# IPNDV Working Group 3: Technical Challenges and Solutions
# Chain of Custody (9) Technology Data Sheet

*September 11, 2017*

**Chain of Custody (CoC) Technology Name:** Radio Frequency Identification (RFID)

**Physical Principle/Methodology of Technology:**

RFID is one method for automatic identification and data capture, and it uses electromagnetic fields to identify and automatically track tags attached to objects. Integrated circuit (IC) in the RF-tag is empowered by the radio wave emitted from a reader/writer and it sends back unique identification (ID) to the reader via radio wave.

The passive RF tags receive electricity from the RFID reader's interrogating radio waves, and electricity is not necessary for it. The longest distance between passive RF tag and reader is about 5 m. Conversely, active RF tags have a local power source such as a battery for the IC and radio transmission, and some of them could be operated at hundreds of meters from the RFID reader. The semi-passive RF tags have a local power source but the electric power is used only for the IC running. The semi-active tags have a capacitor to charge electricity obtained from interrogating radio waves and electricity is used for radio transmission.

According to the exposure test by low energy gamma-ray, normal RFID withstand up to 50 Gy exposure. Radiation-proof RFID were tested under gamma-ray environment (60 keV:241 Am, 30 mSv/h) and all tags survived against 350 Gy exposure. Radiation-proof RFID can also withstand up to 5,000 Gy by high energy gamma-ray (Cs source) and more than 45 Sv by neutron. Heat-resistant RFID can withstand about 70°C to 100°C for use and about 120°C to 250°C for standby.

**Potential Monitoring Use Cases** (pre-dismantlement, dismantlement, post-dismantlement, storage stage):

Chain of custody, monitoring of warheads, materials, equipment, devices.

**Physical Description of Technology** (e.g., approximate size, weight):

RF tags have various shapes depending on their intended use (Figure1). The shapes and forms of RF tags will be related to their performance, such as communication range, heat/water resistance, radiation resistance, and availability.

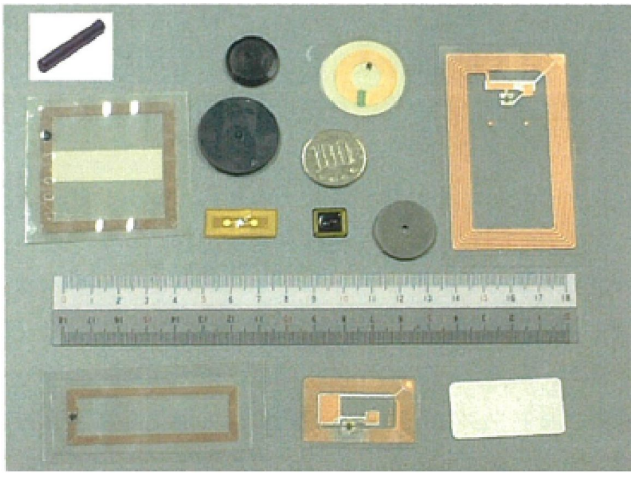

**Figure1: Example of RF tags [1]**

Examples of RFID specifications (Passive, Radiation Resistant):

- 23 mm × 23 mm × 5 mm, <1,000 Gy, Communication range <0.5 m
- 25 mm × 25 mm × 16 mm, <10,000 Gy, Communication range <0.5 m
- 50 mm × 45 mm × 20 mm, <10,000 Gy, Communication range <5,m

**Time Constraints** (e.g., measurement times including distance from object, time to install the equipment):

Time involved for RF tags is by attaching it onto the objects. The readout time using the reader is only a few seconds. The distance between the tag and reader is limited and depends on the type of RFID and environment.

**Technology Complexity** (e.g., hardware, software, and ease of use by personnel):

Simple to read signal from RFID by mobile or fixed transceiver.

**Infrastructure Requirements** (e.g., electrical, liquid nitrogen, etc.):

Electricity for reader and PC for data collection and review. Small batteries are required for active, semi-passive, and semi-active RF tags for power supply (timing for battery exchange of RF tags is generally five years).

**Technology Limitations** (e.g., detection limits for nuclear material, operational temperature range):

Communication range is 10 cm–5m for currently available passive and semi-active RF tags, and up to 200 m for active and semi-passive RF tags. The communication range is affected by surrounding metals and other environmental conditions.

If RFID is attached on the surface of container, there is no affect by shielding. But if it's attached on a warhead or other components that are stored in a shielding container, RFID cannot be workable.

In case RF tags are used on metal shielding, communication range is affected by metals around the RF tags. But RF tags reducing the effect of metals have been also developed.

**Information Collected by the Technology** (used to help determine if an information barrier is required for use):

RF tags can store digital data for the later use (e.g., serial number, ID, date). The memory size of a RF tag is approximately a few hundred bits (it's extensible by using multiple tags). RFID is currently used in a various applications such as access management, tracking of objects, and machine-readable documents.

**Safety, Security, Deployment Concerns**:

Cardiac pacemaker could be affected by the radio waves. Safety consideration for the warhead with radio waves would be required.

Cryptography is required to prevent information security risk.

**Technology Development Stage** (commercially available, development stage ):

Almost all the technologies described are commercially available (TRL 9).

**Cost Estimate:**

RF-tag: USD $10–25/tag (1,000/lot), Reader/Writer: USD $3,000, Antenna: USD $500, Laptop PC: USD $2,000

Installation: USD $3,000 (including cabling)

**Additional System Functionality** (e.g., outside the monitoring use case):

RFID can be used for the containment checking of the warhead container, using change detection technology with IC tag sheet.[1]

**Where/How the Technology Is Currently Used** (e.g., international safeguards, border protection):

Broadly used (product management, border control, forensics evidence, etc.)

**Examples of Equipment:**

See above.

**References:**

JAEA "Application and Technical Challenge of RFID Technology for the Safeguards and Nuclear Security on SF Direct Disposal," (internal document, Japanese only).

Claire Swedberg, "Passive RFID Tracks Changes in Structural Micro-Cracks," *RFID Journal*, available at www.rfidjournal.com/articles/view?15928/2.

[1] News Release, "DNP Develops Crack Detection System of Deteriorating Concrete Structures Including Tunnels," Dia Nippon Printing Co., Ltd. (October 5, 2016), available at http://www.dnp.co.jp/eng/news/10130676_2501.html.