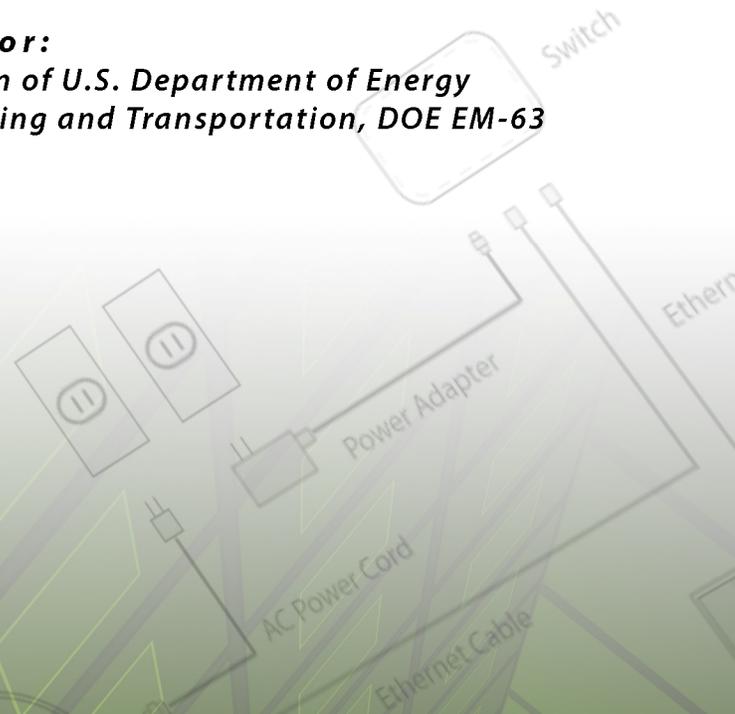


# DOCUMENTATION PACKAGE FOR THE RFID TEMPERATURE MONITORING SYSTEM

(MODEL 9977 PACKAGES AT NTS)

*Prepared for:*

*The DOE Packaging Certification Program of U.S. Department of Energy  
Environmental Management, Office of Packaging and Transportation, DOE EM-63*



The mission of the DOE Packaging Certification Program (PCP) is to ensure the safety of packagings for radioactive and fissile materials and support vital DOE missions across the DOE Complex, as well as EM's risk reduction, cleanup, and site closure activities.

# Memorandum

DATE: FEB 17 2009

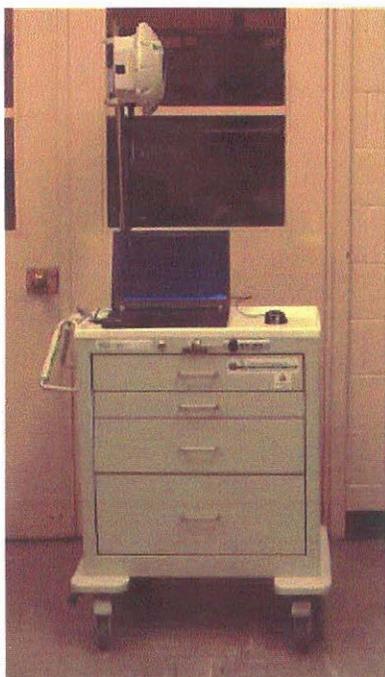
REPLY TO  
ATTN OF: EM-63 (Dr. James M. Shuler, 301-903-5513)

SUBJECT: Documentation Package for the RFID Temperature Monitoring System of Model 9977 Packages at NTS

TO: Distribution

On December 8, 2008, The DOE Headquarters Certifying Official issued Revision 0 of DOE Certificate of Compliance (CoC) USA/9977/B(M)F-96 (DOE-S/T-1) for the Model 9977 packaging. The expiration date for this revision is December 31, 2013. This new certification is a storage/transportation CoC. The Savannah River National Laboratory, at the request of the U. S. Department of Homeland Security, Domestic Nuclear Detection Office (DHS-DNDO), submitted an application on June 26, 2008, requesting the addition of new contents and an extension of periodic maintenance beyond the one-year interval to a maximum of five years. The new contents request was based on the need to ship these materials in the Model 9977 packagings, which reside at the Device Assembly Facility (DAF) on the Nevada Test Site (NTS), to remote locations in support of the DHS-DNDO. These new contents have been approved. Revision 0 of the DOE CoC USA/9977/B(M)F-96 (DOE-S/T-1) for the Model 9977 packaging extended the periodic maintenance to a period of two years subject to the use of the RFIDs to track environmental conditions.

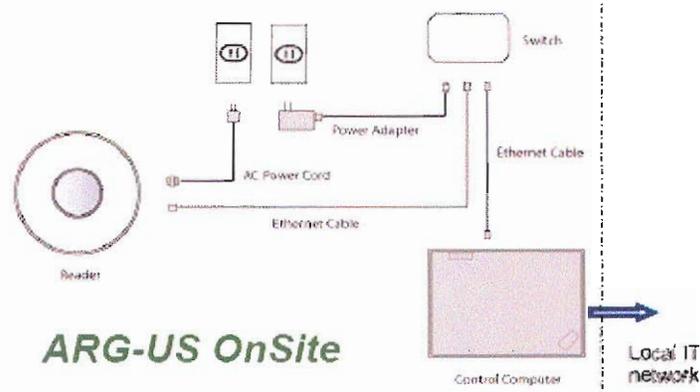
The technical basis for extending the Model 9977 shipping packaging periodic maintenance beyond the one-year interval to a maximum of five years is based on the performance of the O-ring seals and the environmental conditions. The DOE Packaging Certification Program (PCP) has tasked Argonne National Laboratory to develop a Radio-Frequency Identification (RFID) temperature monitoring system for use by the facility personnel at DAF/NTS. The RFID temperature monitoring system, depicted in the figure below, consists of the Mk-1 RFID tags, a reader, and a control computer mounted on a mobile platform that can operate as a stand-alone system, or it can be connected to the local IT network. As part of the Conditions of Approval of the CoC, the user must complete the prescribed training to become qualified and be certified for operation of the RFID temperature monitoring system. The training course will be administered by Argonne National Laboratory on behalf of the Headquarters Certifying Official.



Mk-1 RFID tags



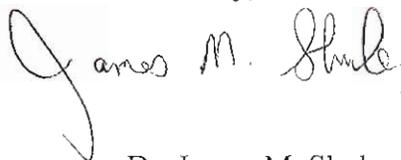
Attached to a Model 9977 drum



Attached is a complete documentation package for the RFID temperature monitoring system of the Model 9977 packagings at NTS. The documentation package will be used for training and certification. It includes the acceptance testing procedure and results of the Mk-1 RFID tags, performance test of the single-bolt seal sensor for the Model 9977 packaging, calibration of built-in thermistors in the Mk-1 RFID tags, procedure for installing and removing the Mk-1 RFID tag on Model 9977 drum, user guide for the RFID reader and software, and various software quality assurance documents prepared in accordance with the software quality assurance plan for the ARG-US system. The documentation package is referenced in Chapter 7 (Operating Procedures), Chapter 8 (Acceptance Tests and Maintenance), and Chapter 9 (Quality Assurance) of the Safety Analysis Report for Packaging Model 9977 B(M)F-96, S-SARP-G-00001, Revision 2, August 2007, as supplemented in Section 5.(e).

If you have any questions, please call me at (301) 903-5513.

Sincerely,



Dr. James M. Shuler  
Manager, DOE Packaging Certification Program

U.S. Department of Energy  
Office of Packaging and Transportation  
EM-63, CLOV-2047  
1000 Independence Ave., SW  
Washington, D.C. 20585  
301-903-5513  
301-903-9770 fax  
[James.Shuler@em.doe.gov](mailto:James.Shuler@em.doe.gov)  
<http://rampac.energy.gov/>



***EM*** ***Environmental Management***  
safety ❖ performance ❖ cleanup ❖ closure  
***DOE Packaging Certification Program***

## Table of Contents

Acceptance Testing Procedure of MK-1 RFID Tags for DOE/EM Nuclear Materials Management Applications .....	PC-02-1
Acceptance Testing Result of MK-1 RFID Tags for DOE/EM Nuclear Materials Management Applications .....	PC-03-1
Performance Test of the Single Bolt Seal Sensor for the Model 9977 Packaging .....	PC-05-1
Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site .....	PC-08-1
Results of Calibration of Built-in Thermistors in RFID Tags .....	PC-09-1a
Results of Thermal Calibration of Second Batch of MK-I RFID Tags .....	PC-09-1b
Procedure for Installing and Removing MK-1 RFID Tag on Model 9977 Drum .....	PC-10-1
User Guide for RFID Reader and Software for Temperature Monitoring of Model 9977 Drums at NTS.....	PC-11-1
Software Quality Assurance Plan (SQAP) for the ARG-US System .....	PC-12-1
Quality Category for the RFID Temperature Monitoring System.....	PC-13-1
The Documentation Package for the RFID Temperature Monitoring System .....	PC-14-1
Software Test Plan and Results for ARG-US OnSite.....	PC-16-1
Configuration Management Plan (CMP) for the ARG-US System.....	PC-17-1
Requirements Management Plan for the ARG-US System .....	PC-18-1
Design Management Plan for ARG-US.....	PC-19-1



**Acceptance Testing Procedure of MK-1 RFID  
Tags for DOE/EM Nuclear Materials  
Management Applications**

**Document Control No. PC-02-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

March 2008



March 11, 2008

PC-02-00-00

TO: Distribution

FROM: Kun Chen DIS-PCLCM

SUBJECT: Acceptance Testing Procedure of MK-1 RFID Tags for DOE/EM Nuclear Materials Management Applications

The MK-1 RFID tags are being produced for testing and potential use in the DOE/EM nuclear material management. The MK-1 tag is based on the Savi ST-676-I RFID tag. The modification consists of rearranging the original circuit boards and antenna board to fit into the MK-1 plastic tag housing, adding a new seal sensor board and a new battery management board, and connecting a customized seal sensor. This document is to be used for acceptance testing of the modified tags. Since the seal sensor and the battery management board are the last item to be inserted in the final assembly (per the drum type), they shall be evaluated later and reported separately.

The specifications of the original ST-676-I tag are summarized in Ref. 1. Each tag has a unique identification number. Depending on the production schedule of the outer casing, some of the tags may not be fully enclosed during the acceptance testing. But this should not affect the electronic performance of the tags.

Only tags that successfully pass every aspect of the assessment procedure shall be treated as *Acceptable*. The unacceptable ones may be repaired and resubmitted for assessment. The assessment results shall be reported in a separate document.

A. Tools for the assessment

1. The SR-650-101 fixed reader (the reader, Ref. 2) and the SmartChain SiteManager (SiteManager, Ref. 3) software shall be used to collect the tag information and read/write the tag memory.
2. Extech Instruments 445815 Humidity Alert II (Ref. 4)

B. Inspection of the RF range

1. Separate the tag and the reader by  $\geq 30$  meters but within a line of sight.
2. Verify the tag information can be collected by the reader using the SiteManager at this range.

C. Inspection of the temperature and humidity sensor

1. Determine the ambient temperature and humidity and verify against a NIST-certified instrument (Ref. 4).
2. Allow sufficient time for the tags to be tested to reach the same ambient state.
3. Using SiteManager, confirm the tag's temperature and humidity readings are within  $\pm 2^{\circ}\text{C}$  and  $\pm 5\%$ , respectively, of the readings of the NIST-certified instrument.
4. Using a heat gun at low setting, briefly blow warm air over the sensors. Verify that there is a reasonable increase of temperature and decrease of humidity. Only a qualitative response is required for this test.

D. Inspection of the shock sensor

1. Drop the tag from 7 cm height to a hard surface (i.e, wooden table top). Verify the shock sensor responds to the impact using the reader and the SiteManager.

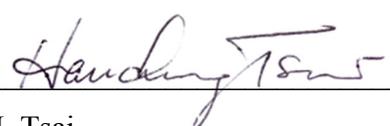
E. Inspection of the seal sensor board

1. Plug the seal sensor (pressed by 1/2 inch bolts and washers, 6 N·M torque) to the tag. Verify the tag alarm is NOT triggered using the reader and the SiteManager.
2. Unplug the seal sensor. Verify the tag alarm is now triggered.

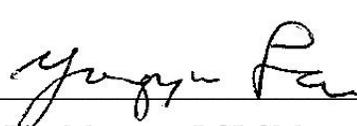
F. Inspection of the memory reading and writing

1. Write a sample inventory file to the tag memory using the reader and the SiteManager.
2. Read the file from the tag memory using the reader and the SiteManager. Verify the reading is consistent with the original file.

Reviewed by: \_\_\_\_\_

  
H. Tsai

Approved by: \_\_\_\_\_

  
Y. Liu, Manager, PCLCM

Distribution:

Y. Y. Liu

H. Tsai

A. McArthur

S. Naday

R. R. Fabian

S.W. Tam

V. Shah

B. Shelton

J. Li

J. Gillette

R. Cirillo

K. Chen

PCLCM Document File

RFID Program File

References:

1. Savi Technology, Inc., Documentation for Savi SensorTag ST-676-I ISO Container Door Tag with Sensors, version 1.0, 805-05125-001 Rev. A, September 2005.
2. Savi Technology, Inc., Documentation for Savi Reader SR-650-101, version 1.0, 805-04399-001 Rev. B, August 2004.
3. Savi Technology, Inc., Documentation for Savi SmartChain Site Manager, version 5.7, 805-04574-001 Rev. E, May 2006.
4. Extech Instruments, Model: 445815, SN: H007172, Certification Number: 4592, Calibration Date: 12/06/2007.

**Acceptance Testing Result of MK-1 RFID  
Tags for DOE/EM Nuclear Materials  
Management Applications**

**Document Control No. PC-03-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

March 2008



March 13, 2008

PC-03-00-00

TO: Distribution

FROM: Kun Chen DIS-PCLCM

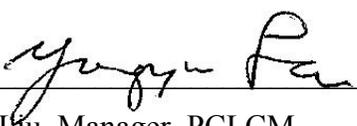
SUBJECT: Acceptance Testing Result of MK-1 RFID Tags for DOE/EM Nuclear Materials Management Applications

The MK-1 RFID tags are being produced for testing and potential use in the DOE/EM nuclear material management. The initial batch of MK1 consists of 22 tags, listed in Table 1. Each tag has been tested following the procedure described in a separate document – *Acceptance Testing Procedure of MK-1 RFID Tags for DOE/EM Nuclear Materials Management Applications* (PC-02-00-00). The testing results are recorded in Table 1.

Table 1. The Acceptance Test Result of the MK1 RFID Tags

Tag ID	Range (m)	Measured T (°C) / H (%)	NIST Ambient T (°C) / H (%)	Heat Gun Test	Shock Sensor	Seal Sensor	Memory
5703179	> 30	23/25	23/24	OK	OK	OK	OK
5703180	> 30	23/26	23/24	OK	OK	OK	OK
5703181	> 30	23/20	23/21	OK	OK	OK	OK
5703182	> 30	23/20	23/21	OK	OK	OK	OK
5703183	> 30	22/24	23/24	OK	OK	OK	OK
5703184	> 30	23/25	23/26	OK	OK	OK	OK
5703185	> 30	23/24	23/24	OK	OK	OK	OK
5703186	> 30	22/24	23/24	OK	OK	OK	OK
5703187	> 30	22/24	23/24	OK	OK	OK	OK
5703188	> 30	22/24	23/24	OK	OK	OK	OK
5703190	> 30	22/25	23/24	OK	OK	OK	OK
5703191	>30	22/24	23/24	OK	OK	OK	OK
5703193	> 30	22/22	23/24	OK	OK	OK	OK
5703194	> 30	22/22	23/24	OK	OK	OK	OK
5703195	> 30	22/24	23/24	OK	OK	OK	OK
5703196	> 30	23/22	23/24	OK	OK	OK	OK
5703197	> 30	24/19	23/22	OK	OK	OK	OK
5703198	> 30	22/24	23/24	OK	OK	OK	OK
5703199	> 30	23/23	23/24	OK	OK	OK	OK
5703200	> 30	22/20	23/22	OK	OK	OK	OK
5703201	> 30	22/23	23/24	OK	OK	OK	OK
5703202	> 30	22/22	23/24	OK	OK	OK	OK

Reviewed by:   
H. Tsai

Approved by:   
Y. Liu, Manager, PCLCM

Distribution:

Y. Y. Liu  
H. Tsai  
A. McArthur  
S. Naday  
R. R. Fabian  
S.W. Tam  
V. Shah  
B. Shelton  
J. Li  
J. Gillette  
R. Cirillo  
K. Chen  
PCLCM Document File  
RFID Program File

# **Performance Test of the Single Bolt Seal Sensor for the Model 9977 Packaging**

**Document Control No. PC-05-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

June 2008



June 12, 2008

PC-05-00-00

TO: Distribution

FROM: Kun Chen DIS-PCLCM

SUBJECT: Performance Test of the Single Bolt Seal Sensor for the Model 9977 Packaging

The single bolt seal sensor is produced for the MK-1 RFID tag to be installed on the model 9977 packaging. The dimensions of the sensor are shown in Appendix A. The sensor contains force-sensitive pads. When compressed, the resistance of the sensor drops from  $M\Omega$  to  $K\Omega$ . When released, the resistance of the sensor bounces back to  $M\Omega$ . This property is used to monitor the integrity of the seal.

In the storage application, the seal sensor is likely to be compressed for years. This test is designed to evaluate the performance of the sensor in long-term usage. To be considered functional, the resistance of the sensor shall remain below  $100 K\Omega$  when compressed, and the resistance of the sensor shall remain above  $1 M\Omega$  when uncompressed. Test shall be continued until the durability of the sensor is proved or the sensor is no longer functional. Use no fewer than four sensors for the nominal compression tests (45 ft-lbs torque) and no fewer than two sensors for the over tests (60 ft-lbs torque).

A. Tools for the test

1. Fluke 187 True RMS Multimeter (calibrated)
2. Torque Wrench (calibrated)
3. Extech Instruments 445815 Humidity Alert II
4. Standard hex cap screw, thread size 5/8-11
5. Hex nut, thread size 5/8-11
6. Washer, stainless steel, 0.658 ID, 1.30 OD

B. Initial test

1. Measure the resistance of the seal sensor; the sensor shall NOT be compressed during the measurement.

2. Place the sensor between two washers; align the hole of the washers to the hole on the sensor.
3. Use a screw to pass through the sensor hole, and tighten the washer with a nut.
4. Fix the nut, and torque the screw to the required value: 45 ft-lbs for the nominal tests and 60 ft-lbs for the over tests.
5. Measure the resistance of the seal sensor.
6. Record all data.

C. Daily test

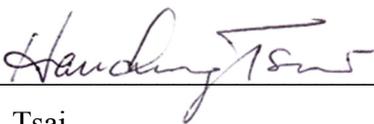
1. Measure the resistance of the seal sensor while the sensor is compressed.
2. Loosen the screw completely and measure the resistance of the seal sensor.
3. Torque the screw to the required value (45 ft-lbs for the nominal tests and 60 ft-lbs for the over tests) and measure the resistance of the seal sensor. Keep the sensor compressed.
4. Repeat Steps 1 through 3 on a daily basis ( $\pm 8$  hours).
5. Record all data
6. Move on to the weekly test after the sensor is proved to function properly after 3 days. Stop the test and assess if the sensor is no longer functional.

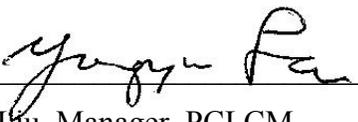
D. Weekly test

1. Measure the resistance of the seal sensor while the sensor is compressed.
2. Loosen the screw completely and measure the resistance of the seal sensor.
3. Torque the screw to the required value (45 ft-lbs for the nominal tests and 60 ft-lbs for the over tests) and measure the resistance of the seal sensor. Keep the sensor compressed.
4. Repeat Steps 1 through 3 on a weekly basis ( $\pm 3$  days).
5. Record all data.
6. Move on to the monthly test after the sensor is proved to function properly after 3 weeks. Stop the test and assess if the sensor is no longer functional.

E. Monthly Test

1. Measure the resistance of the seal sensor while the sensor is compressed.
2. Loosen the screw completely and measure the resistance of the seal sensor.
3. Torque the screw to the required value (45 ft-lbs for the nominal tests and 60 ft-lbs for the over tests) and measure the resistance of the seal sensors. Keep the sensors compressed.
4. Repeat Steps 1 through 3 on a monthly basis ( $\pm 10$  days) until the durability of the sensor is proved or the sensor is no longer functional.
5. Record all data.

