



# Manual Butt Fusion Machines

## COMBAT<sub>4</sub>PROX

# Operator's Manual



## Welcome to the Hayes Family!

The Hayes manual COMBAT PRO-X series butt fusion machines will give many years of service if operation procedures and maintenance are followed carefully and correctly.

- ✓ The COMBAT 4 PRO-X series is suitable for butt fusion pipes and fittings made of HDPE and any other kind of thermoplastic pipes from 1" to 4".
- ✓ This nimble but tough machine is ideal for smaller spaces and easy to set up in the field. This unit is designed to make the fusion process easier when welding small diameter pipes. It requires only one operator and minimal maintenance.
- ✓ Machine consists of pipe alignment carriage, insert sets, Teflon-coated heating plate, electric trimmer and electric stand. *(Optional gauge torque wrench available)*
- ✓ The portable manually operated alignment with or without gauge torque wrench will simplify the job on site. The compact electric trimmer and the heater work with 110V and they only need 700 watts of power each. It will save you time and money while fusing pipe consistently with high-quality results.
- ✓ Designed and manufactured according to the American international standard (Inches) ASTM F2620.

***Do not operate this machine until you have carefully read, and understand all the sections of this manual.***

## About this manual

This manual is only a manufacturer's guide. It does not take the place of proper training by qualified instructors. The information in this manual is operational and cannot cover all the situations that may appear in the field. This guide does not exceed the experience of a professional.

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## IMPORTANT Safety Information

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alerts are shown below.



Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

Signal words “NOTICE” and “IMPORTANT” are used to bring attention to important information. The meaning of these signal words are as follows:

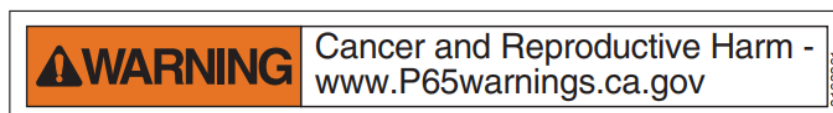
“NOTICE” - Can keep you from doing something that might damage the machine or someone’s property. It may also be used to alert against unsafe practices.

“IMPORTANT” - Can help you do a better job or make your job easier in some way.

### California Proposition 65 Label

The California Office of Environmental Health Hazard Assessment (OEHHA) amended regulations related to “clear and reasonable” Proposition 65 warnings (“Warning”) went into effect August 30, 2018. For Hayes Industrial Solutions, Inc. machines which are sold into and/or operated within California, the included label must stay attached to the machine. The purpose of Proposition 65 is to ensure the public is informed about potential exposures to chemicals which the state of California has determined can cause cancer, birth defects, or other reproductive harm. The list now includes more than 900 chemicals. Hayes Industrial Solutions, Inc. machines are safe, stable and non-toxic under normal condition and when handling correctly, but may contain a trace amount of listed compounds as a result of our manufacturing processes. The requirements for Prop 65 warnings have evolved, however, and these warnings are now required for California equipment.

For more information about Proposition 65, go to [www.P65warnings.ca.gov](http://www.P65warnings.ca.gov).



**NOTICE:** *All data in this Operator’s manual is offered in good faith as typical values. The information was compiled from data supplied by the vendors of the components of this machine and is believed to be accurate. It is the user’s responsibility to determine the safety, potential hazard, toxicity, and suitability for their own use of the machine described herein. Since the actual use by others is beyond our control, no guarantee, expressed or implied, is made by Hayes Industrial Solutions, Inc. as to the effects of such use, the results to be obtained, or the safety, potential hazard and toxicity of the product, nor does Hayes Industrial Solutions, Inc. assume any liability arising out of use, by others, of the product referred to herein. The information is intended only to assist in the safe handling of this machine.*

## Industrial Safety RISK MATRIX



**Avoid serious Injury:** This unit must be operated by trained personnel only.

Skill and knowledge are required to properly use this equipment.

Improper operation, maintenance or repair of this product can be dangerous and could result in injury or death.

Be alert and report anything that you see, feel, smell or hear differently than expected, or that you think is unsafe.

HAZARD	RISK	SOURCE	RISK CONTROL
<b>MECHANICAL</b> 	Cutting Risk	Trimmer	<ul style="list-style-type: none"> <li>Maintain a safe distance during trimming.</li> <li>Keep hands and fingers away from the trimmer blades when is running. Trimmer blades are extremely sharp.</li> <li>Wait for the trimmer to come to a complete stop before removing it from the alignment carriage.</li> </ul>
<b>ELECTRICAL</b> 	Electrocution Risk	Heater	<ul style="list-style-type: none"> <li>Ensure you are using the correct power source.</li> <li>Confirm electrical cords are in good condition.</li> <li>If you are working in a wet environment, proper ground connections help to minimize the chances of an electric shock. Use GFCI electrical connection if possible.</li> <li>Do not allow the cables to come into contact with chemical agents, water or mechanical stress. ®</li> </ul>
		Trimmer	
<b>THERMAL</b> 	Risk of Fire	Heater	<ul style="list-style-type: none"> <li>Do not use the machine in environments with explosion risk (due to the presence of gases, flammable vapors, etc.).</li> <li>Ensure to keep out any material that could deteriorate or ignite with the heater or with the combustion of the heater such as: oil, solvents, paints or varnishes, etc.</li> </ul>
		Trimmer	
	Burn Risk	Heater	<ul style="list-style-type: none"> <li>Wear protective gloves and eyewear. When the heater is on it will burn clothing and skin.</li> <li>Never touch the surface of the heating element when is on. Wait until it completely cooled down.</li> <li>Carefully clean the heating plate with a dry lint free non-synthetic cloth. Move the heating plate cautiously.</li> <li>Do not touch the welding seam or surrounding areas before they have completely cooled down.</li> </ul>
<b>ERGONOMIC</b> 	Injury Risk	Weight	<ul style="list-style-type: none"> <li>Move the large parts of the equipment correctly.</li> <li>Use the appropriate industrial safety positions for cargo handling.</li> </ul>



Both the heater element and the trimmer with electric motor are **NOT EXPLOSION PROOF**. If operating in an explosive atmosphere, heater should be brought up to temperature in a safe environment, then unplugged before entering the explosive atmosphere for fusion. Operation of heater in an explosive atmosphere without necessary safety precautions will result in serious injury or death.

# Manual Butt Fusion Machines

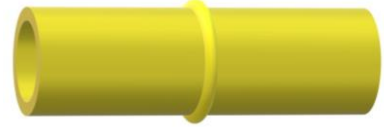
## Introduction

### Application

The HAYES Manual Butt fusion machine is used for welding thermoplastic pipes and fittings by heat and manually controlled force. This method plays a crucial role in joining pipes and fittings, ensuring leak-proof connections and long-lasting joints when maintaining the integrity of fluid transportation networks.

### What is Butt Fusion?

Butt fusion is a thermal welding process used for joining thermoplastic pipe ends or/and fittings, as result of heat fusion and pressure, the molecules of the two pipes melt and mix together and when the joint cools, the molecules of plastics return to their original form and the two parts finally become one monolithic pipe which creates a seamless end-to-end connection.



