California Department of
PublicHealth

RADIATION SOLUTION RS-700
MOBILE RADIATION MAPPING SYSTEM
OPERATION PROCEDURE, VERSION 4

RADIOLOGIC HEALTH BRANCH
RADIOLOGICAL ASSESSMENT UNIT

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                            _10/22/2013_

APPROVAL: DATE

Radiation Solution RS-700: Operation Procedure

RadAssist version 4.5.2.0

SECTION 1: HARDWARE SET-UP
1. Equipment List:
    - ☐ RSX detectors #1 and #2,
    - ☐ RS-701 control box,
    - ☐ Detector cables (2 each, labeled #1 and #2),
    - ☐ Ethernet crossover cable,
    - ☐ power connector (12 VDC or 110 VAC),
    - ☐ GPS antenna,
    - ☐ GPS antenna support (threaded pole or magnetic pad,
    - ☐ GPS antenna cable
    - ☐ GPS electronics (yellow box)
    - ☐ GPS cable (electronics box to RS 701)
    - ☐ GPS power cable
    - ☐ Battery (12V), for GPS
    - ☐ Power inverter, for RS 700 system,
    - ☐ Laptop computer, pre-loaded with RadAssist software, and
    - ☐ Mouse, if desired
    - ☐ Miscellaneous cable ties
2. Visually inspect all components for damage
3. Install detectors securely.
4. Connect detector cable #1 to RS-701 control box DET 1 and detector #1 (Serial number 5121)
   Note: Each end of the detector cable has a different gender - only connect to appropriate connector.
5. Repeat Step 3 for detector #2 (Serial number 5122)
6. Connect Trimble GPS box cable to "GPS" connector on RS-701 control box, labeled COM 1
7. Connect power supply cable (110 VAC or 12 VDC as applicable) to RS-701 control box POWER connector.
    - Note: white wire on 12 VDC is *hot* and the black wire is neutral

SECTION 2: SOFTWARE SET-UP
Set up computer to communicate with RS-701 system.
1. Turn on computer
2. Set IP address of computer as follows: *This requires administrator access*
    a. Click START on lower left of screen
    b. Click SETTINGS
    c. Click NETWORK CONNECTIONS
    d. Choose LOCAL AREA CONNECTION
    e. Under the General tab, select PROPERTIES
    f. Click INTERNET PROTOCOL (TCP/IP) - will highlight
    g. Click on PROPERTIES

      h. Under the General tab, select Internet Protocol (TCP/IP), input:
- i. IP address: **192.168.1.100**
- ii. Subnet mask: **255.255.255.0**
- iii. Default gateway: **192.168.1.149**
- iv. Click on OK

3. Connect Ethernet Cross-Over cable to RS-701 Control box DATA position and the other end in the computer Ethernet connector.
4. Press the silver button on the RS-701 console and hold until the LEDs on console illuminate (about 10 seconds).
   a. Yellow lights for the detector indicate the detectors are performing an automatic gain adjustment (aka energy calibration) - no radioactive sources are required.
   b. Red light indicates an error.
   c. Purple light indicates startup.
   d. Green light indicates all is OK.
5. Start RadAssist (file path: Start, Programs, RSI, and RadAssist)
6. Set Calibration Parameters (menu path: Options, Calibration Parameters)

Table 1: Calibration Parameters

ROI

ROI		Active	Only Up	Name	Start Ch	End Ch	Det.BG	Cosmic	Alt. Beta	Sens. Coef	Unit
01		YES		Range(45-1980)	15	660	0	0	0.0067	1	cps
02		YES		Potassium	457	523	6.3	0	0.0082	12.2	%
03		YES		Ra-226(1764)	553	620	2.2	0	0.0084	1.2	ppm
04		YES		Thorium	803	937	1.5	0	0.0066	0.56	ppm
05		YES		Annihilation	152	190	0	0	0	1	cps
06		YES		Ra-226(609)	182	222	0	0	0	1	cps
07		YES		Cs-137	183	247	0	0	0	1	cps
08		YES		I-131	109	133	0	0	0	1	cps
09		YES		GdCo	30	45	0	0	0	1	cps
10		YES		Gross	1	1024	0	0	0	1	cps

