HOPEWELL DESIGNS INC.

– ENGINEERING, DESIGN and MANUFACTURING –

Automatic setup of procedural calibration points for easy throughput

By Kevin Klem / Spencer Mickum

Hopewell Designs, Inc. provides irradiator systems and radiation shielding throughout the world. We are the premier provider of automated irradiator systems for calibrating radiation survey meters. Our expertise and experience in radiation and shielding design, software development, systems integration, manufacturing, training, and complex project management enables us to deliver quality products and service for hundreds of clients.

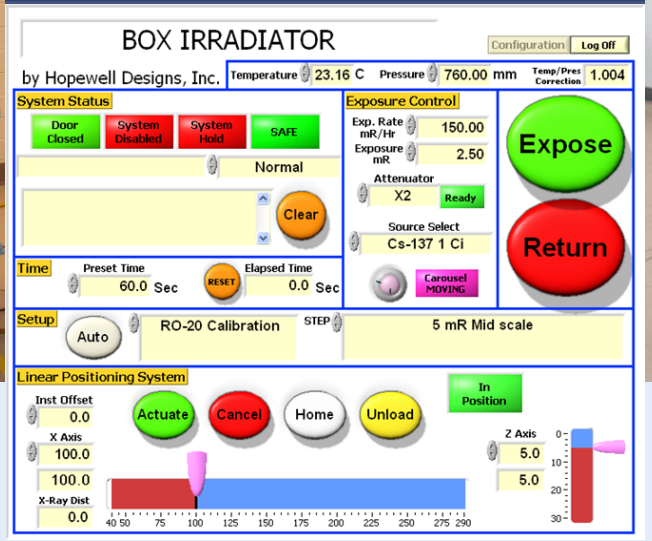
AEP - DC Cook NPP
Duke Energy-Brunswick, Robinson, Harris
Detroit Edison Fermi 2
Energy Northwest-Columbia NPP
FPL-St Lucie NPP
Ft. Calhoun NGS
Millstone NPP
Seabrook NPP
South Texas PEGS
Talen-Susquehanna
Ontario Hydro / Bruce Power

OVERVIEW

- HDI developments have lead to increasing the throughput, ensuring accuracy, and reducing the operator involvement associated with the calibration of portable survey instruments.

- This is done through computer automation, proprietary software, years of experience, and strict adherence to the national and international standards involved with calibration.

