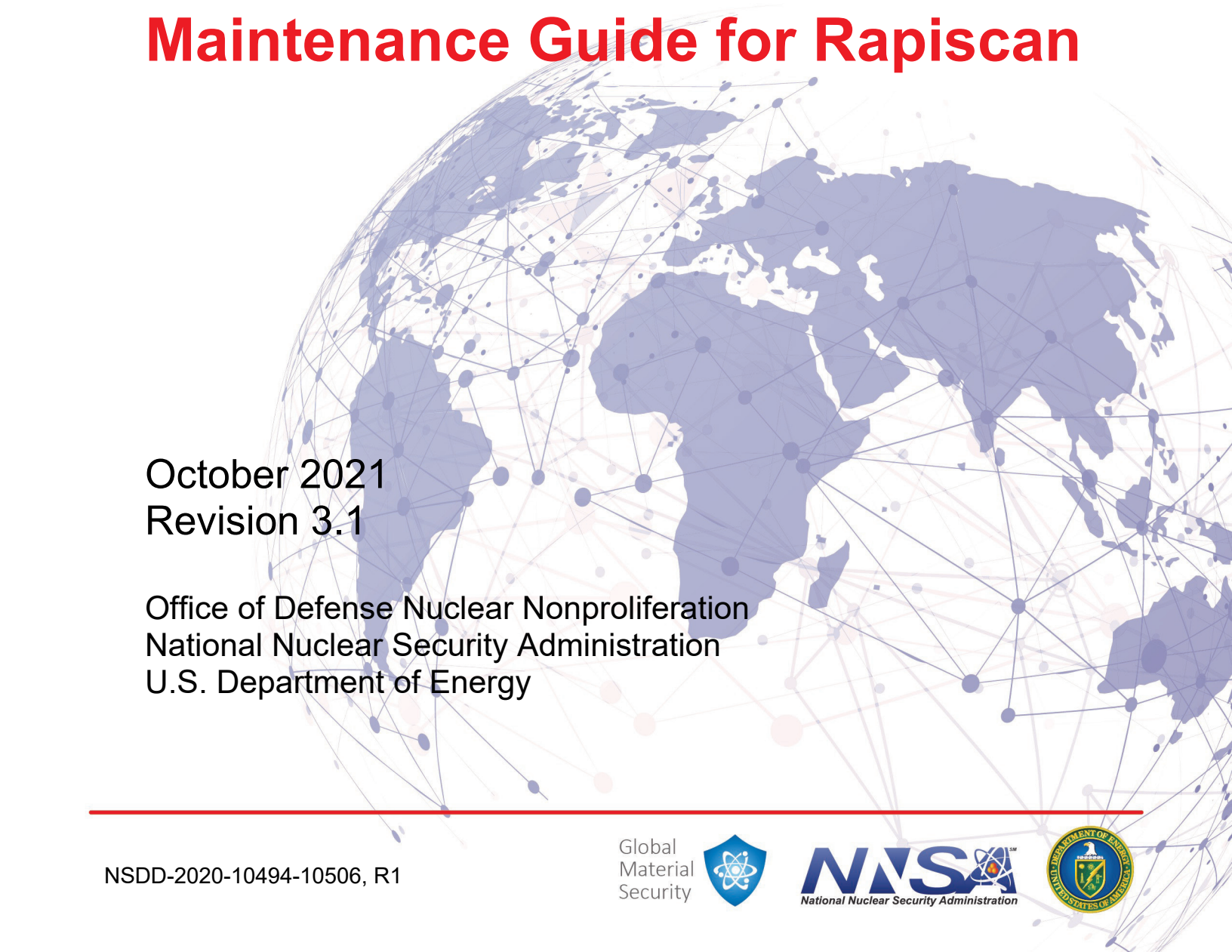
NSDD
NUCLEAR SMUGGLING DETECTION AND DETERRENCE

Radiation Portal Monitor
Maintenance Guide for Rapiscan



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Office of Defense Nuclear Nonproliferation
National Nuclear Security Administration
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NSDD-2020-10494-10506, R1

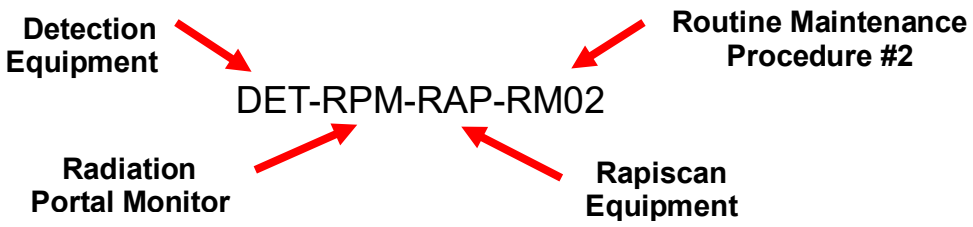
Global Material Security

National Nuclear Security Administration

Routine Maintenance Overview

The maintenance guide contains written procedures for most activities required to maintain a specific set of equipment. Routine maintenance is an essential part of ongoing care and preservation to keep the system functioning at maximum capacity. Routine maintenance procedures follow a consistent format with minor differences specific to the procedure type.

The label of each procedure contains the hierarchy information indicating where to find individual procedures, including equipment type, system, manufacturer, procedure type, and procedure number. The following is an example of the format these procedure labels follow:



D E T - R P M - R A P - R M 0 2

Detection Equipment – Radiation Portal Monitor – Rapiscan Equipment – Routine Maintenance Procedure #2

Routine Maintenance Procedures and Schedule

Rapiscan RPM routine maintenance procedures should be conducted at their respective maintenance frequencies to maximize system functionality, as indicated in the following table.

Identifier	Description	Maintenance Frequency			
		Monthly	Quarterly	Semi-Annual	Annual
DET-RPM-RAP-RM01	Desiccant Replacement	X			
DET-RPM-RAP-RM02	RPM Clean and Inspect		X		
DET-RPM-RAP-RM03	RPM Operational Testing		X		
DET-RPM-RAP-RM04	Battery Load Testing			X	
DET-RPM-RAP-RM05	RPM Functional Compliance Test				X

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Desiccant Inspection and Replacement

DET-RPM-RAP-RM01

Description	Inspect and replace desiccant in Rapiscan radiation portal monitor (RPM).
Equipment Hierarchy	All Rapiscan RPM models
Frequency	Monthly (the frequency of required desiccant replacement will vary from site to site, type and quantity of desiccant and possibly season to season; the recommendation is to start monthly and adjust as necessary)
Skill Level/#	Technician 1 x 1
Tools Required	• Keys to access RPM • Reflective safety vest (if required) • Ladder: 2 meters (6 feet) tall; non-conducting (if required) • Traffic control cones or equivalent (if required) • Safety glasses (if required) • Medium Philips screwdriver • Small Philips screwdriver • Marker for marking the date on desiccant bag
Materials Required	• Desiccant (approximately two 16 oz./0.91 kilograms bags per pillar, depending on local conditions and type of desiccant) • Absorbent cleaning rags • Refuse bag
Expected Duration	5 minutes per pedestrian monitor 10 minutes per vehicle monitor 20 minutes per rail monitor (additional 10 minutes with protective cage)
Safety Concerns	Vehicle traffic
Retest Requirements	None
Final Documentation	Routine maintenance report
Departmental Coordination	Coordinate access with system operators

