Primary ø63 - Secondary ø75
Primary ø90 - Secondary ø125
Primary ø110 - Secondary ø125
Primary ø160 - Secondary ø225

Thanks to an investment of more than 5ML € all our fittings are moulded. This means more compact parts (less bulky installations) and ease of implementation by reducing the time of labour.

FULL SINGLE WALL RANGE

Full range from ø32 mm to ø250 mm.

NO CORROSION

HDPE pipes are resistant to all degrees of water hardness as well as to many chemicals.

They have a high resistance to acids and alkalis in a wide range of concentrations and temperatures.

RESISTANCE TO STRAY CURRENTS

Polyethylene is a very poor electrical conductor, thereby avoiding the risk of perforation of the pipe or fittings caused by stray currents.

LOW PRESSURE DROP

SMARTFLEX™ pipes have reduced pressure losses because their surface is smooth (r 0.007 mm).

ABRASION RESISTANCE

The high resistance to abrasion of the SMARTFLEX™ system provides high velocity of gasoline circulation without erosion problems.

DURABILITY

More than 30 years, depending on the temperature and working pressure.

1.3 FIELDS OF USE

The most common applications for SMARTFLEX™ pipes and fittings, both in suction and pressure installations, are as follows:

- ROAD AND MOTORWAY SERVICE STATIONS
- HARBOUR AND MARINE SERVICE STATIONS (MARINAS)
- FUEL DISTRIBUTION IN AIRPORTS
- FUEL STORAGE TANKS
- GENERATOR CONNECTIONS TO FUEL TANKS

The SMARTFLEX™ system has been optimized for use in underground applications and for the conveyance of the following fuels*:

- Gasoline
- Unleaded petrol 98
- Unleaded petrol 95
- Unleaded petrol 95 with 8-10% ethanol (E10-SE95)
- Methanol
- Toluene
- Kerosene
- Diesel without sulphur
- Diester Diesel
- Fuel (FOD)
- CLAMC (fuel for heating)
- Jet Fuel A
- Biodiesel
- E85

* the list is not complete

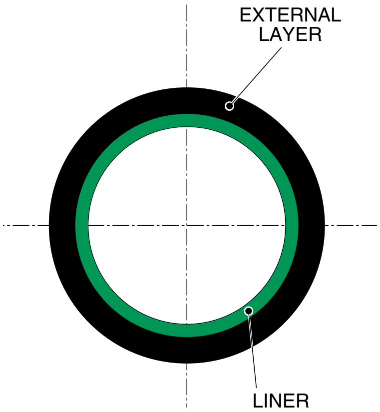
N.B. For special applications such as adblue, def, urea, the metal connection small be stainless steel and the o'rings and gaskets small be made of viton.

It is suitable for all installations:

- Product
- Filling
- Vent
- Vapour recovery VR1 and VR2

It is also used for the conveyance of fuel at airports, in the industrial field and for the transport of aggressive fluids in general (contact NUPI Industrie Italiane for further information).

1.4 SINGLE WALL PIPES



SMARTFLEX single wall pipes for the transport of petroleum products, alcohols, alcohol-gasoline mixtures and biofuels.

A primary pipe is the pipe that carries fuel and is provided of a protective liner.

When primary pipe is used without a secondary pipe it is called a SINGLE WALL pipe.

Primary pipe is a multilayer pipe manufactured through a production process called “co-extrusion” (contemporary extrusion of various layers of pipe comprised of different materials). It combines the excellent mechanical properties of HDPE (High Density Polyethylene) and the low permeability and high chemical resistance of an inner and/or outer layer made of a polymeric material specifically suited to the application.

This inner layer (liner) guarantees the following:

- A barrier impermeable to fuels
- Excellent resistance to wearing
- High resistance to long-term pressure
- Limited head loss

SINGLE WALL SYSTEM	DN (mm)	DN (in)
TSMAH	32 - 40 - 50 - 63 - 90 - 110 - 160 - 200 - 250 - 280 -315	1” - 1”¼ - 1”½ - 2” - 3” - 4” - 6” - 8” - 10” -12”
TSMAU	32 - 50 - 63 - 90 - 110 - 160	1” - 1”½ - 2” - 3” - 4” - 6”
TSMAXP	32 - 50 - 63 - 90 - 110	1” - 1”½ - 2” - 3” - 4”
TSMAUXP	50 - 63 - 90 - 110	1”½ - 2” - 3” - 4”

EN & KIWA SINGLE WALL PIPES	OUTSIDE DIAMETER OD (mm)	OUTSIDE DIAMETER OD (in)	MINIMUM PIPE WALL THICKNESS S min		MINIMUM PIPE INTERNAL DIAMETER ID	
			(mm)	(in)	(mm)	(in)
TSMAH	32	1”	3.0	0.12	26.0	1.02
	40	1”¼	3.6	0.14	32.8	1.29
	50	1”½	4.3	0.17	41.4	1.63
	63	2”	5.3	0.21	52.4	2.06
	90	3”	7.3	0.29	75.4	2.97
	110	4”	8.7	0.34	92.6	3.65
	160	6”	12.4	0.49	135.2	5.32
TSMAU	32	1”	2.9	0.11	26.2	1.03
	50	1”½	4.2	0.17	41.6	1.64
	63	2”	5.2	0.21	52.6	2.07
	90	3”	7.2	0.28	75.6	2.98
	110	4”	8.6	0.34	92.8	3.65
	160	6”	12.3	0.48	135.4	5.33

UL SINGLE WALL PIPES	OUTSIDE DIAMETER OD (mm)	OUTSIDE DIAMETER OD (in)	MINIMUM PIPE WALL THICKNESS S min		MINIMUM PIPE INTERNAL DIAMETER ID	
			(mm)	(in)	(mm)	(in)
TSMAXP	32	1”	4.5	0.18	23.0	0.91
	50	1” ½	4.5	0.18	41.0	1.61
	63	2”	5.5	0.22	52.0	2.05
	90	3”	7.5	0.30	76.0	2.99
	110	4”	8.9	0.35	92.2	3.63
TSMAUXP	50	1” ½	4.1	0.16	41.8	1.65
	63	2”	5.1	0.20	52.0	2.05
	90	3”	7.1	0.28	75.8	2.98
	110	4”	8.5	0.33	93.0	3.66

1.5 DOUBLE WALL PIPES

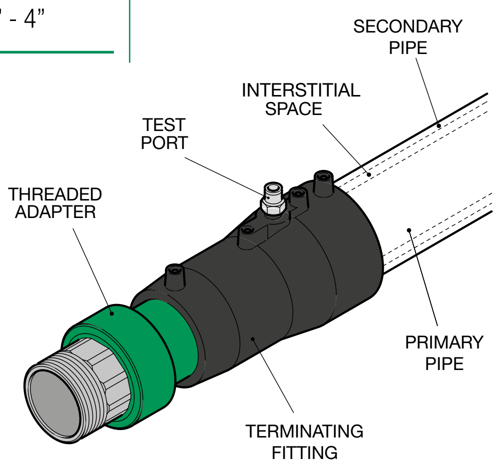
SMARTFLEX double wall pipes for the transport of fuels, alcohols, alcohol-gasoline mixtures and biofuels.

A DOUBLE WALL pipe is a primary pipe contained in a secondary pipe.

In SMARTFLEX double wall pipes, the secondary pipe is not just a containment barrier but it is a real high-density polyethylene pipe capable of sustaining the pressure or pressure drop of an automated monitoring system. This external pipe is also available with an inner barrier layer as requested by Standards (e.g. UL) and by customers' specific requests.

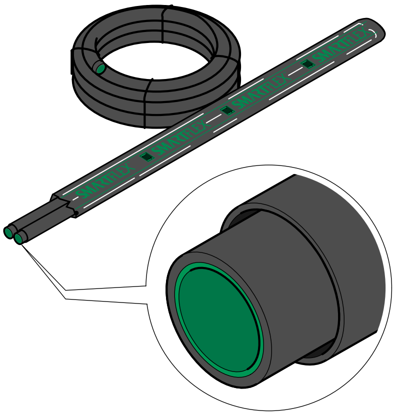
The advantages are as follows:
- Excellent chemical resistance to alcohols, solvents, saline, acid and alkaline solutions
- High resistance to long-term pressure

DOUBLE WALL SYSTEM	DN (mm)	DN (in)
TSMAHD	32 - 50 - 63 - 90 - 110 - 160 - 200	1" - 1"½ - 2" - 3" - 4" - 6" - 8"
TSMAUD	50 - 63 - 90 - 110 - 160	1"½ - 2" - 3" - 4" - 6"
TSMAXPD	32 - 50 - 63 - 90 - 110	1" - 1"½ - 2" - 3" - 4"
TSMAUXPD	32 - 50 - 63 - 90 - 110	1" - 1"½ - 2" - 3" - 4"



AdBlue/DEF/Urea SYSTEM	DN (mm)	DN (in)
TSMAUREA	32 - 50 - 63 - 90	1" - 1"½ - 2" - 3"
TSMADUREA	32 - 50 - 63 - 90	1" - 1"½ - 2" - 3"
SECONDARY SYSTEM	**DN (mm)**	
TSMASUREA	40 - 63 - 75 - 125	1"¼ - 2" - 2"½ - 5"
TSMAHS	40 - 63 - 75 - 125 - 225	1"¼ - 2" - 2"½ - 5" - 9"
TSMAUS	63 - 75 - 125 - 225	2" - 2"½ - 5" - 9"
TSMAXS	50 - 63 - 75 - 125	1"½ - 2" - 2"½ - 5"
TSMAUXS	50- 63 - 75 - 125	1"½ - 2" - 2"½ - 5"

1.6 PIPE PACKAGING



Each package includes a set number of straight lengths (see table below) to allow flexibility in the amount of lengths included in purchase orders.

Each plastic bag contains the following number of straight lengths:

	Outside diameter OD (mm)	Quantity
SINGLE WALL PIPE	32	15
	50	5
	63	4
	90	2
	110	2
	160	1

	Outside diameter OD (mm)	Quantity
DOUBLE WALL PIPE	40	10
	63	4
	75	3
	125	1

The plastic bag is made of black polyethylene.

Product	Model	Color Code	Application
SUPERSMARTFLEX	TSMAXP, TSMAXS, TSMAXPD	Green	NV, VR, FL, PC, PS
SUPERSMARTFLEX	TSMAUXP, TSMAUXS, TSMAUXPD	Yellow	NV, VR
SMARTFLEX H	TSMAH, TSMAHD, TSMAHS	Red	NV, VR, FL, PC, PS
SMARTFLEX	TSMAU, TSMAUS, TSMAUD	Yellow	NV, VR, FL
SMARTFLEX	TSMAUREA, TSMASUREA, TSMADUREA	Silver	NV, VR, FL, PC, PS

PS → Double Wall Pipe
PC → Primary Pipe
NV → Vent Pipe
VR → Vapour Recovery Pipe
FL → Fill Pipe

1.7 FITTINGS

The SMARTFLEX fitting range is the most comprehensive on the market today including the following:

- Single wall electrofusion fittings
- Transition fittings
- Double wall coaxial electrofusion fittings
- Termination electrofusion fittings
- Electrofusion and mechanical penetration fittings
- Mechanical fittings
- Spigot fittings

1.7.1 SINGLE WALL ELECTROFUSION FITTINGS

The single wall electrofusion fitting range includes:

- Couplings (model SME, SMEN)
- 90° elbows (model SGE)
- 45° elbows (model SCE)
- Tees (model STE, STELV)
- End caps (model STPCLEL)
- Reducers (model SRDEL)

All provide a considerable insertion length and thickness, thus ensuring leak tight connection as well as quick and secure installation.

1.7.2 SINGLE WALL FITTINGS

The single wall fitting range includes the following:

- Threaded adapters (model SAM/SAF) with brass, nickel plated brass and AISI 304 stainless steel parts for special applications (e.g. AdBlue/DEF/Urea)
- Long risers (model SALM)
- Swivel adapters (model SAFSW) with gasket resistant to fuels
- Loose flanges (model SFLAK, SFLAKA, SFLAK_PP) suitable for flanged connections. This model is available also with Viton gaskets and AISI 304 stainless steel flanges for special applications (e.g. AdBlue/DEF/Urea)
- Square flange kits (model SAFFQ) for compact connections
- Spigot fittings (SG, ST, STPCL)
- End caps (STPCL)
- Stainless steel threaded adapters.

ATTENTION:

Vacuum, pressure, liquid or gas Leak Monitoring Systems can be used with the SMARTFLEX double wall system.

WARNING:

Mechanical fittings are not certified according to current Standards.

1.7.3 DOUBLE WALL COAXIAL ELECTROFUSION FITTINGS

Double wall electrofusion fittings are manufactured using NUPI Industrie Italiane proprietary procedures and technologies and are the most innovative products of their kind available on the market. SMARTFLEX double wall electrofusion fittings are entirely coaxial, therefore allowing them to have a continuous interstitial space that can be monitored. The interstitial space can be accessed through termination fittings (model SETFV and SETFCV) equipped with special quick connection valves compatible with pneumatic components that are available on the market. It can also be accessed through specific SMARTFLEX double wall fittings equipped with a special test port (model SCEDWTP, SGEDWTP, SMEDWTP and STEDWTP).

The use of these fittings eliminates the need for bypass test tubing. The double wall electrofusion fitting range includes the following:

- Straight connectors (model SMEDW)
- Tees (model STEDW)
- Elbows and bends (model SGEDW and SCEDW)
- Termination fittings (model SETFV and SETFCV)

1.7.4 DOUBLE WALL SPIGOT FITTINGS

The long spigot double wall adapter (model SAWFD) enables a more compact transition and can be used with flex connectors. It is also available with a stainless steel (AISI 304) threaded insert for special applications (e.g. AdBlue/DEF/Urea).

1.8 ENTRY BOOTS (PENETRATION FITTINGS)

Entry boots ensure the correct entry of pipes into the sumps placed over tanks or under dispensers. They provide a perfect leak tightness.

The range includes:

- Electrofusion entry boots (model SEBE/SEBEP) that provide a reliable and fast connection typical of the electrofusion welding process. They can also be installed on the outside of the sump allowing better use of internal space. The available sizes are from 1” (32 mm) to 5” (125 mm).
- Metal/rubber composite entry boots for piping (model SEB). They also provide a reliable entry into the sumps preventing any metal component being exposed to the external environment. The available sizes are from 3/4” (25 mm) to 5” (125 mm).
- Termination fittings (model SEBTF or SEBTFV) for 3” (90 mm) double wall systems.
- Entry boots for fiberglass SW (model SEBEFM) and DW (model SEBEF) sumps. Model SEBEF is suitable for the monitoring of the interstitial space of a double wall sump with glycol. Do not use brine for monitoring. We recommend adding a suitable corrosion inhibitor to the monitoring fluid.

1.9 MECHANICAL FITTINGS

A full range of mechanical fittings (model SBF, SBGF or SBTEF) completes the SMARTFLEX system. Initially designed as connections to pumps and dispensers, they include two fuel resistant gaskets that fit the pipe wall (internally and externally) whilst ensuring maximum joint integrity. They often represent an alternative solution for temporary installations or whenever the presence of explosive vapours does not allow electrofusion operations or in case of repair.

1.10 SUMPS AND ACCESSORIES

Electrofusion HDPE dispenser sumps (model S21DS) and tank sumps (model S22TS) are designed to:

- Ease and accelerate the installation process. They comprise two separate HDPE parts that are joined by electrofusion.
- Obtain a perfectly sealed installation thanks to the electrofusion welding process that allows joining the two parts.
- Optimize transport cost and volume and guarantee sump integrity during transport and storage.
- Offer maximum structural integrity over time.
- They are available in a range of sizes capable of satisfying most installation requests.

The tightness of tank sumps can be tested on site during every installation step by carrying out a vacuum test.

One-piece versions of the tank and dispenser sumps are also available as well as tank sumps with increased wall thickness for specific installations (high groundwater, alluvial soil, low quality backfill material, etc.).

1.11 MANHOLE COVERS

SMARTFLEX Composite Manhole Covers are designed to offer a light weight alternative to steel manhole covers. These covers are class C250 (up to 25 tons) in accordance with EN124 Standard. The covers size 36” can reach class D400 (up to 40 tons).

SMARTFLEX Composite Manhole Covers combine technology, design and composite materials with reliable manufacturing processes to deliver ‘fit for purpose’ covers that offer an attractive commercial solution.

The surface of SMARTFLEX Composite Manhole Covers has a better slip-resistance than metal covers when wet, dry, or worn state and is comparable with a good highway surface. One of the benefits of SMARTFLEX Covers is single person removal and replacement without risk of injury, when using the specific ergonomic lifting tool.

SMARTFLEX Composite Manhole Covers are robust and their top surface has an estimated life of 15 years.

1.12 SKIRTS FOR MANHOLE COVERS

SMARTFLEX skirts are made of polyethylene and are designed to fit perfectly the frame of the covers. Thanks to their conic design they can be easily handled and transported by stacking them one on top of the other.

1.13 TOOLS AND ACCESSORIES











Follow all relevant instructions and use the specific tools and accessories for a correct installation of the SMARTFLEX system.

1.13.1 MULTIFUNCTION WELDING UNIT

The SMARTFLEX multifunction welding unit (Models SSEL8404, SSEL8404L, SSEL8404P, SSEL8404LP, SMARTWELD, SMARTWELDLIGHT) features proprietary software that is designed to make the installer's task as easy and reliable as possible. A user friendly menu guides the installer through the two operating modes: welding mode and pressure test mode.

Welding mode

The multifunction welding unit can be used to weld SMARTFLEX pipes and fittings by electrofusion welding process reading the barcode welding parameters with a barcode scanner.

Pressure test mode

The built-in recorder enables the welding unit to carry out pressure or vacuum tests and/or transfer of testing data. Welding and testing data are stored in the internal memory of the multifunction welding unit and can be downloaded to a computer by means of a Bluetooth connection.

The new SSEL8404LP is incorporated in an innovative, watertight, sand proof, dust proof case that withstands harsh environments and shocks. The case is certified to withstand temperature rating from -33°C to +90°C and is in fact the ideal mean of transportation for sensitive devices.

The new SMARTWELDLIGHT welding machine allows to carry out welds without errors and manage them by using the latest technologies such as WiFi and Internet communication for welding control and data management, smart devices, cloud storage, geolocation through the use of the GPS device and fingerprint detection for the recognition of the identity of the operator.

Installation Tools

The SMARTFLEX system includes a wide range of tools and accessories such as:

- SCUT – Pipe cutter
- RAT0, RAT1A, RATUL, RATOR – Universal scraper
- RAM1, RAM2 – Manual scraper
- SCUTDW – Double wall pipe cutter
- STP – Metal protection templates
- ALL225/4 – Pipe aligner
- MARK – White marker
- RAT0SB, SLRCUT, SLRDW, RATKITRIC – Spare blades
- SPLIDW – Double wall pliers
- BCSCAN, BCSCAN8403 – Barcode scanner

The welding unit model SSEL8404 operates in the following languages: English, Italian, Spanish, French, German, Portuguese, Dutch. There is also a special version for the Russian language.

1.14 MAXIMUM OPERATING PRESSURE AND MINIMUM BENDING RADIUS

The SMARTFLEX system has been designed for buried installations. The following table shows its main characteristics.

Pipe nominal diameter	Maximum operating pressure of primary pipe at 20°C	Maximum operating pressure of secondary pipe at 20°C	Minimum bending radius
1” (32 mm)	116 (psi) 8 (bar)	58 (psi) 4 (bar)	23” (580 mm)
1 1/2” (50 mm)	116 (psi) 8 (bar)	58 (psi) 4 (bar)	35” (900 mm)
2” (63 mm)	116 (psi) 8 (bar)	58 (psi) 4 (bar)	45” (1100 mm)
3” (90 mm)	116 (psi) 8 (bar)	58 (psi) 4 (bar)	-
4” (110 mm)	116 (psi) 8 (bar)	58 (psi) 4 (bar)	-

The pressures indicated in the table above have been calculated based upon laboratory regression curves using hydrocarbons as a testing fluid. Pipes have a nominal pressure (PN) of 12.5 bars (primary pipe) and 6.3 bars (secondary pipe) when tested with water or air considering only their HDPE thickness.

ATTENTION:

For fuels and/or operating conditions other than those listed above, please contact NUPI Industrie Italiane Customer Service.

1.15 PRODUCT WARRANTY

All SMARTFLEX components have a 30-year warranty both for raw material and production process. The only exception is rubber components having a 2-year warranty. To validate this product warranty the SMARTFLEX system shall be installed by SMARTFLEX certified installers only according to the latest installation and assembly instructions.

The warranty is valid only if NUPI Industrie Italiane is provided with the following documents:
- Warranty Certification Form duly completed
- Welding Reports
- Pressure Test Report

The abovementioned documents can be sent by e-mail to the following address:
info@nupinet.com

Or through the Interactive Tracking System (ITS) at:
http://itsnew.nupinet.com

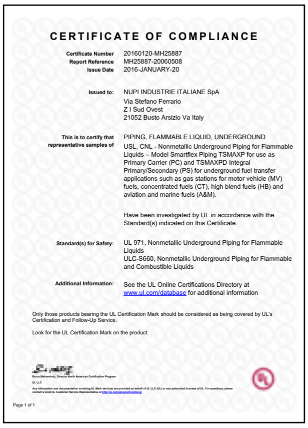
ITS is an Internet based Interactive Tracking System provided by NUPI Industrie Italiane. It allows access to data regarding the installation of the SMARTFLEX system in a specific site (completed welding reports, pressure test results, installed products, installation site etc.).

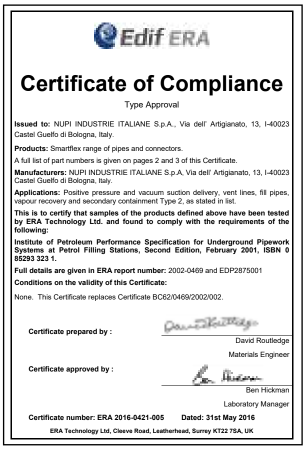
1.16 APPROVALS

The SMARTFLEX™ system is certified by prestigious international certification bodies such as:

- RINA — European Standard - EN14125
- KIWA — The Netherlands - BRL K 552
- UL — United States of America - UL971

The complete list can be downloaded from our website www.nupiindustrieitaliane.com





1.17 REFERENCES

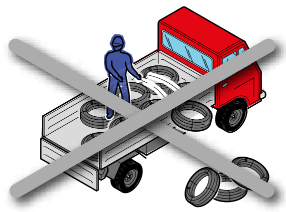
Below the main references of the SMARTFLEX™ system*:

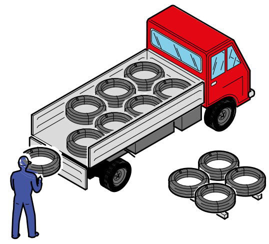
- TOTAL
- BP
- ENI
- TAMOIL
- CHEVRON
- CALTEX
- ENGEN
- PETRONAS
- AVIA
- CEPSA

* The list is not exhaustive

2 • STORAGE & HANDLING

2.1 PIPE LOADING AND UNLOADING





Loading, transporting, unloading, stacking, storing and any other handling operation involving plastic pipes and fittings must be carried out with extreme care using suitable means of transport depending on the type and diameter of the pipe. All necessary safety measures shall be taken to avoid breakage, cracking, or any other damage to the pipes.

Any impact, bending and excessive folding must therefore be avoided, as well as any contact with pointed or blunt objects.

If you are using cranes or similar means of transport for the pipe loading and/or unloading operations, pipes must always be lifted at their centre by means of a lifting beam with adequate width.

Slings must be made of hemp or nylon strips that do not damage the pipe surface.

If loading and/or unloading operations are performed manually, avoid dragging the pipes along the sides or the loading bed of the vehicle, or on any sharp object.

2.2 PIPE TRANSPORT

When transporting pipes, use either vehicles with flat or specific loading beds. The loading bed shall be free from nails or projections.

Secure the pipes firmly before transport. Side supports shall be flat and free from sharp edges.

When loading pipes with fittings installed at their ends, you shall stack them so that they do not touch adjacent pipes.

Large diameter pipes shall be positioned on the vehicle loading bed.

2.3 PIPE HANDLING

You should pay attention during pipe handling to prevent any damage.

Plastics pipes can be damaged if they hit sharp objects or if they are dropped, thrown, or dragged on the ground.

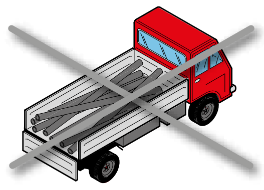
During loading and unloading operations using a forklift, only use forklifts with smooth forks. Make sure that the forks do not hit the pipe during lifting operations.

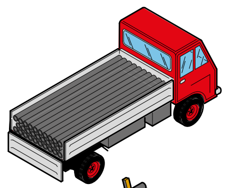
The impact resistance of plastics pipes is poor at low temperatures. You should pay extra care during handling under these conditions.

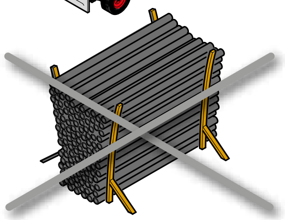
2.4 PIPE STORAGE

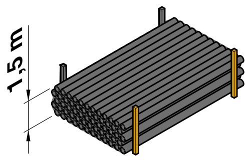
- Although plastics pipes are light, durable, and resistant, take the necessary precautions during storage.
- Stack the pipe sticks or coils on surfaces free from sharp objects, stones, or projections.
- When the pipes are supplied in coils, store them either vertically or horizontally one on top of the other, making sure they are protected from extreme temperature.
- When pipe sticks are stored on racks, these shall provide sufficient support to prevent permanent deformation.
- Do not place pipes near fuels, solvents, oils, grease, paint, or heat sources.
- If pipes are supplied in a bag or other packaging, the bag and/or packaging should be removed as late as possible prior to the installation.

2.5 PIPE STACKING









On site, proper support surfaces must be provided for pipe stacking, as well as indoor spaces protected from weather conditions and free from humidity for the storage of fittings and other accessories.

Support surfaces must be flat without any roughness or rocks. We suggest using wooden surfaces whenever possible.

The stacking height for pipe sticks must not exceed 1.5 m, whatever their diameter.

The stacking height for pipe coils stacked on a flat surface must not exceed 2 m.

If it is necessary to build side supports or to hold the pipes, these shall be installed with pillars at a maximum distance of 1.5 m between them.

Do not remove the end caps that protect pipe ends or the black plastic bags under any circumstances, to avoid the accumulation of leaves, dust, or bugs.

It is not recommended to install pipes that have been stored outdoors and/or without protection for over two years.

NUPI Industrie Italiane supplies pipe sticks inside suitable plastic bags and wooden frames, depending on quantities and transport means, for extra protection.

3 • TECHNICAL DATA

Some countries require that all piping installations for flammable fluid transport must be placed underground. In case of derogation to the rule, the safety measures approved by the local authorities be shall adopted.

In other countries, on the contrary, these above ground piping installations are permitted.

3.1 MECHANICAL IMPACT AND LOADING

Any piping material that is installed aboveground is subject to the rigors of the surrounding environment and to weather conditions. The movement of vehicles or other equipment can damage it and such damage generally results in gouging, deflecting or flattening of the pipe surfaces.

When designing a SMARTFLEX aboveground installation, the following guidelines shall be followed:

- Avoid point loading.
- Meet minimum distance between supports.
- Protect the system against abrasion.
- Support ancillary equipment independently of the pipe.
- Comply with the recommended minimum bending radius.

In general, in an installation where any section of the pipe has been damaged in excess of 10% of the minimum wall thickness, this portion shall be removed and replaced with a new pipe. When the pipe has been excessively or repeatedly deflected or flattened, it may exhibit stress whitening, cracking, breaking or other visible damage.

3.2 INSTALLATIONS WHERE THERMAL EXPANSION IS ALLOWED

Any material is subject to dimensional expansions caused by temperature changes. The coefficient defining this property is called the linear thermal expansion coefficient (α). It relates the dimensional expansions of a body to temperature changes according to the following equation:

(Eqn. 3.2.1) $$\Delta L = \alpha \cdot L \cdot \Delta T$$

Where:

ΔL thermal expansions
L initial length
ΔT temperature change [1]
α linear thermal expansion coefficient

Equation (3.2.1) is valid only when the body movement is not subject to external constraints that limit or modify its freedom of movement.

[1] ΔT represents the temperature change between the pipe operating temperature and the installation temperature.

The following table shows the values of α and of the elasticity modulus E for different materials used in the manufacturing of pipelines.

