CRC®-PC
Smart Chamber

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OWNER'S MANUAL

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An Eczacıbaşı-Monrol Company

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PREFACE

GENERAL

Thank you for purchasing the Capintec, Inc. CRC®-PC Smart Chamber Radioisotope Dose Calibrator. Every effort has been made to insure that the information in this document is complete, accurate, and up-to-date. Capintec, Inc. assumes no responsibility for the results of errors beyond its control. Mention of products manufactured by other companies does not necessarily constitute endorsement by Capintec, Inc.

Please address any comments pertaining to this manual to:

CAPINTEC, Inc.
7 Vreeland Road
Florham Park, NJ 07932
Phone (800) ASK-4CRC
Fax (201) 825-1336

Note: Federal Law restricts this device to sale by or on the order of a physician, pharmacist or other licensed professional.

SYSTEM DESCRIPTION

The CRC®-PC Smart Chamber Radioisotope Dose Calibrator consists of the following:

- Chamber
- Laptop computer (optional)
- Printer (optional)

The CRC®-PC Smart Chamber has the following capabilities:

- Daily and Accuracy test
- Background test
- Moly Test
- Reports
- Setup
- USB interface
- Ethernet interface

YEAR 2000 COMPLIANCE

The CRC®-PC Smart Chamber measurement system contains information technology that accurately processes date and time data between the years 1999 and 2000. These products, when used in combination with products purchased from other manufacturers, whose products properly exchange date and time information, will accurately process the date and time. All future products are committed to meeting the same Year 2000 compliance.

MEDICAL EQUIPMENT SAFETY CLASSIFICATION

- CLASS I EQUIPMENT energized from an external power source.
- TYPE B EQUIPMENT with no applied parts to the patient.
- Ordinary EQUIPMENT without protection against the ingress of water or particulates (IP00).
- Suitable for CONTINUOUS OPERATION.
- NOT suitable for use in an OXYGEN or a FLAMMABLE ENVIRONMENT.

ELECTROMAGNETIC INTERFERENCE POTENTIAL

This equipment complies fully with interference immunity requirements of the standard IEC 60601-1-2 “Medical electrical equipment: Part 1: General safety requirements; 2. Supplementary standard: Electromagnetic compatibility”.

This equipment generates radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to nearby devices. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference, the user is encouraged to try to correct the interference by one of the following measures:

- Increase the separation between the equipment and the affected device.
- Plug the unit into an outlet on a circuit different from that which the affected device is connected.

If this fails to correct the problem, please contact Capintec’s only Authorized Service Center.

IMPORTANT SAFETY INFORMATION

The CRC®-PC Smart Chamber measurement system has been carefully designed to provide years of safe and reliable performance. As with all electrical equipment, however, there are basic precautions that must be observed to avoid injuring yourself, the patient or damaging the equipment.

- ***Follow*** the unpacking and assembly instructions as explained in CHAPTER 4: SYSTEM SETUP, and ***read*** this manual carefully before using this equipment. Be sure to save all provided documents for future reference.
- ***Understand all*** warning and caution labels as explained in CHAPTER 1: SAFETY before operating this equipment.

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CHAPTER 1

SAFETY

GENERAL

These warnings and instructions for use form an integral part of the CRC®-PC Smart Chamber and must therefore be kept available for consultation at all times. Precise compliance with the instructions is an essential condition for normal use, correct application and thus safety of the user.

SYMBOL DEFINITIONS

	Dangerous Voltage Present
	Operator should consult accompanying documents
	AC Voltage (Laptop computer, Power over Ethernet (PoE) Power Module)
	“ON” (power) (Laptop computer)
	“OFF” (power) (Laptop computer)
	Date of manufacture
	CE Mark
	Waste in Electrical and Electronic Equipment (WEEE) – This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately.
	Environmentally Friendly Use Period (EFUP) – 20 years from the date of manufacture – Toxic or hazardous substances or elements contained in the unit will not leak or mutate under normal operating conditions resulting in any environmental pollution, bodily injury or damage to assets.

WARNING AND CAUTION LABELS

Located on the bottom of the chamber are 2 labels.

The first label, (Figure 1-1), contains statements denoting not to remove the cover because there are no adjustments that the user can perform in the chamber.

Figure 1-1

The second label (**Error! Reference source not found.**) pertains to the electrical safety of the chamber. It is necessary because of the high voltage present (approximately 180 Vdc for an “HL” Chamber and approximately 500 Vdc for “RPh” and “PS” Chambers) on the PC board installed in the chamber. A screwdriver is necessary to remove the cover.

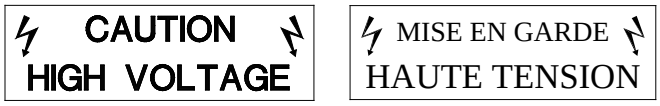

Figure 1-2

CAUTIONS AND NOTES

CAUTION: Only qualified/trained personnel should operate or service this unit.

CAUTION: Do not modify this equipment without Capintec’s authorization.

CAUTION: If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

CAUTION: Do not store high activity radioactive samples in the CRC®-PC Smart Chamber. The Chamber is carefully designed for accurate and precise measurements of high activity radioactive materials. It was not designed to function as a long term storage vessel. Prolonged storage of high activity radioactive samples in the Chamber may cause premature failure of the unit.

CAUTION: In order to obtain a correct reading for a Test Source (Standard Source) Vial, the supplied liner and dipper must be used to achieve the correct geometry. The CRC®-PC Smart Chamber is not designed to use syringe Test Sources in any application.

CAUTION: Capintec, Inc. does not provide the calibration number for any type of Brachytherapy source. The user should have the source calibrated by a regional Accredited Dosimetry Calibration Laboratory (ADCL) site or obtain a calibrated source from the manufacturer and perform your own in-house calibration (All Brachytherapy sources used in IVBT applications must be calibrated in an ADCL facility).

CAUTION: In order to obtain a correct reading for any Brachytherapy sources including HDR & LDR, use the appropriate source holder for the source type being measured to achieve the correct geometry. (e.g. I125 Seed Holder, Ir192 Ribbon Holder, etc). When making a measurement, use the same source holder that was used in determining the calibration number. Verify that the liner has been removed from the chamber before making the measurement. If additional information is needed, contact Capintec, Inc. for further assistance.

CAUTION: In order to obtain a correct reading for any Brachytherapy sources used in IVBT, use the appropriate source holder (Note that IVBT source holders are individually serialized) for the source type being measured to achieve the correct geometry. (e.g. Novoste Seed Holder). When making a measurement, use the same source holder (same serial number) that was used in determining the calibration number. Verify that the liner has been removed from the chamber before making the measurement. If additional information is needed, contact Capintec, Inc. for further assistance.

CAUTION: IVBT source calibration is only to verify source output and is not to be used in treatment planning.

CAUTION: High voltage is present inside the Chamber (up to 180 Vdc for an “HL” Chamber and 500 Vdc for “RPh” and “PS” Chambers). Due to the presence of this high voltage, opening the covers with the system plugged in may be hazardous. Refer all servicing to qualified personnel.

CAUTION: No internal adjustments inside the Chamber may be performed by the user within the conditions of the warranty. Due to the presence of high voltages, opening the cover with the system plugged in may be hazardous. Refer all servicing to qualified personnel.

CAUTION: Except for Brachytherapy, never use the CRC®-PC Smart Chamber without the Chamber liner in place. Liners are inexpensive and easy to replace. A contaminated Chamber is a very costly mistake. If the unit becomes contaminated, remove the liner and clean the unit as stated in CHAPTER 12: CLEANING AND MAINTENANCE, SECTION: CLEANING and DISINFECTING before operating.

CAUTION: Care must be exercised when moving the instrument or when maintenance is performed. The shielded cylinder is heavy ("HL" Chamber: 13.6 kg or 30 lb; "RPh" Chamber: 14.5 kg or 32 lb; "PS" Chamber: 17.8 kg or 39.25 lb). In order to provide the required sensitivity, the wall of the ionization chamber is extremely thin and the chamber is filled with pressurized gas. It is therefore, essential to avoid mechanical shock or vibration of any kind.

CAUTION: When working with a heavy sample (especially a CapMac or Moly Assay Canister) always lower it gently into the Chamber. Dropping any heavy object into the Chamber can cause permanent, expensive damage.

CAUTION: The use of multiplication and division factors in Calibration Numbers is only to maintain a degree of consistency with other Capintec Dose Calibrators. The CRC®-PC Smart Chamber is a direct reading instrument. If multiplication or division is required, the arithmetic will be done by the system. The actual activity is displayed. DO NOT apply these factors to the displayed activity yourself.

CAUTION: It is desirable to leave the unit powered at all times in order to prevent moisture absorption and to maintain the stability of the instrument (especially if the instrument is subjected to high humidity or low temperature).

CAUTION: The sensitivity of the Chamber is somewhat dependent upon the vertical position of the sample within the well. All calibrations were done with a Standard Sample placed in the supplied sample holder (dipper). It should be noted that in this configuration, the sample is not quite at the bottom of the well. If, for any reason, you make a measurement without using the dipper, be sure that the sample is in the correct vertical position. Both the CapMac and the Standard Moly Assay Canister maintain the same position as the dipper.

CAUTION: This equipment generates radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful Electromagnetic Interference (EMI) to nearby devices. However, there is no guarantee that interference will not occur in a particular installation.

⚠ **CAUTION:** If any printer other than one of the models supplied by Capintec is used, the safety of the unit may be compromised or Electromagnetic Interference (EMI) may be introduced into other devices located in the same general area as the CRC®-PC Smart Chamber or the CRC®-PC Smart Chamber may become susceptible to EMI.

⚠ **CAUTION:** Other devices located in the same general area as the CRC®-PC Smart Chamber may affect the operation of the system.

⚠ **CAUTION:** The unit contains lead. Appropriate caution should be taken if the interior of the unit is exposed. The unit should be disposed of in accordance with local and national regulations.

⚠ **CAUTION:** The unit contains a Lithium Battery. This should be disposed of in accordance with local and national regulations.

⚠ **CAUTION:** The user should always verify the validity of any measurement or test result in order to minimize measurement errors.

⚠ **CAUTION:** Connection of the CRC®-PC Smart Chamber to a network that includes other equipment could result in previously unidentified risks to patients, operators or third parties. The user should identify, analyze, evaluate and control these risks.

Note: *It is recommended that periodic (every five years) re-calibration of the unit be performed only by Capintec's Authorized Service Center (reference CHAPTER 12: CLEANING AND MAINTENANCE) to guarantee that the instrument's high reliability is maintained).*

GENERAL SAFETY TIPS

- Unplug the equipment before cleaning it. Use only a damp cloth; do not use solvents or aerosol cleaners.
- To protect the equipment from overheating, do not use the equipment directly in front of a radiator or heat register.
- Do not use the equipment near water, or spill liquids of any kind into the equipment.
- If using the optional Laptop computer and/or PoE (Power over Ethernet), verify that your power source matches the ratings listed on the power modules.
- To avoid damaging any of the cables, do not place anything on them or place them where they will be stepped on. If any of the cables become damaged, replace them immediately.
- Aside from the routine maintenance described in this manual, do not try to service this equipment yourself. Do not make any adjustments other than those outlined in this manual, as you may in-validate the calibration or cause damage requiring extensive repair work. Refer servicing to qualified service personnel.

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CHAPTER 2

FUNCTIONAL & TECHNICAL DESCRIPTION

INTENDED USE

The CRC®-PC Smart Chamber is intended to be used by trained Nuclear Medicine Technologists and Physicians, Radiopharmacists and Medical Physicists for measuring the activity of a radioisotope samples for Nuclear Medicine and Brachytherapy.

Also using the system are Health Physicists with expertise in nuclear medicine and radiation safety – typically used for assessing reproducibility of counting instruments with various Quality Assurance procedures (Linearity, Constancy, Accuracy, etc.).

OPERATOR PROFILE

The operator profile for the Nuclear Medicine Technologists, Physicians, Radiopharmacists and Medical/Health Physicists is as follows:

- **Education:**
  - Minimum: at least an Associate Degree
  - No maximum
- **Knowledge:**
  - Minimum: Understands the basic concepts of nuclear medicine.
  - No maximum

- **Language Understanding:**
  - English

- **Experience:**
  - Minimum: Has minimum training or is under surveillance by a trained user.
  - No maximum

OPERATOR TRAINING

This Owner's Manual contains all of the information required to operate the CRC®-PC Smart Chamber.

FUNCTIONAL DESCRIPTION

The CRC®-PC Smart Chamber provides a precise, accurate, fast and very convenient method of measuring the activity of a radioisotope sample for Nuclear Medicine.

The activity of the sample will be displayed with a proper unit when a sample of unknown strength (activity) of a known radioisotope is placed in the Detector (ionization chamber) and the correct Calibration Number is selected.

The sample must be placed in the same geometry as the Reference Source used to determine the Calibration Number by using the appropriate Source Holder.

Note: *For a detailed description of the basic principles of the calibrator, reference APPENDIX I: PRINCIPLE OF THE CALIBRATOR.*

Most radioisotopes can be measured in the Chamber.

The 6cm diameter and 25cm deep ionization chamber well allows convenient measurements of virtually any radioisotope geometry in clinical use including whole generators, syringes and seed trains.

The external shield of the ionization chamber protects users from exposure to intensive radiation and reduces the effects from background radiation on low-level measurements.

FUNCTIONS

When the instrument is first powered up, Figure 2-1will appear.

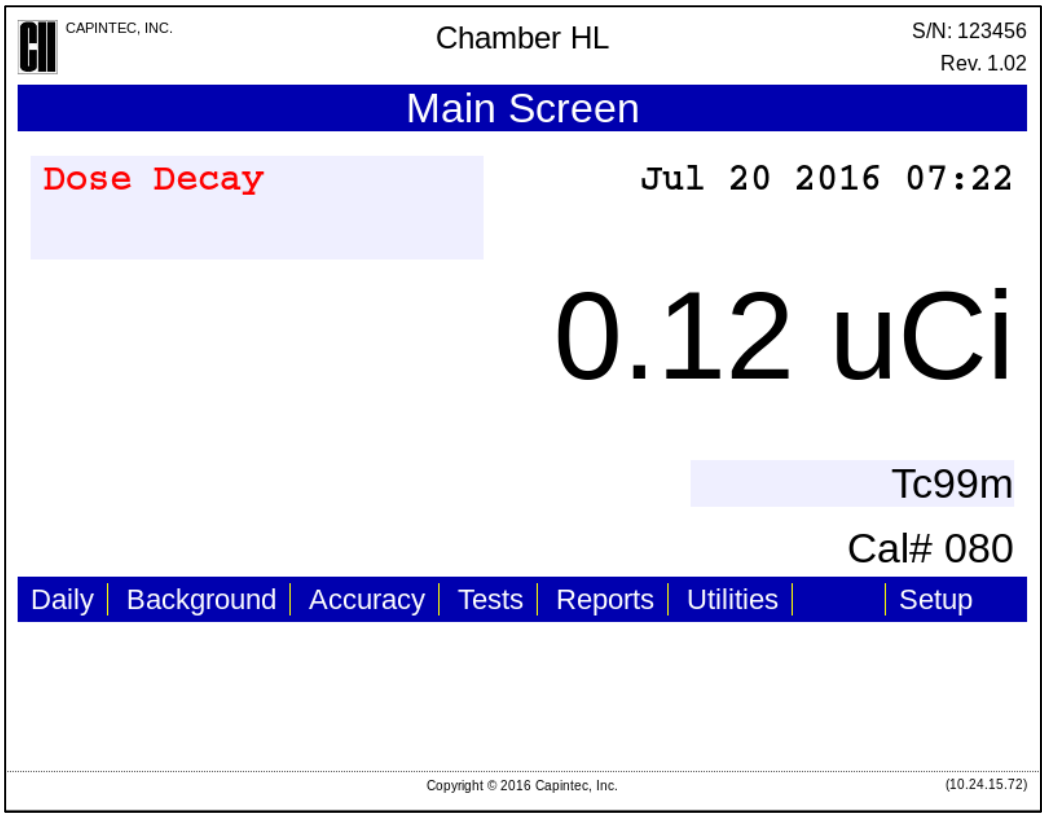

Figure 2-1 Main/Measurement Screen

Note: *The screen will display the revision level of the installed software in the upper right corner.*

Overall Program Flow

The program is accessed through a Web Browser as a website when connected to a PC via the Ethernet cable. The IP address of the web server in the Chamber is supplied by Capintec at installation. If it is desired to use another IP Address, follow the instructions to do so in CHAPTER 5: SYSTEM INITIALIZATION.

Refer to Figure 2-2 for program flow. Access to all functions is done by clicking on the various buttons. The Setup screen is accessed by supplying a User ID and password also provided by Capintec. The Main/Measurement screen provides access to Daily test, Background test, Accuracy test, Moly test, Reports Utilities and Setup.

Setup allows a validated administrator to access the Setup module.

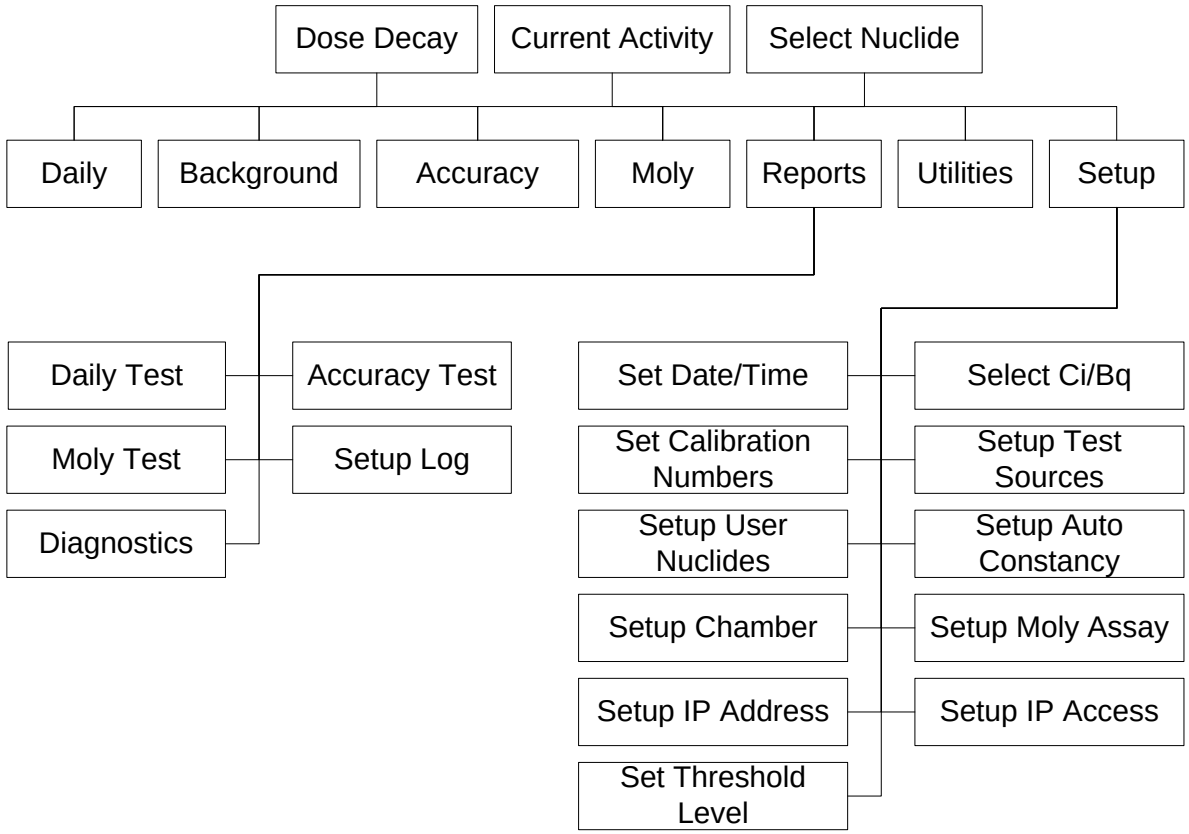

Figure 2-2 Overall Program Flow

TECHNICAL DESCRIPTION

On / Off Switch

There is no on/off switch for the CRC®-PC Smart Chamber. Power is provided by connecting the Chamber to a PC USB port or via a Power over Ethernet (PoE) power module. Refer to CHAPTER 4:SYSTEM SETUP; SECTIONS:TURN-ON PROCEDURES and TURN-OFF PROCEDURES.

Warm Up Period

Approximately 30 minutes should be allowed for the instrument to stabilize. While the instrument is warming up, it is strongly recommended that you become familiar with the functions of the CRC®-PC Smart Chamber.

Environment Requirements

Indoor use only. Pollution Degree 2, Altitude, and Installation Cat. II.

Operational

The instrument should be located where the level of the background radiation is as low and as constant as possible.

The instrument should be located where the temperature is stable within a range of +50°F to +85°F (+10°C to +30°C) and the maximum relative humidity is 90% non-condensing to warrant maximum reliability and accuracy.

The instrument should be located where the barometric pressure is within a range of 27 – 31 inches of mercury (91 – 105 kilopascals).

Storage

The instrument should be stored where the temperature is stable and the range is from +39°F to +110°F (+4°C to +43°C) and the maximum relative humidity is 90% non-condensing to warrant maximum reliability.

The instrument should be stored where the barometric pressure is within a range of 15 – 33 inches of mercury (51 – 112 kilopascals).

CAUTION: If these environmental requirements are not followed, the instrument may display erroneous readings

Power Requirements

CAUTION: If the input voltage to the following items is not within the stated limits, the unit may not function correctly or may be damaged

CRC®-PC Smart Chamber

Power supplied by the USB port.
5 Vdc @ 0.5 amps

Power supplied by PoE (Power over Ethernet) is Class 0 if so powered.

Laptop Computer

Dell Vostro 2520 (or equivalent)
100~240Vac, 50-60Hz, 1.7A

Power over Ethernet (PoE) Module

PowerDsine 3501G (or equivalent)[1]
Input: 100-240Vac, 50/60Hz, 0.43A; ***Output***: +48Vdc, 0.35A

Printer (Optional)

HP Officejet 6000 Series (or equivalent)
100-240Vac, 50/60Hz, 1.5A

[1] If any PoE Power Supply other than one recommended by Capintec is used, the safety of the unit may be compromised or Electromagnetic Interference (EMI) may be introduced into other devices located in the same general area as the CRC®-PC Smart Chamber or the CRC®-PC Smart Chamber may become susceptible to EMI.

Dimensions

Laptop Computer[3]

Weight.....2.5kg.....(5.5lb)

Chamber

Height.....46.3cm.....(18.25in)
Diameter.....17.2cm.....(6.76in)
Weight.....17.8kg.....(39.25lb)
Well Diameter.....6.1cm.....(2.4in)
Well Depth.....25.4cm.....(10.0in)

Cables

Cat 5 Ethernet.....3.05m .....(10ft)
USB.....3.05m .....(10ft)[2]
Printer[3] .....1.8m .....(6ft)

Performance

HL Chamber Performance

Measurement Range:
- Maximum Activity (Tc99m).....246 GBq (6.65 Ci)
- Maximum Activity (F18).....72.5 GBq (1.96 Ci)
- Maximum Activity (Co60) .....37.4 GBq (1.00 Ci)
- Maximum Activity (Co57) .....206. GBq (5.57 Ci)

Resolution .....0.001 MBq (.01 µCi)
Electrometer Accuracy[4] .....better than ±2%
System Precision.....better than ± 0.1% of FSD
System Linearity.....within ±2%
Response Time
- Below 20µCi .....within 25 seconds
- Above 20µCi .....within 4 seconds

RPh Chamber Performance

Measurement Range:
- Maximum Activity (Tc99m).....2,678 GBq (72.4 Ci)
- Maximum Activity (F18).....743.7 GBq (20.1 Ci)
- Maximum Activity (Co60) .....388 GBq (10.5 Ci)
- Maximum Activity (Co57) .....2,334 GBq (63.1 Ci)

Resolution .....0.01 MBq (0.1 µCi)
Electrometer Accuracy .....better than ±2%
System Precision.....better than ± 0.1% of FSD
System Linearity.....within ±2%

[2] If the USB Cable is over 1.8m (6ft) in length, the power pair in the cable must be 24AWG wire. If the cable is 1.8m (6ft) in length or under, the power pair in the cable can be 28AWG wire.
[3] Optional
[4] Overall accuracy is determined by the calibration for the specific nuclide and the sample configuration and the accuracies of the standard sources used for calibration of the electrometer.

Response Time
Below 220µCi.....within 25 seconds
Above 220µCi.....within 4 seconds

PS Chamber Performance

Measurement Range:
Maximum Activity (Tc99m) .....222 GBq (6.00 Ci)
Maximum Activity (F18).....72.5 GBq (1.96 Ci)
Maximum Activity (Co60).....37.4 GBq (1.00 Ci)
Maximum Activity (Co57).....206. GBq (5.57 Ci)
Resolution.....0.001 MBq (.01 µCi)
Electrometer Accuracy[5] .....better than ±2%
System Precision .....better than ± 0.1% of FSD
System Linearity .....within ±2%
Response Time
Below 20µCi.....within 25 seconds
Above 20µCi .....within 4 seconds

Regulatory Listings

The CRC®-PC Smart Chamber has been independently tested and is manufactured in compliance with the following Standards:

EMC

- IEC 60601-1-2 (2007): Medical Electrical Equipment – Part 1 General Requirements for Safety – Section 1.2 Collateral Standard: Electromagnetic Compatibility – Requirements and Tests

Safety

- AAMI ES60601-1 Issued: 2005: Medical electrical equipment Part 1: General requirements for basic safety and essential performance
- CAN.CSA-C22.2 No. 60601-1:08: Medical electrical equipment – Part 1: General requirements for basic safety and essential performance
- IEC 60601-1 Issued: 2005 Ed:3: Medical electrical equipment Part 1: General requirements for basic safety and essential performance
- IEC 60601-1-6 2010 3rd Edition: Medical electrical equipment – Part 1-6: General requirements for basic safety and essential performance – Collateral Standard: Usability

[5] Overall accuracy is determined by the calibration for the specific nuclide and the sample configuration and the accuracies of the standard sources used for calibration of the electrometer.

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CHAPTER 3

GENERAL OPERATING INSTRUCTIONS

GENERAL

This section describes general operating procedures and how to access all other tests and screens.

Note: *These operating instructions are based on using the CRC®-PC Smart Chamber as a web interface device via the Ethernet cable connected to a PC or Laptop. Access to a Nuclear Management Medicine System via a communication protocol whether it is via Ethernet or USB is covered in a separate document.*

MEASUREMENT SCREEN

The CRC®-PC Smart Chamber Main/Measurement screen is shown below.

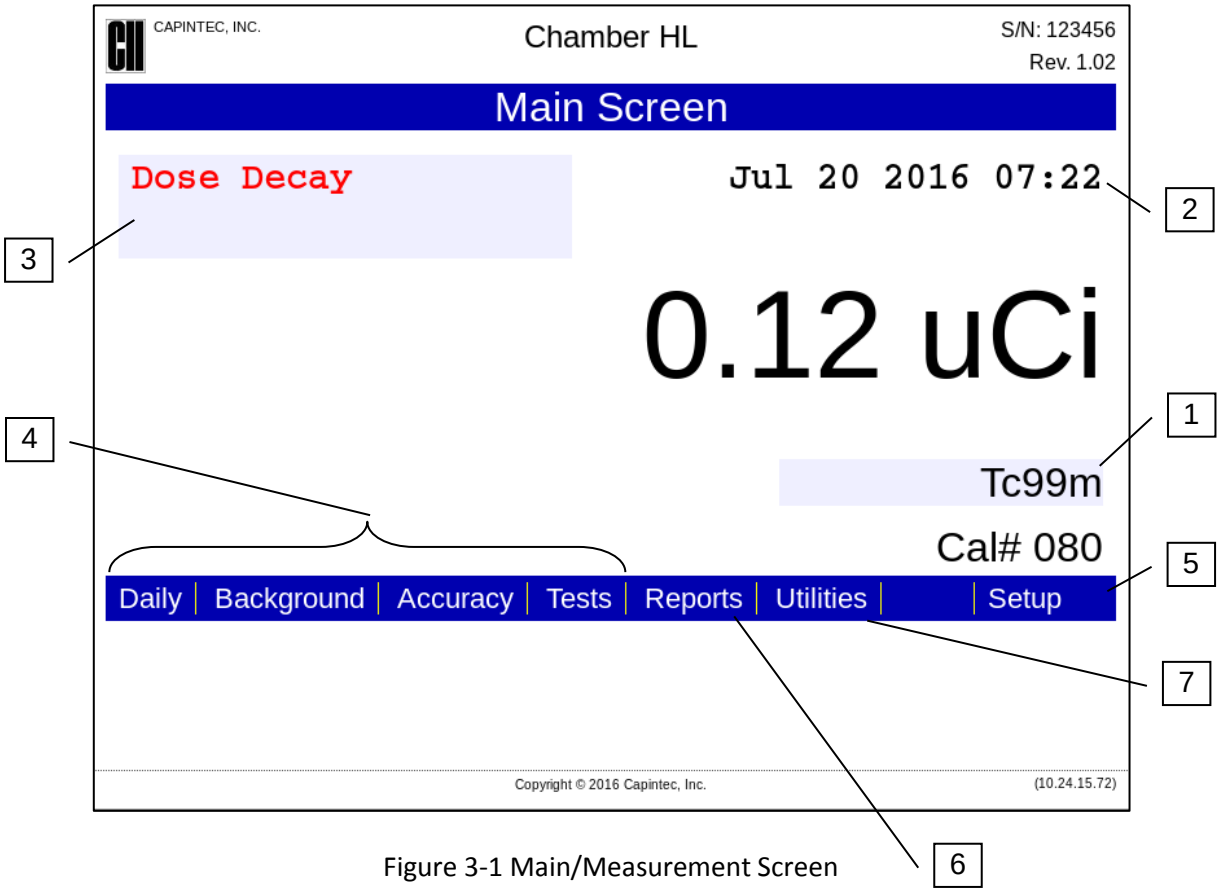


Figure 3-1 Main/Measurement Screen

General usage is briefly described. Specific usage will be given in the appropriate sections.

Nuclide Button 1

This button is located below the measurement and displays the currently selected nuclide. Clicking this button allows the user to select any nuclide in memory (including nuclides added by the user).

When clicked, the Nuclide screen will appear. To select a different nuclide, click on the Nuclide name drop-down list box. A drop-down list of all the nuclides that can be selected will be displayed as shown in Figure 3-2 Nuclide Selection Screen.

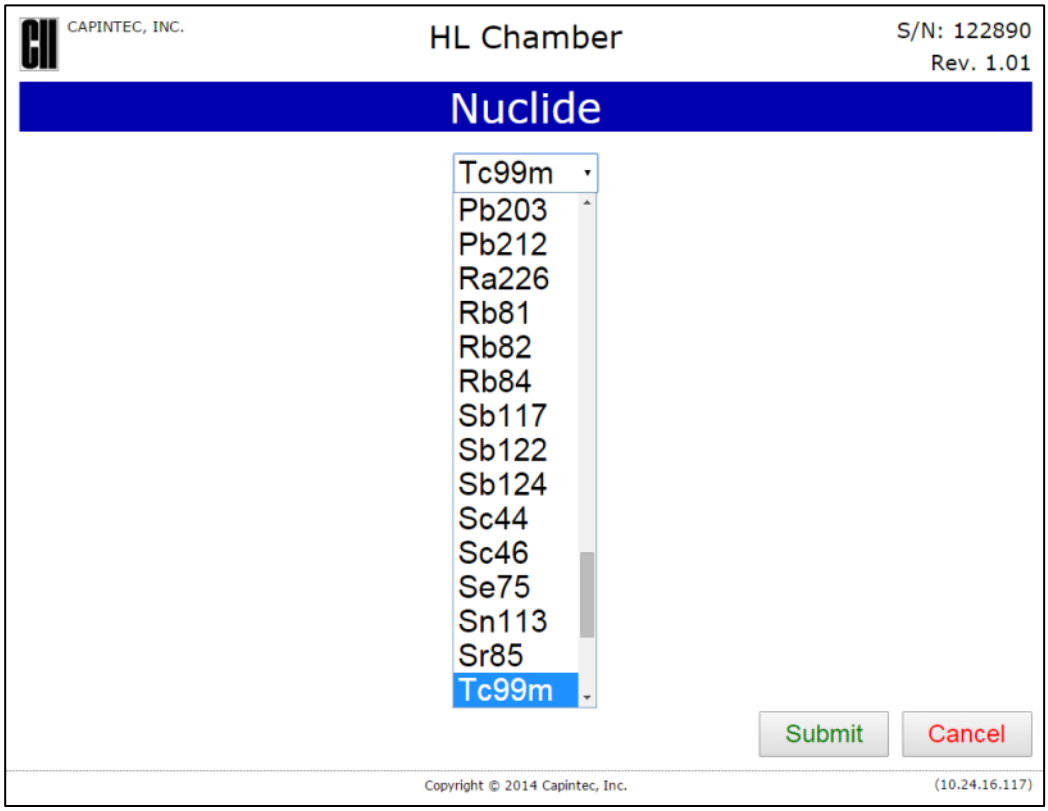


Figure 3-2 Nuclide Selection Screen

Date/Time 2

The current date and time is displayed in the upper right portion of the screen. For information on changing the date and/or time, reference CHAPTER 5: SYSTEM INITIALIZATION; SECTION: SET DATE AND TIME.

Dose Decay Button 3

This button is located in the upper left portion of Figure 3-1 Main/Measurement Screen.

This button allows the entry of a future date and time for the current sample being measured. After the date and time are input, the Dose Decay button will display the activity of the current sample at the specified time in red. Reference CHAPTER 10: MEASUREMENT PROCEDURES; SECTION: DOSE DECAY for more information.

QC Buttons 4

The bottom of the screen holds 4 buttons that are composed of **DAILY**, **BACKGROUND**, **ACCURACY**, and **TESTS** (AutoLinearity and Moly). Reference CHAPTER 8: CHAMBER TESTS and CHAPTER 10: MEASUREMENT PROCEDURES; SECTION: MOLY ASSAY for more information.

Note: *The Moly button is not available on a when using PS Smart Chamber.*

Setup Button 5

The lower right portion of the screen contains the **SETUP** button. This button allows for setting up the system for activity units, date and time, date format, Calibration Numbers, Test Sources, adding User Nuclides, setting of the IP Address and setting the Threshold level. Reference CHAPTER 5: SYSTEM INITIALIZATION and CHAPTER 6: CHAMBER INITIALIZATION for more information.

Reports Button 6

The lower portion of the screen contains the **REPORTS** button. This button allows for the viewing of various reports. Reference CHAPTER 11: REPORTS for more information.

Utilities Button 7

The lower portion of the screen contains the **UTILITIES** button. This button allows for viewing of the Owner's Manual and downloading of the USB Driver and DHCP Server Utility.

CHAPTER 4

SYSTEM SETUP

GENERAL

Initial installation and checkout procedures are described in this section.

RECEIVING CONDITION EXAMINATION

Be sure to verify that the shipping carton(s) is received in good condition, i.e., no damage should be visible and the box(es) should be dry and clean.

Should the instrument be received in a damaged condition, save the shipping container(s) and the packing materials and request an immediate inspection by the carrier.

Capintec, Inc. is not responsible for the damage, which occurs during shipment but will make every effort to help obtain restitution from the carrier.

UNPACKING

The instrument is packed and shipped as a complete unit. All the accessories are contained in the cartons. (If the optional printer is included, it will be in a separate carton.)

The instrument is shipped in a plastic bag in order to provide a dry and clean environment during shipment.

⚠ **CAUTION:** Be sure the instrument has reached room temperature prior to opening the bag. (Leave the box in the room 24 hours before opening it.)

1. Remove all outer packing materials and tapes. The shipping and packing materials should be saved for future use.

2. The following equipment should be found upon unpacking:
   - Chamber with Liner and Dipper
   - USB/Ethernet Interface
   - Ethernet cable
   - USB cable[1]
   - Laptop with Power Cord/Power Supply (optional)
   - PoE Power Module with Power Cord (optional)
   - Printer (optional)

   Note: *If Test Sources are ordered, they will be shipped separately.*

3. Be sure to remove all tape and protective materials from the instrument prior to connecting to the power line.

COMPLETE SYSTEM ASSEMBLY

The CRC-PC Smart Chamber can be connected in several configurations as listed below. How it is connected depends upon your particular setup and requirements.

As shipped from the factory, the CRC®-PC Smart Chamber is set to use a static IP address (169.254.1.1). Also, the default NetBIOS Name (Hostname) is “chamber_XXXXXX” where XXXXXX is the six-digit serial number of the Smart Chamber. Whether the Smart Chamber is connected directly to a local non-networked Computer (Configurations 1 or 2) or to a Local Network Connection (Configurations 3 or 4), either the IP address or the NetBIOS Name can

[1] If the USB Cable to be used is over 1.8m (6ft) in length, the power pair in the cable must be 24AWG wire. If the cable is 1.8m (6ft) in length or under, the power pair in the cable can be 28AWG wire.

be entered into the address bar of a web browser of the local non-networked Computer or a Computer attached to your network. If you are using a Local Network Connection (Configurations 3 or 4) and the Main Measurement screen does not appear in the browser, the static IP address may be blocked on your network. If this is the case, contact your local IT Department for assistance.

- **Configuration 1 – Non-Networked Computer with PoE (Power over Ethernet) Module** – In this configuration, the CRC-PC Smart Chamber is connected to a PoE Module which is connected directly to a non-networked computer using Ethernet cables. Refer to the Configuration 1 – Non-Networked Computer with PoE (Power over Ethernet) Module section on page 4-4-3.
- **Configuration 2 – Non-Networked Computer without PoE (Power over Ethernet) Module** – In this configuration, the Ethernet port on the CRC-PC Smart Chamber is connected directly to the Ethernet port on a non-networked computer using an Ethernet cable and the USB port on the CRC-PC Smart Chamber is connected directly to a USB port on a computer using a USB cable. Refer to the Configuration 2 – Non-Networked Computer without PoE (Power over Ethernet) Module section on page 4-4-5.
- **Configuration 3 – Non-Powered Local Network Connection** – In this configuration, the CRC-PC Smart Chamber is connected to a PoE Module which is connected directly to a Non-powered Local Network connection using Ethernet cables. Refer to the Configuration 3 – Non-Powered Local Network Connection section on page 4-4-6.
- **Configuration 4 – PoE Powered Local Network Connection** – In this configuration, the CRC-PC Smart Chamber is connected directly to a Powered Local Network connection using an Ethernet cable. Refer to the Configuration 4 – PoE Powered Local Network Connection section on page 4-4-8.

Configuration 1 – Non-Networked Computer with PoE (Power over Ethernet) Module

Configuration 1 Assembly and Setup

WARNING: To avoid the risk of electric shock, the optional Laptop Power Supply and PoE Modules must only be connected to a supply main with protective earth.

WARNING: Make sure that the system is positioned so that power plugs are easily accessible at all times. Refer to the TURN-OFF PROCEDURES section on page 4-4-12.

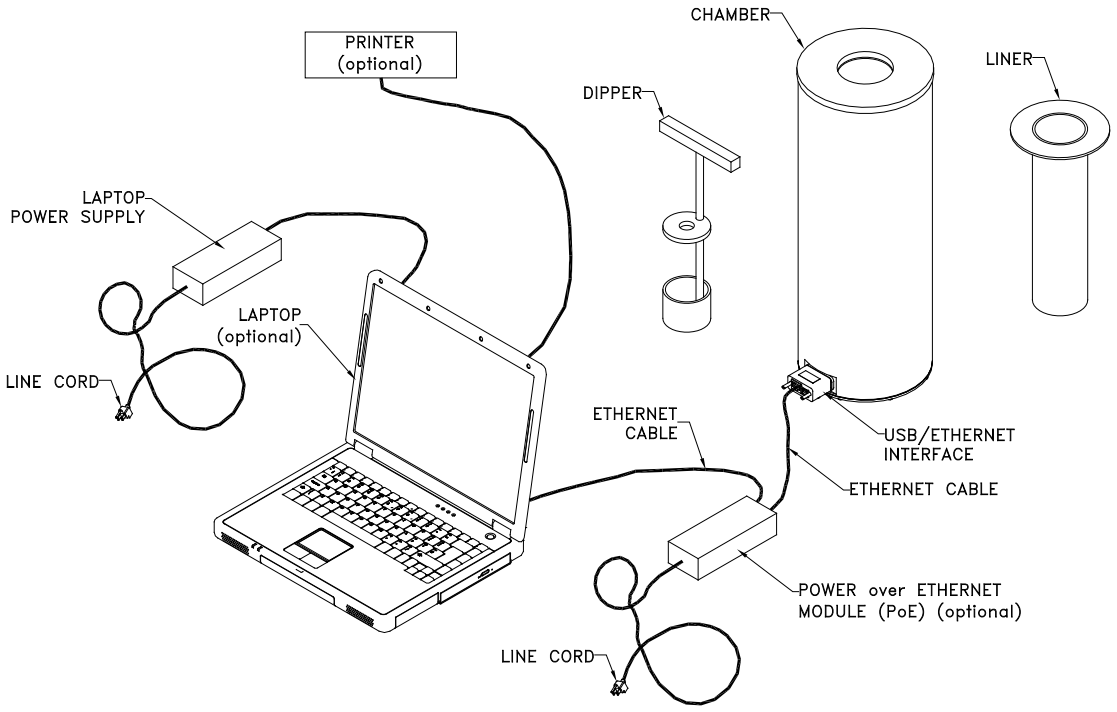


Figure 4-1 Configuration 1 with Optional Accessories

1. Attach the USB/Ethernet Interface to the “D” connector on the Chamber. Secure in place with the 2 attached thumbscrews.
2. Use an Ethernet Cable to connect the “Power Out” RJ45 connector of the Power over Ethernet (PoE) Module to the RJ45 connector of the USB/Ethernet Interface on the Chamber.
3. Use another Ethernet Cable to connect the “Data In” RJ45 connector of the PoE Module to the Ethernet RJ45 connector of the computer.
4. Attach one end of the Laptop Power Supply line cord to the Laptop Power Supply and the other end to AC Line (100-240 Vac).
5. Attach one end of the PoE line cord to the PoE Module and the other end to AC Line (100-240 Vac). Note that the “Port On” indicator light will be green if the Chamber and Cable are connected and functional.

Configuration 1 Turn-on Procedure

1. Verify that the PoE Module is connected to the CRC®-PC Smart Chamber and the Non-Networked Computer and the PoE Module is connected to AC Line (100-240 Vac). Note that the “Port On” indicator light will be green if the Chamber and Cable are connected and functional.
2. Turn the Computer on.
3. Wait approximately 1-2 minutes for the Computer to detect the Smart Chamber.

4. Open Internet Explorer (version 9 or higher).
5. Enter the default IP address or NetBIOS Name (Hostname) in the browser's address bar and press Enter.

   Note: *The IP Address can be changed. Reference CHAPTER 5: SYSTEM INITIALIZATION; SECTIONS SETTING UP THE IP ADDRESS and CONTROL ACCESS BY IP ADDRESS.*

6. After a few seconds, Figure 4-5 Main/Measurement Screen will appear.

Configuration 2 – Non-Networked Computer without PoE (Power over Ethernet) Module

Configuration 2 Assembly and Setup

WARNING: To avoid the risk of electric shock, the optional Laptop Power Supply Module must only be connected to a supply main with protective earth.

WARNING: Make sure that the system is positioned so that power plugs are easily accessible at all times. Refer to the TURN-OFF PROCEDURES section on page 4-4-12.

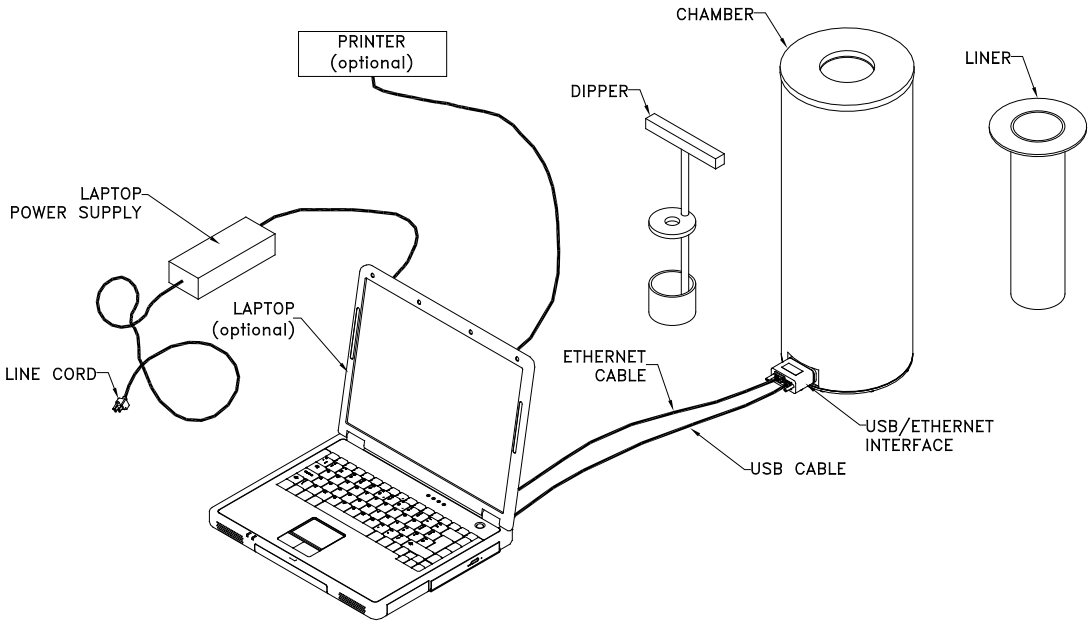


Figure 4-2 Configuration 2 with Optional Accessories

1. Attach the USB/Ethernet Interface to the "D" connector on the Chamber. Secure in place with the 2 attached thumbscrews.

2. Attach one end of the Ethernet Cable to the RJ45 connector of the USB/Ethernet Interface on the Chamber.
3. Attach the other end of the Ethernet Cable to the Ethernet RJ45 connector on the computer.
4. Attach one end of the USB Cable to the USB connector of the USB/Ethernet Interface on the Chamber.
5. Attach the other end of the USB Cable to a USB connector on the computer.

   Note: *If the USB Cable to be used is over 1.8m (6ft) in length, the power pair in the cable must be 24AWG wire. If the cable is 1.8m (6ft) in length or under, the power pair in the cable can be 28AWG wire.*
6. Attach one end of the Laptop Power Supply line cord to the Laptop Power Supply and the other end to AC Line (100-240 Vac).

