



# NITON Corporation

## XL-309

&

## 700series

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# User's Guide Version 5.0 (HTML) Preface

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## Preface

This User's Guide is a detailed instruction and reference manual for NITON XL-309, 701, 701-A, 702, 702-A, 703 and 703-A owners and users. The operation and safety instructions in this Users Guide are complete. This User's Guide is intended to complement the instrument training that NITON provides free-of-charge.

Keep your NITON clean, particularly the beryllium window on the bottom of the instrument. If the beryllium window is dirty, the performance of your NITON will be affected. Clean the window gently with cotton swabs. Clean the instrument's metal case with a soft cloth. Never use water, detergents, or solvents. These may damage the instrument.

**All Service except exterior cleaning must be performed by NITON Corporation. Do not attempt to make repairs yourself. Opening the case of your NITON will void the instrument Warranty.**

Never ship your NITON analyzer back to the factory for *any* reason without calling and obtaining a Return Authorization (RA) Number from NITON Corporation.

### Users Guide conventions

**Warnings:** Provide information on how to safely operate the NITON.

**Cautions:** Provide information on how to avoid damaging the NITON.

**Notes:** Highlight other important information.

**Warnings, cautions, and notes are printed in bold type.**

## **Chapter summaries**

## **Chapter summaries**

### **Chapter 1, Unpacking your NITON**

Supplies instructions for unpacking the shipping container.

### **Chapter 2, Operating your NITON**

Includes basic operating instructions; an overview of NITON XRF test modes; and supplies instructions for instrument calibration, for taking a reading, for downloading data, and for charging and changing battery packs.

### **Chapter 3, Analyzing bulk samples**

**For users of 702, 702-A, 703 and 703-A model analyzers (for multiple elements).**

**For users of XL-309 with optional Lead in Soil Analysis Package (for lead only).**

Supplies instructions for rapid, on-site, multi-element detection and analysis of a variety of bulk samples, including soils, house dust, sludges, and liquids.

### **Chapter 4, Analyzing thin samples**

**For users of 701, 701-A, 703 and 703-A model analyzers (for multiple elements).**

**For users of XL-309 with optional Dust Wipe Analysis Package ( for lead only).**

Supplies instructions for rapid, on-site, multi-element detection and analysis of a variety of thin samples, including filters, dust wipes and thin films.

### **Chapter 5, Analyzing lead paint**

**For users of 701-A, 702-A, 703-A and XL-309 model analyzers.**

Supplies instructions for rapid, on-site detection and analysis of lead-based paint.

### **Chapter 6, Radiation safety**

Includes an overview of radiation safety, instrument radiation profiles, and guidelines for safe operation of NITON XRF analyzers.

## **Chapter 7, Additional Information**

Includes an overview of multi-element XRF analysis; tips to improve sampling and testing; a summary of safety warnings and equipment cautions; and NITON warranty information.

## **Chapter 8, Appendices**

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**NITON Corporation**

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\* XL-309 and 700 Series User's Guide

\* XL-309 Lead Detector

\* 700 Series Multi-element Analyzer

Produced in the United States of America

Registration: NITON Corporation manufactures the XL-309 and 700 Series under the authority of the State of Rhode Island, *License #3A-105-01*. NITON XL-309 and 700 Series have been evaluated for safety in *Sealed Source and Device Evaluation Sheet RI-164-D-101-S*.

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# User's Guide Version 5.0 (HTML) Chapter 1

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## Chapter 1: Unpacking your NITON

1. Inspect the shipping carton for signs of damage such as crushed or water damaged packaging. Immediately notify the shipper and NITON Corporation if any damage is noted.

**Note: The radioactive cadmium<sub>109</sub> source is completely sealed and extremely secure. It meets ANSI standard 33232.**

2. Open the packing carton. If your NITON Spectrum Analyzer is not packed in its carrying case, please call NITON Corporation immediately at (401) 294-1234

3. Verify the contents of the shipping container against the packing list. Please record any discrepancies and notify NITON Corporation.

4. Open the carrying case and visually inspect the instrument for damage before removing it from the case. Call the shipper and NITON Corporation if you find any damage to the case or its contents.

5. Save the shipping carton and all packing materials. Store them in a safe, dry area, Use when the spectrum analyzer is next shipped.

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# User's Guide Version 5.0 (HTML) Chapter 2

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## Chapter 2: Operating your NITON

NITON **XL-309** and **700 Series** Spectrum Analyzers are hand-held, portable XRF detectors, designed to make fast, accurate measurements. The **XL-309** measures concentrations of lead, while **700 Series** instruments measure concentrations of many different elements simultaneously. NITON instruments measure the precision of each reading, store up to 3,000 readings with complete x-ray spectra, and download data quickly to a PC.

NITON designed the radioactive source and shielding of our analyzers with one guiding principle in mind: properly used, these will not expose the NITON user to levels of radiation significantly above natural background levels.

**Note: The accuracy and precision of the data you collect with your NITON XRF will largely depend on your familiarity with the instrument and your knowledge of the media you are testing.**

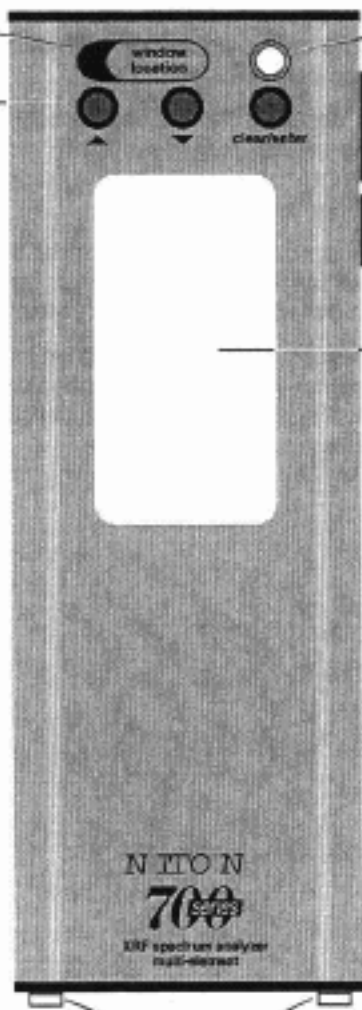
Our free factory training is designed to give you the basic tools to use our instruments. This User Guide supplements our training. You can use it as both a quick reference and a detailed operating manual for

any of our XRF analyzers.

## This is your NITON XRF Spectrum Analyzer

Diagram showing location of radioactive source window

3-button control panel (2 scroll keys and clear/enter key)



Plunger

Safety slide

Shutter release

Hole for lock

Screen

NITON  
700  
XRF spectrum analyzer  
multi-element

Battery pack  
clamp screws

Fig. 2.01 Front view of the NITON 700.

Fig. 2.02

Top view of the your NITON.

Diagram showing location of radioactive source and direction of the emitted x-rays.

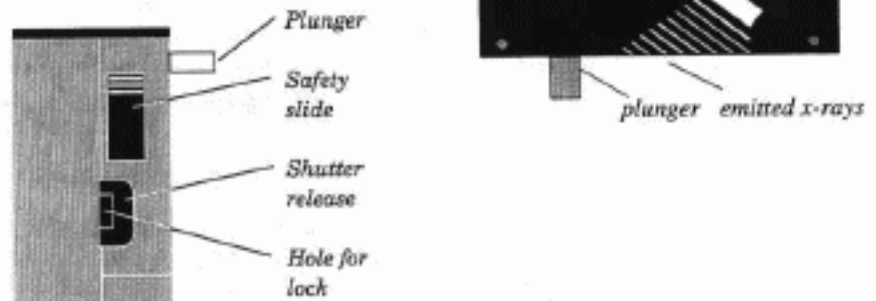


Fig. 2.03

Right side view of your NITON.

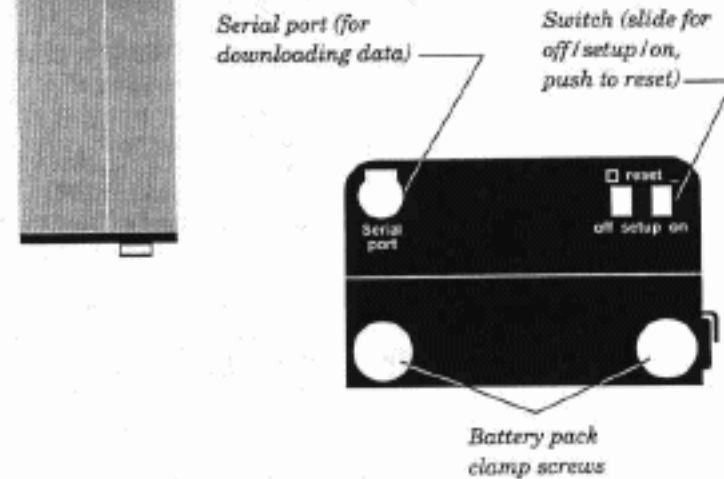


Fig. 2.04

Back view of your NITON

# NITON Spectrum Analyzers operate in the following modes:

## Modes of operation, by model

Model	Bulk Mode	Thin Sample Mode	Paint Modes
● 701	● No	● Yes	● No
● 701-A	● No	● Yes	● Yes
● 702	● Yes	● No	● No

● 702-A	● Yes	● No	● Yes
● 703	● Yes	● Yes	● No
● 703-A	● Yes	● Yes	● Yes
● XL-309	● Opt (lead only)	● Opt (lead only)	● Yes

## Turning on your NITON

**1. Turn on the instrument. Depress and slide the On/Off switch on the bottom of the instrument to the on position (Figure 2.04). Sometimes the instrument's battery saving features momentarily delay start up. If your NITON does not turn on immediately, turn it off, wait a few seconds, and turn it on again. Each time the NITON is turned on, the Main menu appears (Figure 2.05).**

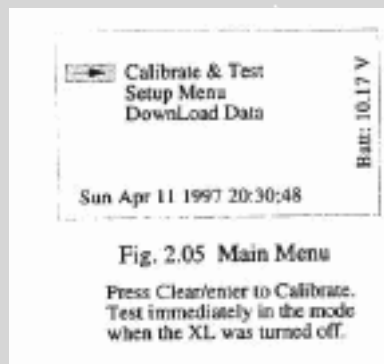


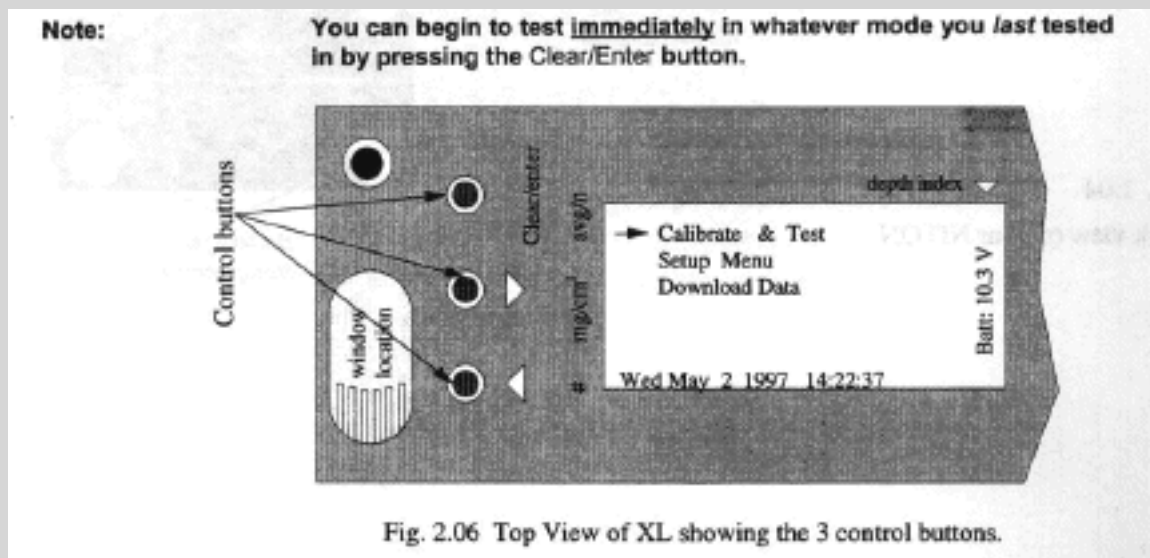
Fig. 2.05 Main Menu

Press Clear/Enter to Calibrate.  
Test immediately in the mode  
when the XL was turned off.

**2. The control panel consists of three buttons (Figure 2.06). These buttons allow you to navigate all of your NITON's screens and menus. Press the Clear/Enter button to *select* the function indicated by the screen arrow. When you turn on your NITON, the Screen arrow is on**

Calibrate & test.

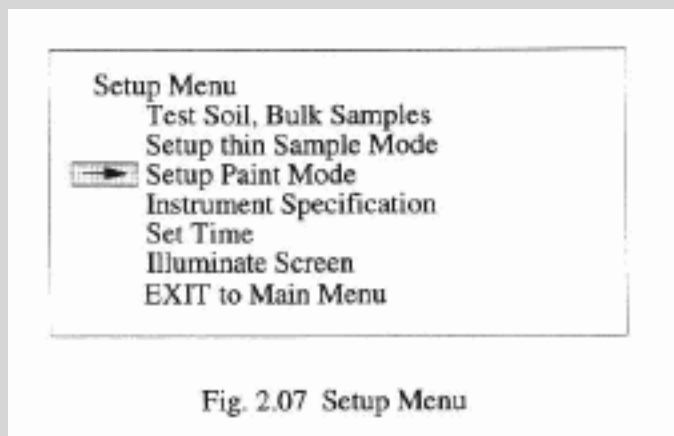
**Note:** You can begin to test immediately in whatever mode you *last* tested in by pressing the Clear/Enter button.



## Getting started

The XL-309 and 700 Series Instruments are highly sophisticated, electronic spectrum analyzers. The more familiar you are with your NITON's operation, the better your measurements and reports will be. Here, in brief, is an outline of how to do various kinds of testing using your NITON. More detailed information is offered in subsequent chapters.

1. Turn on the instrument. When testing in Bulk Sample or Thin Sample modes, leave your NITON on for fifteen minutes prior to testing. *This is not necessary if you are going to test in any of the Paint Modes.* Go to the Setup Menu (Figure 2.07) and set the .mode you wish to test in.

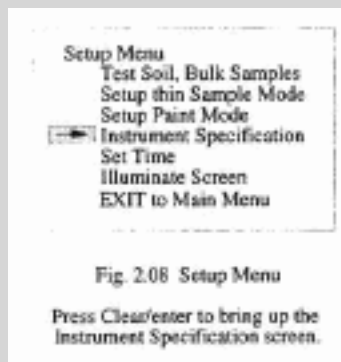


**2. Press Clear/Enter to begin self-calibration.**

**3. When the NITON beeps, calibration is complete. You are now ready to test. For instructions on how to take a measurement, depending on the nature of the media you will be measuring, turn to one of the following chapters: Chapter 3: Analyzing Bulk Samples; Chapter 4: Analyzing Thin Samples; or Chapter 5: Analyzing Lead Paint.**

**Note: Check your instrument's calibration with testing standards before and after testing and at least once per hour during testing.**

## The Setup Menu



**Use the Setup Menu (Figure 2.08) to check your instrument specification; to set the date and time; to illuminate the screen continuously; or to select a different testing mode. Select the Setup Menu from the Main Menu with the Arrow buttons; enter the Setup Menu by pressing Clear/Enter.**

### Instrument Specification

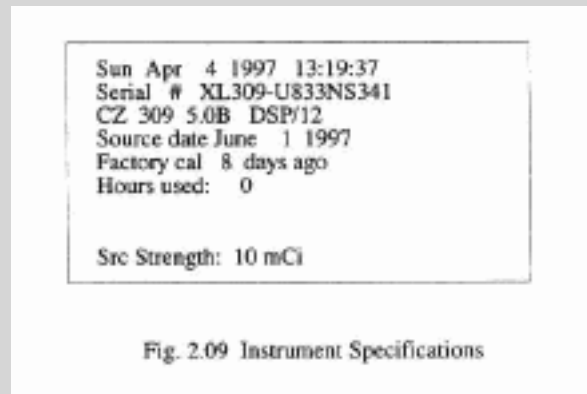


Fig. 2.09 Instrument Specifications

**To check the source strength of your instrument and other useful information, select the Instrument Specification screen (Figure 2.09) from the Setup Menu with the Arrow buttons. Press Clear/Enter. The screen displays the following information:**

- 1. The Day, Month, Date, Year and Time (hours, minutes and seconds).**
- 2. The Instrument Serial Number**
- 3. The instrument Model; and the versions of Firmware and DSP software installed on the instrument.**

- 4. The Source Date, the assay date of the cadmium<sub>109</sub> source.**
- 5. The number of days since the last factory calibration of the instrument.**
- 6. The Hours used, the number of hours the instrument has been used since the last factory calibration.**
- 7. The Source Strength, the current strength of the instrument's cadmium<sub>109</sub> source, in millicuries (mCi).**

**To exit the Instrument Specification screen to the Main Menu, press the Clear/Enter button.**

**Setting the time and date on your NITON**

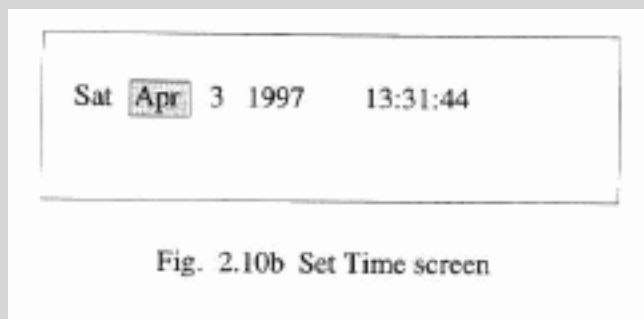
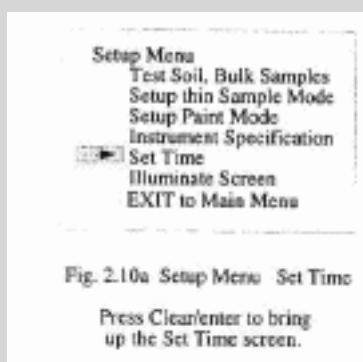
**NITON sets the date and time (EST) on each instrument before it is shipped. Reset as needed when changing time zones, daylight savings time begins and ends, or whenever the time or date is wrong.**

**Caution: Check the Date and Time displayed on the Ready to Test screen. If they are not correct, reset them before taking any measurements. Your readings will not be accurate unless the date and time are correct.**

**To reset the date and time from the Setup Menu, do the following steps:**

- 1. Use the the Arrow buttons to scroll to Set Time (Figure 2.10 a,b).**
- 2. Press Clear/Enter to select it. The Date and Time appear as follows:**

**Month-Day-Year-Hour-Minute-Second**



## **Month-Day-Year-Hour-Minute-Second**

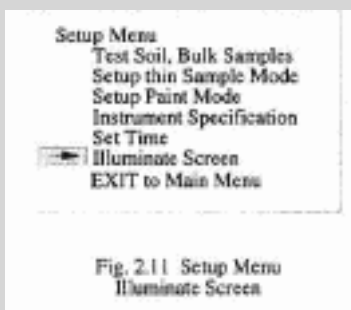
The cursor starts at **Month** and moves to the right. To change the time and date, move from left to right on the screen. For example, To change the **hour** and **seconds**:

1. Press **Clear/Enter** three times to move the cursor to **Hour**.
2. Use the **Arrow buttons** to change the hour to the desired hour. Press **Clear/Enter**.
3. The cursor automatically moves to the next field: **Minute**. Use the **Arrow buttons** to change the minutes to the desired minutes. Press **Clear/Enter** again to move the cursor to **Second**.
4. Use the **Arrow buttons** to change the seconds to the desired seconds. Press **Clear/Enter**.
5. After selecting **Seconds**, the **Main Menu** screen is again displayed, set to **Calibrate & Test**.

**Note: If the year is incorrect, set it first. Use Clear/Enter to move to the year position and the Arrow buttons to set the year. Then press Clear/Enter *five* more times and set the remaining fields as described above.**

## Lighting the LCD screen

In its default mode, your instrument's LCD screen remains back-lit for 15 seconds after any of the three buttons is pressed. You can light the screen any time the instrument is turned on by pressing any of the three buttons. When working in a dark place, you also have the option of lighting the screen continuously.



Take the following steps to either light the screen continuously, or turn off continuous screen lighting if it is currently activated:

1. Use the **Arrow buttons** to select **Illuminate Screen** from the **Setup Menu (Figure 2.11)**.
2. Press the **Clear/Enter button** to turn continuous screen lighting on or off. The instrument will then return automatically to the **Main Menu**.

## Overview of test modes

The **Setup Menu** allows you to choose the pre-programmed test mode best suited for the type of testing that you will be doing. A full chapter is devoted to each mode later in this User's Guide.

**Note: The Setup Menu shows all NITON analyzer modes for all instruments. If you select a test mode which is not available on your NITON instrument, a reminder message will be displayed on the screen.**

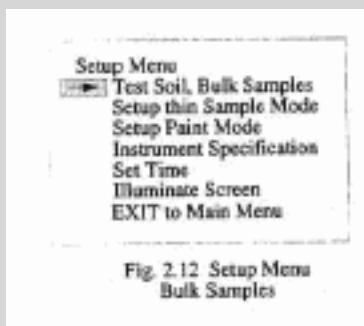
Please contact NITON instrument sales at (800) 875-1578 or your local NITON sales representative to enquire about upgrading your NITON analyzer to add capabilities.

Use the **Arrow buttons** to select the mode you wish to test in. Press **Clear/Enter** to select the mode.

## The Bulk Sample mode

**Bulk Sample Mode** can be used to measure concentrations of contaminants in any fairly homogeneous, fine-grained medium such as soil, ground-up paint chips, a liquid or many other kinds of bulk materials.

**To test in Bulk Sample Mode:**



1. Use the **Arrow buttons** to select

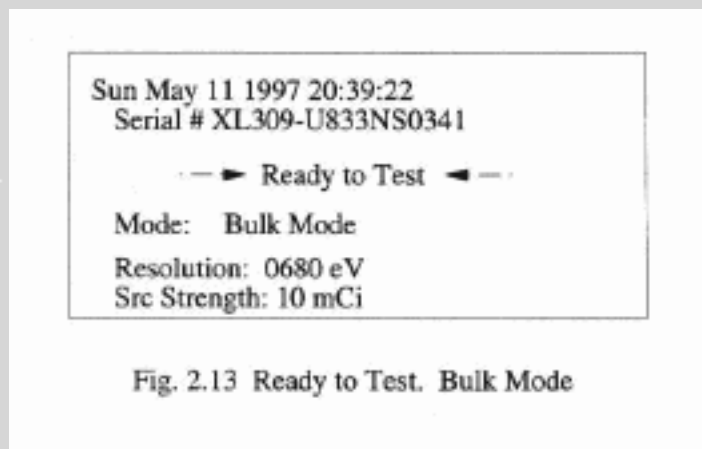
### **Test Soil, Bulk Samples**

from the **Setup Menu (Figure 2.12)**. Press the **Clear/Enter** button.

2. The instrument will return to the **Main Menu** ready to **Calibrate & Test** in Bulk Sample Mode. Press the **Clear/Enter** button.

3. The instrument will initiate self-calibration. This will take one to two minutes. When self-calibration is complete, the instrument will **beep** and display the **Ready to Test** screen for Bulk Sample Mode (**Figure 2.13**).

4. See **Chapter 3: Testing Bulk Samples** for details on how to test particular kinds of bulk samples.



## **The Thin Sample modes**

**Thin Sample Modes** can be used to measure concentrations of contaminants in a variety of thin layers, including deposits on dust wipes, filters and many other substrates, including, for example, thin layers of uranium on concrete.

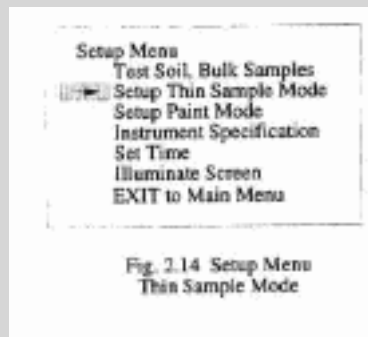
**Caution: The Standard Thin Sample Mode should not be used for quantitative lead-paint testing. Use only the three Paint Testing modes to test lead-based paint.**

There are five Thin Sample Testing modes, each designed for a different type of test media:

1. **37 mm CE Filters:** Used for 37 mm diameter filters (fiberglass or cellulose-ester) used in personal exposure monitoring. This mode can also be used for 37 mm filters used to analyze dust in Dust Vacuum

Methods. In this Thin Sample Mode, three measurements are taken, weighted, and summed for each filter.

2. **TSP/PM Filters:** Used for the larger filters to monitor the concentration of metals in air. In this mode, the instrument averages the measurements you take on the filters.
3. **Dust Wipes:** Used for dust wipes to take samples by wiping surfaces following HUD guidelines for risk assessment and clearance testing for lead in dust.
4. **Standard Thin Sample:** Used for taking single measurements of samples or coatings. In this mode, results are displayed, in micrograms/cm<sup>2</sup>.
5. **User-Definable Thin Samples:** User-definable testing gives you the flexibility to specify custom thin sample measurement protocols.



## Testing in the Thin Sample Modes:

1. Use the **Arrow buttons** to select

### Setup Thin Sample Mode

from the **Setup Menu**. Press **Clear/Enter**.

2. The **Choose Operation Mode for Thin Samples** screen will appear (**Figure 2.14**)
3. Use the **Arrow buttons** to select the mode appropriate for the kind of thin samples you are going to test. Press **Clear/Enter**.
4. The **Choose Operation Mode for Thin Samples** screen will *highlight* the thin sample mode you have selected and the cursor will move to **Exit to Main Menu** (**Figure 2.15**). Press the **Clear/Enter** button to return to the **Main Menu**. Press the **Clear/Enter** button again to initiate **Calibration & Testing** in the thin sample mode you have selected.
5. The instrument will initiate self-calibration. This takes one to two minutes. When calibration is complete, the instrument will **beep** and display the **Ready to Test** screen for the thin sample mode you have selected (**Figure 2.16**).
6. See **Chapter 4: Testing Thin Samples**, for details on how to test thin samples.

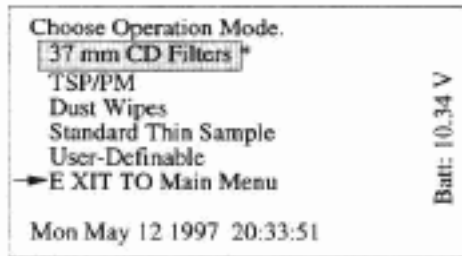


Fig. 2.15 Operation Mode  
Select 37 mm CD Filters

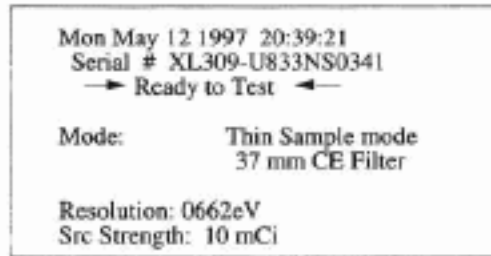


Fig. 2.16 Ready to Test  
37 mm Filter Mode

## The Paint modes

All three **Paint Modes** can be used interchangeably to measure lead concentrations in paint in  $\text{mg}/\text{cm}^2$ . In all paint modes, NITON analyzers simultaneously measure and analyze both K-shell and L-shell lead x-rays to determine (1) the numerical value of the lead in  $\text{mg}/\text{cm}^2$  present in the sample; (2) the 95% confidence interval; and (3) whether the sample has a lead concentration that is **greater-than-or-equal-to** ("**Positive**") or **less-than** ("**Negative**") the lead **Action-level** (in  $\text{mg}/\text{cm}^2$ ) that has been entered.

### Standard Paint Mode

In **Standard Paint Mode**, the instrument reads until a 95% confident reading of "**Positive**" or "**Negative**" versus the **Action-level** is achieved. Then the instrument displays either **Positive** or **Negative**, the **Result** in  $\text{mg}/\text{cm}^2$ , and displays **Surface lead** for all **Positive** readings where the lead is not shielded by overlying layers of non-lead paint.

In **Standard Paint Mode**, testing times will vary somewhat from sample to sample. The instrument will measure *only* until a 95% confident reading of "**Positive**" or "**Negative**" (versus the **Action-level** you have set) has been attained. Most readings take 10 seconds or less.

### Standard Mode + Spectra

**Standard Mode + Spectra** is identical to **Standard Paint Mode** except that the x-ray spectrum is

displayed with each reading.

