Surface Tension Transfer GMAW-STT

Waveform Control Technology™

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Waveform Control Technology™

Surface Tension Transfer

- A modified short-arc process
- For welding root passes in pipe & plate
- Low Heat Input without lack of fusion
- Flexible; different materials & gasses possible
- Unique in the industry

Industry Segments

Markets where STT can be applied

- **Oil & Gas Industry**
- **Cross Country Pipelines**
- **Power Generation**
- **Chemical Industry**
- **Pulp & Paper Industry**
- **Food & Dairy Industry**








Applications with the STT process

Pipe Root-pass Welding

- Mild- & Fine Grained Steel
- Low Alloyed Steel
- Creep Resistant Steel
- Standard 3xx-series Stainless Steel
- Fully Austenitic Stainless Steel
- (Super)Duplex Stainless Steel
- Nickel Alloys

Base materials

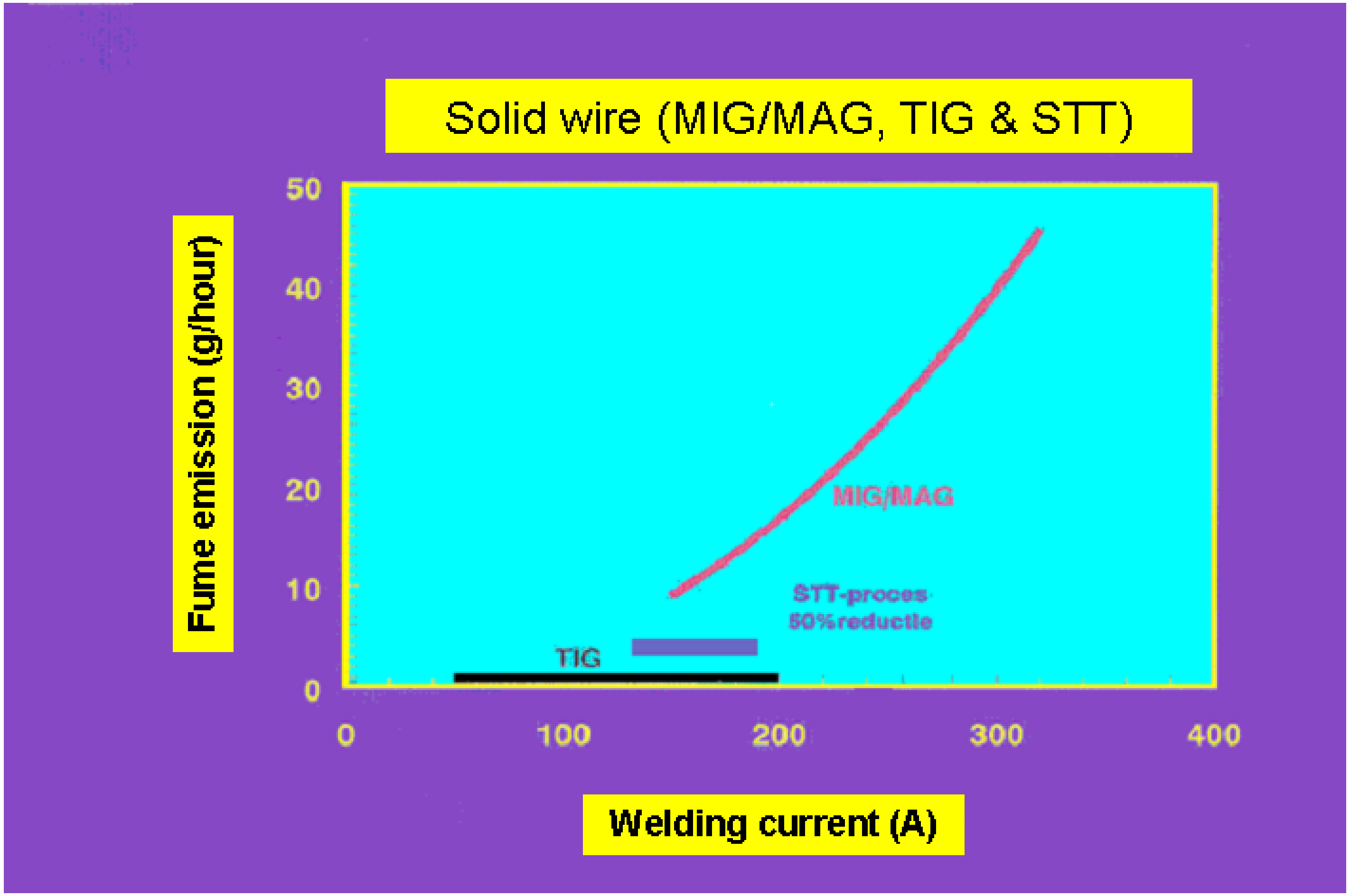
Root Welding Applications

The STT process can replace:

- **Conventional GMAW-Short Arc**
- **Conventional GTAW**

STT replacing short-arc GMAW

- **Eliminates lack of fusion**
- **Virtually eliminates spatter**
- **Good puddle control**
- **Consistent X-ray quality welds**
- **Shorter training time**
- **Low fume generation and low spatter**
- **Various composition of shielding gas**



STT: 50% reduction in fume emission versus conventional GMAW

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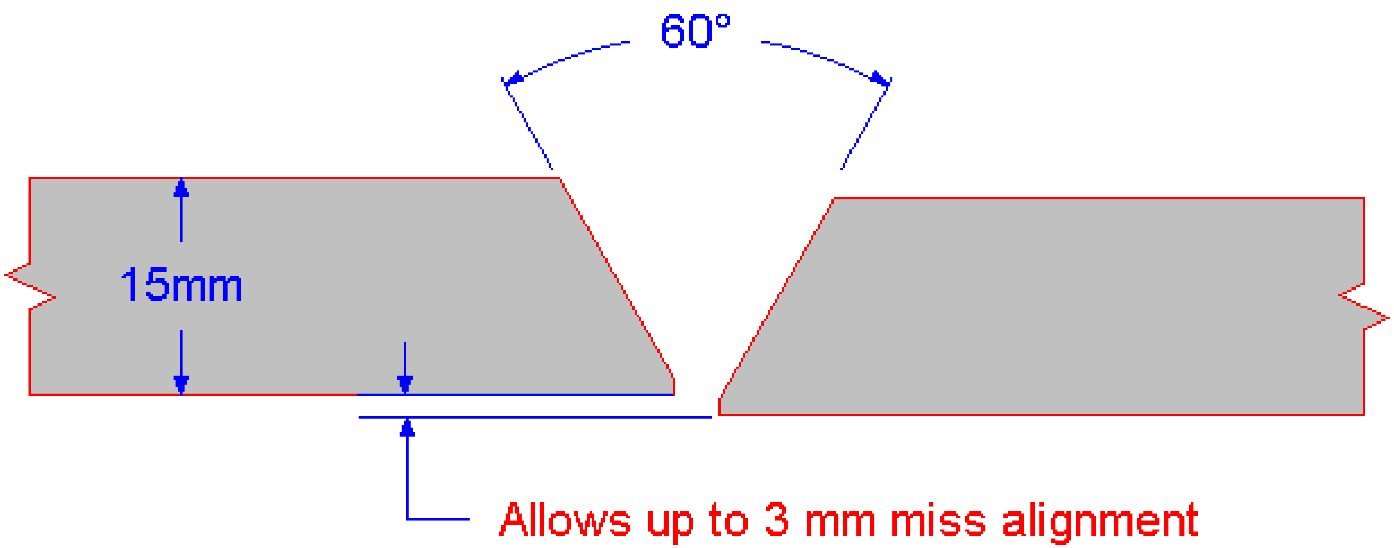
Low Spatter, Defect Free Rootpass