Configuration 2 Turn-on Procedure

1. Verify that the Ethernet cable and USB cable are connected between the Non-Networked Computer and the CRC®-PC Smart Chamber.
2. Turn the Computer on.
3. Wait approximately 1-2 minutes for the Computer to detect the Smart Chamber.
4. Open Internet Explorer (version 9 or higher).
5. Enter the default IP address or NetBIOS Name (Hostname) in the browser's address bar and press Enter.

   Note: *The IP Address can be changed. Reference CHAPTER 5: SYSTEM INITIALIZATION; SECTIONS SETTING UP THE IP ADDRESS and CONTROL ACCESS BY IP ADDRESS.*
6. After a few seconds, Figure 4-5 Main/Measurement Screen will appear.

Configuration 3 – Non-Powered Local Network Connection

Configuration 3 Assembly and Setup

WARNING: To avoid the risk of electric shock, the optional PoE Module must only be connected to a supply main with protective earth.

WARNING: Make sure that the system is positioned so that power plug is easily accessible at all times. Refer to the TURN-OFF PROCEDURES section on page 4-4-12.

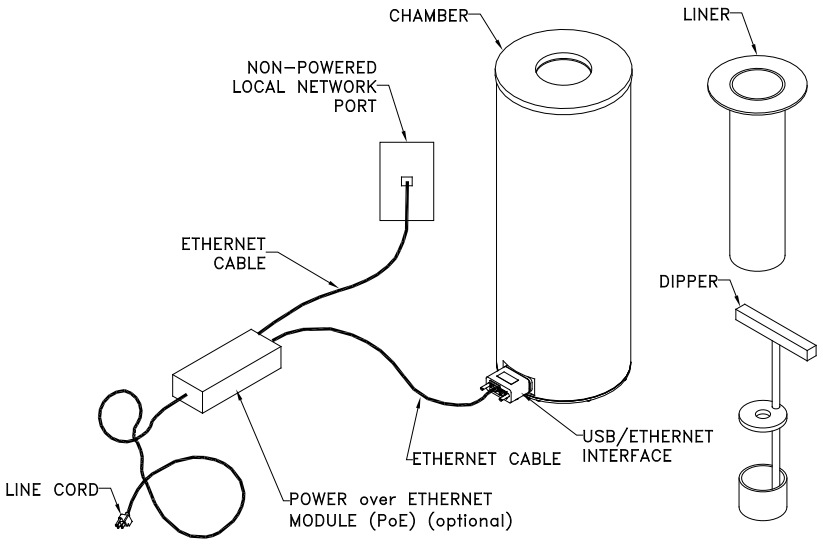


Figure 4-3 Configuration 3 with Optional Accessories

1. Attach the USB/Ethernet Interface to the “D” connector on the Chamber. Secure in place with the 2 attached thumbscrews.
2. Use an Ethernet Cable to connect the “Power Out” RJ45 connector of the Power over Ethernet (PoE) Module to the RJ45 connector of the USB/Ethernet Interface on the Chamber.
3. Use another Ethernet Cable to connect the “Data In” RJ45 connector of the PoE Module to the Non-powered Local Network Connection port.

Configuration 3 Turn-on Procedure

1. Verify that the PoE Module is connected to the CRC®-PC Smart Chamber and the Non-Powered Local Network Port and the PoE Module is connected to AC Line (100-240 Vac). Note that the “Port On” indicator light will be green if the Chamber and Cable are connected and functional.
2. On a Computer attached to your network, open Internet Explorer (version 9 or higher).
3. Enter the default IP address or NetBIOS Name (Hostname) in the browser’s address bar and press Enter.

   Note: *The IP Address can be changed. Reference CHAPTER 5: SYSTEM INITIALIZATION; SECTIONS SETTING UP THE IP ADDRESS and CONTROL ACCESS BY IP ADDRESS.*
4. After a few seconds, Figure 4-5 Main/Measurement Screen will appear.

Configuration 4 – PoE Powered Local Network Connection

Configuration 4 Assembly and Setup

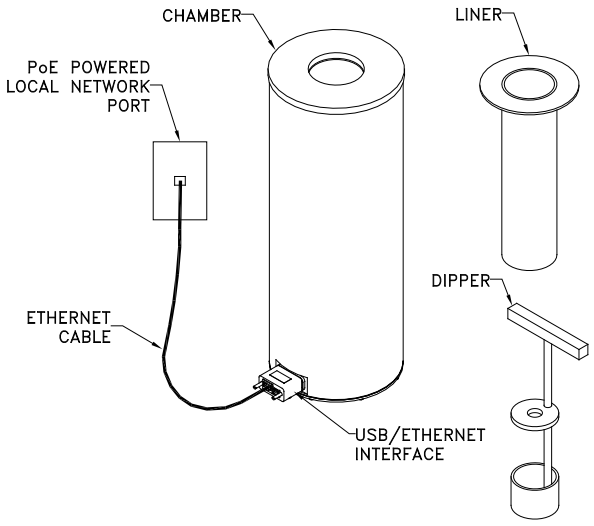


Figure 4-4 Configuration 4

1. Attach the USB/Ethernet Interface to the “D” connector on the Chamber. Secure in place with the 2 attached thumbscrews.
2. Use an Ethernet Cable to connect the RJ45 connector of the USB/Ethernet Interface on the Chamber to the powered Local Network Connection port.

Configuration 4 Turn-on Procedure

1. Verify that the Ethernet cable is connected between the CRC®-PC Smart Chamber and the PoE Powered Local Network Port.
2. On a Computer attached to your network, open Internet Explorer (version 9 or higher).

   Note: *The IP Address can be changed. Reference CHAPTER 5: SYSTEM INITIALIZATION; SECTIONS SETTING UP THE IP ADDRESS and CONTROL ACCESS BY IP ADDRESS.*
3. Enter the default IP address or NetBIOS Name (Hostname) in the browser’s address bar and press Enter.
4. After a few seconds, Figure 4-5 Main/Measurement Screen will appear.

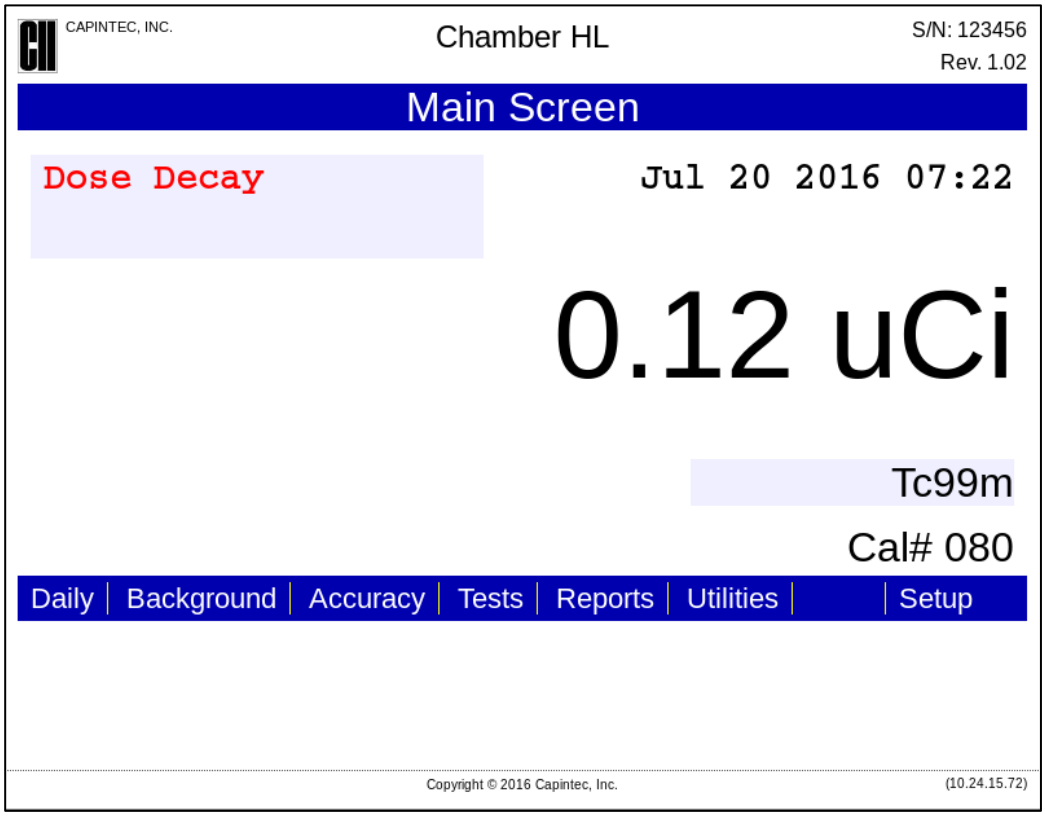


Figure 4-5 Main/Measurement Screen

Note: *The screen will display the revision level of the installed software in the upper right corner.*

Liner, Dipper, and Optional Holders

The supplied Chamber Liner and Dipper are shown below.

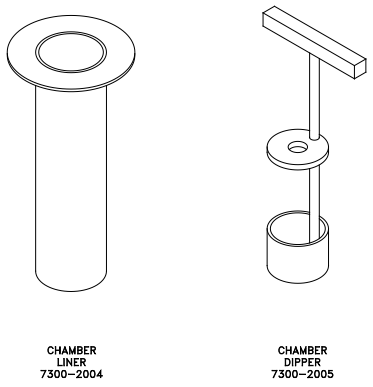


Figure 4-6 Liner and Dipper

The Chamber Liner provides protection against spills. It is made of clear, tough Plexiglass for improved durability. It is recommended that the Liner be installed inside the Chamber at all times.

⚠ **CAUTION:** Never use the calibrator without the Chamber Liner in place. Liners are inexpensive and easy to replace. A contaminated Chamber is a very costly mistake.

The Dipper (Vial/Syringe sample holder) is specially designed to hold syringes and vials of various sizes. It provides a safe, convenient way to hold a vial or syringe during activity measurement. Proper placement in the Chamber is assured every time. The cup portion will accommodate up to a 30ml vial. The Syringe Guide will accommodate 3, 5 and 10cc syringes. An adapter (7310-1109) is available to accommodate a tuberculin syringe (1cc).

For seed measurements, use the appropriate source holder for the source type being measured in order to obtain a correct reading. If additional information is needed, contact Capintec, Inc. for further assistance.

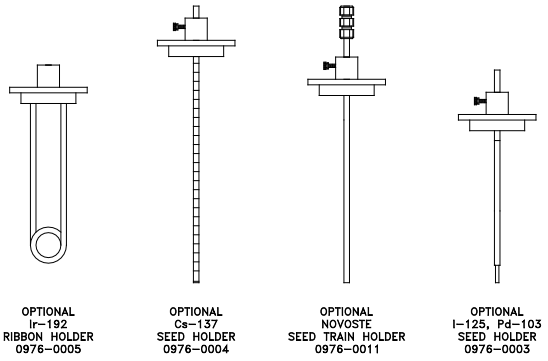


Figure 4-7 Optional Holders

ENVIRONMENT REQUIREMENTS

Indoor use only. Pollution Degree 2, Altitude, and Installation Cat. II.

The instrument should be located where the level of the background radiation is as low and as constant as possible.

The instrument should be located where the temperature is stable within a range of +50°F to +85°F (+10°C to +30°C) and the maximum relative humidity is 90% non-condensing to warrant maximum reliability and accuracy.

The instrument should be located where the barometric pressure is within a range of 27 – 31 inches of mercury (91 – 105 kilopascals).

CAUTION: If these environmental requirements are not followed, the instrument may display erroneous readings.

POWER REQUIREMENTS

CAUTION: If the input voltage to the following items is not within the stated limits, the unit may not function correctly or may be damaged.

CRC®-PC Smart Chamber

Power supplied by the USB port.
5 Vdc @ 0.5 amps

Power supplied by the optional PoE (Power over Ethernet) is Class 0 if so powered.

Laptop Computer (Optional)

Dell Vostro 2520 (or equivalent)
100~240Vac, 50-60Hz, 1.7A

Power over Ethernet (PoE) Module (Optional)

PowerDsine 3501G (or equivalent)[2]
Input: 100-240Vac, 50/60Hz, 0.43A; ***Output***: +48Vdc, 0.35A

Printer (Optional)

HP Officejet 6000 Series (or equivalent)
100-240Vac, 50/60Hz, 1.5A

GENERAL OPERATIONAL SETUP

There are several things that **must** be done before using the CRC®-PC Smart Chamber for the first time. The following briefly describes these steps:

- Verify or set the date/time: Although the date and time are set at the factory, you should verify that the date and time are correct for your location. Reference CHAPTER 5: SYSTEM INITIALIZATION, SECTION: SET DATE AND TIME.
- Select proper units: Ci or Bq. Although the system can be changed at any time, it is recommended that the proper units be set prior to using the unit to prevent confusion. Reference CHAPTER 5: SYSTEM INITIALIZATION, SECTION: CHOOSING Ci or Bq.
- Input Test Source Data: Test Sources (Standard Sources) are used for the Accuracy and Constancy tests. The Accuracy may be tested using Co57, Co60, Ba133, Cs137

[2] If any PoE Power Supply other than one recommended by Capintec is used, the safety of the unit may be compromised or Electromagnetic Interference (EMI) may be introduced into other devices located in the same general area as the CRC®-PC Smart Chamber or the CRC®-PC Smart Chamber may become susceptible to EMI.

or Na22. There can be a Test Source for each of these nuclides. Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: TEST SOURCE SETUP.

- Input Auto Constancy Test Source: The Base Source for the Auto Constancy Test is chosen from the entered Test Sources. Reference CHAPTER 6: CHAMBER INITIALIZATION; SECTION: AUTO CONSTANCY SETUP.
- Adding a Nuclide: The CRC®-PC Smart Chamber contains nuclide data (name, half-life, calibration number) for 90 nuclides. The user may add up to 30 nuclides: the name, Calibration Number and half-life will be added for each one. Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: USER NUCLIDES.
- Changing Calibration Numbers: The Calibration Number for any of the built-in nuclides can be changed. Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: CALIBRATION NUMBERS.
- Selecting the Moly Assay Method: Moly Assay can only be performed with the CRC®-PC Smart Chamber using a CAPMAC or CANISTER. Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: MOLY ASSAY SETUP.
- Setting Mo/Tc Limit: The Mo/Tc limit is set at the factory to 0.15µCi/mCi. This value can be changed. Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: MOLY ASSAY SETUP.

ACCEPTANCE TESTING

The following tests should be performed prior to operational use of the unit.

Chamber Tests

Diagnostics Test

Reference CHAPTER 9: DIAGNOSTICS for instructions on how to perform this test.

Daily Test

Reference CHAPTER 8: CHAMBER TESTS, SECTION: DAILY TEST for instructions on how to perform this test.

Accuracy Test

Reference CHAPTER 8: CHAMBER TESTS, SECTION: ACCURACY TEST for instructions on how to perform this test.

TURN-OFF PROCEDURES

The turn-off procedures are different depending upon the configuration of the system. Follow the appropriate instructions for your system configuration.

Non-Networked Computer with PoE Module

1. Shutdown the Computer.

2. Once the Computer is powered off, unplug the PoE Module line cord from the AC line. Note that the “Port On” indicator light will turn off.

Non-Networked Computer without PoE Module

1. Shutdown the Computer.

Non-Powered Local Network Connection

1. Unplug the PoE Module line cord from the AC line. Note that the “Port On” indicator light will turn off.

PoE Powered Local Network Connection

1. Unplug the Ethernet Cable from the USB/Ethernet Interface on the Chamber or from the Local Network Ethernet port.

No other special steps are required to terminate operation of the CRC®-PC Smart Chamber.

UTILITIES

To access the Utilities Screen, click the **Utilities** button on Figure 4-5 Main/Measurement Screen. Figure 4-8 Utilities Screen will appear.

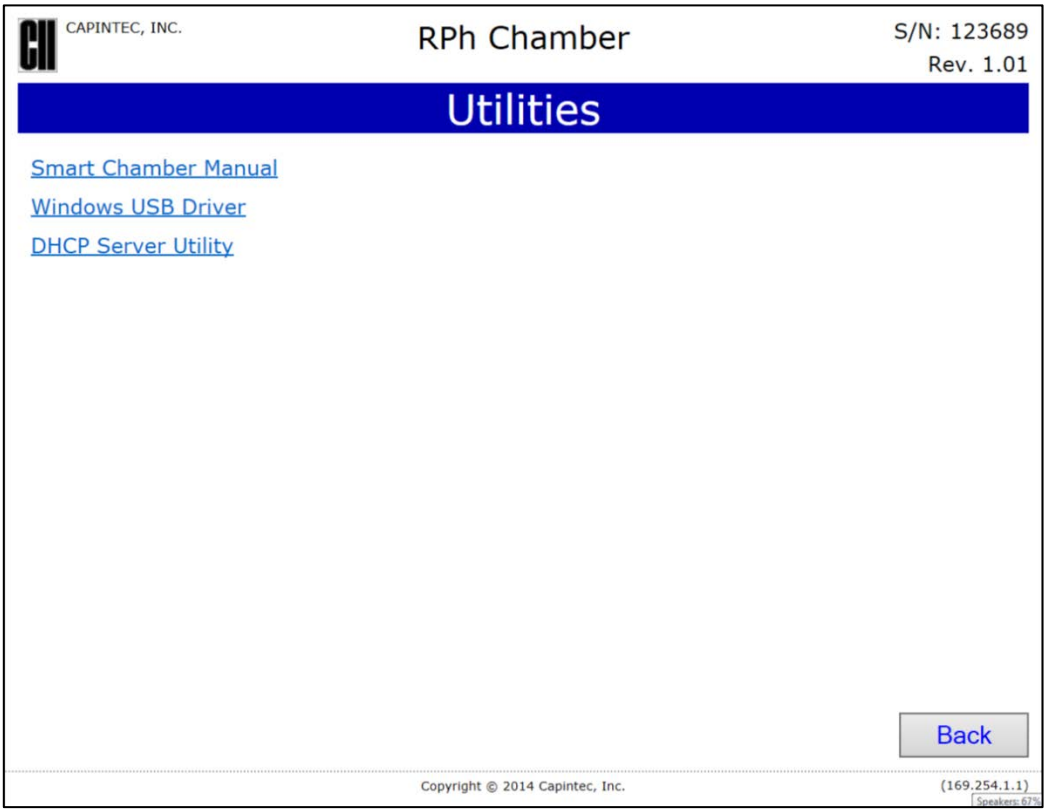


Figure 4-8 Utilities Screen

Smart Chamber Manual

Note: *A pdf viewer program must be installed on the computer in order to view or print the Owner's Manual.*

To view the CRC®-PC Smart Chamber Owner's Manual, click on the **Smart Chamber Manual** link. After a few seconds, the manual will appear in pdf format. The manual may be saved to the computer hard drive or printed.

Windows USB Driver

If the system communicates with the CRC®-PC Smart Chamber through the USB port, the USB Driver should be downloaded and installed.

Click on the **Windows USB Driver** link. Figure 4-9 USB Driver Download Screen will appear.

Figure 4-9 USB Driver Download Screen

Click the **Save** button and save the file to the desired folder.

Using Windows/File Explorer, open the folder where the driver file was saved. Right-click on the ***schamb.inf*** file.

From the pop-up menu, click *Install*. The driver will be installed on the computer.

DHCP Server Utility

This utility is used in systems that are connected to a network. It is used to recover from invalid network configurations.

Click on the **DHCP Server Utility** link. Figure 4-10 DHCP Server Download Screen will appear.

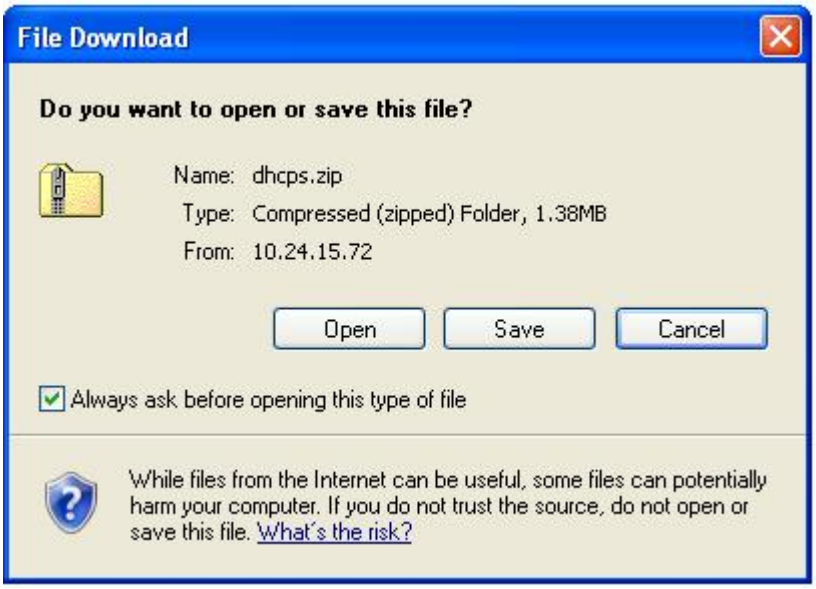


Figure 4-10 DHCP Server Download Screen

Click the **Save** button and save the file to the desired folder.

Using Windows/File Explorer, open the folder where the file was saved.

Double-click the ***dhcps.zip*** file.

Copy **dhcps_install** folder to another folder.

Open the **dhcps_install** folder.

Double-click ***setup.exe*** and follow the installation procedure. This will install the **DHCP Server Utility** program onto the computer.

Reference CHAPTER 5: SYSTEM INITIALIZATION, SECTION: TCP/IP Configuration, DHCP Server for instructions on using the utility.

CHAPTER 5

SYSTEM INITIALIZATION

GENERAL

This section describes initialization and parameter setup for the CRC®-PC Smart Chamber.

All of these functions are accessed via the Setup module.

ACCESSING THE SETUP MODULE

The Setup functions are accessed by clicking the Setup button on the Main/Measurement screen. A User name and Password are required to access the Setup Module.

From the Main/Measurement screen, click the **Setup** button. Figure 5-1 Enter Password Window will appear allowing the user to input a User name and Password.

Figure 5-1 Enter Password Window

Note: *If the User name and Password were entered earlier and the "Remember my password/credentials" checkbox was previously checked, the formerly entered User name will be displayed along with dots for the Password. Clicking the **OK** button will proceed to Figure 5-2 Setup Screen.*

To access the Setup module, the user must log-in as *root*. In the ***User name:*** text box, input root (all lower case letters). To cancel inputting the User name and return to the Main/Measurement screen, click the **Cancel** button.

The default password is *ArrowRoad* (case sensitive).

Note: *It is strongly recommended that the default password be changed. Reference the Changing Password section on page 5-5-8 for more information.*

In the ***Password:*** text box, input ArrowRoad (case sensitive). To cancel inputting the Password and return to the Main/Measurement screen, click the **Cancel** button.

If it is desired to have the computer remember the entered User name and Password, click the "Remember my password/credentials" checkbox to place a check mark in the box. The next time Setup is accessed, the previously entered User name will be displayed along with dots for the Password.

Click the **OK** button. Figure 5-2 Setup Screen will appear.

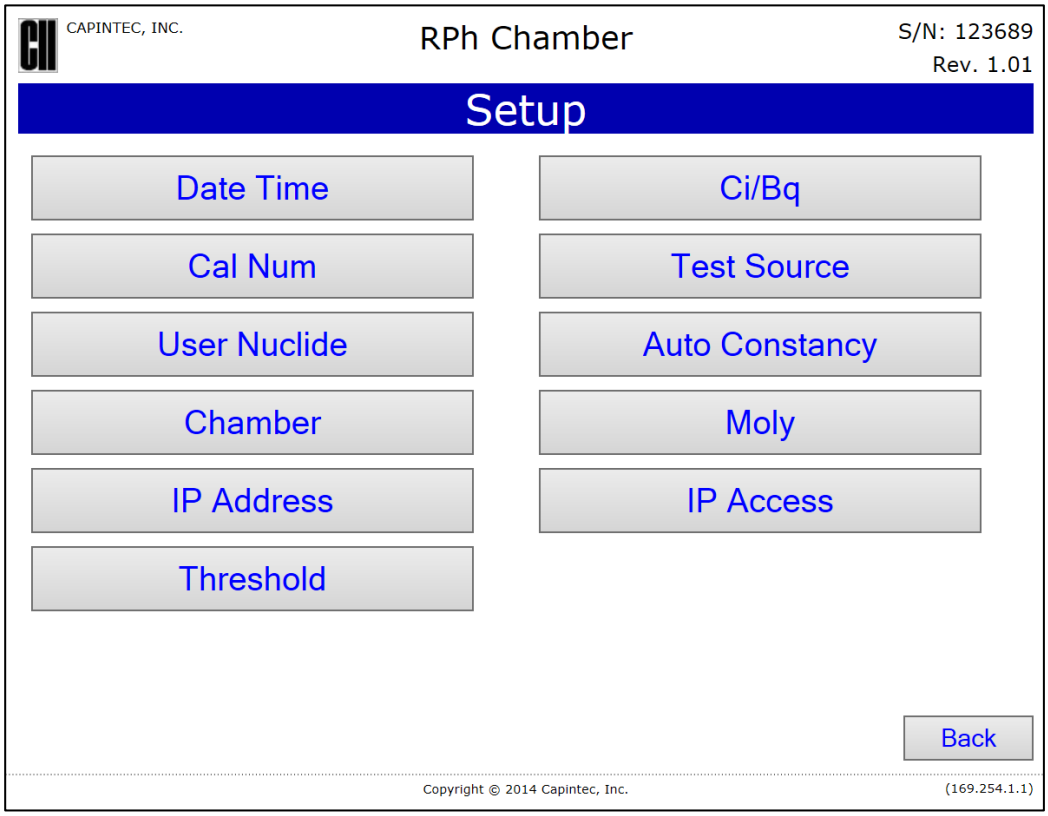


Figure 5-2 Setup Screen

To exit the Setup screen and return to the Main/Measurement screen, click the **Back** button.

Set Date and Time

The system date and/or time is set from the Setup screen.

Date

Click the **Date Time** button. Figure 5-4 Date Entry Screen will appear displaying the current date and time.

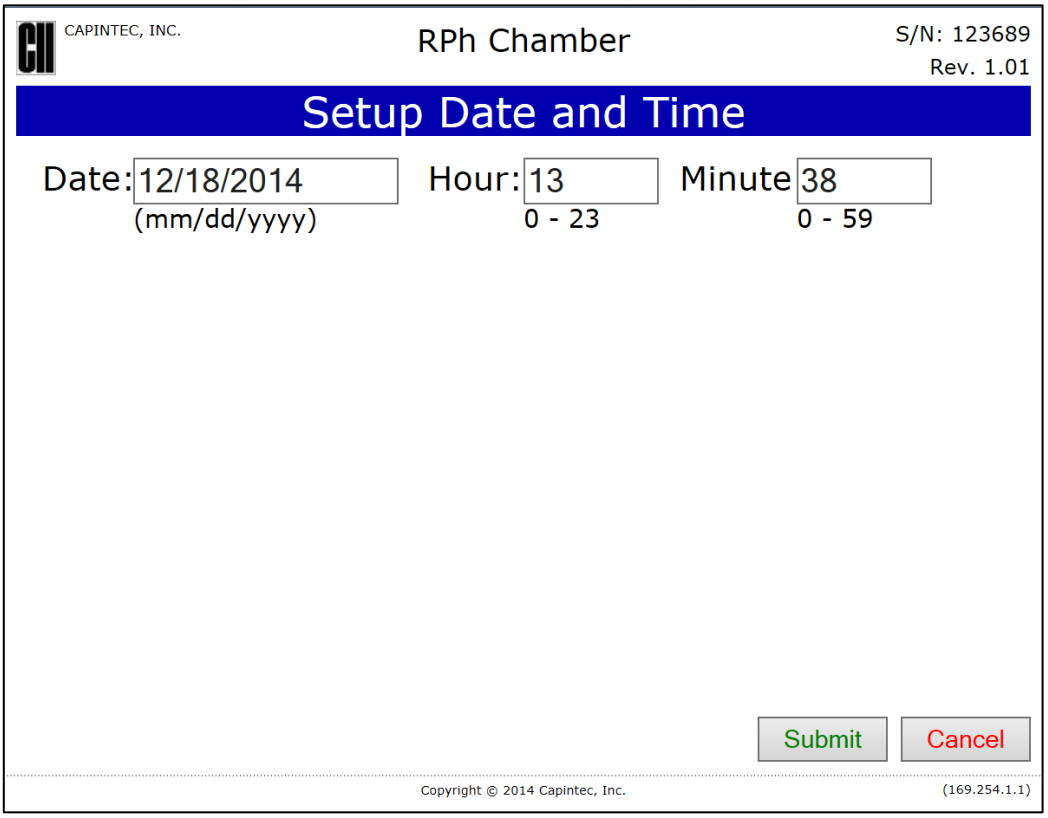


Figure 5-3 Setup Date and Time Screen

To set the Date, click in the ***Date:*** box. A pop-out calendar will appear as shown in Figure 5-4 Date Entry Screen – Calendar.

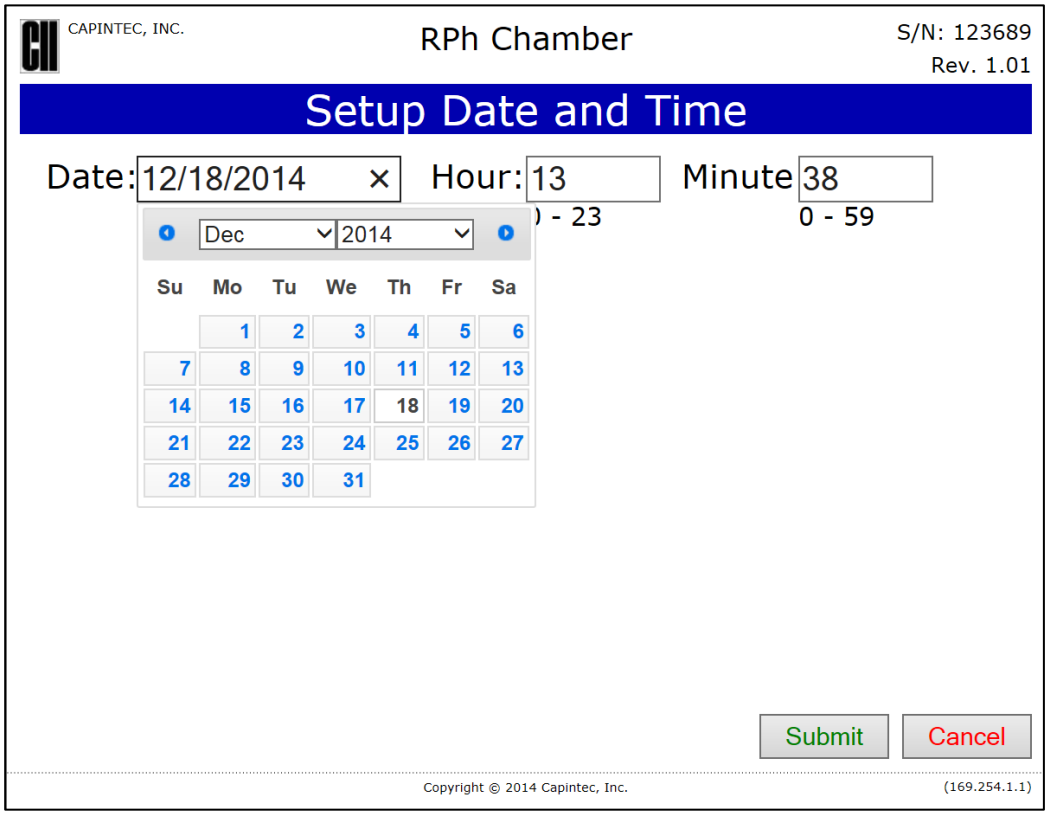


Figure 5-4 Date Entry Screen – Calendar

The appropriate month and year can be entered in two ways using the Calendar:

- Click on the *Month* or *Year* drop-down list box. Choose the appropriate month or year by clicking on the desired selection.
- Click on the **Previous Arrow** button (located to the left of the *Month* drop-down list box) or the **Next Arrow** button (located to the right of the *Year* drop-down list box) to advance the Calendar one month at a time until the correct month and year are displayed.

When the month and year are correct, click on the desired day on the Calendar. The Calendar will close and Figure 5-3 Setup Date and Time Screen will display the set date.

Time

To set the Hour in 24-hour format, click in the ***Hour:*** text box. Input the desired hour (0-23).

To set the Minute, click in the ***Minute:*** text box. Input the desired minute (0-59).

Once the correct date and time are set, click the **Submit** button to save the entered date/time or click the **Cancel** button to discard the changes. Figure 5-2 Setup Screen will re-appear.

Chamber Setup

The Chamber Title, Date Format, Password and Update Software functions are accessed by clicking the **Chamber** button on the Setup screen. Figure 5-5 Setup Chamber Screen will appear.

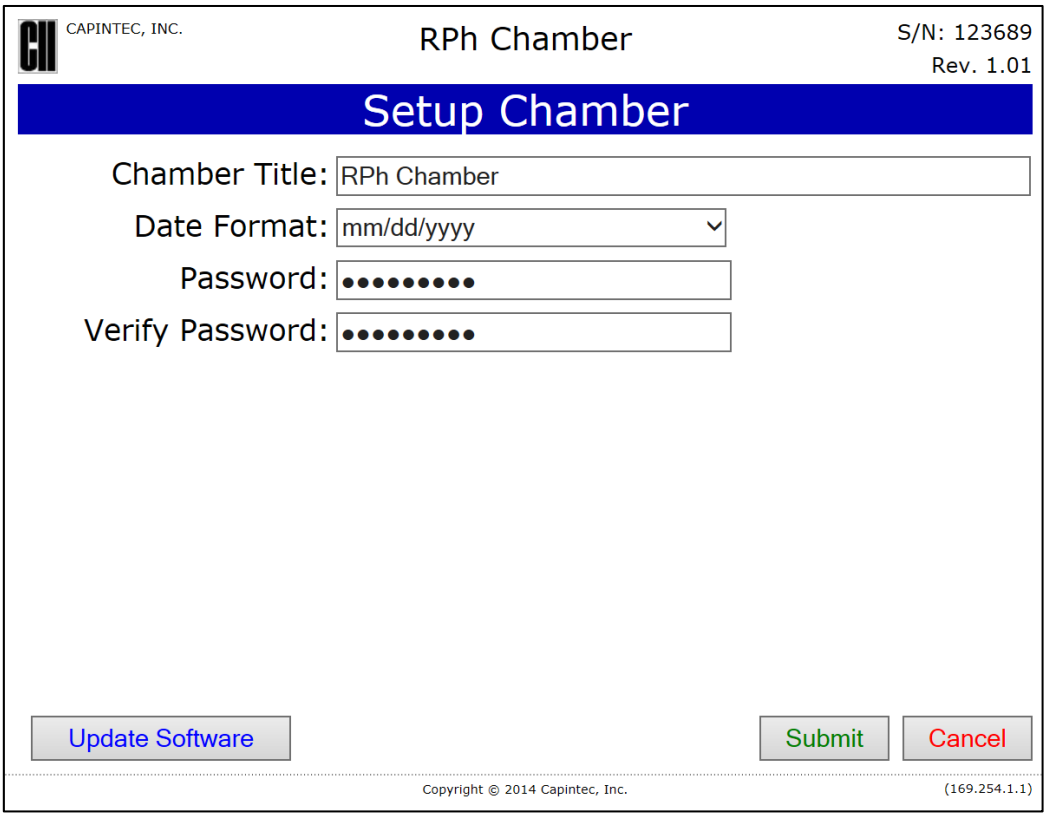


Figure 5-5 Setup Chamber Screen

Setting Chamber Title

The Chamber Title (name) appears on every screen and report. The Chamber Title is not required but should be entered to distinguish it if more than one CRC®-PC Smart Chamber is connected to the system.

Click in the ***Chamber Title:*** text box and input the desired title. The title can contain any combination of 22 alphanumeric characters maximum.

When finished inputting the Chamber Title, click the **Submit** button to save the entered name or click the **Cancel** button to discard the changes. Figure 5-2 Setup Screen will re-appear.

Setting Date Format

The date can be entered, displayed and printed in 3 formats:

- Month Day Year (mm/dd/yyyy)
- Day Month Year (dd/mm/yyyy)
- Year Month Day (yyyy/mm/dd)

The default date format is Month Day Year. This format will be shown throughout the manual.

To set the date format, click on the ***Date Format:*** drop-down list box. The Date Format drop-down list will appear allowing the selection of one of three the formats as shown in Figure 5-6 Date Format Drop-Down List.

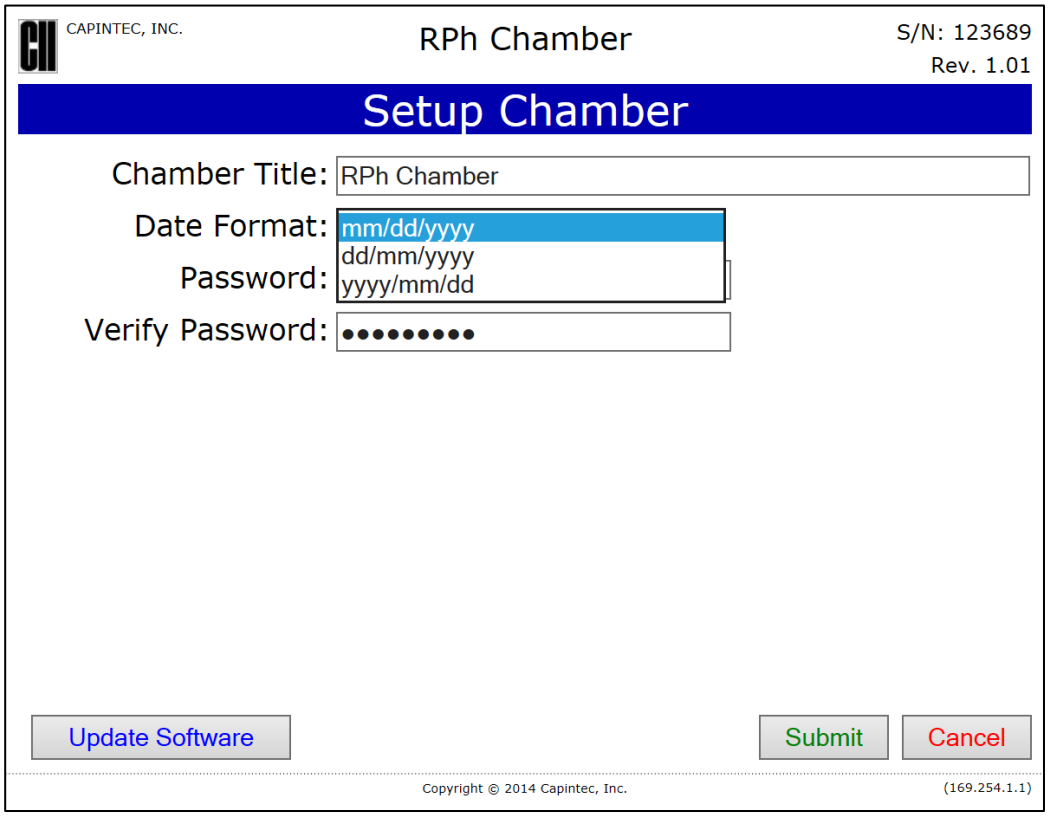


Figure 5-6 Date Format Drop-Down List

Click on the desired date format and then click the **Submit** button to enable the selected format or click the **Cancel** button to discard the changes. Figure 5-2 Setup Screen will re-appear.

Changing Password

Note: *It is strongly recommended that the default password be changed.*

The password that is required to access the Setup functions may be changed from that provided by Capintec.

From Figure 5-5 Setup Chamber Screen, click in the ***Password:*** text box and erase the entered password.

Input the new password in the ***Password:*** text box. The password can contain any combination of 10 alphanumeric characters maximum. The password will not be displayed for security.

Click in the ***Verify Password:*** text box and erase the verify password. Input the new password in the ***Verify Password:*** text box. The verify password will not be displayed for security. ***Password*** and ***Verify Password*** must match to change the password.

If the passwords do not match, a message window will appear. Click the OK button to close the message window and re-enter the password.

Click the **Cancel** button to discard the changes. Click the **Submit** button to save the entered password. Figure 5-7 New Password Verification Window will appear.

Figure 5-7 New Password Verification Window

Input the new password and click the **OK** button. The Password Verification Window will close and Figure 5-5 Setup Chamber Screen will re-appear.

Choosing Ci or Bq

The CRC®-PC Smart Chamber can display activity in Curies or Becquerels. This applies to measurements, Test Source activities and Moly measurements.

To select the desired activity unit, from Figure 5-2 Setup Screen, click the **Ci/Bq** button. Figure 5-8 Set Ci/Bq Screen will appear.

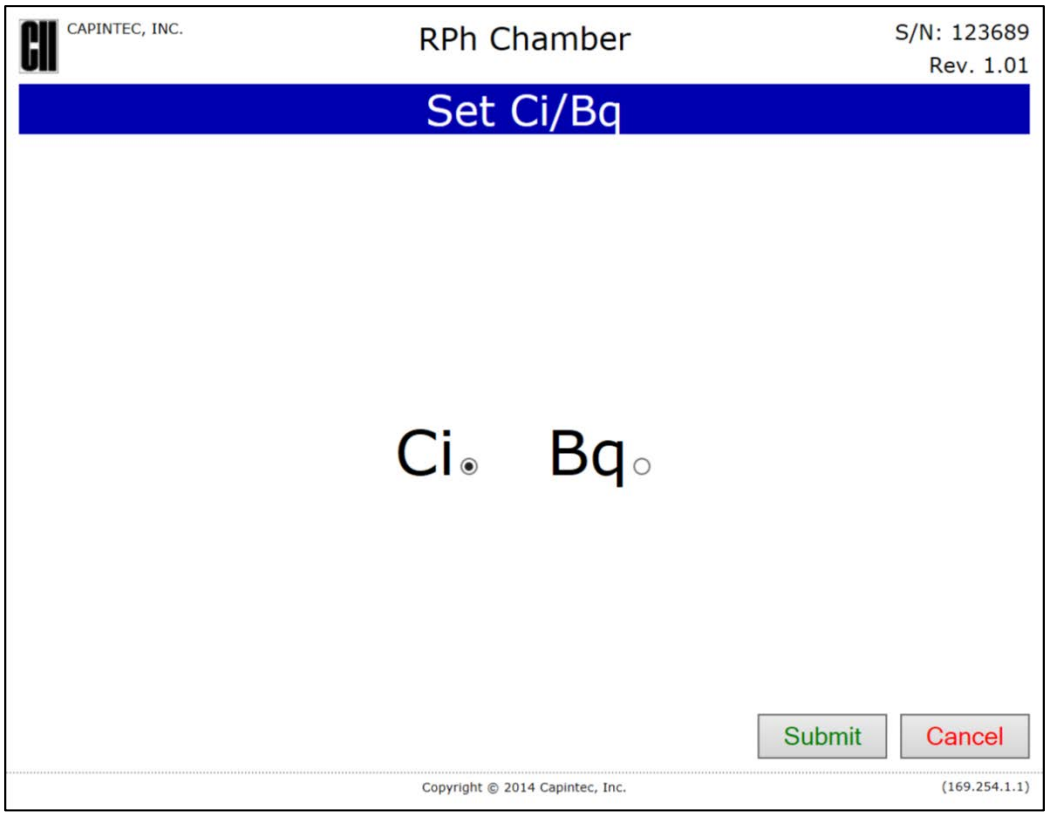


Figure 5-8 Set Ci/Bq Screen

Click the radio button next to the desired activity unit and click the **Submit** button to set the selected activity unit or click the **Cancel** button to discard the changes.

Setting up the IP Address

Ethernet MAC Address Assignment

From Figure 5-2 Setup Screen, click the **IP Address** button. Figure 5-9 Setup IP Address Screen will appear.

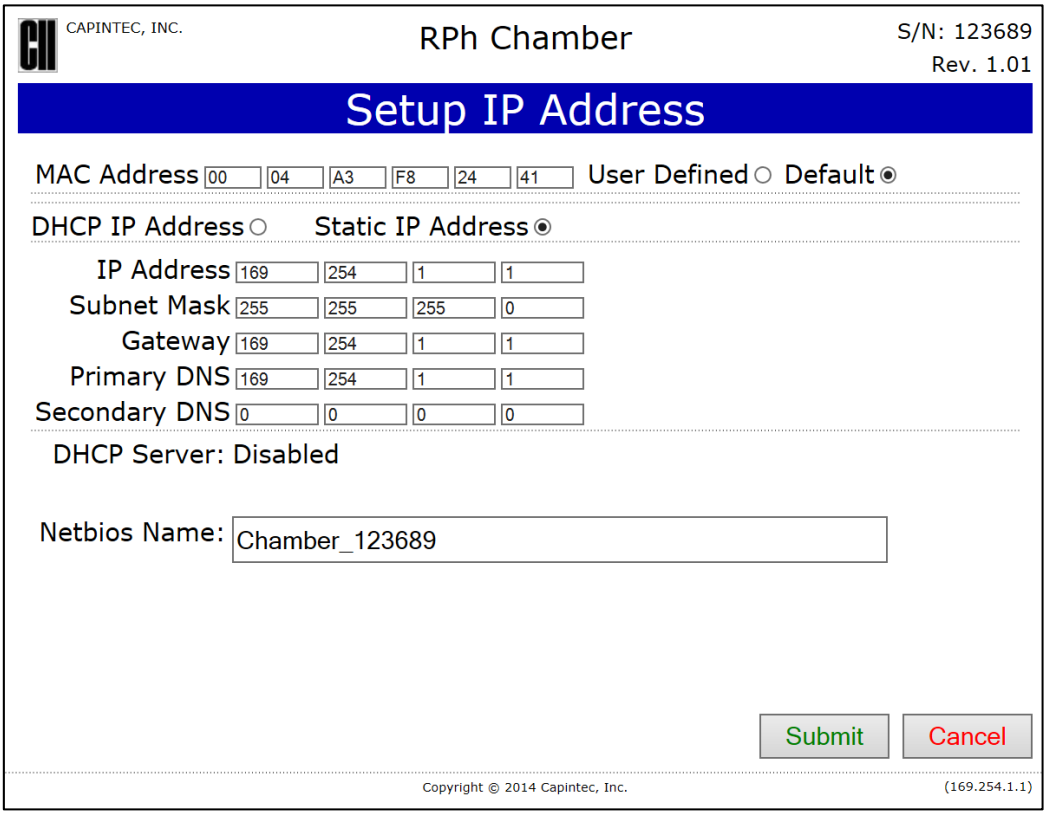


Figure 5-9 Setup IP Address Screen

The current MAC Address is displayed. Each CRC®-PC Smart Chamber has a unique default MAC Address. This is the MAC Address set from the factory. However, the MAC Address can be user defined.

Using the Default MAC Address

If the MAC Address was changed from the default and it is desired to use the default setting, from Figure 5-9 Setup IP Address Screen, click the **Default** radio button and then click the **Submit** button.

