MAGNATECH
ORBITAL WELDING SYSTEMS

Current Technologies for Mechanized Pipeline Welding

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The Past

Cross Country Pipeline Welding Today

Discussion

- *Current problems facing the pipeline industry*
- *Possible solutions*
- *Economic considerations*
- *Weld quality concerns*

Too Many Projects – Too Few Skilled Welders

	# of projects	Total Miles	Total Wt. (tons)
North America	199	37,964	18,236
Latin America	36	19,086	8,713
Europe	51	12,693	6,404
Africa	18	6,222	4,551
Middle East and Asia	107	44,915	25,998
Australasia	18	8,493	3,370
Total	429	129,373	67,271

Pipeline Projects -- 2006-2009

Source: Simdex Future Pipeline Projects Worldwide Guide

Increased Flow Requirements Require Higher Internal Pressures

Higher pressures dictate a choice -

Approach	Advantage	Disadvantage
•Use Pipe With Greater Wall Thickness	• Standard pipeline weld quality standards (API 1104, others) acceptable	•Heavy wall equals greater weight •Higher pipe cost •Higher transportation cost •Longer weld times, longer production duration.
•Use Higher Strength Steel Pipe	•Thinner wall equals lower weight •Lower transportation cost •Shorter weld times, shorter project duration	•Weld defects acceptable under pipeline quality standards may now be unacceptable •Need of more stringent quality standards •More demanding of welders skills •Higher repair rate with manual welding

Development of Pipeline Steels

How Is Most Pipeline Welding Done Today?

- 85% of welding done manually using SMAW (stick electrode) process
- Average age of a welder in north America, Europe, Japan, is 57
- Welder shortage extends to guest workers from developing counties.

Solution to Welder Shortage – Mechanize the Welding Process.

- Improved Productivity
- Improved quality, reduced repair rates
- Allows use of less skilled welders

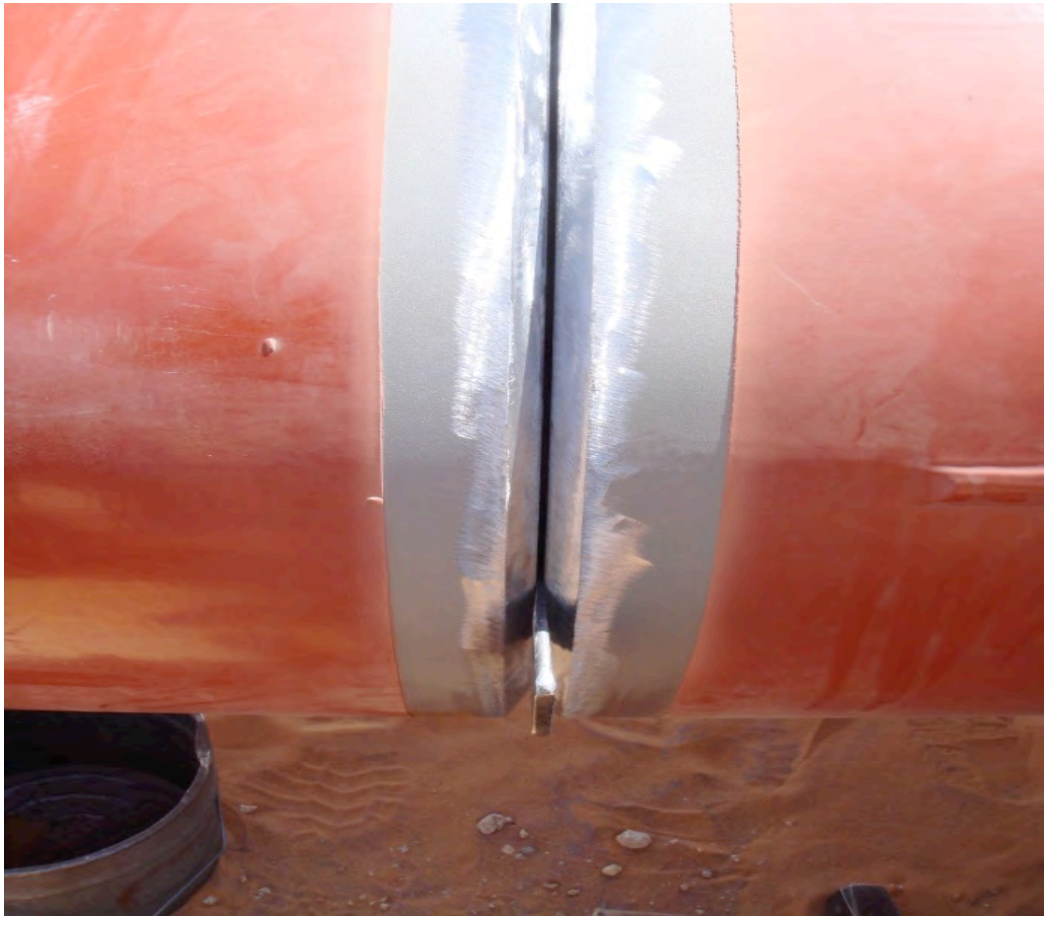
How is Manual SMAW Welding Done Today?

- **No machining of pipe ends, use 30° bevel**

- **Internal clamp used to line up pipe ends**

How is Manual SMAW Welding Done Today?

- **Pipe ends are precisely gapped**



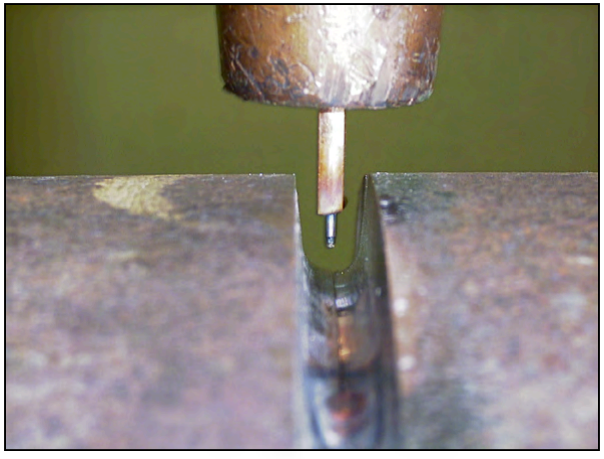
How is Manual SMAW Welding Done Today?