GMAW-Short Arc vs. GMAW-STT			
Conventional GMAW Short Arc		Surface Tension Transfer GMAW-STT	
Cause	Effect	Cause	Effect
Wire crashing in weld puddle	Spatter	Controlled shortening; current is reduced to 10 A for micro seconds when wire shorts in the puddle	Virtually No Spatter
Uncontrolled opening of the arc	Spatter	Controlled pinch effect; current is reduced to 50 A to allow gentle re-establishing of the arc	Virtually No Spatter
Uncontrolled supply of heat	Lack of Fusion	Controls heat supply through Plasma boost and background current energy	Defect Free

STT replacing GTAW

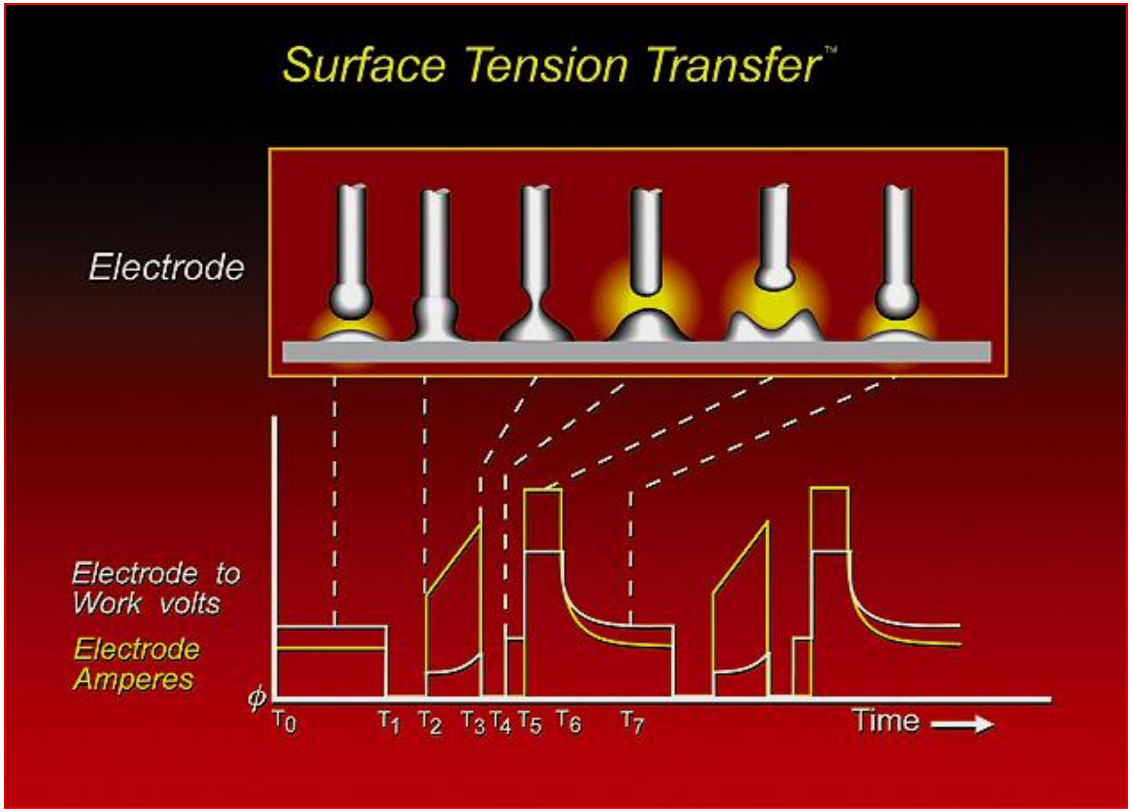
- Up to four (4x) times faster
- Shorter training time
- Low heat input (typical 0.5 - 1.1 kJ/mm)
- The STT rootpass is double the thickness of a GTAW
- Rootpass allows direct filling with SMAW, FCAW, SAW
  - Also allows a 50° bevel with SAW
- Various composition of shielding gas
- Allows poor fit-up (miss alignment)
- Consistent X-ray quality welds