The message “Chamber has restarted. Wait 15 seconds before communicating with the Smart Chamber” will be displayed. Close the web browser. Wait a few minutes for the CRC®-PC Smart Chamber to restart. Restart the web browser to view the CRC®-PC Smart Chamber.

Setting a User Defined MAC Address

The MAC Address can be user defined. To specify the desired MAC Address, input the new MAC Address into the ***MAC Address*** text boxes in Figure 5-9 Setup IP Address Screen and then click the **User Defined** radio button. Click the **Submit** button.

The message “Chamber has restarted. Wait 15 seconds before communicating with the Smart Chamber” will be displayed. Close the web browser. Wait a few minutes for the CRC®-PC Smart Chamber to restart. Restart the web browser to view the CRC®-PC Smart Chamber.

To exit Figure 5-9 Setup IP Address Screen without saving any changes, click the **Cancel** button.

TCP/IP Configuration

Get IP Parameters Automatically (DHCP)

To obtain the IP Address parameters automatically, from Figure 5-9 Setup IP Address Screen, click the **DHCP IP Address** radio button and the click the **Submit** button.

The message “Chamber has restarted. Wait 15 seconds before communicating with the Smart Chamber” will be displayed. Close the web browser. Wait a few minutes for the CRC®-PC Smart Chamber to restart.

Set IP Parameters Manually

Enter values for **IP Address**, **Subnet Mask**, **Gateway**, **Primary DNS**, and **Secondary DNS** in Figure 5-9 Setup IP Address Screen. Click on the **Static IP Address** radio button. Click the **Submit** button.

The message “Chamber has restarted. Wait 15 seconds before communicating with the Smart Chamber” will be displayed. Close the web browser. Wait a few minutes for the CRC®-PC Smart Chamber to restart. Start new web browser to view the CRC®-PC Smart Chamber.

DHCP Server

The CRC®-PC Smart Chamber can act as a limited DHCP server. This mode is used when connecting a CRC®-PC Smart Chamber directly to a PC. The default mode coming from the factory is disabled. The DHCP Server can be enabled from a USB connection. When enabled, the DHCP server is limited to assigning only one IP address and the server only runs for the first three minutes from the initial CRC®-PC Smart Chamber power-up. If the DHCP server is enabled, it can be disabled from either a USB connection or from the Setup IP Address screen.

To access this mode:

1. **Enable the DHCP Server**
    a. Connect the CRC®-PC Smart Chamber to a computer using the USB connection.
    b. Using Windows™ Device Manger, determine the COM port of the CRC®-PC Smart Chamber.
    c. Send Enable Smart Chamber Command

i. Using the Windows DHCP Server Utility, select the Smart Chamber's COM port from the COM Port drop-down box. Click the **Enable DHCP Server** button. (To Disable the DHCP Server, click the **Disable DHCP Server** button.)

OR

ii. Use a serial terminal program, such as PUTTY or Hyper Terminal. Connect the terminal program to the Smart Chamber COM port. Type "dhcps on" into the terminal program. The Smart Chamber will reply with "DHCP Server: Enabled". (To Disable DHCP Server, type "dhcps off" into the terminal program.)

2. Remove power from the CRC®-PC Smart Chamber.
3. Connect the CRC®-PC Smart Chamber Ethernet port directly to a DHCP client (Windows™ PC).
4. Power up the CRC®-PC Smart Chamber.
5. Wait for the DHCP client to recognize the CRC®-PC Smart Chamber.
6. The IP address of the CRC®-PC Smart Chamber will be one less than the address of the computer. In Windows, the PC's IP address can be obtained by typing "ipconfig" into a command window.

Additionally, this mode can be used as a fail-safe mode. If the IP Settings/Access were incorrectly configured, then this mode can be used to access the CRC®-PC Smart Chamber to reconfigure the IP Settings/Access.

NetBIOS Name (Hostname)

The NetBIOS Name can be used to access the Chamber through the web browser without having to know the set IP address.

The default NetBIOS Name is "Chamber_XXXXXX" where XXXXXX is the six-digit serial number of the Smart Chamber.

The NetBIOS Name can be changed. Valid NetBIOS Name characters are A-Z, a-z, 0-9, dash and underscore. The Name is limited to 15 characters.

To view the CRC®-PC Smart Chamber, start the web browser. In the web browser's address bar, input **http://Chamber_XXXXXX** (XXXXX is the serial number) and press Enter.

Control Access by IP Address

The CRC®-PC Smart Chamber provides access control by the client (Web Browser) IP Address. From Figure 5-2 Setup Screen, click the **IP Access** button. Figure 5-10 Setup IP Access Screen will appear

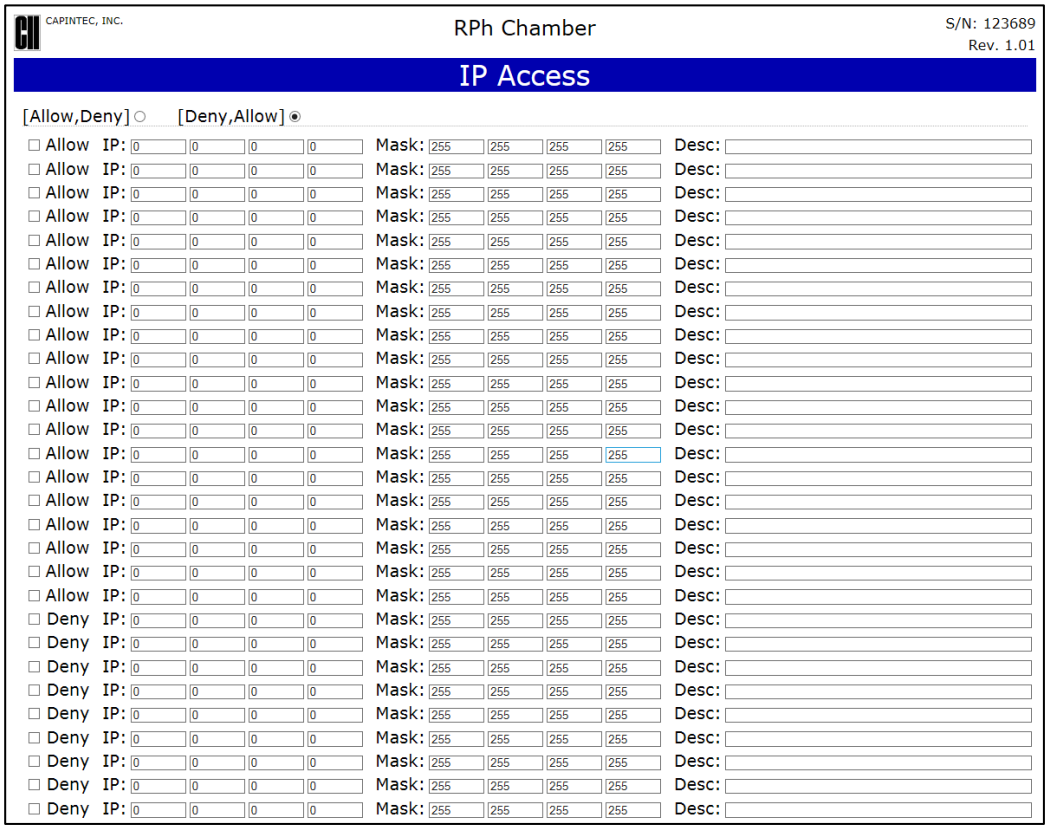


Figure 5-10 Setup IP Access Screen

The Setup IP Access screen has twenty positions to define **ALLOW** IP ranges and twenty positions to define **DENY** IP ranges.

The user can activate an IP range by:

1. Enabling the checkbox on the left,
2. Entering the desired IP address and the Mask and
3. Optionally entering a description.

Example: IP: 192.168.2.0 and Mask: 255.255.255.0 defines IP Ranges 192.168.2.0 – 192.168.2.255

Example: IP: 192.168.2.13 and Mask 255.255.255.255 defines one IP Address 192.168.2.13

Allow, Deny

The **Allow, Deny** radio button allows the CRC®-PC Smart Chamber to evaluate the **ALLOW** IP ranges first and then the **DENY** IP ranges. Hence, the **DENY** IP ranges should in part be in the set of **ALLOW** IP ranges, otherwise it was already denied.

Deny, Allow

The **Deny, Allow** radio button allows the CRC®-PC Smart Chamber to evaluate the **DENY** IP ranges first and then the **ALLOW** IP ranges. Hence, the **ALLOW** IP ranges should in part be in the set of **DENY** IP ranges, otherwise it was already allowed.

PRINTING

If an optional printer was included with the system, the printer driver will already be installed in the Windows™ OS. Printing is accomplished by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl*+*P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

⚠ **CAUTION:** If any printer other than one of the models supplied by Capintec is used, Electromagnetic Interference (EMI) may be introduced into other devices located in the same general area as the CRC®-PC Smart Chamber.

CHAPTER 6

CHAMBER INITIALIZATION

GENERAL

This section describes initialization and parameter setup for the CRC®-PC Smart Chamber.

All of these functions are accessed via the Setup module.

ACCESSING THE SETUP MODULE

The Setup functions are accessed by clicking the Setup button on the Main/Measurement screen. A User name and Password are required to access the Setup module.

From the Main/Measurement screen, click the **Setup** button. Figure 6-1 Enter Password Window will appear allowing the user to input a User name and Password.

Figure 6-1 Enter Password Window

Note: *If the User name and Password were entered earlier and the "Remember my password/credentials" checkbox was previously checked, the formerly entered User name will be displayed along with dots for the Password. Clicking the **OK** button will proceed to Figure 6-2 Setup Screen.*

To access the Setup module, the user must log-in as *root*. In the ***User name:*** text box, input root (all lower case letters). To cancel inputting the User name and return to the Main/Measurement screen, click the **Cancel** button.

The default password supplied from Capintec is *ArrowRoad* (case sensitive).

Note: *It is strongly recommended that the default password be changed. Reference CHAPTER 5: SYSTEM INITIALIZATION; SECTION CHANGING PASSWORD for more information.*

In the ***Password:*** text box, input the current password (case sensitive). To cancel inputting the Password and return to the Main/Measurement screen, click the **Cancel** button.

If it is desired to have the computer remember the entered User name and Password, click the "Remember my password/credentials" checkbox to place a check mark in the box. The next time Setup is accessed, the previously entered User name will be displayed along with dots for the Password.

Click the **OK** button. Figure 6-2 Setup Screen will appear.

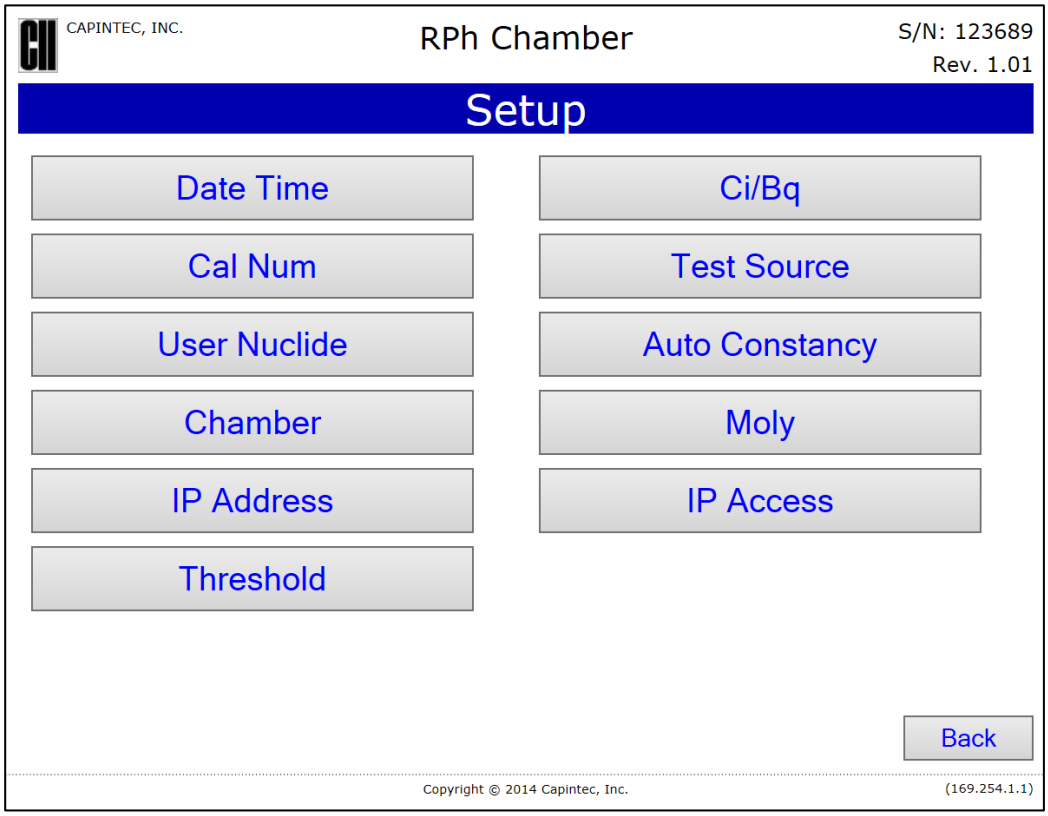


Figure 6-2 Setup Screen

To exit the Setup screen and return to the Main/Measurement screen, click the **Back** button.

TEST SOURCE SETUP

Test Sources (Standard Sources) are used for the Accuracy and Constancy Tests.

The Accuracy and Constancy may be tested using Co57, Co60, Ba133, Cs137 and/or Na22. There can be a Test Source for each of these nuclides. One or more of the Test Sources can be used in the Accuracy part of the Daily Test. One of the sources can be chosen as the base source to be used for the Constancy Test.

The Test Sources that are entered will allow the user to measure the respective Test Source when performing the Accuracy part of the Daily Test or the Accuracy Test itself.

To setup Test Source data, from the Setup screen, click the **Test Source** button. Figure 6-3 Setup Test Sources Screen will appear. The example shows all 5 Test Sources entered.

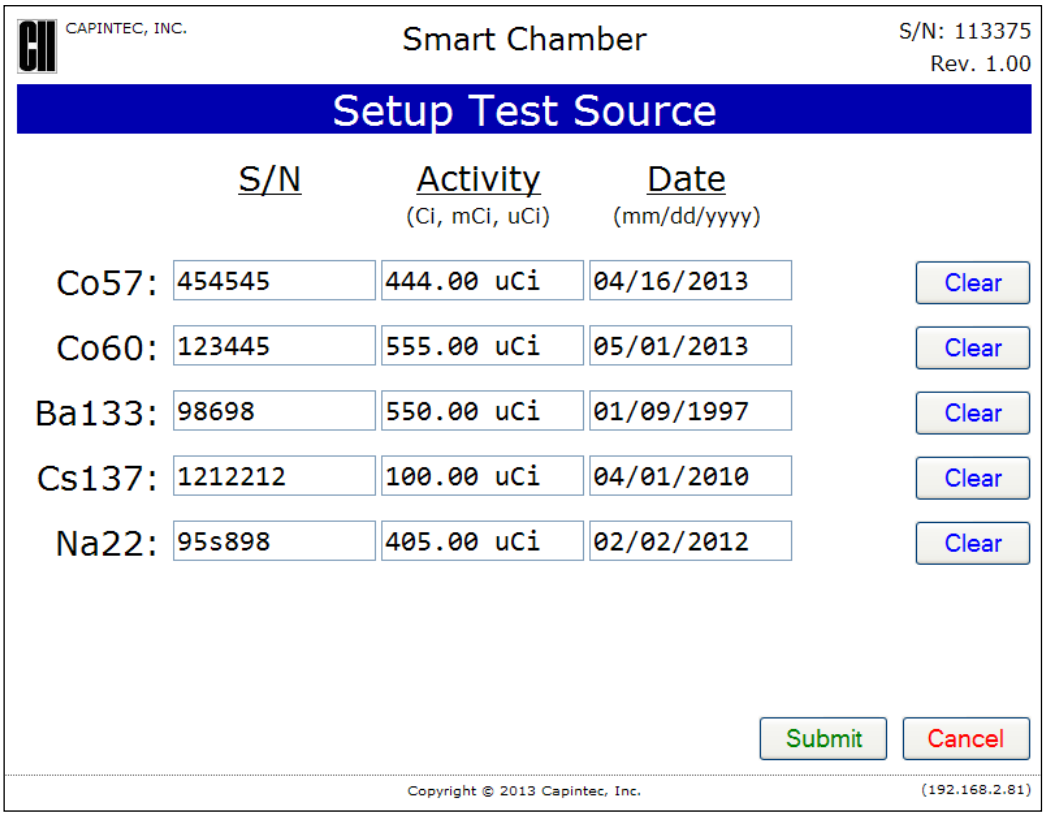


Figure 6-3 Setup Test Sources Screen

Adding a Source

Note: *All fields (**S/N**, **Activity**, **Date**) for the selected source are required and must be completed before exiting the Setup Test Source screen or the message "Xx11 is incomplete" will be displayed (where Xx11 is the name of the Source).*

To input information for the desired Test Source, click in the desired field box and input the appropriate data for that source.

Serial Number (S/N) Field

For the Test Source Serial Number (***S/N***), click in the ***S/N*** text box for the desired source and input the serial number data of the Test Source. The serial number can contain up to 10 alphanumeric characters.

Activity Field

The Calibration Activity must be less than 1 Curie. The current activity (calibration activity decayed to the present time) must be greater than the activity in the table below.

Note: *Capintec strongly recommends replacing the Test Source when the activity decays below the recommended "Minimum at Current Time" limits.*

	Minimum at Current Time		Maximum	
Source	**Ci**	**Bq**	**Ci**	**Bq**
Co57	50.0 µCi	1.85 MBq	1.0 Ci	37000 MBq
Co60	50.0 µCi	1.85 MBq	1.0 Ci	37000 MBq
Ba133	50.0 µCi	1.85 MBq	1.0 Ci	37000 MBq
Cs137	50.0 µCi	1.85 MBq	1.0 Ci	37000 MBq
Na22	50.0 µCi	1.85 MBq	1.0 Ci	37000 MBq

Table 6-1 Test Source Calibration Activity Limits

Click in the ***Activity*** text box for the desired source and input the activity value and the appropriate unit of measure of the Test Source. Note that the unit of measure is case sensitive.

Example: If the activity of the source is 100 µCi, input 100uCi or 100 uCi.

Note: *The available units of measure will change depending on which unit of measurement the system is set to use. i.e. if set for Curies, the available units will be Ci, mCi and uCi; if set for Becquerels, the available units will be GBq and MBq.*

Date Field

For the Test Source Calibration Date, click in the ***Date*** text box. A pop-out Calendar will appear.

The appropriate month and year can be entered in two ways using the Calendar:

- Click on the *Month* or *Year* drop-down list box. Choose the appropriate month or year by clicking on the desired selection.
- Click on the **Previous Arrow** button (located to the left of the *Month* drop-down list box) or the **Next Arrow** button (located to the right of the *Year* drop-down list box) to advance the Calendar one month at a time until the correct month and year are displayed.

When the month and year are correct, click on the desired day on the Calendar. The Calendar will close and ***Date*** text box will display the set date.

When all Test Source information is entered, click the **Submit** button to save the changes or click the **Cancel** button to discard the changes.

Editing Source Data

Any data for any source can be edited simply by clicking the desired text box and inputting the new data as described in the Adding a Source section above beginning on page 6-6-4.

When finished editing the Test Source data, click the **Submit** button save the changes or click the **Cancel** button to discard the changes.

Deleting a Source

Test Sources are removed from the system by clicking the **Clear** button to the right of the desired Test Source to be deleted.

The deleted Test Source text boxes will be blank. Click the **Submit** button save the changes or click the **Cancel** button to discard the changes.

The selected Test Source is now erased from the system.

AUTO CONSTANCY SETUP

The Constancy may be tested using any one of the Test Sources (Co57, Co60, Ba133, Cs137 or Na22). There can be a Test Source for each of these nuclides. One of the sources must be chosen as the base source to be used for the Auto Constancy Test.

To select the Test Source to use as the base Constancy Source, from Figure 6-2 Setup Screen, click the **Auto Constancy** button. Figure 6-4 Setup Auto Constancy Screen will appear.

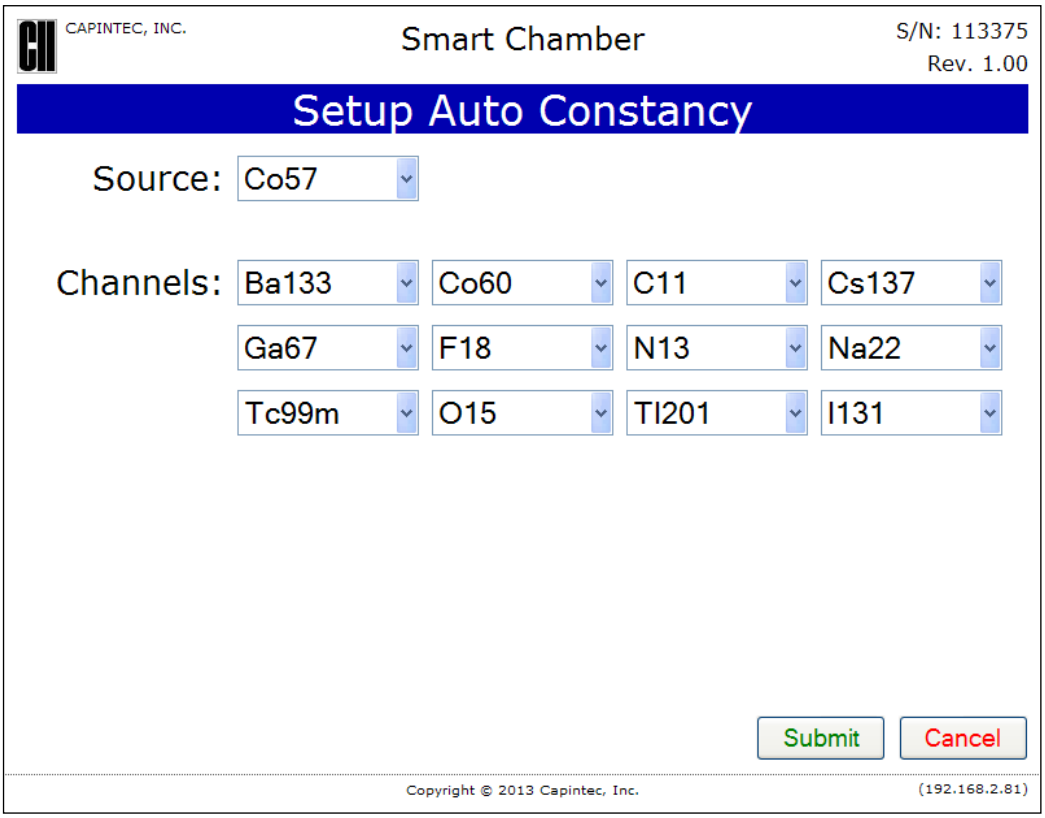


Figure 6-4 Setup Auto Constancy Screen

Click on the ***Source:*** drop-down list box. A list will appear allowing the selection of one of the added Test Sources. Click on the desired Test Source to use as the Constancy base source. In the example above, Co57 is set as the Constancy base source.

Constancy Channels

The Constancy Channels are the nuclides that will be tested during the automated Constancy Test during the Accuracy Test. Up to 12 nuclides may be selected.

Adding Channels

To select Channels to use for Auto Constancy, click on any one of the ***Channels:*** drop-down list boxes. A list will appear allowing the selection of available nuclides. The list consists of the nuclides stored in the CRC®-PC Smart Chamber's memory (both default and user added nuclides) that have a Calibration Number assigned to them (Refer to the CALIBRATION NUMBERS section on page 6-6-12).

User added nuclides are displayed at the top of the drop-down list in the entered order. The remaining nuclides are in alphabetical order. The length of the list will vary depending on which nuclides have a Calibration Number assigned to them (Refer to the CALIBRATION NUMBERS section on page 6-6-12).

Click on the desired nuclide to use as the Constancy Channel. The drop-down list will close and the selected ***Channels:*** list box will be populated with the selected nuclide.

Removing Channels

To remove a nuclide from the Constancy Channels, click on the desired ***Channels:*** drop-down list box. At the top of the list, there is a blank selection. Click on the blank. The drop-down list will close and the selected ***Channels:*** list box will be blank.

To save the changes, click the **Submit** button or click the **Cancel** button to discard the changes.

MOLY ASSAY SETUP

Moly Assay must be performed using either a CAPMAC or CANISTER.

To setup Moly Assay, from Figure 6-2 Setup Screen, click the **Moly** button. Figure 6-5 Setup Moly Assay Screen will appear.

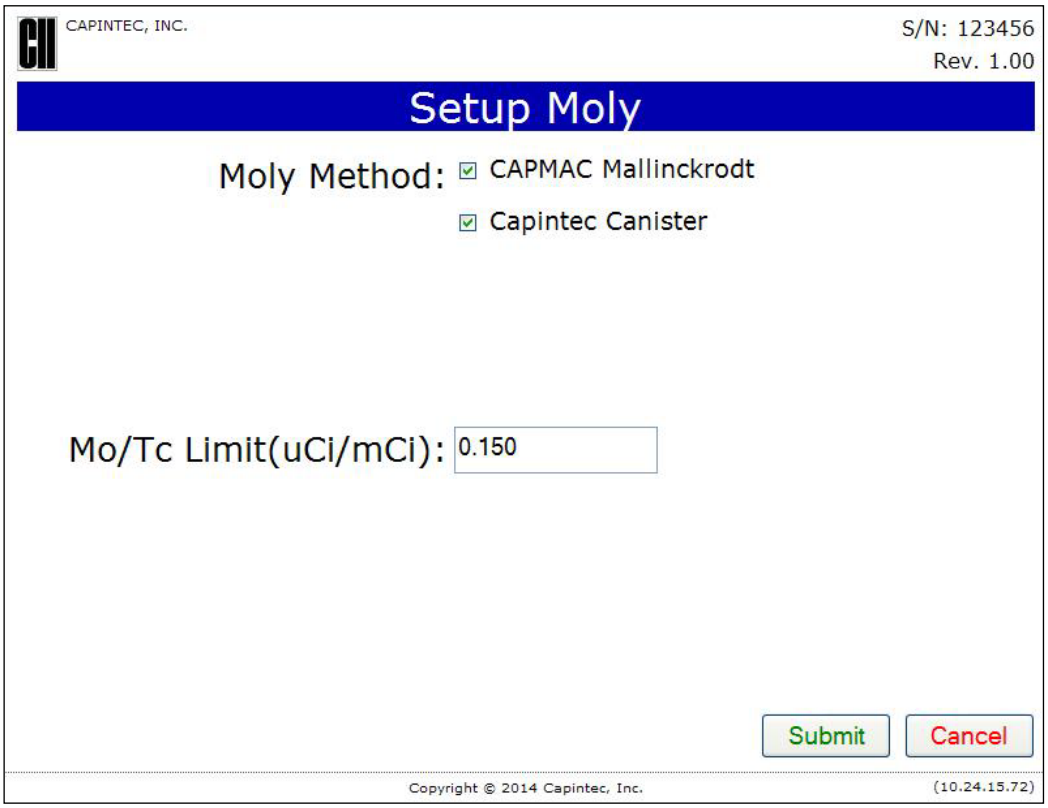


Figure 6-5 Setup Moly Assay Screen

Selecting Moly Assay Method

In the ***Moly Method:*** section, the current selections are displayed (default is none are selected).

Select the desired method(s) by clicking the appropriate checkbox. Each click will toggle the check between on or off.

Moly Assay Limit

The Moly Assay default limit is set to 0.150 µCi/mCi (or 0.150 MBq/GBq). This value can be changed.

To change the limit, click in the ***Mo/Tc Limit:*** text box and input the preferred value.

Note: *The minimum value that can be input is 0.001 µCi/mCi (0.001 MBq/GBq). The maximum value that can be input is 9.999 µCi/mCi (9.999 MBq/GBq).*

To save the changes, click the **Submit** button or click the **Cancel** button to discard the changes. Figure 6-2 Setup Screen will re-appear.

USER NUCLIDES

Adding a Nuclide

The CRC®-PC Smart Chamber contains nuclide data (name, calibration number, half-life) for 90 nuclides. Up to 30 User Nuclides can be added to the system.

To add a nuclide, from Figure 6-2 Setup Screen, click the **User Nuclide** button. Figure 6-6 Setup User Nuclide Screen will appear.

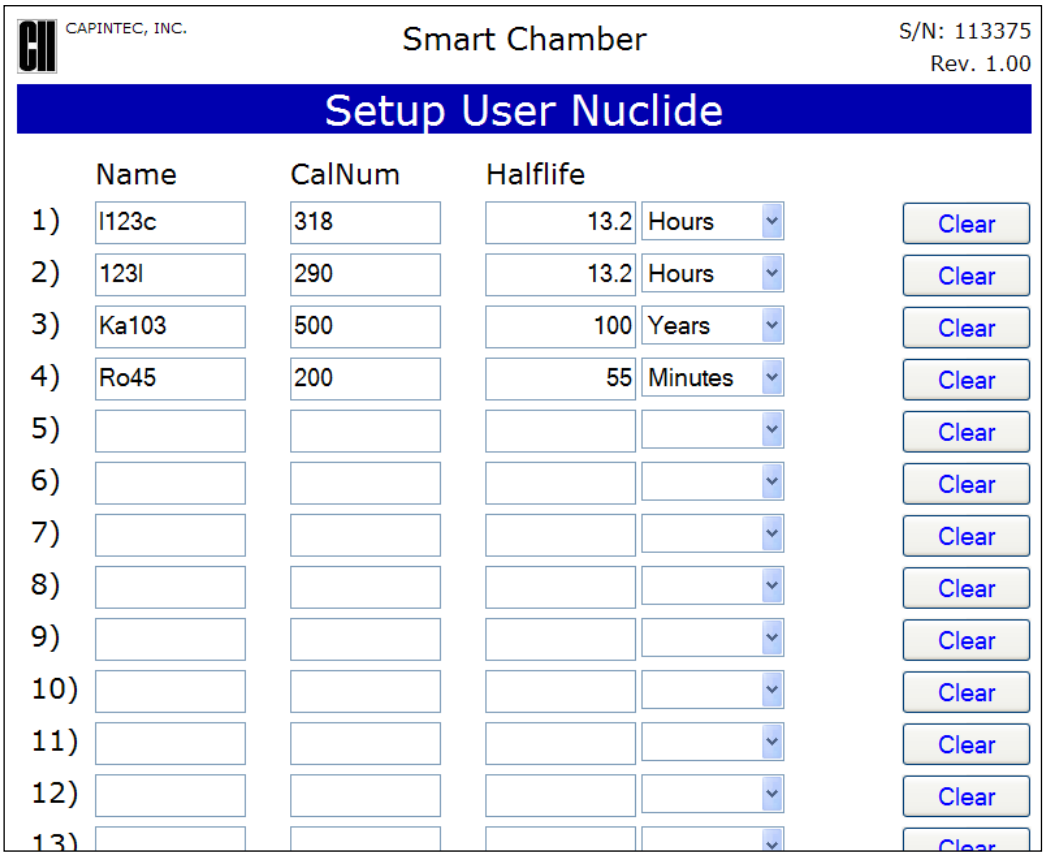


Figure 6-6 Setup User Nuclide Screen

The following parameters are input for each of the added nuclides: ***Name***, ***CalNum*** *and* ***Halflife***. Each of these parameters is described in the sections below.

To input information for the desired nuclide, click the desired field box and input the appropriate data for the nuclide.

All field boxes (***Name***, ***CalNum*** and ***Halflife***) for the nuclide being added are required and must be completed before clicking the **Submit** button or the message “Partial data entered” will appear. Click the **OK** button to dismiss the message. All entered data for the entire line of the incomplete nuclide will be displayed in red text. Input the missing Nuclide information.

After all necessary Nuclide information is input for all added nuclides, click the **Submit** button at the bottom of the screen. The added nuclide(s) is(are) now saved in the system.

All of the entered Nuclide data can cleared by clicking the **Clear** button to the right of the desired Nuclide data.

To cancel adding Nuclides, click the **Cancel** button.

Name Field

This field is the nuclide designation (i.e. Tc99m, Cs137) and consists of up to 6 alphanumeric characters.

CalNum

This field is the Calibration Number for the nuclide (i.e. 080)

A calibration number may include a multiplication sign (* on the keyboard) or a division sign (/ on the keyboard). However, the CRC®-PC Smart Chamber is always direct reading and the multiplication or division sign is only used to be consistent with existing Calibration Numbers.

For multiplication, the number can only be multiplied by 10 or 100. For division, the number can only be divided by 2. Refer to Table 6-2 Calibration Number Limits Table.

	Minimum Calibration # (*a*)	**Maximum Calibration # (*a*)**
Direct Entry (*a*)	10	1200
Multiplication (*a* × 10)	10	1200
Multiplication (*a* × 100)	10	999
Division (*a* ÷ 2)	400	1200

Table 6-2 Calibration Number Limits Table

If the Calibration Number is known for the nuclide, input the number. If the Calibration Number is not known, input 450. The Calibration Number can then be determined using the following procedure.

Determining Calibration Numbers

An initial Calibration Number must be input into the CRC®-PC Smart Chamber for the nuclide. As an initial starting point, choose 450.

Note: *In order to obtain a correct reading for a Vial or Syringe, the supplied Liner and Dipper must be used to achieve the correct geometry. If the source is contained in a different type of container, then contact Capintec, Inc. for further assistance.*

1. Place the standard source of the nuclide in the CRC®-PC Smart Chamber and record the displayed activity.
2. If the displayed activity is **higher** than the measured/calculated activity of the standard source, ***increase*** the Calibration Number. If the displayed activity is **lower** than the measured/calculated activity of the standard source, ***decrease*** the Calibration Number.

3. Re-measure the activity of the standard source.
4. Continue to increase or decrease the Calibration Number (e.g. repeat steps 2 and 3) until the displayed activity matches the measured/calculated activity of the standard source.
5. Record the Calibration Number of the nuclide for future reference.
6. Input the new Calibration Number.

Halflife

This field is the half-life of the nuclide (i.e. 6.01 hr, 30.00 yr) and consists of up to 6 characters (5 digits and a decimal).

Input the value using the keyboard and then click on the drop-down list box. From the drop-down list, click the desired time unit for the halflife. The available time units for halflife are: Minutes, Hours, Days, and Years.

Deleting a Nuclide

Any User Added Nuclide by the may be deleted.

Nuclides are removed by clicking the **Clear** button to the right of the Nuclide to be deleted.

The deleted Nuclide text boxes will be blank. Click the **Submit** button save the changes. The selected User Nuclide is now erased from the system.

Click the **Cancel** button to discard the changes.

CALIBRATION NUMBERS

Calibration Numbers may be added or changed for any of the nuclides stored in the CRC®-PC Smart Chamber's memory.

To add a Calibration Number to a nuclide that does not have a Calibration Number, change an existing Calibration Number or restore the original Calibration Number, from Figure 6-2 Setup Screen, click the **Cal Num** button. Figure 6-7 Setup Cal Num Screen will appear with the currently selected nuclide displayed along with its default Calibration Number and the User defined Calibration Number if one has been entered.

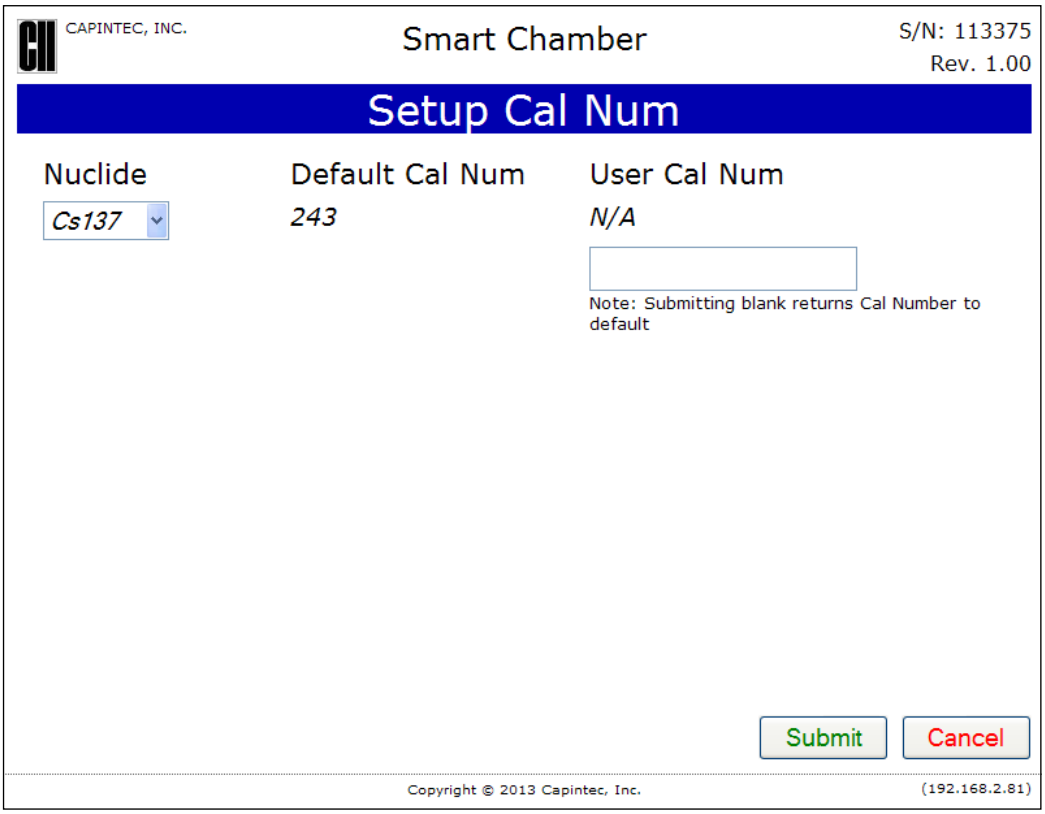


Figure 6-7 Setup Cal Num Screen

To select a nuclide, click on ***Nuclide*** drop-down list box. The list of nuclides will be displayed in alphabetical order as shown in Figure 6-8 Selecting Nuclide for Calibration Number Screen.

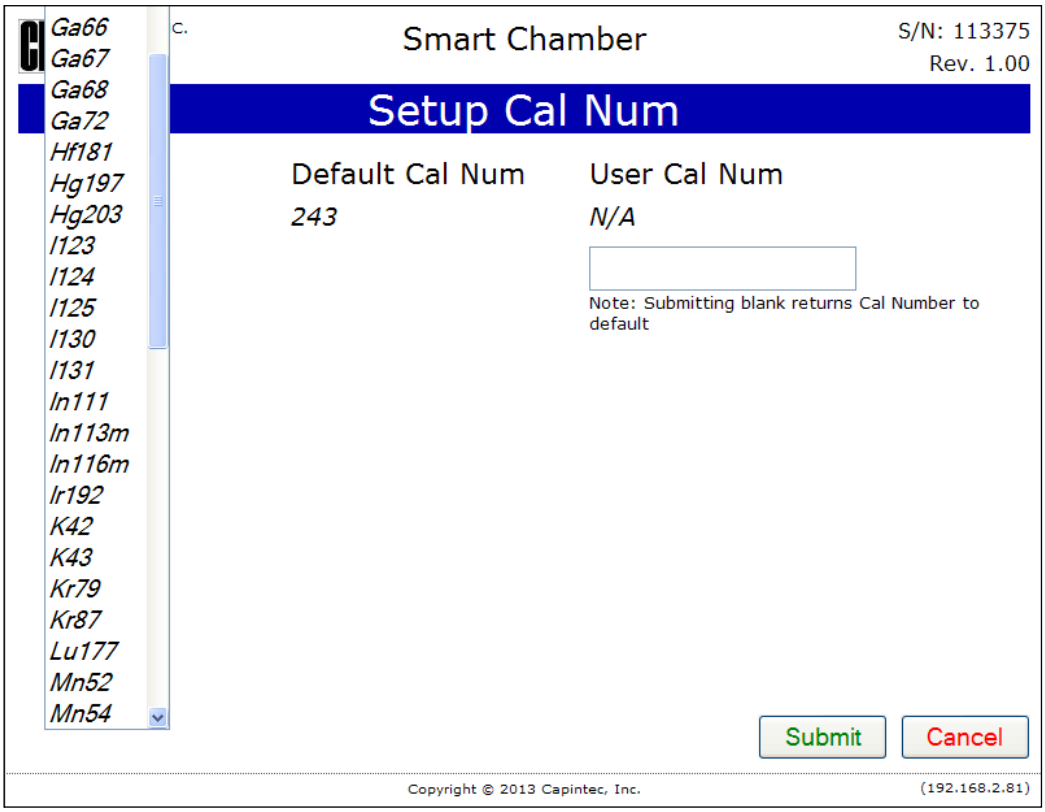


Figure 6-8 Selecting Nuclide for Calibration Number Screen

Scroll through the list as necessary. Click on the desired nuclide. The selected nuclide will appear in the ***Nuclide*** drop-down list box along with the Default Calibration Number and the user defined Calibration Number if one has been entered.

A calibration number may include a multiplication sign (* on the keyboard) or a division sign (/ on the keyboard). However, the CRC®-PC Smart Chamber is always direct reading and the multiplication or division sign is only used to be consistent with existing Calibration Numbers.

For multiplication, the number can only be multiplied by 10 or 100. For division, the number can only be divided by 2. Refer to Table 6-2 Calibration Number Limits Table on page 6-6-11.

To input a new Calibration Number for the selected nuclide, input the Calibration Number in the ***User Cal Num*** textbox and click the **Submit** button. Figure 6-2 Setup Screen will re-appear.

To abort adding, changing or restoring a Calibration Number, click the **Cancel** button. Figure 6-2 Setup Screen will re-appear.

Restoring Original Calibration Numbers

To restore the default calibration number for a nuclide that had its calibration number changed, click on the ***Nuclide*** drop-down list box and select the desired nuclide. The selected nuclide will appear in the ***Nuclide*** drop-down list box along with the Default Calibration Number and the user defined Calibration Number if one has been entered.

Verify that the ***User Cal Num*** textbox is blank (empty) and click the **Submit** button. The selected nuclide will now use the original (default) Calibration Number.

To abort restoring an original Calibration Number, click the **Cancel** button. Figure 6-2 Setup Screen will re-appear.

THRESHOLD

The Threshold allows the user to change the response level and the allowable noise level of the Chamber. If the Chamber is performing according to the user's satisfaction, the default value should be used and no adjustment to the Threshold needs to be made.

To view or change the Threshold, from the Setup screen, click the **Threshold** button. Figure 6-9 Threshold Setup Screen will appear with the default value displayed.

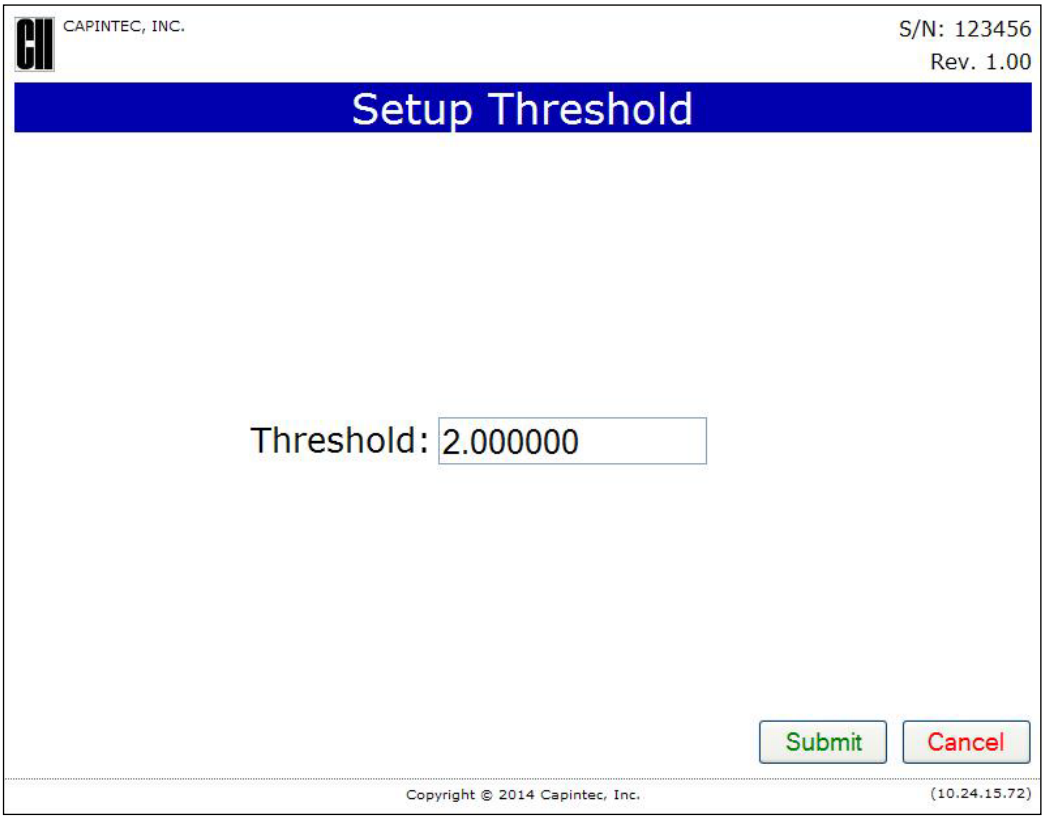


Figure 6-9 Threshold Setup Screen

To exit the screen without making a change, click the **Cancel** button.

To change the Threshold value, enter the desired value and click Submit.

Note: *The lower the Threshold, the response will be more rapid but the reading will be more noisy. The higher the Threshold, the response will be slower but the reading will be less noisy.*

Note: *The minimum value that can be input is 1. The maximum value that can be input is 100.*

The default Threshold values are:

- HL Chamber – 2.000000
- RPh Chamber – 4.000000
- PS Chamber – 8.000000

CHAPTER 7

ACCEPTANCE & QUALITY ASSURANCE TESTS

GENERAL

To insure proper operation of the CRC®-PC Smart Chamber the following tests should be preformed at the indicated intervals.

ACCEPTANCE TESTS

The following tests must be performed in the following order before the initial use of the CRC®-PC Smart Chamber

- Diagnostics – reference CHAPTER 9: DIAGNOSTICS.
- Daily Test – reference CHAPTER 8: CHAMBER TESTS.
- Accuracy (for those nuclides that are not used in the Daily Test) – reference CHAPTER 8: CHAMBER TESTS.
- Linearity – The linearity should be checked over the entire range of activities which are reasonably anticipated to be used.
- Geometry – A geometry test should be performed to determine the effect of volume changes or container variation for isotopes of interest.