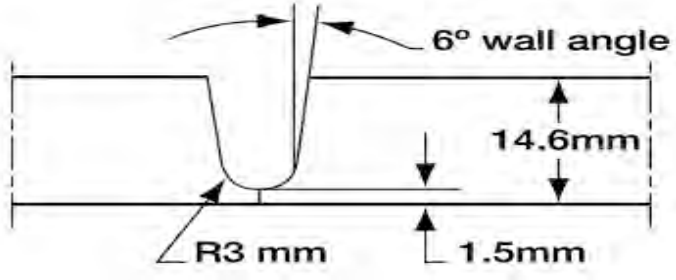
•Initial Root Pass is Made

•Fill and Cap Passes Finish Weld.

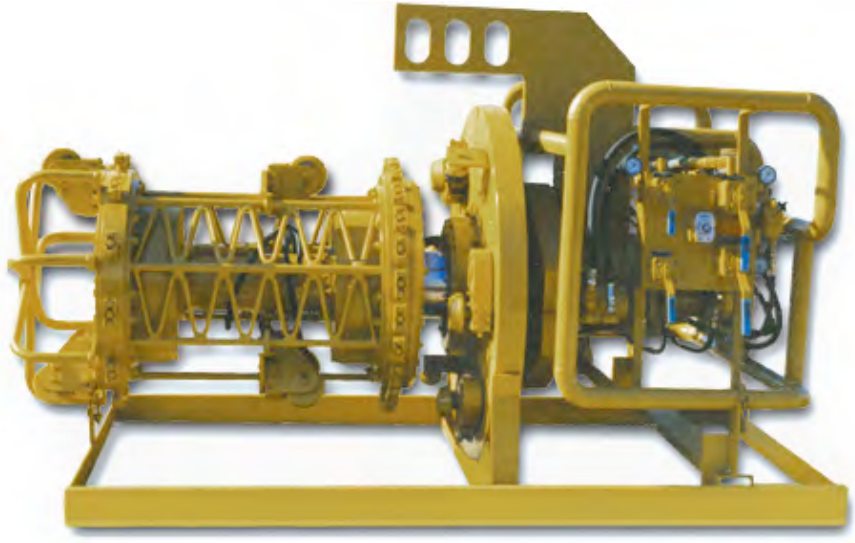
How Have Mechanized Welding Been Done Traditionally?

Most mechanized welding systems use solid wire GMAW (gas metal arc welding.)





Pipe ends must be machined on site using large pipe beveling tools.



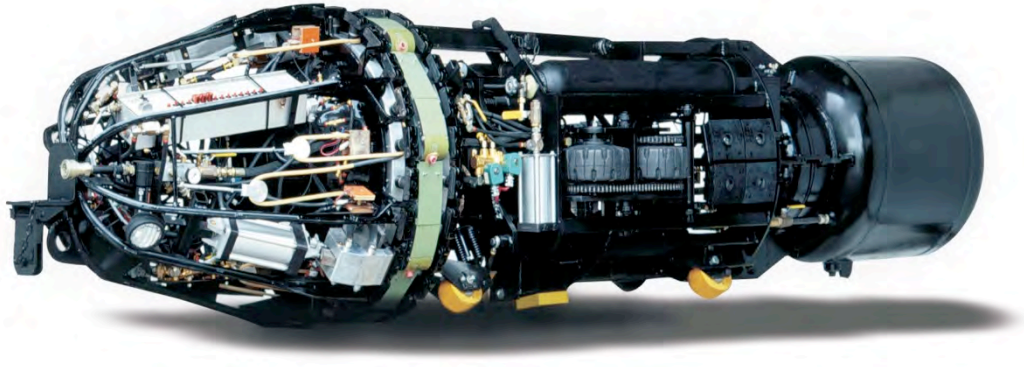
How Have Manual And Mechanized Welding Been Done Traditionally?

Pipeline Welding Root Pass Options

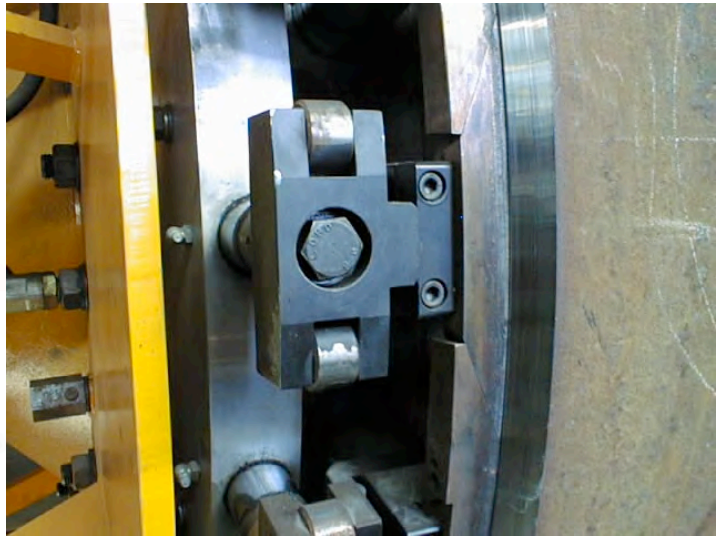
Approach	Advantages	Disadvantages
• Manual Process (SMAW)	• Use standard bevel	• Slower • Variable quality
• Internal clamp with Cu shoes	• Uniform bead penetration	• High equipment cost (special bevel) • Frequent replacement of expansion Cu shoes. • Possible Cu pickup • Not allowed by many customers • Pipe Ends must be calibrated at the mill.
• I.D. welder – GMAW Process (CRC-Evans)	• Very fast • O.D. weld Head can weld Hot pass at same station	• High defect rate • High equipment cost (rental) • Special bevel • Pipe Ends must be calibrated at the mill. • Defective root pass must be cutout • For pipe larger than 20” only

How Have Manual And Mechanized Welding Been Done Traditionally?

