User Manual

DRAWELL
Artist of Science

Please read operating manual before installation and operation.

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TrueX handheld XRF analyzer

operation guide

Version：1.0

Preamble

Thank you for purchasing TrueX X-ray Fluorescence Spectrometer.

This is an Energy Dispersive X-ray Fluorescence Spectrometer.

By using TrueX XRF， you can perform a fast, accurate and non-destructive qualitative and quantitative analysis of the elements from (12Mg) to (92U) in solid, powder and liquid samples.

This instrument integrates a variety of techniques: vacuum technology, high voltage technology, precision processing technology and embedded technology. Please read this manual carefully to conduct a fast and accurate analysis.

Guarantee

Thank you for purchasing TrueX X-ray Fluorescence Spectrometer.

Drawell offers the following guarantee to the equipment you have purchased from us.

1. Warranty time

All parts are warranted for 12 months after the date the customer received the apparatus.

2. Warranty

Any failure arisen during the warranty period will be addressed by **LDrawell**, and the maintenance and replacement parts are provided with no charge.

3. Warranty does not include the following provisions:

1） Misuse.

2） Repair or change done by non- **Drawell/ Drawell**-authorized companies.

3） Failure caused by other products

4） Damage resulted from use in harsh environments, such as high temperatures, high humidity, corrosive gases, explosive gases or strong

vibration.

5） Fire, earthquake or other natural disasters.

6） Severe damage due to vibration or drop after installation.

7） Consumables or the equivalents of consumable parts.

Letter to the User

（1）The copyright of this manual is reserved by **Drawell**.

Therefore, in the absence of **Drawell** 's permission, any part of this manual shall not be reproduced or copied.

（2）The contents of this manual are subject to change without prior notification.

（3）**Drawell** is not responsible for any problems caused by users who do not observe the instructions in this manual.

（4）WIN and WINNT are trademarks or registered trademarks of Microsoft in the United States or other countries. Other company and product names in this manual are registered trademark of the related companies.

Preventive Measures for X-ray Generator

The instrument produces X-ray radiation only at the front of the instrument, i.e., the test window, and in normal circumstances, our users are protected from exposure to X-ray irradiation by the metal shield. The user must use the instrument correctly; otherwise, they will possibly be exposed to X-ray irradiation. Before or during the operation, do not remove any safety lines or make any changes that could interfere with the safe operation.

Be careful of ionizing radiation

Precautions in use

1. Do not use this instrument in places detected with explosive gas or hazardous atmosphere; otherwise, it will cause an explosion.

2. Do not use this instrument in a harmful environment.

3. Without the permission of **Drawell** engineers, do not remove the case of the apparatus. Do not remove it.

If you disregard the instructions in this manual and remove it, **Drawell** takes no responsibility in guaranteeing the safety and reliable performance of the equipment.

4. Keep the surface of the instrument clean.

5. If you use this instrument very frequently (more than 50 samples a day on average), you need to make a thorough check of the instrument once every 2-3 years.

If you need more detailed information, please contact **Drawell**.

CONTENTS

Chapter 1 Introduction

1.1 Description of TrueX system

1.1.1 What Is TrueX?

The TrueX is a handheld enregy dispersive X-Ray fluorescence spectrometer, generally referred to as an XRF analyzer. A complete TrueX package consists of:

Handheld analyzer using an integrated group of instrument components that are sealed in an ergonomically designed, light-weight body. They include:

- ◆ Controller
- ◆ Color touchscreen(ergonomically mounted interactive display)
- ◆ Choice of detectors(PiN or SDD) to meet wide-ranging application goals

Coordinated with these robust characteristics, the instrument's key feature is Truex's proprietary control, data acquisition, and analysis software with customer configured options.

Additional accessoris (standard and optional) include:

- ◆ Li-lon batteries (2) - {Standard}
- ◆ Batterie charging station - {Standard}
- ◆ Rugged waterproof carry case - {Standard}
- ◆ Portable test stand to create a TrueX workstation - {Optional}

1.1.2 What Does TrueX Do?

The expanded TrueX family of handheld XRF instruments delivers fast and precise idenfication and analysis for elements form magnesium to uranium (Mg to U) depending on the selected model. A weatherproof dustproof ultra rugged design including an integral heat sink permits users to conduct diverse analysis testing under severe operating conditions. An added convenience feature for field use is battery"Hot Swapping"

Applications

The analyzer gives accurate chemical analysis for commercial or industrial areas, such as:

Positive Material Identification	Scrap Processing
Mining and Exploration	Environmental Testing
Consumer Safety	Light Element & Aluminum Analysis

1.2 Inspection

Use this procedure:

a. Remove the carry case from the shipping cartons.
b. Open the carry case,Remove the shipping documentation.
c. Verify that all the parts and accessories are included.
d. Verify that no visible damage occurred during shipping.

WARNING

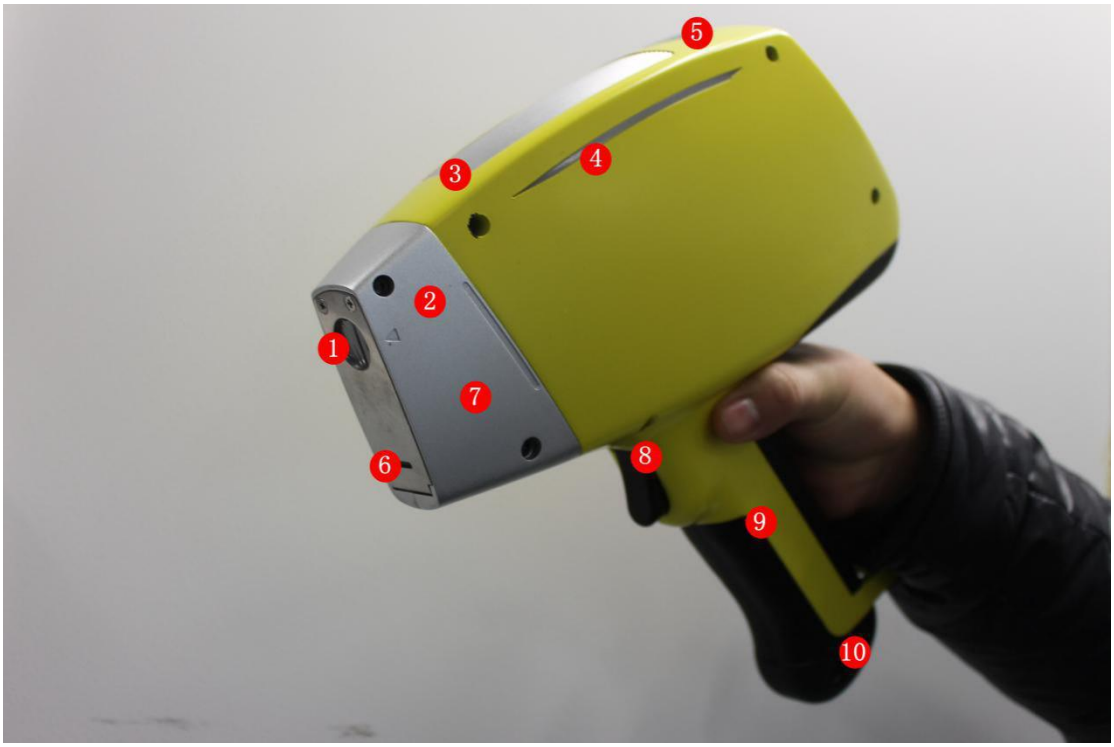
If there is damage to any of the components,DO NOT attempt to use the instrument.Immediately contact Drawell Customer Support :+86 0512 69376270 Or call your local distributor.

