

THE ADVANTAGES OF FULL BODY NORMALIZED ERW PIPE



U. S. Steel Tubular Products
Lone Star Tubular Operations



U. S. Steel's Lone Star Tubular Operations in Lone Star, Texas specializes in the manufacture of Full Body Normalized Electric-Resistance Welded (ERW) tubular products primarily for the oil and gas industry. Mill No. 1 produces ERW pipe ranging from 7" to 16" outside diameter. Mill No. 2 produces ERW pipe ranging from 2-3/8" to 7" outside diameter.

As part of the largest fully integrated tubular products manufacturer in America, Lone Star Tubular Products delivers high-quality ERW pipe that is proudly made in Texas. ERW pipe can be quenched and tempered for additional toughness at one of our three heat treat facilities before being finished and prepared for shipment.

The facility also has three threading facilities with capabilities ranging from 4-1/2" to 16" in all API thread configurations, as well as several specialty/premium thread connections.



Lone Star Tubular Operations ERW Manufacturing Advantage

- Full body normalizing and hot working provide a uniform microstructure that leads to consistent pipe diameter, wall hardness, yield and tensile properties
- All quench and tempered pipe undergoes a full body ultrasonic inspection
- All pipe, regardless of grade, undergoes an ultrasonic weld line inspection after hydrotesting
- 50+ on site Level II and Level III Certified NDT Technicians
- Highly experienced work force

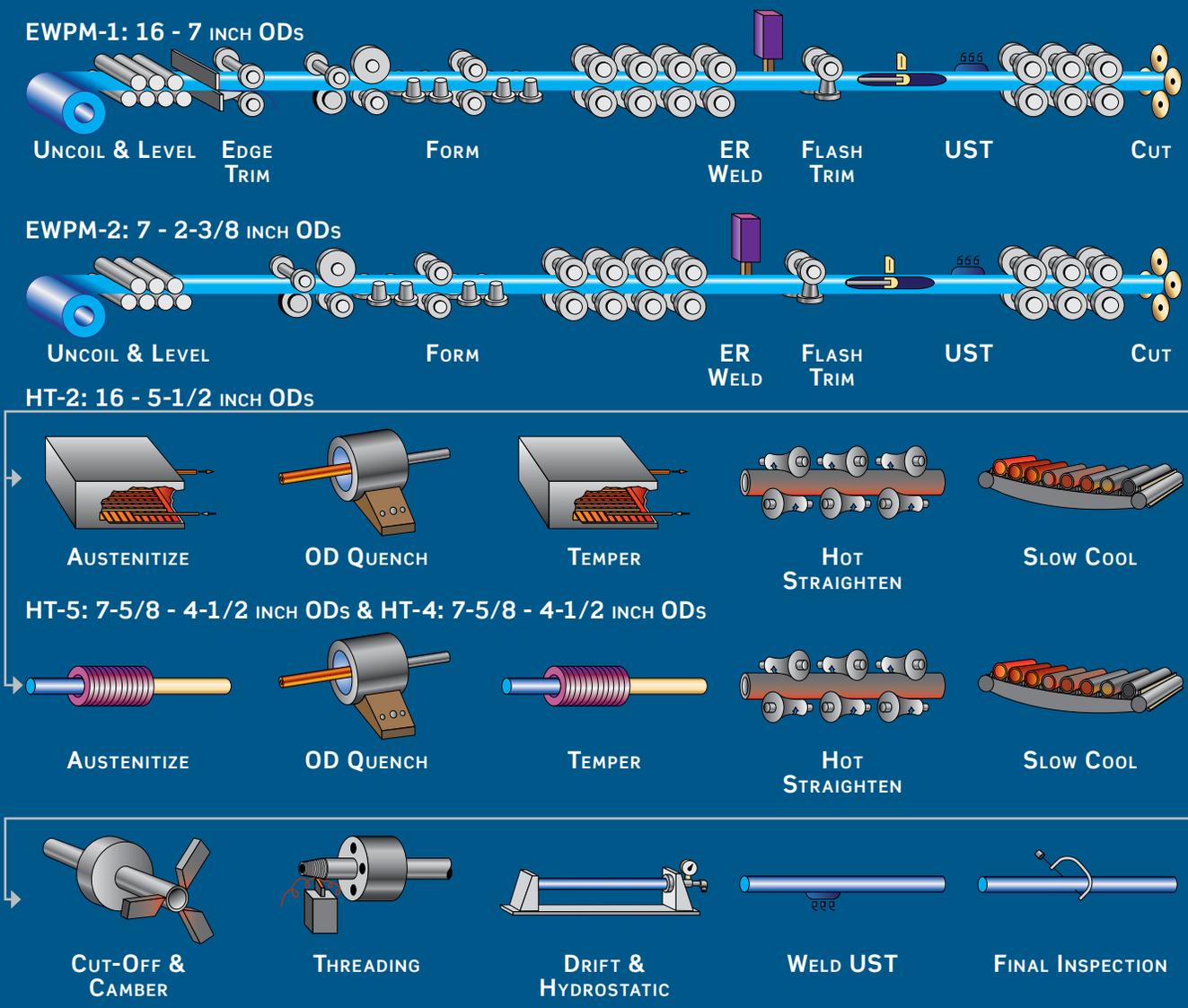
THE ERW MANUFACTURING

Both mills at Lone Star Tubular Operations are solely devoted to manufacturing and distributing high-frequency ERW pipe for customers working in the oil and gas sector.

