

THE PALACEKNOWE PIPELINE DIVERSION FAILURE

The gas release

On Wednesday 22nd December 1993 a steel pipeline carrying natural gas at high pressure fractured at Palaceknowe near the village of Beattock in Dumfries and Galloway.

The sudden gas release produced a large crater over the fracture point and scattered soil debris over the surrounding area. The escaping gas necessitated the closure of the A74 trunk road and the West coast main railway line. Police also evacuated 17 houses.

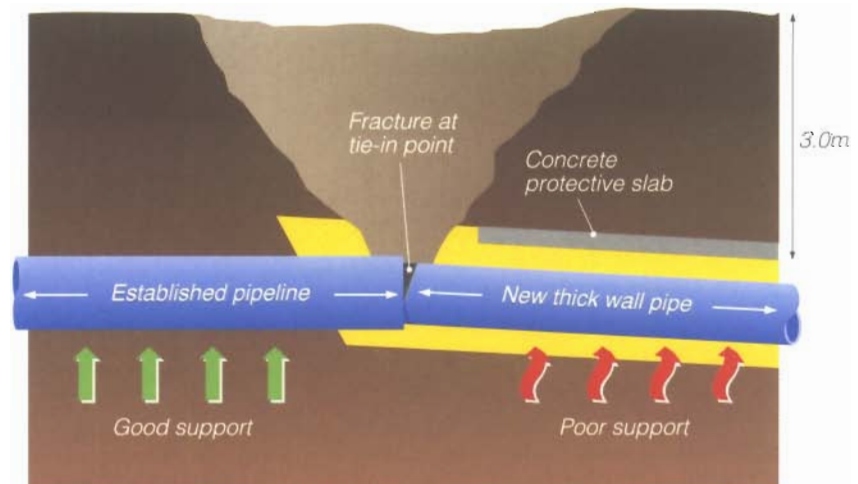
The gas released did not ignite and there was no injury to any members of the public, emergency services' personnel or British Gas staff.

During the initial escape and the subsequent pipeline shutdown approximately 1000 tonnes of natural gas (valued at £100,000) was released to the atmosphere.



The failed pipe could clearly be seen at the bottom of the crater

Beattock





Site measurements



British Gas Engineering
Research Station

Failure investigation

The pipeline failure was investigated by a team of specialists from the British Gas Research and Technology (R&T) Division. This work was carried out with the agreement of the Health and Safety Executive and under the scrutiny of their Inspectors. A separate and independent investigation was also carried out and reported by operational staff from British Gas TransCo (the business unit responsible for the operation and maintenance of the pipeline).

The R&T investigation involved the removal of the failed section of pipeline for a detailed examination of the pipe dimensions, chemistry and material properties. A detailed structural analysis of the pipeline and its failed component was also carried out. Two site investigations at similar pipeline locations completed the study.



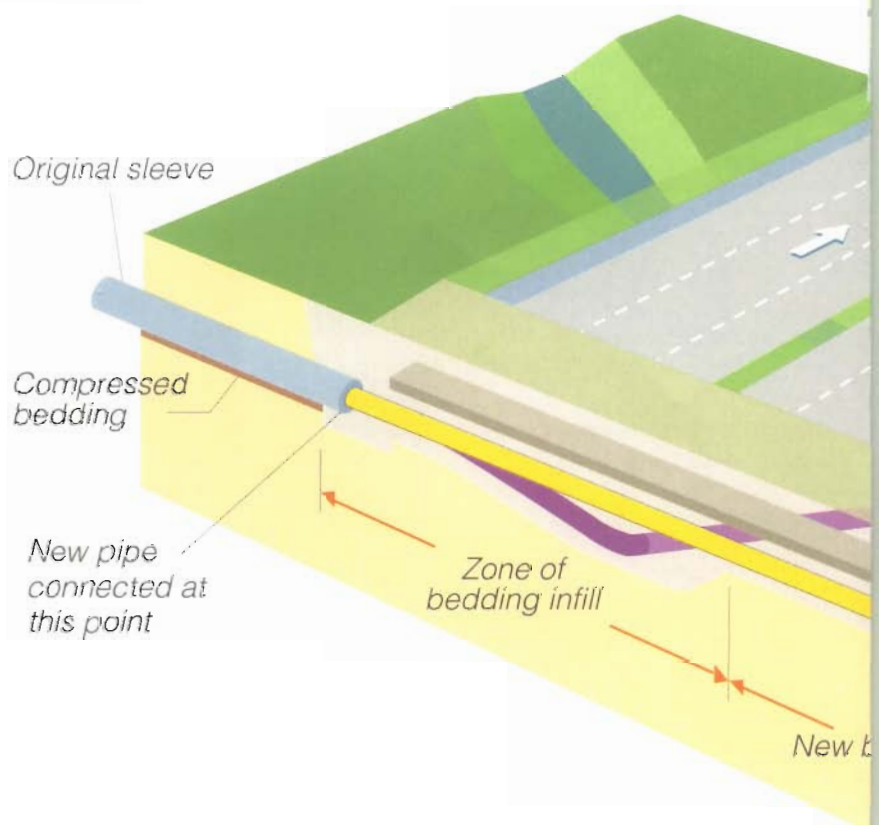
Investigation reports on similar
pipeline installations

