

# Environmentally- Assisted Fatigue Crack Growth in *Irradiated* Stainless Steels

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NRC Meeting on Fatigue Research and  
Related ASME Activities  
June 30, 2016



# Project Background and Results

- Data for estimating environmentally-assisted fatigue (EAF) crack growth rate (CGR) of irradiated stainless steel materials are very limited
- Available data on irradiated stainless steels under cyclic loading show (following slides):
  1. Increased CGR compared to non-irradiated materials at similar test conditions
  2. Increasing CGR as dose increases
- A 2014 pilot study showed that cyclic loading steps on irradiated stainless steels from IASCC CGR studies can provide useful data
- Additional cyclic data on irradiated stainless steel materials were collected and organized in 2015 - 2016, including a GE EAF study and cyclic loading steps that were part of several IASCC CGR studies

## Approach Taken in 2014 EAF CGR Pilot Study

- The EPRI IASCC Database was expanded and enhanced for conducting environmentally-assisted fatigue CGR studies on irradiated materials
- Irradiated fatigue data from Studsvik & Argonne National Lab were analyzed using plots of

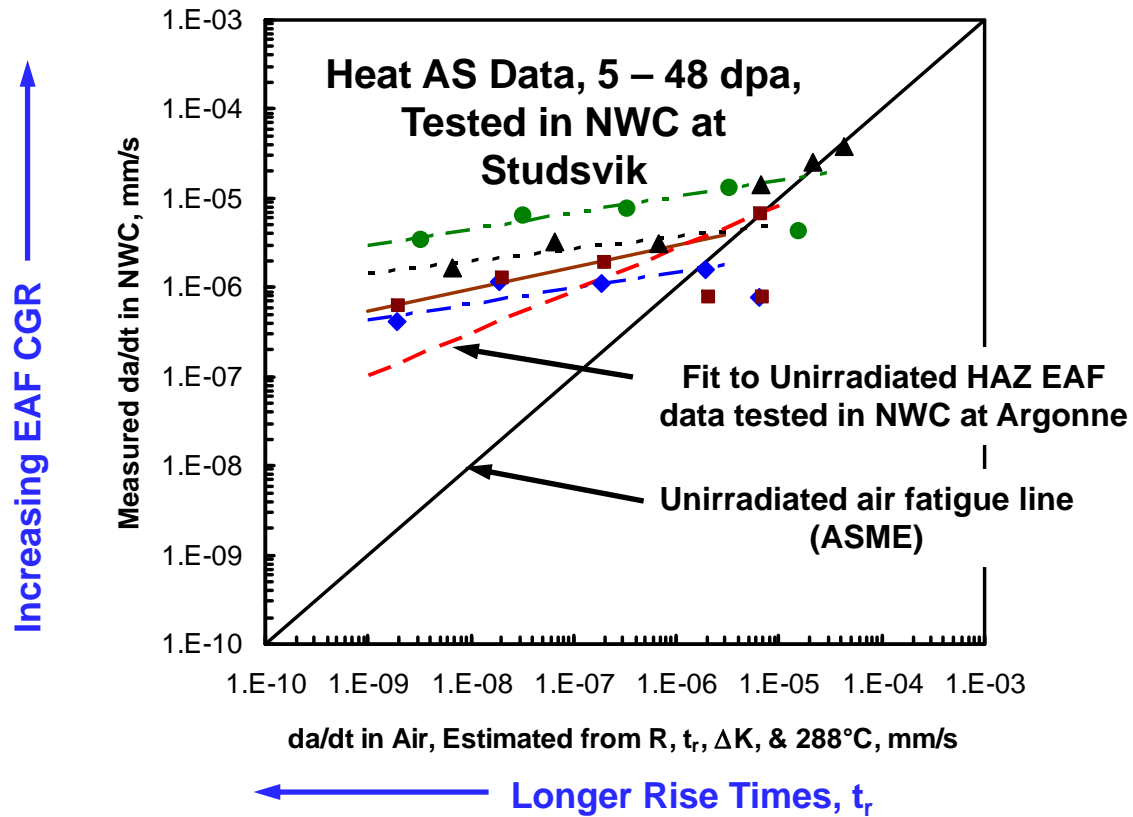
$$\dot{a}_{env} \text{ vs. } \dot{a}_{air}$$

