

Alternative Frequency for Periodic Leakage Rate Testing

Yung Liu, Hanchung Tsai, Kun Chen,
Shiu-Wing Tam, Bud Fabian, and
Jim Shuler

PATRAM 2010
London, UK
October 3-8, 2010



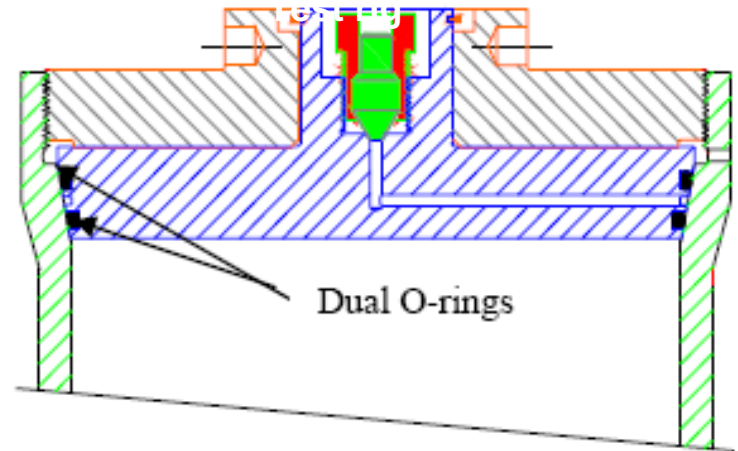
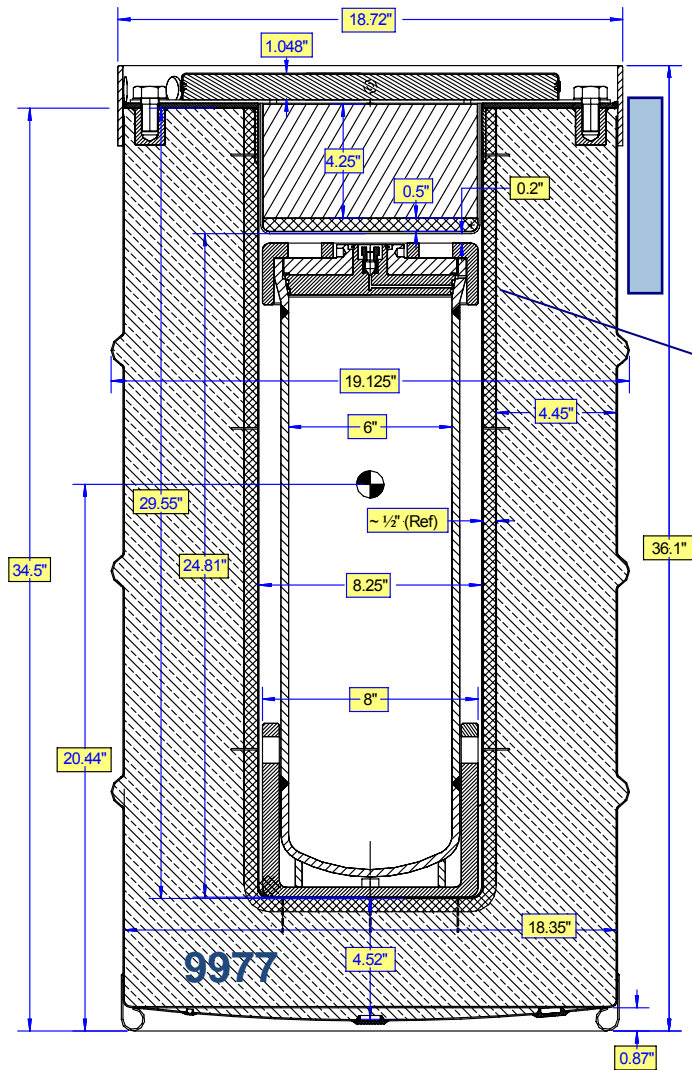
According to ANSI N14.5 Standard

