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Assessment of Mitigation Effectiveness under HWC/NMCA from Core Shroud Reinspection Data

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Objectives

- *Objectives: To evaluate the effectiveness of IGSCC mitigation in BWR internals by MHWC, NMCA and OLNC and to provide the technical basis for inspection relief*

- Evaluation of core shroud reinspection data
  - Normal Water Chemistry (NWC) plants
  - Hydrogen Water Chemistry (MHWC) plants
  - Noble Metal Chemical Addition (NMCA) plants
  - Online Noble Metal Chemical Addition (OLNC) plant

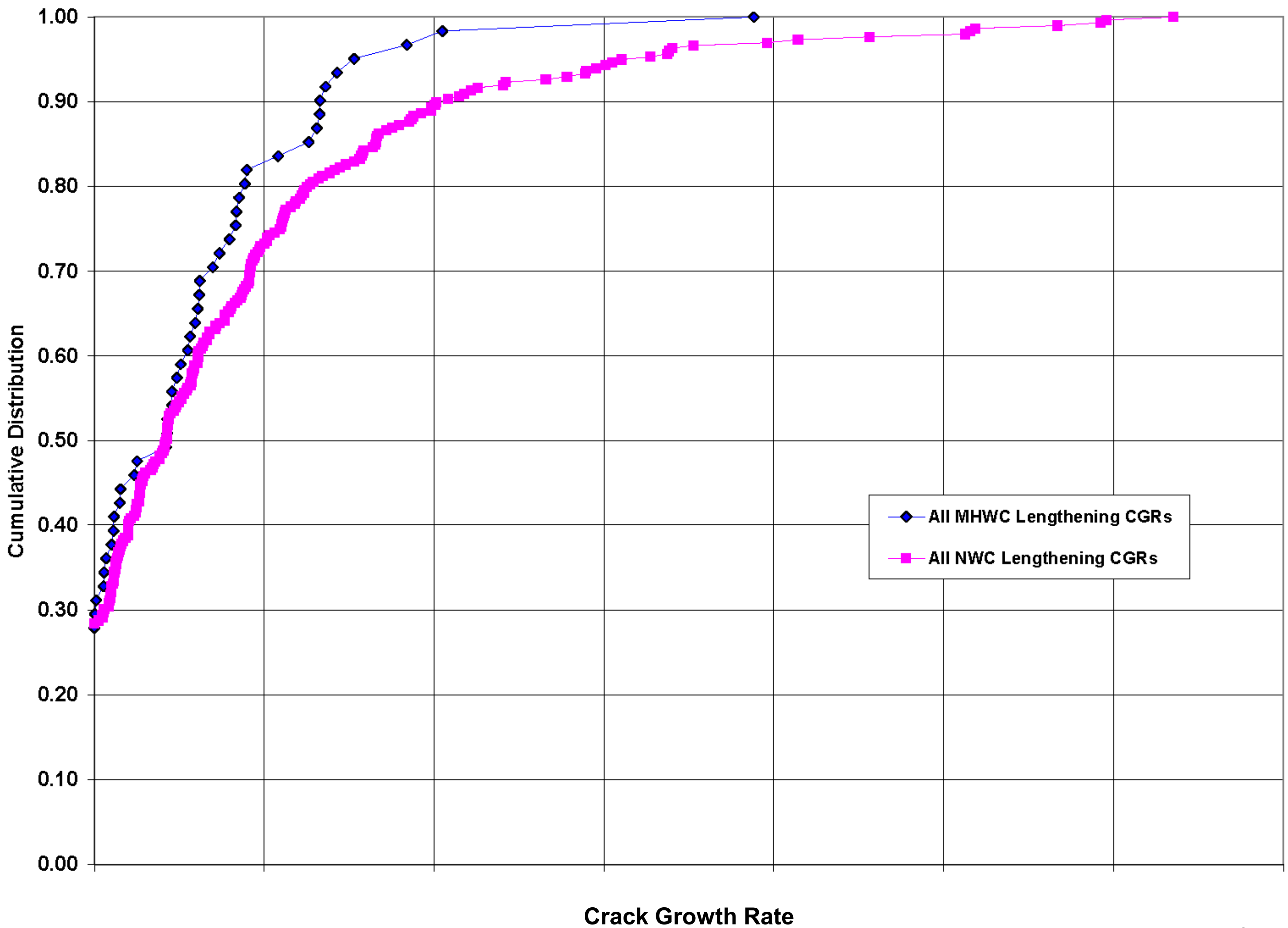
Approach

- Compiled UT inspection data for indications in core shroud circumferential welds
  - Nine Plants - NWC
  - Four Plants - MHWC
  - Four Plants - NMCA
  - One Plant - OLNC
- Determined Crack Growth Rates (CGRs) for length and depth direction of each indication between inspection periods
- Inspection intervals varied from 1 to 4 years for NWC and 2 to 10 years for mitigated plants
- Indications showing negative or zero CGRs were treated as non-growing cracks
- Developed cumulative frequency distributions for measured CGRs
- Compared measured CGRs with bounding CGRs for NWC and HWC used in BWRVIP-14-A
- Compared CGR distributions in NWC versus MHWC, NMCA and OLNC plants