### When to Use Butt Fusion

Butt fusion is commonly used in various industries and applications, including:

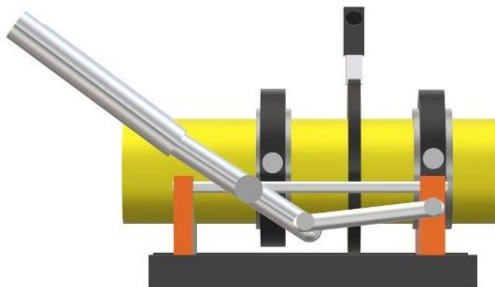
- ✓ **Water and Gas Distribution:** It provides leak-free connections that are critical for the safe and efficient transport of these essential utilities.
- ✓ **Wastewater Management:** In sewage and wastewater systems, where pipes are subjected to a variety of harsh chemicals and environmental conditions, butt fusion is the go-to method for reliable, long-lasting connections.
- ✓ **Industrial Pipelines:** Industries such as chemical processing, mining, and agriculture often rely on butt fusion to join pipes that transport a wide range of materials, from corrosive chemicals to irrigation water.
- ✓ **Geothermal and HVAC Systems:** Butt fusion is used to connect pipes in geothermal heating and cooling systems, ensuring efficient heat transfer and long-term durability.

### Benefits of Butt Fusion

Butt fusion offers several advantages that make it a preferred choice for many applications:

- ✓ **Leak-Proof Joints:** The resulting joints are seamless and completely leak-proof, ensuring the integrity of the fluid or gas being transported.
- ✓ **Longevity:** Butt fusion joints are highly durable and can withstand the test of time, making them ideal for applications where longevity is crucial.
- ✓ **No Need for Solvents or Adhesives:** Unlike other joining methods, butt fusion does not require the use of solvents or adhesives, reducing the risk of chemical contamination.
- ✓ **Low Maintenance:** Once a butt fusion joint is made, it requires minimal maintenance, reducing operational costs.
- ✓ **Consistency:** Butt fusion offers a high degree of repeatability and consistency in joint quality.

### Butt fusion Procedure



The butt-fusion procedure consists of heating the ends of two pipes, a pipe and a fitting, or two fittings, by holding them against a heated plate, removing the heater plate when the proper melt is obtained, promptly bringing the ends together, and allowing the joint to cool while maintaining the appropriate applied force.

An appropriately sized butt fusion machine is used to clamp, align and face the pipe or fitting ends and to apply the specified fusion force/pressure.

## Parts of the Manual butt fusion machine



### Teflon-coated heating plate

The heater is coated to reduce polymer adhesion. The heater temperature is controlled by a microprocessor installed in the electric control unit support.

**Included!**



### Electric Trimmer/Facer

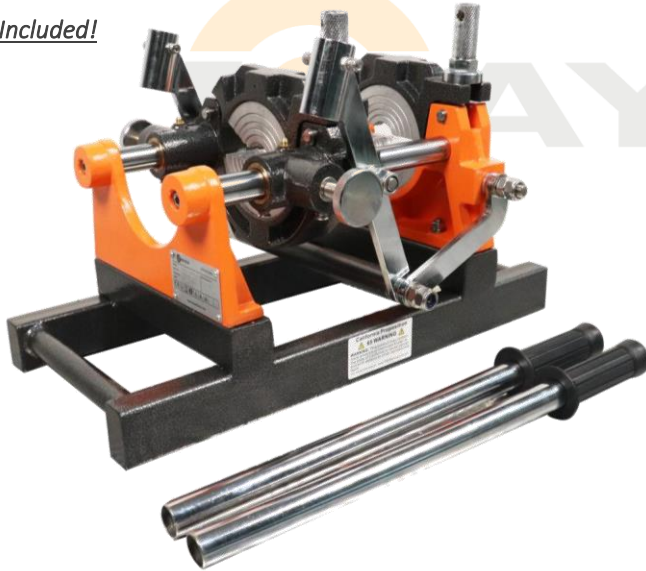
A trimmer or facer is a rotating cutting device used to square-off the pipe or fitting ends to obtain properly mating fusion surfaces.

**Included!**

### Pipe alignment carriage

This pipe alignment carriage has a stationary and a movable clamping fixture for aligning and holding each of the two parts to be fused to assist with pipe welding process. It also includes all the appropriate inserts for clamping different pipe sizes or fitting shapes.

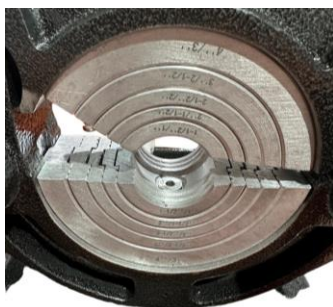
**Included!**



### Electric control unit / support

For more accurate and stable connection, the electric system and temperature display are controlled by the power unit support. It is also a stand for the heater and trimmer.

**Included!**



### Inserts/Clamps

The clamps or inserts need to be installed for the pipe that is being fused. This machine included IPS inserts: 1" 1-1/4" 1-1/2" 2" 2-1/2" 3" + 4" IPS master insert built in the machine.

**Included!**



### Gauge torque wrench

***Optional use of gauge torque wrench.*** If a specified force is required in the fusion procedure, a torque wrench can be used with special adapter.

