

# MODEL BX3 BOX CALIBRATOR

The Model BX-3 Box Calibrator is a self-contained and fully-shielded irradiator system. Compact and ergonomic, this irradiator system is designed for convenient and versatile calibration of a wide variety of radiation survey meters and personnel dosimeters. Both manual and fully automated versions are available to meet the specific needs of the customer.



## FEATURES

- **Self-Contained Exposure Chamber**
- **0 – X8000 Attenuator Set**
- **Single or Dual Source, 300mCi-2200 Ci**
- **Large Viewing Window**
- **Manual or Automated Operation**
- **Dual Axis Positioning Track**
- **Ports for Extendable Probes**
- **Concise Size**

The BX3 Box Calibrator produces a beam of gamma radiation of varying strengths for calibrating survey meters inside a fully shielded enclosure. The irradiator consists of a shielded exposure chamber, one or two sources, shielding, a safety interlock system, and a control system with status indicators.

## SOURCES

The BX can be provided with one or two Cs-137 sources. The range of available sources is from 300 mCi to 2200 Ci. Typical sources and their corresponding exposure rates are:

<b>Cs-137 (Ci)</b>	<b>Maximum (R/hr)</b>	<b>*Minimum (mR/hr)</b>
0.3	1	0.02
1	5	0.06
5	25	0.30
10	50	0.50
20	90	0 1
50	220	0 3
100	450	0 5
450	2000	0 25
1200	5300	0 60
2200	10,000 R/hr	120 mR/hr

\* Minimum exposure rate based on full 8000x attenuation and tract at maximum distance (80cm) from source.

The sources are doubly encapsulated, hermetically sealed, special form sources. The source capsule is fabricated of stainless steel. Source activity is +/- 20%. Sources are supplied with certificates for source activity, exposure rates, and leak tests.

Source(s) are loaded in a rod made primarily of tungsten. The cavity that holds the radioactive source is made from stainless steel to limit the amount of attenuation. Tungsten is placed both above and below the source to limit radiation levels and cross-talk between the sources. Brass guide bushings are attached to the top and bottom of the source rod.

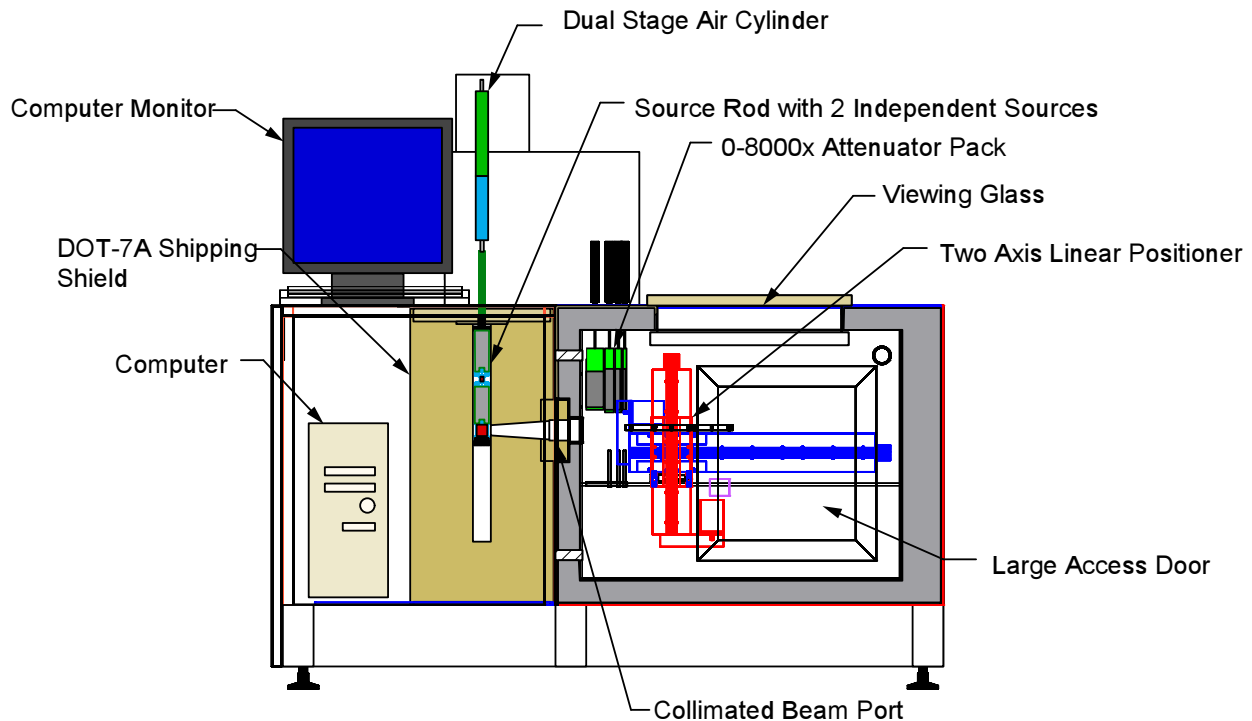
## SHIELDING

The irradiator consists of two shields, one for storing the radiation sources, and the second for housing the exposure chamber. A steel-encased lead cylinder constitutes the shield for the sources. The overall size ranges from 10" dia. x 19" tall to 14" dia. x 26" tall depending on the number and size of the sources. The source rod moves up inside a thin walled stainless tube to the exposed position. It is permanently embedded in the shield and can not be removed. A conical, rectangular beam port extends out the side of the shield to the exposure chamber.