- Purpose of periodic leakage rate testing of RAM packagings for shipment is to confirm containment capabilities of packagings built to an approved design have not deteriorated during a period of use. Testing must be performed
 - within 12 months prior to each shipment,
 - for all containment boundary seals, closures, valves, rupture disks, and other applicable components.
- Cost of leakage rate testing averaged \$2,500 to 3,000 per unit.
- Basis determined and methodologies established for extending interval of periodic leakage rate testing from 12 mo. to a maximum of 5 yrs.
- The extended intervals are based on
 - acceptable results of long-term O-ring performance tests, and
 - continuous monitoring of environmental conditions of packagings provided by **ARG-US**, the radio frequency identification (RFID) system developed by Argonne for the U.S. DOE Packaging Certification Program, Office of Packaging and Transportation.



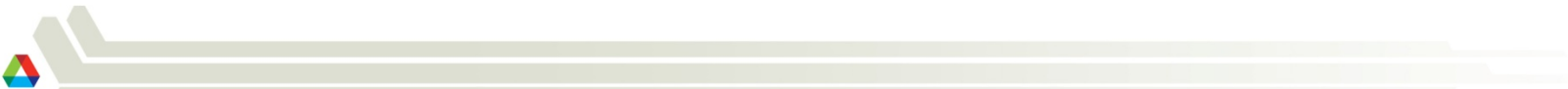
Seal temperature monitoring for Model 9977 (and 9975) packages

RFID tag monitors
“ambient” temperature



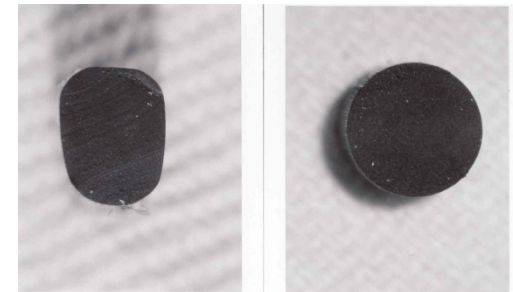
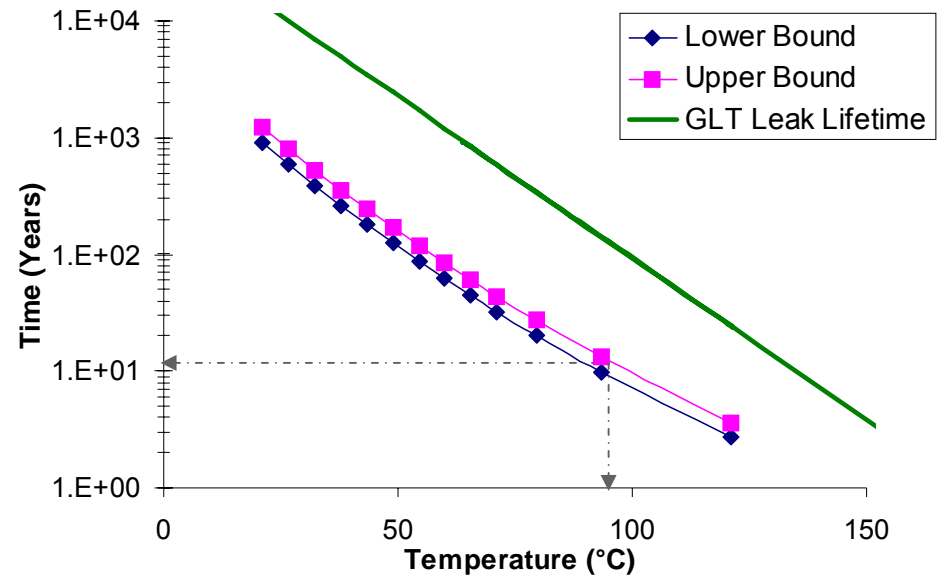
- Field surveillance
- Laboratory testing
- Accelerated aging / life prediction