Originator:	Craig Stinson, Bailey Toon	**Date:**	25 March 2017
Organization:	PNNL	**Version #:**	0
Revision:		**By:**	
Revision:		**By:**	
Approval:	Craig Stinson		

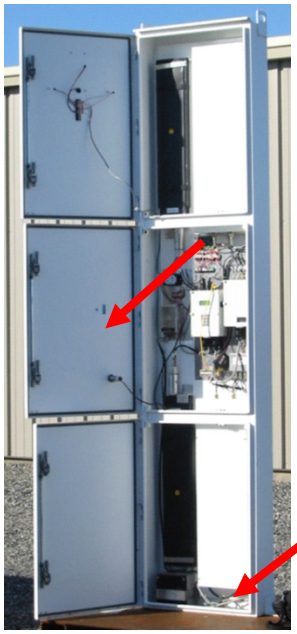
Warning:

- Traffic should temporarily be rerouted or halted during performance of this procedure to ensure maintenance provider safety and to prevent unscreened conveyances from passing.

Caution:

- Place bags away from electrical connections to avoid damage if desiccant leaks. Do not place desiccant bag on top of the neutron detector due to leaking CaCl desiccant bags causing issues in the field. A different location needs to be determined.

Step	Instruction	Remarks
1	**Establish Initial Conditions**	
1-1	Inform system operators upon arrival	
1-2	Brief system operators on expected work, duration, and anticipated alarms and fault indications before starting work	
Warning: Traffic should temporarily be rerouted or halted during conduction of this procedure to ensure maintenance provider safety and to prevent unscreened conveyances from passing.		
1-3	Close lane and set up barriers or establish a safety watch	Use orange safety (traffic control) cones or equivalent per site-specific safety practices.
1-4	Switch off LD-260 and verify green LED is not lit to power off RPM	

Step	Instruction	Remarks
2	**Inspect Desiccant**	
2-1	Inspect existing desiccant bags visually and by feel	 If the bags are only partially depleted, experience will indicate if the bags will last until the next inspection date or if they should be replaced now. Replace it if it feels like slush; it can remain if solid particles are present.
2-2	Document the current date on the existing bag if no replacement is required	
2-3	Inspect interior of RPM cabinets for dirt, debris, and signs of water or rodent/insect infestation	Make note of any problems observed in operator log.
2-4	Clean cabinet interior using absorbent cleaning rags if required	
3	**Replace Desiccant**	
3-1	Remove exhausted desiccant bag(s)	
Caution: Place bags away from electrical connections to avoid damage if desiccant leaks. Do not place desiccant bag on top of the neutron detector due to leaking CaCl desiccant bags causing issues in the field. A different location needs to be determined.		
3-2	Install new desiccant bag(s) in place of removed bag	

Step	Instruction	Remarks
3-3	Properly dispose of exhausted desiccant bag	
3-4	Switch on LD-260 and verify green LED is lit to power on RPM	
4	**Document Maintenance Actions**	
4-1	Inform system operators upon completion of maintenance action	
4-2	Document maintenance performed, times, and results for inclusion in routine maintenance action report	
4-3	Submit routine maintenance report	

RPM Cleaning and Inspection

DET-RPM-RAP-RM02

Description	Cleaning and inspection of Rapiscan radiation portal monitor (RPM).
Equipment Hierarchy	Rapiscan RPM
Frequency	Quarterly
Skill Level/#	Technician 1 x 1
Tools Required	• Keys for RPM • Reflective safety vest (if required) • Safety glasses (if required) • Ladder (if required) • Traffic control cones or equivalent (if required)
Materials Required	• One printed “RPM Cleaning and Inspection Checklist” (per RPM lane) • Gentle detergent spray • Nitrile or latex gloves • Absorbent cleaning rags • Graphite lubricant • Refuse bag
Expected Duration	30 minutes per lane
Retest Requirements	None
Final Documentation	Operation and Maintenance Log (operators) Routine Maintenance Activities Report (LMP) RPM Cleaning and Inspection Checklist
Departmental Coordination	Coordinate site access with radiation detection system operators

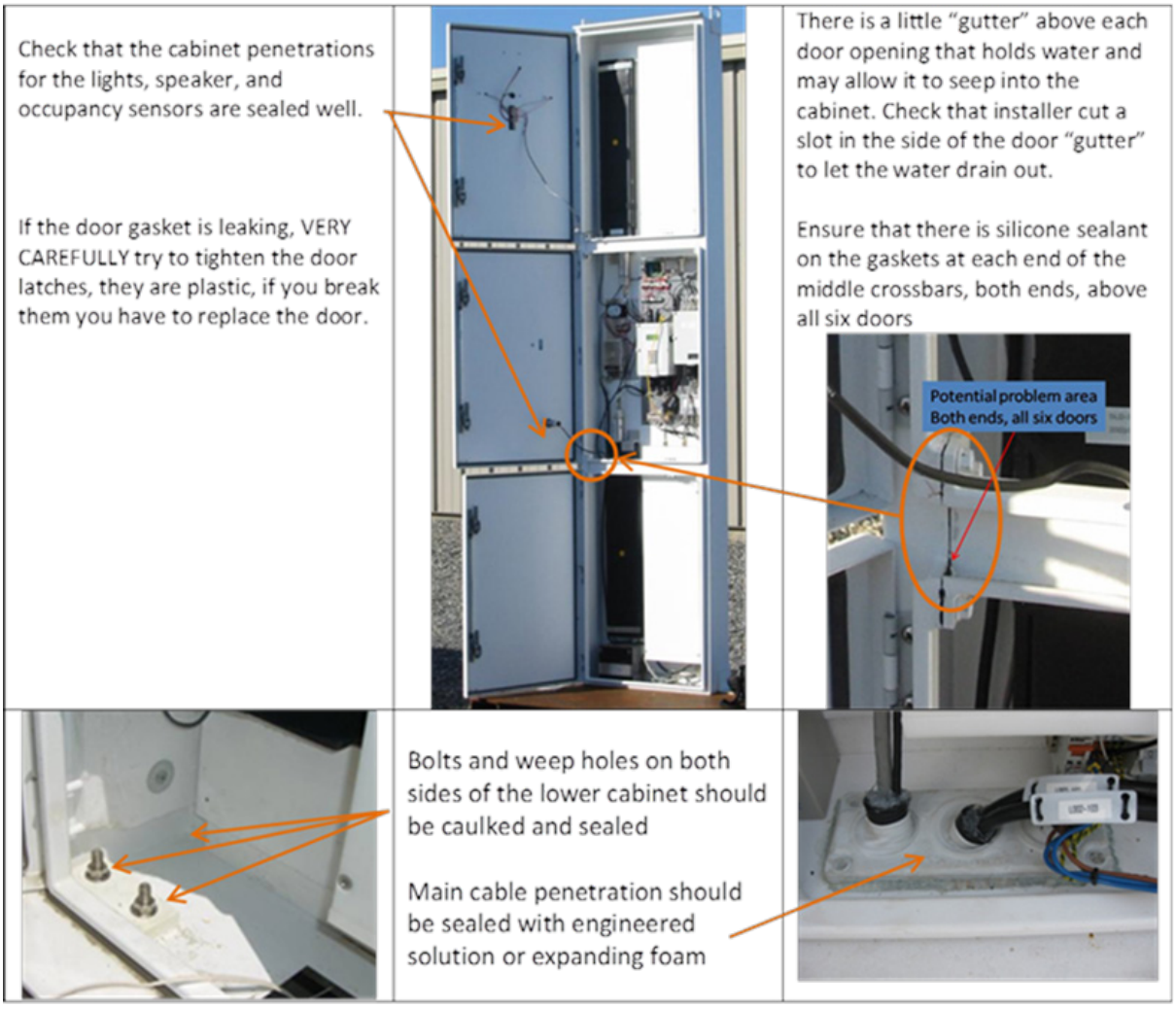
Originator:	Craig Stinson	**Date:**	15 February 2019
Organization:	NSDD	**Version #:**	
Revision:		**By:**	
Revision:		**By:**	
Approval:	Craig Stinson		