## K & L + Spectra Mode

In **K & L + Spectra Mode**, the instrument displays the complete test information *continuously*, from the beginning of each reading, including the K-shell reading with two-sigma confidence interval, the L-shell reading with two-sigma confidence interval, the combined reading (Pb) with two-sigma confidence interval, and the full x-ray spectrum. With each reading, a **Null** result is displayed until a **Positive** or **Negative** result is determined.

In **K & L Mode + Spectra**, you may continue readings indefinitely after a "**Positive**" or "**Negative**" result is obtained, until you have attained a desired measurement time or degree of precision.

**Note:** In all paint testing modes, if a test is stopped *before* a "**Positive**" or "**Negative**" determination has been made, you will get a "**Null**" test result.

## Testing in the Paint Modes:



Fig. 2.17 Setup Paint Mode  
Arrow on Paint Protocol

1. Use the **Arrow buttons** to select

### Setup Paint Mode

from the **Setup Menu**. Press **Clear/Enter**. The **Setup Paint Mode** menu screen will appear (**Figure 2.17**)

2. Use the **Arrow buttons** to select

### Set up Paint Protocol

. Press **Clear/Enter**. The **Paint Protocol** screen will appear (**Figure 2.18**)

3. Use the **Arrow buttons** to adjust the times for the **1st beep**, the **2nd beep** and the **3rd beep** signals for **K & L Mode + Spectra** and to set the **Action level**. Use the **Clear/Enter** button to enter each selection.

1st beep	3 sec
2nd beep	10 sec
3rd beep	30 sec
Action level	1.0

Figure 2.18: Paint protocol screen

4. When the **Action-level** has been entered, the **Setup Paint Mode** screen will re-appear (**Figure 2.17**). Now use the **Arrow buttons** to select a Paint Testing Mode. Press **Clear/Enter**.
5. The **Main Menu** will appear, with the instrument ready to **Calibrate & Test** in the paint mode you have selected. Press **Clear/Enter**.
6. The instrument will self-calibrate in one to two minutes. When self-calibration is complete, the instrument will **beep** and display the **Ready to Test** screen for the paint mode you have selected (**Figure 2.19**).
7. See **Chapter 5: Testing Paint Samples**, for detailed descriptions of all three paint testing modes.

```

Sun May 11 1997 20:39:22
Serial # XL309-U833NS0341

  — ► Ready to Test ◄ —

Mode:          Std Paint
Action Level  1.0
Resolution:   0680 eV
Src Strength: 10 mCi

```

Fig. 2.19 Ready to Test. Paint Mode

## Calibrating your NITON

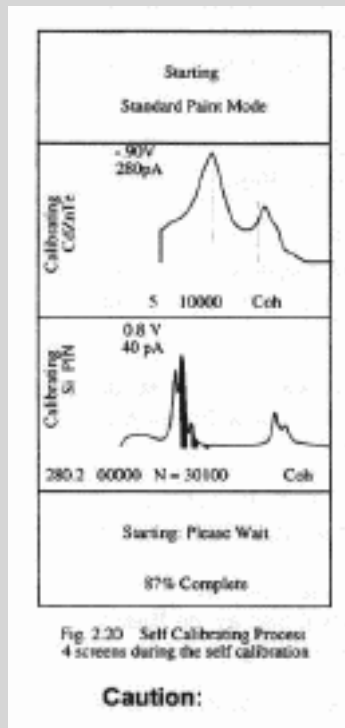
Your NITON has been thoroughly calibrated at the factory. To further assure the best Quality Assurance/Quality Control, your NITON performs a second self-calibration check every time you turn on or reset the instrument.

In addition, NITON has provided you with several standard samples so you may check both calibrations. These tests against known standards insure that the instrument is functioning properly and buttress your results with a permanent record of regular calibrations.

### Instrument self-calibration

When the **screen arrow** (->) is on **Calibrate & test**, press **Clear/Enter** to start the self-calibration process (**Figure 2.20**). Self-calibration takes one to two minutes. When it is completed, the instrument

will beep and the **Ready to Test** screen will appear.



## The ready to test screen

The **Ready to Test** screen (Figure 2.19) displays the following fields:

1. The current **Date** and **Time**.

**Caution: Check the Date and Time. If they are not correct, reset them before taking any measurements (see page 10). Your readings will not be accurate unless the date and time are correct.**

2. The instrument **Serial Number**.

3. The indication that the instrument is **Ready to Test**

4. The testing mode the instrument is ready to test in.

5. The **Action-level** the instrument will use to make either a "Positive" or "Negative" determination of lead in paint testing. The **Action-level** is only used in paint testing modes.

6. The **Energy Resolution**. The lower the number (in eV), the better the instrument will perform.

**Caution: If you try to calibrate the instrument and it does not calibrate successfully, push the Reset Button on the bottom of the instrument and recalibrate. If your NITON does not calibrate successfully in three attempts, please call the NITON Service Department at (401) 294-1234.**

7. The **Source Strength (Src Strength)**. The Source Strength indicates the current activity of the cadmium<sub>109</sub> source in your instrument, in millicuries. Your NITON compensates automatically for the decay of the source.

## Re-calibrating your NITON during testing

To insure the accuracy and precision of your NITON, it is recommended that you re-calibrate hourly during testing. To recalibrate:

Press the **reset** button on the bottom of your NITON.

or turn the NITON off, then on, and press the **Clear/Enter** button.

**Note: Occasionally, your NITON may refuse to take further readings and the screen will display the following message:**

**YOU MUST RECALIBRATE.**

**Typically, this will occur when there is a sudden, very large change in the ambient temperature. When this occurs, recalibrate and continue testing.**

## **How to use your NITON standard samples**

NITON provides sets of standard samples for each testing mode. These are used to check the calibration of the instrument:

1. For **Bulk Sample Mode**, there is a set of three NIST soil standards
2. For **Thin Sample Mode** there is a set of three thin film standards: lead, copper, and iron.
3. For **Lead Paint Mode**, there is a set of government-traceable lead paint films.

**Note: Although the standards do not contain every element our multi-element analyzers test for, when an instrument correctly measures the standards you have received with your 700, your NITON will correctly measure the other elements.**

Test the standards regularly. First, immediately after the instrument finishes self-calibration. Then test the standard samples appropriate to the type of tests you are conducting, and once every 1-2 hours thereafter.

**Warning: Tampering with the 5,500 ppm lead-in-soil standard may cause exposure to lead dust. Keep all standards out of reach of children.**

Caution: Never tamper with Test Standards. They should not be used unless they are completely intact.

## **Soil and Thin Film standards**

To test soil or thin film standards, place the sample in the test platform receptacle and proceed to test as with any prepared sample. The NITON standard soil samples provided with your instrument contain known amounts of several elements. Do not contaminate the thin film samples with your fingerprints. Handle them by the edges with clean hands.

## **Lead paint standards**

1. Place the NITON standard with the colored side face up. Choose the RED strip labelled 1.0 +/- 0.1. Take a reading of that standard. Place the instrument on the standard so that the instrument window is

fully on the standard. Your NITON should display a value between 0.9 and 1.1 mg/cm<sup>2</sup> and should indicate **Surface lead**.

2. Place the same standard with the colored side down. Take a reading of the standard (buried beneath the equivalent of 5-6 coats of non-lead paint). Your NITON should still display a value between 0.9 and 1.1 mg/cm<sup>2</sup> and should not display **Surface lead**.

**Note: If your instrument is testing high on Standard samples, check the surface the Standards are resting on. The surface may contain lead.**

When you test the Standard samples, your instrument should give readings which approximate the certified values. Your instrument should give consistent readings for each sample.

## Downloading data

Your NITON stores up to 3,000 measurements plus their spectra. You can download this data to a computer for reporting or insertion in a database.

**Note: Downloading data does not erase readings. To make room for the next set of data, erase readings after verifying that the data was downloaded successfully (see next section).**

The RS-232 port, on the back of your NITON, accommodates a 4-pin LIMO connector. A LIMO to 9-pin RS-232 connector cable is provided with your NITON. Your NITON can communicate with either a "dumb" or an "intelligent" terminal, such as a VT100 connected to a mainframe computer or a PC-compatible computer.

### Fast data dump

You can download up to 3,000 measurements, their descriptions, and spectra (4-90 keV) in *minutes* using the high-speed compressed format, **NITON/Mid-Hudson Downloading Software**, provided with your instrument.

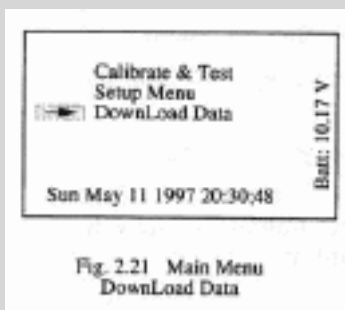
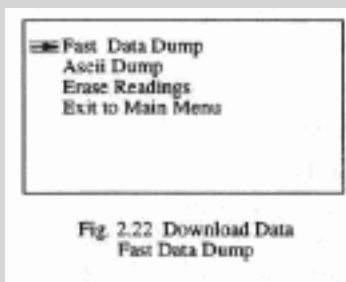


Fig. 2.21 Main Menu  
DownLoad Data

1. Connect your NITON to your computer with the RS-232 port cable that is provided.
2. Using the **Arrow buttons**, select **Download Data** from the **Main Menu** and press **Clear/Enter** (**Figure 2.21**).
3. Select **Fast Data Dump** from the **Download Data menu** (**Figure 2.22**) and press **Clear/Enter**. Select the first to the last readings you wish to download. The **default** setting will download all readings currently stored in memory.

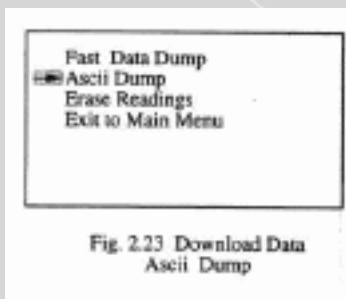


4. When the instrument finishes downloading, it will return to the **Main Menu**.

## ASCII data dump

For users who wish to download data in ASCII format, the NITON can dump its data as an ASCII file to any terminal emulator program.

1. Connect the NITON to your computer with an RS-232 cable.
2. In the **Download Data** screen, press the **Arrow buttons** to scroll to **ASCII dump (Figure 2. 23)**. Press **Clear/Enter**.

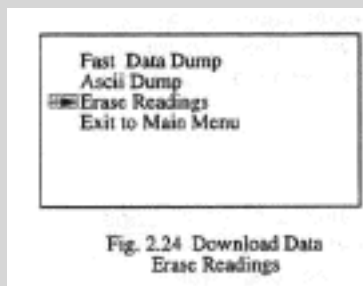


3. When the instrument finishes downloading, it will return to the **Main Menu**.

## Erasing readings

If you do not erase your data, the NITON will continue to record data until the memory is completely full. Then the NITON will start to overwrite older data. Any data that is overwritten in this way will be lost.

Your NITON can store data on up to 3,000 measurements in all **Paint modes**, or 1,000 readings in **Bulk Sample** or **Thin Sample modes**.



**Note:** Download your data before the memory is completely full. Clear the memory after

## downloading.

The erase readings function is designed to protect you from accidentally erasing readings. To erase readings:

1. In the **Download Data** menu, use the **Arrow buttons** to scroll to **Erase Readings (Figure 2.24)**. Press **Clear/Enter**.
2. The **Erase Readings** screen (**Figure 2.25**) appears with the following choices:

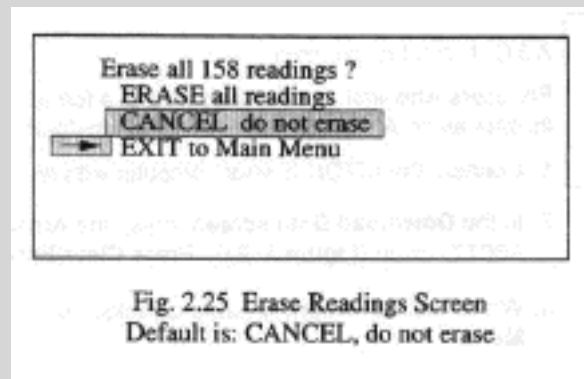
**ERASE all readings**

**-> CANCEL do not erase**

**EXIT to Main Menu**

The screen arrow defaults on **Cancel do not erase**, so that if you select it by mistake, you will not erase any readings.

3. To **Erase Readings**, use the **Up-Arrow button** to go to **ERASE all readings**. Then press **Clear/Enter**. When you enter either **ERASE all readings** or **CANCEL do not erase** your instrument will return to the **Main Menu**, ready to take and store more readings.



## Battery packs and battery charger

Fully charged, each Nickel Metal Hydride battery pack gives eight or more hours of continuous use. It takes about 2.5 hours to fully recharge a spent battery pack if the batteries have been recently used. If the NITON has not been used for several weeks, or if the batteries are completely discharged, they must be pre-charged before they can be recharged. See **Battery Charger**, below.

NITON Battery packs can be recharged at least 500 times. They are warranted to be free of defect when shipped. They are not further covered by manufacturers' warranty. When they need to be replaced, new battery packs may be purchased from NITON.

**Note: Before beginning a test, be certain the battery pack has sufficient charge. It is always a good idea to carry a spare battery pack.**

**Caution:** NITON's Nickel Metal Hydride battery packs discharge at a rate of about 2% per day when not in use.

## Battery pack routine maintenance

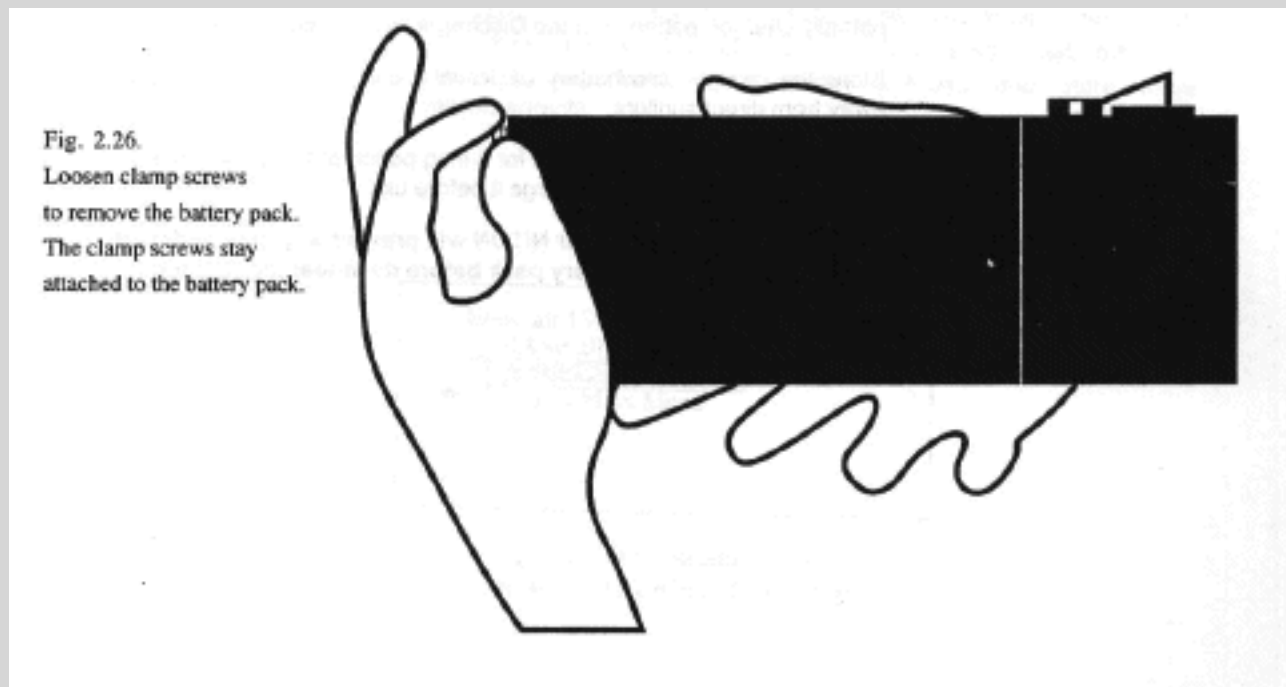
Some guidelines:

- \* Don't leave battery packs on the charger *all* the time. Overnight recharging is recommended.
- \* For longest battery lifetimes, use a battery until completely discharged, and then recharge.
- \* Don't recharge a fully charged battery pack. If you want to charge a partially charged battery, run the Discharge cycle before recharging.
- \* Store the charger and battery packs in a cool, but not cold, place, away from direct sunlight.
- \* When a battery pack is not used for a long period of time, it will lose its charge completely. Fully recharge it before use.

**Note: The lithium battery inside your NITON will prevent any loss of data if you need to change the battery pack before downloading readings.**

## Changing battery packs

### Removing a battery pack



1. Avoid changing the battery pack outdoors. Moisture and dirt can damage a battery.
2. Rest the NITON on a clean surface.
3. Loosen the (2) clamp screws. They do not come off (**Figure 2.26**).
4. Pull the battery pack away from the instrument by grasping the knurled screws and gently rocking the battery pack from side to side while removing it.

## Installing a battery pack

1. Rest the NITON on a clean surface, as before.
2. Slip the notch at the bottom of the battery pack into the wide slot.
3. Gently push the battery pack in, taking care that the battery pack connector is seated properly to the instrument.
4. Tighten the (2) knurled screw clamps that fit into holes on the NITON. If the screw clamps do not tighten, the connectors are not lined up properly. These screw clamps must be tight for a secure connection.

## Recharging battery packs

### Recharging with the AC adapter

1. Lay the battery pack on top of **Battery Charger**. Fit connectors together snugly (**Figure 2.27**).
2. Plug one end of the AC adapter into the power port on the bottom of the charger. Push the plug in, making sure it seats fully.
3. Power up the charger: Plug the other end of the AC adapter into a 110V outlet. The yellow **Power** light will come on and stay on throughout. The green **Charge** light will also come on. It will blink slowly at first, indicating that the battery is on **Pre-charge**, and then stay on with a steady light, indicating that the battery is on **Full Charge**.
4. In **Full Charge** mode, the green **Charge** light will stay on with a steady light while the battery is being charged. It is normal for the charger to make some noise in **Full Charge** mode.
5. In **Trickle Charge mode**: When the battery is fully charged, the charger will automatically switch to **Trickle Charge** mode and the green **Charge** light blinks rapidly.

**Caution: Do not leave battery packs on the Battery Charger longer than necessary.**

## Battery charger



Fig. 2.27. Front view of the battery charger.

## Discharge cycle

Put battery packs on the **Discharge Cycle** only if they are not holding a charge; or, if they are partially charged, run the **Discharge Cycle** before recharging. It takes about eight hours to fully discharge a battery pack. To discharge a battery pack, place it on the charger and:

1. Press the red **Discharge** button. The red **Discharge light** goes on, and the green **Charge** light blinks

slowly, showing charger is in **Discharge** mode.

2. After a full Discharge cycle, the charger automatically recharges the battery.

3. The red **Discharge** light goes out and the green **Charge** light will blink rapidly, showing it is in the **Trickle Mode**.

## Pre-charge

If your NITON battery packs run all the way down, they must be pre-charged before they can be re-charged. The process can take up to 5 hours. A battery is pre-charging when the green **Charge** light on the battery charger is blinking slowly, and the **Discharge** and **Temperature** lights are off.

## Overheating during charge

**Caution: If the red Temp light comes on repeatedly when a battery pack is on the battery charger in the Full Charge cycle, call NITON Customer Service at (401) 294-1234.**

Caution: Do not store the battery packs or battery charger in direct sunlight.

## Using your vehicles 12V DC outlet

[yen] A 12V DC Adapter is provided with your NITON. Instructions are the same as for using the 110V AC Adapter. When you have seated all connections well, the yellow **Power** light will come on.

[yen] Do not use the Discharge Cycle while on the DC outlet.

[yen] Secure the charger so the power cord does not get pulled out while the vehicle is in motion.

[yen] The plug of the DC Adapter has a 5A internal fuse. To check the fuse, unscrew the cap that retains the contact from the end of the plug. Replace this fuse only with a 5A fuse of the same size. If the fuse in the 12V Adapter burns out frequently, call NITON's Service Department at (401) 294-1234.

**Note: Please do not throw away spent battery packs. Return spent battery packs to NITON so we can dispose of them properly.**

# Maintenance, cleaning and repairs

NITON Corporation welcomes any questions or comments you may have about your NITON analyzer. Please do not hesitate to call us at either our Main Office number: (781) 275-9275 or at our Rhode Island Service Facility number: (401) 294-1234.

**Caution: All Service except exterior cleaning must be performed by NITON Corporation. Do not attempt to make repairs yourself. Opening the case of your NITON will void the instrument Warranty.**

Keep your NITON clean, particularly the beryllium window on the bottom of the instrument. If the window is dirty, the performance of your NITON will be affected. Clean the window gently with cotton swabs. Clean the instrument's metal case with a soft cloth. Never use water, detergents, or solvents.

These may damage the instrument.

**Note: Never ship your NITON analyzer back to the factory for *any* reason without calling and obtaining a Return Authorization (RA) Number from NITON Corporation.**

## Storage, transport, and shipping

### Storing and transporting your NITON

All NITON instruments come in waterproof, drop-proof carrying cases with padlocks. NITON instruments can be transported by car or plane or shipped as an ordinary package. There are no restrictions for tunnels or bridges. No notification is required for transportation except the following: There may be disclosure and/or licensing requirements if you take your NITON instrument across state or national boundaries. Please check with the appropriate agencies for details.

No special labelling is required on the outside of case or packaging. A compliance statement must be kept with the instrument case. *Always* transport the unit in its carrying case, and keep the NITON in its case whenever it is not being used. Store the instrument, in its case, in a secure area.

## Shipping your NITON

All NITON instruments must be packed in their original padded carrying cases for shipment. Pack the NITON in its carrying case and ship in either the original carton and packing material or their equivalent.

**Caution: Do not ship your instrument back to NITON for any reason without first notifying NITON Corporation and receiving a Return Authorization Number.**

**Caution: If you return your NITON without the carrying case you will void the instrument warranty. You will also be billed for a replacement case plus any repairs resulting from improper shipping.**

Always enclose a copy of a current leak test certificate when you ship your instrument back to NITON.

**Caution: NITON's license prohibits repairing or upgrading any XRF instrument without a current leak test certificate. If you return an instrument without a current leak test certificate, NITON will perform a leak test and bill you for the leak test.**

Note: Keep a copy of the following statement in the NITON case whenever the instrument is shipped:

THE NITON SPECTRUM ANALYZER CONFORMS TO THE CONDITIONS AND LIMITATIONS SPECIFIED IN 49 CFR 173.422 FOR EXCEPTED RADIOACTIVE MATERIAL, INSTRUMENTS AND ARTICLES, N.O.S. UN-2910. THIS PACKAGE CONTAINS NO MORE THAN 50 mCi CADMIUM<sub>109</sub> IN A PLATED, SOLID, SEALED SOURCE INSTALLED IN AN X-RAY FLUORESCENCE ANALYZER.



[Back to the Table of Contents](#)



# NITON Corporation

## XL-309

&

## 700series

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# User's Guide Version 5.0 (HTML) Chapter 3

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## 3: Analyzing bulk samples

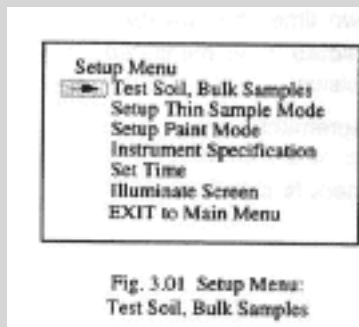
### Overview

The NITON XL-309 may be used to test lead in soil and ground-up paint chips if equipped with optional Lead In Soil Analysis software and hardware. 702, 702-A, 703 and 703-A Model Spectrum Analyzers are multi-element analyzers for bulk media, thick samples of materials such as soil, sludge, and various liquids. Applications include:

- in-situ soil testing,
- in-situ materials testing (e.g., contaminated concrete)
- bagged soil sample testing
- testing sludge, sediments, liquids, and dust in cups,
- testing prepared soil samples.

Choose the **Bulk Sample mode** from the **Setup** screen (**Figure 3.01**).

**Note: Before testing in Bulk Sample mode, turn your NITON on at least 15 minutes prior to testing. This will give you more precise measurements.**



In general, testing methods for bulk media are of two types: Field screening and testing prepared samples. Understanding the difference between these two types of analysis is crucial to getting good data.

Field screening should be used to profile an area, to locate sources of contamination, to determine the boundaries of contamination, or to gather data that will subsequently be used to design a sampling plan. Field screening is usually only approximate; field screening will correlate very well with lab analysis for a highly-homogeneous sample, but may correlate extremely poorly for a non-homogeneous sample.

**Note: For performance evaluation of field XRF results by comparing them to laboratory results (done to justify XRF usage), never use in-situ testing; always gather samples and prepare them before testing.**

When comparing field screening to laboratory analysis, try to compare the same samples. For best results, collect a large sample in a zipper locking storage bag. Shake the bag to mix the sample. Test the bagged sample several times using the NITON and average the readings. Then compare this average reading with lab results.

If you must test in-situ for performance evaluation, take several XRF readings bracketing a spot. Then take a sample for laboratory testing from that spot. For further discussion of field screening, see EPA Method 6200, "Field Screening Using a Field-Portable XRF." Contact NITON for a copy. The EPA accepts field screening using the NITON if the screening is performed using Method 6200. Most states accept EPA Method 6200.

## The measurement screen

On NITON XL-309s with optional Lead in Soil Analysis, *only* lead is displayed in bulk sample testing. On 700 models, only the two highest-concentration elements are displayed (in ppm, with the two-sigma confidence intervals) on the first **Measurement screen (Figure 3.02a)**, with the x-ray spectrum. The black bars on the spectrum display highlight the presence or absence of lead or iron in the sample. The test time is also displayed in nominal (source) seconds.

## The summary screen

When you end a reading, the **Measurement Screen** is replaced by the **Summary Screen (Figure 3.02b)**. On 700 models, results are displayed for 14 elements. The elements are divided into two groups: elements that were detected in the sample, and elements that were not detected. Press the **Arrow buttons**

to scroll through the elements.

**Detection Limit:** For an element to be detected by the NITON in a given sample, the measured concentration of the sample must be at least three times the standard deviation of the measurement. This detection limit will depend on the composition of the sample.

**Precision:** The measurement precision for each element displayed appears to the right of the measured concentration, under the heading "+-". The **precision** of each measurement is two times the standard deviation (sigma). An element is classified **detected** if the measured concentration (in ppm) is at least 1.5 times the precision.

Detected elements are displayed as in the Measurement screen. Non-detected elements are shown as < **xx**, where **xx** is the detection limit for that sample. The detection limit for each element is calculated from each sample.

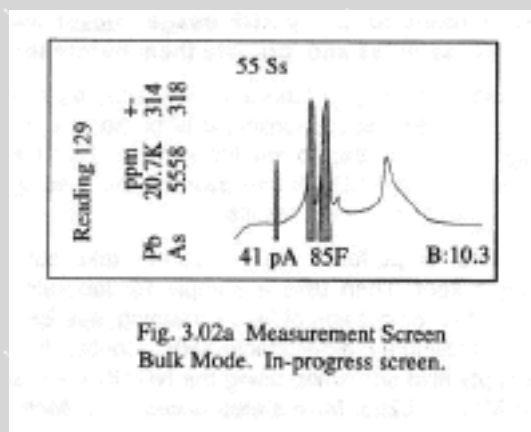


Fig. 3.02a Measurement Screen  
Bulk Mode. In-progress screen.