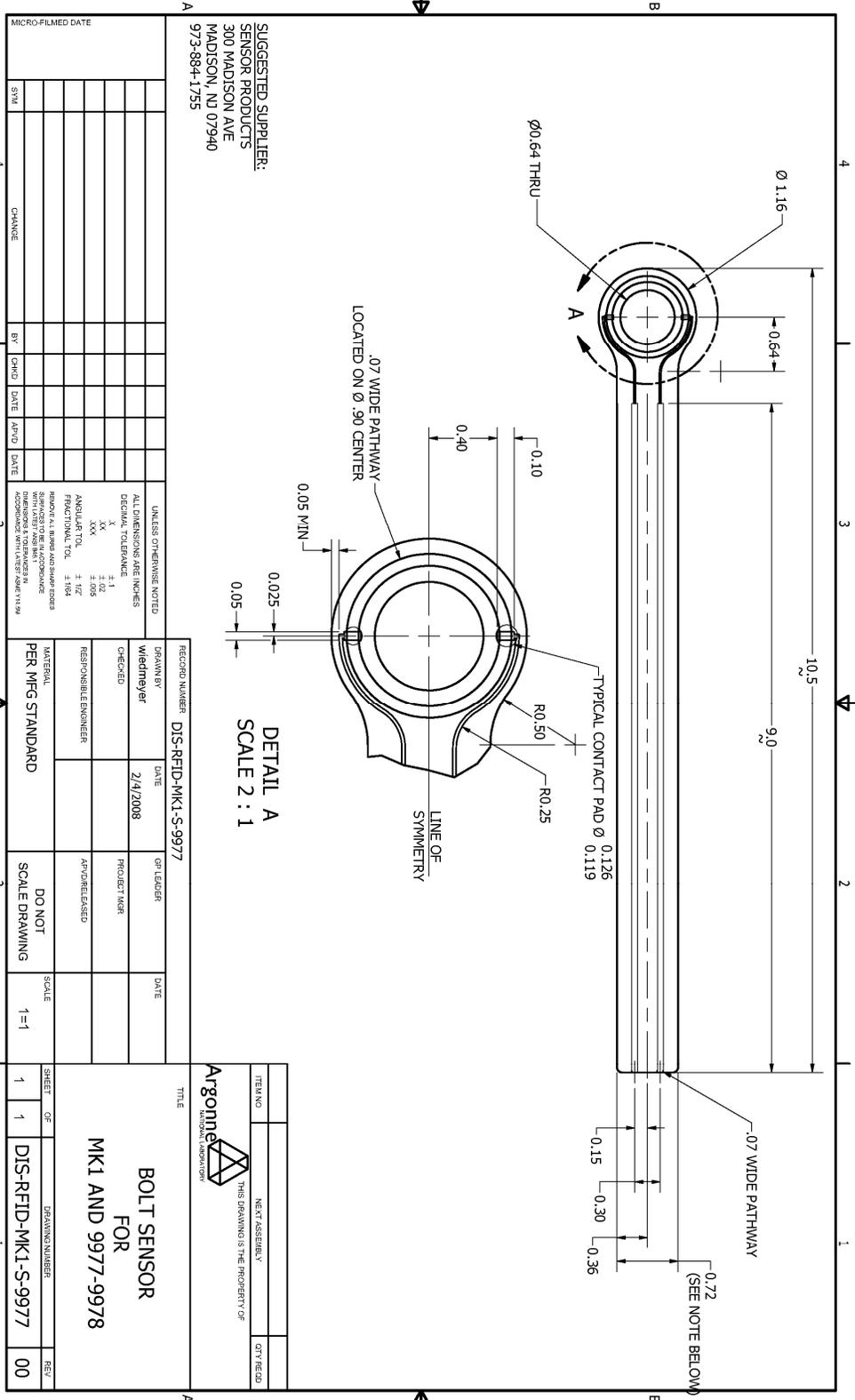
Reviewed by:   
H. Tsai

Approved by:   
Y. Liu, Manager, PCLCM

Distribution:

Y. Y. Liu  
H. Tsai  
R. R. Fabian  
S.W. Tam  
V. Shah  
B. Shelton  
J. Li  
T.W. Alyseworth  
R. Cirillo  
K. Chen  
PCLCM Document File  
RFID Program File

# Appendix A Single Bolt Seal Sensor for Model 9977 Packaging



# **Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site**

**Document Control No. PC-08-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Hanchung Tsai

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

July 2008



July 11, 2008

PC-08-00-00

TO: Distribution

FROM: Hanchung Tsai DIS-PCLCM

SUBJECT: Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site

Ten (10) Mk-1 RFID tags for Model 9977 drums are being prepared by ANL for use at Nevada Test Site (NTS). In service, these tags will continuously monitor and record the ambient temperatures of the drums. Per the addendum for the Safety Analysis Report for Packaging (SARP) prepared by SRNL (S-SARA-G-00003 Rev 0) for Model 9977, the recorded temperature data may allow the maintenance period for the drums to be extended from one year to five. The NTS project is sponsored by the Domestic Nuclear Detection Office (DNDO) of the Department of Homeland Security.

The Mk-1 RFID tag has a built-in thermistor for sensing the ambient temperature. Use this work plan to calibrate the thermistor for all 10 tags. In the calibration, the thermistor output is to be compared with that of certified thermocouples over a range of temperature from 0 to 65°C, in  $\approx 5^\circ\text{C}$  intervals. (According to the tag component vendor, the upper operating temperature for the tags is 70°C.) The acceptable deviation to the certified standard is  $\pm 2^\circ\text{C}$ .

The identification numbers of the ten tags are 5703187, 5703190, 5703191, 5703193, 5703194, 5703197, 5703198, 5703199, 5703200, and 5703201.

All steps defined in the work plan shall be performed by authorized personnel and in accordance with the approved DIS Health and Safety Plan for RFID (PC-07-00-00).

A. Tools and Equipment

1. Ten Type K thermocouples (Omega Model GKMQSS-040-G-6, with certification)
2. Lead wires for Type K thermocouples (Omega Model TFCY-010)
3. One digital thermocouple readout (Omega Model DP460-TC)
4. One rotary dial for thermocouple switching (Omega Model SW142-10-M-PG)
5. An isothermal chamber (in the form of a compact freezer)

6. A Dumore grinder or equivalent (in case a small patch of the freezer steel skin has to be removed to create an RF “window”)
7. A box fan (to distribute temperature inside the isothermal chamber evenly)
8. A heat gun (Grainger Model HG-301AK, with nozzle diffuser)
9. Duct tape
10. RFID reader/software package.

## B. Calibration Procedures

### 1. Initial Set-up (without Tags)

- a. Connect the 10 thermal couples and lead wires to the rotary dial and the digital thermocouple readout per manufacturer’s instructions.
- b. Plug in the freezer and ascertain it works. Then unplug and keep it unplugged. (Note: in this document, “freezer” and “isothermal enclosure” are used interchangeably.)
- c. Route the TCs into the freezer over the door gasket. Position the hot junctions at different locations in the freezer cavity. Affix with duct tape if necessary.
- d. Keep the box fan unplugged. Place the box fan on the bottom of the freezer. Route its power cable over the door gasket.
- e. Keep the heat gun unplugged. Install the nozzle diffuser. Set the power setting at “LOW”. Place the heat gun on the bottom of the freezer. Route its power cable over the door gasket seal.
- f. Close the freezer door. Seal gaps with duct tape if necessary.
- g. With the freezer unplugged, turn on the box fan and the heat gun.
- h. Try out the thermocouples, rotary switch, and the digital display.
- i. When  $\approx 40^{\circ}\text{C}$  is reached, turn off the heat gun and box fan and inspect the inside of the isothermal enclosure. Make sure no walls are deformed due to the heat.
- j. Repeat Steps f through h at  $\approx 50^{\circ}\text{C}$ ,  $\approx 60^{\circ}\text{C}$ , and  $\approx 70^{\circ}\text{C}$ .
- k. At  $\approx 70^{\circ}\text{C}$ , turn off the heat gun but keep the box fan running.
- l. Record and observe temperature uniformity inside the isothermal enclosure and the rate of temperature drop. (If the rate of temperature drop is too low, it is permissible to momentarily turn on the freezer. But make sure temperature uniformity inside the enclosure is maintained.)
- m. Once room temperature is reached ( $\approx 25^{\circ}\text{C}$ ), turn on the freezer. Make sure it still functions after the heat-up to  $70^{\circ}\text{C}$ .
- n. When  $\approx 0^{\circ}\text{C}$  is reached, turn off the freezer. Leave the box fan running.

- o. Record and observe temperature uniformity inside the isothermal enclosure and the rate of temperature rise. (If the rate of temperature rise is too low, it is permissible to momentarily turn on the heat gun. But make sure temperature uniformity inside the enclosure is maintained.)
- p. When room temperature is reached, turn off the box fan.
- q. Open the freezer door and inspect the inside.
- r. The initial set-up is complete.

## 2. Tag Preparation

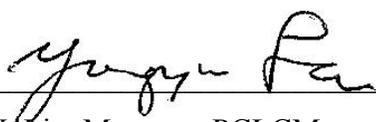
- a. Carefully remove the thermocouples from the isothermal enclosure.
- b. On the workbench, attach one thermocouple to each tag. Use tape to fix the hot junction near the thermistor. The tags may be without the sheet-metal back plate to conserve the space inside the isothermal enclosure.
- c. With the freezer unplugged, place the ten tags on the shelves inside the freezer.
- d. Route the thermocouple lead wires over the freezer door gasket seal as in the Initial Set-up Section. Make sure all the thermocouples stay securely attached to the tags.
- e. Maintain the same positions for the box fan and heat gun in the freezer as in the Initial Set-up Section. Power to both should be off.
- f. Close the freezer door. Seal gaps with duct tape if necessary.
- g. Read the thermistor output of the tags with the RF reader through the closed freezer door. If reading fails, try again with the reader near the door gasket. If it is still unsuccessful, remove a small area of the sheet metal off the freezer door with the Dumore grinder. Make sure the insulation underneath the sheet metal is not disturbed. Query the tags again with the RF reader until successful.

## 3. Calibration

- a. Keep the freezer unplugged.
- b. Turn on the box fan.
- c. Turn on the heat gun and bring the temperature inside the isothermal enclosure to  $\approx 65^{\circ}\text{C}$ .
- d. Turn off the heat gun but leave the box fan running.
- e. Query the tags one by one with the RF reader and compare the tag temperature with the reading of the attached thermocouple. Record the results in the attached data form.
- f. When the temperature dropped to  $\approx 60^{\circ}\text{C}$ , repeat Step e above.
- g. Repeat Step f at temperatures of  $\approx 55, 50, 45, 40, 35, 30, 25^{\circ}\text{C}$ . (If the rate of temperature drop is too low, it is permissible to momentarily turn on the freezer. But make sure temperature uniformity inside the enclosure is maintained.)

- h. Turn on the freezer. Leave the box fan running.
  - i. When  $\approx 0^{\circ}\text{C}$  is reached, unplug the freezer. Leave the box fan running.
  - j. Query the tags one by one with the RF reader and compare the tag temperature with the reading of the attached thermocouple. Record the results in the attached data form.
  - k. When the temperature raises to  $\approx 5^{\circ}\text{C}$ , repeat Step j above. (If the rate of temperature rise is too low, it is permissible to momentarily turn on the heat gun. But make sure temperature uniformity inside the enclosure is maintained.)
  - l. Repeat Step k at temperatures of  $\approx 10, 15,$  and  $20^{\circ}\text{C}$ .
  - m. The calibration is complete.
4. Post-Calibration Wrap-up
- a. Recover all tags and continue their preparation for delivery to NTS.
  - b. Store the thermocouples, digital reader, certification papers and other temperature reading hardware for future use.
  - c. Store the freezer for future use.
  - d. Return all tools to original locations.
  - e. Document the calibration results in a data report.

Reviewed by:   
K. Chen

Approved by:   
Y. Liu, Manager, PCLCM

Distribution:

R. Cirillo

T. Aylesworth

Y. Y. Liu

K. Chen

R. R. Fabian

S.W. Tam

V. Shah

B. Shelton

J. Li

D. Pushis

H. Tsai

PCLCM Document File

RFID Program File



# **Results of Calibration of Built-in Thermistors in RFID Tags**

**Document Control No. PC-09-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Hanchung Tsai

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

July 2008



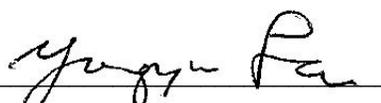
## Results of Calibration of Built-in Thermistors in RFID Tags

July 31, 2008

Prepared by:

Hanchung Tsai

Reviewed by:   
K. Chen

Approved by:   
Y. Liu, Manager, PCLCM

Distribution:

R. Cirillo  
T. W. Aylesworth  
Y. Y. Liu  
H. Tsai  
R. R. Fabian  
S. W. Tam  
V. Shah  
B. Shelton  
J. Li  
K. Chen  
PCLCM Document File

July 31, 2008

PC-09-00-00

TO: Distribution

FROM: Hanchung Tsai DIS-PCLCM

SUBJECT: Results of Calibration of Built-in Thermistors in RFID Tags

REFERENCE: "Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site,"  
H. Tsai, July 11, 2008, PC-08-00-00.

Ten (10) Mk-1 RFID tags for Model 9977 drums have been prepared by ANL for use at the Nevada Test Site. In service, these tags will continuously monitor and record the ambient temperatures of the drums. A calibration, per Reference, is required to verify the temperature readings from these tags.

The subject calibration was conducted on July 28 and 29, 2008. All tag readings agree with the certified thermocouples to within the acceptable tolerance of  $\pm 2^{\circ}\text{C}$  over the test range of 0 – 65°C. Table 1 shows the tabulated results and Figure 1 shows the same results in graphics.

The ten tags are thus suitable for use at NTS for temperature monitoring.

Distribution:

R. Cirillo

T. Aylesworth

Y. Y. Liu

K. Chen

R. R. Fabian

S.W. Tam

V. Shah

B. Shelton

J. Li

D. Pushis

H. Tsai

PCLCM Document File

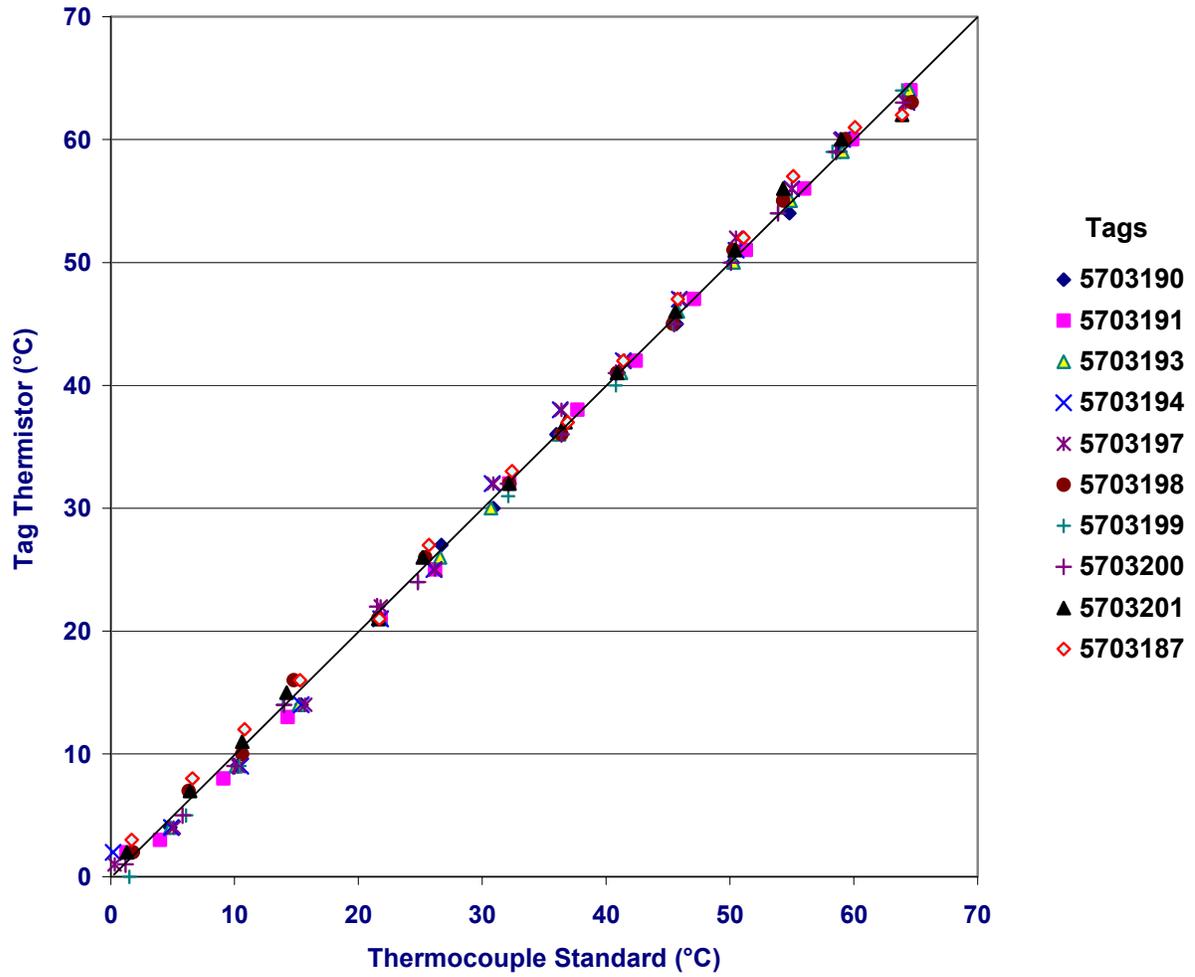
RFID Program File

## Mk-1 RFID Tag Temperature Calibration

H. Tsai 7/29/08

Steps	5703190		5703191		5703193		5703194		5703197		5703198		5703199		5703200		5703201		5703187	
(°C)	TC Std	Tag																		
0	-0.4	0	1.3	2	-0.1	0	0.2	2	0.3	1	1.8	2	1.5	0	1.2	1	1.3	2	1.7	3
5	4.8	4	4.0	3	4.8	4	4.9	4	5.1	4	6.3	7	6.1	5	5.8	5	6.4	7	6.6	8
10	10.2	9	9.1	8	10.1	9	10.5	9	10.3	9	10.6	10	10.4	9	10.0	9	10.6	11	10.8	12
15	15.4	14	14.3	13	15.2	14	15.4	14	15.7	14	14.8	16	13.9	14	14.0	14	14.2	15	15.3	16
20	21.8	21	21.8	21	21.8	21	21.8	21	21.8	22	21.6	21	21.5	21	21.5	22	21.6	21	21.7	21
25	26.7	27	26.2	25	26.6	26	26.1	25	26.2	25	25.4	26	24.8	24	24.8	24	25.2	26	25.7	27
30	30.9	30	32.2	32	30.7	30	30.8	32	30.9	32	32.2	32	32.1	31	32.1	32	32.2	32	32.4	33
35	36.0	36	37.7	38	36.2	36	36.3	38	36.4	38	36.4	36	36.4	36	36.4	36	36.7	37	36.9	37
40	41.0	41	42.4	42	41.2	41	41.4	42	41.5	42	40.9	41	40.8	40	40.8	41	40.9	41	41.4	42
45	45.7	45	47.1	47	45.8	46	45.9	47	46.0	47	45.4	45	45.4	45	45.5	45	45.6	46	45.8	47
50	50.2	50	51.3	51	50.3	50	50.5	51	50.5	52	50.3	51	50.1	50	50.1	50	50.4	51	51.1	52
55	54.8	54	56.0	56	54.9	55	55.0	56	55.0	56	54.3	55	53.9	54	53.9	54	54.3	56	55.1	57
60	58.9	59	59.9	60	59.1	59	59.1	60	58.9	60	59.3	60	58.3	59	58.6	59	59.0	60	60.1	61
65	64.5	64	64.6	64	64.5	64	64.3	63	64.2	63	64.7	63	63.9	64	64.0	63	63.9	62	63.9	62

### Mk-1 Tag Temperature Sensor Calibration



# **Results of Thermal Calibration of Second Batch of MK-I RFID Tags**

**Document Control No. PC-09-01-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Hanchung Tsai

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

November 2008



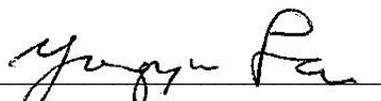
**Results of Thermal Calibration of Second Batch of MK-I RFID Tags**

November 19, 2008

Prepared by:

Hanchung Tsai

Reviewed by:   
K. Chen

Approved by:   
Y. Liu, Manager, PCLCM

Distribution:

R. Cirillo  
T. W. Aylesworth  
Y. Y. Liu  
H. Tsai  
R. R. Fabian  
S. W. Tam  
V. Shah  
B. Shelton  
J. Li  
K. Chen  
PCLCM Document File

November 19, 2008

PC-09-01-00

TO: Distribution

FROM: Hanchung Tsai DIS-PCLCM

SUBJECT: Results of Thermal Calibration of Second Batch of MK-I RFID Tags

REFERENCES: 1. "Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site," H. Tsai, July 11, 2008, PC-08-00-00.  
2. "Results of Calibration of Built-in Thermistors in RFID Tags," H. Tsai, July 31, 2008, PC-09-00-00.

Ten (10) Mk-1 RFID tags prepared by ANL for use at the Nevada Test Site (NTS) were previously calibrated for their thermal performance (Refs. 1 and 2). In service, these tags will continuously monitor and record the ambient temperatures of the 9977 drums.

To provide an adequate supply of spares, eight additional tags were calibrated. The results of this second calibration campaign, conducted on November 18 and 19, 2008, are the subject of this document. The same method of calibration (Ref. 1) was used in this second campaign.

Temperature readings from this second batch of eight tags agreed with those of the certified thermocouples to within the acceptable tolerance of  $\pm 2^{\circ}\text{C}$  over the test range of 0 – 65°C. Table 1 shows the tabulated results and Figure 1 shows the same results in graphics.

These eight tags from the second batch are thus also suitable for use at NTS for temperature monitoring.

