# Improved UOE Pipe-Manufacturing Process Helps Meet Deepwater Pipeline Challenges

Conventional pipeline design, although concerned with many factors, generally centers on the need to withstand the internal pressure in the line. The higher the pressure at which throughput can flow, the higher the flow rate, and the greater the revenue potential for the operator. However, when considering the factors critical for deepwater pipelines, much of the focus shifts to the need to withstand the external pressure on the line, particularly during installation.

With local "infield" lines, such as subsea umbilicals, risers, and flowlines, the challenge is modest because the lines are small in diameter and, thus, inherently resistant to hydrostatic collapse. These lines are generally produced as seamless pipe, which in smaller sizes is readily available and generally a suitable economic solution.

However, deepwater trunklines, especially with long-distance tiebacks, present a greater challenge. These lines must be wider in diameter to meet the production demands of large-scale, high-cost projects. Thicker pipe wall is required to ensure that pipes can withstand the hydrostatic pressure and bending that affect them as they are laid to the seabed. Often, these are 16- to 20-in.-diameter lines, which places them at the economic limit for seamless pipe production methods. A project table including some typical deepwater pipe properties is shown in **Fig. 1.**

It is possible to produce thick-walled, seamless pipe at these diameters by means of the Pilger process, in which hot round steel billets that have been hollowed in the initial phase of production are rolled and stretched until the desired length and diameter are achieved. However, the manufacturing process is slow and the cost of material high.

The most economic method of manufacturing pipe at these wall thicknesses and diameters is the UOE process, in which steel plate is pressed into a U and then an O shape and then is expanded circumferentially. (This process was used in the projects shown in Fig. 1.) The advantages of the UOE process notwithstanding, the current wall-thickness and diameter requirements for deepwater trunkline pipe still have proved challenging from the standpoint of manufacturing economics and installation capabilities. Only a handful of manufacturers are capable of supplying double-submerged, arc-welded (DSAW) pipe that meets specifications for the deepest projects, such as the Shell Perdido development in the Gulf of Mexico.

The acceptability of a pipeline design for a given water depth is determined by means of standard equations that measure the relationship between outside diameter, wall thickness, pipe shape, and material compressive strength.

**Typical Properties**

| Project | Water depth (m) | Outer diameter (in.) | Wall thickness (mm) | Grade | Maximum ovality (mm) |
|---|---|---|---|---|---|
| Bluestream | 2150 | 24 | 31.8 | L450 | 3 |
| Blind Faith | 2130 | 16, 18 | 19.1–20.6 | X65 | 2 |
| Perdido | 2530 | 18 | 19.1–26.9 | X65 | 3 |

***Fig. 1—A project table with typical deepwater pipe properties.***

## Pipe Shape

The finished pipe shape is determined during the manufacturing process and can be optimized by balancing the manufacturing parameters, pipe compression, and expansion. Through the optimization of crimping, U-press, and O-press operations, it is possible to control pipe diameter and wall thickness (hence, ovality) to the point where the specifications of most deepwater projects are met and surpassed **(Fig. 2).** Enhanced tolerances that have been achieved for pipe roundness, wall thickness, and diameter, have reduced design- and production-related uncertainty and resulted in optimized wall thickness.

## Material Compressive Strength

Pipe manufactured by the UOE process undergoes various strain cycles, both tensile and compressive. The combination of these cycles affects the overall behavior of the material in compression. For standard UOE processes, the material response to these strain cycles during forming is a 15% derating of compressive strength. This is known as the Bauschinger effect **(Fig. 3).**

Corus Tubes, over a period of years, observed that the results it obtained from the forming process often yielded higher collapse strengths than those obtained when any of the standard equations were applied. Examination of equation parameters suggested that this benefit could be the result either of greater pipe roundness or increased pipe compressive strength.

This led to a research and process-development program that has provided greater understanding of the mechanisms at work during pipe forming. The enhancement of collapse strength

# Extend Reservoir Productivity


## RAM™ Multilateral Completions for Extended-Reach Wells

Getting liners to bottom in extended-reach multilateral wells can be a problem. The RAM™ Rotating Self-Aligning Multilateral System is the solution. The RAM system allows continuous rotation of lateral liners to bottom, even in wells with step-out ratios greater than 5:1. And, it delivers reliable Level 3 and 5 multilateral junctions with selective flow control and access to all laterals.

Already, the RAM system has helped increase total oil recovery from viscous reservoirs on Alaska's North Slope. To see how it can make extended-reach multilaterals and their related benefits possible for you, contact us today.

