

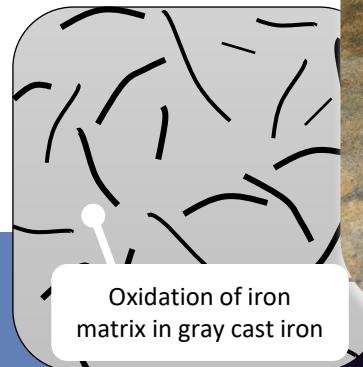
Managing Selective Leaching during Long-Term Operation

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Selective Leaching—preferential corrosion of the more active (less noble) component of an alloy

- *Dealloying*
- *Graphitic corrosion*
- *De-alumification*
- *De-zincification*

May compromise structural integrity with little change in appearance



Commonly used susceptible materials

- *Cast irons*
- *Copper alloys (>15%Zn or 8%Al)*

Operating Experience—Examples

1984

Cast iron in salt
water

Through-wall
corrosion of
component
cooling heat
exchanger

IN 84-71

**Began
1987**

Aluminum
bronze in
raw water

Cracking/
leakage in
essential
cooling
water

components

1993

Aluminum
bronze in
brackish water

Leakage in
service water
valve bodies

IN 94-59

2022

Brass in uncontrolled
indoor air

EDG radiator leak

2019

Cast iron in soil
Rupture of fire
protection
piping during
pump
surveillance

IN 20-04

IN = NRC information notice

EDG = emergency diesel generator

Nonnuclear

Cast iron water
distribution systems,
buried natural gas
piping

Aluminum bronze in
seawater (Navy),
desalination plants



Regulatory Response

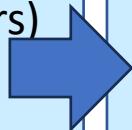
- Oversight of the plant-specific issue
- Generic communications to the industry
 - Informed the industry of operating experience; licensees expected to review and consider actions to avoid similar issues
- Revised guidance for license renewal aging management programs (AMPs)
 - Generic Aging Lessons Learned (GALL) Report NUREG-1800 (initial renewal), NUREG-2191 (subsequent renewal)

Selective Leaching of Materials AMP

NUREG-1800

2001, 2005

- One-time inspection (before 40 years)
- Visual
- Hardness
- Sample based



2010

- Added detail: sample size, timing, acceptance criteria
- Introduced alternative mechanical methods (chipping, scraping)

NUREG-2191

2017

- Added periodic inspections for aggressive environments
- Defined corrective actions (e.g., sample expansion)
- Hardness testing replaced with mechanical and destructive exams



To verify absence of selective leaching

To manage aging (rather than demonstrating absence of aging)

Case Study: Plant-Specific License Renewal AMP

- Plant with significant history of selective leaching of aluminum bronze in essential cooling water system
- Leaks, seepage, cracking
- ~350 susceptible castings, 3,400 welds

Visual inspections

Destructive examinations

- Proactive, one time
- Reactive, when leaks discovered

Ultrasonic examinations

- Time-of-flight diffraction method

Structural integrity evaluations

Lessons

- Plant-specific aging management approaches have often been needed to address unique circumstances
- NRC communications and guidance provide the industry the necessary information and a generically acceptable framework to create a strategy for long-term operation

Ongoing Activities

- Updating NUREG-2191 AMP to address recent operating experience
(aging of coated buried piping, malleable iron)
- Engaging with the industry on its proposed risk-informed approach