Rapiscan®
s y s t e m s

An OSI Systems Company

PRM470
Portable Monitor
Operation and Service Manual
D00092   June 02, 2016   Rev. 2

Foreword

Thank You for choosing a Rapiscan Detection product. This manual is intended for the installation and normal daily use of the equipment. In addition to these instructions, local laws and regulations, and requirements by authorities shall be observed.

The user should read this manual and understand its contents before the installation or use of the equipment.

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Content of this Manual

We have made an effort to ensure that the information in this manual is accurate as of the date of publication. However, the product that you have purchased may contain options, upgrades or modifications not covered by this manual.

If you have any questions about the content of this manual or the product that you have purchased, please contact Rapiscan Systems Customer Service.

No Warranties

The provision of this manual to you creates no express or implied warranties of any kind, including, without limitation any warranties with respect to the accuracy, applicability, completeness or fitness of this manual for any particular purpose.

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Revision History

Name of Document: Operation and Service Manual, PRM470

Document Number: D00092, Revision 2

Rev.	Date	Name	Comments
B	2002-10		Initial draft.
C	2005-12		Update
	2011-09	CB	Update
1	2015-02	CB	Updated to Rapiscan
2	2016-06	CB	Updated safety, liability, graphics, photos and more

Table of Contents

1   IMPORTANT INSTRUCTIONS

Read through this chapter carefully before operating the equipment. Keep this manual so that it is always readily available to the user.

The instructions in this manual shall be followed in all situations, when using, or servicing the equipment. Rapiscan Systems cannot be held responsible for any personal or material damage caused by use contradicting the instructions given in this manual.

All safety regulations must be observed. A dangerous or unsafe manner of operation may be a health risk.

Installation may only be carried out by qualified persons.

Before operating or servicing the equipment, make sure that it poses no risk of personal or material damage.

Do not operate the equipment unless you are fully trained to do so. The operator must know the use, service, and safety instructions of the equipment, and local safety regulations. Service of Rapiscan products shall be performed only by a Rapiscan Systems qualified service provider or authorized contractor qualified service provider.

It is forbidden to operate the equipment when ill, or under the influence of alcohol or drugs.

Original PRM470 spare parts should be exclusively used.

The enclosure should be cleaned using only a mild soap and water. A dampened cloth should be used to prevent water from dripping into the unit.

The end user is responsible for the final calibration of the equipment for the intended application. It is also the end user's responsibility to regularly verify calibration to the desired sensitivity level by using a suitable test object or objects.

If there is any reason to suspect that the security level of the equipment may have deteriorated due to incorrect operation or external damage, the equipment should be removed from operation and an authorized service provider should be called in.

1.1   Types of Alert Messages

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or equipment damage or generally unsafe practices

NOTICE

Indicates an important notice to the reader that does not necessarily involve the possibility of personal injury or equipment damage

All warnings, cautions, notices and instructions presented in this manual should be read and followed by all personnel who will use or maintain this equipment.

Failure to follow all such warnings, cautions, notices and instructions may result in damage to the equipment and/or injury or death to personnel. Such failure may also nullify any warranties provide by the manufacturer.

1.2   Symbols used on Unit and in Manual

General Warning Sign

This sign is used to alert the user to potential hazards. All safety messages that follow this sign shall be obeyed to avoid possible harm.

Recycling Symbol

This symbol means that according to local laws and regulations this product should not be disposed of in the household waste but sent for recycling.

CE Symbol

CE marking on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation.

Symbol for Direct Current (DC)

2   INTRODUCTION

2.1   Scope and Purpose of Manual

This study guide is designed to enable operating and service personnel to properly test, operate, and maintain the Rapiscan Hand-held Gamma/Neutron monitors. Since applications are necessarily site-specific, operation procedures are given in general terms. Service and repair are covered to the board level. Anything more complex than this requires that the instrument or assembly be returned to Rapiscan.

2.2   General Description

Rapiscan Hand-held monitors are highly reliable units for the detection of radioactive materials.

The PRM470 is designed for both indoor and outdoor use but the unit is not water proof.

NOTICE

The unit can be used in wet locations but if the unit is to be used in the rain it is suggested that the unit be placed in a plastic bag to prevent water from entering the unit through any of the unit's openings.

The PRM470 has been designed to provide continuous use for 12 to 16 hours between charges. The charge time is only 4 hours. To charge the unit, turn off the unit and plug the charger into the side panel charger jack and the charger into an AC outlet.