The failed pipeline

A gas transmission pipeline crosses beneath the A74 at Palaceknowe. This pipeline originally became operational in March 1978. A section adjacent to the A74 was replaced in 1993 to accommodate the construction of the M74 motorway. This newer pipe was thicker walled than the original to satisfy design standards for its future location below the motorway. The pipeline was further protected from damage by a concrete slab.

The new section of pipeline was connected to the original pipe at an existing steel construction joint. This special joint provided a seal to a casing around the thin walled pipe. The casing offers protection to the gas transmission pipeline where it crosses below the A74 trunk road. The pipeline failed in this component in the metal alongside the thick walled pipe connection weld.

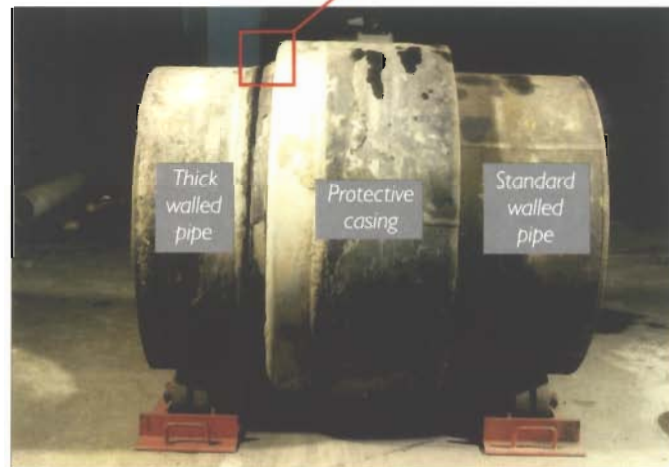
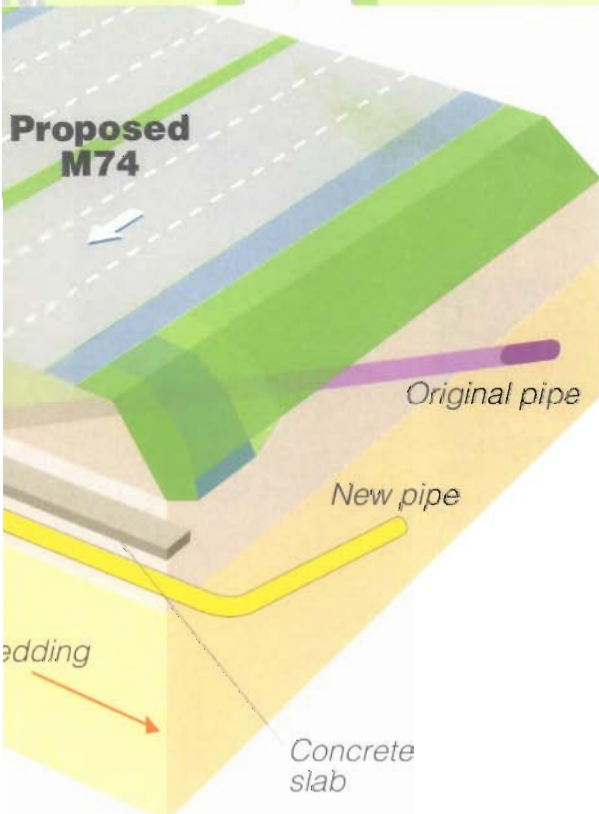
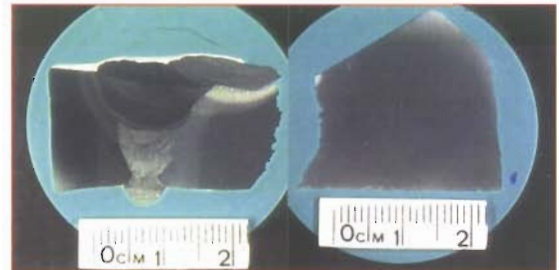
The location of the motorway dictated a modification to the pipeline alignment. This involved a change to the position of a stream crossing and a reduction in the pipeline depth over part of the diversion length. This placed the new pipeline on an area of disturbed ground where the original pipeline had been deeper.