Typical ID welding system



Internal Clamp With Copper Shoes

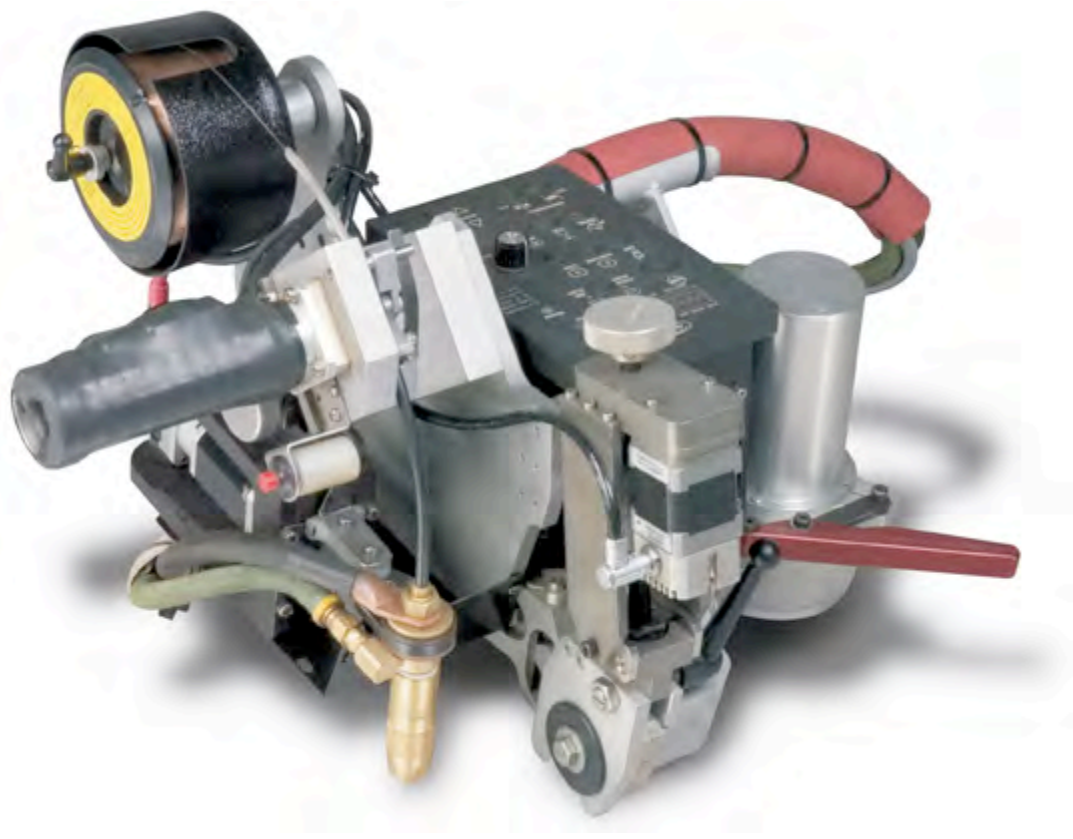


How Have Manual and Mechanized Welding Been Done Traditionally?

Pipeline Welding Fill Pass Options

Approach	**Advantages**	**Disadvantages**
• Manual (Semiautomatic) Processes (SMAW/ GMAW)	• Use standard bevel	• Slower • Variable quality
• Mechanized Welding GMAW Downhill (Short Circuit)	• Fast, rapid move-up time • Increased welds/day • Narrow gap bevel minimizes fill time	• High defect rate • Special bevel required • More passes to fill joint • Short circuit process poorly controlled • Speed limits welder override corrections • Can only be used to 18mm maximum pipe weld thickness.

Typical Fill Pass GMAW Weld Head (Bug)



Economics and Limitations with Traditional Mechanized Welding Approaches

Requires remachining of pipe ends in the field

- Cost of beveling equipment.
- Extra time required.

All suppliers use GMAW in short-circuit mode

- Prone to serious “lack of fusion” type defects.

Copper backing clamp

- Not allowed in certain countries and by certain pipeline owners due to Cu contamination of the weld.
- Cu shoes need frequent replacement at high costs.

Fill and Cap passes

- High Torch Speeds prevent welders from making override corrections.

Internal welder

- Must be rented – (expensive). At least two systems required (one backup).

All welds require <u>both</u> radiographic (x-ray) and 100% ultrasonic inspection

- Cost of third party ultrasonic inspection.

Repairs difficult

- Narrow groove complicates repairs of defects.

Cannot meet more rigorous quality standards

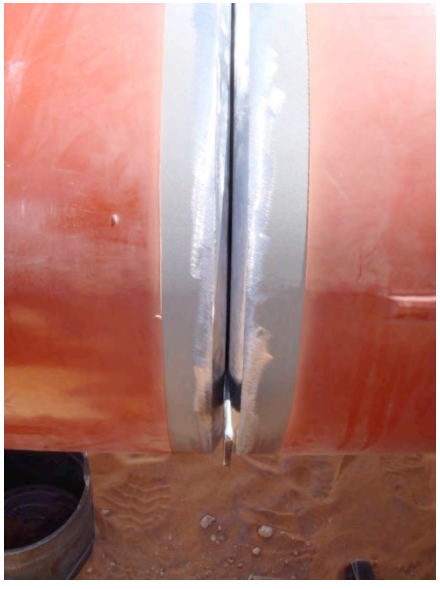
- Welds meet API 1104, but not more demanding quality standards of ASME IX , for example.