Calibration Coefficients Matrix

*	Range (45-1980)	Potassium	Ra-226 (1764)	Thorium	Annihila-tion	Ra-226 (609)	Cs-137	I-131	GdCo	Gross
Range(45-1980)	1	0	0	0	0	0	0	0	0	0
Potassium	0	1	0.7575	0.4155	0	0	0	0	0	0
Ra-2226(1764)	0	0	1	0.2715	0	0	0	0	0	0
Thorium	0	0	0	1	0	0	0	0	0	0
Annihilation	0	0	0	0	1	0	0	0	0	0
Ra-226(609)	0	0	0	0	0	1	0	0	0	0
Cs-137	0	0	0	0	0	0	1	0	0	0
I-131	0	0	0	0	0	0	0	1	0	0
GdCo	0	0	0	0	0	0	0	0	1	0
Gross	0	0	0	0	0	0	0	0	0	1

7. Connect computer software to detectors
   a. Select FILE
   b. Select CONNECT TO DEVICE...
   c. Under DIRECT CONNECTION tab,
   d. Select RS-701 PROTOCOLS displayed,
   e. Select CONNECT.

8. Check GPS settings
   a. Select DEVICE PARAMETERS tab
   b. Check IP address of RS-701 is 192.168.1.149
   c. BAUD: 9600
   d. Byte Size: 8
   e. PARITY: Odd
   f. STOP BITS: 1 (one)
   g. GPS: *External* GPS
9. System is operational when all LEDs on RS-701 console are green.

SECTION 3: INITIAL QA/QC SETUP

System is operational when all LEDs on RS-701 console are green.
1. Perform initial background setup.
   a. Find location(s) where QA/QC tests may be performed multiple times each day. Location should be flat, no sources of elevated radioactivity, and easy to drive UTV and detector each day.
   b. Mark trailer location using paint or flags.
   c. Remove all check sources (minimum of 20 feet away).
   d. Note start time and stop time.
   e. Allow system to collect a *minimum* of 300 seconds of data with no sources present.
   f. Collect a *minimum* of 300 seconds of data with a 1 μCi Cs-137 source present.
   g. Calculate average background value using 300 seconds of data from the Cs-137 region of interest (ROI).
   h. Calculate standard deviation value using 300 seconds of data from the Cs-137 ROI.
2. Perform initial Cs-137 source measurements.
   a. Remove all sources except 1 μCi Cs-137 point source. This source does not require NIST traceability but the same source should be used for all QA/QC.
   b. Place the Cs-137 source on the cart at location noted on frame. All QA/QC measurements will require placing the source at this same position.
   c. Note start and stop time on log.
   d. Collect minimum 300 seconds of source data.
   e. Calculate average background value using 300 seconds of data from Cs-137 ROI.
   f. Calculate one, two, and, three standard deviation values using 300 seconds of new data from the Cs-137 ROI.

SECTION 4: OPERATION

System is operational when all LEDs on RS-701 console are green.
1. Perform QA/QC test at the start and end of each run. No more than 3 hours of data collection should occur between background and source tests.
2. Start collecting data on laptop
   a. Select FILE and
   b. Select START DATA RECORDING.
   c. Choose file name and storage location.
   d. Note name and start time in survey log.
      i. Note: System can automatically collect data without a computer.

3. At the end of data collection,
    a. Select FILE and
    b. Select STOP DATA RECORDING...
4. To retrieve data in the RS-701 console,
    a. Select DEVICE and
    b. Select REQUEST ALL EVENTS, chose file name and save.
5. To turn system off, see Section 6.

SECTION 5: PERIODIC QA/QC CHECK

System is operational when all LEDs on RS-701 console are green.
1. Perform QA/QC test.
   This should be performed at the start and end of each run. No more than 3 hours of data collection should occur between background and source tests.
    a. QA/QC tests should occur in the same physical location, if practical.
    b. Collect background data file by removing all sources of radiation. Note start and stop time on log. Allow system to collect a minimum of 180 seconds of data.
    c. Place ~ 1 µCi Cs-137 point source at location noted on cart. The source does not require NIST traceability but the same source should be used for survey duration.
    d. Note start and stop time on log.
    e. Allow system to collect a minimum of 180 seconds of data with the source in position.
    f. Net source data should be within 2σ of the initial net cps. Project health physicist (HP) may approve up to 3σ deviation on a case-by-case basis.

