DOT PHMSA Weld Seam Quality Workshop - Identifying & Managing Weld Seam Challenges

Wednesday, July 20th, 2011

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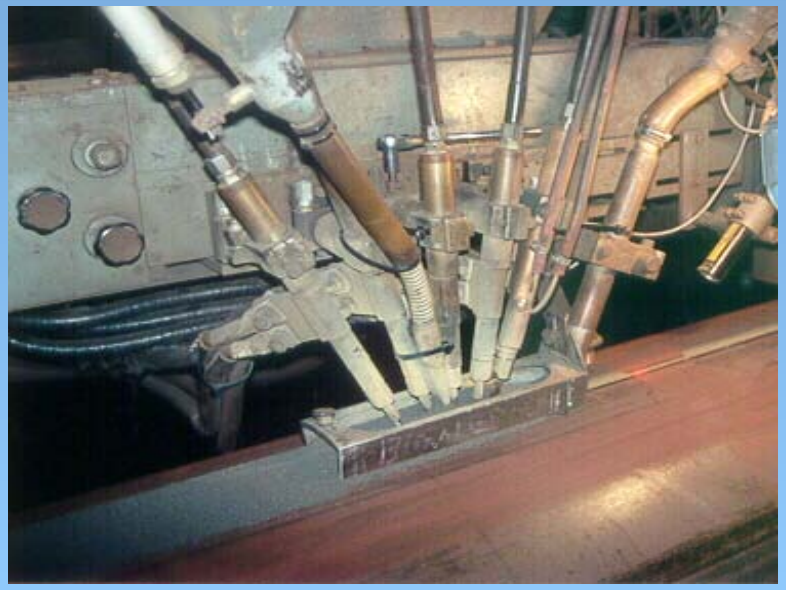
Managing Weld Seam Challenges in the Manufacture of Submerged-Arc Welded Line Pipe

In the manufacture of API line pipe, submerged-arc welding is used to weld the seam of longitudinally-welded pipe (SAWL), the weld seam of spiral welded pipe (SAWH) and the circumferential welds used to join pipe sections (Jointer welds).

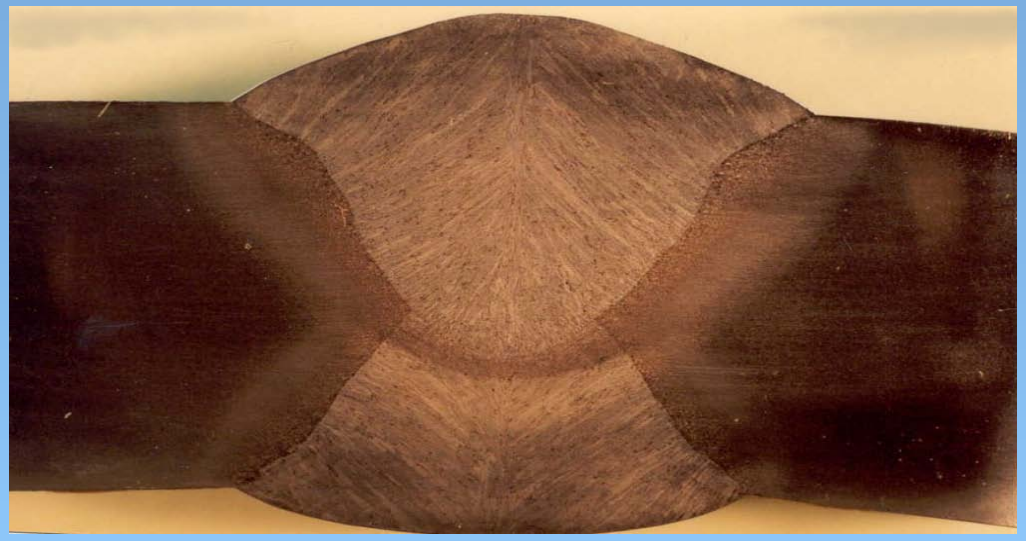
Submerged Arc Welding

Submerged-Arc Welding uses one or more continuously-fed consumable electrodes which become the filler metal in the completed weld. During welding, the molten weld metal is protected from atmospheric contamination by being submerged under a covering of granular fusible flux.



Submerged Arc Welding

In the manufacture of longitudinally-welded pipe and in two-step spiral pipe manufacturing, the formed pipe is initially welded with a tack weld. The tack-welding process is followed by at least two submerged-arc welding passes, one from the OD and one from the ID.



Submerged Arc Welding

To assure high quality SAW welds that are free from defects, it is essential to control the variables in the welding process.

