P1020 / P1030

Risø Ebeam Calibration Phantom

DESCRIPTION

A fixture which is used for the arrangement of discs containing alanine transfer dosimeters, and pouches of B3 film dosimeters, in proper geometry, to ensure that the dosimeters receive the same absorbed dose when irradiated. In addition, this phantom is designed to match the geometry of the 5 MeV and 10 MeV Risø Calorimeters (GEX Part# B600X) to ensure that the phantom and the calorimeter receive the same dose.

APPLICATION(S)

Used when performing in-plant batch calibration of dosimeters in electron beam irradiation facilities. This phantom has been designed and built to provide a consistent method of presenting dosimeters to the beam as detailed in the two references listed near the end of this document. The P1020 is designed for 10 MeV and the P1030 is designed for 5 MeV nominal surface energy of the electrons from the ebeam. Use the model number for the closest approximate ebeam energy (MeV) for the beam being used.

SPECIFICATIONS

Product Dimensions:	Product Weight	Packaging Dimensions:	Packaged Weight:
29.0 cm x 29.0 cm x 10.3 cm (±1.0mm)	P1020 – 0.9 lbs. P1030 – 0.7 lbs.	12.0" x 12.0" x 5.0"	P1020 – 1.8 lbs. P1030 – 1.6 lbs.

Material:	High-Impact Polystyrene (HIPS) disc with Styrofoam jacket.
Color:	White or Black
HIPS Disc Diameter:	140.0 mm ± 0.5 mm
Alanine Cutout Dimensions:	26.0 mm ± 0.5 mm
Film Dosimeter Cutout Dimensions:	85.0 mm x 50.0 mm ± 2.0 mm
HIPS Cover Plate Thickness (P1020 Only):	6.0 mm ± 0.1 mm
HIPS Spacer Plate Thickness:	2.0 mm or 3.0 mm (± 0.1 mm)
Printing:	"RISØ" stamp on outer foam jacket
Packaging:	Cardboard box

Storage:

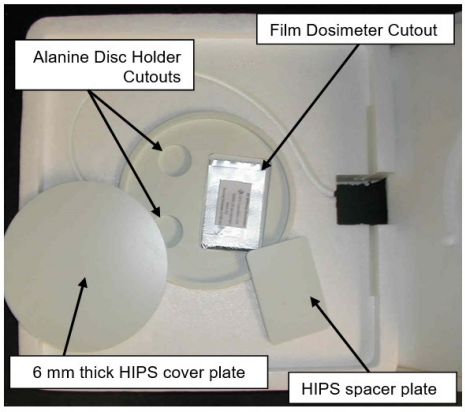
Under any relative humidity conditions at less than 50°C.

Shelf Life:

Foam Jacket – A precise value is not known but the Styrofoam will break down with accumulated radiation; experience suggests this may occur after 1000 kGy of accumulated dose. Replacement jackets are available (GEX Part# B6005), and the user simply transfers the HIPS disc components to a new shell.

HIPS Disc – HIPS is radiation tolerant to many thousands of kilogray (kGy). It is typical that the material will be sufficient for normal usage up to at least 5000 kGy with no significant change in the material density or molecular properties that would cause significant change in the irradiation of dosimeters placed in the device.

PRODUCT PHOTOS



USAGE

Prerequisite: The phantom design alone cannot ensure that the dosimeters receive the same dose. Installation qualification (IQ) of the electron beam should be completed before the phantom is irradiated for dosimeter calibration; the user should confirm that the dose distribution over the area of the phantom is uniform, and should select an optimal arrangement of the phantom in the irradiation zone to maintain this uniformity. Refer to Step 11 for additional suggestions.

1. Remove the foam top piece of the calibration phantom, then remove the round 6 mm thick circular polystyrene plate (P1020 only) to expose the cutout positions used for placement of the dosimeters. Remove the spacer plate(s) from the rectangular cutout (see Figure 2).
2. Place the film dosimeter samples with the appropriate spacer plates into the rectangular cutout and secure with tape noting the following considerations (see Figures 3 and 4).
   - 2.1. Single or dual-sided irradiation
     - 2.1.1. For irradiation from one side only (single-sided irradiation), place a single spacer plate between the electron source and the film dosimeters.
     - 2.1.2. **P1020 only:** For irradiation from both sides (dual-sided irradiation), place a spacer plate of identical thickness on either side of the film dosimeters to attenuate the electrons identically from both sides during irradiation.
   - 2.2. Thickness of spacer plates
     - 2.2.1. When using pouched dosimeters, use the thinner, 2mm thick spacer plate(s).
     - 2.2.2. When calibrating using bare film dosimeters with no packaging, use the thicker, 3mm spacer plate(s).
   - 2.3. Quantity of film dosimeters in each phantom
     - 2.3.1. It is recommended that the user place no more than 6 (six) pouches of dosimeters into the well for any irradiation. Otherwise, the thickness can begin to create a greater attenuation for the films compared to the alanine.
   - 2.4. Orientation of dosimeters in the phantom (see Figure 1)
     - 2.4.1. It is suggested to alternate the dosimeter pouch orientation by 180° when possible to best situate the dosimeters so that all the dosimeters inside the pouch do not stack directly on top of one another. Stacking them all creates additional attenuation that is not desired and may be detrimental to the result of a calibration.