1.3 Tour of the TrueX Package

1. Carry Case
2. Docking Station
3. TrueX Analyzer
4. Cal Check Coupon
5. AC Power Adapter
6. USB Cable
7. Batteries
8. Extra Batteries

1.4 Tour of Instrument

1.4.1 Handheld XRF Analyzer



1. Measurement Window
2. Detector
3. Heat Sink

4. Flash LED
5. I/O(Power)Switch
6. DoubleBeam Window
7. Probe
8. Trigger
9. Handle-Non-Slip Rubber Cover
10. Battery Boot
11. USB data interface
12. Stand Control Interface
13. Adapter Interface
14. Touchscreen for User Interface

1.4.2 Battery charging station

1. Charging station working indicator light
2. Battery charging interface
3. Heat sink window
4. Adapter interface

chart : Battery charging interface

1.4.3 Accessories-List the Standard and Optional Accessories

Standard	**Optional**
◆ batteries	◆ stand
◆ TrueX Docking Station	
◆ USB Cable	
◆ Cal Check Coupon	

1.4.4 STANDARD Accessories

◆ Batteries

Each TrueX contains two lithium batteries, This is the standard configuration, The other end of the battery charging electrode is provided with a miniature display, which can directly display the battery power.

◆ Universal adapter

This adapter is a universal adapter, which can be used for direct charging of the instrument, and can also be charged through the charging station. The input voltage of the adapter is 100-240VAC and the output voltage is 9V.

◆ USB Cable

The test data in the instrument can be exported and printed on the USB data line.

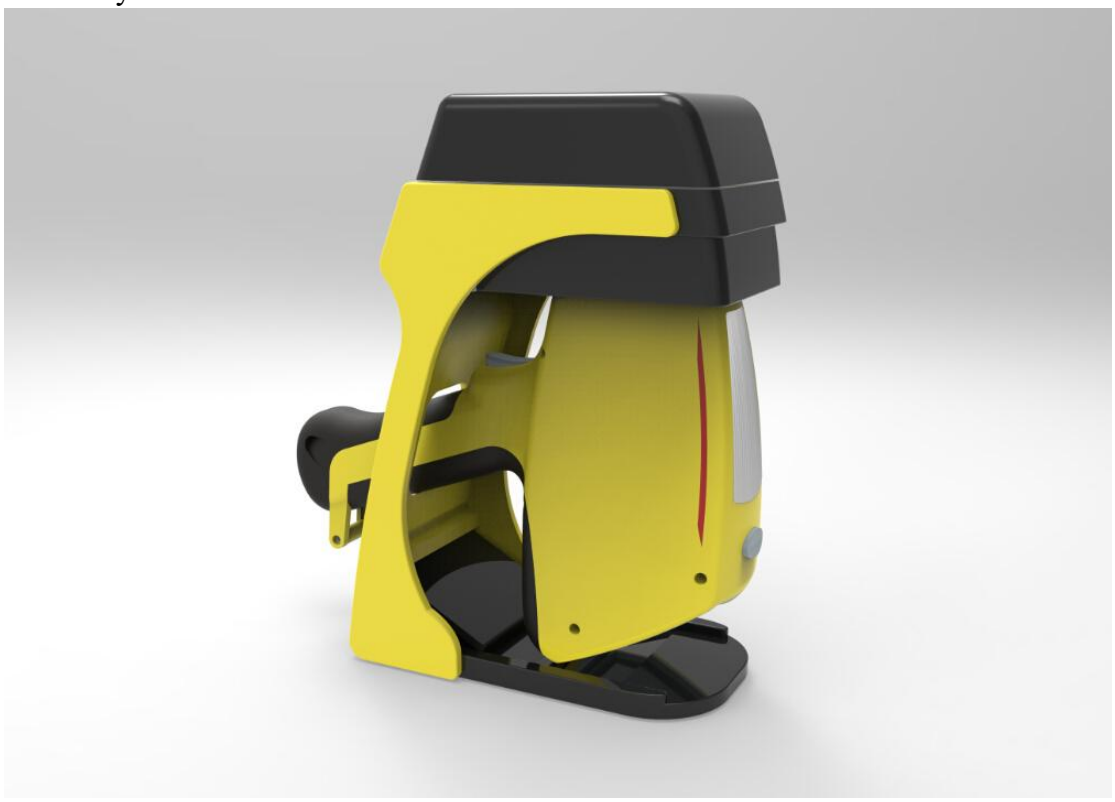
◆ Cal Check Coupon

Standard calibration blocks provide a test standard for testing: Before the instrument work, test the standard block, using the standard data and test data to do the comparison, in order to determine whether the instrument is in the best condition.

1.5 OPTIONAL Accessories

◆ TrueX test stand

The TrueX portable X fluorescence spectrometer is installed on the test stand, which can meet the testing work of the instrument in the laboratory.



Chapter 2 Applications

2.1 TrueX Analyzers preview

TrueX analyzer is a high-performance, high accuracy and easy-to-carry portable X-ray Fluorescence Spectrometer.

2.2 Instrument started

Prepare your TrueX Analyzers. Press the power switch for 3 seconds. Then the instrument is turned on and the power light becomes green.

2.2.1 Basic Operations

Load cell, light press switch for 3 seconds >> Load data >> Warning confirmation >> Enter password 1234 >> Click OK

The Logon Screen will be replaced by a Warning Screen, advising you that this analyzer produces radiation when the lights are flashing. You must acknowledge this warning by selecting the “Yes” button before logging on. Selecting the “No” button will shut your analyzer.

After selecting the “Yes” button, the Virtual Numeric Keypad becomes available for you to log onto the analyzer.

Select your 4 digit security code, followed by the enter (OK) key. The temporary password assigned by default is 1-2-3-4, followed by the “OK” key. If you enter an incorrect number, you can use the “Clear” key to clear everything. After you have completed the log on procedure, the Test Main Menu will appear.

Your Analyzers can be stored and operated in temperature ranging from-10 ℃ to 50 ℃. Temperature higher or lower than the limit may cause damage to your Analyzer. We recommend that you do not try to test in an inappropriate environment. If your instrument shows signs of overheating, e.g., being too hot to handle, please cool it down before resuming the test.