Each hand-held unit contains one gamma detector and can also be outfitted with one 3He tube for neutron measurement.

WARNING

Operation of this unit in a manner not specified by the manufacturer may decrease or eliminate the unit's ability to detect radioactive materials.

2.3   Environmental Conditions

Normal Operation:
Temperature rating is 0°C to 40°C.
Ambient Relative Humidity: 5% - 95% (non-condensing)
Altitude: -200 to 14,000 ft. (-60 to 4,267m)

Storage and Transport:
Temperature: -40° to 185°F (-40°C to 85°C)
Ambient Relative Humidity: 5% - 95% (non-condensing)
Altitude: -200 to 50,000 ft. (-60 to 15,000m)

2.4   Specifications

Gamma Detector: One 3.4" x 2.7" x 1.3" (8.64 x 6.86 x 3.30cm) organic plastic scintillator.

Optional Neutron Detector: One 3/4" dia. X 5" length (1.9 X 12.7cm), 4ATM 3He detector

Sensitivity: Will detect 10g HEU or 1g 239Pu when tested in accordance with ASTM Standard C 1237*

Battery: The unit comes equipped with a 4.8 volt, 2100 mAh nickel–metal hydride (NiMH) four cell battery pack. The average current draw of the unit is 100mA at 4.8 volts.

Charger:
Mains input: 100-240V-/0.3A/50-60Hz
Output: 4.8-12Vdc/0.8A

2.5   Serviceability

Component level part replacement is not practical with this unit. A trained technician can replace the battery pack or possibly a detector but it is recommended that the unit be returned to Rapiscan for repair.

Weight:
Approximately 2.75lb (1.3kg)

Dimensions:
7 7/8"h x 4 3/4"w x 3 5/8"d (20 x 12.07 x 9.21cm)

WARNING

Opening the PRM470 can expose the service personnel to the following risks:
- **Shock from the high voltage supply**
- **Fire if the battery is shorted**
- **Heat if the battery is shorted**
- **Cuts from components within the enclosure**

2.6   Optional Components

2.6.1   Neutron Detector

The Rapiscan Model PRM470 Hand-held Monitor comes equipped with a gamma detector as standard equipment. An optional neutron detector can be added to give additional neutron sensitivity.

2.6.2   Headphones

Headphones may be used with the PRM470 for areas that may be noisy or for situations where the fact that a unit is alarming is not information to be shared by other persons in the area. Headphones are a user supplied item.

3   PRODUCT CONDITIONS

The following steps should be followed to ensure that the PRM470 is handled properly.

3.1   Inspection

Immediately inspect the instrument for mechanical damage, scratches, dents or other defects. It should be examined for evidence of concealed, as well as external damage.

3.2   Damage Claims

If the instrument is damaged in transit or fails to meet specifications upon receipt, notify the carrier and Rapiscan Systems immediately. Shipping cartons, packing materials, waybills and other such documentation should be preserved for the carrier's inspection. Rapiscan will assist in providing replacement or repair of the instrument if necessary.

3.3   Storage

If the instrument is to be stored for any length of time, have a trained technician remove and store any batteries separately in a cool place. If batteries are to be stored for any length of time, they should be inspected, and, if necessary, fully charged at least once a month. Care should always be taken to avoid subjecting the instrument to severe mechanical or environmental shock. The instrument should be stored in a dry, temperature controlled location.

3.4   Shipping

Before returning the instrument for any reason, notify Rapiscan Systems of the difficulty encountered, giving the model and serial numbers of the equipment. Rapiscan will furnish specific shipping instructions.

3.5   Battery Connections

The unit comes with the battery disconnected. Open the unit and plug in the battery.

Battery
Connector
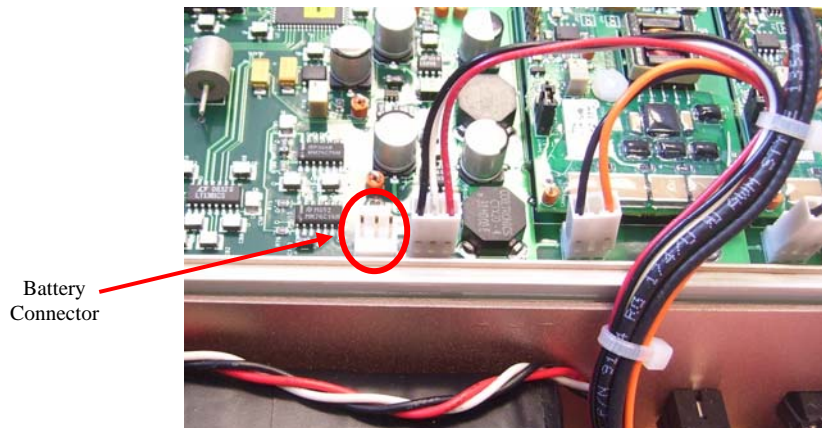
4 SET-UP AND PROGRAMMING