- A very preliminary EAF model was developed based on

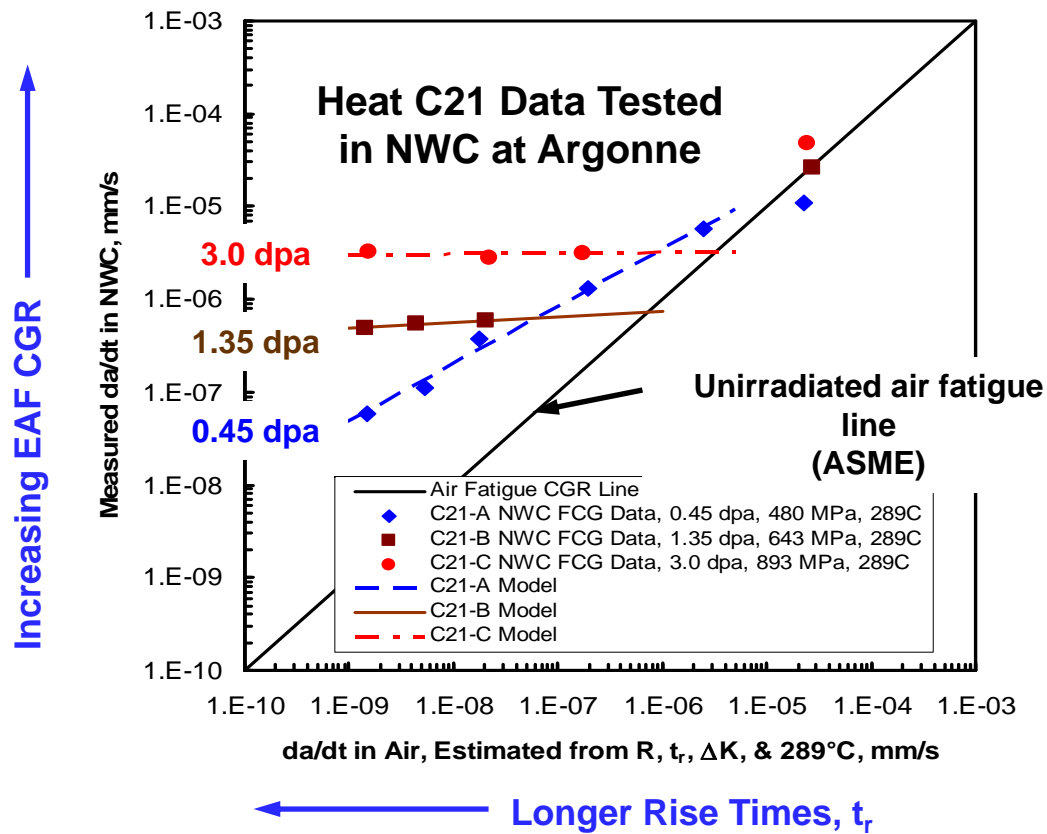
$$\dot{a}_{env} = A(\dot{a}_{air})^N$$

- An interim report was delivered December 2014

# Irradiated EAF Growth Rates in NWC at Long Rise Time are Higher than Unirradiated EAF Rates



# Irradiated EAF CGR at Long Rise Times Increase with Increasing Dose



## 2015 - 2016 Expansion of Data Set

<b>Data Set and Laboratories providing data</b>	<b>Number of Specimens*</b>	<b>Number of CGR points*</b>
<b>2014 Pilot Study Studsvik &amp; Argonne</b>	<b>34</b>	<b>360</b>
<b>2015 - 2016 Expansion adds Halden, U. Michigan, GE, &amp; more Argonne data</b>	<b>36</b>	<b>236</b>

\* Approximate overall size of data set; the subset suitable for modeling is smaller

## Status and Plans: EAF Crack Growth in Irradiated Stainless Steels

- The 2015 – 2016 data set expansion roughly doubled the available data
- Answers to questions and clarifications about the data have been received from experimentalists
- Analysis and modeling are in progress
  - based on the expanded modeling data set
  - incorporating lessons learned in the 2014 pilot study
  - for LWR environments
- Interim results will be presented at EPRI LWR Materials Reliability Conference (Chicago, Aug. 2016)
- The contractor will complete a final report by December 2016
- The report will identify gaps in data coverage and research needs



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