3.4 BUTT FUSION WELDING

3.4.1 INTRODUCTION

The butt welding process consists of the joining of two components (pipes and/or fittings) of equal diameter and thickness in which the surfaces to be welded are heated until melting by contact with a heating element and then, after its removal, are axially (butt) joined by pressure welding. Like Polyfusion and Electrofusion, with butt fusion welding there is no additional contribution or use of filler materials (i.e. welding rod or flux) required to complete the weld.

The instructions below are for guidance only. Unlike socket fusion, butt fusion welding implies that the operators are suitably trained on the use of specific welding machines to be used and have a thorough knowledge of the procedures to be performed. Training is machine-specific, as many details will vary based on specific machine used.

ATTENTION!

Each manufacturer of BUTT FUSION WELDING equipment publish his/her own reference literature based on the working parameters of the equipment produced.

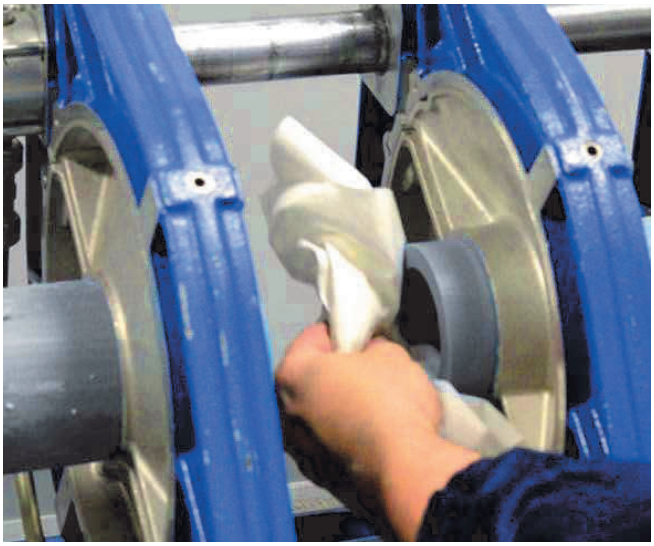
The user SHALL REFER to this specific literature for every detail not expressly stated and for any reference information regarding the equipment.

3.4.2 RECOMMENDATIONS AND WARNINGS

To perform a proper fusion procedure and ensure a reliable joint, it is necessary to remember the following steps:

- The working temperature of the heating element shall be checked using a calibrated contact thermometer. This measurement shall be done after about 10 minutes after the nominal temperature is reached, allowing the heating element to heat up evenly over the entire section.
- Check the surface of the heating element (integrity of the non-stick layer) and properly clean it by using soft paper or cloth, free of fibers.
- Check for the proper functioning of the welding machine.
- Check the efficiency of the clamp supports of the welding machine so that the correct alignment of the pieces to be welded and the parallelism of the surfaces touching each other are ensured.
- Check the drag force of the movable trolley, both as friction and in relation to the load being handled (pipes and/or fittings).
- Check the efficiency of the measuring equipment (pressure gauge and timer).
- Check that the pipes and/or fittings to be welded are of the same diameter and the same thickness (SDR).
- The planing tool provided with the welding machine shall plane and align the pipes and fittings frontally and also absorb the pressures developed during the welding process without deforming the welding point irreversibly.
- The welding machine should be prepared for use according to the manufacturer's instructions.