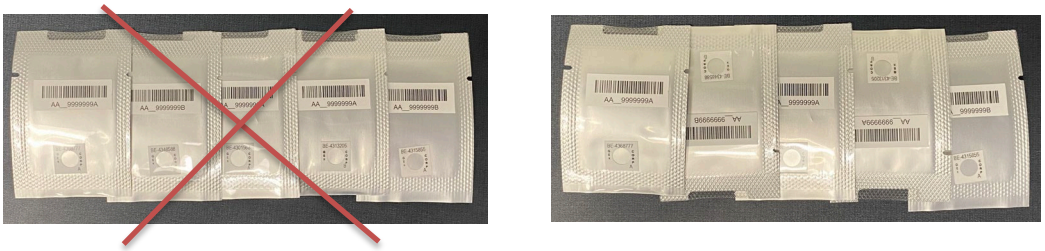


Figure 1 – Film Dosimeter Orientation for Loading

3. Place the alanine transfer dosimeter into one of the circular wells and secure it (see Figure 5).
4. It is essential to measure the maximum temperature during irradiation as accurately as possible when calibrating dosimeters using Alanine Transfer-Standard Dosimeters for in-plant calibration. The calibration laboratory will correct the alanine for the temperature effect on the response of the alanine using this data.

   Two methods of measuring maximum temperature are acceptable when using this phantom:

   a. *Temperature label* – Using masking tape, secure an irreversible temperature label (GEX Part No. P8003 or equivalent) to the body of the phantom, away from, and not covering any dosimeter (see Figure 6 and 7, if applicable).

   b. *Calorimeter* – Alternatively use a GEX Part No. B6001 or B6002 Risø Calorimeter to determine the maximum irradiation temperature; this method will very closely approximate the temperature to the dosimeters and is as good as or better than the temperature labels.
5. **P1020 only** – Place the 6mm thick cover on top of the dosimeter setup. The cover plate should be flush and should be taped flat and securely (see Figure 8).
6. All materials should be secure with no possibility of movement during irradiation.
7. Replace the foam top of the calibration phantom and verify it is secure (see Figure 9).

