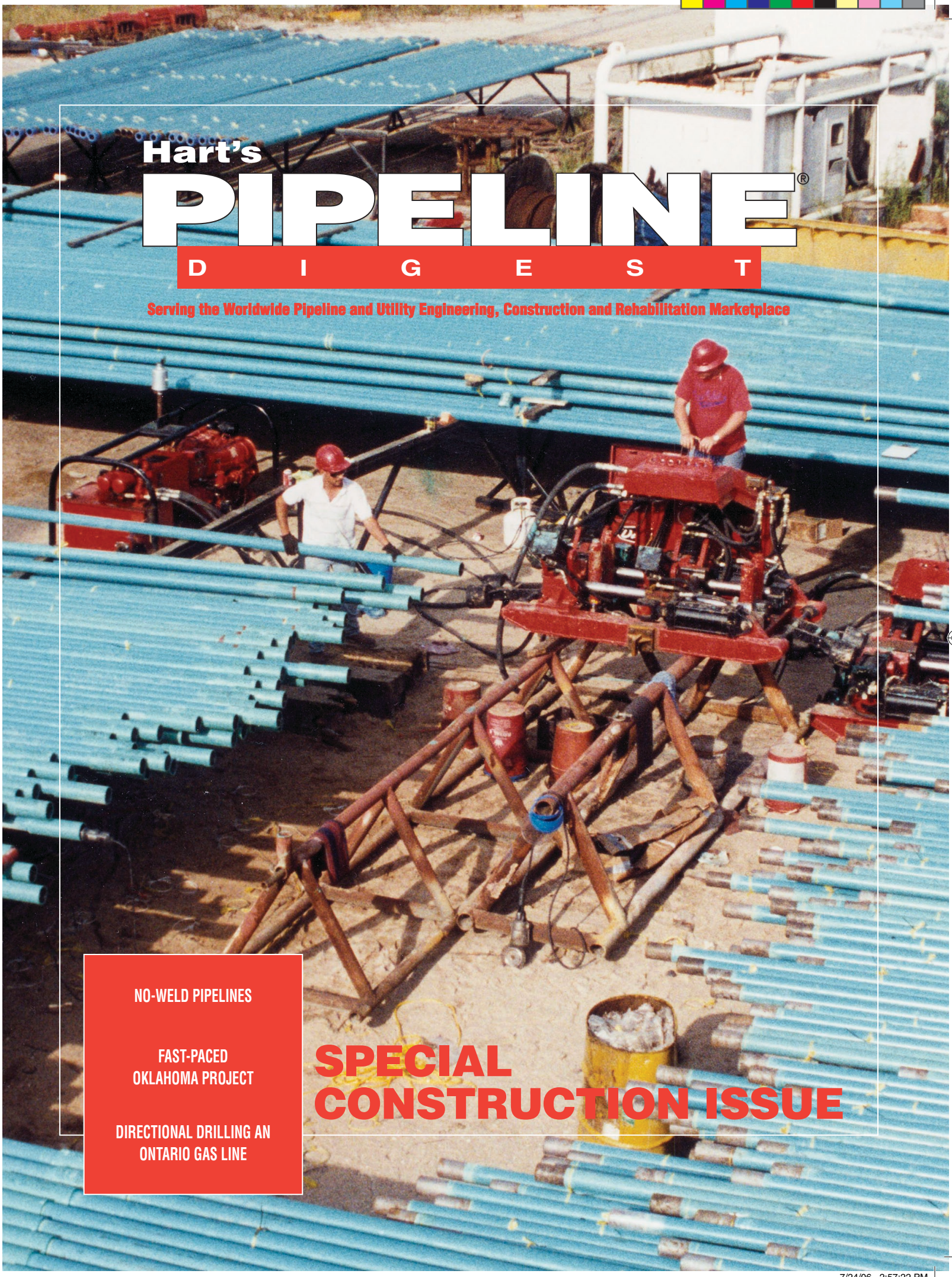

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SPECIAL CONSTRUCTION ISSUE

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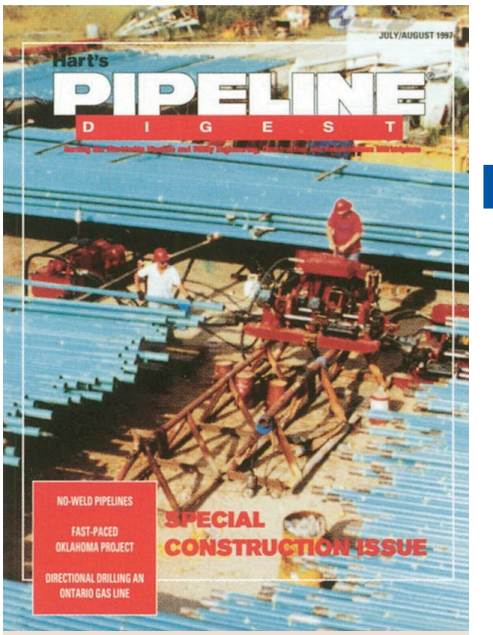

about the cover ▲

Photo provided by Jetair International.
See related article on p. 1.