Viton® GLT ≤ 200°F (93°C)



Model 9975 laboratory O-ring testing (adapted from K. Dunn)

- Baseline properties, CSR Tests, leak rate correlation, aging model
- Mock-up fixtures to evaluate
 - temperatures, radiation dose, vacuum grease, fill gas
 - Leak tightness
 - Degradation of O-rings
- Status — 5 years testing at bounding conditions

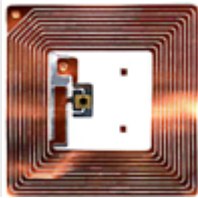


- Aging model developed, 200°F (93°C) fixtures remain leak tight



What is RFID (Radio Frequency Identification)?

- **Tags:** to collect and send signals autonomously or when prompted



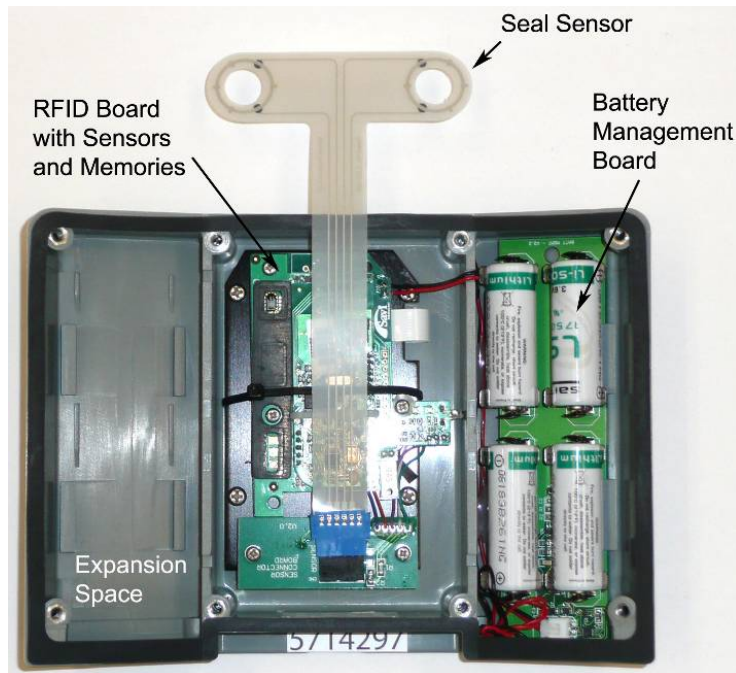
- **Readers:** to communicate with tags and receive signals



- **Application software:** to process data into information for action



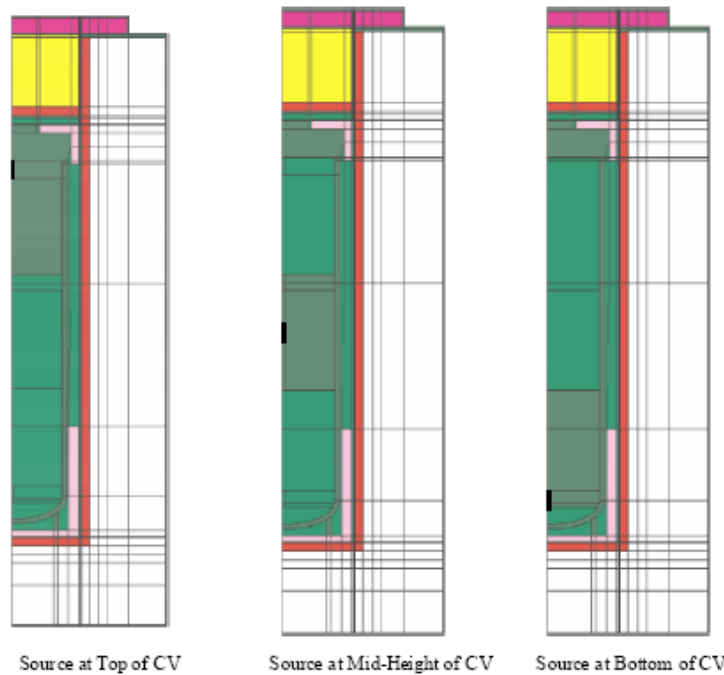
ARG-US RFID surveillance tags — DOE patent pending