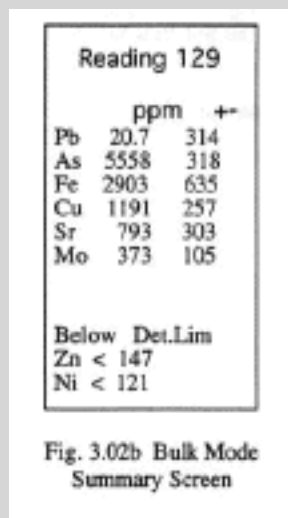


Fig. 3.02b Bulk Mode  
Summary Screen

## In-situ surveys

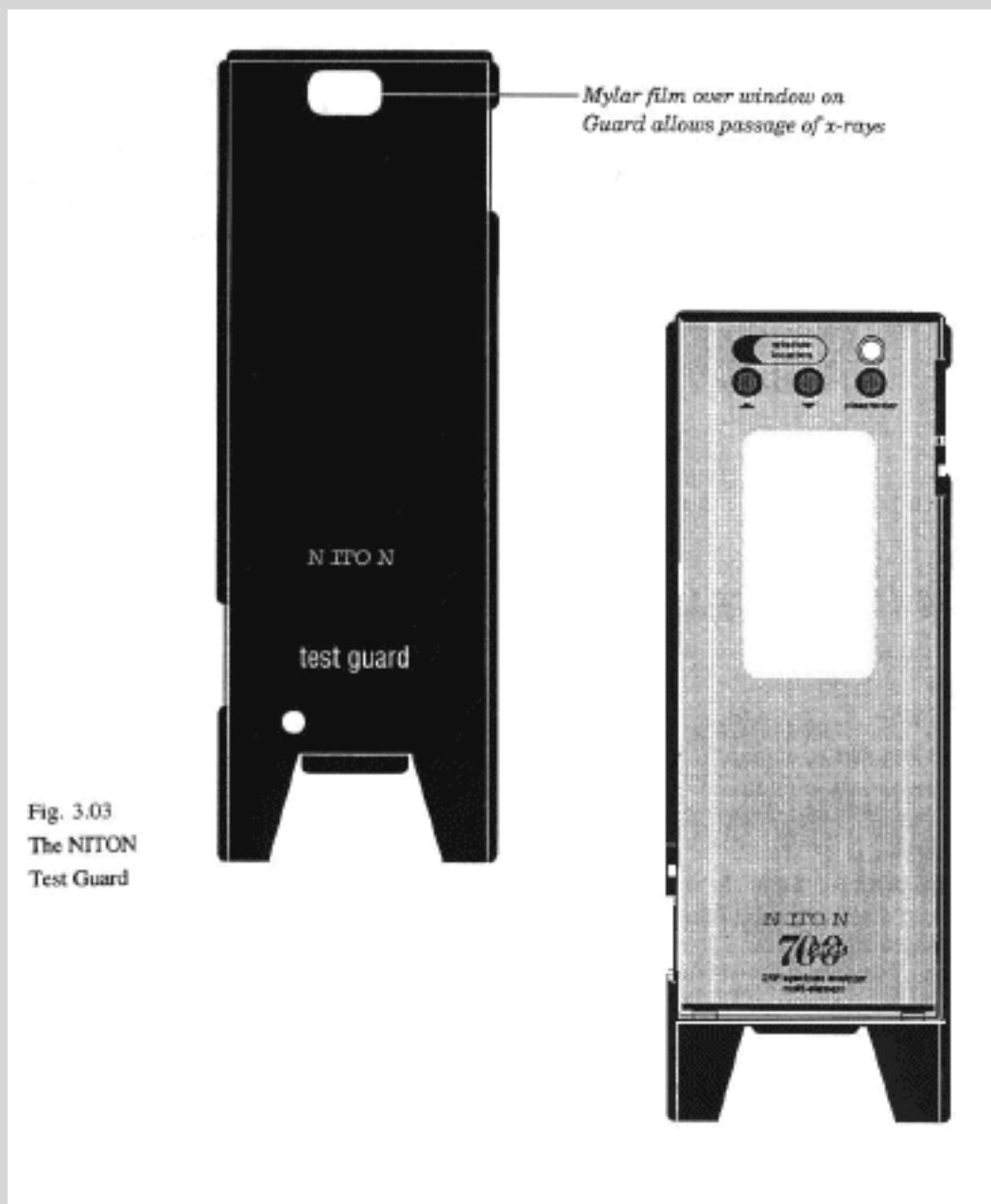
Before you take your first measurement, you must decide whether to test the bulk material

- in-situ (in-place),
- as bagged samples (or, for liquids and sludge, in cups) with a minimum of preparation, or
- in an XRF cup after careful preparation.

**Note: More sample preparation (drying, milling and sieving) will yield greater accuracy. The drier, finer, and more homogeneous the particles, the better the measurements.**

If you are primarily interested in determining whether an element is present (rather than in accurately measuring how much is present), direct measurement is the quickest, simplest way to proceed. Even if you intend to take samples, preliminary direct measurements will help you to survey the site. The analysis of bagged samples is another screening technique.

## The NITON test guard

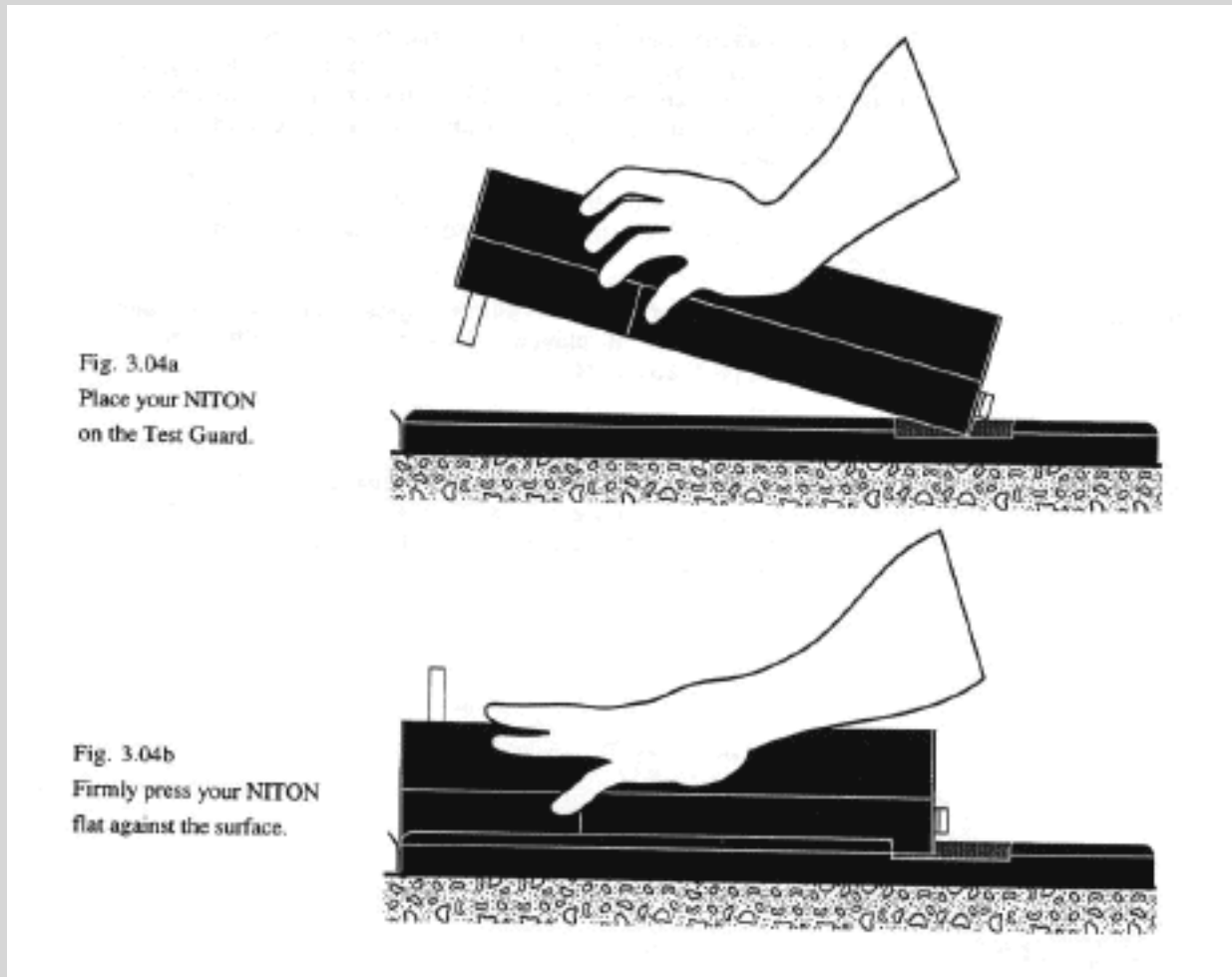


The NITON **Test Guard** (Figure 3.03) is a formed metal plate designed to be placed directly between the ground or other bulk media and the NITON. Use the **Test Guard** for surveys of bulk media *in-situ* or for testing bulk samples in bags. The **Test Guard** shields the unit from contamination and damage.

## Testing in-situ

**Warning: When taking samples from a site where toxic chemicals may be present, always use gloves and respiration equipment for your own protection.**

1. Select a measurement site. Lead-in-soil from paint, for instance, will be concentrated within a few feet of the painted structure. Valid results will depend on a sufficient and appropriate selection of sites to sample.
2. Clear any surface debris or vegetation. Use a flat area so that the NITON will contact the test medium. The finer and more homogeneous the material, the more accurate the measurement. (You can increase your accuracy when testing soil by loosening the soil and letting it dry in the sun before testing.)



3. Place the test guard on ground. Keep the top of the test guard clean.

4. Hold the NITON in one hand.

**Warning: Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring. Never point the NITON at yourself or anyone else when the shutter is open.**

5. Push the safety slide (that locks the shutter release) out from under the shutter release. If the slide is still tucked in, you cannot press in the release nor will the instrument fit on the test guard correctly.

6. Place the NITON on the test guard so that the rectangular opening on the test guard is under the window of the NITON, squeeze the shutter release, and firmly press the instrument flat against the surface of the test guard (**Figure 3.04 a,b**). If you don't squeeze the shutter release, the plunger will not depress. If the plunger is not fully depressed, the window is not fully open and the NITON cannot measure accurately. The back of the unit must be flush with the test guard.

**Note: During the measurement, you do not need to squeeze the shutter release continuously. Hold the NITON firmly against the test guard surface and it will continue to read. Once you lift the instrument, the plunger will back out the bottom, the shutter will close, and the test will be finished.**

7. Watch for indications to decide when the test has reached the desired level of accuracy. A typical screening test will last 20-30 source seconds.

**Warning: In the unlikely event that the plunger gets stuck in the open position, simply push it closed. Then call the NITON Service Department at (401) 294-1234.**

### In-situ depth profiling

An XRF soil test examines only the top millimeter or so of soil. To do depth profiling, simply remove a vertical slice of soil and test several samples from different depths. Doing so rapidly yields information about the depth of contamination.

## Analysis of bagged bulk samples

Sometimes it is convenient to collect samples in plastic bags. Without further preparation of the sample, you can screen the site by testing each bag. Because you are testing through a bag, test results will tend to be 5-10% lower than test results obtained from direct analysis.

### Taking bagged samples

1. Before sampling a site, size it up for differences in soil characteristics. Valid results depend on a sufficient and appropriate selection of sites to sample. Consider the site's topography, texture, drainage, color of topsoil, and past use.
2. Take a composite sample from each predetermined area. Do not combine samples from areas with different compositions or history. **A composite sample made up of samplings from two distinctly different areas is not representative of either area.**

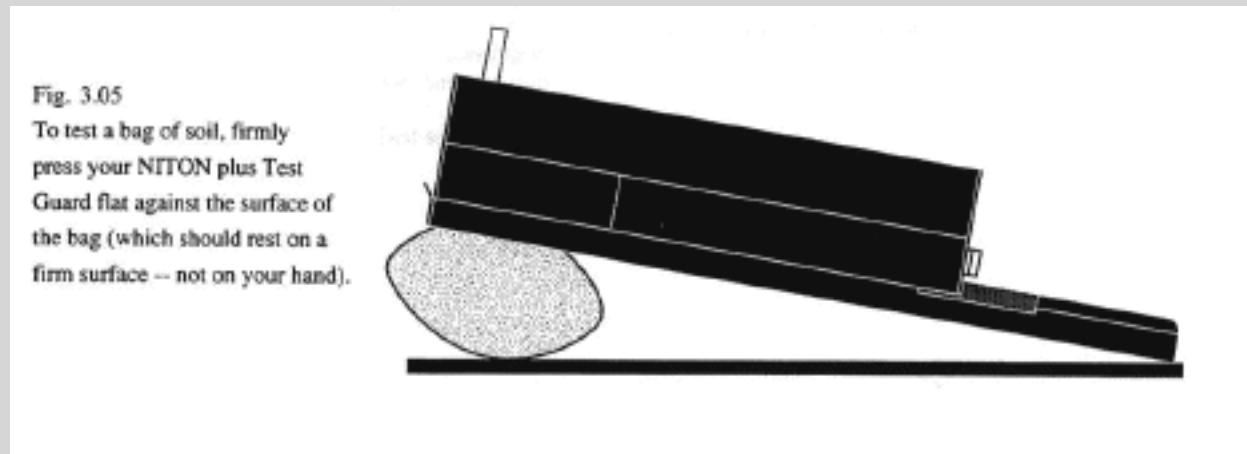
Mix the sample. If it is too large, reduce the sample. Some techniques for reduction and homogenization are described in the section on analysis of prepared samples.

3. Fill a clean plastic bag with 50-100 grams of soil and close it securely (with a twist tie). The accuracy of your measurements will be limited by the thickness of the plastic in the bag you use. 1 mil-thick Polyethylene bags offer a reasonable compromise between accurate readings and bag durability. Be sure to label each bag with your name and the location of the sample site.

### Testing samples in bags

Shape the bag of soil to form a continuous uniform layer of at least 1 cm. (0.4 inch) thickness. Place the NITON test guard on the bag (**Figure 3.05**). Then follow testing in-situ instructions.

**Warning: Do not hold bagged bulk samples in your hand during testing.**



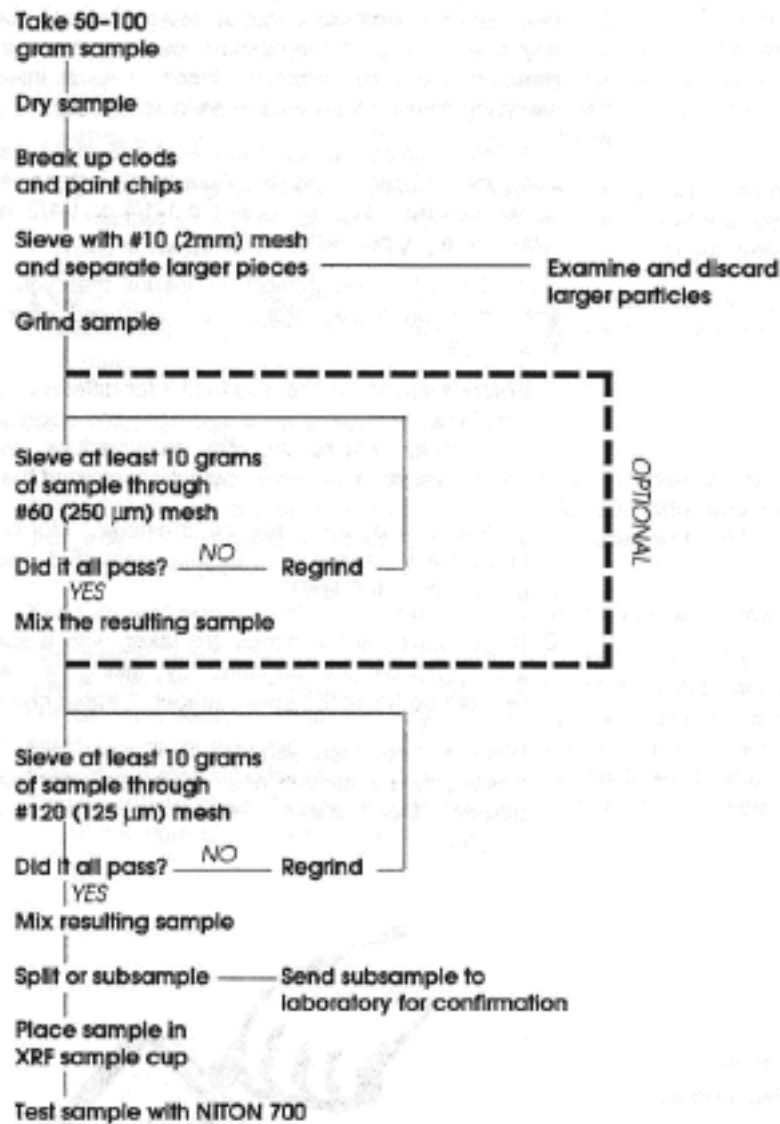
## Analysis of prepared bulk samples

Prepared sample analysis is the most accurate method for determining the concentration of elements in a bulk medium using your NITON. Sample preparation will minimize the effects of moisture, large particle size and variations in particle size.

**Warning: For your protection, when taking samples from a site where toxic chemicals may be present, always use gloves and respiration equipment.**

NITON recommends a specific sample protocol. Following this protocol for preparing and testing samples is vital for achieving a level of accuracy comparable with laboratory results. See **Figure 3.06** for a flow chart of the protocol.

Fig. 3.06 Flow chart of sample preparation protocol recommended by NITON.  
Use of the #60 mesh sieve is optional.



## Taking bulk samples

**Note:** When testing for lead-in-soil in a residential setting, it is standard practice to sample the top 4 to 6 inches of soil.

The soil probe or sampling tube is a very convenient sampling tool. It not only allows speed but it makes more accurate composite samples than any other tool as it may always be inserted to a marked depth and it removes the same amount of soil at each insertion. There are core sampling devices that remove an intact cylinder of undisturbed material.

A shovel, spade, dibble, narrow (1-1/2 inch) garden trowel, or other sampling tool can do the job. Take a half-inch soil slice. A satisfactory soil auger may be made by welding a 1-1/4 or 1-1/2 inch wood bit into

a 1/2 inch pipe equipped with a T-handle.

Take 50-100 gram sample to insure that you have a sample large enough to be representative and unbiased after mixing, grinding, and straining it.

1. Before sampling a site, evaluate it for differences in soil characteristics. Valid results depend on a sufficient and appropriate selection of sites to sample. Test results may be worthless, even highly misleading, unless the samples tested actually represent the area.

Consider topography, texture, drainage, color of topsoil, and past use. Lead, for instance, is usually concentrated near a building with lead paint (within 4-6 feet).

2. If the individual samplings are taken with a spade or trowel, (**Figure 3.07**) reduce the samples by taking a vertical slice (so it is representative of the entire spadeful) about one inch wide.

Place the reduced samples in a clean pail. Then mix the sample thoroughly by stirring and by rotating the pail at an angle of 45 degrees. Don't shake. (You do not want to stratify the sample by weight).



3. Take a composite sample from each predetermined area. Do not combine samples from areas with different compositions or history. A composite sample made up of samplings from two distinctly different areas is not representative of either area.

From each predetermined area, prepare a composite sample by taking several samplings consisting of vertical columns of material approximately 1 inch in diameter. The length of each column should be about 6 inches. Lead from paint is usually concentrated within the top 1-4 inches. The elements you wish to measure and the local history will determine how deep you need to sample.

Package samples from the following areas separately: samples close to painted structures, close to roads, samples close to where various types of waste have been stored, or near pressure-treated lumber.

4. Fill a clean plastic bag and close it securely (with a twist tie). Be sure to label it with the date, the site and the location where you took the sample

### Preparing bulk samples

The equipment you need to prepare samples is included in your kit. Among these are a mortar and pestle (for the XL-309 with lead-in-soil-analysis), an electrically powered grinding mill (included with 700s),

and several sized-sieves.

**Caution: Keep all test equipment clean to prevent contaminated samples.**

The mortar, pestle, and grinding mill may be cleaned with dry paper towels. Water will also clean the mortar, pestle, and the mill's container, but be sure each is absolutely dry before you use them on another sample. The mortar and pestle may be cleansed by grinding clean dry sand in the mortar. Use the short bristle brushes (included in your Bulk Testing Kit) to clean the sieves. When Soil Grinder blades wear out, unbolt the worn blades and replace.

## Cone and quartering

At various times while preparing a sample you may need to divide it. Cone and quartering is a method for splitting the sample into homogenous quarters. Slowly and carefully pour the dry material onto a flat sheet or pan forming a symmetrical cone. Using a flat thin-bladed tool, such as a knife or ruler, divide the cone into equal piles. Divide these in half again. Now you have four samples, each one-quarter the size of the original and each more homogenous than the original.

1. If the sample is moist and cohesive, dry it. To best prepare a sample for presentation to the XRF, the material should be dry and well homogenized. Ideally, the entire sample should be dried to constant weight, sieved to remove gravel and debris, and ground or milled to a fine powder.

The sample can be dried in any of several ways. Choose one of the following: Oven dry the sample for approximately 2 hours at 150° C., until the sample reaches a constant weight; air dry the sample overnight at room temperature in a shallow pan; gently stir and warm the sample in a pan over a hot plate or burner.

Oven drying is inappropriate when volatile compounds may be present in the sample. For example, lead present as tetraethyl lead would be driven off by the heat of drying. Some forms of mercury and arsenic are volatile. Air drying will preserve more of these volatile substances.

2. Grind the sample to break up dirt clods and/or paint chips.

3. Sieve with the #10 (2mm) mesh and separate out the larger pieces (stones, organic matter, metallic objects, etc. Examine the larger particles by eye (look for paint chips), but do not include in the sample.

4. Grind the sample so its particles will be finer and more homogenous. Use mortar and pestle, or an electrically powered grinding mill.

**Warning: Grinding-and-sieving dried samples produces dust. Even clean soil contains silica, which may be hazardous when airborne. Prepare all samples in a ventilated area; wear a mask, gloves, and an apron; and spread a drop cloth.**

5. Sieve at least 10 grams of the sample through #60 (250 um) and #120 (125 um) mesh. Re-grind the unpassed material until the required fraction is able to pass.

6. Mix the resulting sample.

## Putting the sample in an XRF sample cup

The container holding the sample affects the accuracy of the measurement. Use a container with as thin-walled a window as is convenient and use the same kind of container and window for each sample. Consistency and careful attention to detail are keys to accurate measurement.

**Note: The sample container should be a sample cup of a type that can be filled from the rear; that is, the side opposite the window (e.g. Chemplex #1330). NITON recommends using a 1/4 mil mylar film window (Figure 3.08). A supply of cups and windows are included.**

1. Place a circle of mylar film on top of an XRF sample cup. The window goes on the end of the cup with the indented ring. Note that the window may be prepared ahead of time.
2. Secure the film with the collar. The flange inside the collar faces down and snaps into the indented ring of the cup. Inspect the installed film window for continuity and smooth, taut appearance.
3. Set the cup, window-side down, on a flat surface. Fill it with at least three grams of the prepared sample (no more than half-full). Take care that there are no voids or layering.
4. Placing the cup film-side down on a flat surface, tamp the sample into the cup. The end of the pestle makes a convenient tamper. If you intend to re-use the sample, you can, alternatively, place a filter-paper disk on the sample before tamping it.
5. Fill the cup with polyester fiber stuffing to prevent sample movement. Use aquarium filter or pillow filling as stuffing. A small supply of stuffing comes with your bulk sample kit.
6. Fasten the cap on the cup (**Figure 3.09**). Using an indelible pen, write an identifying number on the cup. Keep a record of the sample number, the site and location, the date of the sample, and any other relevant comments.

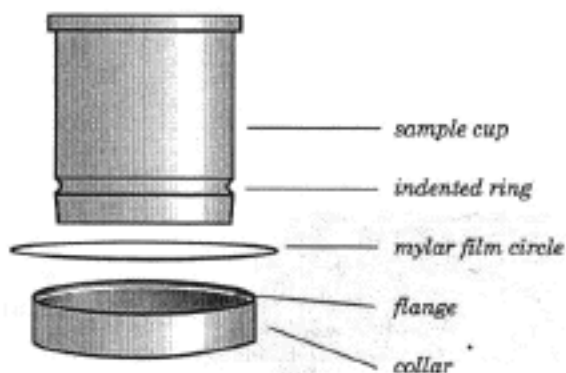


Fig. 3.08 Secure the film by snapping the collar on to the cup.

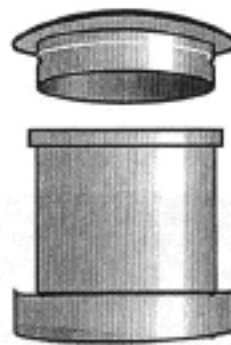


Fig. 3.09 Fasten the cap on the cup.

## Preparing samples of liquids, sludges or dust

### Liquids:

Fill an XRF sample cup with the liquid to be tested (Use no cotton). It is best if some overflows when the

cap is put on, since the cup must be full.

### **Sludge:**

Sludge can be placed directly in an XRF cup for screening. This is considered in-situ testing because no attempt has been made to prepare the sample. For more accuracy, the sludge can be dried, sieved, and ground.

### **Screening dust:**

Use large dust samples taken from a home vacuum cleaner bag. Remove fibers, hairs, and debris. At least three grams of dust are needed to assure accurate analysis. Samples as small as one or two grams may be measured with less accuracy. Even smaller samples (0.3 to 1.0 grams) can be analyzed by applying a weight correction factor and by using a funnel to place the sample in the center of the sample cup.

Prepare in an XRF sample cup and test the same way you would with a soil sample. For risk analysis, it is advisable to use a 60-mesh sieve to isolate and test only fine particles.

## **The bulk testing platform**

The test platform (**Figures 3.10a,b**) is an accessory fixture for holding bulk samples (such as soil or ground paint chips) in standard film-window XRF cups. This fixture snaps quickly and securely to your NITON instrument.

The platform latch screws underneath for storage. Before using the test platform, unscrew the latch and rescrew it on the end of the platform nearest the receptacle for the sample cup.

The test stand securely holds the XRF sample cup in place.

### **Testing the sample;**

Set the NITON test platform on a flat, solid surface. Place the sample cup in the receptacle of the sampler. Included in your kit are some foam disks that you can put in the receptacle under the cup for firmer contact between the NITON and the sample cup window. Attach the NITON to the test stand and follow in-situ bulk sample instructions (**Figures 3.11 a,b**).

Fig. 3.10a  
The Niton  
Test Platform

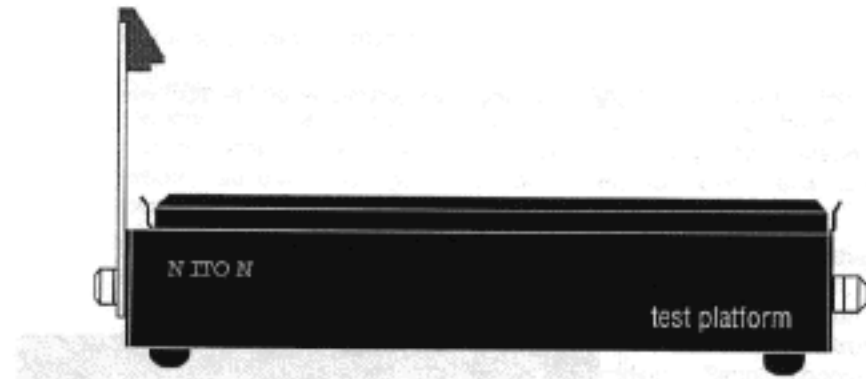


Fig. 3.10b  
The Niton  
Test Platform  
with its latch in  
the stored position.



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# NITON Corporation

## XL-309

&

## 700series

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# User's Guide Version 5.0 (HTML) Chapter 4

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## Chapter 4: Analyzing thin samples

### Overview

The NITON XL can test dust wipes and other thin samples for lead if equipped with optional Dust Wipe Analysis Software and Hardware. The 701, 701A, 703 and 703A Model Analyzers are multi-element analyzers for a wide range of thin samples. Examples of thin samples include:

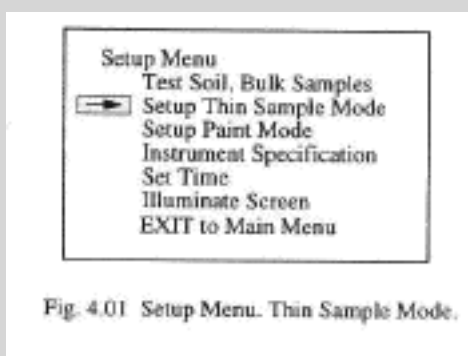
- 37 mm filters used for exposure monitoring filters, and filters used for Dust Vacuum methods
- Total Suspended Particulate (TSP) and Particulate Monitoring (PM) filters,
- dust wipes,
- filters used for measuring suspended and dissolved metal concentrations in liquids, and
- thin coatings deposited on substrates.

Contamination captured on filters or wipes is not usually deposited uniformly, and the filters and wipes are several times larger than the 1 cm x 2 cm scanning window of the instrument. To produce meaningful

results, several readings must be taken for each thin sample measurement. Readings are then summed or averaged.