HWC Availability for MHWC, NMCA and OLNC Plants

Mitigation	Plant	Time-Weighted H_2 Availability %
M-HWC	A	79.8
	B	89.8
	C	90.9
	D	92.2
NMCA	E	92.9
	F	97.9 / 99.1
	G	95.6
	H	97.2
OLNC	I	97.9

Length CGR Distribution (+/- Data) NWC vs. MHWC



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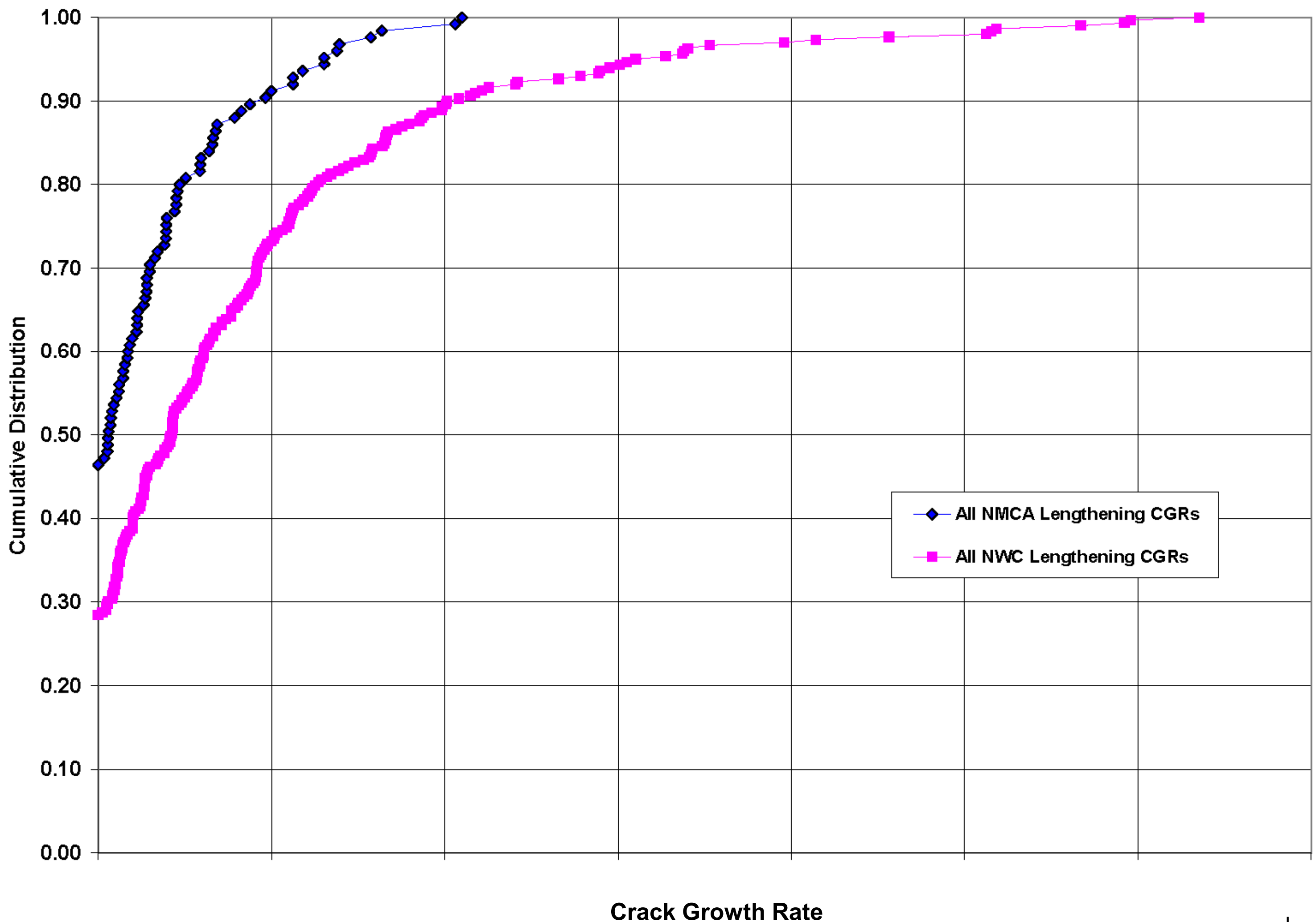
Length CGR Distribution (+/- Data) NWC vs. NMCA