- **Universal form factor**
- **Full sensor suite (seal, shock, temperature, humidity, dosimeter, etc)**
- **Good radiation resistance (>17 yr at 200 mrem/h)**
- **Long battery life (>10 yr)**
- **Clock and non-volatile memory**
- **Omni-communication range \approx 100 m**



Seal temperature calculation for Model 9977 package



- Min-K-2000
- Vermiculite TR-19
- Air
- 304L Stainless Steel
- Load Distributor (Al)
- Last-A-Foam FR-3716
- Compressed Fiberfrax
- 19W Source

Nick Gupta

“Thermal evaluation of 9977 package O-ring under varying thermal loading and temperature conditions,”

Cal. Note, Addendum 9977 SARP, June 23, 2008

Max. decay heat load = 19 W

Table 6: Maximum O-Ring Temperatures

Thermal Loading, W (Watts)	Ambient Temperature, T _a (°F)	O-Ring Temperature, T _{O_Ring} (°F)
19	100	198.4
17	100	189.6
15	125	204.1
13	125	192.8
10	150	200.8
7	150	183.9
5	175	197.2
2	175	181.6
0	200	200

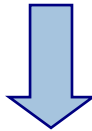
$$T_{O_Ring} = -12.7156 + 5.641 * W + 1.051 * T_a$$

$$T_{O_Ring} = 2.5312 + 3.618 * W + 0.986 * T_a$$

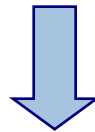


Ambient temperature limits for Model 9977 package

$$T_{\text{O-ring}} = -12.7156 + 5.641*W + 1.051*T_a \leq 200^{\circ}\text{F}$$



$$T_a \leq 202.39 - 5.37*W$$



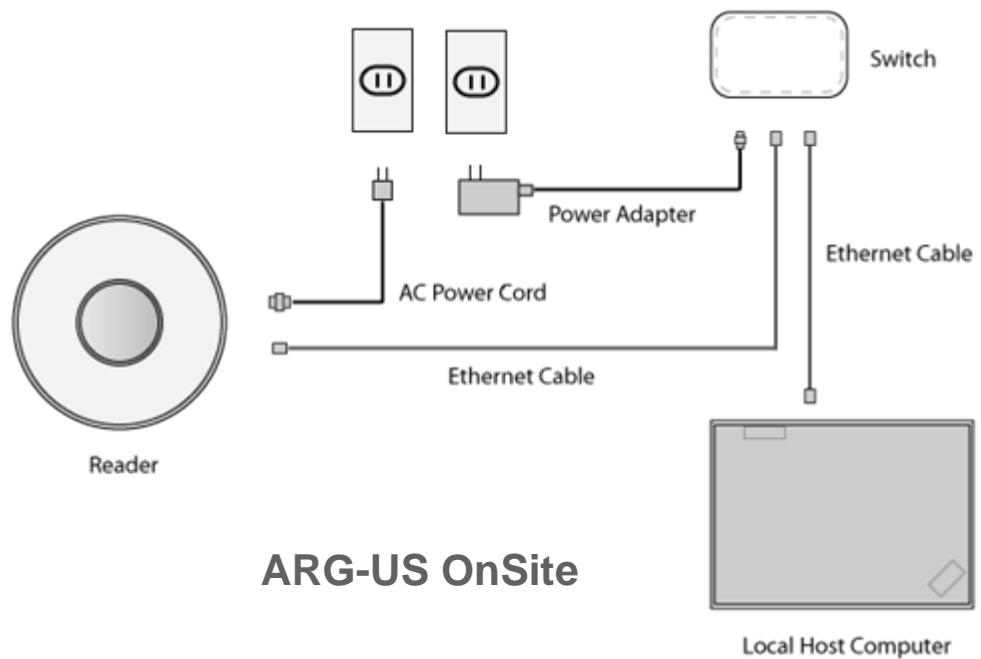
$$T_a \leq 149^{\circ}\text{F} (65^{\circ}\text{C}) \text{ for } W = 10 \text{ Watts}$$



