European Technology Development Ltd

Development of Inspection, Monitoring and Life Assessment Technologies & Guidelines *for* P91 & P92 in-service components

Acronym: '**P91-P92 Inspection & Life Assessment**'

ETD Proposal No: **1265-gsp-proj13**

EXTRACT FROM PROPOSAL – CONTACT US FOR MORE INFORMATION

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1. BACKGROUND AND INTRODUCTION

The 9% Cr martensitic steels have now been in use in the power generation industry for over 20 years. Over this time there have been a number of incidents of cracking and failure in components made from these steels. Thick section components have generally been failing by Type IV cracking at welds. One problem with Type IV failure has been that the cracking starts sub-surface and cannot be always detected by easy to use and more economical procedures such a MPI, replication etc. The cracking only emerges on the surface near the last leg of its journey thus making the structures potentially unsafe. P91 and P92 steels have further problems in that unlike the low alloy ferritic steels operating in the creep regime, the more easily visible changes such as spherodisation and break down of the microstructure at the scale that can be seen under an optical microscope does not occur in these steels. To make matters worse and life assessment more difficult it is now fairly well established that unlike the traditional low alloy steels high Cr martensitic steels do not necessarily go through the stages of creep cavity initiation → cavity growth → micro-cracking → macro-cracking → failure. In 9Cr martensitic steels the stages are reduced to: creep cavity initiation → cavity growth → failure without warning. This means that for these steels it is important that we can measure and relate cavity density, size etc. to remaining life. Another difference between the traditional low alloy steels and 9Cr martensitic steels is that the cavity size in 9Cr martensitic steels for up to about 70% of component life can be of nanometre level thus making cavity detection and quantification by traditional means difficult until late in life. Thus any new techniques for the integrity and life assessment of P91 and P92 steels need to be sensitive enough to resolve small cavity size and quantify the cavity density. This project has set out to achieve all of the above.

As a result of the increasing number of P91 component failures worldwide (and P92 expected to follow the trend as its use becomes more common), interest in the integrity/life assessment, inspection and monitoring of these steels has become acute. Recent systematic research and study, particularly in Europe and Japan, of the inspection and monitoring of component microstructural damage, cavitation and cracking and subsequent analysis are giving indications of the potential new inspection, monitoring and integrity assessment techniques that may be used successfully and require demonstration and validation on feature specimen and plant scale.

For the following reasons ETD considers itself in an ideal position to grasp the potential of success in this area and this proposal is based on ETDs' this background and know-how.

1) ETD has surveyed these studies in depth for its recently completed projects on 'Plant and R&D Experience in the Use of New Steels' and discussed the related issues with the international stakeholders in this area.

2) ETD's recently completed exploratory project "P91: Inspection, Monitoring, Integrity & Life Assessment", Project no 1088-gsp-proj07 (acronym: 'P91 Integrity') has investigated a number of NDE and lifing techniques and identified the most promising ones.

This proposal aims to follow on the above findings and experience by testing and validation of these techniques on feature tests and in-plant trials where feasible. It aims to **make recommendations and produce guidelines** a) For the use of these techniques for early stage damage detection, inspection and component monitoring, and, b) On the methodologies thus developed for the integrity/ life assessment of P91 and P92 components.

This project will test butt-welded pipes under internal pressure creep and creep-fatigue modes and the data will be supplemented by laboratory specimen tests for life assessment purposes. The feature tests will be inspected at regular intervals and monitored by on-line monitoring techniques identified above. Testing conditions will be representative of power plant operating conditions including cyclic operation which is now becoming more common. The results will help build up accurate relationships of different damage parameters with the component remaining life and thus improve plant operator’s confidence in the long term safe operation of high Cr martensitic steels.