Commissioning Bebig Valencia-Type Applicators for a Bravos Afterloader

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ABSTRACT

Purpose:
A Valencia-type applicator was recently created by Bebig for use with Varian GammaMedPlus and Varian Bravos afterloaders using an Ir-192 source. To our knowledge, we are the first site to use this applicator with a Bravos afterloader.

Materials:
20mm and 30mm Valencia-type applicators were obtained for use with a Bravos afterloader. The source to indexer distance (SID) was measured using a HDR 1000 Plus well chamber and Leipzig Applicator Source Holder (well chamber setup). Output was checked via the correspondence factor and the output factor. The correspondence factor was measured with the well chamber setup. The output factor measurement used an Exradin A16 chamber at a depth of 1cm. Dosimetry profiles were measured at the reference depth of 3mm using EBT3 film. Percent depth dose (PDD) values were measured from 1mm to 10mm at 1mm increments with an Exradin A10 chamber. All measurements were compared to the Bebig Instructions for Use (IFU) document with the tolerances suggested by Granero et al. An additional output check was done with thermoluminescent dosimeters (TLD).

Results:
The SID was found to be 112mm for the 20mm and 30mm applicators. Correspondence factors for the 20mm and 30mm applicators were measured as 0.169 and 0.189 (2.8% and -0.30% error), respectively, and are within a 5% tolerance of IFU values. The output factor was calculated to be 0.2234$\frac{cGy\ h}{U}$ and 0.1718$\frac{cGy\ h}{U}$, respectively, and are within uncertainty. Flatness was measured as 2.70% and 2.60% and symmetry as 0.19% and 0.14%, respectively. Flatness and symmetry measurements were within the suggested 5% tolerance. All PDD values were found to be within a 1% and 2% delta of the values suggested in the IFU, respectively. The TLD measurements had a 3.61% and -0.18% error, respectively.

Conclusions:
The Valencia-type applicators were successfully commissioned for use with a Bravos afterloader.

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INTRODUCTION

A Valencia applicator is a conical surface applicator for use with an Iridium-192 afterloader. Unlike a Leipzig applicator, it includes a flattening filter to flatten the 100% isodose line at the reference depth of 3mm. Bebig recently made a new version (Set 1504) that connects to a either a GammaMedPlus or Bravos afterloader (Varian). The set comes with two sizes: 20mm and 30mm.

METHODS & MATERIALS

To commission a Valencia applicator, a physical check of the applicators, the source to indexer distance (SID), lateral flatness and symmetry, percent depth doses (PDDs), and output factors must be checked. These values are compared to values given by the vendor in the Instructions for Use (IFU) document.

The SID was checked with a HDR 1000 Plus well chamber and Leipzig Applicator Source Holder (Standard Imaging). The iridium source was sent to multiple dwell positions with the well chamber in rate mode. The optimal dwell position (sweet spot) is one where the maximum current is measured.

Flatness and symmetry was checked with EBT3 film (Gafchromic). The applicator was placed atop a phantom of solid water with the film 3mm depth and source at the sweet spot. The film was exposed for three minutes then scanned and analyzed with MATLAB (MathWorks). The tolerance for this test is ±5%.

PDDs were checked with a solid water phantom and a Exradin A10 against values in the IFU document for 1mm increments from 1mm depth to 10mm depth. Tolerance for this test is ±3% nominal.

Output was checked with three methods. The direct method uses the output factor:

$$OF(\phi) = \frac{D}{t \times S_K \times PDD(\phi, z)}$$

where D is the measured dose, t the source dwell time, and $PDD(\phi, z)$ the percent depth dose for an applicator with diameter ϕ at a depth z. The indirect method uses the revised correspondence factor:

$$CF_{rev} = \frac{R \times \varphi(p, \theta) \times f}{S_k}$$

where R is the well chamber reading, $\varphi(p, \theta)$ the pressure and temperature correction for pressure p and temperature θ, f the well chamber calibration factor, and S_k the current source air kerma strength. Tolerance for the indirect method is to calculate a value within the uncertainty given in the IFU (±0.0057 and ±0.0044, respectively) and for the direct method ±5%.

A final output check was done with a measurement in solid water with thermoluminescent dosimeters (TLDs). TLD dose was calculated with the output factor formula. Tolerance for the TLDs is ±5%.

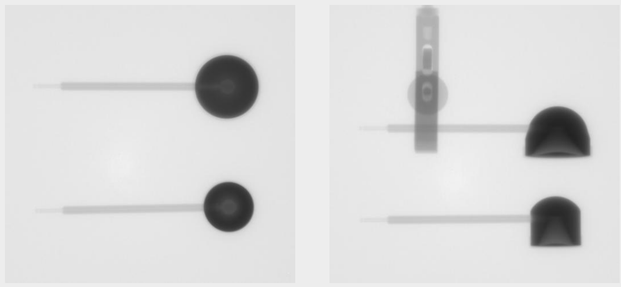

Figure 1. AP (left) and Lateral (right) radiographs of the 20mm (bottom) and 30mm (top) Valencia applicators with treatment caps. In the Lateral radiograph, the 30mm applicator is being held by a metal arm.

