Welding and Repair Technology Center (WRTC) - Program Overview

Nick Mohr, EPRI WRTC, Program Manager

NRC/Industry Technical Exchange
June 17, 2025

Key Projects, Upcoming Deliverables, OE

- No industry trending OE – relatively busy outage season
- Key Projects:
  - Cold Spray – Application of hardfacing, other locations in plant, storage canisters
  - Irradiated Materials Weldability – Ongoing
  - ASME Code Activities and Support – Ongoing
- Select Deliverables in 2025
  - WRTC: Welding and Repair Technical Issues in ASME Codes and Standards - 2025
  - Industry Update on Code Case N-752, Risk-Informed Categorization and Treatment for Repair/Replacement Activities in Class 2 and 3 Systems
  - WRTC: Status Report for the Light Water Reactor Sustainability Collaborative Research Program on Irradiated Materials Weldability

WRTC Overview

- Team
- Members
- Meetings
- RFA Review

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WRTC TEAM

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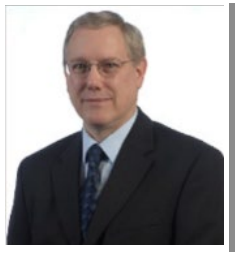

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Background:
Welding Engineering

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Background Welding Processes

- **NRC liaison, Jim Cirilli, Sr. Technical Executive**
- **Advance Manufacturing liaison, David Gandy, Sr. Technical Executive**
- **WRTC Extended Team:**
  - **Joseph Weicks – ASME Codes and Training (R&R), Case N-752**
  - **Dana Couch – Training Development**

7 – Degreed Welding Engineers
2 – Degreed Materials/ Metallurgical engineers

***Primary WRTC contact for ASME Section XI, **Primary WRTC contact for ASME Section IX**

WRTC Base and/or Supplemental Funding Members

United States (TAC)

- 23 of 23 U.S. Utility Organizations participate in WRTC (all operating BWR and PWRs)

International Participation (TAC)

- CANDU Owners Group (COG) – Canada, Romania
- CEZ A.S. – Czech Republic
- Chubu Electric Power Co., Inc. – Japan
- Chugoku Electric Power Co., Inc. - Japan
- Comision Federal de Electricidad (CFE) - Mexico
- Electricite de France S.A. (EDF/MAI) – France
- Emirates Nuclear Energy Corporation - United Arab Emirates
- Eskom - South Africa
- China Huaneng Group (CHNG) – China
- Kansai Electric Power Co, Inc – Japan
- Kernkraftwerk Leibstadt AG (KKL) - Switzerland
- Korea Hydro and Nuclear Power Co. - Korea
- Kyushu – Japan
- MVM Hungarian Electric (Paks) – Hungary
- Nucleoelectrica Argentina S.A. – Argentina
- Shikoku Electric Power Co – Japan
- State Nuclear Power Technology Company (SNPTC) - China
- The Tokyo Electric Power Company, Incorporated (TEPCO) - Japan
- FORO – Spain
- Vattenfall – Sweden
- OKG - Sweden
- Krško – Slovenia
- China National Nuclear Power (CNNP)
- Rolls Royce Power Engineering - United Kingdom
- TaiPower – Taiwan
- JAPC - Japan

Supplemental Non-Utility Memberships

- IHI Corporation – Japan
- Framatome (AREVA) – Germany, France, US
- Fluor
- KAPL/Bettis – Naval Nuclear Labs
- Doosan Heavy Industry – Korea
- WSI – US
- Liburdi Dimetrics
- Structural Integrity Associates
- Westinghouse

Updated 5/27/25

WRTC – Research Focus Areas (RFA)

WRTC organizes research/development work into 8 RFAs (for 2025)

- Each RFA has projects with related scope
  - ~ 50 ongoing projects across all WRTC
- Mix of Tactical (short term) and Strategic (fundamental) Research

1 **Weldability and Welding Alloy Development**

Focuses on key welding alloys, fabricability, and guidance documents

2 **Degraded and Irradiated Materials Repair Solutions**

Focus on the weldability thresholds for repair options, and measurement of the helium effects on weldability

3 **Optimized Joining, Fabrication, and Repair Processes**

Technology transfer for innovative technologies, techniques, and processes, either to support joining processes, code acceptance, or data collection.