OVERVIEW

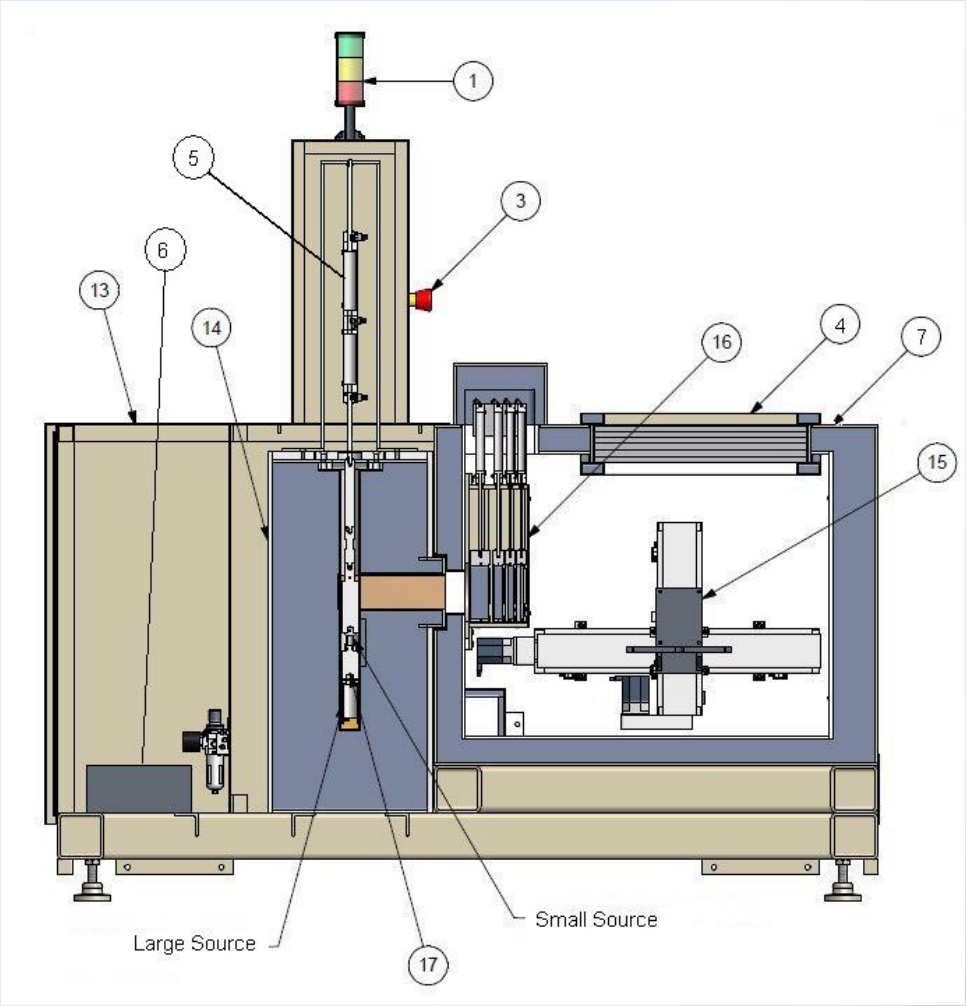


1. Needs and standards for calibration
2. How our irradiators work
3. Auto setup steps
4. Positioning and decay correction
5. Approach to calibration
6. Quality assurance

