

Crack Growth Rate for Alloy 600 Nozzle Material

Update on developments since February 2002

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MRP Crack Growth Rate Approach

- Goal is to establish appropriate CGR guidance for generic application in nozzle base material
- Involvement of MRP 'Expert Panel' (includes ANL/NRC) is ongoing in refining approach
- Crack growth database has been consolidated
- Revised MRP Crack Growth Rate Report will be presented to NRC (proposed date: late May)
- CGR data for base material feeds directly into the probabilistic risk assessment being carried out by SIA

Changes in database since Feb. 02

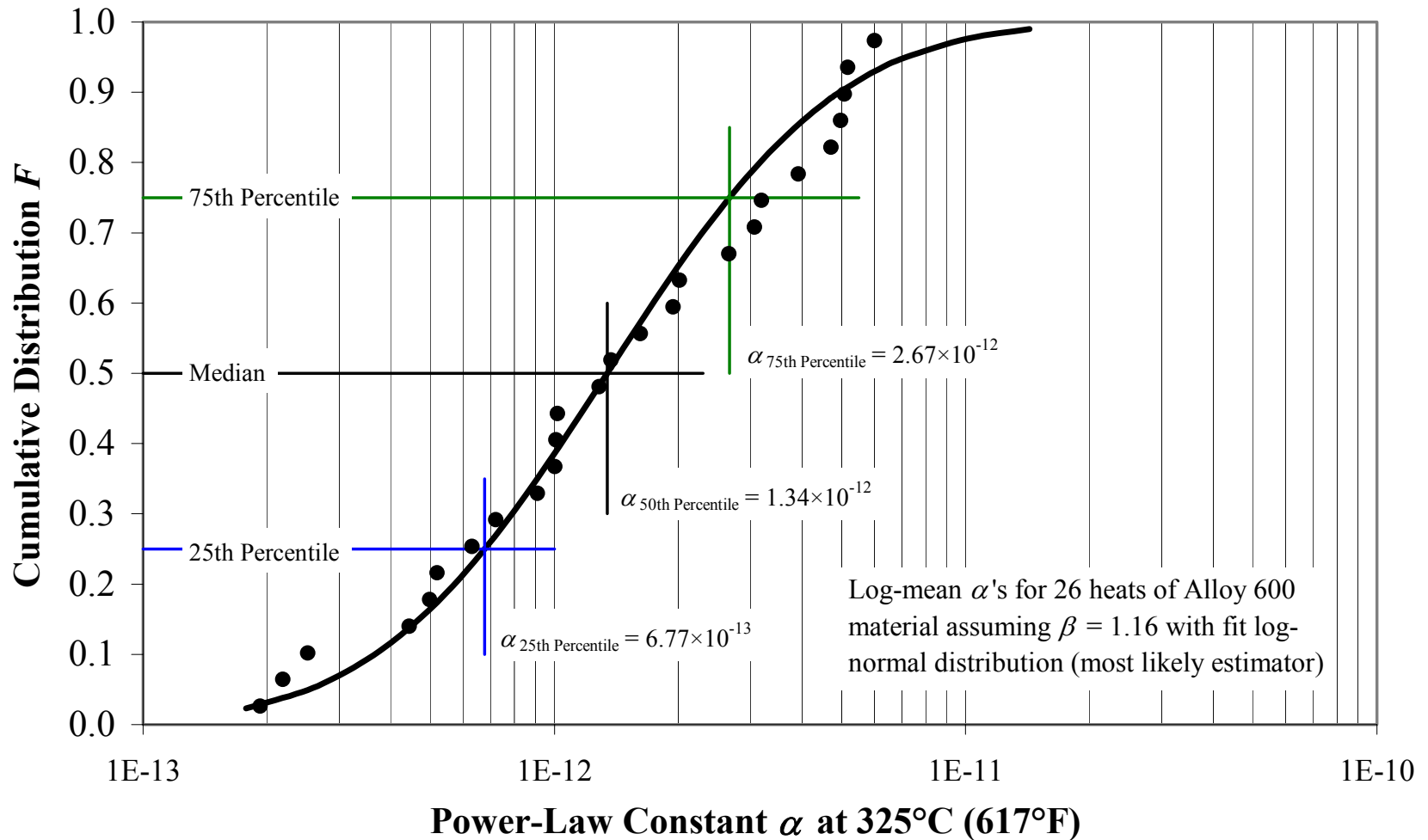
- French re-evaluation has led to changes in the K values for a significant number of laboratory CGR data points from both EdF and CEA
- General trend is to somewhat lower K values for EdF WOL specimens and to somewhat higher K values for CT specimens tested by CEA
- Screening criteria have been defined more precisely and reasons for eliminating some earlier data points revisited
- Additional, high-quality CGR data has been obtained from Spain (CIEMAT), screened and incorporated
- This results in the inclusion of 4 extra heats of Alloy 600 material, bringing the new database total up to 26 heats