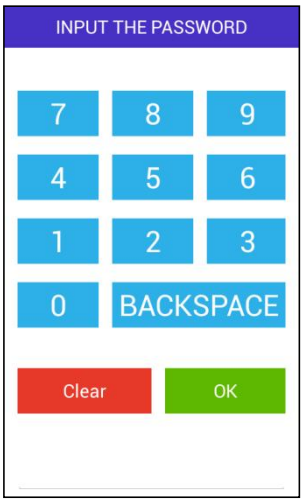


Figure. virtual digital keyboard

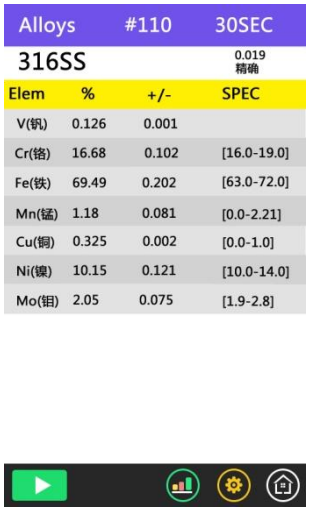
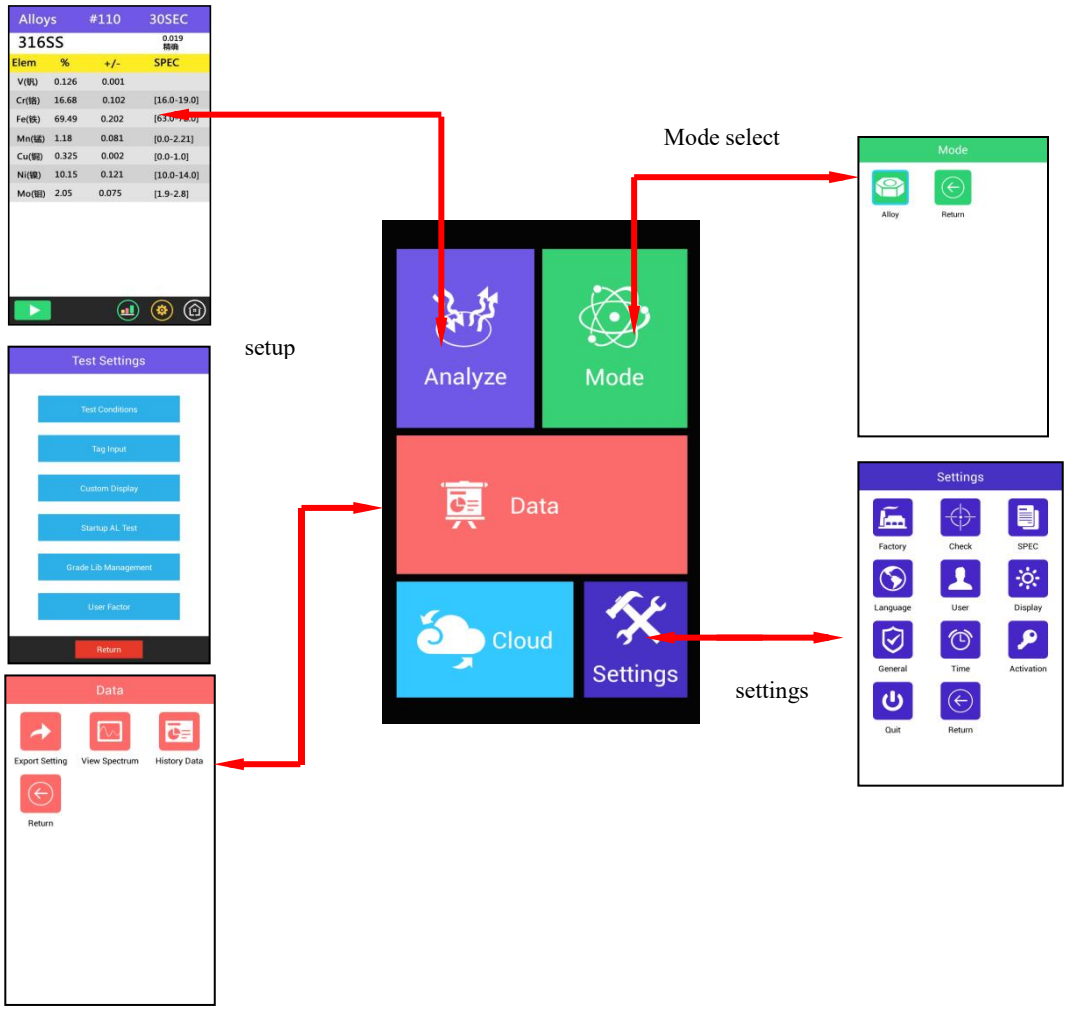


Figure. the test menu

SNAPSHOT of TrueX's User Interface

The TrueX's user interface is introduced by the startup **Radiation Safety** and **Initialization** screens.

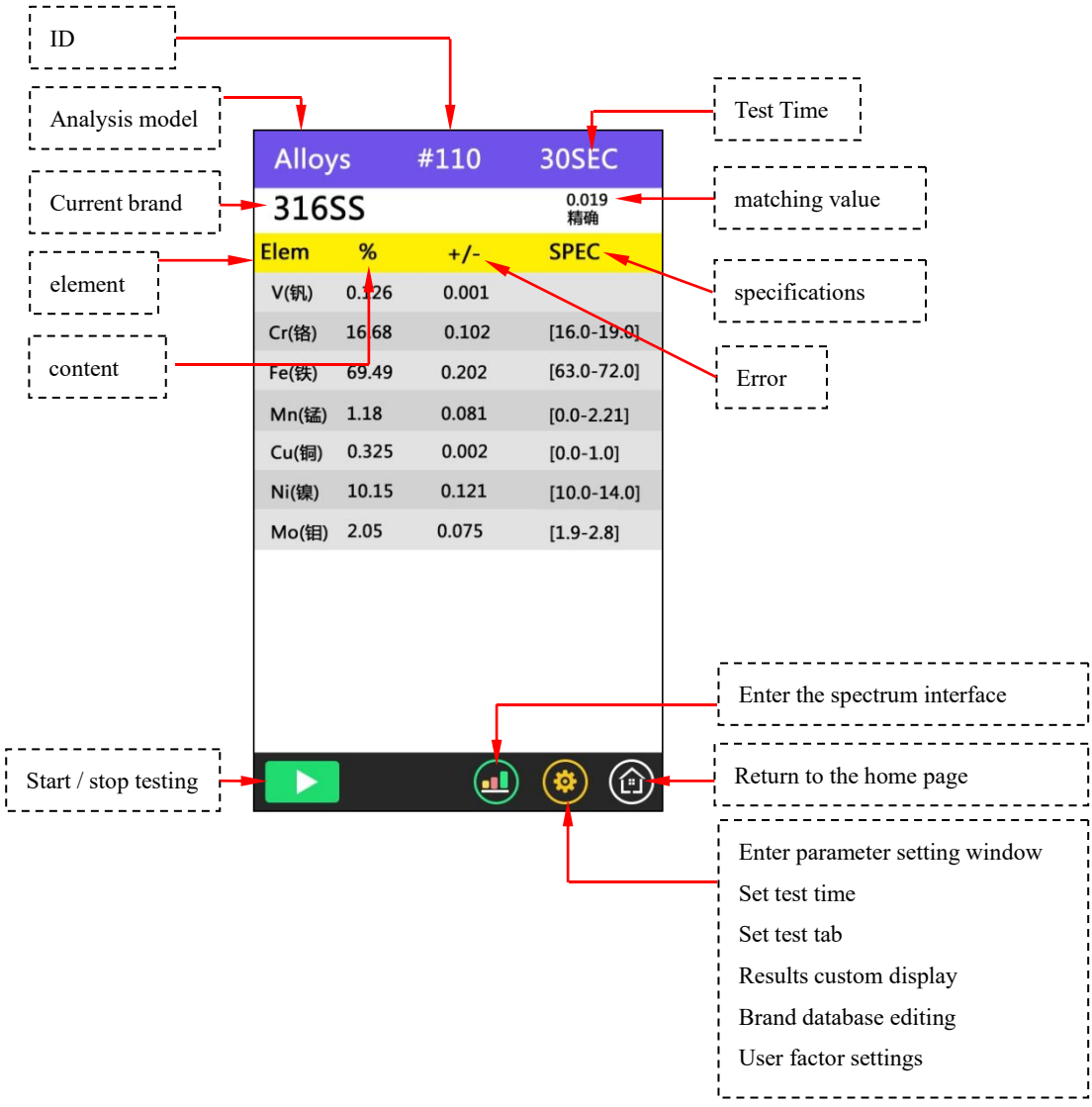
Main operations then revolve around the **Home** screen.



