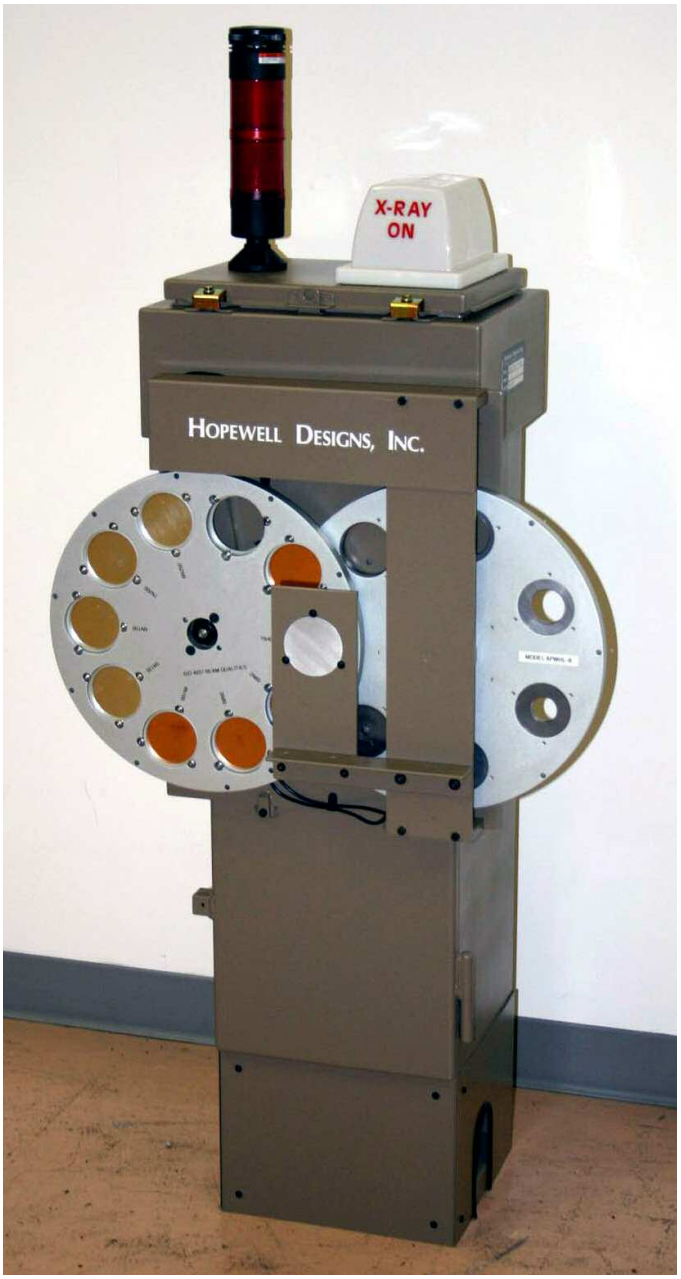
Model X80 X-Ray Beam Irradiator

The Model X80-225kV calibrator is a complete system for irradiating personnel dosimetry badges and radiation detection instruments with x-ray radiation. The major sub-systems of the x-ray system are: 1) the dosimetry grade X-ray system; 2) the shielded enclosure; 3) the beam shutter and collimator; 4) the filter assembly; 5) the system control panel and status indicators; and 6) all control and signal cables.



Model X80-225 X-Ray Beam Irradiator

- **X80-160 - range of 5 to 160 kV**
- **X80-225 - range of 5 to 225 kV**
- **X80-320 - range of 10 to 320 kV**
- **Multiple beam codes available**
- **Fail-Safe Design**
- **Timer or Fully-Automated Operation**
- **Precision Linear Positioning Track**

Dosimetry Grade X-Ray System

The dosimetry grade x-ray system uses a Comet tube-head and Gulmay generators and controller. The X-ray set is integrated with the other sub-systems (shielded enclosure, shutters, etc.) to provide the full irradiator system. The X-ray system consists of the following:

- Tubehead
- Controller
- High voltage generator
- Water cooler

Tubehead

- Double focus: Fine 1.2, Standard 4.0
- Type: Single pole with stationary anode and oil insulation
- Inherent filtration: 1 mm Be
- Emergent beam angle: 40° for tubehead. Emergent angle from shield: 15°.
- Target material: tungsten
- Range: 225 kV, 13 mA @ 3 mm focal, 225 kV, 2.8 mA @ 0.4 focal