Derivation of MRP CGR Curve

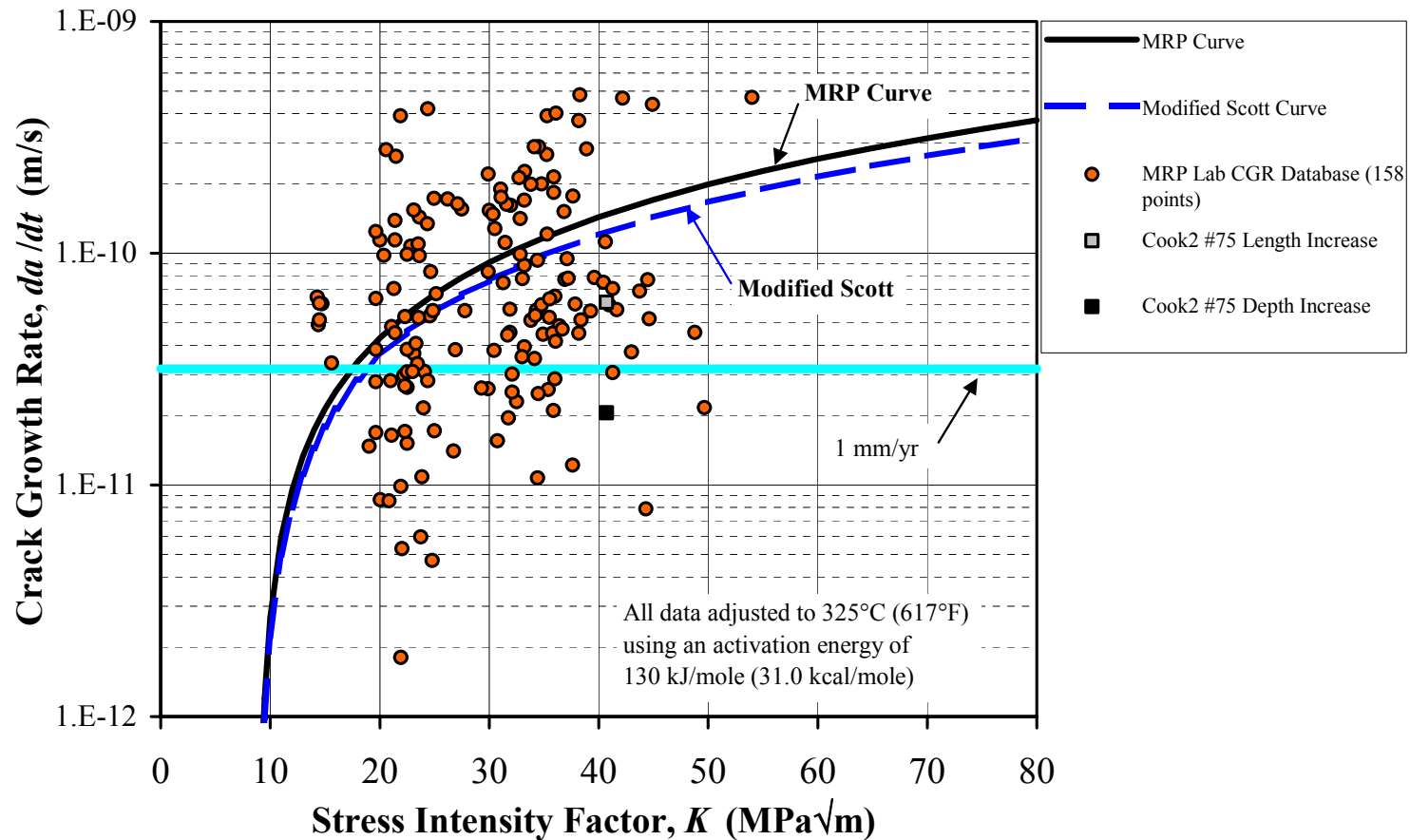
- Approach taken is consistent with ASME code considerations, where the goal is to make a best estimate of the crack growth
- Recommended CGR curve is based on 75th percentile level of the distribution of CGR variability as a function of material heat
- The curve now lies approx. 20% above the modified Scott curve (previously approx. 30% higher)
- Addresses the concern that cracking detected in operating plants would tend to be in components fabricated from more susceptible Alloy 600 heats