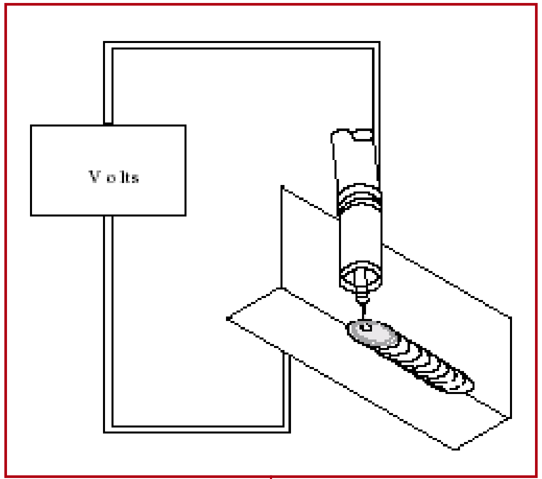
STT allows poor fit up



The STT® process

How does it work

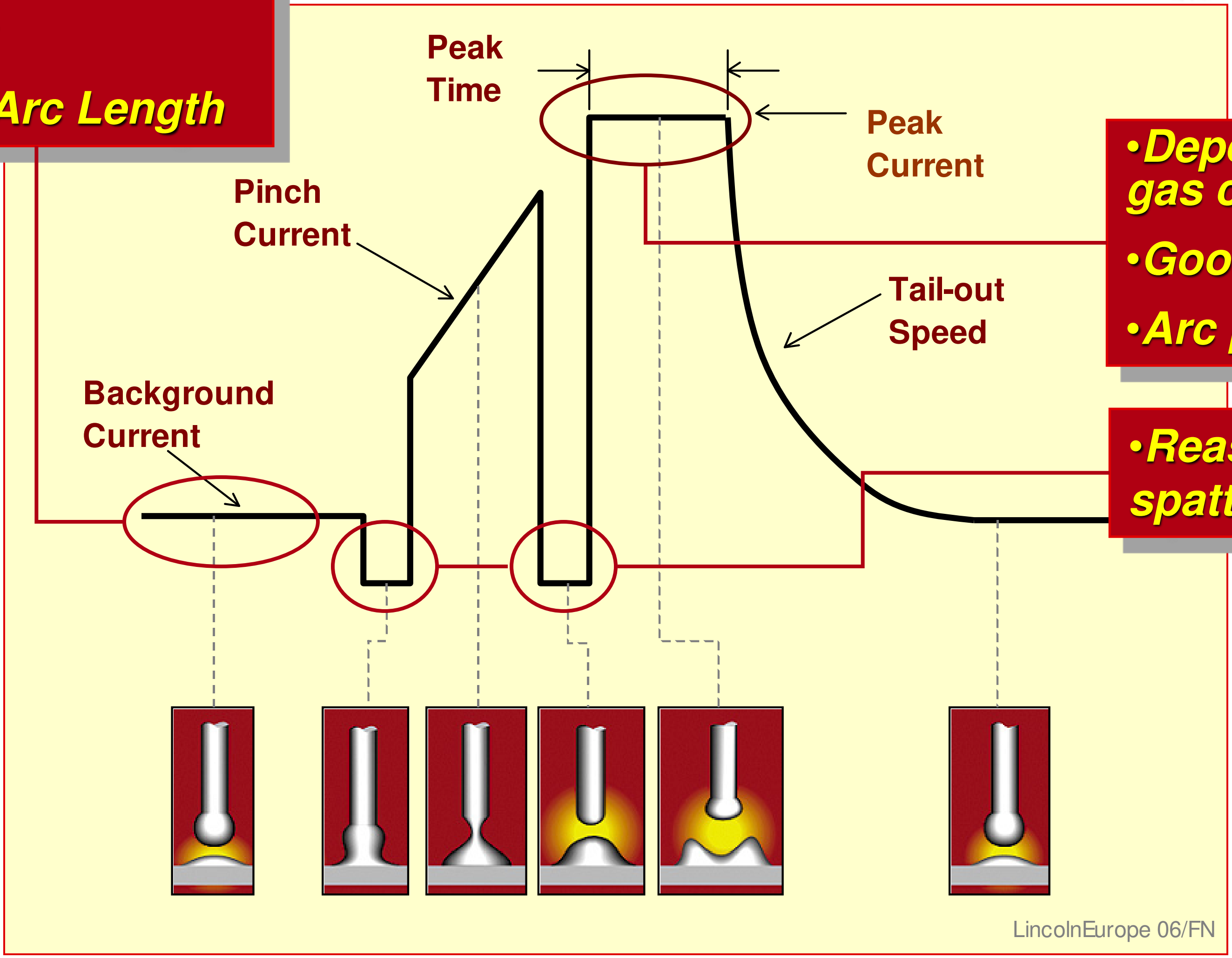




The Arc is monitored constantly

STT Principle

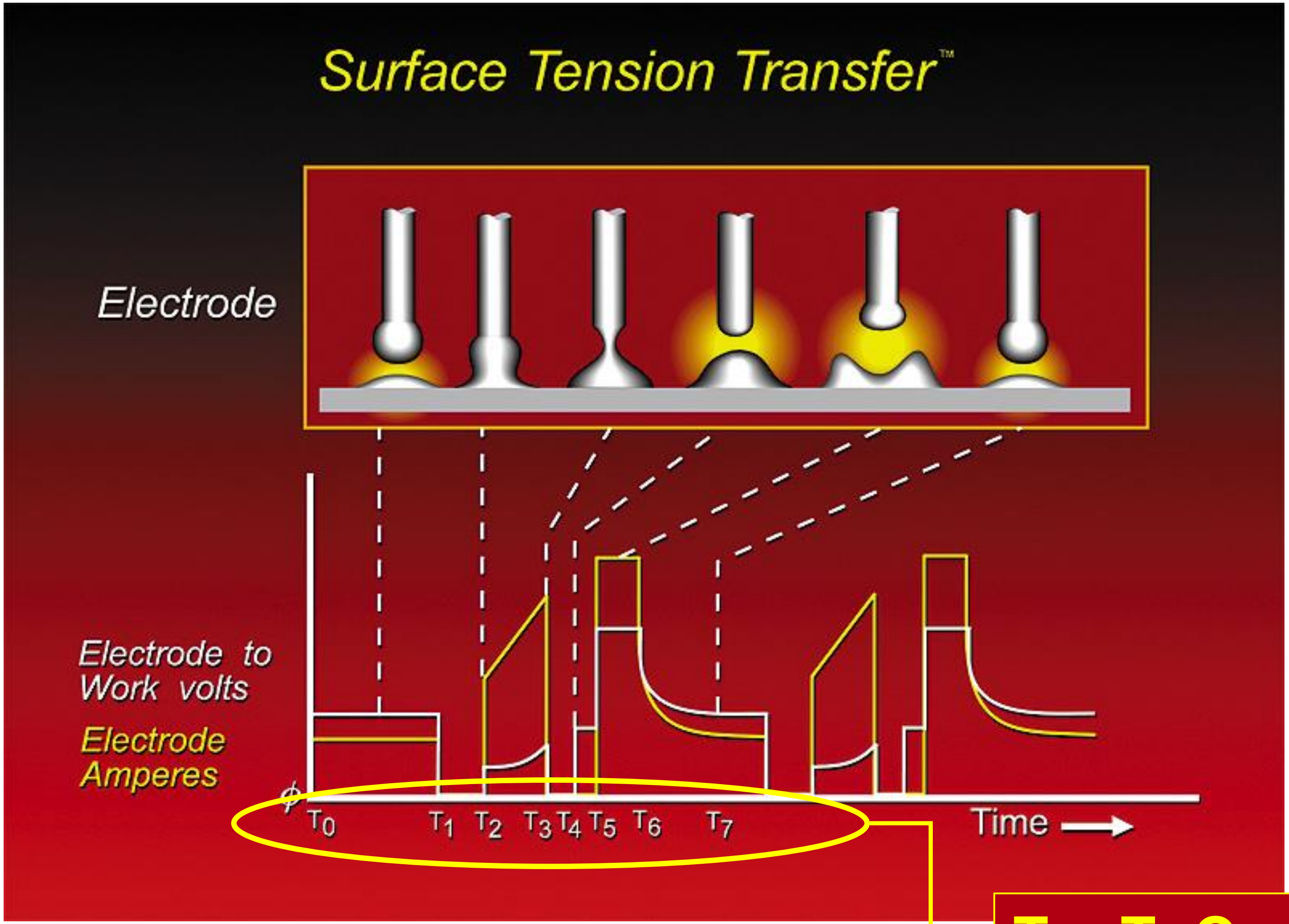
- *Overall heat supply*
- *Wetting*
- *Proper Arc Length*