An Alternate Approach: Magnatech Hybrid Technique

- Use Standard 30° V-Bevel (as delivered from pipe mill)
- Use advanced GMAW process for semiautomatic root pass
- Use mechanized flux core arc welding for fill and cap passes.
- This “new” approach has 15 year history of success

An Alternate Approach: Magnatech Hybrid Technique

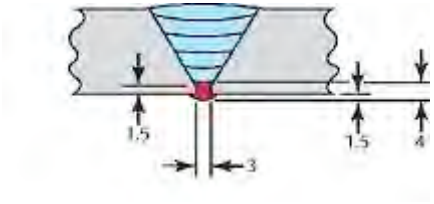
Internal clamp used to align pipes, and then pipe ends are gapped.



(uses same techniques and equipment as used for manual SMAW)

Can Root Pass Welding Be Done With FCAW?

- No. Solution - Use Semiautomatic RMD® or STT® Process for Root Pass



Standard “V” bevel with RMD
GMAW Root and FCAW Fill passes

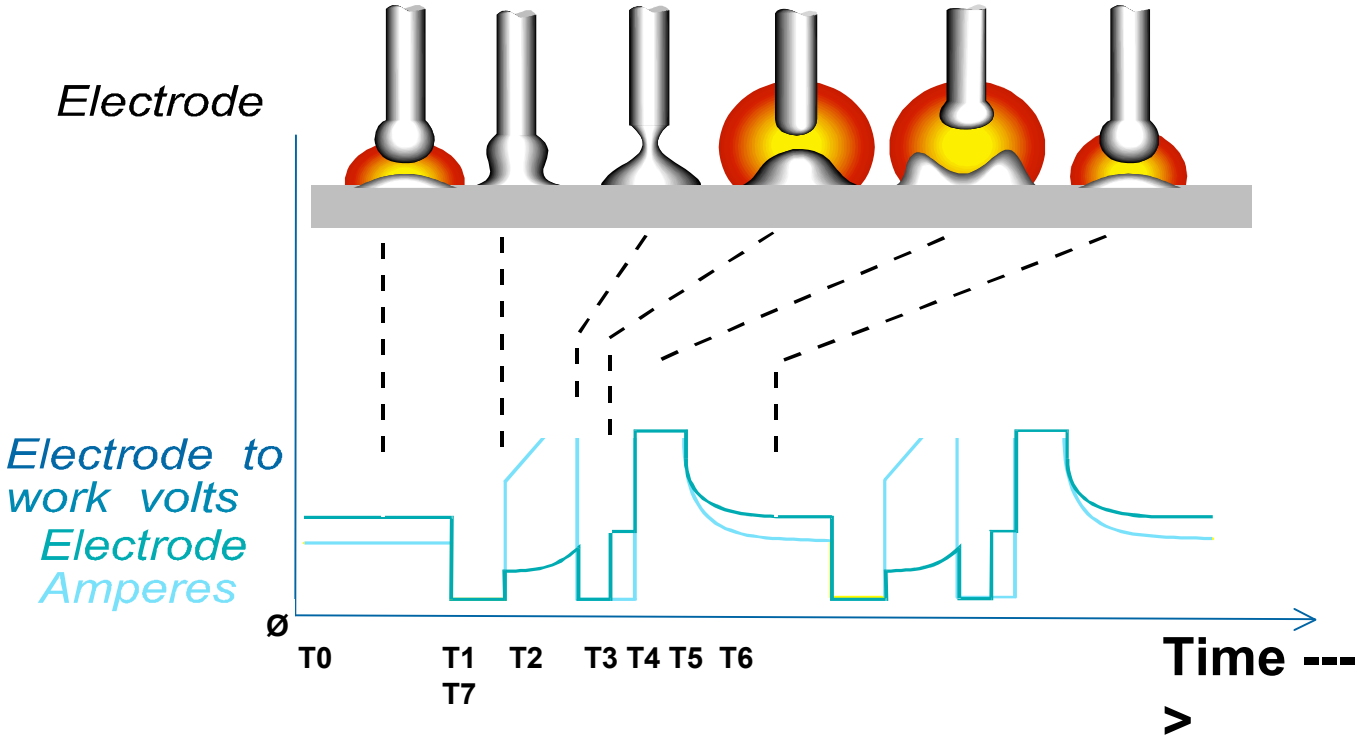
- RMD/STT Processes Provide Adequate Weld Deposit Root Pass To Avoid FCAW re-penetration

Two Advanced GMAW Short Circuit Process For Root Pass Welding

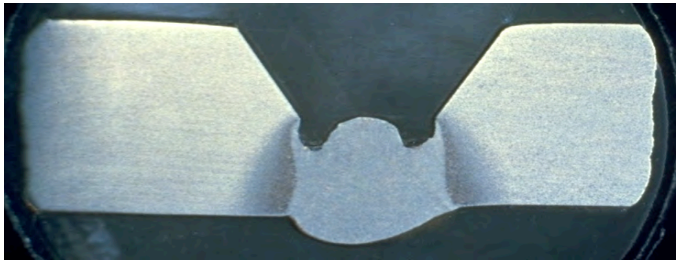
STT®/ RMD® Basics – General Process Review

- Both are unique GMAW processes
- Wire feed speed and current are independently controlled (unlike conventional GMAW technology)

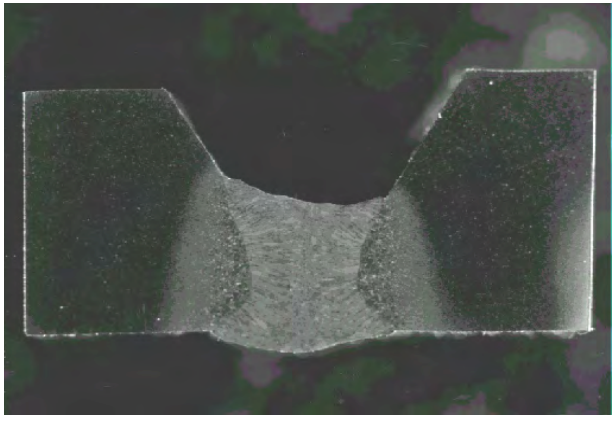
Advanced Root Pass GMAW Process Precisely Controls Arc Wave Form



