Example 17 (1995) - Monitoring stresses in North Sea pipelines

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BACKGROUND AND DESCRIPTION OF PROJECT
The landfall for the two 620 km long, Europipe 1 and Europipe 2 gas pipelines from the oil fields in the North Sea crosses shallow coastal wetlands on the German coast in the Wadden Sea National Park of Lower Saxony. To avoid disturbing these unique wetlands of extreme environmental importance and sensitivity, it was decided that the pipelines would pass under the protected areas in a 2.5 km long tunnel with a diameter of 3.5 m. The tunnel was constructed by the telescope pipe jacking method.

The connection between the pipelines and the Landfall tunnel is made at an offshore Tie-in Chamber, a cylindrical concrete structure 14 m in diameter supported on driven piles. Figures 1 and 2.

FACTORS THAT INFLUENCED THE DESIGN OF THE MONITORING PROGRAM
The design pressure for the two gas pipelines is 156 Barg. They enter one side of the Tie-in Chamber where the connection is made to the two pipes in the Landfall tunnel. As shown in Figure 3, the pipelines change direction in the Tie-in Chamber. This change in direction creates a maximum force of the order of 25000 MN on the Tie-in Chamber and induces large stresses in the pipelines.

SCOPE OF INSTRUMENTATION
Both pipelines were instrumented with strain gauges to monitor the stresses as illustrated in Figure 4. Biaxial inclinometers were used to measure tilt of the Tie-in Chamber.

SAMPLE OF STRAIN MEASUREMENTS IN EUROPipe 1

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Fig. 1. Tie-in Chamber during construction

Fig. 2. Section through the Tie-in Chamber

Fig. 3. Cross section

Fig. 4. Location of strain gauges

Fig. 5. Pressure test of Europipe 1