Warning:

- Vehicle, and/or pedestrian traffic should be temporarily rerouted during conduct of this procedure to ensure maintenance personnel safety and prevent unscreened conveyances from passing through checkpoint.
- If standing water is present in the RPM cabinet interior, implement required site-specific electrical safety procedures, if required.

Step	Instruction	Remarks
1	**Establish initial conditions**	
1-1	Brief operators on expected work, duration, anticipated fault indicators, and arrange lane closures before starting work	Alarms/faults: Operators should expect to receive tamper (TT) fault indications upon cabinet opening.
Warning: Vehicle, and/or pedestrian traffic should temporarily be rerouted or halted during conduct of this procedure to ensure maintenance operator safety and prevent unscreened conveyances from passing through checkpoint.		
1-2	Close lane and set up barriers	Use orange safety cones or equivalent based on site-specific safety practices.
Note: Perform and document each step in this procedure on a Rapiscan RPM Cleaning and Inspection Checklist.		
All discrepancies noted during the performance of this procedure should be corrected immediately, if possible, and documented fully on the RPM Cleaning and Inspection Checklist and routine maintenance report.		
2	**Clean and inspect RPM cabinet exterior**	
2-1	Inspect exterior for dents, scratches, rust, and bare metal	
Note: If rust or bare metal is found, take corrective action. See SLD_Technical Service Bulletin - Painting RPM Cabinets for Corrosion (2015-02-20).		
2-2	Lubricate hinges and keyholes	Use of a dry graphite lubricant is recommended.
2-3	Inspect RPM and pedestal bolts and flanges	If loose, tighten the bolts and flanges.
3	**Clean and inspect RPM cabinet interior**	
Warning: If standing water is present in the RPM cabinet interior, implement site-specific electrical safety procedures, if required.		
3-1	Inspect interior of RPM cabinets for dirt, debris, and signs of water	
3-2	Inspect for cables and wires in neat condition and tied down	
3-3	Inspect desiccant and replace if required	Per DET-RPM-RAP-RM01.
3-4	Inspect battery, cables, and connectors for corrosion and damage	Check for swelling of the battery case and corrosion of battery connections; correct if these conditions exist.

Step	Instruction	Remarks
4	**Inspect RPM cabinet for moisture intrusion**	
4-1	Inspect RPM penetrations for integrity and moisture intrusion such as localized rust	See image below.
4-2	Inspect RPM door seals for leakage	Localized deposit of dust on the inner side of the RPM door is indicative of a loose door or damaged seal.
4-3	Inspect RPM internal surfaces and components for signs of rust and/or mildew	
5	**Return RPM to operational status and document maintenance actions**	
5-1	Close doors and lock cabinets	
5-2	Dispose of waste materials	
5-3	Verify RPM is communicating with central alarm station and that all faults are clear	
5-4	Inform operators that maintenance is complete and RPM is operational	Request that operators record maintenance actions and times in log.
5-5	Document maintenance actions	Document maintenance performed, times, and results for inclusion in the Routine Maintenance Report.



Panel 1

Check that the cabinet penetrations for the lights, speaker, and occupancy sensors are sealed well.

If the door gasket is leaking, VERY CAREFULLY try to tighten the door latches, they are plastic, if you break them you have to replace the door.

Panel 2

Bolts and weep holes on both sides of the lower cabinet should be caulked and sealed.

Main cable penetration should be sealed with engineered solution or expanding foam.

Panel 3

There is a little gutter above each door opening that holds water and may allow it to seep into the cabinet. Check that installer cut a slot in the side of the door gutter to let the water drain out.

Ensure that there is silicone sealant on the gaskets at each end of the middle crossbars, both ends, above all six doors.

Potential problem area. Both ends, all six doors.

RPM Cleaning and Inspection Checklist

Description	Clean and inspect Rapiscan radiation portal monitors

Country:	Date:	Time (am/pm):
Site	Lane Name	
RPM Serial Number:	Temperature:	°C/°F (circle one)

Step	Explanation	Results
2	**Clean and Inspect RPM Cabinet Exterior**	
2-1	Inspect and clean cabinet exterior surfaces and perform rust mitigation as required	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Notes: _____
2-2	Lubricate hinges and keyholes	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
2-3	Inspect and tighten RPM and pedestal bolts and flanges as necessary	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
3	**Clean and Inspect RPM Cabinet Interior**	
3-1	Inspect and ensure interior of RPM cabinets are free of dirt, debris, and signs of moisture	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
3-2	Inspect for cables and wires in neat condition and tied down	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
3-3	Inspect desiccant and replace if required	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
3-4	Inspect battery, cables, and connectors for corrosion and damage	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
4	**Inspect RPM Cabinet for Moisture Intrusion**	
4-1	Inspect RPM penetrations for integrity and moisture intrusion such as localized rust	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____

Step	Explanation	Results
4-2	Inspect RPM door seals for leakage	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
4-3	Inspect RPM internal surfaces and components for signs of rust and/or mildew	Condition: 1 2 3 4 5 (circle one) (1-5 scale = 1 poor to 5 excellent) Note: _____
5	**Return RPM to Operational Status and Document Maintenance Actions**	
5-4	System operators notified upon completion?	Yes/No (Circle one)
5-5	Maintenance actions properly documented?	Yes/No (Circle one)
Maintenance Provider Signature: _____		Date: _____

Rapiscan RPM Operational Testing

DET-RPM-RAP-RM03

Description	Operational testing of Rapiscan radiation portal monitor (RPM)
Equipment Hierarchy	All Rapiscan RPM models
Frequency	Quarterly As retest procedure for corrective maintenance (as applicable)
Skill Level/#	Technician 1 x 1
Tools Required	• Keys to access RPM • Reflective safety vest (if required) • Traffic control cones or equivalent (if required) • Magnet
Materials Required	NSDD Radioactive Check Source Suite
Expected Duration	10 minutes
Safety Concerns	Radioactive source; vehicle traffic
Retest Requirements	None
Final Documentation	Routine Maintenance Report with Operational Checklist
Departmental Coordination	Coordinate site access with system operators

Originator:	Craig Stinson; Bailey Toon	**Date:**	November 30, 2020
Organization:	PNNL	**Version #:**	1
Revision:	Updated pillar names	**By:**	Angela Moore
Approval:	Craig Stinson		

Warning: Traffic should temporarily be rerouted or halted during conduction of this procedure to ensure maintenance provider safety and to prevent unscreened conveyances from passing.