The number of readings, the weight given each reading, and whether the readings are summed or averaged depends on the application. For example, the procedure for testing dust wipes is different from the procedure for testing 37 mm personal exposure filters. The instrument follows a unique procedure for each application. Simply choose the appropriate Thin Sample Mode from the Thin Sample Setup Menu. (See **Figure 4.01**). See the section titled "Setup Thin Sample Mode".

**Note: Before testing in Thin Sample Mode, turn your NITON on at least 15 minutes prior to testing. This will give you more precise measurements.**



## The dust wipe and filter test platform

The Dust Wipe and Filter Test platform is an accessory fixture for holding 37 mm personal exposure filters, larger contamination monitoring filters, and dust wipes (**Figures 4.02, 4.03**). The test platform snaps quickly and securely to your NITON-and detaches just as quickly. It also protects personnel from exposure to radiation.

The front end of the platform is designed to facilitate testing 37 mm personal exposure filters. The test stand securely holds the filter in place in each of the three test positions required for these filters. The clamp holds the instrument.

When testing larger TSP and PM filters, remove the front end. Use the plunger shield to protect the filter from being punctured by the NITON's plunger. The velcro strap on the filter test platform holds the instrument in place and loosens easily to permit you to reposition the filter between each reading.

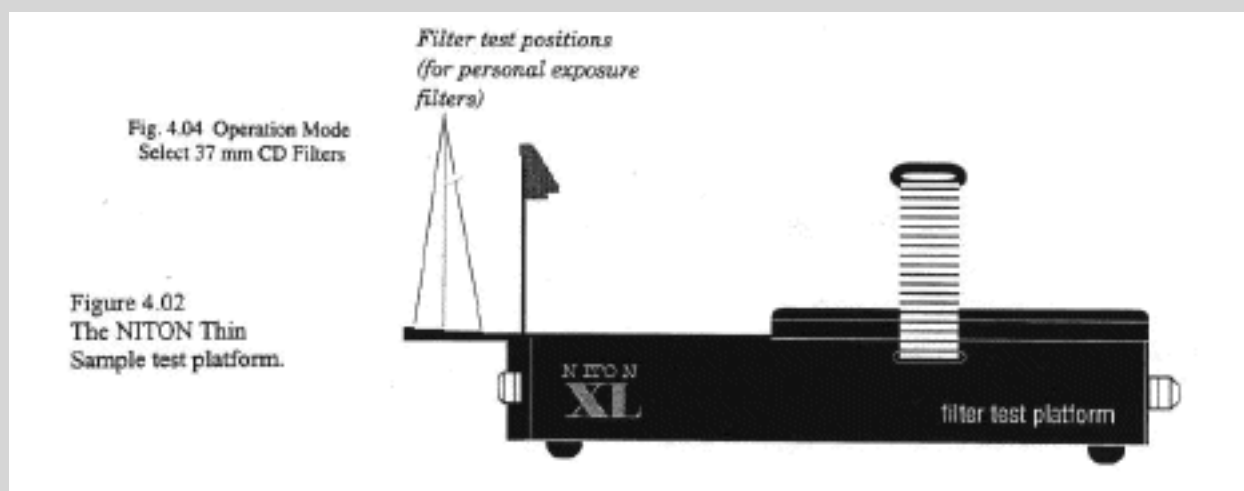
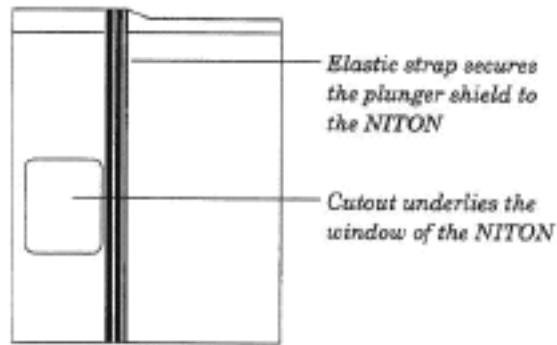


Figure 4.03  
The NITON plunger shield protects PM and TSP filters from puncture.



## 37mm CE and fiberglass filters

Before testing 37mm filters, access the **Setup Menu**, selecting **Setup Thin Sample mode**, and then select **37mm CE Filters** (Figure 4.04). See the following sections for details: "Setup" and "Setup Thin Sample mode".

## Preparing a filter

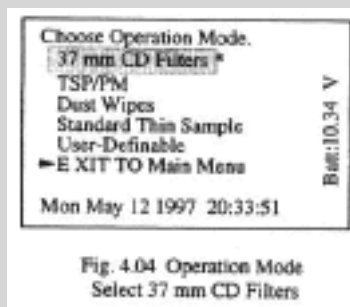


Fig. 4.04 Operation Mode  
Select 37 mm CD Filters

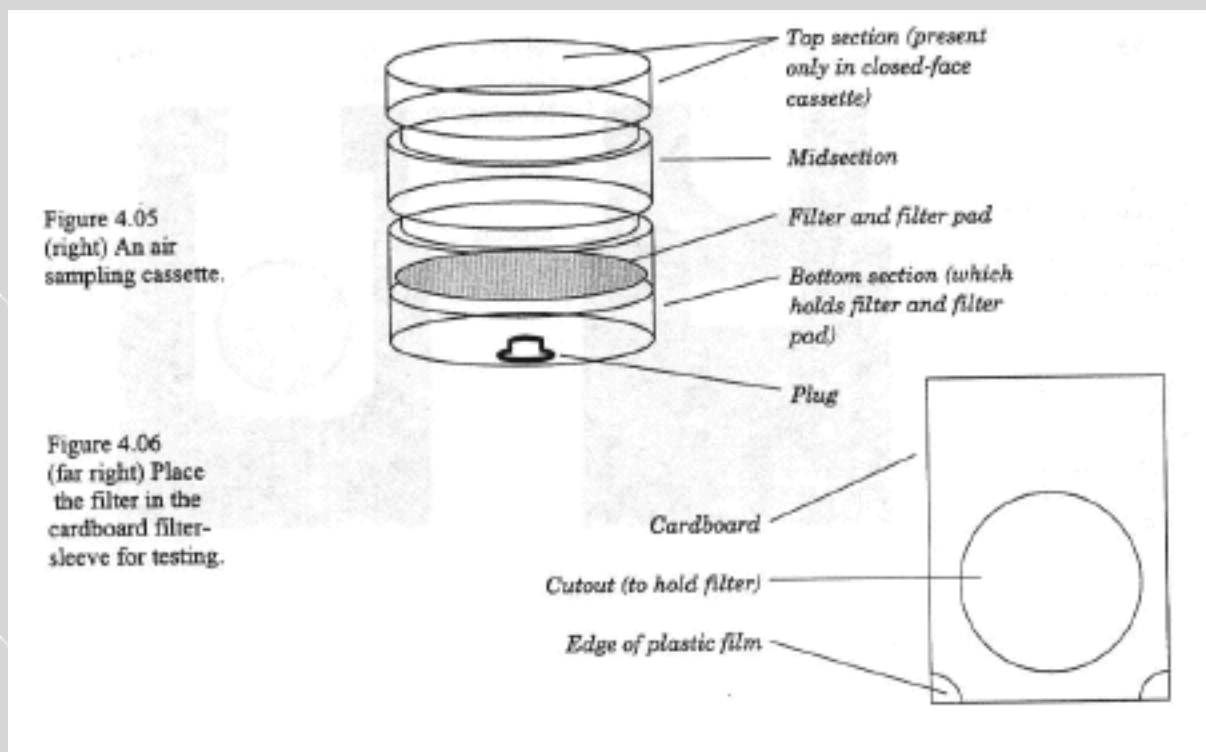
37 mm filters are often used for monitoring personal exposure. Dust vacuum measures (DVM) use the same size filters and are tested in much the same way. To prepare the filter for testing, remove it from the air sampling cassette and load it in a filter sleeve.

The plastic air sampling cassette (Figure 4.05) is closed-face; an open-faced cassette would be missing the top section and plug. The filter sleeve is a piece of cardboard sandwiched between two layers of thin plastic film (Figure 4.06). The cardboard has a circular cutout of slightly larger cutout than the filter.

**Note: To avoid contaminating the test results, wear clean surgical gloves. Take a sleeve. Peel back the top layer of film. Set the sleeve down on a clean surface.**

Remove the bottom plug from the air sampling cassette. Separate the sections of the cassette so you can reach the filter. Using tongs, poke the filter and filter pad through the plug hole to release it from its seat in the cassette. Touching only the edges of the filter and pad, gently separate one from the other with your finger. Then, using the tongs, lift the filter from the cassette and place it on the sleeve in the cutout. Close the sleeve. It doesn't matter if the sleeve wrinkles some.

**Note: It is advisable to practice with several blank filter cassettes before using real samples.**



## Positioning a filter

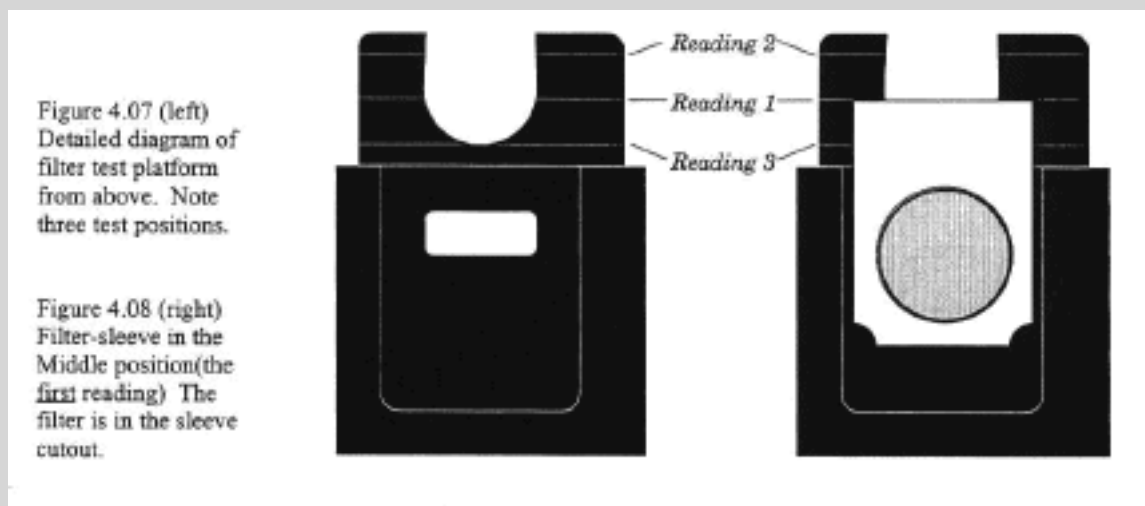
Place the sleeve on the test platform. The test platform has a built-in filter holder, designed to hold 37 mm filters securely under the test window of the instrument.

To accurately determine the concentration of elements on the filter, you must take three readings, each from a different area of the filter (**Figure 4.07**). The XL or 700Series will automatically calculate the total loading, in micrograms, when you complete the three readings. The filter holder has ridges that hold the filter in position for each of the three required readings.

**You must measure the center of the filter first (Figure 4.08).** Place the filter against the middle ridge of the filter holder. This reading is multiplied by a different coefficient than either of the other reading, hence the order is important. Take the first measurement as described in the section *Taking One Reading*.

**Note: The order is important: The middle-of-the-filter reading must be done first.**

Next, slide the filter to the outermost ridge. Take the second measurement (the top of the filter). Finally, slide the filter to the innermost ridge. Take the third measurement. The order of these last two measurements is not important.



## Taking a reading

1. Set the test platform on a flat, solid surface.
2. Holding the NITON in your hand, place it on the test platform so that the filter is under the test window. Squeeze the shutter release, pull back the latch on the platform with your left hand, and firmly press the instrument flat against the platform surface. If you don't squeeze the shutter release, the plunger will not depress. If the plunger is not fully depressed, the window is not fully open and the NITON cannot measure accurately. The window opening must be flush with the test platform to get an accurate reading.

The test platform latch will continue to hold the NITON flush against the sample until you lift it off.

**Note: During the measurement, you do not need to hold the NITON or squeeze the shutter release continuously. Your NITON will continue to test until you lift the instrument from the test platform.**

3. Watch for indications of lead on the screen to decide when the test has reached the desired level of accuracy. A typical test for the quantitative measurement of lead takes 60 nominal, or source seconds. The instrument will beep at 60 nominal seconds.
4. After the desired interval, pull back on the platform latch to release the NITON and lift from the test platform to end the test. The shutter will close automatically. The plunger should be fully extended.

**Warning: In the unlikely event that the plunger gets stuck in the open position, simply push it closed. Then call the NITON Service Department at (401) 294-1234.**

## Reading the display

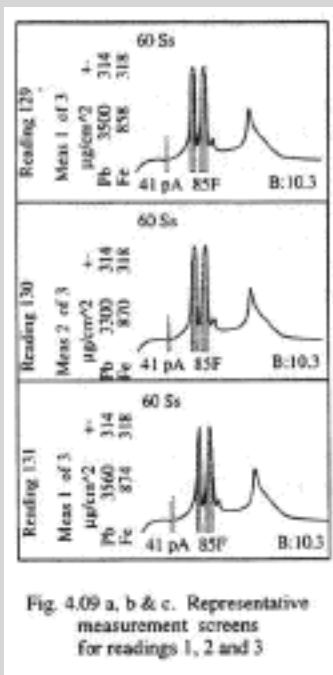
### The Measurement screen

The Measurement screen is displayed during each test and is accessible after the test is complete. For the XL, the screen shows each of the three measurements in micrograms/cm<sup>2</sup> of lead (**Figures. 4.09 a-c**).

**Note: On multi-element models, the initial Measurement Screen always shows lead because lead is**

the element most commonly measured in Thin Sample mode. The element with the next highest concentration (in micrograms/cm<sup>2</sup>) is also shown. To see the other elements, press and hold Clear/Enter for two seconds (Figure 4.09 d). Use the Arrow buttons to scroll through the list of results for all elements.

## The Final Result screen



The **Final Result** screen (**Figure 4.10**) is displayed only after all three measurements are complete. Final results are in units of micrograms. On 700 Series instruments, the screen shows 14 elements, whether they were detected, and how much of each element that was detected on the filter (in micrograms). The **Final Result** screen is given the next reading number.

This screen is divided into three parts. The first shows the metals detected. For the XL, only lead is listed. For the 700 Series, all of the detected elements are listed, in order of decreasing amounts. Next is a list of elements where the result was less than the calculated detection limit. The XL (for lead) and the 700 Series calculates the detection limit for every sample. Each is shown as being less than a number, representing the detection limit for that element, for that sample. The detection limit is calculated using EPA protocols, that the detection limit is three times the standard deviation. Finally, there is a list of these same undetected elements displaying for each the weighted sum and twice the standard deviation (95% confidence level) that the instrument calculated.

These three lists will not fit on the screen at one time. Use the **Arrow buttons** to scroll up or down the screen.

Reading 132		
Final	Result	
Elem	+-	
Pb	6500	514
Fe	1300	450
Cr	1200	735
Cu	580	140
Sr	300	30
Below Det. Lim		
Zr	< 34	
Ni	< 50	
As	< 62	

Fig. 4.10  
Final Result Screen

## TSP and PM Filters

These filters are often used for air monitoring. They are about 8 x 10 inches in size. The samplers are designed for uniform filter deposition. The purpose of the XRF measurement is to determine total micrograms of lead and other metals on the filters. Because the samplers are designed for uniform deposition onto the filters, two measurements are taken on these filters. The choice of two measurements resulted from original testing conducted by NITON Corporation, Galson Corporation, and the New York State Department of Transportation (NYSDOT). Because deposition on the filter is presumed uniform, the NITON averages the two readings.

### Preparing to take a measurement

1. Wear clean surgical gloves
2. Remove the front end of the filter test platform (**Figure 4.11**).
3. Place the plunger guard over the NITON. The elastic strap of the plunger guard should be between the buttons and screen of the instrument.
4. Place one corner of filter over the hole in filter test stand (which corresponds to the position of the test window on the NITON). Measure about two inches in from the edge of the contamination on the filter. Take the first measurement.
5. Take one reading from one quadrant of the filter (**Figure 4.12**). Wipe the bottom of the instrument and test guard after each filter.

**Note: Initial studies have shown that, after two readings, about 1 to 2% of the lead on a filter is removed from the filter and redeposited on the instrument. Hence, wipe the bottom of the instrument to avoid compromising future tests. You may want to have the wipes analyzed. Note that since the accuracy for this method (and for laboratory analysis) is 10-20%, the small error due to removing dust is negligible and can be ignored.**

### Taking a Reading

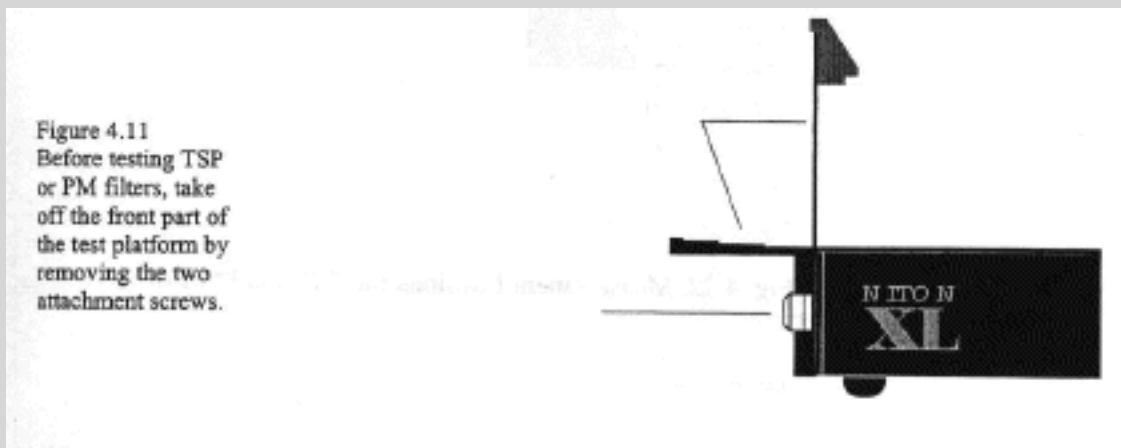


Figure 4.11  
Before testing TSP  
or PM filters, take  
off the front part of  
the test platform by  
removing the two  
attachment screws.

See **Taking a Reading** for 37 mm filters (**Page 49**).

## Testing TSP and PM filters on the sampler

With your NITON, it is possible to test filters while they are still on the sampler (e.g., a Graseby Sampler). First, shut off the sampler. Then place the plunger guard over the NITON. The NITON (with plunger guard) will fit inside of the frame holding the filter.

Take two measurements, as described in the previous section. You will need to hold the NITON against the filter for the length of each test. The test will end when you lift the NITON from the filter. Wipe the instrument and guard after testing each filter.

The official protocol for this procedure is under evaluation by the NYSDOT.

**Note:** Only test for lead, zinc, and arsenic when testing filters directly on a sampler. The steel grid supporting the filters makes it impossible to measure small concentrations of other elements.

*Picture removed  
for editing*

## Reading the display

### The Measurement screen

The Measurement screen is displayed during each test and is accessible after the test is complete. The screen shows each of the two measurements in micrograms/cm<sup>2</sup> of lead (**Figure 4.13 a,b**).

When the two measurements are complete, the XL or 700Series automatically averaged the results to yield the average loading in micrograms/cm<sup>2</sup>. The average is multiplied by 404 cm<sup>2</sup> to yield the total lead and other metals, in micrograms. These results are displayed on the **Final Result** screen (**Figure 4.13c**).

**Note:** Even on multi-element analyzers, lead is always displayed on the first screen. Lead is the

element most commonly measured in Thin Sample mode. To display the next screen, which shows the results for other elements, press and hold Clear/Enter for two seconds. Use the Arrow buttons to scroll through the list of results for all elements.

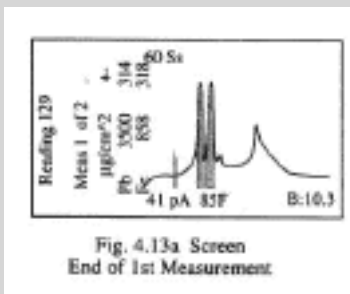


Fig. 4.13a Screen  
End of 1st Measurement

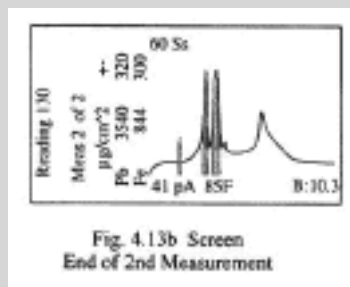


Fig. 4.13b Screen  
End of 2nd Measurement

## The Final Result screen

The Final Result screen (**Figure 4.13c**) is displayed only after both measurements are complete. Final results are in units of micrograms. On 700Series instruments, the screen shows 14 elements, whether they were detected, and how much of each element that was detected on the filter (in micrograms). The Final Result screen is given the next reading number.

This screen is divided into three parts. The first shows the metals detected. For the XL-309, only lead is listed. For the 700 Series, all of the detected elements are listed, in order of decreasing amounts. Next is a list of elements where the result was less than the calculated detection limit. The XL-309 (for lead) and the 700 Series calculate the detection limit for every sample. The detection limit is calculated using EPA protocols, that the detection limit is three times the standard deviation. Finally, there is a list of these same undetected elements displaying for each the weighted sum and twice the standard deviation (95% confidence level) that the instrument calculated.

These three lists will not fit on the screen at one time. Use the **Arrow buttons** to scroll up or down the screen.

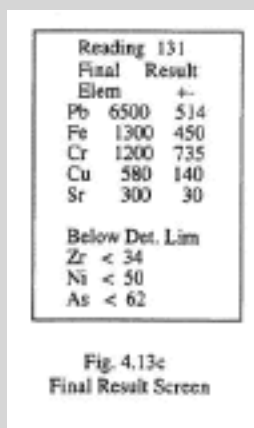


Fig. 4.13c  
Final Result Screen

## Other air-monitoring filters

Low-volume air-sampling techniques use 47 mm diameter filters. The NITON can test these as well. The filters are usually very uniform, so taking a single measurement of the center of the filter is a viable option. Use the **Standard Thin Sample mode (See Page 59)** for this. Results are given in micrograms/cm<sup>2</sup>. The operator should multiply by the area of the filter to obtain results in micrograms. Sum or average several readings, or have the results automatically multiplied by using the **User-defineable Thin Sample mode** to specify a protocol that satisfies your requirements (**See Page 60**).

## Dust Wipes

This section describes the testing of dust wipes. The wipe, recommended by NITON and used in the ELPAT program, is the PaceWipe. It is available from:

Pace Environs  
207 Rutherglen Drive  
Cary, NC 27511  
(800) 361-5323

NITON is developing a procedure for measuring dust wipes that will be reviewed for regulatory approval. What is presented here works in company tests, but is nonetheless tentative pending approval. The NITON displays levels of contamination in micrograms per wipe. The wipe reflects the contamination of the area wiped. Current regulations require lead contamination below 100 micrograms/ft<sup>2</sup> on floors, 500 micrograms/ft<sup>2</sup> on window sills, and 800 micrograms/ft<sup>2</sup> in window wells.

**Note: For the current software release (Version 5.0) the XL and 700Series provide quantitative results for lead only. You may use the 700 Series for screening of other metals on dust wipes, but element-specific correction factors must be implemented in the firmware to make non-lead measurements quantitative. Please contact NITON regarding timetables for new firmware releases that will offer this feature.**

NITON assumes that the operator follows the HUD guidelines for taking a dust wipe that are summarized here. To use the wipe, measure a known area of the surface, preferably one square foot. Wear clean surgical gloves. Wipe the measured square with parallel strokes. Fold the wipe in half. Wipe in strokes 90° to the original direction. Fold the wipe in half again. Thus far, you have followed one of the HUD procedures for taking a wipe test. For more information on taking dustwipes, please refer to "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," Chapter 7.

Now, fold the wipe in half three more times (**Figure 4.14**). You now have a pad measuring about 1 x 1.5 inches (2.5 x 3.7 cm). It is important to fold the wipe neatly, so the final wipe is very nearly a neat square measuring about 1 x 1.5 inches.

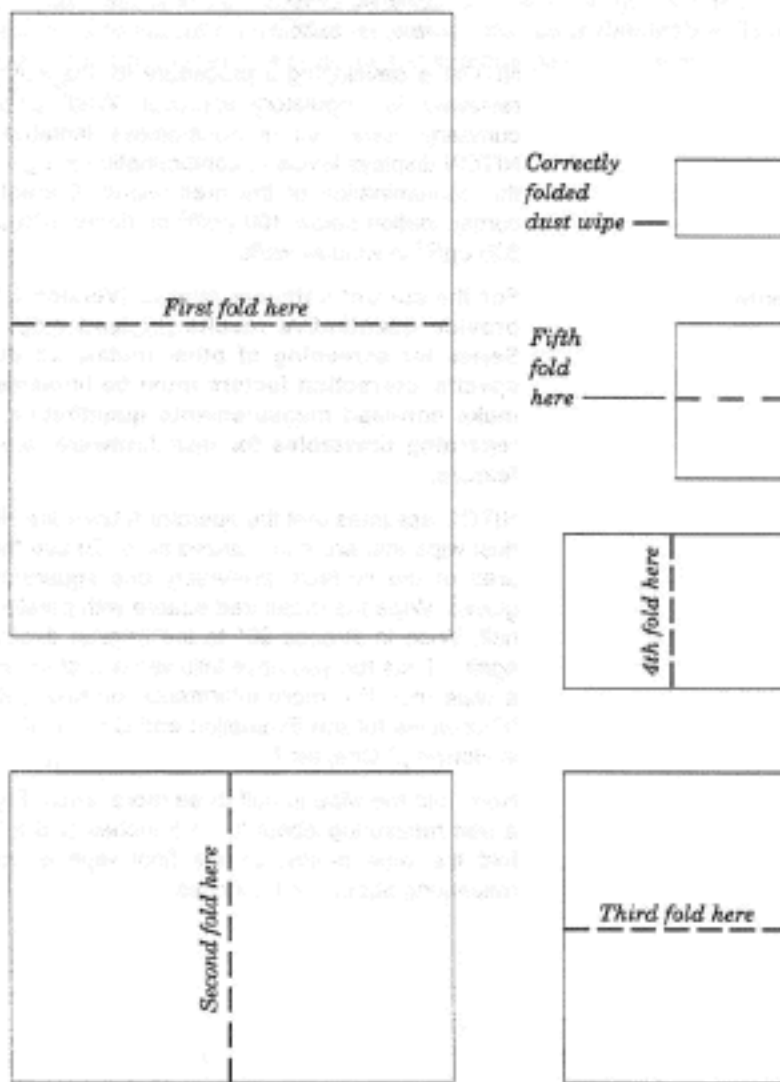


Fig 4.14

Folding the dust wipe. Start at the top left and proceed counterclockwise, making five folds.

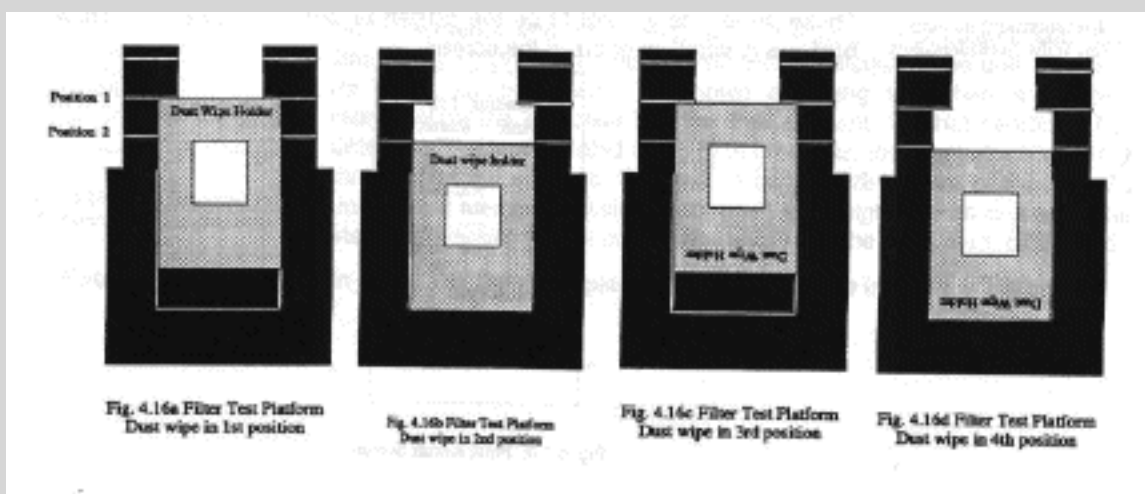
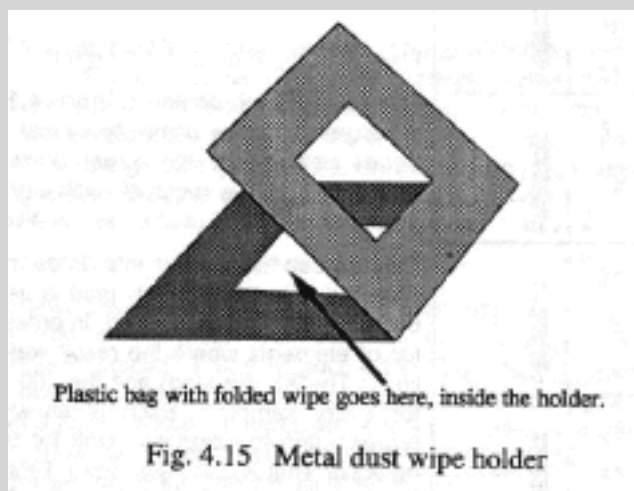
Then put the folded wipe in one of the plastic baggies provided, and place the wipe, in the baggie, in the metal dust wipe holder (**Figure 4.15**). The dust wipe is now ready to test. NITON recommends that the plastic bags NOT be re-used, to eliminate the chance of cross-contamination of subsequent wipes.