4 **Repair Solutions for Structures**

Focuses on supporting spent fuel pools, canisters, tanks, and non-metallic repairs and mitigation

5 **Small Bore Piping Issues**

Focus on alternative to socket welds, small bore failures, remedies and training, and code repairs

6 **Code and Standards**

Technical bases of Code and Regulatory acceptance, optimization, and expansion of current Code

7 **Tactical Implementation of Repair Methods and Training**

Guidance documents, training, and technical information exchange

8 **Advance Manufacturing**

Supporting advance manufacturing methods, material testing and Code Acceptance

WRTC Research Focus Areas (2026+)

- RFA 1 - Materials Weldability and Welding Alloy Development
- RFA 2 - Asset Management of Degraded or Irradiated Materials
- RFA 3 - Innovation and Optimization of Processes
- RFA 4 - Repair Solutions for Balance of Plant
- RFA 5 - Advanced and Additive Manufacturing and Materials
- RFA 6 - Global Regulations and Standards
- RFA 7 - Workforce Development & Training

WRTC TAC – Upcoming Meetings – REGISTER/SAVE THE DATE(s)

June WRTC TAC Meeting – 2025

Date: June 23-26, 2025

Location: Hilton Scottsdale Resort, Scottsdale, AZ (Register Now)

Workshop: Advanced Reactor Overview/ Utility Additive Manufacturing Activities

December WRTC TAC Meeting – 2025

Date: Dec 8 -11, 2025
Location: Marriott Sanibel Harbor, Fort Meyers, FL (Register Now)
Workshop: Overview of Section IX, Construction Codes

June WRTC TAC Meeting – 2026

(in conjunction with NDE)

Date: June 22-26, 2026
Location: Marriott Sawgrass, Ponte Vedra Beach, FL

December WRTC TAC Meeting – 2026

Date: Dec 7 -10, 2026

Location: Hyatt Place/House Charleston Historic District, Charleston, SC

SAVE THE DATE – Joint NDE/WRTC Tech Week 2026

Sawgrass Marriott Golf Resort & Spa

June 22 – 26, 2026

1000 TPC Blvd.
Ponte Vedra Beach, FL 32082

Group Rate: $264/night

Why Have NDE & WRTC Together and What to Expect

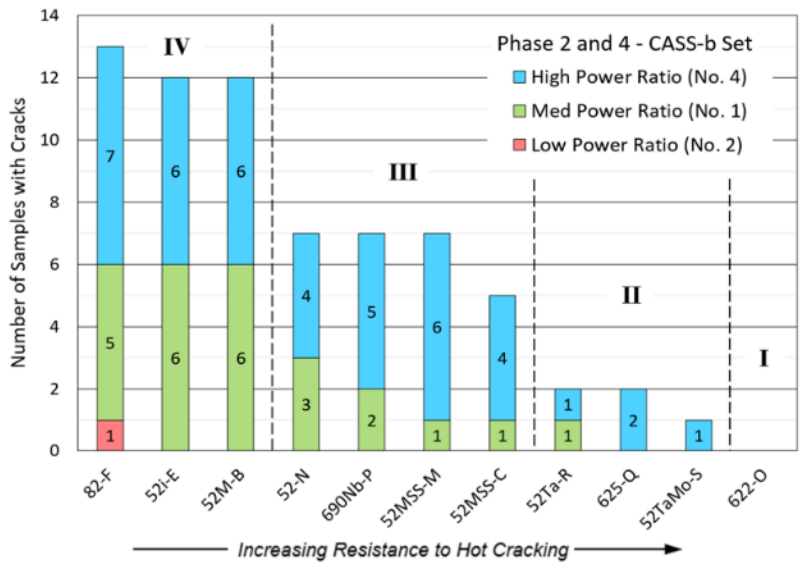
- While distinct, their missions are highly complementary, creating unique opportunities for collaboration and innovation.
- The week will highlight crucial advancements and foster discussions vital for the safe, sustainable, and cost-effective operation of current and future power-producing assets.

