Hypertherm®

Moving pierce technique

For HPR400XD™ and HPR800XD plasma cutting systems

White paper

Moving pierce technique (up to 4-inch stainless steel)

Pierce capacity can be extended by utilizing a technique known as "moving pierce." This technique combined with PowerPierce® technology has extended the stainless steel pierce capacity for the HPR800XD to 4 inches (100 mm) and for the HPR400XD to 3 inches (75 mm).

The torch lifter must have the capability to use transfer height, pierce height, and cut height settings along with cut height and automatic voltage control (AVC) delays. The cutting table and controller must be able to allow motion upon transfer. Hypertherm's EDGE® Pro controller (running Phoenix™ 9.72 or later), Sensor™ THC or ArcGlide® lifter, and ProNest® nesting software all support this technique with the provided parameters.

Basic description

Moving pierce (also known as a running pierce or flying pierce) is a technique that has been used by plasma operators for years in order to have their plasma systems penetrate thick plates without having to resort to other operations such as drilling.

The method of moving pierce described here utilizes a synchronization of torch lifter positioning, table motion, and plasma current ramping to achieve a relatively short pierce lead-in that directs the molten material to the side and away from the torch. At the same time, it keeps the torch as far away from the molten material as possible while also maintaining an arc voltage that the HPRXD power supply can sustain.

The basic process consists of combining motion during piercing to create a trough in the plate that can then be used as an evacuation channel for the molten material to be directed out of the deepening pierce "slot." The molten material is directed to the side of the torch in the opposite direction of the table motion, with the majority being deposited onto the top of the plate surface. Once the arc penetrates the plate the standard settings for cutting can be used.

Limitations, equipment, and safety hazards

Using this technique results in a "rooster tail" of molten material and hot gases that can cause personal injury, damage to equipment, and fires if proper precautions are not taken. Guards may be required to protect operators and to prevent the molten material from reaching any flammable materials (flammable materials should be kept away from plasma cutting operations). Moving pierce direction should be planned such that the molten material is not directed at the lifter, gantry, adjacent torches, controller, or other sensitive equipment.

Note: The moving pierce parameters in this document were developed using linear motion only.

Molten material accumulated on the plate can impact subsequent cutting paths, so you may be required to either carefully plan cutting paths that avoid the slag pile or to stop the cutting process (after the arc has penetrated the plate) to scrape the slag pile from the plate.

Lifter and table motion sequencing

During the moving pierce, both the torch height and the table motion are simultaneously controlled to optimize the thick plate piercing capability. The details for a typical pierce are listed in the following *Lifter sequence* and *Table motion sequence* sections.

Lifter sequence

Refer to Figure 1 for an illustration of the following sequence.

1. An initial height sense (IHS) is performed, and the torch is positioned at the **transfer height.**
2. The torch is started and transfers to the workpiece; current ramp-up begins.

3 After transfer, the torch quickly moves to the **pierce height**, and the table motion begins at the first speed programmed using an embedded "F" code. (See *Table motion sequence* on page 3.)

4 The torch is maintained at the **pierce height** until the **moving delay** has expired (percentage of the total pierce delay).