- *Depends on wire gas combination*
- *Good fusion*
- *Arc pressure*

- *Reason for lower spatter with STT*

How does it Work



T_0 - T_7 One STT Cycle

One STT Cycle

1.) **Background current** (T_0 - T_1): This is the current level of the arc prior to shorting to the weld pool. It is a steady-state current level, between 45 and 100 A.

2.) **Ball time** (T_1 - T_2): When the electrode initially shorts (at the background current), the "arc voltage" detector provides a signal that the "arc" is shorted. The background current is futher reduced to 10 A for approxiametly 0.75 milliseconds. This time interval is referred to as the ball time.

3.) **Pinch mode** (T_2 - T_3): Following the ball time, a high current is applied to the shorted electrode in the form of an increasing, dual -slope ramp. This accelerates the transfer of molten metal from the electrode to the weld pool by applying electronic pinch forces.

(note that the electrode-to-work voltage is not zero during this period. This is due to the high resistivity of iron at its melting point of 1550° C)

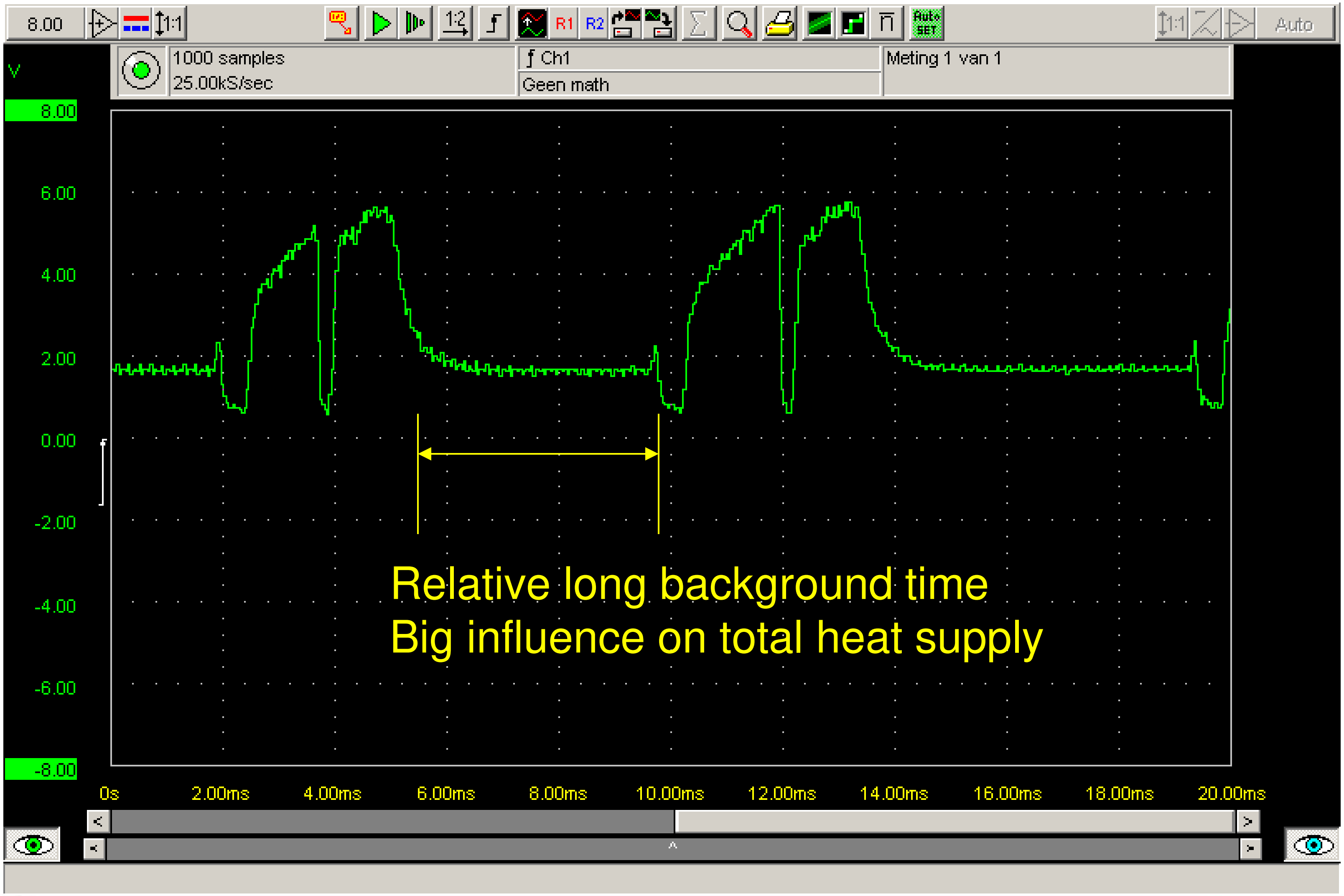
One STT Cycle

4.) **The dv/dt calculation** (T_2 - T_3): This calculation is included within the pinch mode. It is the calculation of the rate of change of the shorted electrode voltage vs. time. When this calculation indicates that a specific dv/dt value has been attained, indicating that fuse separation is about to occur, the current is reduced to 50 A in microseconds. (Note, this event occurs before the shorted electrode separates. T_4indicates the separation has occurred, but at a low current.

5.) **Plasma boost** (T_5 - T_6): This mode follows immediately the separation of the electrode from the weld pool. It is the period of high arc current where the electrode is quickly "melted back." (The geometry of the melted electrode at this point is very irregular.)