225 kV HV Generator

- Type: two phase cascade circuit with solid state rectifiers
- Generator: oil immersed in rugged steel tank
- Ripple: 14 V/mA, frequency 40 kHz. Maximum is 80 volts peak-to-peak.
- Operation at 40 kHz to insure high stability Controller
- Voltage selectable from 5-225 kV in 0.2 kV increments, Accuracy ± 1%. kV drift as a function of temperature is < 100 ppm/°C.
- Current selectable from 0 – 50 in 0.05 mA increments. Current accuracy ± 0.2% of set value for standard focal spot, ±0.2% for fine focus.
- Controller displays set voltage and current when high voltage is not on, actual voltage and current when voltage is on.
- Warm-up: 2 warm up programs are available.

Systems and solutions for irradiation applications, X-Ray inspection, positioning equipment, and radiation shielding. We offer a wide range of standard products and custom designs to match your specific requirements. Call today to see how we can help.

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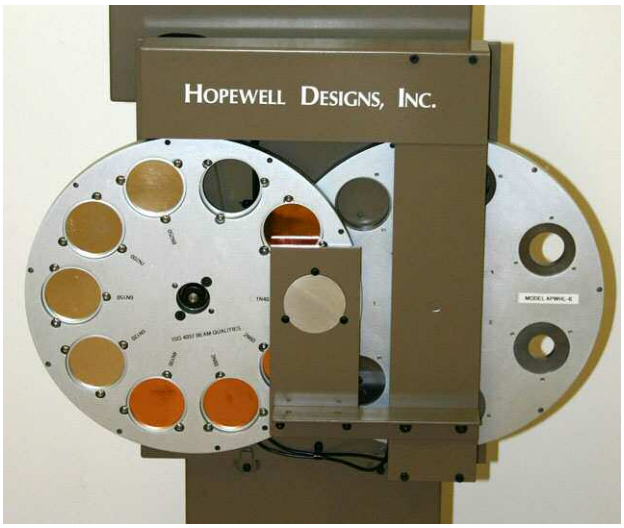
Shielded Enclosure

A shielded enclosure is provided to totally enclose the tube head, head mounts, cables, and high-speed shutter. The enclosure is made of lead sheet with a nominal thickness of 10mm sandwiched between two layers of sheet metal. Exposure rates are limited to less than 5 mR/h at a distance of 30 cm from the enclosure's surface when the tube is operating at any current/voltage combination. The front door can be opened to gain access to the tube head and shutter. Once opened, an interlock disables power to the tube head. Baffled penetrations allow the cables to exit without increasing radiation exposure rates. Overall size is 40cm x 60cm x 120cm approximate weight is 275kg.

The tube head is mounted vertically on a stand. A square bracket bolted to the tubehead sits on the stand. This bracket provides vertical and rotational adjustment to align the beam with the collimated opening at 110cm above floor height. The tubehead can be removed and reinstalled without loss of alignment.



Filter and Aperture Assembly

Beam Shutter & Collimator

A high-speed shutter is located inside the shielded enclosure mounted to the face of the door. This unit consists of a collimated opening, the tungsten shutter, a pivot mechanism, and the electric solenoid. An electric solenoid pulls the shutter open in less than 30 milliseconds. When power is turned off, a spring pulls the shutter closed in the same amount of time. Electric switches indicate shutter position. A tungsten collimator in the beam port of the tubehead limits the size of the beam. This opening in combination with the collimated port on the shield, provides a beam with a 15 degree solid angle.

Safety System

The irradiator system incorporates many features to make it a safe system to operate. "Fail Safe" design constraints have been applied to all components that involve radiation exposure. The safety interlock system must be fully satisfied before an exposure can occur. The emergency-off buttons prevent or stop an exposure. A door interlock at the room entrance door breaks power to the shutter, preventing an exposure. Warning lights at the irradiator and door show x-ray and exposure status. The entire system has been designed to meet or exceed guidelines and regulations found in ANSI Standards N43.3 and NCRP 88.

Control Panels

The irradiator control panel provides for complete control and monitoring of the irradiator. The front panel has expose and return pushbuttons, indicator lights, an emergency off pushbutton, an LCD display that shows exposure time, and a keyed power switch. A keypad provides data entry for exposure time, filter, and attenuator selection. When optional equipment is part of the irradiator, controls are added for these features.

