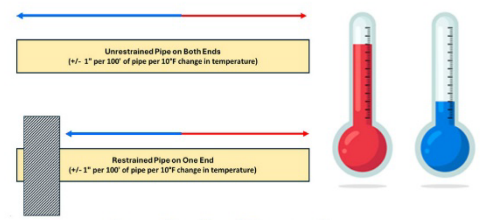
Electrofusion Flex Restraint Information Sheet

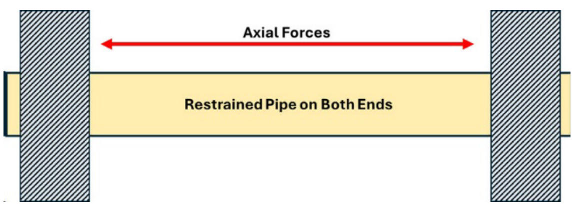
High-Density Polyethylene (HDPE) pipe and fittings are well-known to be thermally stable and possess excellent mechanical properties and chemical resistance; that is why as a construction material, HDPE has become increasingly popular in a growing number of applications. However, there is one HDPE material characteristic that often causes confusion and frustration, particularly when used in above ground and submersible applications.

Eventhough HDPE is thermally stable, it is also known to have a high thermal coefficient of expansion/contraction, which basically means in simple terms, that an HDPE system will will expand or contract when it expereinces changes in temperature. Sure, all pipes expand and contract when they experience fluctuations in temperature, but for HDPE, sudden changes in temperature in ***unrestrained***, above and below grade applications will result (as a rule of thumb), in an expansion or contraction of an HDPE pipe ***+/- 1" per 100' of pipe per 10°F change in temperature.***

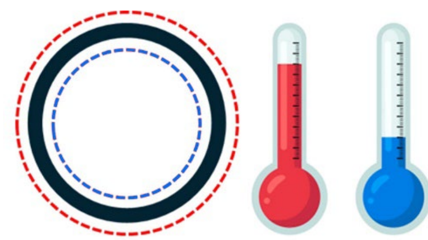


Longitudinal Expansion
(see Plastic Pipe Institute: Second Edition Handbook of PE Pipe; chapter 8, equation 3)

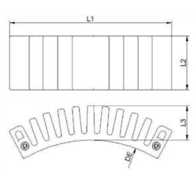
`This can result in a significant movement of pipe in unrestrained systems, and conversely, significant amounts of axial force can be generated in semi-restrained pipe systems that can result in unwanted complications and failures; both senarios must somehow be controlled and managed. So being aware of HDPE's thermal expansion coefficient, and knowing that it can be managed and controlled by the use of Electrofusion Flex Restraints is crucial, and systems should always be designed to account for this potential if fluctuating temperatures are anticipated. The key however, is in how this thermal strain is managed when designing an HDPE piping systems to maximize its overall performance and longevity.



However, what must also be kept in mind, is that the effects of thermal expansion/contraction do not just affect HDPE pipe ***longitudinally***. They also affect an HDPE pipe ***circumfrentially*** as well; so both aspects of this expansion and contraction must be taken into consideration when designing a HDPE piping system – particulaly in above gound and submersible applications. In most below ground systems, HDPE pipe does not move after it has been buried, allowed to relax, and acclimated to its surrounding ambient ground temperature. The HDPE system then becomes much more stable than an above ground pipeline due to the soil friction and earth load on the pipe surface and attached appurtenances.



Circumfrential Expansion



A Surface Mounted Fitting that Fits on IPS & DIPS Pipe

Nominal Size	L [in.]	W [in.]	H [in.]	Weight [lbs.]	Item Code	Axial Load Restraint Capacity (based on a safety factor of 2)
6" IPS/DIPS – 63" IPS/DIPS	7.50	2.45	1.56	0.42	200400	9,500 LBS

Can be Fused on Pipe Diameters 6" thru 10" can be fused on SDR 7 to 17 *Can be Fused on Pipe Diameters 12" thru 63" can be fused on SDR 7 to 26*

For Material and Testing information, please refer to our Molded Electrofusion Fitting Specification Sheet.

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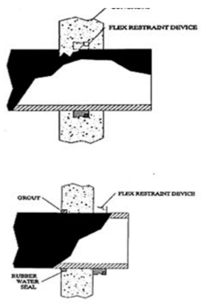
The *IntegriFuse EF Flex Restraints* are designed to be fused directly onto the OD of HDPE pipe. This a unique electrofusion fitting is specifically designed to be a simple, permanent, and robust electrofusion restraint alternative from traditional thrust collars, water stops, and wall anchors.