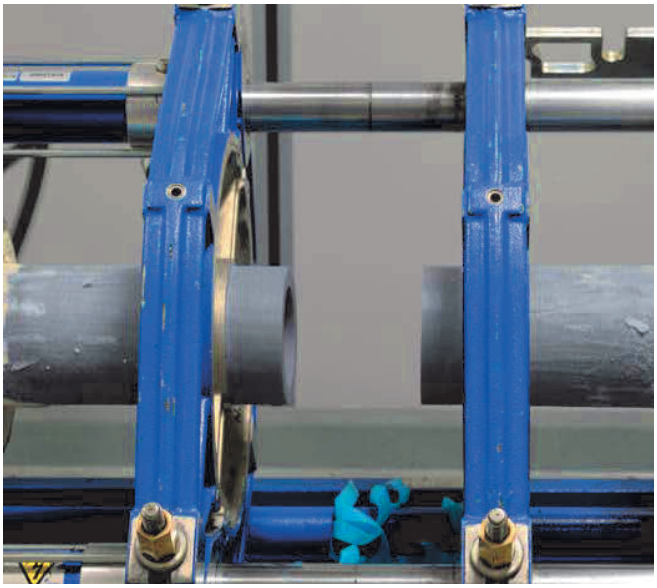
3.4.3 BUTT FUSION WELDING PROCEDURE



PREPARATION FOR WELDING

Cleaning the surfaces

Before positioning the parts to be welded, clean the welding area to remove any dust, grease or dirt.

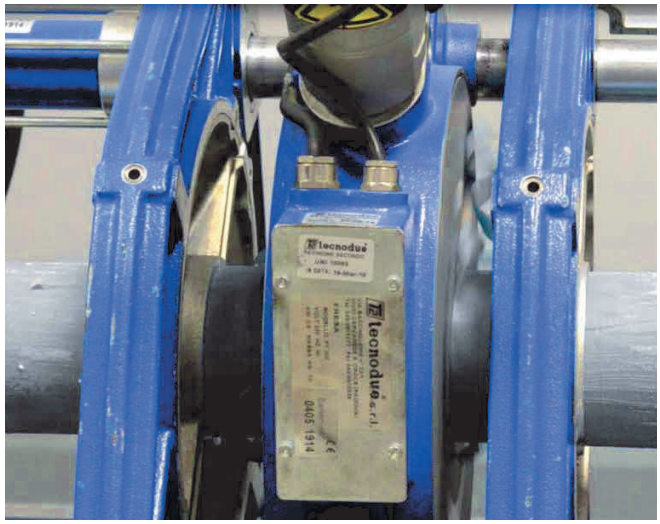


Locking the ends

The pipes and/or fittings must be locked in the clamps of the welding machine so that the contact surfaces to be welded are aligned between them. The possibility of axial movement without significant friction shall be ensured by using rollers or oscillating suspensions to allow the pipe sliding to remove any mechanical stress from the clamps resulting from the weight of the locked pipes.

The pipes and/or fittings shall be positioned so as to contain the misalignment within 10%. To obtain this result, rotate at least one of the elements until the most favorable coupling condition is reached and/or the locking force exerted on the fastening systems of the clamps is not excessive as it could damage the surfaces of the components.

Milling the edges to be welded



The ends of the two components to be welded shall be planed to ensure adequate plane parallelism and to remove any trace of oxide.

The planing operation shall be carried out by bringing the parts close to each other only when the milling cutter inserted between them is working and by exerting gradual pressure such as not to stop the tool and prevent excessive heating of the surfaces in contact.

The planing chips must be formed continuously on both edges to be welded: otherwise, investigate the cause and repeat the process until the required result is reached.

The planer must be turned off only after the removal of the ends to be welded.

After the planing procedure is finished, planing chips shall be removed from the inner surface and the surrounding area of the elements to be welded, by using a brush or a clean cloth, free of fibers, fluff and lint and not synthetic, soaked in a suitable cleaning liquid (e.g. isopropyl alcohol, trichloroethane chlorothene). Do not use any solvent such as gasoline, denatured alcohol or trichlorethylene.

The planed surfaces shall not be touched or otherwise contaminated.