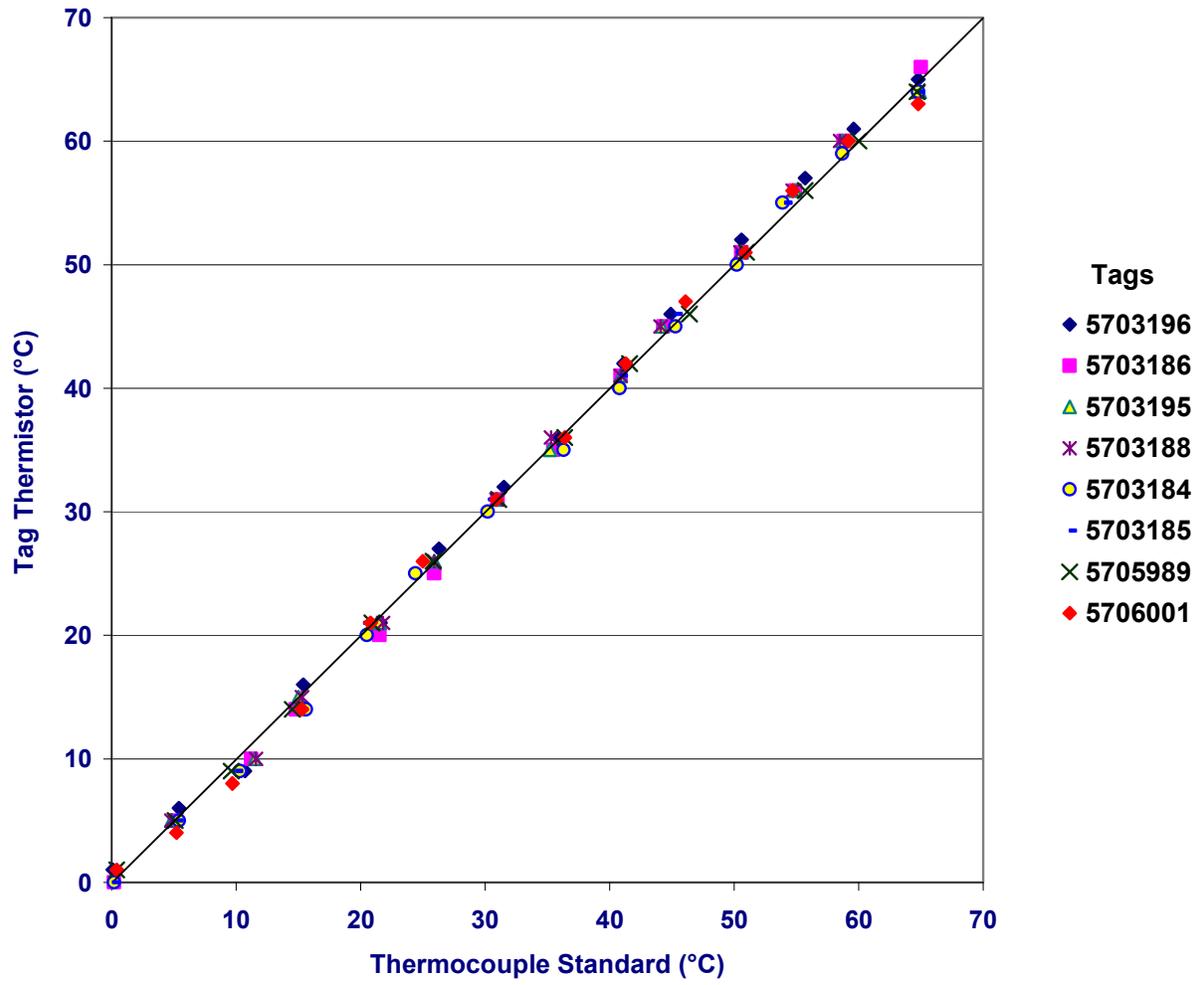
Distribution:

R. Cirillo  
T. Aylesworth  
Y. Y. Liu  
K. Chen  
R. R. Fabian  
S.W. Tam  
V. Shah  
B. Shelton  
J. Li  
D. Pushis  
H. Tsai  
PCLCM Document File  
RFID Program File

## Mk-1 RFID Tag Temperature Calibration

Temp Steps	5703196		5703186		5703195		5703188		5703184		5703185		5705989		5706001	
	(°C)	TC Std	Tag	TC Std												
0	0.1	1	0.2	0	-0.5	0	-0.1	0	0.2	0	0.1	0	0.4	1	0.4	1
5	5.4	6	5.1	5	4.8	5	4.8	5	5.4	5	5.2	5	5.1	5	5.2	4
10	10.7	9	11.2	10	11.5	10	11.6	10	10.3	9	10.0	9	9.6	9	9.7	8
15	15.4	16	14.8	14	15.0	15	15.3	15	15.6	14	15.2	14	14.5	14	15.3	14
20	21.6	21	21.5	20	21.5	21	21.8	21	20.5	20	20.3	21	20.9	21	20.8	21
25	26.3	27	25.9	25	25.9	26	25.9	26	24.4	25	24.6	26	25.8	26	25.0	26
30	31.5	32	31.0	31	31.0	31	30.9	31	30.2	30	30.3	31	31.1	31	30.9	31
35	35.8	36	35.3	35	35.2	35	35.3	36	36.3	35	36.3	36	36.4	36	36.4	36
40	41.1	42	40.9	41	40.9	41	40.9	41	40.8	40	40.9	41	41.6	42	41.3	42
45	44.9	46	44.3	45	44.2	45	44.1	45	45.3	45	45.3	46	46.4	46	46.1	47
50	50.6	52	50.6	51	50.6	51	50.5	51	50.2	50	50.2	51	51.0	51	50.9	51
55	55.7	57	54.9	56	54.9	56	54.7	56	53.9	55	54.1	55	55.7	56	54.7	56
60	59.6	61	58.8	60	58.7	60	58.5	60	58.7	59	58.8	60	60.0	60	59.2	60
65	64.8	65	65.0	66	64.9	64	64.8	64	64.8	64	64.7	64	64.7	64	64.8	63

### Mk-1 Tag Temperature Sensor Calibration



# **Procedure for Installing and Removing MK-1 RFID Tag on Model 9977 Drum**

**Document Control No. PC-10-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

August 2008



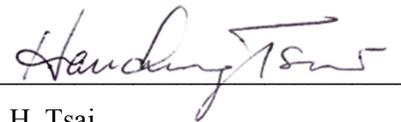
**Procedure for Installing and Removing MK-1 RFID Tag on Model 9977 Drum**

August 5, 2008

Prepared by:

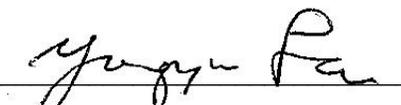
Kun Chen

Reviewed by:



H. Tsai

Approved by:



Y. Liu, Manager, PCLCM

Distribution:

R. Cirillo  
T. W. Aylesworth  
Y. Y. Liu  
H. Tsai  
R. R. Fabian  
S. W. Tam  
V. Shah  
B. Shelton  
J. Li  
K. Chen  
PCLCM Document File

## **1.0 INFORMATION**

### **1.1 Purpose**

This procedure provides instructions for installing and removing a MK-1 RFID tag on a Model 9977 drum.

### **1.2 Scope**

- This procedure provides steps to install a MK-1 tag on a Model 9977 drum.
- This procedure provides steps to remove a MK-1 tag from a Model 9977 drum.
- This procedure does **NOT** provide instructions for receiving or handling a Model 9977 drum.

### **1.3 Applicability**

This procedure shall be used when directed by other procedures or supervision.

## **2.0 PRECAUTIONS AND LIMITATIONS**

It is the user's responsibility to comply with all applicable site, area, and facility specific safety rules and procedures.

## **3.0 PREREQUISITE ACTIONS**

### **3.1 Tools and Equipment**

- Calibrated torque wrench capable of  $45 \pm 5$  ft-lbs torque.

### **3.2 Responsibility**

Personnel using this procedure shall perform steps as directed. Supervisor shall be immediately notified if a step cannot be completed as stated.

## **4.0 PERFORMANCE**

### **4.1 Preparing for the Installation**

1. Remove one of the suitable bolts and its washer from the Model 9977 drum closure lid. Make sure the vent hole of the drum is not blocked by the tag to be installed.
2. Section 4.1 complete.

## 4.2 Installation of the Tag

Note: The as-received Mk-1 tag is fully assembled, as shown in Figure 1.

1. With the tag laying flat on a tabletop, remove the nut attached to seal bolt on the tag.
2. Carefully lift up the tag while keeping the seal sensor washer, seal sensor, and the seal bolt together. See Figure 2.
3. Lower the seal bolt with seal sensor and washer into the emptied bolt hole.
4. Ensure the bend of the tag back plate fits the rim of the drum. **Make sure the ribbon of the seal sensor is not crushed.**
5. Fasten the seal bolt to the torque specified in the Certificate of Compliance (CoC) of 9977 drum ( $45 \pm 5$  ft-lbs).
6. Section 4.2 complete.

## 4.3 Removal of the Tag

1. Remove the bolt that holds the tag on the drum.
2. Remove the seal sensor washer, seal sensor, and bolt all in once.
3. Attach a temporary nut to hold the seal sensor, washer and seal bolt together. Set the tag aside.
4. Section 4.3 complete.

## 5.0 RECORDS

Completed copies of this procedure and work records shall be kept in appropriate documentation file.

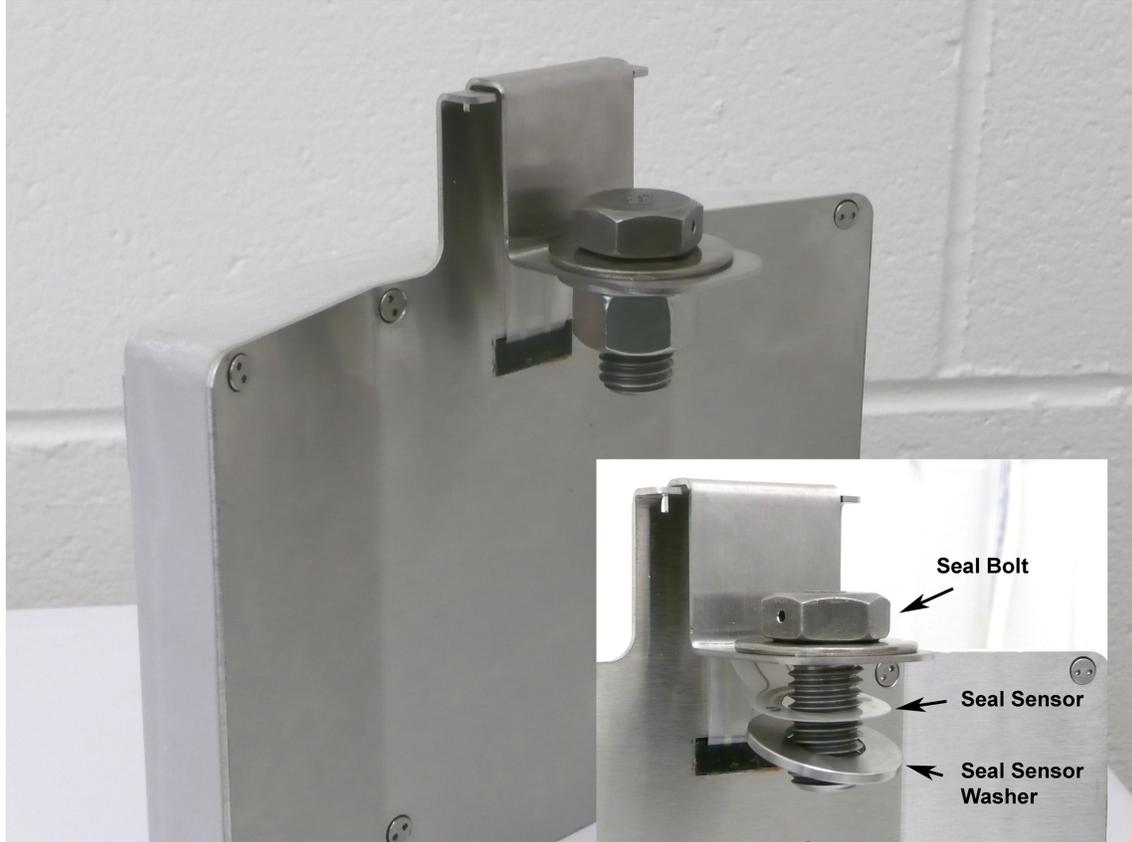


Figure 1 As-received Mk-1 RFID tag (back view). Insert shows seal sensor details with the nut removed.



Figure 2 Holding the assembly while lowering into the drum bolt hole.



# **User Guide for RFID Reader and Software for Temperature Monitoring of Model 9977 Drums at NTS**

**Document Control No. PC-11-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

December 2008



## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	August 2008	Original User Guide
01	December 2008	Updated User Guide for NTS use only

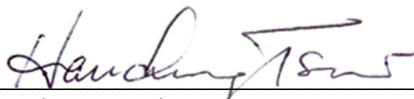
## Approvals

  
\_\_\_\_\_  
Kun Chen, RFID System Developer  
Argonne National Laboratory

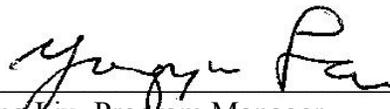
12/30/08  
Date

  
\_\_\_\_\_  
Ralph Fabian, QA Administrator  
Argonne National Laboratory

12/30/08  
Date

  
\_\_\_\_\_  
Hanchung Tsai, RFID System Supervisor  
Argonne National Laboratory

12/30/08  
Date

  
\_\_\_\_\_  
Yung Liu, Program Manager  
Argonne National Laboratory

12/30/08  
Date

## Table of Contents

1	INTRODUCTION.....	PC-11-7
1.1	Components .....	PC-11-8
1.2	Technical Support .....	PC-11-8
1.3	Training.....	PC-11-8
2	READER INSTALLATION.....	PC-11-8
2.1	Connecting the Power Cord of the Reader.....	PC-11-8
2.2	Connecting the Reader Network .....	PC-11-10
2.3	Verifying Reader Network Connection.....	PC-11-10
3	ARG-US.....	PC-11-11
3.1	Logging in as a User.....	PC-11-12
3.2	Logging in as an Administrator.....	PC-11-12
3.3	Changing the Administrator Password.....	PC-11-12
3.4	Collecting Tags .....	PC-11-12
3.5	Reading Drum Status .....	PC-11-14
3.6	Alarms.....	PC-11-14
3.7	Clearing Alarms .....	PC-11-15
3.8	Removing Drums from Area.....	PC-11-15
3.9	Details of Drums .....	PC-11-15
3.10	Drum Contents .....	PC-11-15
3.11	Drum Event History .....	PC-11-16
3.12	Drum Location .....	PC-11-16
3.13	Sensor Settings.....	PC-11-16
3.14	Sensor Logs.....	PC-11-18
3.15	Exporting Sensor Logs of All Tags.....	PC-11-18
3.16	Exit.....	PC-11-18
4	OPERATION SCENARIOS.....	PC-11-19
4.1	Continuous Querying of Drums in Range of the Reader .....	PC-11-19
4.2	Reviewing Tag Temperature Data .....	PC-11-19
4.3	When a Drum Is Sent Away from the Reader.....	PC-11-20

## List of Figures

1. Connection of the Reader Network..... PC-11-9
2. Screenshot of the Site Manager® Console. ....PC-11-11
3. Sample Screenshot of ARG-US OnSite – Main Form.....PC-11-13
4. Sample Screenshot of ARG-US OnSite – Sensor Settings. ....PC-11-17

## 1 INTRODUCTION

Seven (7) Model 9977 drums for use at the Device Assembly Facility (DAF) of the Nevada Test Site (NTS) may be fitted with radio frequency identification (RFID) tags with temperature sensors. The purpose of the RFID implementation is to monitor the temperatures of the drums per the conditions of approval in Certificate of Compliance (CoC) USA/9977/B(M)F-96 (DOE-S/T-1) for these drums; if the temperatures stay below the preset threshold, the drum maintenance period may be extended from one year to two years or possibly longer.<sup>1</sup> The RFID tags and the associated reader system for querying and recording the tag temperatures are furnished by Argonne National Laboratory (Argonne) for the DOE Packaging Certification Program (PCP), DOE/EM-63. A total of ten (10) tags are supplied: seven for mounting on the drums and three as spares.

The accuracy of the temperature sensors in the tags had been verified in prior calibrations.<sup>2, 3, 4</sup> In the intended operation at NTS, a reader may query the tags at 6-hour intervals (adjustable) and transmit the drum temperature data to the control computer. If the drum temperature exceeds the threshold, an alarm will be promptly sent from the tag to the reader/computer. After a temperature alarm, the querying rate automatically will increase to six times an hour until the alarm is cleared by the system administrator.

The tags and reader should be in reasonable proximity (e.g., within 30 m of each other) for optimal system performance. While line-of-sight is not required, massive barriers, such as thick concrete walls, may impede the reader range.

It is anticipated that from time to time, one or more of the drums may be dispatched away from the reader. To address this situation, the tags are preprogrammed to record in their built-in (nonvolatile) memory any temperature changes that are more or less than 3°C (i.e.,  $> \pm 3^\circ\text{C}$ ) from the previous recording. When the drum is later returned to NTS, the stored data can be retrieved from the tag with the reader/computer and be reviewed postmortem. Up to 4,000 lines of records may be stored in this manner before the oldest record is written over by the latest record. If the period away is anticipated to be very long, the  $> \pm 3^\circ\text{C}$  criterion may be relaxed to preclude memory overwriting.

If a failure of the RFID tag or the temperature recording system results in a loss of temperature data for a duration of  $\geq 72$  hours, then the packaging shall have a Nonconformance Report issued against it and be tagged and segregated until the disposition of the Nonconformance Report has been approved by the 9977 Design Authority and Argonne and has been implemented.<sup>1</sup> For routine performance tracking of the RFID temperature monitoring system of the 9977 drums, NTS is required to send a copy of the recorded tag temperature data every month to DOE PCP via Argonne. The data files for this transmittal can be readily extracted from the control computer.

This guide is to be used to operate the reader, control computer, and application software. Handling of the tags is discussed elsewhere.<sup>5</sup>

## 1.1 Components

The following components are supplied by Argonne to support this project.

- 1 reader,
- 1 AC power cord for reader,
- 2 Ethernet cables,
- 1 Ethernet switch with power adapter,
- 1 laptop computer (Lenovo T-60) running Microsoft® Windows® XP,
- ARG-US OnSite software (preinstalled in the laptop computer),
- 10 RFID tags with mounting fixtures for Model 9977 drums, and
- A mobile cart for the control computer and reader.

## 1.2 Technical Support

The technical support team at Argonne can be reached by

- Calling 630-252-4765 between 9 a.m. and 5 p.m. Central Time, and/or
- Sending email to [kchen@anl.gov](mailto:kchen@anl.gov).

## 1.3 Training

Initial training and certification of the NTS personnel to use the RFID system are to be conducted at Argonne. The training and certification requirements are addressed separately. Subsequent refresher training sessions and certifications are to be performed by NTS per NTS local requirements. Argonne can assist in the subsequent training sessions if so requested.

## 2 READER INSTALLATION

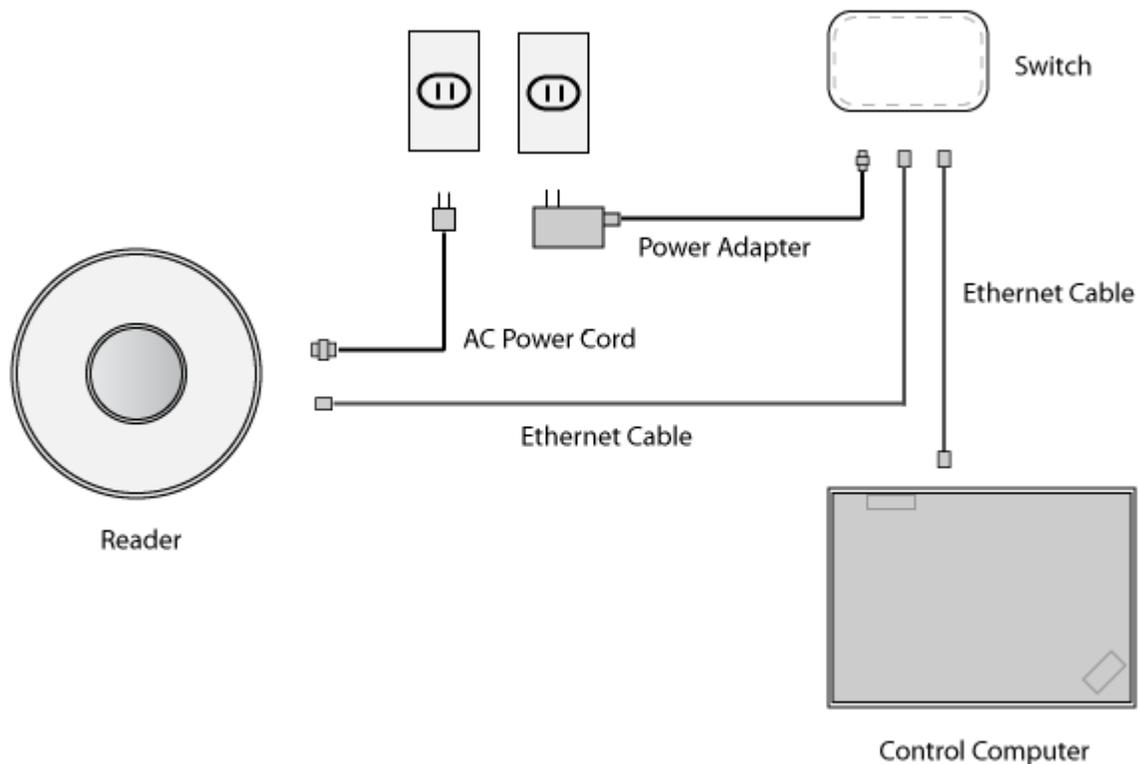
Connection of the reader system components is as depicted in Figure 1.

### 2.1 Connecting the Power Cord of the Reader

The normal power for the reader is 110 VAC. Alternatively, 12 to 24 VDC may be used. The AC power cord is included, but the DC power cord is not.

To connect the AC power cord,

- Plug the power cord's female connector into the reader's socket. Ensure the notch in the socket is aligned with the pin in the power plug.
- Firmly push the locking ring forward and rotate it clockwise to lock the connector.
- Plug the other end of the power cord to the power source.



