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Development of the Wire Seals for the National Safeguards Inspection

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1. Introduction

The national inspection system was launched from August 1997 for 7 facilities and it was expanded to 13 nuclear facilities with regular basis inspection in 1998. In 2011, ROK performed its full implementation to all facilities, being numbered up to 39 facilities since its first full implementation in 1999[1].

Containment and surveillance equipment (C/S) techniques are extensively used for a complementary measure with nuclear material accountancy (NMA) verification. Sealing system is placed in the main C/S categories combined with the optical surveillance. Seals are applied for ensuring COK of the nuclear materials or components concerned without re-measurement of verified items or samples. The national inspection was performed by direct verification of the nuclear materials based on nondestructive analysis (NDA), destructive analysis (DA) with the application of the seals for the first time in 1998. The seals were imported but not offered the speed of application in a radiation control area. In order to have effective inspections, development of the adequate safeguards equipment is necessary.

This paper addresses the main features on the wire seals which KINAC has manufactured.

2. Development of the seal

Seals, sometimes referred to as tamper indicating devices, are used secures materials, documents or any other items in a tamper-proof containment. The purpose of the seals is to provide evidence of any unauthorized attempted to gain access to the secured material [2].

2.1 General Attributes of the Seal

Several factors influence the successful acceptance of the seals. Seals have been selected based on the following generic attributes [3]:

- Low cost
- Resistance to harsh environmental conditions
- Verification of seal serial number and integrity
- Ability to withstand service handling of containers
- Able to show evidence of tampering
- Relative ease and speed of application
- Ability to fit and adhere to variety of containers and their surface materials

2.2 RFID chip

Seal criteria include reliability, in-situ verification to reduce inspection effort. Employing a Radio Frequency Identification (RFID) system has the advantage to offer real time access in the data collection industry. The RFID system consists of two basic elements: the passive transponder for the ID tag and the reader. Passive transponders are micro-chips having no internal power source. The reader emits a low frequency magnetic field via its antenna. When a transponder passes within range, it is exited causing it to transmit its ID code back to the reader. We use a tiny Trovan micro-transponder and a reader with a very short read time. The micro-transponders (ID-100(3)) with dimensions of 3 mm in diameter; 13mm in length [4] were molded inside the seal items.

2.3 Seal Material

We make plastic cap seals which are composed of ABS (Acrylonitrile Butadience Styrene Copolymer) resin which has strong mechanical properties such as impact resistance and toughness. ABS's light weight and ability of injection molding makes it useful in manufacturing seal bodies.

2.4 Seal Design

Ease and speed of sealing operation is mandatory in such a harsh radiation area. We purchased commercial seal products (Trovan-300AEG) but it takes a bit long time to making a knot to close the loop. It has inspired the development of our own design. Some of improvements that we made include ease of use by making it a simple structure to attach the seal wire inside the seal body and low power tamper indication via a relatively fragile seal body. The seal has 2 plastic parts. When squeezed together and engaged, it cannot be opened without leaving any evidence of tampering, e.g. fractures of the tongue and groove joint. The mechanical integrity of the seal is visually checked by inspection on the exterior of the seals.

Figure 1. Seal Structure.

A metal wire is used for sealing and it penetrates through a hole to close the loop inside a cap. The identity of the seal is checked in field. The first seal was designed in 2001. And three modifications were made for its design with a concern for the user friendliness. The seal on the left side in Figure 2 was what we purchased and it was being used until the end of 2000. All the rest of them are what we developed. The latest model is on the right side.

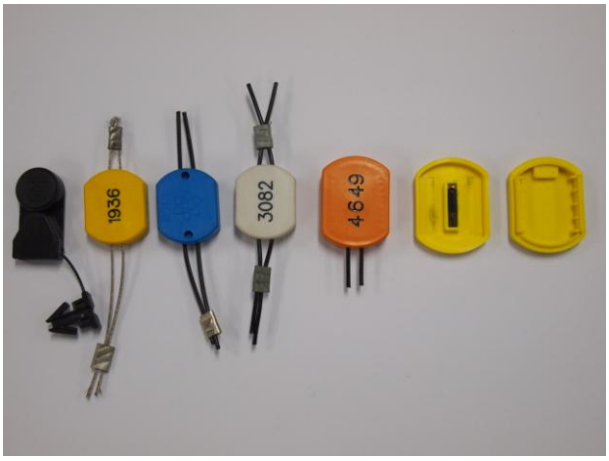

Figure 2. Seal Modifications.

2.5 Applications in Safeguards

We are applying those RFID seals to the equipment hatch, spent fuel transfer canal gate, and missile shield at LWRs and spent fuel transfer campaign tools and interim spent fuel dry storage at OLRs for the national inspection.

Figure 3. Seal at the Spent Fuel Transfer Canal Gate at LWR

3. Conclusion

We developed the seal combining the ABS resin cap providing easily identifiable tamper indications with the RFID for tag identification. The Seal is effectively being used in field with some modifications since the first design in 2001.

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