***Optional***

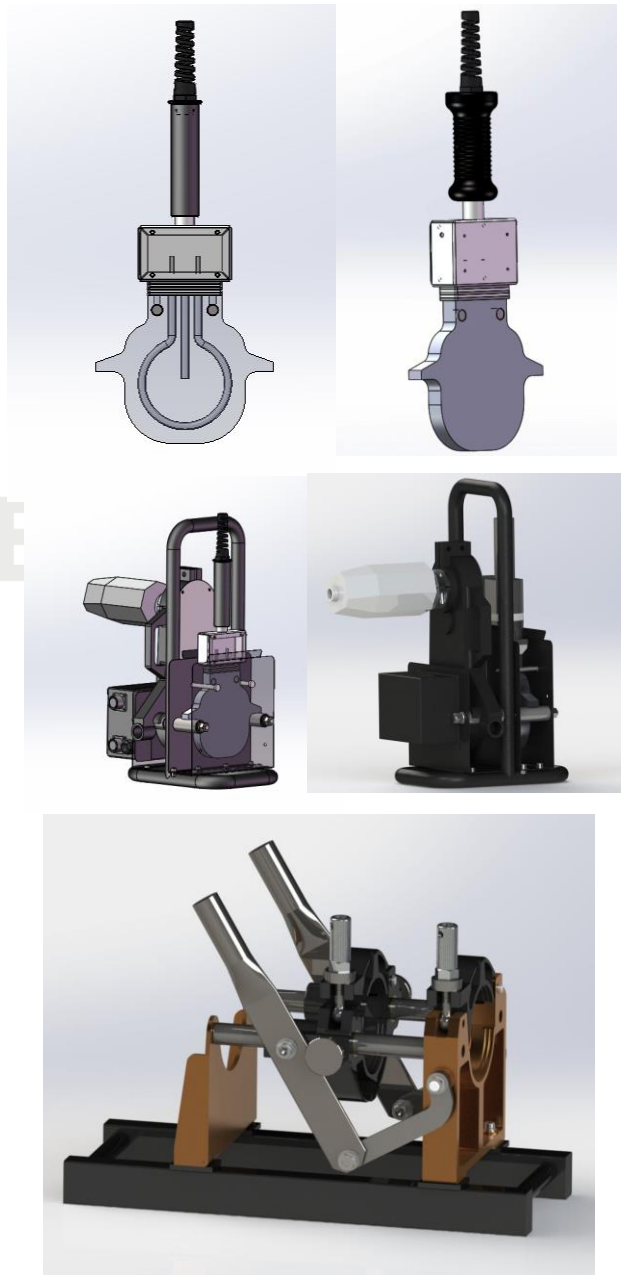
# COMBAT4PRO-X

## 1" – 4" IPS



### PRODUCT SPECIFICATIONS

MODEL	COMBAT4PROX 110 V
Pipe ranges	1" IPS – 4" IPS
Complete set of inserts	1", 1-1/4", 1-1/2", 2", 2-1/2", 3" + 4" IPS master insert built in the machine.
Working temperature	0-518 °F
Displayed	Fahrenheit
Voltage	110V / 1-phase
Frequency	50/60 Hz
Plug type	NEMA 5-15 (USA)
Environment temperature	23-113°F
Difference Temp. Heater	± 41°F
<b>Power Requirements</b>	1700 watts / 16.2 Amps
Heating plate	1000 watts / 6.4 Amps
Trimmer	700 watts / 9.8 Amps
<b>Shipping/Packing</b>	
1 Wood crate	
Gross Weight	GW: 119 lbs. (54Kg)
Net Weight	NW: 83.8 lbs. (38Kg)
Dimensions LxWxH	38" x 17" x 27"
*cm	*(97x43x69 cm)
<b>Dry Weight</b>	
- Pipe Alignment carriage	44.1 lbs. (20Kg)
- Support, heater and trimmer	33.1 lbs. (15Kg)
- Tool Bag	6.6 lbs. (3Kg)
<b>Total Dry Weight</b>	<b>83.8 lbs. (38Kg)</b>
- Wood crate	35.3 lbs. (16Kg)



# Machine Operation

Before operation make sure of the following:



- ✓ Skill and knowledge are required to obtain a good quality joint.
- ✓ The machine should be placed on a stable and dry surface to operate.
- ✓ Check field generator for adequate power supply and fuel sufficient to complete the fusion joint.
- ✓ Pouring water or applying wet cloths to the joint to reduce cooling time is not acceptable.
- ✓ Make sure the blades of the trimmer are sharp and the Teflon in the heating plate is in good condition.
- ✓ Place the appropriate inserts for the pipe OD or the fitting being fused.



- ✓ **Non-stick coating (Teflon):** Coated surfaces have been treated to reduce polymer adhesion. If the polymer adheres to the heating plate, lightly wipe with a clean cotton cloth to remove. Do not use a wire brush or an abrasive.
- ✓ **Welding parameters:** Pipe manufacturers have established qualified fusion procedures which should be followed precisely. You should obtain a copy of the pipe manufacturer's procedures or appropriate joining standard for the pipe being fused.
- ✓ **Heater temperature:** Ensure you select the proper temperature according to the pipe manufacturer's recommendation. The surface temperature of the heating tool plate should be measured periodically with a surface pyrometer prior to initial use and at reasonable time intervals thereafter.





## Setting up the unit

Connect the trimmer and the heater to the electric unit with the special connectors as shown in the image.



Connect the Electric Unit (Support) To the right power source and turn both switches on.



The green light is the desired temperature and the red light is the reached temperature.

Place the appropriate inserts for the pipe OD or the fitting being fused.



Make sure the blades of the trimmer are sharp.



Ensure the Teflon in the heater plate is in good condition.



## Temperature controller setting

- ▶ Switch on
- ▶ Press "SET" for more than 4 seconds until "Sd" is shown in the upper window
- ▶ Press "Δ" or "▽"key. Enter the setting temperature. Press "SET" to confirm

### Deviation correction of temperature control instrument

Switch on



Press "SET" for more than 3 seconds till "SI" is shown in the upper window



Press "SET" until "SC" is shown in the upper window



Press "Δ" or "▽"key, enter temperature correction value, press "SET" key to confirm