**Figure 1 Connection of the Reader Network.**

The reader will turn on automatically. (The reader does not have an on/off switch.) It takes about 30 seconds for the reader to complete initialization. During this time, the LED display panel on the reader shows the reader ID number and IP address.

For best performance, the reader and tags should be located in close proximity (e.g., within 30 m). (The reported reader range in line-of-sight to the tags is  $\approx 100$  m.) While line-of-sight is not necessary, massive obstacles, such as thick concrete walls, may impede the reader range and performance.

## 2.2 Connecting the Reader Network

The reader is connected directly to the supplied Ethernet switch, and the switch is connected to the computer's Ethernet port.

To connect the reader network,

- Remove the protective cap from the reader's Ethernet port.
- Plug the Ethernet cable into the port.
- Connect the switch to the host computer by using another Ethernet cable.
- Connect the power adaptor of the switch.

The LED lights on the switch should be on automatically. It takes about 30 seconds for the switch to be ready.

## 2.3 Verifying Reader Network Connection

After the connection shown in Figure 1 is made, use the Site Manager® console in the computer to ascertain that the reader is recognized.

- Start up the control computer. Password for the Windows login is provided with the computer. (NTS may change this password per local policy.)

**NOTE:** NTS is advised to assign a custodian for the Argonne-supplied control computer to maintain password control. This custodian should be the Point-of-Contact with Argonne for all subsequent PC and software-related issues.

- Start the Site Manager console by clicking the shortcut icon on the desktop. A screenshot of the opened Site Manager console is shown in Figure 2.
- In the Site Manager console, Network panel, click the Ethernet icon to expand the list.
- Verify that that a reader icon with the correct ID number is shown in the list.

**NOTE:** It takes up to 2 minutes for the reader to be recognized by the control computer. When the reader is disconnected from the computer, the reader icon becomes a red dot with a white cross, but the ID number remains. The reader has a unique ID number.

- Close the Site Manager console.

If the reader cannot be recognized by the control computer, check the physical connections and the firewall settings of the computer. If the problem persists, contact Technical Support.

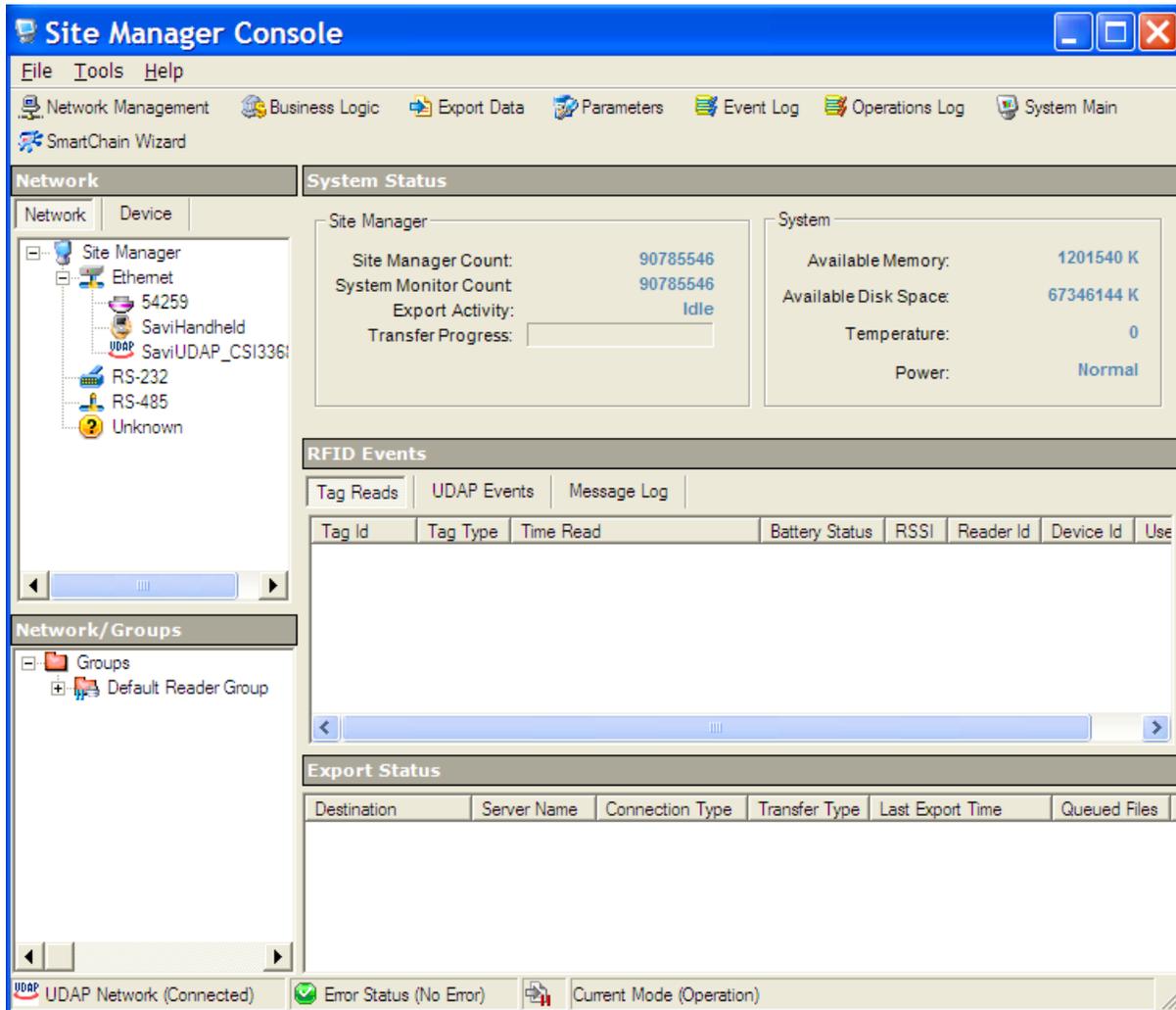


Figure 2 Screenshot of the Site Manager® Console.

### 3 ARG-US

ARG-US is the software system that manages the readers, the tags, and the data flow between them. The version preloaded in the control computer for NTS, called ARG-US OnSite, is designed for a stand-alone operation for security reasons. Additional features (e.g., network, web, database) can be provided if so requested by NTS.

**NOTE:** Argonne recommends that the RFID control computer be at least connected to the NTS local area network. This would enable the responsible individuals (including possibly Argonne Technical Support) to receive automatic email alerts of tag-related alarms. Experience at Argonne has shown this to be highly valuable. Such a local connection would also allow network printers to produce hard copies of relevant tag data for record keeping. Argonne can assist in setting up the automatic email alert features.

ARG-US OnSite offers two privilege levels: **User** and **Administrator**. The **User** is limited to viewing tag data only; the **Administrator**, on the other hand, has control of operation, including entering records, setting alarm levels, adjusting data sampling rates, retrieving stored data, clearing alarms, etc.

### 3.1 Logging in as a User

After clicking the **ARG-US OnSite.exe** shortcut icon on the desktop, the startup screen, similar to the page as shown in Figure 3, requests a password for the **Administrator** privilege. Hit “**Cancel**,” and ARG-US will complete loading in the **User** mode.

### 3.2 Logging in as an Administrator

At the startup of **ARG-US OnSite**, enter the password to attain the **Administrator** mode. The **Administrator** password is provided with the computer.

To exit from the **Administrator** mode, click the **Logout** icon in the upper right corner of the main page (see Figure 3).

**NOTE:** The **Administrator** is strongly urged to log out every time when leaving the control computer. Failure to do so may allow unauthorized individuals to tamper with the system functionality and data in the absence of the **Administrator**.

If the ARG-US program is already running at the **User** privilege level, click the **Login** icon in the upper right corner of the main page (see Figure 3) to login as an **Administrator**.

### 3.3 Changing the Administrator Password

From the pull-down menu **Administration** on the main page (see Figure 3), select **Change Password** and follow the instructions.

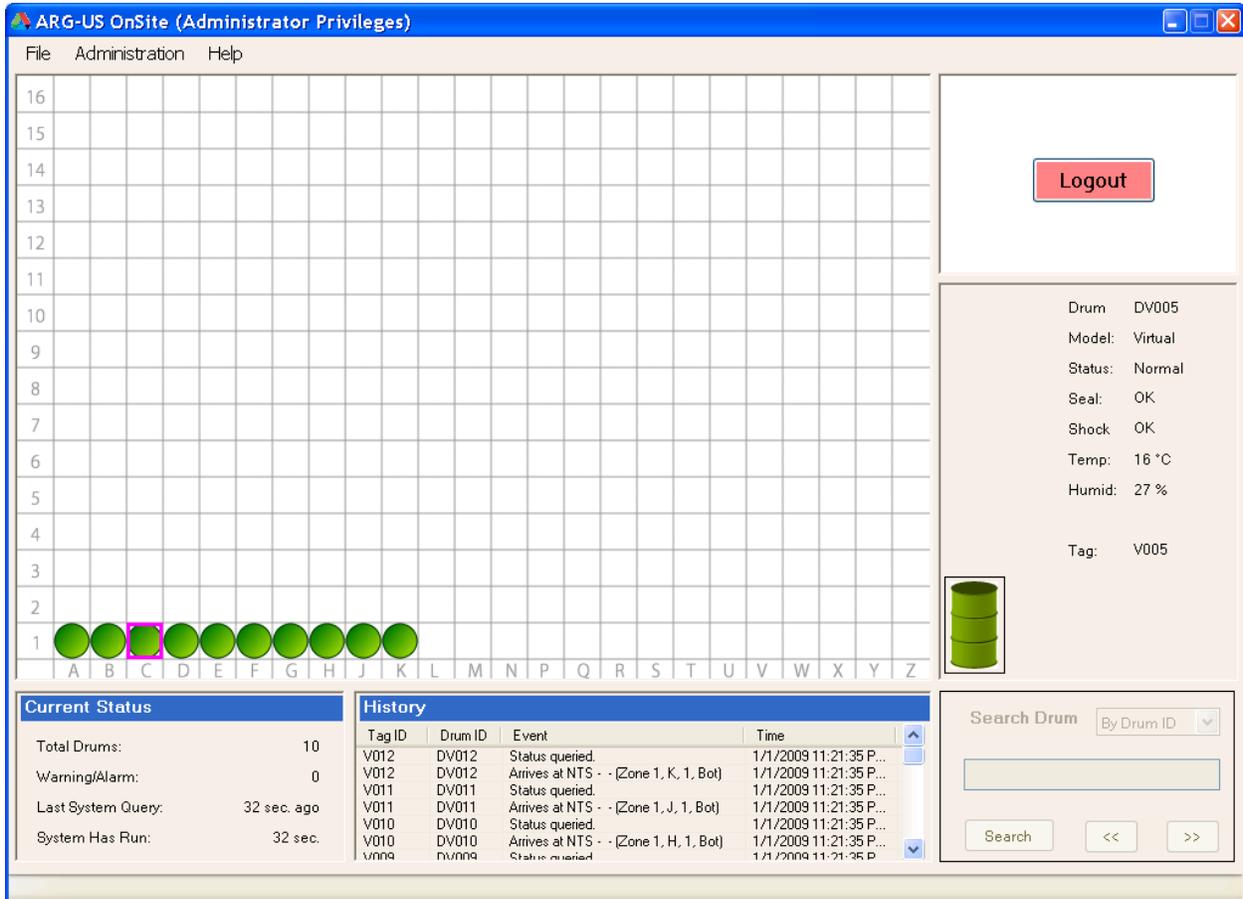
### 3.4 Collecting Tags

The sample main form of ARG-US OnSite is shown in Figure 3. The large grid pane shows a stylized overhead view of the laboratory/storage area. To find the tags, right-click in any blank space of the grid pane and choose **Collect Drums** from the pop-up menu. It takes up to 10 seconds for the system to find all the tags that are within range of the reader. When the search is complete, all tags found are displayed in a pop-up drum list. Check those tags that are to be monitored. (The default is to monitor all tags found within range. Uncheck the unwanted tags if so desired.) Click **OK** to confirm.

**NOTE:** It is strongly advised to keep the three spare tags in the general vicinity of the reader so that they can be queried alongside the on-duty tags. This will ascertain their working status at all times. Querying three additional tags imposes no burden on the system.

After the initial tag collection, the tags to be monitored are displayed in the main grid pane as round symbols (drums), each occupying a grid space. Since each drum has a tag, drum, tag, or drum symbols are used interchangeably in the rest of the document.

On the bottom of Figure 3 are the **Current Status** and **History** panes. Their displays are self-explanatory. The lower-right pane is reserved for search functions, which can be implemented per NTS request.



**Figure 3 Sample Screenshot of ARG-US OnSite – Main Form.**

### 3.5 Reading Drum Status

Both the **User** and **Administrator** can query the tag status. To do this, right-click the drum symbol in the grid pane and choose “Query Status” from the pop-up menu. The collected information – Drum number, Model, Status, Seal, Shock, Temperature, Humidity, and Tag number – is displayed in the **Status** pane on the right. The displayed items are self-explanatory.

**NOTE:** If one just left-clicks a drum symbol, the **Status** pane will display the old information from the last query. The data are likely outdated. To force an update, one can query the tag status by following the instructions above.

The status of the drum as determined by the tag’s built-in sensors is color coded: green for normal, yellow for warning, and red for alarm. The **Administrator** has the ability to adjust the triggering thresholds for each sensor (see Section 3.13). The default threshold setting for the high-temperature alarm is 60°C.

The **Status** pane on the right has the ability to display drums in stacked configuration. Since this configuration is not envisioned at NTS, the feature is not elaborated on here. Contact Technical Support if more information is needed.

**NOTE:** The time stamps displayed by ARG-US OnSite are in Greenwich Mean Time (GMT). Nevada Standard Time is GMT-8.

### 3.6 Alarms

**NOTE:** Even though the drum status is queried every 6 hours (default), monitoring of the current sensor readings against the alarm settings by the tag is continuous. Any violations are promptly reported by the tag to the reader and displayed on the control computer screen. If so arranged, an automatic email alert can be sent when an alarm occurs.

The as-delivered tags are programmed to report over-temperature, high humidity, seal violation, and excessive shock, even though only the temperature data are of importance to the present operation. False alarms from any of the sensors are rare, based on Argonne experience. The **Administrator** can adjust the triggering thresholds associated with each alarm type (see Section 3.13) to make the tags more or less sensitive for the intended operation (storage or transport).

When an alarm is triggered, the drum symbol turns red and flashes on the screen. The sensor that triggers the alarm is highlighted in red in the **Status** pane on the right. The event also shows up as a record, also in red, in the **History** pane at the bottom. The alarm stays on until the **Administrator** clears it. **Users cannot clear the alarm.** When an alarm is reported, the querying frequency is automatically increased to 6 times an hour, to provide more detailed recording until the alarm is cleared.

In addition to the sensor-triggered alarms, ARG-US reports another alarm status: **No Response**. This situation could be caused by tag failure, battery depletion, outside of reader range, etc. This alarm is initiated by the reader when it cannot detect the proper response from the tag during its periodic polling. The affected drum symbol turns red, and the **Status** line in the middle right pane turns red and displays “**No Response**.” Immediate action is required, since this condition will affect drum temperature monitoring and recording.

### 3.7 Clearing Alarms

After investigating and rectifying the cause, the **Administrator** can right-click the alarmed drum and select **Clear Alarm** from the pop-up menu. The process may take several seconds. After the alarm is cleared, the status of the drum is updated automatically, and the symbol and the status line turn green. However, if the cause of the alarm persists (e.g., high humidity), the alarm will be triggered again. Alarm clearing is an action that is automatically recorded in the **History** pane.

### 3.8 Removing Drums from Area

If you want to remove a drum from the storage area, you have to let ARG-US OnSite know. Otherwise, ARG-US OnSite will report a missing drum and trigger an alarm. To remove a drum from the system, right-click in any blank space of the grid panel. Click **Remove Drums** from the pop-up menu. This will open a list that contains all the drums in the system. **Check** the drum that you want to remove and click **OK** to confirm. It may take up to 5 seconds to remove a drum from ARG-US OnSite.

### 3.9 Details of Drums

Right-click a drum and choose **Details** from the pop-up menu. You can open a form that shows the information on an individual tag. The **General** tab shows more information on the drum and the tag. Click Read Tag button to query the drum and show the updated information in the form. Click Close to close the form.

### 3.10 Drum Contents

Right-click on a drum symbol and select **Contents** from the pull-down menu. Initial data entry (drum ID number, drum model, originator, and materials manifest) or subsequent revisions of the drum contents can be done from this screen. Contents are stored in both the tag and the host computer. ARG-US supports AES-256 encryption. If you decide to encrypt the contents stored in the tag, choose the **Encrypted** radio button and enter the **Administrator** password before reading or writing. The contents stored in the host computer are not encrypted. If you don't want encryption, choose **Unicode**. The reading or writing time depends on the length of the contents.

- To read the contents from the host computer – click **Read PC**
- To read the contents from the tag – click **Read Tag**

- To write the contents to the tag and host computer – click **Overwrite**

If it is not desirable to enter the drum contents (e.g., materials manifest), the **Administrator** can leave some or all of the entries blank.

### 3.11 Drum Event History

Right-click the drum symbol to access the **History** tab. The **History** menu can be accessed only by the **Administrator**.

Most of the history records are generated automatically by ARG-US OnSite when events occur (e.g., tag collection, sensor alarm, manual and auto querying, etc.). The **Administrator** may also add notes to the history record. The history tab works similarly to the contents tab. One significant difference is that the new history records do not overwrite the old ones. Rather, they are appended to the record list.

### 3.12 Drum Location

This feature is not essential for the NTS applications; the displayed drum locations on the grid pane of the main page are only symbolic and not related to physical placement.

To move the drum from one location to another in the grid pane, hold down the **Ctrl** key and **drag** the drum in the grid panel to the new location with the mouse, release the mouse button, and then release the **Ctrl** key. Alternatively, grid positions may be viewed and changed by right-clicking the drum symbol and selecting the **Position** tab from the pull-down menu.

### 3.13 Sensor Settings

**NOTE:** It is advised to not change any of the default settings that were preinstalled. Contact Technical Support if adjustments are necessary.

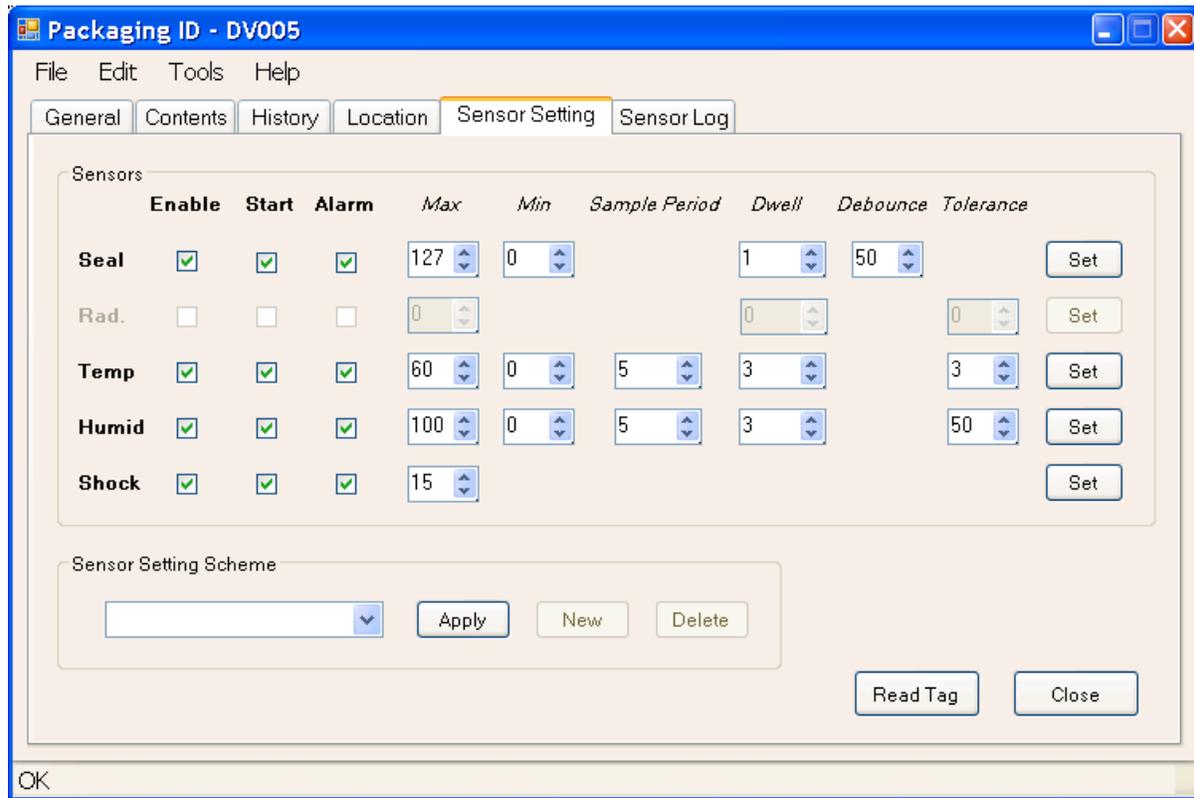
Right-click on a drum symbol and select **Sensor Setting** from the pull-down menu. The submenus, shown in Figure 4, allow the relevant parameters for the sensors to be adjusted. The available sensors are seal, temperature, humidity, and shock.

When the screen is first loaded, the entries are blank. Click **Read Tag** tab at the bottom of the screen to display the current settings of the tag. If the values are acceptable, click **Close** tab to exit.

The first three columns of entries for each sensor are

- Enable – to turn on the sensor.
- Start – to start taking the sensor data.
- Alarm – to activate the alarm function.

The next two columns are for the upper (**Max**) and lower (**Min**, when applicable) thresholds for the sensor alarms. For seal and shock, the available settings are numerical values between 0 and 255.