IntegriFuse EF Flex Restraints are used in an increasing variety of applications including, but not limited to:

- **Wall anchors**
- **Thrust anchors**
- **Rrestricting the movement of submersible concrete anchors**
- **Temporay under bridge by-pass lines,**
- **Manhole rehabilitation restraints**
- **Restricting pull-back forces after slip-lining HDPE**
- **Anchor points for vertical HDPE applications**
- **Securing a pipe repair using a mechanical coupling.**
- **Securing mechsanical connections when connecting HDPE pipe to non-HDPE bell and gasket fittings**



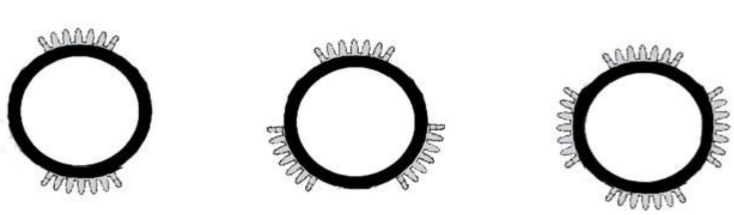
The *IntegriFuse Electrofusion Flex Restaint* design incorporates an innovative "next generation" fusion coil pattern that creates a robust fusion joint on the surface OD of HDPE pipes for the purpose of resisting and controlling axial forces created by temperature induced expansion and contraction.

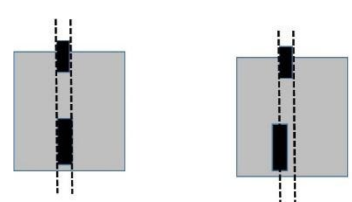
Instead of using the outside edges of the Flex Restraint to serve as the flex restraint cold zone; this second generation design of the IntegriFuse Electrofusion Flex Restraint incorporates an innovative fusion coil pattern that includes built in cold zones that increases our second generation flex restraint performance to 9,500 ft. lbs of axial resitance. A significant increase ove the first generations 7,500 ft. lb. design.

Important Note:

- ***A design engineer must calculate the amount of thrust force that will result from expansion & contraction to decide the proper quantity of Flex Restraints needed for each application.***
- ***Flex Restraints must be equally spaced and equally sectored on the surface of the pipe.***
- ***Flex Restraints require a straight-line orientation around the circumference of the pipe.***

(A minimum of 2 Flex Restraints must always be used to equally distribute the forces being resisted. The maximum # of restraints shown in this chart is how many Flex Restraints can be placed on the pipe surface, end-to-end, around its circumference. If the expected axial forces require more Flex Restraints to be used then can be placed in a single line, place another line of equidistantly spaced Flex Restraints with approx. 9 in. between lines.)





Correct Example Incorrect Example

Electrofusion Flex Restraint Information Sheet

The data provided in the following table is for use only as a guideline for the designer. The maximum number of restraints per pipe OD in this chart only reflects the total number of Flex Restraints that can be placed in a straight line around the circumference of a specified pipe OD. The designer must calculate and figure out all expansion/contraction forces in their specific application and for calculating the right number of flex restraints to be used for restraining those forces. The designer should consider all other affecting factors.

Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**	Pipe OD	Max. # of Restraints**
6"	3	18"	9	30"	15	42"	21
8"	4	20"	10	32"	16	48"	-----
10"	5	22"	11	34"	17	54"	-----
12"	6	24"	12	36"	18	63"	-----
14"	7	26"	13	38"	19		
16"	8	28"	14	40"	20		

***Refers to the maximum number of restraints per pipe OD in this chart only reflects the total number of Flex Restraints that can be placed in a straight line around the circumference of a specified pipe OD.*

Factory Joint Assembly Destructive Test




IntegriFuse Flex Restraints have been lab tested on properly prepared pipe surfaces using a hydraulic cylinder. Pressures were applied to each of the fusion joints until the fitting joint was forced to fail.

A series of three sperate tests were conducted on four different pipe diameters: ranging from 6-inch, 12-inch, 24-inch, and 63-inch. The criteria for success was the fusion joint "must rip the pipe wall out.