Advanced Root Pass Process Advantages



Manual SMAW Process



STT/RMD Process

- Weld nugget - 50% more ligament thickness (5-6 mm versus 2.5 mm for SMAW)
- Optimal bead profile eliminates grinding

Major Advantages of Advanced Root Pass Processes

• Heavy Root Deposit	→	Eliminates Hot Pass
• Solid wire process	→	Low Diffusible Hydrogen
• Solid Wire Process	→	No slag defects
• Low heat input	→	Reduced distortion
• Minimal spatter	→	Reduced cleaning
• Optimal bead contour	→	Less grinding
• “Smart” Processes	→	Minimal training (user friendly)

INSTITUTE APPROVAL

FOR Advanced Root Pass Processes

Ministry of Fuel and Power of Russia
Engineering oil & gas Company - All-Russian Research Institute for Construction and Operation of Pipelines and Enterprises of Fuel & Energy Sector

APPROVAL
VNIIST First vice-president
Mr. V.Khomenko

CERTIFICATE # 21-98

Moscow December 28, 1998

The Stock Company VNIIST - an expert center for the licensing system of the GosGorTechNadzor of the Russian Federation - conducted the certification testing on the semi automatic CO_2 welding (STT process) of non rotate pipe joints.

On the base of complex tests positive results the STT technology, equipment and L-56 solid wire manufactured by the Lincoln Electric Company are recommended for :

- root pass welding of joints of pipes made from steels with up to 588 MPa rated tensile strength;
- fill and cap pass welding of joints of pipes with up to 10 mm wall thickness and made of steels with up to 539 MPa rated tensile strength.

The STT process may be used in the following variants of pipe welding:

- STT process - for root pass, basic coated electrode welding - for other passes;
- STT process - for root pass, semiautomatic welding with Innershield type wire - for other passes;
- STT process - for root, fill and cap passes of pipes with up to 10 mm wall thickness.

Using the STT process in other welding variants may be recommended after additional certification tests.

Pipe joints welding jobs of all the types using the STT process with L-56 solid wire must be accomplished according to Technological Maps and Welding Instructions issued and coordinated in the order defined.

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Chief of The Pipe Welding and Test Center

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19, Okruzhnoy pr., Moscow, Russia Phone: (095) 366-51-84, Fax: (095) 366-62-01