Alarm threshold for “ARG-US OnSite”

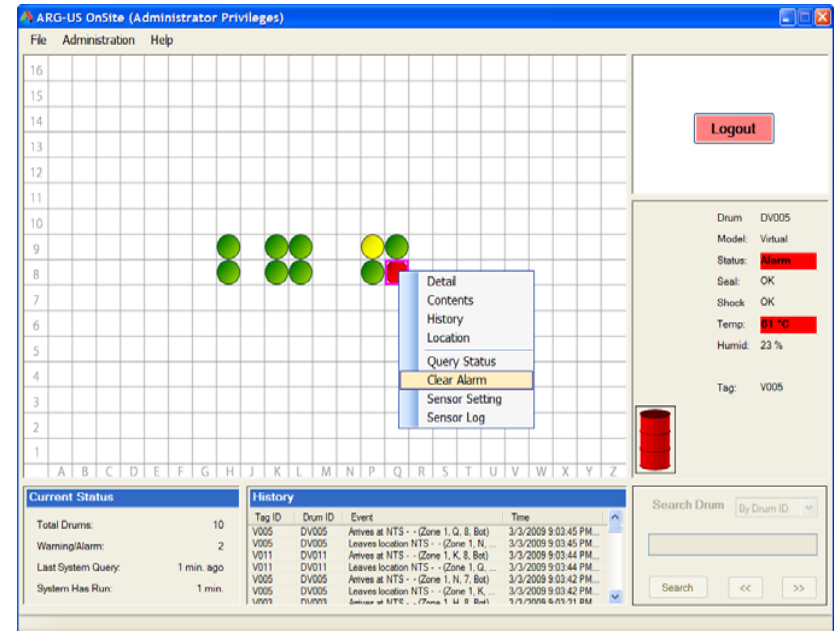
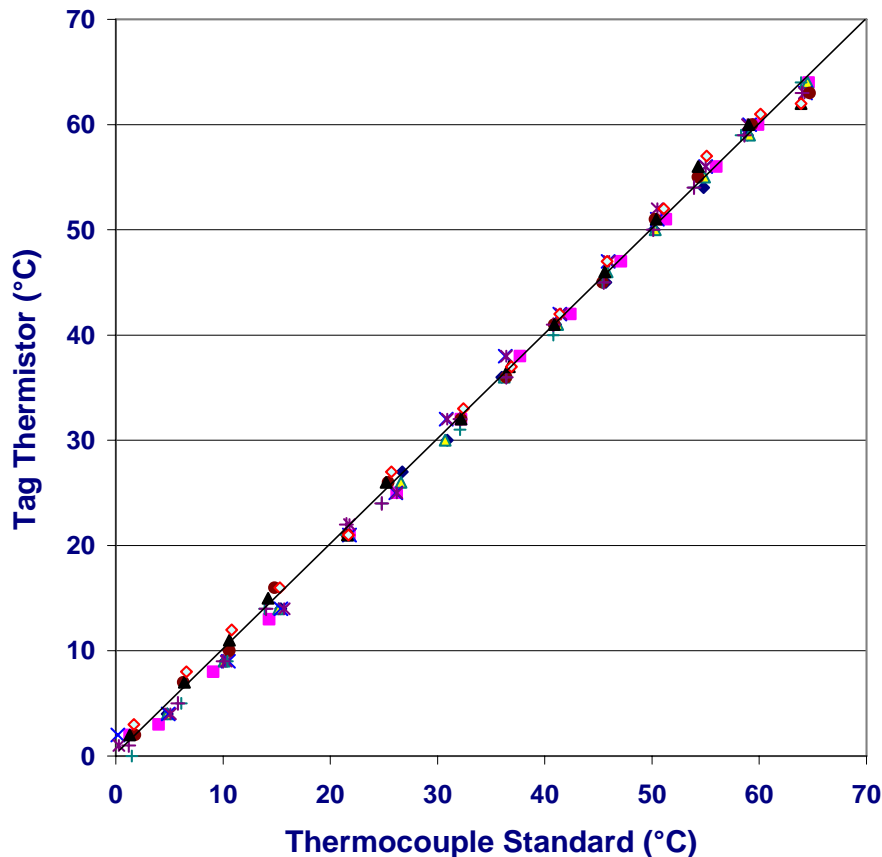