Factors that Contribute to Welding Success:

- Control of Raw Materials
- Control of the Welding Process
- Inspection & Testing
- Material Traceability

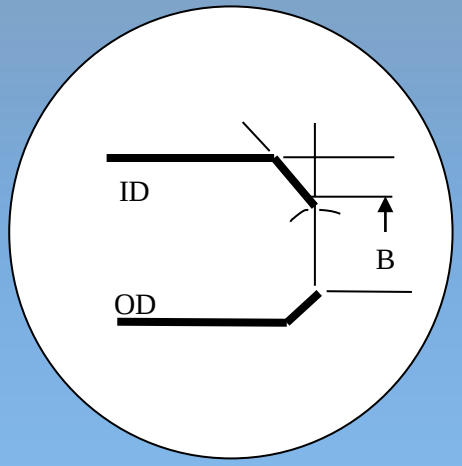
Advances in Manufacture of Plate & Coil for production of Line Pipe include:

- ✓ Clean Steel-Making Practices
- ✓ Fully-killed, low-carbon, micro-alloyed steel having fine-grain microstructure.
- ✓ Control of alloy additions through use of ladle metallurgy stations
- ✓ Continuous Casting
- ✓ Macro-etch
- ✓ Thermo-Mechanical Controlled Rolling
- ✓ Ultrasonic Inspection of Plate / Coil

Control of Essential Welding Variables

Steps to Insure Quality in Submerged-Arc Welds:

- ✓ Selection of the correct weld consumables
- ✓ Proper Bevel Preparation



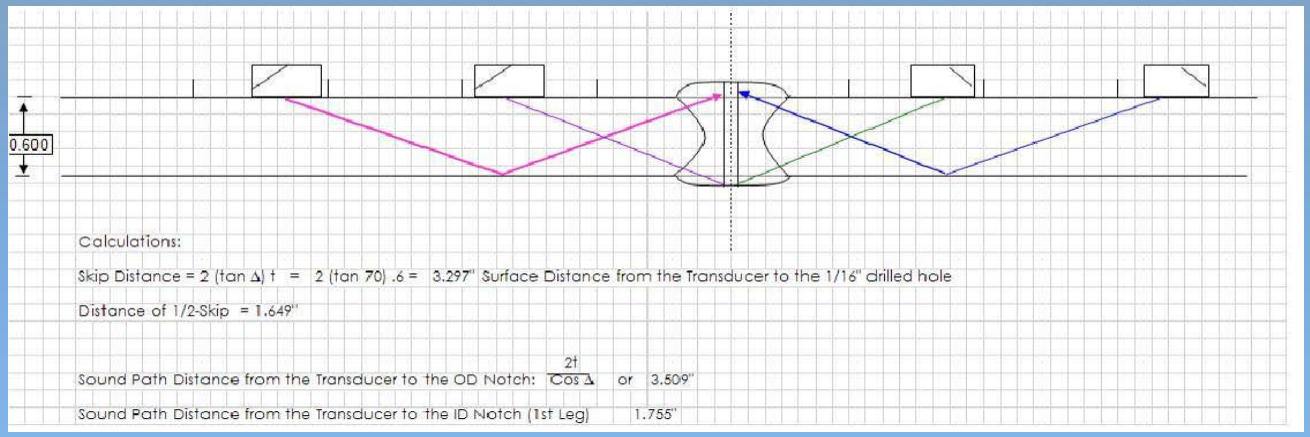
- ✓ Control of Essential Welding Variables
  - -Electrical Characteristics (Amps, Volts, Etc.)
  - -Travel Speed
  - -Heat Input