Alloy 600 Crack Growth Rates

MRP Log-Normal Crack Growth Rate Distribution



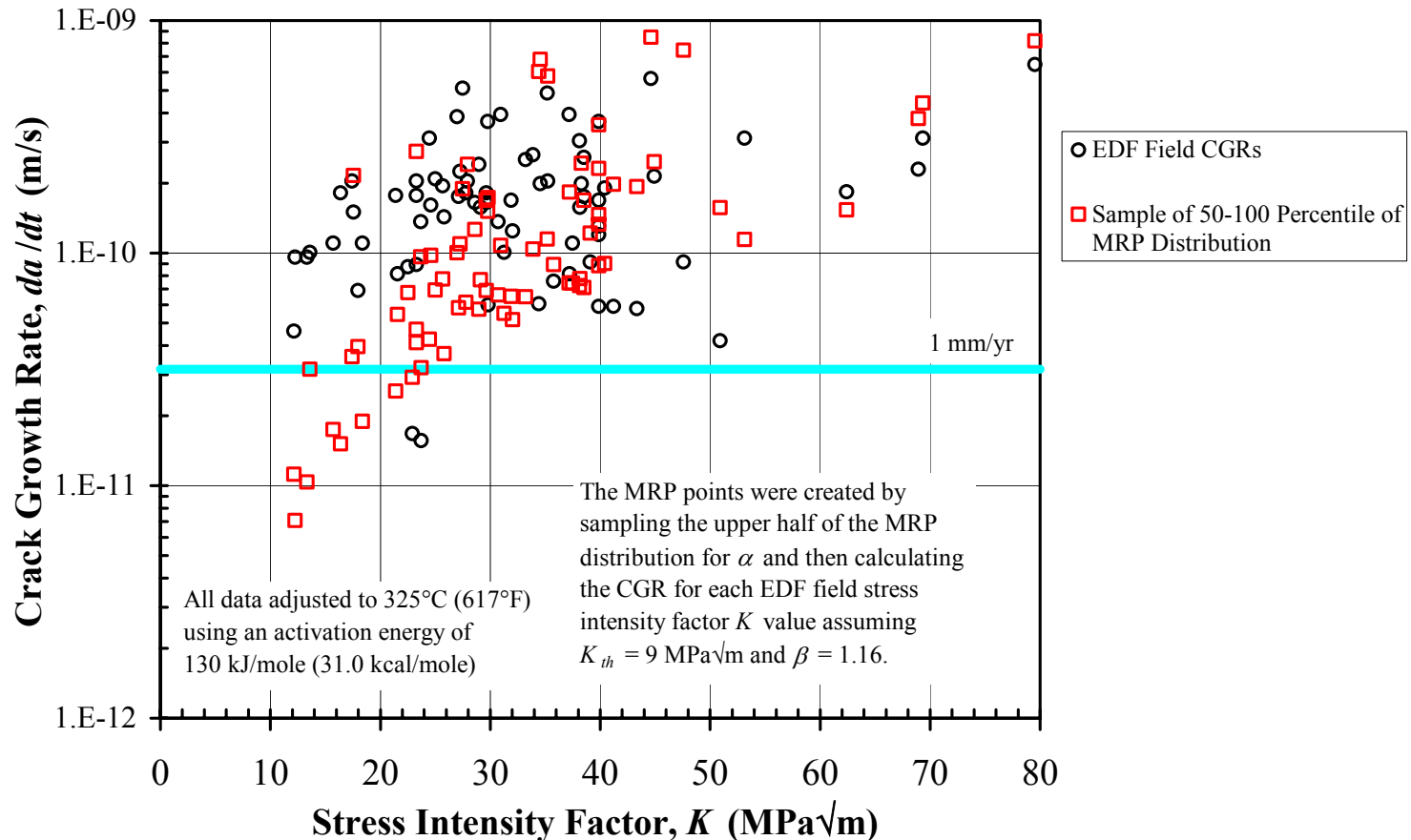
Alloy 600 Crack Growth Rates MRP Laboratory Database