Also approved by many regulatory organizations and pipeline owners

- **Saudi Aramco**
- **Transco**
- **DNV**
- **Statoil**

Manual STT®/RMD® Root Pass

Two welders simultaneously weld root pass

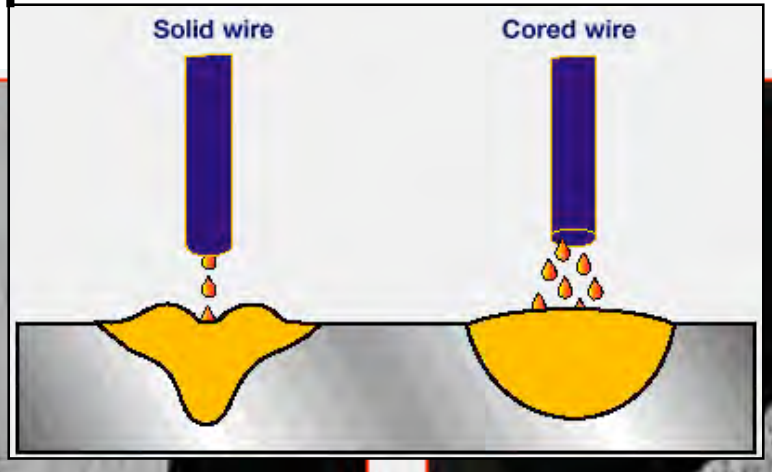
Finished Root Pass

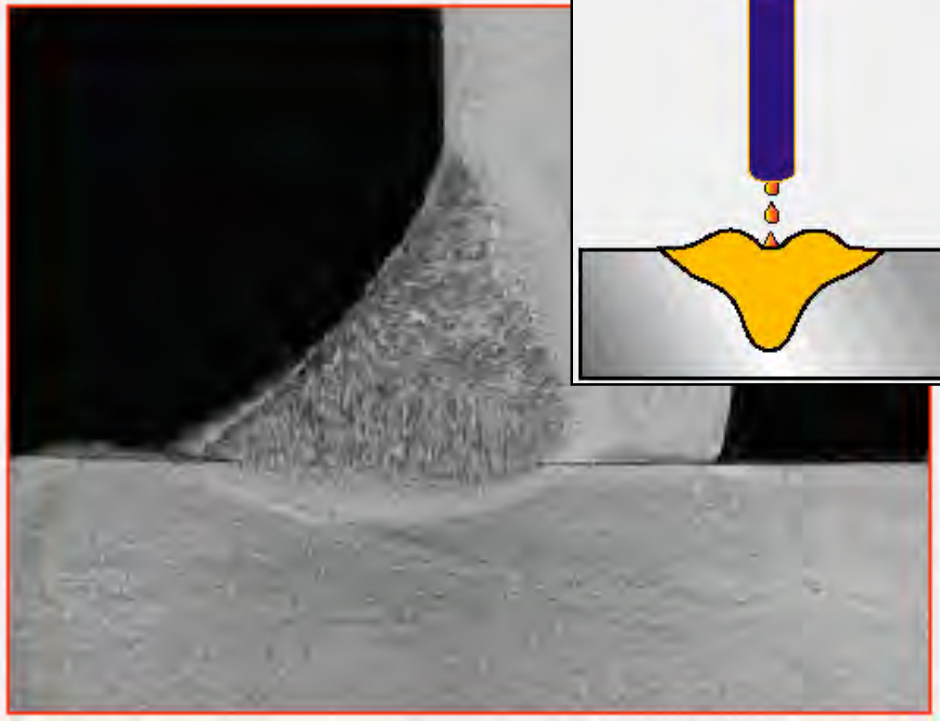
Note Uniform ID Bead

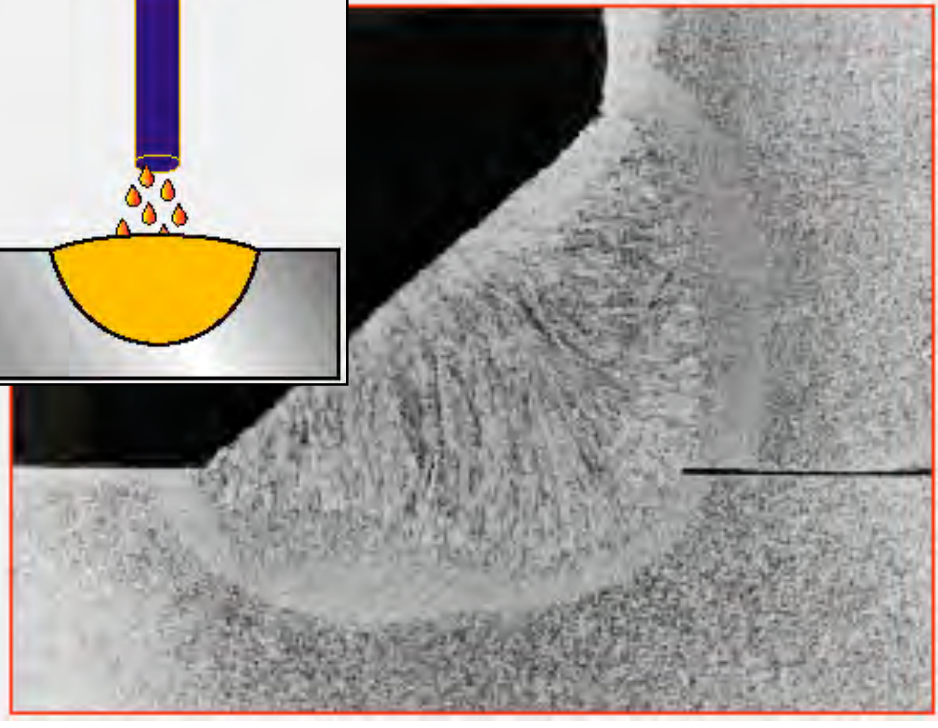
Use Mechanized FCAW for Fill and Cap Pass Welding

Advantage of Flux Core Arc Welding (cored wire) Versus Gas Metal Arc Welding (solid wire)