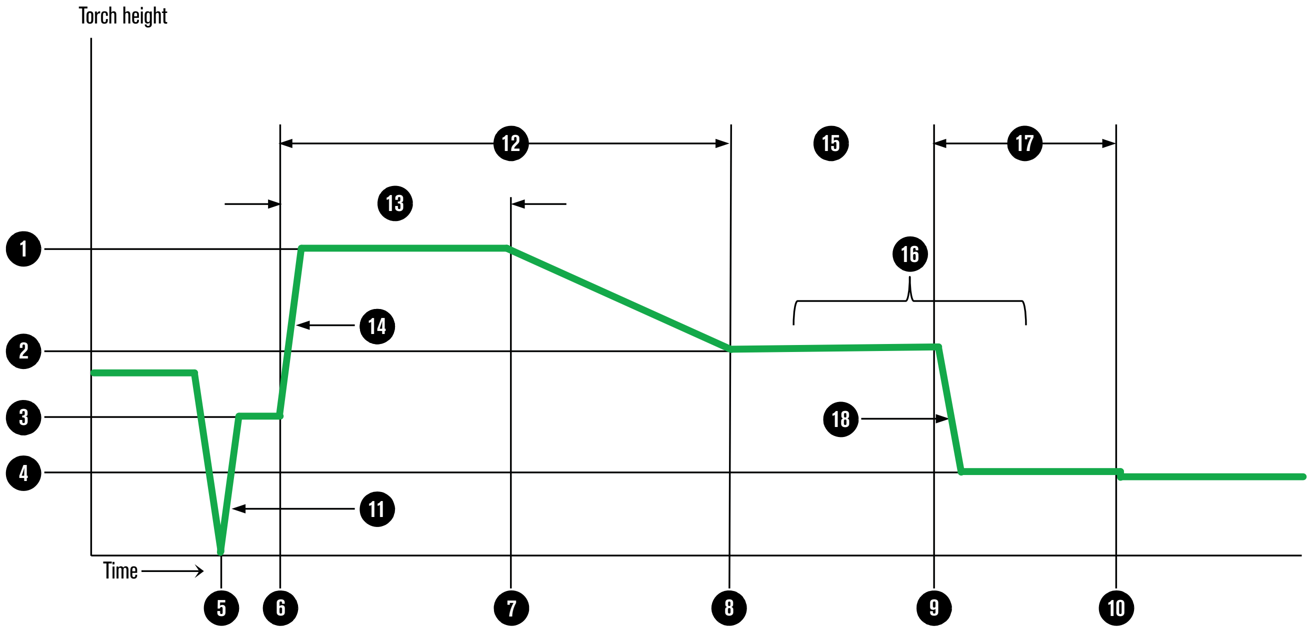
5 When the **moving delay** has expired, the torch will move to the **pierce end height**. This move is timed to arrive at the end height when the **pierce delay** has expired.

6 The torch will remain at the **pierce end height** for the duration of the **cut height delay**. When the **cut height delay** expires, the torch will move to the **cut height** and will remain at this height until the **moving pierce (MP) AVC delay** expires.

7 When the **MP AVC** delay expires, the arc voltage control will begin.

8 The contour cut of the part is completed.

Figure 1 – Moving pierce torch height timing diagram



1 Pierce height

2 Pierce end height

3 Transfer height

4 Cut height

5 Initial height sense

6 Arc transfer, motion begins, shield flow switches from preflow to cutflow (if preflow is lower than cutflow)

7 Torch begins to lower toward pierce end height

8 Torch reaches pierce end height as pierce delay expires

9 Torch lowers to cut height as cut height delay expires

10 AVC begins as MP AVC delay expires prior to starting cut

11 Move to transfer height

12 Pierce delay

13 Moving delay

14 Move to pierce height

15 Cut height delay

16 Arc penetrates plate in this region

17 MP AVC delay

18 Move to cut height

Table motion sequence

Refer to Figure 2 for an illustration of the following sequence.