2.3 Analyze

Test option is the main channel for TrueX analyze, Select the analyze into the analysis interface. Test interface, the default selection the last analysis mode

The sample cover the front window when analyzing, Maintain proper posture, Click the Test button or pull the trigger to start the test. Hold the trigger starts the test, Release the trigger end of the test. The instrument will display the test results, The results For each test, the instrument will automatically save. The stored test data generally contain the following information: test time, alloy grades, matching value, element name, content, etc..



Test Time： Time between start testing to end test

Alloy grades： The instrument will automatically determine the sample belongs alloy grades according to the measurement results of each element content range,If the instrument is no corresponding standard grades library grades, the instrument will be displayed as "No Match". Instrument Standard Grade library presets are stored more than 300 ASTM standard alloy grades.

Match：Indicates that the sample comply with the degree of matching standard grades. This value is smaller the better match. In general: 0-2 indicates exact match, 2-4 indicates a good match, Greater than 4 indicates not match.

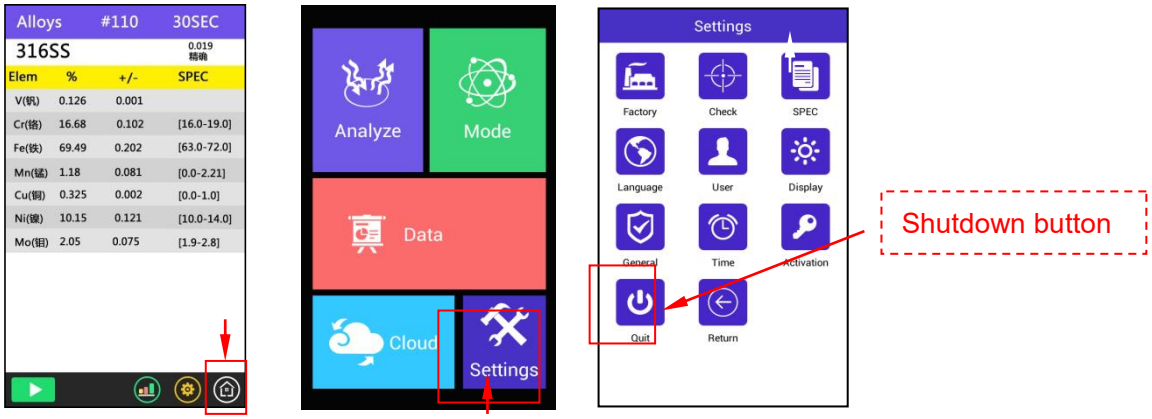
Element content: the content of the test results showed that the main component elements。

Error: Analysis of error is ± 2δ instrument displays error, that is, 95% confidence interval.

When you need to exit the test interface, simply click on the bottom right of the HOME button to complete. (If you are testing, then click on this button is invalid)

- The distance between the sample and the detection window, do not have the space；
- During the test, do not shake the instrument or sample
- When testing samples， human tissue should stay away from the detection window, avoid the X-ray radiation。
- When the left and right indicator is blinking, the X-ray tube is working。

■ **Shutdown**：



Click on the Home button >> Click the settings button >> Click the Quit button >> Click to confirm the shutdown button

Note: when the instrument is closed, the battery should be taken out. Put the instrument in the suitcase and keep properly.

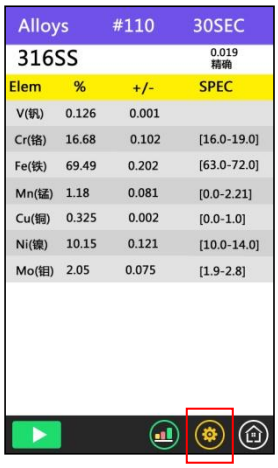
When the need to exit the Test screen, simply click on the HOME button. (If you are testing, this button clicked is invalid)

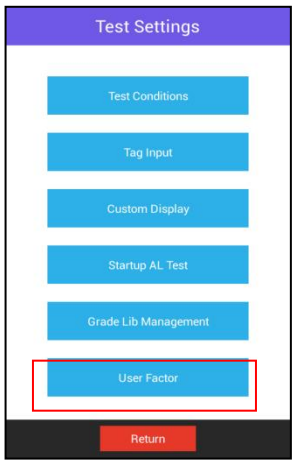
2.4 User Factor Instructions

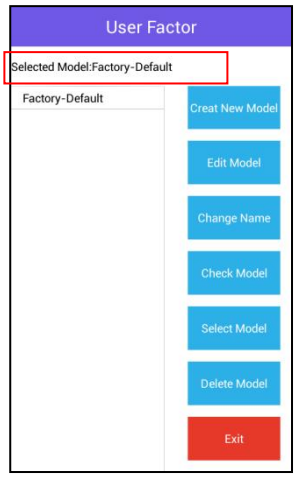
The FP software applied by TrueX equipment can calibrate most co-exist matrix effect, but TrueX analyzer still can not analyze elements lighter than S, as light elment

analysis will affect other elements test. Besides, some elements oxide will cause othe r elements test deviation. Under many condition, this deviation is very small, even the results without calibration are accurate enough, especially for the tests purely for obs erving which elements included. If more accurate data are required, then TrueX equip ment supply the slope/intercept user concerned elements can do calibration automatic ally to improve data quality. It can calibrate single elements also mutiple elements. Th e calibration factors are independent, so will not affect each other mutually.

Before regular test, you should first set deviation allowage scope. And use other methor, e.g.laboratory method to do the sample test, then use TrueX analyzer to meas ure. If the result already meets application demand, then the device does not need to c alibrate. If calibration is essential, then you need to establish calibration factor. The lo cal landscape feature changing requires re-check results whether they are in the scope of allowed deviation.







2.4.1 Process for establishing correction factors

Establishing correction factors need to be measured at least 5 sample.(The more the sample, the better, If it is not enough, there are no less than three），The concerned elements must have a gradient in the content. Increasing the number of measured samples can increase the accuracy of the measurement.