Step	Instruction	Remarks
1	**Establish Initial Conditions**	
1-1	Inform system operators upon arrival	Operators should expect to receive fault and alarm indications during performance of this procedure.
Note: Document each step and verification on attached checklist.		
1-2	Inspect for any physical damage or rodent/insect infestation	
Warning: Traffic should temporarily be rerouted or halted during conduction of this procedure to ensure maintenance provider safety and to prevent unscreened conveyances from passing.		
1-3	Close lane and set up barriers or establish a safety watch	Use orange safety (traffic control) cones or equivalent per site-specific safety practices.
1-4	Switch on LD-260 and verify green LED is lit to power on RPM	
1-5	Disable RPM occupancy sensors	"Relays" Parameter in SC-770 controller must be set to "ON." Audible siren may be disabled per system operator's directive.
2	**Test Gamma Radiation Detection**	
2-1	Initiate and maintain occupancy by interrupting beam of occupancy sensor	
2-2	Hold Cs-137 source, Co-57 source, or both near front of either gamma detector	
2-3	Verify red strobe and audible indications function.	1. On SC-770 controller 2. On the control pillar door 3. On external alarm box (if installed) 4. In CAS
Note: Move the source at least 10m from the detectors.		
2-4	Remove Cs-137 source, Co-57 source, or both from detector	
2-5	Wait at least 30 seconds for background average to stabilize	
2-6	Initiate a gamma hi background fault by holding Cs-137 source, Co-57 source, or both near front of either gamma detector but do **not** initiate an occupancy	

Step	Instruction	Remarks
2-7	Verify amber fault LED indication functions	1. On SC-770 controller 2. On the control pillar door 3. On external alarm box (if installed) 4. In CAS
Note: Move the source at least 10m from the detectors.		
2-8	Remove Cs-137 source, Co-57 source, or both from detector	
2-9	Wait at least 30 seconds for background average to stabilize	
Note: Occupancy sensors must be disabled during testing of fault indications.		
2-10	Disconnect BNC signal cable from any gamma detector to initiate a gamma lo background fault	This can be done on the detector itself or at the SCA-775 box.
2-11	Verify amber fault LED indication functions	1. On SC-770 controller 2. On the control pillar door 3. On external alarm box (if installed) 4. In CAS
2-12	Wait at least 30 seconds for background average to stabilize	
2-13	Reconnect BNC signal cable from step 2-10	
3	**Test Neutron Radiation Detection**	
Note: Because CF-252 sources also emit gamma radiation, a gamma alarm may also occur during this step. If this is unacceptable, either shield the gamma radiation emitted from the source with lead or hold the Cf-252 source near a neutron detector from behind the skid. The lead (Pb) shielding on the back of gamma detectors will help reduce the possibility of a gamma alarm during this step.		
3-1	Initiate and maintain occupancy by interrupting beam of occupancy sensor	
3-2	Hold Cf-252 source near front of neutron detector	
3-3	Verify blue strobe and audible indication functions	1. On SC-770 controller 2. On the control pillar door 3. On external alarm box (if installed) 4. In CAS

Step	Instruction	Remarks
Note: Move the source at least 10m from the detectors.		
3-4	Remove Cf-252 source from detector	
3-5	Wait at least 2 minutes for background average to stabilize	
Note: A gamma hi fault may also occur during this step. If this is unacceptable, either shield the gamma radiation from the source, or try holding the source behind the monitor.		
3-6	Initiate a neutron hi background fault by holding Cf-252 source near front of either neutron detector but do **not** initiate occupancy	
3-7	Verify amber fault indication functions	1. On SC-770 controller 2. on the control pillar door 3. on external alarm box (if installed) 4. in CAS
Note: Move the source at least 10 m from the detectors.		
3-8	Remove Cf-252 source from detector	
4	**Test Tamper Fault Circuitry**	
4-1	Disconnect the AC power supplied to the portal monitor to initiate a “Loss of AC” tamper fault	1. If RPM breaker in associated utility panel is marked: Open the RPMs dedicated breaker inside its associated utility panel. 2. If RPM breaker in associated utility panel is NOT marked: Open the bottom door of the control pillar, use a magnet to defeat the tamper switch and open the AC breaker in the pillar.
4-2	Verify amber fault LED fault indication functions	1. On SC-770 controller 2. On the control pillar door 3. On external alarm box (if installed) 4. In CAS
4-3	Re-energize RPM, remove magnet from door switch, close cabinet door, and allow time for tamper fault to clear	
4-4	Initiate a cabinet open tamper fault	
4-5	Verify amber fault LED fault indication functions	1. On SC-770 controller 2. On the control pillar door 3. On external alarm box (if installed) in CAS

Step	Instruction	Remarks
5	**Document Maintenance Actions**	
5-1	Inform system operators upon completion of maintenance tasks	Assist operator to close out of all operational testing alarms that have been generated in the CAS.
5-2	Document maintenance performed, times, and results for inclusion in routine maintenance report	
5-3	Submit routine maintenance report	Attach electronic copy of Operational Test Checklist to the routine maintenance report.

Rapiscan RPM Operational Testing Checklist

Country:		Date:	
Site Name:		Time (am/pm):	
Lane Name:		Temperature:	°C/°F (circle one)
RPM Model:		RPM Serial Number:	
Step	**Explanation**	**Results**	
1-1	Inspect RPM for physical damage or pest infestation	*Condition:* 1 2 3 4 5 *(circle one)* *(1-5 scale = 1 poor to 5 excellent)* *Notes (damage/rust/moisture):* _____	
2-1 to 2-3	Initiate a gamma alarm and verify that the red strobe and audible indication are functioning properly	Red strobe on control pillar activated? Yes/No (circle one) Audible Alarm on control pillar activated? Yes/No (circle one) Alarm indicated in CAS? Yes/No (circle one) Alarm indicated on SC-770? Yes/No (circle one) Alarm Indicated on External Alarm Box? Yes/No (circle one) Note any deviations: _____	
2-6 to 2-7	Initiate a gamma hi background fault	Amber LED on control pillar activated? Yes/No (circle one) Fault indicated in CAS? Yes/No (circle one) Fault indicated on SC-770? Yes/No (circle one) Fault Indicated on External Alarm Box? Yes/No (circle one) Note any deviations: _____	
2-10 to 2-11	Initiate a gamma lo background fault	Amber LED on control pillar activated? Yes/No (circle one) Fault indicated in CAS? Yes/No (circle one) Fault indicated on SC-770? Yes/No (circle one) Fault Indicated on External Alarm Box? Yes/No (circle one) Note any deviations: _____	