- **30+** Anticipated NDE/WRTC Vendors
- **15+** Anticipated Country Attendance
- **200+** Anticipated Attendees

- A dedicated Technology Showcase on Wednesday afternoon will bring together over 30 vendors from both the NDE and WRTC sectors.
- NDE RIC Meeting
- WRTC TAC Meeting
- Joint General Session
- Performance Demonstration Focus Group

WRTC's RFA 1: Material Weldability and Welding Alloy Development

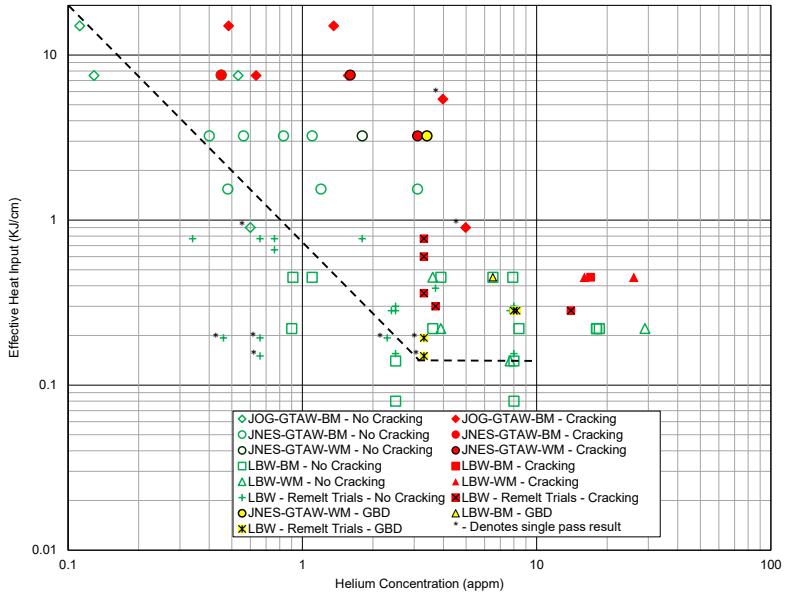
- Research and understand weldability of materials and filler materials
- Representative Demonstrations
- Develop solutions for improved weldability, implementation guidance and lessons learned
  - Current focus on high Cr Nickle alloys (Alloy 52 variants), duplex stainless steel and martensitic SS filler materials
  - Evaluation of alloys for new nuclear and small modular reactors
  - Goal to improved weldability and selection criteria for welding alloys for all applications (overlay, cavity, repair, fabrication)



Performance Comparisons Between NiCrFe Variants

WRTC's RFA 2: Degraded and Irradiated Materials Repair Solutions

- Welding challenges are being evaluated related to the high helium content generated in aged reactor internals
- Conventional and advance welding process under review on representative materials
- Weldability thresholds are being expanded based on effective heat input, helium content and welding process
- Identified as area of collaboration and further discussion with NRC

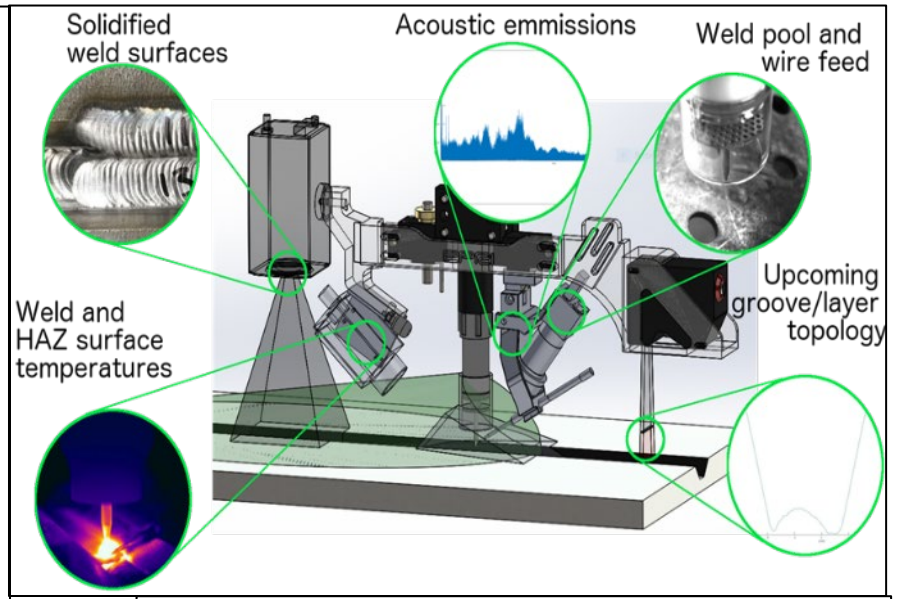


He-Induced Cracking Threshold Plot: 304 SS

WRTC's RFA 3: Optimize Joining, Fabrication, and Repair Processes

- Technology transfer for innovative technologies, techniques, and processes, either to support joining processes, code acceptance, or data collection