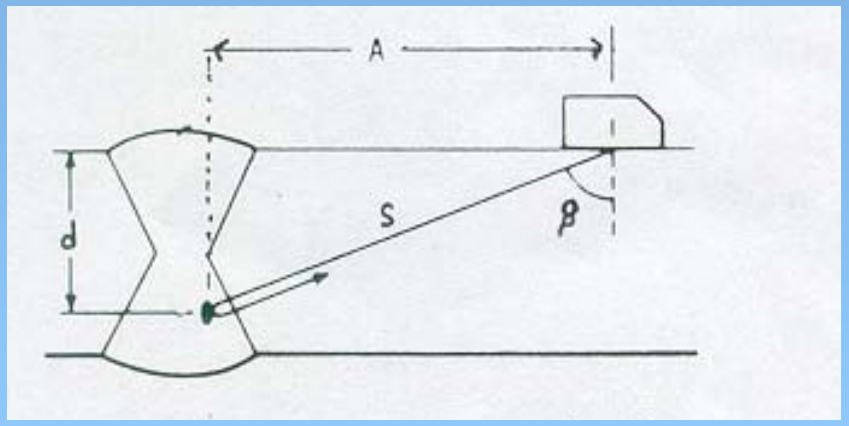
Control of Essential Welding Variables

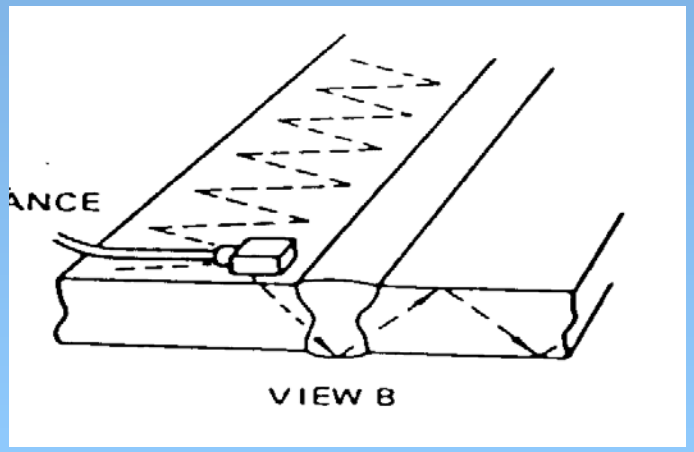
- ✓ Weld Seam Tracking
- ✓ Qualified, Documented Welding Procedures (WPS/PQR)
- ✓ Training/Qualification Program for Welder Operators
- ✓ Control of Repair Welding

Challenges in Inspection & Test

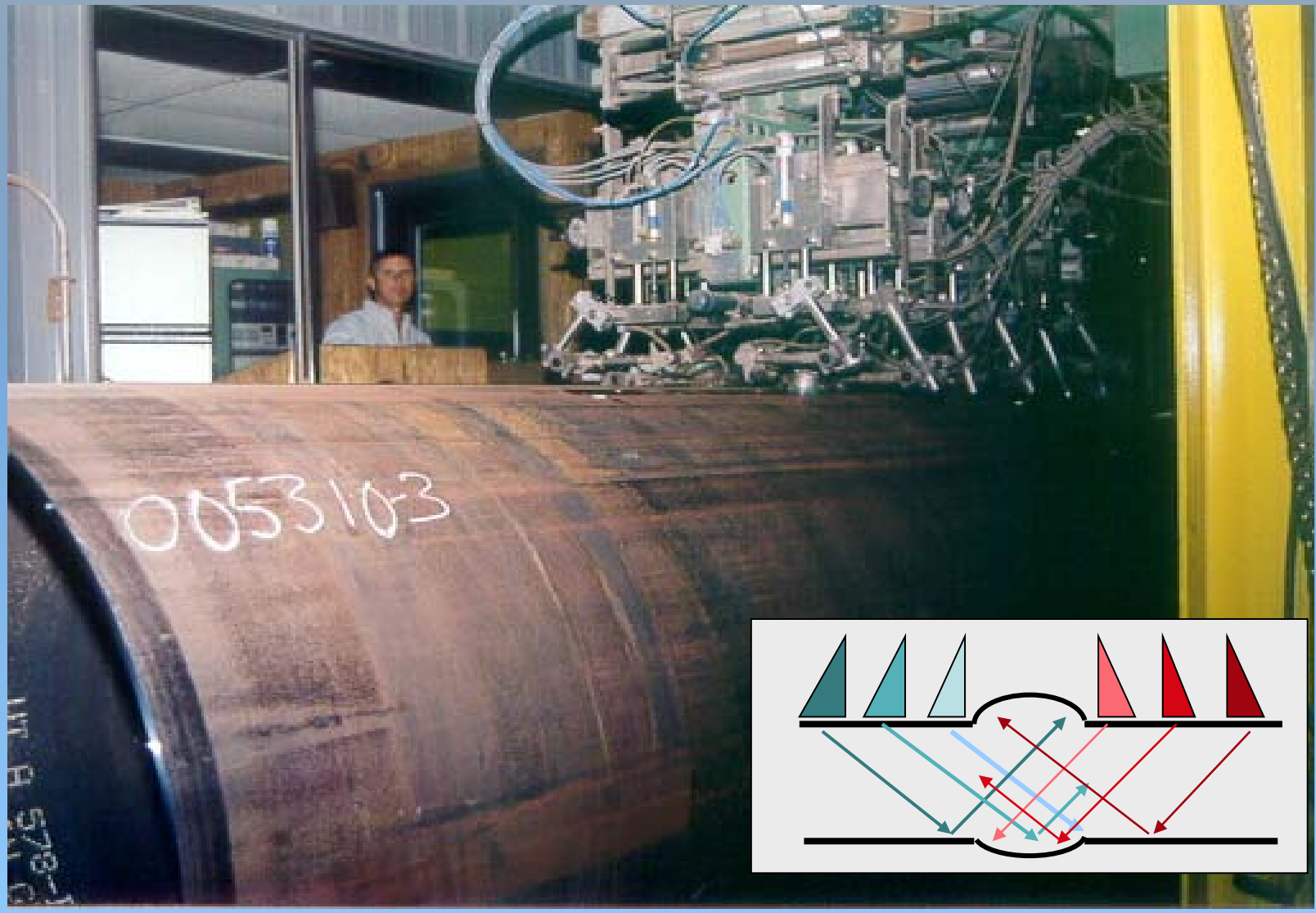
Per API Specification 5L, acceptance criteria for ultrasonic testing of submerged arc welds is based on the signal amplitude from a flaw compared to the signal amplitude of a reflector of known size.