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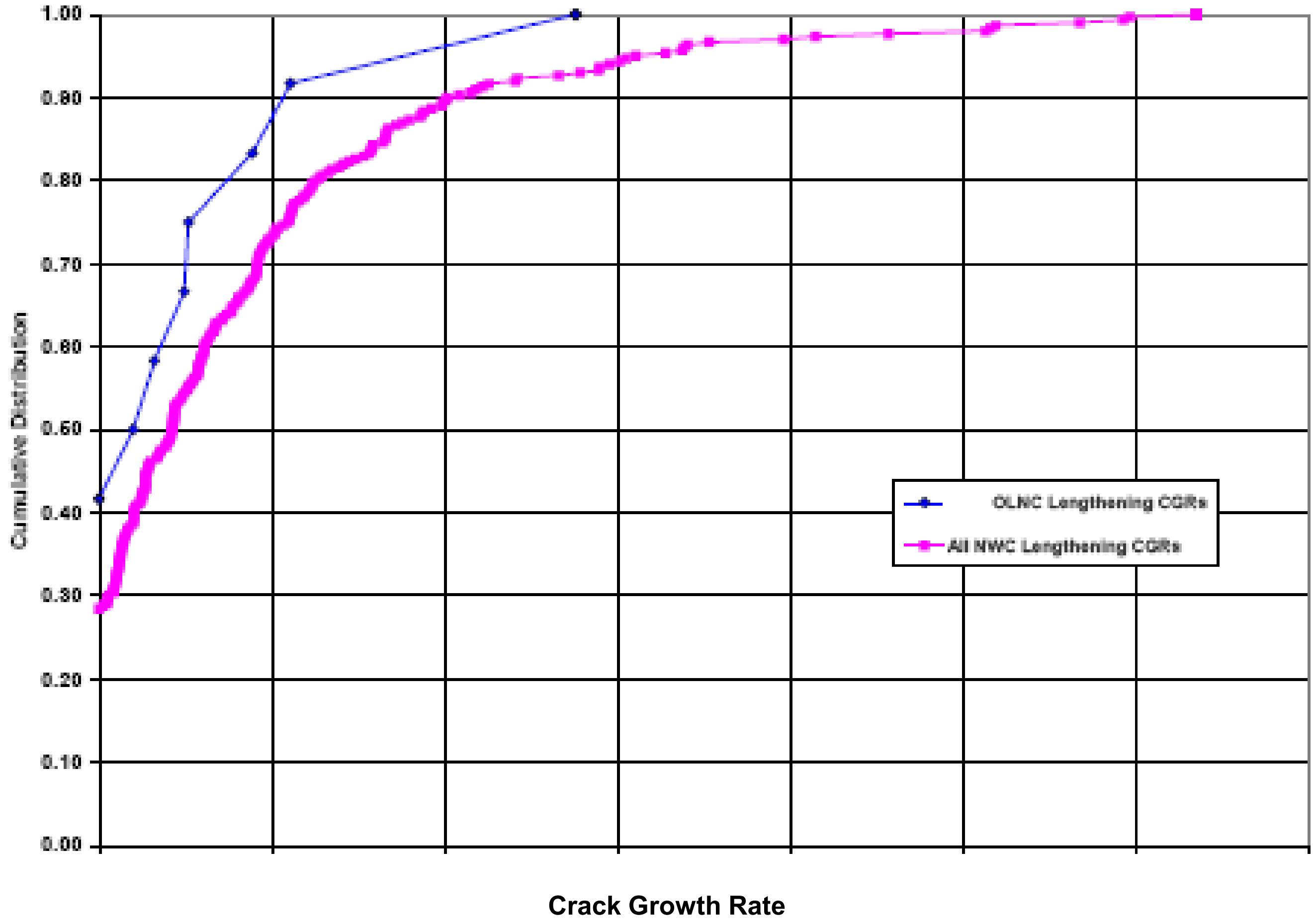
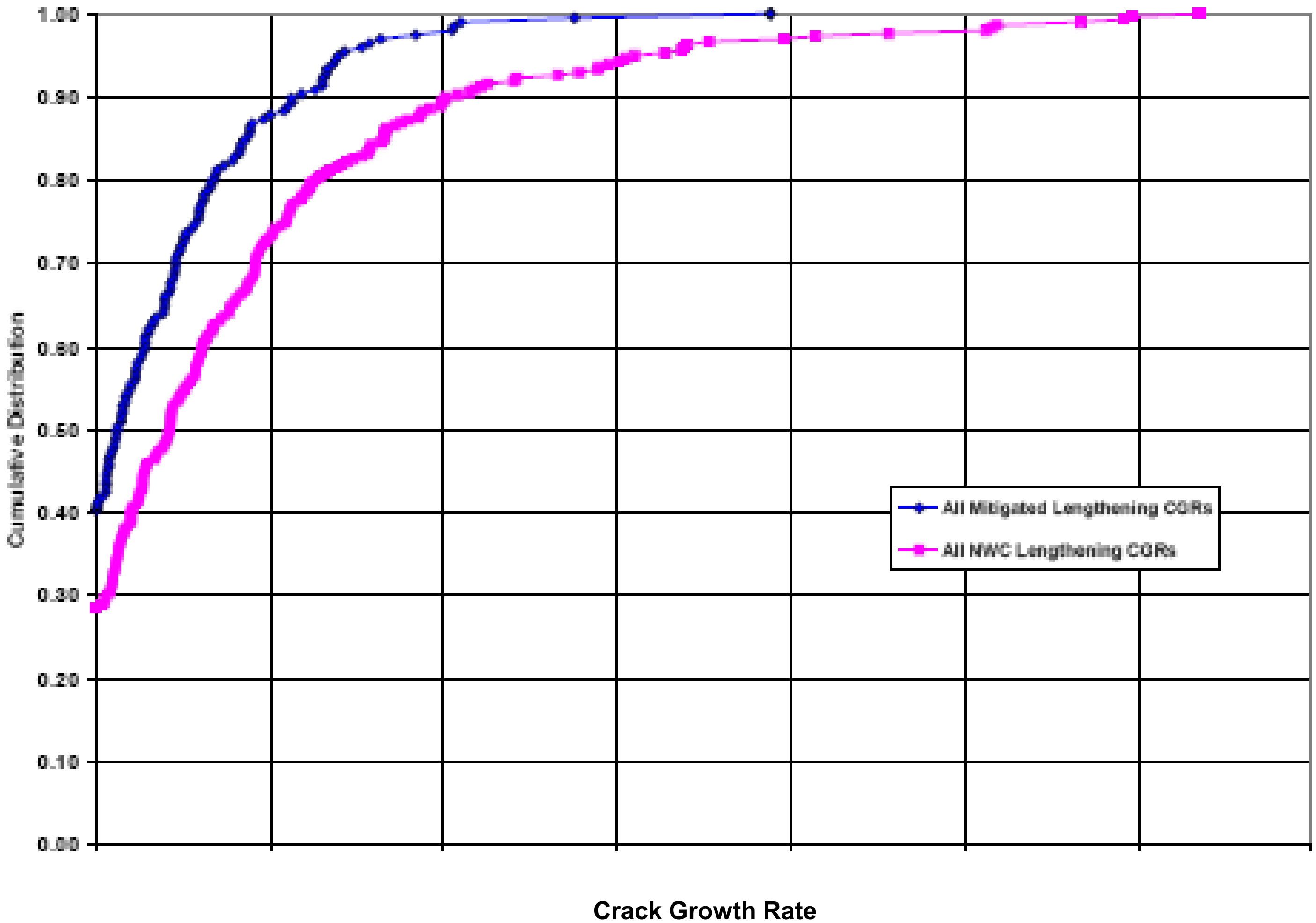
Length CGR Distribution (+/- Data) NWC vs. OLNC