Fusion Joint Test Results (based on ASTM F1055)

Pipe Doiameter	Test #	Hydraulic Pressure @ Failure (psi)	Applied Force @ Breakoff (lbs)	Test Force Average (lbs)
6"	1	3,234	19,293	
6"	2	3,118	18,601	19,005
6"	3	3,205	19,120	
12"	1	3,234	19,293	
12"	2	3,205	19,120	19,293
12"	3	3,263	19,466	
24"	1	3,307	19,726	
24"	2	3,249	19,380	19,409
24"	3	3,205	19,120	
63"	1	3,423	20,418	
63"	2	3,075	18,342	19,351
63"	3	3,234	19,293	

Minimum Value Measured:

19,005 lbs.

Applied Safety Factor:

2.0

Axial Resistance Rated at:

9,500 lbs.

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Installation Procedure:

Integrity Fusion Products strongly requires that all individuals installing electrofusion fittings in permanent field applications should be done only by individuals who have a strong working knowledge of polyethylene and heat fusion methods, that have been properly trained, qualified, and hold a current training certificate issued from a recognized electrofusion fitting manufacturers authorized instructor, and that have demonstrated their understanding of these requirements by correctly preparing electrofusion test assemblies that have been qualified by recognized ASTM destructive testing. Other stipulations and regulations may apply, depending on fitting size, application, local codes, and/or jurisdictional oversight

Step 1 - Find the desired location for the Flex Restraints. Keep Flex Restraints in their original packaging until ready to place and secure.

Step 2 - Remove all sources of contamination from the surface of the pipe using clean water & dry with clean cloth.

Step 3 – Using an approved marking pen, clearly mark the location where each flex restraint is to be installed. Also highlight the complete fusion area with the pen, as this will provide a visual guide while scraping.

Step 4 – Scrape the area where the Flex Restraint is to be placed making sure to remove the thin layer of oxidation from the pipe surface (.007" minimum) using an approved scraper/peeler tool. Scrape/peel the marked area until the required amount of material is removed, and all the pen marks are no longer visible. (Rasps, grinders & wire brushes/wheels are NOT allowed)

Step 5 – Clean the scraped area using a 90% or greater solution of Isopropyl Alcohol and a clean lint free rag making sure that the surface area of the pipe where the Flex Restraints are to be applied are free of contaminates. Remove the Flex Restraint from its packaging and clean the fitting base of the Flex Restraint to remove any accidental contamination of these areas. (NO other cleaning agent is allowed). *<u>Do not touch pipe surface or fitting base after cleaning.</u>*

Step 6 – Place the Flex Restraint at once on the prepared surface where it is to be fused and secure it in pace with a 2" ratchet strap. 2" Ratchet straps are the required application tool due to the ease of use and more reliable distribution of clamping pressures.

Step 7 – While holding the Flex Restraint in place, tighten the 2" ratchet strap until the Flex Restraints are conformed to the pipe wall. When installing just one Flex Restraint, make sure the ratchet buckle is 180 degrees/opposite the flex restraint before tightening. It is critical to ensure that the base of the Flex Restraint contacts the pipe over the entire fusion area, and no gap can be seen between fitting and the pipe. If more than one Flex Restraint is to be fused, make sure that all fittings are in place before completely securing the ratchet straps, ensuring the ratchet buckle is equidistant between two of the Flex Restraints before tightening.

Step 8 – Start generator, connect the processor leads to the Flex Restraint and enter the fusion data by scanning the bar-code or entering the fusion data in manual mode. Due to the location and/or the number of flex restraints being used; It may be necessary to scan a separate fitting to input the fusion data.

Step 9 – After the fusion cycle has completed, leave the Flex Restraint strapped in place until ALL the fittings have cooled.

***** Note: This abbreviated version of our Electrofusion Instructions is for reference and a reminder. For more complete details concerning job site and installation requirements please refer to our Electrofusion Training and Installation Manual.**

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Properly prepared, assembled, and fused Flex Restraints were installed on a pipe sample and tested by applying 3,700 psi to the Flex Restraint joints (the equivalent of 19,700 ft. lbs.) and held for 30 minutes. The test assembly passed and was cut in half to visually inspect the fusion zone for signs of stress and possible failure. None was found.

Properly prepared, assembled, and fused Flex Restraints were installed on a pipe sample and tensile tested to failure.

Available PPI Flex Restraint Calculators

https://www.plasticpipecalculator.com/ThermalExpansion.aspx
https://hdpeapp.com/#/installation/below/anch