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First Prototype of Intrinsically Tamper Indicating Ceramic Seal (ITICS)

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Acknowledgements

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- NA-221 Global Safeguards Program

Agenda

- Background
- Seal Description and Operation
- Tamper Indication
- Unique ID
- Ease of Deployment
- Next Steps

Relevance to Mission

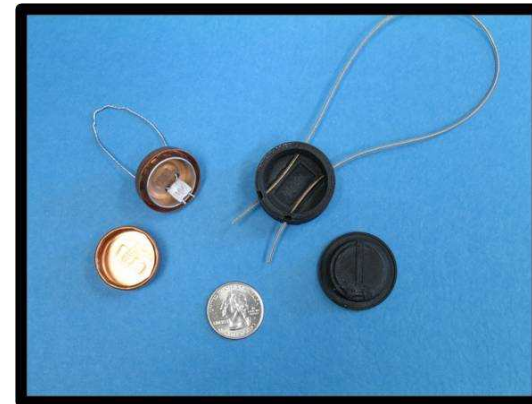
- Tamper indicating seals are critical elements of monitoring regimes to detect
 - Diversion of nuclear material
 - Equipment tampering
 - Declaration noncompliance
- Continual advances required
 - Stay ahead of adversary
- Ceramic Seal improves
 - Security features
 - Tamper indication
 - Unique identification
 - Efficiency
 - In-situ verification
 - Ease of application

Current State of the Art

- Most common loop seal is metal cup used since the 1960s
 - Conventional passive, single use loop seal for hasp applications
 - IAEA, HEU Transparency Program, EURATOM
 - IAEA uses approximately 20,000 per year
 - Issues
 - Verification is labor intensive and not performed in-situ
 - Seal is cumbersome to apply
 - Users have expressed need to replace seal



Picture courtesy SNL



Picture courtesy SNL

Goals and Objectives

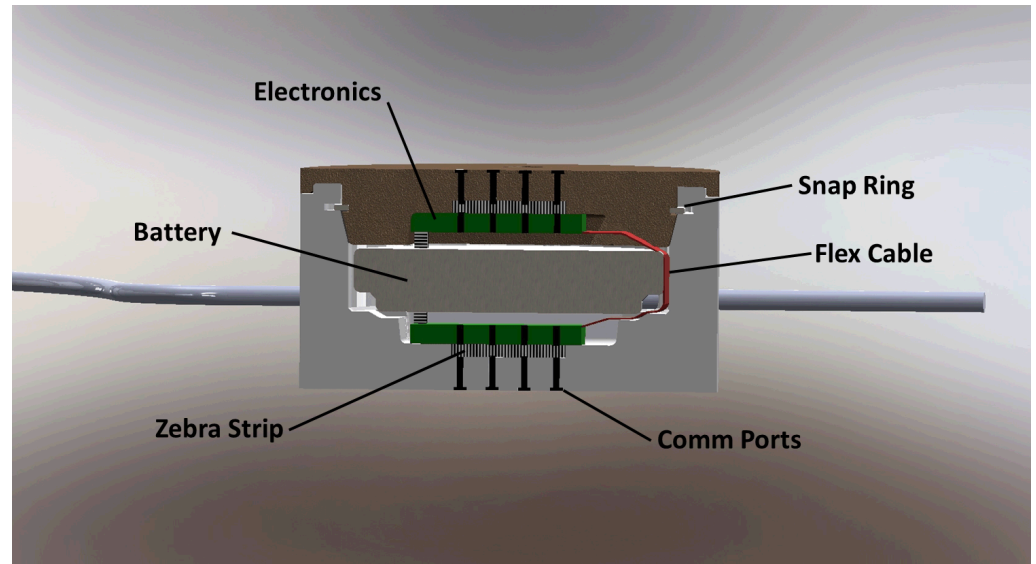
- Research advanced capabilities and develop a prototype next generation seal as a replacement for the metal cup seal
- Advance seal capabilities
 - Improve ease of application
 - Wire-cutting features
 - Self-securing wire feature
 - Create multiple levels of tamper indication
 - Frangible seal body
 - Surface coatings
 - Active detection of state
 - Create unique identification
 - Electronic ID
 - Non-reproducible surface features
- Innovation of Ceramic Seal is advanced capabilities in small volume