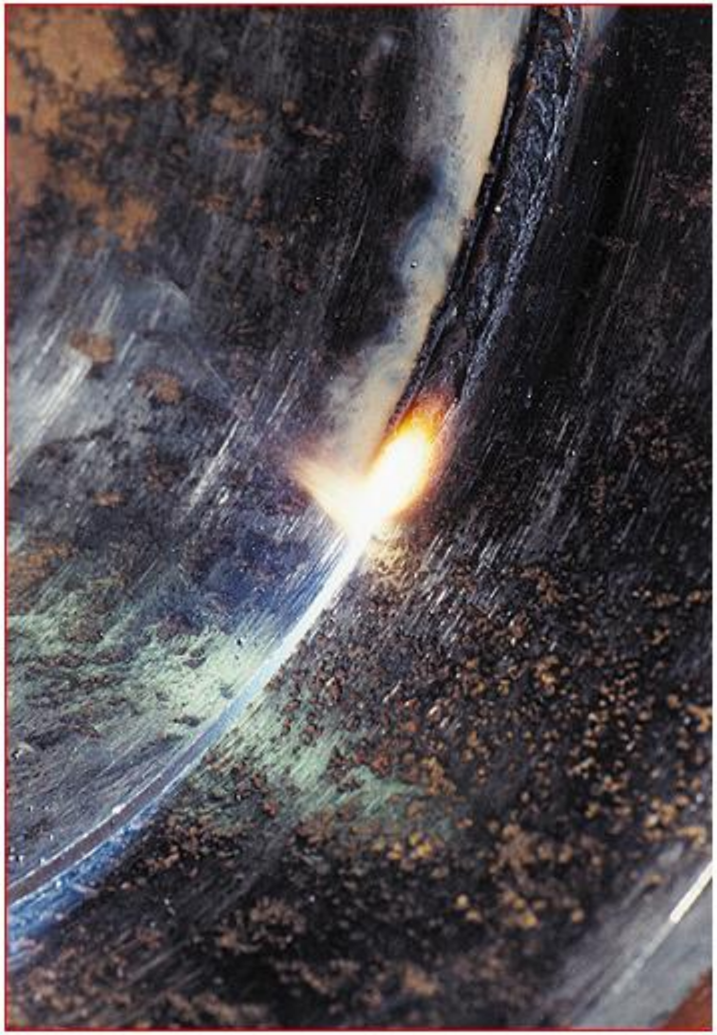
6.) **Plasma** (T_6 - T_7): This is the period of the cycle where the arc current is reduced from plasma boost to the background current level.

Actual Scope Image



STT Welding Parameter Setting

- ***Peak Current***
  - Provides arc pressure
  - depends on wire-gas combo
- ***Background Current***
  - Wetting
- ***Wire Feed Speed***
  - Controls Deposition Rate
- ***Tail-out***
  - Increases Power in the Arc



Current & Wire Feed Speed are controlled independently from each other

Function Background Current

- **To supply enough power to overcome radiation losses in order to maintain the fluidity of the molten drop on the end of the wire**
- **Plate heating is greatly affected by the level of background current.**
- **Determines arc-length at a set peak current.**

Function Peak Current

- **Provide heat into weld and plate to prevent lack of fusion <u>in combination</u> with background current**
- **Provides arc pressure**

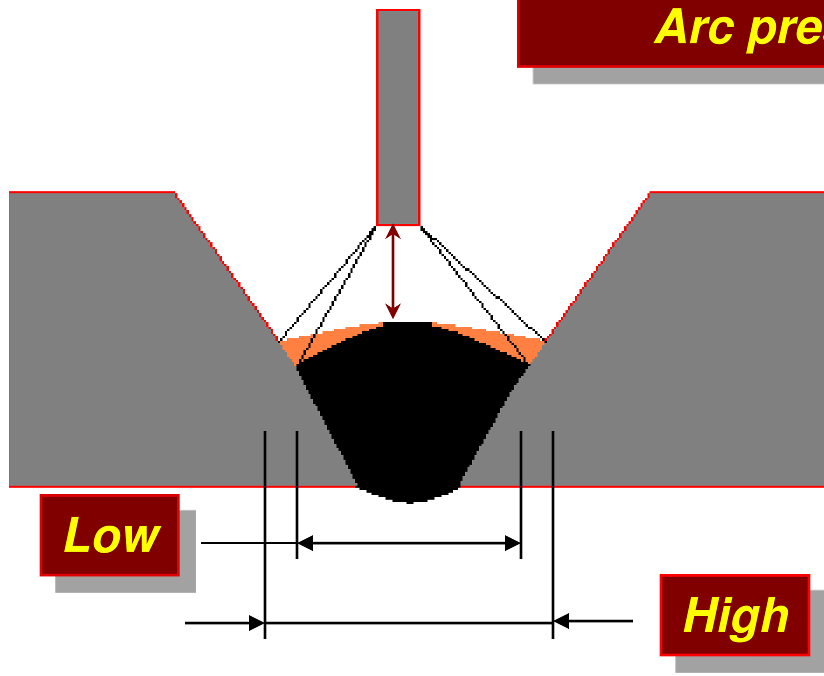
Peak current

- Setting depends on wire diameter and gas composition.
- Provides arc pressure

Peak current = Arc pressure

Back ground current

- Providing the “overall heat”
- More or less wetting.
- Most used control on the STT in combination with WFS.



Tail out

- In the same way as background: increases overall heat
- To be use with high travel speed
- In automation applications,not for pipe welding