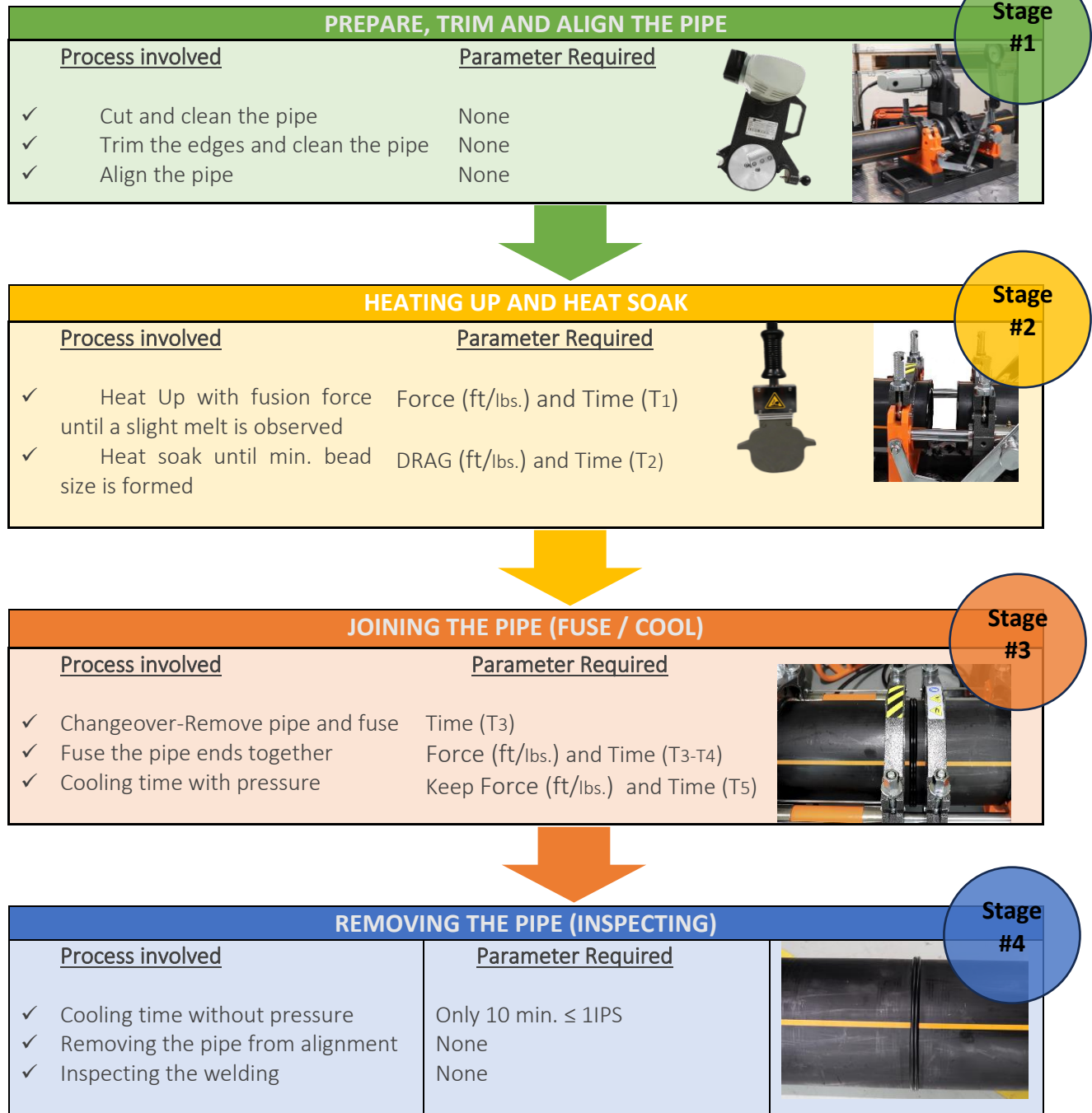
## Welding procedure

### Description of Method

The principle of Butt fusion is to heat to a designated temperature the ends of two thermos plastic pipes until a bead is formed, then fuse them together by application of a sufficient force or pressure. This force or pressure causes the melted materials to flow and mix, thereby resulting in fusion that is stronger than the pipe itself.

*The butt fusion procedure has 4 stages:*




**The Welding Parameters contains the amount of Pressure and Time to apply in each stage.** Obtain a copy of the pipe manufacturer's **Welding Parameters** for the appropriate joining standard for the pipe being fused. Follow the procedure carefully and adhere to all specified parameters. Failure to follow the pipe manufacturer's fusion procedures or appropriate joining standard could result in a bad fusion joint



## Step by step welding procedure

### Stage #1: PREPARE, TRIM AND ALIGN THE PIPE

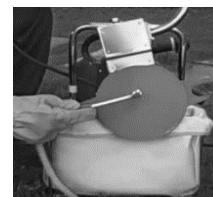
Place pipe support stands at both ends of the butt fusion machine and adjust the support stands to align the pipe with the fusion machine centerline. Install the pipes or fittings being joined in the stationary and movable clamps of the butt fusion machine. Leave enough pipe protruding through the clamps to allow for facing and clamp the pipe or fitting in the machine.

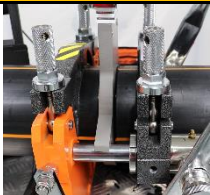


Cut and Clean	Trimming pipes	Alignment
 <p>Cut the pipe and clean the inside and outside of both ends of the pipes with a clean lint-free dry cloth. Remove all dirt from the clamps surfaces where the pipes will be clamped in the butt fusion machine.</p>	 <p>Face the pipe ends until the trimmer bottoms out on the stops and is locked between the clamps to establish clean, parallel mating surfaces between the pipe ends. Open the clamps, remove the trimmer and clean the inside and outside of both ends of the pipes with a clean lint-free dry cloth.</p>	 <p>Check the pipe ends for high low alignment and out-of-roundness. If adjustment is needed, adjust the high side down by tightening the high side clamp. Do not loosen the low side clamp or slippage may occur during fusion. Re-face the pipe ends if excessive adjustment is required and remove any dirt with a clean, lint-free cotton cloth. The maximum OD high-low misalignment allowed in the butt fusion procedure must be less than 10% of the pipe minimum wall thickness.</p>

### Stage #2: HEATING UP AND HEAT SOAK




**Preheat:** Verify that the heater surface temperatures are in the specified temperature range according to the standard. ASTM F 2620-13 (204-232°C / 400-450°F). Please follow pipe manufacturer's procedure. A pyrometer or other surface temperature measuring device should be used before the first joint of the day and periodically throughout the day to insure proper temperature of the heater plate. The thermometer on the electric box indicates internal temperature of the heater which varies from the actual surface temperature.

**NOTICE:** Incorrect heating temperature can result in questionable fusion joints.



Heat Up with force	Heat Soak	Change over
 <p>Bring the pipe ends into full contact with the heating tool at fusion force (ft/lbs.) for time (T1) until a slight melt is observed.</p>	 <p>Decrease the force at the DRAG (ft/lbs.) to start the Heat Soak. Maintain the contact with DRAG (ft/lbs.) (P2) for the Time (T2) until the Bead size (B) is within the recommended range.</p>	 <p>When the proper bead size is observed, quickly remove the heating tool and quickly inspect the pipe ends. The maximum time spent must be less than or equal to (T3).  Bring the pipe together and begin the next step. Joining the Pipe.</p>

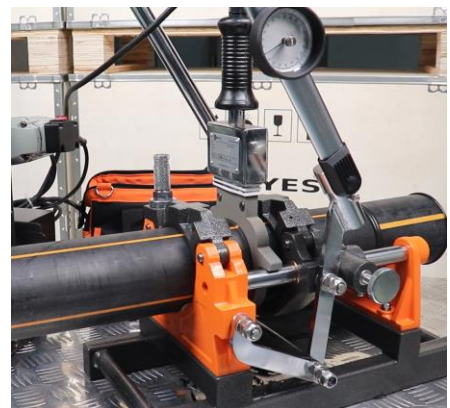
### Stage #3: JOINING THE PIPE (FUSE / COOL)

Fuse pipe together	Cooling with pressure	Cooling Without pressure
 <p>Close the clamps by bringing the pipe ends together. Raise the force gradually and steadily using the set time until a welding Force (ft/lbs.) is reached during the time (T4). Do not use excessive or insufficient force.</p>	 <p>Keep the pipes joined on the carriage aligner under the same fusion Force (ft/lbs.) during the cooling time (T5) until sufficiently cooled. Cooling under fusion Force (ft/lbs.) before removal from the butt fusion machine is important in achieving joint integrity.</p>	 <p>Once the cooling time with force has ended, decrease the force at contact force to 0. For ambient temperatures 100°F and higher, additional cooling time may be needed. <i>Pouring water or applying wet cloths to the joint to reduce cooling time is not acceptable.</i></p>

***A torque wrench can be used when a specified Interfacial Pressure is required.***

Hold this force for at least 10 seconds. After 10 seconds, the locking cams will assist by maintaining jaw position during the cooling cycle.

An interfacial pressure of 60 to 90 psi (0.41 to 0.62 Pa) is used to determine the force required to butt fuse the pipe components. Multiply the interfacial pressure times the pipe area to calculate the fusion force required (lb). For manually operated fusion machines, enough force should be applied to roll the bead back to the pipe surface. A **torque wrench** may be used to apply the proper force. Manual fusion **without a torque wrench** has been used successfully many times.