Figure 2 – Phantom Components

Figure 3 – Film Pouches Loaded

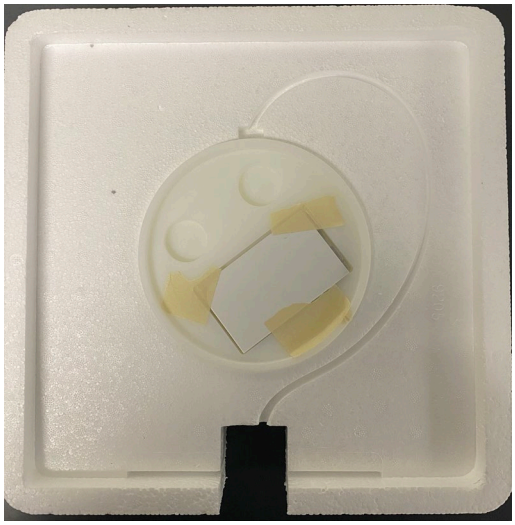


Figure 4 – Film Pouches Secured

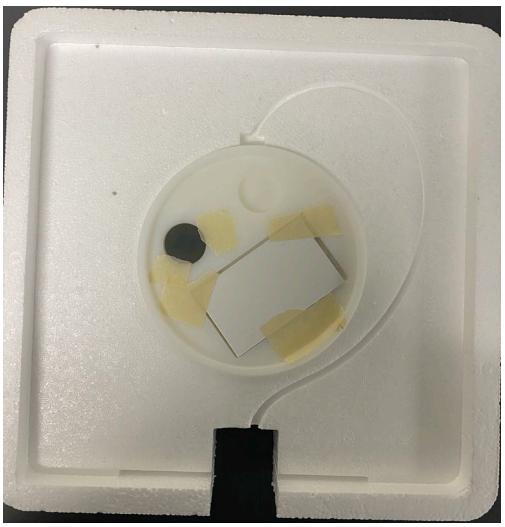


Figure 5 – Alanine Loaded & Secured

Figure 6 – DO NOT remove label backer

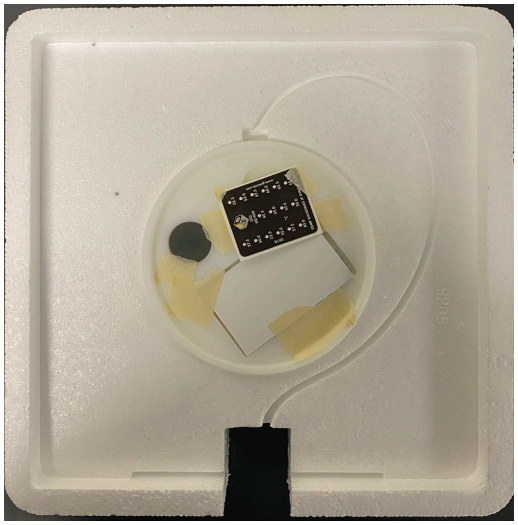


Figure 7 – Temp Label Secured

Figure 8 – Cover Plate Secured (P1020 only)

Figure 9 – Ready for Irradiation

8. Irradiation Instructions:

   8.1. Ensure that the phantom is placed perpendicular to the scan horn of the accelerator and irradiate to the desired dose. See Figure 10 below. If the accelerator is mounted horizontally, rotate the figure 90°.

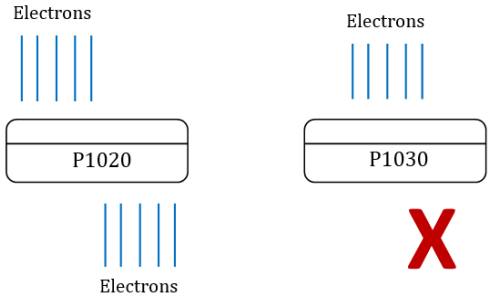


Figure 10 – Irradiation

   8.2. If using a tote, cart, carrier, etc. ensure that the phantom is secure from movement on the carrier/tote/cart.

   8.3. If using a rolling conveyor that moves the products into the irradiator, ensure that the phantom will complete the entire conveyance. The phantom is small and lightweight and must not get stuck at any point in the process. If necessary, the phantom may be placed inside a box or on a piece of foam, metal, or plastic to aid in successful conveyance. However, avoid any material between the phantom and the electron beam during irradiation whenever possible.

9. Consider the 'Precautions' Section below and develop a reproducible procedure for the handling and irradiation of the phantom in the specific ebeam design in which the dosimeters will be calibrated.

   Note: No detail is too small to document in a procedure for using these phantoms. Most users will execute calibration no more than twice per year. Having a very detailed procedure to ensure it is always executed in identical fashion is paramount to the long-term stability of the dosimetry system.

ACCESSORIES

GEX Part No.	Description	Purpose
B6005	Foam Jacket	Replacement of foam jacket on GEX Part #'s B6001, B6002, B6004, P1020, & P1030
P8003	Irreversible Temperature Label	Measurement of the maximum irradiation temperature

PRECAUTIONS

1. Improper geometry of the film dosimeters due to misuse of the spacer plates or the cover plate, or failure to adhere to the irradiation instructions could result in different attenuation to alanine and film dosimeters creating a bias in any resulting calibration that could be detrimental to the user's process or quality for which the results are intended. The user should take care to ensure proper setup of the phantom and irradiation in accordance with the instructions herein each time the product is used.
2. Do not use overly aggressive or permanent adhesive tapes, as the adhesives may leave a residue on the phantom. Light tack tape is recommended.
3. Do not attach GEX Part No. P8003 Irreversible Temperature Labels directly to the phantom; the adhesive is permanent!
4. The maximum temperature during irradiation should not exceed 65°C. Temperatures greater than this are not understood and may cause permanent damage to the phantom. Do no overheat. For irradiation of higher doses, the user must fractionate the dose to keep temperatures below the threshold. For example, 80 kGy = 50 kGy + 30 kGy (always with the highest dose first).
5. Allow to cool completely to room temperature before using again. The temperature must be stable at the time the phantom is placed onto the beam conveyor and not continuing to cool down. This includes when using fractionation; use a second phantom and move the dosimeters and temperature label to a new phantom between fractions.

REFERENCES

1) ISO/ASTM 51261 – Practice for Calibration of Routine Dosimetry Systems for Radiation Processing
2) NPL Report CIRM 29; Guidelines for the Calibration of Routine Dosimetry Systems for Use in Radiation Processing

RELATED DOCUMENTS

- GEX Doc# 100-203, Dosimetry System Calibration – Technical Information Report
- GEX Doc# 100-263, Performing a Dosimeter Batch Calibration – Procedure Template

REVISION HISTORY

DATE	CHANGE DESCRIPTION	REVISION
11/28/2011	Initial release.	A
08/25/2020	Formatted to new PSU document structure and completely revised to better aid the user. Harmonized structure with 100-170 and 100-171 (similar product). ECO 70527.	B