Material	α [°F^{-1}]	α [°C^{-1}]	E [psi]	E [MPa]
SMARTFLEX	7.2×10^{-5}	13×10^{-5}	145,000	1,000
Carbon steel	0.7×10^{-5}	1.2×10^{-5}	29.0×10^{6}	200,000
Stainless steel	0.9×10^{-5}	1.6×10^{-5}	29.0×10^{6}	200,000
Fiberglass	0.9×10^{-5}	1.6×10^{-5}	1.26×10^{6}	8,700

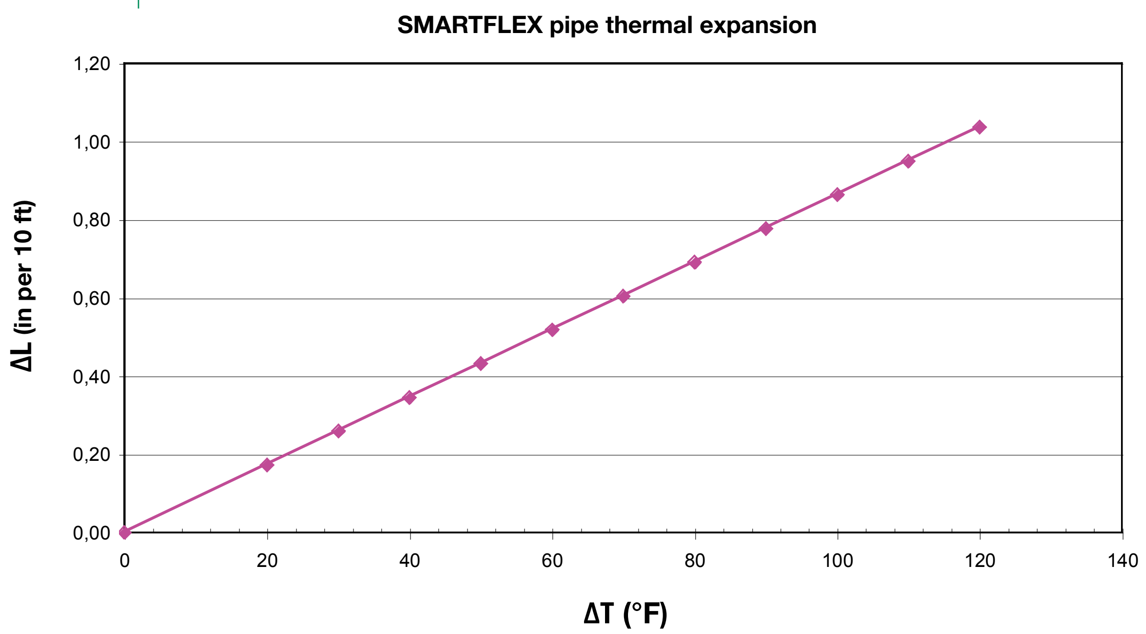
As can be seen, the coefficient α for plastics assumes a value 5 to 15 times greater than that of the most commonly used metallic materials. On the other hand, the elasticity modulus assumes values 100 to 200 times smaller (i.e. plastics show greater elasticity).

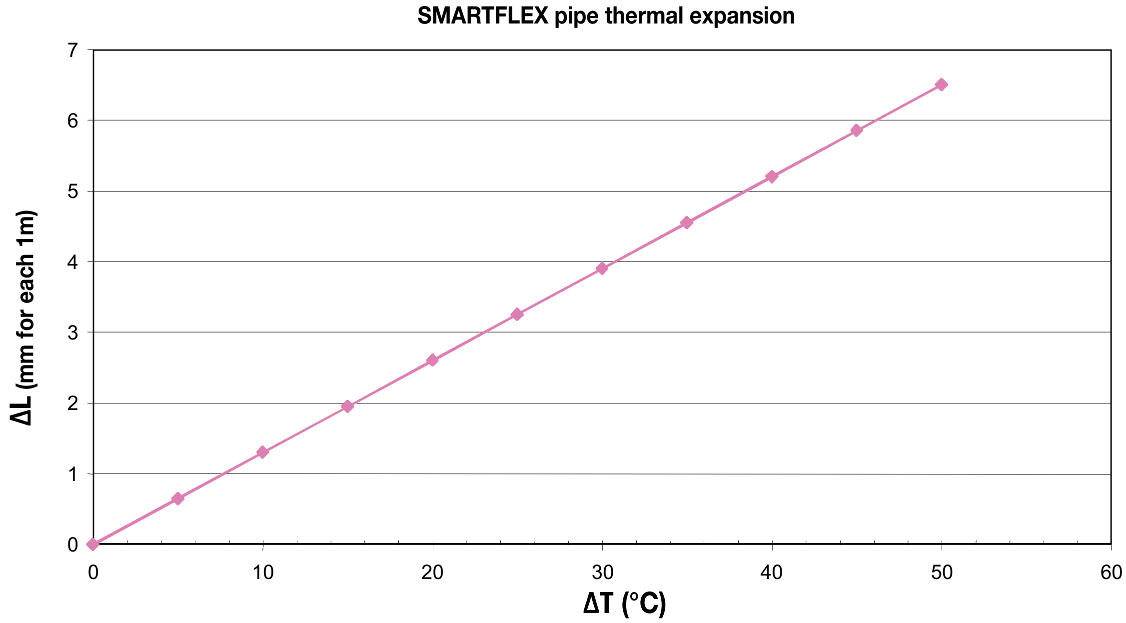
The following table shows the length and temperature changes for single wall pipes.

Table: thermal expansion for single wall pipes

ΔT (°C)	ΔT (°F)	ΔL (mm per 1m)	ΔL (in per 10ft)
30	70	3.9	0.60
40	80	5.2	0.69
50	100	6.5	0.86

The following figure shows thermal expansion of SMARTFLEX single wall pipe in a graph.





If a double wall pipe is free to expand (for example: before being buried and when the end limits yield) the following parameters can be calculated:

ΔL	total structure expansion (that can be found in a new balanced position)
F_1 and F_2	forces that contrast single pipe movement
Ftot	total force at the structure end

Where:

L	initial length
A_1 and A_2	primary and secondary cross-sections respectively
T_1 and T_2	operating temperatures of the primary and the secondary installation respectively
T_0	installation temperature
α	linear thermal expansion coefficient
E	elasticity modulus

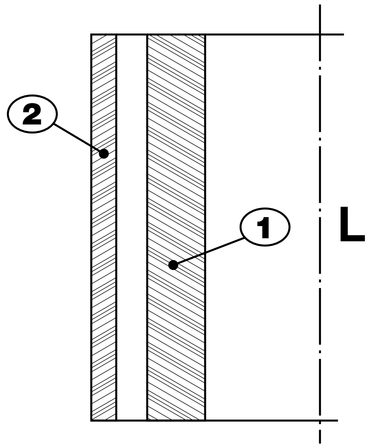
The results from the balance and congruence equations, as well as for the mechanical behaviour analogy for two parallel springs model, are:

$$\Delta L_1 = L\cdot\alpha\cdot(T_1-T_0) - \frac{F_1\cdot L}{A_1\cdot E}$$

$$\Delta L_2 = L\cdot\alpha\cdot(T_2-T_0) - \frac{F_2\cdot L}{A_2\cdot E}$$

$$\Delta L_1=\Delta L_2=\Delta L$$

$$F_{tot} = \frac{\Delta L\cdot E}{L}\cdot\left(\frac{A_1+A_2}{A_1\cdot A_2}\right)$$



1: Primary pipe
2: Secondary pipe

As an example, the following table shows the thermal analysis of a TSMAD50 pipe, presuming that the installation temperature is at 68°F (20°C), that the temperature of the primary pipe conveying relatively cold fluid is at 50°F (10°C) and that the temperature of the secondary pipe is variable (e.g. it could be exposed to sunlight) in case of L=1 m.

Temperature change (T1-T2) °F

	Temperature change (T1-T2) °F			
	40	**50**	**70**	**90**
Ftot (lb)	-1.7	2.5	6.6	10.7
F1 (lb)	15.8	25.8	35.8	45.7
F2 (lb)	-17.5	-23.3	-29.2	-35.0
ΔL1=ΔL2 (in)	-0.006	0.009	0.024	0.039
σ1 (psi)	-211	-344	-477	-611
σ2 (psi)	166	221	277	332

Temperature change (T1-T2) °C

	Temperature change (T1-T2) °C			
	20	**30**	**40**	**50**
Ftot (kg)	-7.5	11.0	29.5	48.0
F1 (kg)	70.6	115.1	159.6	204.2
F2 (kg)	-78.1	-104.2	-130.2	-156.2
L1=L2 (mm)	-0.16	0.23	0.61	0.99
1 (Mpa)	-1.46	-2.37	-3.29	-4.21
2 (Mpa)	-1.14	1.53	1.91	2.29

σ_1 and σ_2 = thermal stress due to temperature changes

Thermal expansion compensation

If thermal expansion is allowed, then the dimensional variations must be estimated. There are two different installation techniques that allow the compensation of thermal expansion:

- Changes in direction/offsets
- Expansion loops (see figure on the following page)

Assuming that the pipe is a cantilevered beam and limiting the strain to a safe 1%, the length of the expansion loop (ℓ) is given by:

(Eqn. 3.2.2)

$$\ell = \sqrt{\frac{3 \cdot \alpha \cdot \Delta T \cdot L \cdot OD}{2 \cdot 0.01}} \cong 12 \cdot \sqrt{OD \cdot \Delta L}$$

Where:

L	length of the pipe run
ΔL	thermal expansion
ΔT	temperature change
α	linear thermal expansion coefficient
OD	pipe outside diameter

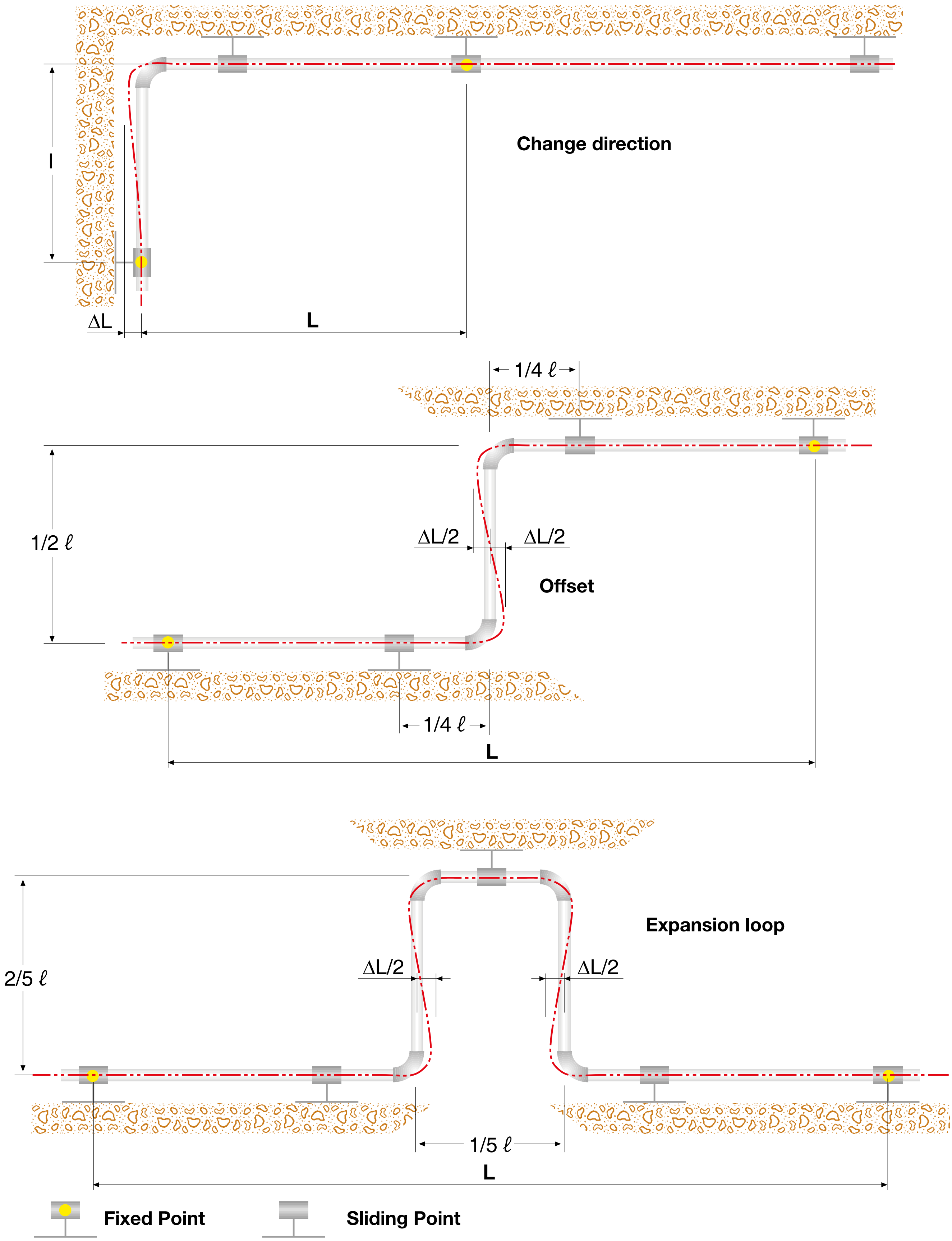
The following table shows the minimum length of the expansion loop according to the outside pipe diameter for various temperature changes. For temperatures other than those indicated, the linear interpolation will approximate the length of the loop within 5%.

Table: minimum loop length (ℓ) according to various temperature changes (°F)

Temperature Change	Length of pipe run (L)	OD							
		1”	1 1/4”	1 1/2”	2”	2 1/2”	3	4”	6”
ΔT = 50°F		Minimum loop length [in] (ℓ)							
	30 ft	17	19	22	24	27	29	32	39
	150 ft	39	43	49	55	60	65	72	87
	300 ft	55	61	69	77	84	92	102	123
ΔT = 70°F		Minimum loop length [in] (ℓ)							
	30 ft	21	23	26	29	32	35	38	46
	150 ft	46	51	58	65	70	77	85	103
	300 ft	65	73	81	91	100	109	121	146
ΔT = 90°F		Minimum loop length [in] (ℓ)							
	30 ft	23	26	29	33	36	39	43	52
	150 ft	52	58	65	73	80	88	97	117
	300 ft	74	83	92	104	113	124	137	165

Table: minimum loop length (ℓ) according to various temperature changes (°C)

Temperature Change	Length of pipe run (L)	OD							
		32	40	50	63	75	90	110	160
ΔT = 30°C		Minimum loop length [cm] (ℓ)							
	10 m	48	54	60	67	73	80	89	107
	50 m	107	120	134	151	164	180	199	240
	100 m	152	170	190	213	232	255	281	339
ΔT = 40°C		Minimum loop length [cm] (ℓ)							
	10 m	55	62	69	78	85	93	103	124
	50 m	124	139	155	174	190	208	230	277
	100 m	175	196	219	246	268	294	325	392
ΔT = 50°C		Minimum loop length [cm] (ℓ)							
	10 m	62	69	77	87	95	104	115	139
	50 m	139	155	173	194	212	232	257	310
	100 m	196	219	245	275	300	329	363	438


I
ΔL
L
Change direction
1/4 ℓ
1/2 ℓ
ΔL/2
ΔL/2
Offset
1/4 ℓ
L
2/5 ℓ
ΔL/2
ΔL/2
Expansion loop
1/5 ℓ
L
Fixed Point
Sliding Point

3.3 INSTALLATIONS WHERE THERMAL EXPANSION IS NOT ALLOWED

For this type of installations, the structure must be calculated and an evaluation of the mechanical characteristics of the material in the working conditions must be made.

Thermal Load
If the dimensional variations caused by temperature changes are totally restrained, then stress (tensil or compression) will develop in the piping itself. The axial stress is given by:

(Eqn. 3.3.1)
$$\sigma = -E \cdot \frac{\Delta L}{L} = -E \cdot \alpha \cdot \Delta T$$

Where:
ΔL thermal expansion
L pipe length
E elasticity modulus
α linear thermal expansion coefficient
ΔT temperature change

The minus sign indicates that, for positive ΔT (heating) the stress will be compressive (conventionally assumed as negative), whereas for negative ΔT the stress will be tensile (conventionally assumed as positive).

The axial forces generated inside the pipe are discharged at the pipe ends near the fixed points (ex. valves, pumps, etc.). They generate forces that can be calculated by multiplying the axial stress σ by the pipe section A:

(Eqn. 3.3.2)
$$F = \sigma \cdot A = -E \cdot \alpha \cdot \Delta T \cdot A$$

Where:
F resulting force
σ thermal stress
A cross section
E elasticity modulus

It is interesting to note that the stress status arising in a situation of inhibited deformation does not depend on the structure geometry (e.g. pipe length or cross section) but exclusively on temperature change, expansion coefficient and elasticity modulus.

The following table shows the thermal end-load according to the temperature change:

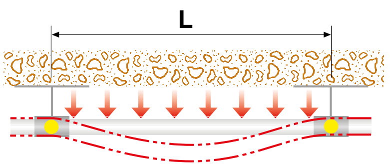
Table: thermal end-load (lb) – SMARTFLEX Single Wall Pipe

Temperature Change	OD [in]						
	1	1 ¼	1 ½	2	3	4	6
	Thermal end-load (lb)						
50°F	269	397	586	899	1746	2531	5194
70°F	357	529	783	1199	2328	3375	6925
90°F	448	661	979	1501	2910	4217	8655

Table: thermal end-load (kg) – SMARTFLEX Single Wall Pipe

Temperature Change	OD [mm]						
	32	40	50	63	90	110	160
	Thermal end-load (kg)						
30°C	122	180	266	408	792	1148	2356
40°C	162	240	355	544	1056	1531	3141
50°C	203	300	444	681	1320	1913	3926

If these loads on the constraints are excessive, a compensation system must be used, as described in the previous paragraph.



Pipe Buckling

Considering the pipe size, constrained at its two ends and subject to thermal expansion like a point-loaded rod, the value of the critical force of pipe buckling is obtained by using equation 3.3.3:

(Eqn. 3.3.3) $$F_{cr} = \frac{\pi^2 E I}{L^2} \quad \text{or} \quad \sigma_{cr} = \frac{\pi^2 E I}{L^2 A}$$

Where:

E elasticity modulus
I moment of inertia
L maximum span length between two anchor points
A pipe cross-section

Pipe buckling will be avoided if:

(Eqn. 3.3.4) $$\sigma < \frac{\sigma_{cr}}{\eta}$$

Where:

η safety coefficient (1,5)
σ thermal stress due to temperature changes

The result of combining equations 3.3.1, 3.3.3 and 3.3.4 is the maximum span length allowed between two anchor points:

(Eqn. 3.3.5) $$L < \sqrt{\frac{\pi^2 I}{\eta A \alpha \Delta T}}$$

Where:

α linear thermal expansion coefficient
ΔT temperature variation

In the following table, the maximum span length between two anchor points is indicated for different diameters and temperature changes ΔT ($\eta = 1.5$).

Table: maximum span length between two anchor points (in)

Temperature Change [°F]	OD							
	32	40	50	63	75	90	110	160
	Maximum span length [in] (L)							
ΔT = 85°F	16	19	24	31	37	44	54	77
ΔT = 105°F	13	17	21	26	31	38	46	67

Table: maximum span length between two anchor points (cm)

Temperature Change [°C]	OD							
	32	40	50	63	75	90	110	160
	Maximum span length [cm] (L)							
ΔT = 30°C	40	49	62	78	93	111	136	196
ΔT = 40°C	34	43	54	67	80	96	118	171

3.4 SUSPENDED PIPE INSTALLATIONS

When installations are suspended, they must be designed taking into account temperature changes and pipeline weight (beam deflection).

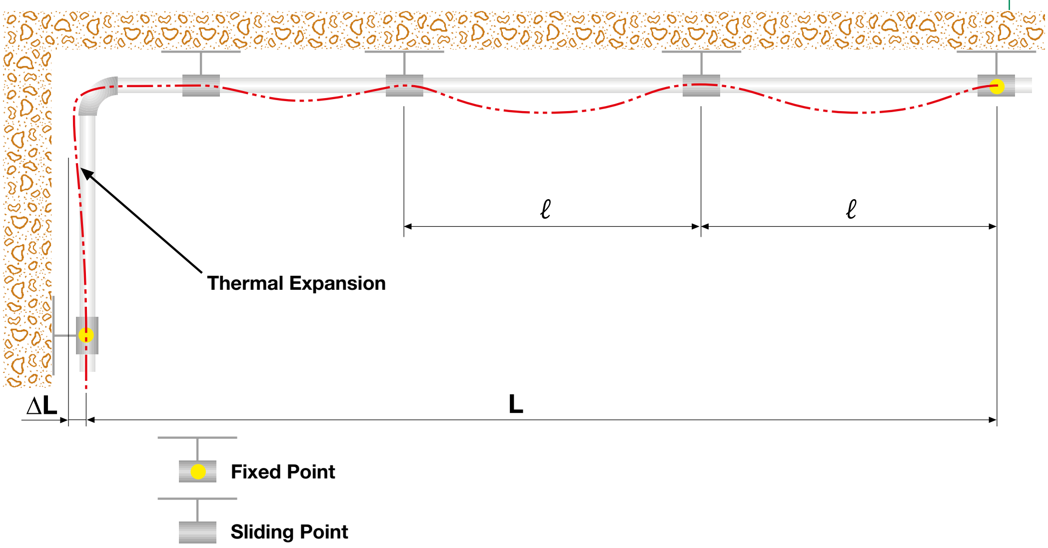
In general, supported applications can be divided into two classes:

A – INSTALLATIONS WHERE THERMAL EXPANSION IS ALLOWED

If thermal expansion is allowed, anchor points must be positioned to compensate the thermal expansion. Once this has been done, the installation designer shall evaluate the deflection due to pipeline weight (including the weight of the fluid) and will check that the obtained value is lower than the maximum allowed values.

Deflection due to pipe weight

When pipe is installed allowing thermal expansion, the calculation of deflection caused by the pipeline weight can be carried out considering the pipe as a uniformly loaded beam with fixed ends at each span. The load is due to the weight of the pipeline itself plus the weight of the conveyed fluid.



The deflection that is generated between spans (Δy) is given by:

(Eqn. 3.4.1) $$\Delta y = \frac{5 \cdot q \cdot \ell^4}{384 \cdot E \cdot I}$$

Where:

$$= W + \pi \cdot \rho \cdot g \cdot \frac{ID^2}{4} (N/m)$$

q total weight per unit length
W weight of the pipe per unit length (N/m)
ρ density of internal fluid (kg/m^3)
ℓ span length (m)
q load per unit length (N/m)
g standard acceleration of gravity (m/s^2)

E	creep modulus of the pipe at average temperature at 10 years (Pa)
ID	internal diameter (m)
OD	outside diameter (m)
I	moment of inertia = $(\pi/64) \cdot (OD^4 - ID^4)$ (m^4)

By limiting the deflection to a safe 0.5% of the span length for safety reasons, it is possible to obtain the maximum span length between two adjacent supports from equation (3.4.1).

Maximum Span Length

OD		Maximum span length (ℓ)	
in	mm	in	cm
1	32	26	66
1¼	40	30	77
1½	50	35	89
2	63	41	104
2½	75	46	118
3	90	52	133
4	110	60	152
6	160	77	196

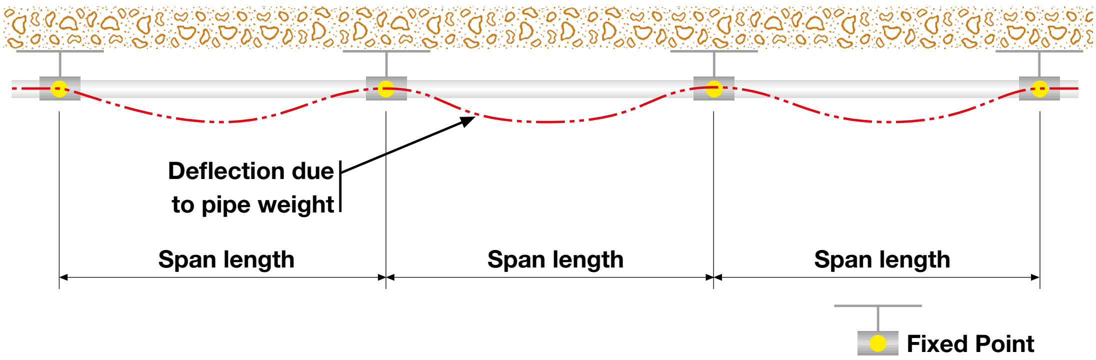
CAUTION:

In the previous calculation, each span between two supports was considered as a single uniformly loaded beam with fixed ends at each span and the benefits of having adjoining segments have not been taken into consideration.

Generally speaking, most suspended pipelines include more than one single span. They usually consist of a series of uniformly spaced spans. Therefore, the actual system will be stiffer than the presumed one, as each segment limits the deflection of its adjacent span. The result of the above mentioned analysis will then be conservative.

B – INSTALLATIONS WHERE THERMAL EXPANSION IS NOT ALLOWED

In this case, the installation designer shall verify that the thermal load will not cause pipe buckling, as described in the previous paragraph.



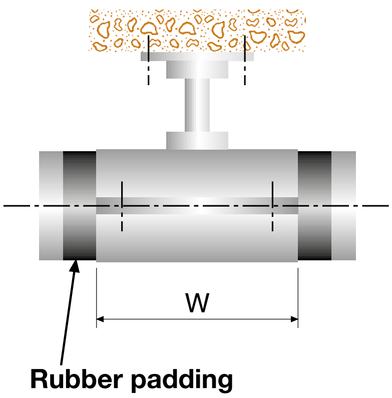
Anchor Points, Brackets and Supports

Anchor points shall be positioned to give the pipe a proper direction and to limit the length variation due to temperature. Therefore, they must have adequate strength to restrain pipe deformation due to the applied forces (temperature load, pipe weight, fluid weight, environmental loads, etc.).

Anchor points are necessary at any direction change or at any pipe size change and where thermoplastic pipes are connected to other materials or to auxiliary items (e.g. valves).

Anchor points and supports are available in different shapes. In any case, they must be free from sharp edges and meet the following minimum dimensions:

- w = 4” (110 mm) for up to 4” (110 mm) diameter pipes
- w = pipe OD for pipes with a diameter larger than 4” (110 mm)



3.5 SECURING OF THREADED FITTINGS

The use of a proper thread sealant is recommended for the securing of threaded fittings. It is always necessary to check the compatibility between the thread sealant and the fluid to be conveyed before using it. Special care has to be used when applying torque while tightening up the fitting. The following table shows the maximum Nominal Torque values recommended.

Thread (in)	Nominal Torque N · m
1”	70
1” ½	80
2”	100
3”	130
4”	150

The following table shows the maximum Nominal Torque values recommended for flanges.

Flange Ø (mm)	Nominal Torque N
32	9
50	10
63	11
90	13
110	13
160	15

WARNING

Excessive torque can cause the polyethylene to detach from the metal insert. This can result in micro leakage.

3.6 WATER HAMMER EFFECT

Piping is subject to sudden pressure increase above its nominal working pressure under special conditions. This pressure increase is known as water hammer effect. It occurs in case of sudden flow change when a pump is suddenly started/shut or when valves are suddenly opened/closed.

It is a very dangerous effect that can cause serious problems and failure if it is not under control.

The use of SMARTFLEX pipes significantly reduces this effect. As a matter of fact, the low elasticity modulus of the pipe significantly reduces pressure peaks while protecting the entire system.

The sudden change of fluid flow Δv causes a pressure increase ΔP given by:

(Eqn. 3.6.1) $$\Delta P = \rho \cdot c \cdot \Delta v$$

Where:

ΔP pressure peak [Pa]

ρ fluid density [kg/m^3]

Δv fluid flow change [m/s]

c velocity of the shock wave in the pipe [m/s]; c depends on the elasticity of both the fluid and the pipe wall.