### Stage #4: REMOVING THE PIPE (INSPECTING)



#### Cooling time without force

(only 10 minutes additional cooling time is required for IPS 1 in. and smaller pipe sizes). Do not apply internal pressure until the joint and surrounding material have reached ambient air temperature.

#### Removing Pipe

After pipe has cooled sufficiently, apply closing force on the lever handle and push the locking cams down into the unlocked position. Unscrew the clamp knobs enough that they can be swiveled outward.

#### Inspecting

Visually check the entire joint. The joint should be smooth symmetry, and the bottom of groove between the beads should not be lower than the pipe surface. The misalignment of two beads should not exceed 10% of the wall thickness.

**NOTE:** Avoid high stress such as pulling, installation or rough handling for an additional 30 min or more after removal from the fusion machine (only 10 minutes additional cooling time is required for IPS 1 in. and smaller pipe sizes). Do not apply internal pressure.



[www.hayesfusion.com](http://www.hayesfusion.com)

## Optional use of Torque Wrench

**SOLD SEPARATELY!**



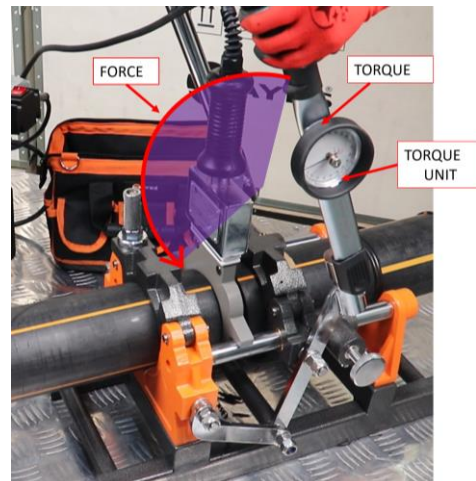
### Torque wrench

If a specified force is required in the fusion procedure, you must use a specialized torque wrench with the reading capacity to apply the proper force.

*“The torque wrench is an additional tool supplied by Hayes that measures the force applied over the pipe in the same direction when pushing or pulling”.*

### Torque units

The reading units shown in the torque could be in **ft·lb** (Pound · Foot) for the American System or **N·m** (Newton · meters) for the International System.



*Make sure you convert your units before using it to set any bearing preloads.*

### How to use a torque wrench?

Hayes has designed a special torque adapter for the machine.

1. Place the **adapter** into the handle socket and tighten it with the screw provided.
2. Insert the **torque wrench** into the adapter head and tighten it with the screw provided.

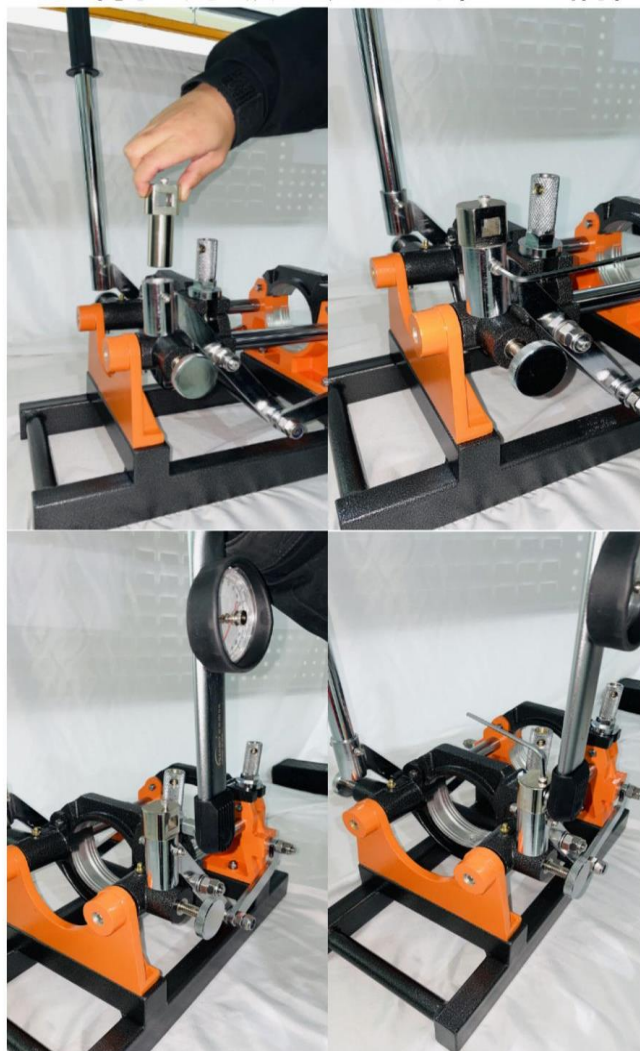
**NOTICE:** Using a different adapter or torque wrench may result in inappropriate forces and torque readings.

### Torque wrench readings

To apply the proper torque reading units ask for the **torque wrench readings Chart**.

**IMPORTANT:** Add the **DRAG** value (the force required to move the pipe at or near the point of fusion) to the overcome **FORCE** for the pipe to be fused and convert the pounds force to torque reading units to assure the proper joining force. This should be determined prior to inserting the heater.

**NOTICE:** Failure to follow pipe manufacturer's heating time, pressure and cooling time may result in a bad joint.



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COMBAT 4PROX

HOW TO CALCULATE FUSION FORCE – ASTM F 2620 (Manual Machine)			
HAYES COMBAT 4 PRO X			
<b>Welding ranges:</b>	1" 1-1/4" 1-1/2" 2" 2-1/2" 3" 4"		1 Mpa= 145 PSI = 10 Bar = 1 N/mm <sup>2</sup>
<b>Torque Wrench:</b>	16.33"	0-100 ft·lb	0-100N·m 415mm
<b>Voltage:</b>	110 V		1mm=0.1cm=0.03937In=0.001217In <sup>2</sup>
<b>Temperature:</b>	400 - 450 °F		1mm <sup>2</sup> = 0.01 cm <sup>2</sup> = 0.00155 In <sup>2</sup>
<b>IFP:</b>	75	PSI	0.52 Mpa
<b>AMERICAN STANDARD ASTM F2620</b>			
FORMULAS AND DEFINITIONS			
FORCE = IFP x AP + DRAG			
<b>IFP</b> Interfacial Pressure <b>Ap</b> Pipe Area = (OD – T) * T * π <b>T</b> Thickness = OD/SDR <b>DRAG</b> Drag pressure - 30 PSI = 0.20 Mpa <b>PSI</b> = lbf/in <sup>2</sup> π / Pi = 3.14		<b>ND</b> = Nominal Diameter <b>OD</b> = Outside Diameter <b>DIN</b> = Internal Diameter <b>SDR</b> = Standard Dimensional Ratio <b>PN</b> = Nominal Pressure	
<u>CALCULATING...</u>			
<b>Pipe size</b>	4	Inches	
<b>SDR</b>	11		
<b>OD of</b>	4	<b>4.50</b> In.	= 114.30 mm
<b>T = OD/SDR =</b>		$\frac{4.50 \text{ In.}}{11.00}$	<b>T = 0.40909</b> In.
<b>Ap = (OD – T) * T * π =</b>	4.50"	-	0.409 x 0.409 x 3.14
<b>Ap =</b>	<b>5.25</b>	In <sup>2</sup>	
<b>FORCE = IFP x AP + DRAG</b>		IFP = 75 PSI	DRAG = 30 PSI
	75 $\frac{\text{lbs}}{\text{in}^2}$	x	5.25 $\frac{\text{in}^2}{\text{in}^2}$
		+	30 $\frac{\text{lbs}}{\text{in}^2}$
<b>FORCE =</b>	<b>394.12</b>	lbs	+ DRAG (30 PSI) measured in ft-lbs

**NOTE:** This formula and calculation are based in the ASTM F 2620 American Standard for HDPE pipe using IFP 75 PSI. For the European Standard the IFP recommended is 21.75 PSI or 0.15 Mpa or 0.15 N/mm<sup>2</sup>.