**Figure 4 Sample Screenshot of ARG-US OnSite – Sensor Settings.**

The next column is **Sampling Period**, which determines how frequently the temperature and humidity sensors compare their readings against the alarm thresholds. For example, if the sample period for temperature is 5, the tag will sample temperature every 5 seconds.

The next two columns, “**Dwell**” and “**Debounce**,” are settings to preclude false alarms from unanticipated signal noises. The default settings should not be altered.

For drums that are to be relocated away from the reader, the last column, “**Tolerance**,” becomes relevant. To keep the temperature monitoring ongoing without the reader, the tags are preprogrammed to record in the on-board memory any temperature changes exceeding this value. If the value is 3, any temperature changes that are  $> \pm 3^{\circ}\text{C}$  from the last recording are entered into the tag memory. When the drum is later returned to NTS, the stored data in the tag memory can then be retrieved for analysis. Up to 4,000 lines of records may be stored in this manner before

the oldest lines are written over by the latest records. If the period away is anticipated to be very long, the  $> \pm 3^{\circ}\text{C}$  criterion may be relaxed.

After adjustments of sensor settings, click “**Set**” to store the changes.

For convenience, two predefined sensor setting schemes are provided. They are the optimal settings for storage or transport. To apply a scheme, simply choose either “Storage” or “Transport” and then click “**Apply**.”

### 3.14 Sensor Logs

To read the sensor log from the tag, first choose **Sensor Name**, then enter the **Start** and **End** values, and then click **Read Tag** button to read. Each record in the log has an address. Newer records have smaller address values. The address of the newest record is 0. If you enter 0 as Start and 1 as End, the newest and second-newest record will be read. The reading time depends on the number of records to be read.

The records are saved to the host computer automatically once they are read from the tag sensor log. You can view the records stored in the host computer by clicking the **Read PC** button. The records shown here include not only those read from the sensor log but also those collected by the reader.

You can export the log by clicking the “**Export**” button. The exported file is in CSV format and can be read by Microsoft Excel®.

### 3.15 Exporting Sensor Logs of All Tags

The information on the tags (e.g., temperature history, contents, etc.) is stored in the local host computer. It is saved in a Microsoft Access® database file in the same directory with the ARG-US executables. By default, the file is in the “C:\ARG-USOnSite\” directory and named “ARG-USOnSite.mdb.”

To export the sensor logs of all tags, from the main form (Figure 3), left-click “**File**” and select “**Export Sensor Log**.” An option lets the user select any one of the sensors or “**All Sensors**.” The exported file is in CSV format and can be read by Microsoft Excel. To export the sensor log of a single drum, follow the instructions in Section 3.14.

### 3.16 Exit

**NOTE:** ARG-US OnSite is a very stable platform and should be allowed to run continuously. Terminating it will stop the auto querying function and lead to possibly undesirable consequences if the down time is long. All prior data are preserved in both the tag and host computer when the user exits ARG-US OnSite. Contact Technical Support for assistance.

Close the main form to exit from ARG-US OnSite. The screen will display “**Finalizing ... Please Wait.**” It may take some time to complete this action, and the system should not be disturbed during this time.

## 4 OPERATION SCENARIOS

### 4.1 Continuous Querying of Drums in Range of the Reader

**Section 5.(d) (8) of the 9977 CoC<sup>1</sup> stipulates a “72-hr rule”:** *“If due to a failure of the RFID tags or the temperature recording system that results in a loss of temperature data for a duration  $\geq 72$  hours, then the packaging shall have Nonconformance Report issued against it and be tagged and segregated until the disposition of the Nonconformance Report has been approved by the 9977 Design Authority and Argonne National Laboratory and has been implanted.”*

After initial tag collection, ARG-US OnSite automatically queries the status of all tags in range and stores the queried data. The default query interval is set at 6 hours, which provides adequate coverage while keeping the quantities of recorded data manageable. The queried temperature data are stored in the control computer.

**NOTE:** To ascertain that the 72-hr rule is not violated, NTS is urged to establish a procedure to inspect the system and review the temperature data periodically: **no less than 3 times a week (e.g., Monday, Wednesday, and Friday.)** If the automatic email alert feature is enacted, this schedule may be relaxed.

### 4.2 Reviewing Tag Temperature Data

**NOTE:** Maintaining a logbook by the local host computer is recommended. Enter all observations in the logbook for future reference.

Perform the following steps to ascertain that the temperature histories of all drums have been normal and properly recorded. Report immediately any abnormalities. Contact Technical Support for assistance if necessary.

- Ascertain all drum symbols in the grid panel are green, indicating there have been no abnormal events since the last inspection.
- Review recent temperature and other event data displayed in the History pane. The records should show every tag has been queried in 6-hr intervals and that all are in normal status.
- From the Main Page (Figure 3), left-click File and select “Export Sensor Log” and “All Sensors.” Export the file to a designated location (or desktop) and review the file for any abnormal events. The exported file is in CSV format and can be read by Microsoft Excel.

- At the end of every month, send a copy of the recorded temperature history data files to DOE PCP via Argonne by email.

### 4.3 When a Drum Is Sent Away from the Reader

It is anticipated that from time to time, one or more of the drums may be dispatched away from the reader (i.e., off site or to a different building). To keep the temperature monitoring ongoing, the tags are preprogrammed to store any temperature changes  $> \pm 3^{\circ}\text{C}$  from the last recording in the on-board memory. When the drum is later returned to NTS, use the procedures stated in Step 3.14 to retrieve the recorded temperature data in the memory. Provide a copy of the retrieved temperature data to DOE PCP via Argonne by email.

Up to 4,000 lines of records may be stored in this manner before the oldest lines will get written over by the latest records. If the period away is anticipated to be very long, the  $> \pm 3^{\circ}\text{C}$  criterion may be relaxed (see Section 3.13) to preclude memory saturation.

Before the drum departs, the **Administrator** has to let ARG-US OnSite know that the drum is about to leave. Otherwise, the “**No Response**” alarm would be triggered in the next polling cycle. To remove a drum from the system, right-click in any blank space of the grid panel. Click **Remove Drums** from the pop-up menu. This will open a list that contains all the drums in the system. **Check** the drum that you want to remove and click **OK** to confirm. Afterwards, there should be one less drum symbol in the main grid panel.

## References

1. Revision 0, DOE Certificate of Compliance USA/9977/B(M)F-96 (DOE-S/T-1), December 8, 2008.
2. H. Tsai, "Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site," PC-08-00-00, July 11, 2008.
3. H. Tsai, "Results of Calibration of Built-in Thermistors in RFID Tags," PC-09-00-00, July 31, 2008.
4. H. Tsai, "Results of Thermal Calibration of Second Batch of Mk-1 RFID Tags," PC-09-01-00, November 19, 2008.
5. K. Chen, "Procedure for Installing and Removing Mk-1 RFID Tag on Model 9977 Drum," PC-10-00-00, August 5, 2008.



# **Software Quality Assurance Plan (SQAP) for the ARG-US System**

**Document Control No. PC-12-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

November 2008



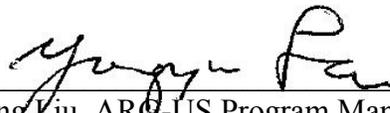
## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	October 2008	Original ARG-US SQAP
01	November 2008	Updated ARG-US SQAP

## Approvals

  
\_\_\_\_\_  
Kun Chen, ARG-US Developer  
Argonne National Laboratory

11/26/08  
Date

  
\_\_\_\_\_  
Yung Liu, ARG-US Program Manager  
Argonne National Laboratory

11/26/08  
Date

  
\_\_\_\_\_  
Ralph Fabian, ARG-US QA Administrator  
Argonne National Laboratory

11/26/08  
Date

  
\_\_\_\_\_  
Craig Swietlik, DIS Software QAR  
Argonne National Laboratory

11/26/08  
Date

## Table of Contents

1	IDENTIFICATION.....	PC-12-7
2	PURPOSE.....	PC-12-7
3	ORGANIZATION OF THIS DOCUMENT.....	PC-12-8
4	BACKGROUND OF ARG-US .....	PC-12-9
5	SCOPE.....	PC-12-10
6	REFERENCED DOCUMENTS.....	PC-12-10
7	DEFINITIONS.....	PC-12-11
8	MANAGEMENT STRUCTURE AND RESPONSIBILITIES.....	PC-12-12
9	PROGRAM MANAGER.....	PC-12-12
10	PROJECT TEST COORDINATOR.....	PC-12-13
11	PROJECT QA ADMINISTRATOR.....	PC-12-13
12	DETERMINATION OF QUALITY LEVEL.....	PC-12-14
12.1	Safety Software Consideration.....	PC-12-15
12.2	Bases for Determination of Quality Level.....	PC-12-15
13	IDENTIFICATION OF REQUIRED DOCUMENTATION.....	PC-12-16
14	SQA DOCUMENTATION.....	PC-12-16
15	PROGRAM MANAGEMENT PLAN.....	PC-12-17
16	SOFTWARE VERIFICATION AND VALIDATION PLAN.....	PC-12-17
17	CONFIGURATION MANAGEMENT PLAN.....	PC-12-18
18	SOFTWARE TEST PLAN.....	PC-12-18
19	SOFTWARE TEST RESULTS .....	PC-12-18
20	REQUIREMENTS DOCUMENTATION.....	PC-12-18

---

21 DESIGN DOCUMENTATION .....	PC-12-19
22 USER DOCUMENTATION .....	PC-12-19
23 IDENTIFICATION OF REQUIRED PRACTICES .....	PC-12-19
24 COMPUTER SOFTWARE MANAGEMENT PRACTICES.....	PC-12-19
25 SOFTWARE DEVELOPMENT PRACTICES .....	PC-12-20
26 SOFTWARE VERIFICATION AND VALIDATION PRACTICES.....	PC-12-20
27 EXEMPTIONS .....	PC-12-21
28 FORWARD TRACEABILITY OF DIS SQAP TO THIS SQAP.....	PC-12-21

### **List of Tables**

1. Abbreviations and Acronyms.....	PC-12-11
2. Evaluation of ARG-US against the Quality Level Criteria.....	PC-12-14
3. Traceability Matrix, DIS SQAP to ARG-US SQAP.....	PC-12-21

## 1 IDENTIFICATION

This document is the Software Quality Assurance Plan (SQAP) for the ARG-US system. In the remainder of this document, it is referred to as the ARG-US SQAP, this SQA plan, or this SQAP.

The unique identifier of this document is PC-12-00-01 (and its revision thereof); it is found on the cover page and in the header of each page.

ARG-US is a system implemented by the Decision and Information Sciences (DIS) Division of Argonne National Laboratory (Argonne) for the U.S. Department of Energy (DOE) Packaging Certification Program (PCP). Further information about the application can be found in Section 4.

## 2 PURPOSE

**All software development undertaken by DIS is required to comply with the DIS Software Quality Assurance Plan, referred to subsequently as the DIS SQAP.** The DIS SQAP provides uniform criteria to determine the level of activities and documentation necessary for assuring the quality of a software development project, as well as the practices to be followed in the course of the development effort. The ARG-US SQAP is one of the documents specifically required for this development effort by the DIS SQAP.

The purpose of the ARG-US SQAP is to:

- Show how the requirements of the DIS SQAP are being met in the ARG-US software development effort;
- Identify the management structure and responsibilities;
- Document the Quality Level applicable to ARG-US software development effort;
- Identify the documentation specifically required by the DIS SQAP for that Quality Level; and
- Identify the procedures and practices that apply to the ARG-US software development effort.

The DIS SQAP is Appendix B of a larger document, the DIS Quality Assurance Plan (QAP), which governs all the work undertaken within DIS. The DIS QAP, in turn, satisfies the requirements of the Argonne Quality Assurance Program Plan (QAPP), which governs all the work undertaken by Argonne.

ARG-US complies with the DIS SQAP; it therefore also complies with the DIS QAP and with the Argonne QAPP.

### 3 ORGANIZATION OF THIS DOCUMENT

The remainder of this document is organized as follows:

- Section 4 gives background information on the purpose and nature of the ARG-US application.
- Section 5 covers the scope of this document.
- Section 6 lists other documents referenced in this document.
- Section 7 defines abbreviations and acronyms used in this document.
- Section 0 identifies the project's management structure and outlines management responsibilities.
- Section 9 describes the role of the Program Manager.
- Section 10 describes the role of the Project Test Coordinator.
- Section 11 describes the role of the Project QA Administrator.
- Section 12 documents the determination of the Quality Level ARG-US.
- Section 13 lists the documentation needed for a project of Quality Level C.
- Section 14 lists the required SQA documentation.
- Section 15 describes the Program Management Plan.
- Section 16 describes the Software Verification and Validation Plan.
- Section 17 describes the Configuration Management Plan.
- Section 18 describes the Software Test Plan Section 19 describes the Software Test Results document.
- Section 20 describes the Systems Requirements Specification documentation.
- Section 21 describes the design documentation.
- Section 22 describes the user documentation.
- On the basis of that Quality Level, Section 13 identifies the documents required for compliance with the DIS SQAP.

- Section 23 documents the practices required by the DIS SQAP, which help assure that the desired quality is achieved.
- Section 24 describes the required computer software management practices.
- Section 25 describes the required software development practices.
- Section 26 describes the verification and validation practices.
- Section 27 documents the agreed-upon exemptions to the requirements imposed by the DIS SQAP.
- Section 28 shows how the requirements listed in the DIS SQAP are met in this project.

#### **4 BACKGROUND OF ARG-US**

The DOE PCP tasked Argonne to develop a radio frequency identification (RFID) system for nuclear materials management. The system consists of battery-powered RFID tags with onboard sensors and memories, a reader network, application software, and database. The tags monitor and record the environmental conditions of the nuclear material packages in real time. They also provide instant warnings or alarms when preset thresholds for the sensors are exceeded. The reader network relays instructions to, and collects data from, the tags. The application software, ARG-US, manages the tags and the reader network and controls the information flow between the tags and the end user/data server. ARG-US provides easy-to-use graphical user interfaces (GUIs) that allow access to all vital information once the user's security and privilege requirements are met.

RFID is one of today's most rapidly growing technologies in the automatic data collection industry. An RFID system for nuclear materials management offers the following significant advantages: enhanced safety and security, reduced need for manned surveillance, real-time access to historical data on status and events, and overall cost-effectiveness.

The ARG-US system interfaces with a commercial software/hardware package that runs the reader network. This package is provided by the manufacturer of the reader network. The commercial package shall be tested as a black box system but integrated with ARG-US, which will provide testing for the integrated system. This testing is further discussed in the ARG-US Test Plan, Section 18 of this SQAP.

## 5 SCOPE

This SQA plan is one of the documents required by the DIS SQAP; others are discussed in Section 13 and cited in Section 6. Together, these documents form the complete record of project-specific quality assurance considerations, requirements, procedures, and practices applicable to the implementation of ARG-US at Argonne and elsewhere.. Exemptions from the requirements imposed by the DIS SQAP are documented in Section 27.

## 6 REFERENCED DOCUMENTS

The following documents are referenced in this SQA plan:

- *Decision and Information Sciences Division—Quality Assurance Plan (DIS QAP)*, Mar. 28, 2003, available on the DIS intranet at [http://www.dis.anl.gov/DISinformation/admintools/DIS\\_QAP\\_rev11.pdf](http://www.dis.anl.gov/DISinformation/admintools/DIS_QAP_rev11.pdf).
- *Decision and Information Sciences Division—Software Quality Assurance [Plan] (DIS SQAP)*, Appendix B of the preceding document.
- *Decision and Information Sciences Division—Software Quality Assurance Tracking Sheet*, Oct. 30, 2003, available on the DIS intranet at [http://www.dis.anl.gov/DISinformation/admintools/software.form2.update\\_Oct2003.pdf](http://www.dis.anl.gov/DISinformation/admintools/software.form2.update_Oct2003.pdf).
- *ANL-E Quality Assurance Program Plan (ANL-E QAPP)*, available on the Argonne intranet at <http://www.aim.anl.gov/manuals/qapp/index.html>.
- *Packagings RFID Tracking System—Demonstration*, PC-01-00-00, Apr. 15 2008.
- *Acceptance Testing Procedure of MK-1 RFID Tags for DOE/EM*, PC-02-00-00, May 7, 2008.
- *Acceptance Testing Result of MK-1 RFID Tags for DOE/EM*, PC-03-00-00, May 7, 2008.
- *Performance Test of the Double-Bolt Seal Sensor for the Model 9975*, PC-04-00-00, Mar. 9, 2008.
- *Performance Test of the Single Bolt Seal Sensor for the Model 9977 Packaging*, PC-05-00-00, June 12, 2008.
- *Performance Test of the Single Bolt Seal Sensor for the Model ES-3100 Packaging*, PC-06-00-00, June 12, 2008.
- *Calibration of Built-in Thermistors in RFID Tags for Nevada Test Site*, PC-08-00-00, July 11, 2008.

- *Results of Calibration of Built-in Thermistors in RFID Tags*, PC-09-00-00, July 31, 2008.
- *Procedure for Installing and Removing MK-1 RFID Tag on Model 9977 Drum*, PC-10-00-00, Aug. 5, 2008.
- *RFID Reader Kit User Guide for Temperature Monitoring of 9977 Drum (Draft)*, PC-11-00-00, Aug. 6, 2008.

## 7 DEFINITIONS

The abbreviations and acronyms used in this SQA plan are defined in Table 1.

**Table 1 Abbreviations and Acronyms**

<b>Abbreviation</b>	<b>Definition</b>
CMP	Configuration Management Plan
COTS	Commercial, Off-the-Shelf
DDD	Database Design Description
DDS	Detailed Design Specification
DIS	Decision and Information Sciences (Division of ANL)
DOE-EM	Department of Energy, Office of Environmental Management
GUI	Graphical User Interface
HLA	High-Level Architecture
IDD	Interface Design Description
ISG	Information Sciences Group (of DIS)
OUO	Official Use Only
PMP	Project Management Plan
QA	Quality Assurance
QAP	Quality Assurance Plan
QAPP	Quality Assurance Program Plan
QAR	Quality Assurance Representative
RFID	Radio Frequency Identification
SQA	Software Quality Assurance
SQAP	Software Quality Assurance Plan
SRS	System Requirements Specification
STP	Software Test Plan
STR	Software Test Results
SVVP	Software Verification and Validation Plan

## 8 MANAGEMENT STRUCTURE AND RESPONSIBILITIES

The DIS SQAP requires software development projects undertaken in DIS to have a well-defined management structure. It defines some of the elements of that structure and imposes particular responsibilities on them. Accordingly, the ARG-US Project has a Program Manager, a Project Test Coordinator, and a Project QA Administrator; their the responsibilities are outlined in the Sections 9 through 11. The associated responsibilities of other management entities within DIS (outside the ARG-US Project) are also discussed below.

## 9 PROGRAM MANAGER

The Program Manager for ARG-US is Yung Liu. The DIS ARG-US developer is Kun Chen. The DIS SQAP imposes the following responsibilities on the Program Manager:

- Assure that all software produced by the ARG-US Project is developed in accordance with the provisions of this SQA plan.
- Develop specific procedures as deemed appropriate. The procedures are outlined in this SQAP or in other documents referenced by this SQAP.

The DIS SQAP imposes the following additional responsibilities on the Program Manager or designee:

- Complete the DIS SQA Tracking Sheet (available on the DIS Intranet) at the start of the ARG-US Project and place it on file in the DIS division office and in the project file. Update the form as necessary as the project evolves and the software development progresses.
- Determine the Quality Level of ARG-US by applying the grading procedure discussed in Section 12.
- Obtain the concurrence of the Program Manager's Group Leader/Center Director and the Project QA Administrator regarding the determination of the Quality Level.
- Periodically (at least once a year), reevaluate the determination of the ARG-US Quality Level to ascertain whether any modifications to the project require a change in the applicable SQA procedures.
- Appoint a Project Test Coordinator, whose responsibilities are outlined in Section 10.
- Appoint a Project QA Administrator, whose responsibilities are outlined in Section 11.

The DIS SQAP also confers the following responsibilities on the Program Manager's Group Leader/Center Director:

- Approve the procedures for the ARG-US Project.
- Sign the DIS SQA Tracking Sheet.
- Provide QA oversight.
- Retain all review forms for the file.

## **10 PROJECT TEST COORDINATOR**

The Program Manager appointed Kun Chen as the Test Coordinator for ARG-US.

The DIS SQAP imposes the following responsibilities on the Project Test Coordinator:

- Write the Software Test Plan (STP) for ARG-US.
- Design and implement the associated test procedures used to ensure that the ARG-US software is stable and meets all functional and performance requirements.
- Ensure that documentation is properly updated and accurate.

## **11 PROJECT QA ADMINISTRATOR**

The Program Manager appointed Ralph Fabian as the QA Administrator for ARG-US.

The DIS SQAP imposes the following responsibilities on the Project QA Administrator:

- Develop, implement, and enforce QA practices and procedures, under the overall authority of the Program Manager.
- Establish and maintain QA files and releases of ARG-US computer software.
- Maintain software trouble reports and change requests (if used).
- Control commercial, off-the-shelf (COTS) software products used in conjunction with the ARG-US Project (e.g., compilers, databases, Windows software, and development tools).

The DIS SQAP also confers the following responsibilities with regard to ARG-US on the DIS Quality Assurance Representative (QAR), who is Craig Swietlik:

- Assist the Project QA Administrator in planning, developing, and implementing this SQA plan.
- Review and approve this SQA plan.

## 12 DETERMINATION OF QUALITY LEVEL

As a first step in setting the scope of the requisite documentation for a software development project undertaken by DIS, the DIS SQAP requires a project-specific SQA plan, such as this one, to determine the project's Quality Level. The determination of the Quality Level is based on the evaluation of the project with respect to six criteria, as outlined in Table B-1 of the DIS SQAP and the accompanying discussion. Each criterion implies a Quality Level associated with that one criterion.