3-1 to 3-3	Initiate a neutron alarm and verify that the blue strobe and audible indication are functioning properly	Blue strobe on control pillar activated? Yes/No (circle one) Audible Alarm on control pillar activated? Yes/No (circle one) Alarm indicated in CAS? Yes/No (circle one) Alarm indicated on SC-770? Yes/No (circle one) Alarm Indicated on External Alarm Box? Yes/No (circle one) Note any deviations: _____
3-6 to 3-7	Initiate a neutron hi background fault	Amber LED on control pillar activated? Yes/No (circle one) Fault indicated in CAS? Yes/No (circle one) Fault indicated on SC-770? Yes/No (circle one) Fault Indicated on External Alarm Box? Yes/No (circle one) Note any deviations: _____
4-1 to 4-2	Initiate “Loss of AC” tamper fault	Amber LED on control pillar activated?
4-4 to 4-5	Initiate “cabinet open” tamper fault	Amber LED on control pillar activated? Yes/No (circle one) Fault indicated in CAS? Yes/No (circle one) Fault indicated on SC-770? Yes/No (circle one) Fault Indicated on External Alarm Box? Yes/No (circle one) Note any deviations: _____
Maintenance Provider Signature: _____		*Date:* _____

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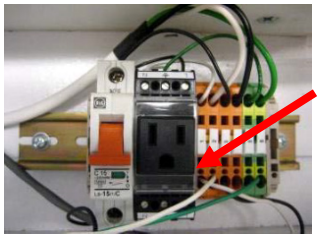
+12 VDC Battery Load Test

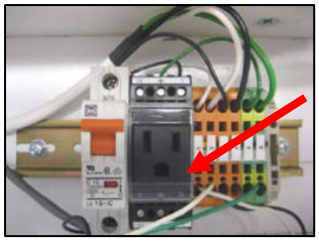
DET-RPM-RAP-RM04

Description	Perform +12 volts direct current (VDC) battery load test.
Equipment Hierarchy	All Rapiscan radiation portal monitor (RPM) models
Frequency	Semi annual
Skill Level/#	Technician 2 x 1
Tools Required	• Keys for RPM • Reflective safety vest (if applicable) • Safety glasses (if applicable) • Traffic control cones or equivalent • Digital multimeter (DMM)
Materials Required	Applicable TSA Operations and Service Manuals
Expected Duration	80 minutes
Safety Concerns	electrical
Retest Requirements	None
Final Documentation	Routine maintenance report
Departmental Coordination	Coordinate site access with system operators

Originator:	Craig Stinson; Bailey Toon	**Date:**	25 March 2017
Organization:	PNNL	**Version #:**	0
Revision:		**By:**	
Revision:		**By:**	
Approval:			

Warning: 120/220 Vac [alternating current] will be present at the input side of the ac circuit breaker.

Step	Instruction	Remarks
1	**Establish Initial Conditions**	
1-1	Inform system operators upon arrival	
1-2	Brief system operators on expected work and duration before starting work	
1-3	Close lane and set up barriers to establish a safety watch	Use orange safety (traffic control) cones or equivalent per site-specific safety practices.
2	**Perform +12 VDC Battery Load Test**	
2-1	Unlock and open RPM cabinets doors as required to access cabinet interior	
2-2	Switch OFF LD-260 and verify green LED is not lit to power off RPM	
Warning: 120/220 Vac will be present at the input side of the ac circuit breaker.		
2-3	Switch ac power off so green window is visible	
2-4	Switch ON LD-260 and verify green LED is lit to power on RPM	Amber “ac” light on LD-260 should not be illuminated.
2-5	Wait for system to perform self-test followed by background radiation measurement	If the RPM cannot start, replace the battery by performing procedure DET-RPM-RAP-CM28.
Standard: Using a DMM, the battery voltage should be approximatly 12 to 13 VDC.		
2-6	Measure and record battery voltage	
2-7	Wait approximately 1 hour	

Step	Instruction	Remarks
Standard: Using a DMM, the battery voltage should be approximatly 12 to 13 VDC.		
2-8	Re-measure battery voltage	If the battery voltage is less than 11 VDC, replace the battery by performing procedure DET-RPM-RAP-CM28.
2-9	Switch ac power on so red window is visible	 Amber “ac” light on LD-260 should illuminate.
2-10	Close and lock RPM cabinets	
3	**Return to Normal Operating Condition**	
3-1	Verify communication has been established with central alarm station	Contact system operators and verify RPM is “online” in central alarm station.
3-2	Close, reopen, and close cabinet doors to clear all tampers from fault queue	
3-3	Open lane	
4	**Document Maintenance Actions**	
4-1	Inform system operators upon completion of maintenance tasks	
4-2	Document maintenance performed, times, and results for inclusion in routine maintenance report	
4-3	Submit routine maintenance report	

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RPM Functional Compliance Test

DET-RPM-RAP-RM05

Description	Perform functional compliance testing of radiation portal monitor (RPM)
Equipment Hierarchy	All Rapiscan RPM models
Frequency	Annually As specified by corrective maintenance retest requirements Following guidance from the Nuclear Smuggling Detection and Deterrence (NSDD) Program
Skill Level/x	Technician 1 x 1, Technician 2 x 1
Tools Required	• Keys to access RPM • Reflective safety vest (if required) • Safety glasses • Ladder; 2 meters (6 feet) tall; non-conducting (if required) • Traffic control cones or equivalent (if required) • Source-holding device (~1.5 m long extending rod or pole) • Flashlight/headlight (recommended) • Laptop computer with current baselined functional compliance test (FCT) datasheet
Materials Required	• SC-770 parameter settings for each RPM at the site **Note*:*** The correct SC-770 parameters are stored in the Los Alamos National Laboratory (LANL) configuration management database and can be found by contacting the NSDD Help Desk or partner country maintenance manager. • Radioactive check sources o Co-57 activity 19 – 400kBq (0.5 – 10.8µCi) o Cf-252 activity 37 – 185kBq (1 – 5µCi) (2,000 – 20,000 n/s) • Vehicle and Pedestrian Monitor VM-250AGN/PM-700AGN Operations & Service Manual
Expected Duration	30 minutes per RPM
Safety Concerns	Electrical and radioactive source
Retest Requirements	DET-RPM-RAP-RM03 *RPM Operational Testing*
Final Documentation	Completed FCT datasheet Routine maintenance report
Departmental Coordination	Coordinate site access with system operators

Originator:	Craig Stinson, Bailey Toon, Brian Tucker	**Date:**	November 30, 2020
Organization:	PNNL	**Version #:**	1
Revision:	Updated pillar names	**By:**	Angela Moore
Approval:	Jamie Hughes		

Warnings:

- Traffic should temporarily be rerouted or halted during conduction of this procedure to ensure maintenance provider safety and prevent unscreened conveyances from passing.
- 12 volts direct current (Vdc) will still be present on the battery and the input to the LD-260 Load Disconnect.
- Do not hold the neutron source on the detector face with your hand or stand near the detector during this step.