Diagnostic Test

When Diagnostics is selected, the instrument's memories and programs are checked and the results are displayed. If a printer is attached to the system, the results can be printed. If any of the tests fail, contact Capintec's only Authorized Service Center at 1-800-227-6832. (Reference CHAPTER 9: DIAGNOSTICS)

Daily Test

The Daily Test should be conducted at the beginning of each working day, prior to measuring any samples which will be administered to patients. These tests consist of an Auto Zero adjustment, a Background measurement, a Chamber Voltage test, a Data Check, an Accuracy Test, and a Constancy Test. (reference CHAPTER 8: CHAMBER TESTS)

When the test is complete, the results are saved to the database. If a printer is attached to the system, a report can be printed from the Reports module. If no printer is available, you may record the data by hand. Copies of the completed reports (either printed or hand written) should be retained in a safe place.

Accuracy Test

If your Accuracy Test includes nuclides that are not used in the Daily Tests, the Accuracy Test should be performed with those nuclides. It will not be necessary to repeat the test for those nuclides that were included in the Daily Test. (reference CHAPTER 8: CHAMBER TESTS)

If a printer is attached to the system, the test results can be printed at the end of all source measurements.

The results may also be saved to a database. They can then be displayed and printed from the reports module.

Note: *Accuracy test requires a dedicated check source of known activity which is measured on a daily basis. This test provides both an accuracy value as well as a long term reproducibility check of the instrument.*

Note: *There is no need to perform a constancy test on alternate calibration (nuclide) settings. This provides no value in terms of instrument operation using a PC readout. However, due to numerous procedures which reference this test, operators who prefer to include this test should refer to CHAPTER 8: CHAMBER TESTS.*

Linearity Test

The linearity of the CRC®-PC Smart Chamber should be checked over the entire range of activities which are reasonably anticipated to be used. The initial linearity should be performed using decay method of measuring a short lived isotope over time. Thereafter, use of calibrated sleeves is acceptable.

DAILY QUALITY ASSURANCE TESTS

Daily Tests

The Daily Test should be conducted at the beginning of each working day, prior to measuring any samples which will be administered to patients. These tests consist of an Auto Zero adjustment, a Background measurement, a Chamber Voltage test, a Data Check, an Accuracy Test. (reference CHAPTER 8: CHAMBER TESTS)

Accuracy Test

If your Accuracy Test includes nuclides that are not used in the Daily Tests, the Accuracy Test should be performed with those nuclides as a part of the Daily Test.

This test is the same as the Accuracy Test described in CHAPTER 8: CHAMBER TESTS, SECTION: ACCURACY and CONSTANCY TEST IN DAILY TEST. This test is performed independently from the other portions of the Daily Test sequence.

The Accuracy Tests cannot be conducted until the Test Source data has been entered (reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: TEST SOURCE SETUP).

If there is a printer attached to the system, the test results can be printed at the end of all source measurements.

Note: *Accuracy test requires a dedicated check source of known activity which is measured on a daily basis. This test provides both an accuracy value as well as a long term reproducibility check of the instrument.*

Note: *There is no need to perform a constancy test on alternate calibration (nuclide) settings. This provides no value in terms of instrument operation using a PC readout. However, due to numerous procedures which reference this test, operators who prefer to include this test should refer to CHAPTER 8: CHAMBER TESTS.*

Contamination Test

This tests the Dipper and/or Liner for contamination and is normally performed at the end of each workday. At the very least, it should be performed once per week. To perform a contamination test:

1. Verify that the Dipper is in the Chamber and no sources are in the Dipper.
2. From the Main/Measurement screen, select Co57 as the nuclide. This is done by clicking the **Nuclide** button (the colored area surrounding the current nuclide name) located below the measurement and selecting Co57 from the Nuclide drop-down list and clicking the **Submit** button.
3. Record the displayed activity.
4. Remove the Dipper from the Chamber and record the displayed activity.
5. Subtract the activity in step 4 from the activity in step 3. This is the amount of contamination of the Dipper.

6. Remove the Liner from the Chamber and record the displayed activity.
7. Subtract the activity in step 6 from the activity in step 4. This is the amount of contamination of the Liner.
8. Should either the Dipper or the Liner exhibit contamination greater than 3 µCi or 0.1 MBq, they should be decontaminated or replaced.
9. Return the Liner and Dipper to the Chamber.

⚠ **CAUTION:** Never use the CRC®-PC Smart Chamber without the Liner in place. Liners are inexpensive and easy to replace. A contaminated Chamber is a very costly mistake.

QUARTERLY TESTS

Diagnostic Test

The Diagnostics Test should be performed as a part of the Quarterly Tests. When Diagnostics is selected, the instrument's memories and programs are checked and the results are displayed. If a printer is attached to the system, the results can be printed. If any of the tests fail, contact Capintec's only Authorized Service Center at 1-800-227-6832. (Reference CHAPTER 9: DIAGNOSTICS).

YEARLY TESTS

Linearity Test

The linearity of the CRC®-PC Smart Chamber should be checked over the entire range of activities which are reasonably anticipated to be used. The initial linearity should be performed using decay method of measuring a short lived isotope over time. Thereafter, use of calibrated sleeves is acceptable.

This can be done by following the AutoLinearity Test as described in CHAPTER 8.

CHAPTER 8

CHAMBER TESTS

GENERAL

This section describes the tests of the Chamber.

Moly Assay is described in CHAPTER 10: MEASUREMENT PROCEDURES; SECTION: MOLY ASSAY.

BACKGROUND

Background measurements are performed by clicking the **Background** button from Figure 8-1 Main/Measurement Screen. (Note that the Background measurement is also part of the Daily Test.) Figure 8-2 Background Remove Sources Screen will appear.

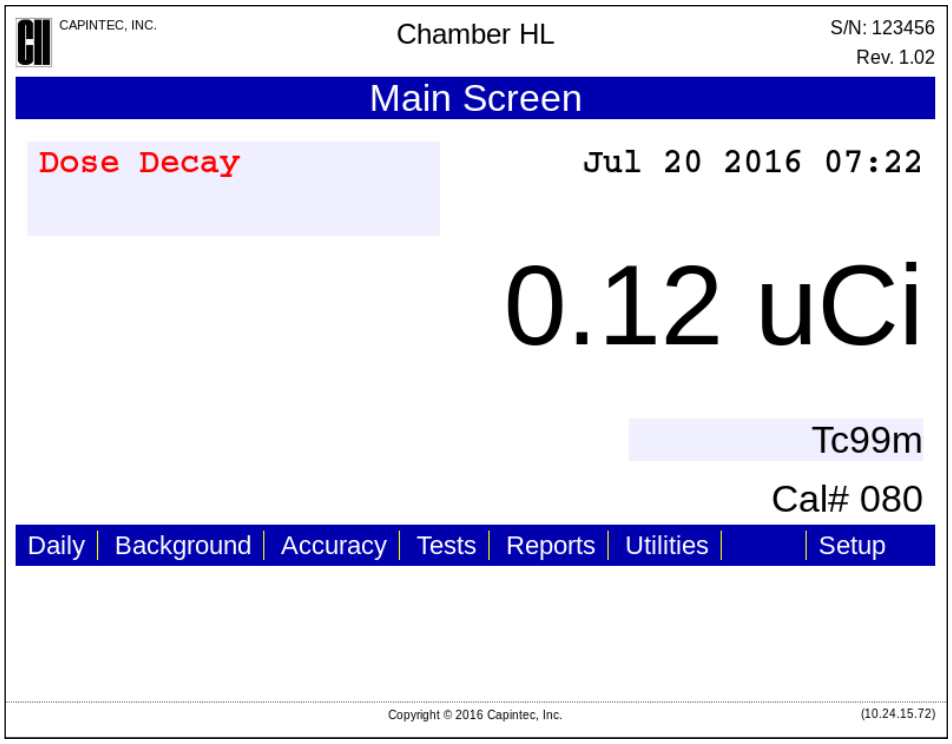


Figure 8-1 Main/Measurement Screen

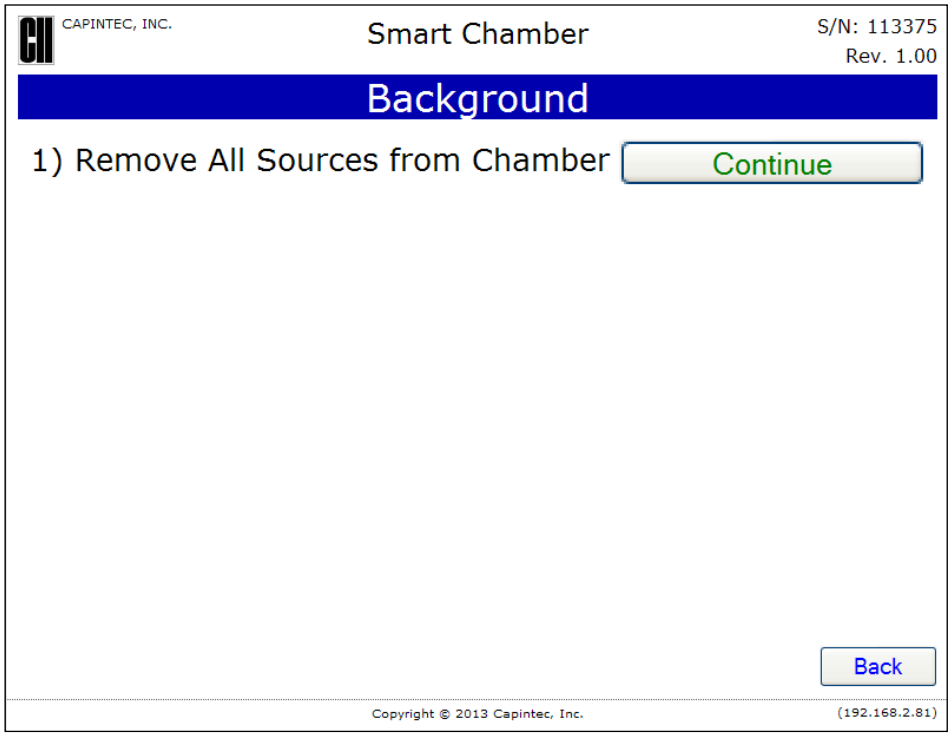


Figure 8-2 Background Remove Sources Screen

Remove all sources from the vicinity of the Chamber and click the **Continue** button. A "Please Wait" message and then a progress bar will appear until a measurement is available.

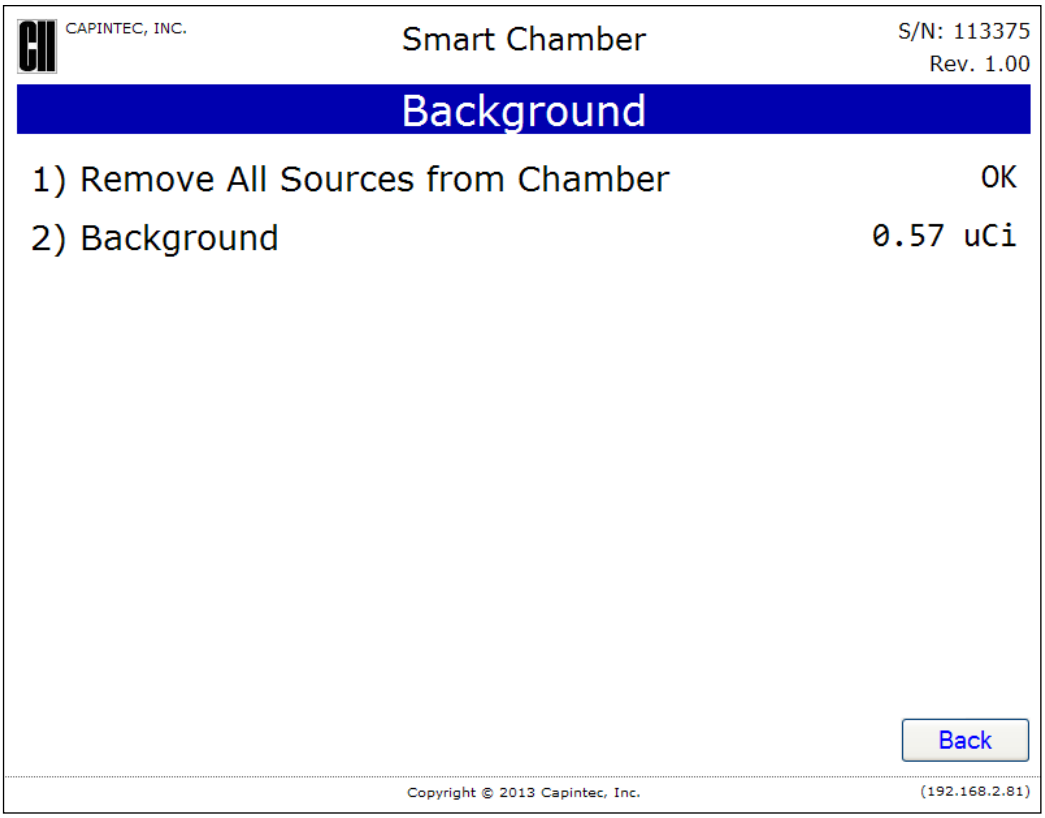


Figure 8-3 Background Result Screen

If the background is high but still acceptable (> 191.3µCi [7.08MBq] to < 5.66mCi [209.4MBq]), the message "HIGH" will appear instead of next to the measurement. Although the value is acceptable, the reason for the high value should be investigated. If any sources are found nearby, repeat the measurement.

If the background is above the acceptable range (> 5.66mCi [209.4MBq]), the measurement will not be shown but Figure 8-4 Background Too High Screen will appear.

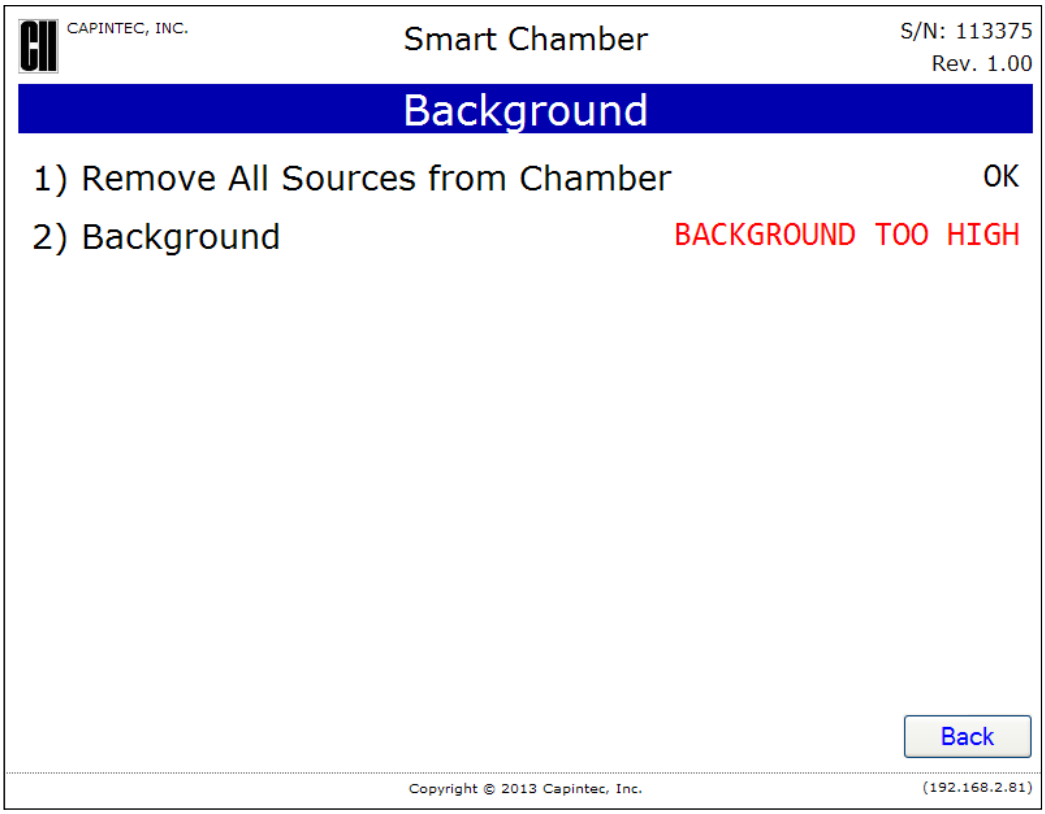


Figure 8-4 Background Too High Screen

This "TOO HIGH" background cannot be accepted by the CRC®-PC Smart Chamber. If the cause of the high reading (nearby source, contaminated well etc.) cannot be found, contact Capintec's only Authorized Service Center at (800) ASK-4CRC.

DAILY TEST

The Daily Test consists of:

- Auto Zero
- Background
- Chamber Voltage
- Data Check
- Accuracy Test
- Constancy Test

To perform the Daily Test, from Figure 8-1 Main/Measurement Screen, click the **Daily** button. Figure 8-5 Daily Test Screen will appear.

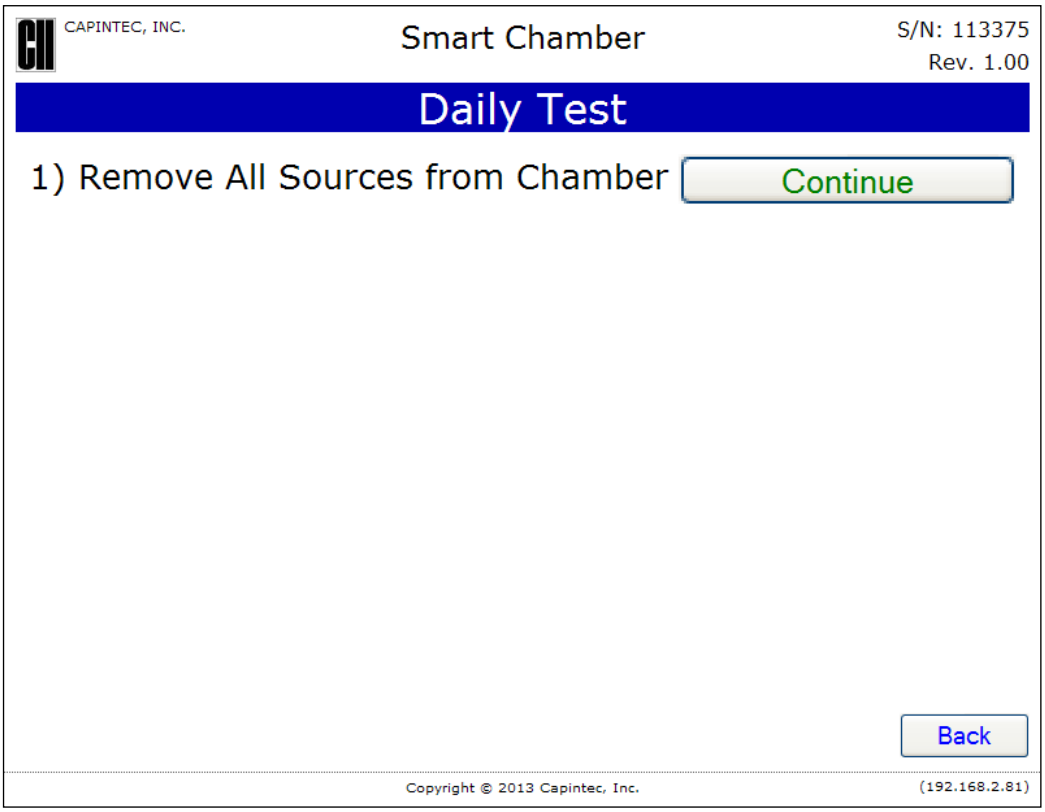


Figure 8-5 Daily Test Screen

When the **Continue** button is clicked, the following tests will automatically be performed:

- Auto Zero
- Background
- Chamber Voltage
- Data Check

Auto Zero

The first part of the Daily Test is the Auto Zero.

A “Please Wait” message will appear until a measurement is available.

If the measured value has drifted more than ±0.30mV since the last measurement, the message “ZERO DRIFT” will be displayed. Check to make sure that no sources are in the area. If any sources are found, remove them and verify the measurement.

If the measured value is out of range (>±10mV), the message “ZERO OUT OF RANGE” will be displayed. Check to make sure that no sources are in the area. If any sources are found, remove them and verify the measurement. If no sources were found, contact Capintec’s only Authorized Service Center at (800) ASK-4CRC.

Background

The second part of the Daily Test is Background measurement.

After the Auto Zero measurement is complete, a “Please Wait” message along with a progress bar will appear until a measurement is available.

If the background is high but still acceptable (> 191.3µCi [7.08MBq] to < 5.66mCi [209.4MBq]), the message “HIGH” will appear next to the measurement. Although the value is acceptable, the reason for the high value should be investigated. If any sources are found nearby, repeat the measurement.

If the background is above the acceptable range (> 5.66mCi [209.4MBq]), the measurement will not be shown and the message “BACKGROUND TOO HIGH” will appear.

This “TOO HIGH” background cannot be accepted by the CRC®-PC Smart Chamber. Click the **Back** button to acknowledge the message. If the cause of the high reading (nearby source, contaminated well etc.) cannot be found, contact Capintec’s only Authorized Service Center at (800) ASK-4CRC.

Chamber Voltage

The third part of the Daily Test is the Chamber Voltage test.

After the Background measurement is complete, a “Please Wait” message will appear until the measurement is available.

The Chamber Voltage measurement is compared with the value input at the factory. If the results are out of range, the message “FAILED” appears next to the measurement. If this occurs, contact Capintec’s only Authorized Service Center at (800) ASK-4CRC.

Data Check

The next part of the Daily Test is a check of the built-in nuclide data.

If this test fails, turn the power off and then back on. This will reload the program and data into memory. Repeat the Daily Test. If the Data Check test continues to fail, contact Capintec’s only Authorized Service Center at (800) ASK-4CRC.

Results

A successful Daily Test result is shown in Figure 8-6 Successful Daily Test.

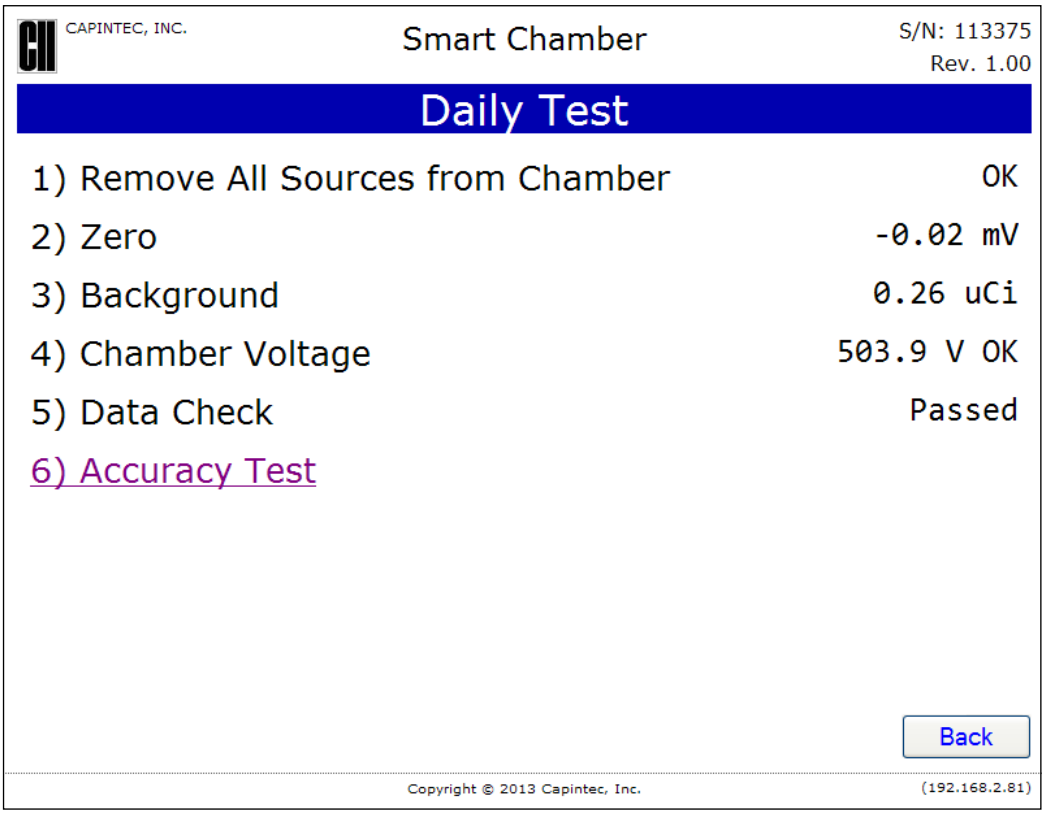


Figure 8-6 Successful Daily Test

When the Daily Test is complete, the results are saved to the database.

Accuracy and Constancy Test in Daily Test

The next part of the Daily Test is the Accuracy Test.

Note: *If no Test Sources are entered, the Accuracy Test hyperlink will not be displayed and the Accuracy and Constancy tests are not performed. The Daily Test will be completed.*

At this point, the following options are available:

- If a printer is attached to the system, the Daily Test results can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, by pressing ***Ctrl*+*P*** on the keyboard or by clicking the Printer icon on the browser's toolbar. If no printer is available, you may record the data by hand. Copies of the completed reports (either printed or hand written) should be retained in a safe place.
- Click the **Back** button to exit the Daily Test and return to Figure 8-1 Main/Measurement Screen.

- If at least one Test Source has been setup, the Accuracy Test can be performed by clicking the **Accuracy Test** hyperlink. Refer to the ACCURACY TEST section below for detailed information.

ACCURACY TEST

The Accuracy Test shows that the CRC®-PC Smart Chamber is providing correct readings over the entire energy scale. The Test Sources that were entered in Setup (reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: TEST SOURCE SETUP) are measured in the Chamber. The measured activity is then compared to the calibrated activity corrected for decay.

The Accuracy Test can be performed directly from Figure 8-1 Main/Measurement Screen by clicking the **Accuracy** button or by clicking the **Accuracy Test** hyperlink from Figure 8-6 Successful Daily Test. The Accuracy Test Start/Home screen will appear.

Note: *The Accuracy Test cannot be conducted until Test Source data has been entered (reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: TEST SOURCE SETUP). If no Test Sources have been entered, the message "No Source Data" will be displayed.*

To abort the Accuracy test, click the **Home** button. Figure 8-1 Main/Measurement Screen will re-appear.

To begin the Accuracy test, click the **Start** button. The Accuracy test screen will appear displaying the Test Sources that were entered in Setup. The actual Test Sources and serial numbers will, of course, depend upon how the test was initially defined.

Insert the desired check source into the Chamber. Click the **Measure** button next to the Test Source to be measured. The screen will be similar to that illustrated in Figure 8-7 Accuracy/Constancy Results Screen and is described as follows:

- **Calculated:** This is the anticipated actual activity of the check source based upon the initial calibration of the source, corrected for decay.
- **Measured:** This is the actual measured activity.
- **Deviation:** This is the percentage deviation of the measured activity from the anticipated activity. If the deviation is greater than ±20%, the reading will be replaced by "ERROR" displayed in red.

  Deviations greater than ±5% should be investigated. If the deviation is greater than 10%, contact Capintec's only Authorized Service Center. Note that higher than expected deviations may be within the limit of error, depending the accuracy of the check source being used.

Click the **Accept** button to accept the measurement. The screen will be similar to that shown in Figure 8-7 Accuracy/Constancy Results Screen.

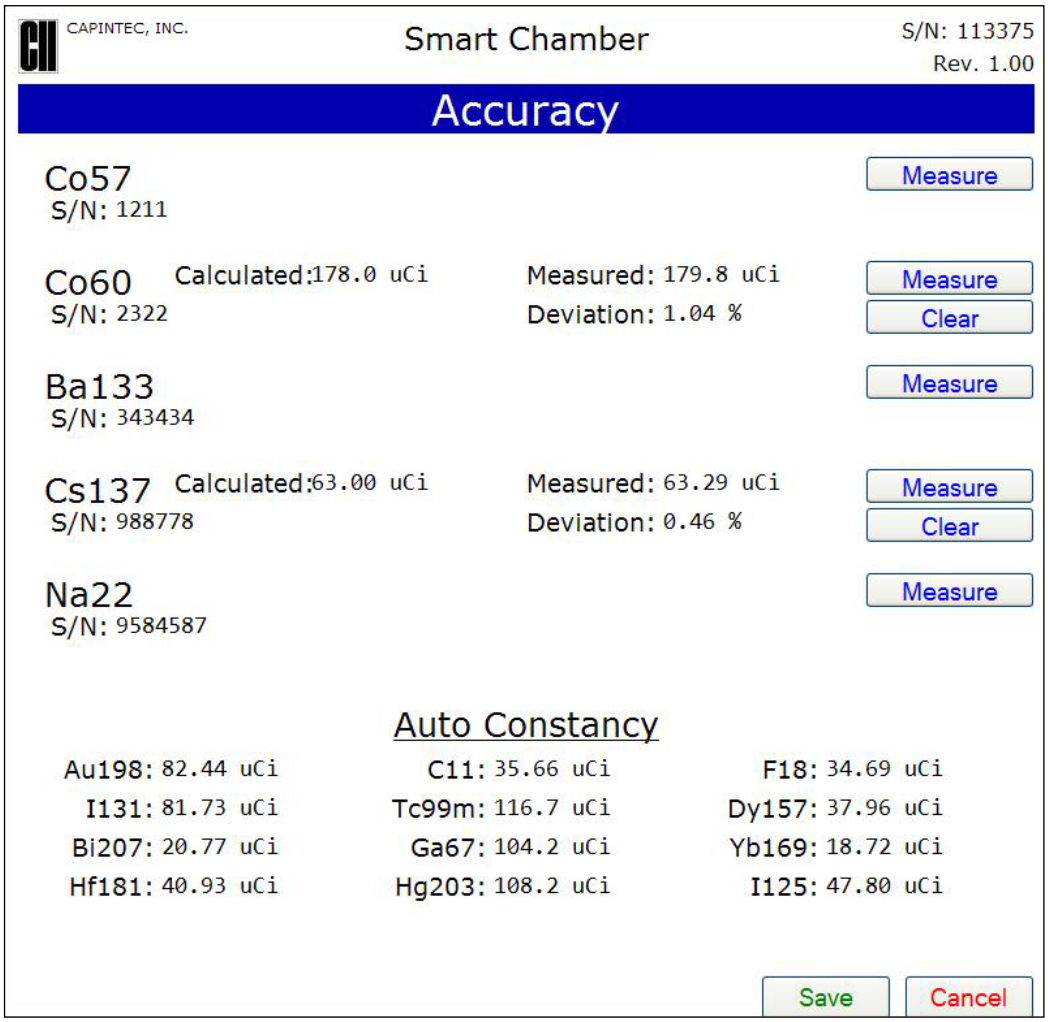


Figure 8-7 Accuracy/Constancy Results Screen

After accepting the Test Source measurement, the Test Source can be re-measured by clicking the **Measure** button next to the desired Test Source or the measurement data can be cleared by clicking the **Clear** button next to the desired Test Source.

If more than one Test Source was entered in Setup, repeat the above the test sequence as many times as required.

Auto Constancy Test

When the Accuracy Test for the Constancy Base Source is being measured, the Auto Constancy measurements of the selected Channels will appear on the lower portion of the Accuracy Test screen similar to that shown in Figure 8-7 Accuracy/Constancy Results Screen.

When the Accuracy Test for the Constancy Base Source is complete, the Auto Constancy results of the selected Channels will appear.

If a printer is attached to the system, the Accuracy Test results can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, by pressing ***Ctrl*+*P*** on the keyboard or by clicking the Printer icon on the browser's toolbar.

Accuracy and Constancy Results

In Figure 8-7 Accuracy/Constancy Results Screen, only 2 of the possible 5 Test Sources that have been set up, have been measured.

In the example, the Auto Constancy results are presented when Cs137 is measured because Cs137 was selected as the Auto Constancy Base Source.

To save the results to the Accuracy Test database report, click the **Save** button.

The results can be displayed or printed via the Reports Module. Reference CHAPTER 11: REPORTS for more information.

To discard the results, click the **Cancel** button.

AUTOLINEARITY TEST

AutoLinearity is an automated version of a standard linearity test. The results of the last AutoLinearity test is stored in the database and can be viewed and printed at any time.

From Figure 8-1 Main/Measurement Screen, click the **Tests** button. Figure 8-8 Test Screen will be displayed.

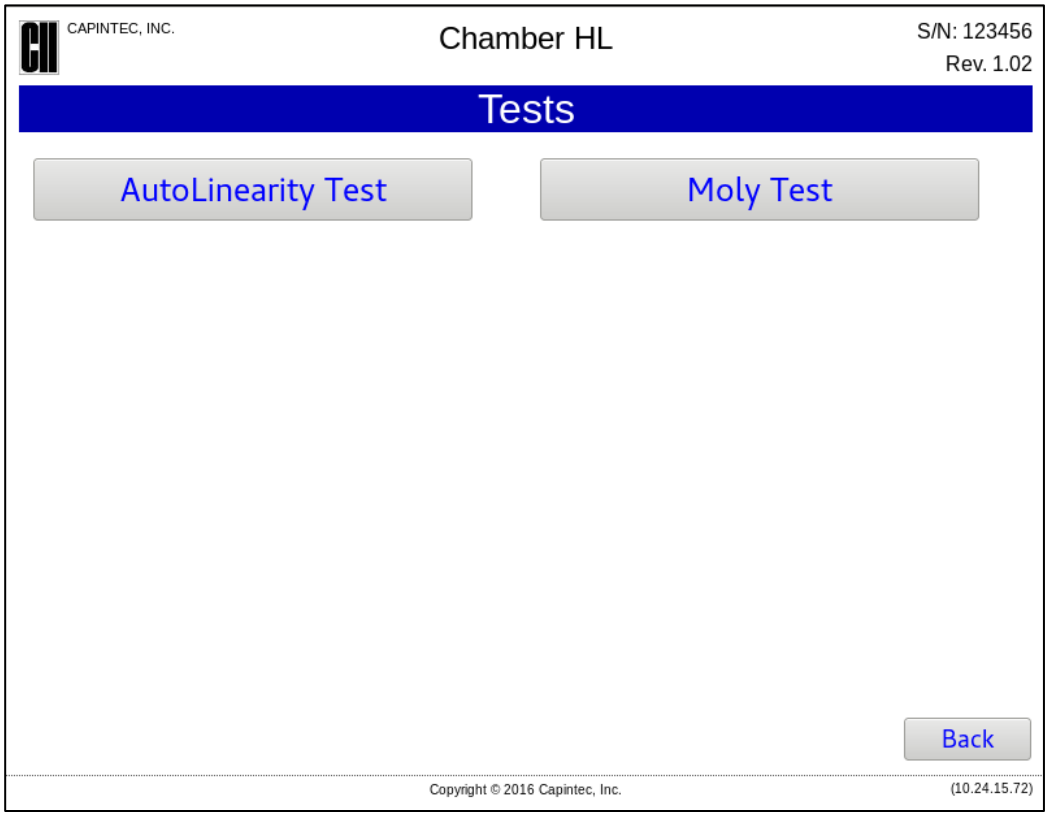


Figure 8-8 Test Screen

To begin the test, click the **AutoLinearity Test** button. Figure 8-9 AutoLinearity Setup Screen will appear.

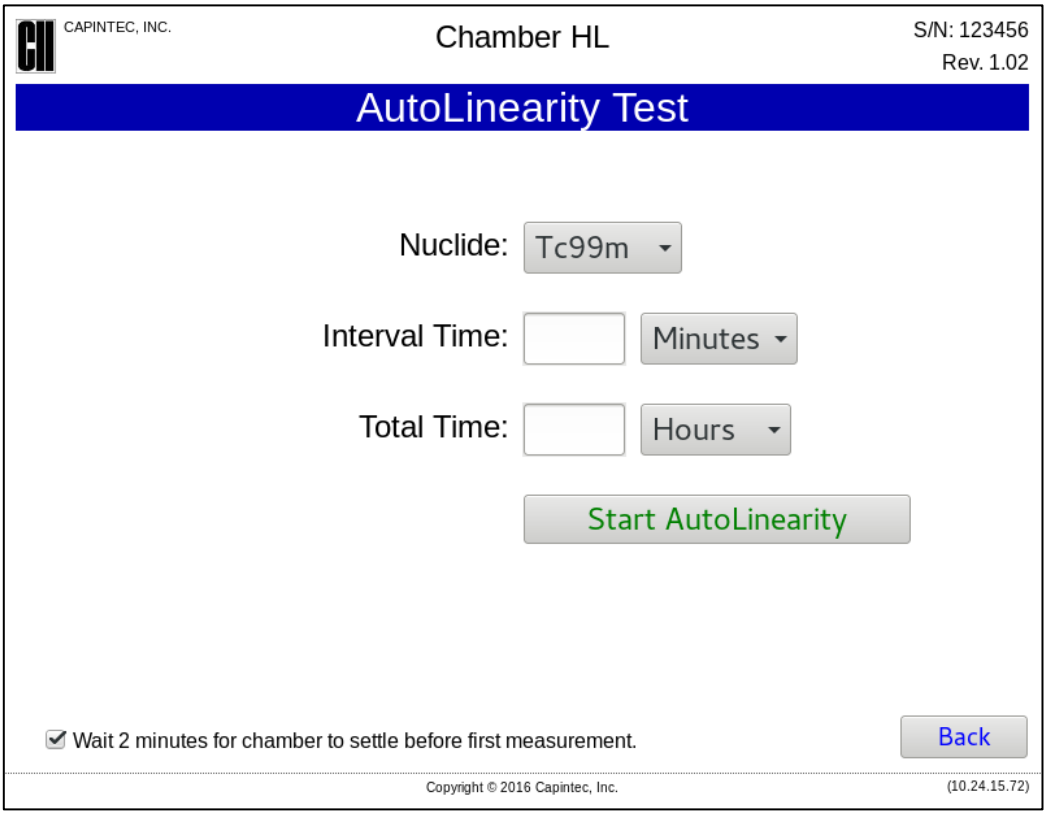


Figure 8-9 AutoLinearity Setup Screen

Selecting Nuclide

To select the nuclide to use for the Linearity Test, click on the Nuclide dropdown list and select the desired nuclide.

Setting Interval Time

Enter the desired number into the Interval Time textbox and click on the Interval Time Unit dropdown list and click on the Interval Time Unit.

Setting Total Time

Enter number into the Total Time textbox and click on the Total Time Unit dropdown list and click on the Total Time Unit

Startup Delay

The “Wait 2 minutes for chamber …” checkbox will delay the start of measurements for two minutes to allow for the measurement to stabilize.

Note: *The number of measurements is calculated from the Total Time and the Interval Time. The number of measurements cannot exceed 100.*

Starting the Test

Once all the values have been entered, click the **Start AutoLinearity** button to begin the test. Figure 8-10 Start AutoLinearity message box will appear.

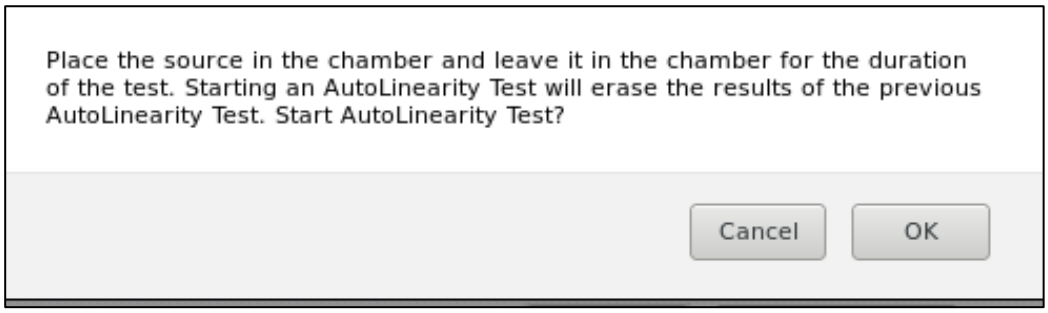


Figure 8-10 Start AutoLinearity message box

Place the source in the Smart Chamber for the duration of the test (Total Time). Starting a new AutoLinearity test will clear the previous AutoLinearity test. Figure 8-10 will appear.

Click on **OK** to proceed with the Test. Figure 8-11 Running AutoLinearity Test Screen will appear.

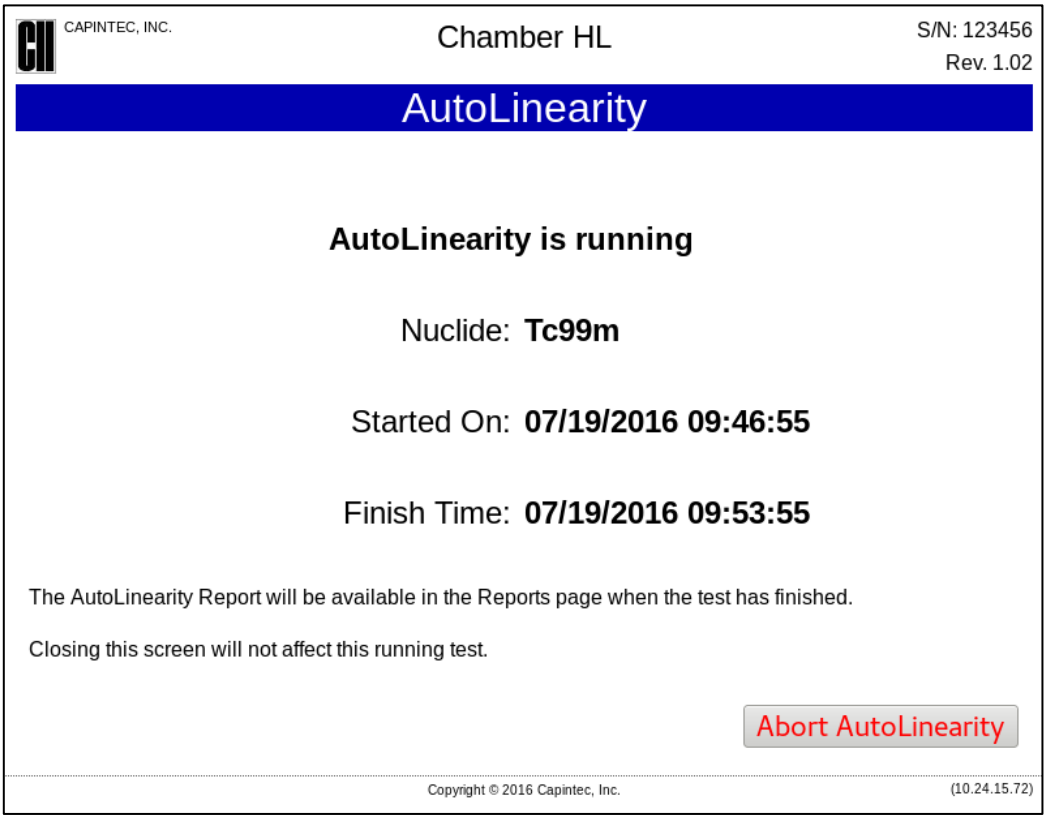


Figure 8-11 Running AutoLinearity Test Screen

Do not remove the source from the Smart Chamber during the AutoLinearity Test. Closing the Web Browser will not affect the AutoLinearity Test. While the AutoLinearity Test, no other Smart Chamber screen will be available. To stop the AutoLinearity Test, click on the **Abort AutoLinearity** button. Figure 8-12 Abort AutoLinearity message box will appear.

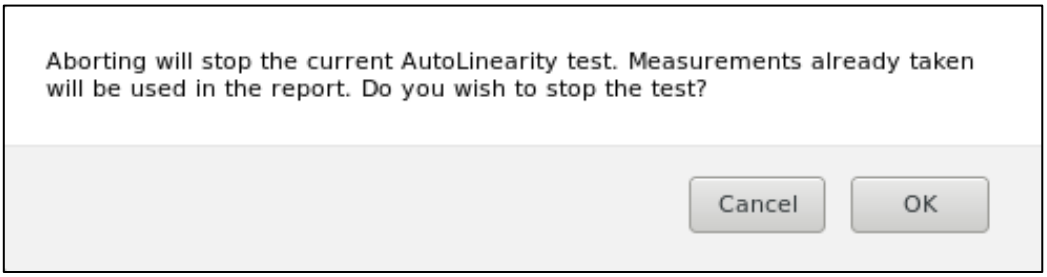
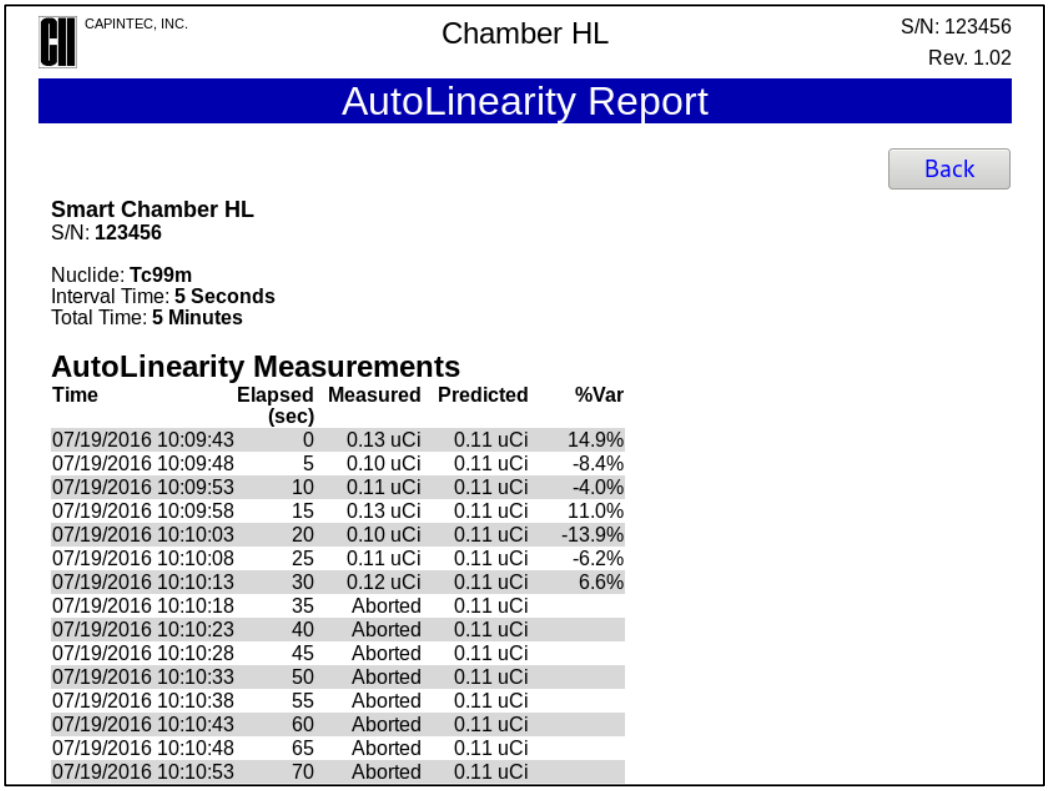


Figure 8-12 Abort AutoLinearity message box

Click on **OK** to stop AutoLinearity Test. Figure 8-13 Aborted AutoLinearity Test Report will be displayed with the measurements taken before the test has been stopped.