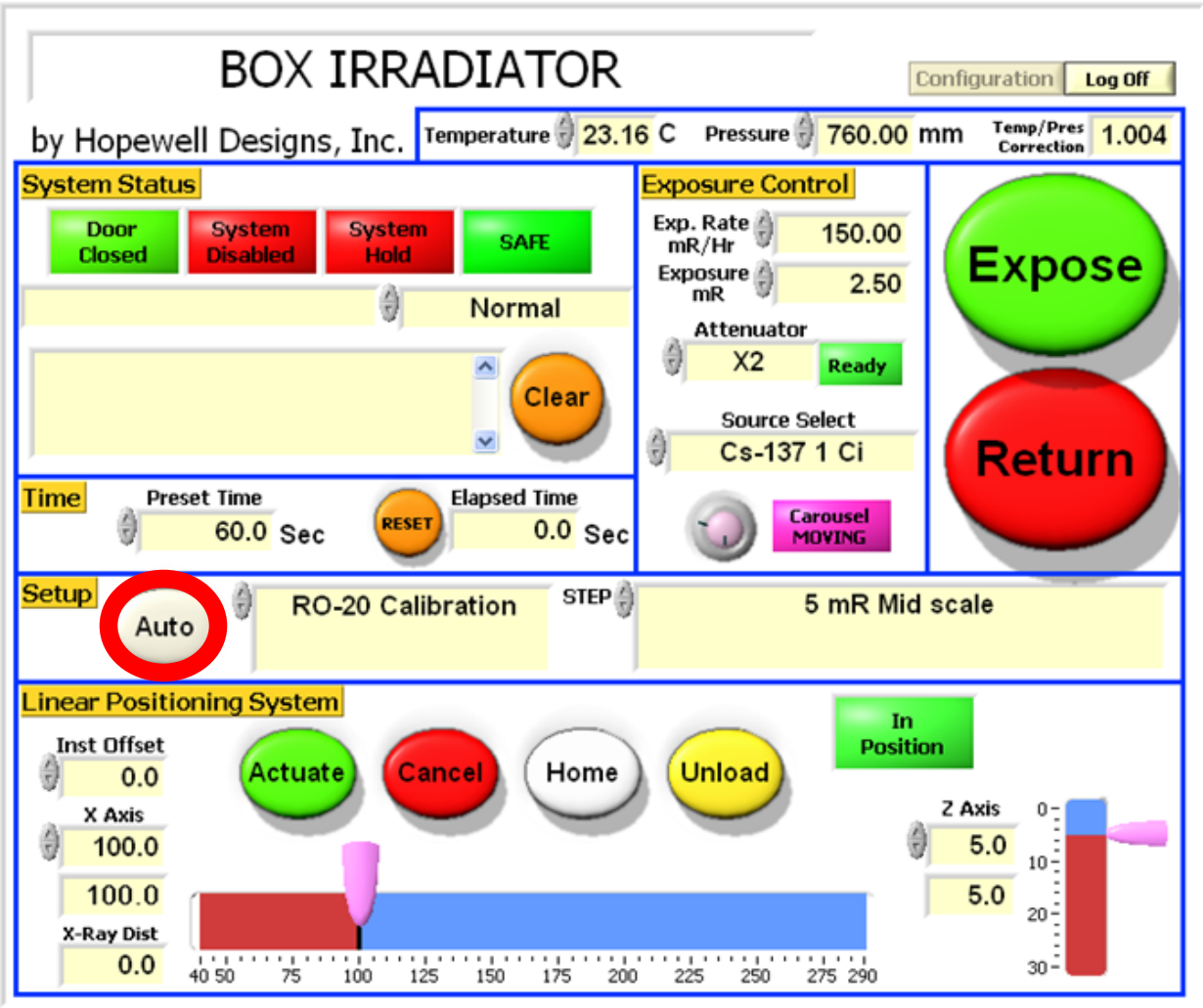
NEEDS AND STANDARDS FOR CALIBRATION

1. The need for calibration of an irradiator is to produce a dataset that precisely and accurately covers the exposure rates over the full range of the irradiator.
2. The procedures and results of the calibration must adhere to the requirements set forth in internationally recognized voluntary consensus standards.
3. The calibration results must be directly traceable to a primary standard.
4. Standards are a systematic method to measure a quantity, such as dose, to a primary quantity, such as the amount of ionization in air, Kerma.
5. The word "standard" is used to refer to radiation detectors, radiation sources, processes, measurements, as well as voluntary consensus guides outlining methods
6. Important to remember that the "standard" is in all cases a uniform quantity allowing a known amount to be compared to a measured amount.

HOW OUR IRRADIATORS WORK



AUTO SETUP STEPS



POSITIONING AND DECAY CORRECTION

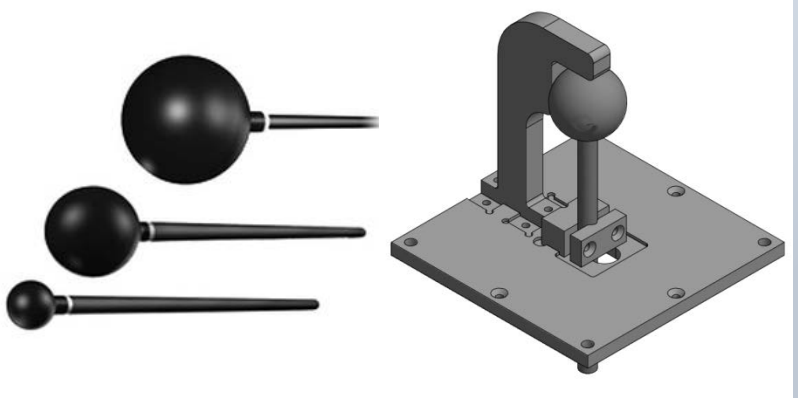
1. Each time a Auto Setup Step is selected, the positioning system precisely moves the instrument to the correct location for the needed exposure rate. The positioning system has a repeatable accuracy of +/- 1 mm. This repeatability is insured from years of annual maintenance and service.

2. The exposure rate changes over time at each location due to the decay of the radioactive source activity. With Hopewell's software, the new location is automatically chosen based on the updated decay information for the source each time you use the irradiator with no need for lookup tables or decay corrections.

3. The calibration results must be directly traceable to a primary standard.

APPROACH TO CALIBRATION

- **Each of Hopewell Designs irradiator systems is calibrated at install and at annual intervals with HDI's suite of measurement equipment annually certified and traceable to the National Institute of Standards and Technology (NIST) and accredited to the ISO/IEC 17025:2005.**



APPROACH TO CALIBRATION

- The appropriate detector is selected for the expected range of exposure rates and is placed in a fixture to standardize the measurement orientation.
- The source of radiation is exposed and measurements are recorded.
- Reproducibility of this measurement is assured by making at least four successive readings.
- Data acquisition is done over the full range of the instrument or device and the results are recorded manually or automatically into a database.

HOPEWELL DESIGNS INC.