Length CGR Distribution (+/- Data) NWC vs. MHWC/NMCA/OLNC for All Plants



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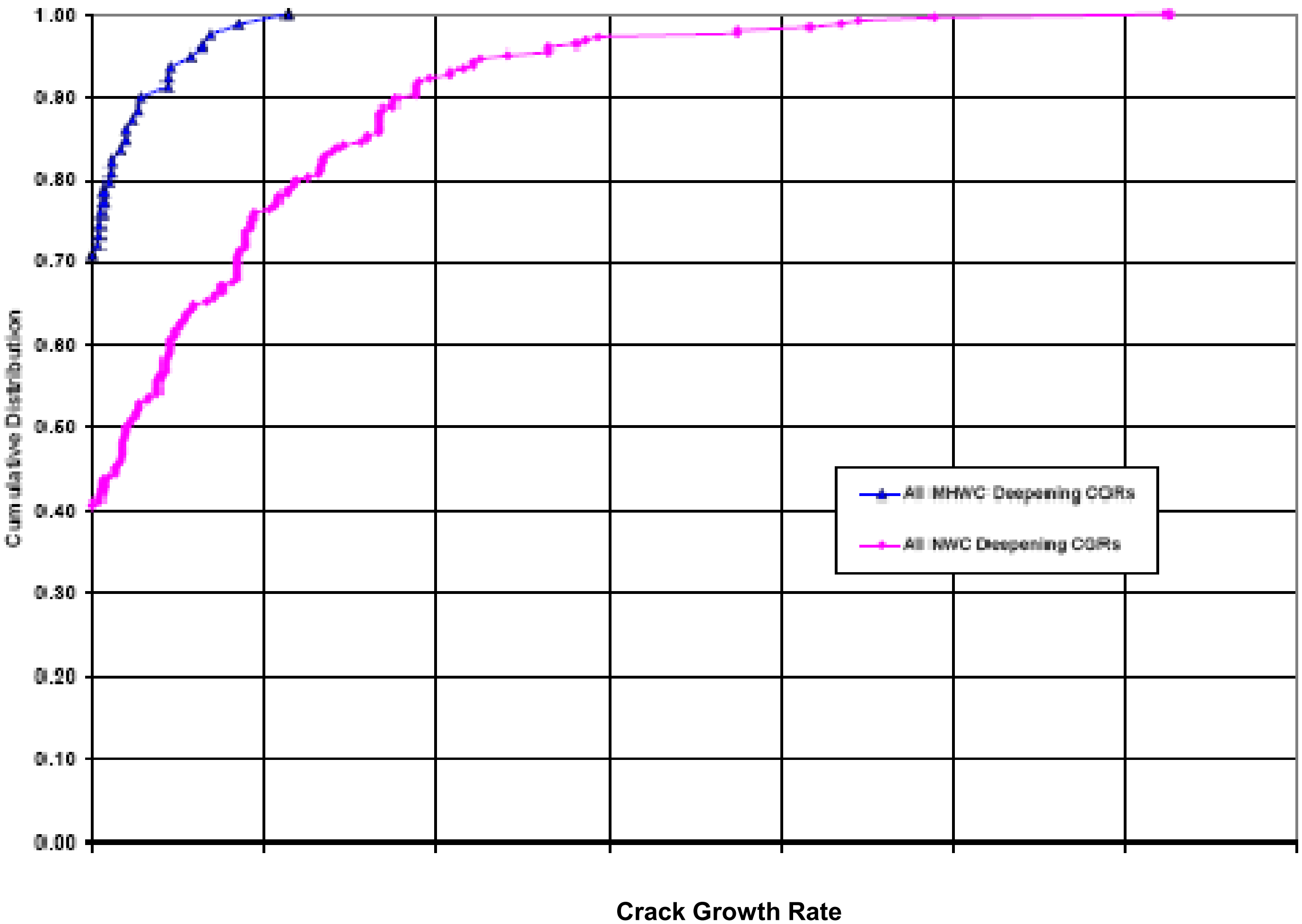
Depth CGR Distribution (+/- Data) NWC vs. MHWC