The basic procedure to establish the correction factors are as follows:

1. Select Factory-Default factor
2. The samples were measured for at least 80 seconds.
3. The correction factor is determined by the sample of known content。
4. Create a new model, In the new model, Put the correction factor into element corresponding item
5. Select the new model as default model.

2.4.2 Calculating a correction factor

For each element, For each element, we have drawn on the figure below standard content ratio (by mass fraction representation)

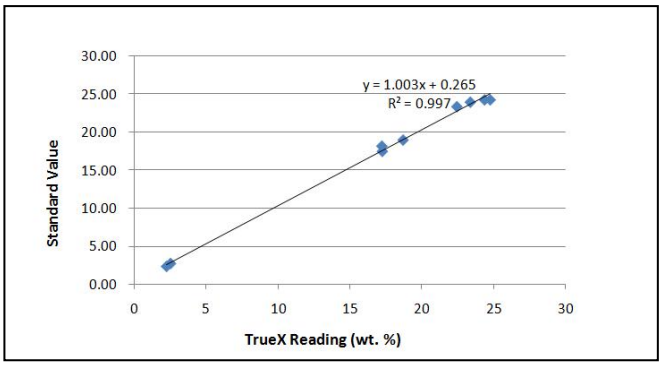


Fig 1. The correction factor linear regression diagram

The slope and intercept should be calculated by linear regression. Y=mx+b，Formula m is the slope, b is the intercept. Then m and b directly enter a new model. The correction factor can be use EXCEL to calculate the linear regression。y value represents laboratory data, x value represents TrueX results.

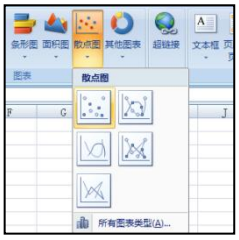
Examples

a) The measured value and the true value correspondence, Recorded in the EXCEL table, Note that the measurement first, the real value after, As shown fig3.

Cu	TrueX	Standard
1#	17. 242	17. 50
2#	17. 212	18. 20
3#	18. 689	19. 00
4#	24. 747	24. 30
5#	24. 359	24. 30
6#	22. 43	23. 40
7#	23. 369	24. 00
8#	2. 515	2. 71
9#	2. 236	2. 32

Fig 3

b) Use the mouse to select all data, Under the Insert menu, select Scatter Plot, Figure 4, Select the first to give Fig 5.



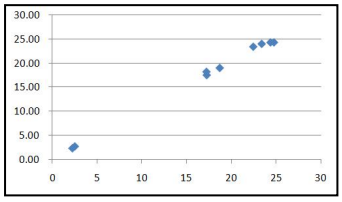


Fig 4

Fig 5

c) Select the data on the coordinates,Right-click, Choose: Add Trendline, The screen will display the dialog box, After "Display formula" check, Press Close to obtain the Fig 7。

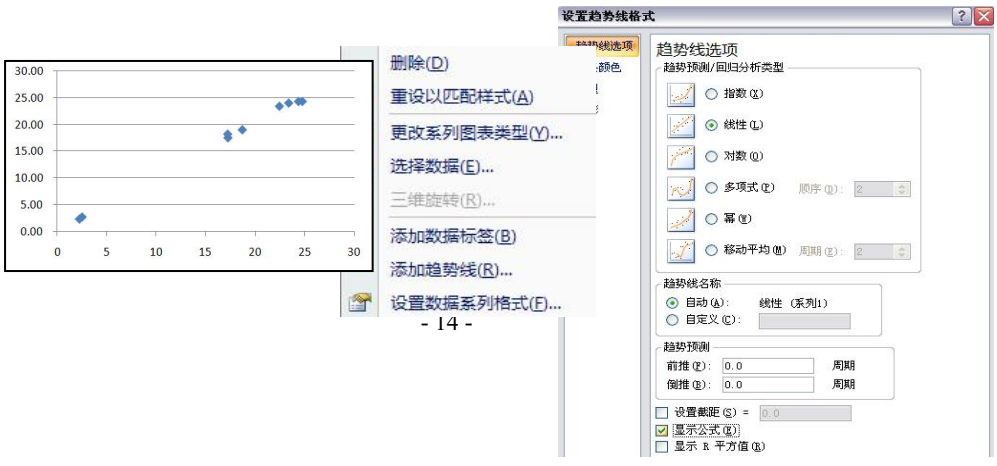


Fig 6

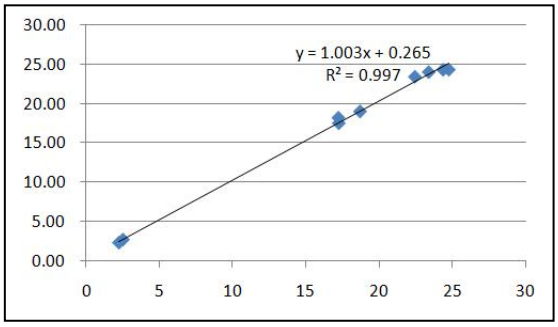


Fig 7

d) According to the formula in Fig. 7, y = 1.003x + 0.265，a correction coefficient can be obtained . 1.003 is the slope, 0.265 is the intercept.

e) Add the slope and intercept values to "turkey mining" model elements Cu, Fig 8.

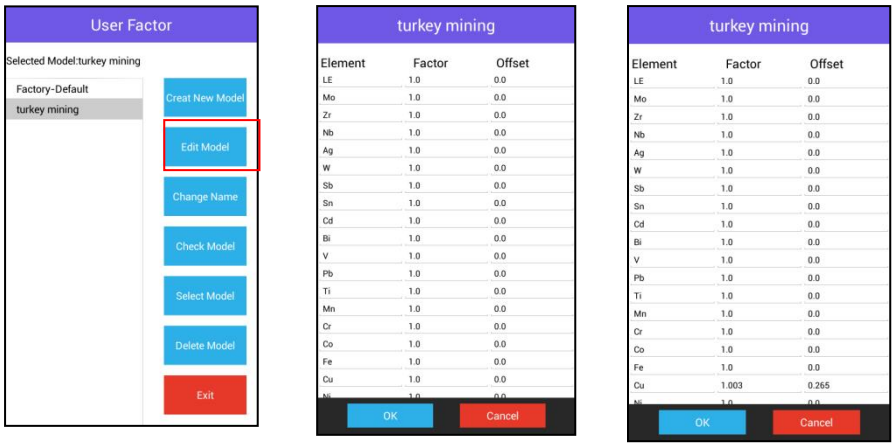


Fig 8

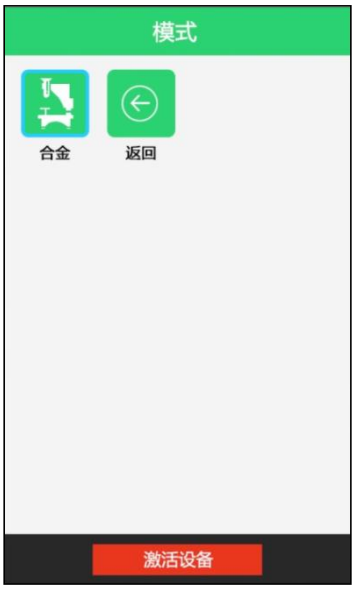
Note1: You can not add intercept negative number. When it is negative, instead of using 0, The same method, add the correction coefficient for other elements.