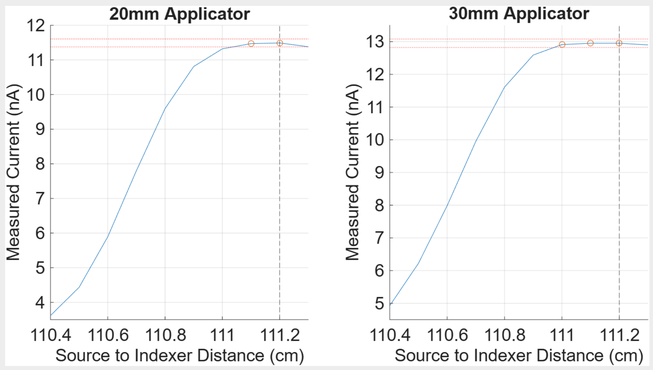

Figure 2. SID check for the 20mm and 30mm applicators. The solid blue lines are the measured current per dwell position, the dotted red lines are ±1% the maximum measured current, circled points show possible sweet spot locations, and the dashed black lines show the chosen sweet spot.

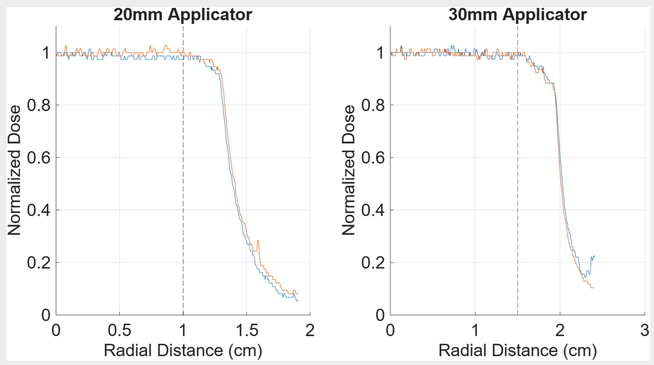

Figure 3. Lateral dose profile for the 20mm and 30mm applicators at 3mm depth. The solid blue and red lines show the right and left sides of the profile, respectively. The dashed black lines show the edge of the flattened region.

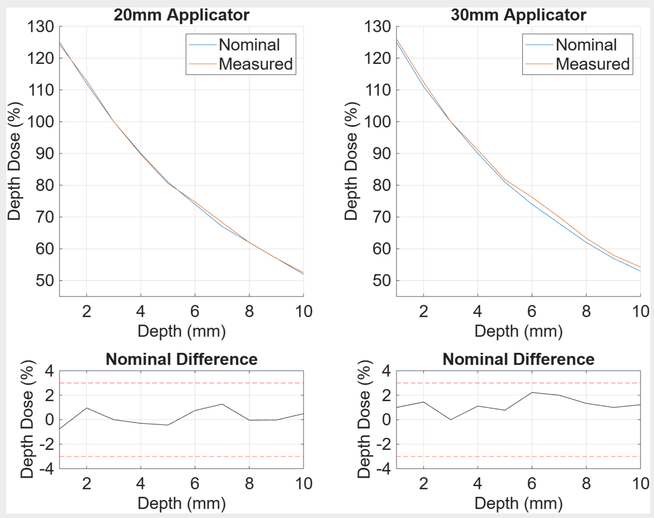

Figure 4. Nominal and Measured PDDs for the 20mm and 30mm applicators. The black lines in the plots below show the nominal percent difference between the nominal and measured PDDs.

Table 1. Output factor data for the direct output check.

	20mm	30mm
Air Kerma Strength (U)	34244.98	
Source Dwell Time (s)	180	
PDD at 10mm depth $(\%)$	0.52	0.53
Measured Dose (cGy)	199.0	156.0
Measured Output Factor $\left(\frac{cGy\ h}{U}\right)$	0.2234	0.1718
Nominal Output Factor $\left(\frac{cGy\ h}{U}\right)$	0.2215	0.1733
Nominal Uncertainty	±0.0057	±0.0044
Difference	0.0019	-0.0015

Table 2. Correspondence factor data for the indirect output check.

	20mm	30mm
Air Kerma Strength (U)	37969.03	
Pressure and Temperature Correction	1.02	
Reading (nA)	13.52	15.21
Measured Correspondence Factor	0.1686	0.1894
Nominal Correspondence Factor	0.164	0.190
Percent Difference	2.80%	-0.30%

RESULTS & DISCUSSION

The applicators were found to be physically sound and without any voids in the internal shielding. Radiographs are shown in figure 1. The sweet spot was measured as 112mm for both the 20mm and 30mm applicators. The full rate results for both applicators are shown in figure 2. Flatness was found to be 2.70% and 2.60% and symmetry 0.19% and 0.14%, respectively (figure 3). Both are within the 5% tolerance. PDDs were measured with 1.3% and 2.2% deltas, respectively, of the values within the IFU (figure 4). The output factors (table 1) were measured as 0.2234 $\frac{cGy\ h}{U}$ and 0.1718 $\frac{cGy\ h}{U}$, respectively, and are within uncertainty. The correspondence factors (table 2) were measured as 0.169 and 0.190, respectively, and within the 5% tolerance (2.80% and -0.30% error, respectively). The dose given to the TLDs were measured as 274.7 cGy and 285.5 cGy, respectively. Doses were 3.61% and -0.18%, respectively, different than the calculated dose of 285 cGy.

CONCLUSIONS

The 20mm and 30mm Valencia-type applicators were successfully commissioned for use on our Bravos afterloader using standard practices from the literature. The applicators have been used to treat twelve patients as of July 2026. A second applicator set was commissioned with this same process in July 2026.

REFERENCES

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