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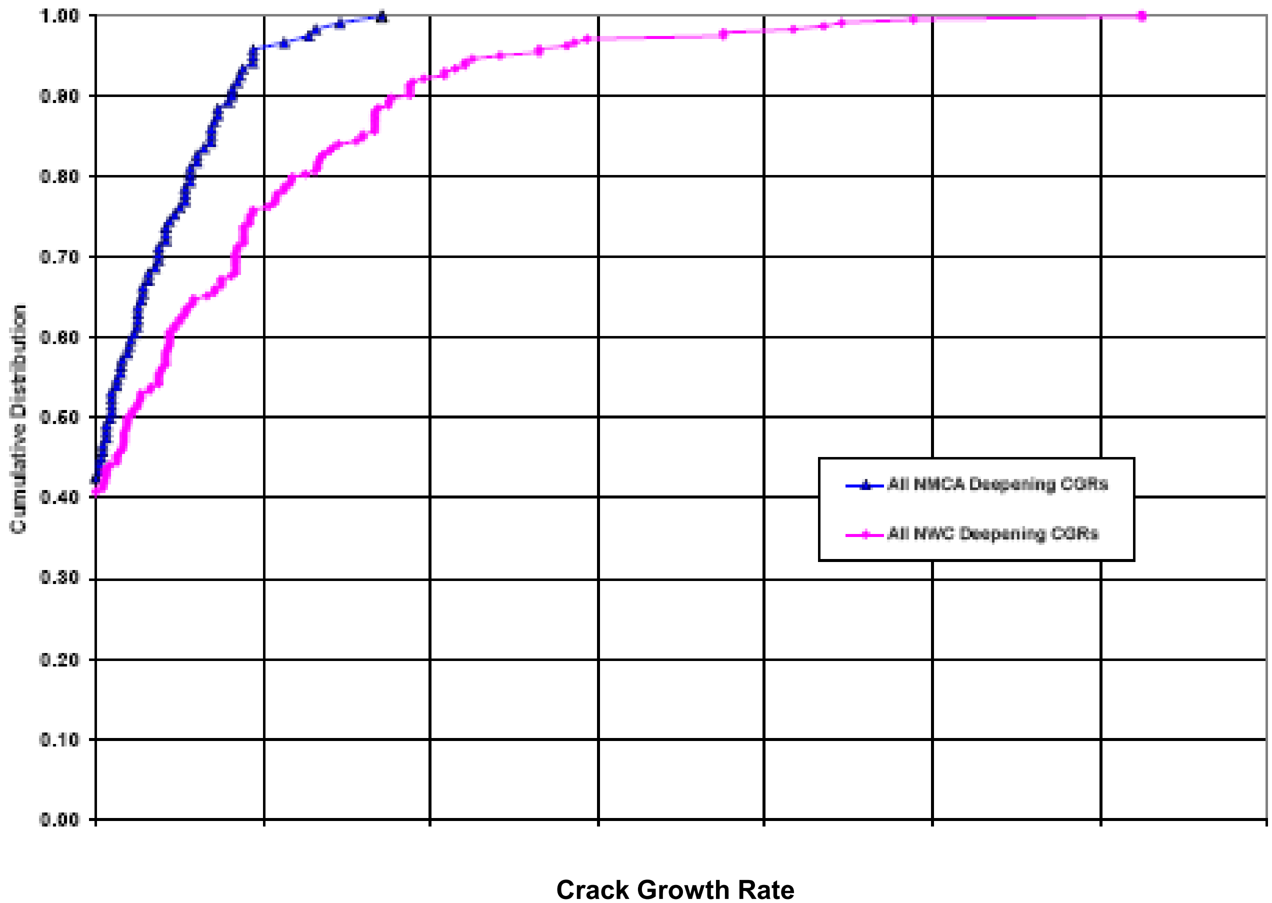