Table 2 shows the result of evaluating ARG-US against each of the criteria.

**Table 2 Evaluation of ARG-US against the Quality Level Criteria**

<b>Criterion</b>	<b>Requirements for Level D: Low</b>	<b>Requirements for Level C: Medium</b>	<b>Requirements for Level A–B: High</b>	<b>Evaluation for ARG-US</b>
Criticality of functions performed	Consequences of failure are negligible, negligible risk	Consequences of failure are moderate to severe	Failure is unacceptable, loss of major assets	C
External impact, user base, visibility, and type of software	Few users, Argonne tool only; proof-of-concept	Limited distribution  Prototype/limited production	Wide distribution, high visibility  Production	C
Complexity, technical risk, and size	Few modules, manageable complexity	Several modules and libraries integrated	Large number of complex components	D
Software development effort in person-years and degree of customization	< 1 person-year  Minimal customization	1–2.5 person-years  Moderate customization	> 2.5 person-years  Significant customization	D
Security or proprietary impact	No security or proprietary impact	Moderate impact on work-for-others or national or Argonne security or proprietary programs or missions	Significant impact on work-for-others or national or Argonne security or proprietary programs or missions	D

<b>Criterion</b>	<b>Requirements for Level D: Low</b>	<b>Requirements for Level C: Medium</b>	<b>Requirements for Level A–B: High</b>	<b>Evaluation for ARG-US</b>
Cost of failure impact	Monetary loss of less than \$100,000	Monetary loss of between \$100,000 and \$1 million	Monetary loss of more than \$1 million	C

## 12.1 Safety Software Consideration

ARG-US is not considered “safety software.” The failure of the RFID tabs will not result in the loss of primary containment, shielding, or sub-criticality of the packaging containing the nuclear materials. Therefore, the RFID tag is not considered an item that is “important to safety,” as defined in Appendix A of Nuclear Regulatory Commission (NRC) Regulatory Guide 7.10 and the chapter on QA in the Safety Analysis Report for Packaging of the Model 9977 Packages. In accordance with Title 10, Part 71 of the Code of Federal Regulations (10 CFR Part 71), as long as the failure of an item does not jeopardize the packaging from performing its important-to-safety functions, the item is not considered to be important to safety.

## 12.2 Bases of Determination of Quality Level

- Criticality of Functions Performed.** The ARG-US software is considered to be Level C on the basis of the consequences of its failure. The failure of the software does not affect the integrity of the packaging relative to shielding, containment, and sub-criticality. The safety and health of the public would not be jeopardized as a result of a failure of the software. The system software developer can facilitate software repairs without affecting package integrity.
- External Impact, User Base, Visibility, and Type of Software.** The ARG-US software is considered to be Level C on the basis of its limited distribution. It will be used at only a few select sites in the near future.
- Complexity, Technical Risk and Size.** The ARG-US software is considered to be Level D based on the basis of the small number of and noncomplexity of its modules. The ARG-US software has three modules: the MK-1 RFID Tag, RFID Reader, and associated software.
- Software Development, Effort in Person-Years, and Degree of Customization.** The ARG-US software is considered to be Level D on the basis of the effort in person-years and degree of customization. Both the developed and the commercial ARG-US software require minimal customization.
- Security of Proprietary Impact.** The ARG-US software is considered to be Level D, since the failure of the software would have no security or proprietary impact.
- Cost of Failure Impact.** The ARG-US software is considered to be Level C, since the failure of the software would not result in a monetary loss in excess of \$1 million. For

example, a failure of ARG-US software might only require the additional leak testing of some packages.

In conclusion, the overall quality level of the ARG-US software is Level C. The basis for this designation is that the overall quality must be at least as high as that of the highest individual criterion identified in Table B-1, Criteria Matrix, of the DIS SQAP. As derived from the above methodology, Level C is the highest level.

### **13 IDENTIFICATION OF REQUIRED DOCUMENTATION**

The Quality Level identified in the previous section determines the extent of documentation required for compliance with the DIS SQAP. According to Table B-2 of the DIS SQAP, the following documentation items are required for a project of Quality Level C:

- SQA documentation,
- Configuration Management Plan,
- Software Test Plan,
- Software test results,
- Requirements documentation,
- Design documentation, and
- User and system documentation.

These items are discussed in the following sections.

### **14 SQA DOCUMENTATION**

The ARG-US Project shall retain the following SQA documents, in accord with the DIS SQAP:

- Master copies of the software;
- Copies of drawing and specifications (in the case of ARG-US, the requirements documentation of Section 20);
- Training records;
- User documentation (Section 22);
- Program documentation (Program Management Plan of Section 15, Software Verification and Validation Plan of Section 16, Configuration Management Plan of Section 17, testing documentation of Sections 18 and 19, and design documentation of Section 21);
- Required project practices and procedures (Section 23);
- Status reports; and

- Project-specific SQAP (this document).

The methods and facilities used to assemble, safeguard, control, and maintain the master copies of the software and other formal documents (i.e., the requirements documentation, user documentation, design documentation, and this SQAP) are described in the ARG-US Configuration Management Plan (CMP). The CMP also describes how versions of the software and the formal documents are numbered. Informal documents (including training records and status reports) are not numbered or subjected to control but will be safeguarded and maintained by the same backup and archival plans as those that apply to formal documents. All of these items shall be maintained for the life of the project. After development has been completed, they will be further retained for a minimum of two years or as long as the software is used by the customer. (After two years, the files may be moved to archival storage.)

## **15 PROGRAM MANAGEMENT PLAN**

The DIS SQAP has a requirement that software developed in DIS be “dealt with in a planned manner throughout its life cycle and that the process [be] appropriately documented” (see Section 25 of this SQAP). This requirement is interpreted to mean that ARG-US shall have a Program Management Plan (PMP), although that particular type of document is not explicitly mentioned in the DIS SQAP or the DIS SQA Tracking Sheet. Topics that will be relevant to the PMP when it is written include the following:

- Project description and history;
- Project sponsorship;
- Project organization, including roles and responsibilities;
- Project goals;
- Project resources;
- Project schedule;
- Nature of the application;
- Design and implementation methodology to be followed;
- Developer training;
- Management practices and procedures; and
- References to subordinate project plans.

## **16 SOFTWARE VERIFICATION AND VALIDATION PLAN**

The DIS SQAP also has requirements for planning, documenting, and conducting software verification and validation (V&V) activities throughout the life cycle of the project (see Section 26 of this SQAP). These requirements are interpreted to mean that ARG-US shall have a Software Verification and Validation Plan (SVVP), although that particular type of document, like the PMP, is also not explicitly mentioned in the DIS SQAP or the DIS SQA Tracking Sheet. Topics that will be relevant to the SVVP when it is written include the following:

- V&V methods,

- Artifacts to be subjected to V&V,
- Roles and responsibilities,
- Standards to be followed (if any), and
- V&V task descriptions.

## **17 CONFIGURATION MANAGEMENT PLAN**

An ARG-US CMP is being prepared. Topics addressed in the CMP, as dictated by the DIS SQAP, are as follows:

- Backup and archival plans,
- Version control,
- Distribution control,
- Virus control, and
- Software problem reports and change requests.

## **18 SOFTWARE TEST PLAN**

Testing is a requisite step before any software versions can be approved and released. An ARG-US Software Test Plan (STP) is being prepared. According to the DIS SQAP, the STP addresses the following types of testing:

- Unit and integration testing,
- Functional testing, and
- Installation testing.

For ARG-US, unit and integration, functional, and installation testing shall be performed by the Project Test Coordinator or designee.

## **19 SOFTWARE TEST RESULTS**

Results of the acceptance test shall be documented by the Project Test Coordinator in a Software Test Results (STR) document. The STR shall identify any testing failures and their resolutions.

## **20 REQUIREMENTS DOCUMENTATION**

A formal System Requirements Specification (SRS) shall be prepared by the Program Manager or designee, working with the sponsor or user representatives. For parts of the system that already exist, the SRS shall be based on the implemented functionality. As required by the DIS SQAP, the SRS shall address the following areas:

- Functionality and system operation;

- Data sources;
- Platform, languages, operating system, and commercial software;
- Interfaces;
- GUI conventions;
- Performance;
- Process flow; and
- Standards.

## **21 DESIGN DOCUMENTATION**

The DIS SQAP requires the preparation of design document(s) covering the following topics:

- Overall structure of the system,
- Definition of system hierarchy and objects,
- Architecture,
- GUI, and
- Interfaces to data.

The design documentation shall be prepared by the ARG-US software developers.

## **22 USER DOCUMENTATION**

The DIS SQAP requires the following user documentation:

- User manual,
- System administrator's manual, and
- Installation manual.

A user manual already exists; it shall be kept up to date, and the other two manuals will be provided by the ARG-US developers.

## **23 IDENTIFICATION OF REQUIRED PRACTICES**

The DIS SQAP requires that conforming projects follow certain practices that are not dependent on the project's Quality Level. One of these is the application of the grading procedure used to determine the project's Quality Level (see Section 12). The remaining practices are discussed in the Sections 24 through 26.

## **24 COMPUTER SOFTWARE MANAGEMENT PRACTICES**

The software management practices discussed in this section shall be followed by the ARG-US system.

- Uniform project software development and maintenance methodologies for ARG-US are being developed and documented, and adequate training for using the methodologies will be provided in the PMP.
- Before being distributed by DIS, ARG-US software shall pass a virus check for all known viruses, as documented in the CMP.
- Directives are being promulgated (and documented in the PMP) to assure compliance with all the terms and conditions of the licenses or other agreements under which the copyrighted or proprietary software incorporated into ARG-US, or used in its development, is obtained.
- The software management practices shall be periodically appraised to identify potential improvements to software quality and productivity and to implement such improvements, as documented in the PMP.

## **25 SOFTWARE DEVELOPMENT PRACTICES**

The software development practices discussed in this section shall be followed by the ARG-US system. They will be documented in the PMP.

- The Program Manager or designee shall assure that the ARG-US software developed and maintained by DIS is dealt with in a planned manner throughout its life cycle and that the process is appropriately documented and traceable. The Program Manager and the sponsor or user representatives shall document the specifications that the ARG-US software must satisfy.

## **26 SOFTWARE VERIFICATION AND VALIDATION PRACTICES**

The software V&V practices discussed in this section shall be followed by the ARG-US system and shall be documented in the SVVP.

- Software verification shall be performed during each phase of software development (i.e., requirements definition, design, implementation, testing, deployment, operation, and maintenance) to ensure that requirements imposed by the previous phase are fulfilled.
- Software validation shall be performed (by acceptance testing) at the end of the implementation phase to ensure compliance with requirements.
- The Program Manager or designee shall coordinate the software V&V activities and ensure the completion of all action items.
- Software V&V activities shall be planned and performed for each system configuration that might affect the software.

- Software V&V activities shall be performed throughout the life cycle of the ARG-US system. (The previous requirement and this one together imply that the system has an SVVP.)

## 27 EXEMPTIONS

There are no exemptions identified at the present time. Any future exemptions agreed upon shall be documented in a later version of this SQAP, along with their rationale.

## 28 FORWARD TRACEABILITY OF DIS SQAP TO THIS SQAP

The DIS SQAP requires each project-specific SQA plan (such as this one) to “detail how each requirement has been met.” The following Traceability Matrix lists all the “requirements” that can be identified in the DIS SQAP<sup>1</sup> and indicates, for each, the section of this SQA plan that addresses how the requirement is being met.

**Table 3 Traceability Matrix, DIS SQAP to ARG-US SQAP**

Requirement Imposed by the DIS SQAP	Where Discussed	
	In the DIS SQAP	In This Document
The project has a Program Manager	§§ 5 ff.	§ 0
The Program Manager assures that all software development products follow specified practices	§ 5.1	§ 9
The Program Manager develops specific procedures as deemed appropriate	§ 5.1	§ 9
The Program Manager or designee completes the DIS SQA Tracking Sheet at the start of the project and places it on file in the division office and in the project file	§ 5.2	§ 9
The Program Manager or designee updates the DIS SQA Tracking Sheet as the project evolves and the software development progresses	§ 5.2	§ 9
The Program Manager or designee determines the Quality Level of the project by applying the specified grading procedure	§ 5.2	§§ 9, 12
The Program Manager or designee obtains the concurrence of the Program Manager’s Group Leader/Center Director and the Project QA Administrator regarding the determination of the Quality Level	§ 5.2	§ 9
Periodically (at least once a year), the Program Manager or designee reevaluates the determination of the project Quality Level to ascertain whether project modifications require a change in the applicable SQA procedures	§ 5.2	§ 9

<sup>1</sup> All the requirements in the DIS SQAP are not collected together and numbered; they are distributed throughout the document and expressed with varying degrees of imperativeness. In representing those requirements in the table, we may have elevated to the status of a requirement some instructions that were only intended as suggestions.

Requirement Imposed by the DIS SQAP	Where Discussed	
	In the DIS SQAP	In This Document
The Program Manager or designee appoints a Project Test Coordinator	§ 5.2	§ 9
The Program Manager or designee appoints a Project QA Administrator	§ 5.2	§ 9
The Program Manager or designee assures that the software developed and maintained by DIS is dealt with in a planned manner throughout its life cycle and that the process is appropriately documented and traceable (which is interpreted to mean that the project has a PMP)	§ 6.3.1	§§ 15, 25
The Program Manager or designee coordinates the software V&V activities and ensures the completion of all action items	§ 6.4.3	§ 26
The Program Manager's Group Leader/Center Director approves project procedures	§ 5.4	§ 9
The Program Manager's Group Leader/Center Director signs the DIS SQA Tracking Sheet	§ 5.4	§ 9
The Program Manager's Group Leader/Center Director provides QA oversight	§ 5.4	§ 9
The Program Manager's Group Leader/Center Director retains all review forms for the file	§ 5.4	§ 9
The project has a Test Coordinator	§§ 5 ff.	§ 0
The Project Test Coordinator writes the project STP	§ 5.2	§ 10
The Project Test Coordinator designs and implements the associated test procedures used to ensure that the software is stable and meets all functional and performance requirements	§ 5.2	§ 10
The Project Test Coordinator ensures that documentation is properly updated and accurate	§ 5.2	§ 10
The project has a QA Administrator	§§ 5 ff.	§ 8
The Project QA Administrator develops, implements, and enforces QA practices and procedures, under the overall authority of the Program Manager	§ 5.3	§ 11
The Project QA Administrator establishes and maintains QA files and releases of computer software	§ 5.3	§ 11
The Project QA Administrator maintains software trouble reports and change requests (if used)	§ 5.3	§ 11
The Project QA Administrator controls COTS software products used in conjunction with the project	§ 5.3	§ 11
The DIS QAR assists the Project QA Administrator in planning, developing, and implementing this SQA plan	§ 5.5	§ 11
The DIS QAR reviews and approves this SQA plan	§ 5.5	§ 11
Documentation and records on the SQA process are maintained for the life of the project	§ 6.1.2	§ 14
SQA files are further retained for a minimum of two years or as long as the software is used by the customer	§ 6.1.2	§ 14

Requirement Imposed by the DIS SQAP	Where Discussed	
	In the DIS SQAP	In This Document
The project has an SQA plan	Table B-2	§§ 13, 14
The SQA plan details how each requirement has been met	§ 6.1.2.1	§ 14
The SQA plan identifies the SQA documentation to be retained	§ 6.1.2.1	§ 14
The SQA plan states the methods and facilities to be used to assemble, safeguard, and maintain this documentation	§ 6.1.2.1	§ 14
The SQA plan designates the retention period of the SQA documentation	§ 6.1.2.1	§ 14
The project has a CMP	Table B-2	§ 13
The CMP addresses specified items	§ 6.1.2.2	§ 17
The project has an STP	Table B-2	§ 13
The STP addresses specified items	§ 6.1.2.3	§ 18
The project has an STR	Table B-2	§ 13
The STR addresses specified items	§ 6.1.2.4	§ 19
The project has a requirements document	Table B-2	§ 13
The requirements document addresses specified items	§ 6.1.3.1	§ 20
The requirements document is developed by the Program Manager and the sponsor or user representative	§ 6.3.2	§ 25
The project has design document(s)	Table B-2	§ 13
The design documents address specified items	§ 6.1.3.2	§ 21
The project develops and documents uniform software development and maintenance methodologies	§ 6.2.1	§ 24
The project provides adequate training for using the methodologies	§ 6.2.1	§ 24
Before being distributed, the software passes a virus check for all known viruses	§ 6.2.2	§ 24
The project establishes directives to assure compliance with all the terms and conditions of licenses or other agreements	§ 6.2.3	§ 24
The software management practices are periodically appraised to identify potential improvements to software quality and productivity and to implement such improvements	§ 6.2.4	§ 24
Software V&V activities are planned and performed for each system configuration that might affect the software	§ 6.4.4	§ 26
Software V&V activities are performed and documented throughout the life cycle of the project (the previous requirement and this one together are interpreted to imply, among other things, that the project has an SVVP)	§ 6.4.5	§§ 16, 26
Software verification is performed during each phase of software development to ensure that requirements imposed by the previous phase are fulfilled	§ 6.4.1	§ 26

<b>Requirement Imposed by the DIS SQAP</b>	<b>Where Discussed</b>	
	<b>In the DIS SQAP</b>	<b>In This Document</b>
Software validation is performed (in the case of ARG-US, by acceptance testing) at the end of the implementation phase to ensure compliance with requirements	§ 6.4.2	§ 26

# **Quality Category for the RFID Temperature Monitoring System**

**Document Control No. PC-13-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Ralph R. Fabian

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

December 2008



## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	October 2008	Original Quality Category
01	December 2008	Updated Clarification of Quality Category

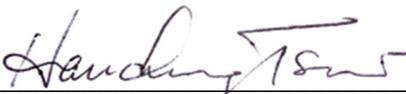
## Approvals

  
\_\_\_\_\_  
Ralph Fabian, RFID System QA Administrator  
Argonne National Laboratory

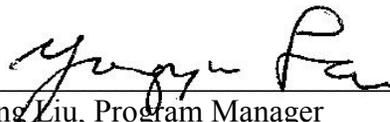
\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Kun Chen, RFID System Developer  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Hanchung Tsai, RFID System Supervisor  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Yung Liu, Program Manager  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

The RFID tag hardware and application software are considered to be non-“Q” (i.e., not safety-related) based on the graded approach described in 10 CFR 71.105(b), Packaging and Transportation of Radioactive Material, and on the definition of quality categories described in Appendix A of the Nuclear Regulatory Commission (NRC) Regulatory Guide 7.10, Establishing Quality Assurance Programs for Packaging Used in Transport of Radioactive Material.

Relative to the RFID hardware, the quality categories are derived from the safety significance of each item and the consequence of its failure to perform based on the design and performance requirements of the item. Should the failure of an item result in the loss of containment, the loss of shielding, or an unsafe geometry that compromises criticality safety, the item is considered to be an important-to-safety item. 10 CFR Part 71 addresses the regulatory requirements of packaging to ensure that public health and safety are protected. In accordance with 10 CFR Part 71, as long as the failure of an item does not jeopardize the packaging from performing its important-to-safety functions, the item is not considered to be important-to-safety. The NRC Regulatory Guide 7.10, Appendix A, embodies the same philosophy.

In application, the RFID tag is attached to the exterior of the packaging by affixing the tag’s sheet-metal top plate under one (e.g., Model 9977) or two (e.g., Model 9975) of the drum’s flange bolts. The bolts are original issue and then are retightened to the same torque specifications as the other flange bolts. The drum lid remains closed at all times during transport and extended maintenance, and the primary and/or secondary containment vessels inside the drum are never exposed. Thus, from the standpoint of configuration, the packaging is not altered in any way by the attachment of the RFID tag. Failure of the RFID hardware will not result in the loss of primary containment, the loss of shielding, or the loss of subcriticality. Therefore, based on the definition of the graded approach in 10 CFR 71.105(b) and NRC Regulatory Guide 7.10, Appendix A, the RFID hardware is not considered to be an important-to-safety item for the packaging.

Argonne National Laboratory has developed application software, called ARG-US, to collect, process, store, and present the RFID tag information. A malfunction of the software may affect some of the above functions but would not impact the containment, shielding, or subcriticality of the packaging in any way. The safety posture of drums with RFID tags is identical to drums without the tags. For this reason, based on the Argonne National Laboratory Decision and Information Sciences (DIS) Division Software Quality Assurance Plan (SQAP), ARG-US has been classified as Level C software — for medium risk, general service, and mission minor applications. The DIS SQAP is based on the Argonne National Laboratory Quality Assurance Procedures Manual. It references the U.S. Department of Energy Orders on quality assurance (QA) and software QA, the Institute of Electrical and Electronics Engineers and the U.S. Department of Defense standards on software QA, and the verification and validation of the software. All quality requirements for Level-C software, including the SQAP, configuration management, testing, and test documentation/results, have been met for the ARG-US software.



# **The Documentation Package for the RFID Temperature Monitoring System**

**Document Control No. PC-14-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

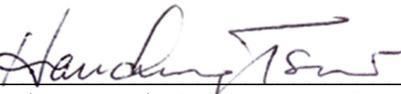
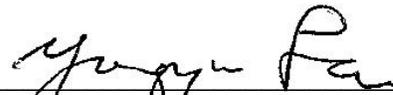
January 2009



## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	October 2008	Original Documentation Package
01	January 2009	Updated User Guide and Software Quality Assurance Plan (SQAP) for the ARG-US System, etc.