CAPINTEC, INC.

Chamber HL

S/N: 123456
Rev. 1.02

AutoLinearity Report

Back

Smart Chamber HL
S/N: **123456**

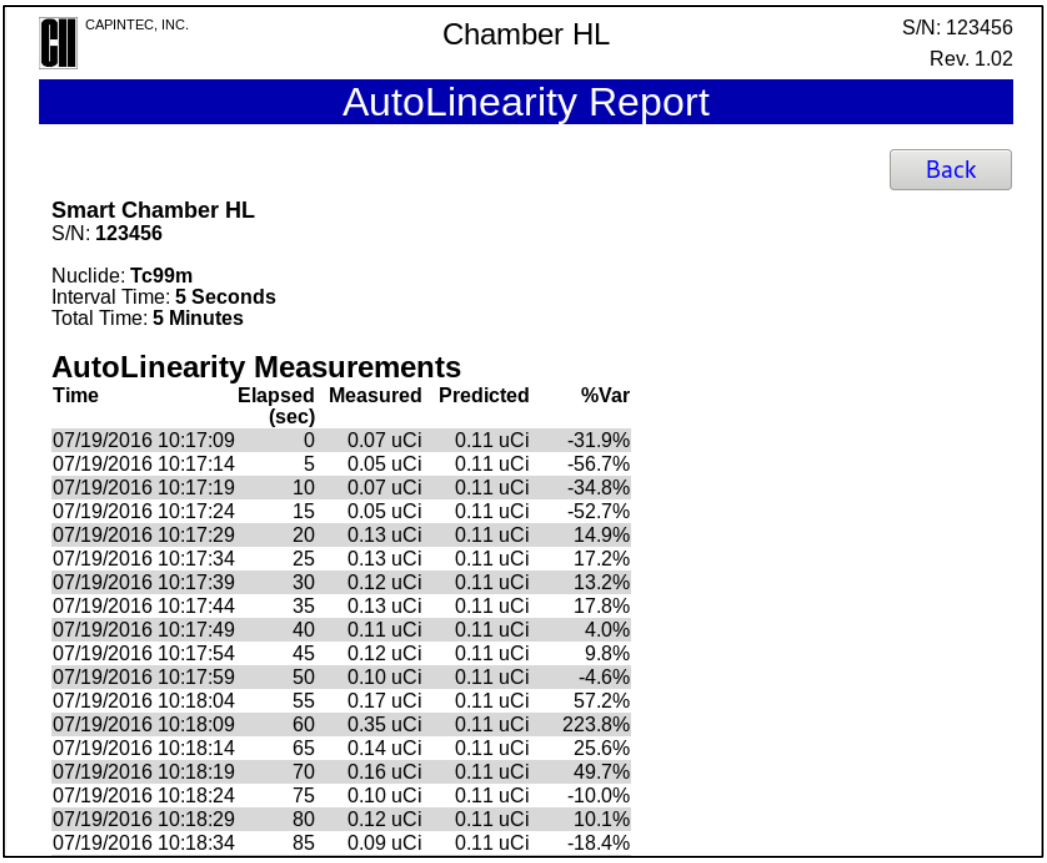
Nuclide: **Tc99m**
Interval Time: **5 Seconds**
Total Time: **5 Minutes**

AutoLinearity Measurements

Time	Elapsed (sec)	Measured	Predicted	%Var
07/19/2016 10:09:43	0	0.13 uCi	0.11 uCi	14.9%
07/19/2016 10:09:48	5	0.10 uCi	0.11 uCi	-8.4%
07/19/2016 10:09:53	10	0.11 uCi	0.11 uCi	-4.0%
07/19/2016 10:09:58	15	0.13 uCi	0.11 uCi	11.0%
07/19/2016 10:10:03	20	0.10 uCi	0.11 uCi	-13.9%
07/19/2016 10:10:08	25	0.11 uCi	0.11 uCi	-6.2%
07/19/2016 10:10:13	30	0.12 uCi	0.11 uCi	6.6%
07/19/2016 10:10:18	35	Aborted	0.11 uCi	
07/19/2016 10:10:23	40	Aborted	0.11 uCi	
07/19/2016 10:10:28	45	Aborted	0.11 uCi	
07/19/2016 10:10:33	50	Aborted	0.11 uCi	
07/19/2016 10:10:38	55	Aborted	0.11 uCi	
07/19/2016 10:10:43	60	Aborted	0.11 uCi	
07/19/2016 10:10:48	65	Aborted	0.11 uCi	
07/19/2016 10:10:53	70	Aborted	0.11 uCi	

Figure 8-13 Aborted AutoLinearity Test Report

If the Running AutoLinearity Test screen is on the browser when the AutoLinearity Test finishes, Figure 8-14 Completed AutoLinearity Test Report will be displayed. However, if the browser is closed, then the AutoLinearity Test Report can be displayed by clicking on the **Reports** button from the Main Screen, clicking on the **AutoLinearity Test** button in the Reports Screen.



CAPINTEC, INC.

Chamber HL

S/N: 123456
Rev. 1.02

AutoLinearity Report

Back

Smart Chamber HL
S/N: **123456**

Nuclide: **Tc99m**
Interval Time: **5 Seconds**
Total Time: **5 Minutes**

AutoLinearity Measurements

Time	Elapsed (sec)	Measured	Predicted	%Var
07/19/2016 10:17:09	0	0.07 uCi	0.11 uCi	-31.9%
07/19/2016 10:17:14	5	0.05 uCi	0.11 uCi	-56.7%
07/19/2016 10:17:19	10	0.07 uCi	0.11 uCi	-34.8%
07/19/2016 10:17:24	15	0.05 uCi	0.11 uCi	-52.7%
07/19/2016 10:17:29	20	0.13 uCi	0.11 uCi	14.9%
07/19/2016 10:17:34	25	0.13 uCi	0.11 uCi	17.2%
07/19/2016 10:17:39	30	0.12 uCi	0.11 uCi	13.2%
07/19/2016 10:17:44	35	0.13 uCi	0.11 uCi	17.8%
07/19/2016 10:17:49	40	0.11 uCi	0.11 uCi	4.0%
07/19/2016 10:17:54	45	0.12 uCi	0.11 uCi	9.8%
07/19/2016 10:17:59	50	0.10 uCi	0.11 uCi	-4.6%
07/19/2016 10:18:04	55	0.17 uCi	0.11 uCi	57.2%
07/19/2016 10:18:09	60	0.35 uCi	0.11 uCi	223.8%
07/19/2016 10:18:14	65	0.14 uCi	0.11 uCi	25.6%
07/19/2016 10:18:19	70	0.16 uCi	0.11 uCi	49.7%
07/19/2016 10:18:24	75	0.10 uCi	0.11 uCi	-10.0%
07/19/2016 10:18:29	80	0.12 uCi	0.11 uCi	10.1%
07/19/2016 10:18:34	85	0.09 uCi	0.11 uCi	-18.4%

Figure 8-14 Completed AutoLinearity Test Report

POWER FAILURE

If the power goes off during the test, the data will not be lost. When the power resumes, the Smart Chamber will automatically return to running the AutoLinearity Test.

Any measurements missed while the power was off will be marked as “Power Failure Skipped”. The measurements marked “Power Failure Skipped” are lost and cannot be recovered.

CHAPTER 9

DIAGNOSTICS

GENERAL

Diagnostics performs functions to test the integrity of the system.

DIAGNOSTICS

From Figure 9-1 Main/Measurement Screen, click the **Reports** button. Figure 9-2 Reports Screen will appear.

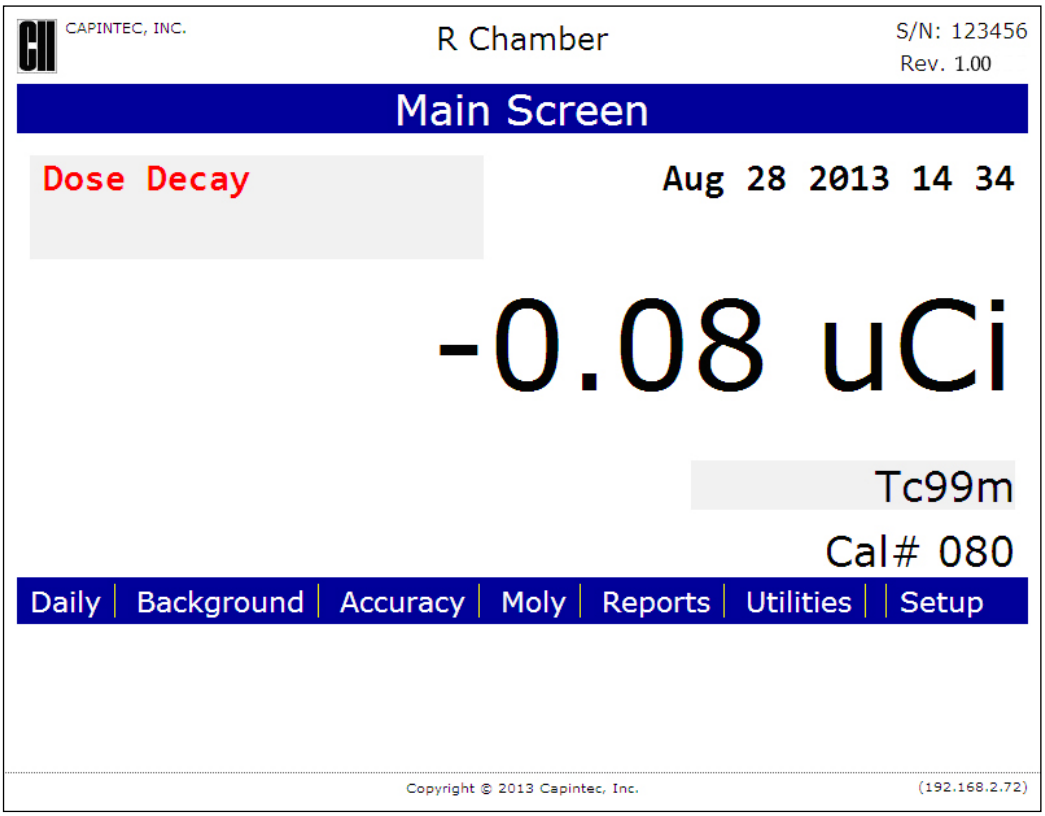


Figure 9-1 Main/Measurement Screen

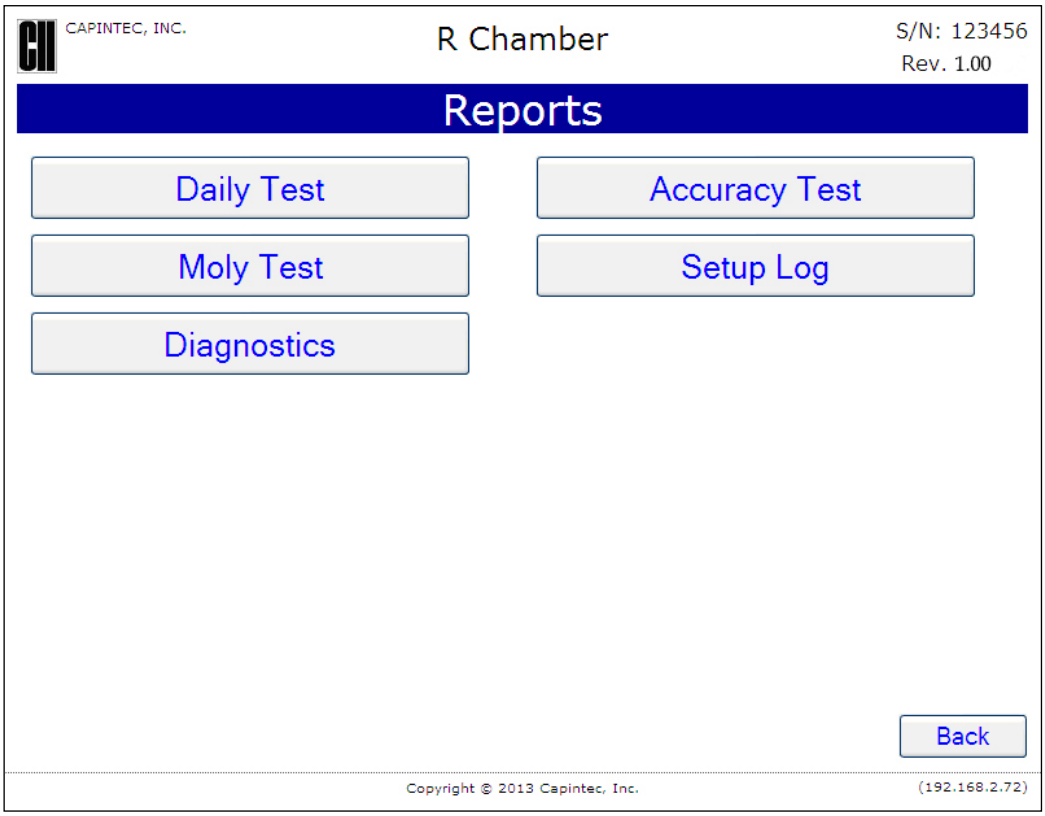


Figure 9-2 Reports Screen

Click the **Diagnostics** button. The system diagnostic testing will begin.

The instrument's memories and programs are checked.

Once the diagnostic routine has completed the following will appear on the screen.

- Flash program checks
- A list of the nuclides, their half-lives and calibration numbers
- User Added Nuclide information
- The Test Source data
- The Auto Constancy settings
- The Moly Assay limit
- System Parameters

If the Diagnostics test fails, the message “Boot Flash: FAIL: xxxx” or “Program Flash: Fail xxxx” will appear.

If the Diagnostics fails, restart the unit and perform the test again. If it fails again, contact Capintec’s only Authorized Service Center (reference CHAPTER 12: CLEANING AND

MAINTENANCE, SECTION: SERVICING) for more information, since this will indicate a SD card error or a system malfunction.

If a printer is attached to the system, the Diagnostics report can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, by pressing ***Ctrl***+***P*** on the keyboard or by clicking the Printer icon on the browser's toolbar.

To exit the Diagnostic Report screen, click the **Back** button located at the top of the Diagnostics report screen. Figure 9-2 Reports Screen will re-appear.

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CHAPTER 10

MEASUREMENT PROCEDURES

GENERAL

Instructions for measuring a source are given in this section.

The Main/Measurement Screen is shown below along with a description of each section.

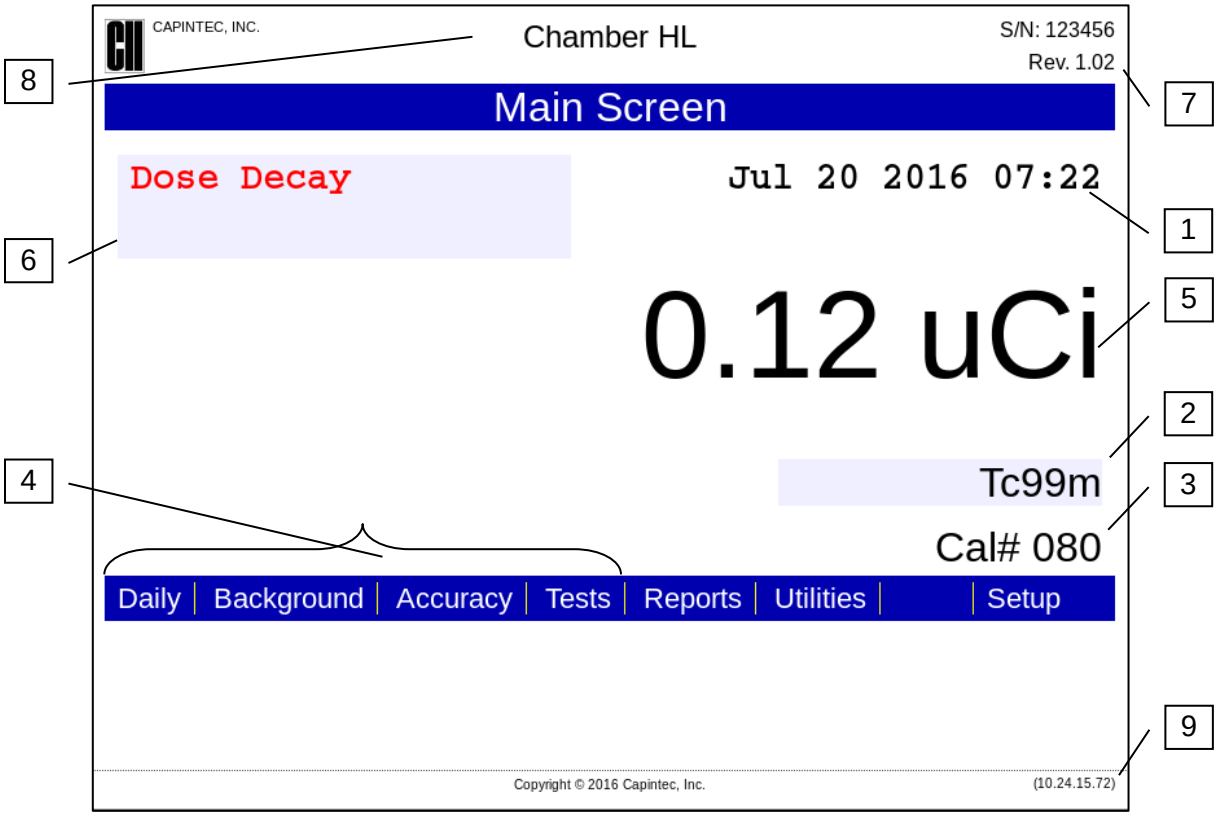


Figure 10-1 Main/Measurement Screen

1. Displays the CRC®-PC Smart Chamber currently set Date and Time.
2. **Nuclide** button – displays the currently selected nuclide.
3. Displays the set Calibration Number of the selected nuclide.
4. **QC** buttons – provides access to system test functions.
5. Displays the measured activity and units of the selected nuclide.
6. **Dose Decay** button – allows the entry of a future date and time.
7. Displays the serial number and the software version of the CRC®-PC Smart Chamber.
8. CRC®-PC Smart Chamber title.
9. Displays the IP Address of the CRC®-PC Smart Chamber.

MEASUREMENT PROCEDURES

Note: *In order to obtain a correct reading for a Vial or Syringe, the supplied Chamber Liner and Dipper must be used to achieve the correct geometry. If the source is housed in a different type of container, contact Capintec, Inc. for further assistance.*

General Activity Measurement Procedure

To measure the activity of a sample:

- Insert the sample into the Chamber.
- Specify the nuclide by clicking anywhere within the colored area surrounding the current nuclide name. The Nuclide screen will appear. Clicking in the Nuclide Name drop-down list will present a list from which the desired nuclide can be selected. This is shown in Figure 10-2 Select Nuclide Screen.

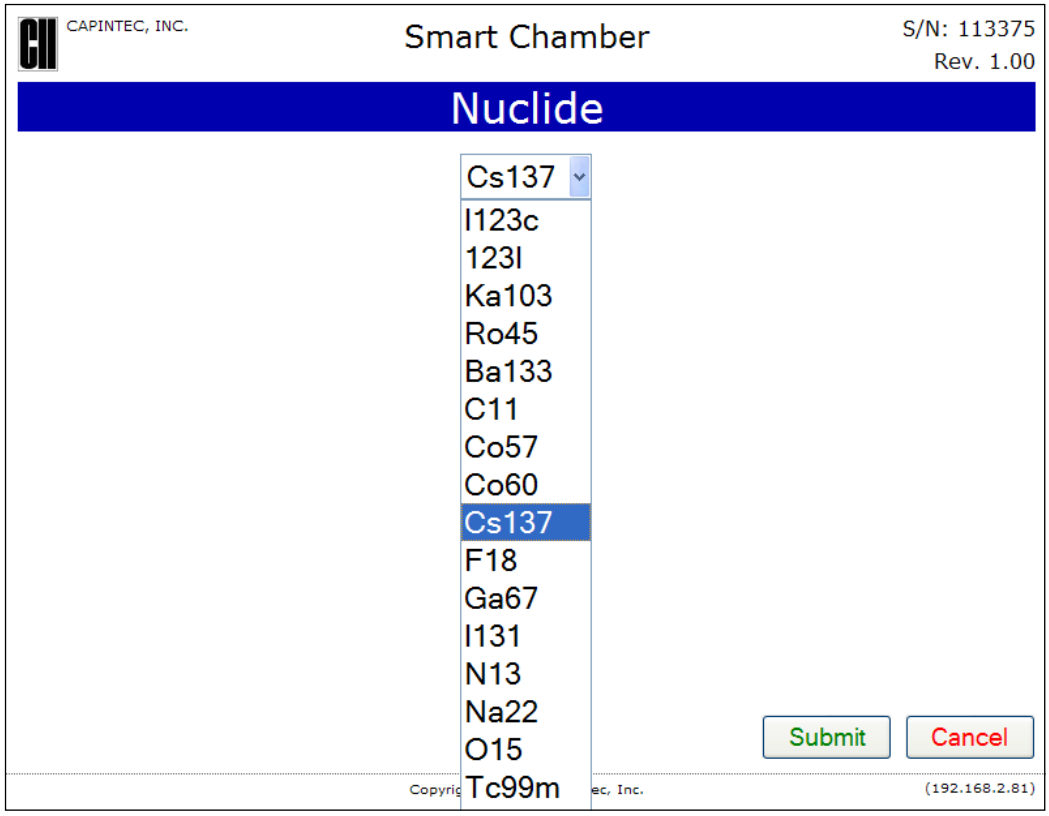


Figure 10-2 Select Nuclide Screen

Scroll the list as necessary until the desired nuclide is visible. Click on the desired nuclide. The drop-down list will close with the selected nuclide name in the box. Click the **Submit** button to change to the selected nuclide.

To print a record of the measurement (if a printer is attached to the system):

- Right-click the mouse and select *Print* from the pop-up menu, press ***Ctrl*+*P*** on the keyboard or click the Printer icon on the browser's toolbar.

To determine what the activity will be at a different time:

- Click anywhere within the colored area surrounding the **Dose Decay** button. Reference the DOSE DECAY section on page 10-10-4 for more information.

Optimizing Low Activity Measurements

Note: *This section applies only to the HL version of the CRC®-PC Smart Chambers.*

The CRC®-PC Smart Chamber has a stated resolution of 0.01µCi, which means that it is capable of detecting activities in the range of a few hundredths of a microcurie.

However, in order to perform meaningful measurements at such a low level, the following conditions must be met:

- The Smart Chamber must be in excellent (as new) working condition (without excessive low end noise or fluctuations),
- The measurement must be made in a low background area, with constant ambient background rate, and
- The measurement should be made over a 2 minute period, taking measurements every 5-10 seconds and the final value averaged.

A low activity rod source for a long-lived isotope (0.05µCi) would be very useful as a QC source to confirm measurement capabilities at low activities.

Changing Units

The central part of the screen contains the measurement unit. Reference CHAPTER 5: SYSTEM INITIALIZATION, SECTION: CHOOSING Ci or Bq for information on setting the unit of measure

DOSE DECAY

It is often desirable to know the activity of the sample at another time (usually in the future).

When another date/time is chosen, the specified date and time will be displayed in the colored area surrounding the **Dose Decay** button along with the calculated activity at that time based on the half-life of the nuclide being measured.

Entering Dose Decay Date/Time

To determine the activity at a different time,

1. Insert the sample into the Chamber.
2. Specify the nuclide as described above.
3. Click the **Dose Decay** button. Figure 10-3 Dose Decay Entry Screen will appear.

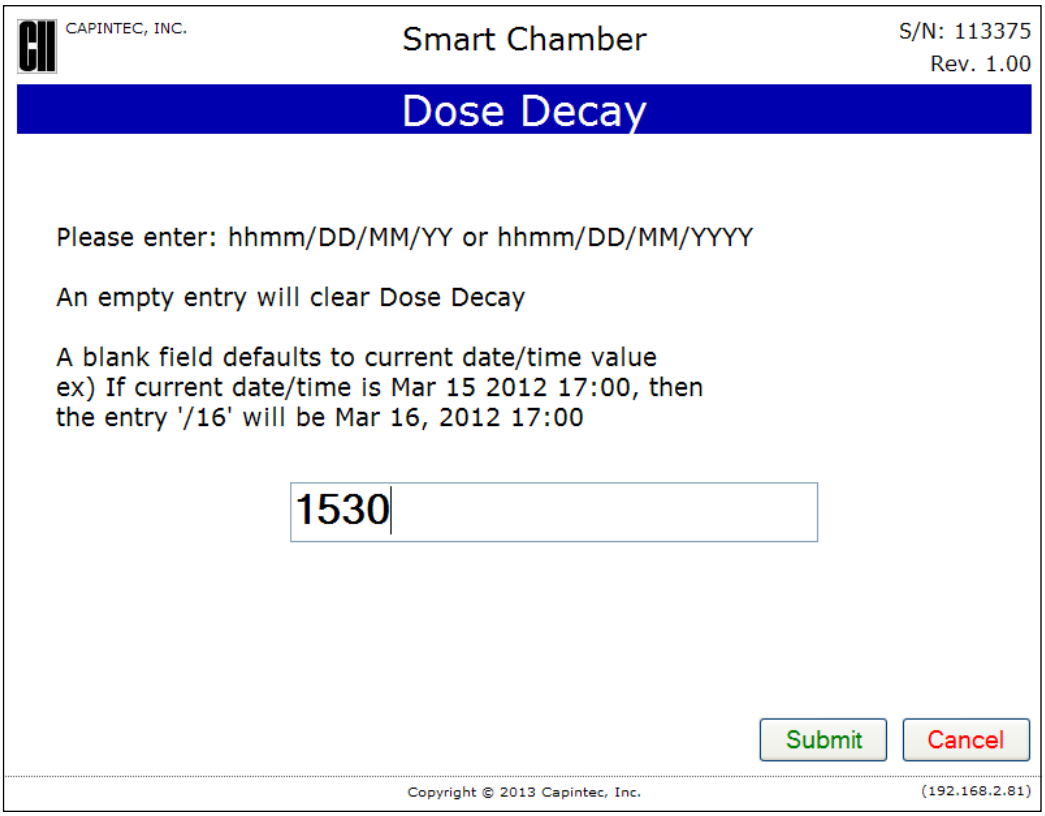


Figure 10-3 Dose Decay Entry Screen

4. Enter the future date. The time/date entry format is hhmm/DD/MM/YY or hhmm/DD/MM/YYYY where:
   - hh= hours (24-hour format) (1 or 2 digit)
   - mm = minutes (2-digit)
   - DD = day (2-digit)
   - MM = month (2-digit)
   - YY = year (2-digit) or YYYY = year (4-digit)

   Only the minimum necessary data has to be entered. Instead of entering the full date, only a limited number of /'s with the respective data need be entered.

   If the date is the same as "today", only hours and minutes (hhmm) need to be entered. That is, if the future time is sometime later in the same day, then all that needs to be input is the time.

   For the example shown in Figure 10-4 Main/Measurement Screen with Dose Decay, the current time is 14:57 and the desired future time is 20:50 today;
   - input **2050** and click the **Submit** button.
     - o **2050** (for the time)

- The Dose Decay box will now be populated with the time of May 7, 2013 20:50.

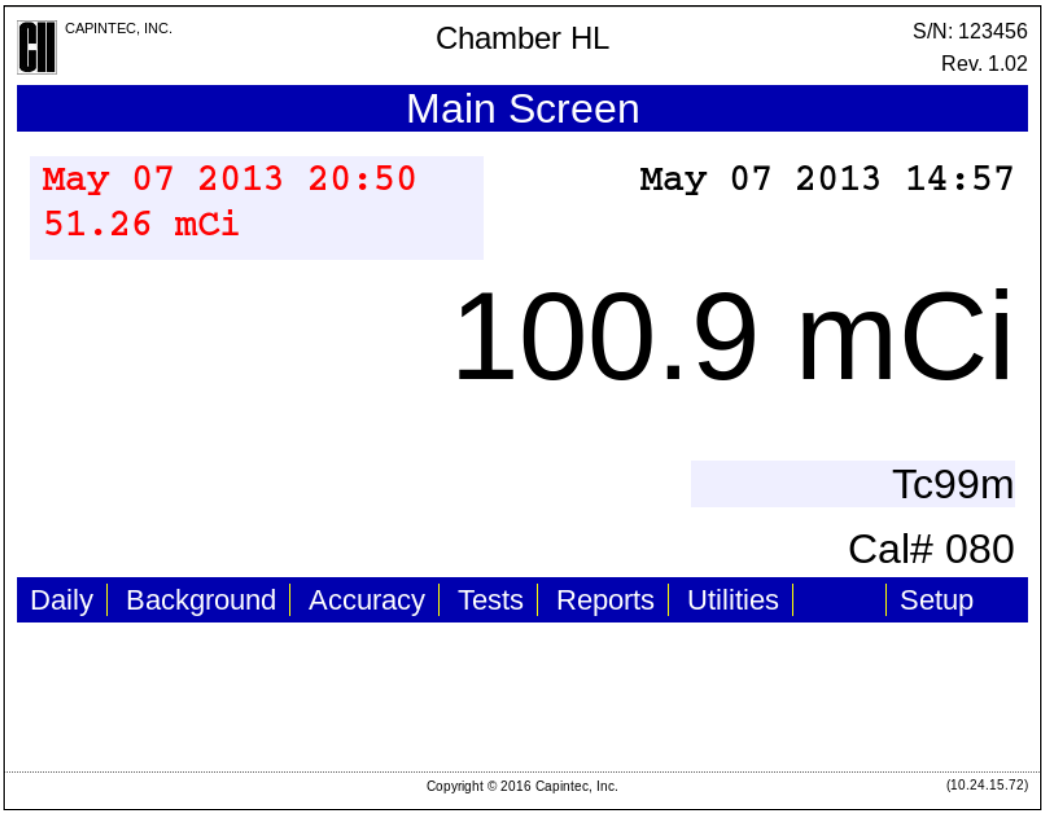


Figure 10-4 Main/Measurement Screen with Dose Decay

If the future time is sometime the next day, then all that needs to be input is the time (hhmm) and day (DD).

For the example shown in Figure 10-4 Main/Measurement Screen with Dose Decay, the current date/time is May 07, 2013 14:57 and the desired future time is 9:00 tomorrow;

- input **900/8** and click the **Submit** button.
    - o **900** (for the time), ***/*** , **8** (for the day)
- The Dose Decay box will now be populated with the time of May 8, 2013 09:00.

If the future time is the same time the next day, then all that needs to be input is the day (DD).

For the example shown in Figure 10-4 Main/Measurement Screen with Dose Decay, the current date/time is May 07, 2013 14:57 and the desired future time is May 08, 2013 14:57 tomorrow;

- input **/8** and click the **Submit** button.
    - o ***/***, **8** (for the day)
- The Dose Decay box will now be populated with the time of May 8, 2013 14:57.

Reference the following chart for more input examples.

If the current date/time is May 07, 2013 14:57

Inputting:	**Results in:**
2050	May 07, 2013 20:50
900/8	May 08, 2013 09:00
/8	May 08, 2013 14:57
//6	June 07, 2013 14:57
///14	May 07, 2014 14:57
2050//6	June 07, 2013 20:50

Table 10-1 Calibration Number Limits Table

To abort the Dose Decay calculation, click the **Cancel** button.

To clear the Dose Decay calculation, verify that the entry box is blank and click the **Submit** button.

PRINTING A RECORD OF THE MEASUREMENT

At any time, a record of the measurement can be printed (if a printer is attached to the system) by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl*+*P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

MOLY ASSAY

The CRC®-PC Smart Chamber steps the user through a Moly Assay procedure. The assay may be performed using a CapMac or Canister.

Note: *Moly Assay cannot be performed with a PS Chamber.*

If one method (CAPMAC or CANISTER) is to be used all the time, choose the method in Setup. (Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: MOLY ASSAY SETUP.)

To perform a Moly Assay, from Figure 10-1 Main/Measurement Screen, click the **Tests** button. Figure 10-5 Test Screen will appear.

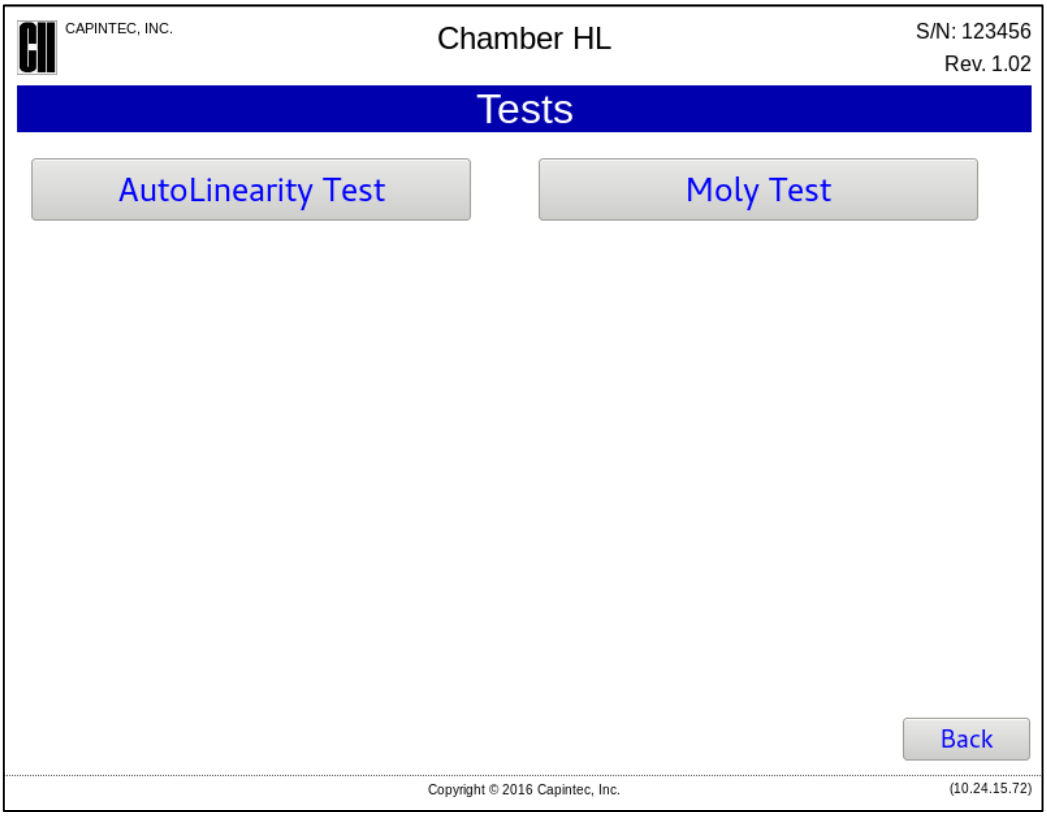


Figure 10-5 Test Screen

Click the **Moly Test** button. If the no assay method has been specified, the message “No Moly Method Enabled” will appear. The method must be chosen first in Setup. (Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: MOLY ASSAY SETUP.) If one or more assay method(s) have been specified, Figure 10-6 Moly Assay Start Screen will appear.

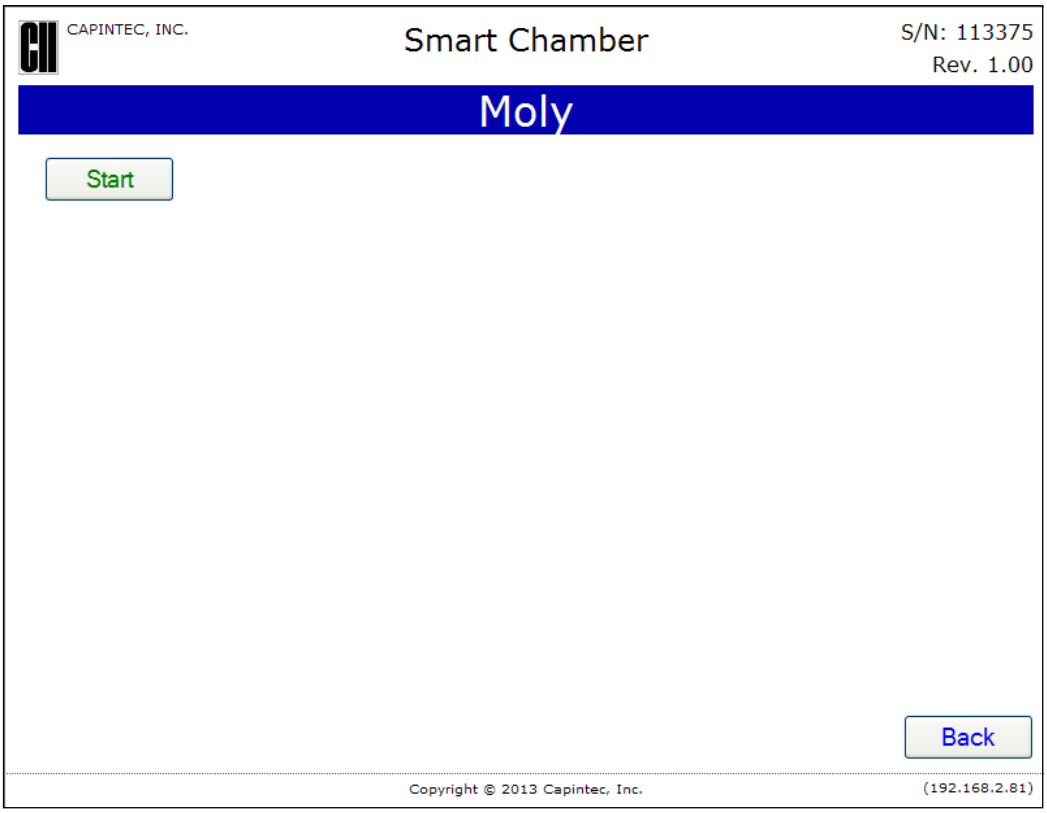


Figure 10-6 Moly Assay Start Screen

To abort the Moly Assay test, click the **Back** button. Figure 10-1 Main/Measurement Screen will re-appear.

To begin the test, click the **Start** button.

- If more than one method was selected in Moly Assay Setup, Figure 10-7 Moly Method Selection Screen will appear. In the example, both methods were selected.

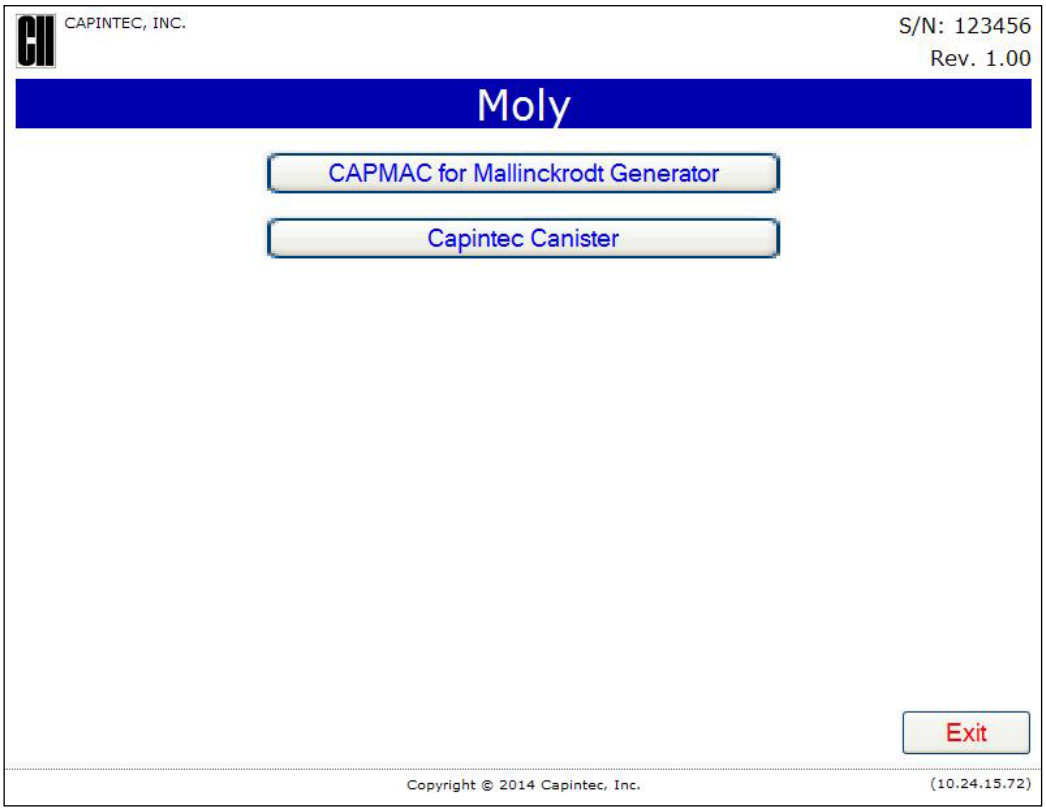


Figure 10-7 Moly Method Selection Screen

To abort the Moly Assay test, click the **Exit** button. Figure 10-1 Main/Measurement Screen will re-appear.

Click the button for the desired method. Figure 10-8 Assay ID Screen will appear for the selected method. In the example, Capintec Canister was chosen.

- If only one method was selected in Moly Assay Setup, Figure 10-8 Assay ID Screen will appear for the selected method. In the example, Capintec Canister was chosen.

Assay ID

The Assay ID is a name used to identify the measurement and must be assigned to the Moly Assay test.

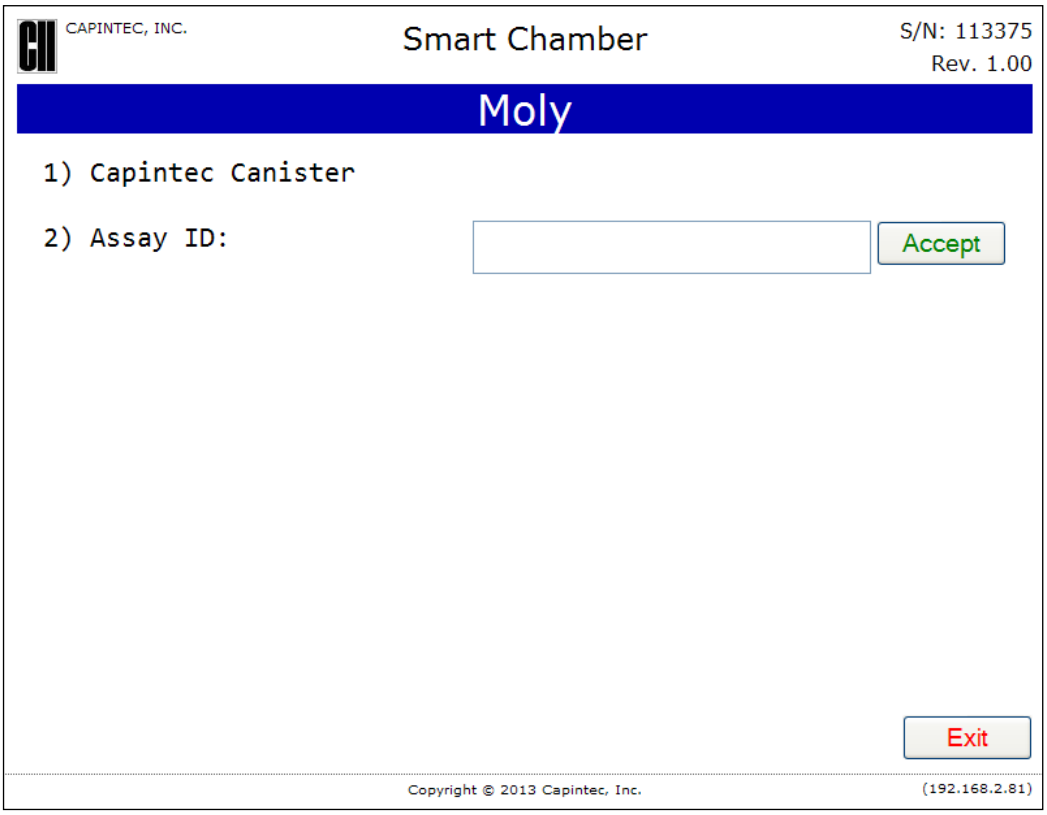


Figure 10-8 Assay ID Screen

To abort the Moly Assay test, click the **Exit** button. Figure 10-1 Main/Measurement Screen will re-appear.

Click in the ***Assay ID:*** text box and input an identifier for the Moly Assay test. Up to 16 alphanumeric characters can be entered.

Once the identifier is complete, click the **Accept** button. Figure 10-9 Moly Assay Background Choice Screen will appear.

Mo99 Background

Measuring the Background for Mo99 is optional. This Background will only be used for the current assay. If it is skipped, the previously measured Background will be used.

Note: *The following examples are for CANISTER. CAPMAC will be exactly the same except that the screens will prompt for measurements in the CAPMAC.*

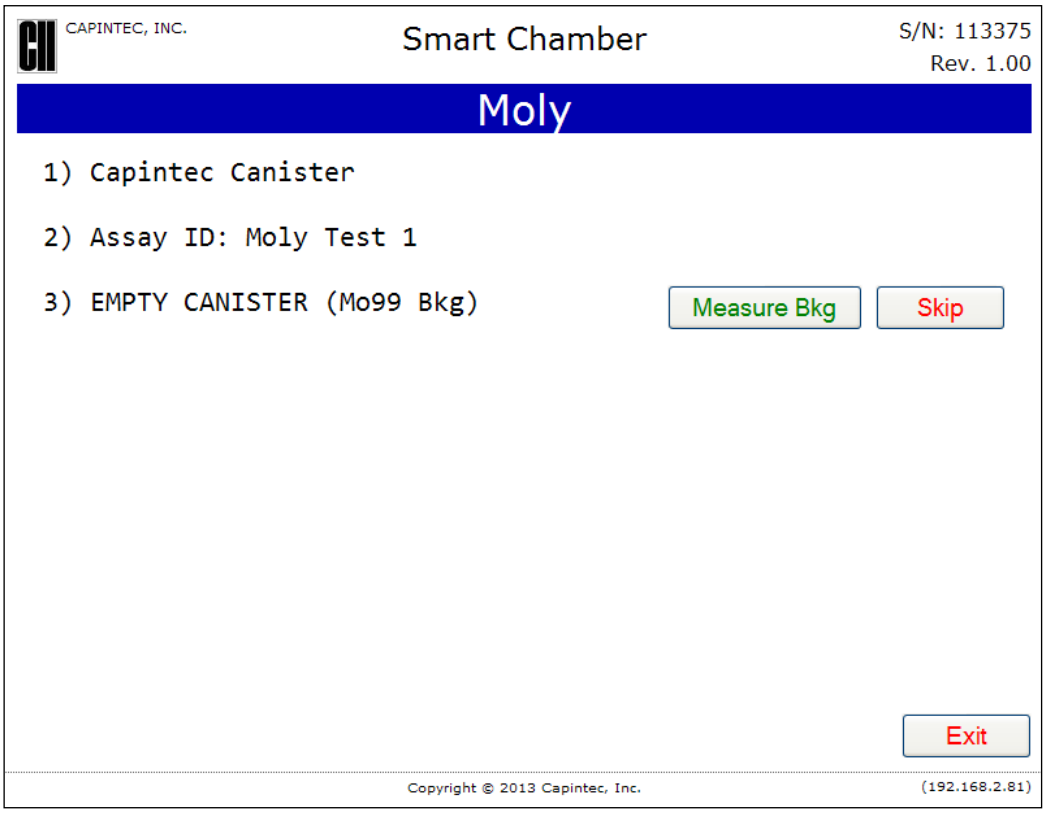


Figure 10-9 Moly Assay Background Choice Screen

To abort the Moly Assay test, click the **Exit** button. Figure 10-1 Main/Measurement Screen will re-appear.

