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ORTEC® warrants that the items will be delivered free from defects in material or workmanship. ORTEC makes no other warranties, express or implied, and specifically NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

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Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

Repair Service

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing, by telephone (865.482.4411) or by facsimile transmission (865.483.2133), of the nature of the fault of the instrument being returned and of the model, serial, and revision (“Rev” on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped PREPAID via Air Parcel Post or United Parcel Service to the designated ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender’s expense, and it will be the sender’s responsibility to make claim with the shipper. Instruments not in warranty should follow the same procedure and ORTEC will provide a quotation.

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Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

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# TABLE OF CONTENTS

WARRANTY .................................................................................................................................................. ii

FIGURES ..................................................................................................................................................... vii

TABLES ......................................................................................................................................................... ix

SAFETY INSTRUCTIONS AND SYMBOLS ................................................................................................ xi

1. GETTING STARTED ................................................................................................................................. 1
   1.1 THE DETECTIVE X TRANSPORT CASE AND CONTENTS ................................................................. 1
   1.2 DETECTIVE X FEATURES ................................................................................................................. 2
   1.3 UNPACKING ....................................................................................................................................... 3
   1.4 POWER-UP ......................................................................................................................................... 5
   1.5 TURNING THE COOLER ON ............................................................................................................... 5

2. SYSTEM OVERVIEW ............................................................................................................................. 7
   2.1 PERSONNEL SAFETY ALERTS ........................................................................................................... 7
   2.2 DATA MANAGEMENT AND COMMUNICATION ................................................................................... 7
      2.2.1 The User Interface ....................................................................................................................... 7
   2.3 GAMMA-RAY DETECTORS .............................................................................................................. 8
   2.4 MODULAR NEUTRON DETECTOR ..................................................................................................... 8
   2.5 DETECTOR REFERENCE POINTS ....................................................................................................... 8
   2.6 DETECTIVE X ACCESSORIES ........................................................................................................ 10
      2.6.1 Power Supply ............................................................................................................................ 10
      2.6.2 Shoulder Strap .......................................................................................................................... 10
      2.6.3 Bluetooth Headset ..................................................................................................................... 10
      2.6.4 USB Cable .................................................................................................................................. 11
      2.6.5 Detector Cover, Optional Collimators, Filter, and Neutron Detector ....................................... 11
   2.7 DETECTIVE X POWER OPTIONS ................................................................................................... 11
      2.7.1 The Internal Batteries ................................................................................................................ 11
      2.7.2 Vehicle Power Adapter Cable ................................................................................................... 12
      2.7.3 External Battery Power Option ................................................................................................ 13
   2.8 INSTRUMENT ENCLOSURE ............................................................................................................... 13
   2.9 COLLIMATORS (green and pink) ....................................................................................................... 14
   2.10 LOW-ENERGY FILTER (red) .......................................................................................................... 14
   2.11 OPERATING CAUTIONS AND NOTES .......................................................................................... 15
   2.12 PREPARING THE DETECTIVE X FOR SHIPMENT ..................................................................... 15
      2.12.1 Shipping Li-ion Batteries ......................................................................................................... 16

3. USING THE DETECTIVE X ...................................................................................................................... 17
   3.1 USER INPUT ...................................................................................................................................... 17
      3.1.1 Moving Back to the Previous Screen ......................................................................................... 18
   3.2 DETECTIVE X SOFTWARE OVERVIEW ....................................................................................... 18
      3.2.1 Adjusting the Audio and Vibratory Alerts ............................................................................... 22
      3.2.2 Exiting and Restarting the Detective X Application ............................................................... 23
   3.3 ALARM CONDITIONS ....................................................................................................................... 23

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APPENDIX D. SPECIFICATIONS AND CARE .......................................................... 75
D.1 DETECTORS ............................................................................................... 75
D.2 HARDWARE ............................................................................................... 75
D.3 PHYSICAL SPECIFICATIONS .................................................................. 76
D.4 COMMUNICATION SOFTWARE ............................................................... 76
D.5 Mobile MCB Server .................................................................................. 76
D.6 CLEANING INSTRUCTIONS ...................................................................... 77
   D.6.1 Cleaning the Exterior ........................................................................... 77
   D.6.2 Cleaning the Fan Compartment ........................................................... 77
D.7 REPLACING THE INTERNAL BATTERIES ................................................. 77
APPENDIX E. NUCLIDE ID TABLE ................................................................... 79
APPENDIX F. TROUBLESHOOTING .................................................................. 85
F.1 DETECTIVE X APPLICATION STOPS ....................................................... 85
F.2 DETECTIVE X WAS Dropped ................................................................. 85
F.3 DETECTIVE X WILL NOT TURN ON ......................................................... 85
F.4 FORGOT THE PASSWORD ....................................................................... 85
F.5 PEAK CENTROID, FWHM, OR CALIBRATION ADJUSTMENT VALUE HAS CHANGED DRAMATICALLY SINCE THE LAST CALIBRATION ..................... 86
F.6 GPS ISSUES ............................................................................................. 86
   F.6.1 Delayed Display of Location Coordinates ........................................... 86
   F.6.2 “GPS Not Communicating” ............................................................... 86
[Intentionally blank]
FIGURES

Figure 1. Transport Case........................................................................................................1
Figure 2. Detective X Side View (with optional neutron detector mounted)...............................2
Figure 3. Top View ...............................................................................................................2
Figure 4. Rear Panel .............................................................................................................3
Figure 5. Rear-Panel Data Connectors ...................................................................................3
Figure 6. Arrows Show Proper Power Connector Orientation ...............................................4
Figure 7. Power Supply Indicator LED ................................................................................4
Figure 8. Power ....................................................................................................................5
Figure 9. Screen After Initial Power Up ................................................................................5
Figure 10. Turn Cooler On ..................................................................................................6
Figure 11. Status: Cooling ....................................................................................................6
Figure 12. Detector vertical reference points ..........................................................................9
Figure 13. Detector horizontal reference points ....................................................................9
Figure 14. Headset with Boom Open ....................................................................................10
Figure 15. Strap with Retractable Stylus ............................................................................10
Figure 16. Collimator/Filter/Neutron Detector Connector .....................................................11
Figure 17. Battery Door, Charge State Indicator, and Pull Tab ............................................12
Figure 18. DC Plug Retention Force Adjustment Slider .........................................................13
Figure 19. Stainless Steel Collimator ..................................................................................14
Figure 20. Li-ion Battery Shipping Label .............................................................................16
Figure 21. (N)avigate and (S)elect Buttons .........................................................................17
Figure 22. Dotted Line on Settings Button Indicates it is Highlighted and Ready to Select (activate)........................................................................................................................................17
Figure 23. The Stylus Makes Text Entry Easy ......................................................................18
Figure 24. Basic Software Organization ..............................................................................19
Figure 25. Detect Mode Screen Details ...............................................................................19
Figure 26. Detect Mode Screen ...........................................................................................21
Figure 27. ID Mode Screen ................................................................................................21
Figure 28. Audio Settings .....................................................................................................23
Figure 29. Setting the Require Acknowledge Flag ................................................................24
Figure 30. Personnel Hazard Alarm ....................................................................................25
Figure 31. Personnel Hazard Full Screen Alarm ...................................................................25
Figure 32. Example of System Error ....................................................................................26
Figure 33. Overrange Condition ..........................................................................................27
Figure 34. Overrange Alarm with Acknowledge Button .......................................................27
Figure 35. Co-60 Identification Latched by the Acknowledge Button ....................................28
Figure 36. The Detect Mode Screen .....................................................................................29
Figure 37. The Signal Index Strip Chart History and Current Level .......................................29
Figure 38. The SNM Index Strip Chart History and Current Level ........................................30
Figure 39. IDs Box ..............................................................................................................30
Figure 40. Threat Sources Always at the Top of the IDs List ................................................................. 31
Figure 41. Detect Mode Integration Time .................................................................................................. 32
Figure 42. Suspect Nuclide Identification Alarm in LCX Mode ............................................................... 33
Figure 43. LCX Mode Enable/Disable Checkbox ................................................................................... 33
Figure 44. ID Mode Screen .................................................................................................................... 34
Figure 45. Entire Spectrum Displayed (showing marker position and channel content) ......................... 35
Figure 46. Expanded Spectrum with Marker near 398 keV (with logarithmic vertical scaling) ............. 36
Figure 47. List of the Most Intense Peaks by Decreasing Q Value ...................................................... 37
Figure 48. Setting the Fixed Count Time in ID Mode ............................................................................. 37
Figure 49. Optional Metadata for ID Mode Data .................................................................................... 38
Figure 50. Enable Collection of Multiple Spectra in a Single File ......................................................... 39
Figure 51. Set Up Parameters for Multiple Spectrum ID Mode ............................................................. 39
Figure 52. Wired Ethernet Settings Page ............................................................................................... 42
Figure 53. Typical WiFi Network Selection ........................................................................................... 42
Figure 54. WiFi Connected .................................................................................................................... 43
Figure 55. Enabling Remote Control Operation ..................................................................................... 43
Figure 56. WiseMo Host Application .................................................................................................... 44
Figure 57. PC-Based WiseMo Guest Application .................................................................................. 45
Figure 58. PC-Based Remote Desktop Window with Default Skin ...................................................... 46
Figure 59. iOS WiseMo Guest App on iPhone Connected to Detective X ............................................. 46
Figure 60. Reachback Settings ............................................................................................................. 47
Figure 61. Reachback Email .................................................................................................................. 48
Figure 62. Remote Control Window .................................................................................................... 49
Figure 63. WiseMo File Manager .......................................................................................................... 49
Figure 64. Recall Details Screen ........................................................................................................... 50
Figure 65. Background Collection for Use in Analysis ......................................................................... 51
Figure 66. Background Settings ........................................................................................................... 52
Figure 67 Neutron Background Changed ............................................................................................. 52
Figure 68. Current Gain Stabilizer Adjustment ..................................................................................... 53
Figure 69. Calibrate Screen .................................................................................................................. 54
Figure 70. Calibration Settings Screen ................................................................................................ 55
Figure 71. Define Calibration Sources .................................................................................................. 55
Figure 72. Default Identification Table Listing ..................................................................................... 56
Figure 73. Preparing to Change Default Innocent Nuclide to Threat Status .......................................... 56
Figure 74. Default Innocent Nuclide Changed to Threat Status (and marked with asterisk) ................. 57
Figure 75. Creating or Changing the Password for Advanced Setup ................................................... 58
Figure 76. Confirmation of Saved Settings ............................................................................................ 58
Figure 77. Partial Contents of Typical Settings.txt File ........................................................................ 59
Figure 78. Launcher Screen .................................................................................................................. 61
Figure 79. Mobile MCB Server UI from the Launcher Application .................................................... 63
Figure 80. MFK Setup ......................................................................................................................... 65
TABLES

Table 1. Battery Specifications (subject to change) ................................................................. 16
Table 2. Threat Energies ........................................................................................................... 34
Table 3. Threshold Values ......................................................................................................... 67
Table 4. Non-Health Status Items ............................................................................................. 67
Table 5. Health Status Items ..................................................................................................... 68
Table 6. File Upload Status Items ............................................................................................ 73
SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

**DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

**WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

**CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol might appear on the product:

⚠️ **ATTENTION** – Consult the manual in all cases where this symbol is marked in order to determine the nature of the potential hazards and any actions that must be taken to avoid them

⚠️ **DANGER** – Hazardous voltage

_VOLT_ **Protective earth (ground) terminal**

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.
1. GETTING STARTED

Congratulations on your purchase of the ORTEC® Detective® X Handheld Radionuclide Identifier. The Detective X is unparalleled in the detection and identification of threat and innocent radionuclides, even in shielded and masked configurations. Although it is a precision scientific instrument, the Detective X is designed for continuous, hard use in the heaviest weather, seas, air, and terrain. It delivers rapid, accurate screening of vehicles, containers, vessels, buildings, rooms, objects, people, and areas; providing an “expert in a box” for radionuclide identification. You can detect radiation, verify radiation alarms, localize the source, identify the radioactive material (even measuring it together with blank and unknown samples for additional rigor and quality assurance), and assess the threat status of the detected material. The straightforward Send to Reachback function can provide a link to technical experts for assessment and adjudication assistance.

This chapter introduces the main features of the Detective X, then walks through the procedure for powering it up and cooling it to operating temperature. More detailed information begins in Chapter 2.

1.1 THE DETECTIVE X TRANSPORT CASE AND CONTENTS

The Detective X is shipped in a rugged, foam-lined transport case suitable for shipment via common carrier or as checked baggage on commercial passenger aircraft. Figure 1 shows the loaded Detective X transport case as delivered from the factory.

![Transport Case Diagram](image)

(Figure 1 shows the optional neutron detector already attached to the front of the unit. If you did not purchase the neutron detector, the unit ships with the detector cover attached, and the cavity for the detector cover is empty.) The case includes an inset for a pair of extra batteries (purchased separately from ORTEC®.)
ORTEC) Note that the instrument is shipped with the cooler OFF to prevent damage from overheating. NEVER operate the cooler when the unit is enclosed in the transport case or wrapped in other insulating material.

1.2 DETECTIVE X FEATURES

Figure 2 through Figure 4 show the major features of the Detective X. Features and operating details are discussed in detail in Chapter 2.

Figure 2. Detective X Side View (with optional neutron detector mounted)

Figure 3. Top View
1.3 UNPACKING

1) Remove the Detective X, the power adapter with DC cable, and the mains adapter package from the case.

2) Referring to Figure 6, on the upper-left of the rear panel, unscrew the protective cover from the DC power connector and plug in the DC power cable from the power supply. The connector is keyed, so use the arrows to line it up correctly, then push in and twist the ring clockwise to lock the connector in place. Do not force or overtighten the connection.
3) Find the mains power cord and the appropriate wall plug adapter for your location. Press the wall plug adapter onto the power cord, and connect the power cord into the power supply. Finally, plug the cord into the wall outlet. The power supply is operating when the indicator LED on the power supply is lit (Figure 7). Note that the internal batteries charge any time the unit is connected to external power, whether or not the touchscreen computer/detector power button is on or off.
1.4 POWER-UP

1) Referring to Figure 3 and Figure 8, the lower (middle) button on the top of the Detective X is the power button. To power up, press and hold the button for at least 5 seconds. The touchscreen will illuminate and the unit will begin its boot-up sequence, which takes just a few seconds. (Note that you also turn off the unit by pressing and holding the power button for about 5 seconds; this interval prevents unintentional power-off.)

2) When boot-up is complete, the Detect Mode home screen will be displayed, as shown in Figure 9. Note the Status: Cooler off indicator, and the red error message, The Cooler is turned off! The next step will be to turn on the cryogenic cooler.

![Figure 9. Screen After Initial Power Up](image)

1.5 TURNING THE COOLER ON

1) In the lower right corner, tap the Settings button to open the Settings page (Figure 10). Then tap Turn Cooler ON. Note that this is an on/off toggle, and the button label changes with the cooler state.

   NOTE Once turned on, the cooler stays on, even if the Power button is turned off. To completely shut down the instrument, turn off the cooler first

2) At this point, the The Cooler is turned off! error message will no longer be displayed, and the instrument status will say Status: Cooling Phase 1.

   At this point, you may temporarily disconnect the instrument from external power and move it to a different location if you wish.

   Cooling will continue through several phases before the status message changes to Status: READY.

3) There is no need to continue displaying the Settings page during cooldown, although you may wish to tap the Status button to display system temperatures and track cooldown progress.
Cooldown from room temperature typically takes less than 8 hours. This is a good time to familiarize yourself with the Detective X’s features and operating instructions. Be sure to see the operating cautions and notes in Section 2.11.
2. SYSTEM OVERVIEW

The Detective X is a high-resolution, handheld radioisotope identifier that uses a radioisotope’s characteristic gamma-ray energies for identification. The large high-purity germanium (HPGe) detector is essential to the sensitivity and accuracy of the instrument. The high resolution of the detector, combined with the Identification Table (APPENDIX E) and proprietary identification algorithms, make the Detective X extremely accurate, even for materials in shielded and masked configurations.

The HPGe detector is cooled by a small, highly reliable mechanical cooler to near-liquid-nitrogen temperature. The cooler is designed for years of continuous duty, so it is always ready at a moment’s notice. For a more detailed discussion, see Sections 2.3 through 2.5.

