SUBJECT: New Mick® Testing

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Report of Brachytherapy Measurement Project

I. Introduction

At the request of Standard Imaging (SI), measurements were performed on April 25, 2006 to determine the measurement effect of the revised Mick® cartridge used in the ONCURA™ 6715 and 6735 sterile convenience packs with respect to previous investigations carried out in 2002. The intent of this measurement study is to determine the difference in well chamber response from the new, more heavily shielded cartridge design. As previously reported, the goal is to establish a numerical correction factor for use in calibration of the 15-seed cartridge in two distinct Standard Imaging well chambers, with respect to the ADCL supplied single seed geometry air kerma strength calibration factor.

II. Methodology

The instruments used in this investigation included the following: SI model IVB1000 (s/n H002091), SI model HDR1000 Plus (s/n A991805), SI model Max 4000 (s/n E001225), Mensor digital pressure gauge (s/n 531059), Omega temperature probe (s/n T-226542), SI custom sterile – pack cartridge holders for each chamber model, and the UW ADCL CNMC standard transfer well chamber model 44C s/n 604021.

The 6715 and 6735 package air kerma strength values according to the manufacturer were specified as follows (both packages had identical source strength labeling):

ONCURA™ I-125 Order ID 81556737: Ref. Date = 21/APR/2006 12:00 CDST
- Decay Factor (DF) to 25/APR/2006 = 0.9544
- Total Air Kerma Strength = 9.32 U x DF = 8.89 U
- Air Kerma Strength per Seed = 0.593 U

The measurement procedure was as follows:
1. Position the 6715 Mick® cartridge containing the Oncoseed model 6711 seeds within the sterile envelope such that the cartridge "plunger" is near the bottom of the envelope. Move the cartridge to one side of the envelope, and carefully roll the envelope firmly around the cartridge.
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2. Place the rolled package into the SI sterile pack cartridge holder such that the base of the holder (stem side of the threaded section) fits into the cartridge notch between the seed section and the stem. Insure that the seed end of the cartridge and most of the excess envelope are facing upward – within the three guide posts of the holder.

3. Place the SI holder into the IVB1000 well chamber, and measure the ionization current in this geometry.

4. Remove the cartridge, rotate 120°, and replace in the holder. Measure and record the ionization current as in 3.

5. Repeat step 4 for the last of three rotational measurements.

6. Repeat steps 2 through 4 in the SI HDR1000 Plus well chamber.

7. Open the envelope, remove the seeds from the cartridge, and calibrate all 15 seeds individually in the UW ADCL CNMC model 44C standard well chamber.

8. Repeat steps 1-6 for the 6735 cartridge containing the Echoseed model 6733 seeds.

III. Measurement Results

The individual seed calibrations from the UW ADCL standard chamber yield the following results for the 6711 seeds supplied by ONCURA™ in the 6715 sterile convenience pack, and for the 6733 seeds supplied by ONCURA™ in the 6735 sterile convenience pack, as shown in Table 1 below. Tables 2 and 3 contain a matrix of results from the various tests for both well chambers. The Cartridge CF is determined for each measurement position by dividing the measured ionization current into the sum of the individually-determined air kerma strength values. The Cartridge CF (CCF) is then divided by the UW ADCL assigned Single-Seed CF (SSCF) to determine the resulting Cartridge Correction Ratio (CCR).

Table 1: Individual Seed Calibration Results

<table>
<thead>
<tr>
<th>Seed ID</th>
<th>6711 I-125 Air Kerma Strength (U)</th>
<th>6733 I-125 Air Kerma Strength (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.580</td>
<td>0.610</td>
</tr>
<tr>
<td>2</td>
<td>0.582</td>
<td>0.604</td>
</tr>
<tr>
<td>3</td>
<td>0.590</td>
<td>0.619</td>
</tr>
<tr>
<td>4</td>
<td>0.576</td>
<td>0.604</td>
</tr>
<tr>
<td>5</td>
<td>0.569</td>
<td>0.612</td>
</tr>
<tr>
<td>6</td>
<td>0.569</td>
<td>0.611</td>
</tr>
</tbody>
</table>
The average individual seed air kerma strength for the 6711 seeds was 0.579 U +/- 1.5%. The sum of the individual seed air kerma strength values was 8.687 U. This result is ~2.3% from the stated package Total Air Kerma Strength. The average individual seed air kerma strength for the 6733 seeds was 0.604 U +/- 2.0%. The sum of the individual seed air kerma strength values was 9.056 U. This result is +1.9% from the stated package Total Air Kerma Strength.

Table 2: I-125 Cartridge Measurement Results in SI IVB1000 Chamber

<table>
<thead>
<tr>
<th>Seed Model</th>
<th>Cartridge Air Kerma Calibration Factor (U/A)</th>
<th>Ratio of Cartridge CF to Single-Seed CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>6711</td>
<td>4.30 E 11</td>
<td>1.80</td>
</tr>
<tr>
<td>6733</td>
<td>4.17 E 11</td>
<td>1.79</td>
</tr>
</tbody>
</table>

IVB1000 Average Cartridge Correction Ratio for the Mick cartridge= 1.80 +/- 5%.

Table 3: I-125 Cartridge Measurement Results in SI HDR1000 Plus Chamber

<table>
<thead>
<tr>
<th>Seed Model</th>
<th>Cartridge Air Kerma Calibration Factor (U/A)</th>
<th>Ratio of Cartridge CF to Single-Seed CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>6711</td>
<td>4.19 E 11</td>
<td>1.76</td>
</tr>
<tr>
<td>6733</td>
<td>4.07 E 11</td>
<td>1.74</td>
</tr>
</tbody>
</table>

HDR1000+ Average Cartridge Correction Ratio for the Mick cartridge= 1.75 +/- 5%.

IV. Discussion

The ratios calculated in Tables 2 and 3 above demonstrate that the seed geometry within the sterile Mick® cartridge pack requires a measurable correction
for determination of source output strength using a well-type ionization chamber. Caution must be exercised to make sure that the process of rolling the envelope and placing the pack into the holder results in the seed section to be in a vertical, reproducible position. The reference location for the cartridge is slightly more difficult to locate after rolling up the envelope. The largest source of clinical variation is most likely to be in locking the holder around the cartridge groove, which is critical for placement of the active seed section within the axial sweet spot of the well chamber. The ridge in the plastic holder should grip the highest part of the threaded section (nearest the plunger end). The other source of significant variation involves the direction the seed stack is facing during measurement. Two trials were performed for each set of measurements to estimate the reproducibility of the stated results. In trial 1, the open side of the cartridge where the seeds are visible, was facing out between two of the three cartridge holder posts. In trial 2, the open side was facing one of the posts, which caused a lower reading due to additional post attenuation. Approximately 3% variance was observed between the two trials, and the stated results are for the average of the two trials. The stated percent uncertainty of 5% should allow for random rotational orientation within the cartridge holder, but these results should be confirmed on site for each clinical set of instrumentation.

V. Conclusion

Due to the similarity in source design and primary air kerma calibration traceability, no distinct difference is observed between the 6711 and 6733 seed models in this investigation to within the 5% measurement variance. To obtain a Cartridge Correction Ratio in terms of total air kerma strength per unit Ampere for either ONCURA™ Sterile Convenience Pack in the Standard Imaging (SI) IVB1000 chamber, multiply the AAPM ADCL supplied single-seed air kerma strength calibration coefficient by 1.80, and for the HDR1000+ chamber, multiply by 1.75. Report prepared by John A. Micka, Associate Director, UWRCL on April 28, 2006.

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