To operate the monitor, press the POWER switch. The display will show Rapiscan Systems along with the model number and version number and the audible will sound. Next, the display counts down to zero until the monitor is ready for operation and displaying a new count. At this time the red and blue LEDs will go on and off (if the unit has both gamma and neutron detectors). Do not move the monitor until it has had an opportunity to acquire a background.

NOTICE

If the instrument is equipped with a neutron detector, give it at least 60 seconds to acquire an initial background. The neutron detectors may see some spurious counts on power up and this will give the instrument time to flush those counts out of the background buffer prior to operation.

4.1 Charging

Ensure the unit has been charged before using.

NOTICE

The charger used on the PRM470 is a smart charger. It is programmed to charge from four to ten nickel–metal hydride (NiMH) batteries. If the PRM470 is allowed to operate while it is being charged the charger itself will often stop charging and display that an error has occurred because there is more current being drawn than just the batteries would require.

NOTICE

There is an inherent risk with NiMH chemistry that overcharging will cause a buildup of hydrogen, causing the cell to rupture. The use of a smart charger prevents the battery pack from being overcharged.

4.2 Set-up

The monitor is fully calibrated at the factory.

The PRM470 has many user programmable parameters that can be used to optimize it for a wide variety of applications.

4.3 Programming the Hand-Held

The Rapiscan PRM Comm PC Communications Program can be downloaded from the Rapiscan website www.rapiscansystems.com. The program requires an IBM/PC compatible computer running Microsoft Windows XP, 2000, NT4, 95, or 98. The program allows the operator to examine the system parameters and download data.

NOTICE

Rapiscan recommends that the PRM470 be shut down prior to connecting or disconnecting the programming computer.

Step	Action
1	Install the Communication Application Software from the Rapiscan website
2	Use a standard RS232 cable or USB to serial converter cable to connect the PRM-470 to the computer
3	Find the Application on the computer by following this path: start→programs→TSA Systems→PRMCOM→PRMCOM
4	When the Application screen comes up you will need to move the cursor to the connect button and left click
5	After a few seconds the computer should connect and the previously stored parameters in the PRM-470 should be displayed
6	If a Data Plot is desired, the TX Data will need to be toggled from OFF to ON
7	If any parameter changes have been made, move the cursor to the SEND PARAMETERS button and left click
8	After a few seconds, data from the PRM-470 should be displayed in the RS232 Data Stream box
9	You can now select the Data Plots tab and view a graph of the data

4.4 Default Parameters

The default parameters are as follows:

Sigma = 3 (Sigma)	Neutron Alarm = 10 (CPS)
Background Time = 20 (sec)	Low Gamma Alarm = 0 (CPS)
Motion Time = 30 (sec)	Restrict Setup = OFF
Gamma LLD = 0.06 (Volts)	Count Mode = Find
Gamma ULD = 5.01	Gamma Units = CPS
Neut LLD = 1.00	Alarm Pitch = 0
Neut ULD = 5.01	TX_Data = OFF

4.5   Parameter Details

Sigma - Changing this value will change the sensitivity of the unit. Alarms are calculated by taking the square root of the background and multiplying that value by the Sigma. The resulting value is the number of CPS above background to cause the unit to alarm. As the Sigma value is raised it will take more CPS above background to cause an alarm.

Background Time - This value controls the amount of time the unit takes to count down and display a background. Increasing the time will help smooth the data and give a more accurate background count. In most cases the default setting of 5 should be the preferred setting.

Motion Time - Adjusting this value changes the amount of time the unit must remain motionless until it switches to background mode. If the value is changed to 0 the unit won't sense motion. The unit will need to be manually put in search or find mode with the panel buttons.

Gamma LLD - The Lower Level Discriminator (LLD) is the value for the lower energy window setting for the unit. Raising this value could cause some of the lower energy sources to be missed during a search. Lowering this value can cause false readings caused by noise. This value should be left at the default setting.