Cautions:

- Make sure to press the release button on back of Ethernet cable before removing.
- Each SC-770 parameter must match the values obtained from the LANL configuration management database.
- Keep gamma detectors protected from direct sunlight.
- It is critical that the RPM be returned to the proper operational configuration before performing RPM alarm checks.

Step	Instruction	Remarks
Note: Step 1 (1 through 1-4) should be performed before traveling to the RPMs.		
1	**Prepare RPM Specific FCT Datasheet**	
1-1	Open most recent baselined FCT datasheet on laptop	
1-2	Save file with unique name (add today's date) and close master copy	An example of a unique file name is **US_PortofEntry_FCT_Lane1_05132016.**
Note: Date of procedure in FCT datasheet is extremely important for correct radioactive source activity and detector efficiency calculations.		
1-3	Enter date of procedure performance in appropriate cell	
1-4	Enter RPM identification information	Complete the General Information section to specifically identify the RPM (see following image).

Step	Instruction	Remarks

TSA Functional Compliance Testing Data Sheet Rev 1.9 (2015-01): Vehicle

General Information

Country		Date as mm/dd/yyyy	
Program (Core/MP/Maintenance)		Monitor Location	
Site Location		IP Address	
SLD Configured Lane Name			
Displayed Lane Name		Subnet Mask	
Manufacturer	TSA Systems/Rapiscan	Serial Number	
Monitor Type	Vehicle	Firmware version	
He3 Tube count(Normal-8, Removed-4)	4	Altitude (m)	
Portal Height (m)		Latitude Coordinate	
Monitor Spacing (m)		Longitude Coordinate	
Cabinet Type			
Other Modifications	☐ Collimator ☐ Dead-time Card	☐ Discrete ☐ Enclosed ☐ Ferrite Core #	
Additional Description			

2 **Verify Gamma Radioactive Source is Sufficient for FCT**

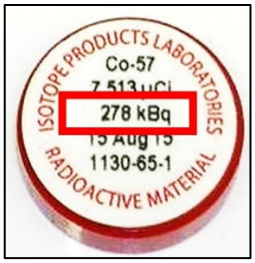
2-1 Enter Co-57 source identification number

Source information is commonly listed directly on the label of the radioactive source; however, this may also be obtained from the Certificate of Calibration that is provided with all radioactive sources.

Source Information

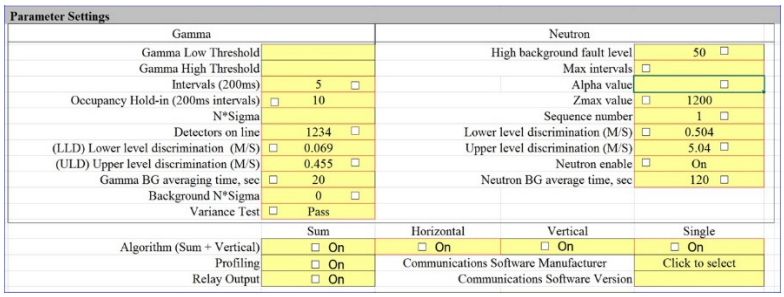
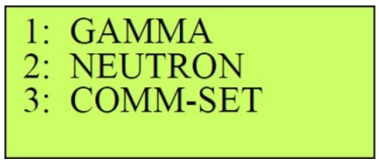
	Gamma Co-57	Neutron Cf-252
Source Identification Number	1130-65-1	
Initial Activity in KBq	278.0	170.0
Initial Activity, neutron/second	N/A	20058
Source calibration date (mm/dd/yyyy)	8/15/2015	4/8/2016
Expiration Date	7/1/2018	1/24/2025
Days since source calibration	309	72
Years since source calibration	0.85	0.20
Current Activity (KBq for gamma)	**126.4**	**19048**

Gamma and neutron check source activities have a significant impact on the results obtained during RPM functional testing. Entering accurate source information into the datasheet is crucial to successful completion of this procedure.

Step	Instruction	Remarks
2-2	Enter Co-57 initial activity in kBq (as listed on source label or source certificate)	 **Source Information** Gamma Co-57 / Neutron Cf-252 Initial Activity in KBq: 278.0 / 170.0 Initial Activity, neutron/second: N/A / 20058 Source calibration date (mm/dd/yyyy): 8/15/2015 / 4/8/2016 Expiration Date: 7/1/2018 / 1/24/2025 Days since source calibration: 309 / 72 Years since source calibration: 0.85 / 0.20 **Current Activity (KBq for gamma): 126.4 / 19048**
2-3	Enter Co-57 source calibration date	 **Source Information** Gamma Co-57 / Neutron Cf-252 Source Identification Number: 1130-65-1 Initial Activity in KBq: 278.0 / 170.0 Initial Activity, neutron/second: N/A / 20058 Source calibration date (mm/dd/yyyy): 8/15/2015 / 4/8/2016 Expiration Date: 7/1/2018 / 1/24/2025 Days since source calibration: 309 / 72 Years since source calibration: 0.85 / 0.20 **Current Activity (KBq for gamma): 126.4 / 19048**
Standard: Current Co-57 source activity must be between 19 and 400 kBq to perform this procedure.		
2-4	Verify Co-57 calculated current activity is within specified limits	**Source Information** Gamma Co-57 / Neutron Cf-252 Source Identification Number: 1130-65-1 Initial Activity in KBq: 278.0 / 170.0 Initial Activity, neutron/second: N/A / 20058 Source calibration date (mm/dd/yyyy): 8/15/2015 / 4/8/2016 Expiration Date: 7/1/2018 / 1/24/2025 Days since source calibration: 309 / 72 Years since source calibration: 0.85 / 0.20 **Current Activity (KBq for gamma): 126.4 / 19048**