In the case of a freely supported pipe, the following equation applies:

(Eqn. 3.6.2)

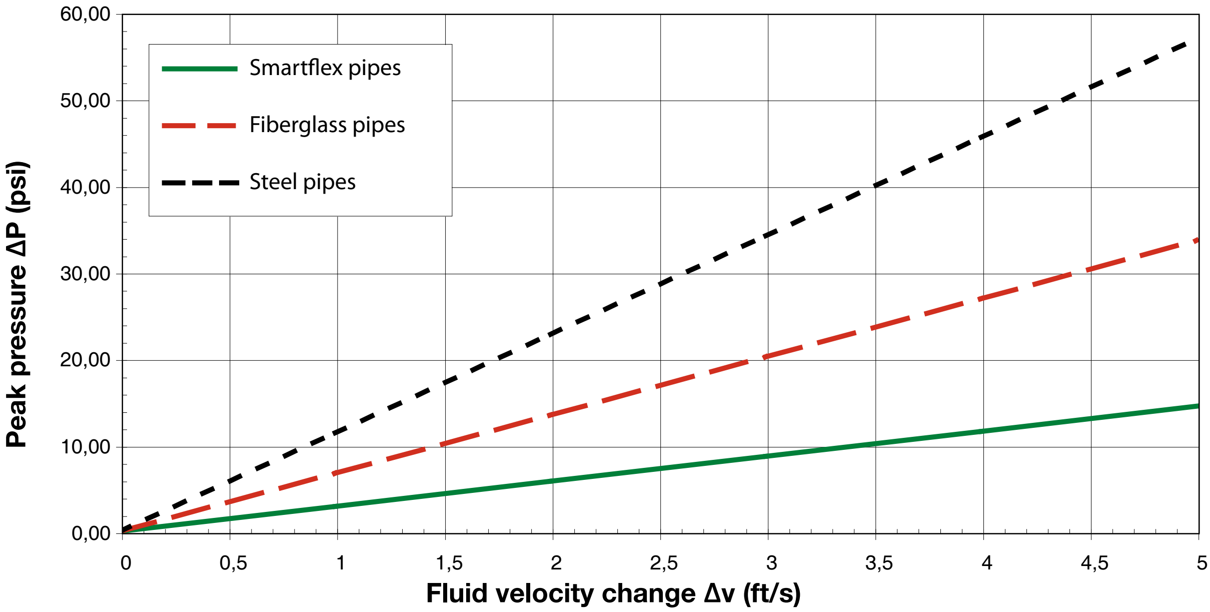
$$c = \sqrt{\frac{\frac{E_p}{\rho}}{\frac{E_p}{E_w} + \frac{D_m}{t}}}$$

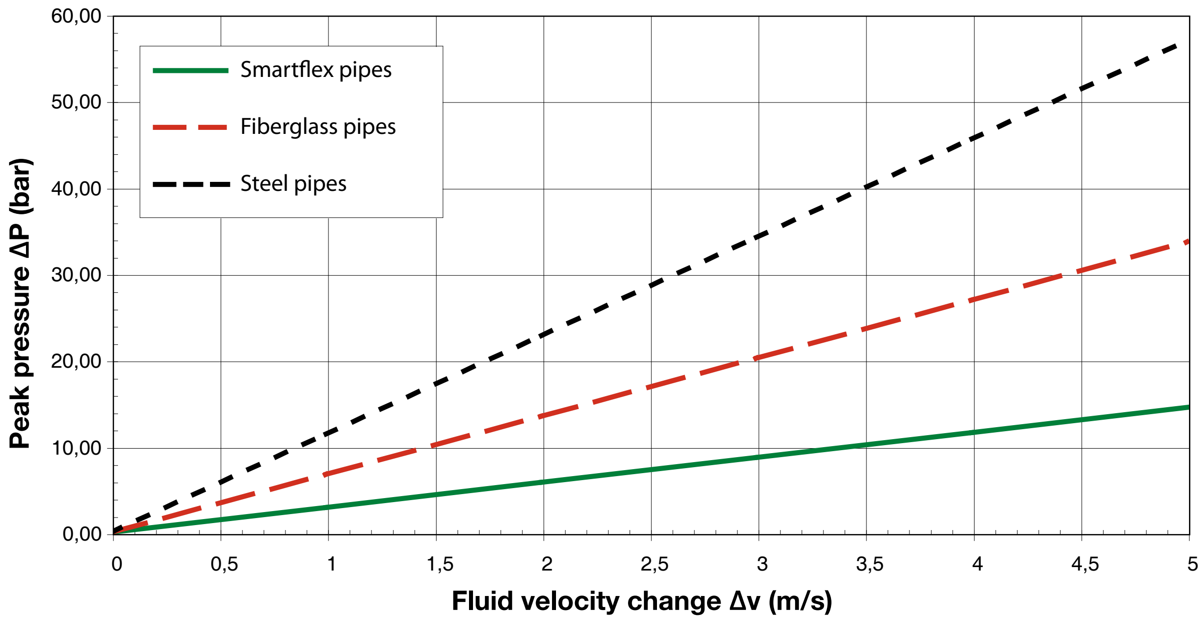
Where:

Ew water elasticity modulus [Pa]
Ep elasticity modulus of the pipe material [Pa]
Dm average pipe diameter [mm]
t pipe thickness [mm]

The following diagram shows the peak pressure generated after a sudden movement (e.g. gate closing where Dv = v due to the complete stop of the flow), in case water is conveyed and for different types of piping. The diagram shows that SMARTFLEX piping provides the lowest pressure peak thanks to its elasticity.

Table: water hammer effect for various types of piping





3.7 HEAD LOSSES

3.7.1 PIPE HEAD LOSSES

Gasoline - Head losses and fluid speed

Q=flow rate l/s or l/min; V=fluid speed (m/s); ΔP= head losses (mm/m)

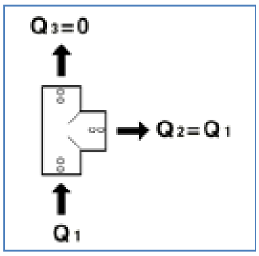
Q	Q	TSMAH32		TSMAH50		TSMAH63		TSMAH90		TSMAH110		TSMAH160	
(l/min)	(l/s)	ΔP	V	ΔP	V	ΔP	V	ΔP	V	ΔP	V	ΔP	V
10	0,17	7,2	0,34	0,7	0,13	0,2	0,08	0,0	0,04	0,0	0,03	0,0	0,01
20	0,33	24,0	0,68	2,5	0,26	0,8	0,16	0,1	0,08	0,1	0,05	0,0	0,02
30	0,50	49,0	1,02	5,0	0,39	1,6	0,24	0,3	0,12	0,1	0,08	0,0	0,04
40	0,67	81,6	1,36	8,2	0,52	2,6	0,32	0,5	0,15	0,2	0,10	0,0	0,05
50	0,83	121,4	1,70	12,2	0,65	3,9	0,40	0,7	0,19	0,2	0,13	0,0	0,06
60	1,00	168,3	2,04	16,9	0,78	5,3	0,48	0,9	0,23	0,3	0,15	0,1	0,07
70	1,17			22,2	0,91	7,0	0,56	1,2	0,27	0,4	0,18	0,1	0,08
80	1,33			28,1	1,04	8,9	0,64	1,5	0,31	0,6	0,20	0,1	0,09
90	1,50			34,7	1,17	11,0	0,72	1,9	0,35	0,7	0,23	0,1	0,11
100	1,67			41,9	1,30	13,2	0,80	2,3	0,38	0,8	0,25	0,1	0,12
110	1,83			49,7	1,43	15,7	0,88	2,7	0,42	1,0	0,28	0,2	0,13
120	2,00			58,1	1,56	18,3	0,96	3,1	0,46	1,2	0,30	0,2	0,14
130	2,17			67,1	1,69	21,1	1,04	3,6	0,50	1,3	0,33	0,2	0,15
140	2,33			76,6	1,82	24,1	1,12	4,1	0,54	1,5	0,35	0,2	0,16
150	2,50			86,8	1,95	27,3	1,20	4,6	0,58	1,7	0,38	0,3	0,18
160	2,67			97,5	2,08	30,6	1,29	5,2	0,61	1,9	0,40	0,3	0,19
170	2,83					34,1	1,37	5,8	0,65	2,1	0,43	0,3	0,20
180	3,00					37,8	1,45	6,4	0,69	2,4	0,46	0,4	0,21
190	3,17					41,7	1,53	7,1	0,73	2,6	0,48	0,4	0,22
200	3,33					45,7	1,61	7,7	0,77	2,9	0,51	0,5	0,24
250	4,2					68,4	2,01	11,6	0,96	4,3	0,63	0,7	0,29
300	5,0							16,0	1,15	5,9	0,76	0,9	0,35
350	5,8							21,2	1,34	7,8	0,89	1,2	0,41
400	6,7							26,9	1,53	9,9	1,01	1,6	0,47
450	7,5							33,3	1,73	12,2	1,14	2,0	0,53
500	8,3							40,3	1,92	14,8	1,26	2,4	0,59
600	10,0									20,6	1,52	3,3	0,71
700	11,7									27,2	1,77	4,3	0,82
800	13,3									34,7	2,02	5,5	0,94
900	15,0											6,8	1,06
1000	16,7											8,2	1,18
1100	18,3											9,8	1,30
1200	20,0											11,5	1,41
1300	21,7											13,3	1,53
1400	23,3											15,2	1,65
1500	25,0											17,2	1,77
1600	26,7											19,3	1,89
1700	28,3											21,6	2,00

Diesel - Head losses and fluid speed

Q=flow rate l/s or l/min; V=fluid speed (m/s); ΔP= head losses (mm/m)

Q	Q	TSMAH32		TSMAH50		TSMAH63		TSMAH90		TSMAH110		TSMAH160	
(l/min)	(l/s)	ΔP	V	ΔP	V	ΔP	V	ΔP	V	ΔP	V	ΔP	V
10	0,17	10,6	0,34	1,1	0,13	0,4	0,08	0,07	0,04	0,03	0,03	0,00	0,01
20	0,33	34,2	0,68	3,6	0,26	1,2	0,16	0,2	0,08	0,08	0,05	0,01	0,02
30	0,50	68,5	1,02	7,1	0,39	2,3	0,24	0,4	0,12	0,2	0,08	0,0	0,04
40	0,67	112,6	1,36	11,7	0,52	3,8	0,32	0,7	0,15	0,3	0,10	0,0	0,05
50	0,83	165,9	1,70	17,1	0,65	5,5	0,40	1,0	0,19	0,4	0,13	0,1	0,06
60	1,00	228,0	2,04	23,4	0,78	7,5	0,48	1,3	0,23	0,5	0,15	0,1	0,07
70	1,17			30,6	0,91	9,8	0,56	1,7	0,27	0,6	0,18	0,1	0,08
80	1,33			38,6	1,04	12,3	0,64	2,2	0,31	0,8	0,20	0,1	0,09
90	1,50			47,4	1,17	15,1	0,72	2,6	0,35	1,0	0,23	0,2	0,11
100	1,67			56,9	1,30	18,2	0,80	3,2	0,38	1,2	0,25	0,2	0,12
110	1,83			67,3	1,43	21,4	0,88	3,7	0,42	1,4	0,28	0,2	0,13
120	2,00			78,3	1,56	24,9	0,96	4,3	0,46	1,6	0,30	0,3	0,14
130	2,17			90,1	1,69	28,7	1,04	5,0	0,50	1,9	0,33	0,3	0,15
140	2,33			102,7	1,82	32,7	1,12	5,6	0,54	2,1	0,35	0,3	0,16
150	2,50			115,9	1,95	36,9	1,20	6,4	0,58	2,4	0,38	0,4	0,18
160	2,67			129,9	2,08	41,3	1,29	7,1	0,61	2,7	0,40	0,4	0,19
170	2,83					45,9	1,37	7,9	0,65	3,0	0,43	0,5	0,20
180	3,00					50,7	1,45	8,7	0,69	3,3	0,46	0,5	0,21
190	3,17					55,8	1,53	9,6	0,73	3,6	0,48	0,6	0,22
200	3,33					61,1	1,61	10,5	0,77	3,9	0,51	0,6	0,24
250	4,2					90,6	2,01	15,5	0,96	5,8	0,63	0,9	0,29
300	5,0							21,4	1,15	8,0	0,76	1,3	0,35
350	5,8							28,1	1,34	10,4	0,89	1,7	0,41
400	6,7							35,6	1,53	13,2	1,01	2,1	0,47
450	7,5							43,9	1,73	16,3	1,14	2,6	0,53
500	8,3							52,9	1,92	19,6	1,26	3,2	0,59
600	10,0									27,1	1,52	4,4	0,71
700	11,7									35,6	1,77	5,7	0,82
800	13,3									45,2	2,02	7,3	0,94
900	15,0											9,0	1,06
1000	16,7											10,8	1,18
1100	18,3											12,8	1,30
1200	20,0											15,0	1,41
1300	21,7											17,3	1,53
1400	23,3											19,7	1,65
1500	25,0											22,3	1,77
1600	26,7											25,0	1,89
1700	28,3											27,9	2,00

3.7.2 FITTING HEAD LOSSES



Tee - Any fuel - Concentrated head losses

Q=flow rate l/s or l/min
Q1 = Q2 ; Q3 = 0
ΔP 1-2 = Head loss in lateral branch (mm)
ΔP 1-3 = Head loss in straight branch (mm)

		STE32		STE50		STE63		STE90		STE110		STE160	
Q	**Q**	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3
(l/min)	**(l/s)**	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)
10	**0,17**	13,5		2,0		0,8		0,2		0,1		0,0	
20	**0,33**	54,1		7,9		3,0		0,7		0,3		0,1	
30	**0,50**	121,6		17,8		6,8		1,6		0,7		0,1	
40	**0,67**	216,2		31,7		12,1		2,8		1,2		0,3	
50	**0,83**	337,9		49,5		18,9		4,3		1,9		0,4	
60	**1,00**	486,5		71,3		27,2		6,2		2,7		0,6	
70	**1,17**			97,1		37,1		8,4		3,7		0,8	
80	**1,33**			126,8		48,4		11,0		4,8		1,0	
90	**1,50**			160,5		61,3		14,0		6,1		1,3	
100	**1,67**			198,2		75,6		17,2		7,5		1,6	
110	**1,83**			239,8		91,5		20,8		9,1		2,0	
120	**2,00**			285,4		108,9		24,8		10,8		2,3	
130	**2,17**			334,9		127,8		29,1		12,7		2,8	
140	**2,33**			388,4		148,2		33,8		14,7		3,2	
150	**2,50**			445,9		170,2		38,8		16,9		3,7	
160	**2,67**			507,3		193,6		44,1		19,2		4,2	
170	**2,83**					218,6		49,8		21,7		4,7	
180	**3,00**					245,0		55,8		24,3		5,3	
190	**3,17**					273,0		62,2		27,1		5,9	
200	**3,33**					302,5		68,9		30,0		6,5	
250	**4,2**					472,7		107,7		46,9		10,2	
300	**5,0**							155,1		67,5		14,6	
350	**5,8**							211,1		91,9		19,9	
400	**6,7**							275,7		120,0		26,0	
450	**7,5**							348,9		151,8		33,0	
500	**8,3**							430,7		187,5		40,7	
600	**10,0**									269,9		58,6	
700	**11,7**									367,4		79,8	
800	**13,3**									479,9		104,2	
900	**15,0**											131,8	
1000	**16,7**											162,8	
1100	**18,3**											196,9	
1200	**20,0**											234,4	
1300	**21,7**											275,1	
1400	**23,3**											319,0	
1500	**25,0**											366,2	
1600	**26,7**											416,7	
1700	**28,3**											470,4	

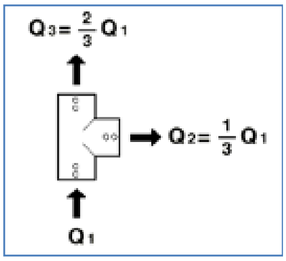
Tee - Any fuel - Concentrated head losses

Q=flow rate l/s or l/min

Q2 = 1/3xQ1 ; Q3 = 2/3xQ1

ΔP 1-2 = Head loss in lateral branch (mm)

ΔP 1-3 = Head loss in straight branch (mm)



		STE32		STE50		STE63		STE90		STE110		STE160	
Q	**Q**	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3
(l/min)	**(l/s)**	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)
10	**0,17**	3,2	2,9	0,5	0,4	0,2	0,2	0,0	0,0	0,0	0,0	0,0	0,0
20	**0,33**	12,9	11,5	1,9	1,7	0,7	0,6	0,2	0,1	0,1	0,1	0,0	0,0
30	**0,50**	29,1	25,9	4,3	3,8	1,6	1,5	0,4	0,3	0,2	0,1	0,0	0,0
40	**0,67**	51,7	46,1	7,6	6,8	2,9	2,6	0,7	0,6	0,3	0,3	0,1	0,1
50	**0,83**	80,8	72,0	11,8	10,6	4,5	4,0	1,0	0,9	0,4	0,4	0,1	0,1
60	**1,00**	116,3	103,6	17,1	15,2	6,5	5,8	1,5	1,3	0,6	0,6	0,1	0,1
70	**1,17**			23,2	20,7	8,9	7,9	2,0	1,8	0,9	0,8	0,2	0,2
80	**1,33**			30,3	27,0	11,6	10,3	2,6	2,3	1,1	1,0	0,2	0,2
90	**1,50**			38,4	34,2	14,6	13,1	3,3	3,0	1,5	1,3	0,3	0,3
100	**1,67**			47,4	42,2	18,1	16,1	4,1	3,7	1,8	1,6	0,4	0,3
110	**1,83**			57,3	51,1	21,9	19,5	5,0	4,4	2,2	1,9	0,5	0,4
120	**2,00**			68,2	60,8	26,0	23,2	5,9	5,3	2,6	2,3	0,6	0,5
130	**2,17**			80,1	71,3	30,6	27,2	7,0	6,2	3,0	2,7	0,7	0,6
140	**2,33**			92,9	82,7	35,4	31,6	8,1	7,2	3,5	3,1	0,8	0,7
150	**2,50**			106,6	95,0	40,7	36,3	9,3	8,3	4,0	3,6	0,9	0,8
160	**2,67**			121,3	108,1	46,3	41,2	10,5	9,4	4,6	4,1	1,0	0,9
170	**2,83**					52,3	46,6	11,9	10,6	5,2	4,6	1,1	1,0
180	**3,00**					58,6	52,2	13,3	11,9	5,8	5,2	1,3	1,1
190	**3,17**					65,3	58,2	14,9	13,3	6,5	5,8	1,4	1,3
200	**3,33**					72,3	64,4	16,5	14,7	7,2	6,4	1,6	1,4
250	**4,2**					113,0	100,7	25,7	22,9	11,2	10,0	2,4	2,2
300	**5,0**							37,1	33,0	16,1	14,4	3,5	3,1
350	**5,8**							50,5	45,0	22,0	19,6	4,8	4,2
400	**6,7**							65,9	58,7	28,7	25,6	6,2	5,5
450	**7,5**							83,4	74,3	36,3	32,3	7,9	7,0
500	**8,3**							103,0	91,8	44,8	39,9	9,7	8,7
600	**10,0**									64,6	57,5	14,0	12,5
700	**11,7**									87,9	78,3	19,1	17,0
800	**13,3**									114,8	102,2	24,9	22,2
900	**15,0**											31,5	28,1
1000	**16,7**											38,9	34,7
1100	**18,3**											47,1	42,0
1200	**20,0**											56,0	49,9
1300	**21,7**											65,8	58,6
1400	**23,3**											76,3	68,0
1500	**25,0**											87,6	78,0
1600	**26,7**											99,6	88,8
1700	**28,3**											112,5	100,2

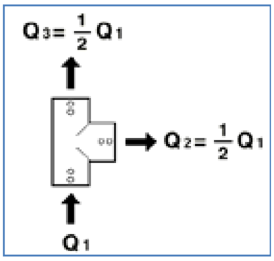
Tee - Any fuel - Concentrated head losses

Q=flow rate l/s or l/min

Q2 = 0.5xQ1 ; Q3 = 0.5xQ1

ΔP 1-2 = Head loss in lateral branch (mm)

ΔP 1-3 = Head loss in straight branch (mm)



		STE32		STE50		STE63		STE90		STE110		STE160	
Q	**Q**	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3	ΔP1-2	ΔP1-3
(l/min)	**(l/s)**	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)	**(mm)**	(mm)
10	**0,17**	8,2	6,6	1,2	1,0	0,5	0,4	0,1	0,1	0,0	0,0	0,0	0,0
20	**0,33**	32,9	26,6	4,8	3,9	1,8	1,5	0,4	0,3	0,2	0,1	0,0	0,0
30	**0,50**	74,0	59,8	10,9	8,8	4,1	3,3	0,9	0,8	0,4	0,3	0,1	0,1
40	**0,67**	131,6	106,2	19,3	15,6	7,4	5,9	1,7	1,4	0,7	0,6	0,2	0,1
50	**0,83**	205,6	166,0	30,2	24,3	11,5	9,3	2,6	2,1	1,1	0,9	0,2	0,2
60	**1,00**	296,1	239,0	43,4	35,0	16,6	13,4	3,8	3,0	1,6	1,3	0,4	0,3
70	**1,17**			59,1	47,7	22,6	18,2	5,1	4,1	2,2	1,8	0,5	0,4
80	**1,33**			77,2	62,3	29,5	23,8	6,7	5,4	2,9	2,4	0,6	0,5
90	**1,50**			97,7	78,9	37,3	30,1	8,5	6,9	3,7	3,0	0,8	0,6
100	**1,67**			120,6	97,4	46,0	37,2	10,5	8,5	4,6	3,7	1,0	0,8
110	**1,83**			146,0	117,8	55,7	45,0	12,7	10,2	5,5	4,5	1,2	1,0
120	**2,00**			173,7	140,2	66,3	53,5	15,1	12,2	6,6	5,3	1,4	1,2
130	**2,17**			203,8	164,5	77,8	62,8	17,7	14,3	7,7	6,2	1,7	1,4
140	**2,33**			236,4	190,8	90,2	72,8	20,6	16,6	8,9	7,2	1,9	1,6
150	**2,50**			271,4	219,1	103,6	83,6	23,6	19,0	10,3	8,3	2,2	1,8
160	**2,67**			308,8	249,2	117,9	95,1	26,8	21,7	11,7	9,4	2,5	2,0
170	**2,83**					133,0	107,4	30,3	24,5	13,2	10,6	2,9	2,3
180	**3,00**					149,2	120,4	34,0	27,4	14,8	11,9	3,2	2,6
190	**3,17**					166,2	134,1	37,9	30,6	16,5	13,3	3,6	2,9
200	**3,33**					184,1	148,6	41,9	33,9	18,3	14,7	4,0	3,2
250	**4,2**					287,7	232,2	65,5	52,9	28,5	23,0	6,2	5,0
300	**5,0**							94,4	76,2	41,1	33,2	8,9	7,2
350	**5,8**							128,5	103,7	55,9	45,1	12,1	9,8
400	**6,7**							167,8	135,4	73,0	58,9	15,9	12,8
450	**7,5**							212,4	171,4	92,4	74,6	20,1	16,2
500	**8,3**							262,2	211,6	114,1	92,1	24,8	20,0
600	**10,0**									164,3	132,6	35,7	28,8
700	**11,7**									223,6	180,5	48,5	39,2
800	**13,3**									292,1	235,8	63,4	51,2
900	**15,0**											80,2	64,8
1000	**16,7**											99,1	80,0
1100	**18,3**											119,9	96,8
1200	**20,0**											142,7	115,1
1300	**21,7**											167,4	135,1
1400	**23,3**											194,2	156,7
1500	**25,0**											222,9	179,9
1600	**26,7**											253,6	204,7
1700	**28,3**											286,3	231,1

90° Elbow - Any fuel - Concentrated head losses

Q=flow rate l/s or l/min; ΔP= head losses (mm)

Q	Q	SGE32	SGE50	SGE63	SGE90	SGE110	SGE160
(l/min)	(l/s)	ΔP (mm)					
10	0,17	7,1	1,0	0,4	0,1	0,0	0,0
20	0,33	28,2	4,1	1,6	0,4	0,2	0,0
30	0,50	63,5	9,3	3,6	0,8	0,4	0,1
40	0,67	112,8	16,5	6,3	1,4	0,6	0,1
50	0,83	176,3	25,8	9,9	2,2	1,0	0,2
60	1,00	253,8	37,2	14,2	3,2	1,4	0,3
70	1,17		50,7	19,3	4,4	1,9	0,4
80	1,33		66,2	25,3	5,8	2,5	0,5
90	1,50		83,7	32,0	7,3	3,2	0,7
100	1,67		103,4	39,5	9,0	3,9	0,8
110	1,83		125,1	47,7	10,9	4,7	1,0
120	2,00		148,9	56,8	12,9	5,6	1,2
130	2,17		174,7	66,7	15,2	6,6	1,4
140	2,33		202,6	77,3	17,6	7,7	1,7
150	2,50		232,6	88,8	20,2	8,8	1,9
160	2,67		264,7	101,0	23,0	10,0	2,2
170	2,83			114,0	26,0	11,3	2,5
180	3,00			127,8	29,1	12,7	2,8
190	3,17			142,4	32,5	14,1	3,1
200	3,33			157,8	36,0	15,6	3,4
250	4,2			246,6	56,2	24,5	5,3
300	5,0				80,9	35,2	7,6
350	5,8				110,1	47,9	10,4
400	6,7				143,8	62,6	13,6
450	7,5				182,0	79,2	17,2
500	8,3				224,7	97,8	21,2
600	10,0					140,8	30,6
700	11,7					191,7	41,6
800	13,3					250,4	54,3
900	15,0						68,8
1000	16,7						84,9
1100	18,3						102,7
1200	20,0						122,3
1300	21,7						143,5
1400	23,3						166,4
1500	25,0						191,1
1600	26,7						217,4
1700	28,3						245,4

45° Elbow - Any fuel - Concentrated head losses

Q=flow rate l/s or l/min; ΔP= head losses (mm)

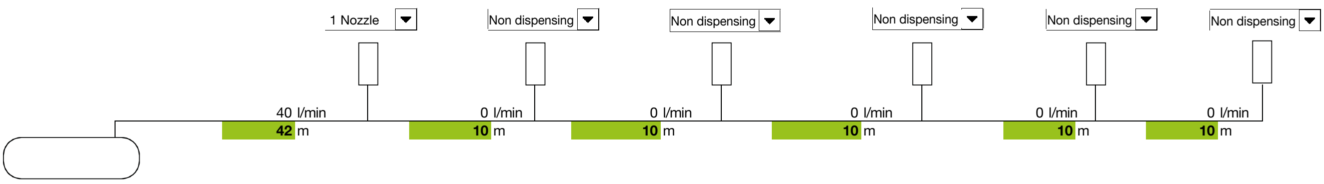
Q	Q	SCE32	SCE50	SCE63	SCE90	SCE110	SCE160
(l/min)	(l/s)	ΔP (mm)					
10	0,17	1,8	0,3	0,1	0,0	0,0	0,0
20	0,33	7,1	1,0	0,4	0,1	0,0	0,0
30	0,50	15,9	2,3	0,9	0,2	0,1	0,0
40	0,67	28,2	4,1	1,6	0,4	0,2	0,0
50	0,83	44,1	6,5	2,5	0,6	0,2	0,1
60	1,00	63,5	9,3	3,6	0,8	0,4	0,1
70	1,17		12,7	4,8	1,1	0,5	0,1
80	1,33		16,5	6,3	1,4	0,6	0,1
90	1,50		20,9	8,0	1,8	0,8	0,2
100	1,67		25,8	9,9	2,2	1,0	0,2
110	1,83		31,3	11,9	2,7	1,2	0,3
120	2,00		37,2	14,2	3,2	1,4	0,3
130	2,17		43,7	16,7	3,8	1,7	0,4
140	2,33		50,7	19,3	4,4	1,9	0,4
150	2,50		58,2	22,2	5,1	2,2	0,5
160	2,67		66,2	25,3	5,8	2,5	0,5
170	2,83			28,5	6,5	2,8	0,6
180	3,00			32,0	7,3	3,2	0,7
190	3,17			35,6	8,1	3,5	0,8
200	3,33			39,5	9,0	3,9	0,8
250	4,2			61,7	14,0	6,1	1,3
300	5,0				20,2	8,8	1,9
350	5,8				27,5	12,0	2,6
400	6,7				36,0	15,6	3,4
450	7,5				45,5	19,8	4,3
500	8,3				56,2	24,5	5,3
600	10,0					35,2	7,6
700	11,7					47,9	10,4
800	13,3					62,6	13,6
900	15,0						17,2
1000	16,7						21,2
1100	18,3						25,7
1200	20,0						30,6
1300	21,7						35,9
1400	23,3						41,6
1500	25,0						47,8
1600	26,7						54,3
1700	28,3						61,4

3.8 PIPING SIZE CALCULATION

NUPI Industrie Italiane recommends to use its SMARTFLEX PRESSURE LOSS SPREADSHEET to choose the proper piping size. The file can be downloaded without logging in from our website at: **NUPI INDUSTRIE ITALIANE/LITERATURE/INDUSTRIAL DIVISION (SMARTFLEX)/ SOFTWARE/ 154…..xls**

The SMARTFLEX Pressure Drop Calculator allows to check that the product pipe size is adequate to the site conditions. It is a Microsoft Excel spreadsheet that evaluates the fluid flow through the pipe and, consequently, the pressure drop along the pipe runs.

Below is a sample image showing correct dimensioning.