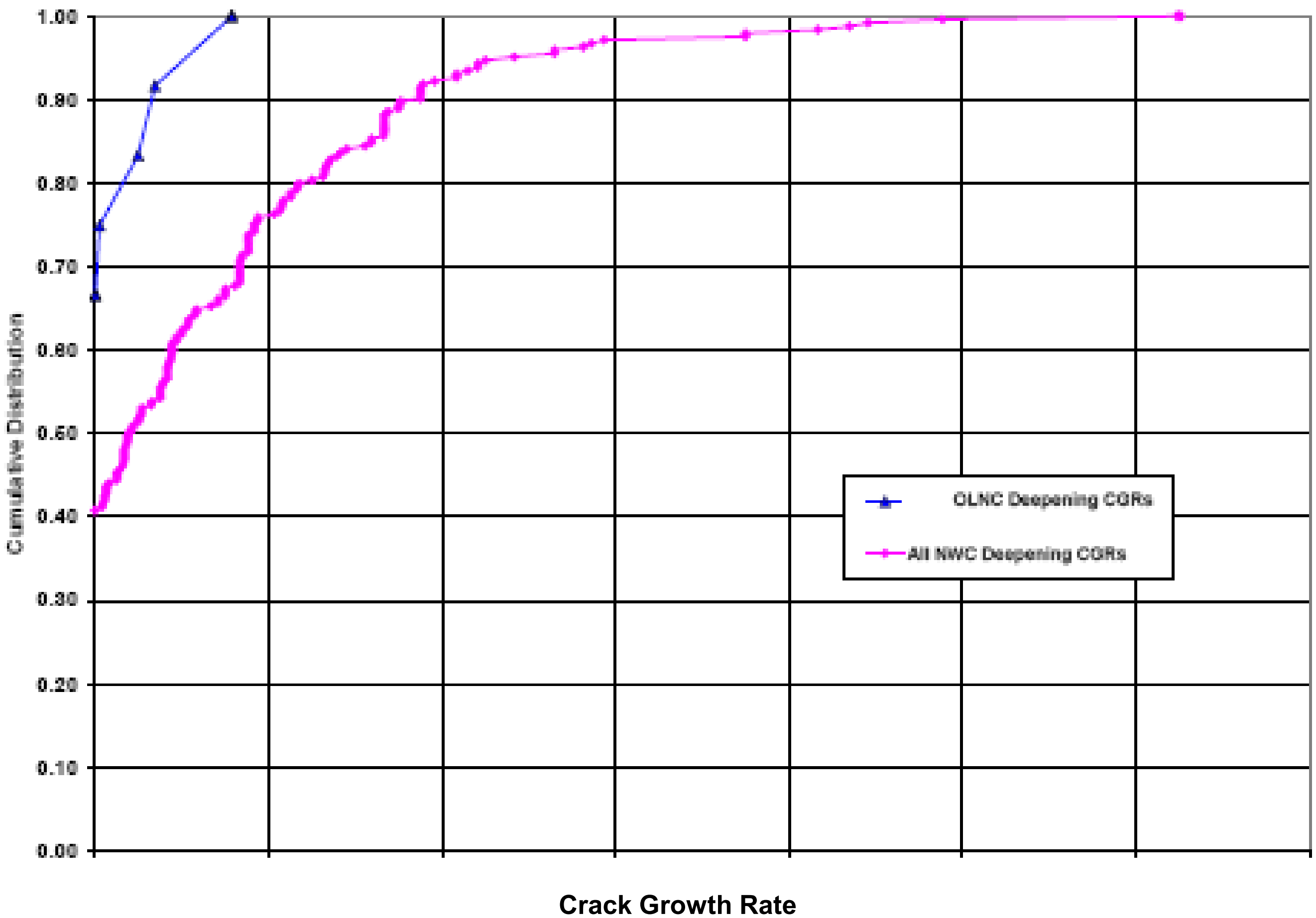
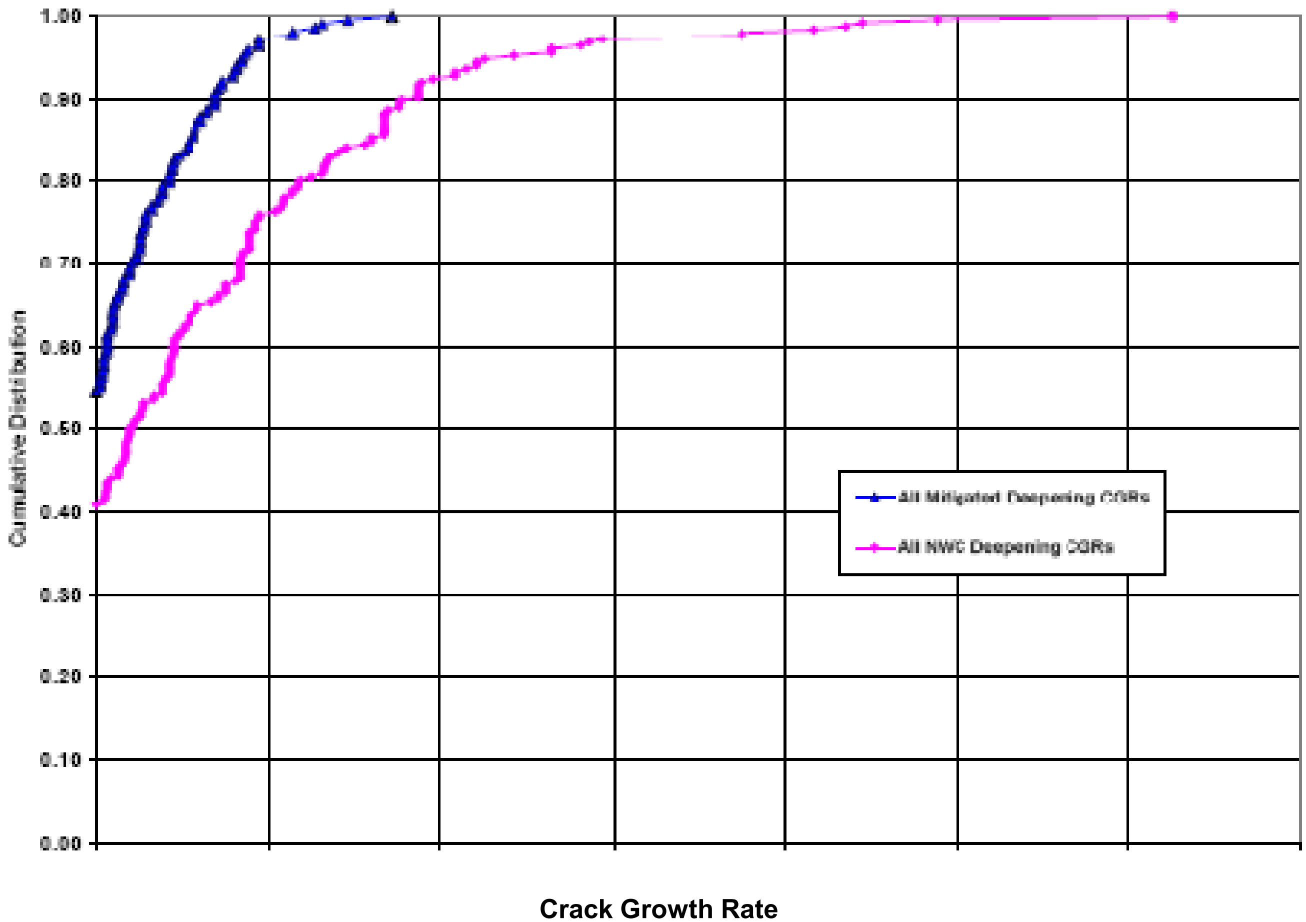
Depth CGR Distribution (+/- Data) NWC vs. NMCA