The exposure chamber shield is box shaped with an interior size of 16" deep x 24" tall x 31" long. Access to the interior is provided by a 15" x 15" hinged door on the front of the shield. A lockable latch holds the door closed. In addition, a safety interlock holds the door closed during an exposure. A 2" diameter port in the side of the chamber allows extendable probes such as teletectors to be calibrated. It is located close to the source shield to provide maximum exposure rates.

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# Cross Section of the BX3 Box Calibrator



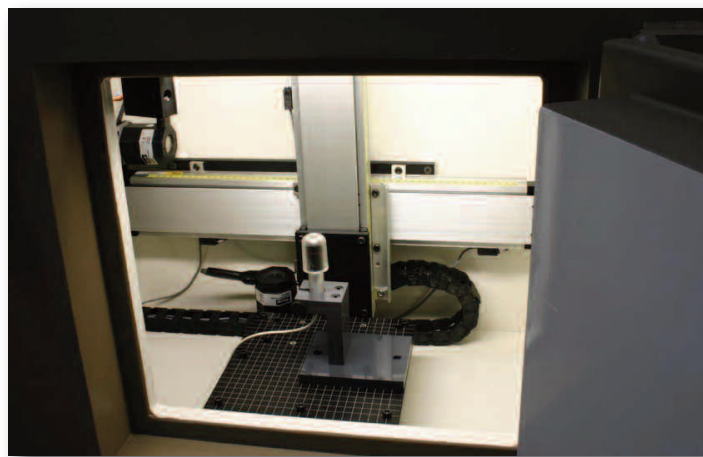
Lead provides sufficient shielding to limit the radiation level to less than 0.5mR/h at 12" from the surface of the shield. All lead is totally encased in steel.

## VIEWING WINDOW

A leaded glass viewing window in the top of the shield allows the instrument to be read during an exposure. The 12" x 18" window allows the instrument to be read over the full range of travel of the positioning track.

## ATTENUATORS

A set of 4 lead attenuators, X2, X4, and X10 and X100 provide exposure rates from 0 to X8000. Each attenuator can be independently operated to provide a combination of 16 exposure ranges. The attenuators can be moved out of the way so that instruments can be placed next to the beam port to achieve the highest possible exposure rate.



*View thru door of track and instrument platform*

## POSITIONING TRACK

A linear positioning track (LPS) can position the instrument platform with an accuracy of  $\pm 0.1$  mm. The instruments can be moved over a range of 60 cm to change exposure rates by a factor of 20. This distance change, in combination with the X8000 attenuator set, provides a dynamic range for each source of 16,000. An adjustable vertical axis provides 12 cm of adjustment to align instruments in the beam centerline. Scales on each axis confirm the position. The 15 cm x 15 cm platform has grid lines at 1 cm spacing, and tapped holes on a 10 cm spacing to allow instruments to be accurately positioned.

For manual systems, the LPS is moved by hand cranks. The X-axis crank is located outside the exposure chamber and has a display to show position. The Y-axis crank is located at the bottom of the axis.

When the computer control system is used, the LPS is moved via stepper motors and software control. A position is selected on the control screen (or an exposure rate entered), and the platform automatically moves to position. Jigs are available for a wide assortment of instruments.

## SOURCE HANDLING SYSTEM

The source is moved vertically from the shielded to the exposed position. For manual systems, the operator lifts a rod to raise the source to the exposed position.

For electronic and computer controllers, the source is moved by a pneumatic air cylinder. When the cylinder is actuated, the source rod moves to the exposed position. When the air cylinder is deactivated, the source rod returns to the home/storage position where the source is shielded on all sides with lead and tungsten. Sensors on the air cylinder indicate source position

## SAFETY INTERLOCK SYSTEM

The safety interlock system is an integral part of the design to prevent inadvertent exposure to staff. "Fail Safe" design constraints have been applied to all components that involve source exposure.

A door interlock is provided for the exposure chamber door. When the door is open, power to the source solenoid is broken, preventing source exposure. When an exposure is in progress, the door is locked and cannot be opened.

A red warning light is mounted above the source tower, and is on whenever the source is not fully shielded. A green light is on when the source is fully shielded.