To skip measuring the Background now and use the previous Background measurement, click the **Skip** button. The *Mo99 Bkg:* will be marked as “Skipped”.

To measure the Background now, remove all sources from the vicinity of the Chamber and click the **Measure Bkg** button. A progress bar will appear until a measurement is available.

When the measurement is available, Figure 10-10 Moly Assay Background Measurement Accept Screen will appear.

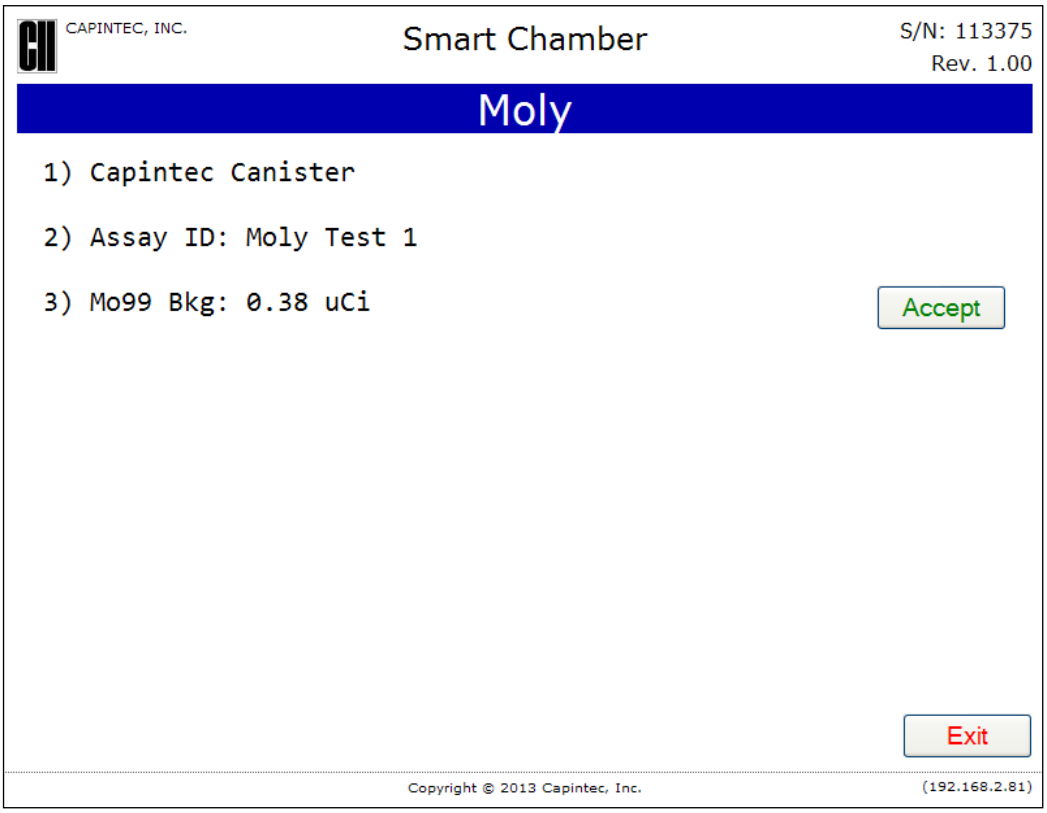


Figure 10-10 Moly Assay Background Measurement Accept Screen

If the Background is high but still acceptable (>1.008mCi [37.3MBq] to 321.8mCi [11.9GBq]), the message “HIGH” will appear. Although the measurement is acceptable, the reason for the high measurement should be investigated. If any sources are found nearby, repeat the measurement.

If the background is above the acceptable range, the measurement will not be shown but Figure 10-11 Moly Assay Background Measurement Too High Screen will appear.

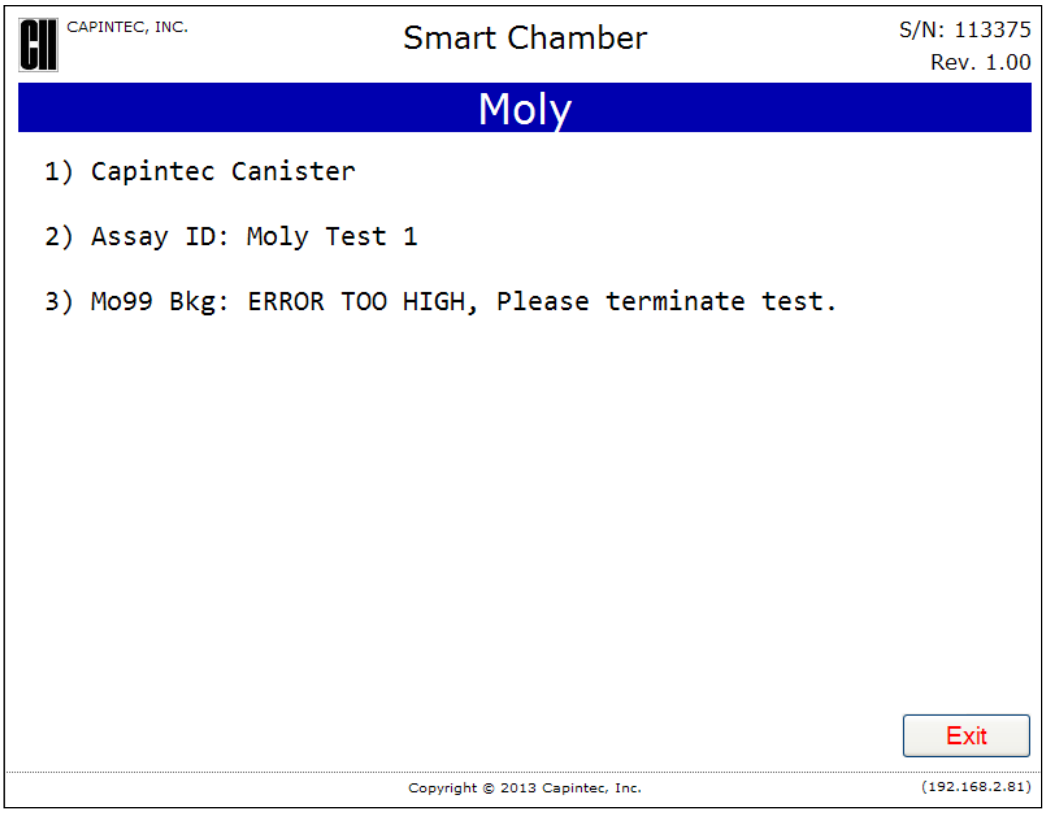


Figure 10-11 Moly Assay Background Measurement Too High Screen

This "TOO HIGH" background cannot be accepted by the CRC®-PC Smart Chamber. If the cause of the high reading (nearby source, contaminated well etc.) cannot be found, contact Capintec's only Authorized Service Center at (800) ASK-4CRC.

To abort the Moly Assay test, click the **Exit** button. Figure 10-1 Main/Measurement Screen will re-appear.

To accept the Background measurement, click the **Accept** button.

Mo99 Assay

The next step is to measure the eluate in the CapMac or Canister.

Click the **Continue** button to measure the Mo99 Assay. A progress bar will appear until a measurement is available.

When the measurement is available, Figure 10-12 Moly Assay Eluate Accept Screen will appear.

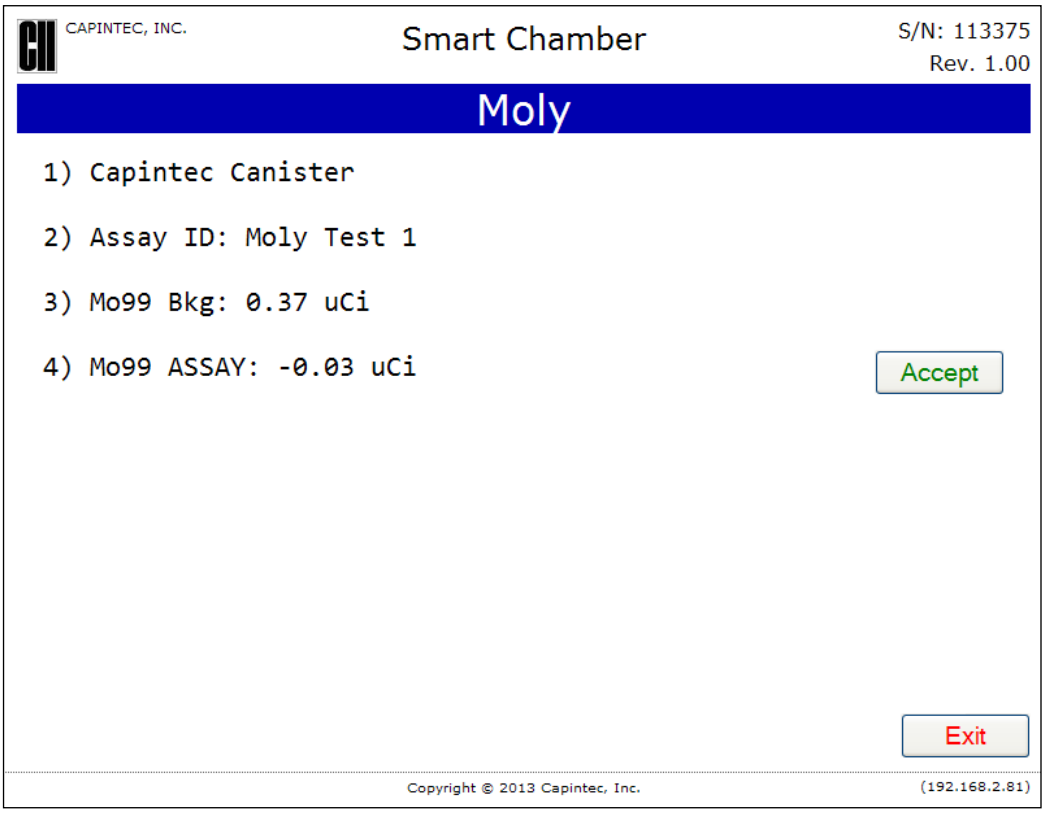


Figure 10-12 Moly Assay Eluate Accept Screen

Since this is also a measurement of a very low activity, the activity will be tested to see if it's too high (1.00mCi [37MBq] to 100.0Ci [3700GBq]) the same way that Mo99 Background is tested. If the Mo99 activity is higher than desirable, Figure 10-13 Mo High Screen will appear.

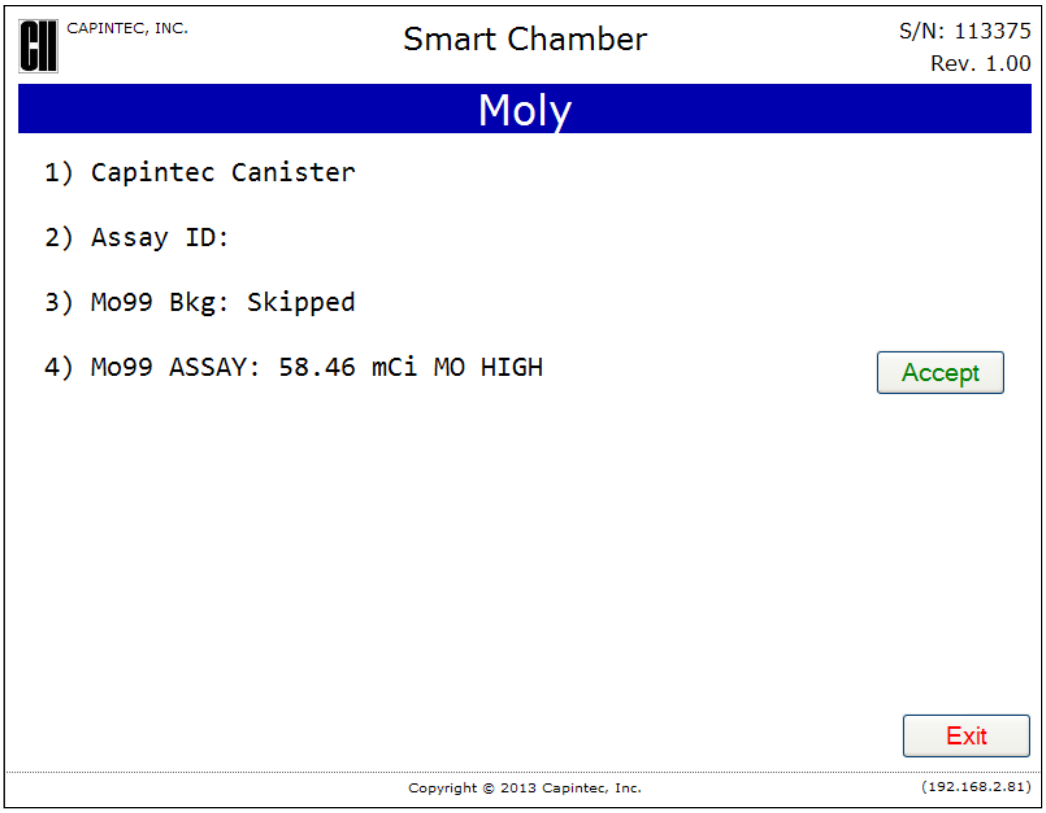


Figure 10-13 Mo High Screen

If the Mo99 activity is above the acceptable range, the measurement will not be shown but the message “OVER RANGE, Please terminate test” will appear.

To abort the Moly Assay test, click the **Exit** button. Figure 10-1 Main/Measurement Screen will re-appear.

Click the **Accept** button to accept the Mo99 Assay measurement.

Tc99m Assay

The Tc99m Assay is performed next.

Click the **Continue** button to measure the Tc99 Assay. Figure 10-14 Moly Assay Tc99m Accept Screen will appear.

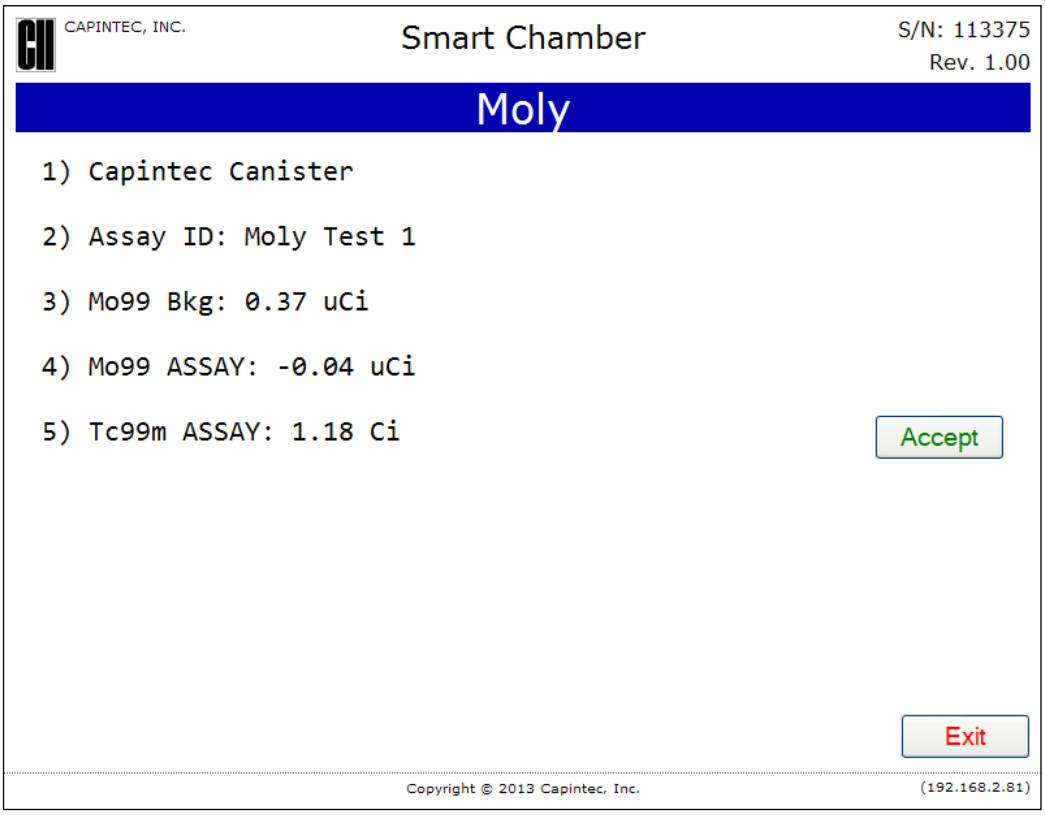


Figure 10-14 Moly Assay Tc99m Accept Screen

To abort the Moly Assay test, click the **Exit** button. Figure 10-1 Main/Measurement Screen will re-appear.

Click the **Accept** button to accept the Tc99m Assay measurement. Figure 10-15 Moly Assay Calculate Concentration Screen will appear.

Enter Volume

The next step is to enter the volume of the elution.

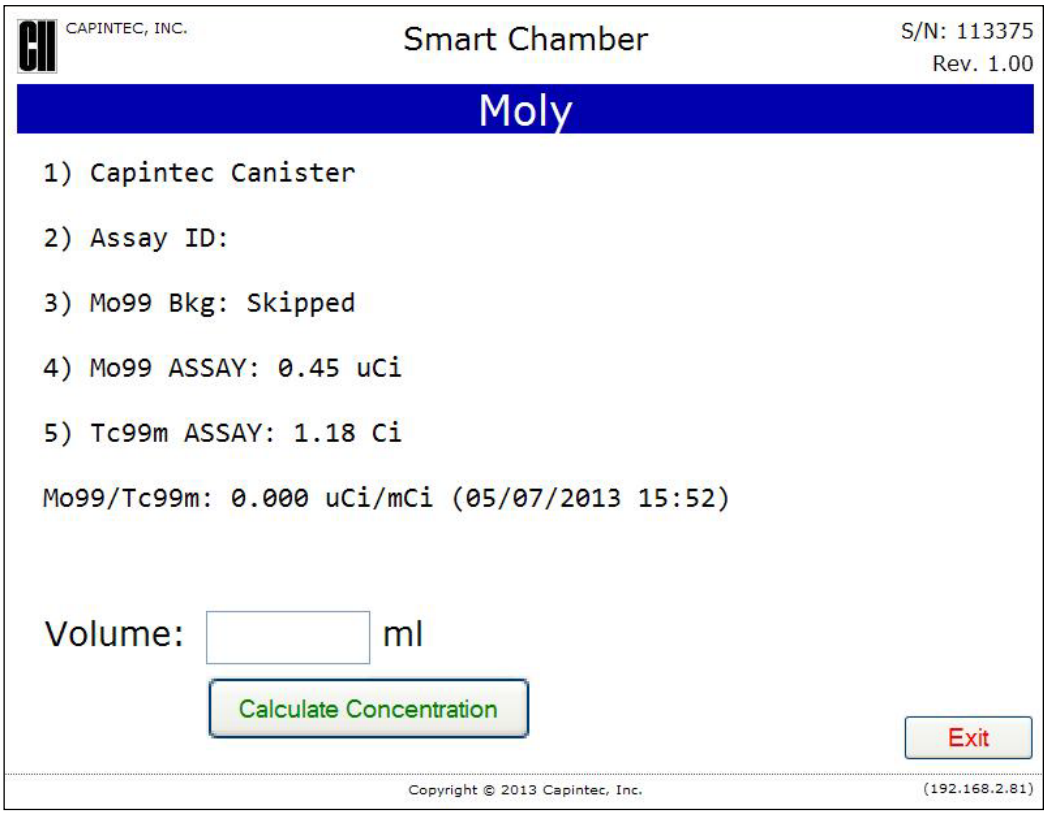


Figure 10-15 Moly Assay Calculate Concentration Screen

Input the volume of the elution in milliliters and click the **Calculate Concentration** button.

Note: *The minimum value that can be input is 0.1. The maximum value that can be input is 100.0.*

The concentration of the elution is calculated and displayed as shown in Figure 10-16 Moly Assay Results Screen.

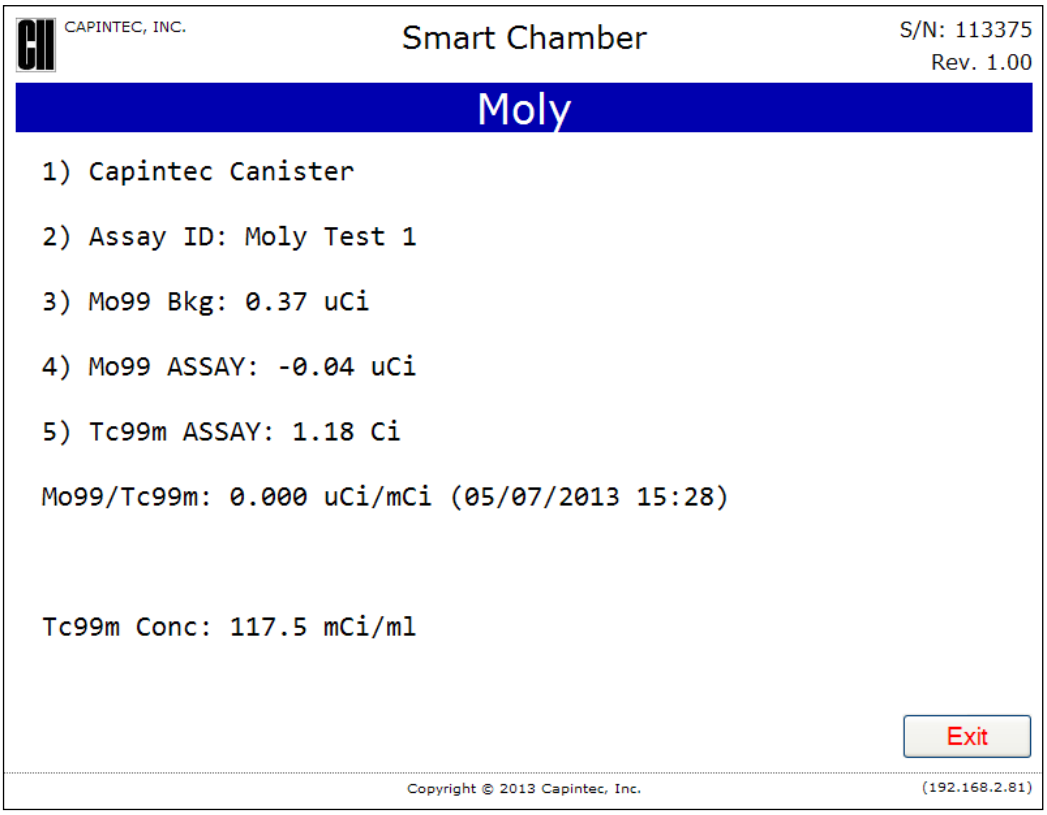


Figure 10-16 Moly Assay Results Screen

Moly Assay Results

If the measured Tc99m activity is below 1.0 mCi, the message “ACTIVITY TOO LOW” will appear on the screen. Click the **Exit** button to return to Figure 10-1 Main/Measurement Screen.

The Mo99/Tc99m ratio is calculated and compared to the allowable value (which can be changed in Moly Setup – Reference CHAPTER 6: CHAMBER INITIALIZATION, SECTION: MOLY ASSAY SETUP.

If the calculated Mo/Tc limit is higher than the allowable limit, the message “MO TOO HIGH – DO NOT USE” will appear as shown in Figure 10-17 Mo/Tc Ratio Too High Screen. Click the **Exit** button to return to Figure 10-1 Main/Measurement Screen.

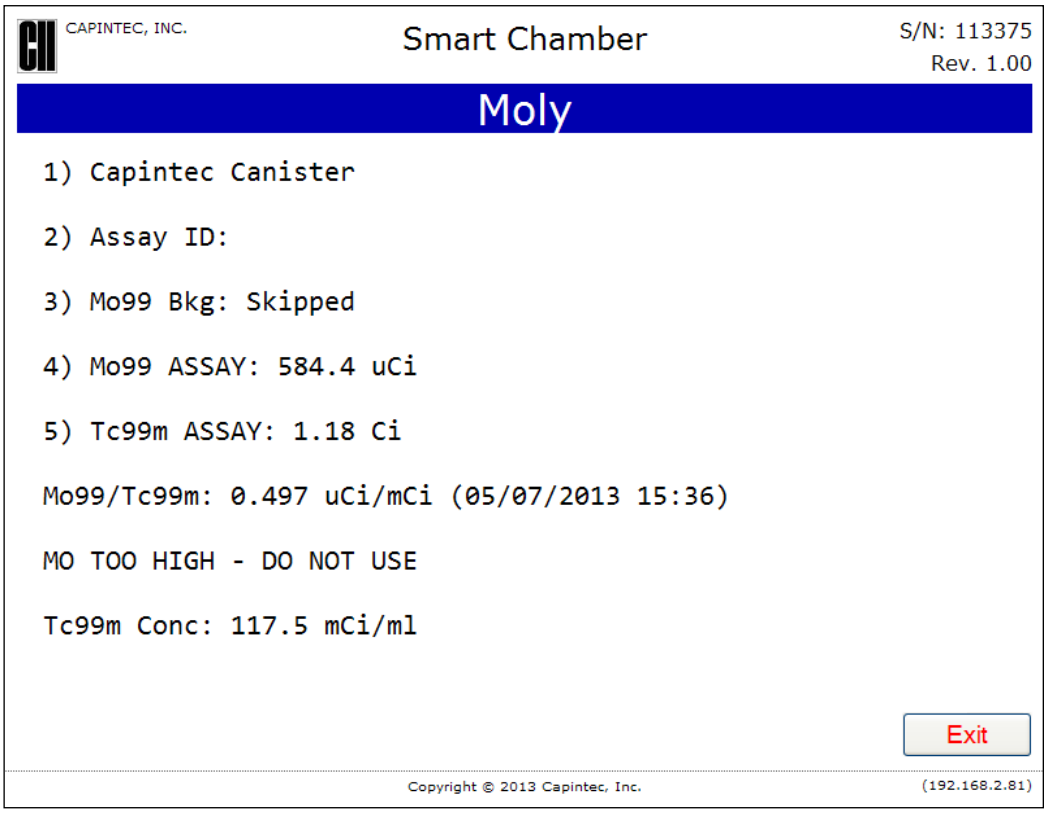


Figure 10-17 Mo/Tc Ratio Too High Screen

If the calculated Mo/Tc ratio is within the allowable limit, the time when the ratio will exceed this limit is also calculated.

If the calculated usable time is less than 12 hours, a usage caution message is displayed depending upon the useable time for the elution. An example of such a case is shown in Figure 10-18 Moly Assay Results – Less than 12 hours Screen.

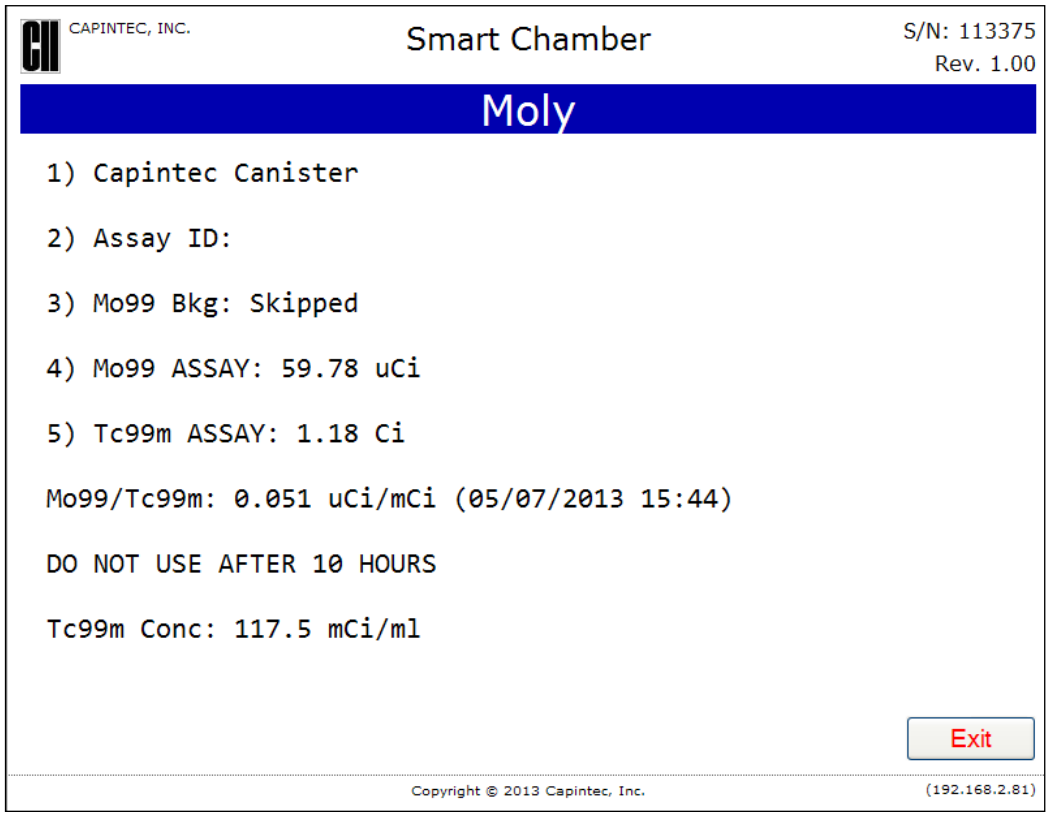


Figure 10-18 Moly Assay Results – Less than 12 hours Screen

If the calculated usable time is more than 12 hours, no message is displayed as shown in Figure 10-19 Moly Assay Results – More than 12 hours Screen.

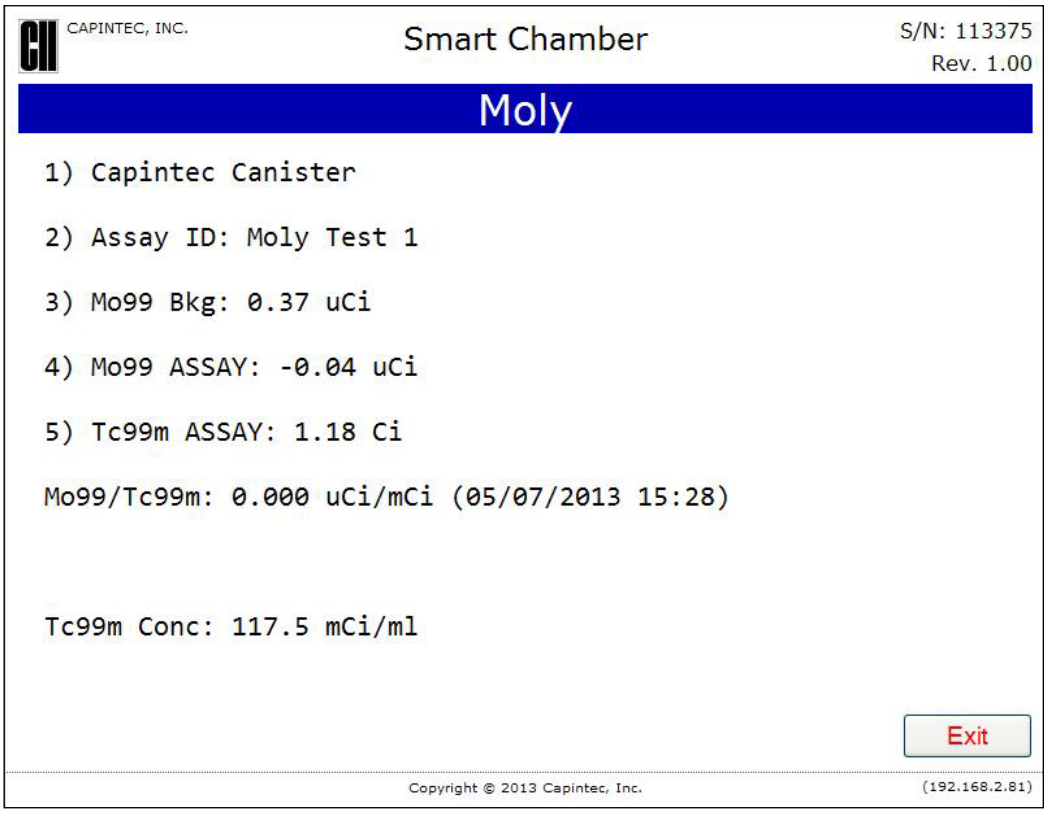


Figure 10-19 Moly Assay Results – More than 12 hours Screen

Click the **Exit** button to return to Figure 10-1 Main/Measurement Screen.

CHAPTER 11

REPORTS

GENERAL

This chapter describes the functions available in the Reports Module.

From Figure 11-1 Main/Measurement Screen, click the **Reports** button. Figure 11-2 Reports Screen will appear.

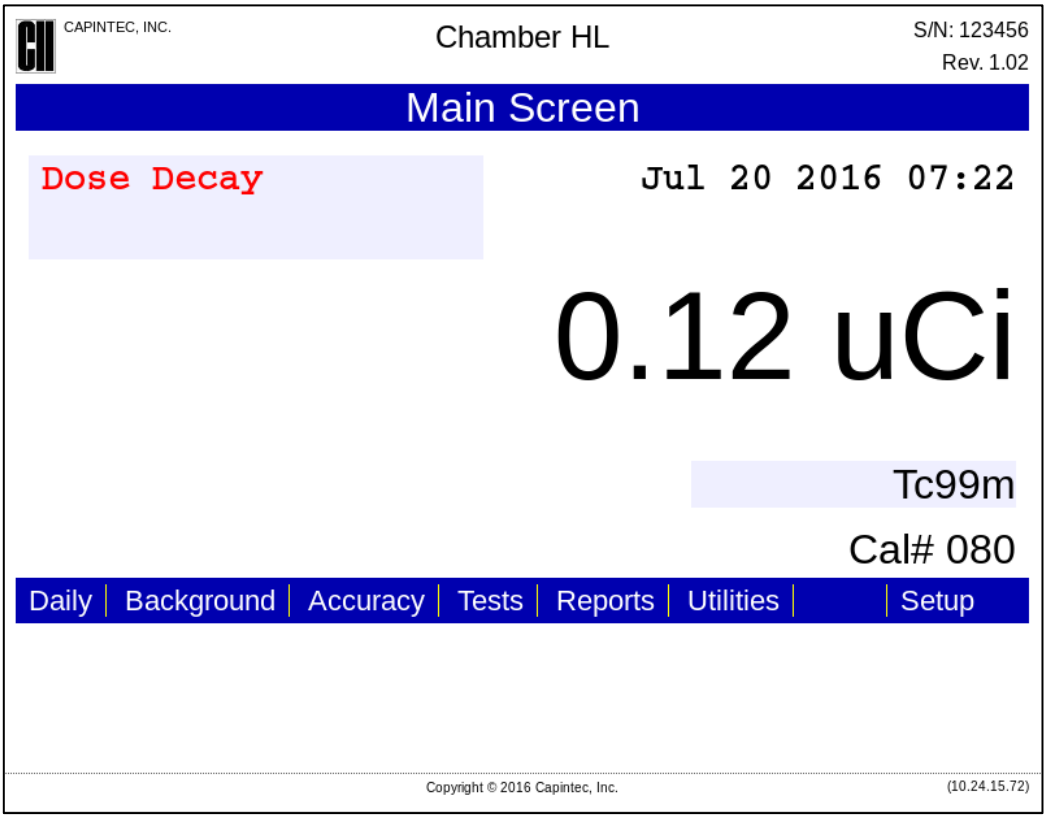


Figure 11-1 Main/Measurement Screen

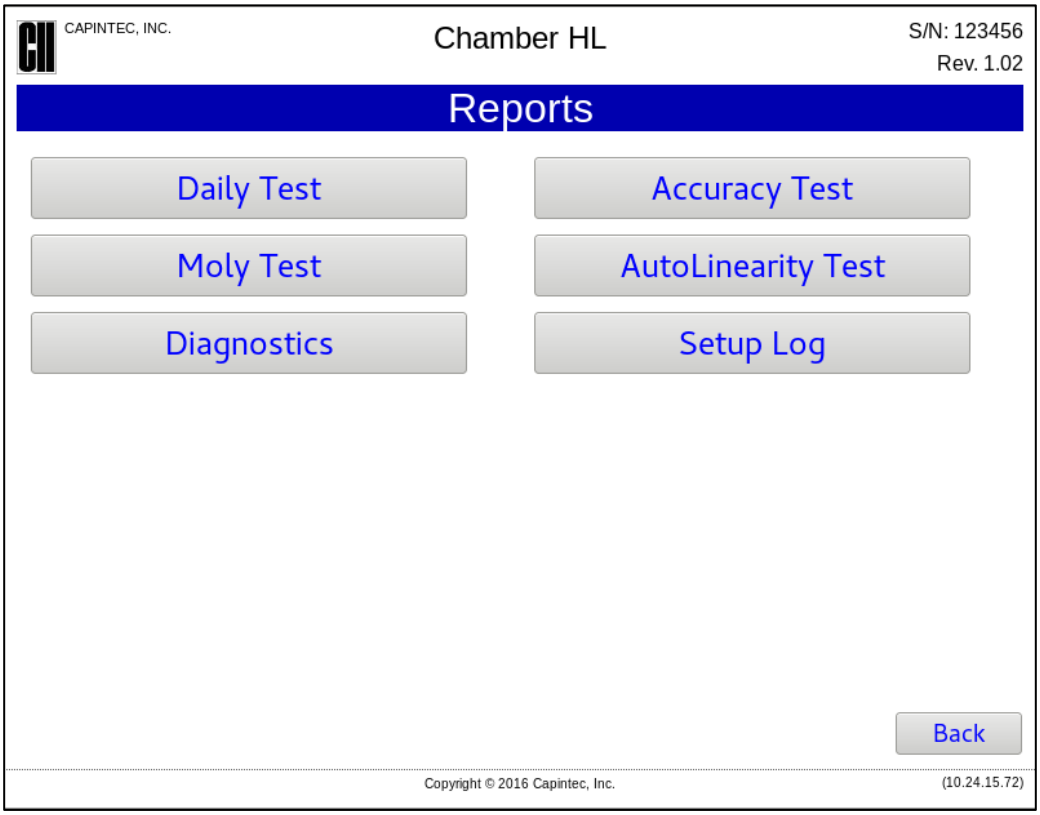


Figure 11-2 Reports Screen

SETTING DATES

The Daily Test, Accuracy Test, Moly Test, and Setup Log reports all operate in the same fashion. When any of these buttons are clicked, a date range screen will appear.

The default ***From:*** and ***To:*** dates are both set to the current day. To change either of the default dates, click in the desired box. The Date Entry pop-out Calendar will appear as shown in Figure 11-3 Calendar in Daily Test Report Screen.

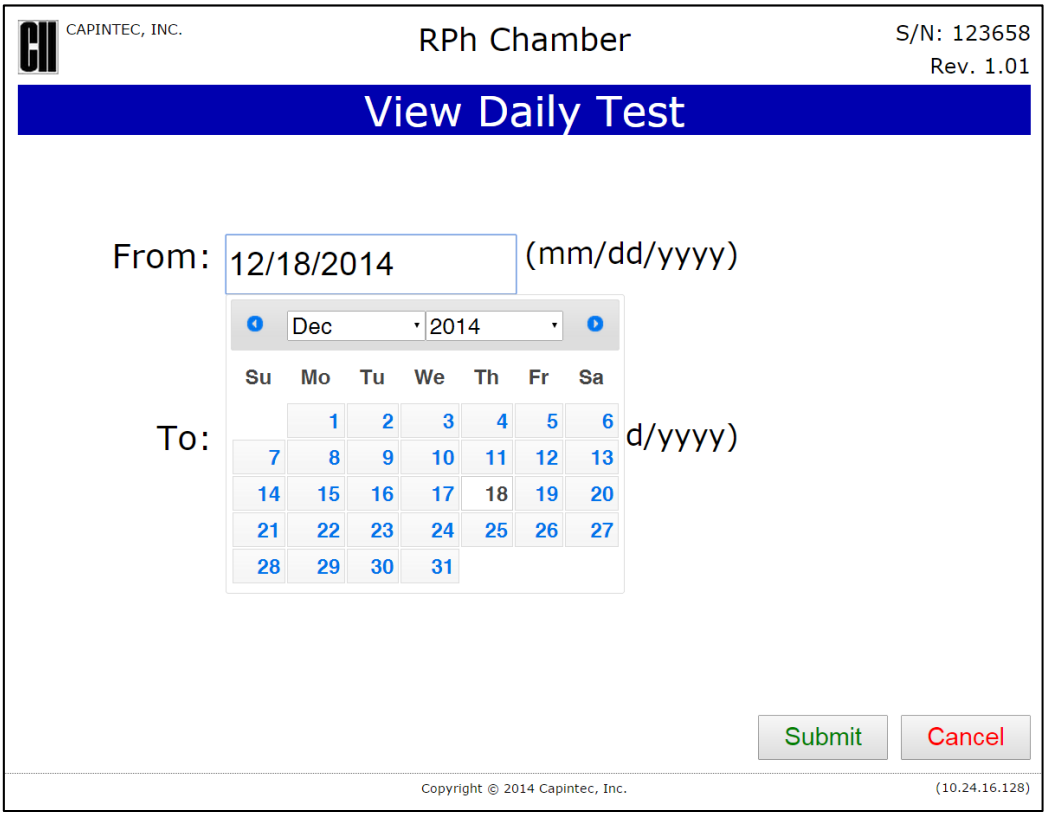


Figure 11-3 Calendar in Daily Test Report Screen

The appropriate month and year can be entered in two ways using the Calendar:

- Click on the *Month* or *Year* drop-down list box. Choose the appropriate month or year by clicking on the desired selection.
- Click on the **Previous Arrow** button (located to the left of the *Month* drop-down list box) or the **Next Arrow** button (located to the right of the *Year* drop-down list box) to advance the Calendar one month at a time until the correct month and year are displayed.

When the month and year are correct, click the desired day on the Calendar. The Calendar will close and selected box will display the set date.

Once both of the dates are set to the desired values, click the **Submit** button. The system will display the selected report within the time window selected.

An example of each report is presented below.

DAILY TEST REPORT

Clicking the **Daily Test** button and setting the dates (as described in the SETTING DATES section on page 11-11-3) produces a report similar to that shown in Figure 11-4 Daily Test Report. The report contains the following information:

- The date and time of each test
- Zero: the measured value and if Zero Drift or Zero Out of Range occurred
- Background: the measured activity and if High or Too High occurred
- Chamber Voltage: the measured value and if the test Failed
- The status of the Data Check

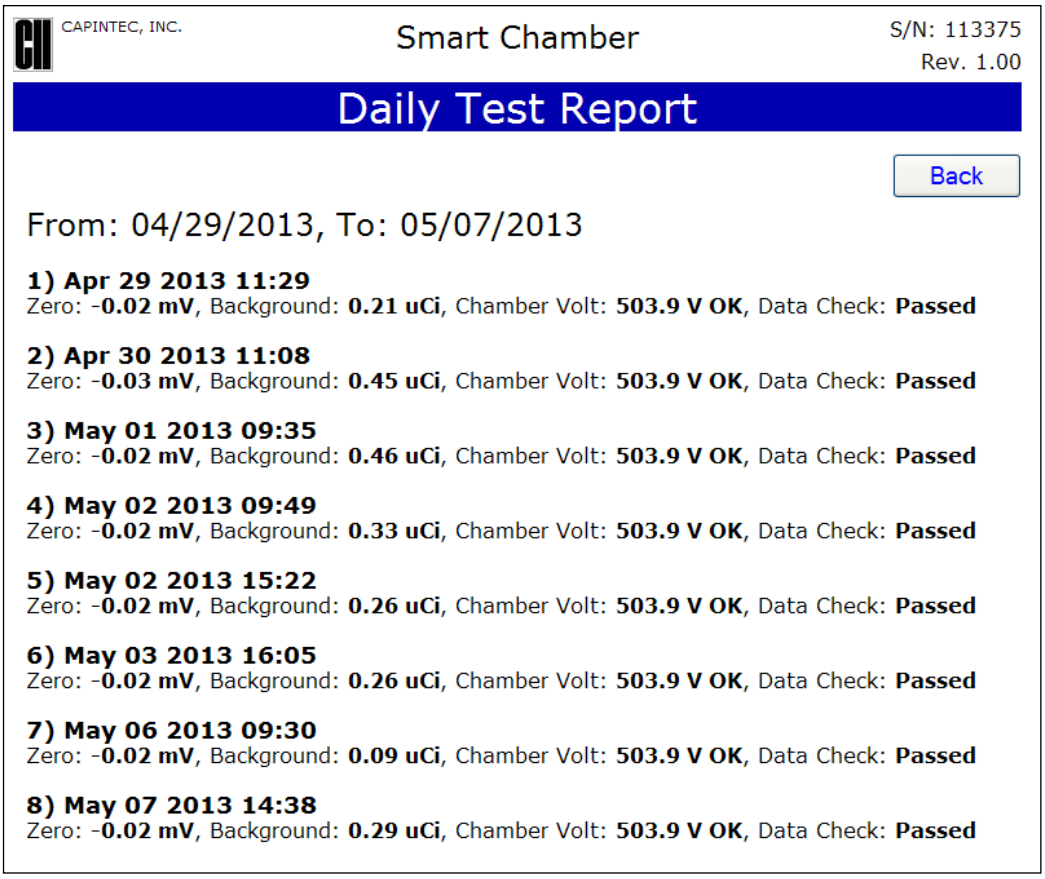


Figure 11-4 Daily Test Report

If a printer is attached to the system, the report can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl*+*P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

Click the **Back** button to return to the View Daily Test Date Range screen.