- Some key activities
  - Cold Spray process and other repair processes are being evaluated for Spent Fuel Canisters
  - Alternative methods for measuring heat input (Effective Heat Input). Supporting Hardness drop criterion for temper bead and Effective Heat input for temper bead
  - Adaptive Feedback welding being researched to control welding conditions through AI, and machine learning control



Adaptive Feedback Welding Technology

WRTC's RFA 4: Repair Solutions for Structures

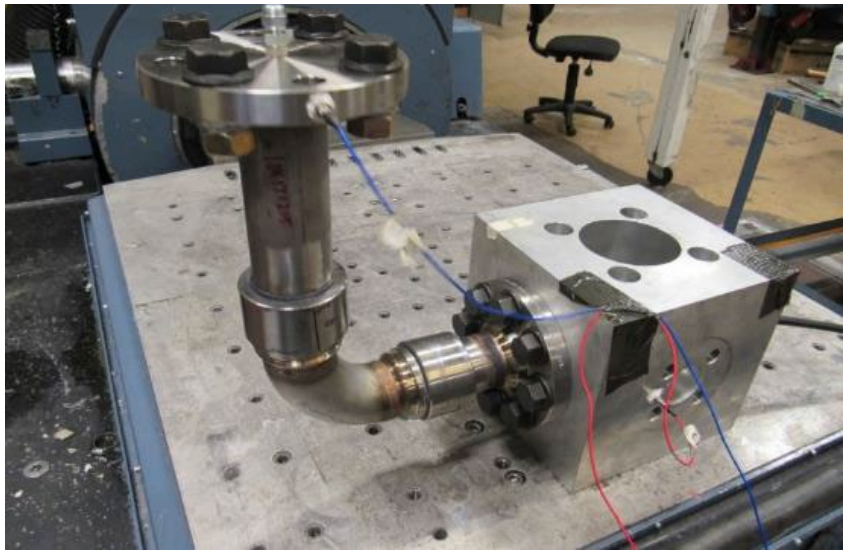
- Development of repair solutions for critical nuclear structures - current focus on containment, spent fuel pool (SFP), and dry cask storage system (DCSS) structures
- Interface with EPRI Extended Storage Collaboration Program (ESCP)
- New case for Repair & Replacement of canisters is planned for future discussion with NRC.

Dry Cask Storage (NRC, ML062200058)

WRTC's RFA 5; Small Bore Piping Issues

- Training material for understanding small bore piping issues, high cycle fatigue, and leak sealing.
- Implementation guidance for Mechanical joints and fittings (Lokring)
- Understanding small bore piping issues and eliminating small bore piping failures
- Socket welds and overlay leak repairs

High cycle fatigue testing of elbow mechanical fitting

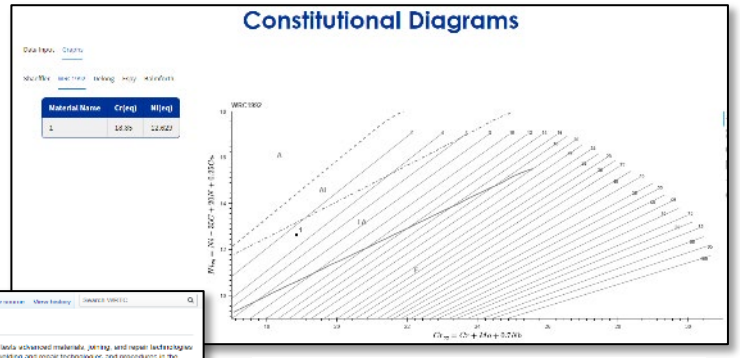


WRTC's RFA 6: Codes and Standards

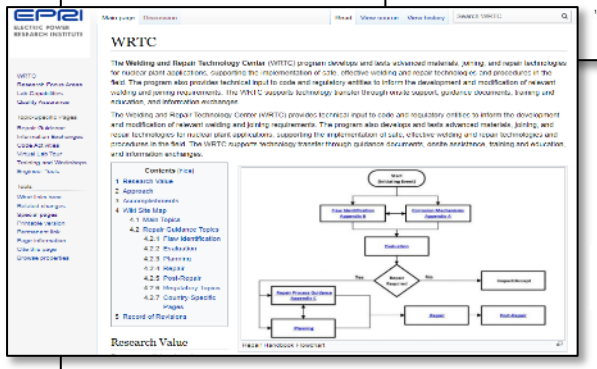
- Promote and progressing Codes and Regulatory adoption of Code Cases, Code Revisions via technical basis research, industry papers (e.g. PVP), etc.
- Reduce burden in requirements based on industry practices and promote utilization of repair processes.
- Publishes an Annual Report on status of Code changes, Code Cases, and Technical Issues