SECTION 6: SHUTTING THE SYSTEM DOWN

1. Perform QA/QC test; see Section 5.
2. Select FILE and STOP DATA RECORDING... if still collecting.
3. Exit out of RadAssist
4. Press and hold silver POWER button on back of RS-701 console until lights on the console turn off.
5. Disconnect cables
6. Change computer IP address to OBTAIN AN IP ADDRESS AUTOMATICALLY, using Step #7
7. Setup baud rate equal to 38,400 on RS-701 Com-1 for external GPS, on RS-701 DEVICE PARAMETERS tab on RadAssist program

SECTION 7: INSTRUCTIONS FOR DATA CAPTURE AND FILE CONVERSION

1. If a computer was not used for data collection, retrieve raw data from Rad Mapping system (RMS) by inserting USB memory stick to RS-701 console. Data will be automatically downloaded when a memory stick is inserted. The LED on RS-701 will stop flashing when data is downloaded.
2. Copy files to directory on computer hard drive.
3. Choose File conversion #1 (step 4) _OR_ File conversion #2 (step 5), then continue to step 6.
4. File conversion #1 – *multiple* data files or *single* data file per survey unit only, provides specific control of Virtual Detector Configuration.

a. Start RSV2RAW File Converter (file path: Start, Programs, RSI, Tools, RSV2RAW File Converter)

b. File Name: Browse to location data file is stored.

c. Click CONVERT

d. Default places the converted file into the same folder as the original.

e. Create a new folder and place copies of the *.RFL files in it, renumbering them so the numbers are unique and sequential, for example, RSV0000.RFL, RSV0001.RFL, RSV0002.RFL, RSV0003.RFL, etc.

f. Open RadAssist program by selecting RadAssist icon.

g. Select "Options" menu, open "Calibration Parameters" and check against Table 1: Calibration Parameters.

h. Select "Data Processing" tab at bottom of window.

    i. Select "Load Raw Files Directory (*.gz, *.rfl)

    ii. Browse to file with converted data file(s).

    iii. Select file to be processed.

    iv. Select "Show Loaded Data"

5. File conversion #2 – *single* data file per survey unit only

a. Open RadAssist program by selecting RadAssist icon.

b. Select "Options" menu, open "Calibration Parameters" and check against Table 1: Calibration Parameters. Click "OK"

c. Select "Data Processing" tab at bottom of window.

d. Click "Load" button.

    i. Select "Load RSI Virtual Files(*.rsv)

    ii. Browse to file with converted data file.

    iii. Select file to be processed.

    iv. Select "Show Loaded Data"

6. Select "Export" button

a. Exported Data Range screen

    i. Data range: ALL DATA, click NEXT>

b. Export Data Format screen

    i. Output format: CSV, click NEXT>

c. CSV Export Options

    i. Sample time format: UTC YYYY/MM/DD/HH:MM:SS,

    ii. GPS data format: LLA WGS84 Coordinates,

    iii. Output following fields: ROI, LiveTime, Doserate (per VD) only, click NEXT>.

        1. For spectra analysis, also select Virtual Spectrum 1, click NEXT>.

d. Virtual Detector Configuration screen (file conversion #1 process only)

    i. Top box: Virtual Detector 1

    ii. Virtual Detector Definition: VdGmm1D

    iii. Detectors to be summed together:

        1. Detector Pack 1: only highlight **1** and **2**

        2. Detector Pack 2-4: leave grayed out, click NEXT>.

e. Ignore Errors screen (file conversion #1 process only)

    i. Do not select anything, click NEXT>.

    f. Filter Samples screen
        i. Leave all fields blank, click FINISH.
    g. Export Done, select "Open Exported File" button, if desired.

SECTION 8: EXCEL SPREADSHEET ANALYSIS

1. Open spreadsheet; *do not save* until after the second macro has run.
   a. Click "Enable Content" button
   b. Automatic Header Generator: enter your full name as it should appear in the header. Click the "OK" button. This step cannot be skipped.
2. Open survey data *.cvs* file (DEX_*)
   a. IMPORTANT: Do NOT delete any excess rows or columns in the *.cvs* file. The macro will not run properly, if you do.
3. Right click sheet tab (DEX_*), select "Move or Copy …"
   a. "Move Selected sheets To book:", choose "RS 700 Analysis Template"
   b. "Before sheet:" highlight "Imported Data"
   c. Click "Create a Copy" button
   d. Click "OK"
   e. Close *.cvs* file, it is no longer needed
4. Select "DEX_*" tab
   a. Select All by clicking in the top rectangle in the first numbered column, hold down CTRL-C simultaneously to copy
5. Select "Imported Data tab
   a. Select All by clicking in the top rectangle in the first numbered column, hold down CTRL-V simultaneously to paste, overwriting all in "Imported Data" tab.
6. Using the Microsoft Excel "Developer" tab, select 'Macros', select "SimpleClean" then click "Run".
   a. To activate the "Developer" tab on the Excel ribbon:
      i. Select the "File" tab, click "Options"
      ii. Select "Customize Ribbon" then click the "Developer" box on the right so that a check mark appears. Click "OK".
7. Text Box #1: GPS Processing
   a. "Do you want to INTERPOLATE/DELETE GPS errors?" Click "Yes" or "No" button
      i. "Yes" is intended for moving mapping, where there are few GPS errors
      ii. "No" is intended for data sets where mapping is not important, ie stationary measurements.
8. Text Box #2: Microsoft Excel
   a. " __ + __ = __ " ends the first step of the 'SimpleClean' macro. The numbers show GPS error(s) + detector error(s) = Total error(s).
9. Text Box #3: Background Comparison Option
   a. Do you wnt to COMPARE your data to a BACKGROUND?
      i. "Yes" or "NO" or "Cancel"
      ii. User choice effects which sheets are retained in the spreadsheet. This option provided a more versatile single analysis suite and prevented version incompatibilities.