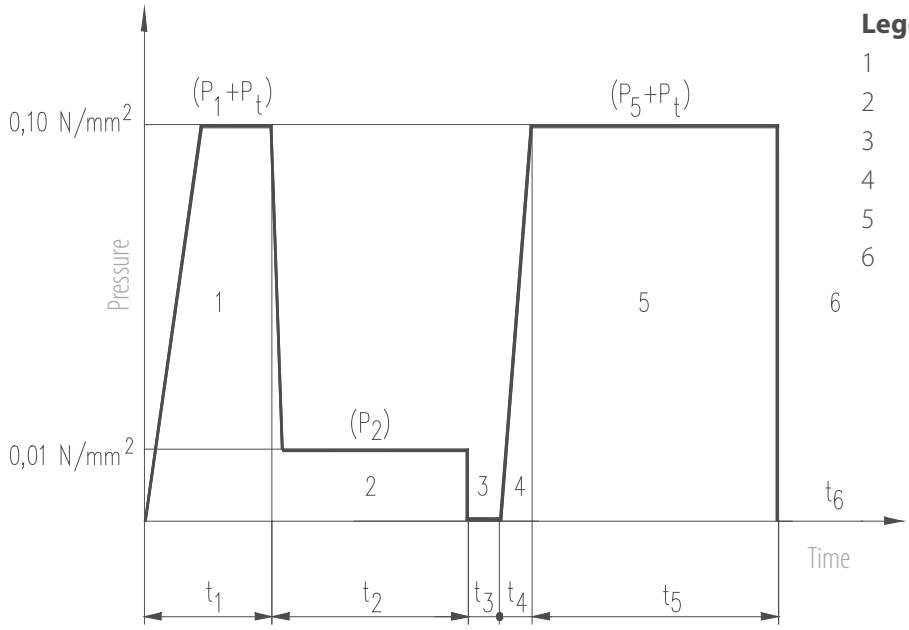
At the end of this phase, by bringing the two ends into contact, the space between the two edges must not exceed the value of 0.02 inches (0.5 mm), a value that is half way between 1/64th of an inch and 1/32nd of an inch (which is difficult to measure, but can be estimated by checking using the width of a sheet of standard thin 20 pound paper). The value referenced above is slightly less than the thickness of standard 20 pound paper).

WELDING PROCEDURE

Welding procedure by means of contact heating elements

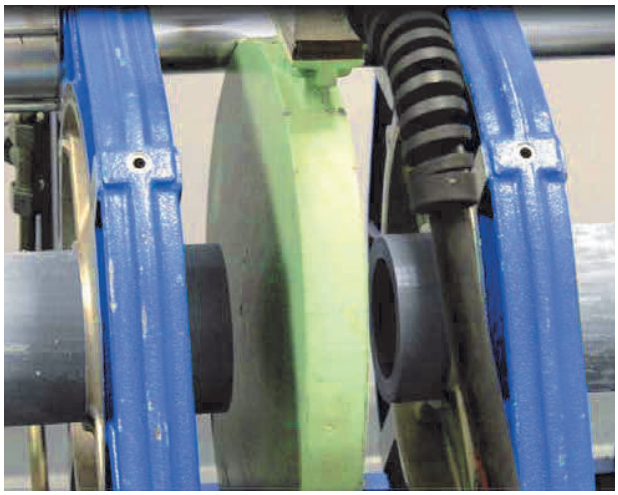
The butt fusion welding of pipes and/or fittings by means of contact heating elements shall be carried out following the different steps of the welding procedure shown in the Figure below.

In particular:
Phase 1 : Approaching and preheating
Phase 2 : Heating
Phase 3 : Removing the heating element
Phase 4 : Reaching the welding pressure
Phase 5 : Welding
Phase 6 : Cooling



Legend

1 Phase 1 : Approaching and preheating
2 Phase 2 : Heating
3 Phase 3 : Removing the heating element
4 Phase 4 : Reaching the welding pressure
5 Phase 5 : Welding
6 Phase 6 : Cooling



WELDING PHASES

Phase 1: Approaching and preheating

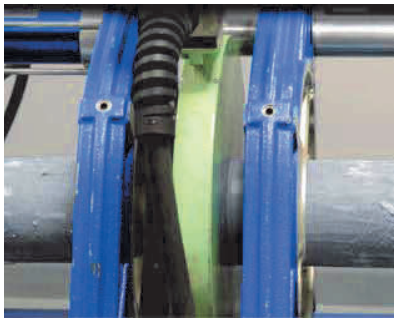
Place the heating element on the welding machine, taking care to insert it properly in order to ensure its stability on the supports of the machine base.

Place the edges close to the heating element and apply the initial welding force [pressure (P1 + Pt)] for a time t1 and wait until the bead has reached height h on both welding edges, as shown in Table 2 (pages 70, 71).