### Approvals

 _____ Kun Chen, RFID System Developer Argonne National Laboratory	<u>1/30/09</u> Date
 _____ Ralph Fabian, RFID System QA Administrator Argonne National Laboratory	<u>1/30/09</u> Date
 _____ Hanchung Tsai, RFID System Supervisor Argonne National Laboratory	<u>1/30/09</u> Date
 _____ Yung Liu, Program Manager Argonne National Laboratory	<u>1/30/09</u> Date

**Documents Included in the Documentation Package for  
the RFID Temperature Monitoring System at NTS**

<b>NO.</b>	<b>DATE</b>	<b>AUTHOR</b>	<b>SUBJECT TITLE</b>
<b>PC-02-00-00</b>	3/11/2008	K. Chen	Acceptance Testing Procedure of MK-1 RFID Tags for DOE/EM
<b>PC-03-00-00</b>	3/13/2008	K. Chen	Acceptance Testing Result of MK-1 RFID Tags for DOE/EM
<b>PC-05-00-00</b>	6/12/2008	K. Chen	Performance Test of the Single Bolt Seal Sensor for the Model 9977 Packaging
<b>PC-08-00-01</b>	7/11/2008	H. Tsai	Calibration of Build-In Thermistors in RFID Tags for Nevada Test Site
<b>PC-09-00-00</b>	7/31/2008	H. Tsai	Results of Calibration of Build-in Thermistors in RFID Tags
<b>PC-09-01-00</b>	11/19/2008	H. Tsai	Results of Thermal Calibration of Second Batch of MK-I RFID Tags
<b>PC-10-00-00</b>	8/05/2008	K. Chen	Procedure for Installing and Removing MK-1 RFID Tag on Model 9977 Drum
<b>PC-11-00-01</b>	12/30/2008	K. Chen	User Guide for RFID Reader and Software for Temperature Monitoring of 9977 Drum
<b>PC-12-00-01</b>	11/26/2008	K. Chen	Software Quality Assurance Plan (SQAP) for the ARG-US System
<b>PC-13-00-01</b>	12/30/2008	R. Fabian	Quality Category for the RFID Temperature Monitoring System
<b>PC-16-00-01</b>	12/30/2008	K. Chen	Software Test Plan and Results for ARG-US OnSite
<b>PC-17-00-01</b>	12/30/2008	K. Chen	Configuration Management Plan (CMP) for the ARG-US System
<b>PC-18-00-01</b>	12/30/2008	K. Chen	Requirements Management Plan for the ARG-US System
<b>PC-19-00-00</b>	1/30/2009	K. Chen	Design Management Plan for ARG-US



# **Software Test Plan and Results for ARG-US OnSite**

**Document Control No. PC-16-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

December 2008

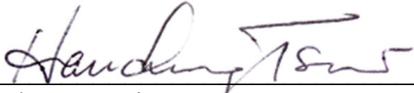


### Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	November 2008	Original Test Plan of ARG-US Onsite
01	December 2008	Updated Test Plan and Results of ARG-US Onsite

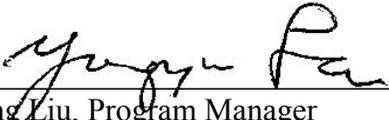
# Approvals

PC-16-4



Hanchung Tsai, RFID System Supervisor  
Argonne National Laboratory

12/30/08  
Date



Yung Liu, Program Manager  
Argonne National Laboratory

12/30/08  
Date

Tester: Kun Chen and Brian Craig

Date of Testing: December 15, 2008

Version Tested: ARG-US OnSite 1.0

This software test plan has been developed to test ARG-US OnSite version 1.0 (the software). This version of ARG-US OnSite is designed specifically for monitoring the ambient temperature of the Model 9977 packages at the Nevada Test Site (NTS). There shall be a maximum of seven tags to be used on the packages and two other tags for spares. The software shall be used only for monitoring, recording, and reporting temperature violations. Other functions of the software will not be used at NTS. Thus, only functions that are needed for temperature monitoring are tested. Should there be a need to use other functions of the software, a new version of the test plan shall be prepared. After passing the test, the software, along with other components of the ARG-US system, will be frozen for deployment at NTS. The software shall be evaluated in use by the NTS staff. Their comments and bug reports, if any, shall be used for future improvement.

PC-16-5

## Test Case: System login

- Test Case Identifier: PC-ARG-US-PT-01
- Description Summary: Login as an administrator or an observer
- Related Details: The ARG-US OnSite software starts in observer mode, where only limited functions are available. The user must login in as an administrator to obtain full access to the ARG-US OnSite software.
- Dependencies: None

Step	Action	Input	Expected Result	Actual Result (based on input)	Pass / Fail	Comments
1.1	Start the ARG-US OnSite software.		The software enters observer mode. The observer can only view and query the status of the tags. Other functions are not available.	The software automatically prompts for administrator mode.	P	Tests 1.1–2.13 have been conducted by Brian Craig.
1.2	Switch to administrator mode.		The software prompts for the administrator password.	Login was clicked to switch to administrator mode. OK.	P	
1.3	Enter a bad administrator password and click “OK” to confirm.	Bad administrator password	The software does not enter administrator mode. The software prompts again for the administrator password.	The software displayed a prompt and returned to observer mode.	P	
1.4	Enter the administrator password and click “OK” to confirm.	Administrator password	The software enters administrator mode. The administrator has full access to the functions that are currently available. The available functions are “Collect Drums,” “Remove Drums,” “Detail,” “Contents,” “History,” “Location,” “Clear Alarm,” “Sensor Setting,” “Sensor Log,” and dragging drums in the form.	The software successfully entered administrator mode.	P	
1.5	Exit administrator mode.		The software switches back to observer mode. The observer can only view and query the status of the tags. Other functions are not available.	The software successfully switched to observer mode.	P	

### Test Case: Monitor the ambient temperature

- Test Case Identifier: PC-ARG-US-PT-02
- Description Summary: Use the ARG-US OnSite software to retrieve the temperature reading from the RFID tag
- Related Details: Conducting this test case requires the ARG-US OnSite to run in administrator mode. The instructions for operating the ARG-US OnSite software are in the “User Guide for RFID Reader and Software for Temperature Monitoring of 9977 Drum,” document number PC-11-00-01. The temperature measurement testing/calibration in different temperature zones has been conducted separately. The procedure and results are documented in “Calibration of Build-In Thermistors in RFID Tags for Nevada Test Site,” document number PC-08-00-01, and “Memo — Results of Calibration of Build-in Thermistors in RFID Tags,” document number PC-09-00-00.
- Dependencies: PC-ARG-US-PT-01

Step	Action	Input	Expected Result	Actual Result (based on input)	Pass / Fail	Comments
2.1	Place at least seven RFID tags within 30 meters (approximately 100 feet) from the RFID reader. Collect the drums (or tags) using ARG-US OnSite software.		All drums (or tags) shall be collected by ARG-US OnSite.	All tags were collected successfully.	P	
2.2	Add all drums (or tags) to the ARG-US OnSite software.		Round labels appear in the main form one by one.	All tags were added to the grid alongside each other.	P	
2.3	Click on each drum (or tag) in the main form and check the status.		After the drum (or tag) is clicked on, the information of the drum (or tag) appears in the main form.	The information for each drum was displayed when the drum was clicked.	P	

PC-16-7

Step	Action	Input	Expected Result	Actual Result (based on input)	Pass / Fail	Comments
2.4	Place three RFID tags and one certified thermometer together for longer than 1 hour. Read the temperatures from the tags using ARG-US OnSite. Read the temperature of the thermometer.		The temperature difference between the tags and the thermometer shall not exceed 2 °C.	After 1 hour at 24 °C, all tags were within the 2 °C threshold of the ambient temperature.	P	
2.5	Change the temperature upper threshold to be lower than the current temperature using ARG-US OnSite. Do this to three different tags.	Set the temperature max to 20 °C for three tags.	All three tags shall show “Alarm” status in ARG-US Onsite. The label that represents the tag is in red and blinking.	The first drum triggered an alarm almost immediately. Other drums triggered an alarm after 5 minutes.	P	
2.6	Change the temperature upper threshold to be higher than the current temperature. Heat the tag to a temperature higher than the upper threshold. Do this to three different tags.	Cooled the tags to 10 °C using outside ambient temperature. Cleared the alarm status. Brought the tags back inside (24 °C ambient).	All three tags shall show “Alarm” status in ARG-US OnSite. The label that represents the tag is in red and blinking. The current temperature reading shall be higher than the upper threshold.	As the tags were heated above the temperature threshold, they eventually triggered an alarm.	P	

Step	Action	Input	Expected Result	Actual Result (based on input)	Pass / Fail	Comments
2.7	Trigger a temperature "Alarm" at a certain time. Record the temperature and the time. Check if the event has been recorded in the database file. Do this to three different tags.	Heated the tag from below the temperature threshold of 20 °C to above it using body heat.	All the "Alarm" events shall be recorded in the database file. The difference between the database event time and the actual event time shall be less than 10 seconds. The difference between the temperature recorded in the database file and the actual temperature shall not exceed 1 °C.	Alarms were not triggered for ~5 minutes, unless there was a manual tag query performed.	P	The sample rate of the temperature sensor was set to every 5 minutes. This caused the delay of the alarm. The manual query that triggered the alarm shows that the alarm function worked as desired.
2.8	Check the information of the tag in the "General" form.		The tag information shown in the main form matches the information shown in the "General" form.	The information matched.	P	
2.9	Open the "Location" form. Change the coordinate values.	Entered the coordinates of 5, 4, 2.	The drum (or tag) shall be moved in the main form to the location specified by the coordinate values.	The drum successfully moved to location 5, 4, 2.	P	
2.10	Hold the "Ctrl" key, and drag and drop (left button) the drum (or tag) to a new location in the main form.		The drum (or tag) shall be moved to the new location in the main form.	The drum successfully moved to the location dragged and dropped.	P	
2.11	Open the "Sensor Log" form. Choose "Temperature" as the sensor name. Click the "Read Tag" button.		The temperature log stored in the tag shall be read and displayed in the sensor log panel.	The log displayed only one record from the tag's temperature log.	P	The default number of output records is 1. To show more records, the "Start" and "End" values must be specified.
2.12	In the "Sensor Log" form, choose "Temperature" and click "Read PC."		The temperature log stored in the database shall be read and displayed in the sensor log panel.	The PC temperature log showed all the data from the database.	P	

Step	Action	Input	Expected Result	Actual Result (based on input)	Pass / Fail	Comments
2.13	Use the “remove drums” function to remove one to three drums (or tags) from the ARG-US OnSite software.	Selected one drum to remove.	The label that represents the removed tag disappears from the main form.	The drums that were selected to be removed were removed from the GUI.	P	
2.14	Let ARG-US OnSite run for longer than 1 week. Check the database for the tag status records.		The information for all the tags is recorded in the database approximately every 6 hours.	The system has been running for 3 weeks, and records were stored in the database approximately every 6 hours.	P	Kun Chen has been running a stability test in building 212. This test result is from Kun Chen.

# **Configuration Management Plan (CMP) for the ARG-US System**

**Document Control No. PC-17-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

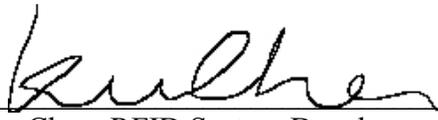
December 2008



## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	November 2008	Original CMP for the ARG-US System
01	December 2008	Updated CMP for the ARG-US System

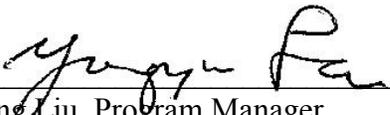
## Approvals

  
\_\_\_\_\_  
Kun Chen, RFID System Developer  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Ralph Fabian, RFID System QA Administrator  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Yung Liu, Program Manager  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

## Table of Contents

1	PURPOSE.....	PC-17-6
2	BACKGROUND .....	PC-17-6
3	RELATED PROGRAM DOCUMENTS.....	PC-17-6
4	CONFIGURATION MANAGEMENT .....	PC-17-7
4.1	Configuration Management Process .....	PC-17-7
4.2	Release Management.....	PC-17-8
4.3	Release Identification.....	PC-17-8
4.4	Change Requests .....	PC-17-9

## List of Figures

1	Configuration Management Process .....	PC-17-8
2	Software Change Request Form .....	PC-17-10
3	Software Change Tracking Matrix.....	PC-17-11

## 1 PURPOSE

The purpose of this Configuration Management Plan (CMP) is to establish the configuration management (CM) activities to be followed by Argonne National Laboratory in providing technical support to ARG-US for the U.S. Department of Energy's (DOE's) Packaging and Certification Program. The plan establishes CM activities to maintain the integrity of code development throughout the process and to control versions of code, documentation, and deliverables.

## 2 BACKGROUND

The Packaging Certification Program in DOE's Office of Environmental Management (EM), Office of Packaging and Transportation (EM-63), has requested that Argonne develop a radio frequency identification (RFID) system for nuclear materials management. The system consists of battery-powered RFID tags with onboard sensors and memories, a reader network, application software, and a database. The tags monitor and record the environmental conditions of the nuclear material packages in real time. They also provide instant warnings or alarms when preset thresholds for the sensors are exceeded. The reader network relays instructions to, and collects data from, the tags. The application software, ARG-US, manages the tags and the reader network and controls the information flow between the tags and the end user/data server. ARG-US provides easy-to-use graphical user interfaces that allow access to all vital information once the user's security and privilege requirements are met.

The RFID is one of today's most rapidly growing technologies in the automatic data collection industry. An RFID system for nuclear materials management offers the following significant advantages: enhanced safety and security, reduced need for manned surveillance, real-time access to status and event history data, and overall cost-effectiveness.

The ARG-US system interfaces with a commercial software/hardware package that runs the reader network. This package is provided by the manufacturer of the reader network.

*Note:* ARG-US is currently in the prototype stage. The CM tracking of versions and changes will begin when development is beyond the prototype stage into initial test deployments and production.

## 3 RELATED PROGRAM DOCUMENTS

The Software Quality Assurance Plan (SQAP) for the ARG-US System, PC-12-00-01, describes how quality assurance (QA) activities for the ARG-US system are addressed. The plan encompasses all data management and software systems being developed.

## 4 CONFIGURATION MANAGEMENT

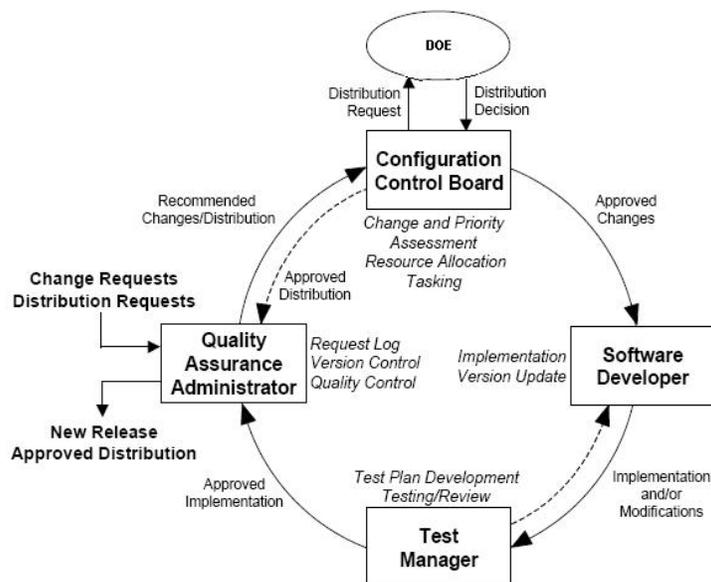
The CM process involves the formal control of all computer software and supporting documentation throughout the system life cycle. The life cycle extends from concept development and requirements definition through operation and maintenance. It entails configuration identification, control, status accounting, release management, and audit and assessment activities. On the simplest level, software CM may require only that a list and backup of files be kept for any particular software system. As the complexity of the software grows, however, the complexity of managing the resulting software system also increases. This plan considers both approaches for software CM, as well as a traditional document numbering approach for document CM, to ensure cost-effective implementation of all CM practices.

### 4.1 Configuration Management Process

Figure 1 depicts the CM process that will be applied to all software, data, and document changes and release requests relating to ARG-US. Consistent adherence to the CM process specified in Figure 1 assures the overall quality and integrity of Argonne's delivered products throughout the entire product life cycle. Although this process is greatly simplified for data and document CM activities, the process identified in Figure 1 is designed to encompass all CM activities in an efficient way for complex software systems.

As indicated at the top of Figure 1, a Configuration Control Board (CCB) will be established to review, approve, and document all major software changes and releases relating to ARG-US. The CCB consists of the QA Administrator, Program Manager, Technical Manager, and Test Manager. The Program Manager has final budgeting, scheduling, and release authority for products destined for DOE or internal use at Argonne.

In all situations, the QA Administrator will be the single entry (exit) point for all recommended (approved) change and distribution requests (see Figure 1). After performing logging, versioning, and quality control procedures, the QA Administrator will pass the recommended request to the CCB. The CCB will perform the evaluation and assessment of the proposed request's design and staffing impacts and practicality. Approved distribution requests will be returned to the QA Administrator for final processing. Approved change requests will be delivered to the software developer, where the change will be implemented and modified pending the final approval of the Test Manager. The resulting approved implementation will be delivered to the QA Administrator for release management prior to final release or distribution of the product.



**Figure 1 Configuration Management Process**

## 4.2 Release Management

Organizationally, CM is a functional responsibility of the QA Administrator (as illustrated in Figure 1). This separates the software development functions, which are controlled by the Technical Manager, from the software review and release functions to avoid any possible bias regarding product adequacy. The QA Administrator will elicit assistance from the Program Manager, Technical Manager, and Test Manager, as needed, to evaluate, implement, and test software changes.

## 4.3 Release Identification

A system release, or version identification, scheme will be used to track all software and document releases. In the case of software releases, two release parameters will be required to account for the structure of complex software systems. The first parameter will ensure that specific code changes are reflected in the executable program. A second tracking parameter will manage the proliferation of code changes. Because software can be readily modified and any changes can have major ramifications, coordinating and keeping track of these changes is essential. The following paragraphs explain how software release identification will be conducted at Argonne.

An executable system (or program) represents a collection of numerous software modules. Each release of the ARG-US program shall be assigned a unique *version* number (e.g., 1.0). Because ARG-US is comprised of many modules, a unique *revision* number is associated with each module (e.g., 0.1). Every time a specific module is modified, a new revision number is associated with the module. Thus, there is a relationship between each module revision number and any given system version number, which the CM system tracks.

Each version and release shall be archived to CD or DVD and maintained as a permanent record of that version, along with notes on the new features or changes contained in that version.

This information shall be automatically tracked using the open-source version tracking system, Concurrent Versioning System (CVS), or a similar system. The CVS provides version, build, and process management solutions for software project teams engaged in complex program development. In addition to the automated CM processes identified, each software module developer shall furnish a short note describing the reasons for all changes implemented in each new revision.

#### 4.4 Change Requests

Software configuration change control procedures shall be implemented to ensure accountability and traceability of software configuration modifications that take place throughout the development and evolution processes. Change control shall be applied in a cost-effective manner, recognizing that controls add to the up-front cost of developing and maintaining software, while the lack of change control increases the vulnerability of the software and the potential cost associated with software failure. Considering the function of the software and the recognized risks of the application, the following controls shall be implemented.

Any changes to ARG-US shall require prior authorization, and all changes shall be approved and documented before taking effect. An audit trail will enable the QA Administrator to document all software modifications and provide a record of what changes were made, who made the changes, why the changes were made, and the date of change. A similar process will be followed for data collection, document, and report releases.

Generic change request forms, like the form illustrated in Figure 2, will be used to document, track, and manage all software-related actions. The change request form is used for notification that:

1. A defect has been found in the software or documentation,
2. A new requirement has been identified for possible implementation, or
3. An enhancement has been identified for consideration.

Users will be able to assign a priority code to each request — *high*, *medium*, or *low* — if they opt to do so. An issue number shall be assigned to each request and be used for internal tracking. The ARG-US development team shall build a software change tracking matrix as an index of the change request forms. A generic software change tracking matrix is shown in Figure 3.

### Change Request/BUG Tracker Form

Issue No. \_\_\_\_\_

#### Description of Issue

- Issue raised by (name) \_\_\_\_\_
- Date and time \_\_\_\_\_
- Priority (check one)  Low  Medium  High
- Program/window/dialog box/menu name (if known) \_\_\_\_\_
- Version number and/or date (if known) \_\_\_\_\_
- Description of issue and suggestions for resolving it (attach sample if needed):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

#### Resolution of Issue

Referred to \_\_\_\_\_  
 Referral date and time \_\_\_\_\_  
 New revision/version number (if applicable) \_\_\_\_\_  
 New revision/version date (if applicable) \_\_\_\_\_  
 Description of resolution:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

- Resolution reviewed by (name) \_\_\_\_\_
- Resolution review date and time \_\_\_\_\_
- Results of review (check one)  Acceptable  Unacceptable  Deferred

Figure 2 Software Change Request Form

### Change Tracking Matrix

**Title of the software:**

<b>Version No.</b>	<b>Change/Action Requested</b>	<b>Issue No.</b>	<b>Completion Date</b>	<b>Comments</b>
<b>1.0</b>	<b>Initial release</b>			

**Figure 3 Software Change Tracking Matrix**



# **Requirements Management Plan for the ARG-US System**

**Document Control No. PC-18-00-01**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

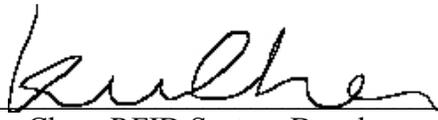
December 2008



## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	November 2008	Original Requirements
01	December 2009	Updated Requirements

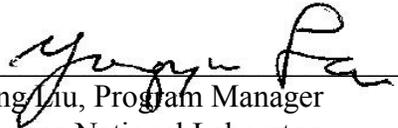
## Approvals

  
\_\_\_\_\_  
Kun Chen, RFID System Developer  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Ralph Fabian, RFID System QA Administrator  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

  
\_\_\_\_\_  
Yung Liu, Program Manager  
Argonne National Laboratory

\_\_\_\_\_  
12/30/08  
Date

## Table of Contents

1	PURPOSE.....	PC-18-6
2	BACKGROUND .....	PC-18-6
3	RELATED PROGRAM DOCUMENTS.....	PC-18-7
4	REQUIREMENTS BASELINE.....	PC-18-7

## Tables

1	Management Documents.....	PC-18-7
2	Requirements Baseline.....	PC-18-8

## **1 PURPOSE**

The purpose of this Requirements Management (RM) Plan is to establish the requirements baseline for activities to be followed by Argonne National Laboratory in providing technical support to the ARG-US system for the U.S. Department of Energy's (DOE's) Packaging and Certification Program.