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CONSTRUCT PIPELINES WITHOUT WELDING

By R.J. Verbeck and M.J. Holland, Jetair International Inc.

A positive seal coupling system that uses only two pieces of joining equipment and a four- or five-man joining crew increases pipelay rates over conventional welding.

Fig. 1. Hydraulically actuated clamping doors hold the pipe end to be inserted in place.

Providing a cost-effective alternative to welding in pipeline construction, a positive seal coupling (PSC) system joins pipe using a press-on, mechanical, metal-to-metal interference fit coupling with a tapered inside diameter (ID) smaller than the outside diameter (OD) of the pipe it is designed to join. A PSC is first installed on one end of each joint of pipe before mobilization to the field. During pipeline construction operations, the positive seal joining unit holds the pipe end to be joined in place, and then presses the pipe end into the open coupling end. Each newly joined pipe joint is cradled in the joining unit which is suspended from a pipelayer sideboom. The joining process takes less than a minute.

Positive Seal Coupling

Developed as an alternative to welding to join internally coated pipe, the PSC system from Jetair International Inc. eliminates the internal coating damage caused by welding. (The coupling can also join internally bare pipe.) The coupling can join pipes with wall thickness schedules of up to 160 and API 5L Grades through X65, seamless or ERW. The PSC connection requires no X-ray, further enhancing pipelay rates. Minimal pipe end preparation is required and the system uses the standard API 30° weld bevel pipe end. There is no ID size restriction to product flow or pigging operations.

In conjunction with the controlled interference fit, the coupling also features finely machined internal serrations and annular grooves. After the pipe end is pressed into the coupling, these inward angled serrations and grooves grip the pipe's outer surface and form a trap for a secondary sealant epoxy. The coupling's solid grip on the pipe is a result of the high interfacial bearing pressure which is generated between the coupling and pipe by the interference fit design.

The PSC system can also include an elastomeric spacer ring gasket (SRG) positioned inside the center of the coupling. The SRG is shaped to conform to the profile of the pipe bevel ends and serves as a bumper between the pipe ends to prevent damage to the pipe's internal coating at the pipe ends. As an associated benefit, the SRG forms a third independent seal in the PSC system when it is energized between the pipe ends upon completion of the connection make up.

When used with externally FBE coated pipe, the PSC system can also eliminate field connection shrink sleeve, tape wrap or other external

coating joint repair. A pipeline construction innovation developed by Jetair enables the positive seal joining unit to grip directly onto the FBE coating with only a cosmetic impression on the FBE surface. In this process, the PSC exterior is also FBE coated. Therefore, when the field PSC connection is completed, the pipeline's exterior is continuously FBE coated, end-to-end.

Joining Equipment

Jetair also designs and manufactures the equipment used to join pipe with the PSC. The positive seal joining unit is portable and has its own hydraulic power unit. The joining unit holds the pipe end that is to be inserted in place with long hydraulically actuated clamping doors (Fig. 1). At the opposite end of the unit, the coupling is held in place with hydraulic clamping doors and coupling shoulder backups. The joining unit then presses the pipe end into the coupling to a premarked insertion depth of one half the coupling length using parallel, horizontal hydraulic "ram" cylinders. Design of the pipe clamps and coupling backups maintains true alignment during insertion.

After insertion is completed, the clamping doors are opened and elevating vee rollers on both ends of the joining unit raise the connection and pipe several inches out of the joining area. The pipe is then cradled on the vee rollers which allows the newly joined joint of pipe to roll freely through the joining unit as it is carried by a pipelayer sideboom to the pipeline end for the next connection. (Fig. 2).

Joining units are manufactured in three sizes to accommodate different pipe size ranges (Table 1).

Examples of some actual axial forces required to complete a PSC insertion are shown in Table 2.

All necessary power for the joining unit is supplied by a hydraulic power unit which is mounted on a wheeled trailer hitched to the back of the pipelayer sideboom. (Fig. 3).