10. Text Box #2: Microsoft Excel
    a. "Data may exist in the sheet(s) selected for deletion. To permanently delete the data, press Delete." Click "Delete" button.
        i. Standard Excel warning: Sheet deletion is necessary to specialize the workbook for comparing to background or not.
11. Check "Oplog" for macro function log.
12. **Save file** as Excel Workbook (*not* a macro-enabled workbook), extension .xlsx.
    a. Naming protocol: "[Site] [numerical date_time of survey][Survey Unit] ", for example "HPS 20100823_122208 IR7-D.xlsx"
    b. Excel Dialog box, last line: To continue saving as a macro-free workbook, click Yes.
    c. Close file. Necessary step, otherwise the VBA project/macros are not removed.
13. NOTE: Results on "Summary" for the Average, St Dev. etc. include data removed from "Raw Data" due to GPS acquisition error.
14. Delete unnecessary spectra columns on "Imported Data" and "Raw Data" tabs for smaller file size, optional.
15. Delete "DEX_*" tab for smaller file size, optional.
16. If "Compare to Background" option was selected:
    a. Select a suitable background measurement .xlsx file
    b. Enter background averages and standard deviations for the ROIs on the "Summary" sheet.
17. Check "Summary" or "Summary-No bkgd" for significant figure errors.
18. Conversion is complete.
19. Review results
    a. Graphs and tables for outlier measurements
    b. Proportions of data points in " < 2 sigma", "2 sigma – 3 sigma", and "> 3 sigma".

SECTION 9: INSTRUCTIONS FOR USING SURFER (FIELD MAPPING)

Create a classed post map by performing the following steps:

1. Open the Surfer program.
    a. Select New Classed Post Map (menu path Map, Post Map, New Classed Post Map).
    c. Open XXXXXX.csv or XXXXXX.xlsx file. XXXXXX is the file you want to plot.
    d. From the *Classed Post Map Properties* **General** tab, select the following:
        i. X Coordinate: Long,
        ii. Y Coordinate: Lat,
        iii. Z Value: Column Q or higher (ROI of interest),
    e. From the *Classed Post Map Properties* **Labels** tab, use all default values.
    f. From the *Classed Post Map Properties* **Classes** tab, the number of classes should be 3 and the binning method should be equal number. Change classes as follows:
        i. Class 1 upper value to the "average $+ 2\sigma$"
        ii. Class 2 lower value to the "average $+ 2\sigma$" and the upper value to the "average $+3\sigma$"
        iii. Class 3 lower value to the "average $+ 3\sigma$" and the upper value to the highest integer on the survey

g. Symbols:

i. Values less than the "average + 2 σ " – 'Grass Green' equal arm crosses " **✚** "

ii. Values between "background + 2 σ" and "background +3 σ" use 'Deep Yellow' triangles " ▲ ".

iii. Values greater than "average + 3 σ ", use 'Red' dots " ● "

iv. Adjust symbol size to scale of plot, generally with red dots largest and green crosses smallest

2. Select **Apply** and then **OK** when complete.

3. Save file by selecting **File, Save As**, and then XXXXXX.srf. XXXXXX is the name of the original file.

SECTION 10: VERSION HISTORY

1. Version 1 – draft version
2. Version 2 – signed version, approved November 15, 2010
3. Version 3 – signed version,
    a. Version history added
    b. Document name changed to Radiation Solution RS-700 Mobile Radiation Mapping System, Operation Procedure"
    c. Name change for three ROIs:
        i. TotCount changed to "Range(45-1980)
        ii. Uranium changed to "Ra-226(1764)
        iii. ROI 10 changed to" Gross"
            1. Start channel ; 1
            2. End channel: 1024
4. Version 4 – update for new RadAssist software, version 4.5.2.0