APPROACH TO CALIBRATION

RecordN	CalYea	CalMon	CalDa	CalRunID	Irradia	S	Source	Attenuat	Distance	ExpRate	Vali	NetCharge	Durati	Temperatu	Pressur
4583	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	8.7000E+01	4.35E+02	1	-2.75E-11	1.0	21.0	735.3
4584	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	8.7000E+01	4.34E+02	1	-2.75E-11	1.0	21.0	735.3
4585	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	8.7000E+01	4.34E+02	1	-2.75E-11	1.0	21.0	735.3
4586	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	8.1916E+01	4.88E+02	1	-3.09E-11	1.0	21.0	735.3
4587	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	8.1916E+01	4.87E+02	1	-3.09E-11	1.0	21.0	735.3
4588	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	8.1916E+01	4.88E+02	1	-3.09E-11	1.0	21.0	735.3
4589	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	7.7129E+01	5.49E+02	1	-3.48E-11	1.0	21.0	735.3
4590	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	7.7129E+01	5.49E+02	1	-3.47E-11	1.0	21.0	735.3
4591	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	7.7129E+01	5.49E+02	1	-3.48E-11	1.0	21.0	735.3
4592	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	7.2621E+01	6.19E+02	1	-3.92E-11	1.0	21.0	735.3
4593	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	7.2621E+01	6.18E+02	1	-3.91E-11	1.0	21.0	735.3
4594	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	7.2621E+01	6.19E+02	1	-3.92E-11	1.0	21.0	735.3
4595	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.8377E+01	6.97E+02	1	-4.41E-11	1.0	21.0	735.3
4596	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.8377E+01	6.97E+02	1	-4.42E-11	1.0	21.0	735.3
4597	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.8377E+01	6.98E+02	1	-4.42E-11	1.0	21.0	735.3
4598	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.4381E+01	7.88E+02	1	-4.99E-11	1.0	21.0	735.3
4599	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.4381E+01	7.88E+02	1	-4.99E-11	1.0	21.0	735.3
4600	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.4381E+01	7.88E+02	1	-4.99E-11	1.0	21.0	735.3
4601	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.0619E+01	8.93E+02	1	-5.65E-11	1.0	21.0	735.3
4602	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.0619E+01	8.93E+02	1	-5.66E-11	1.0	21.0	735.3
4603	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	6.0619E+01	8.92E+02	1	-5.65E-11	1.0	21.0	735.3
4604	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.7076E+01	1.01E+03	1	-6.39E-11	1.0	21.0	735.3
4605	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.7076E+01	1.01E+03	1	-6.39E-11	1.0	21.0	735.3
4606	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.7076E+01	1.01E+03	1	-6.39E-11	1.0	21.0	735.3
4607	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.3741E+01	1.15E+03	1	-7.26E-11	1.0	21.0	735.3
4608	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.3741E+01	1.15E+03	1	-7.26E-11	1.0	21.0	735.3
4609	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.3741E+01	1.15E+03	1	-7.26E-11	1.0	21.0	735.3
4610	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.0600E+01	1.30E+03	1	-8.21E-11	1.0	21.0	735.3
4611	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.0600E+01	1.30E+03	1	-8.21E-11	1.0	21.0	735.3
4612	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	1	5.0600E+01	1.30E+03	1	-8.21E-11	1.0	21.0	735.3
4613	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	8.7000E+01	1.95E+02	1	-1.23E-11	1.0	21.0	735.3
4614	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	8.7000E+01	1.95E+02	1	-1.23E-11	1.0	21.0	735.3
4615	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	8.7000E+01	1.95E+02	1	-1.24E-11	1.0	21.0	735.3
4616	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	8.1916E+01	2.20E+02	1	-1.39E-11	1.0	21.0	735.3
4617	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	8.1916E+01	2.20E+02	1	-1.39E-11	1.0	21.0	735.3
4618	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	8.1916E+01	2.19E+02	1	-1.39E-11	1.0	21.0	735.3
4619	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	7.7129E+01	2.48E+02	1	-1.57E-11	1.0	21.0	735.3
4620	2016	11	29	A6 1Ci X0-X8000	Box	0	Small 1 Ci	2	7.7129E+01	2.48E+02	1	-1.57E-11	1.0	21.0	735.3

APPROACH TO CALIBRATION

- Energy dependent calibration coefficients provided by a secondary standards dosimetry laboratory as part of the annual recalibration are used to convert the measured current or charge induced by radiation to exposure.
- Factors such as temperature and pressure are recorded and a temperature/pressure correction factor is included in results.
- Calibration may be insufficient for assessing instrument response below 1 uGy/hr (0.1 mrad/hr) and extrapolation is preferred over analyzing measured results with narrow signal to noise ratio.

QUALITY ASSURANCE

- Each presented measurement result is accompanied with a statement of uncertainty adhering to the Guidance on the Expression of Uncertainty in Measurement.
- The overall uncertainty of the measured data points is required to be less than 5% following ANSI N323.
- The maximum difference between the measured data and the calculated curve is required to be less than 5% following the guidelines of ISO 4037 for extrapolation between measured points.
- The following statistics and uncertainties are presented with the final report: exposure rate, exposure rate combined standard uncertainty, exposure rate expanded uncertainty with 95% confidence interval, and maximum difference between calculated fit and measured data.

THANK YOU

- Instrument calibration
- Shielding – shipping casks, ALARA
- Custom Automation Systems
- Sample changers
- Automated dosimeter readers
- Consulting Services
- Irradiator calibration – gamma, neutron & beta
- Design, training, consulting for calibration laboratories
- MCNP analysis