INPUT DATA

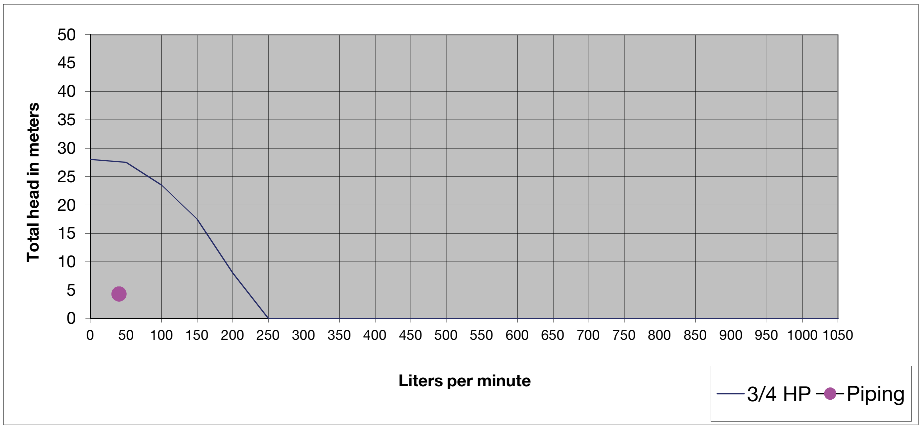
Fluid Type	Gasoline
Pipe Nominal Size	TSMAH50
STP power	3/4 HP

HYDRAULIC

Flow rate per nozzle	40 l/min
Elevation (tank-dispenser)	4 m

OUTPUT

Pressure losses	2504 Pa
Pressure losses	0,025 bar
Pressure losses	0,34 m
Pressure losses + elevation	31828,10 Pa
Pressure losses + elevation	0,32 bar
Pressure losses + elevation	4,34 m
Maximum fluid speed	0,51 m/s



4 • INSTALLATION INSTRUCTIONS OF PIPES AND FITTINGS

4.1 INTRODUCTION

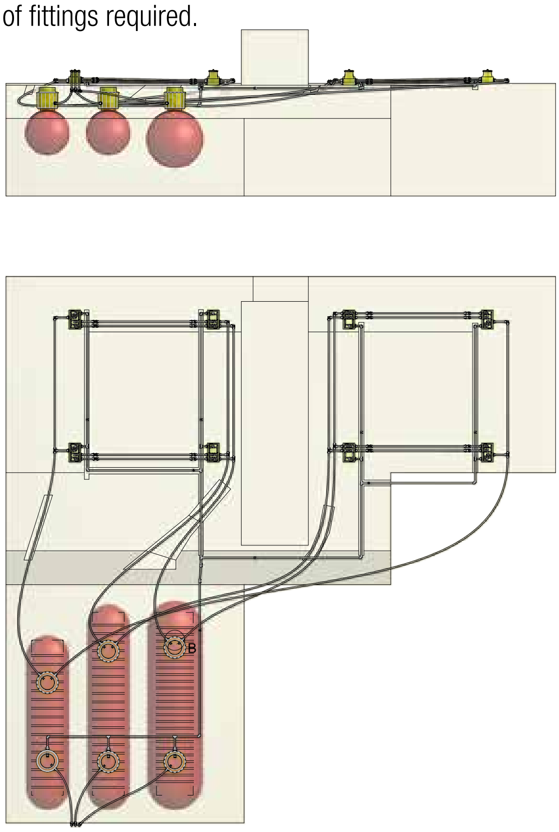
Before starting any installation, all installers shall be familiar with the installation procedures described in this catalogue.

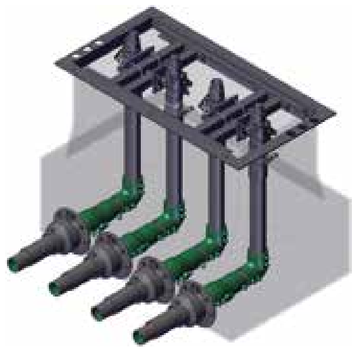
Every installation is different depending on the service station size, piping size and weather conditions. Therefore, it is important to follow the general guidelines that apply to most piping installations i.e.:

- A two-worker crew is the minimum recommended for most average-size service stations, however, the number of people in the crew must be increased by one person if larger pipe diameters are to be installed or when installing double wall pipes.
- Ensure all necessary tools and equipment are at the construction site prior to commencing the installation of pipes and fittings.
- Establish a working schedule so that all phases of the installation are carried out in a timely manner.

4.2 INSTALLATION LAYOUT

Advanced planning for the piping layout is essential to ease the installation process and possibly reduce the number of fittings required.





We recommend using pipes in coils to connect the tank to the first product dispenser and straight lengths between other product dispensers.

If compliance to California Air Resources Board (CARB) recommendations is required, use only straight lengths for vapour recovery and vent.

All piping shall slope by at least 1:100 (1/8” per foot or 1cm per meter) towards the tank. It is necessary to take precautions to prevent the formation of siphon traps or wells.

4.3 TRENCHING AND BACKFILLING

Proper construction of trenches is important to assure that the SMARTFLEX system is installed under the best possible conditions. Trenches should be wide and deep enough to accommodate the pipe and the backfill material.

When using tamping equipment, prevent vibration from driving small stones into the pipe walls. The amount of compaction and the type of soil determine the soil modulus.

Two pipes crossing over one another must be separated by a minimum of 2” (5 cm) of compacted backfill material to prevent point loading conditions or 1” (2.5 cm) of protective Styrofoam.

What is generally considered as flexible is a type of pipe that changes its shape when it encounters loads such as those transmitted by the soil to underground installations.

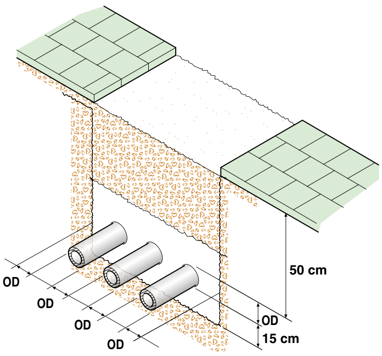
The designer and the installer shall use the backfill material to limit the deformation of the pipes within an acceptable range.

The level of interaction between the pipe and the backfill material soil surrounding it essentially depends on: burial depth, soil characteristics and backfill material, superficial loads and pipe resistance to deflection.

Generally, pipes and fittings should be installed at a minimum depth of 20” (50 cm). Installations requiring shallower or deeper depths may be used when designed in accordance with the specific project requirements (for example: when high frost load conditions are present).

For shallow installations, the minimum burial depths shown in the table below are recommended:

Surface type	Minimum burial depth
Unpaved	20” (50 cm)
4” (10 cm) asphalt	12” (30 cm)
4” (10 cm) concrete	10” (25 cm)



All piping shall be separated by a distance of at least its diameter from any other pipe as well as the trench wall (see figure). The material removed while excavating the trench can be re-used as backfill material only if it fulfills the required criteria (as outlined in chapter 6.1.5). The trench must be properly filled and compacted.

The support allowed by the backfill material is proportional to its rigidity. For this reason, the backfill material in contact with the piping must be well compacted.

The rigidity of the backfill above the pipe also has an important role in transmitting superficial loads to the pipe. Loads on the pipe are significantly reduced when the forces on the soil above and around the pipe are redistributed.

The more rigid the backfill above the pipe is, the less force is transmitted to the pipe.

Along with the characteristics of the backfill material of the trench, the material around the pipe must also be taken into consideration. Special attention must be given to soft clay and humid soils or sandy soils that can flake and make the walls of the trench unstable during excavation.

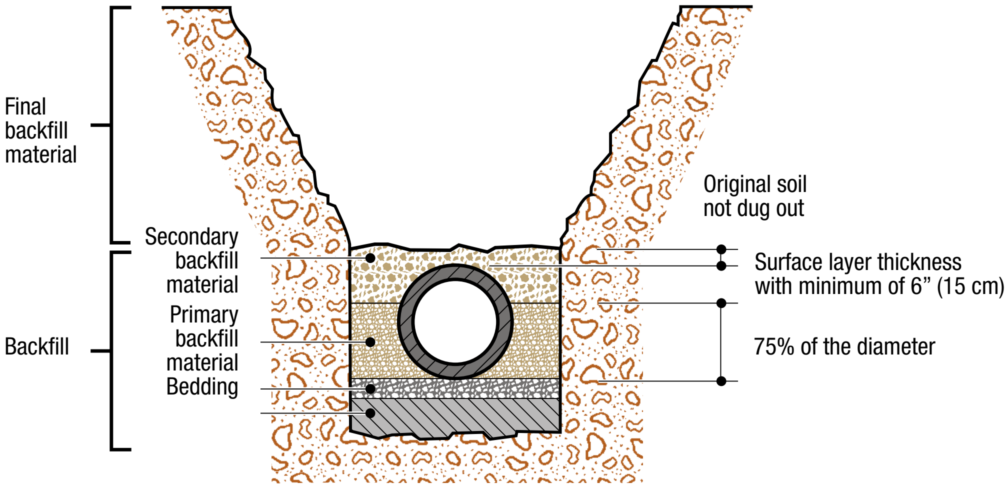
Flexible piping can be installed in similar circumstances without particular deformations if these conditions are respected. The main goal for installations with flexible piping is to avoid them being deflected. Pipe deflection can occur due to two main reasons: the first is the installation (that reflects the care and techniques used when the pipes are installed) and the second is the workload.

4.4 BACKFILL

The backfill material surrounding the pipes can be that which is present or imported, such as gravel or granules or material excavated directly from the trench (filling material).

This material must guarantee resistance, rigidity, contact uniformity and stability to minimize pipe deflection due to the soil pressure.

We recommend wetting the layer of sand in contact with the pipe repeatedly to obtain the best compacting results possible.



Groundwork: required only when the bottom of the trench does not provide a suitable base for the pipe bedding.

Bedding: it evens out the bottom of the trench to guarantee a uniform support base for the entire length of the pipe. When necessary, it also assures that slopes required for the pipe will be respected.

Primary backfill material: this material provides primary support against lateral pipe deflection. This area should cover at least 75% of the pipe diameter along the trench bedding.

Secondary backfill material: the material in this area basically distributes superficial loads and isolates the pipes from any possible effect derived from the final backfill material.

Final backfill material: the nature and quality of this material is less important than the other two regarding the effects on flexible pipes. In any case, a rigid fill helps reduce the stress created by superficial loads. To avoid possible impacts or loads concentrated on the pipes during and after filling the trench, the backfill material should not contain large stones, organic material or rubble.

In any case the reduction of the superficial loads is favoured by a rigid backfill.

The backfill material shall not include big stones, organic material or rubble to avoid any shock or concentrated load on the piping both during and after the trench filling.

4.5 BACKFILL CLASSIFICATION

When selecting backfill, pay close attention to the size of the granules, as well as to the form and distribution of the grains. Generally, material with large grains provides maximum rigidity and offers the best resistance.

Round grains tend to roll around easier compared to irregular grains that tend to lock into one another therefore providing better resistance to damage.

For example, gravel has a typical modulus of 1.000 psi (7 MPa) without being compacted, while sand requires light compaction (Proctor density of 85%) to achieve the same modulus.

Refer to Standards ASTM D3839 or AWWA C950, CEN/TR 1295-3 and CEN TS 1046 for further details.

Recommended types of backfill material are:
- Clean washed rough sand
- Pea gravel, 1/8” to 3/4” (3 mm to 19 mm)

Mixed material tends to offer better characteristics than material with consistent characteristics. All backfill material must be dry and free from ice, snow or debris.

Along with the grain characteristics, density also provides an important effect on the rigidity of the underground installation. For example, the grains lock into each other in a dense soil. Movement in the soil is restrained and much energy is required, whereas in a mobile soil, movement causes rolling and sliding of the grains, which requires much energy. Mobile soils cause more deflection than dense soils for certain superficial loads.

When a pipe is deflected, two effects might occur:
- The pipe pushes against the material surrounding it and forces the soil to move. When this occurs, the soil resists it and prevents further deflection.
- Vertical deflection causes the load transmitted to the pipe to be reduced and produces an “arch” effect in the soil.

Compaction is therefore a fundamental parameter. Compaction should be of a W level type (Well compacted material) or at least M level type (Moderately compacted material) according to the classification as per European Standard CEN/TR 1295-3 or equivalent (eg CEN TS 1046).

Backfill material has been grouped into five main classes. Backfill with low numbers corresponds to larger grains, which are more suitable for pipe burial.

Class 1 and 2 soils (GS1 and GS2 according to the European Standard CEN/TR 1295-3) are granular and provide maximum support as shown by the high elasticity coefficient of the soil (E). The high permeability of materials belonging to class I and II eases trench drainage while making this material suitable in conditions where problems may occur due to water.

When a pipe is set under water level in the soil, granular backfill should be used (class 1 and 2). It is important that the grains are irregular to reduce eventual movement to a minimum.

Table: ratio between compaction class, backfill material type and Proctor density

Compaction class	Backfill material class			
	1	2	3+4	5
Low (N)	100	90	87	84
Moderate (M)	100	93	90	87
Good (W)	100	97	95	92

4.6 CONCRETE BACKFILL

Concrete backfill turns the piping installation into a rigid system. Short piping sections can be embedded in concrete without any problem but precautions have to be taken in case of long sections.

Failure to do so will result in concrete and plastic to have no connection between them and the pipe may be free to shrink and expand according to temperature changes.

We suggest to embed the whole piping section into concrete including fittings and to constrain the piping every 5 metres by means of well fastened metal pipe clamps that will function as fixed points. In case of double wall piping, the pipe clamps shall be oval shaped in order to lock the primary pipe on the secondary pipe.

4.7 MULTIFUNCTION WELDING UNIT

All the instructions and guidelines regarding safety precautions are outlined in the multifunction welding unit (model **SSEL8404**) user's manual. However, please pay close attention to the following:

- The multifunction welding unit can be used only for electrofusion welding of NUPI Industrie Italiane SMARTFLEX pipes and fittings. It is not intended for use with any other electrofusion piping system.
- The unit can perform testing functions when used with the SMARTFLEX Pressure Test Unit (model SENS010) or the Vacuum Test Unit (model SVTU).
- Certified installers/operators are responsible for assurance of recommended energy/power sources. Power sources should be checked (confirmed) for compliance to the following specifications: -110 VAC, 50 Hz (min.) with a 10% tolerance -220 VAC and 50 Hz (min.) with a 10% tolerance.
- Inspect the multifunction welding unit, power cords and barcode reading device and replace any damaged components prior to use. Care must be taken not to damage the barcode reading device.
- Download the welding and pressure test reports and erase the data from the memory at the completion of each job.

The multifunction welding unit incorporates a system that automatically controls all steps of the welding procedure and informs the operator about errors and/or faults by means of signals or alarms. The alarm/error code is always shown on the LCD display and recorded on the welding report. Types of Alarm/Error Codes are:

- Error 0 successful weld
- Error 2 ambient temperature value outside limits for electrofusion
- Error 4 short circuit, overload, load current exceeded
- Error 5 open circuit
- Error 6 parameter control error
- Error 11 memory full
- Error 12 internal temperature exceeded
- Error 13 power supply interruption
- Error 14 no data in machine memory
- Error 22 manual or forced interruption of welding
- Error 23 power supply voltage outside parameters
- Error 30 not a NUPI fitting
- Error 31 fitting resistance out of tolerance range
- Error 101 RAM memory data and date/time not valid
- Error 200 pressure test stopped manually by the user
- Error 201 pressure loss in the system being tested

NEW AUTOMATIC WELDING UNIT WITH BARCODE SCANNER - LIGHT VERSION

New welding unit for SMARTFLEX system welding up to diameter 160 - USB technology that allows the transfer of data easily to your PC or download unit.

Weight 13 kg, completely automated thanks to a barcode system that reduces human errors, full welding report and pressure test report.

ITS

ITS is an Internet based Interactive Tracking System provided by NUPI Industrie Italiane. It allows access to data regarding the installation of the SMARTFLEX system in a specific site (completed welding reports, pressure test results, installed products, installation site etc.).

For further information you can download the User manual from the documents section of NUPI Industrie Italiane website www.nupiindustrieitaliane.com

MULTIFUNCTION - SMART - WELDING UNIT INCORPORATED IN SUITCASE WITH BARCODE SCANNER

A new evolved welding unit as the Smartweld associated with the app “Nupi Welding Cloud” allows a 360° management of all information related to the costruction site, the weld itself, the traceability of the products installed, the mapping using GPS tracking as well all testing activities later.

The welding unit is incorporate in the most innovative waterproof case. The case is watertight, waterproof, sand proof, dust proof and able to withstand harsh environments and shocks.

4.8 CHECKS PRIOR TO ELECTROFUSION WELDING

Before commencing the electrofusion welding process, check that the site generator, if required, is working correctly and efficiently. Check the condition of the extension leads and the presence of emergency fuel supply to ensure that electrical power will be supplied for the entire duration of the welding process. Finally, check the multifunction welding unit cables and ensure that all components are working properly.

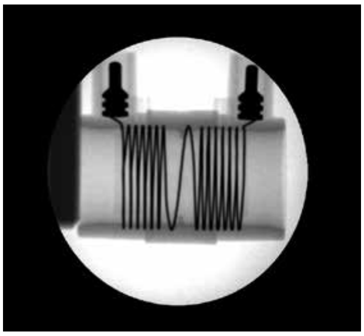
The quality of the electricity you intend to use must also be checked: if a generator powers the multifunction welding unit, ensure that it is of the asynchronous type. Correct welding requires careful use of the extension leads. The cross-section/length ratio is of vital importance. NUPI Industrie Italiane recommends the following lengths and sizes:

WARNING:

The misuse of the multifunction welding unit can result in hazardous situations for both the operator and the integrity of system components. Prior to commencing any welding operation, ensure you read the user's manual carefully.

Recommended cable cross-section	Recommended cable length
0.10 (in^2) 2,5 (mm^2)	19-22 (ft) 6-7 (m)
0.16 (in^2) 4,0 (mm^2)	30-36 (ft) 9-11 (m)
0.24 (in^2) 6,0 (mm^2)	49-55 (ft) 15-17 (m)

4.9 ELECTROFUSION WELDING



SMARTFLEX installation technology is based on "electrofusion", one of the most used connection methods in the installation of polyethylene pipes. Electrofusion is the thermal junction process between pipe and fitting obtained by heating a resistance wire included in the fitting. Due to the Joule effect, the thermal energy created by this resistance heating softens the components in contact causing them to melt and amalgamate after the cooling down period.

To be welded, all SMARTFLEX electrofusion fittings require maximum voltage of 42 V as requested in international safety standards.

All SMARTFLEX fittings are provided with a barcode label that allows the acquisition of the welding parameters by means of a barcode scanner.

Regarding the use of generators to weld the fittings, the following rule is valid:

a 3KV generator is sufficient for 1" or 2" fittings
a 5KV generator is sufficient for 3" or 4" fittings

Note: The power of the generator is to be used only for the welding unit. If you want to connect more than one unit, you need greater generator power.

Single and double wall coaxial fittings contain electrical wires that provide the required heat to weld the pipe and fittings together (X-ray of a sleeve shown as example) when connected to the multifunction welding unit. Each fitting connection is identified by a barcode, which contains the specific welding parameters (required voltage and welding time) and a description of the specific fitting to be welded, the characteristics of the fitting (type and size) and other information regarding the facility, batch number and raw material type. This system also allows complete traceability of each fitting.

Only SMARTFLEX Certified Installers can access the welding unit using their specific SMARTCARD that contains an identifiable barcode and the following information:

- Operator's name, photograph and serial number
- Company name and complete address
- Product
- Training level indicated by the competencies codes listed in the table below
- Language
- Expiration date
- Contact information

NUPI Industrie Italiane regularly trains and reviews certified installers worldwide.

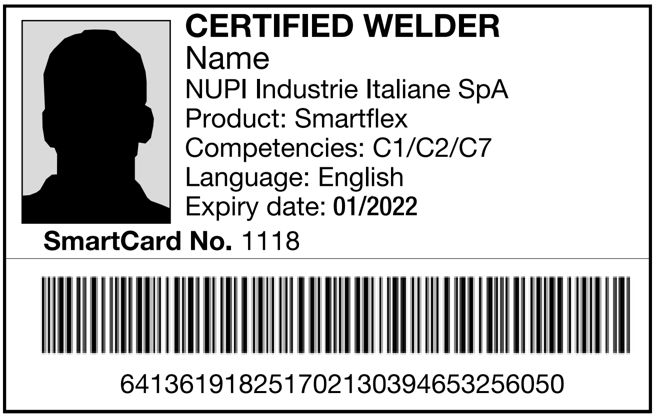


Table: Competency codes

C1	Single wall pipe
C2	Double wall pipe
C3	Double wall fill pipe
C4	UL listed pipe
C5	Containment sumps
C6	SMARTCONDUIT
C7	Installation equipment
C8	Electrofusion entry boots
C9	Entry boots for fiberglass
C10	Leak monitoring
C11	Pressure testing

4.10 GENERAL GUIDELINES FOR ELECTROFUSION WELDING

Cutting
Cut the pipe perpendicularly at the correct length using the appropriate pipe cutter (Model SCUT).

Note: a cut which is not perpendicular to the pipe axis can influence its correct and complete insertion. As a consequence, some melt material could enter into the pipe during welding or two resistance wires might touch leading to a short circuit.

Scraping
Scrape the entire piping area involved in the welding process using the revolving scraper to completely remove the outer layer.

WARNING: Never use under any circumstances sand paper, emery cloth, files, knives or sharp objects.

Insertion length
Clearly mark the insertion length on the pipe using the proper white marker (Model MARK).

Cleaning
Clean the ends of the pipe, the fitting spigot and the socket with a clean cloth soaked with a recommended cleaning solvent (Model **LID1**). Do not touch the parts that have just been cleaned.

Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. Their grade must be of the CABs/industrial type and they must not contain traces of water or oil. The use of other primers or solvents is not allowed.

Assembly
Insert the pipes into the fittings ensuring that the insertion depth previously indicated on the pipe is reached.

Always use the aligner (model ALL225/4) whenever possible to support the pipes and keep them in line during welding and cooling process.

Electrofusion welding
Connect the two welding lead connectors to the fitting, turn on the machine and follow the instructions shown on the display.

Read the barcode on the fitting with the barcode scanner connected to the welding unit to carefully respect the appropriate welding time.

Refer to the welding unit manual for the correct welding procedure.

Note: Ensure to scrape and completely remove the green outer layer of the **SUPERSMARTFLEX** pipe from the primary pipe until the black polyethylene layer is clearly visible on the outside of the pipe before commencing the welding process. Remove the outer layer completely, including the tie layer, until you reach the black HDPE layer. For a correct installation, please refer to the procedures and assembly instructions of each SMARTFLEX product.

Fig.1

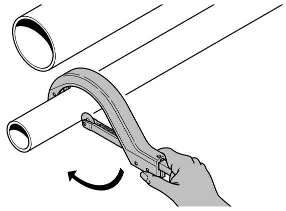


Fig.2

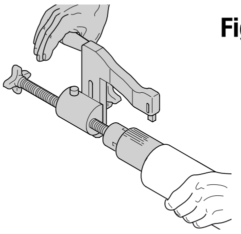


Fig.3

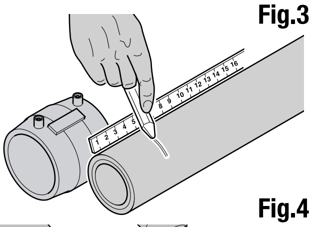


Fig.4

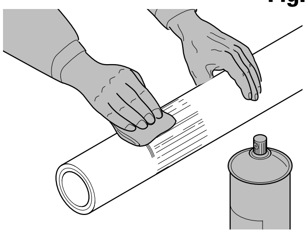


Fig.5

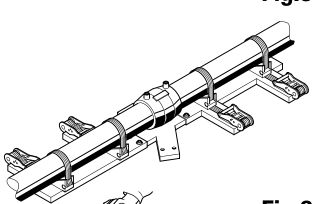
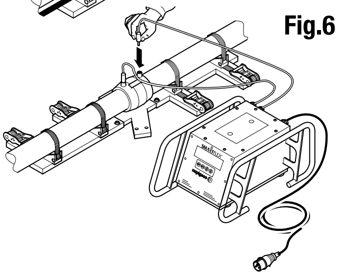


Fig.6



CAUTION:

After cleaning the pipes and fittings, ensure that any residual solvent has evaporated prior to inserting the pipe ends into the fitting.

WARNING:

Some degreasers and solvents are extremely flammable. Be sure to read any warning labels on the package. Never use gasoline, turpentine, denatured alcohol (methylated spirits), tricloroethylene or diesel fuel to clean contaminated surfaces, as these products are generally greasy and may leave an oily film on the welding surface that would block molecular fusion of the two parts that are to be welded together.

When the welding process is completed, let the assembly cool without moving it for the time indicated on the fitting barcode.
The following basic recommendations apply:

- electrofusion welding shall be carried out in dry areas. In the event of rain, fog or excessive exposure to the sun rays, work should be carried out under appropriate protection;
- it is recommended that electrofusion welding is carried out within the ambient temperature range from +14°F to +113°F (from -10°C to +45°C);
- scrape the entire area of the pipe involved in the welding process. The external oxidized layer must be removed in a uniform manner from the entire circumference and for a depth of:
  - 0.004” (0,10 mm) for outside diameters up to 2” (63 mm)
  - 0.006” (0,15 mm) for outside diameters up to 4” (110 mm) or larger;
- use the SMARTFLEX marker (model MARK) to clearly mark the insertion length on the pipe;
- it is important to properly align pipes and fittings during the welding and cooling process to within a maximum angle of 15°;
- whenever possible use the aligner (model ALL225/4) to avoid deflection and eliminate stress on the welded connection;
- the pipe aligner must only be removed after the welded pipe and fitting have cooled completely but not before the cooling down period shown in the fitting barcode;
- the joining surfaces must be clean and dry before the electrofusion welding operation commences;
- in the event of a power outage, welding can be restarted only after the fitting and pipe have cooled down completely. This can only be undertaken once, otherwise replace the fitting;
- before disconnecting the welding leads from the fitting, it is good practice to mark the welded socket with the weld number displayed on the welding unit screen or any other mark so that before the pressure test any non-welded fitting can be easily identified.

Note: For detailed welding procedures of any SMARTFLEX component, please refer to the individual installation instructions that can be downloaded from the documents section of NUPI Industrie Italiane website www.nupiindustrieitaliane.com. You can also request them to our Technical Department at info@nupinet.com.

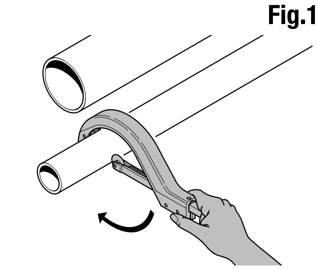
4.11 CHECKS AFTER ELECTROFUSION WELDING

Non-destructive checks on electro-welded assemblies consist mainly of a visual inspection checking the following:

- that any misalignment between the two pipes does not exceed 10°-15°;
- that correct in-fitting insertion lengths have been observed;
- that there is no escape of molten material;
- that an area of the pipe that has been scraped is protruding outside the fitting [(at least 3/8”) (10 mm)];
- that no parts of the wire of the inserted fitting will protrude.

4.12 ASSEMBLY INSTRUCTIONS OF COAXIAL DOUBLE WALL FITTINGS Ø50 (Ø50/63), Ø63 (Ø63/75) AND MODEL SGEDW110 (Ø110/125)

Fig.1



Cut the primary and secondary pipes to the same length using the appropriate pipe cutter (Model SCUT).

Fig.2

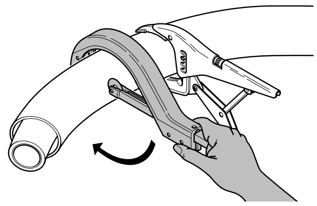
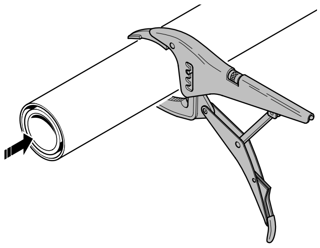
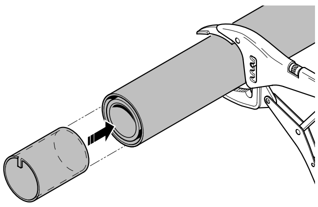


Fig.3



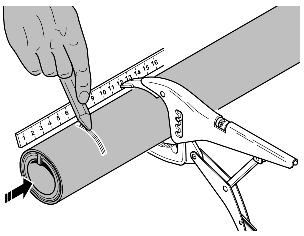
Ensure the primary pipe is constrained by using the pliers for double wall pipes (Model SPLIDW).

Fig.4



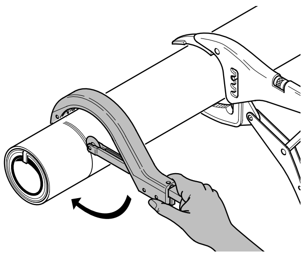
Insert the metallic protective sleeves (Model STP) between the secondary and primary pipes.

Fig.5



Use the appropriate marker (Model MARK) to clearly indicate on the secondary pipe the measurement **Px**.

Fig.6



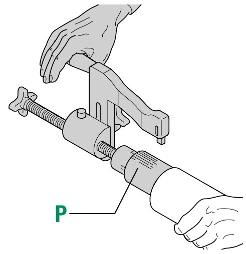
Cut the pipe at the correct length using the appropriate pipe cutter (Model SCUTDW or Model SCUT).

Scrape the primary pipe to a length equivalent to **P**, using the universal scraper (Model RAT1A).

For primary pipes ø50 and ø63 you can use also RATURBO50 or RATURBO63 scrapers.

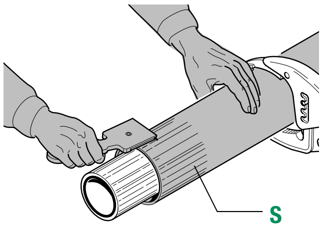
Note: For a correct installation of the **SUPERSMARTFLEX** pipe, ensure to **SCRAPE AND COMPLETELY REMOVE THE GREEN OUTER LAYER** from the primary pipe until the black polyethylene layer is clearly visible on the outside of the pipe. Remove the outer layer completely, including the tie layer, until you reach the black HDPE layer. The omission of this step can cause a weld to fail.