### Taking dust wipe measurements

Take four measurements, positioning the metal dust wipe holder on the number one position of the test stand, then the number two position of the test stand; then rotate the dust wipe holder 180 degrees (without turning the holder over) and again test on the number one position followed by the number two position (**Figure 4.16**). This procedure assures that the entire area of the folded dust wipe is measured by the analyzer.

### Taking a reading

See Taking a Reading for 37mm Filters (See Page 49).



## Reading the display

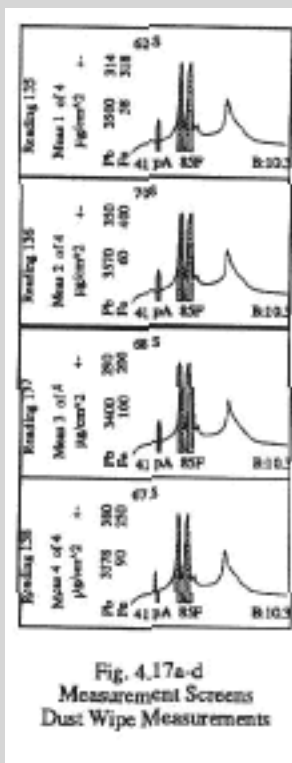
### The Measurement screen

The Measurement screen is displayed during each test and is accessible after each test is complete. For the XL, the screen shows each of the four measurements in micrograms/cm<sup>2</sup> of lead (**Figure 4.17a-d**). When all four measurements are complete, the NITON automatically sums the four test results to achieve the correct reading. This result is given in the **Final Result** screen (**Figure 4.17e**).

**Note: Even on 700 Series instruments, only two elements are displayed on the first screen: lead and the element with the highest concentration (other than lead).**

To display the next screen, which shows the results for other elements, press and hold **Clear/Enter** for two seconds. Use the **Arrow buttons** to scroll through the list of results for all elements.

### The Final Result screen



The Final Result screen (**Figure 4.17e**) is displayed only after all four measurements are complete. Final results are in units of micrograms. On 700 Series instruments, the screen shows 14 elements, whether they were detected, and how much of each element that was detected, on the filter (in micrograms). The Final Result screen is given the next reading number.

This screen is divided into three parts. The first shows the metals detected. For the XL, only lead is listed. For the 700 Series, all of the detected elements are listed, in order of decreasing amounts. Next is a list of elements where the result was less than the calculated detection limit. The XL (for lead) and the 700 Series calculates the detection limit for every sample. Each is shown as being less than a number, representing the detection limit for that element, for that sample. The detection limit is calculated using EPA protocols, that the detection limit is three times the standard deviation. Finally, there is a list of these same undetected elements displaying for each the weighted sum and twice the standard deviation (95% confidence level) that the instrument calculated.

These three lists will not fit on the screen at one time. Use the **Arrow buttons** to scroll up or down the screen.

Reading 139	
Final Result	
Elem	+-
Pb	12000 514
Fe	900 450
Cr	1200 735
Cu	580 140
Sr	300 30
Below Det. Lim	
Zr	< 34
Ni	< 50
As	< 62

Fig. 4.17e Final Result Screen

# Standard thin sample mode

The Standard Thin Sample mode should be used to test thin samples that have uniform contamination or deposition. These include many filters for liquids and gases, various types of coatings, and the leaves of plants. Operators who want to make a single measurement and obtain a result in units of micrograms/cm<sup>2</sup> should use Standard Thin Sample mode.

**Caution: The Standard Thin Sample Mode should not be used for quantitative lead-paint testing. Use only the three Paint Testing modes to test lead-based paint.**

In the Standard Thin Sample mode, each measurement is a separate test. For this reason, there is no **Final Result** screen in this mode. The results of each test are given in micrograms/cm<sup>2</sup> for lead only (XL) or for up to 14 elements (700Series).

**Note: Using Standard Thin Sample Mode to test any coating may yield lower-than-actual test results.**

Standard Thin Sample Mode does not correct for shielding caused by the presence of overlaying coatings. Thus, for coatings testing, the results should be viewed as the *minimum* amount of contaminants present. If an element is not detected, it may be that the element is present but entirely shielded by overlaying coatings. Beware. Do not rely on negative results when testing paints and other coatings in this mode.

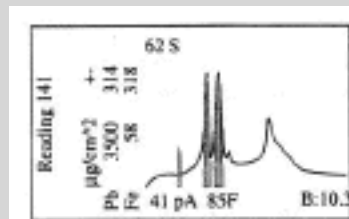


Fig. 4.18 Measurement Screen  
Standard Thin Sample Mode

Reading 141	
Meas 1 of 1	
µg/cm <sup>2</sup>	←
Pb 12000	514
Fe 900	450
Cr 1200	735
Cu 580	140
Sr 300	30
Below Det. Lim	
Zr	< 34
Ni	< 50
As	< 62

Fig. 4.19 Final Result Screen  
Standard Thin Sample Mode

## The Measurement screen

The Measurement screen is displayed during each test and is accessible after each test is complete. For the XL, the screen shows the measurements in micrograms/cm<sup>2</sup> of lead (**Figure 4.18**). For the 700 Series the screen displays lead and the element with the highest concentration other than lead, in micrograms/cm<sup>2</sup>. When the measurement is concluded, the display is changed to show all the elements, in micrograms/cm<sup>2</sup> (**Figure 4.19**). Use the **Arrow buttons** to scroll through the list of elements.

This screen is divided into three parts. The first shows the metals detected. For the XL, only lead is listed. For the 700 Series, all of the detected elements are listed, in order of decreasing amounts. Next is a list of elements where the result was less than the calculated detection limit. The XL (for lead) and the 700 Series calculates the detection limit for every sample. Each is shown as being less than a number,

representing the detection limit for that element, for that sample. The detection limit is calculated using EPA protocols, that the detection limit is three times the standard deviation. Finally, there is a list of these same undetected elements displaying for each the weighted sum and twice the standard deviation (95% confidence level) that the instrument calculated.

**Note: In Standard Thin Sample mode all results are in units of micrograms/cm<sup>2</sup>.**

## User-definable thin sample testing

**User-definable Thin Sample mode** allows you to set up your own protocol for testing thin samples. The user defines the number of measurements that constitute a set, the coefficient applied to each, and whether the measurements are to be summed or averaged.

### Specifying a Protocol

You specify your own measurement protocol in this mode. When you select **User-Definable** from the **Setup Thin Sample Mode menu**, the screen (**Figure 4.20a**) is displayed. The menu allows you to customize an application. You can average or sum your choice of up to 9 of readings.

In most custom applications, where deposits on a thin sample are not uniformly spread across the sample, readings should be averaged or summed. Using this screen's menu, you can customize how readings are summed or averaged for a particular application.

**Note: Whatever configuration you enter will be saved in the instrument's memory. When you select the User-Definable mode, the last configuration entered will be recalled.**

### To Define a Protocol:

\* **Avg or Sum:** Use the **Arrow buttons** to select either **Avg** or **Sum**. Press **Clear/Enter**. Your choice will be shaded. If **Avg** is chosen, your NITON will average the number of readings you have specified. If **Sum** is chosen, readings will be summed instead of averaged. (Refer to **Figure 4.20a.**)

\* **# readings:** To tell the instrument how many readings to use when calculating an average or sum: Use the **Arrow buttons** to increase or decrease the number of readings you wish to average or sum. Press **Clear/Enter**. The number must be between 1 and 9. (Refer to **Figure 4.20b.**)

\* **Range:** This allows the operator to set the numeric range of the coefficients, from 0.0001 to 9999. The same range must be used for all coefficients. First, set the decimal place by using the **Arrow buttons**. The decimal place determines the range of possible values for the coefficients. When the decimal place is set press **Clear/Enter**. (Refer to **Figure 4.20c.**)

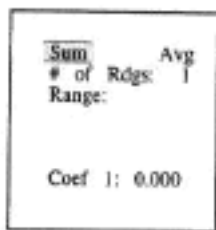


Fig. 4.20a Thin Sample User Defined Screen

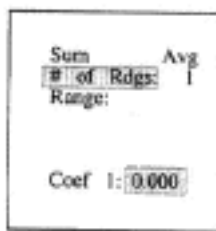


Fig. 4.20b Thin Sample Set # of Readings

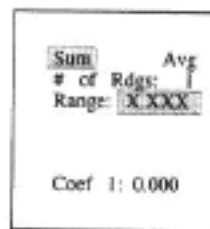


Fig. 4.20c Thin Sample Setting Range

\* **Coefficients:** (Refer to **Figure 4.20d**). Enter each coefficient. Moving from left to right, set the value of each digit that constitutes the coefficient. First use the **Arrow buttons** to set the value, then press **Clear/Enter** to move to the next digit to the right. To move to the next digit without changing the current digit, press **Clear/Enter**. Repeat this process until every digit of the coefficient has been set. After every digit has been set, press **Clear/Enter** to move to the next coefficient. When finished with the last coefficient, press **Clear/Enter** to return to the **Main Menu**. By setting coefficients, you can calculate a *weighted sum*, in which the result of each reading is multiplied by the coefficient entered for that reading. For a simple (un-weighted) sum, set each coefficient to 1.0. All unused coefficients should be set to 0.0 (0.0 is the **default** setting).

From the **Main Menu**, enter **Calibrate and Test**. When the NITON is finished self-calibrating, you may begin testing.

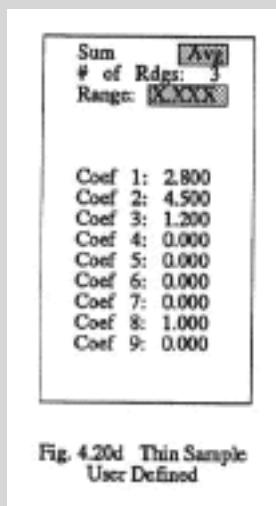


Fig. 4.20d Thin Sample User Defined

### Example:

Suppose you would like to perform a weighted sum of three consecutive measurements, using the formula:

$$(2.800 \times \text{Measurement 1}) + (4.5 \times \text{Measurement 2}) + (1.2 \times \text{Measurement 3})$$

The screen for setting up the protocol should appear as follows:

**Sum**  
**# of Rdgs = 3**  
**Range: X.XXX**

**Coef 1: 2.800**

**Coef 2: 4.500**

**Coef 3: 1.200**

**Note: In User-Definable Thin Sample mode, you must take exactly the number of readings that you have specified for each test in this mode before proceeding to the next test.**

When you conclude each measurement within the protocol, the analyzer will display the results, in micrograms/cm<sup>2</sup> (**Figure 4.09a**). When the protocol is complete, the analyzer will display a **Final Result** screen (**Figure 4.09d**).

**Note: The units of measurement will be determined by the coefficients you have chosen. In "User-Definable" Mode, the units are not necessarily micrograms.**

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The logo for NITON, consisting of the word "NITON" in a bold, sans-serif font, enclosed in a rectangular border.

[Back to the Table of Contents](#)



# NITON Corporation

## XL-309

&

## 700series

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# User's Guide Version 5.0 (HTML) Chapter 5

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## Chapter 5: Analyzing lead paint

### Overview

Lead paint mode is standard on NITON XL-309, 701-A, 702-A and 703-A Spectrum Analyzers. In addition to the silicon PIN-diode detector standard in all NITON analyzers, all NITON analyzers equipped to test lead in paint have a second detector: a cadmium-zinc-teluride (CdZnTe) detector optimized to measure lead K-shell x-ray fluorescence.

**Caution: The Standard Thin Sample Mode (on 701, 701-A, 703 and 703-A analyzers, and available as an option on XL-309s) should not be used for quantitative lead-paint testing. Use only the three Paint Testing Modes (on 701-A, 702-A, 703-A, and XL-309 analyzers) to test lead-based paint.**

### Getting started

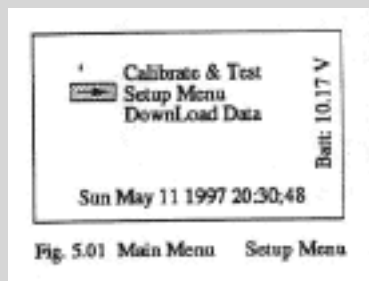


Fig. 5.01 Main Menu Setup Menu

1. Turn on your NITON Analyzer
2. Use the **Arrow buttons** to select

### Setup menu

from the **Main menu**. Press **Clear/Enter** (Figure 5.01).

3. Use the **Arrow buttons** to select

### Setup Paint mode

from the **Setup menu**. Press **Clear/Enter** (Figure 5.02).

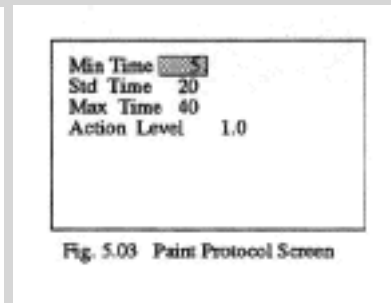
Fig. 5.02 Setup Menu  
Setup Paint Mode

Fig. 5.03 Paint Protocol Screen

4. Go to *step 5* unless you want to change the **Action-level** or **beep time** settings. If they are not changed, the NITON will default to the last settings entered. To change settings, enter **Setup Paint Protocol** from the **Setup Paint** screen. The **Setup Paint Protocol** screen allows you to set the **Action-level** and **beep times** (Figure 5.03). When you have set the paint protocol, the instrument will return automatically to the **Setup Paint** screen.

5. From the **Setup Paint** screen (Figure 5.04), select one of the three paint testing modes: **Standard Paint Mode**, **Standard Mode + Spectra** or **K & L Readings + Spectra**. When you have selected a paint testing mode, the instrument will return automatically to the **Main Menu**.

6. Select **Calibrate and Test**. The instrument will then initiate its auto-calibration sequence. This will take one to two minutes. When calibration is complete, the instrument will beep and display the **Ready to Test** screen for whichever of the three paint modes you selected in *Step 5* (Figure 5.05). The **Ready to Test** screen displays the paint testing mode you have selected, the date and time, the instrument serial number, the action-level, the instrument energy resolution and the current source strength.

**Caution:** Check the *Date* and *Time* displayed on the **Ready to Test** screen. If they are not correct, reset them before taking any measurements. Your readings will not be accurate unless the date and time are correct.

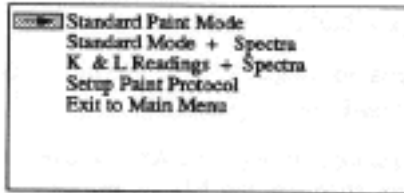
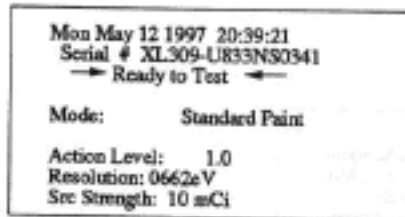


Fig. 5.04 Setup Paint screen

Fig. 5.05 Ready to Test  
Standard Paint Mode

## Taking a measurement

**Warning:** Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring. Never point the NITON at yourself or anyone else when the shutter is open.

**Caution:** When testing the *exterior* of the window sash from the inside of a room, avoid standing in the path of the NITON's radiation beam. The direction of the beam is drawn on the cover of the instrument (Figure 5.06 a,b). It is easier to avoid the radiation beam if you hold the instrument in your right-hand.



Fig. 5.06a Front/top view of XL showing the position of the inspection window and the source.

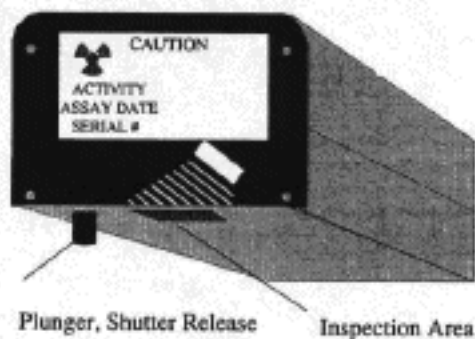


Fig. 5.06b. Front/bottom view of XL showing the position of the inspection window and the source.

## How to take a measurement

1. Push the safety slide (that locks the shutter release) out from under the shutter release. When the slide is in place, you cannot press in the release (**Figure 5.07**).
2. **When you are using the Barcode Data Entry System:** Attach the light pen bar-code reader and wrist-mounted bar codes. Flick the **Barcode Reader** across one of the bar codes to display the **Data Entry screen (Figure 5.08)**. Enter the test location and other test information with the **Barcode Reader**.
3. Place the NITON on the painted surface, squeeze the shutter release, and press the NITON against the surface.

**Note:** The shutter-release trigger must be activated and the window at the back of the instrument must be flush against the surface for instrument to take reliable readings. The instrument must be held against the surface throughout each measurement. You do not need to hold the shutter release continuously.

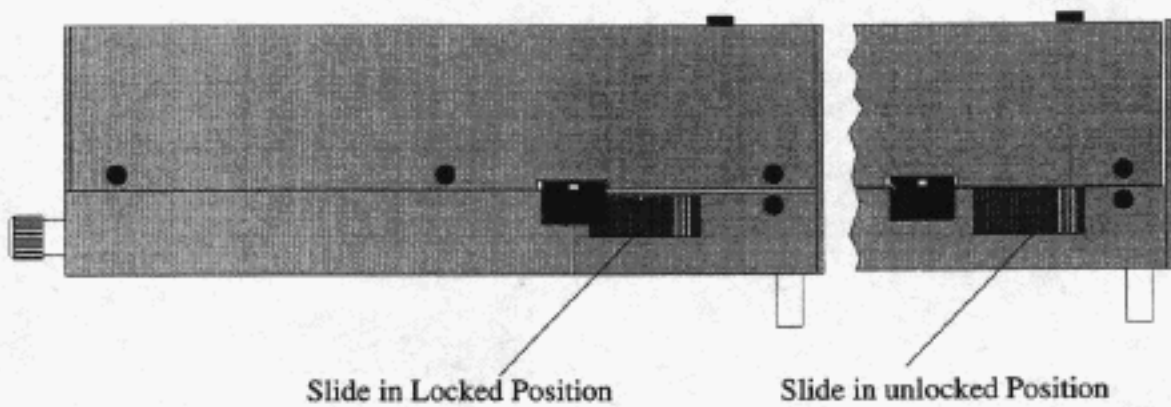


Fig. 5.07 Slide lock shown in locked position (left) and unlocked position (right).

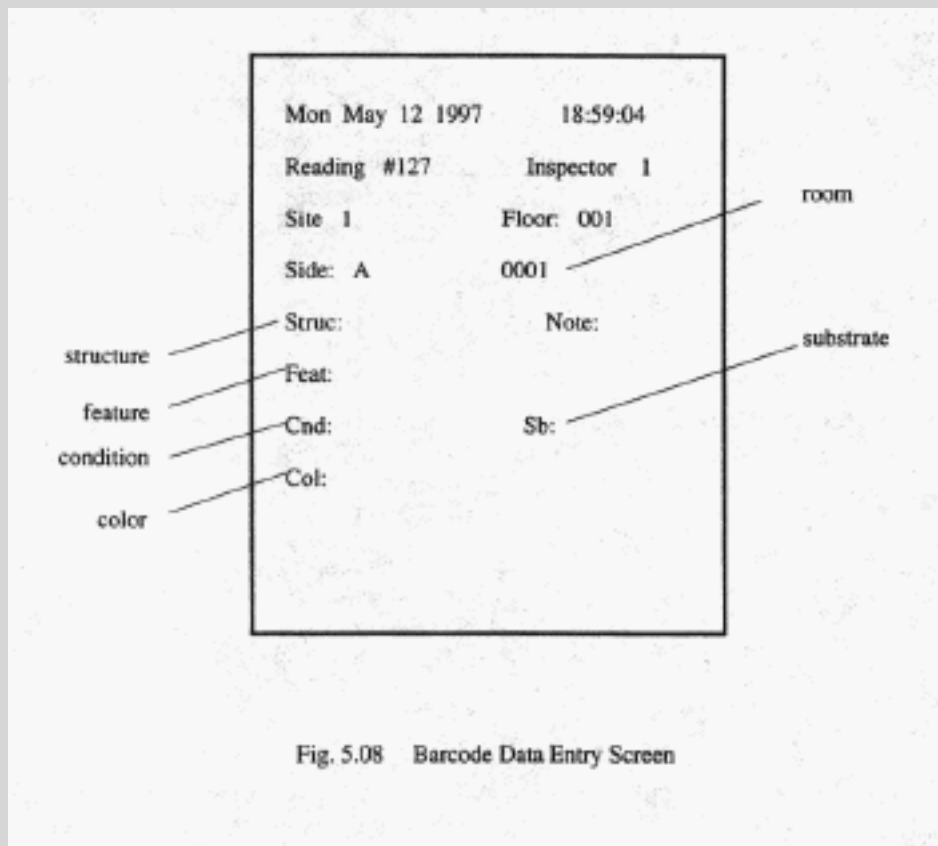


Fig. 5.08 Barcode Data Entry Screen

4. Please refer to **Reading the display** (see **Page 69**) for screen descriptions in each paint mode.

5. When the test is finished, lift the NITON from the surface. The shutter will close automatically.

**Warning:** In the unlikely event that the plunger gets stuck in the open position, simply push it closed. Then call the NITON Service Department at (401) 294-1234.

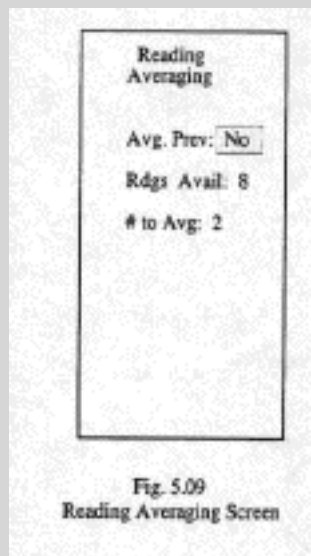


Fig. 5.09  
Reading Averaging Screen

6. Your NITON Analyzer can average up to 100 readings at a time. To set up the **Averaging Screen**, hold down the **Clear/Enter** button to toggle through the testing and data entry screens to the **Reading Averaging** screen (**Figure 5.09**). If you select **Yes** to average readings, you will be prompted to select the number of readings you wish to average. To take additional readings, simply repeat steps 3 through 5. Your NITON will display both the average of the current and previous readings and the number of readings being averaged.

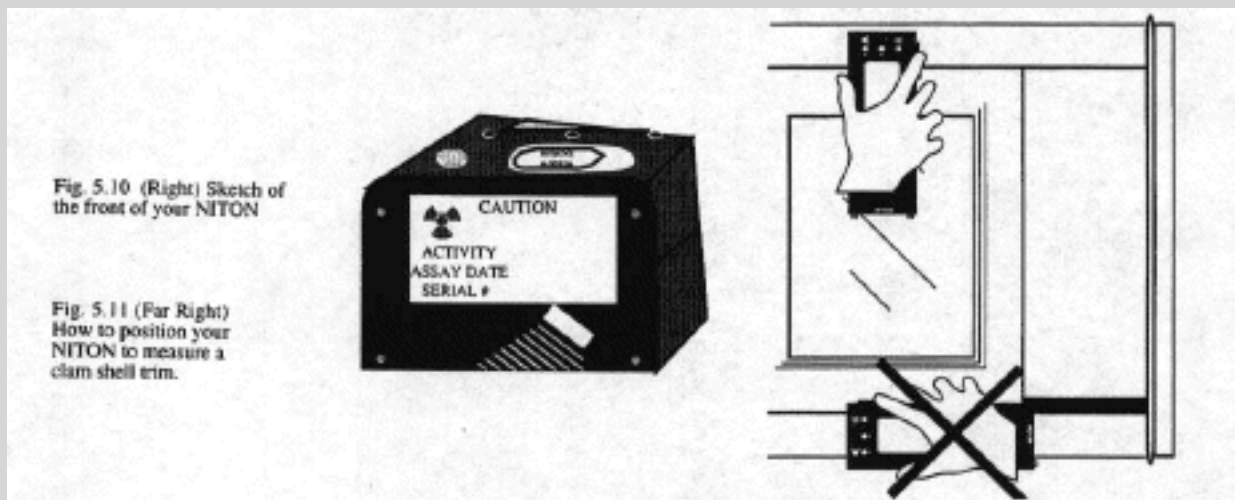
### Using the NITON on flat and curved surfaces

Using your NITON, you can take measurements of any surface a child can mouth; only  $5\frac{1}{8}$  inch (1.6 cm) is required.

1. A sketch of the window is printed on the front of the NITON's case so you can position the instrument properly (**Figure 5.10**). The window of the instrument must be flat against the paint surface or it cannot read properly.

3. Your NITON Analyzer can measure accurately many curved surfaces. Position the instrument so that its window is flat on the surface. The rest of the instrument doesn't have to lie flat. E.g., on slightly rounded clam shell trim, turn the NITON at right angles to the trim so that its window runs parallel with the length of the trim (**Figure 5.11**). On a cast iron radiator, find a spot against which the NITON's window can lie flat.

**Note:** On *very* highly curved surfaces (such as quarter-round moldings or balusters) the NITON will tend to underestimate the amount of lead present. On very highly curved surfaces, your NITON can only be used to positively identify high concentrations of lead.



## How long is a Test

In any of the three paint testing modes, your NITON can measure paint samples in as little as one second; most readings take less than ten seconds. The testing time will depend primarily on the amount of lead in the sample that you are testing compared to the action level you have set. The closer the actual lead concentration in the sample is to the action level, the longer it will take the NITON to make a 95% confident "Positive" or "Negative" determination.

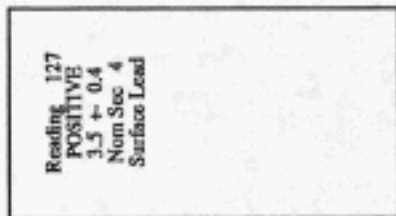
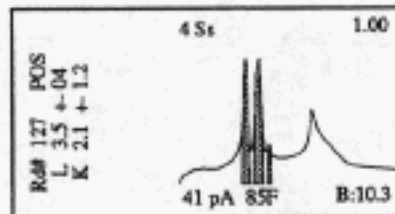
In **Standard Paint Mode** and **Standard Paint Mode + Spectra**, the instrument will measure the paint sample only until a 95% confident reading of "Positive" (greater-than-or-equal-to) or "Negative" (less-than) versus the action-level you have set has been attained. In **K & L Mode + Spectra**, the instrument will also display a "Positive" or "Negative" result and will beep as soon as a 95% confident reading is attained. You then have the option to continue readings until you have achieved a given reading time or degree of precision.

**Note: For all paint testing modes, if you terminate a test *before* a "Positive" or "Negative" determination is attained by the instrument, it will display a "Null" test result.**

### Reading the display

In **Standard Paint mode**, the instrument displays **Please Wait** until a 95% confident reading is achieved. If there is lead in the sample, the instrument will indicate **Lead present** on the **Please Wait** screen.