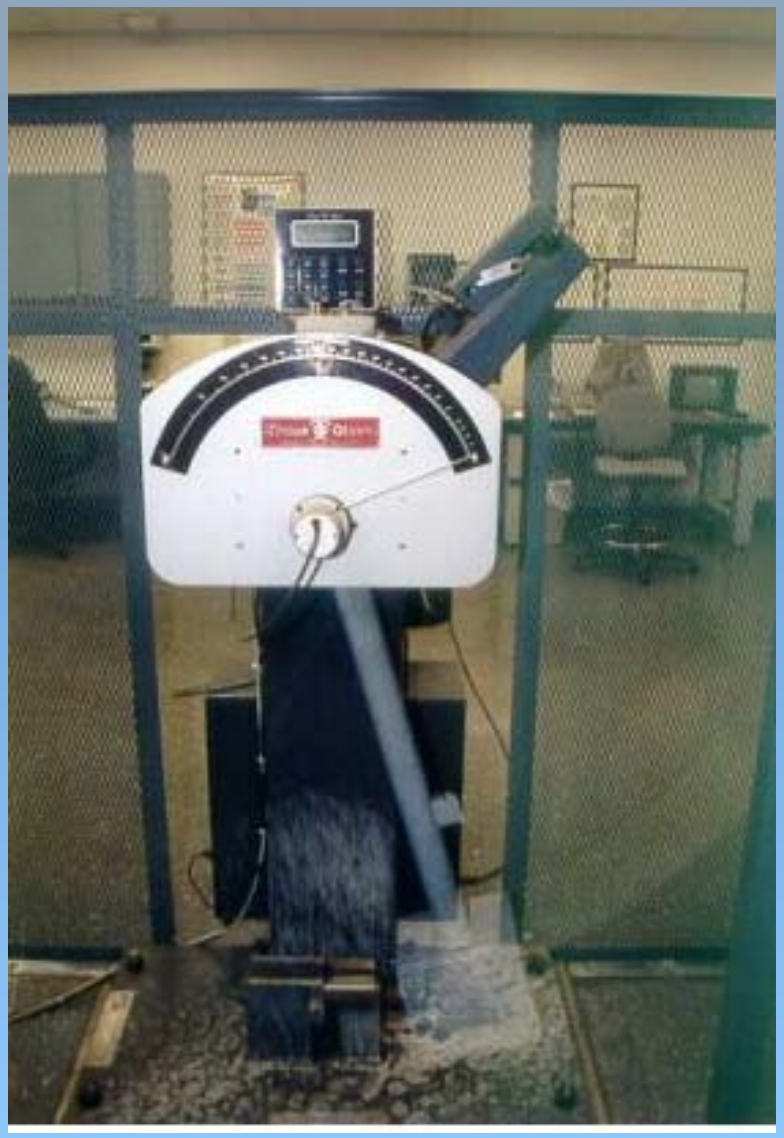




Challenges in Inspection & Test



Challenges in Inspection & Test



As pipe mill efficiencies continue to improve, pipe production rates increase. This puts additional demand on the test labs to maintain pace with pipe production and have all required tests completed prior to product release.

Challenges in Inspection & Test

To meet the challenges in inspection & testing, recent advances in Inspection & Test include:

- ✓ Comprehensive training programs for Certification of NDT Technicians and for Laboratory Technicians
- ✓ Validation of NDT processes to assure that systems have adequate detection capability for finding naturally-occurring imperfections
- ✓ Use of advanced inspection techniques such as digital X-Ray and Phased Array Ultrasonic Inspection and assuring that industry specifications and standards maintain pace with the available technology
- ✓ Addition of high-speed sample preparation and lab testing equipment to assure that the welds meet the all requirements prior to product release.

Material Traceability

Additional attention should be paid to the issue of product traceability.

Traceability considerations:

- Raw Material certifications / records
- Traceability of weld consumables
- Traceability of welding parameters, including those for repairs
- Tracking through the manufacturing process
- Traceability to Hydrotest / NDT records
- What is the strategy for product release
- How are rework pipe designated?
- What is the strategy that assures that only pipe meeting all requirements is permitted to be released to a customer?

Material Traceability

Recent improvements in traceability include:

- Use of unique pipe numbers to track pipe through the manufacturing process

- Use of Bar Codes in pipe stencils and labels

- Use of Radio Frequency Identification (RFID) tracking

Thank-you for your attention

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