Fig.7



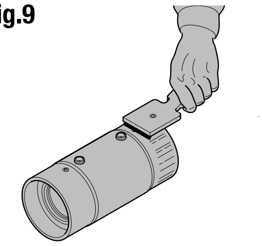
Scrape the secondary pipe to a length equivalent to **S** using the manual scraper (Model RAM1) or the universal scraper (Model RAT1A or RATOR25125).

Fig.8



Scrape the fitting spigot with the manual scraper (Model RAM1). If the fitting is taken from its protective wrapping and used immediately it is not necessary to scrape it.

Fig.9

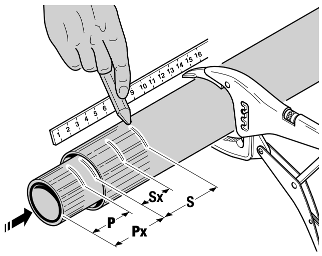


Note: Never use under any circumstances sand paper, emery cloth, files, knives or sharp objects.

Use the appropriate marker (Model MARK) to clearly indicate the insertion length **Px** on the primary pipe and **Sx** (as listed in the table below) on the secondary pipe.

Note: When possible, always use the pipe aligner (Model ALL225/4) to eliminate stress and/ or tension during the welding process.

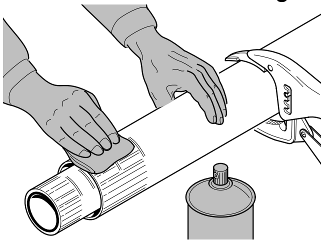
Fig.10



ITEM	Sx	S	P	Px
	mm	mm	mm	mm
SMEDW50	47	100	56	60
SMEDW63	60	120	62	70
SCEDW63	60	120	62	70
SGEDW50	47	100	56	60
SGEDW63	60	120	62	70
STEDW50	47	100	56	60
STEDW63	60	120	62	70
SGEDW110	105	200	95	115
SCEDW110	105	200	95	115

ITEM	Sx (scrape + 10 mm)	P (scrape + 10 mm)
	mm	mm
SETFCV50	40	35
SETFCV63	40	35
SETFCV110	64	59

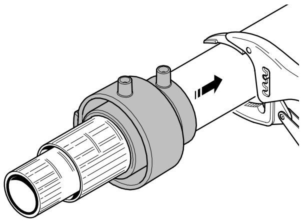
Fig.11



Clean the ends of the primary and secondary pipes, the fitting spigot and the internal part of the reducers with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

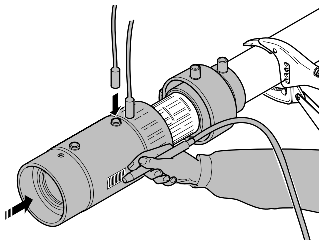
Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. The use of other primers or solvents is not allowed.

Fig.12



Fit the reducer and slide it along the secondary pipe.

Fig.13



WELDING OF THE PRIMARY PIPE

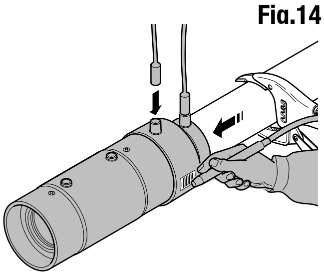
Check that the pipes are correctly clamped with the pliers (Model SPLIDW), then insert the primary pipe ensuring that the insertion length **Px** is reached.

Electrofusion welding of pipe and fitting may now commence following the instructions shown on the welding unit's display.

WE NOW RECOMMEND TO PERFORM THE PRESSURE TEST ON THE PRIMARY LINE

The test can be performed only after the cooling down process has been completed.

Fig.14



WELDING OF THE SECONDARY PIPE

Slide the reducer until it fits correctly on the fitting and check the insertion length **Sx** previously marked on the pipe is visible.

Note: Do not force the pipe to a complete stop inside the fitting as this may shut off the interstitial space.

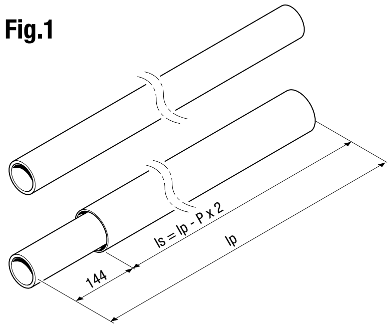
Electrofusion welding of secondary pipe may now commence following the instructions shown on the welding unit's display.

WE NOW RECOMMEND TO PERFORM THE PRESSURE TEST ON THE SECONDARY LINE

The test can be performed only after the cooling down process has been completed.

4.13 ASSEMBLY INSTRUCTIONS OF COAXIAL DOUBLE WALL FITTINGS Ø90 (Ø90/125)

Fig.1

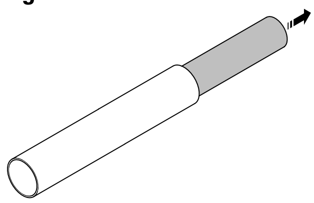


Cut the two pipes perpendicularly using the appropriate pipe cutter (Model SCUT or Model SCUTDW) to the correct length for the installation, then remove a further length equal to **P** x 2 (as listed in the table below) from the secondary pipe using the appropriate pipe cutter (Model SCUT or Model SCUTDW).

ITEM	P	S
	mm	mm
SMEDW90	72	87
SCEDW90	72	87
SGEDW90	72	87
STEDW90	72	87

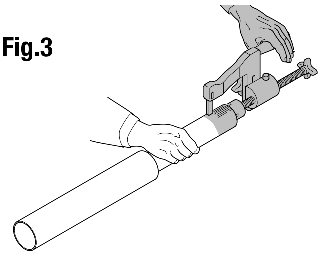
ITEM	P (scrape + 10 mm)	S (scrape + 10 mm)
	mm	mm
SETFV90	56	78

Fig.2



Separate the primary pipe from the secondary pipe.

Fig.3

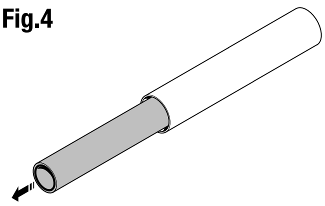


Scrape the primary pipe to a length equal to **P** using the universal scraper (Model RAT1A).

Note: Never use under any circumstances sand paper, emery cloth, files, knives or sharp objects.

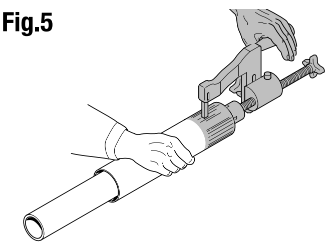
Note: For a correct installation of the **SUPERSMARTFLEX** pipe, ensure to **SCRAPE AND COMPLETELY REMOVE THE GREEN OUTER LAYER** from the primary pipe until the black polyethylene layer is clearly visible on the outside of the pipe. Remove the outer layer completely, including the tie layer, until you reach the black HDPE layer. The omission of this step can cause a weld to fail.

Fig.4



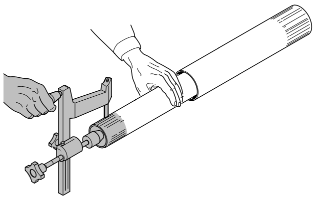
Separate the primary pipe from the secondary pipe.

Fig.5



Scrape the secondary pipe to a length equal to **S** using the universal scraper (Model RAT1A).

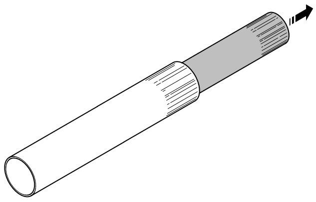
Fig.6



Scrape the other end of the primary pipe to a length equal to **P** using the universal scraper (Model RAT1A).

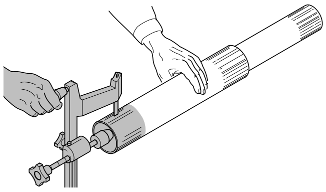
Note: For a correct installation of the **SUPERSMARTFLEX** pipe, ensure to **SCRAPE AND COMPLETELY REMOVE THE GREEN OUTER LAYER** from the primary pipe until the black polyethylene layer is clearly visible on the outside of the pipe. Remove the outer layer completely, including the tie layer, until you reach the black HDPE layer. The omission of this step can cause a weld to fail.

Fig.7



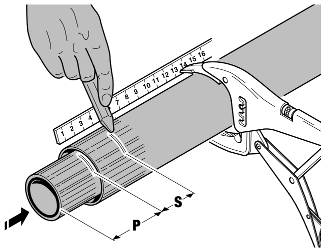
Separate the primary pipe from the secondary pipe.

Fig.8



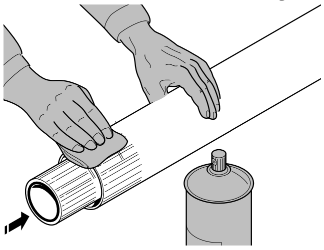
Scrape the secondary pipe to a length equal to **S** using the universal scraper (Model RAT1A).

Fig.9



Use the appropriate marker (Model MARK) to clearly indicate the insertion lengths on the surface of the primary and secondary pipes.

Fig.10

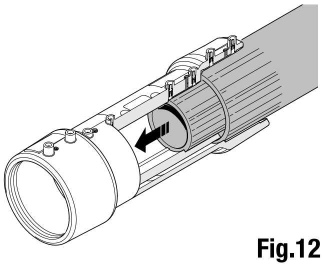


Clean the ends of the primary and secondary pipes, the fitting spigot and the internal part of the reducers with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. The use of other primers or solvents is not allowed.

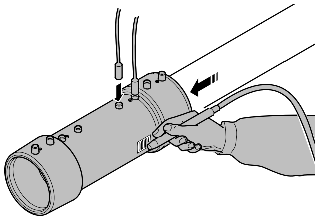
Note: When possible, always use the pipe aligner (Model ALL225/4) to eliminate stress and/or tension during the welding process.

Fig.11



Insert the double wall pipe into the fitting, ensuring that the marked insertion depth is reached (the pipes come to a stop inside the fitting).

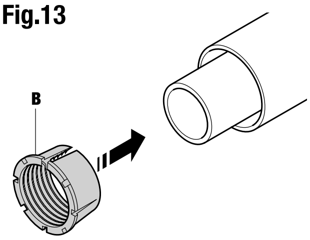
Fig.12



You can now commence the welding process of the primary pipe following the instructions shown on the welding unit's display.

WE NOW RECOMMEND TO PERFORM THE PRESSURE TEST ON THE PRIMARY LINE
The test can be performed only after the cooling down process has been completed.

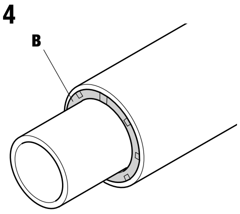
Fig.13



Insert the centering ring B shown in the drawing between the pipes that will be welded on the other side of the fitting.

By blocking the centering ring **B** between the primary pipe and the secondary to the insertion distance **P**, clearly indicate the insertion lengths on the surface of the primary and secondary pipes. Insert the double wall pipe into the fitting, making sure to reach the insertion lengths and repeat the steps.

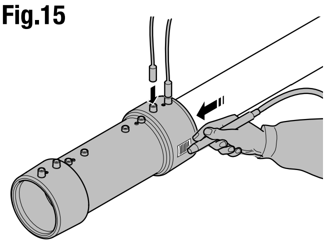
Fig.14



The centering ring **B** functions as a barrier to the movement of the secondary pipe to ensure a correct weld, so that the two pipes come to a stop inside the fitting.

Since it is not necessary to use the ring during the welding of the pipes inside the first part of the fitting, only one centering ring will be included in the package of Models **SMEDW90, SGEDW90** and **SCEDW90**, while two rings will be included in the package of Model **STEDW90**.

Fig.15

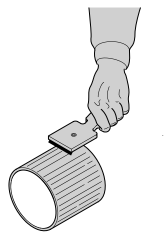


You can now commence the welding process of the secondary pipe following the instructions shown on the welding unit's display.

WE NOW RECOMMEND TO PERFORM THE PRESSURE TEST ON THE SECONDARY LINE
The test can be performed only after the cooling down process has been completed.

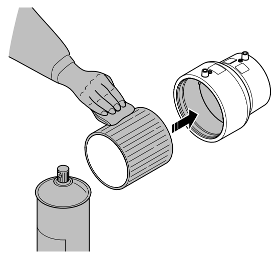
4.14 ASSEMBLY INSTRUCTIONS MODEL SMEDWR110125

Fig.1



Scrape the secondary coupler to its complete length.

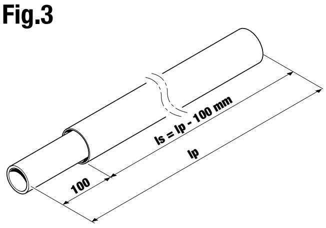
Fig.2



Clean one of the fitting spigots and the internal part of one of the reducers with a recommended cleaning solvent (Model LID1).

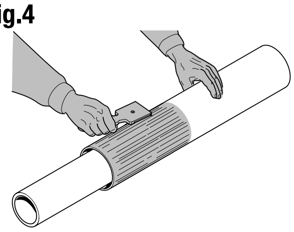
Insert the cleaned spigot of the secondary coupler inside the cleaned reducer to its complete stop. Before carrying out this step, check and clearly mark the insertion length on the spigot of the secondary fitting.

Fig.3



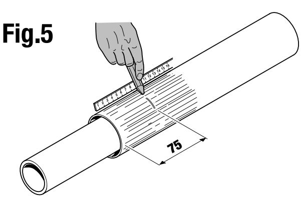
Cut the secondary pipe to a length equal to about 100 mm.

Fig.4



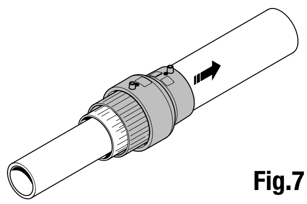
Scrape the secondary pipe to a length of 270 mm (1.5 times the length of the reducer).

Fig.5



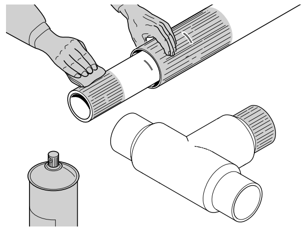
Mark the insertion length of the secondary pipe equal to about 75 mm, using the appropriate marker (Model MARK).

Fig.6



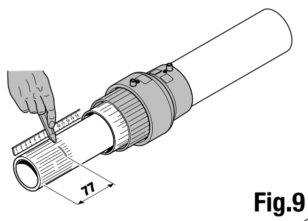
Slide the reducer that has just been assembled on the scraped secondary pipe.

Fig.7



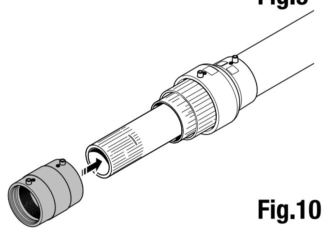
Let the primary pipe come out of the assembly as per figure 6, scrape it and clean it to a length equal to its insertion length inside the primary coupler.

Fig.8



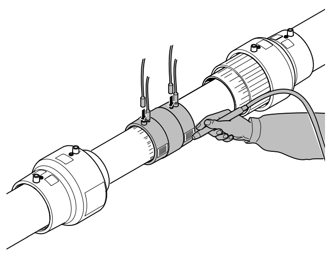
Mark the insertion length of the primary pipe inside the primary straight connector equal to about 77 mm, using the appropriate marker (Model MARK).

Fig.9



Insert the primary pipe inside the coupler.

Fig.10

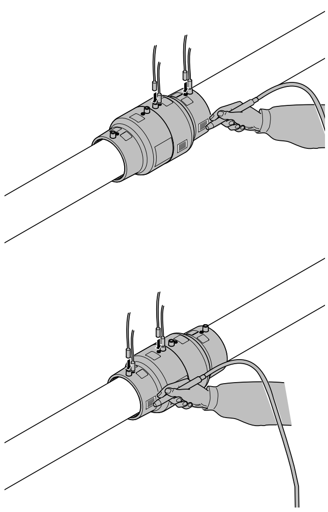


Repeat the operations indicated in the previous points for the other end of the fitting, by scraping the secondary pipe to a length corresponding to 1 time the length of the reducer (about 180 mm instead of 270 mm).

Weld the primary pipe by reading the barcode indicated on the coupler.

Slide the pre-assembled spigot of the secondary fitting on the primary coupler that has just been welded.

Fig.11-12



Clean the free spigot of the secondary coupler and the two ends of the secondary pipe previously scraped with a recommended cleaning solvent (Model LID1).

Insert the second reducer on the free spigot of the secondary fitting.

Make sure that the two secondary pipes have been inserted to the insertion lengths previously marked.

Weld the secondary pipe.

When the weld is finished and after the fitting passed the hydraulic test, cut/tear off the brass parts of the welding pins so that the copper wire is not visible. Insulate the end of the welding pin by using insulating tape or paste. Place the covered wires so that they remain inside the secondary reducer.

Note: We recommend to insulate all cable lugs or metal ends that are visible inside the cavity or non-grounded.

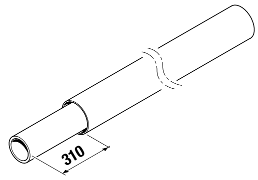
Note: We strongly recommend to proceed with the welding of the whole primary line and carry out the pressure test to check the tightness of the joints before proceeding with the welding of the secondary line.

4.15 ASSEMBLY INSTRUCTIONS MODEL STEDWR110125

Measure the insertion length of the primary pipes. It is the distance between the complete stop inside the primary tee and the spigot rim of the secondary tee (about 310 mm for the sides of the tee, about 195 mm for the outlet).

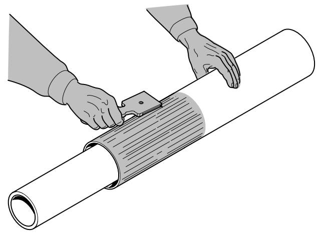
Cut the secondary pipes to the insertion length of the primary pipes previously measured.

Fig.1



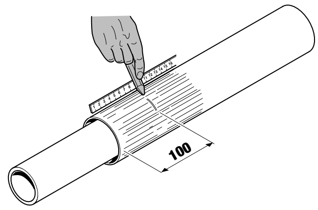
Scrape the secondary pipes to a length of 300 mm each.

Fig.2



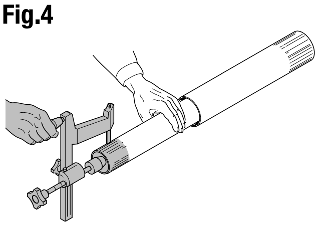
Mark the insertion length of the secondary pipes equal to 100 mm each.

Fig.3



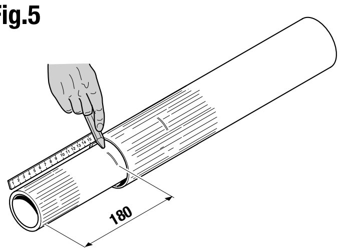
Scrape the primary pipes to a length of 100 mm each.

Fig.4



Mark the insertion length of the primary pipes (about 180 mm for the sides of the tee, about 80 mm for the outlet).

Fig.5



Scrape the secondary fitting spigot to a length of 120 mm.

Fig.6

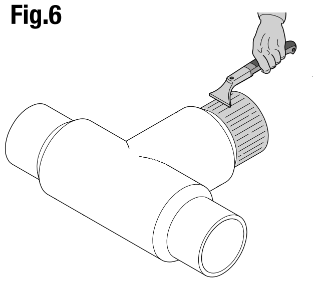
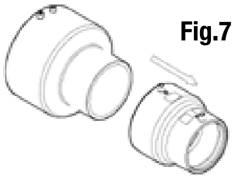
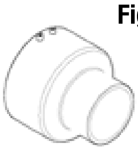


Fig.7



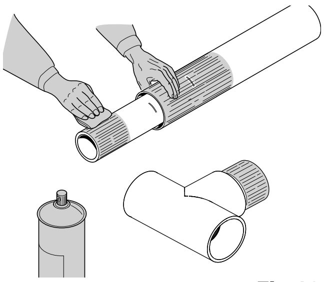
Separate the reducers.

Fig.8



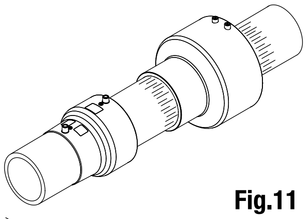
Scrape the spigot of the reducer.

Fig.9



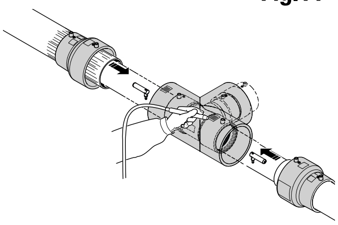
Clean the external surfaces of the pipes, the internal and external surfaces of the fitting and the internal surface of the reducer with the recommended cleaning solvent.

Fig.10



Slide the reducers on the secondary pipes to the whole length of the scraped part.

Fig.11

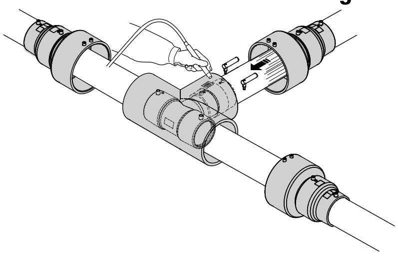


Insert the two primary pipes inside the fitting in both the ends of the long side to its complete stop inside the internal tee.

Insert the 90° connectors inside the welding pins.

Weld the two primary pipes of the long side at the same time (the internal fitting is single-wire) by reading the barcode indicated on the long side of the external tee.

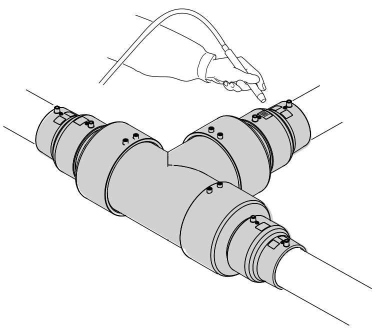
Fig.12



Insert the primary pipe to its complete stop inside the coupler placed on the short side of the internal tee.

Insert the 90° connectors (short side) inside the welding pins of the welding machine and weld by reading the barcode indicated on the side of the outlet.

Fig.13



Slide the electric reducers on the secondary fitting spigot previously scraped and cleaned. Make sure that the insertion length indicated in figure 5 is reached.

First of all, weld the ø225 reducer, then weld the ø160/125 reducer.

Weld the reducers by reading the barcode indicated on the reducers.

When the weld is finished and after the fitting passed the hydraulic test, cut/tear off the brass parts of the welding pins so that the copper wire is not visible. Insulate the end of the welding pin by using insulating tape or paste. Place the covered wires so that they remain inside the secondary reducer.
Note: We recommend to insulate all cable lugs or metal ends that are visible inside the cavity or nongrounded.

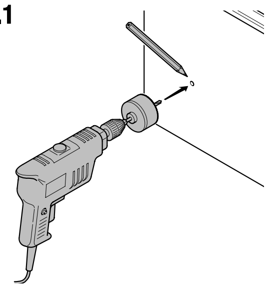
Note: We strongly recommend to proceed with the welding of the whole primary line and carry out the pressure test to check the tightness of the joints before proceeding with the welding of the secondary line as the welding pins will remain trapped in the interstitial space of the secondary line. It will not be possible to repeat the welding operation.

5 • INSTALLATION INSTRUCTIONS OF ENTRY BOOTS

5.1 ASSEMBLY INSTRUCTIONS FOR ENTRY BOOT MODEL SEBE

After tracing the center, make a small central hole.

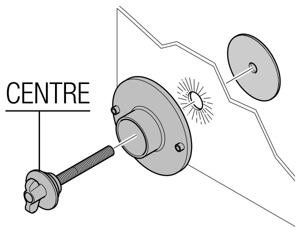
Fig.1



Make the hole for the mounting tool using a Ø24 mm saw and scrape the outer surface of the sumpfor the whole area involved in the welding operations.

Mount the steel disk of the mounting tool Model SEBECOMT inside the sump and the aluminium centering disc outside the sump, at the center of the entry boot.

Fig.2

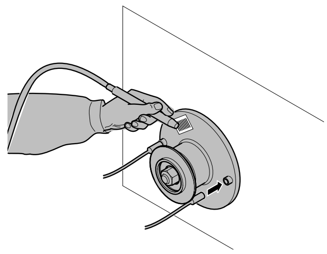


Tighten the bolts all the way.

Weld the body of the entry boot on the sump.

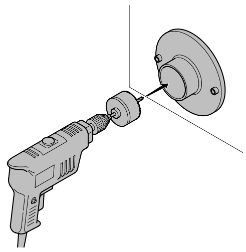
During welding, tighten the bolts again.

Fig.3



After welding the assembly and once the cool down time has elapsed, open the center of the entry boot with a saw having the following diameter:
Ø 51mm for entry boots Model SEBE32, SEBE40, SEBE50
Ø 79mm for entry boots Model SEBE63
Ø 98mm for entry boots Model SEBE75
Ø 140mm for entry boots Model SEBE90, SEBE110, SEBE125

Fig.4



Mounted entry boot with the central hole open for the passage of a double wall pipe.

Fig.5

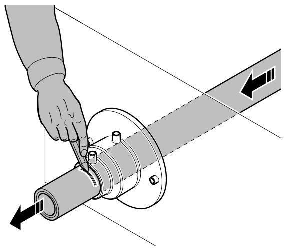
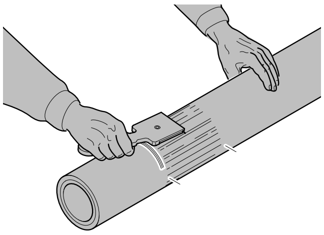


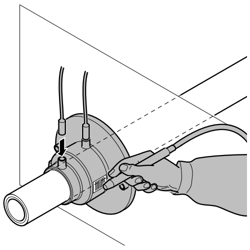
Fig.6



Scrape the pipe surface with the circumferential scraper Model RATOR25125:
- scrape the primary pipesto a length of about 80 mm;
- scrape the secondary pipes to a length of about 300 mm to allow the pipe to pass through the entry boot until the stop inside the terminal fitting.

Insert the primary pipe until the stop inside the terminating fitting.

Fig.7



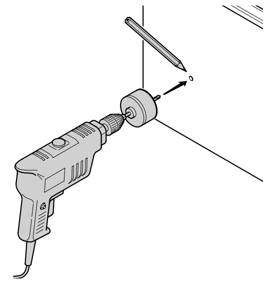
Insert the secondary pipe until the stop inside the terminating fitting.

Once all the connections inside the sump have been completed, weld the entry boots on the pipes.

5.2 ASSEMBLY INSTRUCTIONS FOR ENTRY BOOT MODEL SEBEP

After tracing the center, make a small centering hole.

Fig.1



Make the hole for the mounting tool by using a saw with the following diameter:

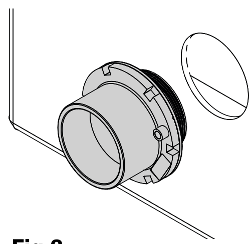
Ø 79 mm for entry boots Model SEBEP40

Ø 111 mm for entry boots Model SEBEP63, SEBEP75, SEBEPC110129, SEBEPC110229, SEBEPC110511, SEBEC110

Ø 152 mm for entry boots Model SEBEP90, SEBEP110, SEBEP125

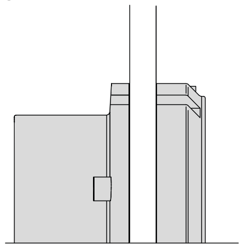
Insert the entry boots inside the hole until the stop...

Fig.2



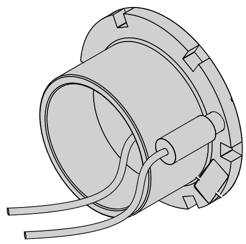
...by screwing the clamping ring completely on the other side.

Fig.3



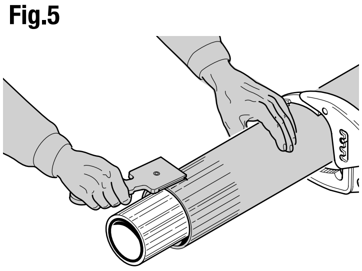
Weld the body of the entry boot on the sump.

Fig.4



Scrape the surface of the pipes with the circumferential scraper Model RATOR20075.

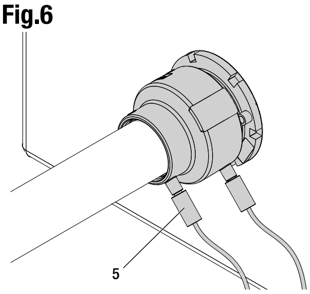
Fig.5



Insert the primary pipe into the terminating fitting until the stop.

Insert the secondary pipe into the terminating fitting until the stop.

Fig.6



<u>Once all the connections inside the sump have been completed,</u> weld the entry boots on the pipes.

(entry boots Model SEBEP63 and SEBEP75 can be mounted inside and/or outside – entry boot Model SEBEP125 shall be mounted outside).

