DEVELOPMENT OF A MECHANICAL DAMAGE FRACTURE MECHANICS MODEL FOR UKOPA

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Advantica Project Reference: 1/05292

Project Start Date: 1 March 2004

Project End Date: 31 May 2004

Progress Report Date: 26 April 2004

Project Objectives:

Damage due to external impact is the strongest threat to transmission pipeline integrity. This has been recognised for many years and a fracture mechanics based model was developed by British Gas over twenty years ago to determine the relationship between failure pressure and defect size. An extensive experimental test programme involving in excess of 130 pipe and ring tests was undertaken and a semi-empirical relationship between failure pressure and defect size was constructed. This relationship is used as a basis for assessing the significance of reported defects and more recently as a basis for determining the likelihood of occurrence of a future failure.

The understanding of fracture mechanics has increased considerably over the past 25 years. However, whilst some limited effort, based on this understanding, has gone towards the improvement of the external interference model this does not compare with the effort that has been focused on corrosion and fatigue. Moreover, where improvements have been introduced a divergence in the structure of the models is emerging. Notably, models used by HSE and NGT have significant mechanistic differences.

Consequently, the existing models are notably far less advanced than the models used to address damage due to both construction and corrosion defects. This is an issue of obvious concern since external interference is the most onerous threat and pipelines are increasingly being operated at higher stress levels than before.

The objective of the project is to develop a new fracture model (limit state function) that is capable of predicting failure. Experimental data originally used to derive the original fracture model will be used to develop a revised model that will enable an alignment of the HSE and NGT models to be made.

Summary of Progress:

All experimental data used to derive the original fracture model by Hopkins and Cairns (ERS 2381 and ERS 2382) has been analysed using the original experimental data. This data includes 111 ring and 21 vessel tests. As has been previously recognized, considerable scatter in the test data is observed when the results are plotted on a failure assessment diagram, as shown in Figure 1. Sensitivity studies are now being progressed by varying the input parameters for each data point in order to determine how failure can be best predicted. In particular, the focus of work

will now concentrate on modeling the dent-gouge as a notch with a micro crack and incorporation of appropriate residual stress fields.

Project Status/Issues:

This project was started later than scheduled due to operational constraints, however, it is on target for delivery on the 31st May 2004. The project is being overseen by Vinod Chauhan, Solution Consultant, who has extensive experience in the use of R6 and other fracture mechanics models.

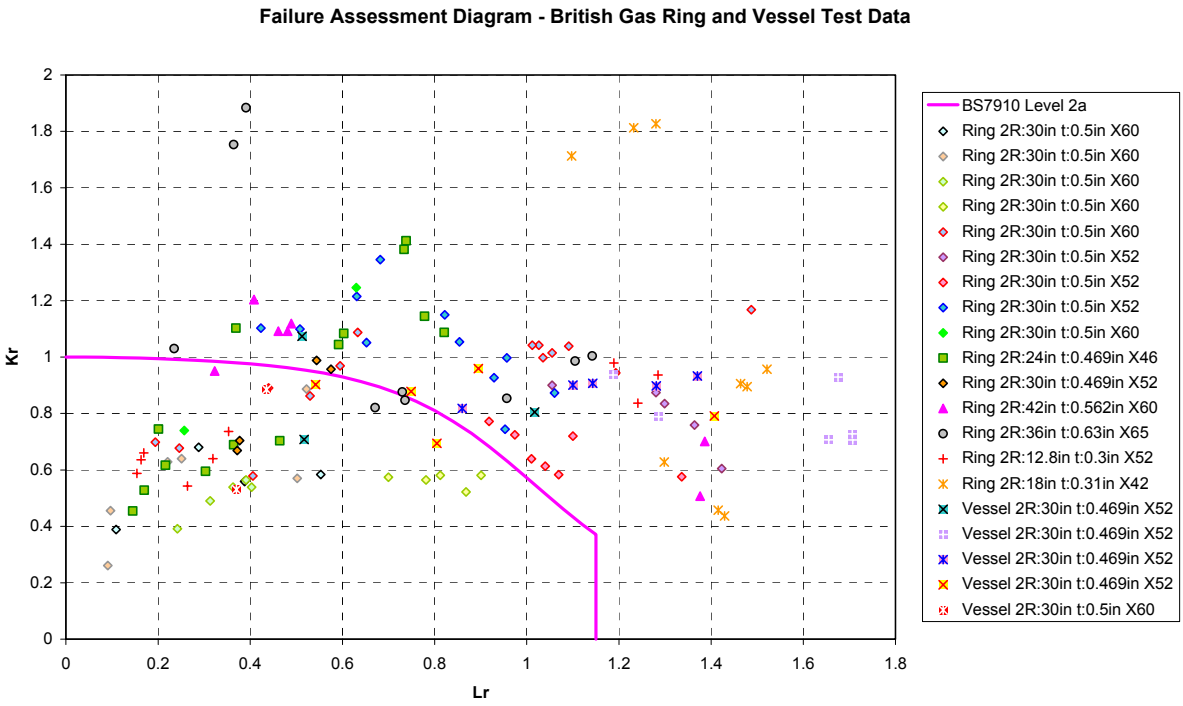

Figure 1. Results of ring and vessel tests plotted on Level 2A FAD