The **Fusion Force** in the manual machines is calculated in lbs. as the pound of force, in the example above a 4" IPS pipe SRD 11 need 394.12 **pound-force** (symbol: **lbf**, sometimes **lb f**)

When using a **torque wrench**, you must convert the **pound-force** to **Torque units**.

The reading units shown in the torque dial is shown in ft·lb (Pound · Foot) for the American System or N·m (Newton · meters) for the International System.

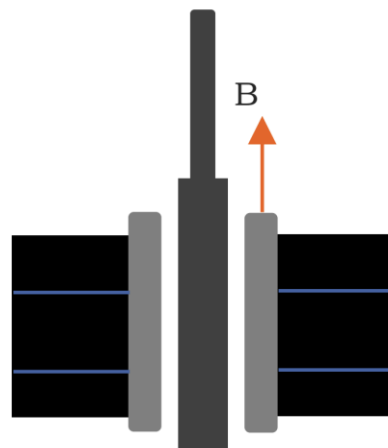
To apply the proper torque reading units ask for the [torque wrench readings Chart](#).

**Make sure you convert your units before using it to set any bearing preloads.**

## Glossary of terms

### Welding terminology

T = Time  
P = Pressure  
B = Bead size



### Pipe terminology

ND = Nominal Diameter  
DIN = Internal Diameter  
OD = Outside Diameter  
T = Thickness  
PN = Nominal Pressure  
SDR = Standard Dimensional Ratio

*Relation between the Outside diameter and Thickness of the wall*

### Temperature terminology

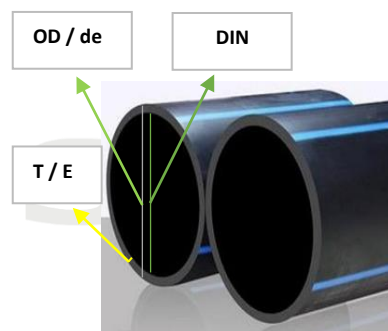
Celsius to Fahrenheit

$1^{\circ}\text{C} = 33.8^{\circ}\text{F}$

$1^{\circ}\text{F} = -17.22^{\circ}\text{C}$

$\Delta^{\circ}\text{F} = (\text{X}^{\circ}\text{C} * 9/5 + 32) = ^{\circ}\text{F}$

$\Delta^{\circ}\text{C} = (\text{X}^{\circ}\text{F} - 32 * 5/9) = ^{\circ}\text{C}$



### Fusion Force terminology (Manual Machines)

Pound-force = lbf, sometimes lb f

Pound · Foot = ft·lb

Newton · meters = N·m

Torque wrench = measures the force applied over the pipe in ft·lb or N·m

### Pressure terminology (Hydraulic Machines)

PSI = Pound square inches

MPa = Mega Pascal

1 MPa = 10 Bar = 145 PSI =  $1 \text{ N/mm}^2 = 100 \text{ N/cm}^2$

1 In<sup>2</sup> = 6.4516 cm<sup>2</sup>

1 cm<sup>2</sup> = 100 mm<sup>2</sup> = 0.155 In<sup>2</sup>

1 mm<sup>2</sup> = 0.01 cm<sup>2</sup> = 0.00155 In<sup>2</sup> = 0.00001076 Ft<sup>2</sup>

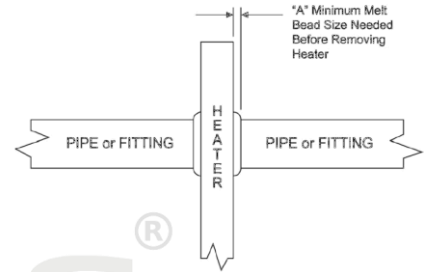
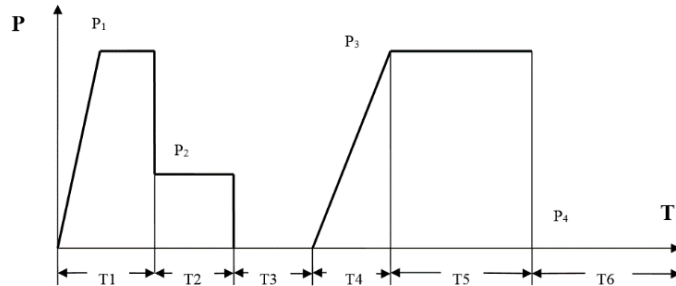


# Reference Welding Standard

According to the ASTM F 2620 (United States)



Pipe and fitting manufacturers have established qualified fusion procedure which should be followed precisely. You should obtain a copy of the pipe manufacturer's fusion procedures or appropriate joining standard for the pipe being fused. Follow the procedure carefully and adhere to all specified parameters.



TEMPERATURE: 400 – 450 °F (204 – 232 °C)

IFP: 75 PSI = 0.517 MPa = 0.517 N/mm<sup>2</sup> = 5.17 Bar

DRAG: 30 PSI

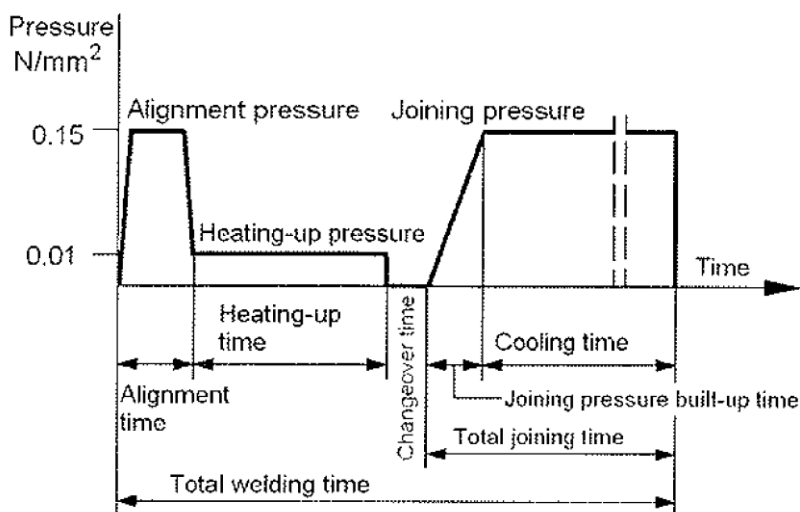
HEAT UP	HEAT SOAK		BEAD UP (MINIMUM BEAD SIZE)	
HEAT UP force P1	HEAT SOAK P2	Time T2 (s)	If Outside Diameter in. (mm)	Min. Bead Size in. (mm)
IFP*Ap + DRAG	Drag 30 PSI	4.5 min (270 s) x 1" (25.4 mm) Wall Thickness (T)	< 2.37 (60)	1/32 (1)
<b>Time T1:</b> 10 s on 14 in. pipe and smaller			≥2.37 (60) < 3.5 (89) >3.5 (89) < 8.62 (219) > 8.62 (219) < 12.75 (324) > 12.75 (324) ≤ 24 (610) > 24 (610) < 36 (900) > 36 (900) ≤ 65 (1625)	1/16 (1.5) 3/16 (5) 1/4 (6) 3/8 (10) 7/16 (11) 9/16 (14)