Step	Instruction	Remarks
3	**Verify Neutron Radioactive Source is Sufficient for FCT**	
3-1	Enter Cf-252 source identification number	Source information is common listed directly on the label of the radioactive source; however, this may also be obtained from the Certificate of Calibration that is provided with all radioactive sources. **Source Information** Source Identification Number: Gamma Co-57 = 1130-65-1; Neutron Cf-252 = IG-88 Initial Activity in KBq: 278.0; 170.0 (KBq) Initial Activity, neutron/second: N/A; 20058 n/sec Source calibration date (mm/dd/yyyy): 8/15/2015; 4/8/2016 Expiration Date: 7/1/2018; 1/24/2025 Days since source calibration: 309; 72 Years since source calibration: 0.85; 0.20 **Current Activity (KBq for gamma)**: **126.4**; **19048** n/sec Gamma and neutron check source activities have a significant impact on the results obtained during RPM functional testing. Entering accurate source information into the datasheet is crucial to successful completion of this procedure.
3-2	Enter Cf-252 source activity in kBq (as listed on source label or source certificate)	**Source Information** Source Identification Number: Gamma Co-57 = 1130-65-1; Neutron Cf-252 = IG-88 Initial Activity in KBq: 278.0; 170.0 (KBq) Initial Activity, neutron/second: N/A; 20058 n/sec Source calibration date (mm/dd/yyyy): 8/15/2015; 4/8/2016 Expiration Date: 7/1/2018; 1/24/2025 Days since source calibration: 309; 72 Years since source calibration: 0.85; 0.20 **Current Activity (KBq for gamma)**: **126.4**; **19048** n/sec **Note**: The neutron activity is converted to neutrons per second (n/s or n/sec), which is another common measure of neutron activity.
3-3	Enter Cf-252 source calibration date	**Source Information** Source Identification Number: Gamma Co-57 = 1130-65-1; Neutron Cf-252 = IG-88 Initial Activity in KBq: 278.0; 170.0 (KBq) Initial Activity, neutron/second: N/A; 20058 n/sec Source calibration date (mm/dd/yyyy): 8/15/2015; 4/8/2016 Expiration Date: 7/1/2018; 1/24/2025 Days since source calibration: 309; 72 Years since source calibration: 0.85; 0.20 **Current Activity (KBq for gamma)**: **126.4**; **19048** n/sec
Standard: Current Cf-252 source activity must be between 37 and 185 kBq to perform this procedure.		
3-4	Verify Cf-252 calculated current activity is within specified limits	Current Cf-252 source activity must be between 2,000 and 20,000 n/s to perform this procedure. **Source Information** Source Identification Number: Gamma Co-57 = 1130-65-1; Neutron Cf-252 = IG-88 Initial Activity in KBq: 278.0; 170.0 (KBq) Initial Activity, neutron/second: N/A; 20058 n/sec Source calibration date (mm/dd/yyyy): 8/15/2015; 4/8/2016 Expiration Date: 7/1/2018; 1/24/2025 Days since source calibration: 309; 72 Years since source calibration: 0.85; 0.20 **Current Activity (KBq for gamma)**: **126.4**; **19048** n/sec

Step	Instruction	Remarks
4	**Establish Initial Conditions**	
4-1	Inform system operators upon arrival	
4-2	Brief system operators on expected work, duration, anticipated alarms, and fault indications before starting work	Operators should expect numerous fault indications and alarms during procedure.
Warning: Traffic should temporarily be rerouted or halted during conduction of this procedure to ensure maintenance provider safety and prevent unscreened conveyances from passing.		
4-3	Close lane and set up barriers or establish a safety watch	Use orange safety (traffic control) cones or equivalent per site-specific safety practices.
Caution: Make sure to press release button on back of Ethernet cable before removing.		
4-4	Disconnect Ethernet connector from top of RPM SC-770 controller	
4-5	Disable occupancy sensor	For vehicle monitor, disconnect both break-beam sensor receivers (usually*) located in the control pillar, and then disconnect 12 Vdc to the ultrasonic sensor in the auxiliary pillar. For pedestrian monitor, place a piece of black tape over sensor of infrared curtain (SPY-2), or simply stand clear of occupancy sensor when door is opened. Disabling the sensors will prevent the RPM from sensing an occupied condition and going into fast-count mode when the RPM doors are opened or a maintenance technician is working in and around the pillars. *In some installations, break-beam sensor receivers have been moved to the auxiliary pillar. It is important that receivers be disconnected; if the transmitters are disconnected a constant state of occupancy will result.
5	**Verify Parameter Settings are Correct**	
5-1	Switch ON LD-260 and verify green LED is lit to power on RPM	
5-2	Wait for system to perform self-test followed by background radiation measurement	

Step	Instruction	Remarks
Caution: Each SC-770 parameter must match the values obtained from the LANL configuration management database.		
5-3	Record SC-770 parameter values	Enter Program Mode by pressing “0.” Enter the password **1234** and press “#” (enter). Navigation of parameter settings can be found in the Vehicle and Pedestrian Monitor VM-250AGN/PM-700AGN Operations & Service Manual.  If parameter settings do not match currently approved settings from LANL database, set to match.
5-4	Manually enter variable values	Variable values include parameters such as N*Sigma and Alpha value.
5-5	Click the check box to confirm fixed values	
5-6	Return to SC-770 main menu	Press “#” button until the SC-770 displays the main menu. 
6	**Perform Gamma Detector Efficiency Measurements**	
Caution: Keep gamma detectors protected from direct sunlight.		
Note: Verify there are no radiation sources within 20 meters of the RPM while gathering gamma and neutron background count rate data.		
6-1	Navigate SC-770 to SHOW COUNTS for gamma detectors	From SC-770 main programming menu, press 1: GAMMA 2: FUNCTIONS 1: SHOW COUNTS

Step	Instruction	Remarks
6-2	Record measured gamma background count rate for each gamma detector	Stand clear of all gamma detectors, watch displayed count rate for each channel on SC-770, record average background count rate for each channel in correct cells on FCT datasheet.

Sensitivity Measurements		Temperature
☐ Used Dead-Time & Efficiency Assist		
Gamma Detector Data	Measured Background Count Rate	Source Count Rate (Co-57)
Master Lower (1)		
Master Upper (2)		
Slave Lower (3)		
Slave Upper (4)		
Sum	0	
Background Suppression	10%	Assumed

Standard: Due to the low energy of Co-57 gammas, the count rate on either side of the source may vary. Always use the label side for consistency in data acquisition.

Note: Verify distance between source and detector is minimized to warrant accurate efficiency measurements.

6-3	Place label side of Co-57 gamma source against yellow dot at center of detector	The source must be held firmly against the detector with a low-density tool such as a wooden dowel or pencil.

Note: Verify that there are no additional radiation sources within 20 meters of the RPM while gathering gamma and neutron radiation count rate data.

6-4	Record gamma count rate in appropriate “Source Count Rate (Co-57)” cell	Stand clear of all gamma detectors, watch displayed count rate for each channel on SC-770, record average Co-57 count rate for each channel in correct cells on FCT datasheet.

Sensitivity Measurements		Temperature
☐ Used Dead-Time & Efficiency Assist		
Gamma Detector Data	Measured Background Count Rate	Source Count Rate (Co-57)
Master Lower (1)	1113	
Master Upper (2)	1084	
Slave Lower (3)	1236	
Slave Upper (4)	1588	
Sum	5021	
Background Suppression	10%	Assumed