Note2: When you need to create another correction coefficient, First should be select the factory-Default, And then Test the standard sample, Otherwise, the result will be a great error, As above, And pay attention to create a different model.

2.3.2 "Mode" option

在系统主界面选择模式选项即可进入模式界面，列出可供使用的工作曲线。显示的项目取决于用户订购的仪器配置，如有需要请联系本公司。在该界面用户可以选择一条曲线设置为默认曲线。

Select the mode option in system main interface to enter to the mode interface, lists available work curve. The display items depend on the subscription instrument configuration, if necessary, please contact the company. In this interface, the user can select a curve as the default curve.



点击“合金”可以进入合金测试菜单。
点击“ROHS”可以进入 ROHS 测试菜单。
点击“矿石”可以进入矿石测试菜单。
点击“土壤”可以进入土壤测试菜单。

Chapter 3 Maintenance Guide

3.1 Maintenance, cleaning and repair

To ensure reliability, please keep the instrument clean, especially the test window in front of the instrument. Please use cotton or soft cloth to clean the test window and the instrument surface. Washing medicine is forbidden. Don’t put the instrument into the water. If the test window has any abrasion, damage or pollution, contact Drawell service center for further advice.

Attention: All the maintenance should be authorized by Drawell

except for surface cleaning and changing of test window membrane. Don't try to repair the instrument by yourself. Drawell won't be responsible for any damage caused by your own repair and the warranty time prescribed on the contract will be invalid at that time.

3.2 Change test window membrane

1. Disassemble the panel in front of the test window.
2. Remove old membrane.
3. Clean the back part of the panel and install the new membrane.
4. Adjust the position of the screw.
5. Fix the screw into the hole but not too tight.

3.3 Storage & Transportation

3.3.1 Storage

Regulations in nearly all countries will require that you store your analyzer in a secured place to prevent access, use, and/or removal by unauthorized individuals. Storage requirements will vary from country to country, particularly with regard to storage at temporary job sites or away from your primary storage location, such as hotels, motels and in vehicles. You should contact your local Radiation Control Authority to identify the specific storage requirements in your jurisdiction.

3.3.2 Transportation

There are no radiation regulations released by US Department of Transportation (DOT) or International Air Transport Association (IATA) regarding shipping of the Beethor X3G Series analyzer. It is recommended that you ship the Beethor X3G Series in its carrying case and add an over-pack to protect the sophisticated parts inside the analyzer.

Do NOT ship the analyzer with the battery pack connected to the analyzer!

Chapter 4 Radiation and General Safety

This chapter covers topics related to radiation safety and general safety when using a TrueX analyzer. All operators of the TrueX should be familiar with the instructions provided in this chapter in order to handle the TrueX in a safe manner. In

addition to reading the information presented here, Drawell recommends that instrument users participate in a radiation safety and operational training class offered by Drawell.

WARNING: treat radiation with respect. Do not hold your analyzer near the window during testing. Never point your analyzer at yourself or anyone else when the shutter is open.

4.1 Radiation Protection Basics

The TrueX analyzer contains an x-ray tube which emits radiation only when the user turns the x-ray tube on. When the x-ray tube is on and the shutter is open, as during a measurement, the analyzer emits a directed radiation beam. Reasonable effort should be made to maintain exposures to radiation as far below dose limits as is practical. This is known as the ALARA (As Low as Reasonably Achievable) principle. For any given source of radiation, three factors will help minimize your radiation exposure: Time, Distance, and Shielding.

4.1.1 Time

The longer you are exposed to a source of radiation, the longer the radiation is able to interact in your body and the greater the dose you receive. Dose increases in direct proportion to length of exposure.

4.1.2 Distance

The closer you are to a source of radiation, the more radiation strikes you. Based on geometry alone, dose increases and decreases with an inverse-squared relation to your distance from the source of radiation (additional dose rate reduction comes from air attenuation). For example, the radiation dose one foot from a source is nine times greater than the dose three feet from the source. Remember to keep your hands and all body parts away from the front end of the analyzer when the shutter is open to minimize your exposure.

4.1.3 Shielding

Shielding is any material that is placed between you and the radiation source. The more material between you and the source, or the denser the material, the less you will be exposed to that radiation. Supplied or optional test stands are an additional source of shielding for analysis. A backscatter shield accessory is also available and may be appropriate in some applications.

4.2 Exposure to Radiation

Exposure to Radiation Human dose to radiation is typically measured in rem, or in one-thousandths of a rem, called millirem (mrem), 1 rem = 1000 mrem. Another unit of dose is the Sievert (Sv), 1 Sv = 100 rem. The allowable limit for occupational exposure in the U.S (and many countries internationally) is 5,000 mrem/year (50 mSv/year) for deep (penetrating) dose and 50,000 mrem/year (500 mSv/year) for shallow (i.e., skin) dose or dose to extremities. Deep, shallow, and extremity exposure from a properly used the Beethor X3G Series analyzer should be less than 200 mrem per year, (2.0 mSv per year) even if the analyzer is used as much as 2,000 hours per year, with the shutter open continuously. The only anticipated exceptions to the 200 mrem maximum annual dose are: 1) routine and frequent analysis of plastic samples without use of a test stand, backscatter shield, or similar additional protective measures, or 2) improper use where a part of the body is in the primary beam path. NEVER OPERATE THE DEVICE WITH A PART OF YOUR BODY IN THE PRIMARY BEAM PATH OR WITH THE PRIMARY BEAM PATH DIRECTED AT ANYONE ELSE. Also, consider the use of protective accessories such as a shielded test stand or backscatter shield (or equivalent) when performing routine and/or frequent analysis of any of the following:

- Plastic (or similarly low density) samples,
- Thin samples (such as foils, circuit boards, and wires)
- Samples that is smaller than the analysis window.

4.3 Monitoring your radiation exposure

Individuals can be monitored for the radiation dose they receive by use of radiation dosimetry devices (dosimeters). Monitoring dose using a dosimeter can be a way of identifying improper use and at the same time demonstrating proper use. In some locations, dosimetry is required by regulations and in others it is optional. It is normally required when the user could reasonably be expected to receive in excess of 10% of the annual dose limit. Beethor recommends that you determine and obey the local regulatory requirements concerning radiation monitoring of occupational workers.

4.4 Pregnancy and Radiation Exposure

International guidance documents (e.g., ICRP Publication 60 and NCRP Publication 116*) recommend that the radiation dose to the embryo/fetus of a pregnant woman should not exceed a total of 500 mrem (10% of normal radiation worker limit) during the gestation period. While this dose limit exceeds the dose limit to a trained operator, pregnant workers may want to take special precautions to reduce their exposure to radiation. For more information see the U.S. NRC Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure" which can be found on the

resource CD.

* The International Commission on Radiological Protection, ICRP, is an independent Registered Charity, established to advance for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionizing radiation.

