McSCAMP

Minimising nuclear component stress corrosion cracking through advanced machining parameters

OBJECTIVES

In the original light water reactor designs, stress corrosion cracking (SCC) phenomena were not explicitly considered. Beginning in the mid-1970s, the pressurized water reactor fleet worldwide suffered from a series of SCC incidents that were mostly confined to Alloy 600 steam generator (SG) tubing, initially from the secondary side (ODSCC) then from the primary side (PWSCC). The ensuing tube damage resulted in substantial economic loss for utilities in the 1980s and premature replacements of SG in the USA and elsewhere. In the early 1980s, alloy X-750 GT support pins also began to suffer from PWSCC and many have been replaced. Subsequently, PWSCC extended in the 1990s to wrought Alloy 600 components, most notably reactor pressure vessel (RPV) upper head nozzle penetrations for control rod drive mechanisms. ODSCC of thermally treated Alloy 600 SG tubing has also been observed. McSCAMP aims to develop a theoretical framework supported by small-scale experimental validation to assess manufacturing methods for NPP components such as SGs, RPV head piping and threaded connections, to reduce the residual stresses imparted during machining and prevent later SCC. The project will lead to a deeper understanding of the factors which cause residual stresses, and will investigate advanced machining methods (such as dry and cryogenic machining) for reducing the imparted stresses.

DESCRIPTION OF WORK

The project consists of a desk study and a small experimental program. The desk study has the following aims:

- Assess the philosophy behind new innovative reactor designs and technologies in relation to design, materials and manufacture.
- Identify the key machining parameters producing unwanted residual stresses in stainless steel nuclear components, using information gained from previous work on machining, and residual stress evaluation.
- Identify available advanced machining techniques such as dry machining and the use of cryogenic coolants.
- Conduct a design of experiments to determine which parameters should be tested for the reduction of residual stresses.

The experimental program has the following aims:

- Conduct machine parameter testing on steel test coupons in accordance with the design of experiments.
- Inspect the surface and below surface material responses to the different machining parameters through various destructive evaluation techniques.
- Collate the results of inspection and recommend further work into identifying the optimum machining parameter conditions for improving surface integrity.

MAIN RESULTS / HIGHLIGHTS

- State-of-the-art report (consortium restricted)
- Report on machining trials (NUGENIA restricted)
- Material inspection report (NUGENIA restricted)
- Final project report (public)
- Dissemination roadshow (public)

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Improving surface integrity of machined steel

DURATION

1 April 2015 – 30 September 2016
18 months

CONTACTS

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PARTNERS

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