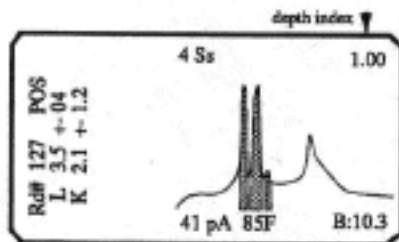
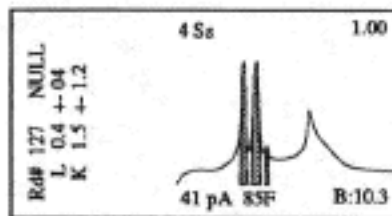
When a 95% confident reading is achieved, the instrument will display the reading number; either a "Positive" or "Negative" reading; the result in  $\text{mg}/\text{cm}^2$ ; the reading time in nominal (source) seconds; and will display **Surface lead** for all positive readings where the lead is not shielded by layers of non-lead paint (**Figures 5.12 a,b**).

Fig. 5.12a Instrument Reading  
Standard Point ModeFig. 5.12b Instrument Reading  
With Spectrum Displayed

**Standard Mode + Spectra** is identical to Standard Mode except that the x-ray spectra is displayed with each reading.

In **K & L Mode + Spectra**, the instrument displays the following information, updated continuously during each reading: the **reading number**, the **nominal seconds**, the **L-shell reading** (displayed as **L**) with the two-sigma confidence interval, the **K-shell reading** (displayed as **K**) with the two-sigma confidence interval, the **combined reading** (displayed as **Pb**) with the two-sigma confidence interval, the **full x-ray spectrum**, and the **Depth Index** (Figure 5.13).

**Note:** During each reading in **K & L + Spectra** mode, *before* a 95% confident Positive or Negative determination has been made, the instrument displays a "Null" test result (Figure 5.14). When a 95% confident determination has been made, the instrument beeps, and the reading classification switches from Null to either Positive or Negative.

Fig. 5.13 Instrument Reading  
With Spectrum DisplayedFig. 5.14 Instrument Reading NULL  
Reading in Progress

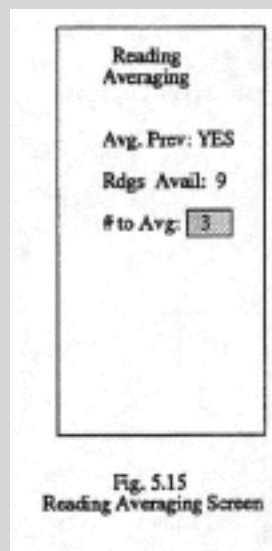
## The Depth Index (K & L + Spectra mode)

The **Depth Index (DI)** is a numerical indication of the amount of non-lead paint covering the lead detected by the instrument. The position of the DI on the screen is indicated by an arrow painted on the front of the NITON (**Figure 5.13**). A DI less than 1.5 indicates lead very near the surface layer of paint. A DI between 1.5 and 4.0 indicates moderately covered lead. A DI greater than 4 indicates deeply buried lead.

### Averaging readings

Two or more readings may be averaged by specifying the parameters in the **Averaging Screen (Figure 5.15)**. To start or stop averaging, go to the **Averaging Screen** by holding down the **Clear/Enter** button until the screen appears. You may enter the **Averaging Screen** whenever the instrument is in one of the paint testing modes. Once in the **Averaging Screen**, press **Clear/Enter** *briefly* to move the cursor between lines on the screen. Press the **Arrow buttons** to change averaging parameters. If, for example, you set the **# to avg** at two, subsequent tests will be grouped in twos and averaged.

To add the next measurement to the current average, enter **Avg YES**; if you enter **Avg NO** the next reading will not be averaged. Use the **Arrow buttons** to toggle between **Avg YES** and **Avg NO**.



### Toggling between paint modes

At any time when a reading is displayed, you may toggle from the paint mode you are in to one of the other paint modes by pressing **Clear/Enter** until that paint reading is displayed in the desired paint mode.

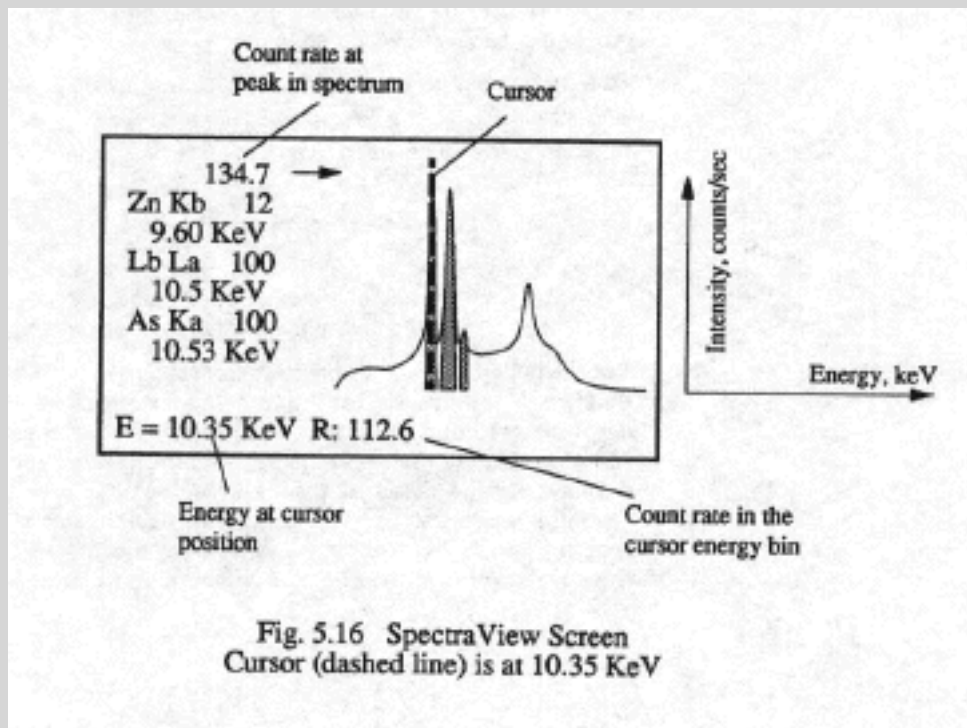
**Note:** Your NITON will continue to take readings in the most recently displayed paint mode until another paint mode is selected. If you scroll to previous readings using the Arrow buttons, the instrument will also display the readings in the *current* paint mode being displayed, regardless of the paint mode that was used when the readings were taken. You toggle between paint modes after any reading simply by pressing and holding the **Clear/Enter** button until the paint mode you want to see appears on the screen.

# SpectraView

**SpectraView** is standard on all 700 models. **SpectraView** comes with XL-309s equipped with either the optional **Lead-in-Soil Analysis** package or the **Dust Wipe Analysis** package. **SpectraView** is also available on XL-309s as a separate option. With **SpectraView**, you can quickly scan the entire x-ray spectrum for a non-quantitative assessment of dozens of elements.

## How to use SpectraView:

After taking a paint measurement in any mode, you can toggle to the **SpectraView** screen (**Figure 5.16**) with the **Clear/Enter** button. Once in the **SpectraView** screen, use the **Arrow** buttons to scroll through the spectrum. The vertical cursor-line indicates the current position along the spectrum.



In **SpectraView** mode, the spectrum is displayed in a linear scale, auto-scaled so that the highest peak on the screen reaches the top of the scale. To the *left* of the spectrum is a list of the elements with XRF energies close to where you are currently looking on the spectrum. (**Figure 5.17**). To determine if a given element is present, look at the bottom of the screen. Next to the number indicating the **position** of the **Spectraview** cursor on the energy-level scale (from 4 to 100 keV) is a number representing the **x-ray count rate** (in counts per second) at that energy-level.

**Note:** **SpectraView** cannot be used to determine exact element concentrations in a sample.

## SpectraView zoom

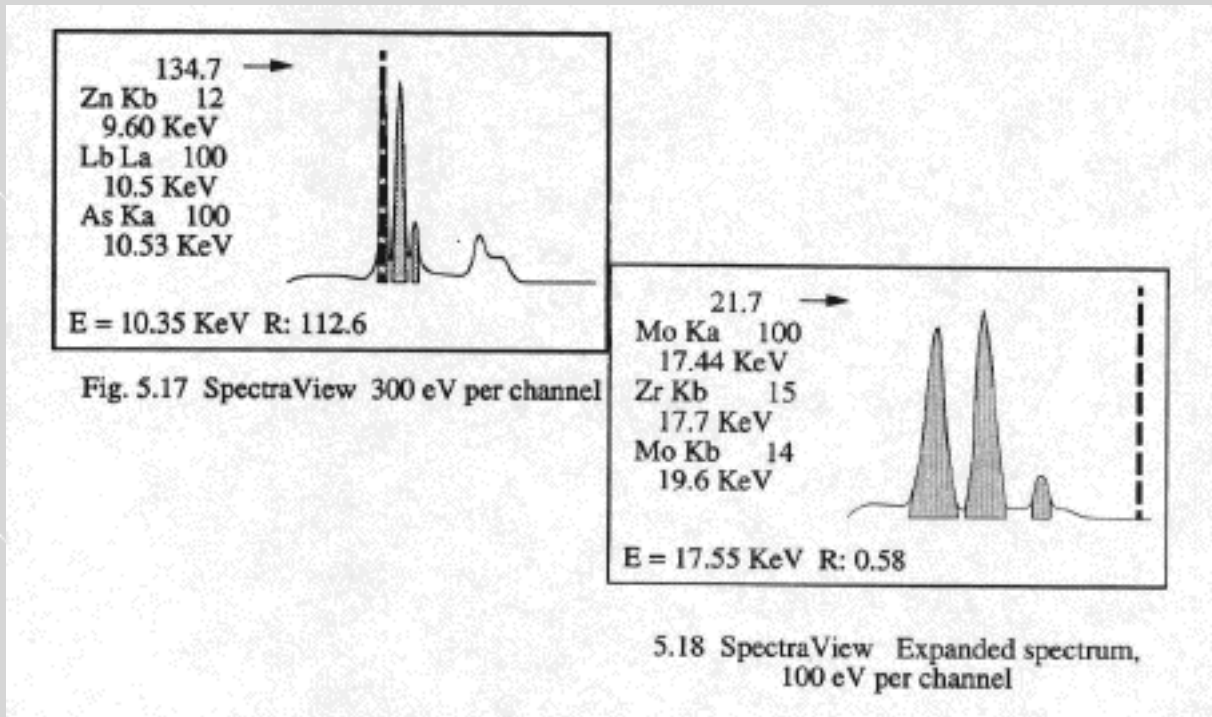
To look at a part of the spectrum in greater detail, use the SpectraView zoom feature.

1. Use the **Arrow** buttons to move the cursor to the *center* of a spectral peak.
2. Push **Clear/Enter** four times in rapid succession.

3. The part of the spectrum you were looking at will appear in expanded form so you can look at it in detail (**Figure 5.18**).

## To exit SpectraView

To exit **SpectraView** and continue testing, simply start another measurement. The measurement will be taken in the last paint testing mode you used.



**NITON**

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# NITON Corporation

## XL-309

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# User's Guide Version 5.0 (HTML) Chapter 6

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## Chapter 6: Radiation Safety

NITON has designed its XRF analyzers so that there is virtually no measurable radiation external to any part of the instrument when the shutter is closed. When our instruments are used according to instructions, there is minimal radiation exposure even with the shutter open. NITON XRFs contain sealed cadmium<sub>109</sub> radioactive sources. The source is designed to remain secure even under extreme conditions, so that even if the instrument is broken, crushed or burned, there will be no leakage of radioactive material.

During manufacturing, each sealed source is placed in a solid metal source holder. A plug is screwed into the access hole and secured with a set screw and Loctite. The source is completely secure in its housing because the aperture at the other end of the housing is smaller than the source. The small aperture is sealed with a beryllium metal window that is transparent to the cadmium x-rays and gamma-rays. The source assembly is secured in the NITON's aluminum case. The case has tamper proof screws.

The following table lists typical radiation doses encountered in everyday living and lists the annual

occupational radiation dosage limits for adults set forth in NITON's Materials license from the Rhode Island Radiation Control Agency, Section A.2.3.

- **Typical Radiation Doses in mR (NCRP, 1987)**

● Average total dose in US. (annual)	● 360 mR
● Average worker exposure (annual)	● 210 mR
● Average exposure for underground miner (annual)	● 400 mR
● Exposure for airline crew (1,000 hours at 35,000 ft)	● 500 mR
● Additional from living in Denver at 5300' (annual)	● 25 mR
● Additional from 4 pCi/l radon in home (annual)	● 1,000 mR
● Typical chest x-ray	● 6 mR
● Typical head or neck x-ray	● 20 mR
● Typical pelvis/hip x-ray	● 65 mR
● Typical lumbar spine x-ray	● 130 mR
● Typical upper G.I. x-ray	● 245 mR
● Typical barium enema x-ray	● 405 mR
● Typical CAT scan	● 101 mR
Minimum detectable dose on a standard film badge	● 5 mR

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- Annual occupational dosage limits:

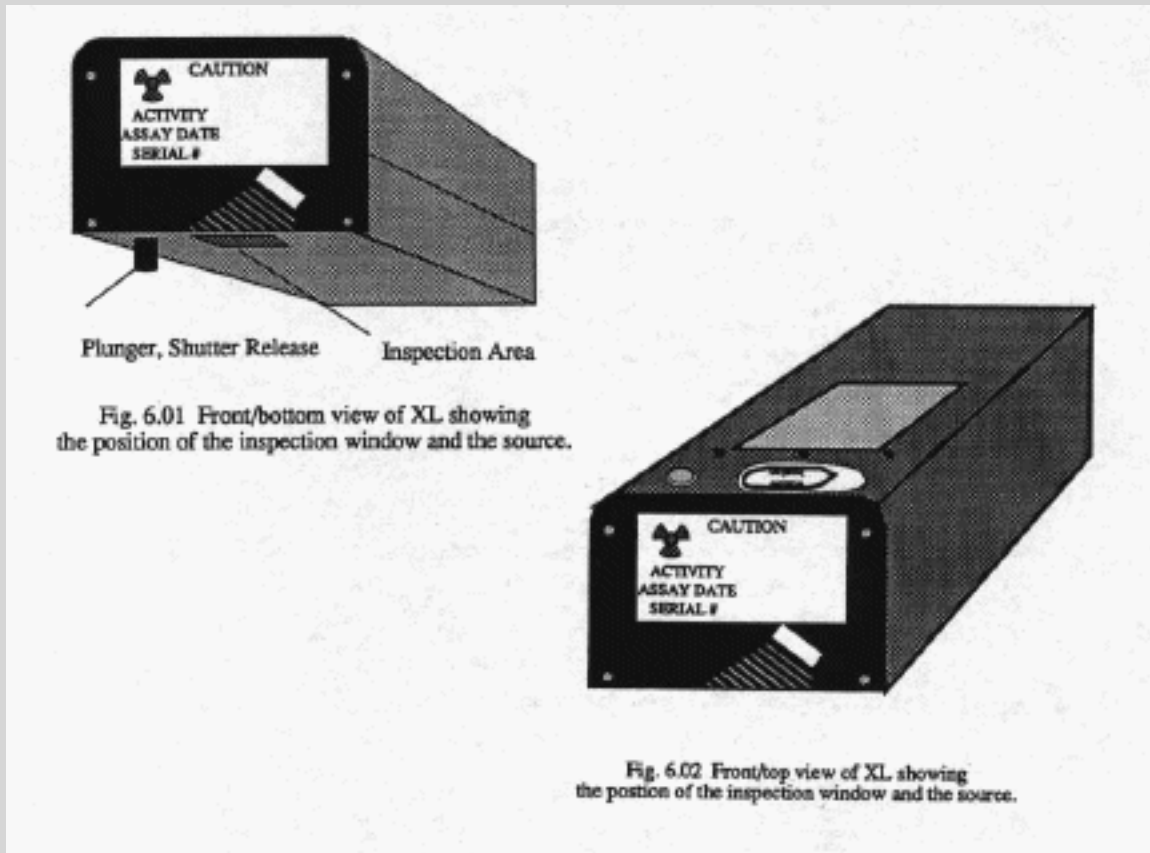
● Maximum allowable for the general public (annual)	● 500 mR
● Annual Occupational Dose Limits for Adults:	
● The lesser of (1) total effective radiation dose	● 5,000 mR
● or the (2) <u>sum</u> of the deep dose equivalent plus the committed dose equivalent to any individual organ or tissue <i>other</i> than the lens of the eye	● 50,000 mR.
● For a pregnant worker or a minor	● 500 mR.
● Eye dose equivalent	● 15,000 mR.
● Shallow dose equivalent to the skin or any extremity	● 50,000 mR.

## How to use your NITON safely

Each NITON is designed to be safe as possible. However, we strongly recommend that you follow these precautions to insure your safety and the safety of those around you:

- Always be aware of the location of your instrument's radioactive source and the direction of its beam of x-rays. The location of the source and the direction of its beam are both clearly marked on the front (**Figure 6.01**) and top side (**Figure 6.02**) of your NITON.
- Open the shutter *only* to do a test.

During testing, a strong beam of radiation (gamma-rays and x-rays) is continuously emitted through the beryllium window at the bottom of the NITON. There will be some radiation at the front and top-front of the instrument. There is negligible radiation where your hand should be holding the instrument.



**Warning:** Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring (Figure 6.03). Never point the NITON at yourself or anyone else when the shutter is open.

**Caution:** When testing the *exterior* of the window from the inside of a room, avoid standing in the path of the NITON's radiation beam. The direction of the beam is drawn on the cover of the instrument (Figure 6.03). It is easier to avoid the radiation beam if you hold the instrument in your right hand.

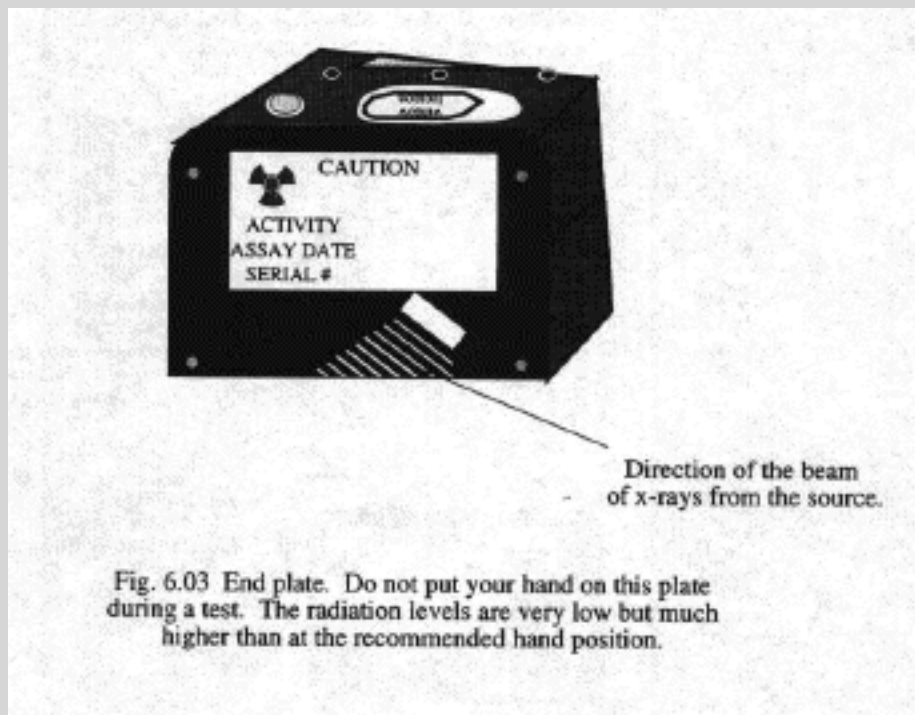


Fig. 6.03 End plate. Do not put your hand on this plate during a test. The radiation levels are very low but much higher than at the recommended hand position.

## Shutter safety

Your NITON is designed so you cannot accidentally open the shutter or leave it open accidentally when you lift the instrument from a surface.

To open the NITON's shutter and to keep it open, the instrument must be held against a surface. The shutter will close as soon as you cease to hold your NITON against a surface.

1. The shutter should be open only during a test.
2. Under no circumstances should the shutter be open when the instrument is not in use.
3. Your NITON clearly indicates any time the shutter is open (**Figure 6.04**). The plunger will stick up through the instrument case whenever the shutter is open.

**Warning: In the unlikely event that the plunger gets stuck in the open position, simply push it closed. Then call the NITON Service Department at (401) 294-1234.**

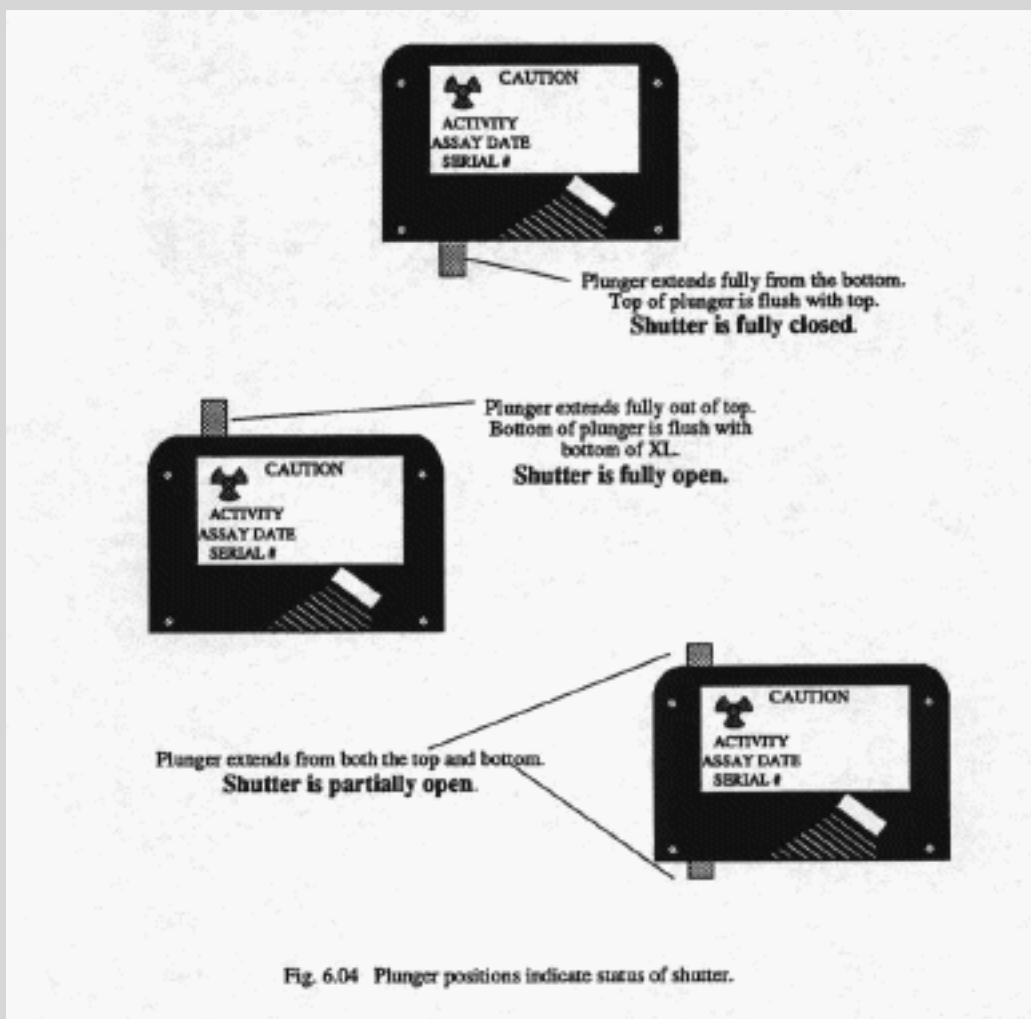


Fig. 6.04 Plunger positions indicate status of shutter.

## Monitoring your radiation exposure

There is virtually no measurable radiation from a NITON when its shutter is closed. The maximum dosage to which you are exposed when properly operating your NITON is 0.1 mR/hr on the fingers of the hand holding the instrument with the shutter open.

As an additional precaution to insure that your radiation exposure is always minimal, NITON strongly recommends that you wear a dosimeter at all times when using the instrument.

**Note: Your state may have regulations concerning radiation monitoring.**

A dosimeter badge is usually worn close to the parts of your body that are most sensitive to radiation, such as your reproductive organs and your eyes. These badges are available from many companies. One company selling dosimeters is:

Landauer, Inc.  
2 Science Road  
Glenwood, IL 60425-9979.

Each month, your radiation badge company will send you a new badge.

**Warning: Wearing a dosimeter badge does not protect you against current exposure. A dosimeter badge measures your exposure after the fact. If, at any time, you find measurable exposure, call**

**NITON immediately at (401) 294-1234.**

# The principles of radiation safety

Your exposure to radiation is related to three factors: time, distance, and shielding. Human exposure to radiation is typically measured in rems, or in one-thousandths of a rem, called millirems (mR).

As noted previously in this chapter, the allowable limit in the US. for occupational exposure is 5,000 mR/year for a whole-body and 50,000 mR for shallow penetration of extremities. Exposure from a properly-used NITON will be less than 50 mR per year, even if the instrument is used 2,000 hours per year.

**Warning: Pregnant female workers may want to take special precautions to reduce their exposure to radiation. Qualified scientists have recommended that the radiation dose to pregant women should not exceed 500 mR/year because of possible risk to the fetus.**

For a given source of radiation three factors will determine the radiation dosage you receive from the source:

## Duration of Exposure

The longer you are exposed to a source of radiation the more radiation strikes your body and the greater the dose you receive. Dosage increases in direct proportion to the length of exposure.