2.1 PERSONNEL SAFETY ALERTS

The Detective X alarms when the radiation level exceeds a user-defined safety threshold (see Section 3.3.2). Alerts for high gamma-ray and (where equipped) high neutron exposure rates are both visual and audible.

2.2 DATA MANAGEMENT AND COMMUNICATION

The networking capabilities incorporated in the Detective X allow the user to transfer and email spectra from the instrument using either wired or wireless connections. You can use the remote connection to control the Detective X from any popular device; see Section 3.8.

Acquired spectra are saved on the Detective X’s rear-panel USB flash drive (see Figure 5). The Detective X also supports automatic save and Send to Reachback capability over the network. If the network is unavailable, the message is saved and sent when the network is available.

2.2.1 The User Interface

The user interface is a high-resolution, color touchscreen. The Detective X is operated either by the Select (S) and Navigate (N) buttons, located just above the power button (see Figure 3); or the touchscreen. These two input methods give you versatility in operation. Responders wearing protective gloves will find the buttons easy to use.

There are two operation modes:

- **Detect Mode** — This screen (see Figure 36 on page 29) is a general survey tool for locating radioactive material. The Signal Index quickly shows changes in radiation levels allowing the user to follow the signal strength to locate and then accurately identify (ID) a source. See Section 3.4
- **ID Mode** — When a nuclide ID is displayed or when the Signal Index rises, tap the Identify button to begin collecting one or more spectra from the item of interest (see Figure 44 on page 34). These spectra are analyzed locally and may be sent to reachback for a more in-depth study. See Section 3.5.

The software provides multiple free-form fields in which you can document measurement conditions (see Figure 49 on page 38).

Additionally, the Detective X allows you to collect a set of spectra — measurement blanks, knowns, and unknowns — and pack them all into a single N42 file so reachback personnel can be certain of the conditions
under which each spectrum was collected. Measurements can be sent to reachback automatically over a wired or wireless internet connection (Section 3.9).

2.3 GAMMA-RAY DETECTORS

Detective X uses a large, coaxial, P-type high purity germanium (HPGe) detector crystal. Dimensions of the crystal are nominally 65 mm in diameter by 50 mm long. (See also the specifications in APPENDIX D.) This large diameter has the high frontal surface area necessary for excellent sensitivity to low-energy gamma rays. The large crystal depth provides stopping power for high-energy gamma rays, and the large crystal volume increases the likelihood that gamma rays will be fully absorbed by the detector, increasing the likelihood that the gamma ray can an identified.

The HPGe detector is used both for radionuclide identification and for determining low-level gamma-ray exposure rates. It can also detect beta radiation by recognizing a characteristic bremsstrahlung energy spectrum.

The Detective X uses three detectors to determine the gamma-ray exposure rate over a wide range from <0.05 milliroentgen (mR)/h to >1 R/h, an exposure rate range of around 6 powers of 10. For low exposure rates (below ~2 mR/h), the rate is determined from the HPGe detector spectrum. For exposure rates above this value, the instrument uses low- and high-range, internally compensated Geiger-Müller tubes. The Detective X switches between these detectors automatically to report dose rate.

2.4 MODULAR NEUTRON DETECTOR

The optional Detective X neutron detector is a large volume segmented lithium-6 fluoride/zinc sulfate (Li\textsubscript{6}F/ZnS) detector formed in a U-shape that sits behind the HPGe detector so that it does not block the sides of the detector from absorbing gamma rays. The highest sensitivity to neutrons is in the forward direction, that is, when the front of the instrument is pointing at the radiation source. Digital pulse processing is applied separately to each segment, increasing the neutron detection probability while still maintaining a very low false-positive rate.

The neutron detector module is held in place with magnetic mounts, and may be removed and replaced with the (passive) detector cover to reduce weight when you do not need neutron detection. It mates via a connector (Figure 16) that the Detective X software reads to determine the device type. That information is added to the N42.42 files, and the software automatically uses the ambient background correction file for the configuration with the neutron detector. Note that removing or installing the neutron detector may trigger a neutron alarm; ignore it.

Note that the Detective X is capable of detecting neutron sources even without a dedicating neutron detector as the system is equipped to detect gamma rays emitted through neutron activation of common surrounding materials. This is especially true for units configured for an 8 MeV energy range.

2.5 DETECTOR REFERENCE POINTS

For radiation fields from extended sources (e.g., a container full of NORM) or far-field point sources (>1 m from the instrument), the precise location of the detector the Detective X software uses to determine exposure rate is not important. When point sources are close to the instrument, the readings from the
different detectors may not agree because they are in different places in the instrument enclosure, and the dose rate is varying rapidly with position.

If you wish to test the dose-rate measurement capability with a point source, especially at close range, it is important to know the reference points of the instrument’s detectors because test procedures, such as American National Standards Institute (ANSI) or International Electrotechnical Commission (IEC) tests, prescribe the use of point sources at specified distances from the detector reference point. Figure 12 and Figure 13 show the detector reference points; note that they are not marked on the enclosure.

![Figure 12. Detector vertical reference points](image)

![Figure 13. Detector horizontal reference points](image)
2.6 DETECTIVE X ACCESSORIES

The following standard accessories are supplied with the Detective X, and are included in the shipping container (refer to Figure 1):

- User’s manual
- Universal power supply with captive DC cable
- AC mains cord with male adapters for any mains power source
- Heavy duty shoulder strap with retractable stylus
- Bluetooth® headset and charger
- 12-V automobile power adapter
- USB cable (USB A to USB mini B, 3 m)
- Detector cover (see text)

2.6.1 Power Supply

The power supply is rated at 100–240 VAC and 50/60 Hz. The DC cable to the Detective is captive, and the mains socket is IEC 320 C14 compatible.

2.6.2 Shoulder Strap

The shoulder strap is connected by quick-release fasteners that clip to diagonal corners of the Detective X (Figure 2 shows the attachment points on the right side of the housing; there are two on the left side, as well). The two strap orientations give both right- and left-handed users a clear view of the display. The strap includes a stylus attached by a retractable polyaramid cord (Figure 15). The stylus is especially useful for operating the touchscreen if you are wearing protective gloves, and for entering alphanumeric information. When not in use, the stylus is held against the strap with an embedded magnet. (Note that the stylus ships from the factory with a protective rubber boot over the end [red circle in figure] that you may discard.)

2.6.3 Bluetooth Headset

The Bluetooth headset (Figure 14) can be used to listen to the audible alarms and indicators privately or in a noisy environment. The headset is paired to the unit at the factory, and is ready to for use. Simply remove the headset from its packaging, peel away the protective film from the speaker, and flip open the headset boom to power it on. It will connect automatically, and all sounds from the Detective X speaker will be rerouted to the headset. To route the sounds back to the instrument speaker, simply close the headset. The headset has its own mains charger, included in the headset packaging; and runs for more than 8 hours on a charge.

Figure 14. Headset with Boom Open

Figure 15. Strap with Retractable Stylus
2. SYSTEM OVERVIEW

2.6.4 USB Cable
The Detective X is supplied with a 3-m (~10-ft) USB cable for connecting the unit to a PC running Microsoft Windows 7, 8.x, or 10; or Linux (see Figure 5). When cabled to a PC, the Detective X appears as a USB flash drive to the PC, so files can be easily transferred with no special software. As is good practice with any flash drive to prevent data corruption, we recommend ejecting the Detective X prior to removing the cable, either with the “Eject” command in Windows File Explorer or the “ Safely Remove Hardware and Eject Media” option.

2.6.5 Detector Cover, Optional Collimators, Filter, and Neutron Detector
The detector cover is a molded, low-density plastic cover that protects the detector endcap from impacts and moisture ingress when it is not protected by a collimator or neutron detector. The cover is held in place with magnets for easy switch-out with collimators or a neutron detector. Simply pull the cover forward and away from the endcap to remove.

The optional collimators, filter, and neutron detector replace the detector cover and protect the detector endcap from damage. Each of these devices mates to the Detective X via the connector shown in Figure 16. The Detective X software reads the connector to recognize which type of device is mounted, records that information in the N42.42 files, and uses the corresponding ambient background file for that device. For more discussion, see Sections 2.4, 2.9, and 2.10.

![Collimator/Filter/Neutron Detector Connector](image)

Figure 16. Collimator/Filter/Neutron Detector Connector

2.7 DETECTIVE X POWER OPTIONS

2.7.1 The Internal Batteries
The Detective X uses two high-capacity lithium-ion (Li-ion) batteries, which charge whenever the unit is connected to external mains or 12-V power. The Detective X can operate for up to 8 hours on a fully charged pair at room temperature. At extremely low temperatures (~20°C), the batteries can operate for up to 5 hours.

A 5-bar LCD display on the end of the battery opposite the charging blades (Figure 17) shows its state of charge, and can be used to distinguish spent batteries from charged ones. The instrument provides audible and visual alerts when the batteries are roughly 90% depleted (approximately 45 minutes remaining). The internal circuitry will not overcharge the batteries, so the Detective X may be left on external power indefinitely.

**NOTE** You may also run the Detective X on one battery at a time, using either battery bay. We encourage you to do so, because it makes the unit almost 1 lb lighter. *This will..."
of course cut the run time in half. However, it’s fast and easy to hot-swap the batteries one-at-a-time without interrupting data collection.\(^1\)

Spare batteries are available from ORTEC (see Section D.7), and the transport case has cutouts for a spare pair. An external dual-battery charger is also available (P/N DETECTIVE-X-ACC-DUAL-CHGR\(^2\)).

To change a battery:

1) Loosen the captive thumbscrews on the rear-panel battery hatch.

2) Grasp the pull tab on the end of the battery and exert a steady pull (do not yank) until it slides out.

3) Orient the fresh battery so the grooves on the side will mate with the charging blades in the battery socket.

4) Slide the battery into the socket, and gently but firmly push to seat it on the charging blades. Do not force the battery into the socket; recheck its orientation if it does not seat easily.

Typical battery lifetime is 3–5 years; see Section D.7 for information on replacing the batteries. See also the discussion on shipping Li-ion batteries in Section 2.12.

Figure 17. Battery Door, Charge State Indicator, and Pull Tab

2.7.2 Vehicle Power Adapter Cable

The 12-V vehicle power adapter cable lets you charge the Detective X from a standard 12-V automobile power receptacle. The plug allows you to adjust the retention force with a slider on the side of the plug (see Fig. 16). Adjust it for a given receptacle so that the plug fits snugly, but not so tightly that inserting the adapter deforms the receptacle. This will provide adequate electrical contact and minimize heating of the connector.

---

1 Note that if you are using two batteries that have different amounts of charge, the Detective X will run on the more charged battery until it matches the discharge state of the other, then the circuitry will begin using both. This is transparent to the user (unless you monitor the charge bars on the back of the batteries).

2 All part numbers subject to change; contact your ORTEC representative or our Global Service Center, or visit our website.
The adapter cable is fused at 10 A. Before using it, inspect the receiving receptacle for damage and excessive wear. Do not try to power the Detective X from a worn or damaged receptacle.

![DC Plug Retention Force Adjustment Slider](image)

**Figure 18. DC Plug Retention Force Adjustment Slider**

### 2.7.3 External Battery Power Option

ORTEC also offers an interface cable for external 2590-type batteries, commonly used for military applications, that will allow the Detective X to operate for up to a total of 16 hours without external power or a battery swap. The part number is DETECTIVE-X-ACC-2590-CABLE.

Please note that the Detective X transport case is not designed for the shipment of these high capacity batteries.

### 2.8 INSTRUMENT ENCLOSURE

The Detective X enclosure is molded from high-impact polycarbonate that absorbs mechanical shock without cracking or permanently deforming, does not degrade under exposure to ultraviolet light (direct sunlight), boasts an F1 rating per UL 746C. With all covers and caps in place, the Detective X enclosure is watertight. The Detective X is not certified for use in explosive atmospheres.

An air plenum through the middle of the instrument provides an exit path for waste heat from the cryogenic cooler. The instrument has a variable-speed cooling fan that pulls cool air through the back of the enclosure and expels warm air through a vent on the bottom. Components inside the plenum (including the cooling fan) are tightly sealed against water and dust ingress. With an IP 65 rating, the Detective X can be used even in heavy rainfall.

A pressure equalization breather is located on the bottom of the instrument to ensure excessive air pressure does not build up inside the unit at high altitudes, as might be encountered during air transport.

The speed of the cooling fan increases under high heat conditions as when initially cooling the detector, decreases under normal conditions, and turns off completely at low ambient temperatures.

Adequate airflow over the cryogenic cooler is important for efficient cooler operation. Always ensure the air can flow freely through the instrument. Failing to do so will result in excessive battery usage and excessive time to initially cool the detector. Never block the air inlet at the back of the unit or the exit vent on the bottom of the instrument. Be aware that placing the unit on a soft surface such as a sofa or even a thick carpeted floor can result in the bottom air vent becoming blocked. It is best to set the unit on its side when resting it on soft surfaces.
2.9 COLLIMATORS (green and pink)

ORTEC offers two standard collimators for the Detective X:

- DETECTIVE-X-ACC-COL-ST  4mm Stainless Steel (colored green; see Figure 19)
- DETECTIVE-X-ACC-COL-W  4mm Tungsten (colored pink)

Collimators reduce sensitivity of the instrument to radiation sources not directly in front of the instrument, enhancing the unit's ability to locate a radiation source.

Both use the magnetic mounting system used for the passive detector cover and the neutron detector, so they are easy to install and remove. Both also mate via a connector (Figure 16) the Detective X software reads to determine collimator type. That information is added to the N42.42 files, and the correct ambient background file is used. Note that before first use of a particular collimator type, you will have to take an ambient background measurement with that collimator installed; see Section 3.11. Until you have run this background, the status area on the screen will say “Background not found.”

The tungsten collimator is the most effective of the two because tungsten is more than twice as dense as stainless steel. Unfortunately, this also means the tungsten collimator is more than twice as heavy, so it may not be as convenient to use in the field.

NOTE
When exposed to low-energy gamma rays, tungsten produces an x-ray with an energy very near the primary energy used for identifying unshielded americium (Am)-241. Therefore, if the Detective X reports an ID for unshielded Am-241 when the tungsten collimator is mounted, be sure to remove the collimator and measure the source again to verify the ID. Sensitivity to a shielded Am-241 source located in front of the instrument is not adversely affected by either collimator.

2.10 LOW-ENERGY FILTER (red)

A low-energy filter is offered for applications where it is important to identify radioactive materials in the presence of very high levels of low-energy gamma rays. This situation often occurs with aged plutonium due to ingrowth of americium. The filter allows the plutonium to be correctly identified even in the presence of high levels of americium that would otherwise produce an overrange alarm (see Section 3.3.4).

The ORTEC part number for the low-energy filter is:

- DETECTIVE-X-ACC-RCFILTER  Graded low-energy shield (colored red)

As with collimators, neutron detector, and the passive detector cover, the low-energy filter is easy to install and remove. The Detective X maintains different ambient background correction files for configurations with and without the low-energy filter. The filter’s connector (Figure 16) identifies it to the Detective X. That information is added to the N42.42 files, and the correct ambient background file is used. Note that before first use of the filter, you must take an ambient background measurement with the filter installed; see Section 3.11.
2.11 OPERATING CAUTIONS AND NOTES

- The integrated computer that controls the ORTEC Detective X is intended exclusively for the tasks detailed in this operator’s manual. Using this computer for any other purpose may void the warranty.
- The Detective X contains no user-serviceable parts. Only the batteries can be changed/replaced. Breaking the seal on the case voids the warranty. The Detective X is to be opened only by ORTEC-authorized service personnel.
- **WARNING** The power adapter/charger must not be exposed to water. When in use, it should be placed on a dry, flat, dust-free surface. When not in use, it should be disconnected from the AC power supply and covered to protect it from moisture and dirt. Any covering used in storage must be completely removed from the power/charging adapter before connecting the power adapter to the input power source. Make sure the power connections for both the Detective X and power adapter are clean and dry before connecting to the input power supply.
- **CAUTION** The Detective X enclosure is waterproof. If all covers and seals, including the detector cover (or neutron detector), are in place, the instrument will operate even after brief immersion in water.
- Keep all rear-panel covers and caps in place, when not in use, to prevent ingress by dust and water.
- The Detective X is designed for use at temperatures between −20°C to +50°C (−4°F to +122°F). It dissipates heat from the cooler via a heat sink enclosed in the fan cooling tunnel. The variable-speed fan pulls air in from the rear panel and exhausts from vents in the bottom of the enclosure. **Do not place the Detective X upright in mud, loose soil or sand, standing water, dense grass; or on thick carpet or any surface that restricts this airflow.** On surfaces such as these, you may place the unit on its side to allow proper airflow. Whenever possible, avoid placing it on a warm or hot surfaces, such as sun-heated pavement, for extended periods. **Do not leave the instrument in a hot vehicle.**
- **CAUTION** To avoid damaging the cooler and to comply with transportation regulations, be sure the cooler is turned off before shipping the Detective X. The unit can be shipped as soon as the cooler is turned off; there is no need to wait until the detector warms up.
- For the answer to any questions about using, maintaining, or shipping this instrument, contact an ORTEC representative or our Global Service Center first. If the Detective X requires service, you must contact ORTEC before returning the instrument. If the original foam-lined transport case is not available, **ORTEC will supply a suitable container.**

2.12 PREPARING THE DETECTIVE X FOR SHIPMENT

**CAUTION** When shipped in either the transport case or alternative packaging, the Detective-X cooler **must be turned off to avoid damage from overheating.** Leaving the cooler on will cause the instrument to quickly overheat, which will damage the instrument and void the warranty.