Depth CGR Distribution (+/- Data) NWC vs. OLNC

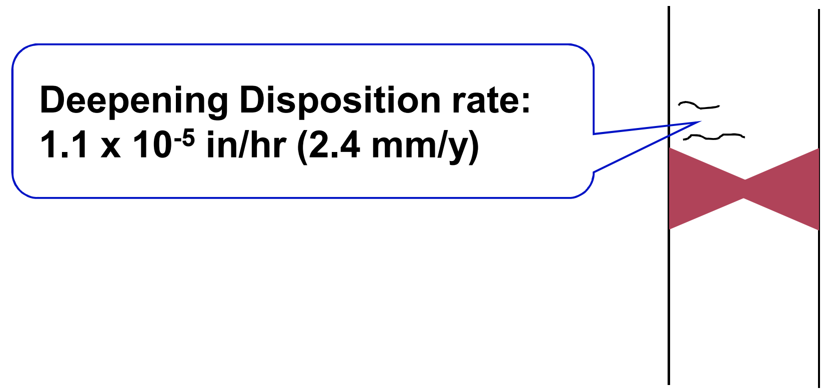


Depth CGR Distribution (+/- Data)
NWC vs. MHWC/NMCA/OLNC for All Plants

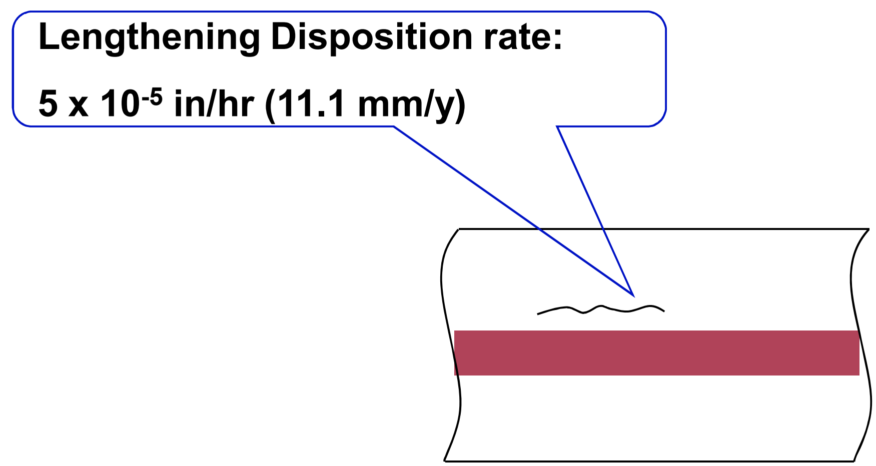


Summary

- Data reflects a decrease in deepening CGR for MHWC/NMCA/OLNC when compared to NWC
  - **BWRVIP-14-A approved deepening disposition rate bounds 96% of MHWC/NMCA/ OLNC deepening rates**
  - **55% showed no deepening**