WRTC's RFA: 7 – Tactical Implementation of Repair Methods and Training;

- Development and implementation of specific repair solutions such as guidance for implementing new and innovative repairs and mitigation methods.
- Innovative tools developed for helping members find relevant information quickly
- Trending and tracking of industry performance and development / maintenance of guideline documents.
- OE, training, workshops, information exchanges, training, and assessment/ benchmarking activities **(Knowledge Transfer)**



Metallurgical Calculators



WRTC Wiki

WRTC's RFA 8; Advance Manufacturing - Development and Evaluation

- Explore potential advanced manufacturing, materials and applications, reduce barriers to implementation
- Provide technical bases documents
- Progressing code and regulatory adoption
- Powder Metallurgy, Additive, Hardfacing and Coatings Applications for new and operating fleets

Direct Energy Deposition Valve Body

PM-HIP Scaled SMR Head and Valve body

WRTC Capabilities and Facilities- Charlotte NC

- Full Welding and Material Laboratories
  - **Welding:** Manual/Machine GTAW, GMAW Laser Beam, Robotic GMAW
  - **Weld/Material Testing**: Impact testing, Micro/macro hardness (single point/mapping), Instrumented Indention Testing, Incremental Hole Drilling, Gleeble System, Button Melting System, Cast Pin Tear Testing, Transvarestraint Testing, Creep Testing, Calorimetry System
  - **Microscopy**: Scanning Electron Microscope, Optical Microscopes/Laser Scopes, Alloy Analysis
  - **Machining:** Full machine shop capabilities

- View Capabilities and facilities using our Virtual Lab Tour of EPRI facilities
  - https://wvlt.epri.com/
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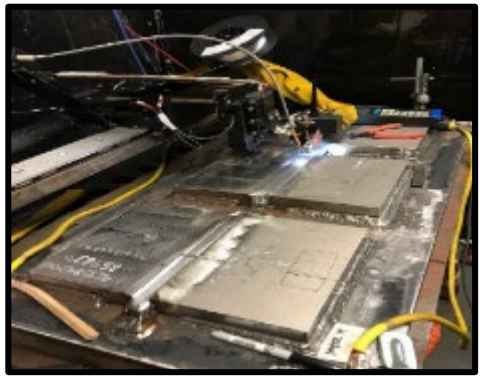

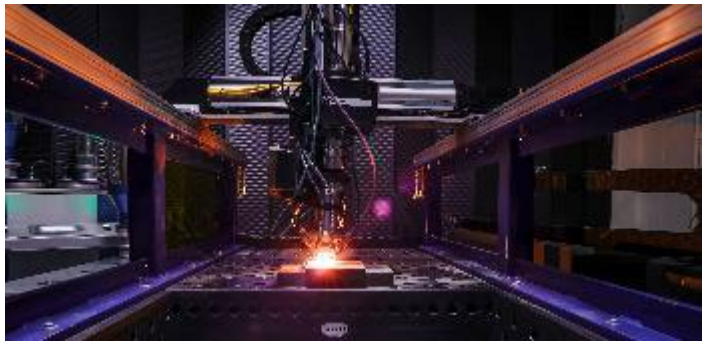

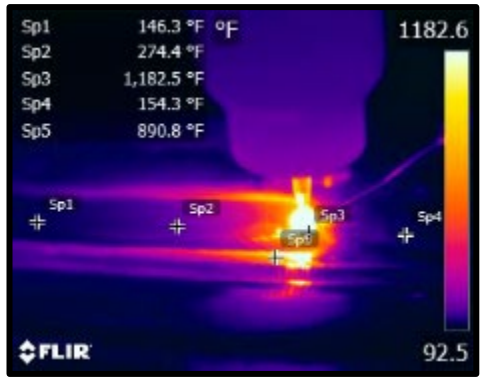

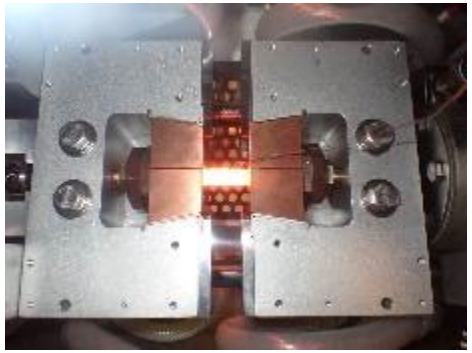

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