Phase 2: Heating

Once the bead has reached height h, the contact pressure between the edges and the heating element is reduced to a low enough pressure to insure contact with the heating element during the heating phase.

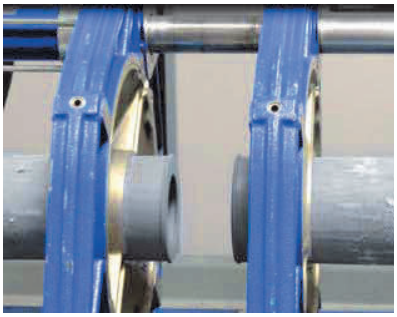
Keep the parts in contact with the heating element for the time t2 (Table 2).



Phase 3: Removing the heating element

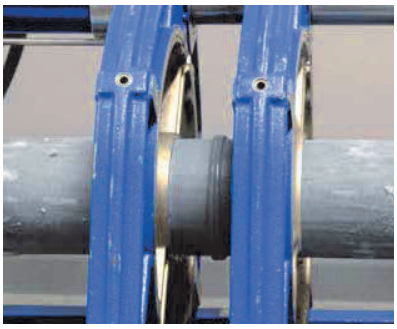
Remove the heating element, making sure not to damage the edges of the two parts to be welded.

The removal must be rapid to avoid excessive cooling of the heated edges. The Changeover Time t3, is reported in seconds, is the amount of time from the removal of the heating element to the contact with the edges (phase 4). The maximum allowable changeover time varies according to wall thickness as shown in Table 2.



Phase 4: Reaching the welding pressure

Once the heating element has been removed, bring the edges into contact. Gradually increase pressure until the value (P5 + Pt) (phase 5) is reached so as to prevent excessive leakage of melted material from the edges in contact. Reaching the final welding force [welding pressure (P5 + Pt)] must take the amount of time t4 shown in Table 2.



Phase 5: Welding

Keep the edges in contact under pressure (P5 + Pt) for a time t5, expressed in minutes, as shown in table 2, unless the welding is performed in-line (e.g. on a pipe rack, on pipe hangers, performed on a vertical line, etc.) in which case the full welding time t6 must be observed while the pipes are clamped.

Phase 6: Cooling

Once the welding time is over (phase 5), the welded joint can be removed from the welding machine, without being subjected to significant stress. Allow the welded joint to completely cool to ambient temperature.

3.4.4 BUTT FUSION WELDING PARAMETERS

TABLE 2: BUTT WELDING PARAMETERS FOR NIRON PP-RCT PIPING

SIZE OF PIPE	SDR	INITIAL WELDING FORCE LBS	INITIAL BEAD SIZE INCHES, h	HEAT SOAK TIME SECONDS, t2	MAX CHANGE OVER TIME, t3 s	REACH FULL WELD PRESSURE, t4 s	WELDING FORCE LBS	NORMAL COOLING TIME MINUTES, t5	IN-LINE COOLING TIME MINUTES, t6
2" (63 mm)	7.3	33	1/32	197	5	6	33	3.5	12
2½" (75 mm)	7.3	47	1/32	221	6	7	47	4.5	14
3" (90 mm)	7.3	68	1/32	249	7	11	68	5	20
4" (110 mm)	7.3	101	1/32	283	8	9	101	6.5	24
5" (125mm)	7.3	130	1/32	307	9	16	130	7.5	27
6" (160 mm)	7.3	214	1/16	359	10	19	214	9.5	34
8" (200 mm)	7.3	334	1/16 - 3/32	411	11	23	334	12	41
10" (250 mm)	7.3	522	1/16 - 3/32	460	13	27	522	15	51
12" (315 mm)	7.3	828	3/32	519	16	37	828	18	62
14" (355 mm)	7.3	1053	3/32	552	17	42	1053	21	69
2" (63 mm)	9	28	1/32	175	5	6	28	3	12
2½" (75 mm)	9	40	1/32	195	6	7	40	3.5	12
3" (90 mm)	9	56	1/32	217	7	9	56	4	14
4" (110 mm)	9	84	1/32	249	7	11	84	5	20
5" (125mm)	9	109	1/32	268	8	13	109	6	23
6" (160 mm)	9	179	1/32	315	9	16	179	7	28
8" (200 mm)	9	279	1/16	361	10	19	279	9	35
10" (250 mm)	9	436	1/16 - 3/32	413	11	23	436	12	42
12" (315 mm)	9	692	1/16 - 3/32	468	13	28	692	15	52
14" (355 mm)	9	880	3/32	497	14	34	880	17	58
2" (63 mm)	11	23	1/64	156	5	6	23	2.5	9
2½" (75 mm)	11	33	1/64	172	6	7	33	3	9
3" (90 mm)	11	47	1/32	192	6	8	47	3	9
4" (110 mm)	11	71	1/32	217	7	9	71	4	11
5" (125mm)	11	92	1/32	237	7	11	92	5	12
6" (160 mm)	11	149	1/32	277	8	13	149	6	24
8" (200 mm)	11	233	1/32	320	9	17	233	7	29
10" (250 mm)	11	365	1/16	366	10	19	365	9	35