5.3 ASSEMBLY INSTRUCTIONS FOR ENTRY BOOTS FOR CABLES MODEL SEBEPC

Fig.1

Insert the entry boot into the hole until the stop on the outside of the sump…

Fig.2

…by completely screwing the tightening ring and the entry boot for cables on the inside of the sump.

Fig.3

Weld the body of the entry boot on the sump.

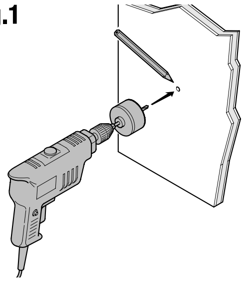
Fig.4

Connect the corrugated pipe and the electric cables and tighten the clamps.

5.4 ASSEMBLY INSTRUCTIONS OF AN ELECTROFUSION ENTRY BOOT FOR FIBERGLASS TANKS - MODEL SEBEF-SEBEFM

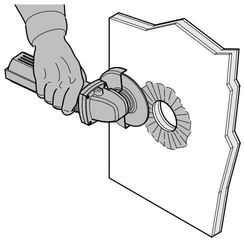
Assemble the mandrel (Model SMAN) and the hole saw (Model STAZ) and insert them into the power drill. Mark the position along the long side of the sump where the entry boot (Model SEBEF-SEBEFM) is to be installed. Now drill the required hole through the wall of the sump. Repeat the procedure if more than one entry boot is to be installed.

Fig.1



STAZ57 57 mm - 2"¼	To be used with SEBEF, SEBEFM_A and SEBEF_A diameters 1" (32 mm) and 1 ¼" (40 mm)
STAZ89 89 mm - 3"½	To be used with SEBEF, SEBEFM_A and SEBEF_A diameters 1 ½" (50 mm), 2" (63 mm) and 2 ½" (75 mm)
STAZ152 152 mm - 6"	To be used with SEBEF, SEBEFM_A and SEBEF_A diameters 3" (90 mm), 4" (110 mm) and 5" (125 mm)

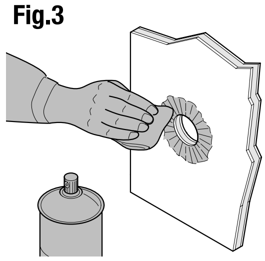
Fig.2



Prepare the surface of the sump's wall where the entry boot is to be installed with an angle grinder fitted with the appropriate sanding disc.

ATTENTION: The sanded area around the hole shall be larger than the outside diameter of the entry boot.

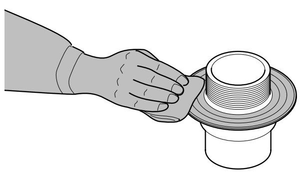
Fig.3



Clean all the components involved in the assembly with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

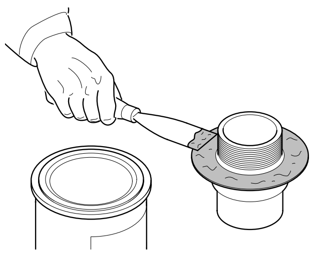
Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. The use of other primers or solvents is not allowed.

Fig.4



Use a proper emery cloth to clean thoroughly the SEBEF - SEBEFM brass flat surfaces.

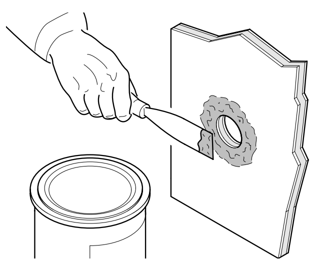
Fig.5



Pour and spread a consistent layer of epoxy sealant (Petrol Seal) over the contact side of the brass flanges. Avoid any spillage of product.

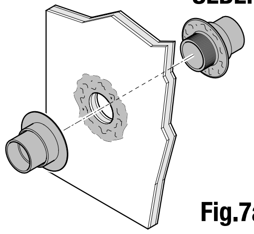
ATTENTION: During this process, avoid contaminating the SEBEF - SEBEFM threaded parts and the internal surface of the sump.

Fig.6



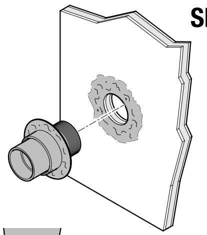
Assemble the two components of the entry boot together centring the flanges through the hole.

Fig.7a
SEBEF



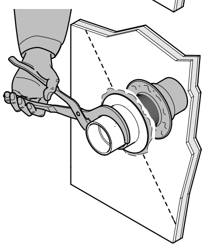
Assemble the two components of the entry boot together centring the flanges through the hole.

Fig.7a
SEBEFM



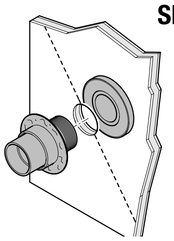
Insert the entry boot centering the flange through the hole

Fig.8a
SEBEF



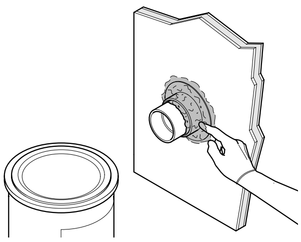
Tighten the SEBEF - SEBEFM assembly (special filter pliers are available).

Fig.8b
SEBEFM



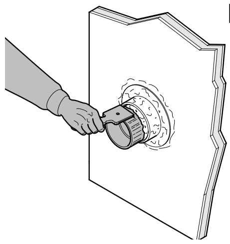
Tighten the threaded flange onto the fitting.

Fig.9



Pour and spread the Epoxy Sealant “Petrol Seal” on each side of the entry boot using the tip of the gloved finger and coat all the metal surfaces.

Fig.10

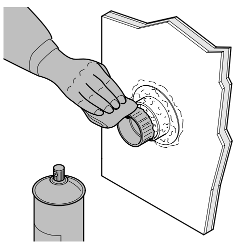


Let the assembly cure for the appropriate time (24 hours).

ATTENTION: Protect the fitting from any direct contact with water (such as rain) during the curing time.

After the curing time, scrape the HDPE ends using the manual scraper (Model RAM1).

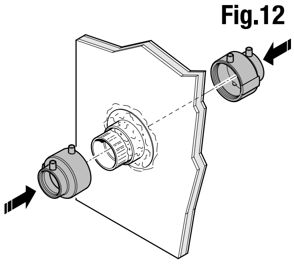
Fig.11



Clean the scraped surfaces with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. The use of other primers or solvents is not allowed.

Fig.12

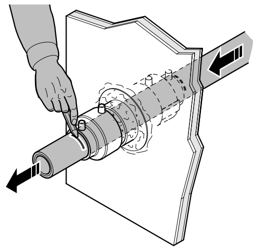


Place the reducers on the entry boot previously scraped and cleaned.

Note: As regards the installation procedure of Model SEBEFM, from figure 12 onwards it is understood that the front side of the sump shows the installation procedure of SEBEF and SEBEFM, whereas the back side refers to figure 8b for Model SEBEFM.

Insert the pipe into the entry boot until the correct position is reached. Use the appropriate marker (Model MARK) to indicate the position at the contact point between the pipe and the reducer on the outside surface of the pipe.

Fig.13

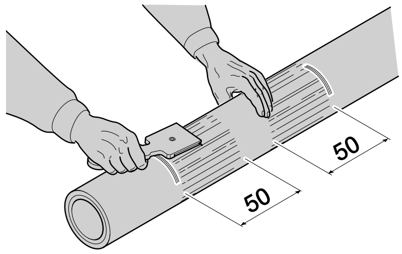


Remove the pipe and scrape along its length where it is to be welded using the manual scraper (Model RAM1).

Scrape 50 mm (1" ½) from each side from the point previously marked.

Note: For a correct installation of the **SUPERSMARTFLEX** pipe, ensure to **SCRAPE AND COMPLETELY REMOVE THE GREEN OUTER LAYER** from the primary pipe until the black polyethylene layer is clearly visible on the outside of the pipe. The omission of this step can cause a weld to fail.

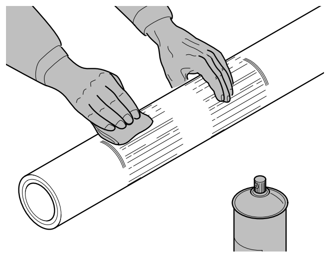
Fig.14



Clean the scraped surface with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. The use of other primers or solvents is not allowed.

Fig.15



Re-insert the pipe through the fitting until it lines up with the previously marked position.

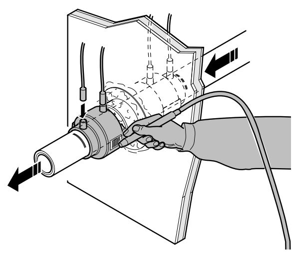
Weld each reducer by scanning the barcode sticker and following the instructions on the welding unit's display.

Note: Wait until the cooling down time shown on the barcode has elapsed before performing other operations.

ATTENTION: The preferred fluid to be used for monitoring purposes is PP glycol.
DO NOT USE BRINE!
The use of a proper corrosion inhibitor to be added to the monitoring fluid is also recommended. Please contact our Technical Department for other types of fluid.

ATTENTION: We recommend to flow air into the sump annulus when the epoxy is not dry yet to make sure that the purge holes remain open and free of blockage.

Fig.16



HOLE SAW (STAZ) - ENTRY BOOT SIZE MATCHING CHART

Code	ø	Notes
19STAZ51	51	for SEBE Ø 32, 40, 50
19STAZ57	57	for SEBEFM/A, SEBEF/A Ø 32,40
19STAZ70	70	for SEB Ø 25, 32, 40
19STAZ79	79	for SEBE Ø 63
19STAZ89	89	for SEBEFM/A, SEBEF/A Ø 50, 63, 75
19STAZ98	98	for SEB Ø 50, 63, 75, 90 and SEBE Ø 75
19STAZ111	111	for SEBEP Ø 63,75
19STAZ140	140	for SEB Ø 110, 125 - SEBE Ø 90, 110, 125
19STAZ152	152	for SEBEFM/A, SEBEF/A Ø 90, 110, 125, SEBEP Ø 90, 110, 125

6 • INSTALLATION INSTRUCTIONS OF SUMPS

6.1 SMARTFLEX TANK SUMPS: INSTRUCTIONS FOR A PROPER INSTALLATION

6.1.1 INTRODUCTION AND GENERAL INFORMATION

SMARTFLEX tank sumps, along with pipes, fittings and accessories, form a complete system for the secondary containment. This section contains information about tank sumps and the operating procedures to ensure their correct installation.

It is important to read these instructions before starting the installation.

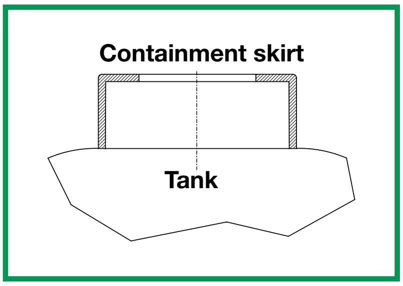
6.1.2 APPLICATIONS

The SMARTFLEX system includes the following 11 tank sump models all available also as 2-piece electrofusion models.

They are:

- STS4536
- STS5238
- S22TS4536
- S22TS5238
- STS5238N
- S22TS5238N
- S22TS5238KTN
- S22TS5238KTLR
- S22TS5238LR
- STS5238NHBD
- STS6538NHBD

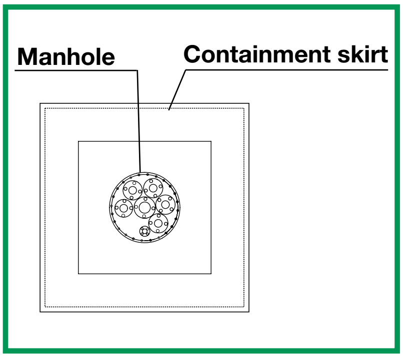
SMARTFLEX tank sumps must be placed in the space between the containment skirt's upper side and tank frame. Sumps are very important elements of the system, their function being that of a two-way liquid isolation chamber, thus preventing:
• the entering of ground water and any other external liquid;
• the leakage of any contained product from the tank into the environment.
All SMARTFLEX sumps are made of HDPE which makes them chemically and structurally suitable for buried applications and crack / break resistant to underground loads.



6.1.3 INSTALLATION STEPS

These are the most important steps:

a) Mount the sump on the containment skirt
b) Install entry boots
c) Install pump (when required) and fittings
d) Install the sump cover
e) Install the manhole cover at ground level

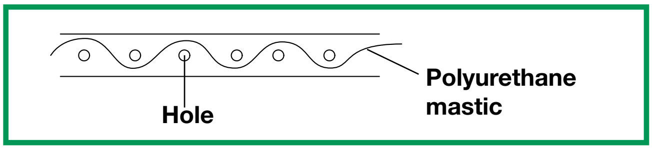


Normally, the containment skirt, situated on the tank's upper surface, is folded to create an inwards shelf large enough to allow assembly by bolts.

1. Having particular care to align the sump centrally over the containment skirt, using a ruler and a grease pencil, mark the sump's base.
2. Cut along the line.
3. Align the sump centrally over the containment skirt and make at least 8 holes on every side.
4. Bolt the sump base on the containment skirt.

Fit a gasket between the sump and the containment skirt in order to ensure that the assembly is watertight. **The gasket is not included in the sump (except for KT one).**

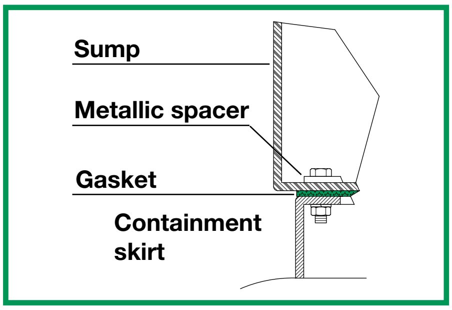
Put a rim of polyurethane mastic running around the holes both above and below the gasket (see figure below).



Insert some metallic spacers along the skirt's perimeter (normally 4 are used) to achieve a better pressure distribution over the gasket. Tighten the bolts in a "cross-way" for a better distribution of the screwing strength. Due to the many possible tank/sump assembly configurations and environmental situations, it is advisable to purchase gaskets and spacers according to specific needs.

At this point you can install entry boots, pipes and fittings.

Before welding the entry boots proceed with the pressure test of the piping.



6.1.4 TANK SUMP ASSEMBLY INSTRUCTIONS

Note: As a first step, it is necessary to cut out the base of the sump to the correct shape and dimensions so it can be centered on the tank manway collar. Please take Into consideration the direction of the pipework.

ATTENTION: In order to have suitable space necessary to assemble the various components inside the sump, we recommend to carry out the electrofusion welding process of the upper section at the completion of the process.

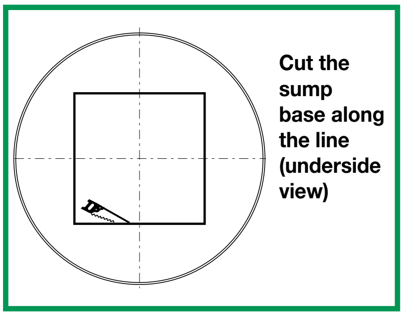
ATTENTION: Clearly mark the three components of each sump to avoid mixing parts (base, riser, cover) moulded by different moulds.

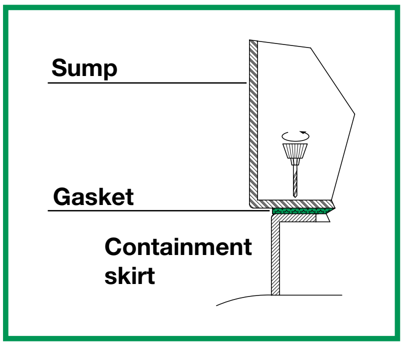
Clean all the components involved in the welding process with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. The use of other primers or solvents is not allowed.

Note: When scraping, a perfectly even surface is required, please take care to remove any roughness that could cause the weld to fail.

Position the upper section of the sump on its base. Please take care not to damage the connectors necessary for the welding process and correctly align the arrows shown on both components.





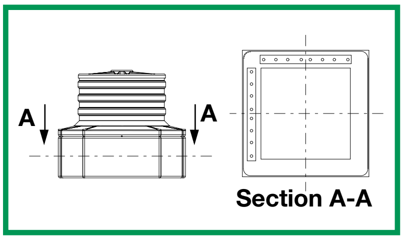


Fig.1

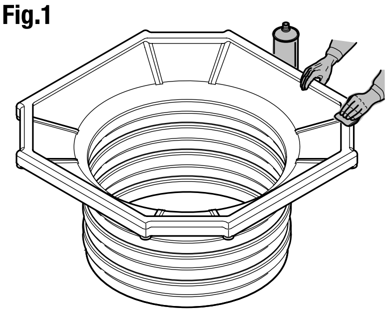


Fig.2

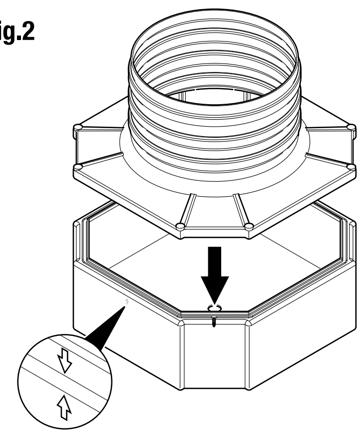
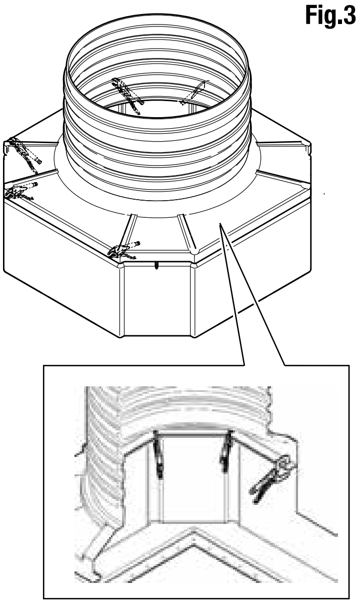
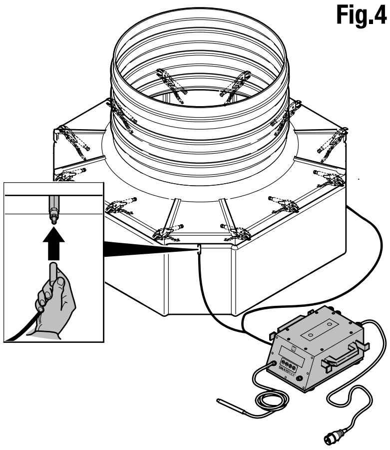


Fig.3



Secure the two components together using 12 clamps (8 positioned on the corners and 4 positioned on the long sides).

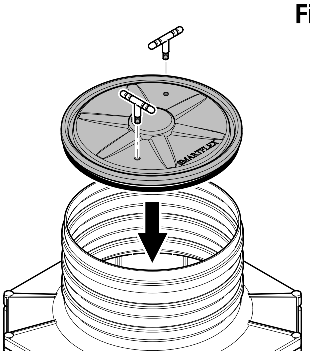
Fig.4



Weld the sump using the specific barcode supplied with every sump, following the instructions shown on the welding machine's display.

Wait until the cooling down time shown on the barcode of the sump has elapsed, then remove the clamps.

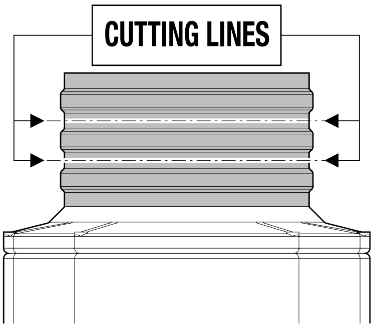
Fig.5



Before positioning the lid on the riser (upper) section of the sump, ensure that the gasket/seal is correctly positioned on the riser's edge and is not damaged in any way. This is necessary to obtain an effective seal. Tighten the suitable handles to complete the installation.

The new versions of STS5238 (N) and STS5238LR offer a new lid with a threaded cap and a new mounting kit available upon request.

Fig.6



Note: If required, you can cut the riser (upper) section of the sump to the required height. The cut surfaces must be flat and without any sharp or rough edges.

If necessary, it is possible to assemble the lid closure kit (Model 19SKF to be ordered separately). Just insert the hexagon head screw complete with its threaded pivot insede one of the pre-holes along the riser, then insert the L-shaped bracket and tighten with the special wing nut.

To perform a vacuum test on the lid it is necessary to follow these steps:

1. Remove one of the two handles.

2. Drill a 6 mm hole through the base of the handle assembly point on the lid.

3. Screw the quick fit connector (Model SVT6) properly sealed with thread sealant.

4. Connect the specific test tube for the test (Model STT6).

5. Connect the ejector (Model SVE) and the vacuum test unit (Model SVTU) following the specific instructions.

The vacuum test shall be performed at -0.05 bar for 30 minutes.

Note: Once the test is complete it is recommended to put the handle back on the lid, sealing the thread with a thread sealant.

Fig.7

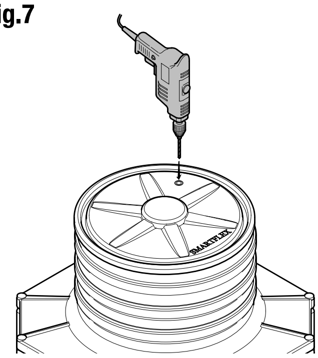
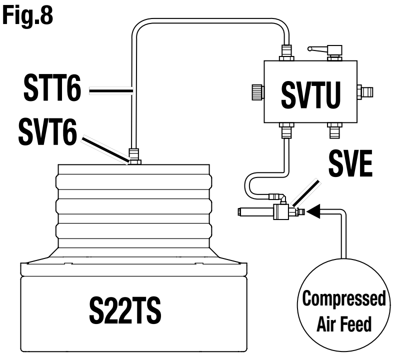


Fig.8



6.1.5 BACKFILLING

After the sump installation, it is necessary to backfill the area that surrounds the sump. This operation, frequently carried out without particular attention, is one of the fundamental steps to obtain a correct positioning of the backfilling material that supports the sump.

Backfilling material must be round and evenly shaped, as sharp object would puncture the sump thus initiating cracks. It is standardized by a number of different Standards such as CEN TS 1046.

In any case, the material laid around the sump must be compacted to prevent ground shifts which could eventually damage the sump and affect the system stability. Particular care should be taken when filling the area between the sump base and the upper surface of the tank.

According to mechanical strength evaluations for the installation of SMARTFLEX sumps, here are NUPI Industrie Italiane's specifications:

- **Gs 2 Soil:** well graded gravels, gravel-sand mixtures, poorly graded gravel-sand mixtures, coarse grained granular soil predominantly sand sized, such as single sized sands, in particular:
  - Pea gravel with size diameter between 8-25 mm (1/3”-1”)
- **Gs 3 Soil:** mixed grained soils such silty gravel-sand mixtures, silty sands, clayey sands, in particular:
  - Coarse grained sand with low fine fraction

  In this case, when backfilling, make sure that the material is uniformly distributed and packed around the tank sumps. All sand backfill material shall be clean and free to flow.

ATTENTION: All backfilling materials must be dry and free from snow, ice and debris. The use of different materials from those specified may cause serious damage and/or affect the performance of the SMARTFLEX sump and the warranty.

ATTENTION: The cover installation guidelines are not exhaustive. It is always recommended to refer to national rules and oil company regulations.

6.1.6 MANHOLE COVER INSTALLATION GUIDELINES

1. Lip (if used): concrete around the frame should be a minimum of 200 mm circumference around the frame and a minimum* strength rating of 32 Mpa*. The lip surface must be level with the top edge of the frame. This is to ensure that the manhole frame has no undue stress from vehicles and allows for a suitable level area for the lifting tool to work correctly.
2. Asphalt/Concrete/Concrete pavers: asphalt or concrete surrounding the lip should fall away from the lip to allow for water shedding. Degree of fall is the responsibility of the installer as it must comply with site conditions.
3. Reinforced concrete: the frame is placed in position on a reinforced concrete bed with a minimum* strength rating of 40 Mpa* (min. depth 100 mm) ensuring it is fully supported and ensuring that the surrounding concrete (+60 mm depth for lip) is not protruding above the frame upper lip. Prevent voids in the concrete under the frame, especially near the housing.

The concrete supporting the frame must be completely flat and is in complete contact with the underside of the frame.

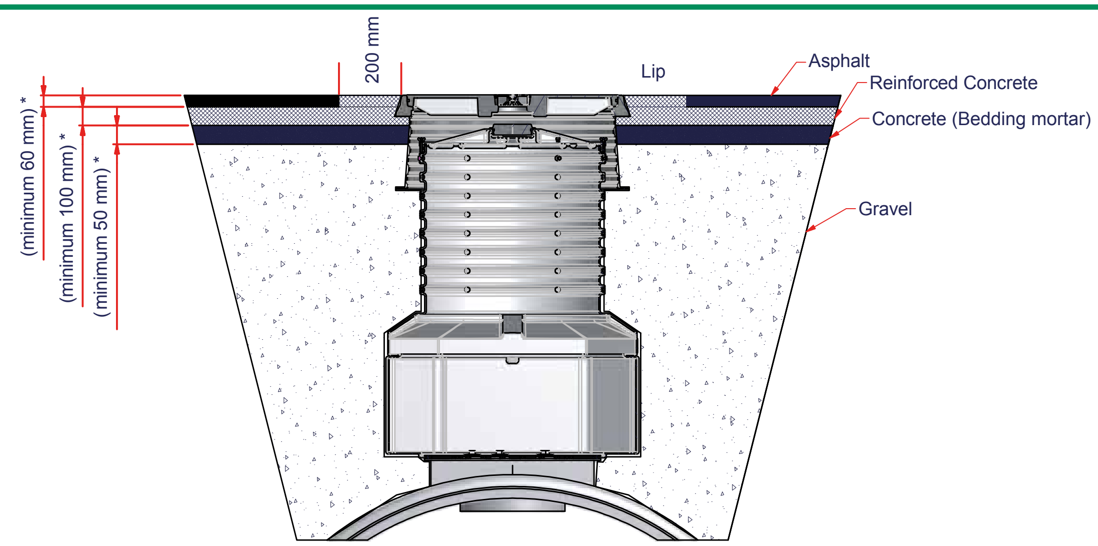
The exposed surface of the lip concrete around the frame should have a flat finish (compliant to local safety requirements).

4. Concrete slab: the concrete and reinforced concrete over it should have sufficient strength to support the weight of the vehicular traffic passing over or parked above it.

   Allow sufficient curing time of the concrete (depending on the ambient temperature) before vehicular traffic is allowed to pass over the cover.

5. Gravel: gravel materials should be compacted under the concrete slabs without placing any load on the sump/riser walls and skirt.
6. Care should be taken when compacting the material near and where it comes in contact with the sump, riser and skirt.

Minimum*: concrete strength rating to be in accordance with the Oil Company or Local Government specifications.



* INFORMATION TO BE DEFINED ACCORDING TO THE NATIONAL RULES OR TRAFFIC INTERESTED

6.1.7 MATERIAL SPECIFICATION & INSTALLATION GUIDE

1. Bedding Mortar

Industry Standards: BBA/HAPAS approved. Conforms to HA104/09 and suitable for access covers conforming to BSEN124:1994.
Meets with the specifications laid out in the SROH, DRDNI and NRA. Conforms to BT specification LN550.

We recommend Ultracrete Envirobed HA104® or equivalent.

Characteristics:

- Non-shrink
- 15 minute workability
- Can be used in wet/cold weather
- Compressive strength of 51 N/mm² in 3 hours
- Tensile strength of 5.8 N/mm² in 3 hours
- Set time of 30 minutes (temperature dependant)

Remove any old bedding or packing materials, and ensure the substrate is clean and sound. When using Envirobed HA104® the substrate should be wetted down prior to application of the mortar.

Envirobed HA104® should be mechanically mixed as follows; 1 unit of Envirobed powder with 1 unit of Envirobed liquid.

The amount of liquid required may be adjusted depending on the required consistency.

Envirobed HA104® should be immediately placed on the supporting structure, allowing a 5 mm excess thickness and used within five minutes of mixing.

The SSC frame is lowered into position and placed on the bedding mortar ensuring that it is fully supported and checking that the frame does not overhang the mortar at any point.

Care should be taken to prevent voids in the bedding material under the frame, particularly in the vicinity of the cover seating.

The frame is tamped down into place, ensuring the correct level is obtained. This can be checked by placing a straight edge over the frame and surrounded surface. Exposed surfaces of the bedding mortar around the frame must be float finished, ensuring any voids or loose material is removed and the inside surface pointed to a smooth finish. Once the bedding mortar has achieved sufficient strength the back fill material is placed.

2. Back Fill Flowable Concrete

Industry Standards: BBA/HAPAS Approved. Meets with the specifications laid out in the SROH. We recommend Ultracrete's QC10 F or equivalent.