X-Ray and Irradiator Control Panels

The x-ray control panel provides control over the voltage and current for the x-ray system. High voltage and generation of x-rays is controlled at this panel. High voltage can be turned on only when all safety interlocks are satisified.
When power is applied to the irradiator panel via the keyed power switch, indicator lights turn on to show shutter position. Interlock status is displayed on the LCD display. When the safety interlock circuit is satisfied, the shutter can be opened by pressing the expose pushbutton. The indicator lights change from green to red to show the shutter is open. The shutter is closed when the exposure time is reached or when the return pushbutton is pressed.

A timer allows both preset and manual operation for the time of exposure. Exposure time can be set and is displayed up to 1,000,000 seconds. When zero is entered for time, the exposure operates in manual mode and will continue until the return pushbutton is pressed.

The controller monitors for error conditions and will terminate an exposure when an error occurs. Errors include safety interlock circuit opened during exposure, emergency off switch actuated, low air pressure, as well as other items. Before an exposure can continue, the error must be cleared, the safety interlock circuit satisfied, and the expose pushbutton pressed.

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OPTIONAL EQUIPMENT

Other X80 Models

The X80 X-Ray Beam Irradiator is available with other X-ray systems: Model X80-160 with a range of 5-160 kV; X80-320, range of 10-320 kV, and X80-100-M that uses a tubehead with a molybdenum target for mammography calibration systems.

Filter Assembly

The filter assembly is designed to modify the spectral characteristics of the x-ray beam to meet the various beam codes required for calibrating instrumentation. It consists of a 38cm aluminum disk mounted on the front of the shielded enclosure with 10 holes 7cm in diameter. The disk is rotated by a pulley and motor at the rate of 3 rpm. Proximity sensors detect when the selected filter is in position and stop the motor. Positioning accuracy is ±0.5 mm. The holes in the disk are designed to hold filters ranging in thickness from 0.1mm to 15mm. The disk can be easily removed and another disk installed when more than 10 beam codes are used.

A set of filters are provided to produce the beam definitions as called for in the ISO 4037-3, 1999 “X and g Reference Radiations for Calibrating Dosimeters and Dose Ratemeters and for Determining Their Response as a Function of Photon Energy”. The filters consist of high purity aluminum, copper, etc. as required to meet the above beam definitions.

A bracket in front of the filter wheel holds fixed filtration. A mounting bracket is provided for a transmission chamber. It can be easily removed to change out a filter wheel.

Filter Wheels

Model FilterWhl-10. Additional filter wheels can be added to the x-ray system as required. Each wheel consists of the aluminum disk and a set of up to10 filters.

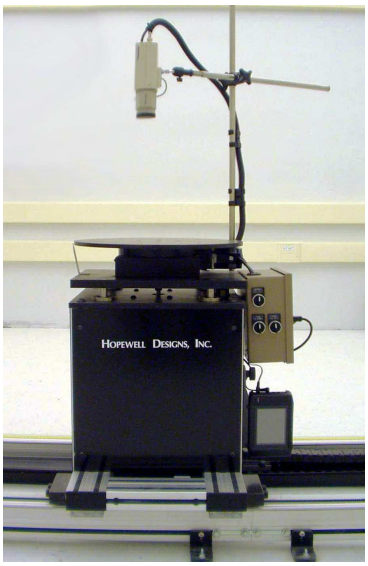
Aperture Wheel Assembly

Model ApWhl-6. The aperture assembly is designed to modify the beam diameter of the x-ray beam to meet the various beam configurations required for calibrating instrumentation. It consists of a 30cm disk mounted on the front of the shielded enclosure with 6 lead disks 6cm in diameter. Aperture sizes range from 1cm to 6cm in 1cm increments. The disk is rotated by a pulley and motor at the rate of 3 rpm. Proximity sensors detect when the selected aperture is in position and stop the motor. Positioning accuracy is ±0.5 mm. The disk is engraved with sequential numbers (1-6) that correspond to those on the controller.

Half-Value Layer Kit

Model HalfValueKit-M. Thickness of filter material for specific beam codes must be verified prior to use of the X-ray beam irradiator. This process requires aluminum and copper material and a collimator to measure the half-value layers of each beam code. The half-value layer kit includes a set of aluminum and copper material of varying thicknesses, a shelf to hold the material in the beam, a lead collimator, and a stand to hold the ion chamber.

Linear Positioning System



The linear positioning system (LPS) provides a means to precisely position a radiation survey instrument or TLDs an exact distance from the irradiator. The LPS, operated via the control panel, can move up to four axes over a range of 10 meters with an accuracy of ± 1 mm. The LPS consists of a framework, linear rails, up to four axes of travel, a platform, and drive system.