Detective X should always be shipped in its transport case with the cooler turned off. To turn the cooler off, first turn the unit on (if it is not already on) by holding the power button down for at least 5 seconds. From the settings screen, tap the **Turn Cooler Off** button and answer yes to the “Do you really want to turn the cooler off?” query. Finally, hold the power button for at least 5 seconds to turn the instrument off.
In instances where you are shipping a Detective X back to the factory for service, remove both batteries from the unit and place them in the spare-battery cutouts in the transport case.

**NOTE** The Detective X contains no radioactive sources and no corrosive materials. The refrigeration device contains 108 cm$^3$ of nonflammable, nontoxic helium at a pressure of 2700 kPa, and is exempt from special handling precautions per US DOT 49 CFR 173.307(a)(4).

### 2.12.1 Shipping Li-ion Batteries

Be aware that Li-ion batteries have special requirements for safe shipping. This is the same battery technology used in most cell phones, laptop computers, and other portable devices. Regulations change often to meet new challenges, so be sure you know the current requirements for this type of battery prior to shipping, especially when shipping spare batteries.

The United Nations Committee of Experts on the Transport of Dangerous Goods provides guidance for shipment of Li-ion batteries contained in equipment or packed with equipment under designation UN 3481. (Shipment of Li-ion batteries not installed or packed with equipment is covered by designation UN 3480, which has different and more stringent requirements and is not discussed here.)

As of January 2017, the Detective X with batteries installed and packed in the ORTEC-supplied transport case does not require any special labeling or shipping considerations on common carriers (e.g., FedEx, UPS, DHL) because the device contains only two Li-ion batteries with battery capacity less than 100 Wh each. You may also ship up to two (2) spare batteries in the transport case, by inserting them in the cutouts provided in the foam lining, if you apply an additional Lithium Battery Mark to the transport case, as shown in Figure 20. The bottom of the label should list the telephone number of the person who is responsible for the package and can be contacted to answer questions that may arise during shipping. Compliant labels are available from shipping supply vendors.

Table 1 shows information that may be needed to determine compliance with future regulations.

**Table 1. Battery Specifications (subject to change)**

<table>
<thead>
<tr>
<th>Battery Manufacturer:</th>
<th>Inspired Energy (<a href="http://www.inspired-energy.com">www.inspired-energy.com</a>)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Model Number:</td>
<td>NH2054HD34</td>
</tr>
<tr>
<td>Battery Energy Capacity:</td>
<td>98 Wh per battery</td>
</tr>
<tr>
<td>Battery Weight:</td>
<td>&lt; 0.5 kg</td>
</tr>
<tr>
<td>Instrument Battery Capacity:</td>
<td>2 batteries</td>
</tr>
<tr>
<td>Conformance:</td>
<td>Tested to UN38.3. Certificate of Compliance is available at <a href="http://www.inspired-energy.com">www.inspired-energy.com</a></td>
</tr>
</tbody>
</table>

![Figure 20. Li-ion Battery Shipping Label](image-url)
3. USING THE DETECTIVE X

3.1 USER INPUT

Most users will likely interact with the Detective X by tapping the large touchscreen buttons with a finger. Alternatively, you can operate the instrument using the **Navigate (N)** and **Select (S)** tactile buttons located on the handle, just above the Power button. This is the perhaps the most practical way to operate the instrument while wearing thick gloves. The (N) button is used to move a highlight between onscreen buttons. The (S) button is then used to activate the highlighted onscreen button.

In Figure 22, note the dotted line just inside the perimeter of the onscreen **Settings** button. *This dotted line indicates that the Settings button currently has the highlight.*

- Pressing the (N) button, when the **Settings** button has the highlight, moves the highlight to the onscreen **Identify** button. Pressing (N) again switches the highlight back to the onscreen **Settings** button.
- Pressing the (S) button activates the onscreen button that currently has the highlight.

![Figure 21. (N)avigate and (S)elect Buttons](image)

Some screens allow you to capture alphanumeric data that will be stored in the N42.42 file along with the radiological measurement data. If you have large hands, or are wearing gloves and using the (N)/(S) buttons, you may wish to use the supplied stylus, which is tethered to the carrying strap (Figure 15). Figure 23 shows a typical text-entry screen where the stylus may work best.

![Figure 22. Dotted Line on Settings Button Indicates it is Highlighted and Ready to Select (activate)](image)

You can also enter alphanumeric data with a PC keyboard, when operating the Detective X remotely. This is the most convenient way to enter text, especially complex text such as email addresses. Remote operation offers many benefits, and is discussed in detail in Section 3.8.
3.1.1 Moving Back to the Previous Screen

Many Detective X screens have a Back button. When you select Back, all changes that have been made on that screen are saved without a Yes/No prompt, and you are returned to the previous screen. (This is different than the operation of the back button on internet browsers, which typically abandon any changes unless you click a “save” button.) Therefore, if you make unintended changes on a Detective X screen and do not remember how to restore original value(s), the safest course of action may be to cycle the power off/on rather than pressing the Back button.

3.2 DETECTIVE X SOFTWARE OVERVIEW

Figure 24 provides a simplified roadmap of the Detective X software, as configured by default. The software starts up on the Detect Mode screen. All other screens are accessible from this screen in a hierarchical manner.

- Tapping the Settings button on the Detect Mode screen opens the Settings screen, which gives all users access to the major functions needed to search for and identify radionuclides.

- Tapping the Advanced button opens the Advanced Setup page, which accesses CONOPS-dependent configuration settings and spectrometry functions. Because of this, access to the Advanced Setup page can be password-protected; see Section 3.14.
Almost all Detective X screens show the same of status information at the top of the display. Figure 25 shows the status indicators, which are discussed in the following list.
1) Message space for elapsed time, gain stabilizer status messages under special conditions, and Mobile Field Kit connection status when enabled.

2) System readiness indicator. **Status: READY** indicates the detector is at operating temperature and all hardware and software is ready for use.

3) Screen name.

4) Battery time remaining.

5) Current date and time in Coordinated Universal Time (UTC; also known as Zulu time). Warnings such as high gamma dose-rate are also posted in this part of the screen.

6) Low-Confidence Expert (LCX) mode indicator, displayed when LCX mode is enabled (see Section 3.4.5).

7) Gain stabilizer disabled indicator. Displayed only when the stabilizer has been disabled.

8) Mobile Field Kit connection status. Displayed only when the MFK interface has been enabled. Blue indicates connected. Red indicates not connected.

9) WiFi connection status. Green indicates connected. Grey indicates no connection. Red indicates WiFi has been disabled. Note that WiFi is automatically disabled when a wired network connection is established.

10) Bluetooth headset connection status. Green indicates connected. Grey indicates no connection. Red indicates Bluetooth has been disabled.

11) Speaker enabled or disabled.

12) GPS location determined when green, otherwise red.

13) Power system status. External power with battery charged, external power with battery charging, or battery capacity remaining.

14) Gamma dose rate.

15) Total gamma count rate.

16) Space for overrange and personnel hazard alarms.

The startup screen for Detective X is the Detect Mode screen (Figure 26). All other screens are accessible from this screen in a hierarchical manner. The Detect mode screen is useful for locating and in most cases also identifying radioactive sources. The Detect Mode screen performs a complete analysis of recently collected data twice per second and shows recent history. However, data collected from the Detect Mode screen are not saved. See Section 3.4 for a detailed discussion of Detect Mode.
ID Mode is accessible from the Detect Mode screen via the Identify button. Data collected in ID Mode is always saved. Data collection in ID Mode works differently than in Detect Mode. While Detect Mode only analyzes recent data, ID Mode continues to accumulate data from the time the measurement is started until it is ended. In this way, ID Mode can provide a much more sensitive measurement than Detect Mode and spectral data suitable for analysis by reachback experts. The ID Mode screen also allows the user to view spectral data and a list of the highest intensity energy lines in the gamma-ray spectrum while data is collected. Figure 27 shows the ID screen where data has been accumulating for nearly 19 minutes to identify a very weak source. Data collection is stopped when the End Now button is pressed. Then an opportunity is given to enter free form information about the measurement that will be included in the saved file. See Section 3.5 for a detailed discussion of ID Mode.

The Detect and Identify Modes are each highly customizable. Through various advanced settings the Detective X may be tailored to fit specific concepts of operation.
Here is a list of some of the configurable options the Detective X provides. These settings can easily be deployed to other Detective X instruments using export and import settings functionality. It is a good idea to review this list to determine how the Detective X might best be configured for your particular application. It is also possible to maintain different settings files for use in different applications or different user groups.

- Audible alarms verses none.
- Tactile alarms (vibration) verses none.
- Exposure rates at which Personnel Hazard Alarms are triggered.
- Overriding of default library classification of Innocent and Threat nuclides.
- Manual or automatic file transfer to reachback.
- Reachback organization email address and email server details.
- Mobile Field Kit server communication details.
- Requirement for all alarms to be acknowledged by user verses disappearing when the alarm condition ends. See Section 3.3.
- Collection of data in ID Mode for a specific duration and then end automatically verses collecting data until the user actively stops the data collection.
- Allow multiple measurements to be made in ID Mode (knowns, unknowns, and blanks) and data combined in a single file.
- Allow viewing spectral data on instrument verses not.
- Inclusion of GPS location data in spectra files verses none.
- Password protected Advanced Settings verses open.
- Minimum time to be allotted for ambient background measurements.
- Automatically stabilize on environmental K40.
- Duration of “recently collected data” to be analyzed and charted in Detect Mode.
- Low-Confidence Expert (LCX) Mode to increase sensitivity dramatically in Detect and ID Modes, with the tradeoff of more alarms (includes a host of additional related settings).
- Nuclide to be used for energy calibration.
- Requirement to measure ambient background any time an energy calibration is performed.

3.2.1 Adjusting the Audio and Vibratory Alerts

Audio volume can be adjusted (or turned off) and the vibration can be turned on/off. To do this, navigate to the Advanced Setup screen and tap the Audio button. This will open the page shown in Figure 28.

Settings here are self-explanatory with the possible exception of the Gamma tick sensitivity, which controls the rate at which the simulated survey meter “tick” sound is produced for a given radiation field intensity.
3.2.2 Exiting and Restarting the Detective X Application

Tapping Exit App, from the Advanced Setup screen, takes you to the orange Launcher screen, which is discussed in APPENDIX A. From the Launcher, you can run other ORTEC applications installed on the Detective X’s computer. By default, the only other available application is the Mobile MCB Server, which allows you to use the Detective X as a high-resolution gamma spectrometer. See APPENDIX B for details on using the Mobile MCB Server and accessing the Detective X’s laboratory spectrometer functionality. To return the instrument to its standalone identifier functionality, tap the DetectiveX button on the Launcher screen.

3.3 ALARM CONDITIONS

The conditions that can cause the Detective X to alarm are listed here in order of priority, highest to lowest:

- Personnel Hazard
- System Errors
- Overrange
- Nuclide Identified

Alarms are indicated by messages posted to the display. By default they are accompanied by characteristic, short-duration audio alerts and vibration of the instrument’s handle. When you use the Bluetooth headset, the audio is routed there; and is rerouted to the Detective X when you power down the headset.

By default, alarm messages are displayed as long as the alarm condition exists, and are removed when the condition no longer exist. For example, bringing a source anywhere near the instrument while in Detect Mode will likely result in a “Nuclide Identified” alarm. The Detective X will display the nuclide ID and provide a short audio alarm, and the handle will vibrate for a moment. The nuclide ID will continue to be displayed for as long as it is detected. When the source is removed from the area, the nuclide ID will be removed from the screen.
3.3.1 Require Alarms to be Acknowledged?

You can choose whether or not to require all alarms be acknowledged. If you enable the Require acknowledge option, alarms will be latched; and an Acknowledge button, color coded according to the nuclide ID threat level, will be displayed at the bottom of the Detect Mode and ID Mode screens. Alarms will be presented for acknowledgment, one at a time in order of alarm priority. The alarm message will not disappear until the user taps the Acknowledge button. In addition, audio and vibratory indications will persist until the alarm is acknowledged.

To enable/disable alarm acknowledgement, navigate to the Advanced Setup screen and tap Analysis. This will open the Analysis Settings screen (Figure 29). Tap to mark/unmark the Require acknowledge checkbox.

![Figure 29. Setting the Require Acknowledge Flag](image)

3.3.2 Personnel Hazard Alarm

The Personnel Hazard alarm is shown in Figure 30. By default, this alarm is triggered when gamma dose rate exceeds 10 µSv/hr or neutron flux rate exceeds 25 nps/cm². These thresholds (and units for gamma dose rate) are adjustable from the Advanced Setup page by tapping the Dose Alarms button. With the default values, the personnel hazard alarm will occur before the overrange alarm, which is fixed at an exposure rate of 2 mR/hr (about 17 µSv/hr dose).

The Personnel Hazard Alarm is indicated by messages on all screens that include the status header. It is accompanied by short-duration audio and vibratory alarms (if enabled). Note that the gamma dose-rate meter in the display header will continue to be updated with the current dose rate.

If the unit is configured to require all alarms to be acknowledged, a full-screen alarm (Figure 31) will be displayed with audio and vibratory alarms if enabled that persist until acknowledged by the user. Messages in the header will persist as long as the hazard condition exists.
3.3.3 System Errors

System Errors refer to conditions that indicate that the system is in a degraded or non-operational state as noted below.

- The Cooler Is Turned Off
- Internal System Error
- Error Retrieving Health
- Error Retrieving Data
- Bias Voltage Error
- Low Battery!
- USB Flash Storage is Low!

- USB Storage is missing!
- +12 Volt Error
- −12 Volt Error
- +3 Volt Error
- Detector Temp High
- New Background Required
- Ge Background Error
• Neutron Background Error
• Neutron State-of-Health Error
• GM Tube Background Error
• Stabilizer Error

The system constantly checks for the error conditions listed above. As long as all of these self-tests pass and the instrument is operating properly, the status is reported as READY.

Alarm messages are displayed under the gamma count-rate meter in the display header, and are accompanied by short-duration audio and vibratory alarms (if enabled). The instrument status changes to NOT READY and any affected functions are disabled. An alarm message persists as long as the error condition exists. When there are multiple simultaneous error conditions, the Detective X cycles through the error messages one-at-a-time.

If the unit is configured to require all alarms to be acknowledged by the user, the acknowledge button will latch the system error and audio and vibratory alarms will persist if enabled until acknowledged. The user may have to return to the Detect Mode screen to silence the alarm by acknowledging the system error. Once acknowledged, the error message in the header will persist as long as the error condition exists.

![Detection Mode Screen](image)

Figure 32. Example of System Error

### 3.3.4 Overrange Alarm

Overrange alarms are indications of radiation exposure rates so high that instrument performance is degraded. Gamma Over-range alarms are triggered at a fixed gamma exposure rate of 2 mR/h. At this exposure rate, the HPGe detector’s dead time is so high that it cannot efficiently generate nuclide IDs. Neutron Over-range alarms are triggered only when the neutron detector is installed, and at a neutron exposure rate greater than 1000 nps/cm².

**CAUTION** Neutron exposure rates in excess of this value will permanently degrade resolution of the HPGe detector after several hours.