Solid wire Ø1.0 mm **Cored wire Ø1.2 mm**

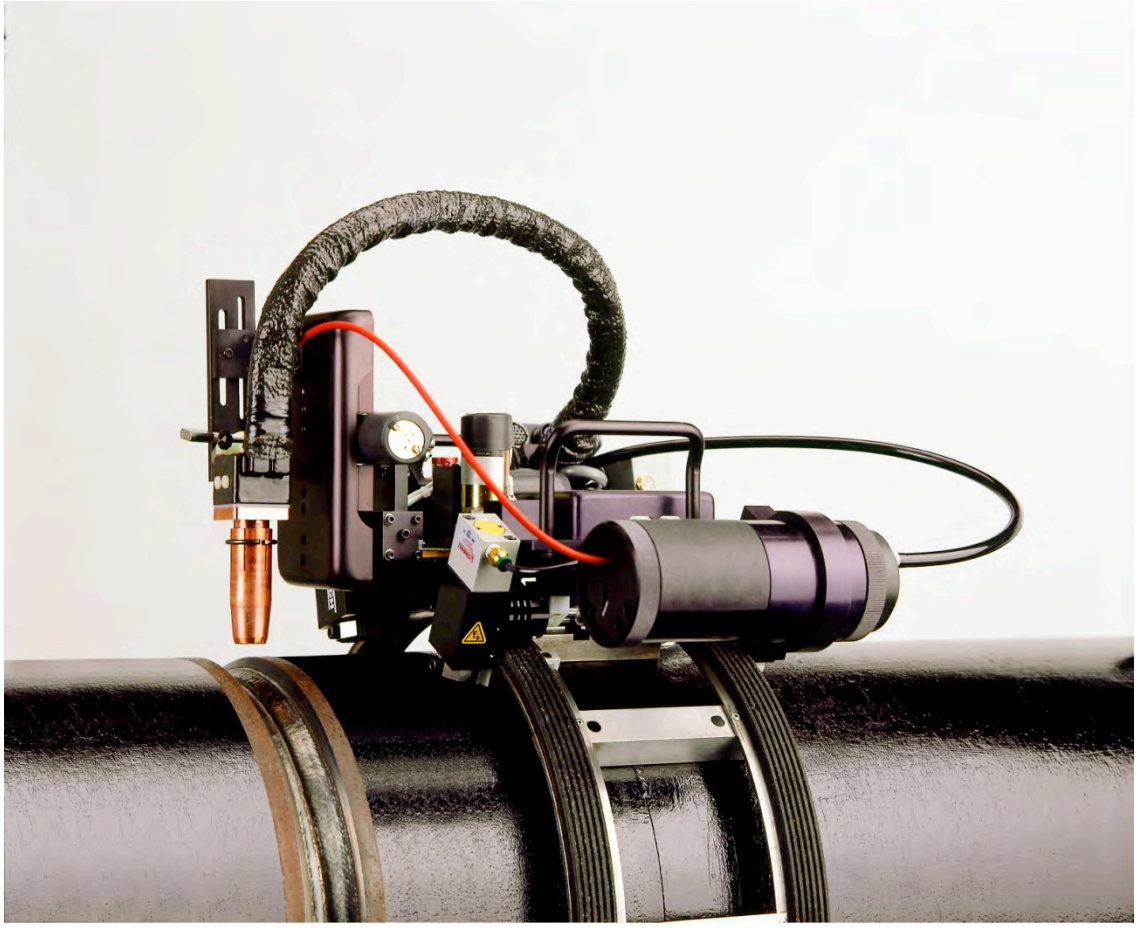




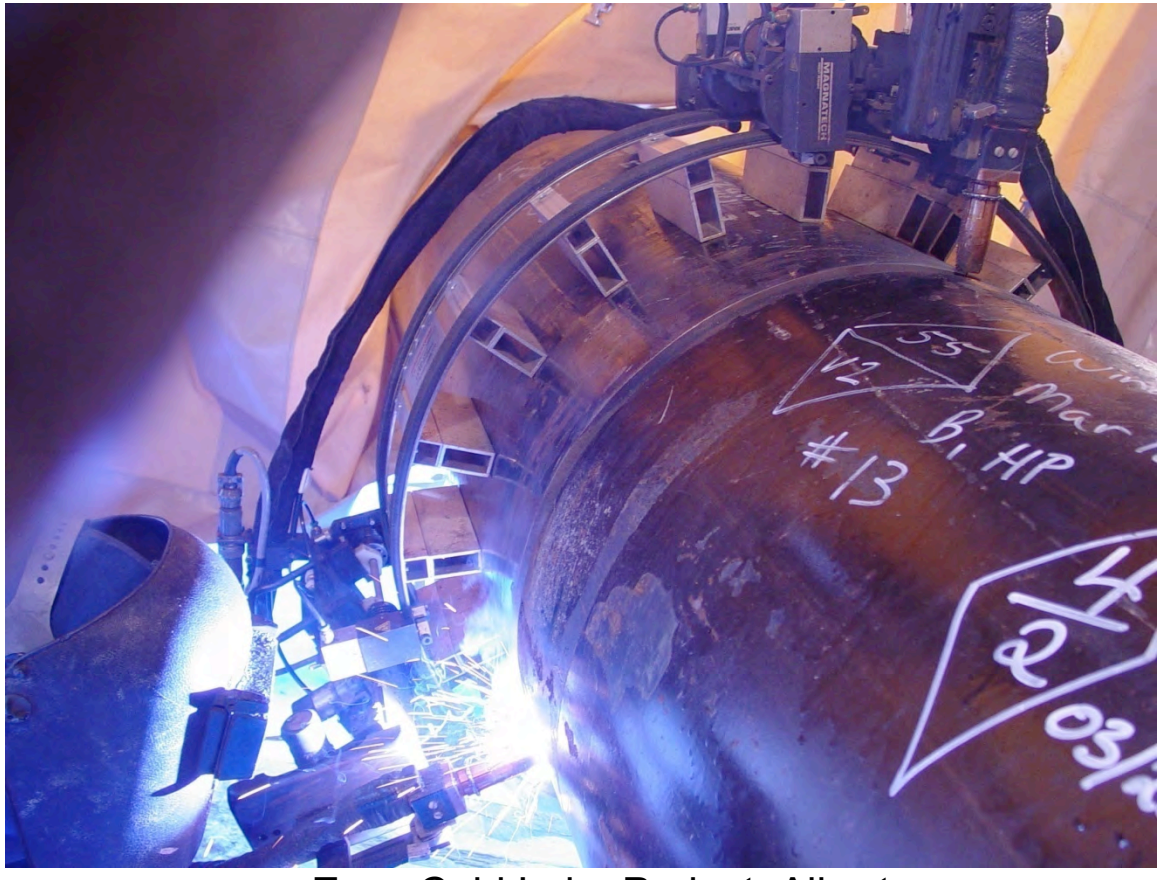


Note wide weld bead and deep penetration in this fillet weld

Typical Fill Pass FCAW Weld Head (Bug)



Use Mechanized FCAW for Fill and Cap Pass Welding



Esso Cold Lake Project, Alberta
18”-20” O.D. x 25mm Wall, X65

Mechanized FCAW Cap Passes

FCAW Process Minimizes Most Repairs

Suedrohrbau
Saudi Arabia Ltd.
Capital 10,000,000 SR Fully Paid
C.R. 2050050266
Chamber of Commerce 76867

شركة سودروربـاو
العربية السعودية المحدودة

Ref: RB/pvs/

Date : 7th February 2007

TO WHOM IT MAY CONCERN

We are pleased to state that we are using **Magnatech Pipeliner II Systems** on our new Saudi Aramco Project, C/No. 66000014789 (BI No.10-00100-0001), Hawiyah NGL Recovery Plant Upstream & Downstream Gas Pipelines for construction of 48" and 56" pipelines, and using the Magnatech Pipeliner II Systems we were able to achieve a very high quality of welding.

Pipeline descriptions and number of joints involved are as follows:

48" X 0.605" & 0.871" wall thickness = 53 km length
No. of joints welded = 1145 joints

56" X 0.649" & 0.893" wall thickness = 10.4 km length
No. of joints welded = 188 joints

The cumulative weld repair rate on linear basis was **0.011%.**

We take this opportunity to place on record our appreciation of the efficacy and efficiency of the Magnatech Pipeliner II Systems and, going by our experience, would not hesitate to recommend them to other construction contractors with pipeline projects in hand.

Yours faithfully,
Suedrohrbau Saudi Arabia Ltd.,

Riad Bazzi
Projects Director

SUEDROHRBAU S.A. LTD. C.R. 2050050266

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Note: 0.011% repair rate on linear basis

Economics of "New" Approach

- Eliminates costs of remachining pipe ends at jobsite.
- Eliminates need to "calibrate" (round) pipe ends at mill.
- Minimizes welding skills for root pass.
- Tolerant of poor fit up (mismatch) between pipe ends.
- FCAW process eliminates most defects and repairs.
- Eliminates need for ultrasonic inspection of welds.

Typical Recent FCAW Pipeline Applications:

Otis Eastern
Water Pipeline Project - 48"O.D.

Saudi Aramco - Haradh Gas Gathering Manifold
32" x 18mm wall, X-65. 20 Pipeliner systems. Zero repair rate.