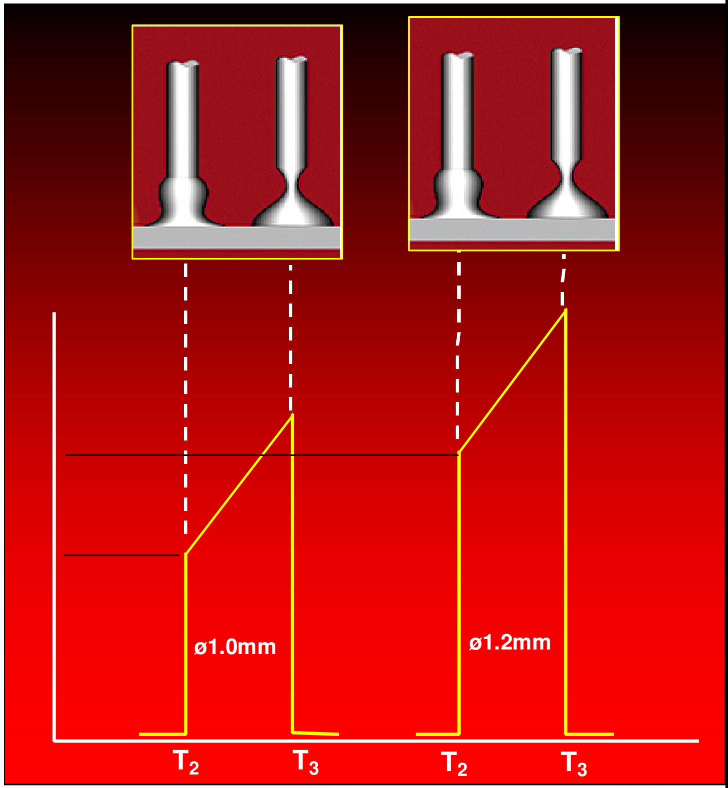
Back ground = Wetting

STT II Switch Options

Wire size

- **0.035" and smaller (1.0mm)**
- **0.045" and larger (1.2 mm)**

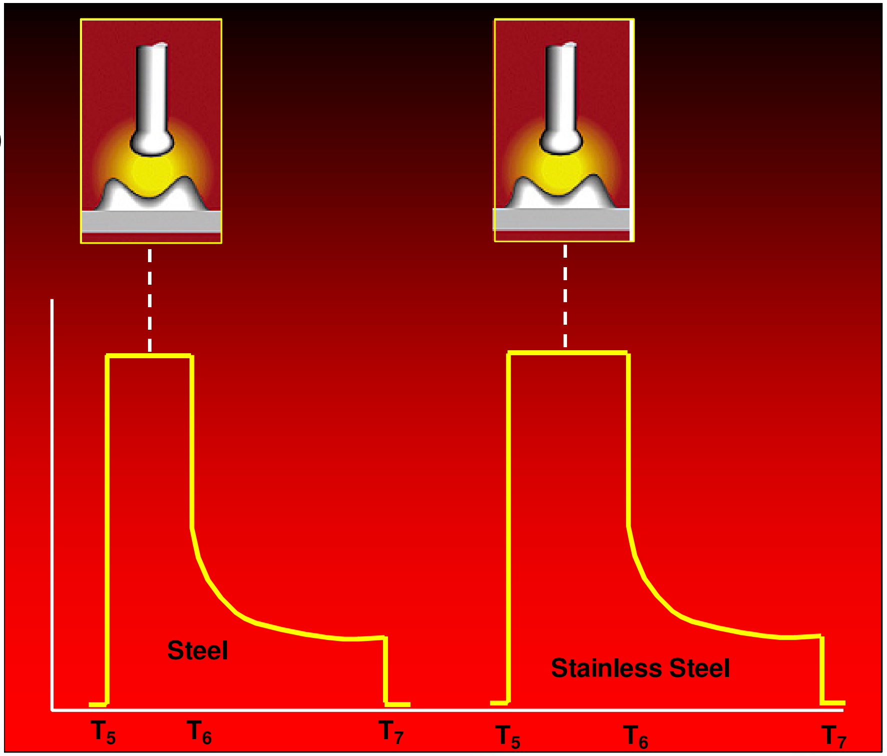
- **An ø 1.2 mm wire requires more energy before the pinch effect occurs compared to an ø1.0mm wire .**
- **The "1.0 - 1.2 mm" switch provides the proper energy level per diameter**
- **Flexibility: ø1.0mm suitable to cover all wall thicknesses.**
- **Optimum ligament: ø1.2mm**



STT II Switch Options

Wire type

- Steel
- Stainless Steel



- In the Stainless Steel mode the peak-time is approximately doub resulting in a lower frequency
- It is advisable to keep the STT II source in the Steel mode, even when welding stainless steel
- For manual applications the stainless steel mode is to hot.