The appropriate action in either case is to move away from the source to a point where the alarm is no longer triggered. Recovery from an overrange alarm is immediate; as soon as you increase the distance from the Detective X to the source enough that the overrange message disappears, the unit returns to READY status.
The alarm message **Warning! Over-Range!** (Figure 33) is accompanied by short-duration audio and vibratory alarms (if enabled). The alarm also shows up as a red threat ID in both Detect and ID Modes.

![Figure 33. Overrange Condition](image)

If the unit is configured to require you to acknowledge all alarms, a **Detector Over-Range Alarm!!!** message will overwrite the IDs Box (Figure 34) and latch the condition. Audio and vibratory alarms (if enabled) will persist until you tap the **Acknowledge** button.

You may then have to return to the Detect Mode screen to silence the alarm by acknowledging the condition. Once acknowledged, the **Warning! Over-Range!** message in the header will persist as long as the condition exists.

![Figure 34. Overrange Alarm with Acknowledge Button](image)

**NOTE**  
The gamma dose-rate meter in the display header will continue to function up to and beyond exposure rates of 1 R/hr, even as the instrument’s ability to identify radiation sources is increasingly compromised and, at very high gamma count rates, drops to zero.
3.3.5 Nuclide-Identified Alarm

When the instrument is in either Detect Mode or ID Mode, it continuously analyzes the acquired data and when a nuclide is identified, it will report the nuclide name in the identification list. This will be accompanied by a short-duration audio and vibratory alarm (if enabled). The identification will remain in the list until the source is no longer in the field of view.

In cases where the instrument is on the edge of a detection, and the ID comes and goes, audio/vibratory alarms will not be retriggered unless the identification falls out of the list for more than 15 seconds (consistent with the duration of the Signal Index and SNM Index charts.)

If the unit is configured to require you to acknowledge all alarms, the Acknowledge button will latch the nuclide ID, and audio and vibratory alarms (if enabled) will persist until you tap the button.

In the case of multiple simultaneous IDs, the Acknowledge button will present the highest-priority (i.e., highest threat-level) nuclides for acknowledgment first.

![Diagram](image.jpg)

**Figure 35. Co-60 Identification Latched by the Acknowledge Button**

3.4 DETECT MODE

The Detect Mode screen (Figure 36) is the startup screen. Use it to survey areas and fixed or moving objects for sources of radioactivity.

The Detect Mode screen displays Signal Index and SNM Index strip charts in the middle of the screen. They are real-time indicators of the presence of radioactive material, updating every 0.5 second and scrolling from right to left.

- The Signal Index (Section 3.4.1) indicates the presence, above background, of all gamma-ray emissions.
- The SNM Index (Section 3.4.2) indicates whether detected gamma-ray emissions are characteristic of Special Nuclear Material. If the neutron detector is attached, the neutron flux is included in the SNM Index calculation.
When radioactive nuclides are identified during the search process, the IDs appear in the section below the strip charts. Note the potassium (K)-40 identification in Figure 36. These IDs are present as long as the material remains in the detector field of view, then are removed from the screen.

**IMPORTANT** These strip charts are indirect indicators to be used as quick visual tools, not as count-rate or dose-rate meters for the protection of human health!

### 3.4.1 The Signal Index

The Signal Index reflects the level of the gamma ray flux, as the detector receives more or fewer gamma ray interactions the signal index increases and decreases.

The Signal Index (Figure 37) is based on the total background-subtracted gamma-ray count rate for all threat and innocent nuclides, as well as gamma rays emitted by radionuclides that may not be included in the software’s Identification Table. The vertical scale is logarithmic, and the peak height increases as the distance between the Detective X and a gamma-ray source decreases (whether you are moving closer to the source or vice versa). The index value on the right is dimensionless, and is provided for comparison purposes only. The horizontal scale is linear in time for a total time of 15 seconds.

When a nuclide ID alarm is generated, the background color for that section of the chart will change from white to red for a threat ID, green for an innocent ID, or yellow for a suspect ID. This background color will persist for as long as the radionuclide is present in the detector’s field of view. Note that suspect IDs are only generated when the LCX analysis mode (Section 3.4.5) is enabled.
3.4.2 The SNM Index

The SNM Index is a function of the maximum confidence factor (Q value) for all SNM indicators in the Identification Table. These include U, Pu, Np, Am, and neutrons. The SNM Index (Figure 38) works the same way the Signal Index does, but is filtered to reflect only those gamma (and neutron) IDs characteristic of the Special Nuclear Material radionuclides in the ID tables.

![Figure 38. The SNM Index Strip Chart History and Current Level](image)

3.4.3 Identification (IDs) Box

The IDs Box list all nuclides currently in the detector’s field of view.

![Figure 39. IDs Box](image)

Each row in the IDs Box contains the following:

**Classification, ID String, Sub-Classification, Q Value**

Classification values are defined as:
- Innocent (reported as I), with a green background
- Suspect (reported as S), with a yellow background
- Threat (reported as T), with a red background

ID String:
- Nuclide name from the Identification Table (see APPENDIX E)

Sub-Classification values are defined as:
- Bremsstrahlung (reported as Brem.)
- Industrial (reported as Ind.)
- Medical (reported as Med.)
- Neptunium (reported as Np.)
- NORM (reported as NORM)
- Other (reported as Oth.)

---

• Plutonium (reported as Pu)
• Thorium (reported as Th)
• Uranium (reported as U)

The Q value (confidence factor) will be displayed to 1 decimal place on the right side of the ID listing. For nuclides with only one primary peak, this confidence level is the net counts in the peak divided by the peak uncertainty. As the net counts in the peak increase, the uncertainty decreases and the confidence level correspondingly increases.

**IMPORTANT** The confidence value stored in the N42.42 file is the displayed Q value divided by 100 so the file will meet the schema requirements. Although uncommon, Q values greater than 100 all result in a maximum valid stored N42.42 file confidence value of 1.

In cases where there are multiple IDs and simultaneous alarms, the index charts will display the color of the highest priority alarm, and the highest-priority (highest threat-level) alarms will be displayed first in the list, as illustrated in Figure 40.

Note that an ID will be removed from the IDs Box when the corresponding source leaves the detector field of view. However, the acknowledge button (if enabled) will continue to display the ID until you have acknowledged it. Moreover, the Identify button will be disabled until all alarms have been acknowledged.

If more than 2 nuclides are identified, a scroll bar will be displayed on the right edge of the box so you can scroll down and view all entries.

### 3.4.4 Detect Mode Integration Time

By default, Detect Mode analyzes data collected over the last 8 seconds, and repeats this every 0.5 second. Detect Mode is suited to situations where the instrument is being moved in relation to a radioactive source. Ideally, the integration time should be matched to the amount of time a possible point source would be in the field of view of the detector. For typical search scenarios, where an operator is carrying the instrument and slowly walking past a source that is perhaps 1 m (3 ft) away, an 8-second integration time is a reasonable choice.
value. As distance to the source increases or as speed decreases, a longer integration time will produce better sensitivity. In scenarios where the source might be speeding past the instrument in close proximity, a shorter integration time will be better.

To change the Integration time:

- From the Advanced Setup screen, tap Analysis to open the page shown in Figure 41.
- Tap and drag the slider to adjust the Integration time from 1 to 30 seconds. Note that this integration time has no effect in ID Mode.

![Figure 41. Detect Mode Integration Time](image)

### 3.4.5 Low-Confidence Expert (LCX) Mode

For instances where false negatives must be eliminated at all cost, the Detective X provides a special “low-confidence” analysis mode, intended for use by experienced spectroscopists. In LCX Mode, a new “Suspect” class of nuclide ID alarm is presented by the Detective X. A suspect alarm is generated when a threat nuclide is identified at a lower confidence level than that required for the standard analysis mode’s high-confidence threat ID alarm. When enabled, LCX Mode operates in both Detect Mode and ID Mode.

Suspect alarms are posted on the display with a yellow background, as illustrated in Figure 42. Presenting these yellow suspect alarms, in addition to the normal, high-confidence ID alarms for Innocent (green) and Threat (red) nuclides, makes it easy to determine the information being added by enabling LCX Mode.

**NOTE** While these additional suspect alarms can dramatically increase detection probability, they can also increase false alarm probability. Therefore, we strongly recommend experimenting with this mode before widely deploying it.
3. USING THE DETECTIVE X

3.4.5.1 CUSTOMIZING LCX MODE

In addition to providing suspect alarms for threat nuclides, LCX Mode adds additional suspect alarms based on unqualified peaks in the energy spectrum associated with threat materials. These alarms can be used to increase sensitivity even further. Individual thresholds may be set for each item. The threshold for a yellow suspect neutron alarm can also be adjusted here, by tapping and dragging the slider, to provide more sensitivity from the neutron detector.
**NOTE**  These alarms indicate the presence of peaks only, without any interference or background corrections. For example, **186 peak detected** does not necessarily indicate that U-235 is present; it may instead be that the instrument is seeing one of several nuclides that emit a gamma ray near 186 keV.

Tabs are divided by gamma-ray energy, each of which is associated with a specific radionuclide. Some tabs include an enable/disable checkbox that allows you to exclude that peak. Unmarking the checkbox stops the peak (for example, the 1001-keV peak) from being reported at all. Table 2 shows the nuclides associated with the energies on the tabs.

<table>
<thead>
<tr>
<th>Energy (keV)</th>
<th>Nuclide</th>
</tr>
</thead>
<tbody>
<tr>
<td>375/414</td>
<td>Plutonium</td>
</tr>
<tr>
<td>186</td>
<td>Uranium</td>
</tr>
<tr>
<td>356</td>
<td>Barium (test and demonstration)</td>
</tr>
<tr>
<td>1001</td>
<td>Uranium</td>
</tr>
<tr>
<td>661/722</td>
<td>Americium</td>
</tr>
<tr>
<td>Neutron</td>
<td>Any</td>
</tr>
</tbody>
</table>

### 3.5 IDENTIFY MODE

From the Detect Mode screen, tapping the **Identify** button displays the ID Mode screen (Figure 44). Use this mode to identify radionuclides by counting an object or area of interest from a stationary position for an extended time. Data is acquired for a preset time or until you manually stop the acquisition (see Section 3.5.3).

The ID Mode screen has an **IDs Box** similar to that on the Detect Mode screen. However, because all of the data accumulated from the start of this ID Mode session is analyzed (rather than only the last few seconds of data, as in Detect Mode), **nuclide IDs rarely drop out of the IDs Box in this mode**.

![Figure 44. ID Mode Screen](image-url)
3. USING THE DETECTIVE X

- For best results, position the Detective X as close as reasonably possible to low-activity sources.
- For high-activity sources, a **WARNING! Move Back** message may be displayed above the Status: READY indicator if you are too close. You will obtain better ID performance if, before entering ID Mode, you move back from the source until the message disappears.
- If alarm acknowledgement is enabled (Section 3.3.1), the Ack (acknowledge) button will be displayed (refer back to Figure 40) and you must acknowledge each ID before proceeding, just as in Detect Mode.
- While acquiring data in ID Mode, you can also tap the Spectrum radio button to view the spectrum in real time (Section 3.5.1); or tap Intense to view the 10 highest-confidence gamma-ray lines in real time (Section 3.5.2).

3.5.1 Spectrum View

The Spectrum view (Figure 45) shows the histogram of the gamma-ray energy spectrum being acquired in real time. To display the spectrum, simply tap the Spectrum radio button. This feature gives experienced users more information about the nuclides present so more informed decisions can be made about the material under investigation.

**NOTE** In cases where you do not want operators to view the spectrum, you can disable the Spectrum radio button on the Password Settings page under Advanced Setup (Section 3.14).

The spectrum window has a vertical marker line and the bottom of the screen displays the position of the marker in energy (keV) and the number of counts in the marker channel. To move the marker to a different location, tap the desired position. The marker will move and the energy and counts-per-channel will update. The operator can also tap and drag the marker left or right to a new location. These operations are typically more practical when remotely controlling the instrument from a PC. (See Section 3.8.)

![Figure 45. Entire Spectrum Displayed (showing marker position and channel content)](image)

The spectrum display control buttons are just below the spectrum window. Their function is to change the display in different ways for better interpretation of the spectrum.
The control button functions are:

- **Full/Zoom** — In the expanded view, the Full button restores the display to 16K channels. (see Figure 45) In the full view, the Full button changes to Zoom and vice versa. When the Zoom button is selected, it focuses the screen to the region surrounding the marker (see Figure 46). Tapping the Full button returns to the 16K-channel spectrum view. In this way, you can easily look at the peaks in the spectrum in detail, or move quickly from energy to energy in Full mode.

- **Zoom In <>** — The <> button expands the display by halving the number of channels displayed, so the peaks appear wider. The center channel of the new display will be the marker position.

- **Zoom Out >>** — The >> button contracts the display by doubling the number of channels displayed, so the peaks appear narrower. The center channel of the new display will be the marker position. Channel zero (0) is the leftmost side of the display, and channel 16384 is the rightmost side of the display.

- **Lin/Log** — This button toggles the spectrum’s vertical scale between linear mode, which automatically adjusts the vertical scale limit based on the tallest peak in the spectrum; and logarithmic mode.

![Figure 46. Expanded Spectrum with Marker near 398 keV (with logarithmic vertical scaling)](image)

### 3.5.2 Intense View

Tapping the Intense button displays a continuously updating list of the 10 highest-confidence peaks currently being detected. The Energy and Confidence are ordered by highest to lowest confidence level; and displayed in two columns, left-to-right then down, so you can see all of the peaks at a glance (see Figure 47). As discussed earlier, the confidence level is the net counts in the peak divided by the peak uncertainty. As the net counts in the peak increase, the uncertainty decreases and the confidence level increases proportionally.
3. USING THE DETECTIVE X

3.5.3 Ending the ID Mode Measurement Manually or Automatically

Advanced operators can use the spectral display and top peaks list to guide them in choosing how long they need to accumulate data in ID Mode. Optionally, a fixed counting time (a counting preset) can be specified; this is more practical in many instances because it removes time subjectivity in making measurements. Enter the fixed counting preset on the Analysis Settings page (Figure 48), which is accessed from the Advanced Setup page. The Identify preset field is blank by default, indicating no counting preset has been set (or you can disable the preset by entering a value of zero [0] seconds). Tapping the Identify preset field pops up a numeric keypad so you can enter the desired count time.

3.5.3.1 CAPTURING OPTIONAL METADATA

The Detective X can generate a lot of data quickly. To help make sense of it later, you may find it useful to capture useful information about the spectrum you are collecting at the time you collect it. For this reason,
when the ID Mode acquisition ends, the screen shown in Figure 49 opens to give you the option of capturing several kinds of information that will be saved along with the radiological data in the N42.42 file.

![Figure 49. Optional Metadata for ID Mode Data](image)

To add a new **Location**, **Item description**, or **Condition**, tap the associated **Edit** button to open the data entry field. After that, recent entries for each field will be available on a droplist by tapping the down arrow next to the field.

When you are finished entering metadata, tap **Finish** to save it and return to the Detect Mode screen.

Prior to setup, the **Reachback** button will be disabled (gray), as shown in Figure 49. Section 3.9 covers setup of reachback data transfer for ID Mode measurements.

### 3.5.4 Multiple ID Measurements in One Data File

For very high levels of measurement confidence, the Detective X has a **Multiple spectra analysis** option that lets you wrap data collected from an unknown sample with that collected from a blank sample and a known sample, and save the data from each related measurement in the same N42.42 data file.

To configure the Detective X for this mode of operation:

- On the Advanced Setup screen, tap **Analysis** to open the Analysis Settings page, then tap to mark **Multiple spectra analysis** checkbox. See Figure 50.
- In this mode, each time you enter ID Mode, the Multi ID Mode page shown in Figure 51 will be displayed so you can set up and annotate the multiple measurements to be made.

#### 3.5.4.1 Setting Up and Performing Multiple Measurements

The Multi ID Mode page allows you to define and collect a series of spectra, one at a time, until you have collected the desired data set. The software then saves all of the spectra and metadata in a single N42.42 file.

To set up and perform this type of measurement:

1) Select the desired category of spectrum from the **Next spectrum type** field. The options are **Blank**, **Known**, and **Unknown**. A typical measurement series might consist of one Blank, one Known, and one or
more Unknowns. However, there are no restrictions on what type or how many of each type of spectra go into the Multi ID Mode measurement file.