To ensure that the platform is precisely aligned to the radiation beam and remains parallel to the beam throughout its travel, the framework for the linear rails is designed and manufactured to be extremely rigid and flat. The framework is extruded aluminum. The linear rails are mounted on extruded aluminum brackets that fit into framework. The framework is made in two sections to facilitate installation. Adjustable feet on the legs allow the framework to be leveled. The framework is bolted to the floor.

High precision linear rails are provided to keep the platform exactly aligned to the radiation beam. The rails consist of parallel, hardened steel round ways. Four precision ball bushings ride on the rails to provide accurate, repeatable positioning with a minimum of backlash or side-play. The LPS can have up to four axes of travel: the X-axis is parallel to the radiation beam, the Y-axis is perpendicular to the beam, the Z-axis is vertical, and the R-axis rotates in the horizontal plane. Each axis includes a scale (in cm) to confirm positioning. Typical ranges are: X-axis 10 meters; Y-axis 1 meter; Z-axis 40 cm; and Rotational axis 360°.

Model X80 X-Ray Beam Irradiator

The platform is designed to facilitate mounting instruments and phantoms in a stable, repeatable fashion. It is made from aluminum plate that has been black anodized. A grid is engraved on the plate in 1 cm squares. Holes are drilled and tapped in the plate in 10 cm intervals to allow jigs to be bolted to the platform. Platform size is 30 cm x 40 cm. It can hold 100 lb. without deflection.

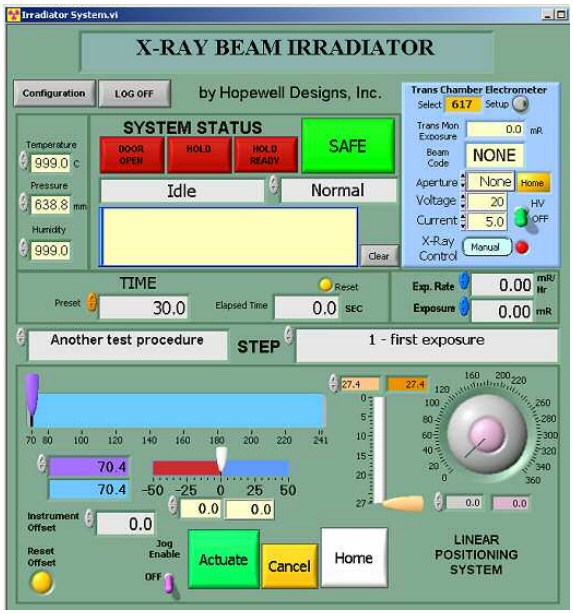
The LPS is offered with manual, automated, or a combination of drive systems. With manual X, Y and R axes, the operator manually moves the axis to the desired position and clamps it in place. The Z-axis is driven by a motor manually controlled by the operator with a switch on the platform.

The automated system uses stepper motors to provide extremely accurate positioning via computer control without sacrificing speed or ease of use. The X-axis operates at a maximum speed of 20 cm/s, and the Z-axis at 1 cm/s. Positioning accuracy, even on 10 meters systems, is ± 1 mm.

Computer Based Control Panel

- Controls X-Ray System
- Calculates Exposure Rate
- Automatic Set-Up of Irradiator
- Automated Calibration of Irradiator

The X80 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 screen shows controls and indicators for interlock status, expose/shielded state, preset and elapsed time, preset and actual positions for track, beam code and current selection, and automatic



Computer Control Software

Computer Control Panel

set up procedure and step. The automated controller uses the latest model of computer and includes electronic interfaces to the inputs and outputs, the linear positioning track, and the electrometer.

With the power of the computer available for calculations, the irradiator control system can calculate the x-ray current based on a desired exposure rate. This calculation is based on a polynomial equation that precisely matches the measurement data collected for that beam code/current/position combination. When current is changed, the exposure rate is calculated. The same arrangement holds for time and exposure – when one is changed, the other is calculated and displayed.

The one button set up routine speeds up instrument calibration and increases accuracy by quickly configuring the irradiator to match the instrument's calibration procedure. With the change of one button, this routine configures beam code, attenuator, track position, current 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 current at specific distances. This data must be collected for each beam code. With the computer control system, this process is automated. The computer is connected to the electrometer via GPIB or RS-232 interface. Once the operator sets up the sequence, the control system performs the exposures, 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.

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