PSC Installation and Pipeline Construction

For internally coated pipe, the PSC installation process starts after the coating has been applied. The first end PSC installation is often done in the pipe coating plant's yard but it can be done anywhere with sufficient room, pipe racks, and a forklift. If the pipe is externally FBE coated, bare pipe-end cut backs must be masked as the pipe is being coated. The cut backs are normally ½-in. less than the PSC's insertion depth to allow a short length of the coating to enter the coupling when the pipe insertion is completed.

Then the pipe ends are cleaned with an abrasive blast back to ½-in. less than the full insertion depth. If abrasive blasting is not possible, a power wire brush can be used. Any sharp corners at the OD of the weld bevel are removed with a quick pass around the edge using a power grinder. These two operations are the only requirements for pipe end preparation.

The pipe ends are then checked for proper OD tolerance in accordance with API Specification 5L. Go and no-go rings or calipers are used for this purpose. If the pipe ends passes the OD tolerance check, the proper insertion depth is then marked on the pipe. As the foregoing work progresses, the steel mill or coating plant pipe identification markings are checked on each joint of pipe to confirm the client's specified wall thickness and grade designation.

Before the pipe end is inserted into the coupling, a lubricant/sealant, usually a specially-formulated epoxy, is applied to the internal bore of the coupling and the external surface of the pipe ends. The epoxy serves as a lubricant at the coupling-pipe interface during pipe insertion and prevents metal galling. As an added benefit, the epoxy lubricant, trapped between the coupling's serrations, cures to form a sealant throughout the interface between the coupling and pipe surface and around the pipe ends at the SRG. This additional epoxy seal is secondary to the primary metal-to-metal seal.

Fig. 2. (Below) Vee rollers cradle the pipe, allowing it to roll freely through the joining unit as it is carried by a pipelayer sideboom.

Table 1. Joining Unit sizes.

Nominal pipe size range capability, in.	Joining unit weight, lb	Maximum insertion force capability, lb
2 to 4	4,500	130,000
4 to 8	8,500	400,000
8 to 12	18,500	1,000,000

Table 2. Axial forces required to complete a PSC insertion.

Nominal pipe size, in.	Pipe wall thickness, in.	API 5L pipe grade	Required insertion force, lb
4	0.337	X52	80,000
8	0.322	X52	200,000
12	0.406	X52	480,000

For the first end, yard PSC installation, the joining unit is positioned alongside pipe racks and a coupling and SRG are installed on one end of each pipe joint (Fig 4). The pipe insertion process is a straight, press-in operation without any pipe rotation. The pipe is rolled endwise into and out of the joining unit from the pipe racks. After PSC installation, the SRG is seated and the excess epoxy is cleaned off of its exposed face. The ends are capped and pipe is then shipped to the field for pipeline construction.

In the field, the joining unit is suspended from a pipelayer sideboom. Next, a second, leading sideboom picks up and sets the next pipe joint to be connected into the joining unit's pipe clamping doors. Backhoes are often used for this set-in function on smaller pipes. Maximum pipelay rates can be achieved by using two lead set-in sidebooms/backhoes which leapfrog each other to pick up and set in the next pipe joint. (Fig. 5).

The use of two set-in sidebooms/backhoes will keep up with the speed of the PSC pipeline construction process and allow pipelay rates as fast as one joint every two minutes.

If the pipeline is going to be laid directly into a ditch, it is customary to use a following "lay down" side-boom/backhoe to hold the pipeline relatively

Fig. 5. (Below) Two set-in backhoes leapfrog each other to pick up and set in the next pipe joint.

Fig. 3. (Below) The joining unit has its own hydraulic power unit.

Fig. 4. (Below) In the first end, yard PSC installation, a coupling and SRG are installed on one end of each pipe joint.

horizontal behind the joining unit so that the pipeline's weight doesn't excessively tilt the joining unit.

Internal Hydrostatic Pressure Testing of PSC Pipelines

The standard internal hydrostatic test pressure limit for pipelines joined with the PSC system is 90% of the calculated specified minimum yield strength (SMYS) internal pressure of the pipe itself. This limit conforms well with the various ASME piping codes. Sometimes it is possible to design higher pressure capabilities into the PSC connection.

The highest hydrotest pressure run to date on actual field pipeline PSC connections was done by Petroleum Development Oman, the Sultanate of Oman. PSCs were used to install a section of an NPS 6-in. Schedule 120, Grade X60 pipeline in PDO's Upstream LNG Long Term Well Test Facilities. The line was successfully tested at 6,440 psi for 24 hours. The positive seal coupling system is simple and it works.