*www.multilateralwells.com*
*multilateral.wells@bakeroiltools.com*

BAKER HUGHES Baker Oil Tools

THE Completion and Intervention Company

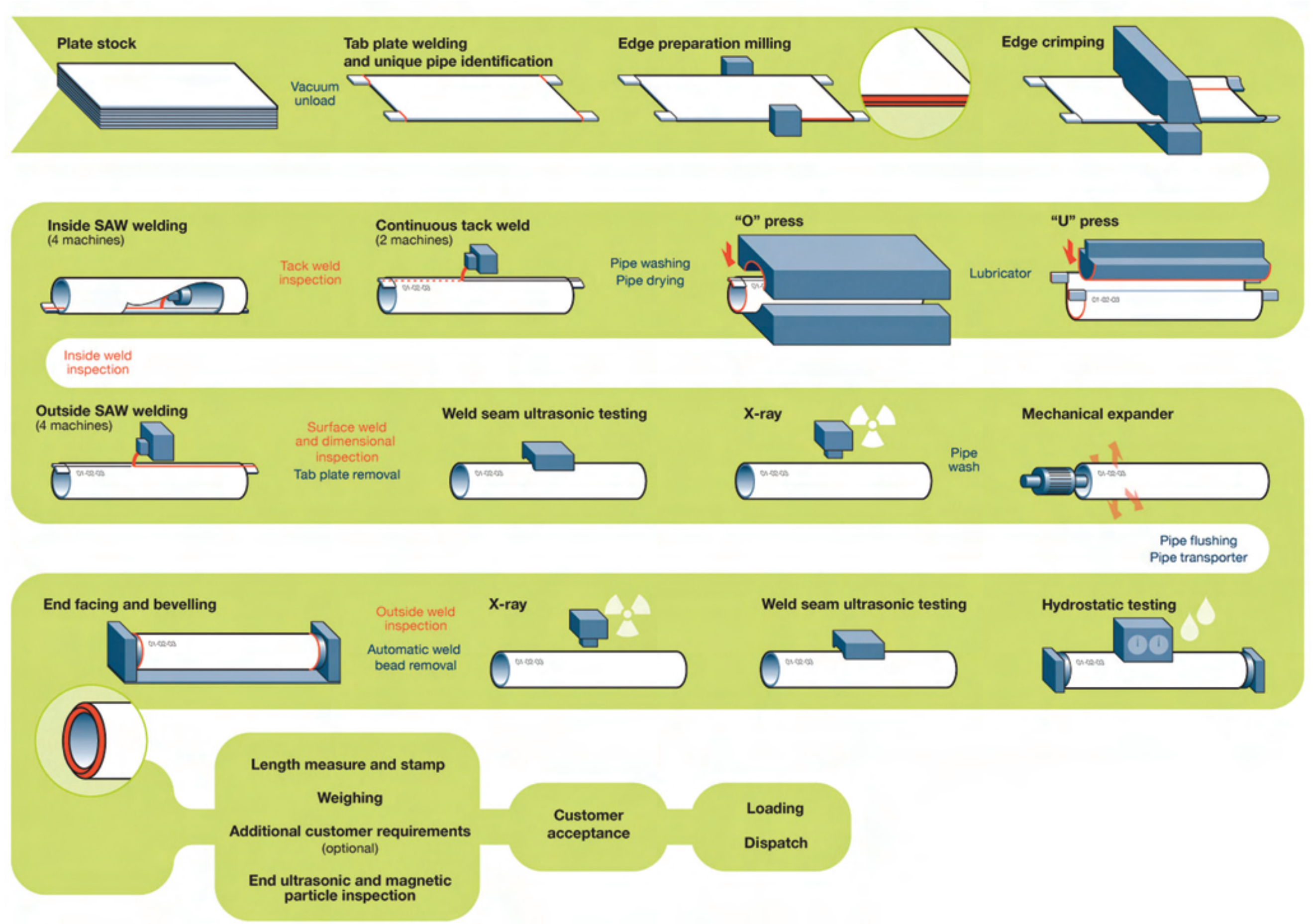


***Fig. 2—A diagram of the UOE pipe-manufacturing process.***

was found to be a result both of improved pipe shape and pipe strength. Work by the company has now made possible a reversal of much of the Bauschinger effect in UOE pipe-manufacturing operations. Consequently, higher compressive strengths than those normally expected have been achieved.

By optimizing the various compression and expansion cycles, it has been possible to determine a set of manufacturing conditions that enable collapse performance to be enhanced, providing the potential for reducing pipe wall thickness for future deepwater applications. Among the benefits expected to result from this process development are

- Reduced material cost
- Reduced welding cost
- Reduced installation time
- Reduced pipe weight for logistics and submerged pipe-weight considerations
- Increased design scope that will widen options for deepwater developments

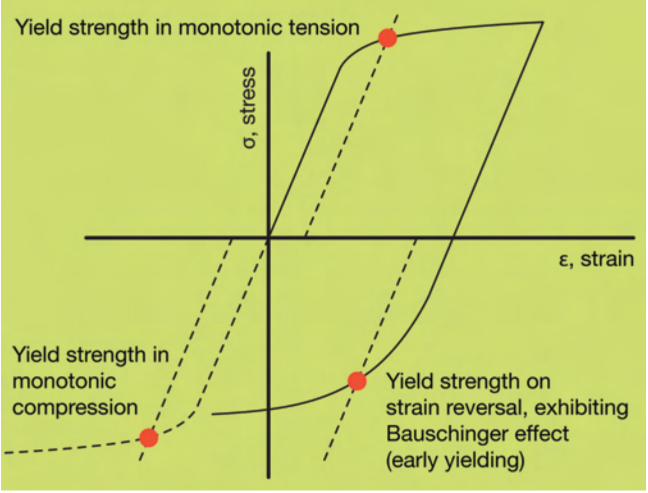


***Fig. 3—Material early yielding on strain reversal due to Bauschinger effect.***

## Conclusion

Pipelines in deep water require the tightest dimensional tolerances to maximize resistance to collapse and maximize girth-weld fatigue resistance. With lines from 16- to 28-in. diameters envisioned for future deepwater export pipeline systems, DSAW UOE pipe manufacturing will be a vital enabling technology. Work continues to be done to improve the performance of this manufacturing process, with the goal of helping the oil and gas industry develop projects in deeper and deeper waters.

*Information provided by Richard Freeman, Business Development Manager (Energy Business), and Martin Connelly, Technical Manager (Energy Business), Corus Tubes.* **JPT**