## **2 BACKGROUND**

The DOE Packaging Certification Program in DOE's Office of Environmental Management (EM), Office of Packaging and Transportation (EM-63), has tasked Argonne to develop a radio frequency identification (RFID) system for nuclear materials management. The system consists of battery-powered RFID tags with onboard sensors and memories, a reader network, application software, and a database. The tags monitor and record the environmental conditions of the nuclear material packages in real time. They also provide instant warnings or alarms when preset thresholds for the sensors are exceeded. The software provides easy-to-use graphical user interfaces that allow access to all vital information once the security and privilege requirements are met.

The RFID is one of today's most rapidly growing technologies in the automatic data collection industry. Employing an RFID system has the potential to offer the following significant advantages: enhanced safety and security, reduced need for manned surveillance, real-time access to status and event history data, and overall cost-effectiveness.

The RFID reader and software collect tag information. The reader and software are designed to communicate with the MK-1 RFID tags that are attached to the Model 9977 drums at the Device Assembly Facility in the Nevada Test Site. The reader and software save the data (e.g., ambient temperature in particular) collected at regular intervals to verify that the environmental temperature condition is maintained for the containment O-ring of the Model 9977 drum. The maximum allowable temperature for the Viton O-ring is 200 °F. Depending on user requirements, the reader and software have the capability to send data to the central database servers.

Long-range radio frequency communication enables effective monitoring of many tagged items over a 328-foot (100-meter) radius — ideal for vaults, laboratories, and warehouses. Ethernet connection allows multiple readers to be networked together.

A user-friendly graphical user interface is used to provide a seamless interface to the ARG-US software platform, which provides real-time, end-to-end visibility of nuclear packages throughout transportation and storage.

### 3 RELATED PROGRAM DOCUMENTS

In keeping with Argonne's objective of implementing standard business practices, this document is one of the required management documents. Other related documents also are listed in Table 1.

**Table 1 Management Documents**

<b>Document</b>	<b>Contents</b>
Requirements Management Plan for the ARG-US System (PC-18-00-01)	Describes how requirements management activities and changes to requirements are addressed. Also outlines the requirements baseline.
Software Quality Assurance Plan (SQAP) for the ARG-US System (PC-12-00-01)	Describes how software quality assurance (QA) activities are addressed. The SQAP encompasses all data management and analytic software systems being developed, as well as the analysis products that are generated from using these software systems.  The practices and procedures described are utilized in all data collection, tool development, tool maintenance, report creation, and software receipt/distribution activities.
Configuration Management Plan (CMP) for the ARG-US System (PC-17-00-01)	Establishes configuration management activities to maintain the integrity of analysis throughout the analysis process and to control versions of documentation and deliverables.

The Requirements Management Plan defines the activities that have been established for managing and tracking the project requirements. Changes to the baseline are controlled by using traceable configuration management procedures.

### 4 REQUIREMENTS BASELINE

Table 2 provides a detailed listing of the requirements that define the baseline. The satisfaction of the requirements for the tags must be proven by hardware testing. The procedures and results of the hardware testing are not included in the software QA document, but are documented in the hardware QA document. The requirements listed in Table 2 do not include requirements for the data encryption, central server, central database, and Web applications. Those requirements may be included in a future version of this document. Additional requirements may be derived from the baseline detailed in Table 2. These could include, for example, functional and operational requirements for analytic tools, databases, and information management systems.

**Table 2 Requirements Baseline**

<b>Component Area</b>	<b>Requirements</b>
Tags	<ul style="list-style-type: none"> <li>• Monitor the drum/tag ID, seal integrity, temperature, humidity, shock, and battery information for all tags</li> <li>• Report the temperature, as measured within 2°C of actual ambient temperature over a range of 0-65°C</li> <li>• Promptly display alarm incidents and automatic notifications</li> <li>• Communicate with the reader over a distance ≈30 meters</li> <li>• Establish a prototype to handle seven tags</li> </ul>
Local Database	<ul style="list-style-type: none"> <li>• Store the tag and drum information</li> </ul>
Local User Interface	<ul style="list-style-type: none"> <li>• Display the configuration of drum storage</li> <li>• Change the configuration of drum storage</li> <li>• Collect tags in the range</li> <li>• Query details on any drum</li> <li>• Clear the alarm triggered by a tag</li> <li>• Change tag sensor settings</li> <li>• Retrieve tag sensor logs</li> </ul>
Local System	<ul style="list-style-type: none"> <li>• Query and record the status of each tag in a preset frequency</li> <li>• Operate reliably for a long period</li> </ul>
Security	<ul style="list-style-type: none"> <li>• Secure administrator privilege with password protection</li> </ul>

# **Design Management Plan for ARG-US**

**Document Control No. PC-19-00-00**

Prepared for:

DOE Packaging Certification Program  
DOE EM-63

Prepared by:

Kun Chen

Decision and Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

January 2009



## Revision History

<b>Revision Number</b>	<b>Date</b>	<b>Description</b>
00	January 2009	Original Design Management Plan for ARG-US

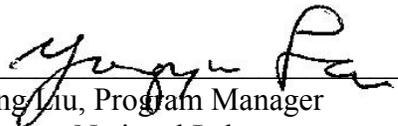
## Approvals

  
\_\_\_\_\_  
Kun Chen, RFID System Developer  
Argonne National Laboratory

\_\_\_\_\_  
1/30/09  
Date

  
\_\_\_\_\_  
Ralph Fabian, RFID System QA Administrator  
Argonne National Laboratory

\_\_\_\_\_  
1/30/09  
Date

  
\_\_\_\_\_  
Yung Liu, Program Manager  
Argonne National Laboratory

\_\_\_\_\_  
1/30/09  
Date

## Table of Contents

1	INTRODUCTION.....	PC-19-6
2	OVERALL STRUCTURE OF THE SYSTEM.....	PC-19-6
3	ARG-US ONSITE.....	PC-19-7
4	ARG-US DATABASE.....	PC-19-8
5	ARG-US WEB.....	PC-19-9
6	REFERENCES.....	PC-19-11

## List of Figures

1	Overall Structure of the ARG-US System.....	PC-19-6
2	Screenshot of the ARG-US OnSite Graphical User Interface.....	PC-19-7
3	Class Diagram of ARG-US OnSite.....	PC-19-8
4	Table Diagram of the ARG-US Database.....	PC-19-9
5	Screenshot of ARG-US Web.....	PC-19-10

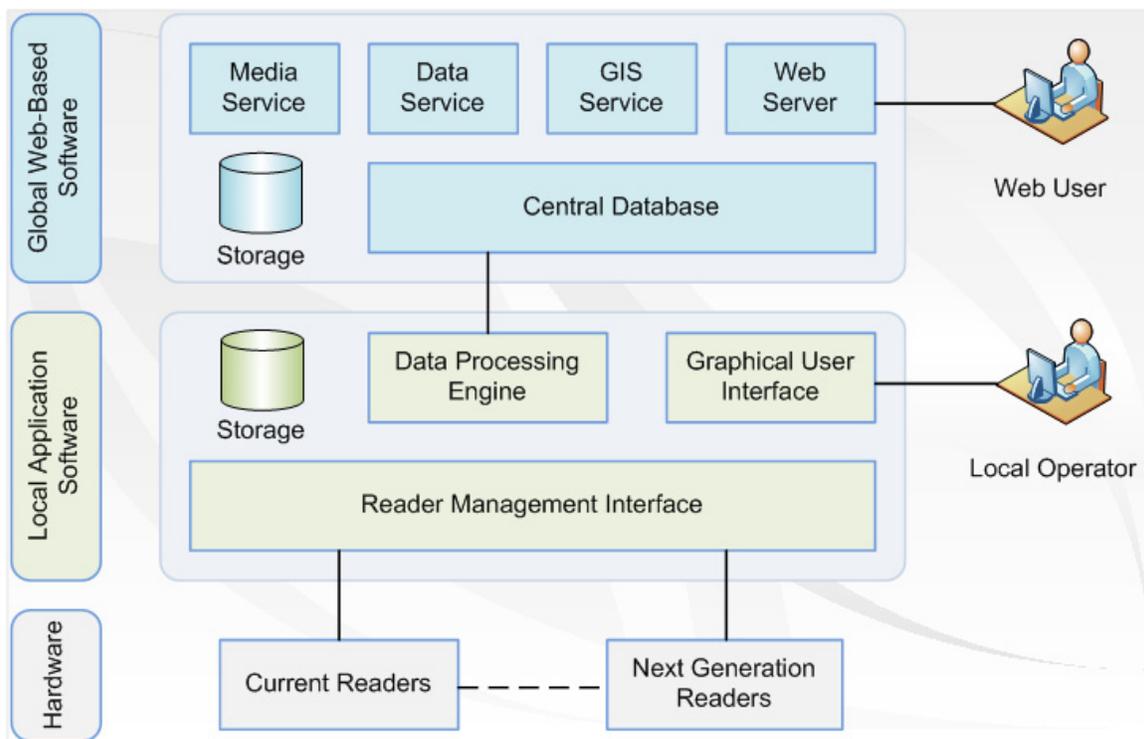
## 1 INTRODUCTION

This document is the design management plan for the ARG-US system — a modern, RFID-based, nuclear-material management system. It has been developed by the Decision and Information Sciences Division of Argonne National Laboratory for the U.S. Department of Energy’s Packaging and Certification Program. The purpose of this document is to describe the design of the ARG-US system to facilitate system management and future development. In the remainder of this document, the design management plan is referred to as the *design document* or *design plan*.

The design document is one of the documents required by the Decision and Information Sciences Division Quality Assurance Plan (DIS QAP).<sup>1</sup> Other required documents are discussed in the *Software Quality Assurance Plan (SQAP) for the ARG-US System*.<sup>2</sup>

## 2 OVERALL STRUCTURE OF THE SYSTEM

The ARG-US system is a nuclear-material management platform for data collection, processing, and distribution. The system operates different types of data collection hardware — in most cases, RFID readers. The system processes and consolidates the data collected by the hardware to a local work station and/or to a central database. The data are then presented to the user by a variety of means, including Web applications. The overall structure of the system is shown in Figure 1.



**Figure 1 Overall Structure of the ARG-US System**

### 3 ARG-US ONSITE

ARG-US OnSite is the local application software that operates the hardware and sends the data to the central database. It is the fundamental building block of the ARG-US system. ARG-US OnSite has a graphical user interface (GUI) for the local user. A screenshot of the GUI is shown in Figure 2. When not connected to the central database, ARG-US OnSite can work as a stand-alone system. The design of ARG-US Onsite emphasizes flexibility so that a change of hardware requires minimal modification of the software. Figure 3 shows the class diagram of ARG-US OnSite.

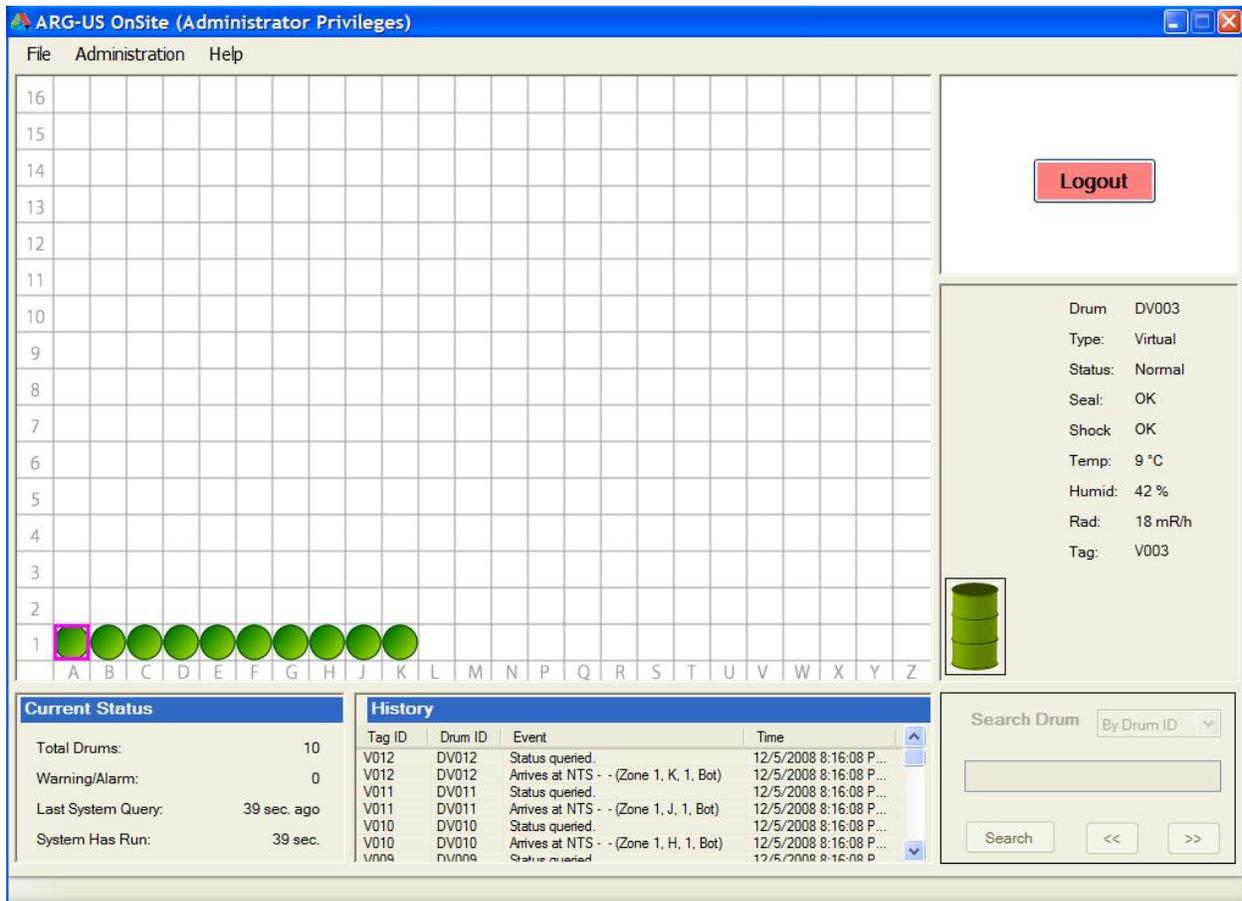


Figure 2 Screenshot of the ARG-US OnSite Graphical User Interface

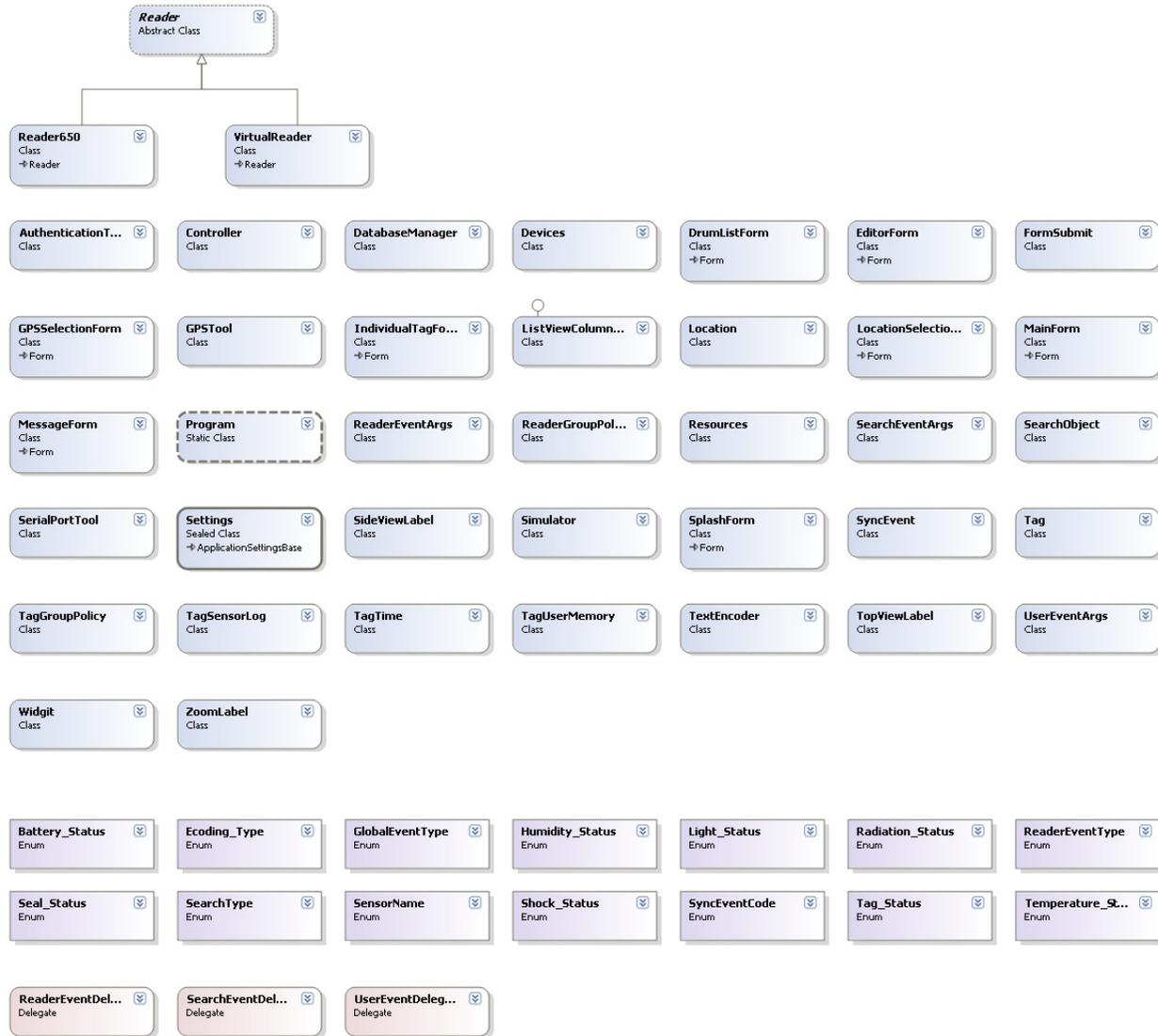


Figure 3 Class Diagram of ARG-US OnSite

#### 4 ARG-US DATABASE

The ARG-US system uses an SQL database to store the data. The database is designed specifically for management of nuclear materials packages. The diagram of the database is shown in Figure 4.





### Packagings RFID Tracking System



#### Site Map of ANL Bldg. 212

#### U.S. Map

Location:

#### Overhead View of Site, Zone 1

#### Drums at Selected Location in Zone 1

Drum ID: 018  
 Tag: 5703193  
 Model: ES3100  
 Originator: Y-12/ORNL  
 Tag Last Queried: 5/16/08 23:09 GMT  
 Sensor Status: **Warning**  
 Seal: OK  
 Shock: OK  
 Temperature: 21°C (-25 to 45°C)  
 Battery: **Low**  
 Humidity: 38% (0 to 70%)  
 Radiation: N/A  
 Contents: Empty drum with "fictitious" U metal and alloy cylinders, U-235 enrichment = 100 wt%; max. mass U-235 = 18 kg (with spacers). CSI = 0. (See Table 1: Loading limits for metal and alloy in solid geometric shapes in CoC USA/9315/B(U)F-96, Rev. 7 for additional details.)

#### Summary Status of ANL Bldg. 212

Total drums: 98    Database updated: 6/2/08 18:55 GMT  
 Alarm / No Response: 0    Page refreshed: 1/14/09 22:59 GMT  
 Warning: 1    Refresh rate:

#### Event History of Drum 018

Event Time (GMT)	Event
4/30/08 19:49	Arrives at ANL - Bldg. 212 - (Zone 1, W, 15, Bot)
4/30/08 19:49	Leaves location ANL - Bldg. 212 - (Zone 1, D, 1, Bot)
4/30/08 19:48	Alarm was cleared manually.
4/30/08 19:47	Shock Limit Exceeded (0 ~ 10).
4/30/08 19:47	Checking the Cause...
4/30/08 19:47	Arrives at ANL - Bldg. 212 - (Zone 1, D, 1, Bot)
4/18/08 14:38	Contents of the package have been entered.

#### Search For Drums at All Locations

Drum ID:   
 Contents:   
 Originator:   
 Model:

#### Reports



[Help](#) | [Contact Information](#)



Figure 5 Screenshot of ARG-US Web

## 6 REFERENCES

1. Decision and Information Sciences Division Quality Assurance Plan (DIS QAP), ANL/DIS, March 28, 2003. Available on the DIS Intranet at [http://www.dis.anl.gov/DISinformation/admintools/DIS\\_QAP\\_rev11.pdf](http://www.dis.anl.gov/DISinformation/admintools/DIS_QAP_rev11.pdf).
2. Software Quality Assurance Plan (SQAP) for the ARG-US System, ANL/DIS/PCLCM, PC-12-00-01, February 2009.