Gamma ULD - The Upper Level Discriminator (ULD) is the value for the upper energy window setting for the unit. Lowering this value could cause some of the higher energy sources to be missed during a search. This value should be left at the default setting.

Neut LLD - Sets the voltage of the neutron channel lower level discriminator

Neut ULD - Sets the voltage of the neutron channel upper level discriminator

Neutron Alarm - This value is the threshold for a neutron alarm in CPS. Increasing this value will mean that it will take more neutrons to cause the unit to alarm.

Low Gamma Alarm - Gamma background CPS that fall below this value will cause a Gamma Low Fault message to be displayed on the unit.

Restrict Setup - The default setting for this feature is off. This will allow any user to change the unit's parameters by using the front panel buttons. If you want to prevent parameters from being changed in the field, then the Restrict Setup should be turned ON.

Count Mode - Displays the current or previously used search mode.

Gamma Units - Changes how the data is being displayed. The selections are Counts per Second (CPS), MilliRem per Hour (mR/Hr), and MicroSieverts per Hour (uSv/Hr). The mR/Hr and uSv/Hr are not energy compensated. Values are estimated. This is not to be used as a survey instrument.

Alarm Pitch - Adjusting this parameter causes the pitch of the SEARCH mode audible alarm to change. The FIND mode audible alarm is unaffected by this control. This feature can be useful to someone who has hearing difficulties for a particular range of tones.

TX Data - Must be ON for the Application to display received count data and show plots of the data. Parameters can be viewed and changed without needing this ON. To conserve the battery, this feature should be turned OFF after you have finished observing the data or plots.

4.6   Programming From the Front Panel

Front Panel switches (see photos on next page)

POWER - turns the unit on/off

MODE - Change mode from background to fast count. Hold down to enter menu. When in the menu, MODE acts as an ENTER button.

LIGHT - Turns the back-light on/off. When in the menu, LIGHT acts as an up arrow.

S/F - Search/Find - toggles fast count between search and find modes. When in the menu, S/F acts as a down arrow.

Internal motion switch - An internal motion switch senses when the unit is picked up or set down. If Motion Timeout is enabled (any value other than zero), the unit will enter background mode whenever the unit has set motionless for a user defined amount of time (see Motion Timeout below). If enabled, the unit will automatically change modes from background to search or find when the unit is picked up.

Menu - To enter the menu, press and hold MODE. "SETUP MODE" will be displayed along with a menu item. To change the value of a menu item, press MODE. "Adjust Value" will be displayed along with the current value of the menu item. Use the "LIGHT (up)" and "S/F (down)" buttons to increase or decrease the value. When the desired value is displayed, press MODE to accept. To view additional menu items, press the "S/F (down)" button to advance to the next item or press "LIGHT (up)" to return to the previous menu item. Below is a list of available menu items.

Front Panel

Side Panel

4.7   Menu Items

ITEM	RANGE	DESCRIPTION
Sigma	1-100	Allows user to adjust the Sigma alarm threshold
Bkg Time	1-1000	Background time in seconds
Motion Timeout	0-3600	Adjusts how long the unit will remain in search or find mode before entering background mode if left motionless. Zero will disable motion timeout and the user will be required to change modes manually
Neu Alarm	1-10000	Adjusts the neutron alarm level in counts per second
Gamma LLD	0-5.00	Sets the voltage of the gamma channel lower level discriminator
Gamma ULD	0-5.00	Sets the voltage of the gamma channel upper level discriminator
Neut LLD	0-5.00	Sets the voltage of the neutron channel lower level discriminator
Neut ULD	0-5.00	Sets the voltage of the neutron channel upper level discriminator
Audio Adj	0-200	Sets the SEARCH mode alarm tone. The higher the number the higher the tone
Low Gamma	0-10000	Sets the low alarm fault value for the gamma channel
Units	CPS,mR/Hr,uSv/Hr	Sets the gamma channel display units (mR/Hr,uSv/Hr are not energy compensated. Values are estimated This is **not** to be used as a survey instrument)
CAL CPS/mR/Hr		Allows the user to calibrate the unit for CPS per mR/Hr. To perform the calibration, place the unit in a known mR/Hr field and adjust the K-factor with the "LIGHT (up" and "S/F (down)" buttons until the mR/Hr display matches the known field
TX DATA	ON/OFF	Turns RS-232 one second blind broadcast of count data on/off IMPORTANT: Turn off to increase battery life
EXIT		Exit the menu and return to operation

If these parameters are changed, the changes should be documented and retained for future reference.