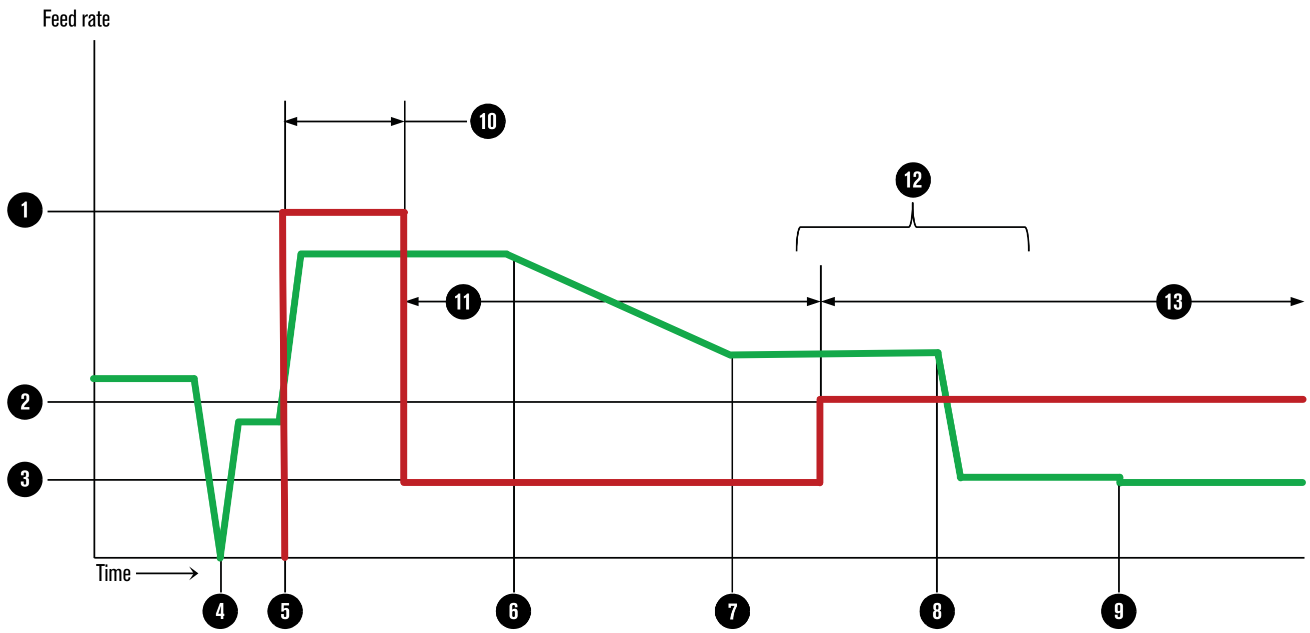
1 After transfer, the table motion begins for the first segment at a fast gouge speed (the first "F" code) for the required segment length necessary to establish the evacuation channel (or trough).

2 The second segment table motion begins at an intermediate speed (second "F" code) for the required segment length necessary to penetrate the plate.

3 The third segment of table motion begins at the programmed **cut speed**. The remainder of the cut is completed at this speed (third "F" code).

4 Finally, the contour cut of the part is completed.

Figure 2 – Moving pierce table motion timing diagram



1	Gouge speed	7	Torch reaches pierce end height as pierce delay expires
2	Cut speed	8	Torch lowers to cut height as cut height delay expires
3	Creep or intermediate speed	9	AVC begins as MP AVC delay expires prior to starting cut
4	Initial height sense	10	Establishes evacuation trough
5	Arc transfer, motion begins, shield flow switches from preflow to cutflow (if preflow is lower than cutflow)	11	Penetration of plate advances while molten material is evacuated via trough
6	Torch begins to lower toward pierce end height	12	Arc penetrates plate in this region
		13	Transition to cut speed as arc penetrates plate

Embedded part program parameters

If you are using the EDGE Pro controller, use the following list of parameters to control the moving pierce (MP) sequence.

Table 1 – Moving pierce (MP) embedded part program parameters

Parameter name	Embedded program code	Description
MP feed #1 - fast gouge	F45 G01 X0 Y1	Speed = 45 ipm (1143 mm/m) Move 1 inch (25 mm) Y axis
MP feed #2 - intermediate	F20 G01 X0 Y0.5	Speed = 20 ipm (508 mm/m) Move 0.5 inch (13 mm) Y axis
MP feed #3 - cut speed	F10 G01 X0 Y2.5	Speed = 10 ipm (254 mm/m) Move 2.5 inch (65 mm) Y axis
Transfer height factor	G59 V604 F300	Transfer height = 300% of cut height
Pierce delay	G59 V601 F8.0	Total pierce delay = 8.0 seconds
Moving delay (lifter)	G59 V610 F50	Percent moving delay = 50% of pierce delay
Pierce height factor	G59 V602 F500	Pierce height = 500% of cut height
Pierce end height factor	G59 V611 F250	Pierce end height = 250% of cut height
Cut height delay	G59 V605 F3.0	Cut height delay = 3.0 seconds
Cut height	G59 V603 F0.25	Cut height = 0.25 inches (6 mm)
MP AVC delay	M51T15	MP AVC delay = 4 seconds (the M51T value is the sum of MP AVC delay, cut height delay, and pierce delay)

Thick stainless steel moving pierce parameters

The following tables contain the moving pierce parameters (both English and metric) that have been developed for piercing up to 4 inches (100 mm) of stainless steel.

