Errata

Approval Date: July 12, 2018

Code Cases will remain available for use until annulled by the applicable Standards Committee.

Case N-889
Reference Stress Corrosion Crack Growth Rate Curves for Irradiated Austenitic Stainless Steels in Light Water Reactor Environments
Section XI, Division 1

Inquiry: When performing an analytical evaluation of a flaw in accordance with IWB-3132.3, what stress corrosion crack growth rate curves may be used for irradiated austenitic stainless steels exposed to light water reactor environments?

Reply: It is the opinion of the Committee that the stress corrosion crack growth rate curves for analytical evaluation of flaws in irradiated austenitic stainless steels exposed to light water reactor environments given below may be used.

1 INTRODUCTION

Stress corrosion cracking (SCC) growth rates in materials vary under the combined effects of three primary variables: material susceptibility, environment aggressiveness, and loading severity. Irradiation affects each of these primary variables. The crack growth rate reference curves in this Case use irradiated yield stress to represent the effects of radiation.

2 NOMENCLATURE

A_i, B_i = intermediate results, yield stress model, MPa
a = crack depth, in. (mm)
C = coefficient for a particular environment, $(\text{in./hr})/\{(\text{ksi})^{\nu}(\text{ksi}\sqrt{\text{in.}})^{\eta}\}$ $[(\text{mm/s})/\{(\text{MPa})^{\nu}(\text{MPa}\sqrt{\text{m}})^{\eta}\}]$
d = irradiation dose, dpa, for light water reactors; 1 dpa $\cong 7 \times 10^{20}$ n/cm^2, E > 1 MeV
da/dt = crack growth rate, in./hr (mm/s)
K = Mode I stress intensity factor, $\text{ksi}\sqrt{\text{in.}}$ $(\text{MPa}\sqrt{\text{m}})$
m, m' = temperature coefficient, yield stress model, 1/°C
r = pre-irradiation strengthening parameter, dimensionless
S_T = temperature adjustment function, dimensionless
T_F, T_C = application temperature, °F (°C)
T_K = application temperature in Kelvin, K
η = fitted exponent on K, dimensionless
ν = fitted exponent on $\sigma_{0.2}$, dimensionless
$\sigma_{0.2}$ = irradiated yield stress, ksi (MPa)

3 SCOPE

This Case provides reference stress corrosion crack growth rate curves for use in flaw growth evaluations for irradiated austenitic stainless materials in pressurized and boiling water reactor environments.

3.1 APPLICABLE MATERIALS

Materials covered by this Case are wrought austenitic stainless steels and cast austenitic stainless steels (cast equivalents of Series 300 stainless steels) and associated weld metals including the HAZ (Series 300 stainless steels).

This Case is not applicable to wrought Type 321 or to dissimilar metal welds.

3.2 APPLICABLE TEMPERATURE RANGE

(a) The equations and reference curves within this Case are applicable to the metal temperature ranges shown in Table 1.

(b) An adjustment term, S_T, is provided to adjust the reference curves for application temperature within stated ranges shown in Table 1. The reference temperature for Figures 1, 1M, and 2 is 550°F (288°C). All application temperatures other than 550°F (288°C) require the calculation of the adjustment term S_T.

3.3 APPLICABLE WATER ENVIRONMENT

The applicable water environment for a Boiling Water Reactor (BWR) and a Pressurized Water Reactor (PWR) is defined in Table 1.

3.4 APPLICABLE LOADING

(a) The applicable loading range acting on the crack includes quasi-static and constant loading.

Case N-xxx

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2 NOMENCLATURE

A_i, B_i	Intermediate results, yield stress model, MPa
C	Coefficient for a particular environment, (in./hr)/{(ksi)$^{\nu}$(ksi$\sqrt{}$in.)$^{\eta}$} [(mm/s)/{(MPa)$^{\nu}$(MPa$\sqrt{}$m)$^{\eta}$}]
K	Mode I stress intensity factor, ksi$\sqrt{}$in. [MPa$\sqrt{}$m]
S_T	Temperature adjustment function, dimensionless
T_F, T_C	Application temperature, °F [°C]
T_K	Application temperature in Kelvin, °K
a	Crack depth, in. [mm]
d	Irradiation dose, dpa, for light water reactors 1 dpa $\cong$ 7 x10^{20} n/cm^2, E > 1 MeV
da/dt	Crack growth rate, in./hr [mm/s]
m, m'	Temperature coefficient, yield stress model, 1/°C
r	Pre-irradiation strengthening parameter, dimensionless
η	Fitted exponent on K, dimensionless
ν	Fitted exponent on $\sigma_{0.2}$, dimensionless
$\sigma_{0.2}$	Irradiated yield stress, ksi [MPa]

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