Enclosure 5

Presentation Slides for the Westinghouse-NRC Meeting on Westinghouse EnCore Accident Tolerant Fuel: Chromium Coated Cladding

(Non-Proprietary).

September 2019

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

Westinghouse EnCore® Accident Tolerant Fuel: Chromium Coated Cladding

Closed Session

September 18-19, 2019

The following material is based upon work supported by the United States Department of Energy under Award Number DE-NE0008824

Agenda

Day 1 – September 18

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms

Day 2 – September 19

- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

ISG: Interim Staff Guidance

Westinghouse Non-Proprietary Class 3

Licensing Plans

Agenda

- Licensing Plans
  - Licensing Topical Report Plans
  - Interaction of Upcoming Topical Report Submittals
  - Review of Near and Long-Term Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Westinghouse

Westinghouse Non-Proprietary Class 3

Licensing Plan Overview

[ ]d,e

Topical Report Material Properties and Performance

[ ]d,e

Topical Report Supporting Information

[ ]d,e

Regulatory Criteria

To show compliance to Regulations (GDC 10, 10 CFR 50.46, etc.), the following NRC guidance is consulted

- SRP Section 4.2 – Fuel Rod Design
- ISG for Chromium Coated Cladding
  - Impact on basic material properties
  - Impact on fuel performance (SRP 4.2 criteria)
  - New damage mechanisms
- SRP Section 4.3 – Nuclear Design
- SRP Section 4.4 – Thermal Hydraulic Design
- SRP Section 6.2.1 – Containment Functional Design (Mass and Energy Releases, etc.)
- SRP Chapter 15 – Transient and Accident Analysis

Topical report will describe the impact of coated cladding on key performance and acceptance criteria

Westinghouse

Interaction with Existing Topical Reports

d,e

Interaction of Upcoming Topical Report Submittals

[ ] d,e

Westinghouse

Quality Assurance and Change Control

d,e

Summary of Near and Long-Term Plans

d,e

LTR: Lead Test Rod
LOCA: Loss of Coolant Accident
PCT: Peak Cladding Temperature
DNB: Departure from Nucleate Boiling

Description of Coated Cladding

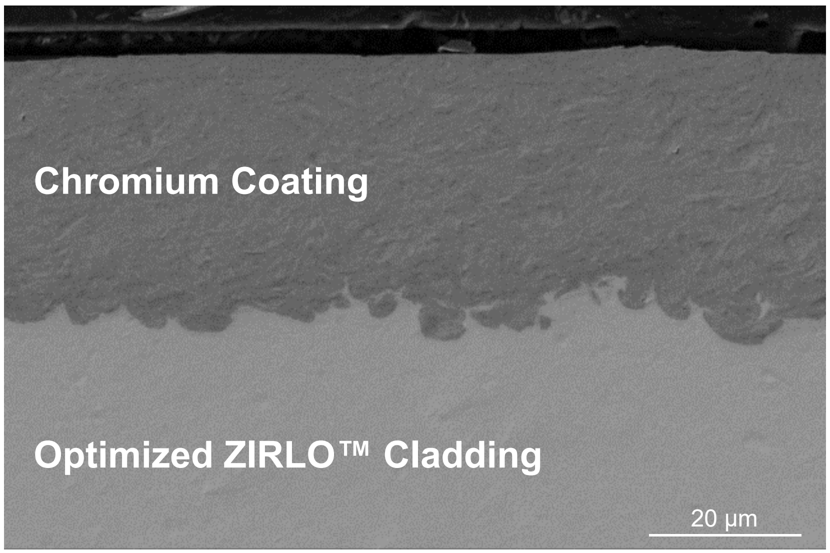
Agenda

- Licensing Plans
- Description of Coated Cladding
  - Product Definition
  - Material Specification
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Westinghouse

Product Definition of Chromium Coated Cladding

- Thin, adherent, and dense chromium (Cr) layer
- Substrate cladding properties unchanged with coating addition