Picture courtesy SNL

Seal Description and Operation

- Thread wire through item and seal base
- Assemble seal pieces
- Apply seal application tool



Tamper Indication

- Seal body – frangible
- Fluorescent coatings
 - Passive measures sensitive to surface modifications of seal body
 - Development by SRNL
 - Inclusion in second prototype
- Electronics
 - One microcontroller unit on each half of seal body
 - Each periodically wakes up and verifies the identity of the other with secret key cryptography (AES-128)
 - Secret keys destroyed upon
 - Disassembly of seal
 - State of health
 - Handheld reader downloads status and event messages in-situ

Adhesives

- Adhesive functioning as barrier to external environmental conditions
- Working with Avery Dennison to develop a new adhesive system
- Future use of adhesives based on vulnerability review (VR) and design modifications

Unique Identification

- Electronics
 - Each seal will have a unique identifier
 - Handheld reader verifies unique identity in-situ through contacts on seal body
- Laser Surface Authentication
 - Development by SRNL
 - Inclusion in second prototype

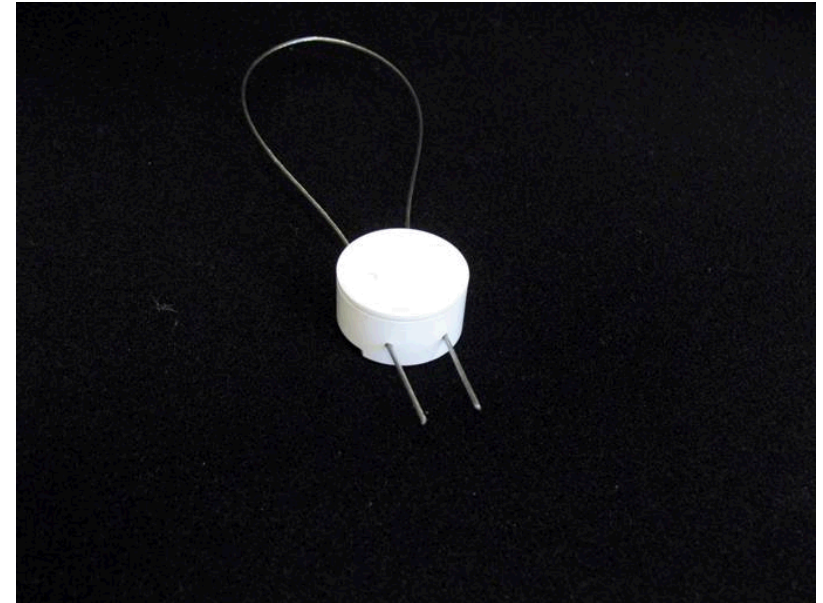
Wire Cutting

- Wire can be cut using
 - Seal application tool
 - Internal seal cutter
- Required force and wire alignment may decide method
- Within seal, implement cutting edge by joining metal to ceramic via brazing
 - Challenges
 - Braze joint strength adequate to cut through wire
 - Optimize cutting edge shape
 - Optimize shear interface
- Status
 - Successfully cut wire with WC cutting feature brazed to ceramic on bench top model
 - Next steps will test alternate cutting methodologies

Pre-prototype Seal



Picture courtesy SNL



Picture courtesy SNL

Seal without electronics sent to VR team for testing of materials, closure, and wire (battery included to secure wire)

Next Steps

- Incorporation of VR findings into second prototype
- Lessons learned from first prototype into second prototype
- Low temperature co-fired ceramic (LTCC) with embedded electronics
- Updated adhesives from Avery Dennison