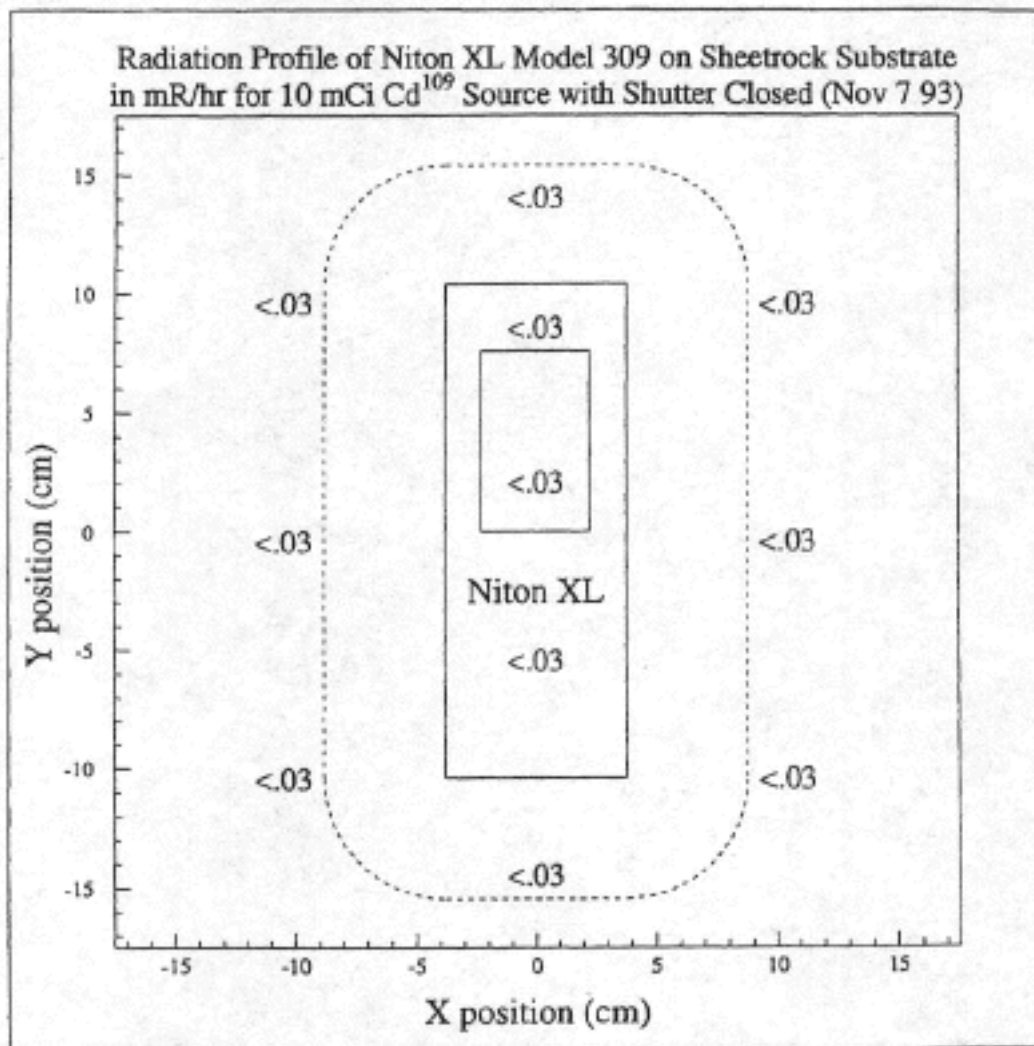
## Distance from the source

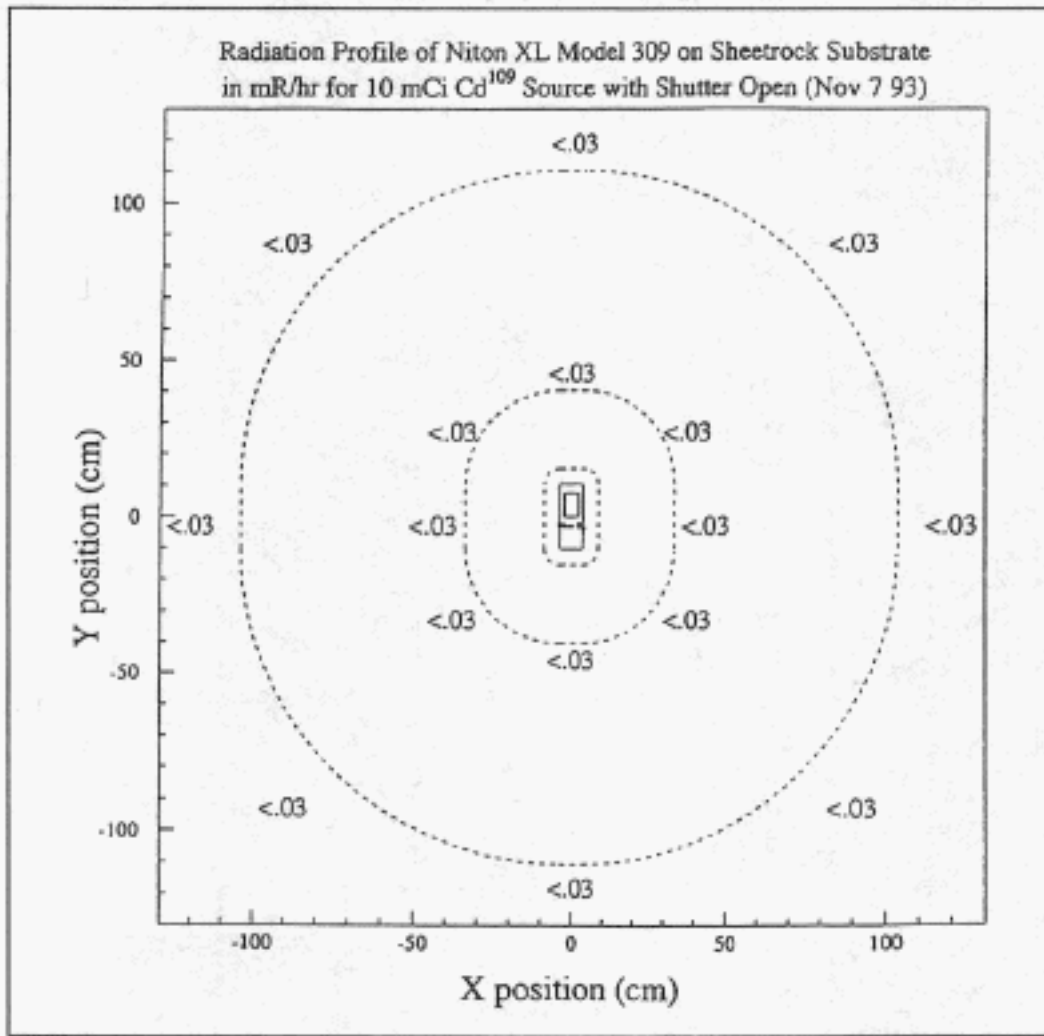
The closer you are to a source of radiation, the more radiation strikes you. The dosage increases in inverse-squared relation to the distance from the source. For example, the radiation dose one inch from a source is *nine* times greater than the dose three inches from the source, and *144* times greater than the dose one foot from the source. Keep your hand away from the source-end of your NITON when the shutter is open to minimize your exposure.

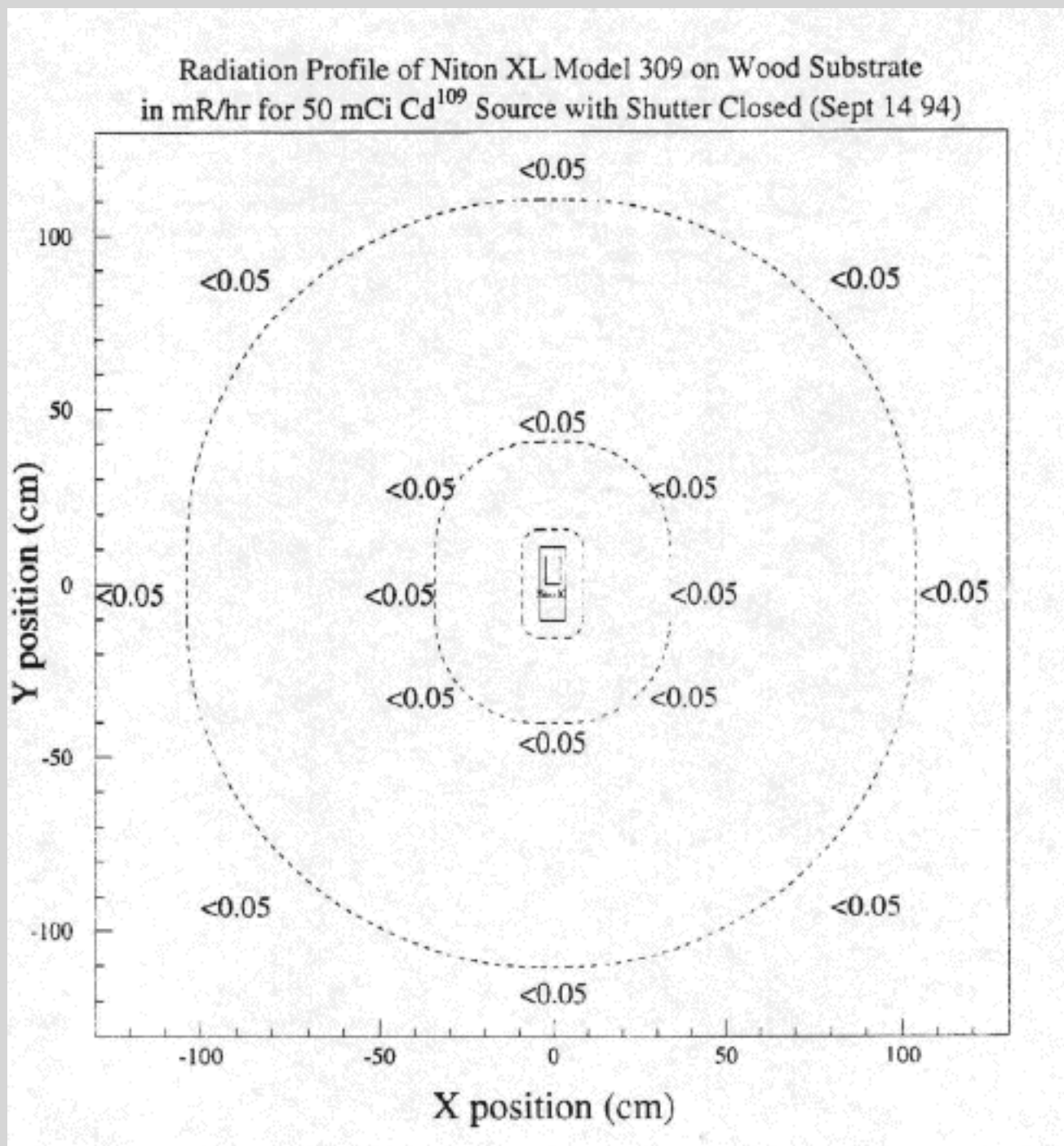
## Shielding

Every NITON XRF emits virtually no radiation with the shutter closed because the cadmium<sub>109</sub> source is thoroughly shielded in every direction. This shielding absorbs nearly all of the radiation produced by the source - except when the shutter is open during testing. With the shutter open, the instrument emits a directed radiation beam of about one mR/hr intensity; the direction is clearly indicated by the diagram on the front of the NITON. Always hold your NITON so as to avoid the radiation beam.

## Instrument radiation profiles







## Instrument radiation profiles

### Wipe testing

The shielding on your NITON is designed to hold up even under extreme conditions, including the instrument's being crushed or burned. The continued effectiveness of the instrument's radiation shielding should be tested every six months with a thorough leak test of the instrument (**Figure 6.05**).

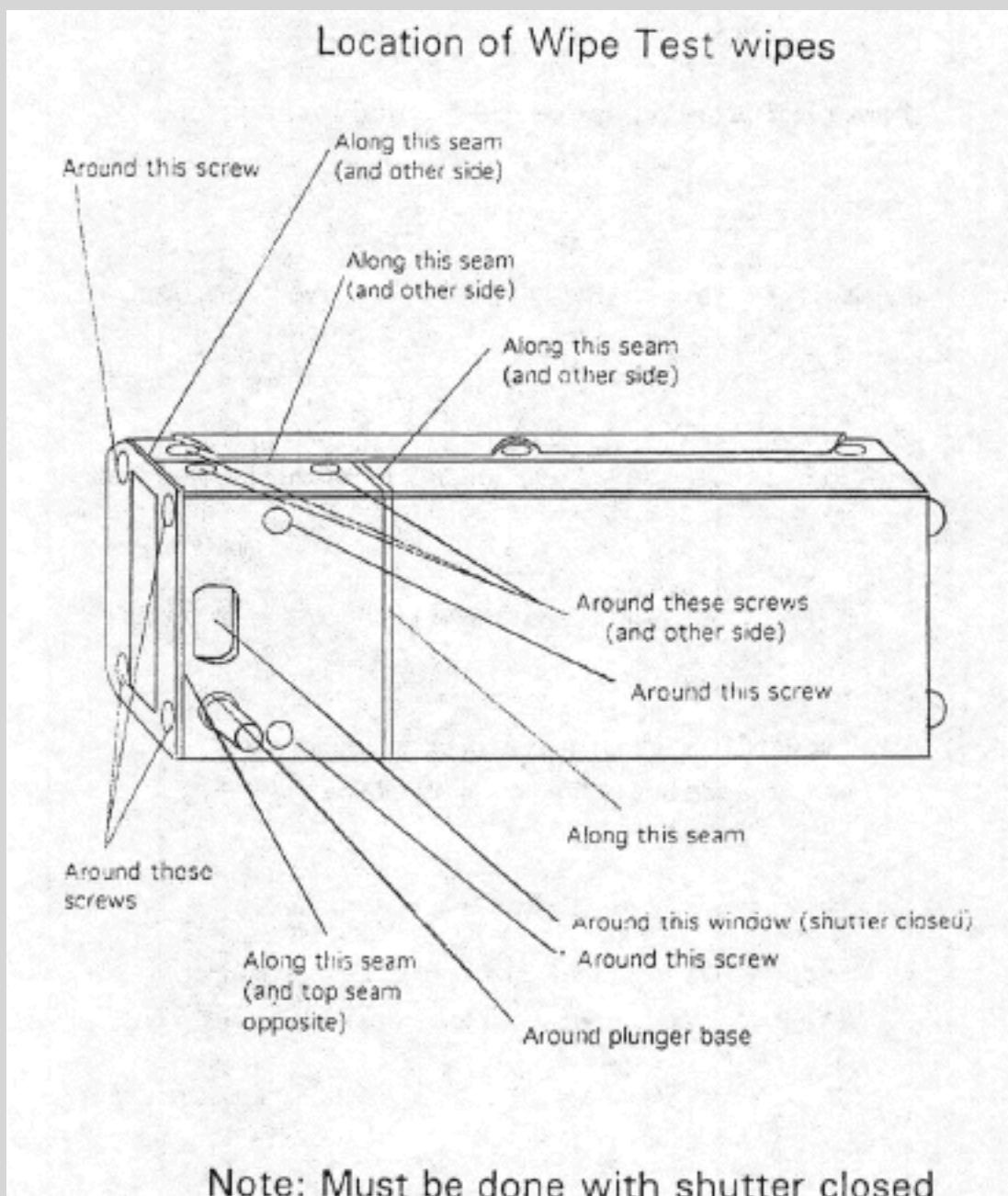
NITON's license requires that leak tests be done every 6 months. Leak test kits, with full instructions, are available from several vendors. These vendors will remind you when it's time to do another semi-annual leak test on your NITON. Please follow the accompanying instructions and promptly mail the test sample

to the laboratory. The following are just a few of the labs that offer leak tests:

Applied Health Physics  
2986 Industrial Blvd.  
Bethel Park, PA 15102  
Tel: (412) 835-9555

Stan A. Huber Consultants  
200 N. Cedar Road  
New Lenox, IL 60451  
Tel: (800) 383-0468

Valley Safety Services  
330 Old Enfield Road  
Belchertown, MA 01007  
Tel: (413) 323-9571





**If your NITON is damaged, destroyed, lost or stolen:**

Immediately

- Notify the Office of Radiological Safety in your state Dept. of Health.

Telephone: \_\_\_\_\_

- **Notify NITON Corp's Radiation Safety Officer, Dr. Don Sackett.**

During regular business hours: (800) 875-1578

Evenings and weekends: (617) 275-1424

- If your NITON is lost or stolen, or damaged in a car accident:

Also immediately notify your state police.

Telephone: \_\_\_\_\_

- If your NITON is damaged in a fire or an explosion:

Also immediately notify your local fire department.

Telephone: \_\_\_\_\_

Please fill in the phone numbers on this page today. Keep copies where you can find them in case of an emergency.

\_\_\_\_\_



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# User's Guide Version 5.0 (HTML) Chapter 7

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## Chapter 7: Additional Information

### Multi-element analysis (700 Series only)

#### Overview

700 Series analyzers can quantify concentrations of many elements. The normally displayed elements are: arsenic, barium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, rubidium, strontium, zinc and zirconium. The best detection limits are for molybdenum, rubidium, strontium and zirconium, as well as niobium and yttrium, which are not ordinarily displayed. 700's also have excellent detection limits for lead and mercury, as well as for gold, tungsten and uranium, which are not ordinarily displayed. 700's detect barium, chromium, cobalt, iron, manganese, and nickel with somewhat less sensitivity; the same applies to calcium, scandium, titanium, and vanadium, which are not ordinarily displayed. Finally, 700's detect arsenic, copper and zinc, but there are sometimes problems associated with the measurement of these elements due to cross-element interference. In particular, when zinc and copper are both present in a sample, the element with the higher concentration of the two can be

measured more accurately.

## Cross-Element Interference

700 Series users should be aware that interference between elements can reduce the sensitivity of the 700 to certain elements in certain situations. Interference occurs when the spectra of two or more elements partially or totally overlap (that is, the elements have nearly identical x-ray fluorescent energies).

### Note:

**All NITON analyzers correct automatically for cross-element interference in all modes. These corrections are performed automatically and continuously, throughout each test.**

NITON instruments correct for these cross-element interferences in all modes. In some instances, however, these corrections will worsen the detection limits and precision of the instrument in **Bulk Sample** and **Thin Sample** modes. For example, in the presence of high concentrations of zinc (>10,000 ppm), the 700 Series analyzer will be unable to detect slight trace concentrations of copper that would be detected if a large amount of zinc was not present. Another example: Very high concentrations of iron (>30,000 ppm) may produce false-positive readings for very small concentrations of manganese and/or cobalt.

## Tips for better testing

### Define Data Quality Objectives (DQOs)

Before implementing a sampling and analysis program, consider the data quality objectives (DQOs) for the particular site and job. For what purpose is the data being collected? What types of decisions will be made as a result of the data? What are the action-levels for the analytes you are testing at the site? What is known about the extent and distribution of the contaminant? What are the implications of possible mis-classification of samples?

The answers will help to determine the precision and accuracy you need to attain for different phases of the program. These in turn will help you to determine sample-collection procedures, sample preparation methods, sample measurement times, and your requirements for quality assurance and laboratory support.

### Standard Operating Procedures

To obtain good test data in your study, it is essential to develop a written Standard Operating Procedure for sampling, measuring, and reporting data. A systematic procedure will help you to produce data of uniform quality. Typically, the Standard Operating Procedure is a written document that details the steps to be taken in handling the samples, standards, equipment, and data, including quality assurance measures, such as calibration checks and laboratory confirmation.

### Warm up and calibration checks

All Niton analyzers should be turned on at least 15 minutes prior to testing in **Thin Sample** or **Bulk Sample** modes. This procedure is not necessary in any of the paint testing modes.

**Note: Your instrument should be calibrated before and after testing and at least once per hour during testing.**

Check your instrument by testing **Standard Samples** of known concentration every time you calibrate. Check both a low-level standard (or "blank" ), and a high-level standard, (or "spike") of known concentration. Tests of **Standard Samples** should be recorded and kept with the sample test data.

### **Compare samples with and without preparation**

Set aside part of a sample and prepare the rest. Measure both the prepared and the unprepared portions. Small differences (+/-30%) are to be expected.

### **Send samples to a lab for confirmation**

Have some samples measured by atomic absorption spectrophotometry by a certified laboratory. This will verify the correctness of your technique and alert you to any site-specific biases.

Split some samples and analyze each sample with both the XRF and with atomic absorption spectrophotometry in a lab. Your Standard Operating Procedure should specify the number of confirmatory samples (perhaps 10 percent of all samples), what actions will be taken in response to the results, and what records will be kept.

### **Range, precision and limits**

#### **Range of accurate measurement**

NITON XRFs are calibrated to give accurate values for most elements in concentrations of 10,000 ppm or less. This is because the linear range of the Compton Normalization Method is from 0 ppm to approximately 10,000 ppm (1%). For actual concentrations of 10,000 ppm to 20,000 ppm (1% to 2%), NITON's may overstate the elemental concentration. For content above 20,000 ppm (2%), readings may exhibit even greater deviation.

This deviation results from the extreme x-ray absorption of lead relative to the typical matrix. In terms of x-ray properties, the sample with greater than 20,000 ppm (2%) lead behaves more like lead than the matrix. It may be possible to develop a calibration curve for a specific soil matrix with a very high concentration of lead. If you wish to measure lead in such matrices, please contact Dr. Don Sackett at NITON Corporation for further information at (617) 275-9275.

#### **95% confidence intervals**

The precision of a measurement is expressed as the uncertainty or error of the measured result. For every measurement, the NITON gives an uncertainty range that represents a 95% (or "2-sigma") confidence interval. The 95% confidence interval is the interval between the measured-result-minus-the-uncertainty-range to the measured-result-plus-the-uncertainty-range. For example, if you took 100 measurements of a sample, you would expect 95 of the measurements to fall within the 95% confidence interval.

## Detection limits (DLs)

The detection limit (DL) is the lowest concentration of analyte in a sample that can reliably be distinguished from zero concentration in a sample. In XRF, the DL is usually defined as three times the standard deviation (sigma) of fluctuation in the background.

A estimate of the DL can be obtained by measuring a blank standard. Use a standard measurement time (e.g. 60 source seconds). The estimated DL is 1.5 times the two-sigma precision of the measurement.

The method detection limit (MDL) may be a more realistic measure of sensitivity in actual field conditions. The MDL can be determined by replicate analysis of a blank or low level soil standard. This procedure may be carried out in the laboratory or field. The number of replicate blank measurements should be at least 7. If the replicate blanks are interspersed with the regular measurements as part of the continuing calibration verification (CCV), then the MDL will include the error resulting from instrument drift. Calculate the mean and standard deviation of the replicate measurement series. The bias is the mean minus the standard's known concentration. The MDL is 3 times the standard deviation. The MDL should be reasonably close to the estimated DL. Conservatively, one should report the DL to be the largest value among the estimated DL, MDL, and bias.

In actual usage, a measurement result that exceeds the DL is considered strong evidence of the analyte's presence in the sample. A measurement result that does not exceed the DL for an analyte is reported as "not detected."

## Quantitation limit (QLs)

The quantitation limit (QL) is the lowest concentration of analyte that can be reliably measured at high enough precision to allow comparisons among measurements. The XRF industry usually defines QL as 10 times the standard deviation (or "10-sigma") or fluctuation in the background level. QL is therefore 3.33 times the DL. Similarly, the method quantitation limit (MQL) is simply 3.33 times the MDL.

Regulatory bodies often require analytical methods used to establish compliance with a standard or action level to achieve a quantitation limit (QL) equal to or below the standard or action level.

## Summary of warnings

**Warning: Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring. Never point the NITON at yourself or anyone else when the shutter is open.**

**Warning: Wearing a dosimeter badge does not protect you against current exposure. A dosimeter measures your exposure after the fact. If, at any time, you find measurable exposure, call NITON immediately at (401) 294-1234.**

**Warning: Pregnant female workers may want to take special precautions to reduce their exposure to radiation. Qualified scientists have recommended that the radiation dose to pregnant women should not exceed 500 mR/year because of possible increased risk to the fetus.**

**Warning: In the unlikely event that the plunger gets stuck in the open position, simply push it closed. Then call the NITON Service Department at (401) 294-1234.**

**Warning: Tampering with the 5,500 ppm lead-in-soil standard may cause exposure to lead dust. Keep all standards out of reach of children.**

**Warning: Always use gloves and respiration equipment for your protection when taking samples from a site where toxic chemicals may be present.**

**Warning: Grinding and sieving dried samples produces dust. Even clean soil contains silica, which may be hazardous when airborne. Prepare all samples in a ventilated area; wear a mask, gloves, and an apron; and spread a drop cloth.**

**Warning: Do not hold bagged bulk samples in your hand during testing.**

## Summary of cautions

**Caution: Do not attempt to make repairs yourself. All Service except exterior cleaning must be performed by NITON Corporation. Any attempt to open your NITON instrument will void the instrument warranty.**

Caution: Do not return your NITON without the carrying case. You will void the instrument warranty. You will also be billed for a replacement case plus any repairs resulting from improper shipping.

Caution: Do not return your instrument to NITON without a current leak test. NITON's license prohibits us from repairing or upgrading our instruments without a current leak test certificate. If you return an instrument without a current leak test certificate, NITON will perform a leak test and bill you for the leak test.

Caution: Do not ship your instrument back to NITON for any reason without first notifying NITON Corporation and receiving a Return Authorization Number.

Caution: Do not store the battery packs or battery charger in direct sunlight.

Caution: Do not leave battery packs on the battery charger longer than necessary.

Caution: If the red Temp light comes on repeatedly when a battery pack is on the Battery Charger in the Full Charge cycle, call NITON Customer Service at (401) 294-1234.

Caution: NITON's Nickel Metal Hydride battery packs discharge at a rate of about 2% per day when not in use.

Caution: If you try to calibrate the instrument and it does not calibrate successfully, push the Reset Button on the bottom of the instrument and recalibrate. If your NITON does not calibrate successfully in three attempts, please call the NITON Service Department at (401) 294-1234.

Caution: Check the **Date** and **Time** displayed on the Ready to Test screen. If they are not correct, reset them before taking any measurements. Your readings will not be accurate unless the date and time are correct.

Caution: Never tamper with Test Standards. They should not be used unless they are completely intact.

Caution: The Standard Thin Sample Mode should not be used for quantitative lead-paint testing. Use only the three Paint Testing modes to test lead-based paint.

Caution: When testing the *exterior* of the window sash from the inside of a room, avoid standing in the path of the NITON's radiation beam. The direction of the beam is drawn on the cover of the instrument. It is easier to avoid the radiation beam if you hold the instrument in your right-hand.

Caution: Keep all test equipment clean to prevent contaminated samples.

## Warranty

NITON will warranty parts and labor for any manufacturer's defects for 15 months. No precision instrument is warranted if crushed, dropped on the floor or in a bucket of water. All service, including repair, maintenance and source replacements, must be performed by NITON Corporation. Any attempt to open the metal case of your NITON instrument will nullify this warranty.

### **Limited Warranty Provision for Use with Purchase and License Agreement for NITON Corporation XRF Detection instruments:**

(a) Except as otherwise agreed in writing, NITON Corporation warrants, under normal conditions of operation, each product sold (except for components not of its manufacture) against defects of material and workmanship, provided that such product has been properly utilized. This warranty applies to the original purchaser only and shall commence to run from the date of shipment and shall continue for a period of fifteen (15) months. In any event, NITON Corporation's liability for any such defects of material and workmanship shall not exceed the cost of replacement of defective parts upon timely notification of such defect in writing delivered to NITON Corporation's home office. NITON Corporation shall not be liable for damage or destruction caused during delivery or caused other than by employees of NITON Corporation.

(b) Material, accessories, parts, or items of equipment furnished by suppliers to NITON Corporation and used in the manufacture of NITON Corporation products are guaranteed by NITON Corporation only to the extent of the original manufacturer's express warranty to NITON Corporation for a period not to exceed the warranty period described in paragraph (a) above and provided that the purchaser shall have notified NITON Corporation so as to enable NITON Corporation to avail itself of its rights under such original manufacturer's express warranty.

(c) NITON Corporation shall, at its option, repair such defects or replace the parts or products found defective. All defective parts are to be returned, freight prepaid, immediately to NITON Corporation for inspection and credit. NITON Corporation will make no allowance for repairs or alterations made by the purchaser unless made with the advance written consent of NITON Corporation. NITON Corporation assumes no liability for costs of disassembly of defective parts and equipment. Shipment by purchaser of all repairs and replacements under this warranty are F.O.B. NITON Corporation's factory or authorized service representative and method of shipment will be determined by NITON Corporation. The purchaser will pay shipping costs and insurance in both directions of products, parts, or components shipped for warranty service hereunder. The purchaser will be responsible for risk of loss in both direction. Replaced

parts or components will become the property of NITON Corporation. Replacement parts or components may contain recycled, refurbished, or remanufactured parts equivalent to new parts and shall be warranted for the remainder of the original warranty period for the products.

(d) NITON Corporation shall not be liable for delays, deprivation of use, or any other damages, direct or indirect, which may result to the purchaser because of defects in the product or because of the purchaser's inability to operate it or use it to his satisfaction. NITON Corporation will not be liable to anyone for special or consequential damages of any kind. NITON Corporation neither assumes nor authorizes any person to assume for it, any other obligation or liability with respect to NITON Corporation products.

EXCEPT FOR THE FOREGOING EXPRESS WARRANTY, THERE ARE NO WARRANTIES, REPRESENTATIONS, OR GUARANTEES, EXPRESS OR IMPLIED, EXCEPT AS ARE EXPRESSLY SET FORTH HEREIN. THE FOREGOING WARRANTY IS THE ONLY WARRANTY MADE BY NITON CORPORATION. ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ON THIS PRODUCT IS LIMITED IN DURATION TO THE TWO YEAR DURATION OF THIS WRITTEN WARRANTY. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS OR THE EXCLUSION OF LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.