Characteristics:

- Shrinkage compensated and fibre-reinforced
- Flowable
- 5 -10 minute workability
- Compressive strength 20 N/mm² in 1.5 hours
- Flexural strength 6N/mm² final set, Tensile strength 3N/mm² final set
- Set time 10 - 20 minutes (depending on temperature)

QC10 F is mechanically or hand mixed by adding the bag of cement to the sand/aggregate and mixed with water until a smooth, flowable consistency is achieved. If a stiffer mix is required, reduce water accordingly until the desired consistency is achieved. *Reduced water will accelerate product set. Remove ponded water. The area to be filled should be wetted and the material placed within 5 minutes of mixing, to 60mm below the required surface fill level, and compacted ensuring no voids are present. The final surface is then rough floated to achieve a textured level surface ready to receive the wearing course.

3. Surface Course and Edge Sealant

Industry Standards: BBA/HAPAS Approved. Meets with the specification laid out in the SROH 2010, SROR 2003 DRDNI and NRA.

For Class 0, 1 and 2 Roads

We recommend Hot Rolled Asphalt (HRA) should be used in accordance with local Department of Transport requirements.

Thrubeam covers are suitable for installations with HRA up to a maximum depth of 100 mm.

For Class 2, 3 and Road

Hot Rolled Asphalt (HRA), Ultracrete Instant Road Repair® or equivalent. We recommend Ultracrete Instant Road Repair® or equivalent.

Characteristics:

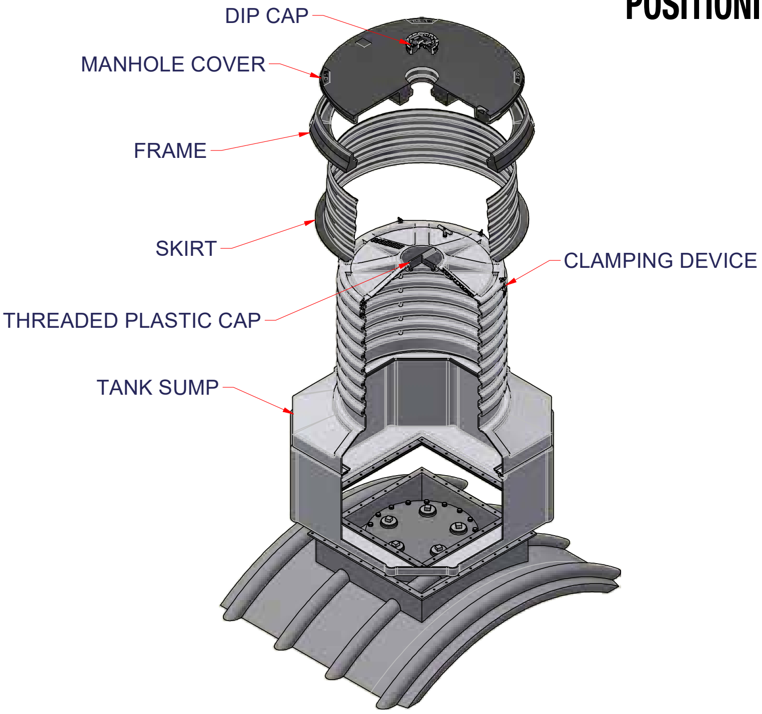
- PSV65
- 10 mm graded hard stone
- Excellent workability in all weather conditions
- Instantly trafficable
- 25 kg bags or tubs for easy handling

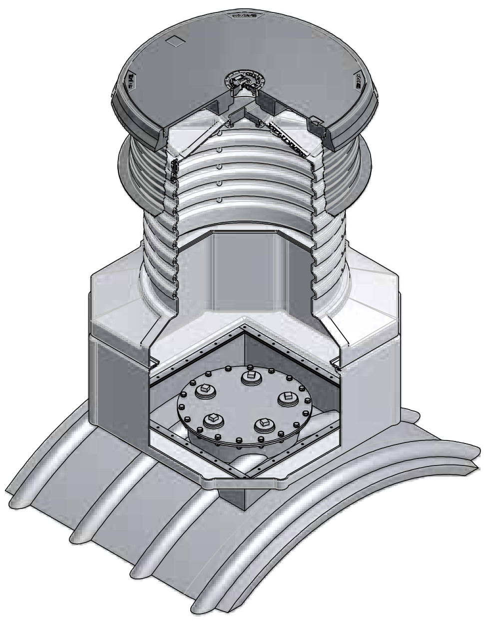
Once the backfill concrete has reached sufficient strength, all horizontal and vertical edges, including the manhole frame should be sprayed with Ultracrete SCJ Seal and Tack Spray ensuring all the surfaces are liberally covered.

The use of Ultracrete Instant Road Repair® is recommended (45 mm compacted to 30 mm - 2 layers required). Hot lay materials can be used.

ATTENTION: The cover installation guideline is not exhaustive. It is always recommended to refer to national rules and oil company regulations.

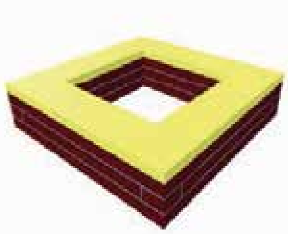
POSITIONING STEPS



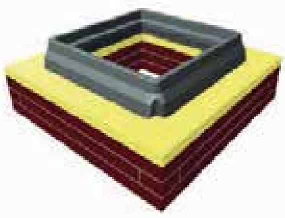


SMARTFLEX™

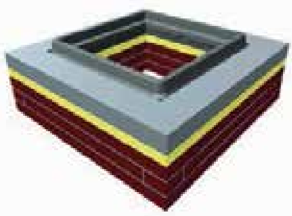
Bedding mortar applied



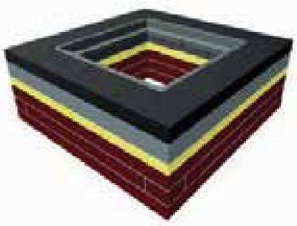
Setting of the frame on the bedding mortar



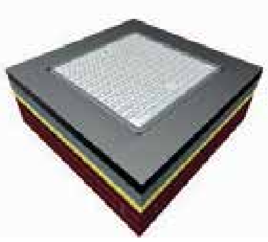
Backfill flowable concrete



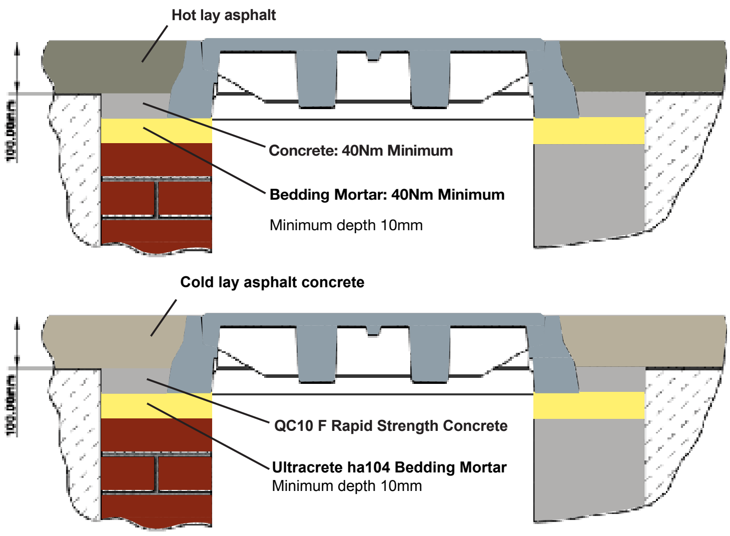
Surface course



Surface course and edge sealant

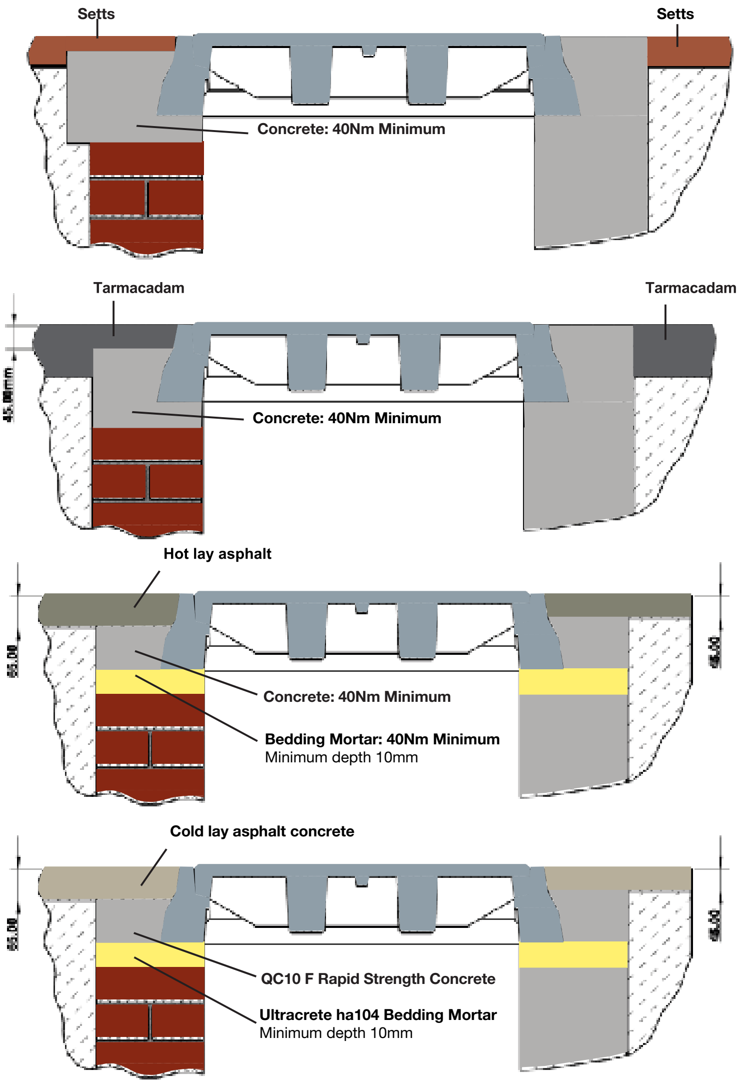


Reinstatement of openings: Compliant with SROH



Instarmac Reinstatement Products

Alternative Installation Methods



Instarmac Reinstatement Products

The frame is to be installed to the appropriate standard/specification for that particular installation. For reference purposes only. This drawing is not a specification.

6.2 INSTALLATION INSTRUCTIONS FOR TANK SUMPS MODEL S22TS5238N/_LR

Make a rib with polyurethane mastic with high modulus elasticity below and above the gasket.

Cut the base of the tank sump according to the relevant standard.

Place the bottom of the tank sump by installing the reinforcing elements and the bolts.

Tighten the bolts deeply by cross-tightening them.

Mount the entry boots and if they are of the electrofusion type just weld the body on the sump and do not weld the reducer.
Connect all the pipes.
Pressure test the pipes at 6 bar for the primary and 4 bar for the secondary for 2h – If the pressure test has been successful, weld the reducer.

ASSEMBLY OF THE BASE AND RISER

Make sure that the electrical resistance on the base of the sump and the lower surface of the riser are clean.

Assemble the sump by mounting the riser on the base, making sure that the two arrows coincide.

Warning!!! Do not mix risers or covers of different sumps. Each sump must be composed of the 3 elements that come in the package.

Join the two parts (upper and lower) from the inside using at least 12 locking pliers (one in each corner and one in the middle of the long sides).

Connect the welding pins of the welding machine to the two terminals of the resistors placed on the sides of the sump.

Weld the sump using the SMARTFLEX welding machine (the welding data are indicated on the label included in the fitting bag).

Align the cover and the riser by aligning the two arrows.

If the cover has to be locked, mount the 6 clamps (Model 19SKF).

The height of the riser can be adjusted (see instructions).

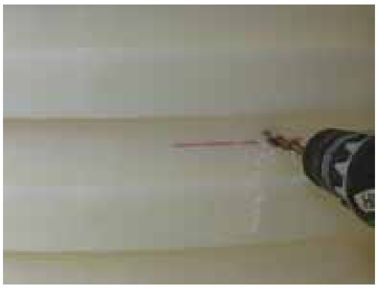
If it is necessary to perform the vacuum test of the sump you need to:
- Drill the polyethylene with a 10 mm point below the ¼” insert.

- Screw a ¼” threaded fitting (Model 19SVT6).
- Place a bag of sand in the middle of the cover to ensure a uniformly distributed load.
- Perform the test with a maximum vacuum of -0.05 bar.

If the passage of a gauge is needed, it is possible to mount an entry boot on the cover.
- Make 6 mounting holes with a Ø 8 mm point.
- Open the center with a Ø 98 mm hole saw.

Install the entry boot Model SEB50.

If it is necessary to cut the riser you shall:
- Use a sabre saw with a 48 mm wide guide plate (see photo).



- Make a 10 mm hole above the middle of the ring to be cut.

- Insert the blade into the hole, activate the sabre saw and turn around the ring.
- Cut around the ring without interruption.

OPTIONAL

We suggest to use the two-component moldable, self-extinguishing insulating rubber paste item code 19SBPASTE for a perfect insulation of the welding pins.

Take a small equal quantity of the two products from the two jars.

Mix the two products for two minutes maximum to obtain a uniform compound.

Connect the welding pins of the welding machine to the two terminals of the resistors placed on the sides of the sump.

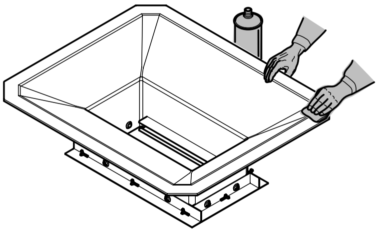
Position the compound on the welding wire and the resistor as shown in the photo. Make sure you cover also the part below the resistor.

After 5 minutes, the insulating paste is ready and it is possible to start the welding operations. Weld the sump using the SMARTFLEX welding machine.

Remove the welding cables and leave the compound on the covered part.

6.3 ASSEMBLY INSTRUCTIONS OF AN ELECTROFUSION DISPENSER SUMP - MODEL S21DS

Fig.1



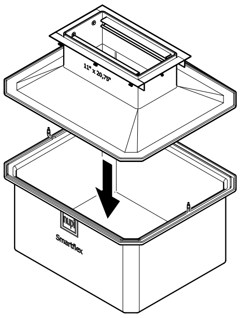
ATTENTION: In order to have suitable space necessary to assemble the various components inside the sump, we recommend to carry out the electrofusion welding process of the upper section only at the completion of the piping installation process.

Clean all the components involved in the welding proccess with a clean cloth soaked with a recommended cleaning solvent (Model LID1).

Note: The following solvents may be used, **Acetone, Isopropyl Alcohol, Trichloroethane and Dichloromethane**. Their grade must be of the CABs/industrial type and they must not contain traces of water or oil. The use of other primers or solvents is not allowed.

Note: When scraping, a perfectly even surface is required, please take care to remove any roughness that could cause the weld to fail.

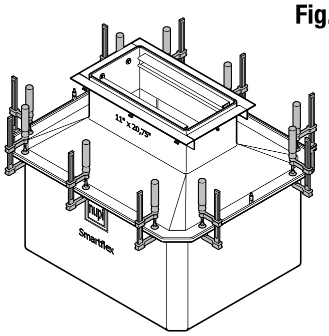
Fig.2



Position the upper section of the sump on the base.

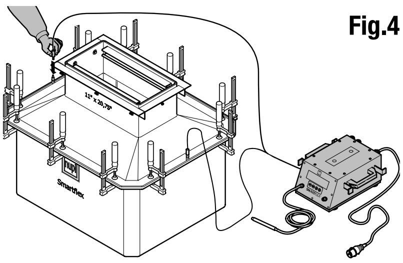
Note: Take care not to damage the connectors necessary for the welding process.

Fig.3



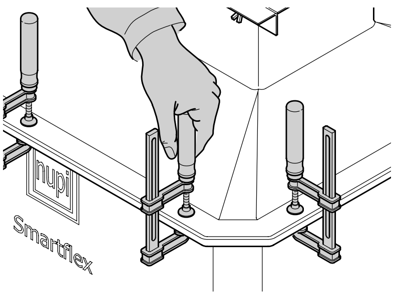
Secure the two components together using 10 clamps (3 positioned on the long sides and 2 on each short side).

Fig.4



Weld the sump using the specific barcode, following the instructions shown on the welding machine's display.

Fig.5



During the welding and cooling down time further tighten the clamps to increase the adhesion between the two components.

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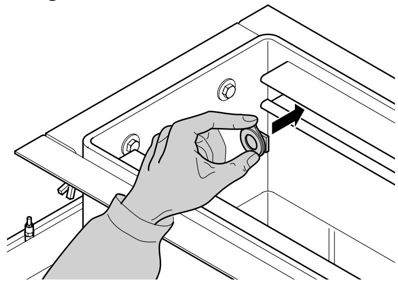
Wait until the cooling down time shown on the barcode of the sump has elapsed, then remove the clamps.

Note: At this stage ensure all nuts and bolts are tight on strut assemblies as they may have loosened during transit.

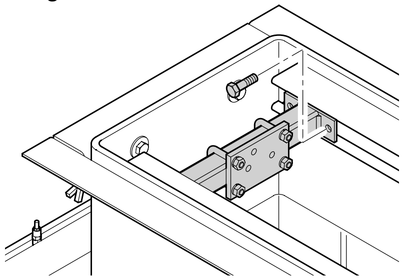
Insert the nuts provided inside the side struts positioned on the long sides of the sump. Slide the nuts into the correct position.

Fig.6



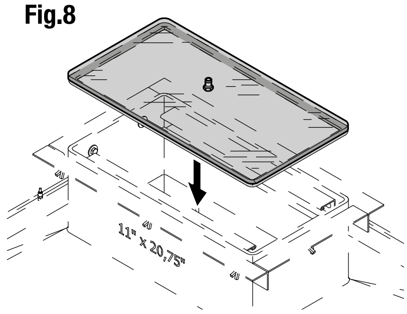
Secure the stabilizer bars on the side struts using the studs provided.

Fig.7



Position the plexiglas lid onto the top of the sump.

Fig.8

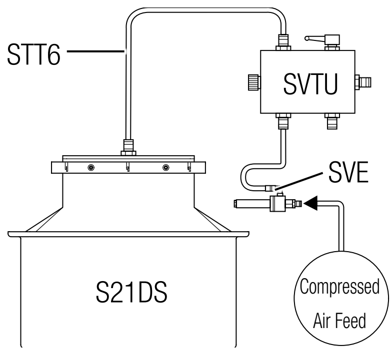


Note: To perform a vacuum test on the lid it is necessary to follow these steps:

1. Connect the specific test tube for the test (Model STT6).
2. Connect the ejector (Model SVE) to the compressor line to generate a vacuum to commence the vacuum test.
3. Connect the test line to the vacuum test unit (Model SVTU) following the specific instructions.

The vacuum test for all dispenser sumps (Models S21DS2111, S21DS2518, S21DS3016, S21DS4216 and S21DS4620) shall be performed at a Pr = -0.05 bar for 20 minutes.

Fig.9



7 • MODIFICATION AND REPAIR OF SMARTFLEX SITES

The purpose of this document is to give a short guideline on how to operate when doing a modification or repair of a SMARTFLEX piping system. This guideline is in any case not exhaustive and should never surpass the national/local regulation and practices, particularly in terms of health and safety regulations.

Operators shall perform all the operations described below. They shall consider all the necessary safety procedures in terms of health and safety of the on-site personnel and take into consideration all the relative environmental aspects and rules.

For additional information, please make reference to:

- IP – Code of safe practice for contractors working on filling stations.
- APEA – Design, construction, modification, maintenance and decommissioning of filling stations.

PROCEDURE

1. Turn off and shut down the electrical supply to the submersible pump (if present) and the dispensers. This may require the assistance of authorised personnel.
2. Disconnect the pump and any dispenser devices.
3. Prepare the UST closest dispenser hose to release pipeline pressure and to empty the product into a suitable sealed containment vessel.
4. Empty the line completely of any fuels.
5. Test the confined space in the sump to be repaired by the use of an (O_2) Oxygen sensor/meter.
6. Before any personnel enter the sump, check the presence of enough (O_2) Oxygen.
7. Close the ball valve of the submersible pump.
8. Open the test ports on the secondary containment fittings.
9. Detach the product line from the tank sump connection.
10. Assure to collect any residual fluid into the sealed containment vessel.
11. Open the shear valve access ports of the interested line to permit the fluid to flow down to the tank sump.
12. Close the shear valve when the line is completely drained and dried.
13. Ventilate the sump to achieve an Oxygen (O_2) level suitable for personnel to re-enter (20-25%).
14. Remove the filled containment vessel from the tank sump.
15. Proceed with the repairing process following the SMARTFLEX installation instructions.
16. During the repairing process, make suce the line and the sumps continuously purged with an inert gas like Nitrogen. It is important to monitor continuously the (O_2) Oxygen level.
17. Fill the line to be repaired and the sumps with Nitrogen until no Oxygen (O_2) is present (to be checked with the (O_2) Oxygen meter).
18. Place the welding unit as far as possible from the repairing site/area, aboveground, ensuring that the connecting cables are not tensioned.
19. Turn off the Nitrogen supply and immediately commence the welding process.
20. At the end of the welding process, turn off the welding unit power supply and again start to convey Nitrogen into the line and sump leaving the connecting cables connected to the fitting.
21. The flow of Nitrogen should continue for least 20-30 minutes during the cooling down period.
22. Permit air exchange and when the (O_2) level again reaches 20-25% the operator can enter the welding zone and disconnect the cables.
23. Once the repairing process has been completed, the line shall be pressure tested as per the SMARTFLEX instructions.
24. After a positive result of the pressure test has been achieved, the line can be re-commissioned and start working again.

8 • SMARTFLEX PRESSURE TEST

All SMARTFLEX installations must be pressure tested before being placed in service.

The primary pipe and secondary containment pipe (where applicable) shall be tested separately. The primary pipe shall be tested before completing all the welds in the secondary system.

A pressure gauge with test pressure at mid-scale is recommended. If the SMARTFLEX Pressure Test Device SENS010 is used as testing device please refer to its specific user's manual.

If the installation has pressure constraints due to the presence of auxiliary devices, please contact our technical office before starting the test.

The following table provides testing parameters. Higher test pressures must be approved by the manufacturer.

	Gaseous Fluids		**Liquid Fluids**	
	Test Pressure	**Test Duration**	**Test Pressure**	**Test Duration**
Primary pipe	87 psi (6 bars)	2 hours	116 psi (8 bars)	2 hours
Secondary pipe	58 psi (4 bars)	2 hours	58 psi (4 bars)	2 hours
Rubber termination fittings	5 psi (0.3 bar)	2 hours	5 psi (0.3 bar)	2 hours

The conditions above are valid for the pipe at ambient temperature (20°C). For higher temperatures, wait for the conditions to be restored. The pipe shall NOT be tested when it is hot (pipe temperature > 35°C). It is recommended to carry out the pressure test in the early morning during the warm season of the year.

The pressure test shall be carried out on pipe runs with a maximum length of 100 metres in order to avoid that small pressure drops due to micro leaks will spread on the entire system under test and will not be detected.

The SMARTFLEX system includes a special testing device (Model SENS010) to be connected to the welding unit and the fluid generator. Barcode PRESSURE TEST CARDS are available for test performing.

Prior to commencing any pressure test it is good practice to inspect all welded fittings to ensure all fittings have been welded correctly.

The fluids recommended for the test are: compressed air, nitrogen, helium or water.

Make sure that the filling phase of the sumps to be monitored is carried out gradually, avoiding overpressures.

Record the ambient temperature at the beginning and at the end of testing, as temperature changes will affect gas pressure inside the pipe.

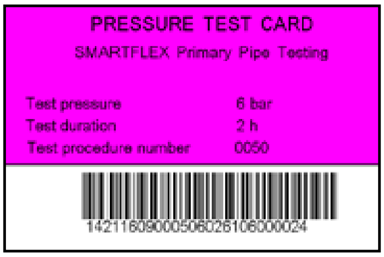
Pressure change due to temperature (only for gaseous fluids) is 0.35% for °C and 0.19% for °F. [e.g. $\pm \Delta T = -18°F$ (-10°C) will cause $\Delta P = -3.5\%$, hypothesizing that the temperature at the start of the test is around 60°F (+15°C)]. A net pressure change (after temperature compensation) of -2% is typically considered acceptable to take into account eventual micro leakage of testing devices.

CAUTION:

Before testing the primary pipe, ensure that the test ports on the double wall fittings are open and that the interstice is properly vented.

CAUTION:

If gaseous fluids are employed for the pressure test, adequate safety precautions must be taken.

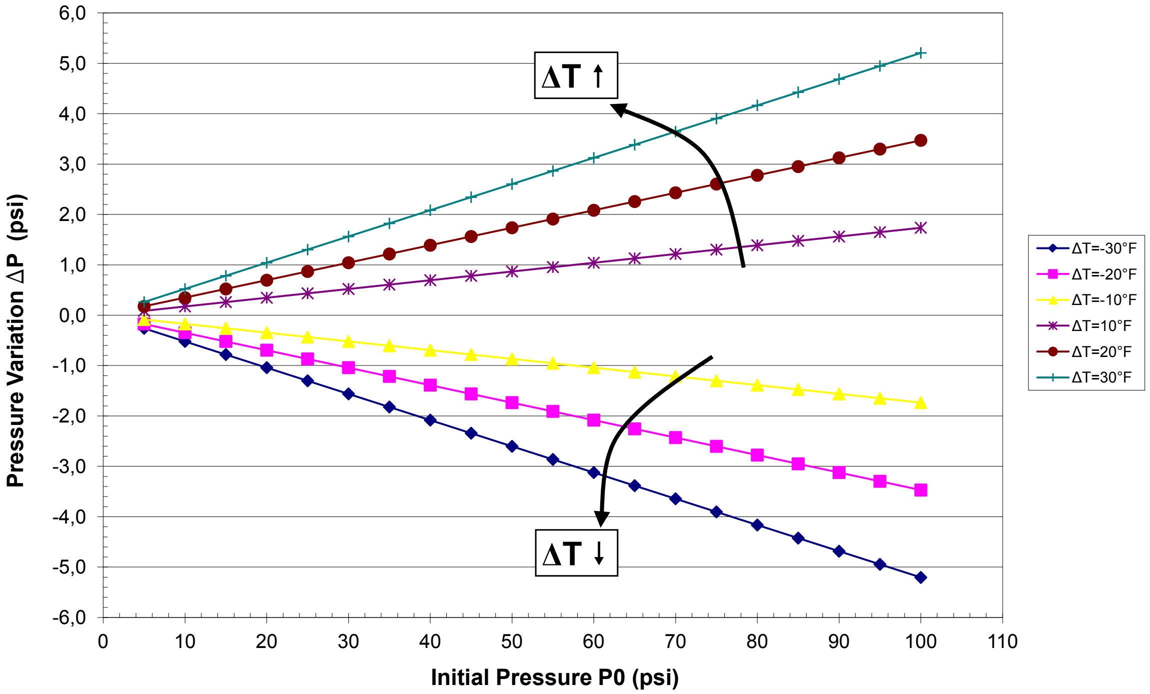


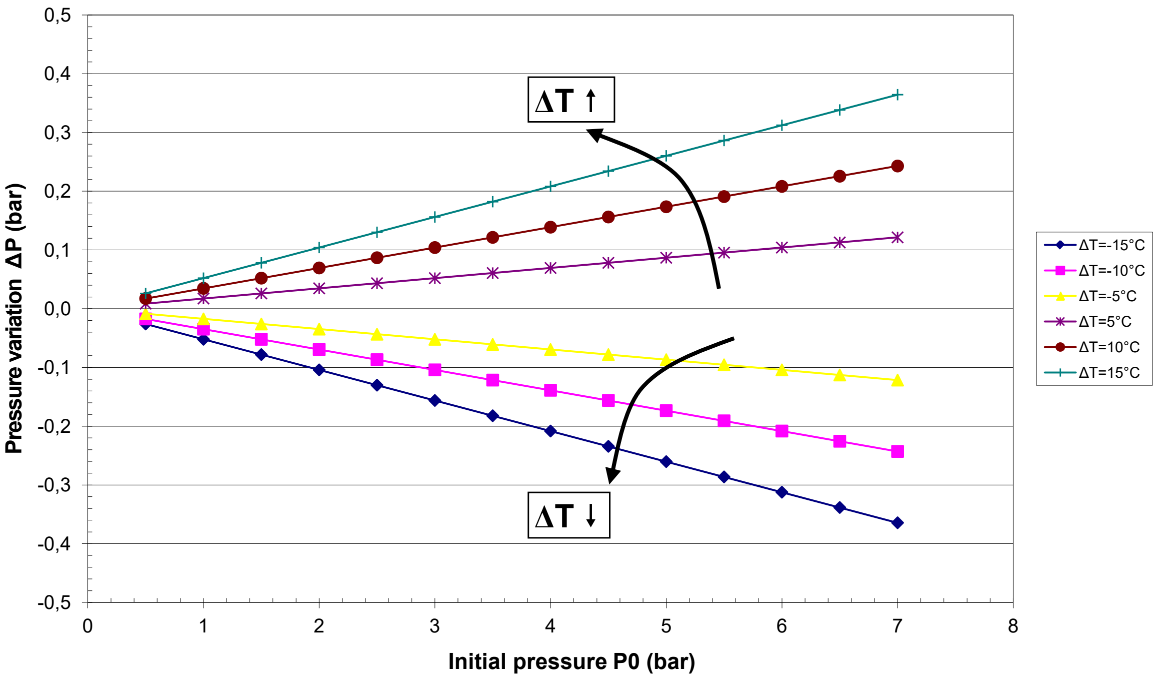
The following table shows the final pressure P (psi) in function of initial pressure P0 (psi) and of temperature change ΔT (°F).