Table 2 – Thick stainless steel moving pierce (MP) parameters – English

Process	Thickness (inch)	Speed 1 (ipm)	Speed 2 (ipm)	Speed 3 (ipm)	Segment 1 (inch)	Segment 2 (inch)	Segment 3 (inch)	Transfer Height Factor (% Cut Height)	Pierce Delay (Seconds)	Percent Moving Delay (% Pierce Delay)	Pierce Height Factor (% Cut Height)	Pierce End Height Factor (% Cut Height)	Cut Height Delay (Seconds)	Cut Height (inch)	MP AVC Delay (Seconds)
800 A H35/N_2	4	40	6	11	2	1	1.5	150	6	50	475	275	8	0.5	2
400 A H35-N_2/N_2	3	45	20	10	0.998	0.417	2.5	300	8	50	500	250	3	0.25	4
400 A H35-N_2/N_2	2	45	15	20	0.75	0.417	1.5	300	4.8	50	500	250	0.5	0.25	5.7

Table 3 – Thick stainless steel moving pierce (MP) parameters – metric

Process	Thickness (mm)	Speed 1 (mm/m)	Speed 2 (mm/m)	Speed 3 (mm/m)	Segment 1 (mm)	Segment 2 (mm)	Segment 3 (mm)	Transfer Height Factor (% Cut Height)	Pierce Delay (Seconds)	Percent Moving Delay (% Pierce Delay)	Pierce Height Factor (% Cut Height)	Pierce End Height Factor (% Cut Height)	Cut Height Delay (Seconds)	Cut Height (mm)	MP AVC Delay (Seconds)
800 A H35/N_2	100	1016	152	279	50.8	25.4	38.1	150	6	50	475	275	8	12.7	2
400 A H35-N_2/N_2	75	1143	508	254	25.3	10.6	63.5	300	8	50	500	250	3	6.4	4
400 A H35-N_2/N_2	50	1143	381	508	19.1	10.6	38.1	300	4.8	50	500	250	0.5	6.4	5.7

Sample EDGE Pro code for 400 A – 3-inch (75-mm) stainless steel

The following sample code from a Hypertherm EDGE Pro CNC assumes the use of U.S. customary units (inches) and is intended to provide an example of the codes that may be used to perform a moving pierce on a 3-inch (75-mm) stainless steel plate at 400 A.

G99 X1 Y180 I0 J0	
G20	(select English units [inches])
G91	(incremental programming mode)
G43X0.265	(kerf value = 0.265 inches)
G41	(enable left kerf compensation)
G59 V502 F35	(plasma torch/consumable type)
G59 V503 F2	(material type)
G59 V504 F400	(current setting)
G59 V505 F23	(plasma/shield gas type)
G59 V507 F58	(material thickness)
G59 V600 F202	(arc voltage)
G59 V601 F8	(pierce delay)
G59 V602 F500	(pierce height factor)
G59 V603 F0.25	(cut height)
G59 V604 F300	(transfer height factor)
G59 V605 F3	(cut height delay)
G59 V610 F50	(moving delay = 50%)
G59 V611 F250	(pierce end height = 250%)
M07	(plasma start)
M51T15	(MP AVC delay = 4) (Add pierce delay, cut height delay, and AVC delay)
F45	(gouge speed)
G01 X0 Y.9975	(linear motion)
F20	(creep speed)
G01 X0 Y.4166	(linear motion)
F10	(cut speed)
G01 X0 Y2.5	(linear motion)
M08	(plasma stop)
G40	(disable kerf compensation)
M02	(end of program)

www.hypertherm.com

One of Hypertherm's long-standing core values is a focus on minimizing our impact on the environment. Doing so is critical to our, and our customers' success. We are always striving to become better environmental stewards; it is a process we care deeply about.

Greener Cuts™

807840

Hypertherm®

Cut with confidence®