Steel arrives at the mills as coils to be slit to precise widths. The strip steel is uncoiled and leveled, then passed through a series of forming rolls, which transform the strip from flat steel to round pipe sections. The edges of the strip are burnished for welding and are then joined through the use of an electric

current and applied pressure that welds the pipe edges together without the use of extra metal.

Once the weld is complete, the flash metal, which is extruded by the weld process, is removed from the ERW pipe inside and outside surfaces. The pipe is then cut to length by a flying rotary cut-off and the weld's integrity is checked by in-line ultrasonic test equipment.

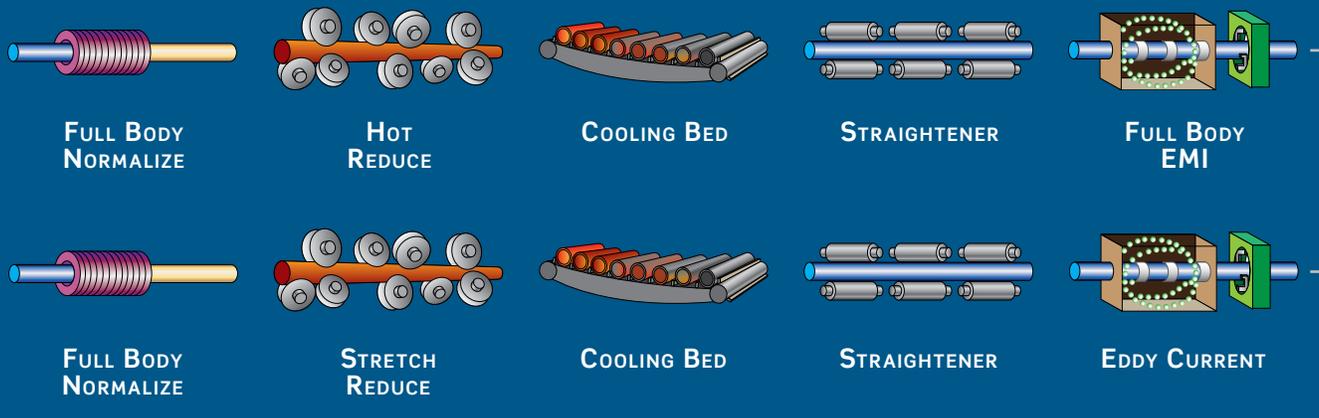


ING PROCESS

After testing, all Lone Star ERW pipe is full body normalized by passing through a battery of induction furnaces where it is heated to temperatures above 1,650° F. It is then hot reduced to size, cut to ordered length and air-cooled.

After cooling, every pipe is straightened, visually inspected, stenciled with the appropriate identity and queued for final finishing or quench and tempering. Laboratory tests

confirm compliance to other mechanical property requirements and pipe specifications.



THE ADVANTAGES OF FU

All welded tubes pass through a continuous normalizing furnace where they are heated above the steel pipe's upper critical temperature, 1,650° to 1,900° F.

Hot working after full body normalizing initiates a very fine grain and homogenous microstructure. Residual stresses, untempered martensite and bainitic grain structure are eliminated in this process.

The result is a uniform microstructure that equates to consistent through wall hardness, yield and tensile properties both longitudinally and circumferentially along the length of each pipe.

High-Frequency Welded Seam Annealed products offer good performance in a variety of applications, however, they do contain variations in hardness and microstructure of the heat affected zone and pipe body, which can have a negative impact on resistance to various types of corrosion. These variations are reduced with the grain refinement achieved during hot working at the normalizing temperatures of Full Body Normalized products. Lone Star Tubular Operation's ERW process offers improved performance properties and product characteristics gained with Full Body Normalized product.



No. 2 mill
welding
process



No. 2 mill
forming process

Pipe exiting
stretch reducer



LL BODY NORMALIZING

Bond Plane Microstructure



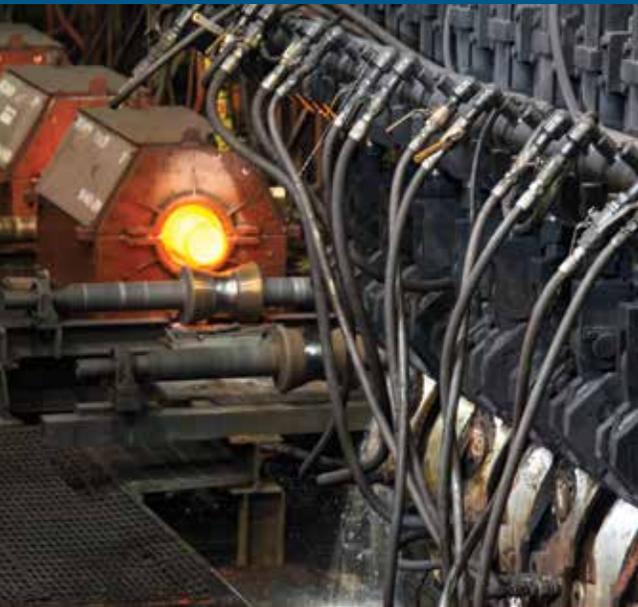
"As welded" microstructure showing weld bond plane and HAZ (Heat Affected Zone) with "hour glass" very evident.



A seam annealed microstructure.



U. S. Steel full body normalized and hot reduced microstructure. No visible HAZ. Weld bond plane virtually invisible.



Full body normalizers



Full body ultrasonic operator station

Full body ultrasonic inspection



Coupling pre-screw and buck-on





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