Microstructure of As-fabricated Chromium-coated Cladding

Full Length Chromium-coated Cladding

Specification of Chromium Coated Cladding

a,c

Benefits of Coated Cladding

Westinghouse

Westinghouse Non-Proprietary Class 3

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding

a,c

- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

[ ]d,e

[ ]a,c

[ ]d,e

[ ]b,c

Westinghouse

[ ]d,e

[ ]b,c

[ ]d,e

[ ]a,c

[ ]d,e

[ ]d,e

[ ]d,e

[ ]a,b,c

[

]d,e

a,c

[

]d,e

b,c

Westinghouse

Westinghouse Non-Proprietary Class 3

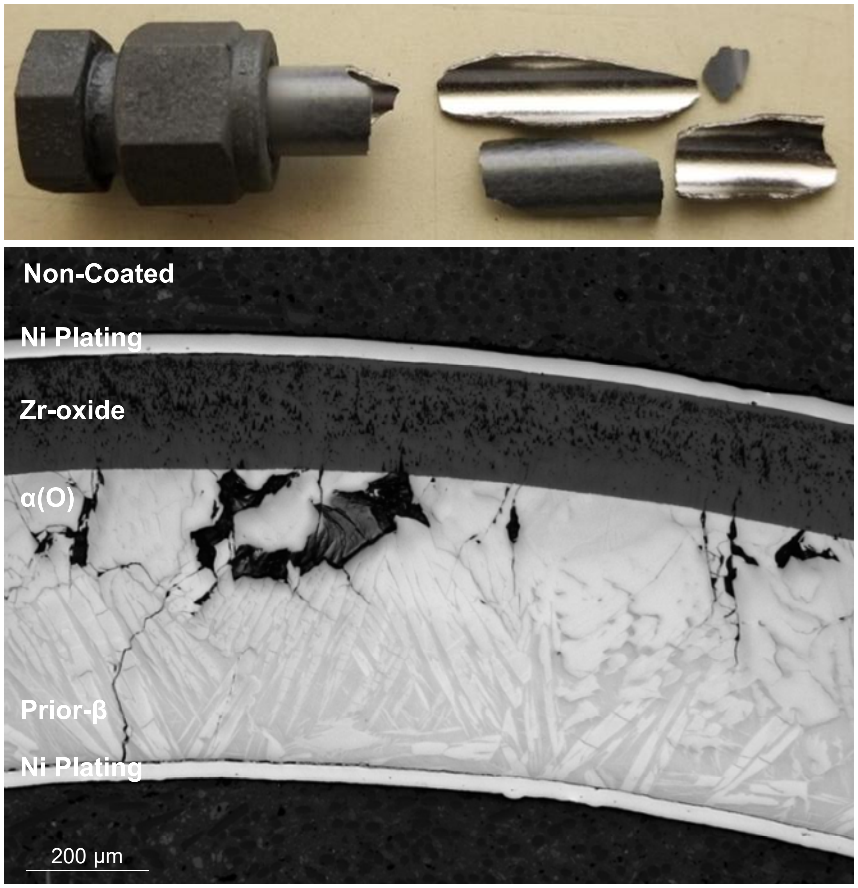
[

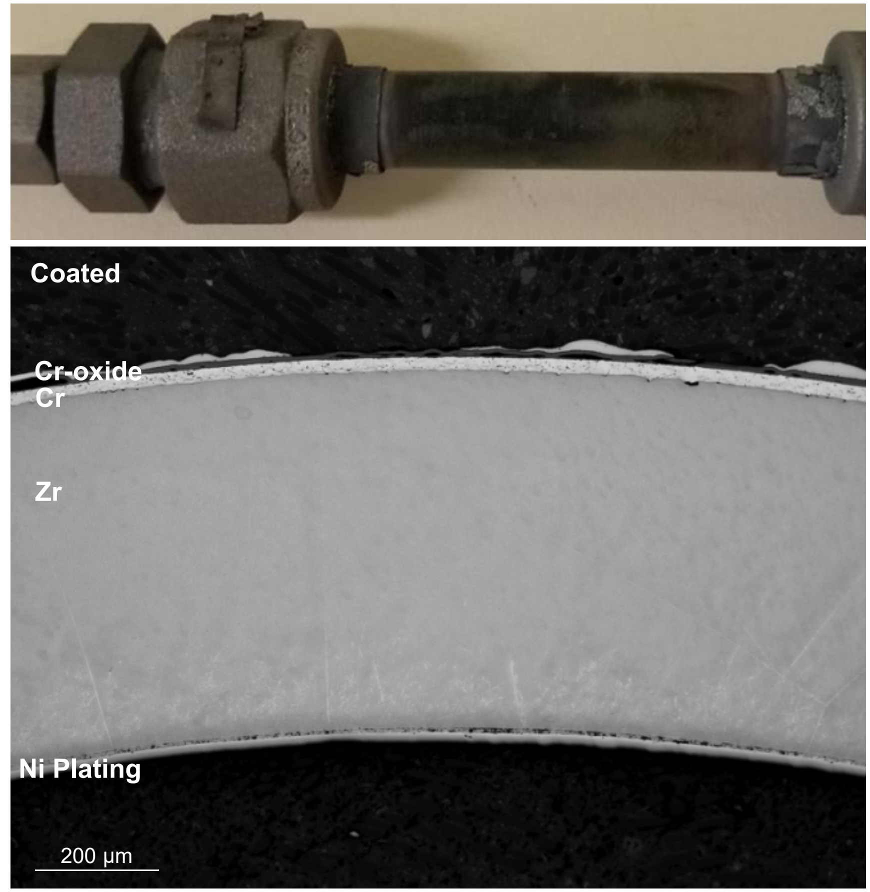
]d,e

b,c

Westinghouse Non-Proprietary Class 3

High Temperature Corrosion: 1200°C, 3600 seconds





*Ni plating applied for metallographic purposes

Minimal oxidation and improved ductility retention with coatings for severe design-basis accident conditions

Westinghouse

Lyons, J.L., et al. “Westinghouse Chromium-Coated Zirconium Alloy Cladding Development and Testing,” Top Fuel Light Water Reactor Fuel Performance Conference, Seattle, WA, 2019.

Westinghouse Non-Proprietary Class 3

[ ]d,e

[ ]b,c

Westinghouse Non-Proprietary Class 3

[ ]d,e

[ ]a,b,c

Westinghouse

[ ]d,e

[ ]a,b,c

Westinghouse

Westinghouse Non-Proprietary Class 3

Summary: Coated Cladding Benefits

[ ]a,c

Westinghouse

Material Properties and Performance

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
  - Thermomechanical Performance
  - Thermohydraulic Performance
  - Mechanical testing
  - In-reactor Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Westinghouse

Thermomechanical and Thermohydraulic Performance

[ ] a,c

- **Tests**:
  - Creep
    - [Thermal Creep] a,c
  - Departure from Nucleate Boiling (DNB)