MOLY TEST REPORT

Clicking the **Moly Test** button and setting the dates (as described in the SETTING DATES section on page 11-11-3) produces a report similar to that shown in Figure 11-5 Moly Test Report. The report contains the following information:

- The date and time of each test
- The assigned Assay Identifier
- The selected measurement method
- Mo99 Background: the measured activity or Skipped if skipped
- Mo99 Assay: the measured activity and if High occurred
- Tc99m Assay: the measured activity and if Activity Too Low occurred
- The set Mo99/Tc99m Limit value
- The measured Mo99/Tc99m Ratio
- The calculated usable time if it is less than 12 hours
- The entered volume of the elution in milliliters
- The calculated Mo99/Tc99m elution Concentration

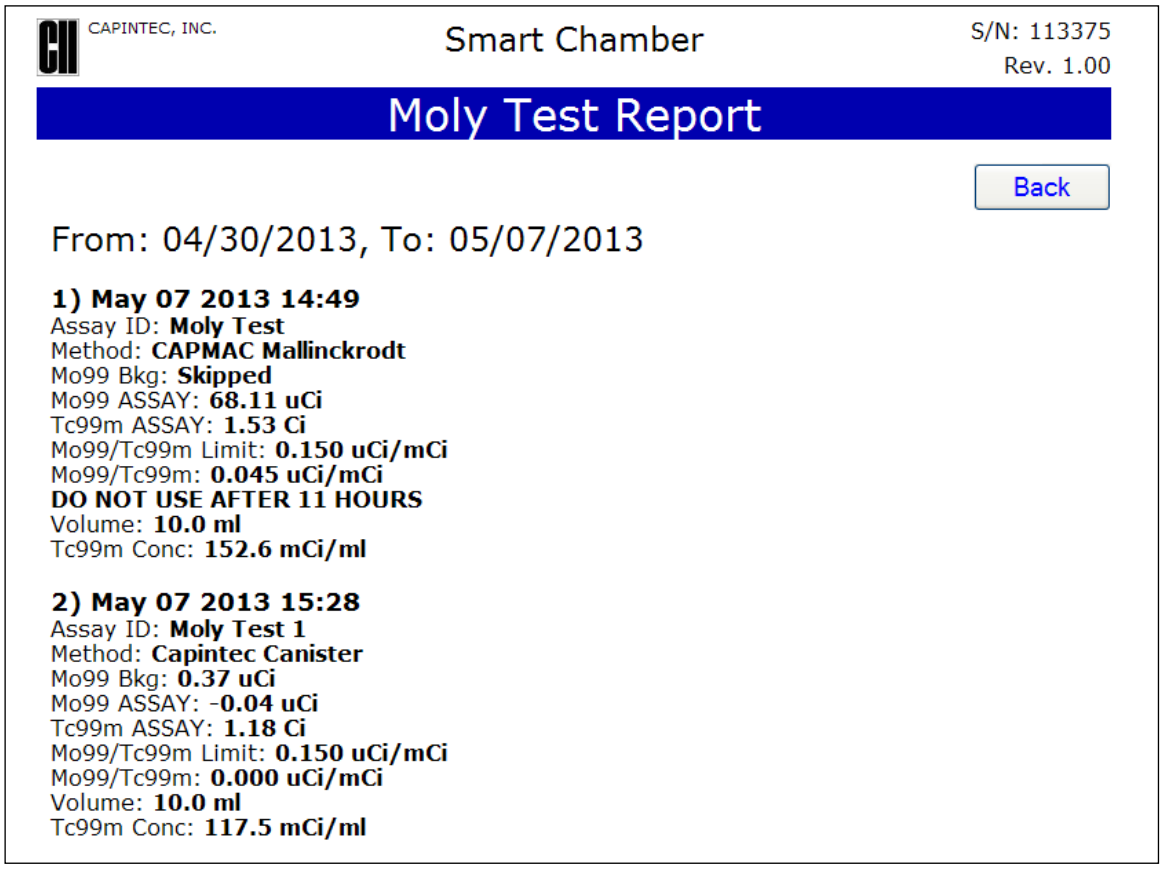


Figure 11-5 Moly Test Report

If a printer is attached to the system, the report can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl+P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

Click the **Back** button to return to the View Moly Test Date Range screen.

ACCURACY TEST REPORT

Clicking the **Accuracy Test** button and setting the dates (as described in the SETTING DATES section on page 11-11-3) produces a report similar to that shown in Figure 11-6 Accuracy Test Report. The report contains the following information:

- The date and time of each test
- For each Test Source measured:
    - the Serial Number
    - the anticipated actual activity of the check source based upon the initial calibration of the source, corrected for decay
    - the actual measured activity
    - the percentage deviation of the measured activity from the anticipated activity
- if set up for Auto Constancy, the Auto Constancy Channels results

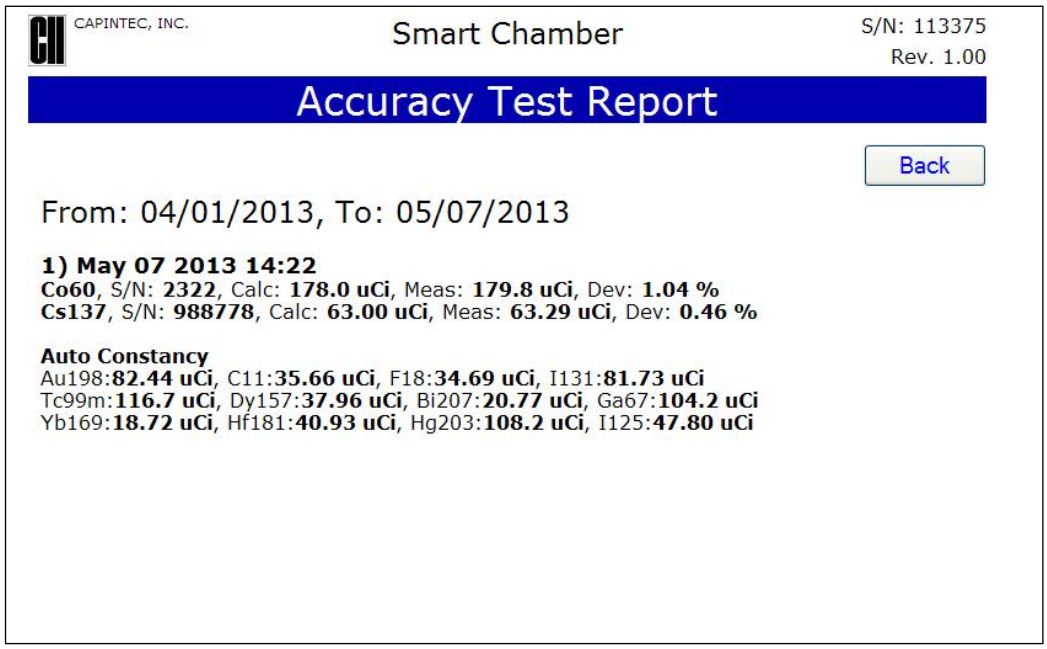


Figure 11-6 Accuracy Test Report

If a printer is attached to the system, the report can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl+P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

Click the **Back** button to return to the View Accuracy Test Date Range screen.

SETUP LOG

Clicking the **Setup Log** button and setting the dates (as described in the SETTING DATES section on page 11-11-3) produces a report similar to that shown in Figure 11-7 Setup Log Report.

The Setup Log Report provides the user with a time constrained report of the actions taken in Setup where a **Submit** button was clicked.

The report contains the following information:

- The date and time of each action
- The action taken

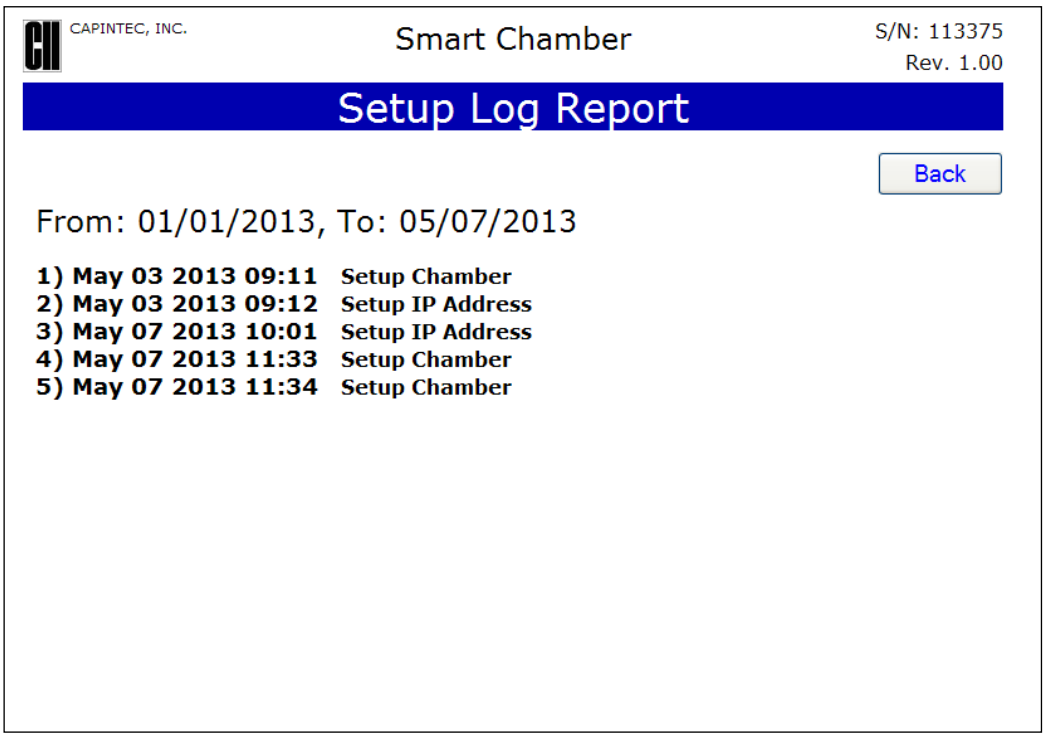


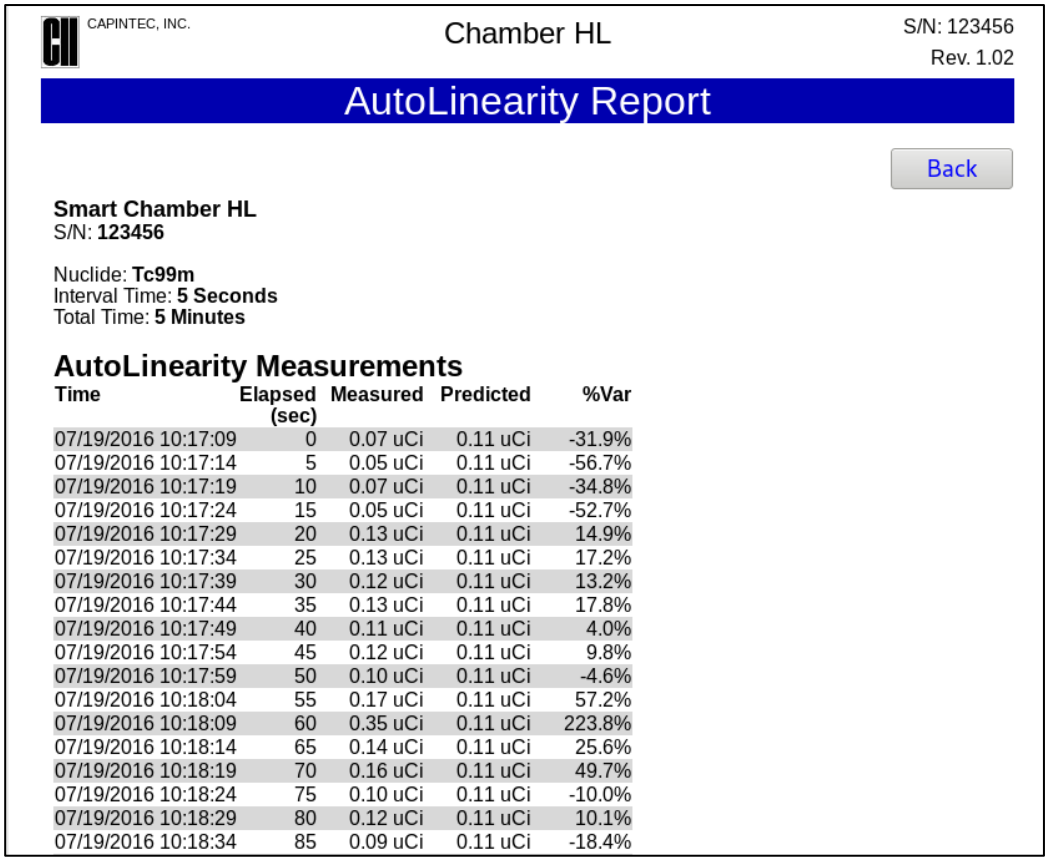
Figure 11-7 Setup Log Report

If a printer is attached to the system, the report can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl+P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

Click the **Back** button to return to the View Setup Log Date Range screen.

AUTOLINEARITY TEST REPORT

Clicking the **AutoLinearity Test** button will display the last AutoLinearity Test Report.



CAPINTEC, INC.

Chamber HL

S/N: 123456
Rev. 1.02

AutoLinearity Report

Back

Smart Chamber HL
S/N: **123456**

Nuclide: **Tc99m**
Interval Time: **5 Seconds**
Total Time: **5 Minutes**

AutoLinearity Measurements

Time	Elapsed (sec)	Measured	Predicted	%Var
07/19/2016 10:17:09	0	0.07 uCi	0.11 uCi	-31.9%
07/19/2016 10:17:14	5	0.05 uCi	0.11 uCi	-56.7%
07/19/2016 10:17:19	10	0.07 uCi	0.11 uCi	-34.8%
07/19/2016 10:17:24	15	0.05 uCi	0.11 uCi	-52.7%
07/19/2016 10:17:29	20	0.13 uCi	0.11 uCi	14.9%
07/19/2016 10:17:34	25	0.13 uCi	0.11 uCi	17.2%
07/19/2016 10:17:39	30	0.12 uCi	0.11 uCi	13.2%
07/19/2016 10:17:44	35	0.13 uCi	0.11 uCi	17.8%
07/19/2016 10:17:49	40	0.11 uCi	0.11 uCi	4.0%
07/19/2016 10:17:54	45	0.12 uCi	0.11 uCi	9.8%
07/19/2016 10:17:59	50	0.10 uCi	0.11 uCi	-4.6%
07/19/2016 10:18:04	55	0.17 uCi	0.11 uCi	57.2%
07/19/2016 10:18:09	60	0.35 uCi	0.11 uCi	223.8%
07/19/2016 10:18:14	65	0.14 uCi	0.11 uCi	25.6%
07/19/2016 10:18:19	70	0.16 uCi	0.11 uCi	49.7%
07/19/2016 10:18:24	75	0.10 uCi	0.11 uCi	-10.0%
07/19/2016 10:18:29	80	0.12 uCi	0.11 uCi	10.1%
07/19/2016 10:18:34	85	0.09 uCi	0.11 uCi	-18.4%

Figure 11-8 AutoLinearity Test Report

If a printer is attached to the system, the report can be printed by right-clicking the mouse and selecting *Print* from the pop-up menu, pressing ***Ctrl*+*P*** on the keyboard or clicking the Printer icon on the browser's toolbar.

Click the **Back** button to return to the Reports screen.

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CHAPTER 12

CLEANING AND MAINTENANCE

GENERAL

This chapter provides the information necessary for the user to perform the basic maintenance of instrument cleaning and general preventative maintenance. There are no internal adjustments or calibration settings that may be done by the user within the conditions of the warranty.

⚠ **CAUTION:** REFER ALL SERVICING TO A QUALIFIED SERVICE REPRESENTATIVE!

It is recommended that periodic (every three to five years) re-calibration of the CRC®-PC Smart Chamber be performed only by Capintec's Authorized Service Center to guarantee the instrument's high reliability is maintained. Contact Capintec's only Authorized Service Center for servicing or re-calibration at (800) ASK-4CRC.

CLEANING AND DISINFECTING

CAUTION:

- DISCONNECT THE POWER BEFORE CLEANING.
- TO AVOID ELECTRICAL SHOCK OR DAMAGING OF THE CRC®-PC SMART CHAMBER, NEVER ALLOW WATER OR LIQUIDS TO PENETRATE THE CHAMBER OR THE COMPUTER SYSTEM ENCLOSURES.
- DO NOT USE AEROSOL DISPENSERS TO SPRAY THE EQUIPMENT WITH CLEANING SOLUTIONS OR LIQUIDS.
- TO AVOID DAMAGING, DO NOT USE AROMATIC HYDROCARBONS, CHLORINATED SOLVENTS OR METHANOL-BASED CLEANING SOLUTIONS.
- PRIOR TO CLEANING OR DISINFECTING THE LINER AND/OR DIPPER, REMOVE THEM FROM THE CHAMBER. CAUTION: NEVER USE THE CALIBRATOR WITHOUT THE CHAMBER LINER IN PLACE. LINERS ARE INEXPENSIVE AND EASY TO REPLACE. A CONTAMINATED CHAMBER IS A VERY COSTLY MISTAKE.

Cleaning Instructions

Computer Screen

Use a soft cloth lightly dampened with water. Wipe the screen as necessary to remove dust, fingerprints, and/or smudges.

Computer Case

Use a soft cloth lightly dampened with water. Wipe the surfaces of the case and the keyboard keys as necessary to remove dust, fingerprints, and/or smudges.

Keyboard

Use a can of compressed air with a narrow, straw-like extension to blow away any trapped particles from under the keys. If you spill liquid on the keyboard, shut down the computer immediately. Turn the computer upside down to allow the liquid to drain and dry overnight before you attempt to use it again. If the keyboard fails to function after drying, it will have to be replaced.

Chamber

Wipe the surfaces clean using a damp, non-abrasive cloth or sponge and a mild detergent and water; do not use solvents or aerosol cleaners. After cleaning, wipe all surfaces dry with a soft, non-abrasive cloth. To avoid scratches, do not use abrasive pads.

Liner/Dipper

Remove the Liner and/or Dipper from the Chamber and wipe the surfaces clean using a damp, non-abrasive cloth or sponge and a mild detergent and water; do not use

solvents or aerosol cleaners. After cleaning, wipe all surfaces dry with a soft, non-abrasive cloth. To avoid scratches, do not use abrasive pads.

Replace the Liner and Dipper in the Chamber.

⚠ **CAUTION:** Never use the CRC®-PC Smart Chamber without the Chamber Liner in place. Liners are inexpensive and easy to replace. A contaminated Chamber is a very costly mistake.

Printer

If a printer was included with the system, refer to the printer Owner's Manual for proper cleaning procedures.

Printer Cartridges

Clean the print cartridges when you notice that lines or dots are missing or smudged on the printed text or graphics. Refer to the printer's User Guide for instructions on cleaning the Print Cartridges. Align the print cartridges when you notice that color ink does not properly line up with black ink. Refer to the Printer's User Guide for instructions on aligning the print cartridges.

Disinfecting Instructions

All surfaces can be disinfected with bleach using a mixture of 1 cup of bleach per gallon of water. Wipe all surfaces using a non-abrasive cloth lightly dampened with the bleach mixture. After disinfecting, wipe dry with a soft, non-abrasive cloth.

All surfaces can also be wiped with soft cloth lightly dampened with alcohol, such as an alcohol prep pad. After wiping, the surface can be left to air dry.

Liner/Dipper

Remove the Liner and/or Dipper from the CRC®-PC Smart Chamber and disinfect as directed above.

Replace the Liner and Dipper in the Chamber.

⚠ **CAUTION:** Never use the CRC®-PC Smart Chamber without the Chamber Liner in place. Liners are inexpensive and easy to replace. A contaminated Chamber is a very costly mistake.

PREVENTATIVE MAINTENANCE

The following preventative maintenance should be performed at the specified intervals. General cleaning is at the discretion of the user (see Cleaning Instructions above). It is recommended to periodically perform the Quality Assurance Tests as described in CHAPTER 7: ACCEPTANCE & QUALITY ASSURANCE TESTS.

Tests must be performed in an environment where the temperature is stable within a range of +50°F to +85°F (+10°C to +30°C) and the maximum relative humidity is 90% non-condensing. The unit should be powered-up for at least one-half hour prior to performing any measurements. No other precautions need to be observed.

⚠ **CAUTION:** If these environmental requirements are not followed, the instrument may display erroneous readings.

The Quality Assurance Tests should be immediately performed if:

- The equipment has been subjected to extreme physical stress,
- Liquids enter the unit, or
- Any cable shows signs of damage.

DISPOSAL

The following items should be taken into consideration before disposing. These items should be disposed of in accordance with local and national regulations. Please contact Capintec, Inc. or an authorized disposal company to decommission your equipment.

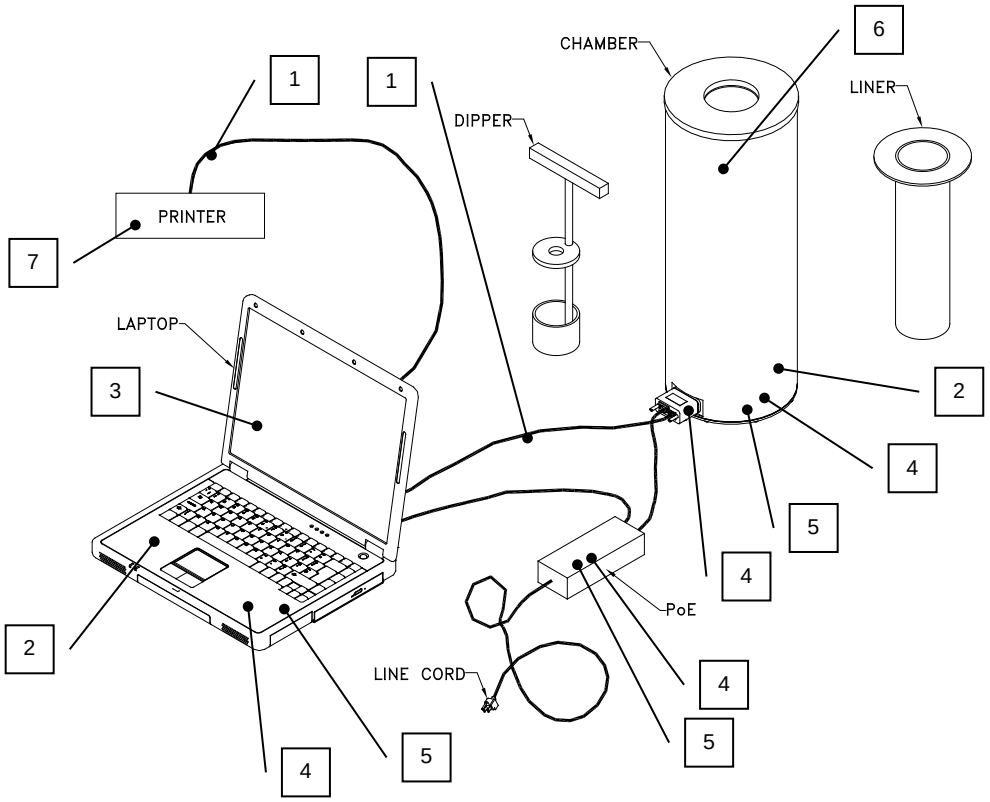

Figure 12-1

No.	Recycling/Material Code	Important Information
1	External Electrical Cables	
2	Lithium Battery	Contained in the Laptop and on the CPU printed circuit board inside of the Chamber.
3	Laptop Computer	Contact computer manufacturer for disposal instructions.
4	Printed Circuit Boards	Laptop, PoE, Iometer, CPU, Adapter
5	Electrolyte Capacitor	Laptop, PoE, CPU Printed Circuit Board
6	Lead	Lead Shielding around Chamber
7	Printer	Contact printer manufacturer for disposal instructions.

SERVICING

The system is covered by a one year limited warranty, under normal conditions of use.

There are no user serviceable parts contained in the system.

Every five years, the system should be returned to Capintec's only Authorized Service Center for a complete verification.

CAPINTEC, Inc.
7 Vreeland Road
Florham Park, NJ 07932
Phone (800) ASK-4CRC
Fax (201) 825-1336

TROUBLESHOOTING

Some problems may be very easy to diagnose and correct in the field with little or no equipment. If a problem should occur, check here before you call for service. You may be able to save a considerable amount of time and money.

Nothing appears on the display.

Make sure the USB and Ethernet cable are connected to the Laptop.

High Background indication.

- Chamber Well, Liner, or Dipper may have become contaminated. Reference CHAPTER 7: ACCEPTANCE & QUALITY ASSURANCE TESTS, SECTION: QUALITY ASSURANCE TESTS, Contamination Test.
- Background may actually be high. Check by removing the Dipper and placing a lead sheet over the top of the Chamber Well.

Readings appear overly noisy for low activities.

- Make sure that the Chamber is on a solid surface and is not subject to vibration.

Indication of significant negative activity.

- Background level may have changed. Perform a new Background measurement. Reference CHAPTER 8: CHAMBER TESTS, SECTION: BACKGROUND.

The time is reset to 00:00.

- The internal Lithium Coin Battery may be depleted. Although the battery is meant to last the lifetime of the Chamber it would need to be replaced at the factory if this occurs.

Printer will not respond.

- Make sure printer is turned on
- Confirm that there is paper in printer
- Verify that the printer driver is installed on the Laptop.

RELATED PRODUCTS

The following accessories and replacement parts are available from Capintec. Call Capintec's only Authorized Service Center at (800) ASK-4CRC for answers to your questions or to place an order.

- CAPMAC Moly Assay Kit (specify generator).....CALL
- Dose Calibrator Reference Sources.....CALL
- Shielded products for PET .....CALL
- Standard Moly Assay Kit 5130-0006
- Calicheck Linearity Test Kit.....5120-2144
- Ionization Chamber Well Inserts (Liners).....7300-2004
- Plastic Sample Holders (Dippers).....7300-2005
- Environmental Shield 7300-2450
- Flush Mount Mounting Flange.....7310-2307
- Shielded Platform with 2mm shielded glass 5150-3010
- Shielded Platform with 4mm shielded glass 5150-3011
- CAP-Lift remote lowering/raising of syringes or vials.....5130-30251

Note: *Circuit diagrams, component parts lists, descriptions and calibration instructions are available to appropriately qualified personnel.*

SHIPPING

If for any reason the CRC®-PC Smart Chamber must be returned to Capintec, the shipping carton must contain the following or equivalent labeling as shown in **Error! Reference source not found.** and **Error! Reference source not found.**. Label stipulating the maximum environmental conditions for safe storage and shipment.

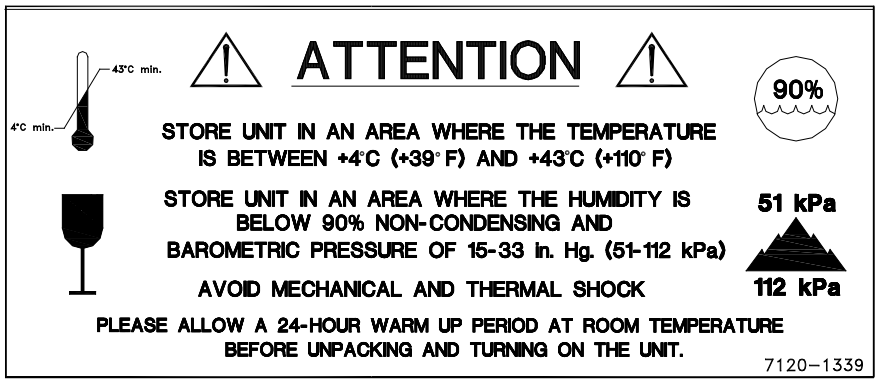

Figure 12-2

Figure 12-3

In order to ship this product, all appropriate Department of Transportation (DOT) and, if shipped by air, the International Aviation and Transportation Administration (IATA) requirements for the shipment of the pressurized (19 psig) Ionization Chamber Detector must be met.

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APPENDIX I

PRINCIPLE OF THE CALIBRATOR

GENERAL

The definition of activity, the basic principle of the calibrator, and the detailed discussion on the calibration are presented in this section.

DEFINITION OF ACTIVITY

Activity

Activity is defined as:

The activity, A, of a quantity of a radioactive nuclide is the quotient of dN by dt, where dN is the number of spontaneous nuclear transformations which occur in this quantity in time interval dt.

$$A = \frac{dN}{dt}$$

The special unit of activity is Curie (Ci):

$$1\ Ci = 3.7 \times 10^{10} \quad s^{-1} \text{ (exactly)}$$

Note: *The term nuclear transformation is meant to designate a change of nuclide of an isomeric transition. (ICRU REPORT 19, 1971)*

The SI (International System of Units) unit for activity is the reciprocal second, s^{-1}, and is named the Becquerel (Bq), i.e.

$$1\ Bq = 1 \text{ Nuclear Transformation per second}$$

$$1\ Ci = 3.7 \times 10^{10}\ Bq$$

Types of Transformations

α-decay

The nucleus emits a helium nucleus (α-particle).

Electron Capture (ε-decay)

The nucleus captures one of its own orbital electrons, usually from the K shell, and a neutrino is emitted.

β^- Decay

The nucleus emits an electron (β^- particle), and a neutrino.

β^+ decay

The nucleus emits a positron (β^+ particle) and a neutrino.

Nuclear Transition

A photon (electromagnetic radiation, γ-decay), electron (Internal Conversion Electron Emission, CE) or electron-positron pair (Internal-pair emission, e±) is emitted by a nucleus in a transition from a higher to lower energy state.

No nuclear transformation occurs if there is no change in the atomic number or the mass number. The de-excitation of a nucleus in its unstable state (metastable state) is, however, included in the definition of activity.

MEASUREMENT OF ACTIVITY

A Nuclear Transformation is always associated with one or more of the following types of radiation:

α, β^+, β^- and γ Photons

We can, therefore, measure activity by detecting one or more of the above radiations.

α-Particle Radiation

The most energetic α-particle emitted by a radionuclide has an energy of less than 10MeV, which corresponds to a range of about 10mg/cm^2 (8cm in air). Because of its short range, an α-particle from a radionuclide cannot penetrate to the ionization chamber's sensitive volume and therefore, cannot be detected.

All α-decays, however, are accompanied by photon radiation as the daughter nucleus decays to its ground state. The activity of a nuclide that decays through α radiation can therefore, be measured by detecting the associated photon radiation.

β^+ Radiation

β^+ particle (positron) emitted from a nucleus comes to rest in the media by losing its kinetic energy mainly by direct ionization processes and then annihilates with an electron to produce two photons of 511keV each. These photons are easily detected by the ionization chamber. De-excitation photons are also associated with β^+ decay.

β^- Radiation

The ejected electron loses kinetic energy in matter mainly by direct ionization.

The range of most emitted β's is very short. It should be noted that in β^+ and β^-emission, the emitted electron or positron has a continuous energy spectrum, which ranges from E_{max} to zero, where E_{max} is the maximum transition energy. β-rays (with the exception of a small portion of very high energy βs) will be stopped in the sample, in the chamber liner, and in the chamber wall.

As the electron decelerates, it also produces continuous low energy photon emission called Bremsstrahlung (stopping or braking radiation).

Many radionuclides that decay by β emission also emit de-excitation photons (x-rays, γ-rays), which can be detected by the ionization chamber.

Electron Capture

The actual electron capture process cannot be detected since the electron is not emitted but is captured by the nucleus. The capture of the orbital electron, however, leaves a vacancy in the atomic orbital shell, resulting in x-rays as the atom de-excites.

The energy of K x-ray is approximately

$$E_k \cong \frac{Z^2}{100} \text{ keV}$$

where Z is the atomic number of the daughter nucleus.

γ-rays are also often given off as the daughter nucleus de-excites.

Photon Radiation

Photon radiation is associated with most nuclear transformations. A high-energy photon interacts with matter very weakly. Photon intensity is therefore, not altered substantially by the surrounding media, i.e., measurement of activity can be accomplished with a minimum of disturbance from the sample configuration.

As can be seen from the above, in all cases we are detecting photons. We will therefore, discuss photons and their interactions with matter in detail.

PHOTONS

Photon is the general term for a quantum of radiation. Photons are classified according to their method of production.

γ-Rays

Photons resulting from nuclear transitions, nuclear reaction or annihilation of particles (e.g., electron-positron annihilation) are called Gamma-rays (γ-rays). Radioisotope sources (radionuclides) are the most common means of γ-ray production. Radioisotope γ-sources emit photons of one or more discrete energies.

X-Rays

X-rays are associated with the deceleration of electrons or with orbital electron transitions in atoms.

The radiation from a γ-source is often accompanied by characteristic x-rays from transitions of the orbital electrons in the daughter atom.

Bremsstrahlung

When very fast electrons are brought to rest in a medium (or pass through media) a continuous low energy photon spectrum occurs. This is called Bremsstrahlung ("stopping or braking radiation").

The intensity and the energy spectrum of Bremsstrahlung are highly dependent upon the source configuration and media surrounding the sample.

In this manual, the term photon will be used when the method of production of the radiation has no bearing on the discussion.

Interactions of Photons with Matter

There are three mechanisms by which photons can interact with matter and, thus, deposit their energy. These mechanisms are: Photoelectric effect, Compton Effect, and, pair production. The energy of the photon determines which process (or processes) is possible.

Photoelectric Effect

The photoelectric effect is an interaction between a photon and an electron that is bound to an atom. In the photoelectric process, the photon is absorbed by the atom and a bound electron is ejected. The kinetic energy of the ejected electron is equal to the photon energy minus the binding energy of the electron. The binding energy of an electron is the energy that must be supplied in order to remove the electron from the atom.

In nuclear medicine, we are interested in photon energies of 20keV or greater. At these energies, all the electrons in the materials used for the chambers are able to participate in the photoelectric process. The photoelectric effect is the most important process at low energies. However, for photon energies much greater than electron binding energies, the processes described below become more important and the number of photoelectric interactions occurring becomes small. At a given energy, the number of photoelectric interactions per unit mass varies as the 4^{th} power of the atomic number and is inversely proportional to the atomic weight of the medium (Z^4/A).

Compton Effect

The Compton Effect is a collision between a photon and an electron that can be considered unbound. An electron can be considered to be unbound (or "free") if the energy of the incident photon is much greater than the binding energy of the electron. The kinetic energy of the scattered electron is not constant, but is a function of the angle through which it is scattered. The scattered photon must interact again in order to impart all of its energy to the medium.

The Compton Effect is the dominant process for photon energies from 100keV to about 10MeV in the region of the atomic numbers for detector materials. At 100keV, the maximum kinetic energy of the scattered electron is about 30 percent of that of the incident photon; at 1MeV, it is about 80 percent; and at 10MeV, it is about 98%.

The number of Compton interactions per unit mass varies directly as the atomic number and inversely as the atomic weight of the medium (Z/A).

Pair Production

The process of pair production is difficult to comprehend because it is strictly a relativistic quantum mechanical effect. What is observed to take place is that in the presence of the electric field of a nucleus, the incident photon disappears and an electron and a positron appear. (A positron is a particle with the same properties as an electron, except that it has a positive charge.)

In order to produce an electron-positron pair, the incident photon must have an energy of at least twice the mass of an electron, i.e., 1.022MeV. This process dominates for very high energies, that is, above about 10MeV. The number of pair production interactions per unit mass is proportional to the square of the atomic number and inversely proportional to the atomic weight of the medium (Z^2/A).

IONIZATION CHAMBER MEASURING PROCESS

An ionization chamber consists of two or more electrodes. The electrodes confine a volume of gas and collect the charge (ions) produced by radiation within the volume. Thus, ionization chambers can be used to measure radiation fields if the relationship between the radiation field and the charge produced is known.

The radiation enters the chamber through the chamber wall and interacts with the gas in the chamber or with the chamber wall. It must be pointed out that photons cannot produce ionization directly, but must first interact with the chamber material (gas and wall) producing electrons. That is, through a series of interactions, the photon transfers its energy to one or more electrons.

The electron is slowed down through collisions with the chamber gas (argon). The collisions knock electrons off the molecules producing positive ions (this is the ionization process).

The collection voltage across the chamber sets up an electric field. The positive ions will drift towards the negative electrode and the electron (and negative ions if they are formed) will drift towards the positive electrode, thus producing a current. The electronic circuitry then measures either the current or the total charge produced during the period of interest.

The number of ions produced in the chamber is directly related to the energy deposited in the chamber by the radiation.

DETAILED DISCUSSIONS

Effects of the Integral Shield

The advantage of the shield is the reduction of radiation exposure to the personnel handling the radioisotopes, as well as reduction of the background effects on the activity measurements.

It is important to note, however, that if a shield is placed around or near a calibrator, the sensitivity of the ionization chamber is enhanced due to backscattering of photons by the shielding. Above about 250keV, the scattering of photons is mainly forward and at the low energy region, attenuation of photons by the outer wall of the chamber becomes significant. For a CRC® calibrator, the backscattering effects are more significant for photons of energies between 70keV and 250keV than photons in other energy regions.

Effects of the Container

The radioactive standard materials in the ampoules now being provided by NIST are a good approximation to an assay of a radiopharmaceutical in a plastic syringe or in a glass syringe (a wall thickness of about 1.2mm), even for radioisotopes that decay with a significant abundance of low-energy photons.

The user should select, whenever possible, a standardized procedure, volume, and container for all radioactivity measurements. The plastic syringe is convenient since it represents the delivery vehicle to the patient in most clinical situations.

Significant errors will occur in some instances, e.g., if the radioisotope is assayed in an appreciably different material and/or wall thickness than that of the standards.

The ampoules of recently available standards from NIST are uniform. Plastic syringes also have a rather uniform wall thickness and absorption is low. However, a random sampling of 5, 10, 25, 50, and 125ml size multi-injection dose vials from several sources indicated that the wall thickness varied randomly from 1 to 3mm quite independently of the volume of glass vial.

The assay of radioisotopes having a significant abundance of low- energy gamma-, x-, and/or high-energy beta-ray radiation may be affected by changes in the sample configuration used to assay the radio-pharmaceutical if the samples are severely different from the standard source. In such cases, an independent check or determination of a calibration appropriate to a user's needs is advised. Fortunately, most radioisotopes can be accurately assayed independently of the sample size.

Effects of Impurities

An Ionization chamber itself does not have intrinsic energy- discrimination capability. The presence of radioisotope impurities will affect the reading of the instrument unless the effect of impurities is eliminated by photon filtration as is done with Mo99 breakthrough in Tc99m. However, the presence of low-level radionuclide impurity does not negate the usefulness of a radioisotope calibrator, if the user is aware of its presence and has an independently determined calibration including photons arising from the impurities.

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APPENDIX II

HL CHAMBER CALIBRATION NUMBERS

DETERMINING CALIBRATION SETTING NUMBERS

A method of determining a calibration setting number is described in this section.[1]

Response and Sensitivity

It is very convenient to express the response of the detector to a radioisotope, A, relative to that of a standard reference material, e.g. Co60.

$$R_A \equiv \frac{\left(\frac{\text{Detector Output due to Sample A}}{\text{Activity of Sample A}}\right)}{\left(\frac{\text{Detector Output due to SRM Co60}}{\text{Certified Activity of SRM Co60}}\right)} \qquad (1)$$

The sensitivity of the detector for a photon of energy E_i is defined as:

$$S_i \equiv \frac{\text{Detector Output due to } 3.7\times10^{10} \text{ Photons of } E_i}{\text{Detector Output due to one Curie of Co60}} \qquad (2)$$

The detector response and the sensitivity have the following relation:

[1] See Suzuki, A., Suzuki M.N., and Weis A.M.: Analysis of a Radioisotope Calibrator; Journal of Nuclear Medicine Technology Dec. 1976 for more detailed discussions.

$$R_i \equiv \sum_i I_i S_i \qquad (3)$$

Where I_i is the intensity of the photon whose energy is E_i.

The procedure is to measure the response of the detector to all the available primary standard samples and to establish the sensitivity of the detector as a function of photon energy so as to satisfy equation (3) for all standards.

Once the sensitivity curve has been determined, the response of the detector to any radioisotope may be calculated using equation (3), provided that the decay data are known.

The sensitivity curve for a CRC® Ionization Chamber is given in Figure A1-1.

The figure depicts the sensitivity of the ionization chamber as a function of photon energy up to 1.9MeV. Above a photon energy of 200keV, the ionization in the chamber is mainly due to electrons resulting from Compton scattering of photons by the filling gas (argon) and the chamber walls (aluminum).

The peak in the low-energy region of the sensitivity curve is due to the rapid increase in photoelectric effect as photon energy decreases and to the attenuation of low energy photons by the sample holder, the chamber liner and the chamber walls, as well as the absorption of photons in the sample material and its container.

Although a significant fraction of photons with energies below 50keV are stopped in the chamber wall, some photons could enter the sensitive volume of the chamber and could, therefore, contribute to the activity measurement. All photons with energies below about 13keV are stopped before they reach the sensitive volume of the chamber and, therefore, these photons do not contribute to the activity measurement.

Calibration Setting Numbers

The relationship between the response of the detector and the gain setting (relative to that for Co60, in order for the instrument to give a direct reading of the activity) is given by:

$$G_A \equiv \frac{1}{R_A} \qquad (4)$$

The calibration setting number is linearly related to the chamber response.

All the calibrators are calibrated with certified Cobalt 60 and Cobalt 57 standard source.

A calibration setting number of 990 was assigned to Co60 and 112 was chosen for Co57.

The calibration setting number of CRC® Calibrator for radioisotope A, N_A, is given by:

$$N_A = \left(R_A - \left(1 - \frac{(R_{Co60} - R_{Co57})}{(N_{Co60} - N_{Co57})} * N_{Co60} \right) \right) * \frac{(N_{Co60} - N_{Co57})}{(R_{Co60} - R_{Co57})} \qquad (5)$$

Entering numerical values:

$$\begin{aligned} &N_{Co60} = 990 \quad N_{Co57} = 112 \\ &R_{Co60} = 1.000 \quad R_{Co57} = 0.189 \pm 2\% \\ &\text{one obtains:} \quad N_A = 1076(R_A - 0.080) \end{aligned} \qquad (6)$$

The accuracy of the sensitivity curve and the calibration number determination was tested by calculating calibration numbers for all the radioisotope standards used for the studies of the sensitivity. The agreement between the calculated and the observed responses were all within ±3%.

The accuracy of the chamber response calculation for a particular radioisotope, hence the accuracy which can be attained by using a calculated Calibration Setting Number depends not only on the accuracy of the available primary standards used to determine Figure A1-1, on the nuclear data, on the variation in the chamber sensitivity and electrometer gain setting, but also on the sample configuration due to low energy photon absorption.

The calibration Setting Numbers for pure and equilibrium state radioisotopes for the CRC® Calibrators are listed in this Appendix.

Since the determination of the Calibration Numbers and the calibrations (normalization) of the instrument are performed using standard reference materials issued by the NIST and/or the LMR, the Calibration Numbers for radioisotopes are given for sample configuration similar to those issued by the NIST.

All of the NIST standards, with the exception of Xe133, were of the liquid solution form. Approximately 5g of radioactive liquid were sealed in borosilicate glass ampoules having a diameter of about 17mm, a length of 40mm, and a wall thickness of 0.6mm. The Xe133 standard was sealed together with inactive xenon gas in a borosilicate glass ampoule having a volume of about 5ml, a length of 45mm, a diameter of 15mm, and a wall thickness of 1.3mm.

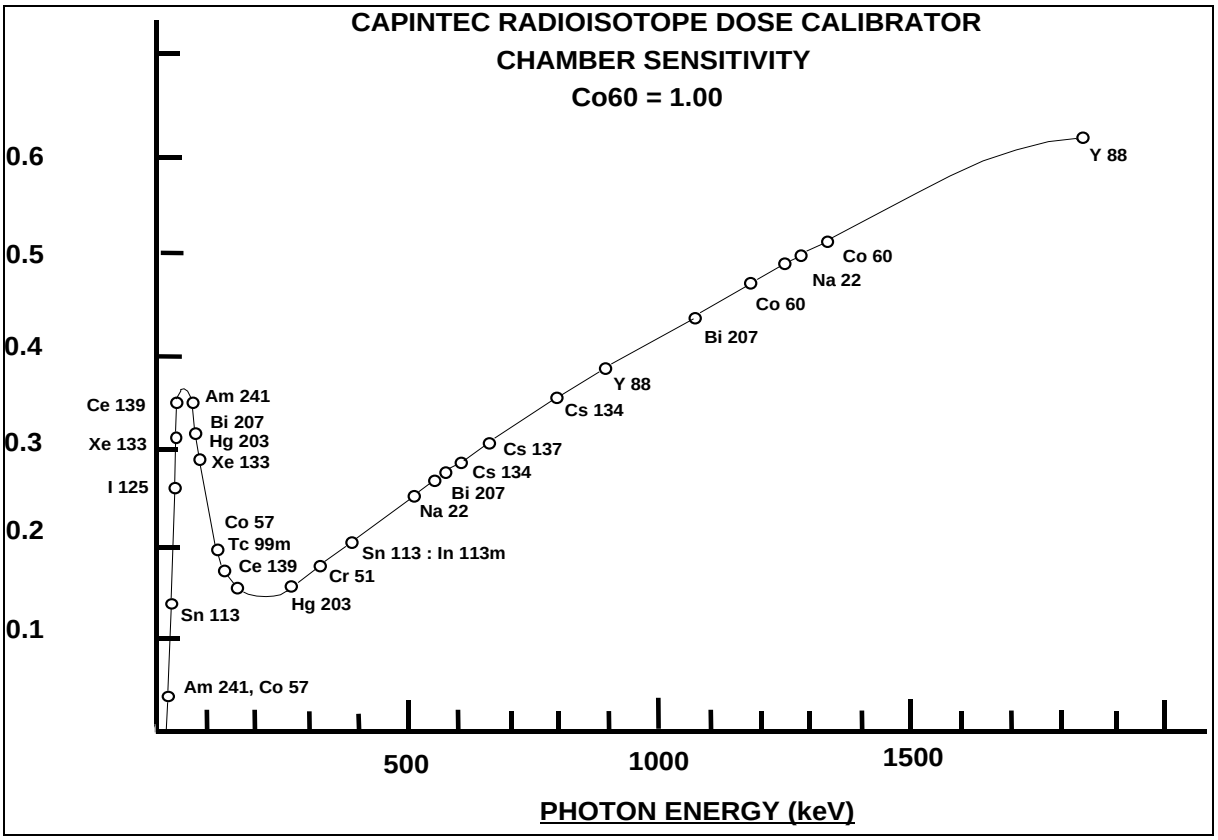

Figure AII-1

CALIBRATION SETTING NUMBERS

The Calibration Setting Numbers in Table I are applicable to the Capintec Radioisotope Calibrator only.

The CRC®-PC Smart Chamber is a direct reading instrument. No manual multiplication or division should be performed, even if the Calibration Setting Number is followed by a multiplication sign "×" or a division sign "÷" and a number.

If the sample contains radioactive impurities, the meter indication will always be higher than the actual activity of the principal isotope. It will not, however, be the total activity of the principal isotope and the impurities.

If a Radium Needle is measured, the reading will be lower than the true activity in the needle due to the shielding effects (filtration) of the needle. To estimate the true activity in a needle, increase the reading obtained with a calibration number for Ra226 (778) by 2% for each 0.1mm of platinum wall thickness. For example, add 10% to the reading for a 0.5mm wall platinum needle and add 20% to the reading for a 1.0mm wall platinum needle to estimate the true Radium activity.