Cause of failure

The diversion had involved a change in the vertical level of the pipeline and this had placed the new pipe on a layer of soil infill materials. One of these materials was subsequently found to be sensitive to compression under water saturation. This would have occurred at some time after pipeline construction and backfilling. The soils also exhibited compression under the action of the considerable depth of material above the pipeline. A concrete protective slab produced additional loading and compression to the soils below the pipeline. The combined loading from the concrete slab and overburden material produced a differential settlement along the pipeline which produced a very high bending load at the pipe to casing joint.

Section through girth weld showing location of fracture



Cut out section of pipeline containing the fracture

Additional finding

Whilst the nature of the weld and pipe was not a contributory factor to the failure of the joint, it was found during the investigation that the strength of joints of this type could be improved by modifying the welding technique.

Actions taken to avoid a similar incident

- A number of similar pipeline diversions with the type of construction joint that failed have been checked through detailed structural analysis. Calculations were validated against two detailed investigations of similar diversions. Construction records, project personnel and photographs have also been consulted where available. These checks have demonstrated that all other similar diversions to Palaceknowe are satisfactory.
- The following British Gas standards and engineering documents have been reviewed and are being amended where necessary:

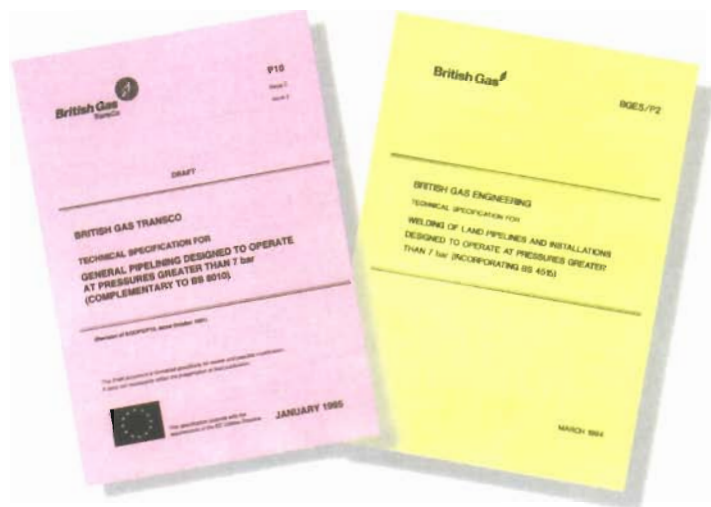
General Pipelining Specification - Engineering Requirements. BGC/PS/P10. October 1981.

Departmental Standard for Civil Engineering and Building Works. PD/DS/120.

Pipelines Engineer's Instruction E20 - Principles of pipe selection for and design of crossings of roads, canals, railways and other services. August 1987.

Welding of land Pipelines and Installations designed to operate at pressures greater than 7 bar. BGES/P2. March 1994 (includes the amendments).

- All new construction contracts include the amendments.



CONCLUSION

The failure is attributed to settlement of the new pipeline over an extensive area of infill material which was placed beneath the new pipe as part of the construction operation. Failure took place as a result of overload of the pipeline structure at this point.