Figure 50. Enable Collection of Multiple Spectra in a Single File

Figure 51. Set Up Parameters for Multiple Spectrum ID Mode

2) Assign a name to this spectrum in the Next spectrum label field. This is a free-form field that allows you to enter information about the spectrum you are about to collect. The field is initially populated with the text used the last time this type of spectrum was acquired. Recent entries for each spectrum type are available by tapping the down arrow on the right side of the field, or you can enter a new label by tapping the Edit button.

3) Enter a preset count time for this acquisition, in seconds, in the Next time preset field; or leave the field blank or enter a zero (0) if you intend to manually stop data collection. Note that the Identify preset count time on the Analysis Settings page is ignored when you are in multiple-spectrum ID Mode.

The field is initially populated with the time used the last time this type of spectrum was acquired. Recent entries for each spectrum type are available by tapping the down arrow on the right side of the field, or you can enter a new label by tapping the Edit button.
4) You are now ready to acquire the spectrum. Position the source (or blank), remove all other nearby sources, then tap the lower-right Collect [spectrum type] Sample button (the button label will depend on the spectrum type selected). The ID Mode screen (Figure 44) will be displayed. Wait for the count preset to elapse or tap End Now to manually stop data acquisition.

5) When spectrum acquisition is complete, the screen will switch to the Multi ID Mode screen (Figure 51), and wait for you to enter information for the next spectrum. The bottom-left Spectra counter will track the number of spectra you have added to the file so far; and the Back button will change to Finalize.

6) Each time you acquire a spectrum on a blank sample, its spectrum is saved internally. You can then tap Last Blank to add it to the current N42.42 file, or to any subsequent file until the next blank spectrum is acquired. Known spectra are handled the same way, and you can tap Last Known to add the most recent known spectrum to the current file or to any subsequent file until the next known spectrum is collected. This feature saves you the time of unnecessarily repeating blank and known measurements.

7) After all spectra have been added to the file, tap Finalize. This will take you to the optional metadata page shown in Figure 49, where you can enter additional information.

8) To complete the multiple-spectrum measurement, tap the Finish button to return to Detect Mode.

3.6 MANUAL DATA FILE TRANSFER

The Detective X saves all data collected in ID Mode. Data files are saved in ANSI N42.42-2012 format. Files will have a background spectrum and one or more measurement spectra. The filename format is:

XXXXXX_YYYY_MM_DD_HH_MM_SSS

where the 7 Xs represent an ever-increasing counter, and the remaining string is the UTC date-time stamp.

The spectral file can be viewed with U.S. government-supplied software; MCA emulation software such as Los Alamos National Laboratory’s PeakEasy or Sandia National Laboratory’s Cambio; or our GammaVision® Gamma-Ray Spectrum Analysis and MCA Emulator application (A66-BW).

Data files can be accessed in several ways with Detective X. Perhaps the easiest way to gain access to the files is to configure the system to email data files as discussed in Section 3.9. The files are also accessible via the USB port behind the IO access panel on the rear of the instrument. Refer back to Figure 5.

With the instrument in Detect Mode, use the USB cable included with the instrument to connect a PC to the Detective X. No special drivers are required. The Detective X will then automatically relinquish control of its flash drive to the PC. Logically, the Detective X will appear as a flash drive to the PC; and files can be copied, deleted, renamed, etc., using Windows File Explorer or any other tool on the PC. Instrument status while connected to the PC will show NOT READY because, in this mode, Detective X file storage is available only to the PC. When ready to disconnect from the PC, do so by ejecting the Detective X in File Explorer or by using the Windows “Safely Remove Hardware and Eject Media” feature. The Detective X will be of type Mass Storage Device, with the DET X FLASH label.) Then disconnect the USB cable and replace the hatch covering the data ports.

Yet another alternative for accessing data files is to physically remove the flash drive from the Detective X and plug it into a USB port on a PC. We do not recommend this method because the removal of the device occurs without warning to the Detective X software, and there is a small possibility of file corruption when
the flash drive is removed. This method does however ensure all collected data is completely removed from the Detective X — a feature that may be important for some users.

**NOTE** The Detective X will show a **NOT READY** status until either the original flash drive is replaced or a new one is inserted. Spare flash drives are available from ORTEC as part number DETECTIVE-X-ACC-16GB-USBFLASH. **Do not use an aftermarket flash drive.**

When remotely controlling a Detective X from a PC, the entire file system on the unit can be accessed with the WiseMo Guest application discussed in Section 3.8. Flash drive contents are displayed under a folder named `C:\Hard Disk\`. This method allows you to access files at the same time the Detective X software is fully functional.

### 3.7 CONNECTING THE DETECTIVE X TO A NETWORK

Even though Detective X does not require a network connection, operation is significantly enhanced when the instrument is connected to a network, and further enhanced if the network gives you access to the internet. You can connect to a network either through a wired Ethernet connection or through a WiFi network. Most mobile phones can be used as WiFi hotspots; this type of internet connection is ideal from a convenience standpoint. However, if a high level of data security and portability are important, the Detective X’s wired Ethernet connection can be routed to an encrypted radio or a satellite phone.

Detective X features that require network access include reachback email notifications, remote control, and Mobile Field Kit interactions. You can also manually transfer data files via a network connection.

Typically, the easiest way to network enable a Detective X is to simply plug a site infrastructure RJ45 Ethernet cable into the unit’s rear panel. The wired connection is enabled by default on the Detective X, and it will automatically obtain appropriate settings from the DHCP server on the host network. This type of connection is useful in a CONOPS where users collect data in the field, then return to an office to send queued data to the reachback organization. After just a few setup steps (see Section 3.9), you can simply connect the Ethernet cable and the Detective X will send emails to the reachback organization automatically. The wired Ethernet connection can also be configured for more specialized applications that require the Detective X to use a fixed IP address and associated settings.

Network settings and information are available via the Communications button located on the Settings page. The Wired Ethernet tab for this page is shown below for a connected Detective X. The Configure Ethernet button can be used in instances where DHCP should not be used to determine network settings. Notice that the WiFi status icon in the top right of the display shows red meaning disabled. All WiFi network connections are automatically disabled any time a wired connection is made to prevent bridging between networks at potentially different security levels.
Connection to WiFi networks requires an extra step to first identify the target WiFi network. Select the WiFi tab on the communications settings tab. Check the box to enable WiFi and then tap the **Configure WiFi** button. This brings up screen that list all available WiFi networks. Tap the button to the left of the desired network name and the system will connect and request credentials if the network is secured. Use the **Add a network...** button to access hidden WiFi networks.

Use the back arrow in the upper left corner of this screen to return to the Detective X Communications Settings page. The **Browser** button here can be used to verify internet access. Some public networks require credential entry from the browser prior to granting full internet access.
The IP address assigned to the Detective X and displayed on this screen will be required later in setting up remote control operation. The connection will automatically be reestablished after a power cycle of the Detective X.

**NOTE** If the connection is lost due to low signal, it will be necessary to enter the Configure WiFi screen once again to reestablish connection.

### 3.8 REMOTE CONTROL OF DETECTIVE X

Remote control of Detective X is extremely convenient for a number of tasks. Detective X is preloaded with the WiseMo Host application which allows other devices to control it remotely over a network connection. Internet access is not necessary for remote control of the unit.

Remote control is disabled by default on the Detective X for security reasons. To enable remote control, access the WiseMo tab on the Communications settings page and check the box to Enable WiseMo.
When this box is checked, the WiseMo Host application will be made visible. See Figure 56. Tap the Hide icon to return to the Detective X software application and leave the WiseMo software running in the background, ready to connect to a WiseMo Guest application running on a remote machine.

![WiseMo Host Application](image)

**Figure 56. WiseMo Host Application**

To remotely control the Detective X, it is necessary for the guest system (the system controlling the Detective X) to run a WiseMo Guest application. The application is available free for iOS devices from the Apple App Store and Android devices on Google Play. Search for “wisemo”. Free trials of the PC based guest application are available from [www.wisemo.com](http://www.wisemo.com) (choose offline-only connectivity as Detective X does not support iCloud connections). Perpetual licenses are available for a very reasonable fee (SKU WR2WOLP-170).

The Detective X and the PC must connected to the same network for remote control. The main window for the WiseMo Guest application is shown in Figure 57. To connect, first click on All connections on the left side panel. Find the IP address reported on the WiFi tab of the Detective X Communications Settings page (or the Wired Ethernet tab, if appropriate for your connection) when the instrument is connected to the network. Enter this IP address in the Guest application window and press the connect button. When contact is made with the Detective X, a password will be requested. All Detective X instruments use the same password for this purpose: **ortec**
Figure 57. PC-Based WiseMo Guest Application

The remote desktop window is shown in Figure 58. The default skin is more appropriate for a mobile phone than a radionuclide identifier, but functions as needed. To remove the skin, choose **Do not use skin** on the Display tab of the Wisemo Guest Connection Properties dialog. (Connection must be reestablished before changes here take effect.)
Figure 58. PC-Based Remote Desktop Window with Default Skin

The WiseMo Guest iOS app works in a manner similar to the PC-based version, and is shown in Figure 59. Connecting the Detective X to a mobile phone provided WiFi hot spot and then controlling the Detective X from that phone using the WiseMo Guest app is very convenient for some applications.

Figure 59. iOS WiseMo Guest App on iPhone Connected to Detective X

The WiseMo Guest application provides a wide range of functionality in addition to remote control. Some of this functionality can be very useful. Unfortunately, the Guest application provides full access to many items on the Detective X that we strongly recommend users do not change. For many applications, this functionality is best left disabled, when not in use, for security purposes. Remote control can be disabled on the Detective X on the WiseMo tab of the Communication Settings page. Simply unmark the **Enable WiseMo** checkbox and confirm to exit the WiseMo Host application. You can re-enable functionality at any time by marking the same box. This will restart the WiseMo Host application. Press the **Hide** button to return to the Detective X application.
3.9 REACHBACK EMAIL SETUP

Once a Detective X is connected to the internet, it can email measurement data collected in ID Mode anywhere in the world for further analysis. When the instrument is not connected to the internet, it can queue data until a later time when it is connected.

Setup for reachback email is simple.

![Reachback Settings](image)

Figure 60. Reachback Settings

Figure 60 shows the reachback settings page accessible through the Advanced settings button. All that is required to enable reachback emails is to enter valid destination and the reply-to email addresses. The reply-to email address becomes the destination of an email when the receiver chooses to reply to the message sent by the Detective X. This would typically be an email address monitored by the operator of the instrument. The operator name and operator contact numbers are optional free form fields to help the receiver identify the source of the email message. By default, measurement data must be manually queued for reachback and a button to perform this task is provided after data is collected in ID Mode. Previously collected data can also be queued for reachback on the Recall Settings page. The instrument can also be configured to automatically send ID Mode data to reachback.

Figure 61 shows the email as received. The attached spectrum file is saved in ANSI N42.42 format, which is compatible with the ANSI N42.42-2012 standard. The file will have a background spectrum and one or more measurement spectra. The filename format is: XXXXXXX_YYYY_MM_DD_HH_MM_SSS. Note that the date and time stamp used in the spectrum name is UTC (Zulu) time.

As noted earlier, the spectral file can be viewed with U.S. government-supplied software; MCA emulation software such as PeakEasy and Cambio, or our GammaVision application.
Figure 61. Reachback Email

3.9.1 SMTP Server for Reachback Email

The Detective X sends email using a standard SMTP protocol. Detective X sends the email message to an SMTP server and then the SMTP server routes the message to its recipient. By default, messages are sent to an ORTEC managed SMTP server using the reachback@ortec-online.com account. We strongly recommend that you modify the settings to use a private SMTP server instead. This task need not be done during initial startup, but should be completed prior to deploying the Detective X to the field.

The process for changing the SMTP server used by Detective X involves exporting the Settings.txt file from the Adv. Setup page (see Figure 62), editing that file to specify a new server, then re-importing the modified settings file. Relevant lines in the Settings.txt file are shown below, with sample values provided. Actual values will be supplied by your email provider.

DefaultEnableSsl STRING True
DefaultSenderEmailAddress STRING someone@somewhere.com
DefaultSmtpPassword STRING ThePassword

***NOTICE*** This came from an external source. Use caution when replying, clicking links, or opening attachments.
DefaultSmtpPort STRING 70
DefaultSmtpServerAddress STRING smtpout.secureserver.net
DefaultSmtpUsername STRING someone@somewhere.com

The easiest way to modify these settings is to start a PC-based remote control session. Then select the Expt. Settings button on the Advanced Setup page to save a current settings file to the Detective X flash drive. In the remote control window, click the File Transfer button ( ) on the left side of the toolbar.

![Remote Control Window](image)

**Figure 62. Remote Control Window**

Find the Setting.txt file located in the C:\Hard Disk\ folder. Double-click the file to open it in Notepad and enter relevant values for the new SMTP server. Close the Notepad window and save changes.

![WiseMo File Manager](image)

**Figure 63. WiseMo File Manager**

Select the Impt. Settings button to import the modified settings. Cycle power so the new settings will take effect and manually send a file to reachback to test operation.
3.10 RECALLING PREVIOUSLY COLLECTED DATA FILES

The Recall page accessible from Settings allows you to sort through all of your data. Key data can be manually sent to reachback from here, and data collected in error can be deleted.

The first Recall screen simply list all data that resides on the machine in chronological order with newest data files at the top. Remember that file names are simply the encoded time/date when the file was saved. When searching for a particular data set or group of data sets, the initial Recall screen will be used to scroll through lots of data files quickly. The operator will then select a data file with a time/date in the neighborhood of file(s) of interest and then tap the Details button.

The Recall Details screen then allows the operator to move through data sets one at a time to zero in on particular data sets of interest. See Figure 64.

Information about each data set is displayed here one data set at a time. The operator can see whether or not the file has already been sent to reachback, operator entered meta data associated with the data set, and nuclide identifications made while collecting the data. Identifications made on Blank and Known spectrum types in multiple-spectrum mode are excluded from this list of identifications.

3.11 MEASURING AMBIENT BACKGROUND

A valid and representative background is important in the analysis of the spectrum in the detect and identify modes. Detective X maintains separate background data for each accessory potentially mounted to the front of the unit (neutron detector, collimators, passive detector cover). If an accessory is mounted to the front of the unit with which no background data has been collected, the unit will show a “No Background!” error and status will be NOT READY until background is collected with the particular accessory mounted. Note that Detect Mode will continue to function in this instance but ambient background could be misinterpreted as NORM. Identify Mode cannot be entered without applicable ambient background data.

The Background Calibration screen is accessed from the Settings screen, and data collection begins immediately. See Figure 65. The screen displays a simple histogram output of the live spectra. The operator may touch the screen to select a given channel which results in the channel number and channel counts being
displayed on the bottom of the screen. To abort the background collection, just tap the **Back** button and confirm. Background data from a previously completed collection will continue to be used in this case. By default, background data must be collected for at least 30 minutes before it can be saved; and data collection will continue beyond 30 minutes until you end the measurement and save it. In general, the longer background data are allowed to accumulate, the better.

Figure 65. Background Collection for Use in Analysis

When the background collection is complete, the system analyzes the spectrum to determine if there is enough K-40 in the background to enable the system gain stabilizer. This will be the case for most all situations with maritime applications presenting the potential exception. If sufficient K-40 is not found in the background spectrum, the gain stabilizer will be disabled.

Background collection can be customized on the Background Settings page accessible from Advanced Setup. See Figure 66.

For some applications, a 30-minute background collection is impractical and a shorter time can be specified here. Realize that shorter background times carry with them a risk in that ambient background may not be optimally characterized. Short background times may not allow optimization of detection probability and false alarm probability for naturally occurring nuclides (including uranium). Also, very short background times may not allow accurate determination of K-40 activity and so the gain stabilizer may not be enabled in instances where it really should be enabled.

By default, the system will continue to acquire background data until the operator specifically ends the acquisition recognizing that more time is better. In some instances this behavior may not be preferred. The longer data is acquired prior to saving, the more opportunity exists for things to go wrong (such as a coworker passing by the instrument with a check source in hand or batteries expiring). This screen allows the system to be configured to automatically end and save background data once the minimum time has elapsed.
For special cases, the gain stabilizer can be completely disabled from this screen. *Gain stabilization is highly recommended where ID performance is important.* However, if you are collecting spectral data simply for analysis by a reachback organization, where known and blank spectra are collected along with spectra from the object of interest, ID performance is less important and gain stabilization across these measurements becomes an undesired data collection parameter change.