Initial pressure (psi)	Temperature variation ΔT (°F)						
	-27	-18	-9	0	+9	+18	+27
	Final pressure (psi)						
5	4.7	4.8	4.9	5.0	5.1	5.2	5.3
10	9.5	9.7	9.8	10.0	10.2	10.3	10.5
15	14.2	14.5	14.7	15.0	15.3	15.5	15.8
20	19.0	19.3	19.7	20.0	20.3	20.7	21.0
25	23.7	24.1	24.6	25.0	25.4	25.9	26.3
30	28.4	29.0	29.5	30.0	30.5	31.0	31.6
35	33.2	33.8	34.4	35.0	35.6	36.2	36.8
40	37.9	38.6	39.3	40.0	40.7	41.4	42.1
45	42.7	43.4	44.2	45.0	45.8	46.6	47.3
50	47.4	48.3	49.1	50.0	50.9	51.7	52.6
55	52.1	53.1	54.0	55.0	56.0	56.9	57.9
60	56.9	57.9	59.0	60.	61.0	62.1	63.1
65	61.6	62.7	63.9	65.0	66.1	67.3	68.4
70	66.4	67.6	68.8	70.0	71.2	72.4	73.6
75	71.1	72.4	73.7	75.0	76.3	77.6	78.9
80	75.8	77.2	78.6	80.0	81.4	82.8	84.2
85	80.6	82.0	83.5	85.0	86.5	88.0	89.4
90	85.3	86.9	88.4	90.0	91.6	93.1	94.7
95	90.1	91.7	93.4	95.0	96.6	98.3	99.9
100	94.8	96.5	98.3	100.0	101.7	103.5	105.2

Initial pressure (bar)	Temperature variation ΔT (°C)						
	-15	-10	-5	0	+5	+10	+15
	Final pressure (bar)						
0.5	0.47	0.48	0.49	0.50	0.51	0.52	0.53
1	0.95	0.97	0.98	1.00	1.02	1.03	1.05
1.5	1.42	1.45	1.47	1.50	1.53	1.55	1.58
2	1.90	1.93	1.97	2.00	2.03	2.07	2.10
2.5	2.37	2.41	2.46	2.50	2.54	2.59	2.63
3	2.84	2.90	2.95	3.00	3.05	3.10	3.16
3.5	3.32	3.38	3.44	3.50	3.56	3.62	3.68
4	3.79	3.86	3.93	4.00	4.07	4.14	4.21
4.5	4.27	4.34	4.42	4.50	4.58	4.66	4.73
5	4.74	4.83	4.91	5.00	5.09	5.17	5.26
5.5	5.21	5.31	5.40	5.50	5.60	5.69	5.79
6	5.69	5.79	5.90	6.00	6.10	6.21	6.31
6.5	6.16	6.27	6.39	6.50	6.61	6.73	6.84
7	6.64	6.76	6.88	7.00	7.12	7.24	7.36

The following diagram shows the pressure change ΔP (psi) in the system, considering an initial pressure P0 and according to various temperature changes ΔT (°F).





Note: the procedure described above is a quick test procedure carried out under a so-called low pressure. This testing procedure could rarely not allow the detection of anomalies caused by faulty welds e.g. pasted welds, excessive offset or pipe that has not reached its correct position inside the fitting.

In case the pressure test had a negative result due to a leaking fitting detected through soapy water or a suitable leak detection gas, the test shall be interrupted and the fitting shall be removed and replaced with a new one.

Problem solving in case of leak at any welded assembly

Considering that the electrofusion welding process is an optimal welding process (as it is based on molecular fusion between the materials that creates the assembly), possible leaks of the welded parts can occur only for the following reasons:

- The welding process was interrupted. Therefore, it was not completed correctly (the welding unit displays an error on the screen).

Or:

- The pipes and fittings were not scraped and cleaned correctly. In this case, the material may not have properly melted.

Since it is not possible to determine defective welding solely through a visual examination, we recommend:

- Re-welding the fitting one further time.
- Repeating the pressure test once welded and cooled.

Guidelines for system maintenance

The following guidelines shall be explained to the installer during their training:

- If a leak or anomaly is detected in any part of the system (by inspecting the sumps or through the leak monitoring system), the problem must be resolved by the maintenance person immediately.
- If the piping system is damaged or if there is a leak, the manufacturer or distributor shall be contacted for further advice.

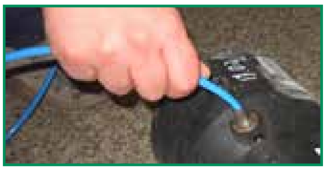
The service station operator shall be informed accordingly.

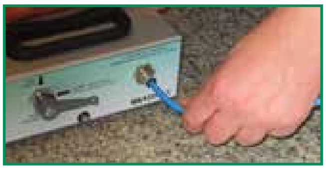
CAUTION:

Ignoring or disabling any monitoring system alarm may cause future damage.

8.1 SYSTEM PRESSURE TEST UNIT

After welding the connections correctly, wait until the cool down time has elapsed (suggested time 1-2 hours) and remove the alignment tool. It is now possible to carry out the pipe pressure test.





Necessary equipment:

- MULTIPURPOSE WELDING UNIT SET UP FOR PRESSURE INSPECTIONS
- DEVICE FOR NETWORK INSPECTIONS UNDER PRESSURE (00ESENSxxx)
- COMPRESSOR OR NITROGEN TANK WITH SUITABLE REDUCER

Plant setup

Before beginning the test, provide any point on the line with a ø6 mm RILSAN adaptor.

Connections

SYSTEM>PRESSURE GAUGE

Insert one end of the Rilsan tube into the quick connector in the pipe to be tested. The other end must be connected to the pressure testing device under the label ‘TO SMARTFLEX PIPEWORK’.

PRESSURE FLUID > PRESSURE GAUGE

Connect the source of pressure fluid (compressed air or nitrogen tank) to the pressure gauge under the label ‘TEST FLUID INLET’.

PRESSURE GAUGE >WELDING UNIT

Connect the connection cable from the pressure gauge (DATA PORT) to the welding unit. In the upper door of the welding unit you will find the “DATA PORT” connection.

ATTENTION: Before beginning the pressure test, check that the handle of the DUMP VALVE is in the CLOSED position and that the handle of the FILL VALVE is in the OPEN position.

Starting the pressure test

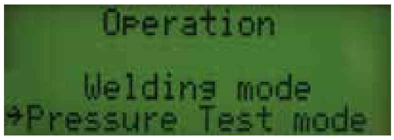
To begin the pressure test, the welding unit must be connected correctly and positioned in:

OPERATOR CODE

OPERATION

Welding Mode

→ Pressure Test



OPERATION

→ Data Recording

Download USB Memory

Delete Memory

Choose Memory

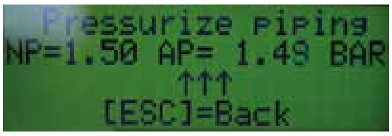
Readings taken during pressure tests are saved upon user's choice of eight different memories; use the cursor up/down arrow keys to select the memory and then press ENTER to confirm or ESCAPE to return to the previous menu.
If the memory has not been used previously, no description appears next to the memory name (MEM1, MEM2, etc.).
The system will propose the first free memory available.

Read B/C Pressure

Select the Test Card (pressure test data cards) suitable for the test to be carried out among those provided with the pressure gauge.
The Test Card contains the following data:
IP: Initial test pressure
FP: Final test pressure
Dur: Total test duration expressed in minutes or hours.
Rate: time lapse between pressure and temperature readings.
Ex: Dur 5 min / Rate 30 sec = 10 readings
Barcode to be scanned: collects all the data contained on the card for automatic transfer by barcode scanner.

The welding unit will summarize all the test data on the next screenshot.
MID: Identification
TID: Test protocol
NP: Nominal test pressure
Values reported by the welding unit may have a tolerance of +2.5% compared to the IP.
MP: Minimum test pressure allowed
Below this value, the test has failed.
n.Test: Number of tests to be carried out
After having checked that the data are correct, press ENTER to continue or ESCAPE to cancel the operation.

At this point, the welding unit asks the operator to confirm that the pressure test unit connected to the welding unit is the right model. Check that the ID number on the aluminium packaging is the same as the one requested by the multifunction welding unit and then press ENTER.
If the pressure test unit model is different from the one requested by the welding unit, contact the nearest SMARTFLEX Distributor or NUPI Industrie Italiane S.p.A. Technical Assistance Service.

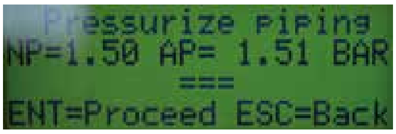


At this point the pipeline may be put under pressure.

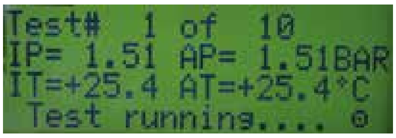
The following screen appears:
↑↑↑: Graphic signal that suggests INCREASING the pressure
↓↓↓: Graphic signal that suggests DECREASING the pressure
===: Pressure OK

To increase the pressure, proceed as follows:
1. Close the dump valve on the pressure test unit.
2. Slowly open the fill valve on the pressure test unit, keeping it open until the pressure, which can be read on the screen, reaches the required test valve pressure (IP).

IMPORTANT:
- Once the system is filled, let the pressure stabilize for 30-40 minutes.
- The initial pressure may have a tolerance of +2.5%.

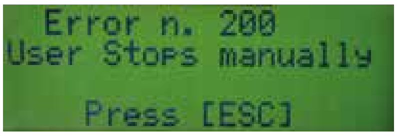


Wait a few more minutes for the pressure to stabilize in the entire line.



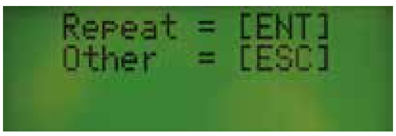
The welding unit is ready to begin the pressure test.
Press ENTER.
The progression of tests carried out is indicated in the first line.
IP: Initial pressure
AP: Actual pressure
IT: Initial temperature
AT: Actual temperature

If during the test the pressure drops below the minimum pressure allowed (MP), an error message will appear indicating 'Test Failed'.



The test may be stopped at any time by pressing ESCAPE. In this case, an error message will appear on the screen.

If the test is completed with positive results, the message shown in the screenshot on the left will appear on the screen. If you do not wish to print the test report, press ESCAPE.



The screen will appear as follows.
Press ENTER to go back and read the barcode for the test or press ESCAPE to return to the insertion of general data.

At the end of the pressure test, discharge the line by slowly opening the dump valve.

Deleting the test reports
Select the Cancel Memory option to cancel the contents of a specific memory.
Press ENTER to continue or ESCAPE to return to the main menu.
Select the memory to be cancelled by using the up/down arrow keys and then confirm the selection with ENTER.
Press ENTER to confirm the cancellation or ESCAPE to return to the previous screen.

Glossary

ENT Enter (confirm)

ESC Escape (return to previous screen)

B/C Barcode
The barcode for the pressure test is to be found in the TEST CARDS and collects all the data contained on the card for automatic transfer by barcode scanner.

IP Initial test pressure required (data contained on test card)

PF Final test pressure required (data contained on test card)

NP Nominal test pressure. Values reported by the welder may have a tolerance of +2.5% compared to the IP.

MP Minimum test pressure allowed. Below this value, the test has failed.

AP Actual pressure. Values reported by the welding unit during the test.

Dur Total duration of test expressed in minutes or hours (data contained on test card).

Rate Time lapse between one reading and the next during the pressure test (data contained on test card)

MID Identification of the memory

TID Test protocol

n.Test Number of tests carried out

↑↑↑ Graphic reminder that suggests INCREASING the pressure

↓↓↓ Graphic signal that suggests DECREASING the pressure

=== Pressure OK

IT Initial test temperature

AT Actual temperature

9 • BIOFUELS

9.1 BIOFUELS: THE ANSWER IS THE SMARTFLEX SYSTEM

A biofuel is a fuel that is produced through contemporary biological processes, such as agriculture and anaerobic digestion. In other words, it can be obtained from the processing of agricultural raw materials, biomass and wood. Biofuels are therefore considered as a renewable energy source. Their natural origin is more easily absorbable by nature and allows to reduce the greenhouse gas emissions from private transport by 70% and reduce the import of oil from abroad.

These two issues are taken very seriously by the European Union which requires all member countries to meet at least 2% of national energy demand by using biofuels, an intermediate target towards the final target of 5.75 % to be reached by December 2010 (20% by 2020).

There are two main biofuels: biodiesel and bioethanol.

It is important to emphasize that materials previously considered suitable for installations transporting traditional fuels are not just as suitable for the transport of new biofuels.

As for piping, thermoplastic piping are the most suitable ones (preferably made of HDPE with a suitable barrier layer) as they are absolutely unaffected by biofuels that cause instead a strong corrosive action on traditional metals. This is due to a more oxidizing environment due both to the higher percentage of water contained and the increased bacterial growth of yeasts and mold and the relative change of PH caused by their metabolites.

Precaution should be taken then for the metal parts in contact with biofuels. Stainless steel, bronze and nickel-plated brass or aluminum are the most suitable ones.

The SMARTFLEX system offers a complete range of pipes and fittings to meet all the necessary requirements for the proper transport of biofuels.

The SMARTFLEX system has already been tested and certified by RINA (ex ERA TECHNOLOGY) for the transport of E85 and biodiesel at 100% (EN14125).

10 • ELECTROSTATIC SAFETY OF THE SMARTFLEX SYSTEM

The SMARTFLEX piping system has received the complete electrostatic safety certification by exceeding the many rigorous tests required by the Wolfson laboratory (UK).

Plastic piping that are made conductive and metal pipework that is conductive by its own nature cannot be defined as completely safe as regards the electrostatic risk and each installation must be carefully evaluated. For example, conductive metal pipework must be properly earthed and conductive plastic piping installations must be conductive in every part, both pipes and fittings, and must be properly earthed. Failure or poor achievement of this precaution could even increase the electrostatic risk.

Certificate of Electrostatic Safety

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

PTB

Electrostatic charges are generated through a process arising from the presence in parts per million (or billion) of ions in the fuel.

Positive or negative ions selectively stick to any interfacial surface in contact with the fuel, such as the inner wall of the pipe, due to selective chemical absorption.

As a consequence, the inside surface of the pipe acquires a unipolar charge and ions of the opposite polarity in the fuel are attracted to it. A charged layer then extends from the wall into the fuel in a thickness that increases with decreasing fuel conductivity. The net charge in the pipe is zero when the fuel is at rest.

When the fuel flows, the ions in the boundary layer tend to be carried along, while the opposite charge on the wall dissipates to earth at a rate depending primarily upon the pipe material's conductivity. In any piping system, either metal or plastic, the primary source of charge generation is due to the flow of fuel through the pipe.

In addition to the electrostatic charging mechanisms, there is also the possibility of electrostatic charge being generated by friction with pipe wall and other plastic components, such as the walls of tanks or sumps, etc. In such cases, the mechanism of frictional charge generation could be rubbing or brushing with clothing.

The construction of a non-conductive pipe with a conductive inner liner implies the need to use continuity bridges inside the assemblies and periodically check the continuity of the installation and its grounding. This increases the risks of the installation. If a bridge is not well positioned or forgotten, it interrupts the continuity of the system thus converting it into a capacitor with a consequent risk of ignition. In addition, periodic monitoring of the installation and its grounding is both difficult and expensive. The use of the SMARTFLEX system, which is wholly non-conductive, is therefore absolutely safe and is preferred to a non-conductive system with a conductive inner liner.

10.1 TESTS

In order to investigate the electrostatic potential developed on the various components of a SMARTFLEX piping installation, a test pipeline was created at the Wolfson Electrostatics Laboratories (UK).

The test set-up enabled electrostatic measurements to be undertaken at various points during the flow of low conductivity fuel, which was pumped through the SMARTFLEX pipeline at high velocity using a pneumatic diaphragm pump.

The SMARTFLEX system under test comprised two sections, a 63 mm diameter pipe and a 90 mm diameter pipe. It also included a number of electro-welded couplers and spigot fittings.

In order to perform these fuel flow trials, 600 litres of refined iso-octane and toluene (50:50 mixture) were used. A pump able to deliver over 200 litres per minute was chosen in order to obtain practical worst-case electrostatic charging situations (i.e. four or five nozzles delivering fuel simultaneously at a flow of 40 litres per minute.

The maximum allowed flow is equal to 250 litres per minute for each pipe.

A total of 22 test runs were undertaken with the main controlled variable being flow direction and fuel conductivity.

Measurements were taken on each run to determine the electrostatic potential on the pipe wall and the electrostatic potential developed on the fittings and electrofusion couplers.

10.2 CONCLUSIONS

With regard to the issue of electrostatic ignition hazards, the investigation described above has demonstrated that:

- The SMARTFLEX system does not show any significant increase in the electrostatic ignition hazard as compared to conventional metal pipe work for the same type of installations.
- Based on the typical fuel flow of gas station applications, there is no risk of hazardous brush discharges from the pipe due to fuel flow.
- As a rule of good practice, it is recommended to earth all metal components such as valves, entry boot rings, etc. It is also recommended to stop up/close off or insulate the welding pins of the electrofusion fittings if not earthed. When the welding process has ended, the metal welding pins shall be removed from any free welding wire and the wire ends shall be protected or insulated.
- The electrostatic potentials developed on the walls of the piping during fuel flow are at least two orders of magnitude lower than the electrical breakdown strength of polyethylene. Therefore, no danger of electrical breakdown through the pipe wall exists.

New biofuels comprising alcohols (EtOH - E85) are not dangerous according to electrostatic safety if conveyed using the SMARTFLEX system. E85 is more conductive than gasoline (up to 10 times more conductive than crude oil) therefore the charge disperses quickly by reducing the risk of electrostatic storage.

11 • FREQUENTLY ASKED QUESTIONS

General Questions

Does NUPI Industrie Italiane develop and manufacture its own piping systems?

Yes, it does! NUPI Industrie Italiane develops, designs and manufactures all its products at the company's manufacturing plants in Italy and U.S.A.

Is it true that all plastic piping systems swell or expand when in contact with hydrocarbon vapours?

Absolutely not! SMARTFLEX pipes will not expand in length when exposed continuously to hydrocarbon vapours inside sumps. The reason is that the pipe and fittings employ high-density materials, which ensure a higher degree of hydrocarbon resistance.

Is the SMARTFLEX piping system rigid or flexible?

The SMARTFLEX piping system is classified as semi-rigid. Therefore, it offers the rigidity required by CARB (California Air Resources Board) regulations and, at the same time, the flexibility required by installers during the installation process.

How do you become a SMARTFLEX certified installer?

The SMARTFLEX piping system can only be installed by SMARTFLEX certified installers. The operator must attend a SMARTFLEX Certified Installer Training course prior to obtaining the Certified Installer credentials. Certified Installer Training is valid for a period of three years. Contact NUPI Industrie Italiane or your local distributor for further information.

What is the warranty on SMARTFLEX products?

The SMARTFLEX piping system offers a 30 year warranty. In order to validate the warranty, the SMARTFLEX piping system must be installed by a certified installer in accordance with the latest published installation instructions.

It was reported recently that a thermoplastic flexible pipe system "swelled/expanded" (grew in length) due to continuous exposure to hydrocarbon vapours within a containment sump. The abnormal growth caused a failure of the containment sump entry fittings. Will the SMARTFLEX piping system behave in the same manner?

Absolutely not! SMARTFLEX pipes will not noticeably swell or expand in length when exposed continually to hydrocarbon vapours inside sumps. The reason is that the pipe and fittings employ high-density materials, which ensure a higher degree of hydrocarbon resistance.

Are there any other piping manufacturers that offer pipe and fitting traceability?

Barcode technology is offered all over the world, but this does not imply traceability. The barcode alone is just a quicker way to enter the welding parameters into the welding machine.
SMARTFLEX is a true traceable system as it integrates:

- Double barcode fittings.
- A proprietary welding unit featuring a simple program that allows downloading of the welding parameters and system pressure tests.
- ITS: a web based application which provides the end user and NUPI Industrie Italiane to enter, store and retrieve all the specific site installation data.
- Production facilities certified according to Standards ISO 9001 and ISO 14001.

Why are SMARTFLEX pipes non-conductive?

As demonstrated by extensive tests, SMARTFLEX pipes are inherently safe as regards the electrostatic risk. The construction of a non-conductive pipe with a conductive inner liner implies the need to use continuity bridges inside the assemblies and periodically check the continuity of the installation and its grounding. This increases the risks of the installation. If a bridge is not well positioned or forgotten, it interrupts the continuity of the system thus converting it into a capacitor with a consequent risk of ignition. In addition, periodic monitoring of the installation and its grounding is both difficult and expensive. The use of the SMARTFLEX system, which is wholly non-conductive, is therefore absolutely safe and is preferred to a non-conductive system with a conductive inner liner.

What is the ITS system?

ITS is an Internet based Interactive Tracking System provided by NUPI Industrie Italiane. It allows to access relevant data regarding the installation of the SMARTFLEX system in a specific site (completed welding reports, pressure test results, installed products, installation site etc.).

What is the recommended backfill material?

Sand and pea gravel. Please refer to the SMARTFLEX Technical Catalogue, section 4.4.

What is the pressure rating of a piping system?

The pressure rating (or max. operating pressure) is the estimated gauge pressure that the medium in the pipe can exert continuously with the likelihood that failure of the pipe will not occur. All SMARTFLEX primary and secondary pipes are sized to have a pressure rating of 116 psi (8 bars) and 58 psi (4 bars) respectively.

Are both BSP and NPT threaded fittings available for the SMARTFLEX piping system?

Yes, they are! All SMARTFLEX threaded fittings are available in both BSP and NPT threads.

Can the interstitial space be monitored?

Yes it can! Thanks to SMARTFLEX double wall coaxial fittings that allow the interstitial space to remain uninterrupted throughout the whole line.

What is the pipe bending radius?

Nominal pipe diameter (in)	Nominal pipe diameter (mm)	Minimum bending radius (ft)	Minimum bending radius (mm)
1”	32	2 1/4	580
1 1/2”	50	3	900
2”	63	4	1100

What is the double barcode?

The double barcode contains additional information that allows the complete tracking of the fitting including production plant, raw material batch number and product characteristics.

Is the SMARTFLEX piping system suitable for biofuels?

Yes, it is! The SMARTFLEX piping system is suitable for the conveyance of biofuels and their blends (e.g. E85, biodiesel etc.).

Is the SMARTFLEX piping system suitable for AdBlue/DEF/Urea?

Yes, it is! NUPI Industrie Italiane created a multilayer pipe (SMARTFLEXUrea) specifically designed to satisfy the requirements of AdBlue/DEF/Urea conveyance in compliance with DIN70070 Standard. In addition, we provide a wide range of stainless steel (AISI 304) fittings for this application.

Is it possible to carry out the electrofusion process while in presence of explosive vapours?

No, it is not! Prior to commencing the electrofusion welding process, any residual hydrocarbons (liquid or vapour) must be eliminated from the line. This can be done by fluxing the line with an inert gas (e.g. nitrogen).

What is required to download welding or pressure test reports from the welding unit?

You need to install the software that can be found in the USB stick provided with the welding unit and an additional USB stick.

What are the main advantages of the SMARTFLEX double wall piping system versus other piping systems currently available on the market?

The SMARTFLEX double wall piping system is in fact a real double wall pipe system as the secondary pipe is not a simple jacket but a structural pipe. For this reason, the SMARTFLEX double wall piping system can be continuously monitored (24/7) at a pressure of 55 psi (3.8 bars), except when rubber components are present.

What connecting methods shall be used to install the SMARTFLEX piping system?

The primary connection method for the SMARTFLEX system is based on the electrofusion welding technology. Mechanical connection methods are also available.

Can the SMARTFLEX piping system be used for both pressure and suction systems?

Yes, it can! SMARTFLEX can be used for both pressure and suction systems.

Are the welding units and monitoring systems available in 110 and 220-volt versions?

Yes, they are! Please refer to the SMARTFLEX Product Catalogue.

Does NUPI Industrie Italiane provide a leak monitoring system?

Yes, it does! It is an over-pressure system that contains a leak monitoring unit (Model SMSIT), a manifold and tubes to connect the system to the double wall fittings via a specific quick-connecting valve.

Is the SMARTFLEX piping system specifically designed for use with petroleum products, alcohol mixtures, biofuels and their blends?

The SMARTFLEX piping system is specifically designed and manufactured for the conveyance of automotive fuels. This includes all gasoline, diesel fuels, alcohol/gasoline mixtures and biofuels.

Can the primary and secondary lines be tested together?

No, they can't! Only all the primary lines or all the secondary lines can be connected and tested together (using the specific manifolds Model SMANIF and SMST). As the test pressures vary for the two pipelines, please refer to the Technical Catalogue, section 7, for further information.

In the event that the internal pipe liner has been excessively exposed to ultra-violet (UV) rays, what corrective action should the installer perform?

The installer shall remove not less than 5 cm or one pipe diameter, whichever the greater, off the end of each exposed pipe.

What is the ambient temperature range within which electrofusion welding can be carried out?

From +14°F to +113°F (-10 C° to +45 °C).

What is the minimum recommended burial depth for SMARTFLEX pipes and fittings?

It is 20" (50 cm).

If pipes are crossed over one another, is there any particular procedure required?

Yes, there is! The pipes should be protected by a minimum of 2" (5 cm) of compacted backfill material or 1" (2,5 cm) of protective Styrofoam to prevent point-loading damage of the pipes.

Is it important to align the pipes and fittings during the welding and cooling process?

Yes, the pipes and fittings must be aligned during the entire welding and cooling process to allow welding to be correctly performed. A maximum misalignment of 10-15° is allowed.

In the event of a power shortage, can the electrofusion welding process be restarted?

The electrofusion welding process can only be restarted after the assembly has completely cooled down, to ambient temperature. NOTE: this operation can only be performed once.

Can SMARTFLEX welding units be used in potentially explosive environments?

SMARTFLEX welding units are NOT intrinsically safe devices and may only be used on pipe sections that do not contain hydrocarbons. Always refer to local regulations and laws for the use of electrical devices in service stations.

Since HPDE pipe has a higher coefficient of thermal expansion than reinforced fiberglass pipe, how does the installer determine the correct length of pipe to cut between two points?

This is not a real issue when installing SMARTFLEX pipes. Just measure the pipe, cut it to the appropriate length and install it. Although SMARTFLEX has a higher expansion coefficient than either metal or fiber-reinforced materials, its elastic modulus is much lower (from 10 to 200 lower). This means that the load applied to pipe constraints due to thermal expansion/contraction (in "restraining" installations) and pipe expansion (in "free-supporting" installations) is usually negligible and lower than the results obtained with the previously mentioned pipes.

If the barcode reading device fails to read a specific barcode, how should the installer proceed?

The installer must get an identical fitting and read its barcode in order to continue the welding process. If the problem persists, please contact our Customer Service at +39 0331 344211 or info@nupinet.com.

How does the SMARTFLEX piping system react to hydrocarbon permeability?

SMARTFLEX piping system permeability to petroleum products and alcohol fuels is negligible and completely in compliance with the main international certification requirements. Infact, SMARTFLEX pipes and fittings are created with special "barrier" materials that assure high resistance to petroleum products and biofuels.

CERTIFICATIONS

Is the SMARTFLEX piping system EN14125 certified?

Yes, it is! NUPI Industrie Italiane manufactures a specifically designed single and double wall piping system named TSMAH and TSMAHD to meet the requirements of the new EN14125 Standard. Moreover, TSMAU and TSMAUD pipes are certified for fill, vent and vapour recovery.

Is the SMARTFLEX piping system UL971/ULc certified?

Yes, it is! NUPI Industrie Italiane created a specially designed single and double-wall piping system named SUPERSMARTFLEX (TSMAXP, TSMAUXP and TSMAXPD, TSMAUXPD) to meet the requirements of the new UL971 and ULC Standards.

Is the SMARTFLEX piping system KIWA certified?

Yes, it is! NUPI Industrie Italiane created a specially designed single and double-wall piping system named TSMA and TSMAD to meet this Standard.

Is the SMARTFLEX piping system IP Second Edition certified?

Yes, it is! NUPI Industrie Italiane created a specially designed single and double-wall piping system named TSMA, TSMAD and TSMAU to meet this Standard.

WARNING: This document contains recommendations and information about products manufactured by NUPI Industrie Italiane S.p.A. and NUPI AMERICAS (NUPI group) and their installation. It is based on currently available data and is representative of the product under specified conditions. However, factors such as changes in environment, application, installation, operating procedure or extrapolation of data may produce different results.

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