Hidd Bahrain Water Pipeline
42”, 56”, 72” O.D. x 15mm wall X60, 10 km

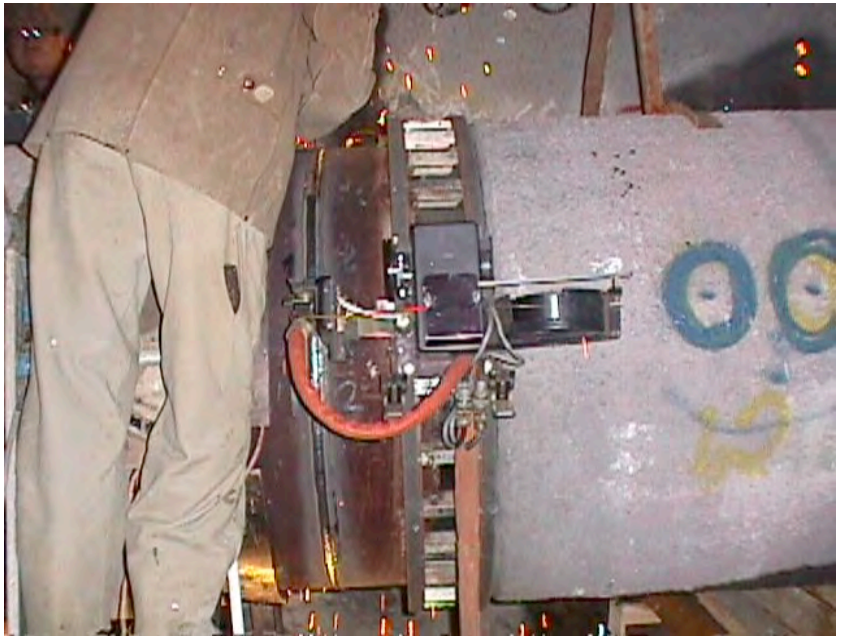
Chad - Double-Joining Pipes

Chad - Double-Joining
24” O.D. X65

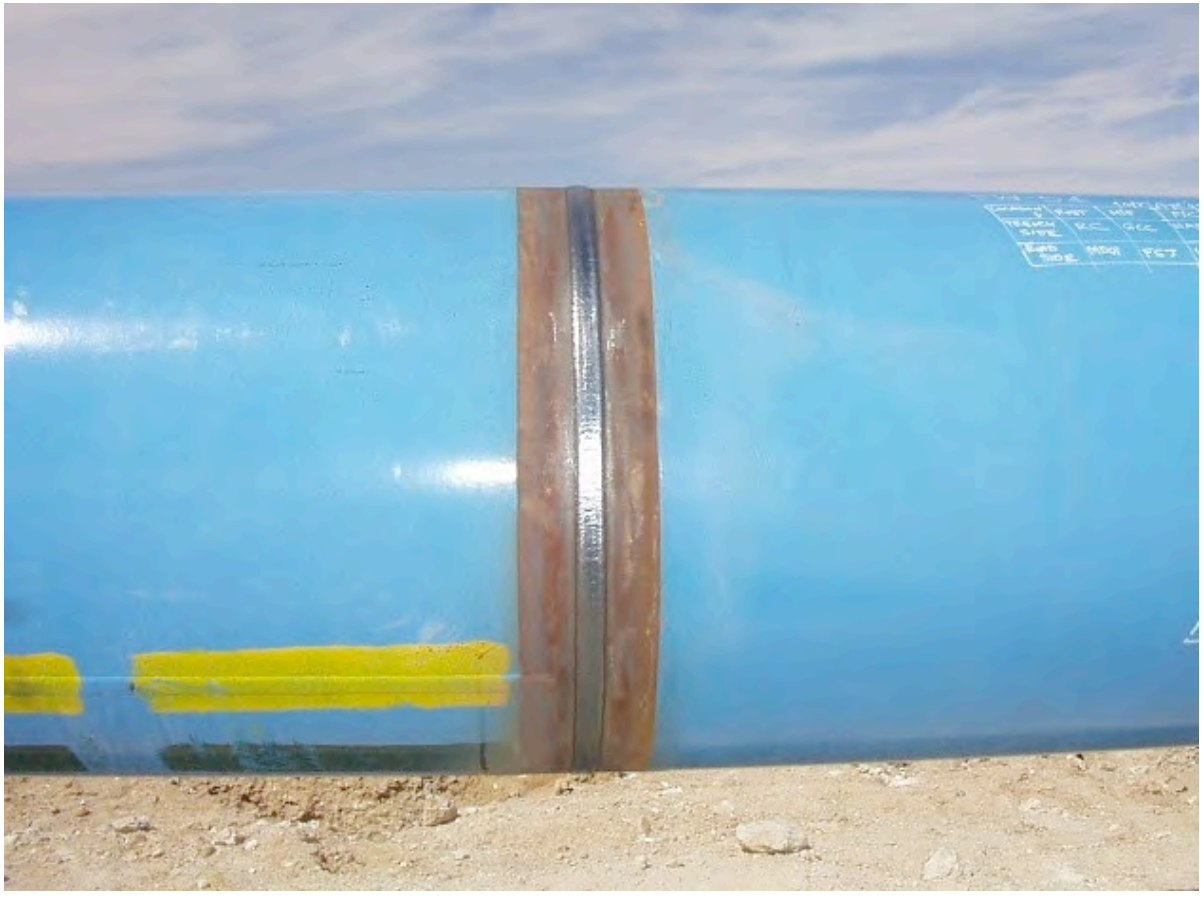
Grane Project, Norway – Gas Pipeline Landfall in Tunnel
28” O.D. x 26mm Wall
Nine Systems

Esso Cold Lake Project, Alberta Canada
Steam Injection in Heavy Crude Wells

Dong Gas Pipeline, Denmark
24” x 15m wall, X-65
187 km
Contractor: Per Aarsleff



Landfall Project, Kalstø, Norway
40” x 53mm, X-65
Contractor: JV KAARSTOE Pipeline Contractors



A Perfect Weld – The end sometimes justifies the means