When saving background data for an instrument that is equipped with a neutron detector, a check is made that the measurement background is statistically in line with the previous background measurement. If the current measurement is significantly lower or higher than to previously measurement a message will be posted stating such. The message may indicate there is a neutron source in the vicinity (perhaps a test source that is not well shielded in its container). This message is also typically displayed when new background data is measured at a different altitude than a previous measurement.

### 3.12 SYSTEM ENERGY CALIBRATION

#### 3.12.1 A Brief Introduction to Gain Stabilization

The Detective X typically maintains near-perfect energy calibration by relying on environmental K-40, which produces a dependable gamma-ray peak at 1460.75 keV. The Detective X automatically adjusts the detector’s amplifier gain to keep this reference peak in a known region of the spectrum histogram. With the 1460.75-keV peak in a known location, the software “knows” the relative positions of all other gamma rays in the Identification Table.

Several factors can cause the system gain to change, and the K-40 reference peak to shift slightly such that the automatic circuitry must re-center the peak in its expected histogram region. The most significant of these are detector temperature and long-term electronics drift. Both of these changes occur at an extremely slow rate. This means these changes can be accurately tracked by the gain stabilizer, even when the
concentration of environmental K-40 is very low. Note that detector temperature is regulated in the Detective X. However, the bulk temperature of the detector element will continue to change by very small increments for several hours after system has reached the threshold operating temperature and the status has changed to READY. The gain stabilizer can easily correct for this slowly moving effect.

The gain stabilizer typically makes adjustments very gradually. Note, however, that if the instrument is subjected to a significant mechanical shock, the gain can change instantaneously, forcing the stabilizer to quickly correct for the situation. Rapid movement of the stabilizer is an indication that the system is still working to put the K-40 peak in the correct location. This condition is indicated by a “Stabilizer rapid movement” system error, and the status is NOT READY until the stabilizer zeroes on its new value. Restabilization should take no more than 30 minutes.

The gain stabilizer can adjust the amplifier gain to move the K-40 peak the equivalent of 7.5 keV either up- or down-channel, as needed, which is more than enough under normal circumstances. However, in typical circumstances (such as the shock mentioned above), ±7.5 keV may not be sufficient. The Stabilizer out of range error will be displayed and the status will change to NOT READY. This error will typically be preceded by a “Stabilizer rapid movement” error as adjustments are applied quickly in an effort to correct the situation. The current Gain Stabilizer adjustment is shown on the Status screen accessible from Settings. See Figure 68. This figure shows that the stabilizer has currently made an adjustment equivalent to ~0.82 keV, which is 9.9% of the available range. If this value is beyond about 60%, it is time to consider recalibrating the unit. Otherwise, the gain stabilizer may reach the limit of its ability to correct the K-40 peak position while you are out in the field, in which case, the status will change to NOT READY until the unit is recalibrated.

3.12.2 Calibrating the Detective X

The energy calibration is a single-point calibration that simply adjusts the system gain. The shape of the calibration curve is fixed, and has been determined at the factory. Calibration is easy to perform with a nominal 1-microcurie (μCi) cesium (Cs)-137 check source (user-supplied). The process typically takes less than 5 minutes.

1) Place the source in front of the instrument to obtain a gamma count rate of approximately 500 cps.

2) Tap Settings to open the Settings screen, then tap Calibrate to display the screen shown in Figure 69.
3) Tap Start Calibration Now. The stabilizer will be turned off, and the current stabilizer adjustment (if any) will be reset to zero. The acquisition will begin, and the spectrum will be displayed on the lower left of the screen.

4) When enough counts have been accumulated to accurately determine the centroid of the Cs-137 peak, the system will report the degree of adjustment necessary. Tap Use Improved Calibration to complete the process.

**NOTE** If you tap the Back button before tapping Use Improved Calibration, the old calibration will be retained and the new one will be discarded.

![Image of Calibrate Screen](image)

Figure 69. Calibrate Screen

The Restore Default button reinstalls the factory calibration, which is useful for diagnostic purposes; however, the factory calibration is typically not optimum for an instrument once it leaves the factory.

**3.12.2.1 Using Alternate Calibration Sources**

Other sources can be used to energy calibrate the system as well. In fact, environmental K-40 can be used to calibrate the instrument. This is useful when no Cs-137 check source is available. Calibrating with K-40 can take a long time in some environments (note that seawater contains essentially no K-40), therefore, you may wish to purchase an inexpensive potassium chloride “salt substitute” from a grocery. From the Advanced Setup screen, tap Cal Settings to open the screen shown in Figure 70. Select the desired source from the Calibration sources list.

**3.12.2.2 Require New Background after Calibration**

Although not necessary for the onboard nuclide identification algorithm, you may wish to force collection of a new background spectrum each time a new energy calibration is performed. Tap the Require background after calibration checkbox to mark it; this will disable ID Mode after an energy calibration until a new background spectrum is collected.

**3.12.2.3 Adding More Calibration Sources**

Cs-137 and K-40 are defined by default as calibration sources. The selected source in the Calibration sources field tells you which source is expected on the Calibrate screen (Figure 69). If you wish to add other sources, to a total of four, tap the Setup button to open the dialog shown in Figure 71.
Tapping an empty cell in the table shown on this screen enables entry of a source name and energy. Good candidates for additional energy calibration sources are Co-60 (1332.5 keV) and Th-232 (2615.5 keV for 208Tl daughter). Low-energy sources (less than 500 keV), such as Ba-133, should be avoided because they force a high fraction of the total energy range to be extrapolated instead of interpolated. If you intend to use the system with the gain stabilizer permanently disabled, then calibrating with Th-232 is highly recommended.

### 3.13 MODIFYING NUCLIDE THREAT STATUS

Figure 72 shows the **ID Table** page, which lets you change the innocent nuclides in the Identification Table to threat status and back. You cannot change default threat nuclides to innocent status. They are always categorized as threats because of their association with Special Nuclear Material or bremsstrahlung caused by a shielded, high-activity beta emitter. Note also that the list of nuclides in the Identification Table is fixed; you cannot remove or add nuclides.
• To change an innocent nuclide to threat status, tap the scrollbar or use the up/down arrow buttons (▲▼) to move through the list, tap to highlight the desired nuclide (Figure 73), then tap the top-right button, which will be labeled Make Threat (the button will be disabled for default threat nuclides). An innocent nuclide that has been changed to threat status will be marked in the list with an asterisk (*), as shown in Figure 74.

• To revert a nuclide to its default innocent status, highlight it and tap the top-right button, which will now be labeled Make Innocent.

• To restore all nuclides to their factory default settings, tap Reset and confirm the reset action. There is no undo for the reset operation; you must make the desired changes again.

Figure 72. Default Identification Table Listing

<table>
<thead>
<tr>
<th>ID Table Version:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
<tr>
<td>Threat</td>
</tr>
<tr>
<td>Threat</td>
</tr>
<tr>
<td>Threat</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
</tbody>
</table>

Figure 73. Preparing to Change Default Innocent Nuclide to Threat Status
To output the list of nuclides and their current classifications to a text file that can be exported to a computer, tap **Save to File**. The file will be saved in the USB drive’s `\data` folder under the filename `nuclides.txt`.

### Figure 74. Default Innocent Nuclide Changed to Threat Status (and marked with asterisk)

#### 3.14 PASSWORD-PROTECTING THE ADVANCED SETTINGS AND ID MODE SPECTRUM VIEW

As shipped from the factory, the Advanced Setup is accessible to all users from the Settings screen. Because the advanced options can significantly affect how the instrument works, the Detective X software allows you password-protect this screen. You can also decide whether to display the ID Mode spectrum. From the Advanced Setup screen, tap the **Password** button to open the screen shown in Figure 75.

#### 3.14.1.1 PASSWORD

A blank password (all characters deleted; not a series of spaces) is the “no password” option. The password is case-sensitive, alphanumeric, may include spaces, and may be of any length.

**IMPORTANT** *There is no “factory default” password.* If you forget the password, contact your ORTEC representative or our Global Service Center for assistance.

#### 3.14.1.2 ID Mode Spectrum

To display or hide the ID Mode spectrum, tap the **Allow display of spectrum** checkbox to respectively mark or unmark it.
DEPLOYING MULTIPLE UNITS WITH IDENTICAL SETTINGS

As this manual makes evident, the Detective X gives you a multitude of configuration options. Manually configuring even two units identically would be an extremely challenging exercise. Setting up more than two units identically would be far more cumbersome. To make this task easier, Detective X allows you to create a settings file that you can export to multiple instruments. This will ensure all of your Detective Xs operate identically.

To export settings:

- Select the Export Settings button from the Advanced Setup screen.
- This will write the current settings to an ASCII text file named Settings.txt, which will be saved in the root folder of the rear-panel USB flash drive. Any previous Settings.txt file will be overwritten. Change the name or save the file if you want to save the settings.
- Figure 77 shows the partial contents of a Settings.txt file. The contents can be viewed by connecting a PC to the micro USB connector on the rear panel (see Figure 5). Simple changes can be made with a text editor if necessary.
- You are now ready to temporarily move the first unit’s USB flash drive to a second Detective X, then import the settings file by tapping the Import Settings button on the second unit’s Advanced Setup screen. Settings will only be imported from a file named Settings.txt located in the root of the USB flash drive. Before the second unit’s settings are overwritten, you will be asked to confirm the overwrite.
You may wish to maintain several sets of settings for different applications. To switch between those, just copy the desired settings file to a file named Settings.txt and import. Default factory settings can always be restored by tapping the Restore Settings button.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AckAlarms</td>
<td>STRING</td>
<td>False</td>
</tr>
<tr>
<td>AllowMultiSpec</td>
<td>STRING</td>
<td>False</td>
</tr>
<tr>
<td>AllowViewDisplay</td>
<td>STRING</td>
<td>True</td>
</tr>
<tr>
<td>AutoBackground</td>
<td>STRING</td>
<td>False</td>
</tr>
<tr>
<td>AutoCalEnergy0</td>
<td>STRING</td>
<td>661.60</td>
</tr>
<tr>
<td>AutoCalEnergy1</td>
<td>STRING</td>
<td>1460.83</td>
</tr>
<tr>
<td>AutoCalEnergy2</td>
<td>STRING</td>
<td>1332.51</td>
</tr>
<tr>
<td>AutoCalEnergy3</td>
<td>STRING</td>
<td>0.00</td>
</tr>
<tr>
<td>AutoCalSrc0</td>
<td>STRING</td>
<td>Cs-137</td>
</tr>
<tr>
<td>AutoCalSrc1</td>
<td>STRING</td>
<td>K-40</td>
</tr>
<tr>
<td>AutoCalSrc2</td>
<td>STRING</td>
<td>Co-60</td>
</tr>
<tr>
<td>AutoCalSrc3</td>
<td>STRING</td>
<td>NULL</td>
</tr>
<tr>
<td>AutoCalSrcIndex</td>
<td>DWORD</td>
<td>0</td>
</tr>
<tr>
<td>BackgroundAcqTime</td>
<td>STRING</td>
<td>30</td>
</tr>
</tbody>
</table>

Figure 77. Partial Contents of Typical Settings.txt File
[Intentionally blank]
APPENDIX A. LAUNCHER INTERFACE

The Launcher application automatically controls which application runs on the Detective X computer on power-up. In addition, when you exit an application, the Launcher screen presents you with the list of all applications you can access on the instrument. The DetectiveX and Mobile MCB Server applications are installed by default, and the Launcher is configured to start the DetectiveX application. Figure 78 shows the default Launcher screen. It displays a button for each available application, and the mark in the checkbox beside the DetectiveX program indicates this is the application that will run on power-up.

To start an application, just tap its button.

![Launcher Screen](image)

**Figure 78. Launcher Screen**

**NOTE** There are no Detective X functions outside of the Launcher. The Exit button at the bottom of the Launcher screen is reserved for ORTEC use.
APPENDIX B. MOBILE MCB SERVER

Our Mobile MCB Server application governs communication between the Detective X and a host computer when you use the Detective X as a high-performance, benchtop gamma spectrometer in conjunction with ORTEC spectroscopy applications such as MAESTRO or GammaVision. The user manual for your PC-based ORTEC spectroscopy product contains complete instructions on installing and configuring all of the software necessary to communicate with and use the Detective X as a benchtop spectrometer.

![Mobile MCB Server UI from the Launcher Application](image)

**Figure 79. Mobile MCB Server UI from the Launcher Application**

**B.1 THE CONNECTIONS/MCB PROPERTIES LAYER**

All ORTEC spectroscopy applications use a standardized interface layer to communicate with supported gamma spectrometers. This interface reveals properties particular to a given spectrometer through a multi-tab “MCB Properties” dialog. This interface is called CONNECTIONS in our other product literature, and the core of its functionality is a component called the Universal MCB Interface (UMCBI). The ORTEC Programmer’s Toolkit (P/N A11-BW) allows knowledgeable users to write custom applications that use the UMCBI to communicate with generic MCBs (contact your ORTEC representative for more information).

The MCB Properties dialog allows you to adjust the Detective X spectrometer’s properties — conversion gain, bias voltage, the zero and gain stabilizer settings, counting resets, etc. — which will remain in effect only as long as the Detective X is connected to the PC. When you disconnect the unit and the DetectiveX application restarts, all factory settings will be restored; and the Detective X will return to its normal, standalone operation mode.

Note that only the spectrometer interface is exposed when you connect the Detective X to a host computer via the Mobile MCB Server. You cannot access the Detective X application, its nuclide IDs, or any other

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4 “MCB” is an acronym for multichannel buffer, a legacy ORTEC term to denote to a device that that produces a counts-vs-channel histogram, where channel is linearly related to the energy deposited in the detector when the detector absorbs (or partially absorbs) a gamma-ray.
information calculated by the Detective X’s onboard computer. The MFK interface described in APPENDIX C provides a much higher-level connection to the Detective X that may be needed in some instances.

B.1.1 Accessing the Detective X via Network

Once the Detective X is connected to a host computer via USB, CONNECTIONS makes it possible for multiple users on the same local network to access the instrument via ORTEC spectroscopy applications. Alternatively, the Detective X can be directly connected to the local network using Ethernet or WiFi with the same result. Network connections are established via the Mobile MCB Server application the same way they are established in the Detective X application. See Section 3.7. The Mobile MCB Server also allows you to connect to a PC via USB by tapping the **USB** tab and then the **Control (MCA mode)** option. The **Bluetooth** tab is currently not supported.

B.2 QUANTITATIVE SPECTROSCOPY WITH GAMMAVISION

The Detective X does not measure or store efficiency calibration information in the files it creates. To use the Detective X files in quantitative calculations in programs such as GammaVision, it is necessary to collect spectra from reference sources and perform the calibration in GammaVision. The GammaVision manual includes detailed instructions on this procedure.
APPENDIX C. MOBILE FIELD KIT INTERFACE

Mobile Field Kit (MFK) is a product of Asynchrony, a division of World Wide Technology. The Detective X is ready to connect to MFK, as delivered. When connected to the host MFK server, the Detective X periodically polls the server, sending status information and retrieving and executing commands as specified by the server. A network connection is a prerequisite for setup and use of MFK. See Section 3.7.

The MFK server is specified on the MFK setup page accessible from Advanced Setup. See Figure 80. MFK reporting is enabled when you enter a valid server URL, and is disabled when the MFK server URL field is blank.

![Figure 80. MFK Setup](image)

Tap the Example URL button to populate the MFK server URL field with a sample URL that shows the necessary syntax. You must then edit the example URL to provide the actual server URL. Finally, tap the Test button to contact the server and verify connectivity. Your MFK administrator can recommend settings for the other options on this page.

The following sections provide detailed information on the communication protocol implemented on the Detective X to support the MFK system.

C.1 METHOD

When connected with the host MFK server, the Detective X sends a status message to the MFK at defined intervals. Initially, the default setting to send and receive messages is once every 5 seconds. If experience shows this frequency overloads the Detective X or the network, the Detective X has a setup option that allows the operator to change the update frequency.
The Detective X sends the status message by sending an `http://GET` request to the MFK webserver. The URL of the request will include a query string consisting of name=value pairs that represent the status information items. Table 4 and Table 5 define the status items and their format.