CHANGEOVER (Heater Removal)		JOINING THE PIPE (FUSE / COOL)	
Wall Thickness in. / (mm)	Time T3 (s)	JOINING FORCE P3	Cooling under force Time T5 (m)
0 – 5	4	IFP*Ap + DRAG	11 min (660 s) x 1" (25.4 mm) Wall Thickness (T) For ambient temperatures 100°F and higher, additional cooling time may be needed.
0.20-0.36 (5-9)	8		
>0.36-0.55 (9-14)	10		
>0.55-1.18 (14-30)	15		
>1.18-2.5 (30-64)	20		
>2.5-4.5 (64-114)	25		
		<b>Time T4:</b> <i>T3 &amp; T4 is the max time allow Open/Close</i>	

P4 - T6 (Cooling force and cooling time without force)

# Reference Welding Standard

According to the DVS 2207-1 (European Standard)



TEMPERATURE: (200 – 220 °C) (392 – 428 °F)  
 IFP: 0.15 N/mm<sup>2</sup> = 21.76 PSI = 0.15 MPa = 15 Bar  
 DRAG: 0.01 N/mm<sup>2</sup>

HEAT UP	BEAD UP (MINIMUM BEAD SIZE)		HEAT SOAK	
HEAT UP FORCE	Wall Thickness (mm)	Min. Bead Size (mm)	HEAT SOAK FORCE	HEAT SOAK TIME 10 times the Wall Thickness pipe in seconds Time T2 (s)
Under Force: 0.15 N/mm <sup>2</sup>	...4.5	0.5	Under Force: ≤ 0.01 N/mm <sup>2</sup>	...45
	4.5 – 7	1.0		45 – 70
	7 – 12	1.5		70 – 120
	12 – 19	2.0		120 – 190
	19 – 26	2.5		190 – 260
	26 – 37	3.0		260 – 370
	37 – 50	3.5		370 – 500
50 – 70	4.0	500 – 700		

CHANGEOVER (Heater Removal)		JOINING THE PIPE (FUSE / COOL)		
Wall Thickness (mm)	Per Wall thickness (Max. time) Time T3 (s)	JOINING FORCE	Joining pressure build-up Time T4 (s)	Cooling Time Under Joining force Time T5 (m)
...4.5	5	Under Force: 0.15 ± 0.01 N/mm <sup>2</sup>  The areas to be weld should meet with a speed of nearly zero.	5	6
4.5 – 7	5 – 6		5 – 6	6 – 10
7 – 12	6 – 8		6 – 8	10 – 16
12 – 19	8 – 10		8 – 11	16 – 24
19 – 26	10 – 12		11 – 14	24 – 32
26 – 37	12 – 16		14 – 19	32 – 45
37 – 50	16 – 20		19 – 25	45 – 60
50 – 70	20 – 25	25 – 35	60 – 80	

## HDPE Thermoplastic pipe sizes IPS DIPS mm Chart Conversion

Nominal Pipe Size IPS (Known as Inches)	Real Size Outside Diameter (OD) (Inches)	Real Outside Diameter (OD) (mm) 1 Inch = 25,4 mm	Closer Metric Pipe size or (mm) (Not the same)	Real Size Outside Diameter (OD) (mm)
1/2" IPS	0,84"	21,34 mm	20 mm	20.3
3/4" IPS	1,05"	26,67 mm	25 mm	25.3
1" IPS	1,32"	33,40 mm	32 mm	32.3
1-1/4" IPS	1,66"	42,16 mm	40 mm	40.4
1-1/2" IPS	1,90"	48,26 mm	50 mm	50.5
2" IPS	2,38"	60,33 mm	63 mm	63.4
3" IPS	3,50"	88,90 mm	90 mm	90.6
4" IPS	4,50"	114,30 mm	110 mm	110.7
6" IPS	6,63"	168,28 mm	160 mm	161
8" IPS	8,63"	219,08 mm	200 mm	201.2
10" IPS	10,75"	273,05 mm	250 mm	249.7
12" IPS	12,75"	323,85 mm	315 mm	314.6
14" IPS	14,00"	355,60 mm	355 mm	354.2
16" IPS	16,00"	406,40 mm	400 mm	399.3
18" IPS	18,00"	457,20 mm	450 mm	449.9
20" IPS	20,00"	508,00 mm	500 mm	499.4
22" IPS	22,00"	558,80 mm	550 mm	563.4
24" IPS	24,00"	609,60 mm	600 mm	629.2
25" IPS	25,00"	635,00 mm	630 mm	633.8
28" IPS	28,00"	711,20 mm	700 mm	
32" IPS	32,00"	812,80 mm	800 mm	807.2
36" IPS	36,00"	914,40 mm	900 mm	908.1
42" IPS	42,00"	1066,80 mm	1000 mm	1009
48" IPS	48,00"	1219,20 mm	1200 mm	

## Cold weather procedures

- ✓ When the ambient temperature becomes colder, it will require a longer heating time to develop an indication of melt and the final bead size. The pipe wall thickness and pipe diameter are primary factors to consider when determining the necessary heating cycle time.
- ✓ The heating plate temperature range shall not be exceeded to accommodate cold weather conditions. That could drastically damage the heating iron, ruin the pipe and it also can cause an undesired accident.
- ✓ **Do not apply additional force** during the heat soak to accommodate cold weather conditions
- ✓ Cold Ambient Temperatures below -4°F (-20°C) is generally not recommended without special provisions such as a portable shelter or trailer or other suitable protective measures with auxiliary heating.
- ✓ **Wind**— Exposure of the fusion heater plate and pipe to wind can result in unacceptable temperature variations during butt fusions and possible joint contamination. When extreme wind conditions exist, the provision of a suitable shelter is required to protect the pipe and fusion heater plate to ensure a more consistent environment is provided.
- ✓ The fusion operator shall be aware of ambient weather conditions to make adjustments to the fusion procedure, these modifications require validation through the production of test fusions and their assessment by comparison to visual guidelines and bend testing.