* The National Council on Radiation Protection and Measurements (NCRP) was chartered by the U.S. Congress in 1964 as the National Council on Radiation Protection and Measurements.

4.5 How to Use the TrueX Analyzer Safely

The TrueX analyzer is designed to be safe to operate provided that it is used in accordance with manufacturers' instructions. Under conditions of normal use, monitored operators seldom receive a measurable dose and have not been known to receive in excess of 10% of the annual occupational dose limits (a criterion that would require monitoring under regulation in the U.S.). In addition to proper use of the Beethor X3G Series, it is recommended that you follow these precautions to ensure your safety and the safety of those around you.

4.5.1 Know where the beam is

The primary beam is a directed beam out of the front of the analyzer that can have high dose rates. The secondary beam, or scattered beam, has much lower dose rates.

4.5.2 The Shutter-Open Indicator Lights

When the lights are flashing, the primary beam is on, the shutter is open, and radiation is being emitted from the front of the analyzer. (This does not include the brief flash of the lights when first turning the analyzer on.)

4.5.3 Handle and Use with Respect

Avoid holding the front of the analyzer when the x-ray tube is energized and the shutter is open. Never point the instrument at yourself or anyone else when the shutter is open and the x-ray tube is energized. Never look into the path of the primary beam.

4.5.4 Follow a Radiation Protection Program

Your organization should establish, document, and follow a Radiation Protection Program.

4.5.5 Take Proper Care of your TrueX Analyzer

Keeping your analyzer maintained in good condition will help minimize the risk of accidental exposure. Mechanical malfunction of the shutter can be avoided by maintaining the Kapton window, as described in the User Guide. This prevents foreign objects from entering your Beethor X3G Series.

4.5.6 Avoid Over-Exposures

Direct contact with the window could result in overexposures in the times indicated in Table 0-4 below.

4.5.7 Safe Handling of Samples

As mentioned many times in this chapter, never place any part of your body in the path of the X-ray beam. There is always a safe way to handle samples whether they are small, irregularly shaped, or of low density. Never look into the path of the primary beam.

Small Samples

A small sample would be any sample that is smaller than the Kapton window. Small samples present a unique risk because they don't block the entire beam path. The difficulty with placing small samples down on a work surface to analyze them is that you may get readings from the work surface that interfere with analytical results. A test stand is an effective way of analyzing small samples accurately and safely. Never hold samples during analysis or look into the path of the primary beam.

Irregularly Shaped Samples

Irregularly shaped samples may not allow the proximity button to be depressed, or they may not entirely cover the primary beam and cause additional scattering. A back scatter shield is a safe way of reducing your radiation exposure while effectively analyzing an irregularly shaped sample.

Low Density Materials (such as plastics)

X-rays are attenuated more through denser materials and less through low density materials such as plastic. This causes higher dose rates in the scattered radiation. If you are frequently handling low density samples, you should consider the use of test stands, backscatter shields, or the equivalent.

4.6 Emergency Procedures

This page contains emergency contact information that should be available to the operator at all times.

4.6.1 Lost or Stolen Instrument

If the TrueX analyzer is lost or stolen, notify your Radiation Safety Officer (RSO) or the equivalent responsible individual at your company or institution immediately. Your company's RSO, as well as other important emergency contacts, are listed below. Your company RSO may need to notify the X-ray tube regulatory authority and the local police. It is also recommended that a notification is made to Drawell.

4.6.2 Damaged Instrument

Minor Damage

If the instrument is intact but there is indication of an unsafe condition such as a cracked case, a shutter mechanism failure, or the lights remain flashing after a measurement is terminated, follow these steps:

1. Stop using the instrument
2. Remove the battery. The x-ray tube cannot produce radiation when the battery is disconnected. The instrument is now safe to handle.
3. Place the instrument securely in the holster
4. Place the instrument in the carrying case that came with the instrument.
5. Notify your Radiation Safety Officer (RSO) or the equivalent responsible individual at your company or institution immediately.
6. You or your RSO should call Drawell at one of their contact numbers listed below for additional instructions and guidance.

Major damage

If the instrument is severely damaged:

1. Perform the same steps as described above for minor damage. There will be no radiation hazard as long as the battery is removed from the instrument.
2. Place all components in a plastic bag and contact Drawell.

Chapter 5 Sample preparation

5.1 Analysis of Prepared Samples

Analysis of bagged bulk samples

Sometimes it is convenient to measure 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 lower than test results obtained from direct analysis. This effect will vary depending on the element analyzed and the thickness of the plastic through which the sample is tested. Bagged samples can be retested and/or be further prepared and then retested, allowing samples of particular interest to be more accurately analyzed.

5.1.1 Sample Collection

Examine the site for differences in soil characteristics before sampling. Valid results depend on a sufficient and appropriate selection of sites to sample. Incorrect sample collection may give rise to misleading or meaningless results, regardless of the analysis method. Delineate sections with different characteristics and treat them as different areas. It may be desirable to subdivide larger areas even if they have the same characteristics to ensure a thorough examination.

Make certain to label each bag thoroughly. Common information included on each bag includes the person and/or the company who collected the sample, the location and area where the sample was taken, and the date the sample was collected.

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

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

5.1.2 Preparing Bulk Soil Samples

TrueX 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.

The equipment you need to prepare samples. Among these are a mortar and pestle,

several different sized metal sieves, cups to hold the samples.

CAUTION: All test equipment must be kept clean to prevent contamination of samples.

5.2 Cleaning Your Equipment

5.2.1 Sample Preparation

Prior to analysis, the material should be dry and well homogenized. Ideally, the entire sample should be dried to constant weight, sifted to remove gravel and debris, and ground or milled to a fine powder.

Dry the sample if it is moist and cohesive. 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. Note: 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.
- « Air dry the sample overnight at room temperature in a shallow pan.
- « Stir gently and warm the sample in a pan over a hot plate or burner.

5.2.2 Coning and Quartering

You may need to divide your sample at various times during preparation. Coning and quartering is a method for dividing the sample into homogenous quarters.

- « Pour the dry material slowly and carefully onto a flat sheet or pan, forming a symmetrical cone. Divide the cone into equal piles using a flat thin-bladed tool, such as a knife or ruler. 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.
- « Grind the sample to break up dirt clods and/or paint chips.

WARNING! Grinding and sifting 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.

Sift using the #10 (2mm) mesh and separate out the larger pieces (stones, organic matter, metallic objects, etc. Examine the larger particles by eye but do not include in the sample. Grind the sample again so its particles will be finer and more homogenous. Use mortar and pestle, or an electrically powered grinding mill. Sift at least 10 grams

of the sample through #60 (250 μm) and #120 (125 μm) mesh. Re-grind the un-passed material until the entire fraction is able to pass. Mix the resulting sample.

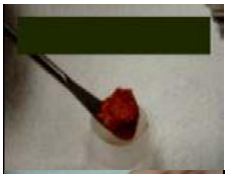
5.2.3 Placing the Sample in an XRF Sample Cup

The container used to hold the sample will affect 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.