For example, if the base URL for reporting status was `http://172.20.1.50/status`, then a status message that reports just the time, model, serial number, and mode of operation would be the URL:

```
http://172.20.1.50/status?M=Detective-X&S=508&T=235913&MOD=Detect
```

The Detective X reads the response from the MFK webserver. The body of the MFK webserver response can be a command (See Section C.13) or it may be null.

Any failures in sending the status message, whether they be a network failure exception, timeout exception, or failing Status Code in the response are ignored. Status messages are never resent upon failure. If Failure occurs, the Test button on the MFK screen checks that its status message succeeded, since its purpose is to test the network connection. (See Section C.11)

If a status message is still in the process of being sent when it is time to send another status message, the new status message is skipped. Once sending the current status message completes, future messages are sent on the normal schedule.

### C.2 STATUS ITEMS

In general, every status message includes every item (key=value pair from Table 4 and Table 5). However, any status item for which information is not available is excluded from the status message.

Note that the Detective X information sent through MFK including the Hardware Model, Hardware Serial Number, gamma ray and neutron count rates, gamma ray dose rate, health status items, GPS and the battery life are not available in circumstances when the onboard computer cannot talk to the spectrometer. This would occur briefly when the machine boots, when the Detective X is used as a spectrometer connected through Mobile MCB Server and under the control of another computer, or if the Detective X is broken.

The GPS-related status items will be missing if there is not a GPS on the instrument (some custom configurations of Detective X may lack GPS), or when the GPS cannot get a fix. Note that the operator might have Latitude and Longitude reported but no altitude. In circumstances when there are too few satellites, the GPS is not able to calculate the altitude.

The Q Value and Q Threshold status items (QU235=, TU235=, QPU239=, TPU239=, Q BA133=, TBA133=) are reported only when a survey (Identify) is in progress. Ba-133 is listed because it is a common innocent source used for training to simulate SNM response.

For the purpose of Detective X MFK Integration, a “Survey” is equivalent to an “Identify” measurement, which is the only time these Q Values are reported.

The Threshold values used are the default values used in the Detective X software and may be modified in the Detective X registry under the HKEY_CURRENT_USER/Software/Detective X Registry tree. These values may be modified using off-the-shelf remote registry editors, such as CeRegEdit. Default values are listed in Table 3.
The Time of Day, Software Description, and Detective X Operating Mode are the only items that are always known to the onboard computer. All other status items are optional.

The END= key is only sent on the last status message before ending the communication of periodic messages. See Section C.12.

### Table 3. Threshold Values

<table>
<thead>
<tr>
<th>Threshold</th>
<th>Value</th>
<th>Registry Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu-238</td>
<td>2.0</td>
<td>MfkPuThreshold</td>
</tr>
<tr>
<td>U-235</td>
<td>2.5</td>
<td>MfkUThreshold</td>
</tr>
<tr>
<td>Ba-113</td>
<td>2.0</td>
<td>MfkBaThreshold</td>
</tr>
</tbody>
</table>

### Table 4. Non-Health Status Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Key</th>
<th>Value Type</th>
<th>Example Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware Model</td>
<td>M=</td>
<td>String</td>
<td>Detective-X</td>
<td></td>
</tr>
<tr>
<td>Hardware Serial Number</td>
<td>S=</td>
<td>String</td>
<td>508</td>
<td>New for Detective-X</td>
</tr>
<tr>
<td>Product Name</td>
<td>P=</td>
<td>String</td>
<td>Detective-X</td>
<td></td>
</tr>
<tr>
<td>Date and Time</td>
<td>T=</td>
<td>Date</td>
<td>2014-04-10 23:59:59</td>
<td>Time zone UTC (Zulu time)</td>
</tr>
<tr>
<td>Message Key</td>
<td>KEYID=</td>
<td>String</td>
<td>2F4211B6-40BF-4953-AA90-E497FA1C41E6</td>
<td>Optional UUID string for security.</td>
</tr>
<tr>
<td>Latitude</td>
<td>LAT=</td>
<td>Number</td>
<td>-4807.038</td>
<td>48 degrees 7.038 minutes south</td>
</tr>
<tr>
<td>Longitude</td>
<td>LON=</td>
<td>Number</td>
<td>-11831.072</td>
<td>118 degrees 31.072 minutes</td>
</tr>
<tr>
<td>GPS Bearing</td>
<td>B=</td>
<td>Number</td>
<td>84.4</td>
<td>84.4 degrees true</td>
</tr>
<tr>
<td>Number of satellites used for GPS bearing</td>
<td>F=</td>
<td>Number</td>
<td>5</td>
<td>Indicates the quality of the GPS fix</td>
</tr>
<tr>
<td>GPS Horizontal dilution of position</td>
<td>DOP=</td>
<td>Number</td>
<td>9</td>
<td>Indicates the quality of the GPS fix</td>
</tr>
<tr>
<td>Max Gamma ray Count Rate</td>
<td>G=</td>
<td>Number</td>
<td>113</td>
<td>Maximum count rate seen since last message (counts per second)</td>
</tr>
<tr>
<td>Max Neutron Count Rate</td>
<td>N=</td>
<td>Number</td>
<td>112</td>
<td>Maximum count rate seen since last message (cps)</td>
</tr>
<tr>
<td>Max Dose Rate</td>
<td>D=</td>
<td>Number</td>
<td>.09</td>
<td>Maximum dose rate seen since last message (uSv/h)</td>
</tr>
<tr>
<td>Battery 1 Time Left</td>
<td>BAT1=</td>
<td>Number</td>
<td>3600</td>
<td>Time left in seconds</td>
</tr>
<tr>
<td>Battery 1 Percent Left</td>
<td>PER1=</td>
<td>Number</td>
<td>100.0</td>
<td>Percent of charge left (100% is full charge).</td>
</tr>
<tr>
<td>Operating Mode</td>
<td>MOD=</td>
<td>String</td>
<td>Survey</td>
<td>For Detective-X, these are: “Detect” (Detect mode), “Survey” (Identify mode)</td>
</tr>
<tr>
<td>Q-Value for U-235</td>
<td>QU235=</td>
<td>Number</td>
<td>1.23</td>
<td>Only reported during Survey (Identify) Mode</td>
</tr>
<tr>
<td>Q Threshold for U-235</td>
<td>TU235=</td>
<td>Number</td>
<td>3.09</td>
<td>Only reported during Survey (Identify) Mode</td>
</tr>
<tr>
<td>Item</td>
<td>Key</td>
<td>Value Type</td>
<td>Example Value</td>
<td>Notes</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Q-Value for PU-239</td>
<td>QPU239=</td>
<td>Number</td>
<td>1.23</td>
<td>Only reported during Survey (Identify) Mode</td>
</tr>
<tr>
<td>Q Threshold for PU-239</td>
<td>TPU239=</td>
<td>Number</td>
<td>3.09</td>
<td>Only reported during Survey (Identify) Mode</td>
</tr>
<tr>
<td>Q-Value for BA-133</td>
<td>QBA133=</td>
<td>Number</td>
<td>1.23</td>
<td>Only reported during Survey (Identify) Mode</td>
</tr>
<tr>
<td>Q Threshold for BA-133</td>
<td>TBA133=</td>
<td>Number</td>
<td>3.03</td>
<td>Only reported during Survey (Identify) Mode</td>
</tr>
<tr>
<td>Deadtime</td>
<td>DEAD=</td>
<td>Number</td>
<td>20</td>
<td>In percent, 0 to 100. Deadtime is available only during Survey (Identify) Mode.</td>
</tr>
<tr>
<td>End Status Reports</td>
<td>END=</td>
<td>Number</td>
<td>1</td>
<td>The value is always 1. This key is only sent when ending status reporting.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status Line in MFK Window</th>
<th>Key</th>
<th>Value Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector Temp</td>
<td>HDT=</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Body Temp</td>
<td>HBT=</td>
<td>Percent</td>
<td>Not available if HC=0</td>
</tr>
<tr>
<td>Cold Tip Temp</td>
<td>HCTT=</td>
<td>Percent</td>
<td>Not available if HC=0</td>
</tr>
<tr>
<td>+12 Volts</td>
<td>H12=</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>−12 Volts</td>
<td>H-12=</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>3.3 Volts</td>
<td>H3.3=</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Ion Pump Volts</td>
<td>HIP=</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Bias Voltage</td>
<td>HBV</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Cooler Status</td>
<td>HC=</td>
<td>0 or 1</td>
<td>Cooler running status. Zero (0) means the cooler is off.</td>
</tr>
</tbody>
</table>

### C.3 MFK HEALTH STATUS

MFK Health status keys begin with the letter “H”.

Most of the keys have a percentage as their value. This is just a number. The number will never be above 100 meaning 100% or perfect health. A value of 0 (or a negative value) means the device is not operational. For example, a very warm Detector might have HDT=−312.

The interface does not display any fraction after the decimal point; as there is not enough precision in these numbers.

#### C.3.1 Implications of Cooler Health

The normal operation of the machine is HC=1 which means that the cooler is on. When HC=0, either the cooler has failed or has been manually switched off. Either way, HC=0 indicates an alarm condition.
The Detector Temp (reported by the HDT= key) will start to increase causing its health percentage to go down, and once HDT= reaches 0, the machine will cease to function. (The time this takes depends upon the environment.)

The values of the HBT= and HCTT= keys are unavailable when HC=0. If HC=0, the HBT= and HCTT= keys will not be in the status string.

C.4 BATTERY STATUS ITEMS

The Detective X has a battery, and the communication computer, encryption device, and wireless networking device have one or more batteries. The keys BAT1=, PER1= and BAT2=, PER2= will be used to report the status of the Detective X batteries. If status for other batteries is available, additional keys (changing 1 in the keys to 3, 4…) will be used to report their status.

C.5 VALUE ENCODINGS

- Hardware model, the value for the M= key is: Detective-X
- Program Name, the value for the P= key is: Detective-X

C.6 DATE-TIME

The values of the T= key are in the form: YYYY-MM-DD HH:mm:ss

where:

- YYYY is the four-digit year
- MM is the two-digit month
- DD is the two-digit day of month
- A space separates date and time
- HH is the two-digit hour (24-hour clock)
- mm is the two-digit minutes
- ss is the two-digit seconds

The time zone is always UTC.

Note that this string will require URL encoding, and thus will look different in the raw status message URL. In particular, the space will be encoded as “+” and the colon will be encoded as “%3A”. See http://en.wikipedia.org/wiki/Query_string

C.7 LATITUDE AND LONGITUDE

The values of the LAT= and LON= keys are floating point numbers. If v is the value of the key, the value can be broken down into degrees and minutes using the following formulas and conventions:
if (v < 0) v = -v;
degrees = (int) (v/100.0);
minutes = v – degrees*100.0;

For latitudes, a positive number means north and a negative number means south.
For longitudes, a positive number means east and a negative number means west.

C.8  MAXIMUM VALUES

The G=, N=, D=, QBA133=, QU235=, and QPU239= keys report the maximum value that the associated statistic has had since the last attempt to send a status message.

These statistics are checked by the Detective X, once per second, and compared against the current maximums. After attempting to send a status message, the current maximums are set to zero. Thus, if a status message is sent once every 15 seconds, the maximums will be the largest of the last fifteen 1-second values for their respective statistic.

C.9  DOSE RATE

The units for the D= key are microsieverts per hour (µSv/h). You can convert the values to millirems per hour (mrem/h) by dividing by 10.0.

C.10  Q VALUE

During Survey Mode (i.e., Identify mode), the Detective X computes statistics called Q values that give the probability that U-235, Pu-239, or Ba-133 are present. As noted earlier, Ba-133 is an innocent source used for training purposes. The Q value represents the distance from the origin of the Normal Probability curve. A Q value of 3.09 is roughly a 99.9% probability. The greater the value of Q, the more likely the associated source is present.

Thresholds must be ≥1.0 and ≤10.0. Q Values can take on any floating-point value.

C.11  TEST STATUS MESSAGE

The second Advanced screen has a button labeled MFK that opens the MFK settings screen. This screen allows you to enter the base URL to which the query string containing the status items will be appended.

On the screen is a Test button that, when you tap it, immediately sends a status message using a URL that contains a minimal query string comprising only time and mode (the mode will be Test).

For example, if the base URL is:

http://PPP_PEER:8080/ORTEC

and the time of day (UTC) is:

2009-12-02 21:16:46
then, the full status URL will be:

http://PPP_PEER:8080/ORTEC?T=2009-12-02+21%3A16%3A46 &MOD=Test

Unlike normal status messages, the Test button will check that its status message succeeded (i.e., received a good status from the HTTP Get). The purpose of the Test button is to make sure the network connection is properly set up so that it reports whether its test message succeeded. A command can be included in the web server’s response to the test status message; see Section C.13.

C.12 END STATUS REPORTS MESSAGE

The MFK setup screen on the Detective X has a Report to MFK dropdown menu that controls whether MFK status should be sent:

- Always
- Never
- when on battery

The default value is Always. The End Status Reports message is sent if status has been reported previously and either of the following happens:

- Report to MFK is changed to Never.
- Report to MFK is when on battery and the Detective X is connected to external power.

Note that the End Status Reports message is only sent if normal status has been previously reported. For example, if the setting is when on battery, and the Detective X is disconnected from external power, then very quickly reconnected, no End Status Reports message will be sent. The rationale for this is that the MFK never saw a status message reported from the Detective X, so it does not need to see an End Status Reports message (saying that the reports are ending).

The End Status Reports message has a query string in the URL that includes only the M=, S=, T= keys, along with an END=1 key value pair. (The M= and S= will be missing if their values are not available.)

NOTE Because the Detective X will not attempt a status report if a status report is already in progress, an End Status Reports message might be discarded because the previous normal status message is still in progress.

C.13 COMMANDS IN RESPONSE TO MESSAGES

The webserver may send a single command back to the Detective X in response to the status message. The command appears in the body (HTML part) of the response.

The body may begin with an optional <!DOCTYPE> tag. If present, the entire <!DOCTYPE> tag must be on a single line. The Detective X recognizes the <!DOCTYPE> tag line to be present if the first three characters of the first line of the file are “<ID”. Note the “D” must be uppercase. Once recognized, the <!DOCTYPE> tag line is discarded.
Following the optional &lt;!DOCTYPE&gt; tag, a command may appear. The command has the form of an HTML comment. The entire command must be on a single line.

All lines following &lt;!DOCTYPE&gt; tag are ignored in the body as unrecognized commands and are quietly ignored.

To be recognized, a command must either be the first line of the body or the second line when following a line that starts with “&lt;!”.

**C.14 ID COMMAND**

A command of the form: &lt;-- ID n --&gt;

where n is replaced with an integer causing the Detective X to enter Identification mode. If the Detective X is already in ID Mode, it remains in that mode until the elapsed time of “n” seconds. After “n” seconds, the Detective X ends the survey as if the Save and Exit button is selected. The survey file is stored in the N.42 format then sent to MFK.

For the ID command to be recognized, the first 8 characters on the line must be: “&lt;-- ID ” (note the space before the “I” and after the “D”).

If the value of n is less than zero, it is treated as if it had the value zero. The command &lt;-- ID 0 --&gt; causes the Detective X to exit Survey mode and upload a results file as soon as possible. (This might take more than zero [0] seconds because commands only reach the Detective X on the normal MFK Status reporting interval, and then event timers that cause the Detective X to process commands have to trigger.)

If another ID command is received while a Survey is in progress, the new command cancels the old one and is executed. For example: Assume an ID command with n = 100 causes the Detective X to enter Survey mode. Twenty-five (25) seconds into the execution of that Survey, another ID command with n = 50 is given. Then, after approximately 75 seconds of Survey, a result file will be uploaded.

**C.15 STATUS COMMAND**

A “STATUS” command does not affect ID Mode. A STATUS command has its normal effect of changing the status reporting interval, but will not cause ID Mode to exit or cancel any countdown to automatically uploading a result file.

A command of the form: &lt;-- STATUS n --&gt;

With this command, replacing n with an integer causes the Detective X to change the Detective X reports status frequency. After receiving this command, the Detective X changes the status reporting interval to once every n seconds. Thus, if n = 1, the Detective X attempts to report its status every 1 second. This is the maximum reporting frequency. Remember that the Detective X will skip sending a new status message if the previous status message is not complete before the time interval for the next status command. Therefore, the maximum frequency (shortest interval) that status messages can be sent depends on the speed of the network and the responsiveness of the webserver. The reply from the webserver must arrive at the Detective X before the status message currently being sent is complete).
APPENDIX C. MOBILE FIELD KIT INTERFACE

Sending the value of $n = 0$ causes the Detective X to switch back to the user-selected status update interval. Any value of $n$ less than 0 is ignored. (i.e., negative numbers or decimal values are not accepted; only positive whole integers).