ABBREVIATIONS USED IN TABLE I

Abbreviation	Meaning	Abbreviation	Meaning
eqb.	equilibrium	D	days
S	seconds	Y	years
H	hours	E	exponential, i.e.,
M	minutes		3E5 = 3×10^5

UNCERTAINTY DUE TO SYRINGE CORRECTION

The Calibration Setting Numbers are given for approximately 5 grams of radioactive solution in a standard source ampoule made of about 0.6mm thick borosilicate glass. The standard radioactive source in the ampoule is, however, a good approximation for a radiopharmaceutical in a plastic syringe or a glass syringe (wall thickness about 1.2mm) for most radioisotopes.

In general, the attenuation of radiation by a plastic syringe is less than for the standard ampoule, while for most glass syringes, the attenuation will be greater than for the standard ampoule.

The anticipated syringe corrections are listed on the table under the column "Uncertainty Due to Syringe Correction". For example, the required correction for I125 activity is estimated to be about, ±25%. This means that you should add 25% to the meter reading if the I125 is in a glass syringe or subtract 25% if it is in a plastic syringe.

Since the attenuation of low energy radiation is very dependent upon the material of the container, the value given in the syringe correction column should be used mainly as a guide giving relative magnitude.

If a measurement of activity in a glass vial is anticipated, the container correction for low energy isotopes will be substantial. It could be about 3 to 5 times that for a syringe.

If no value is given in this column, the correction is not significant, except for a container differing greatly from the standard ampoule (e.g. very thick glass container, vial made of glass which contains lead, etc.).

UNCERTAINTY DUE TO PUBLISHED DATA

This is the uncertainty on the value of the activity. From calibration numbers calculated from decay data, the uncertainty given is calculated using only the reported errors on the intensity of the γ and/or x-rays. For calibration numbers measured from NBS standard reference materials (known as SRM;s), the uncertainty given is the reported uncertainty on the activity of the SRM. For these numbers, the reference is given as NBS (or LMR - Laboratoire de Metrologie de la Radioactivite - France), and year of source.

HALF-LIFE

The number before the letter is the value of the half-life. The number following the letter is the reported uncertainty on the half-life.

Examples:

12.34	D1	means	12.34	days	±0.01	days
12.34	D11	means	12.34	days	±0.11	days
12.340	D1	means	12.340	days	±0.001	days
1.234	D1	means	1.234	days	±0.001	days

REFERENCES

This is the source of the data from which the calibration number was calculated. NBS or LMR means that the calibration number was obtained by measuring a standard reference material (SRM).

NM75 (Nuclear Medicine 75): L.T. Dillman and F.C. Von Der Lage, Radionuclide Decay Schemes and Nuclear Parameters for Use in Radiation-Dose Estimation. NM/MIRD Pamphlet No. 10, 1975.

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NDT70: M.J. Martin and P.H. Blichert-Toft. Radioactive Atoms: Auger-Electrons, α-, β-, γ- and X-Ray Data. Nuclear Data Tables A, Vol. 8, Nos.1, 2. October, 1970

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TABLE I

CAUTION: The calibration numbers given in this table are based upon the NIST SRM geometry (5ml of solution in glass ampoule with 0.6mm wall thickness). Listed numbers should provide an accuracy of ±5% when compared to a NIST SRM. Different source geometries (e.g. capsules, seeds, ribbons) may require geometry correction factors or different calibration numbers. However, no warranty of any kind can be made as to their accuracy, since there are many other uncontrollable factors (as well as the accuracy of the published data) involved in the determination of the overall accuracy of an assay. Reference previous sections of this manual for a discussion of some of the conditions under which the calibration numbers are valid.

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{7}Be	Beryllium	179 x 10			53.284 D 4	NM75	
^{11}C	Carbon	457			20.38 M 2	ORNL76	
^{13}N	Nitrogen	457			9.965 M 4	ORNL76	
^{15}O	Oxygen	462			122.24 S 14	ORNL76	
^{18}F	Fluorine	472			109.71 M 2	NIST 08	
^{22}Na	Sodium	957		1.7	2.602 Y 1	NBS73	Ref. for 0.51, 1.27 MeV
^{24}Na	Sodium	658 ÷ 2			14.959 H 4	ORNL76	
^{26}Al	Aluminum	481 ÷ 2			7.2E5 Y 3	ORNL76	
^{27}Mg	Magnesium	331			9.458 M 12	ORNL76	
^{28}Mg	Magnesium	719	3	4	20.91 H 3	ORNL76	Pure; NOTE: NM75 yields a Cal. No. of 804
^{28}Al	Aluminum	583			2.244 M 3	ORNL76	Pure
^{28}Mg	Magnesium (Eqb. ^{28}Al)	656 ÷ 2	3	4	20.91 H 3	ORNL76	Reading gives ^{28}Mg Act. in eqb. sample. Teqb after 15 minutes.
^{28}Al	Aluminum (Eqb. ^{28}Mg)	656 ÷ 2			2.244 M 3	ORNL76	Reading gives ^{28}Al Act. in eqb. sample. Teqb. after 15 minutes
^{28}Mg ^{28}Al	Magnesium Eqb. Aluminum	656	3			ORNL76	Reading gives sum of ^{28}Mg & ^{28}Al activity in equilibrium sample.
^{32}P	Phosphorus	750 × 100		1.2	14.29 D 2	NBS76	Estimation use only.
^{38}Cl	Chlorine	470		2	36.51 M 4	NDT70	
^{40}K	Potassium	520 × 10			1.28E9 Y 1	NM75	
^{41}Ar	Argon	468			1.827 H 7	ORNL76	
^{42}K	Potassium	033 or 152 × 2		3	12.36 H 1	ORNL76	
^{43}K	Potassium	430		2	22.3 H 1	ORNL76	
^{44}Sc	Scandium	938			3.927 H 8	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{44}Ti	Titanium	514	2	2	47.3 Y 12	ORNL76	
^{46}Sc	Scandium	822			83.79 D 2	ORNL76	
^{47}Ca	Calcium	373			4.536 D 2	ORNL76	Pure; ^{47}Ca decays to ^{47}Sc. Eqb. in 90 days.
^{47}Sc	Scandium	026 or 618 × 2			3.351 D 2	ORNL76	Pure; see App. IV for non-eqb.
^{48}V	Vanadium	569 ÷ 2			15.974 D 3	ORNL76	
^{49}Ca	Calcium	956		2	8.72 M 2	NDT70	Pure; decays to ^{49}Sc
^{51}Cr	Chromium	100 × 10		1.25	27.702 D 4	NBS76	Ref. for 320 keV
^{52}Mn	Manganese	676 ÷ 2			5.591 D 3	ORNL76	
^{52m}Mn	Manganese	461 ÷ 2			21.1 M 2	ORNL76	Decays to ^{52}Mn
^{52}Fe	Iron	374			8.275 H 8	ORNL76	^{52m}Mn will contribute to dose.
^{54}Mn	Manganese	309			312.14 D 5	ORNL76	
^{55}Fe	Iron	374			2.72 Y 2	ORNL76	
^{55}Co	Cobalt	481		7	17.54 H	NDS76	
^{56}Co	Cobalt	648 ÷ 2			77.9 D 12	NDT70	
^{56}Ni	Nickel	844		4	6.1 D 3	NDT70	Decays to ^{56}Co; See App. IV
^{56}Mn	Manganese	627		2	2.577 H 1	ORNL76	
^{57}Co	Cobalt	112		1.9	271.7 D 2	NBS76	Ref. for 122 keV Capintec Low Energy Reference.
^{58}Co	Cobalt	389			70.82 D 3	ORNL76	
^{59}Fe	Iron	430			44.51 D 2	ORNL76	
^{60}Co	Cobalt	990		1.0-NBS 1.5-LMR	5.2714 Y 5	NBS75	Ref. for 1.17, 1.33 MeV Capintec High Energy Reference
^{62}Cu	Copper	448			9.74 M 2	NM75	Pure
^{62}Zn	Zinc	217			9.22 H	NM75	Pure
^{62}Zn	Zinc (Eqb. ^{62}Cu)	760					Reading gives ^{62}Zn Act. in eqb. sample. Eqb. after 1.5 hours.
^{62}Cu	Copper (Eqb. ^{62}Zn)	745					Reading gives ^{62}Cu Act. in eqb. sample. Eqb. after 1.5 hours.
^{62}Zn + ^{62}Cu	Zinc Eqb. Copper	333				NM75	Reading gives sum of ^{62}Zn & ^{62}Cu activity in equilibrium sample.

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{64}Cu	Copper	015 or 115 × 2			12.701 H 2	ORNL76	
^{65}Zn	Zinc	172			243.9 D 1	ORNL76	
^{66}Ga	Gallium	903		2	9.40 H 7	ORNL76	
^{67}Cu	Copper	052		4	2.575 D 3	ORNL76	
^{67}Ga	Gallium	100		1.4	3.261 D 1	NBS78	
^{68}Ga	Gallium	416			68.0 M 2	ORNL76	
^{69m}Zn	Zinc	143			13.76 H 3	ORNL76	
^{72}As	Arsenic	795			26.0 H 1	ORNL76	
^{72}Ga	Gallium	470 ÷ 2		2	14.10 H 1	ORNL76	
^{73}As	Arsenic	324 × 10	4	3	80.30 D 6	ORNL76	
^{73}Se	Selenium	748			7.15 H 8	ORNL76	Decays to ^{73}As.
^{74}As	Arsenic	304		5	17.78 D 3	ORNL76	
^{75}Se	Selenium	258		2.5	119.8 D 1	NBS75	
^{76}As	Arsenic	110		6	26.32 H 7	ORNL76	
^{77}As	Arsenic	481 × 100		26	38.8 H 3	ORNL76	Estimation use only.
^{77}Br	Bromine	091		3	56 H 2	ORNL76	
^{79}Kr	Krypton	050		3	35.04 H 10	ORNL76	
^{81}Rb	Rubidium	174			4.58 H	NM75	Pure
^{81m}Kr	Krypton	915 × 10			13 S 1	NM75	Pure
^{81}Rb / Eqb. / ^{81m}Kr	Rubidium / Eqb. / Krypton	270				NM75	Reading gives act. of ^{81}Rb or ^{81m}Kr in equilibrium sample. Eqb. after 2 minutes.
^{82}Br	Bromine	536 ÷ 2		2	35.34 H 2	ORNL76	
^{82}Rb	Rubidium	504			1.273 M 2	NM75	
^{84}Rb	Rubidium	347			32.77 D 4	NM75	
^{85m}Kr	Krypton	065		1	4.480 H 8	ORNL76	Decays to ^{85}Kr
^{85}Kr	Krypton	031 × 100		2	10.72 Y 1	ORNL76	
^{85}Sr	Strontium	193		1.0	64.854 D 3	NBS75	
^{86}Rb	Rubidium	411 × 10			18.64 D 2	ORNL76	
^{86}Y	Yttrium	711 ÷ 2			14.74 H 2	ORNL76	
^{86}Zr	Zirconium	167	18	3	16.5 H 1	ORNL76	
^{87}Kr	Krypton	250		6	76.3 M 5	ORNL76	
^{87m}Sr	Strontium	095			2.805 H 3	ORNL76	Pure
^{87}Y	Yttrium	170		1	80.3 H 3	ORNL76	Pure

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{87}Y	Yttrium (Eqb. ^{87m}Sr)	357				ORNL76	Reading gives ^{87}Y Act. in eqb. sample. Eqb. after 18 hours.
^{87}Y ^{87m}Sr	Yttrium Eqb. Strontium	341		2		ORNL76	Reading gives sum of ^{87}Y & ^{87m}Sr activity in equilibrium sample.
^{88}Rb	Rubidium	189		14	17.8 M 1	ORNL76	
^{88}Y	Yttrium	465 ÷ 2		1.8	106.61 D 2	NBS73	
^{89}Rb	Rubidium	768		1	15.2 M 1	ORNL76	
^{90}Y	Yttrium	48 × 10			64.0 H 1	NIST92	Estimation use only.
^{91}Y	Yttrium	850 × 10			58.5 D 4	NDT70	Almost pure β decay. Estimation use only.
^{94}Nb	Niobium	673			2.03E4 Y 16	ORNL76	
^{95}Nb	Niobium	285			34.97 D 1	NDT70	Pure
^{95}Zr	Zirconium	271			64.02 D 5	NDT70	Pure
^{95}Zr ^{95m95}Nb	Zirconium Eqb. Niobium	145			^{95m}Nb 3.61 D 1	NDT70	Reading gives sum of ^{95m}Nb & ^{95}Nb activity in equilibrium sample. Eqb. after 2 years.
^{97}Nb	Niobium	249			72.1 M 7	ORNL76	
^{97}Zr ^{97m}Nb	Zirconium Eqb. Niobium	341		12	16.90 H 5	ORNL76	Reading gives sum of ^{97}Zr & ^{97m}Nb activity in equilibrium sample. Eqb. after 10 minutes.
^{97m}Nb	Niobium	271			60 S 1	ORNL76	
^{97}Ru	Ruthenium	116	15	2	2.9 D 1	ORNL76	Decays to ^{97m}Tc
^{97m}Tc	Technetium	256 × 10	65		91.0 D	NM75	Estimation use only.
^{99}Mo	Molybdenum (in Std. Mo Kit)	080 × 5 or 246× 10 or 030 × 3.5				NTS78	
^{99}Mo	Molybdenum (in CAP-MAC)	030 × 4 or 204 × 10				NBS78	
^{99}Mo	Molybdenum (in MAC-S)	030 × 4 or 204 × 10				NBS78	
^{99}Mo	Molybdenum (Eqb. ^{99m}Tc)	165	2	1.9	65.92 H 2	NBS78	
^{99m}Tc	Technetium	080	2	2.1	6.007 H 1	NBS76	
^{99m}Tc	Technetium (in CAP-MAC)	042		2.1	6.007 H 1	NBS76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{99m}Tc	Technetium (Eqb. ^{99}Mo)	175	2			NBS78	
^{99}Mo	Molybdenum						Reading gives sum of ^{99}Mo & ^{99m}Tc activity in equilibrium sample.
	Eqb.	145	2			NBS78	
^{99m}Tc	Technetium						
^{103}Pd	Palladium	562 × 10	50	4	16.97 D 2	ORNL76	Pure
^{103}Pd	Palladium						Reading gives sum of ^{103}Pd & ^{103m}Rh activity in equilibrium sample. Eqb. after 9 hours.
	Eqb.	634 × 10	50	5		ORNL76	
^{103m}Rh	Rhodium						
^{103m}Rh	Rhodium	631 × 100	50	5	56.114 M 6	ORNL76	
^{103}Ru	Ruthenium	165	50	3	39.26 D 2	ORNL76	
^{103}Ru	Ruthenium						Reading gives sum of ^{103}Ru & ^{103m}Rh activity in equilibrium sample. Eqb. after 9 hours.
	Eqb.	172	50			ORNL76	
^{103m}Rh	Rhodium						
^{106}Ru	Ruthenium (Eqb. ^{106}Rh)	027 or 140 × 2			369 D 2	NDT70	Reading gives ^{106}Ru Act. in eqb. sample. Eqb. after 5 minutes.
^{106}Ru	Ruthenium						Reading gives sum of ^{106}Ru & ^{106}Rh activity in equilibrium sample.
	Eqb.	480 × 10			369 D 2	NDT70	
^{106}Rh	Rhodium						
^{108m}Ag	Silver	830	3		127 Y 21	ORNL76	
^{108}Ag	Silver	099 × 10	6	15	2.37 M 1	ORNL76	Large β contribution.
^{109}Cd	Cadmium	047 or	40	4	462.6 D 4		Reading gives act of ^{109}Cd, ^{109m}Ag, or Total Act. in eqb. sample. Eqb. after 6 minutes.
	Eqb.	180 × 2					
^{109m}Ag	Silver				39.8 S		
^{109}Pd	Palladium				13.427 H 14		Reading gives act of ^{109}Pd, ^{109m}Ag, or Total Act. in eqb. sample. Eqb. after 6 minutes.
	Eqb.	435 × 10			39.8 S		
^{109m}Ag	Silver						
^{110m}Ag	Silver	554 ÷ 2		2	249.8 D 1	ORNL76	
^{111}Ag	Silver	054 × 10		30	7.45 D 1	ORNL76	
^{111}In	Indium	303	10	1.36	2.805 D 1	NBS77	
^{113}Sn	Tin	022 or 129 × 2	35	5	115.08 D 3	MARTIN77	For pure ^{113}Sn.
^{113m}In	Indium	076	7	2	1.658 H 1		Separated for pure ^{113m}In.
^{113}Sn	Tin						Reading gives act. of ^{113}Sn, ^{113m}In, or Total Act. in eqb. sample. Eqb. after 15 hours.
	Eqb.	180	15	3.2	NBS73,77		
^{113m}In	Indium						
^{115m}In	Indium	058	15	2	4.486 H 4	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{116m}In	Indium	974		3	54.15 M 6	ORNL76	
^{117m}Sn	Tin	180	15	2	13.61 D 4	ORNL76	
^{117}Sb	Antimony	082	3	2	2.80 H 1	ORNL76	
^{119m}Sn	Tin	657 × 10	35	4	293.0 D 13	ORNL76	
^{121m}Te	Tellurium	187	12	9	154 D 7	ORNL76	Pure
^{121}Te	Tellurium	373	10	3	17 D 1	ORNL76	Pure
^{121m}Te ^{121}Te	Tellurium Eqb. Tellurium	645					Reading gives act. of ^{121m}Te or ^{121}Te in eqb. sample. Eqb. in 120 days. See App. IV for non-eqb. samples.
^{121m}Te ^{121}Te	Tellurium Eqb. Tellurium	572					Reading gives sum of ^{121m}Te or ^{121}Te in eqb. sample.
^{122}Sb	Antimony	146		6	2.70 D 1	ORNL76	
^{123}I	Iodine	277	15	1.9	13.221 H 3	NBS77	Ref. for 28 keV x-ray.
^{123m}Te	Tellurium	177	12		119.7 D 1	NDT70	
^{124}Sb	Antimony	720			60.20 D 3	ORNL76	
^{124}I	Iodine	570	5		4.18 D 2	ORNL76	
^{125}I	Iodine	319	25	1.45	59.6 D 2	NBS76	
^{125}Sb	Antimony	289	10		2.758 Y 1	NDT70	Pure
^{125}Sb	Antimony (Eqb. ^{125m}Te)	371	12		2.758 Y 1	NDT70	Reading gives ^{125}Sb Act. in eqb. sample. Eqb. after 1 year.
^{125}Sb ^{125m}Te	Antimony Eqb. Tellurium	364	12			NDT70	Reading gives sum of ^{125}Te and ^{125m}Te in eqb. sample. See App. IV for non-eqb. activity.
^{125m}Te	Tellurium	259	25		57.40 D 5	NDT70	
^{126}I	Iodine	240	10	18	13.02 D 7	ORNL76	
^{127}Xe	Xenon	371	12	5	36.4 D 1	ORNL76	
^{129m}Te	Tellurium	817 × 10	20	5	33.6 D 1	ORNL76	Pure
^{129}Te	Tellurium	679 × 10	15	13	69.6 M 2	ORNL76	Pure
^{129m}Te ^{129}Te	Tellurium Eqb. Tellurium	054					Reading gives act. of ^{129m}Te or total act. in eqb. sample. Eqb. in 10 hours.
^{129}Cs	Cesium	397	15	20	32.06 H 6	ORNL76	NM75 gives 488
^{129}I	Iodine	166	20		1.57E7 Y 4	ORNL76	
^{129m}Xe	Xenon	362	20	3	8.0 D 2	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{130}I	Iodine	984			12.36 H 1	ORNL76	
^{131}I	Iodine	151		1.65	8.021 D 1	NBS76	Decays to ^{131m}Xe. 1.1% feeding.
^{131m}Xe	Xenon	089	20	3	11.9 D 1	ORNL76	
^{131}Cs	Cesium	148	20	3	9.69 D 1	ORNL76	
^{131}Ba	Barium	505	10	7	11.8 D 2	ORNL76	
^{132}Te	Tellurium	315	10	5	76.3 H 2	ORNL76	Pure
^{132}I	Iodine	999			2.30 H 3	ORNL76	Pure
^{132}Te	Tellurium (Eqb. ^{132}I)	675 ÷ 2					Reading gives ^{132}Te Act. in eqb. sample. Eqb. after 1 day.
^{132}I	Iodine (Eqb. ^{132}Te)	653 ÷ 2					Reading gives ^{132}I Act. in eqb. sample.
^{132}Te + ^{132}I	Tellurium Eqb. Iodine	663				ORNL76	Reading gives sum of ^{132}Te and ^{132}I in eqb. sample.
^{132}Cs	Cesium	485	10	2	6.475 D 10	ORNL76	
^{133}I	Iodine	225			20.8 H 1	ORNL76	Decays to ^{133m}Xe.
^{133m}Xe	Xenon	100	20	3	2.19 D 1		Decays to ^{133}Xe. See App. IV.
^{133}Xe	Xenon	188	12	1.95	5.243 D 1	NBS76	
^{133m}Ba	Barium	132	12	3	38.9 H 1	ORNL76	Decays to ^{133}Ba.
^{133}Ba	Barium	591	10	3	10.5 Y 1	ORNL76	
^{134}Te	Tellurium	533	3	6	41.8 M 8	ORNL76	
^{134m}Cs	Cesium	037 or 160 × 2	15		2.91 H	NM75	Decays to ^{134}Cs.
^{134}Cs	Cesium	726		2.3	2.065 Y 1	NBS73	
^{135m}Xe	Xenon	181	3		15.29 M 3	ORNL76	Decays to ^{135}Xe. See App. IV.
^{135}Xe	Xenon	085	2		9.09 H 1	ORNL76	
^{135m}Ba	Barium	130	15	4	28.7 H 2	ORNL76	
^{136}Cs	Cesium	489 ÷ 2		4	13.1 D 1	ORNL76	
^{137}Cs + ^{137m}Ba	Cesium Eqb. Barium	220		2.0	30.0 Y 2 2.553 M 1	NBS73	Ref: 661.6 & 32.9 keV. Reading gives ^{137}Cs or Total Activity of eqb. sample. Often referred to as "Cs-137" Source.
^{139}Ba	Barium	445 × 10	5	12	82.8 M 2	ORNL76	
^{139}Ce	Cerium	352	5	2.6	137.64 D 2	NBS73	Ref: 36.8 keV
^{141}Ce	Cerium	061	5	5	32.50 D 1	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{142}Pr	Praseodymium	226 × 10		14	19.13 H 4	ORNL76	
^{144}Pr	Praseodymium	137 × 10		5	17.28 M 5	ORNL76	Estimation use only. β dominant.
^{144}Ce ^{144}Pr	Cerium Eqb. Praseodymium	387 × 10	5	2.8	285.0 D 1	NBS73	Ref: 36.7 & 133.5 keV. Reading gives sum of ^{144}Ce & ^{144}Pr Act. in equilibrium sample. Eqb. after 2 hours.
^{145}Pm	Promethium	207	10	3	17.7 Y 4	ORNL76	
^{147}Nd	Neodymium	213	5	4	10.98 D 1	ORNL76	
^{157}Dy	Dysprosium	424	5		8.1 H 1	NM75	
^{169}Yb	Ytterbium	948	3	2.5	32.03 D 1	NBS78	
^{171}Tm	Thulium	292 × 100	4		1.92 Y 1	NM75	
^{175}Yb	Ytterbium	308 × 10	2	13	4.19 D 1	ORNL76	
^{177}Lu	Lutetium	450 × 10	2	7	6.71 D 1	ORNL76	
^{181}Hf	Hafnium	387		6	42.4 D 1	ORNL76	
^{181}W	Tungsten	165	3	11	121.2 D 3	ORNL76	
^{188}W	Tungsten	111 × 100			69.4 D 5	NM75	Decays to ^{188}Re. Eqb. after 7 days. See App. IV
^{188}Re	Rhenium	496 × 10			16.98 H 2	NM75	
^{188}W	Tungsten (Eqb. ^{188}Re)	522 × 10					Reading gives ^{188}W Act. in eqb. sample. Eqb. after 5 days.
^{188}Re	Rhenium (Eqb. ^{188}W)	516 × 10					Reading gives ^{188}Re Act. in eqb. sample.
^{188}W ^{188}Re	Tungsten Eqb. Rhenium	217 × 10					Reading gives sum of ^{188}W & ^{188}Re activity in equilibrium sample.
^{190m}Os	Osmium	858			9.90 M	NM75	
^{191}Os	Osmium	250	2	13	15.4 D 2	ORNL76	
^{192}Ir	Iridium	408			73.83 D 1	NDS73	
^{194}Ir	Iridium	469 × 10		18	19.15 H 3	ORNL76	
^{197}Pt	Platinum	686 × 10	2	6	18.3 H 3	ORNL76	
^{197}Hg	Mercury	197	2	2.9	64.1 H 1	NBS76	Ref. for 70 & 77 keV.
^{198}Au	Gold	149		1.65	2.696 D 2	NBS78	
^{199}Au	Gold	053		6	3.139 D 7	ORNL76	
^{201}Tl	Thallium	205	2	2.0	72.91 H 2	NBS76	
^{203}Hg	Mercury	093		1.1	46.60 D 1	NBS73	
^{203}Pb	Lead	344		2	51.88 H 1	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{204}Tl	Thallium	420 × 100	2	2	3.78 Y 2	NDT70	
^{207}Bi	Bismuth	846		1.7	32.2 Y 9	NBS73	Ref. for 1064, 569.7, 76.7, & 1772 keV.
^{208}Tl	Thallium	571 ÷ 2			3.053 M 4	NM75	
^{212}Pb	Lead	101			10.64 H 1	NM75	Decays to ^{212}Bi. Eqb. after 1 hr. See App. IV.
^{212}Bi	Bismuth	489 × 10			60.55 M 6	NM75	
^{212}Pb	Lead (Eqb. ^{212}Bi)	158					Reading gives ^{212}Pb Act. in eqb. sample. Eqb. after 8 hours.
^{212}Bi	Bismuth (Eqb. ^{212}Pb)	135					Reading gives ^{212}Bi Act. in eqb. sample.
^{212}Pb Eqb. ^{212}Bi	Lead Bismuth	030 or 146 × 2					Reading gives sum of 212Pb & 212Bi activity in equilibrium sample.
^{224}Ra	Radium	646 × 100			3.66 D 4	NM75	
^{226}Ra	Radium + chain of daughters	778		0.5	1600 Y 7	NBS73	Reading in grams. Commonly referred to as "Radium "Source. 1.025 g/Ci of Ra-226.
^{239}Np	Neptunium	147		6	2.355 D 4	ORNL76	
^{241}Am	Americium	055	4	1	432.2 Y 5	LMR69	Ref. for 59.5 & 14 keV.

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APPENDIX III

RPH CHAMBER CALIBRATION NUMBERS

CALIBRATION SETTING NUMBERS

The Isotope Calibration Numbers in Table I are applicable to the Capintec CRC®-PC Smart Chamber RPh only.

The CRC®-PC Smart Chamber is a direct reading instrument. No manual multiplication or division should be performed, even if the Calibration Setting Number is followed by a multiplication sign "× " or a division sign "÷ " and a number.

If the sample contains radioactive impurities, the meter indication will always be higher than the actual activity of the principal isotope. It will not, however, be the total activity of the principal isotope and the impurities.

UNCERTAINTY DUE TO SYRINGE CORRECTION

The Calibration Setting Numbers are given for approximately 5 grams of radioactive solution in a standard source ampoule made of about 0.6 mm. thick borosilicate glass. The standard radioactive source in the ampoule is, however, a good approximation for a radiopharmaceutical in a plastic syringe or a glass syringe (wall thickness about 1.2 mm) for most radioisotopes.

TABLE I

Radioisotopes		Calibration Setting Number	Half-Life (NCRP-58)	Ref.
^{11}C	Carbon 11	467	20.38 Minutes	See Note
^{15}O	Oxygen 15	474	122.24 Seconds	See Note
^{13}N	Nitrogen 13	470	9.965 Minutes	See Note
^{18}F	Fluorine 18	480	109.71 Minutes	NIST
^{57}Co	Cobalt 57	112	271.7 Days	NIST
^{60}Co	Cobalt 60	990	5.271 Years	NIST
^{133}Ba	Barium 133	674	10.5 Years	NIST
^{137}Cs	Cesium 137	243	30.0 Years	NIST

Note: *These Calibration Numbers were determined by inter-comparison with a standard Capintec CRC®-15R Dose Calibrator. No NIST standards are yet available. They should be used for estimation purposes only.*

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APPENDIX IV

INTERFACE SPECIFICATIONS

OVERVIEW

Communications is initiated by the computer. The computer sends a command to the Chamber, which then responds to the command.

INTERFACES

The hardware interface to the Chamber is either Ethernet or USB.

Over the Ethernet, commands are sent over a HTTP protocol to a JSON (Java Script Object Notation) web service on the Chamber. Commands that do not require a parameter are sent over as an HTTP GET. Commands that require a parameter, are sent over as a HTTP POST with the parameter encoded as a name=value pair. The response from the Chamber is JSON formatted text.

Over the USB, commands are sent over a CDC (Serial) protocol. When the CDC driver is installed on a Windows computer, the Smart Chamber appears as a COM port in Windows. The command is sent to the Chamber in a packet with a packet check sum and a packet id. Ideally, the packet id should be unique (ex. running number) with every packet sent. The response from the Chamber is JSON text inside a packet with a packet check sum and an echo of the packet id from the command packet. The packet id ensures that the command and response are correctly paired. Check sums are used check the data integrity of the packet.

CDC PACKET STRUCTURE

Command Packet

The command packet is enclosed by a start character (STX=02h) and an end character (ETX=03h). The beginning of the packet is the check sum. The check sum is for the data in the packet excluding the STX, ETX. The check sum is a two byte hex string. A six character packet id follows the check sum. The packet id is echoed in the response packet. A one character command follows the packet id. The parameter follows the command character. Parameter characters are only included if the specific command requires a parameter.

| STX | C | C | I | I | I | I | I | I | X | P | … | P | ETX |

| STX |	- 02h
| C | C |	- check sum
| I | I | I | I | I | I |	- packet id
| X |	- command
| P | … | P |	- parameter
| ETX |	- 03h

Example: Read Activity command with Packet ID “hello1”. The Read Activity does not have a parameter.

Command Packet: 02h, 39h, 37h, 68h, 65h, 6Ch, 6Ch, 6Fh, 31h, 52h, 03h

Packet Breakdown:
02h = STX
39h = '9' (check sum)
37h = '7' (check sum)
68h = 'h' (packet id)
65h = 'e' (packet id)
6Ch = 'l' (packet id)
6Ch = 'l' (packet id)
6Fh = 'o' (packet id)
31h = '1' (packet id)
52h = 'R' (command)
03h = ETX

check sum = 68h + 65h + 6Ch + 6Ch + 6Fh + 31h + 52h = 297h = 97h or '9', '7' as hex string

Response Packet

The response packet is enclosed by a start character (STX=02h) and an end character (ETX=03h). The beginning of the packet is the check sum. The check sum is for the data in the packet excluding the STX, ETX. The check sum is a two byte hex string. A six character packet id follows the check sum. The packet id is the echo of the command packet id. If the command packet id is unavailable (i.e. truncated), then the packet id of the response will be filled with ' ' (20h). A one character packet status follows the packet id. The packet status codes are described Table 1. The JSON text follows the status character.

| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id echo
| S | - packet status
| JSON | - JSON text
| ETX | - 03h

Example: Response to the command above.

Response Packet: 02h, 46h, 45h, 68h, 65h, 6Ch, 6Ch, 6Fh, 31h, 30h, JSON TEXT, 03h

Packet Breakdown:
02h = STX
39h = 'F' (check sum)
37h = 'E' (check sum)
68h = 'h' (packet id)
65h = 'e' (packet id)
6Ch = 'l' (packet id)
6Ch = 'l' (packet id)
6Fh = 'o' (packet id)
31h = '1' (packet id)
52h = '0' (status) JSON TEXT
03h = ETX

check sum = 68h + 65h + 6Ch + 6Ch + 6Fh + 31h + 30 + JSON Text = 62FEh = FEh or 'F', 'E'
as hex string

COMMANDS

Read Activity

The Read Activity command returns the activity from the chamber using the current nuclide.

The JSON status will be set to “Chamber is busy”, if the Chamber is running a) Daily Test, b) Background, c) Accuracy Test, d) Moly Assay.

The “Smart Chamber Title”, “Smart Chamber Serial Number” and “JSON status” are always valid in the response. All other fields in the JSON Text are only valid if the JSON status is “Ok”.

Web Service HTTP GET: ws_get_activity.htm

CDC Command Packet
| STX | C | C | I | I | I | I | I | I | 'R' | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id
| 'R' | - Read Activity Command (52h)
| ETX | - 03h

CDC Response Packet
| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id (echoed from Command Packet)
| S | - packet status (See Table 1)
JSON - JSON Text (only if packet status = '0' (30h))
| ETX | - 03h

JSON Text

Name	Type	Description
title	string	SmartChamber Title
sn	string	SmartChamber Serial Number
status	integer	JSON Status (See Table 2)
nuclide	string	Nuclide Measured
sec	integer	Measurement time (0 – 59)
min	integer	Measurement time (0 - 59)
hr	integer	Measurement time (0 - 23)
day	integer	Measurement time (1 - 31)
mon	integer	Measurement time (1 - 12)
yr	integer	Measurement time (2012 - 2111)
activity	string	Measured Activity
unit	integer	Measured Unit (See Table 3)

Set Nuclide

The Set Nuclide command changes the current nuclide. The current nuclide has been changed, if the JSON status is “Ok”.

The JSON status will be set to “Chamber is busy”, if the Chamber is running a) Daily Test, b) Background, c) Accuracy Test, d) Moly Assay.

Web Service HTTP POST: ws_post_nuclide.htm
Parameter (name=value): nuclide=xxxxxx (min 1 chars, max 6 chars) ex: Cs137

CDC Command Packet
| STX | C | C | I | I | I | I | I | I | 'N' | n | n | n | n | n | n | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id
| 'N' | - Set Nuclide Command (4Eh)
| n | n | n | n | n | n | - Nuclide Name (min 1 chars, max 6 chars) ex) Cs137
|ETX| - 03h

CDC Response Packet
| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id (echoed from Command Packet)
| S | - packet status (See Table 1)
JSON - JSON Text (only if packet status = '0' (30h))
|ETX| - 03h

JSON Text

Name	Type	Description
title	string	SmartChamber Title
sn	string	SmartChamber Serial Number
status	integer	JSON Status (See Table 2)

Set Time

The Set Time command changes the date/time. New time has been set, if the JSON status is "Ok".

The JSON status will be set to "Chamber is busy", if the Chamber is running a) Daily Test, b) Background, c) Accuracy Test, d) Moly Assay.

Web Service HTTP POST: ws_post_time.htm
Parameter (name=value): datetime=YYYYMMDDhhmmss
YYYY = year (2012 - 2111)
MM = month (01 - 12)
DD = day (01 - 31)
Hh = hour (00 - 23)
mm = minute (00 - 59)
ss = second (00 - 59)

CDC Command Packet
| STX | C | C | I | I | I | I | I | I | 'T' | Y | Y | Y | Y | M | M | D | D | h | h | m | m | s | s | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id
| 'T' | - Set Time Command (54h)
| Y | Y | Y | Y | - Year (2012 – 2111)
| M | M | - Month (01 – 12)
| D | D | - Day (01 – 31)
| h | h | - Hour (00 – 23)
| m | m | - Minute (00 – 59)
| s | s | - Second (00 - 59)
|ETX| - 03h

CDC Response Packet
| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id (echoed from Command Packet)
| S | - packet status (See Table 1)
JSON - JSON Text (only if packet status = '0' (30h))
|ETX| - 03h

JSON Text

Name	Type	Description
title	string	SmartChamber Title
sn	string	SmartChamber Serial Number
status	integer	JSON Status (See Table 2)

Read Moly Result

The Read Moly Result command retrieves the result of a Moly Assay from the Chamber. This command is only successful if the JSON status is “Ok”.

The “SmartChamber Title”, “SmartChamber Serial Number” and “JSON status” are always valid in the response. All other fields in the JSON Text are only valid if the JSON status is “Ok”.

Web Service HTTP GET: ws_get_moly_result.htm

CDC Command Packet

| STX | C | C | I | I | I | I | I | I | 'M' | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id
| 'M' | - Read Moly Result Command (4Dh)
| ETX | - 03h

CDC Response Packet

| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id (echoed from Command Packet)
| S | - packet status (See Table 1)
JSON - JSON Text (only if packet status = '0' (30h))
| ETX | - 03h

JSON Text

Name	Type	Description
title	string	SmartChamber Title
sn	string	SmartChamber Serial Number
status	integer	JSON Status (See Table 2)
dbid	integer	Index of record in the database
assay_id	string	Assay ID
method	integer	Moly Method (See Table 4)
mo99_bkg_measured	boolean	Moly Background Measured/Skipped (true/false)
mo99_bkg_high	boolean	Moly Background Measurement High flag
mo99_bkg_activity	string	Moly Background Measurement
mo99_bkg_unit	integer	Moly Background Measurement Unit (Table 3)
mo99_high	boolean	Moly Measurement High flag
mo99_activity	string	Moly Measurement
mo99_unit	integer	Moly Measurement Unit (See Table 3)
tc99_activity	string	Tc99m Measurement
tc99_unit	integer	Tc99m Measurement Unit (See Table 3)
mo_tc_result	integer	Assay Result (See Table 5)
mo_tc_limit	string	Mo/Tc Limit
mo_tc	string	Assay Mo/Tc
mo_tc_unit	integer	uCi/mCi or MBq/GBq (See Table 6)
expires	integer	Hours to expire. (-1 if hours are greater than 11)

Name	Type	Description
conc_avail	boolean	Is concentration available (true/false)
volume	string	Volume in ml
tc99_conc	string	Tc99m concentration
tc99_conc_unit	integer	Tc99m concentration unit (See Table 7)
sec	integer	Assay time (0 - 59)
min	integer	Assay time (0 - 59)
hr	integer	Assay time (0 - 23)
day	integer	Assay time (1 - 31)
mon	integer	Assay time (1 - 12)
yr	integer	Assay time (2012 - 2111)

Start Daily Test

The Start Daily Test command will start the daily test. A Daily Test ID needs to be supplied as a parameter in this command. Ideally, the id should be unique (ex. running number) with every call to this command. This id should be used in the Get Daily Test Result command.

If the Daily Test was started, then the JSON status is “Ok”. The results of the Daily Test are not returned in the response. The results of the Daily Test are returned in the response from the Get Daily Test Result command. Implementing the daily test function requires the computer to send the Start Daily Test command, which is followed by polling the Chamber with the Get Daily Test Result command. The polling frequency should not exceed once per second.

The JSON status will be set to “Chamber is busy”, if the Chamber is already running a) Daily Test, b) Background, c) Accuracy Test, d) Moly Assay.

Web Service HTTP POST: ws_post_daily_start.htm
Parameter (name=value): id=xxxxxxxxxx (min 1 chars, max 10 chars)
The *Daily Test ID* is supplied when the daily test is started. It is used later in the Get Daily Test Result command.

CDC Command Packet
| STX | C | C | I | I | I | I | I | I | 'D' | i | i | i | i | i | i | i | i | i | i | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id
| 'D' | - Start Daily Test Command (44h)
| i | i | i | i | i | i | i | i | i | i | - Daily Test ID (min 1 chars, max 10 chars)
|ETX| - 03h

CDC Response Packet
| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | - packet id (echoed from Command Packet)
| S | - packet status (See Table 1)
JSON - JSON Text (only if packet status = '0' (30h))
|ETX| - 03h

JSON Text

Name	Type	Description
title	string	SmartChamber Title
sn	string	SmartChamber Serial Number
status	integer	JSON Status (See Table 2)

Get Daily Test Result

The Get Daily Test Result command will return the result of the Daily Test started by the Start Daily Test command. The id passed in this command should be the same as the one passed in the Start Daily Test command.

This command should be used to poll the Chamber until the test has finished and returns the result. The polling frequency should not exceed once per second. The JSON status is "Chamber is busy", while the Daily Test is in progress. Once the Daily Test has finished, JSON status changes to "Ok".

The "SmartChamber Title", "SmartChamber Serial Number" and "JSON status" are always valid in the response. All other fields in the JSON Text are only valid if the JSON status is "Ok".

Web Service HTTP POST: ws_post_daily_result.htm
Parameter (name=value): id=xxxxxxxxxx (min 1 chars, max 10 chars)
The *Daily Test ID* should be the same id used in the Start Daily Test command.

CDC Command Packet
| STX | C | C | I | I | I | I | I | I | 'd' | i | i | i | i | i | i | i | i | i | i | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | - packet id
| 'd' | - Get Daily Test Result Command (64h)
| i | i | i | i | i | i | i | i | i | i | - Daily Test ID (min 1 chars, max 10 chars)
|ETX| - 03h

CDC Response Packet

| STX | C | C | I | I | I | I | I | I | S | JSON | ETX |

| STX | - 02h
| C | C | - check sum
| I | I | I | I | I | I | - packet id (echoed from Command Packet)
| S | - packet status (See Table 1)
JSON - JSON Text (only if packet status = '0' (30h))
|ETX| - 03h

JSON Text

Name	Type	Description
title	string	SmartChamber Title
sn	string	SmartChamber Serial Number
status	integer	JSON Status (See Table 2)
dbid	integer	Index of record in the database
zero	string	Chamber Zero Result
zero_error	boolean	Chamber Zero Error (true/false)
background	string	Chamber Background Result
background_error	boolean	Chamber Background Error (true/false)
chamber_voltage	string	Chamber Voltage Test Result
chamber_voltage_error	boolean	Chamber Voltage Error (true/false)
data_check	string	Data Check Result
data_check_error	boolean	Data Check Error (true/false)
sec	integer	Daily Test time (0 - 59)
min	integer	Daily Test time (0 - 59)
hr	integer	Daily Test time (0 - 23)
day	integer	Daily Test time (1 - 31)
mon	integer	Daily Test time (1 - 12)
yr	integer	Daily Test time (2012 - 2111)

*Table 1: **Packet Status Code***	
Code	**Description**
'0' (30h)	Ok
'1' (31h)	Check sum error in command packet
'2' (32h)	Invalid command code in command packet
'3' (33h)	Truncated check sum in command packet
'4' (34h)	Truncated packet id in command packet
'5' (35h)	Missing command code in command packet

*Table 2: **JSON Status Code***	
Value	**Description**
0	Ok
1	Invalid name in name=value pair (Web Service specific)
2	Invalid value in name=value pair (Web Service specific)
3	Chamber is busy
4	Daily Test ID cannot be found (Get Daily Test Result specific)
5	Invalid Second (Set Time specific)
6	Invalid Minute (Set Time specific)
7	Invalid Hour (Set Time specific)
8	Invalid Day (Set Time specific)
9	Invalid Month (Set Time specific)
10	Invalid Year (Set Time specific)
11	Invalid Date (Set Time specific)
12	Unable to set Real Time Clock chip (Set Time specific)
13	Unable to find Moly Test (Read Moly Result specific)
15	Unable to find nuclide (Set Nuclide specific)

*Table 3: **Activity Unit***	
Value	**Description**
-1	N/A (Not Available, because JSON status is not 'Ok')
0	Over range
1	uCi
2	mCi
3	Ci
4	kBq
5	MBq
6	GBq

*Table 4: **Moly Method***	
Value	**Description**
-1	N/A (Not Available, because JSON status is not 'Ok')
0	Capintec Canister
1	CAPMAC Mallinckrodt
2	CAPMAC Bristol Myers

*Table 5: **Moly Assay Result***	
Value	**Description**
-1	N/A (Not Available, because JSON status is not 'Ok')
0	Ok
1	Caution
2	Mo High
3	Mo Too High, Do not use
4	Tc99m Too Low

*Table 6: **Mo/Tc Unit***	
Value	**Description**
-1	N/A (Not Available, because JSON status is not 'Ok')
0	uCi/mCi
1	MBq/GBq

*Table 7: **Concentration Unit***	
Value	**Description**
-1	N/A (Not Available, because JSON status is not 'Ok')
1	uCi/ml
2	mCi/ml
3	Ci/ml
4	kBq/ml
5	MBq/ml
6	GBq/ml

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NEW PRODUCT WARRANTY

Conditions and Limitations

CAPINTEC warrants our products to be free from defects in material and workmanship for a period of 24 months after delivery to the original buyer (unless indicated otherwise). Our obligation under this warranty is limited to servicing or adjusting products returned to our factory for that purpose promptly upon any claim under this warranty, provided our examination discloses to our satisfaction that the affected parts were originally defective and have not been subjected to misuse, abuse, mishandling or improper operation. This warranty extends to every part of the product except batteries, fuses, ink, magnetic storage media, toner, transistors or any other normally consumable item. In no event shall we be liable for transportation, installation, adjustment or any other expenses which may arise in connection with such products or their servicing or adjustment.

This warranty is expressly in lieu of any other express or implied warranties, and we make no warranty that the products sold herein are merchantable or are suitable for any particular purpose. The benefits of this warranty shall extend only to the buyer and to none other. We shall have no liability of any nature arising out of the use or application of the product in conformity with this warranty. If the product shall fail to perform in conformity with the warranty made herein, we shall be liable solely for the repair and replacement of the product as provided herein above, and shall have no other liability in respect of such failure or performance, or any consequences therefrom, including, without limitation, business impairment or loss, personal injury or property damage.

No agent, employee, or representative of ours has any authority to bind us to any representation or warranty concerning the product sold herein, and unless a representation or warranty made by an agent, employee or representative is specifically included herein, it shall not be enforceable by the buyer. No waiver, alteration or modification of the foregoing conditions shall be valid, unless made in writing and signed by an executive officer of our corporation.

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CAPINTEC, INC.

DECLARATION OF CONFORMITY
THE EC DIRECTIVE AND CE MARKING

We, Capintec, Inc.
7 Vreeland Road
Florham Park, NJ 07932
Phone (800) ASK-4CRC
Fax (201) 825-1336

declare under our sole responsibility that the product CRC®-PC SMART CHAMBER (HL, RPh, PS) to which this declaration relates is in conformity with the Medical Device Directive 93/42/EEC.

This product is in conformity with the following standards or other normative documents following:

1. IEC 60601-1
2. IEC 60601-1-2
3. IEC 60601-1-6

Certified to Annex V of the Directive 93/42/EEC on Medical Devices
Dose Calibrators, Class I with measuring function
Certified through Intertek Semko AB, Notified Body MDD
CE Mark as shown denotes conformance to the above statement.

CE 0413

The Technical Construction File is maintained at:
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7 Vreeland Road
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The authorized representative located within the Community is:
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Date of issue: 7/12/16

Place of issue:
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Mary Anne Yusko

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Vice President, Product Development & Regulatory Affairs