6-5	Repeat for each gamma detector in RPM	

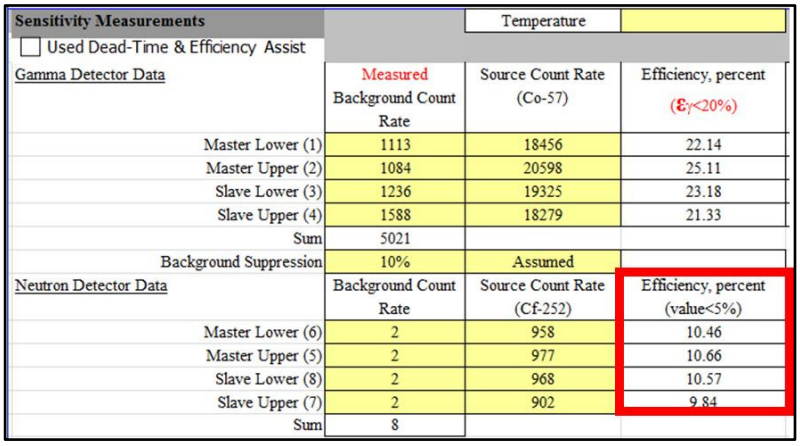
Step	Instruction	Remarks
Standard: Gamma detector efficiency should be greater than 20%.		
6-6	Verify gamma detector efficiency	**Sensitivity Measurements** ☐ Used Dead-Time & Efficiency Assist Temperature Gamma Detector Data / Measured Background Count Rate / Source Count Rate (Co-57) / Efficiency, percent (ε_γ<20%) Master Lower (1): 1113 / 18456 / 22.14 Master Upper (2): 1084 / 20598 / 25.11 Slave Lower (3): 1236 / 19325 / 23.18 Slave Upper (4): 1588 / 18279 / 21.33 Sum: 5021 Background Suppression: 10% / Assumed
6-7	Go to SC-770 main menu	Press "#" button until the SC-770 displays the main menu. 1: GAMMA 2: NEUTRON 3: COMM-SET
7	**Perform Neutron Detector Efficiency Measurements**	
7-1	Enter "fixed" neutron background count rate for each neutron detector	Record 1 counts per second (cps) for each neutron tube installed on each channel. • Rail monitor (RM) (4 tubes per detector) = 4 cps • Vehicle monitor (VM)/pedestrian monitor (PM) (2 tubes per detector) = 2 cps • VM/PM (1 tube per detector) = 1 cps **Sensitivity Measurements** ☐ Used Dead-Time & Efficiency Assist Temperature Gamma Detector Data / Measured Background Count Rate / Source Count Rate (Co-57) Master Lower (1): 1113 / 18456 Master Upper (2): 1084 / 20598 Slave Lower (3): 1236 / 19325 Slave Upper (4): 1588 / 18279 Sum: 5021 Background Suppression: 10% / Assumed Neutron Detector Data / Background Count Rate / Source Count Rate (Cf-252) Master Lower (6): 2 / 958 Master Upper (5): 2 / 977 Slave Lower (8): 2 / 968 Slave Upper (7): 2 / 902 Sum: 8
7-2	Navigate SC-770 to SHOW COUNTS for neutron detectors	From SC-770 main programming menu, press 2: NEUTRON 2: FUNCTIONS 1: SHOW COUNTS

Step	Instruction	Remarks
Warning(s): Do not hold the neutron source on the detector face with your hand or stand near the detector during this step.		
Notes: • During the neutron detector efficiency tests, verify no one is near the neutron detectors as this will artificially raise the neutron count. • Ensure distance between source and detector is minimized for accurate efficiency measurements.		
7-3	Place Cf-252 neutron source against yellow dot on center of detector	It is acceptable to use adhesive tape for this step.
Note: Ensure that there are no additional radiation sources within 20 meters of the RPM while gathering gamma and neutron radiation count rate data.		
7-4	Record neutron count rate in appropriate “Source Count Rate (Cf-252)” cell	Stand clear of all neutron detectors, watch displayed count rate for each channel on SC-770, record average Cf-252 count rate for each channel in correct cells on FCT datasheet.
7-5	Repeat for all neutron detectors in RPM	

Sensitivity Measurements | Temperature

☐ Used Dead-Time & Efficiency Assist

Gamma Detector Data	Measured Background Count Rate	Source Count Rate (Co-57)
Master Lower (1)	1113	18456
Master Upper (2)	1084	20598
Slave Lower (3)	1236	19325
Slave Upper (4)	1588	18279
Sum	5021	
Background Suppression	10%	Assumed
Neutron Detector Data	**Background Count Rate**	**Source Count Rate (Cf-252)**
Master Lower (6)	2	
Master Upper (5)	2	
Slave Lower (8)	2	
Slave Upper (7)	2	
Sum	8	

Step	Instruction	Remarks
Standard: Neutron detector efficiency should be greater than 5% (VM with 2 helium tubes per detector) or 3.5% (VM with 1 helium tube per detector).		
7-6	Verify neutron detector efficiency	
8	**Return Equipment to Normal Operating Condition**	
8-1	Exit SC-770 programming mode	Press "#" until SC-770 exits programming mode and returns to normal operating mode.
8-2	Reconnect Ethernet cable at top of SC-770 module	Ethernet connector will audibly "click" when the connector is seated properly.
Caution: It is critical that the RPM be returned to the proper operational configuration prior to performing RPM alarm checks.		
8-3	Perform RPM Operational Test and document results	Perform procedure DET-RPM-RAP-RM03 RPM Operational Testing. Verify all faults and alarms indicate properly at the RPM if personnel and communication with the CAS are available. Verify the faults and alarms are displayed on the CAS workstation at this time as well. Place a check in each box on the FCT to indicate that each fault and alarm was successful (image below).

Sensitivity Measurements — Temperature

☐ Used Dead-Time & Efficiency Assist

Gamma Detector Data	Measured Background Count Rate	Source Count Rate (Co-57)	Efficiency, percent (Eγ<20%)
Master Lower (1)	1113	18456	22.14
Master Upper (2)	1084	20598	25.11
Slave Lower (3)	1236	19325	23.18
Slave Upper (4)	1588	18279	21.33
Sum	5021		
Background Suppression	10%	Assumed	
Neutron Detector Data	**Background Count Rate**	**Source Count Rate (Cf-252)**	**Efficiency, percent (value<5%)**
Master Lower (6)	2	958	10.46
Master Upper (5)	2	977	10.66
Slave Lower (8)	2	968	10.57
Slave Upper (7)	2	902	9.84
Sum	8		

Alarm Checks

	Gamma	Gamma Lamps	Neutron	Neutron Lamps
High level background	☐ Verified	☐ Yellow	☐ Verified	☐ Yellow
Occupancy	☐ Verified	☐ Red	☐ Verified	☐ Blue
Low level background	☐ Verified	☐ Yellow		
Tamper Fault	☐ Verified	Name (first,last) of person completing this form		Signature
Alarm messages on Ethernet output	☐ Verified			

Speed and Occupancy Sensor Checks

Occupancy Sensor:	☐ IR Beam	☐ Verified	☐ Ultra Sonic	☐ Verified	☐ Radar	☐ Verified
Speed is reading	☐ Verified					

Step	Instruction	Remarks
8-4	Switch LD-260 to OFF position and verify green LED is not lit to power off RPM	
9	**Document Maintenance Actions**	
9-1	Inform system operators upon completion of maintenance tasks	
9-2	Document maintenance performed, times, and results for inclusion in routine maintenance report	An electronic copy of all FCT datasheets should be archived in the LMP records and submitted with the report. Click on the link at the bottom of the FCT datasheet to send the file. Please click to send to LANLReportsPOC@lanl.gov for inclusion in the SLD RPM Database
9-3	Submit routine maintenance report	Attach datasheet to routine maintenance report. If performed for annual test requirement, attached datasheet to maintenance status report.