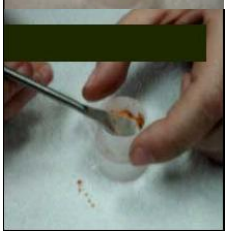
Note: The sample container should be a sample cup of a type that can be filled from the rear; that is, the side opposite the window. Drawell recommends using a 1/4 mil (6.3mm) Polypropelene film. A supply of cups and films are included.

Place a circle of polypropelene film on top of an XRF sample cup. This film goes on the end of the cup with the indented ring. Drawell recommends preparing the cup ahead of time, if possible.

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.



Set the cup on a flat surface film-window-side down. Fill it with at least five grams of the prepared sample, making sure that no voids or uneven layers.



Lightly tamp the sample into the cup. The end of the pestle makes a convenient tamper.

Place a filter-paper disk on the sample after tamping it.

Fill the rest of 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.

Cap the cup.

Place a label on the cup. Use a pen with indelible ink and write identifying information on the cup. Keep a record of the sample designation, the site and location, the date of the sample, and any other relevant comments.

Cup is ready for testing.

Appendix

X-ray Emission Energies Arranged Alphabetically by Element

Symbol	Atomic Number	Atomic Weight	Kα	Kβ	Lα	Lβ	Lγ	Le
Al	13	26.99	1.49					
Si	14	28.09	1.74	1.84				
P	15	30.97	2.02	2.14				
S	16	32.06	2.31	2.47				
Cl	17	35.45	2.62	2.82				
Ar	18	39.94	2.96	3.19				
K	19	39.1	3.31	3.59				
Ca	20	40.08	3.69	4.01	0.34	0.34		
Sc	21	44.96	4.09	4.46	0.40	0.40		
Ti	22	47.90	4.51	4.93	0.45	0.46		
V	23	60.94	4.95	5.43	0.51	0.52		
Cr	24	51.99	5.41	5.95	0.57	0.58		
Mn	25	54.94	5.90	6.49	0.64	0.65		
Fe	26	55.84	6.40	7.06	0.70	0.72		
Co	27	58.93	6.93	7.65	0.78	0.79		
Ni	28	58.7	7.47	8.27	0.85	0.87		
Cu	29	63.54	8.04	8.91	0.93	0.95		
Zn	30	65.38	8.63	9.57	1.01	1.03		
Ga	31	69.72	9.24	10.26	1.10	1.12		
Ge	32	72.5	9.88	10.98	1.19	1.22		
As	33	74.92	10.53	11.73	1.28	1.32		
Se	34	78.9	11.21	12.50	1.38	1.42		
Br	35	79.9	11.91	13.29	1.48	1.53		
Kr	36	83.8	12.63	14.12	1.59	1.64		
Rb	37	85.47	13.38	14.97	1.69	1.75		
Sr	38	87.82	14.14	15.85	1.81	1.87		
Y	39	88.91	14.93	16.75	1.92	2.00		
Zr	40	91.22	15.75	17.69	2.04	2.12	2.30	1.79
Nb	41	92.91	16.58	18.65	2.17	2.26	2.46	1.90
Mo	42	95.94	17.44	19.63	2.29	2.39	2.62	2.01
Tc	43	99	18.33	20.65	2.42	2.54	2.79	2.12
Ru	44	101.0	19.24	21.69	2.56	2.68	2.96	2.25
Rh	45	102.9	20.17	22.76	2.70	2.83	3.14	2.38
Pd	46	106.4	21.12	23.86	2.84	2.99	3.33	2.50
Ag	47	107.9	22.10	24.99	2.98	3.15	3.52	2.63
Cd	48	112.4	23.11	26.14	3.13	3.32	3.72	2.77
In	49	114.8	24.14	27.38	3.29	3.49	3.92	2.90

Sn	50	118.6	25.19	28.60	3.44	3.67	4.13	3.04
Sb	51	121.7	26.27	29.85	3.61	3.84	4.35	3.19
Te	52	127.6	27.38	31.13	3.77	4.03	4.57	3.34
I	53	126.9	28.51	32.44	3.94	4.22	4.80	3.48
Xe	54	131.3	29.67	33.78	4.11	4.42	5.04	3.64
Cs	55	137.3	30.85	35.15	4.29	4.62	5.28	3.79
Ba	56	137.3	32.07	36.55	4.47	4.83	5.53	3.95
La	57	138.9	33.30	37.99	4.65	5.04	5.79	4.12
Ce	58	140.1	34.57	39.45	4.84	5.26	6.05	4.29
Pr	59	140.9	35.86	40.95	5.03	5.49	6.32	4.45
Nd	60	144.2	37.19	42.48	5.23	5.72	6.60	4.63
Pm	61	147	38.54	44.05	5.43	5.96	6.89	4.82
Sm	62	150.4	39.91	45.65	5.64	6.21	7.18	4.99
Eu	63	152.0	41.32	47.28	5.85	6.46	7.48	5.18
Gd	64	157.2	42.76	48.95	6.06	6.71	7.78	5.36
Tb	65	158.9	44.23	50.65	6.28	6.98	8.10	5.55
Dy	66	162.5	45.73	52.38	6.50	7.25	8.42	5.74
Ho	67	164.9	47.26	54.16	6.72	7.53	8.75	5.94
Er	68	167.2	48.82	55.96	6.95	7.81	9.09	6.15
Tm	69	168.9	50.41	57.81	7.18	8.10	9.42	6.34
Yb	70	173.0	52.04	59.69	7.41	8.40	9.78	6.54
Lu	71	175.0	53.59	61.61	7.65	8.71	10.14	6.75
Hf	72	178.4	55.38	63.56	7.90	9.02	10.51	6.96
Ta	73	180.9	57.11	65.56	8.15	9.34	10.81	7.17
W	74	183.8	58.86	67.59	8.40	9.67	11.28	7.39
Re	75	186.2	60.66	69.66	8.65	10.01	11.68	7.60
Os	76	190.2	62.48	71.78	8.91	10.35	12.09	7.82
Ir	77	192.2	64.35	73.93	9.17	10.71	12.51	8.04
Pt	78	195.0	66.25	76.13	9.44	11.07	12.94	8.27
Au	79	197.0	68.19	78.37	9.71	11.44	13.38	8.49
Hg	80	200.5	70.16	80.66	9.99	11.82	13.82	8.72
Tl	81	204.3	72.18	82.99	10.27	12.21	14.28	8.95
Pb	82	207.2	74.23	85.36	10.55	12.61	14.76	9.18
Bi	83	208.9	76.32	87.77	10.84	13.02	15.24	9.42
Po	84	209	78.46	90.24	11.13	13.44	15.74	9.66
At	85	210	80.64	92.75	11.42	13.87	16.25	
Rn	86	222	82.86	95.32	11.72	14.32	16.77	
Fr	87	223	82.12	97.93	12.03	14.77		
Ra	88	226	87.44	100.6	12.34	15.23	17.80	10.62
Ac	89	227	89.79	103.3	12.65	15.71	18.41	
Th	90	232	92.19	106.1	12.97	16.2	18.98	11.12
Pa	91	231	94.64	108.9	13.29	16.7	19.55	11.36
U	92	238.0	97.14	111.8	13.61	17.22	20.16	11.62

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