4.8   Field Electronic Alignment Procedures

WARNING

This procedure involves high voltage and should only be performed by a trained technician!

Tools and equipment
Since the electronic alignment procedures require specialized tools and knowledge, only a trained technician should work on these instruments.

- Oscilloscope with greater than 20 Meg. Band width
- Tweaker or small slotted screwdriver
- Digital voltmeter with a resolution of 0.1 millivolts
- High voltage probe with a range of 10,000 Vdc and Zin ≥100MΩ
- 5-10µCi ^{137}Cs test source

NOTICE

Other mono-energetic sources may be used. Call Rapiscan for full details.

Gamma
1.   Use the scope to set the high voltage for a first stage gain of 1.5 volt with the ^{137}Cs (GHA TP1 and R10 upper board). (Reference drawings 3 and 10)
2.   Adjust the second stage gain for 4.0V with the 137Cs (GHA TP2 and R17 upper board). (Reference drawings 3 and 10)

Neutron
1.   Max out the second stage gain, measure the resistance from the wiper to ground and back the pot off 100 ohms from max, nominally 4.9 kohms. (GHA TP2 and R17 lower board). (Reference drawings 3 and 10)
2.   Set the high voltage for 1,200 if the anode lead is red and 980 if the anode lead is white (GHA TP1 and R10 lower board). (Reference drawings 3 and 10)

5   OPERATIONAL TEST

Due to the many different environments and materials being monitored, the operational test will vary from site to site, although several general principles apply in all cases.

1. Select an appropriate source, and instruct the user to approach the source with the Rapiscan Systems PRM470 in the SEARCH or FIND mode.
2. Record the distance at which the unit alarms.
3. Repeat the test several times and record the sources and sizes used.

5.1   Gamma and Neutron Maintenance

WARNING

This procedure involves high voltage and should only be performed by a trained technician!

Little maintenance is required. Periodic inspection is recommended to insure proper functioning.

 This should include (but is not limited to):
- visual inspection for loose wires, etc.
- field calibration
- checking the settings of the unit
- performing a test using sources

CLEANING
- **The enclosure should be cleaned using only a mild soap and water. A dampened cloth should be used to prevent water from dripping into the unit.**

5.2   Component Access

Battery : To remove, disconnect the in line connector between the printed circuit board and the battery and lift it out. To reinstall the battery, reverse the above.

The **gamma detector assembly** can be removed by disconnecting the cabling and removing the brackets that secure them in place. Handle these with care to avoid damage which could cause light leaks. To replace, set the detector in place and fasten the Velcro straps, and connect the cabling.

The **neutron detector assembly** can be removed by disconnecting the cabling and removing the brackets that secure them in place. Handle these with care to avoid damage. To replace, set the detector in place and fasten the Velcro straps, and connect the cabling.

6 GLOSSARY

CPS or cps: Counts Per Second

LCD: Liquid Crystal Display

LED: Light Emitting Diode

LLD: The Lower Level Discriminator provides an adjustable threshold that determines the lowest signal level that will be accepted as a nuclear pulse by the system's electronics. Some systems have both upper and lower level discriminators that can be used to set a discriminator window. The discriminator window can be used to effectively reduce the background counts, and increase system sensitivity to certain isotopes.

Low Background Alarm or Low Background Fault: The condition that occurs if the counts fall below the programmed low background level. This condition prevents further operation until the problem is corrected. Usually set in cps.

Standard Background: Standard background requires the full background time for the initial background and updates.

ULD: The Upper Level Discriminator provides an adjustable threshold that determines the highest signal level that will be accepted as a nuclear pulse by the system's electronics.

7   PARTS LISTS

It is recommended that you should contact Rapiscan Systems at RapiscanTSASales@osi-systems.com and supply the information listed in section 7.1.

7.1   Spare Parts Ordering Information

To facilitate the processing of spare parts orders the following information is required.
Product Number
Product Serial Number
Rapiscan Stock number
Part description (from parts list)
When ordering programmed proms, the software version is required. This can be found on the prom label.

NOTICE

Model number suffixes are generally not included in the text of the manual. However, the suffixes in the parts lists must be included on orders for spare parts.

FOR ASSISTANCE CALL:
Rapiscan Systems
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8   LIST OF DRAWINGS

* Proprietary information not included with the manual. Contact Rapiscan for assistance