## MANUAL CONTROL PANEL

The control panel is available in 3 versions: manual, electronic, and computer control. The manual control panel has a keyed power switch, an expose button, and a timer. The key for the power switch is captured in the ON position. To start an exposure, the expose button is pushed, which actuates a solenoid to unlock the source rod. The operator lifts the source handle while the expose button is actuated. When the source handle is placed in either exposed position, the timer begins counting and continues until the operator returns the source to the shielded position. A reset button zeros the timer.

## ELECTRONIC CONTROLLER

The electronic controller adds the ability to do timed exposures. An electronic controller has a digital display for exposure time, and a keypad for time entry. A pneumatic air cylinder is connected to the source rod and moves the source between the shielded and exposed position(s). Exposure begins when the operator presses the expose button, and ends when preset time is reached or when the return button is pressed. Operator can select desired source when the dual source system is supplied. Attenuators are selected and actuated via the controller's keypad. All safety interlocks are still incorporated into the control system: the door must be closed before an exposure can occur; and when the source is exposed, the door is locked.



*Large Door for Easy Access to Instrument Platform*



*Computer Controller Showing LCD Touch Screen*

**This option includes the following enhancements:**

- **Electronic controller with keypad for data entry**
- **Pneumatic operation of source rod**
- **Pneumatic operation of attenuators**

## AUTOMATED CONTROLLER

The BX3 can be supplied with a computer based control system. This approach offers several advantages: calculation of exposure rate via polynomial equation, automatic set up of irradiator, automated calibration of irradiator, and enhanced ease of use. The computer touch screen shows controls and indicators for interlock status, expose/shielded state, preset and elapsed time, preset and actual positions for track, source and attenuator selection, and automatic set up procedure and step. The automated controller uses the latest model of computer and includes circuit boards for interfacing to the inputs and outputs, the linear positioning track, and the electrometer.

- **Calculates Exposure Rate & Decay Correction**
- **Automatic Set-Up of Irradiator**
- **Automated Calibration of Irradiator**

With the power of the computer available for calculations, the irradiator control system can calculate the track's X-axis distance based on a desired exposure rate. This calculation includes decay correction and is based on a polynomial equation that precisely matches the measurement data collected for that source/attenuator/position combination. When distance is changed, the exposure rate for that position is calculated. The same arrangement holds for time and exposure – when one is changed, the other is calculated and displayed.

The automatic set up routine speeds up instrument calibration and increases accuracy by quickly configuring the irradiator to match the instrument's calibration procedure.

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With the change of one button, this routine configure source, attenuator, track position or exposure rate, and time or exposure. These configurations are arranged in procedures and steps that the user defines. Whenever the operator changes a step, the irradiator is re-configured to match that step. The irradiator calibration requires that hundreds of data points be collected to determine exposure rates for distances along the positioning track. This data must be collected for each source and each attenuator. With the computer control system, this process is automated. The computer is connected to the electrometer via GPIB interface.

The irradiator control system presents a set up screen that allows the operator to specify distances, exposure time, and number of exposures at each position. Once the operator starts the exposure, the control system performs the exposures at each position, collects the exposure rate from the electrometer and saves it to a spreadsheet file. The automated sequence continues until all data is collected. An equation curve fit program is used to fit the data to a polynomial equation. This equation is then coded into the software control program.

The computer based control system enhances ease-of-use by automating and simplifying many steps of the calibration process. It handles the mundane, repetitive tasks and lets the operator concentrate on the calibration procedure.

This option includes the following enhancements:

- **Computer control system with touch screen**
- **Irradiator control software**
- **Pneumatic operation of source rod, controlled via computer**
- **Pneumatic operation of attenuators, controlled via computer**
- **Stepper motors for both axes of linear positioning track**

## SPECIFICATIONS

Physical Size: 70" wide x 24" deep x 58" tall. Top of exposure chamber is at 38" from floor. Recommended working space: 4 ft. x 6 ft.

Weight: 4000-7000 Lbs. depending on model

Viewing Window: 12" x 18"

Power Requirements: 120 VAC, 1 Amp.

Compressed Air: 80 PSI, < 1SCFM (for systems with electronic controllers only)



## SELECTING YOUR MODEL

The box calibrator is available in several models to meet a wide range of requirements. Three basic versions are supplied based on source size. The irradiator can be supplied with 1 or 2 sources. The control system can be manual, electronic, or computer controlled.

### Model

BX3-12-1-a-c	1 source, maximum 12 Ci
BX3-12-2-a-b-c	2 sources, maximum 12 Ci
BX3-360-1-a-c	1 source, maximum 360 Ci
BX3-360-2-a-b-c	2 sources, maximum 360 Ci
BX3-2600-1-a-c	1 source, maximum 2600 Ci
BX3-2600-2-a-b-c	2 sources, maximum 2600 Ci

**a** - Specify size for first source. Standard sizes are (in Curies):

0.3	10	200
0.5	20	450
1	50	1200
5	100	2200

**b** - Specify source size for second source.

**c** - Specify control system

- M for manual control,
- E for electronic control, and
- A for automated computer control

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