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# NITON Corporation

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## 8: Appendix A

### x-ray emission energies by atomic number

● Element		● Atomic		● Average	KeV	of	X-ray	Fluor.
● Name	● Symbol	● No.	● Weight	● K alpha	● K beta	● L alpha	● L beta	● L gamma
● titanium	● Ti	● 22	● 47.90	● 4.5	● 4.9			
● vanadium	● V	● 23	● 50.94	● 4.9	● 5.4			
● chromium	● Cr	● 24	● 52.00	● 5.4	● 5.9			
● manganese	● Mn	● 25	● 54.94	● 5.9	● 6.5			
● iron	● Fe	● 26	● 55.85	● 6.4	● 7.1			
● cobalt	● Co	● 27	● 58.93	● 6.9	● 7.6			
● nickel	● Ni	● 28	● 58.70	● 7.5	● 8.3			
● copper	● Cu	● 29	● 63.55	● 8.0	● 8.9			
● zinc	● Zn	● 30	● 65.38	● 8.6	● 9.6			
● gallium	● Ga	● 31	● 69.72	● 9.2	● 10.3			
● germanium	● Ge	● 32	● 72.59	● 9.9	● 11.0			
● arsenic	● As	● 33	● 74.92	● 10.5	● 11.7			

● selenium	● Se	● 34	● 78.96	● 11.2	● 12.5			
● bromine	● Br	● 35	● 79.90	● 11.9	● 13.3			
● krypton	● Kr	● 36	● 83.80	● 12.6	● 14.1			
● rubidium	● Rb	● 37	● 85.47	● 13.4	● 15.0			
● strontium	● Sr	● 38	● 87.62	● 14.1	● 15.8			
● yttrium	● Y	● 39	● 88.91	● 14.9	● 16.8			
● zirconium	● Zr	● 40	● 91.22	● 15.7	● 17.7			
● niobium	● Nb	● 41	● 92.91	● 16.6	● 18.6			
● molybdenum	● Mo	● 42	● 95.94	● 17.4	● 19.6			
● tellurium	● Te	● 52	● 127.60	● 27.4	● 31.1	● 3.8	● 4.0	● 4.6
● iodine	● I	● 53	● 126.90	● 28.5	● 32.4	● 3.9	● 4.2	● 4.8
● xenon	● Xe	● 54	● 131.30	● 29.7	● 33.8	● 4.1	● 4.4	● 5.0
● cesium	● Cs	● 55	● 132.91	● 30.9	● 35.1	● 4.3	● 4.6	● 5.3
● barium	● Ba	● 56	● 137.33	● 32.1	● 36.6	● 4.5	● 4.8	● 5.5
● lanthanum	● La	● 57	● 138.91	● 33.3	● 38.0	● 4.7	● 5.0	● 5.8
● cerium	● Ce	● 58	● 140.12	● 34.6	● 39.5	● 4.8	● 5.3	● 6.0
● praseodymium	● Pr	● 59	● 140.91	● 35.9	● 41.0	● 5.0	● 5.5	● 6.3
● neodymium	● Nd	● 60	● 144.24	● 37.2	● 42.5	● 5.2	● 5.7	● 6.6
● promethium	● Pm	● 61	● (145)	● 38.5	● 44.0	● 5.4	● 6.0	● 6.9
● samarium	● Sm	● 62	● 150.35	● 39.9	● 45.6	● 5.6	● 6.2	● 7.2
● europium	● Eu	● 63	● 151.96	● 41.3	● 47.3	● 5.8	● 6.5	● 7.5
● gadolinium	● Gd	● 64	● 157.25	● 42.8	● 48.9	● 6.1	● 6.7	● 7.8
● terbium	● Tb	● 65	● 158.92	● 44.2	● 50.7	● 6.3	● 7.0	● 8.1
● dysprosium	● Dy	● 66	● 162.50	● 45.7	● 52.4	● 6.5	● 7.2	● 8.4
● holmium	● Ho	● 67	● 164.93	● 47.3	● 54.2	● 6.7	● 7.5	● 8.7
● erbium	● Er	● 68	● 167.26	● 48.8	● 56.0	● 6.9	● 7.8	● 9.1
● thulium	● Tm	● 69	● 168.93	● 50.4	● 57.8	● 7.2	● 8.1	● 9.4
● ytterbium	● Yb	● 70	● 173.04	● 52.0	● 59.7	● 7.4	● 8.4	● 9.8
● lutecium	● Lu	● 71	● 174.97	● 53.7	● 61.6	● 7.7	● 8.7	● 10.1
● hafnium	● Hf	● 72	● 178.49	● 55.4	● 63.6	● 7.9	● 9.0	● 10.5
● tantalum	● Ta	● 73	● 180.95	● 57.1	● 65.6	● 8.1	● 9.3	● 10.9
● tungsten	● W	● 74	● 183.85	● 58.9	● 67.6	● 8.4	● 9.7	● 11.3
● rhenium	● Re	● 75	● 186.2	● 60.7	● 69.7	● 8.7	● 10.0	● 11.7
● osmium	● Os	● 76	● 190.2	● 62.5	● 71.8	● 8.9	● 10.4	● 12.1
● iridium	● Ir	● 77	● 192.2	● 64.3	● 73.9	● 9.2	● 10.7	● 12.5
● platinum	● Pt	● 78	● 195.09	● 66.2	● 76.1	● 9.4	● 11.1	● 12.9
● gold	● Au	● 79	● 196.97	● 68.2	● 78.4	● 9.7	● 11.4	● 13.4
● mercury	● Hg	● 80	● 200.59	● 70.2	● 80.7	● 10.0	● 11.8	● 13.8

● thallium	● Tl	● 81	● 204.37	● 72.2	● 83.0	● 10.3	● 12.2	● 14.3
● lead	● Pb	● 82	● 207.19	● 74.5	● 85.4	● 10.5	● 12.6	● 14.8
● bismuth	● Bi	● 83	● 208.98			● 10.8	● 13.0	● 15.2
● polonium	● Po	● 84	● (209)			● 11.1	● 13.4	● 15.7
● astatine	● At	● 85	● (210)			● 11.4	● 13.9	● 16.2
● radon	● Rn	● 86	● (222)			● 11.7	● 14.3	● 16.8
● francium	● Fr	● 87	● (223)			● 12.0	● 14.8	● 17.3
● radium	● Ra	● 88	● (226)			● 12.3	● 15.2	● 17.8
● actinium	● Ac	● 89	● (227)			● 12.7	● 15.7	● 18.4
● thorium	● Th	● 90	● 232.04			● 13.0	● 16.2	● 19.0
● protactinium	● Pa	● 91	● (231)			● 13.3	● 16.7	● 19.6
● uranium	● U	● 92	● 238.03			● 13.6	● 17.2	● 20.2

## 8: Appendix B

### X-ray emission energies by element

● Element		● Atomic	● Average	KeV	of	X-ray	Fluor.	
● Name	● Symbol	● No.	● Weight	● K alpha	● K beta	● L alpha	● L beta	● L gamma
● actinium	● Ac	● 89	● (227)			● 12.7	● 15.7	● 18.4
● arsenic	● As	● 33	● 74.92	● 10.5	● 11.7			
● astatine	● At	● 85	● (210)			● 11.4	● 13.9	● 16.2
● barium	● Ba	● 56	● 137.33	● 32.1	● 36.6	● 4.5	● 4.8	● 5.5
● bismuth	● Bi	● 83	● 208.98			● 10.8	● 13.0	● 15.2
● bromine	● Br	● 35	● 79.90	● 11.9	● 13.3			
● cerium	● Ce	● 58	● 140.12	● 34.6	● 39.5	● 4.8	● 5.3	● 6.0
● cesium	● Cs	● 55	● 132.91	● 30.9	● 35.1	● 4.3	● 4.6	● 5.3
● chromium	● Cr	● 24	● 52.00	● 5.4	● 5.9			
● cobalt	● Co	● 27	● 58.93	● 6.9	● 7.6			
● copper	● Cu	● 29	● 63.55	● 8.0	● 8.9			
● dysprosium	● Dy	● 66	● 162.50	● 45.7	● 52.4	● 6.5	● 7.2	● 8.4
● erbium	● Er	● 68	● 167.26	● 48.8	● 56.0	● 6.9	● 7.8	● 9.1
● europium	● Eu	● 63	● 151.96	● 41.3	● 47.3	● 5.8	● 6.5	● 7.5
● francium	● Fr	● 87	● (223)			● 12.0	● 14.8	● 17.3
● gadolinium	● Gd	● 64	● 157.25	● 42.8	● 48.9	● 6.1	● 6.7	● 7.8
● gallium	● Ga	● 31	● 69.72	● 9.2	● 10.3			
● germanium	● Ge	● 32	● 72.59	● 9.9	● 11.0			
● gold	● Au	● 79	● 196.97	● 68.2	● 78.4	● 9.7	● 11.4	● 13.4

● hafnium	● Hf	● 72	● 178.49	● 55.4	● 63.6	● 7.9	● 9.0	● 10.5
● holmium	● Ho	● 67	● 164.93	● 47.3	● 54.2	● 6.7	● 7.5	● 8.7
● iodine	● I	● 53	● 126.90	● 28.5	● 32.4	● 3.9	● 4.2	● 4.8
● iridium	● Ir	● 77	● 192.2	● 64.3	● 73.9	● 9.2	● 10.7	● 12.5
● iron	● Fe	● 26	● 55.85	● 6.4	● 7.1			
● krypton	● Kr	● 36	● 83.80	● 12.6	● 14.1			
● lanthanum	● La	● 57	● 138.91	● 33.3	● 38.0	● 4.7	● 5.0	● 5.8
● lead	● Pb	● 82	● 207.19	● 74.5	● 85.4	● 10.5	● 12.6	● 14.8
● lutecium	● Lu	● 71	● 174.97	● 53.7	● 61.6	● 7.7	● 8.7	● 10.1
● manganese	● Mn	● 25	● 54.94	● 5.9	● 6.5			
● mercury	● Hg	● 80	● 200.59	● 70.2	● 80.7	● 10.0	● 11.8	● 13.8
● molybdenum	● Mo	● 42	● 95.94	● 17.4	● 19.6			
● neodymium	● Nd	● 60	● 144.24	● 37.2	● 42.5	● 5.2	● 5.7	● 6.6
● nickel	● Ni	● 28	● 58.70	● 7.5	● 8.3			
● niobium	● Nb	● 41	● 92.91	● 16.6	● 18.6			
● osmium	● Os	● 76	● 190.2	● 62.5	● 71.8	● 8.9	● 10.4	● 12.1
● platinum	● Pt	● 78	● 195.09	● 66.2	● 76.1	● 9.4	● 11.1	● 12.9
● polonium	● Po	● 84	● (209)			● 11.1	● 13.4	● 15.7
● praseodymium	● Pr	● 59	● 140.91	● 35.9	● 41.0	● 5.0	● 5.5	● 6.3
● promethium	● Pm	● 61	● (145)	● 38.5	● 44.0	● 5.4	● 6.0	● 6.9
● protactinium	● Pa	● 91	● (231)			● 13.3	● 16.7	● 19.6
● radium	● Ra	● 88	● (226)			● 12.3	● 15.2	● 17.8
● radon	● Rn	● 86	● (222)			● 11.7	● 14.3	● 16.8
● rhenium	● Re	● 75	● 186.2	● 60.7	● 69.7	● 8.7	● 10.0	● 11.7
● rubidium	● Rb	● 37	● 85.47	● 13.4	● 15.0			
● samarium	● Sm	● 62	● 150.35	● 39.9	● 45.6	● 5.6	● 6.2	● 7.2
● selenium	● Se	● 34	● 78.96	● 11.2	● 12.5			
● strontium	● Sr	● 38	● 87.62	● 14.1	● 15.8			
● tantalum	● Ta	● 73	● 180.95	● 57.1	● 65.6	● 8.1	● 9.3	● 10.9
● tellurium	● Te	● 52	● 127.60	● 27.4	● 31.1	● 3.8	● 4.0	● 4.6
● terbium	● Tb	● 65	● 158.92	● 44.2	● 50.7	● 6.3	● 7.0	● 8.1
● thallium	● Tl	● 81	● 204.37	● 72.2	● 83.0	● 10.3	● 12.2	● 14.3
● thorium	● Th	● 90	● 232.04			● 13.0	● 16.2	● 19.0
● thulium	● Tm	● 69	● 168.93	● 50.4	● 57.8	● 7.2	● 8.1	● 9.4
● titanium	● Ti	● 22	● 47.90	● 4.5	● 4.9			
● tungsten	● W	● 74	● 183.85	● 58.9	● 67.6	● 8.4	● 9.7	● 11.3
● uranium	● U	● 92	● 238.03			● 13.6	● 17.2	● 20.2
● vanadium	● V	● 23	● 50.94	● 4.9	● 5.4			

● xenon	● Xe	● 54	● 131.30	● 29.7	● 33.8	● 4.1	● 4.4	● 5.0
● ytterbium	● Yb	● 70	● 173.04	● 52.0	● 59.7	● 7.4	● 8.4	● 9.8
● yttrium	● Y	● 39	● 88.91	● 14.9	● 16.8			
● zinc	● Zn	● 30	● 65.38	● 8.6	● 9.6			
● zirconium	● Zr	● 40	● 91.22	● 15.7	● 17.7			

## 8: Appendix C

### x-ray emission energies by energy (keV)

● KeV	● Name	● Symbol	● KeV	● Name	● Symbol	● KeV	● Name	● Symbol
● 3.8	● tellurium	● Te	● 3.9	● iodine	● I	● 4.0	● tellurium	● Te
● 4.1	● xenon	● Xe	● 4.2	● iodine	● I	● 4.3	● cesium	● Cs
● 4.4	● xenon	● Xe	● 4.5	● titanium	● Ti	● 4.5	● barium	● Ba
● 4.6	● cesium	● Cs	● 4.6	● tellurium	● Te	● 4.7	● lanthanum	● La
● 4.8	● cerium	● Ce	● 4.8	● barium	● Ba	● 4.8	● iodine	● I
● 4.9	● vanadium	● V	● 4.9	● titanium	● Ti	● 5.0	● praseodymium	● Pr
● 5.0	● lanthanum	● La	● 5.0	● xenon	● Xe	● 5.2	● neodymium	● Nd
● 5.3	● cerium	● Ce	● 5.3	● cesium	● Cs	● 5.4	● chromium	● Cr
● 5.4	● vanadium	● V	● 5.4	● promethium	● Pm	● 5.5	● praseodymium	● Pr
● 5.5	● barium	● Ba	● 5.6	● samarium	● Sm	● 5.7	● neodymium	● Nd
● 5.8	● europium	● Eu	● 5.8	● lanthanum	● La	● 5.9	● manganese	● Mn
● 5.9	● chromium	● Cr	● 6.0	● promethium	● Pm	● 6.0	● cerium	● Ce
● 6.1	● gadolinium	● Gd	● 6.2	● samarium	● Sm	● 6.3	● terbium	● Tb
● 6.3	● praseodymium	● Pr	● 6.4	● iron	● Fe	● 6.5	● manganese	● Mn
● 6.5	● dysprosium	● Dy	● 6.5	● europium	● eu	● 6.6	● neodymium	● Nd
● 6.7	● holmium	● Ho	● 6.7	● gadolinium	● Gd	● 6.9	● cobalt	● Co
● 6.9	● erbium	● Er	● 6.9	● promethium	● Pm	● 7.0	● terbium	● Tb
● 7.1	● iron	● Fe	● 7.2	● thulium	● Tm	● 7.2	● dysprosium	● Dy
● 7.2	● samarium	● Sm	● 7.4	● ytterbium	● Yb	● 7.5	● nickel	● Ni
● 7.5	● holmium	● Ho	● 7.5	● europium	● Eu	● 7.6	● cobalt	● Co
● 7.7	● lutecium	● Lu	● 7.8	● erbium	● Er	● 7.8	● gadolinium	● Gd
● 7.9	● hafnium	● Hf	● 8.0	● copper	● Cu	● 8.1	● tantalum	● Ta
● 8.1	● thulium	● Tm	● 8.1	● terbium	● Tb	● 8.3	● nickel	● Ni
● 8.4	● tungsten	● W	● 8.4	● ytterbium	● Yb	● 8.4	● dysprosium	● Dy
● 8.6	● zinc	● Zn	● 8.7	● rhenium	● Re	● 8.7	● lutecium	● Lu
● 8.7	● holmium	● Ho	● 8.9	● copper	● Cu	● 8.9	● osmium	● Os
● 9.0	● hafnium	● Hf	● 9.1	● erbium	● Er	● 9.2	● gallium	● Ga

● 9.2	● iridium	● Ir	● 9.3	● tantalum	● Ta	● 9.4	● platinum	● Pt
● 9.4	● thulium	● Tm	● 9.6	● zinc	● Zn	● 9.7	● gold	● Au
● 9.7	● tungsten	● W	● 9.8	● ytterbium	● Yb	● 9.9	● germanium	● Ge
● 10.0	● mercury	● Hg	● 10.0	● rhenium	● Re	● 10.1	● lutecium	● Lu
● 10.3	● gallium	● Ga	● 10.3	● thallium	● Tl	● 10.4	● osmium	● Os
● 10.5	● arsenic	● As	● 10.5	● lead	● Pb	● 10.5	● hafnium	● Hf
● 10.7	● iridium	● Ir	● 10.8	● bismuth	● Bi	● 10.9	● tantalum	● Ta
● 11.0	● germanium	● Ge	● 11.1	● polonium	● Po	● 11.1	● platinum	● Pt
● 11.2	● selenium	● Se	● 11.3	● tungsten	● W	● 11.4	● astatine	● At
● 11.4	● gold	● Au	● 11.7	● arsenic	● As	● 11.7	● radon	● Rn
● 11.7	● rhenium	● Re	● 11.8	● mercury	● Hg	● 11.9	● bromine	● Br
● 12.0	● francium	● Fr	● 12.1	● osmium	● Os	● 12.2	● thallium	● Tl
● 12.3	● radium	● Ra	● 12.5	● selenium	● Se	● 12.5	● iridium	● Ir
● 12.6	● krypton	● Kr	● 12.6	● lead	● Pb	● 12.7	● actinium	● Ac
● 12.9	● platinum	● Pt	● 13.0	● thorium	● Th	● 13.0	● bismuth	● Bi
● 13.3	● bromine	● Br	● 13.3	● protactinium	● Pa	● 13.4	● rubidium	● Rb
● 13.4	● polonium	● Po	● 13.4	● gold	● Au	● 13.6	● uranium	● U
● 13.8	● mercury	● Hg	● 13.9	● astatine	● At	● 14.1	● strontium	● Sr
● 14.1	● krypton	● Kr	● 14.3	● radon	● Rd	● 14.3	● thallium	● Tl
● 14.8	● francium	● Fr	● 14.8	● lead	● Pb	● 14.9	● yttrium	● Y
● 15.0	● rubidium	● Rb	● 15.2	● radium	● Ra	● 15.2	● bismuth	● Bi
● 15.7	● zirconium	● Zr	● 15.7	● actinium	● Ac	● 15.7	● polonium	● Po
● 15.8	● strontium	● Sr	● 16.2	● thorium	● Th	● 16.2	● astatine	● At
● 16.6	● niobium	● Nb	● 16.7	● protactinium	● Pa	● 16.8	● yttrium	● Y
● 16.8	● radon	● Rn	● 17.2	● uranium	● U	● 17.3	● francium	● Fr
● 17.4	● molybdenum	● Mo	● 17.7	● zirconium	● Zr	● 17.8	● radium	● Ra
● 18.4	● actinium	● Ac	● 18.6	● niobium	● Nb	● 19.0	● thorium	● Th
● 19.6	● molybdenum	● Mo	● 19.6	● protactinium	● Pa	● 20.2	● uranium	● U
● 27.4	● tellurium	● Te	● 28.5	● iodine	● I	● 29.7	● xenon	● Xe
● 30.9	● cesium	● Cs	● 31.1	● tellurium	● Te	● 32.1	● barium	● Ba
● 32.4	● iodine	● I	● 33.3	● lanthanum	● La	● 33.8	● xenon	● Xe
● 34.6	● cerium	● Ce	● 35.1	● cesium	● Cs	● 35.9	● praseodymium	● Pr
● 36.6	● barium	● Ba	● 37.2	● neodymium	● Nd	● 38.0	● lanthanum	● La
● 38.5	● promethium	● Pm	● 39.5	● cerium	● Ce	● 39.9	● samarium	● Sm
● 41.0	● praseodymium	● Pr	● 41.3	● europium	● Eu	● 32.5	● neodymium	● Nd
● 42.8	● gadolinium	● Gd	● 44.0	● promethium	● Pm	● 44.2	● terbium	● Tb
● 45.6	● samarium	● Sm	● 45.7	● dysprosium	● Dy	● 47.3	● holmium	● Ho
● 47.3	● europium	● Eu	● 48.8	● erbium	● Er	● 48.9	● gadolinium	● Gd

● 50.4	● thulium	● Tm	● 50.7	● terbium	● Tb	● 52.0	● ytterbium	● Yb
● 52.4	● dysprosium	● Dy	● 53.7	● lutetium	● Lu	● 54.2	● holmium	● Ho
● 55.4	● hafnium	● Hf	● 56.0	● erbium	● Er	● 57.1	● tantalum	● Ta
● 57.8	● thulium	● Tm	● 58.9	● tungsten	● W	● 59.7	● ytterbium	● Yb
● 60.7	● rhenium	● Re	● 61.6	● lutecium	● Lu	● 62.5	● osmium	● Os
● 63.6	● hafnium	● Hf	● 64.3	● iridium	● Ir	● 65.6	● tantalum	● Ta
● 66.2	● platinum	● Pt	● 67.6	● tungsten	● W	● 68.2	● gold	● Au
● 69.7	● rhenium	● Re	● 70.2	● mercury	● Hg	● 71.8	● osmium	● Os
● 72.2	● thallium	● Tl	● 73.9	● iridium	● Ir	● 74.2	● lead	● Pb
● 76.1	● platinum	● Pt	● 78.4	● gold	● Au	● 80.7	● mercury	● Hg
● 83.0	● thallium	● Tl	● 85.4	● lead	● Pb			

## 8: Appendix D

### Chemical composition of NIST samples

#### Non-certified value standards

Non-certified values are provided for information only. All non-certified values are listed in parentheses. Standards for many elements do not have certified values. This occurs because (1) some bias is suspected in one or more of the methods used for certification, or (2) two independent methods of certification are not available. As more data becomes available, certified-value standards will likely become available for some of these elements.

**Table D-1. High standard certified values**

● by percent weight			● by parts per million		
● Element	● percent weight	● range ±	● Element	● micrograms/g	● range ±
● Aluminum	● 6.44	● 0.08	● Antimony	● 38.4	● 3.0
● Calcium	● 1.25	● 0.03	● Arsenic	● 626	● 38
● Iron	● 3.38	● 0.10	● Barium	● 707	● 51
● Magnesium	● 0.853	● 0.042	● Cadmium	● 21.8	● 0.2
● Manganese	● 1.01	● 0.04	● Copper	● 2,950	● 130
● Phosphorus	● 0.106	● 0.015	● Lead	● 5,532	● 80
● Potassium	● 2.11	● 0.11	● Mercury	● 32.6	● 1.8
● Silicon	● 28.97	● 0.18	● Nickel	● 14.3	● 1.0
● Sodium	● 1.14	● 0.06	● Silver	● 35.3	● 1.5
● Sulfur	● 0.240	● 0.006	● Vanadium	● 76.6	● 2.3
● Titanium	● 0.283	● 0.010	● Zinc	● 6952	● 91

**Table D-2. High standard non-certified values**

● by percent weight		● by parts per million	
● Element	● percent weight	● Element	● micrograms/g
● Carbon	● (3)	● Bromine	● (6)
		● Cerium	● (57)
		● Cesium	● (107)
		● Chromium	● (39)
		● Cobalt	● (10)
		● Dysprosium	● (5.4)
		● Europium	● (1)
		● Gallium	● (34)
		● Gold	● (0.6)
		● Hafnium	● (3.2)
		● Holmium	● (0.6)
		● Indium	● (5.1)
		● Lanthanum	● (34)
		● Molybdenum	● (19)
		● Neodymium	● (23)
		● Rubidium	● (2)
		● Samarium	● (7.8)
		● Scandium	● (8.7)
		● Strontium	● (240)
		● Thallium	● (1.3)
		● Thorium	● (13)
		● Tungsten	● (93)
		● Uranium	● (25)
		● Ytterbium	● (1.3)
		● Yttrium	● (23)

**Table D-3. Low standard certified values**

Titanium

● by percent weight			● by parts per million		
● Element	● percent weight	● range ±	● Element	● micrograms/g	● range ±
● Aluminum	● 7.50	● 0.06	● Antimony	● 7.9	● 0.6
● Calcium	● 1.89	● 0.05	● Arsenic	● 17.7	● 0.8
● Iron	● 3.50	● 0.11	● Barium	● 968	● 40
● Magnesium	● 1.51	● 0.05	● Cadmium	● 0.38	● 0.01

● Phosphorus	● 0.062	● 0.005	● Chromium	● 130	● 4
● Potassium	● 2.03	● .06	● Cobalt	● 13.4	● 0.7
● Silicon	● 29.66	● 0.23	● Copper	● 34.6	● 0.7
● Sodium	● 1.16	● 0.03	● Lead	● 18.9	● 0.5
● Sulfur	● 0.089	● 0.002	● Manganese	● 538	● 17
● .342	● 0.024	● Mercury	● 1.40	● 0.08	
		● Nickel	● 88		
		● Selenium	● 1.57	● 0.08	
		● Silver	● 0.41	● 0.03	
		● Strontium	● 231	● 2	
		● Thallium	● 0.74	● 0.05	
		● Vanadium	● 112	● 5	
		● Zinc	● 106	● 3	

Table D-4. Low standard non-certified values

● by percent weight		● by parts per million	
● Element	● percent weight	● Element	● micrograms/g
● Carbon	● (1.2)	● Cerium	● (42)
		● Cesium	● (5.3)
		● Dysprosium	● (3.5)
		● Europium	● (0.9)
		● Gallium	● (14)
		● Gold	● (0.3)
		● Hafnium	● (3.7)
		● Holmium	● (0.54)
		● Iodine	● (5)
		● Lanthanum	● (23)
		● Molybdenum	● (2.0)
		● Neodymium	● (19)
		● Rubidium	● (96)
		● Samarium	● (3.8)
		● Scandium	● (12)
		● Thorium	● (11)
		● Tungsten	● (2)
		● Uranium	● (3)
		● Ytterbium	● (1.6)
		● Yttrium	● (18)
		● Zirconium	● (160)

**Table D-5. Medium standard certified values**

● by percent weight			● by parts per million		
● Element	● percent weight	● range ±	● Element	● micrograms/g	● range ±
● Aluminum	● 6.53	● 0.09	● Antimony	● 19.4	● 1.8
● Calcium	● 2.88	● 0.08	● Arsenic	● 105	● 8
● Iron	● 2.89	● 0.06	● Barium	● 726	● 38
● Magnesium	● 1.05	● 0.03	● Cadmium	● 41.70	● 0.25
● Phosphorus	● 0.086	● 0.007	● Copper	● 114	● 2
● Potassium	● 2.45	● 0.08	● Lead	● 1162	● 31
● Silicon	● 30.44	● 0.19	● Manganese	● 638	● 28
● Sodium	● 1.14	● 0.03	● Mercury	● 6.25	● 0.19
● Sulfur	● 0.042	● 0.001	● Nickel	● 20.6	● 1.1
● Titanium	● 0.306	● 0.023	● Selenium	● 1.52	● 0.14
			● Silver	● 4.63	● 0.39
			● Strontium	● 245.3	● 0.7
			● Thallium	● 2.47	● 0.15
			● Vanadium	● 81.6	● 2.9
			● Zinc	● 350.4	● 4.8

**Table D-6. Medium standard non-certified values**

● by percent weight		● by parts per million	
● Element	● percent weight	● Element	● micrograms/g
● Carbon	● (2)	● Bromine	● (5)
		● Cerium	● (69)
		● Cesium	● (6.1)
		● Chromium	● (47)
		● Cobalt	● (10)
		● Dysprosium	● (5.6)
		● Europium	● (1.1)
		● Gallium	● (15)
		● Gold	● (.03)
		● Hafnium	● (7.3)
		● Holmium	● (1)
		● Indium	● (1.1)
		● Iodine	● (3)
		● Lanthanum	● (40)
		● Molybdenum	● (1.6)
		● Neodymium	● (31)
		● Rubidium	● (110)

- Samarium ● (5.9)
- Scandium ● (9)
- Thorium ● (14)
- Tungsten ● (3)
- Uranium ● (2.6)
- Ytterbium ● (2.7)
- Yttrium ● (25)
- Zirconium ● (230)

## 8: Appendix E

### Detection limits

#### Soil Measurement Detection limits (in ppm)

● 60 Src Seconds	● Low NIST (2709)	● Silicon Dioxide
● molybdenum	● 25	● 20
● zirconium	● 35	● 20
● strontium	● 60	● 25
● rubidium	● 70	● 30
● lead	● 80	● 45
● arsenic	● 275	● 220
● zinc	● 130	● 90
● copper	● 230	● 150
● nickel	● 630	● 285
● cobalt	● 1,500	● 390
● iron	● 1,000	● 840
● manganese	● 4,600	● 1,000
● chromium	● 5,400	● 1,400

#### Filter Measurements

#### Detection limits (in micrograms/filter)

● 60 Src Seconds	● 37 mm CE	● 25 mm CE	● Glass Fiber
● molybdenum	● <6	● 3	● -
● zirconium	● <6	● 3	● -
● strontium	● <7	● 3	● -
● rubidium	● <7	● 3	● -
● lead	● 7	● 4	● 15
● arsenic	● 28	● 14	● -
● zinc	● 6	● 3	● -

● copper	● 7	● 4	● -
● nickel	● 10	● 5	● -
● cobalt	● <20	● 8	● -
● iron	● 25	● 13	● -
● manganese	● <50	● 20	● -
● chromium	● 40	● 20	● -

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