For the STATUS command to be recognized, the first 12 characters on the line, including spaces, must be:

“<!- STATUS “ (note there is a space before the first “S” and after the last “S”).

A STATUS command can be given at any time without disturbing the state of an ID command.

This command may be useful when the Detective X is mounted on a robot. The normal reporting frequency of status may be too infrequent to allow a robotic search. Remember: We are shooting for a 5-second status update, but we may find that every 30 seconds is more reasonable.

C.16 FILE UPLOAD

The file upload is done using an http POST request following the protocols given in:

- rfc1867 (which specifies http file upload)
  - Title: Form-based File Upload in HTML
- rfc1521 (which specifies multipart message format)
  - Title: MIME (Multipurpose Internet Mail Extensions) Part One: Mechanisms for Specifying and Describing the Format of Internet Message Bodies

The URL used is the base URL plus a query string that contains status items in Table 6.

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>T=</th>
<th>Time file was saved, not necessarily current time. See Table 4 format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware Model</td>
<td>M=</td>
<td>Same as Table 4</td>
</tr>
<tr>
<td>Hardware Serial Number</td>
<td>S=</td>
<td>Same as Table 4</td>
</tr>
<tr>
<td>Type of file being uploaded</td>
<td>FILETYPE=</td>
<td>Value is: RadionuclideIdentifier</td>
</tr>
</tbody>
</table>

When FILETYPE= RadionuclideIdentifier, the file being uploaded is a (.n42 2012 format) file containing a histogram and ID results from Identify (e.g. Survey) mode.

For example, if the base URL is: http://PPP_PEER:8080/ortec, the URL used to upload a file might be:


The following headers, which describe the uploaded file, appear in the http message (per rfc1867 - Form-based File Upload in HTML):
Content-Disposition: form-data; name="file1"; filename="fullpath" Content-Type: application/octet-stream

Content-Transfer-Encoding: binary

Where, “fullpath” is the filename that was used for the file when it was stored on the Detective X, including the full directory path. The webserver may or may not wish to base the filename used to store the uploaded file on fullpath.

The webserver is not permitted to send a command to the Detective X in response to a file upload.
APPENDIX D.  SPECIFICATIONS AND CARE

See also Section 2.12 for additional information on the Detective X’s batteries and cryocooler.

D.1 DETECTORS

**Nuclide Identification**  P-type, high-purity germanium (HPGe) crystal with coaxial construction. Crystal nominal dimensions 65 mm diameter × 50 mm length.

**Cryostat and Cooler**  Hardened cryostat, with high-reliability, low-power Stirling cooler. The cryostat design is such that the Detective X can be switched off at any time, and power subsequently reapplied, without having to wait for a full thermal cycle (i.e., full warm-up before cooldown). This feature greatly increases system availability during measurement campaigns.

**Cooldown Time**  The high-reliability cooler is designed for continuous operation. Between making measurements, the unit is powered from a DC supply, car battery, or other device. Initial cooldown time depends on ambient temperature, but is typically 8 hours at 25°C.

**Gamma Dose Rate Detector**  Three detectors determine the gamma dose rate over a wide range from <0.05 mR/h to >100 R/h, a dose-rate range of over 6 decades. Instrument switches between the three automatically.

**Neutron Detector Module**  The optional neutron detector is a large volume-segmented lithium-6 fluoride/zinc sulfate (Li6F/ZnS) detector that is ANSI N42.34 2015 compliant.

D.2 HARDWARE

**Digital MCA and Data Processor**

- **Display**  4.3-in. WQVGA (480 × 272 pixels), sunlight-readable, touch-sensitive; operate with finger or stylus.

- **Data Processor**  FREESCALE I.MX535 operating at 1 GHz.

**Data Storage**

- **Media**  To internal RAM; and removable, low-profile USB flash drive. The unit is shipped with a 16 GB flash drive, which holds over 100,000 spectra.

- **File Format**  ANSI N42.42.

**Computer Interfacing**  USB and Ethernet TCP/IP v4 connections via standard RJ45 Ethernet connection (10/100Base-T — 10/100Mbps, autosensing). Ready for use with MFK (Mobile Field Kit for DoD users), ORTEC GammaVision, iOS devices, and Android devices. WiFi (802.11) communication software. Wireless Mobile MCB Server software.

**Wireless Connectivity**  IEEE 802.11b wireless and Bluetooth.

**GPS**  The instrument is equipped with an internal GPS. The location information associated with a measurement is optionally stored in the N42 files.
Digital MCA with Internal Storage of Multiple Spectral Data

- Digital Noise Suppression "LFR Filter”.
- Conversion Gain 16K channel.
- Maximum Number of Stored Spectra Unlimited on removable media.

D.3 PHYSICAL SPECIFICATIONS

Maximum Overall Dimensions Including handle and HPGe detector endcap: 15.5 in. L × 6.25 in. W × 8.25 in. H (39.5 cm L × 16 cm W × 21 cm H).

Weight 15.4 lb (6.98 kg), gamma only; 16.8 lb (7.2 kg) gamma/neutron.

Internal Battery 2 rechargeable lithium ion, 98 Wh each, nominal. Over 8 h of battery life at 25°C when HPGe detector is cold. <4-h time to charge. Internal battery is easily swapped.

External Battery Battery lifetime may be extended indefinitely by the use of optional external battery packs. An external military battery (Model 2590) weighs less than 3.25 lb and extends lifetime to >16 hours.

Input Power 12–17 V DC from battery or DC power supply (universal mains supply included).

Power Usage Highest during cooldown and charging battery: <100 W. Cold with fully charged battery <35 W.

Operation Range

- Temperature −20°C to +50°C.
- Humidity 95% non-condensing.

Enclosure IP65; sealed against ingress of dust and water. All perforations (connectors, memory cards, etc.) are sealed by rubber plugs.

D.4 COMMUNICATION SOFTWARE

The Detective X is a member of the ORTEC CONNECTIONS family. Remote MCA control, even over a network, is achieved simply by the use of ORTEC CONNECTIONS products such as MAESTRO MCA Emulation software.

Multiple spectra may be block-transferred from the instrument controller to an external PC via the USB connection. The Detective X appears as a flash drive when connected to a laptop or PC. Exported files are in the N42 format, and may be read by many programs used by reachback teams, such as CAMBIO and PeakEasy, and by ORTEC software products such as GammaVision.

Detective X is equipped with IEEE 802.11b wireless and Bluetooth, allowing the Detective X to be used with cell phones, laptops, and remote computer systems. The Detective X is ready to use with MFK software, ORTEC GammaVision software, iOS devices (iPhone®, iPAD), and Android® devices.

D.5 MOBILE MCB SERVER

The Mobile MCB Server software application enables the Detective X to communicate wired or wirelessly with ORTEC software applications such as MAESTRO, GammaVision, and Detective® Remote.
Users can develop their own applications through the use of the optional the ORTEC Programmer’s Toolkit (P/N A11-BW).

### D.6 CLEANING INSTRUCTIONS

#### D.6.1 Cleaning the Exterior

- Disconnect the instrument from external power, turn off the cooler, and power off the computer interface.
- Attach the caps on all power and external counter ports. Ensure the communication port cover is in place and fastened with the captive screws. Finally, make certain the battery covers are in place and fastened with their captive screws. *Failure to secure all covers will allow water and/or dust to enter the instrument enclosure!*
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a mild detergent and water solution. *Do not use abrasive cleaners.*
- Dry the instrument with a towel and turn on the computer and cooler.
- *Allow the instrument to dry completely* before reconnecting it to the external power supply.

#### D.6.2 Cleaning the Fan Compartment

The external cooling fan is in a sealed chamber to prevent water ingress through this area, and the fan itself is sealed to prevent damage from water. If the Detective X has been used in salt spray or extremely dusty conditions, you may follow these instructions to remove the residue by pouring a small amount of water through the fan chamber:

- Disconnect the instrument from external power, turn off the cooler, and power off the computer interface.
- POUR small to moderate amounts of water through the fan chamber. *Do not use pressurized water, as with a hose; and DO NOT IMMERSE!*
- *Allow the instrument to dry completely* before turning on the computer and cooler, then reconnect it to the external power supply.

### D.7 REPLACING THE INTERNAL BATTERIES

The typical service life of the Detective X’s Li-ion batteries is 3–5 years. When the internal batteries no longer maintain a charge for a significant period, they must be replaced. Replacements are available from ORTEC as part number DETECTIVE-X-ACC-BAT. *We strongly recommend replacing the batteries in pairs.*

*After replacing the batteries (unless they have been pre-charged), the Detective X must be connected to external power for 3–4 hours to fully charge the new batteries.*

Return the old batteries to ORTEC for recycling.

For more information, contact an ORTEC representative or our Global Service Center.
### APPENDIX E. NUCLIDE ID TABLE

The following tables list the default Detective X innocent and threat radionuclide identifications for library version 9.3.1. Note that you can optionally change the status of innocent nuclides to threat status (but not vice versa), as discussed in Section 3.13.

<table>
<thead>
<tr>
<th>ID String</th>
<th>Classification</th>
<th>Priority</th>
<th>Sub-Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001 keV peak present</td>
<td>Suspect</td>
<td>1</td>
<td>Uranium</td>
</tr>
<tr>
<td>186 keV peak present</td>
<td>Suspect</td>
<td>1</td>
<td>Uranium</td>
</tr>
<tr>
<td>2235 keV peak present</td>
<td>Threat</td>
<td>1</td>
<td>Other</td>
</tr>
<tr>
<td>2614 keV peak present</td>
<td>Suspect</td>
<td>1</td>
<td>Uranium</td>
</tr>
<tr>
<td>356 keV peak present</td>
<td>Suspect</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>375/414 keV peak present</td>
<td>Suspect</td>
<td>1</td>
<td>Plutonium</td>
</tr>
<tr>
<td>662/722 keV peak present</td>
<td>Suspect</td>
<td>1</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ac-225</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Ac-227</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ag-110m</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Am-241 (shielded)</td>
<td>Threat</td>
<td>1</td>
<td>Plutonium</td>
</tr>
<tr>
<td>Am-241 (unshielded)</td>
<td>Threat</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ar-41</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>As-72</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>As-74</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>At-211</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Au-198</td>
<td>Innocent</td>
<td>3</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ba-133</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ba-140</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Be-7</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Beta emitter</td>
<td>Innocent</td>
<td>1</td>
<td>Bremsstrahlung</td>
</tr>
<tr>
<td>Bi-207</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Bi-212 (Th-232/U-232 daughter)</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Bi-214 (Ra-226 daughter)</td>
<td>Innocent</td>
<td>4</td>
<td>NORM</td>
</tr>
<tr>
<td>Br-76</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Br-76 (heavily shielded)</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Br-76 (shielded)</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Br-77</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ca-47</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>ID String</td>
<td>Classification</td>
<td>Priority</td>
<td>Sub-Classification</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Cd-109</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Cd-115</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ce-139</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Ce-141</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Ce-144</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Cf-252/Cf-249</td>
<td>Threat</td>
<td>1</td>
<td>Other</td>
</tr>
<tr>
<td>Cm-242</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Cm-243</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Cm-244</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Co-55</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Co-56</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Co-56 (shielded)</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Co-57</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Co-57 (shielded)</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Co-58</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Co-60</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Cr-51</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Cs-131</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Cs-134</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Cs-137</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Cu-64</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Cu-67/Ga-67</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Elevated Radiation</td>
<td>Threat</td>
<td>1</td>
<td>Other</td>
</tr>
<tr>
<td>Enriched Uranium</td>
<td>Threat</td>
<td>1</td>
<td>Uranium</td>
</tr>
<tr>
<td>Eu-152</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Eu-154</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Eu-155</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Eu-156</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>F-18</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Fe-59</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Ga-64</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Ga-64 (shielded)</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>Ga-67</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Ga-67 (shielded)</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Gd-153</td>
<td>Innocent</td>
<td>3</td>
<td>Other</td>
</tr>
<tr>
<td>Gd-159</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
<td>ID String</td>
<td>Classification</td>
<td>Priority</td>
<td>Sub-Classification</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------</td>
<td>----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Ge-68/Ga-68</td>
<td>Innocent</td>
<td>3</td>
<td>Medical</td>
</tr>
<tr>
<td>Geiger Muller CR</td>
<td>Threat</td>
<td>1</td>
<td>Geiger Muller</td>
</tr>
<tr>
<td>HEU</td>
<td>Threat</td>
<td>1</td>
<td>Uranium</td>
</tr>
<tr>
<td>Hf-181</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Hg-203</td>
<td>Innocent</td>
<td>2</td>
<td>Industrial</td>
</tr>
<tr>
<td>Ho-166</td>
<td>Innocent</td>
<td>2</td>
<td>Other</td>
</tr>
<tr>
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APPENDIX F. TROUBLESHOOTING

F.1 DETECTIVE X APPLICATION STOPS

The Detective X incorporates a computer running the Windows Mobile operating system. Occasionally, the operating system will stop responding to external commands. Press and hold the power button until the computer shuts down and restarts; this may take 10–20 seconds (the mechanical cooler will continue running). This will reset the operating system and automatically relaunch the Detective X application.

F.2 DETECTIVE X WAS DROPPED

Although it is a precision scientific instrument, the Detective X has been designed for field use in the most challenging conditions, and should survive reasonable levels of mechanical abuse. It has been drop-tested to destruction in development, and is known to have a high degree of survivability to “normal” shock and vibration.

If the instrument is dropped:

- Inspect the exterior for evidence of mechanical damage or distortion.
- Listen to the cooler: If you hear any unusual noises (rattling or pinging) from the cooler, contact your local ORTEC representative or our Global Service Center.
- Cycle the unit’s power as follows: Disconnect from any external power source, disconnect any USB connection, and press and hold the On/Off button for approximately 20 seconds. Wait 5 seconds, then turn the unit back on. This should reset any mechanical relays that may have been deactivated by the drop.
- Monitor the unit for the next few hours to ensure that the display reads **Status: READY** (indicating that the cooler, bias voltage, and gain stabilizer are functioning properly). If gain stabilizer errors are indicated, perform a calibration as described in Section 3.12.

If the unit fails in one or more of these respects, or if one or more hardware diagnostic settings indicate a hardware failure, contact your local ORTEC representative or our Global Service Center for assistance.

*Remember that there are no user-serviceable parts inside the Detective X and opening the case will void the warranty.*

F.3 DETECTIVE X WILL NOT TURN ON

Connect the Detective X to an external power source and attempt to turn it on by pressing and holding the Power button for about 5 seconds. If this fails, contact our Global Service Center for assistance.

F.4 FORGOT THE PASSWORD

There is no master password. Contact your ORTEC representative or our Global Service Center for assistance.
F.5 PEAK CENTROID, FWHM, OR CALIBRATION ADJUSTMENT VALUE HAS CHANGED DRAMATICALLY SINCE THE LAST CALIBRATION

This is a highly unlikely occurrence. The Detective X is an advanced digital design, and is highly stable when operating correctly.

- If the energy calibration appears highly variable, contact our Global Service Center or your ORTEC representative. Changes of the order of 0.1% are to be expected. This might simply be due to counting statistics in the spectrum. A change much larger than this, say 0.5%, bears investigation. Apparent changes in the reported FWHM calibration are most likely to be statistical variations. If the (gain) calibration adjustment value is stable, the unit is functioning properly.
- If large changes in the calibration continue to occur, contact our Global Service Center or your ORTEC representative.

F.6 GPS ISSUES

F.6.1 Delayed Display of Location Coordinates

If the GPS has not received signals from GPS satellites for >30 days (e.g., if it has not been in use or has been used continuously indoors), it may take 10–15 minutes outdoors for the unit to update and begin displaying location information.

F.6.2 “GPS Not Communicating”

This message is displayed if the Detective X software loses contact with the GPS unit. Contact your ORTEC representative or our Global Service Center.

**NOTE** GPS signals typically do not penetrate buildings, so the Detective X will not reliably collect location information indoors.