Westinghouse

Thermomechanical Performance: Thermal Creep

[ ]b,c

Westinghouse

Thermomechanical Performance: Thermal Creep

b,c

Thermomechanical Performance:
[ ]a,c

[ ]b,c

Thermohydraulic Performance : [ ]a,c

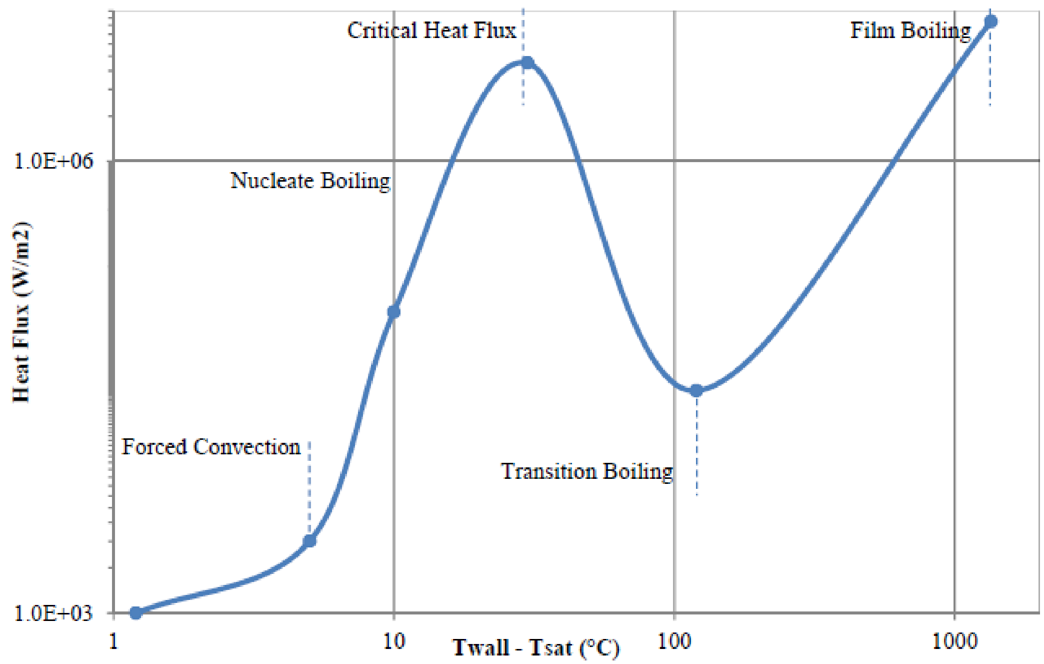
[ ]a,b,c

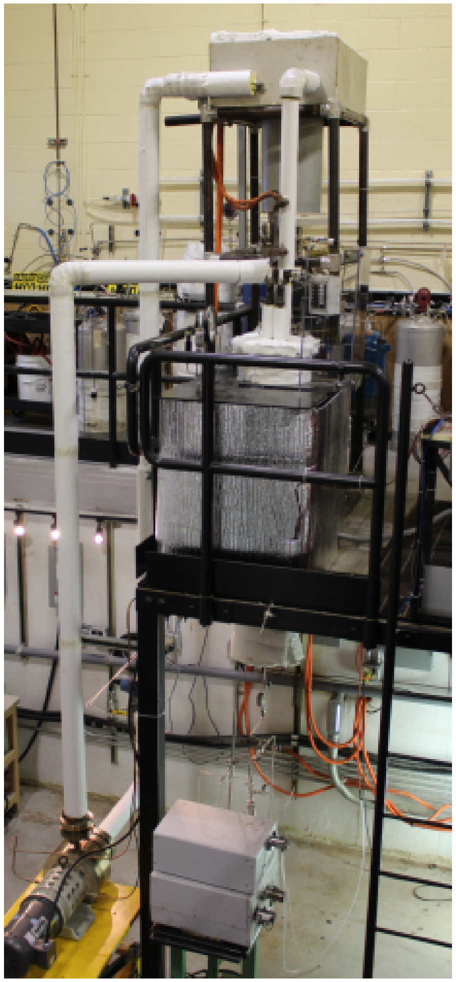
Thermohydraulic Performance: [ ]a,c

[ ]b,c

Thermohydraulic Performance: DNB, CHF, Crud

- Tests conducted in the westinghouse advanced loop tester (WALT) loop under PWR conditions
  - Critical heat flux (CHF) for DNB
  - Crud growth via precursor injections





Westinghouse

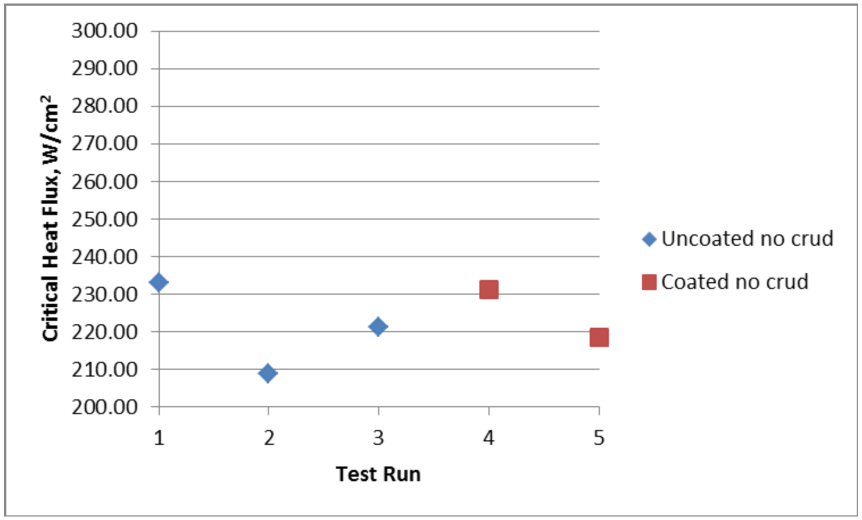
Karoutas, Z., et al. "Critical Heat Flux and Crud Walt Loop Measurements for Westinghouse Accident Tolerant Fuel," Top Fuel Light Water Reactor Fuel Performance Conference, Seattle, WA, 2019.

Westinghouse Non-Proprietary Class 3

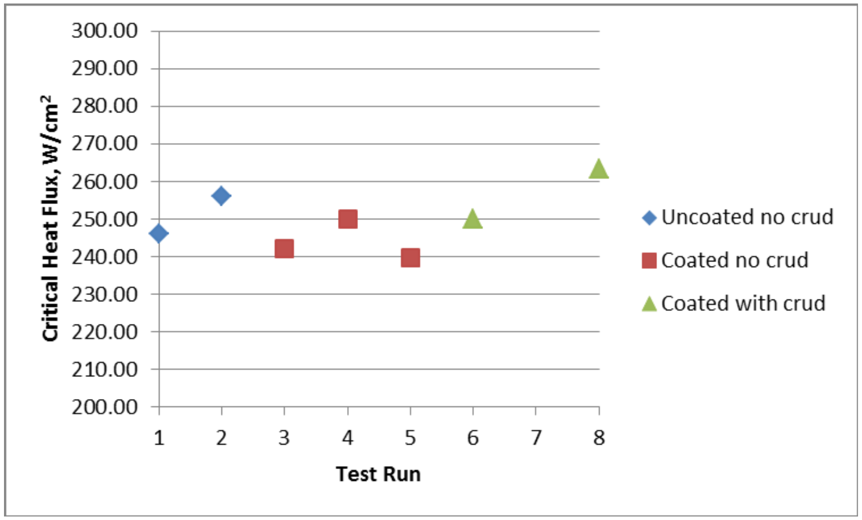
Thermohydraulic Performance: DNB

- Maximum heat flux reached ~300 W/cm^2
- Coated cladding evaluated to have no adverse impact on DNB performance
- No observable impact of crud on Heat Flux

Flow 2.40 m^3/hr



Flow 3.41 m^3/hr



Demonstration of equivalent DNB performance

Westinghouse

Karoutas, Z., et al. "Critical Heat Flux and Crud Walt Loop Measurements for Westinghouse Accident Tolerant Fuel," Top Fuel Light Water Reactor Fuel Performance Conference, Seattle, WA, 2019.

Mechanical Performance

[ ] a,c

- **Tests**:
  - Tensile Testing to Failure and 1% Strain

[ ] a,c

Mechanical Performance: Tensile Testing to Failure

- Room temperature tensile testing to failure

a,b,c

Westinghouse

Mechanical properties compare well with those of the substrate and meet specifications

Mechanical Performance: Tensile Testing to 1% Strain

[ ] b,c

Mechanical Performance: [ ]a,c

[ ]a,c

Mechanical Performance: [ ]a,c

[ ]b,c

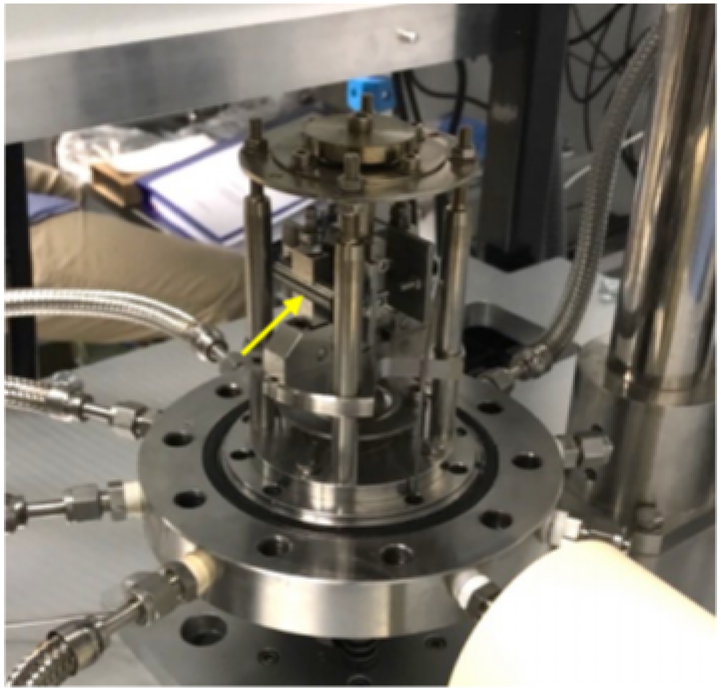
Mechanical Performance: [ ]a,c

[ ]b,c

Westinghouse

Mechanical Performance: Grid-to-Rod-Fretting (GTRF)

- Autoclave fretting impact rig (AFIR) at Oak Ridge National Laboratory
- Simulated pressurized water environment
  - Capabilities to control water chemistry: B, Li, H



Water Temp (°C)	Pressure (bar)	Cladding-Dimple Load (N)	Oscillation Frequency (Hz)	Oscillation Stroke Length (um)	Test Duration (hr)
204	21-24	0.5 ± 0.1	25	75 ± 10	20.5

Westinghouse

S. Lazarevic, R. Lu, C. Favede, G. Plint, P. Blau, J. Qu, "Investigating Grid-to-Rod Fretting of Nuclear Fuel Claddings Using a Unique Autoclave Fretting Rig," 2018.

Mechanical Performance: GTRF

[ ]b,c

Mechanical Performance: Wear Testing

a,c

Mechanical Performance: Wear Testing

[ ]b,c

In-Reactor Performance

[ ] a,c

- **Tests**:
  - Test Reactor Data
    - Halden
    - MIT nuclear research reactor (MITR)
    - Advanced test reactor (ATR)
  - Commercial Reactor Experience
    - Byron (Exelon)
    - Doel (Tractebel)

In-Reactor Performance: Irradiation Experience

[ ]b,c

Westinghouse

Westinghouse Non-Proprietary Class 3

In-Reactor Performance: MITR-2

[ ]b,c

Westinghouse

Westinghouse Non-Proprietary Class 3

In-Reactor Performance: MITR-2 and -3

b,c

Westinghouse

In-Reactor Performance: MITR-3 [ ]a,c

[ ]b,c

In-Reactor Performance: ATR – ATF2

[ ]a,c

In-Reactor Performance: Byron LTR PIE

[ ]a,c

Westinghouse Non-Proprietary Class 3

In-Reactor Performance: Doel LTR Program

a,c

Westinghouse

Summary: Materials Properties and Performance

[ ]a,c

New Damage Mechanisms

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
  - Coating Adherence and Damage
  - Cr-Zr Interdiffusion
  - Eutectic Formation
  - Residual Stress
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Observed Crack Behavior

[ ]b,c

Coating Cracking: Bending

[ ]b,c

Coating Cracking: Hoop Strains

b,c

Westinghouse Non-Proprietary Class 3

[ ]a,c

[ ]b,c

Westinghouse

[ ]a,c

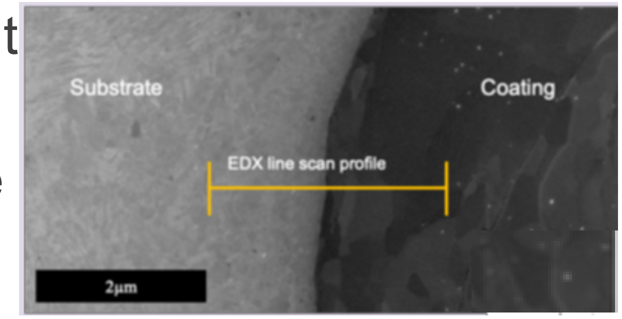
[ ]b,c

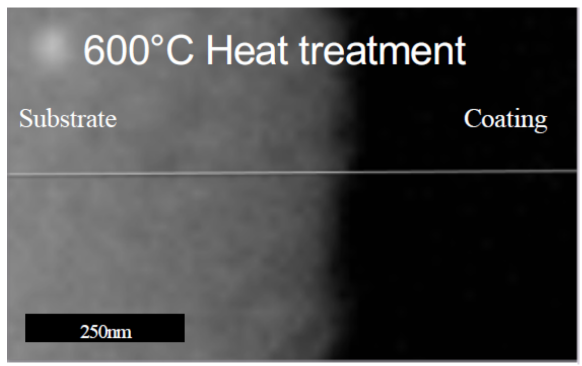
[ ]a,c

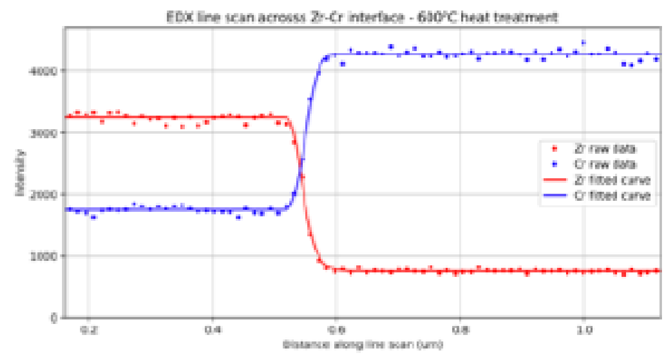
[ ]b,c

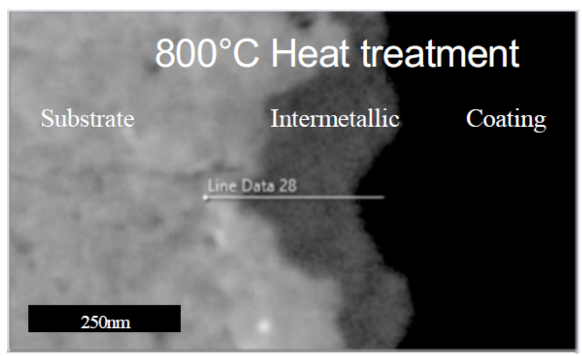
Heat Treatments: Cr/Zr Interdiffusion

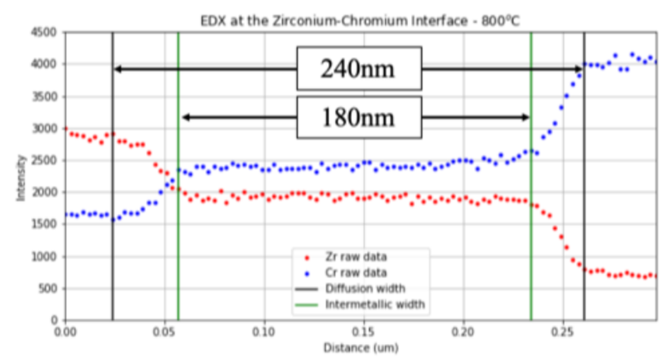
- 60 minute heat treatment
- Abrupt temperature excursion during particle impact
  - No apparent impact on performance in as-deposited condition
- Critical temperature for formation of intermetallic











Experiments focusing on interface behavior

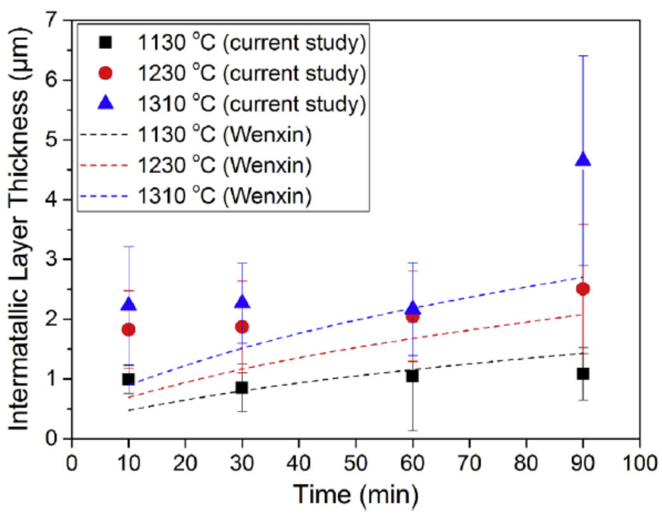
Westinghouse

*All measurements made at room temperature

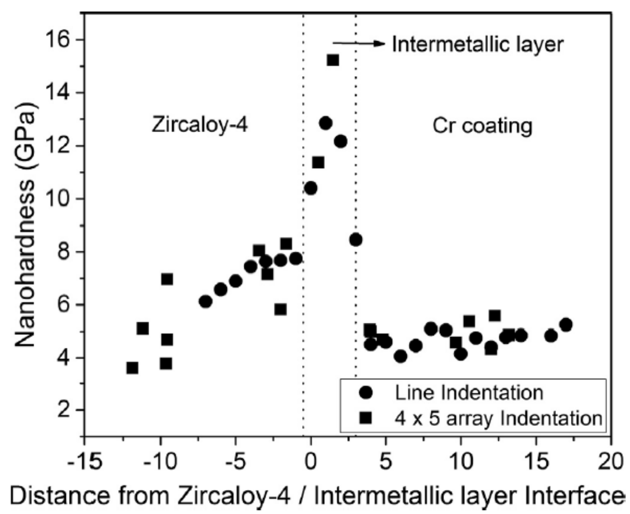
Callum Hunt, Univ. of Manchester, AMS Meeting 2019

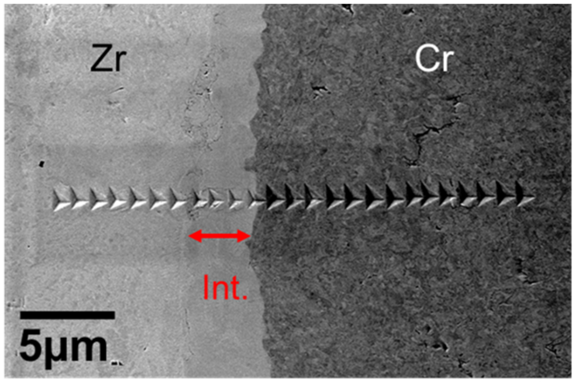
High Temperature Exposure: Cr/Zr Interdiffusion

- Kinetics of interlayer formation slow, observed thickness consistent with estimates in PNNL PIRT[1]
- Increased hardness of reaction layer
  - Slightly higher than reported values in PNNL PIRT



Kinetics of $ZrCr_2$ reaction





Nanohardness measurements across interface (1310°C steam temperature, 90min)

Limited formation of Intermetallic

PNNL: Pacific Northwest National Laboratories
PIRT: Phenomenon Identification and Ranking Table

1. K.G. Geelhood, W.G. Luscher, “Degradation and Failure Phenomena of Accident Tolerant Fuel Concepts: Chromium Coated Zirconium Alloy Cladding,” January 2019.
2. Yeom et. al. ANS Meeting, June 2019

Radiation Effects: Cr/Zr Interface

b,c

Ultra-high Temperature (UHT) Testing Above Eutectic

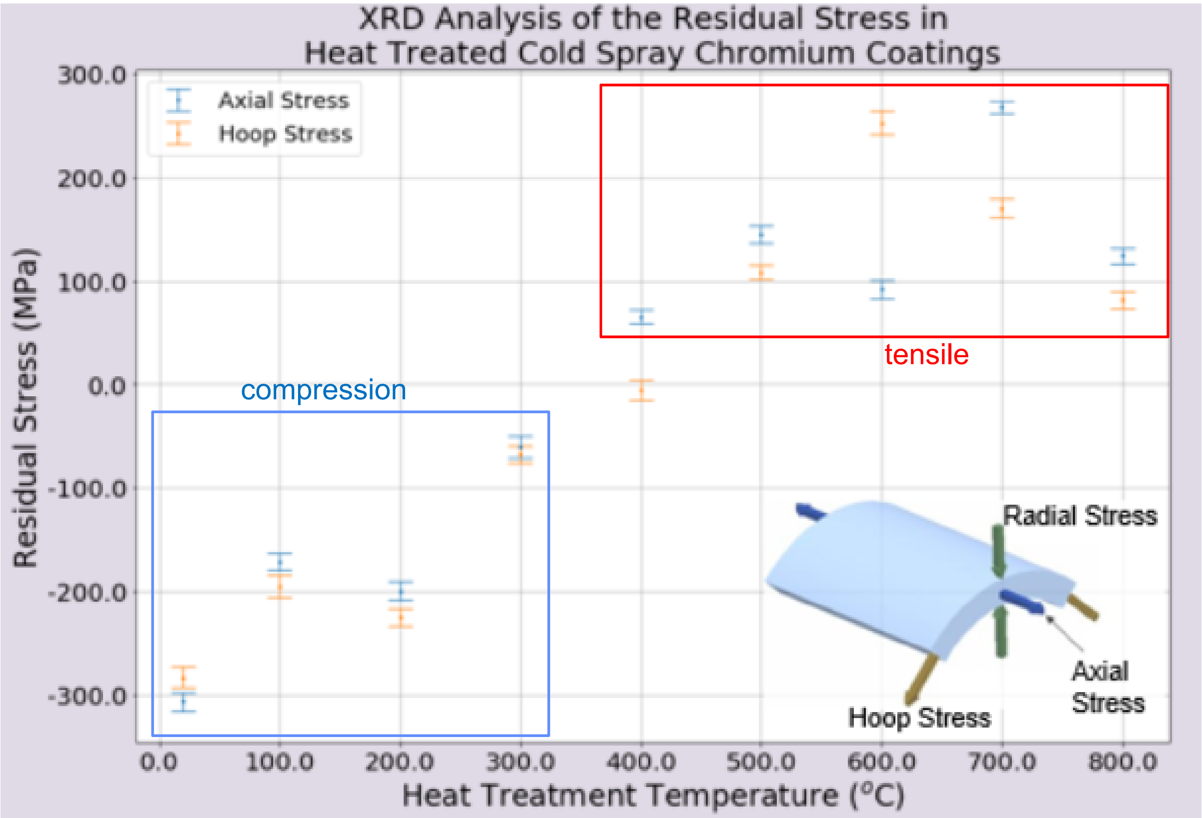
b,c

Eutectic Formation

b,c

Residual Stress

- 60 minute heat treatment
- Residual stress measured using x-ray diffraction and material properties
- Heat treating is observed to relieve compressive stresses into tensile stresses



Stresses in the coating are expected to anneal out at operating temperatures

*All measurements made at room temperature

Callum Hunt, Univ. of Manchester, AMS Meeting 2019

Summary: New Damage Mechanisms

[ ]b,c

Westinghouse

Impact on Analytical Methods and Alignment with ISG

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
  - Normal Operation and AOOs
  - Accident Conditions
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Westinghouse

Impact on NRC-Approved Analytical Methods

[ ]d,e

Westinghouse

Fuel Rod Design Methods

[ ]d,e

Impact of Coating on Overall Cladding Material Properties

a,c

Main Impact on Fuel Performance Models

[ ]a,c

Westinghouse

Main Impact on Fuel Performance Models (Cont'd)

[ ]a,c

Westinghouse

Adaptation of PAD5 for Coated Cladding

a,c

Impact on Clad Temperature

a,c

Impact on Fuel Temperature

a,c

Westinghouse

Application Methodology

[ ]a,c

FRD Design Criteria (SRP 4.2) Clad Stress

- Design Limit
  - Based on ASME Boiler and Pressure Vessel (BPVC) code
  - Unirradiated yield strength (YS) and ultimate tensile strength (UTS) represent the lowest yield stress
    - YS and UTS for coated cladding are similar to the base material

[ ] a,c

Westinghouse

FRD Design Criteria (SRP 4.2) Clad Strain

- Design Limit
  - The total tensile strain, elastic plus plastic, due to uniform cylindrical fuel pellet deformation during any single Condition I or II transient shall be less than 1% from the pre-transient value

[ ]a,c

FRD Design Criteria (SRP 4.2)
Rod Internal Pressure

- Design limit
  - No clad liftoff (NCLO)
  - No hydride reorientation
  - No extensive DNB propagation

[ ] a,c

FRD Design Criteria (SRP 4.2)
Clad Fatigue

- Design Limit
  - The fatigue life usage factor is limited to less than 1.0 to prevent reaching the material fatigue limit, considering a safety factor of 2 on stress amplitude or a safety factor of 20 on the number of cycles, whichever is more limiting

[ ] a,c

FRD Design Criteria (SRP 4.2)
Cladding Oxidation, Hydriding and CRUD

[ ]a,c

FRD Design Criteria (SRP 4.2)
Fuel Rod Axial Growth

- Design Limit
  - The fuel rods shall be designed with adequate clearance between the fuel rod and the top and bottom nozzles to accommodate the differences in the growth of fuel rods and the growth of the assembly with interference

[ ] a,c

Westinghouse

FRD Design Criteria (SRP 4.2) Cladding Flattening

- Design Limit
  - The fuel rod design shall preclude clad flattening during projected exposure

[ ]a,c

Westinghouse

FRD Design Criteria (SRP 4.2)
Clad Free Standing

- Design Limit
  - The cladding shall be short-term free standing at beginning of life, at power, and during hot hydrostatic testing

[ ]a,c

Westinghouse

FRD Design Criteria (SRP 4.2)
Fuel Pellet Overheating (Power to Melt Only)

- Design Limit
  - The fuel rod centerline temperature shall not exceed the fuel melt temperature during Condition I and II operation, accounting for degradation of the melt temperature due to burnup and the addition of integral burnable absorbers

[ ]a,c

Westinghouse

FRD Design Criteria (SRP 4.2) Pellet-to-Cladding Interaction

- Limit
  - The NRC SRP does not require a specific design criterion for pellet-to-cladding interaction (PCI)
  - Related criterion -1% clad strain and fuel overheating must be met

[ ]a,c

Westinghouse

Summary – Fuel Rod Design

[ ]a,c

Safety Analyses Methods

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Review of Safety Limits by Analysis Area

- SAFDLs in SRP are covered / considered by various methods

SAFDL	Applicable Analysis
C.3.1: Overheating of the Cladding (SRP 4.2, II.1.B.iii)	DNB Events (CHF performance)
C.3.2: Excessive Fuel Enthalpy (SRP 4.2, II.1.B.v)	RIA
C.3.3: Bursting (SRP 4.2, II.1.B.vii)	LOCA, RIA
C.3.4: Mechanical Fracturing (SRP 4.2, II.1.B.viii)	LOCA (seismic), FHA
C.3.5: Cladding Embrittlement (SRP 4.2, II.1.C.i)	LOCA
C.3.6: Violent Expulsion of Fuel (SRP 4.2, II.1.C.ii)	RIA
C.3.7: Generalized Cladding Melting (SRP 4.2, II.1.C.iii)	RIA (Cr-Zr eutectic)
C.3.8: Fuel Rod Ballooning (SRP 4.2, II.1.C.iv)	LOCA
C.3.9: Structural Deformation (SRP 4.2, II.1.C.v)	LOCA (seismic)

Degradation Mechanisms are covered by various design basis analyses

Westinghouse

New Safety Limits by Analysis Area

- New SAFDLs for chromium-coated cladding

SAFDL	Applicable Analysis
C.4.1: Coating Cracking	LOCA, RIA, DNB Events
C.4.2: Coating Delamination	LOCA, RIA, DNB Events
C.4.3: Cr-Zr Interdiffusion	LOCA
C.4.4: Radiation Effects on Cr	none
C.4.5: Subsurface Damage	Precluded by material qualification
C.4.6: Residual Stress	none
C.4.7: Galvanic Corrosion	none
C.4.8: Defects	Precluded by material qualification
C.4.9: Eutectic Formation	Locked Rotor

Degradation Mechanisms are covered by various design basis analyses

Westinghouse

LOCA

a,c

LOCA:

[ ]a,c

[ ]a,c

LOCA:

[ ]a,c

a,c

Westinghouse

LOCA:
[ ]a,c

[ ]a,c

LOCA:

[ ]a,c

[ ]a,c

LOCA: High Temperature Creep

[ ]a,c

LOCA:
High Temperature Creep

a,c

LOCA:

[ ]a,c

[ ]a,c

LOCA: New SAFDLs & Degradation Mechanisms

a,c

LOCA: FSLOCA EM Updates

a,c

LOCA: NOTRUMP EM Updates

a,c

Westinghouse

Westinghouse Non-Proprietary Class 3

Non-LOCA Transient Analysis: Reactivity Insertion Accident (RIA)

[ ] a,c

Westinghouse

Westinghouse Non-Proprietary Class 3

Non-LOCA Transient Analysis: Reactivity Insertion Accident (RIA)

[ ]a,c

Westinghouse

Non-LOCA Transient Analysis: Reactivity Insertion Accident (RIA)

a,c

Non-LOCA Transient Analysis: Locked Rotor

a,c

Non-LOCA Transient Analysis: Modeling

a,c

Westinghouse

Non-LOCA Transient Analysis: New SAFDLs

[ ]a,c

Non-LOCA Transients
New RIA Criteria

a,c

Non-LOCA Transients
DNB Propagation Evaluation Method

a,c

Westinghouse Non-Proprietary Class 3

Thermal-Hydraulic Design

a,c

Westinghouse

Other Safety Analysis Areas

a,c

Transportation and Spent Fuel Pool Storage

Westinghouse

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Transportation of Non-Irradiated ATF Fuel

- Westinghouse has performed engineering evaluation of chromium-coated cladding:
  - Concluded that this clad variation did not impact package safety case or result in change to Traveller package Certificate of Compliance (CoC)
- Westinghouse sent LTR-LCPT-19-18 to NRC on August 1, 2019
  - Letter requested ". . . *clarification of NRC position and assessment regarding the specification of cladding additives as allowable content under the Zirconium alloy fuel cladding specification in the CoC for USA/9297/AF-96 Revision 11 Model No. Traveller STD, XL and VVER*"
- A meeting was held with the NRC on August 30, 2019 to ensure understanding of the Westinghouse request.
- Westinghouse has asked for NRC response to support communications with European Competent Authorities during transport planning.
- Depending on NRC's response, a special arrangement may be required for near term European deliveries and Cr coating may need to be specifically added to the Traveller CoC.

Westinghouse

Spent Fuel Pool Criticality

- Background
  - WEC is the Analysis of Record holder of various vintages of Spent Fuel Pool (SFP) and New Fuel Vault (NFV) analyses.
  - No Generic Topical Report
  - Impacts to SFP criticality addressed on a case by case basis when plant fuel/operations management changes require a license amendment request
  - As a result, impacts to SFP criticality analyses are handled on case by case basis

Spent Fuel Pool Criticality

- Technical Detail
  - SFP
    - Assemblies in fuel storage pools are undermoderated
    - Moderation between assemblies or Regions will not change as the moderator displacement between assemblies/regions is not significant
    - Additional thin coating with small interaction cross section will:
      - Displace an additional small amount of moderator;
      - Have potential for small parasitic absorption effect (moderation will be minimal as energy loss in collisions will be insignificant)
    - As a result, any discernable impact will be conservative
  - NFV
    - Fast system
    - Minimal interaction cross section, no expected impact

Westinghouse

Discussion of ISG and PIRT

Westinghouse

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Draft Interim Staff Guidance (ATF-ISG-01)

- Topic: Allowance for conservatism in lieu of test data
  - It is recommended that statements be added in the introduction section to clarify that reasonably conservative models or assumptions could be defined where explicit data does not yet exist, subject to review and approval.
    - Example situation: [

]a,c

Draft Interim Staff Guidance (ATF-ISG-01)

- Topic: Cracks and Inspection
  - Example: Appendix B: "…It is also recommended that in-reactor data from rods with cracked coatings be evaluated to assess if there is aggressive corrosion at cracks or interfaces."
    - → Aggressive corrosion at cracks or interfaces could be assessed ex-reactor.
  - It is recommended that language be added: Requirements for crack inspection and performance testing need to support performance benefits / assumptions claimed.

Westinghouse

Draft Interim Staff Guidance (ATF-ISG-01)

- Topic: [

]a,c

PIRT Objectives

- Objectives
  - Ascertain the influence of the coated cladding on important phenomena expected during normal operation, anticipated occurrences, design basis accidents, and beyond design basis accidents
  - Determine the degree to which the coating behavior and its impact on the phenomena are understood
  - Assess the test matrix to increase knowledge of important phenomena where gaps are identified by the PIRT
- Panel discussions held May 2019
- Report (Revision 0) finalized August 2019

PIRT Process

- Followed the evaluation model development and assessment process (EMDAP) Guidance
- Convened experts within Westinghouse covering the full range of fuel conditions (normal operation, transients, accidents)
- After the discussions, compared with results of PNNL PIRT

[ ] a,c

Next Steps

- PIRT is a ‘living document’
  - Updates to reflect new testing or experience
    - Additional testing
    - Generation of irradiated data
    - Lead test rod campaigns
  - Updates to reflect new methodology decisions
    - Bounding / conservative treatments

Summary

Agenda

- Licensing Plans
- Description of Coated Cladding
- Benefits of Coated Cladding
- Material Properties and Performance
- New Damage Mechanisms
- Impact on Analytical Methods and Alignment with ISG
- Safety Analysis Methods
- Transportation and Spent Fuel Pool Storage
- Discussion of ISG and PIRT
- Summary

Summary

- Westinghouse has developed chromium-coated cladding, achieving insertion of LTRs in commercial reactors
- The addition of a chromium layer shows significant improvements with respect to corrosion, and does not negatively affect the properties or performance of zirconium-based cladding under normal operations
- The coating also improves high-temperature behavior in accident conditions
- Westinghouse will justify implementation of chromium-coated cladding in the near-term topical report submittal

Timeline of Key Activities

[ ]d,e

Next Major Milestones

[ ]d,e