- Data reflects a decrease in lengthening CGR for MHWC/NMCA/OLNC when compared to NWC
  - **Approved lengthening rate bounds 88% of MHWC/NMCA/OLNC lengthening rates**
  - **40% showed no lengthening**



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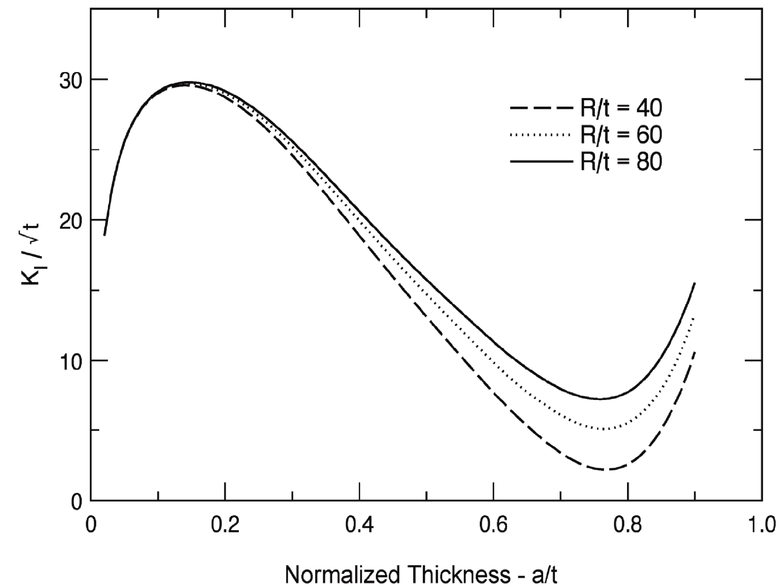
Mitigation Effectiveness in MHWC/NMCA/OLNC Plants - Conclusions

- Analysis of re-inspection data of core shrouds of eight MHWC/NMCA/OLNC mitigated plants strongly supports the effectiveness of mitigation compared to the NWC plants
- Effects of the decreasing residual stress fields may also play a role in decreased deepening rates
- These results were published in a revision to BWRVIP-174 in 2009
- The study will be updated again in 2011 with data from additional MHWC/NMCA/OLNC plants



BWR reinspection data provide strong evidence that NMCA, OLNC and MHWC are effective in mitigating IGSCC and support extended reinspection intervals

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BWRVIP Strategy for Optimizing Inspection of Reactor Vessel Internals

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Background

- BWRVIP Inspection & Evaluation (I&E) Guidelines were developed using the available inspection data, operating experience and industry knowledge on degradation mechanisms at the time the reports were published
  - Initial guidelines were largely based on safety considerations and did not consider the extent of degradation issues in the fleet or the potential benefit of mitigation (e.g. HWC)
- Post-implementation of I&E Guidelines
  - Large amount of inspection data has now been generated which provides insight on component degradation and mitigation effectiveness
  - Widespread implementation of HWC / NMCA
  - BWRVIP R&D efforts have improved industry knowledge on degradation mechanisms
  - NDE improvements both in UT and VT

Objective

- BWRVIP intends to re-visit the I&E Guidelines and to optimize the inspection programs based on:
  - Latest field inspection data and fleet operating experience
  - SCC mitigation associated with HWC / NMCA
  - Current NDE capabilities
  - Component repairs
  - In-situ crack growth rate studies
  - Structural analyses

Priority of Components

#	I&E Guideline	Priority
1	Core Spray (BWRVIP-18R1)	High
2	Jet Pump (BWRVIP-41R2)	
3	Shroud (BWRVIP-76)	
4	Shroud Support (BWRVIP-38)	
5	CRD Guide Tubes (BWRVIP47-A)	
6	Vessel ID Brackets (BWRVIP-48-A)	Medium
7	Top Guide Rims / Pins (BWRVIP26-A)	
8	SLC / Core DP Piping (BWRVIP-27-A)	
9	LPCI Coupling (BWRVIP-42-A)	
10	Access Hole Cover (BWRVIP-180)	
11	Jet Pump Beam (BWRVIP-138 R1)	
12	Top Guide Grid Beam (BWRVIP-183)	Low
13	Core Plate Bolts (BWRVIP-25)	
14	Steam Dryer (BWRVIP-139-A)	
15	Bottom Head Drain Piping (BWRVIP-205)	

Summary

- I&E Guideline Inspection Optimization Roadmap completed
- Priority of components defined
- Component specific evaluations of high priority components to be conducted in 2010-2012
- Briefings with NRC anticipated to review preliminary results and obtain feedback

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