PSC Pipeline Construction Projects

Consolidated Contractors International Co. constructed a 77.3 mile NPS 10-in., 10.75-in. OD pipeline for the Abu Dhabi National Oil Co. from Maqta to Habshan in Abu Dhabi using 10,204 PSCs (Fig. 6).

Fig. 6. Construction of a 77. 3 mile NPS 10 in. pipeline for the Abu Dhabi National Oil Co. used 10,204 PSCs.

The line pipe was coated internally and externally with fusion bonded epoxy (FBE). As a result, no field joint wrap/repair was required and left the pipeline continuously coated both inside and out upon completion of the field PSC make up.

More than 70 miles (9,793 joints) of mainline construction were completed in only 45 days - a 218-joint, 1.65 mile per day average for the single pipelay spread. Further, the 45 gross days net down to 36 days of actual pipeline construction time after adjusting for third party downtime and equipment relocations. This yields a true construction average of 272 joints (2.1 miles) per 10-hour workday. The construction highlight was the joining and laying of 401 joints – 3 miles of pipeline – in a single day.

Dual pipelines (NPS 3-in. and 4-in.) were simultaneously joined, laid and jet sled trenched using PSCs for Fina Oil & Chemical Co. in Vermilion Block No. 16, Gulf of Mexico. The pipelay operation schedule was daytime 12 hour pipelay days using Diamond Services Inc.'s 180 ft. x 40 ft. Lay Barge LB5. Two joining units were mounted on the laybarge with one unit above and behind the other (Fig. 7). Both units were operated by a single operator plus a two man crew. Both pipes sizes were externally coated with FBE but were internally bare. One feature of this project was that all of the 4.8 mile of line pipe were double-jointed onshore with PSCs (Cover Photo), saving additional expensive offshore pipelay time.

On the most productive day, 0.9 mile of each line (1.8 miles of pipeline total) was joined, laid and jet trenched in a single 12-hour day. That included nine stops for anchor moves, eight stops for welded anode installation, crew lunch and dinner, and about 2 hours of cumulative time waiting on the trench jetting sled to catch up with the pipelay rate. The net pipelay time was about 4 hours for the total 1.8 mile of pipeline. ■

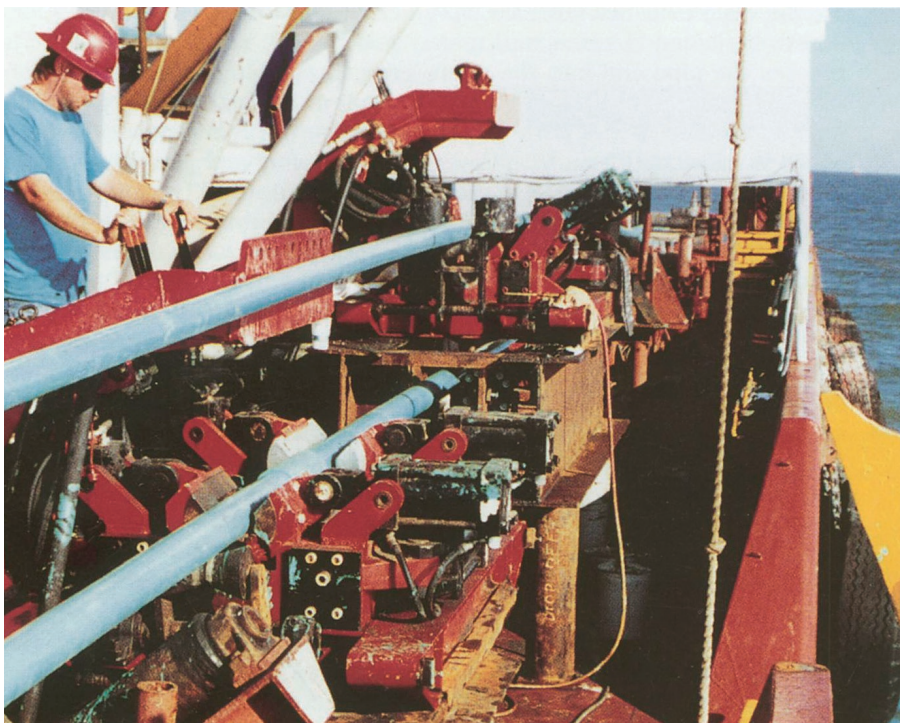

Fig. 7. Two joining units were mounted on the laybarge for a project for Fina.

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