Application

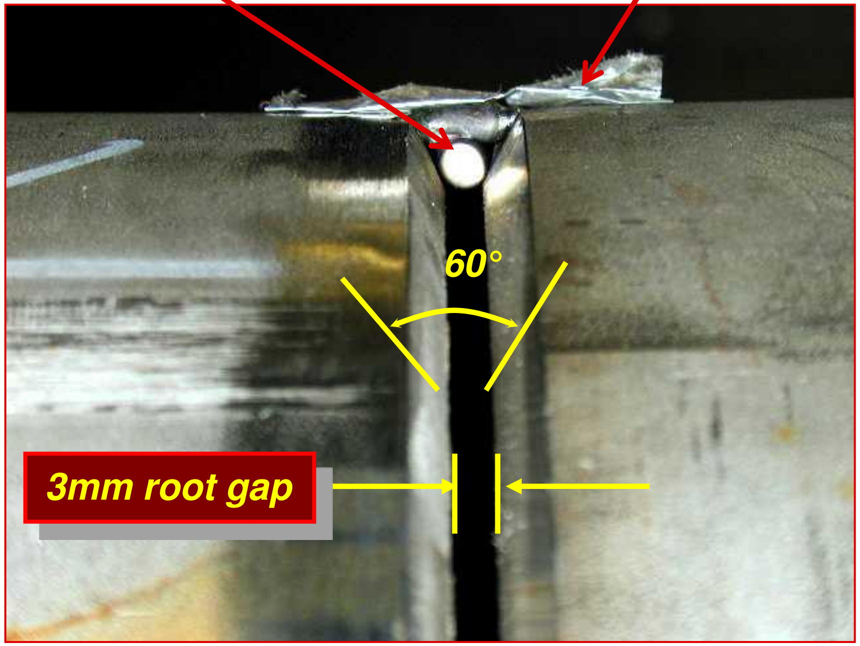
Pipe diameter: *10"x 8 mm*

Base material: *AISI 316L*

Position: *3G-down*

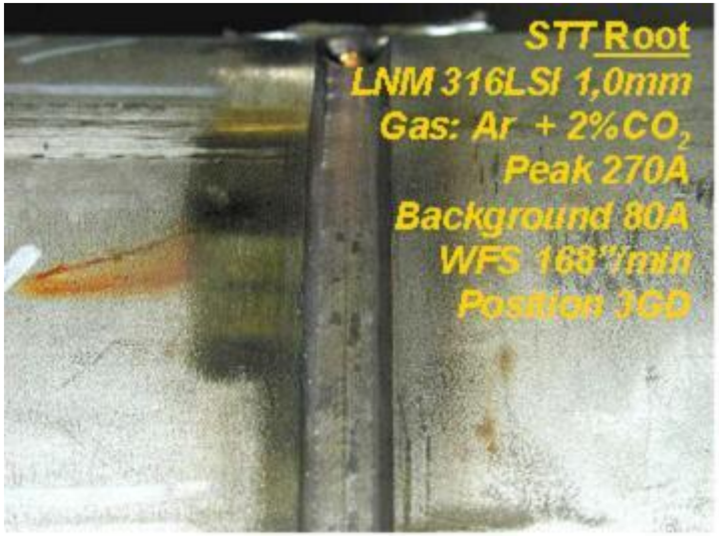
Shielding gas *Ar + 2% CO_2*

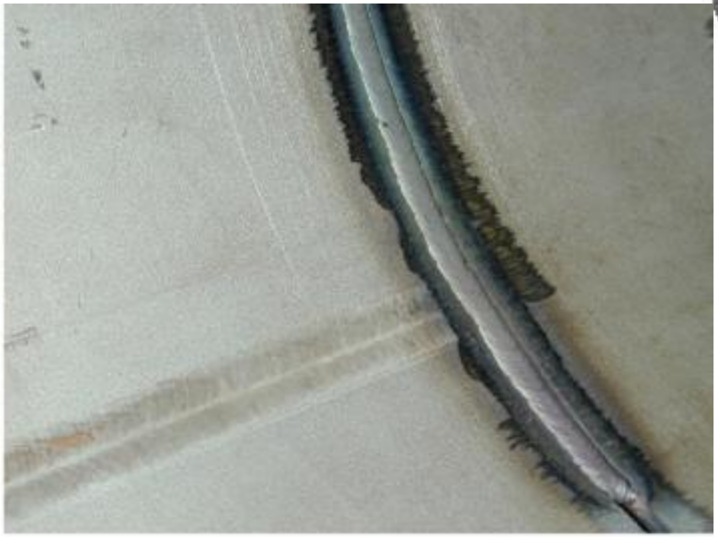
Backing gas: *95%Ar 5%H_2*

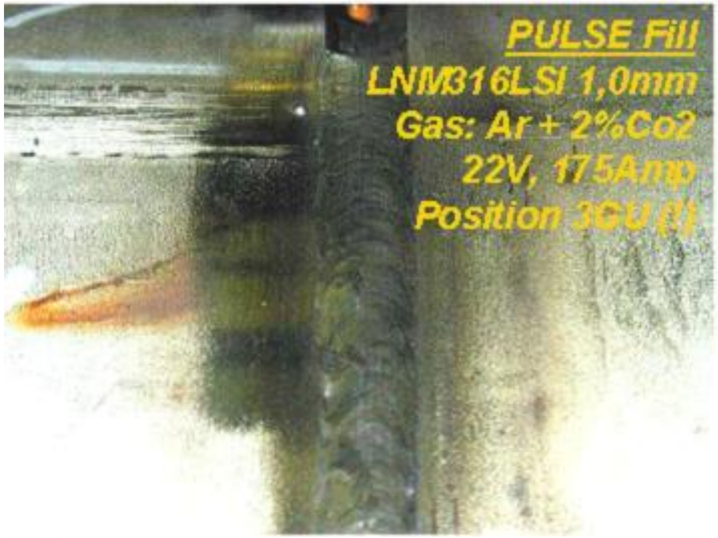


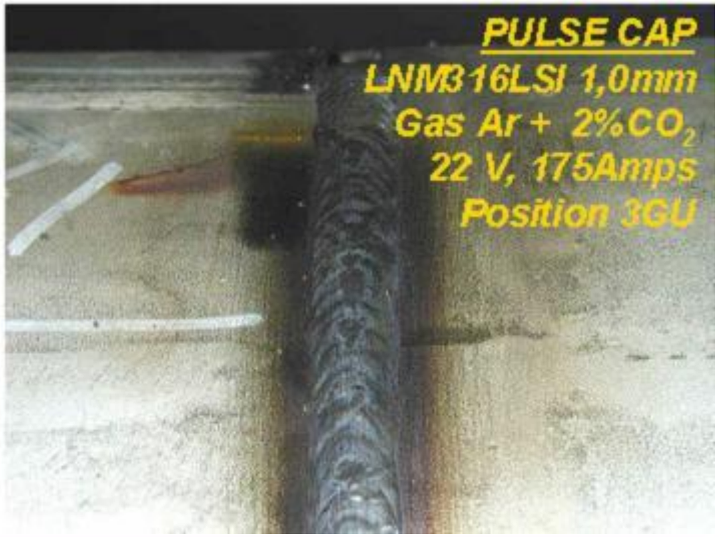
Application: Stainless Root Pass

Application
Stainless pipe





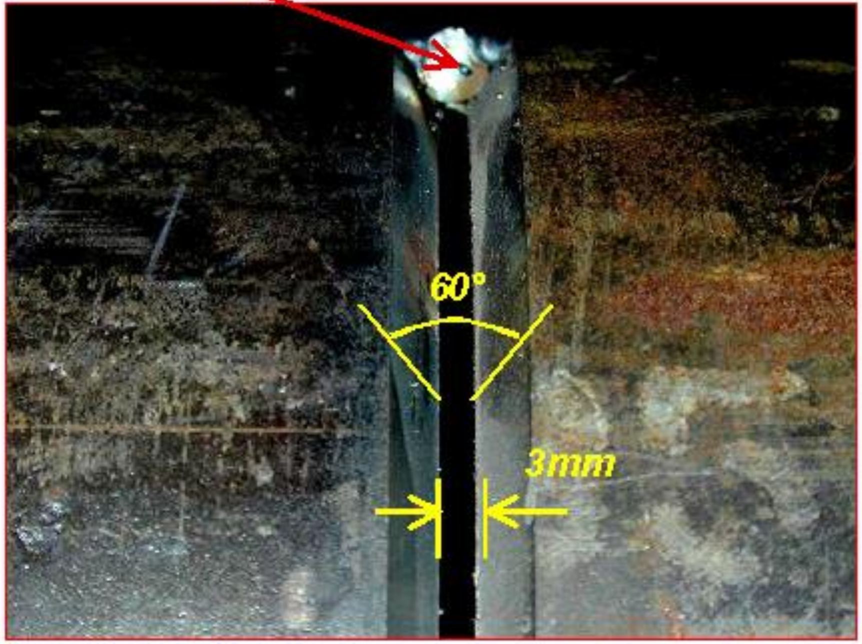




Application:

Pipe diameter: 6”x 10mm
Base material: X42
Position: G3(D)
Shielding gas: Ar + 20%CO_2
Backing gas: N.A.