ARG-US OnSite RFID system — shown on mobile platform



QA of ARG-US OnSite — hardware and software

Calibration of temperature sensor in MK-II RFID tags



SQA includes

- design control, version control,
- software functionality and reliability tests,
- user documentation, and document control

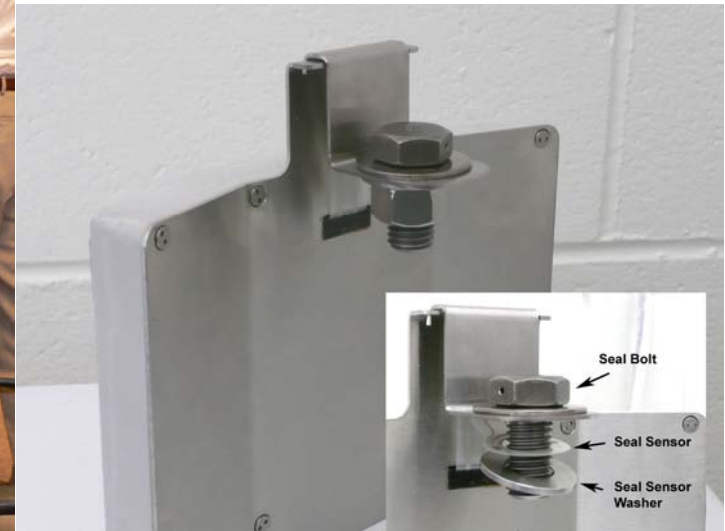
and meets software QA requirements of NQA-1.



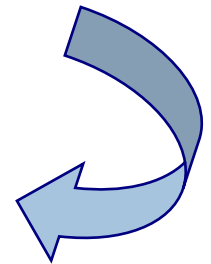
ARG-US OnSite — training and certification



RFID Guide ANL/DIS-09-5



- Training session at Argonne
- *Half-day for general user*
 - *Full day for administrator*



Summary and conclusions

- Methodologies established to extend the interval of periodic leakage rate testing for Model 9975, 9977, and 9978 packages from 12 months to a maximum of 5 years.
- Extensive data from both laboratory and field tests showed that the original Viton® GLT O-ring fixtures have maintained a leaktight seal at room temperature for over 4 years of exposure at 200°F. The data on the Model 9975 packages are applicable to the Model 9977 and 9978 packages because they all use the Viton® GLT O-rings for the containment vessels and have the same closure designs.
- The ARG-US OnSite RFID temperature monitoring system, including the MK-series RFID tags, readers, and application software, has been developed and tested to meet the applicable quality assurance standards and requirements.
- The ARG-US OnSite RFID system (1) continuously monitors the ambient temperature of the packages reliably, (2) issues an alert/alarm when the ambient temperature threshold is exceeded, (3) records the event of violation, and (4) provides the basis for choosing an alternative frequency for periodic leakage rate testing.
- Extending the interval of periodic leakage rate testing of the packaging enhances safety and reduces the exposure of personnel to radiation and facility operating costs.