Application of MRP CGR Curve

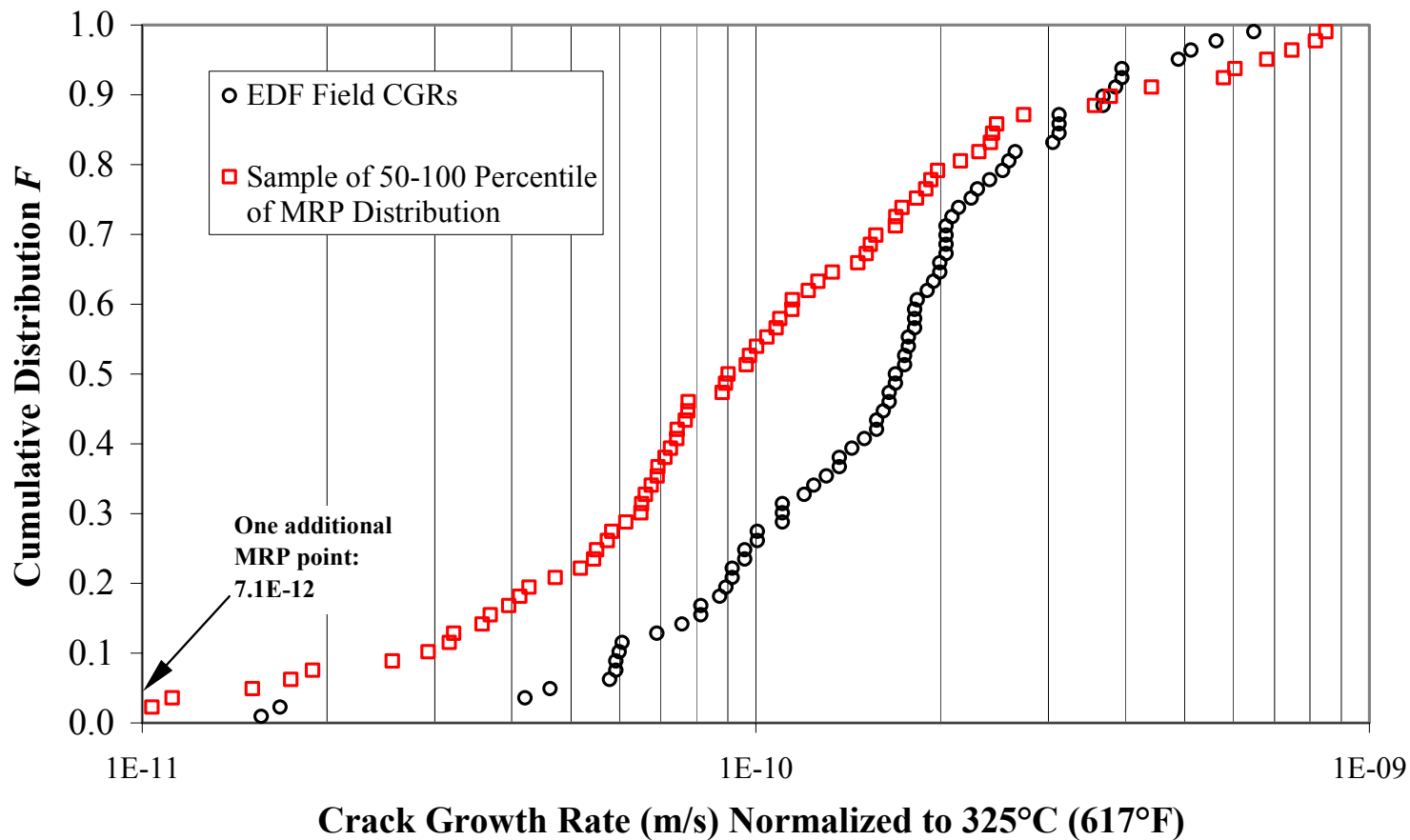
- The final MRP recommended curve is intended for disposition of detected PWSCC flaws in thick-walled Alloy 600 components exposed to normal PWR primary water
- Thus it will be directly applicable to **axial ID flaws** in RVH nozzle base material
- Newly developed, statistical comparison of MRP database with temperature-corrected French field data shows reasonable agreement (median values of cumulative distributions differ by a factor of about 1.6)
- Approach is considered to be appropriate with regard to the actual nozzle material in US plants

Comparison of EDF Plant Data and Samples from MRP Distribution



Reference for EDF Plant Data: Amzallag, C. and F. Vaillant. "Stress Corrosion Crack Propagation Rates in Reactor Vessel Head Penetrations in Alloy 600," *Ninth International Symposium on Environmental Degradation of Materials in Nuclear Power Systems—Water Reactors* (Newport Beach, CA, August 1–5, 1999), Edited by F. P. Ford, S. M. Brummer, and G. S. Was, The Minerals, Metals & Materials Society (TMS), Warrendale, PA, 1999, pp. 235–241.

Cumulative Distributions of EDF Plant Data and MRP Samples



CGR in OD Annulus Environment

- For evaluation of (hypothetical) **OD cracking** above the J-groove weld, the MRP continues to recommend that CGR values from the revised curve be multiplied by 2x to allow for uncertainty in the exact composition of the external chemical environment
- A subgroup of the Expert Panel has revisited the relevant arguments in the light of the Davis Besse experience and found that they remain correct as long as leak rates are low (typically < 1 liter/h or 0.004 gpm)
- Plant experience has shown this to be the usual case
- Analysis would no longer be valid, however, if leak rates were sufficiently high to result in a large, local decrease in temperature and appreciable corrosion of low-alloy steel

Ongoing Work

- Immediate priority is finalization of the MRP-55 report on CGR in Alloy 600 base metal and submission for NRC review (July)
- Work with the Expert Panel continues so as to develop a recommended approach to CGR for the weld metals (Alloy 182/82)
- Some additional experimental work is being initiated by EPRI (e.g. via a DOE/NEPO program)
- MRP will continue to update NRC on all further CGR developments