### Quality welding assurance recommendations

#### Butt Fusion of different wall thicknesses:

The butt fusion procedure is based on joining piping components (pipes and fittings) having the same outside diameter and the same wall thickness (the same SDR) per ASTM or other industry product specifications. Try to butt fusion pipes and fittings that have the same outside diameter but different wall thickness is not recommended.

The quality of butt fusion joints made between pipes of unlike wall thickness is highly dependent on the performance properties of the thermoplastic material used for the pipes or fittings being joined. Consult the pipe or fitting manufacturer for applicable butt fusion procedures for components with dissimilar wall thicknesses.

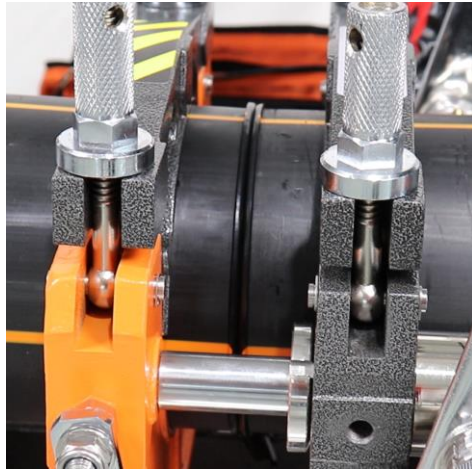
#### The correct fusion pressure:

Follow the fusion pressure parameters. If the ends of the pipes (fittings) are brought together with excessive force, molten material may be pushed out of the joint and cold material brought into contact forming a “cold” joint. If too little force is used, voids and weak bonded areas can develop in the joint as molten material cools and contracts.

# Butt fusion visual appearance guideline

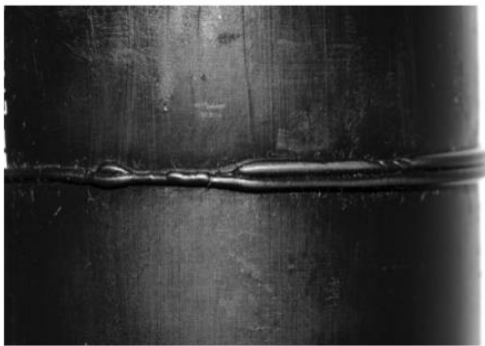
Reference: ASTM F 2620

## ACCEPTABLE VISUAL APPEARANCE



Proper double roll-back bead.  
Proper alignment.

## UNACCEPTABLE VISUAL APPEARANCE



Incomplete face-off.



Improper alignment in fusion machine—mitered joint.



"high-low" pipe alignment.  
Visually mitered joint.



Contamination in joint.

Improper

# Recommendations

## Preventative Maintenance

The Hayes manual COMBAT PROX series butt fusion machines will give many years of service if operation procedures and maintenance are followed carefully and correctly.

### PROPERLY HANDLE ELECTRICAL CORDS

- ✓ Yanking or pulling on the cord instead of gently unplugging it can strain the cord's connections, leading to frayed wires, loose connections, or even short circuits. This can result in costly repairs or the need to replace damaged equipment.
- ✓ Following safe handling techniques ensures personal safety and device longevity.
- ✓ Regularly inspect and maintain electrical cords to prevent accidents. Avoid overloading outlets, protect cords from damage, and keep them away from moisture, children, and pets.
- ✓ Hold the plug firmly, making sure to grip it by the insulated portion. Avoid pulling on the cord itself, as this can strain the connections and potentially damage the cord and the plug.

### STORE

- ✓ Keep the machine and all its components clean and well maintained to ensure the best performance.
- ✓ Store machine inside, in a dry cover area, out of the element of the weather.

### CLEAN AND DRY

- ✓ Clean the pipe alignment with a soap and water, wash as needed and keep it dry. Never pressure wash.
- ✓ Protect the heater, trimmer and the electric power unit from water and other chemicals agents.
- ✓ Keep the heater clean to avoid build-up plastic pipe residue, when cleaning the tool don't use an abrasive pad or steel wool. Use a non-synthetic cloth that won't damage or scratch surfaces.
- ✓ Keep the trimmer and its blades clean and lubricated for optimum performance.
- ✓ Make sure all the cables and connections are clean.
- ✓ Never allow dirt, water, or other foreign matter to enter the electric power unit.

### REMOVE DIRT AND LUBRICATE

- ✓ **Alignment:** Remove oily dirt buildup from guide rods and use WD-40 to lubricate it and wipe it. Do not leave the cleaning agent on the guide rods. Lubricate guide rod bushings with SAE 10W-40 motor oil through the oil holes on the movable jaw.
- ✓ Occasionally add a drop of oil to pivot pins and shafts.
- ✓ Wash and clean bearings and threads in kerosene or solvent and keep them lubricated.

### KEEP EVERYTHING NICE AND TIGHT

- ✓ Ensure all screws, nuts, bolts, and snap rings are secure and tight.

### ADJUSTING TEMPERATURE

Allow heater to stabilize at the new temperature (5 to 10 minutes) after adjusting.

## Machine Maintenance and Inspection

Part	Serial #	Details	Satisfactory or needs repair
Electric trimmer / Facer		Inspect the trimmer blades for damage and sharpness	
		Check cord, plug and sockets	
		Trimmer does not wobble when trapped between jaws	
		Check for loose pieces, screws and mechanical connections	
Teflon-coated heating plate		Check cord, plug and sockets	
		Heater surface is clean and the PTFE coat is in good condition	
		Surface temperature checked with pyrometer	
		Check for loose pieces, screws and mechanical connections	
Electric control unit / support		Check cord, plug and sockets	
		Check display indicator and connections	
		Check Contactors	
		Check Breakers	
		Check for loose pieces, screws and mechanical connections	
Pipe alignment carriage		Ensure clamp knob bearings are lubricated and move freely	
		Ensure the mobile handles aren't bend	
		Ensure all nuts and bolts are tight	
		Check guide rods condition	

***Make as many copies of this page as you need.***

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## DISCLAIMER OF LIABILITY

Hayes Industrial Solutions, Inc. accepts no responsibility of liability for fusion joints. Operation and maintenance of the product is the responsibility of operators. We recommend qualified joining procedures to be follow when using Hayes Industrial Solutions, Inc. equipment. Hayes Industrial Solutions, Inc. makes no further warranty of any kind whatever, express or implied; and all implied warranties of merchantability and fitness for a particular purpose which exceed the obligation are hereby disclaimed by Hayes Industrial Solutions, Inc.

**Remember your product information to activate your warranty.**

Model No: \_\_\_\_\_

Serial No.: \_\_\_\_\_

Inspector: \_\_\_\_\_

Date of the purchase: \_\_\_\_\_

Distributor: \_\_\_\_\_





## HAYES FUSION Quality Certificate

Hayes Industrial Solutions, Inc. is the Legal Company name of record for this information.

Dear Customer,

Your machine has been fully tested and inspected for quality assurance by our technical department.

- COMBAT4PROX # \_\_\_\_\_
- COMBAT6PROX # \_\_\_\_\_
- COMBAT8PROX # \_\_\_\_\_

This welding machine meets the Hayes Industrial Solutions, Inc. quality standards and is released for field use.

Date:

Signature: