NRC Staff Review of Westinghouse Topical Report WCAP-18483-P, "EnCore Chromium Coated Cladding for Use in PWRs"

Open Session Presentation to the Advisory Committee on Reactor Safeguards

June 26, 2026

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Presentation Outline

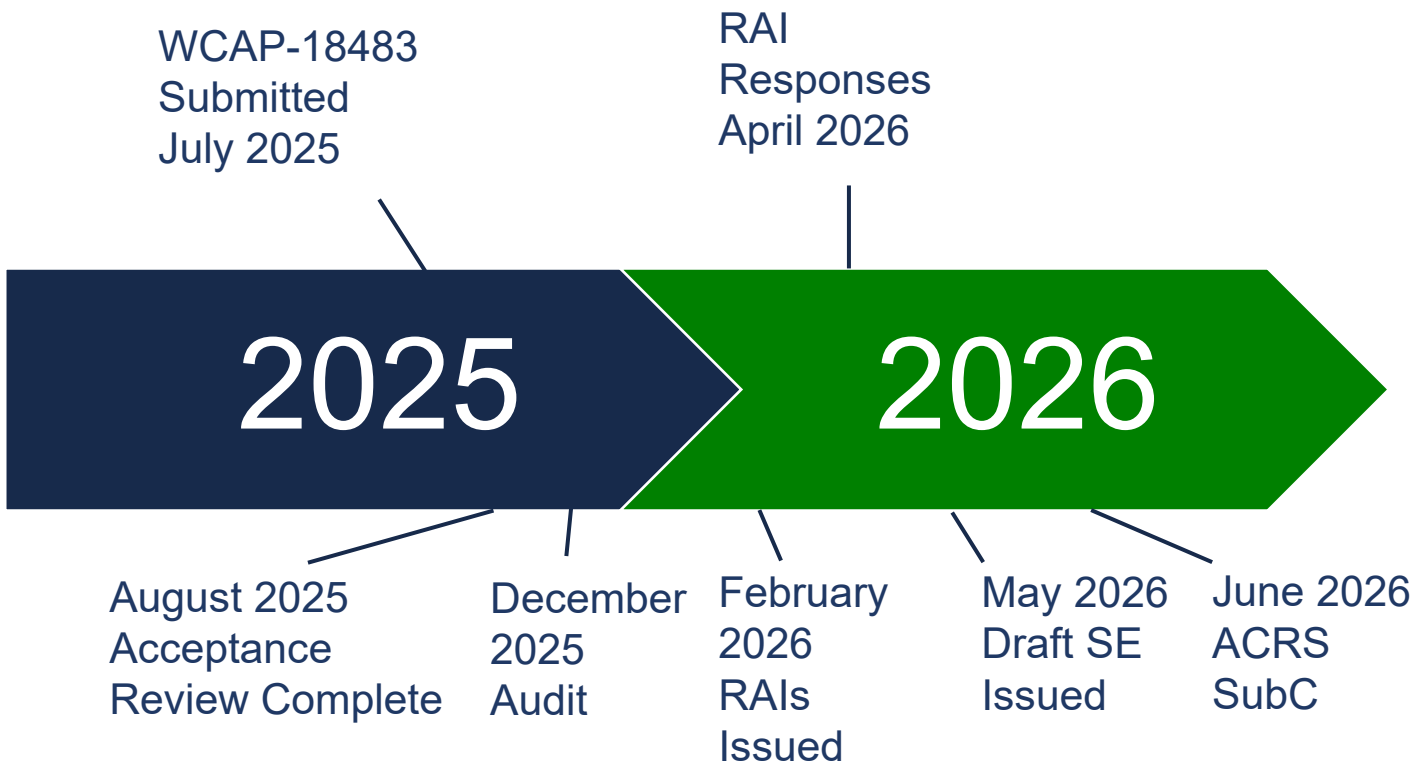
- Introduction
- Review timeline
- Key regulatory requirements and guidance
- Review focus areas
- Conclusions

Introduction

- WCAP-18483-P Topical Report (TR) describes Westinghouse Electric Company (WEC) EnCore chromium-coated cladding
- The first coated TR to be submitted to the NRC
- The WCAP-18483-P TR most notably includes:
  - Characterization of the properties and behavior
  - Irradiation programs and operating experience
  - Licensing criteria
  - Impact on steady-state and safety analysis methods

WCAP-18483-P TR Review Timeline

WEC



NRC

Key Regulatory Requirements and Guidance

Fuel and Core Performance

- General Design Criterion 10
  - Specified acceptable fuel design limits to assure cladding integrity for normal operation and anticipated operational occurrences
- NUREG-0800, Standard Review Plan, Chapter 4.2, “Fuel System Design”
  - The fuel system is not damaged due to normal operation and anticipated operational occurrences
  - Fuel system damage is never so severe as to prevent control rod insertion when required
  - The number of fuel rod failures is not underestimated for postulated accidents
  - Core coolability is maintained

Key Regulatory Requirements and Guidance

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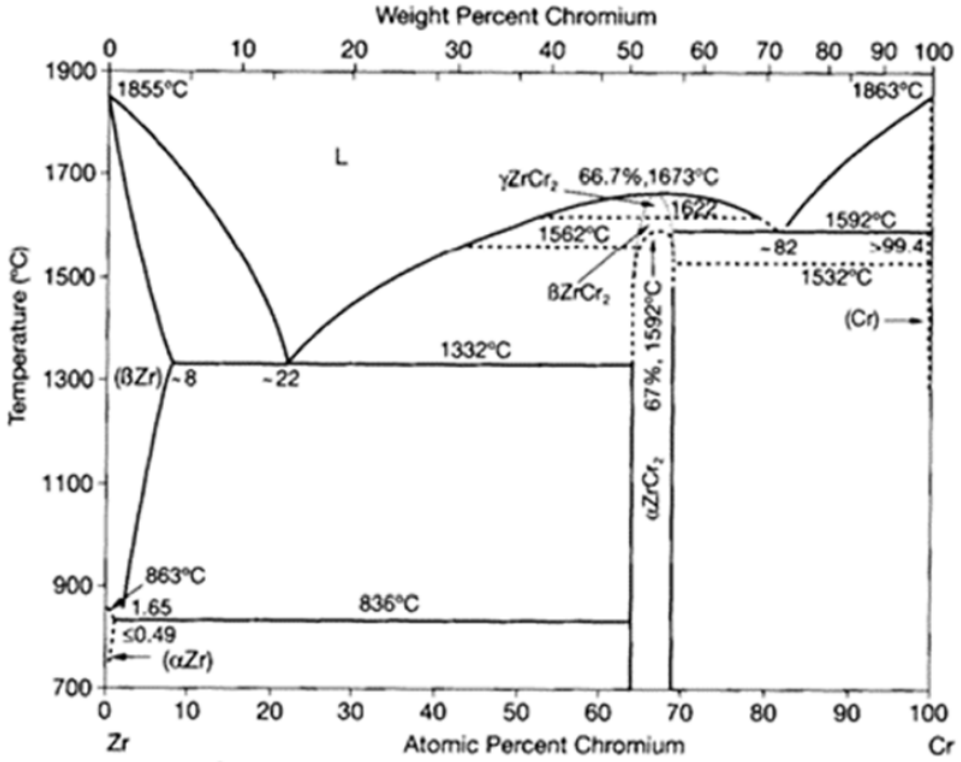
Loss-of-Coolant Accident (LOCA)

- 10 CFR 50.46
- General Design Criterion 35
- Appendix K to 10 CFR 50
- NUREG-0800, Standard Review Plan
  - Chapter 15.6.5, “Loss-of-Coolant Accident”
  - Chapter 15.0.2, “Review of Transient and Accident Analysis Methods”
- Regulatory Guide 1.157, “Best-Estimate Calculations of Emergency Core Cooling System Performance”
- Regulatory Guide 1.203, “Transient and Accident Analysis Methods”

Key Regulatory Requirements and Guidance

ATF-ISG-2020-01 provides staff guidance for reviews of Cr-coated zirconium alloy claddings

- Identifies new degradation mechanisms/considerations
  - Coating cracking
  - Coating delamination
  - Cr-Zr interdiffusion
  - Radiation effects on chromium
  - Subsurface damage
  - Residual stress
  - Galvanic corrosion
  - Eutectic formation (2429°F (1332°C))
- ISG on 10 CFR 50.46(b) limits: “it is not known if these limits will be acceptable for Cr-coated Zr cladding”



Zr-Cr Phase Diagram (Arias & Abriata, 1986)

Review Focus Areas

- In-reactor irradiation experience
- New models
- New failure mechanisms/considerations
- LOCA post-quench ductility acceptance criteria
- Non-LOCA acceptance criteria

Conclusions

The NRC staff determined that the EnCore cladding and associated analysis methods described in TR WCAP-18483-P are acceptable subject to the three limitations and conditions in the following areas:

1. Regulatory definition of EnCore cladding
2. Reactor and fuel assembly design
3. Operating domain (i.e., burnup)

Questions

Table of Abbreviations

10 CFR	Title 10 of the *Code of Federal Regulations*
ACRS	Advisory Committee on Reactor Safeguards
ACRS SubC	Advisory Committee on Reactor Safeguards Subcommittee
Cr	Chromium
ISG ATF-ISG-2020-01	Interim Staff Guidance (ISG) ATF-ISG-2020-01, “Supplemental Guidance Regarding the Chromium-Coated Zirconium Alloy Fuel Cladding Accident Tolerant Fuel Concept”
NRC	U. S. Nuclear Regulatory Commission
NUREG-0800, Standard Review Plan	Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NUREG-0800)
PWR	Pressurized Water Reactor
RAI	Request for Additional Information
SE	Safety Evaluation
WCAP-18483-P	WCAP-18483-P/NP, Revision 0, “EnCore® Chromium Coated Cladding for Use in Pressurized 16 Water Reactors” (Proprietary/Non-Proprietary)
WEC, Westinghouse	Westinghouse Electric Company
Zr	Zirconium