TABLE 2: BUTT WELDING PARAMETERS FOR NIRON PP-RCT PIPING

SIZE OF PIPE	SDR	INITIAL WELDING FORCE LBS	INITIAL BEAD SIZE INCHES	HEAT SOAK TIME SECONDS, t2	MAX CHANGE OVER, t3 s	REACH WELD PRESSURE, t4 s	WELDING FORCE LBS	NORMAL COOLING TIME MINUTES, t5	IN-LINE COOLING TIME MINUTES, t6
12" (315 mm)	11	579	1/16 - 3/32	420	11	24	579	12	44
14" (355 mm)	11	736	1/16 - 3/32	447	12	27	736	14	48
16" (400 mm)	11	934	1/16 - 3/32	477	14	32	934	15	54
18" (450 mm)	11	1203	3/32	507	15	35	1203	17	60
20" (500 mm)	11	1460	3/32	533	16	38	1460	19	65
22" (560 mm)	11	1831	3/32 - 1/8	- - -	17	43	1831	22	71
24" (630 mm)	11	2316	3/32 - 1/8	- - -	18	45	2316	25	- - -
2" (63 mm)	17	16	1/64	108	5	6	16	1.5	5
2½" (75 mm)	17	22	1/64	129	5	6	22	2	6
3" (90 mm)	17	32	1/64	145	5	6	32	2	7
4" (110 mm)	17	47	1/64	164	6	7	47	2.5	10
5" (125mm)	17	59	1/32	176	6	7	59	3	10
6" (160 mm)	17	100	1/32	210	6	8	100	4	11
8" (200 mm)	17	156	1/32	204	7	11	156	5	20
10" (250 mm)	17	244	1/32	278	8	13	244	6	24
12" (315 mm)	17	388	1/32	324	9	17	388	8	29
14" (355 mm)	17	493	1/16	348	9	18	493	9	33
16" (400 mm)	17	626	1/16	377	11	20	626	10	37
18" (450 mm)	17	806	1/16 - 3/32	406	11	22	806	11	41
20" (500 mm)	17	978	1/16 - 3/32	426	11	24	978	12	45
22" (560 mm)	17	1227	1/16 - 3/32	453	12	27	1227	14	50
24" (630 mm)	17	1552	1/16 - 3/32	483	14	32	1552	16	55

Note:
1. Butt Welding of Niron PP-RCT is to be performed at a heating element temp of 410°F ± 18°F.
2. Cooling time represents the time the pipe and/or fittings must be held clamped in the machine under pressure after joining.
3. When welding is performed in a bench type setting, normal cooling times can be observed. When welding is performed in place (e.g. up in the air or on pipe racks, then the full cooling time shown in the last column titled “In-Line Cooling” must be used.
4. Inline referes to welding pipe while it is on hangers, on a pipe rack, or in a vertical position.
5. In all cases, substantial presure or bending stress must be avoided on the welded assembly until the full cooling time in the last column is observed.
6. The information in the chart above is for manual butt fusion machines. When using a hydraulic machine, the welding pressure to be used (in place of the welding force) will depend on the specific machine used and the drag force required. This will vary by specific hydraulic machine type.