Tack weld with bullet inside the joint



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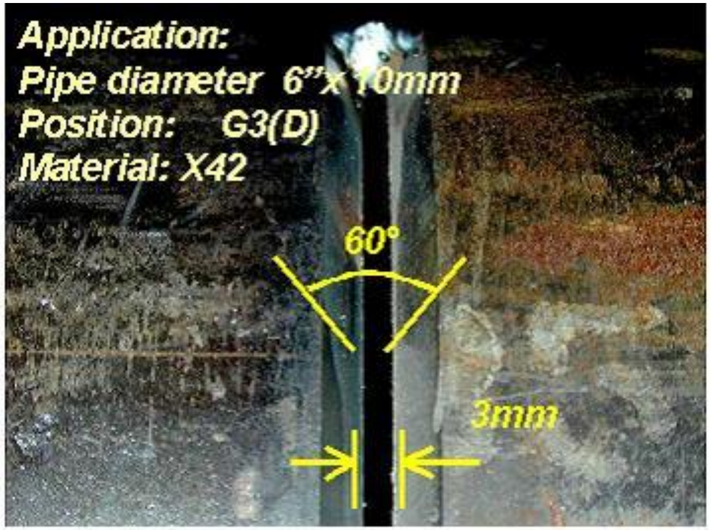
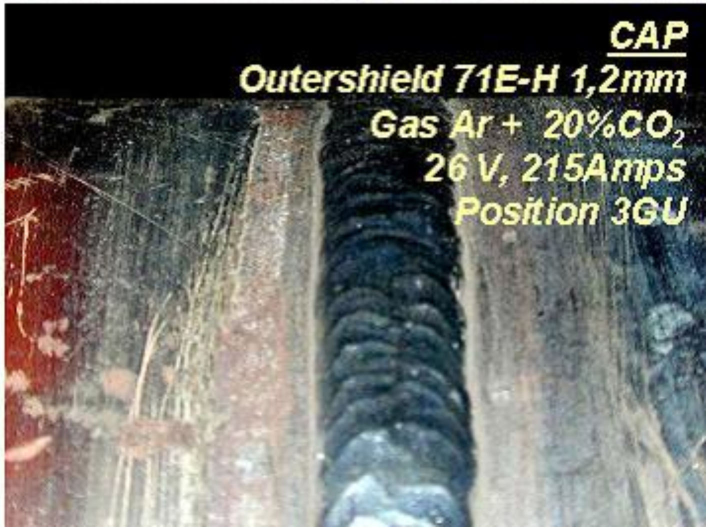
Application
Mild Steel

Application: Steel Root Pass





Calculating Heat Input

With the STT process, heat input is calculated consistent with the way it's calculated when the GMAW short-arc or GMAW-pulse is applied, using:

- ***Average Current***
- ***Average Voltage***

Both are displayed on the wire feeder

How To Calculate Heat-Input			
Process	*Parameters*		
GMAW Spray	Actual Current	Actual Voltage	Travelspeed
GMAW-Pulse	Average Current	Avergae Voltage	
GMAW Short-Arc			
GMAW-STT			

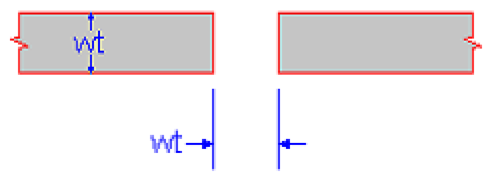
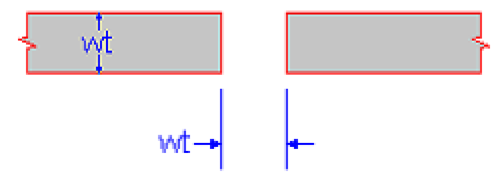
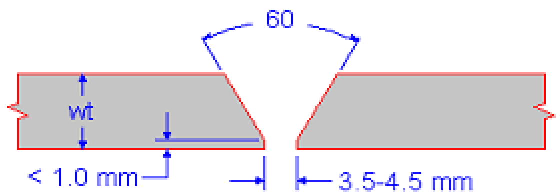
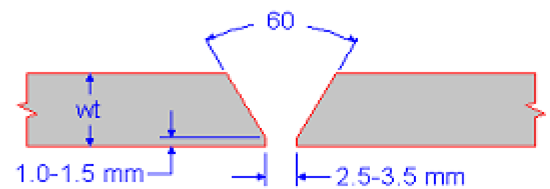
- Power Source: ***STT II***

- Powerssource:
- ***Powerwave S350***
- ***STT module***

Flexible solutions, depending on shop layout or job site

Setting STT Procedures

STT Welding Parameter Guideline & Joint Configuration
Applicable for Un-, Low, & High Alloyed Materials (wire ø1.0 mm)

Wall Thickness	Welding Position 1G / PA (Rotating)	Welding Position 5G Down / PG
< 3.5 mm		
>3.5 mm		

Wall Thickness	1G / PA Peak Current	1G / PA Backgrond Current	1G / PA Wire Feed Speed	5G Down / PG Peak Current	5G Down / PG Backgrond Current	5G Down / PG Wire Feed Speed
<3.5 mm	230-240	50-65	290-330	230-240	45-55	290-330
< 8 mm	260-270	55-65	330-360	250-260	50-65	320-360
>8 mm	260-270	65-85	360-420			

LSW06/AvdS-DR

Shielding & Backing Gas Selection Table

	Mild & Low Alloyed Steel	Regular 3xx Stainless Steel	(Super) Duplex Stainless Steel	Fully Austenitic Stainless Steel	Nickel Alloys
100% CO_2	+	-	-	-	-
Ar + 20% CO_2	++	-	-	-	-
Ar + 20% CO_2 + He	+	-	-	-	-
Ar + 2% CO_2	-	++	+	+	-
Ar + 28% He + 2%CO_2	-	+ *	++	++	-
Ar + 30% He	-	-	-	-	+
Ar + 28% He + 2%H_2	-	-	-	-	++
Backing gas					
Ar	(+)	+	++	+	+
N_2	(+)	+	++	+	+
N_2 + 5%H_2	-	++	-	++	++

++	First option
+	Second option
(+)	Optional
-	Not recomended
*	Only when wall thickness > 6 mm

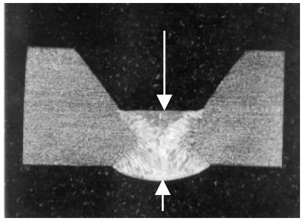
LSW06/AvdS-DR

Surface Tension Transfer:

- ***Patented Lincoln Electric welding process***
- ***Modified short-arc process***
- ***Full electronic controlled arc***
- ***For a variety of base materials & gasses***
- ***STT II single function power source***
- ***Powerwave S350-STT Combines STT processes with Pulse-MIG***
- ***Over 15 years experience in major global projects***

Surface Tension Transfer

- Up to 4 times faster compared to GTAW
- No lack of fusion problems associated with common GMAW-short-arc
- Extremely low spatter level
- Low heat input
- Low fume compared to conventional GMAW
- Large ligament (4.5 mm) allows direct filling with SAW or FCAW



The premium "root pass" process