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## Implementation of the IAEA-TECDOC-1583 with IMRT and VMAT test plans as a dosimetric verification for AAA and Acuros XB algorithms using heterogeneous phantom

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**Purpose:** To compare the dosimetric performance of anisotropic analytical algorithm (AAA), Acuros XB Dose-To-Water (AXB-Dw), and Acuros XB Dose-To-Medium (AXB-Dm) in heterogeneous phantoms following the test cases recommended by the IAEA-TECDOC-1583, a set of IMRT and VMAT test cases were also included to cover all clinically used techniques.

**Methods and Materials:** A collection of 15 clinical test cases (T1, T2, ...T15) were selected to cover the whole spectrum of the beams used in external radiotherapy treatments. Different beam arrangements that are clinically relevant were tested for different setups (SSD & SAD). The plans (3D-CRT, IMRT, & VMAT) were generated using Eclipse treatment planning system (ver. 13.6; Varian Medical Systems, Palo Alto, CA). The generated plans were delivered on TrueBeam linac (ver. 2.0; Varian Medical Systems, Palo Alto, CA). In this study, the plans were calculated using three photon energies (6X, 10X and 15X) using the CIRS-Thorax phantom model 002LFC (CIRS Inc) as the heterogeneous test phantom for all the test cases, shown in figure 1. The standard 0.6 cc Farmer ion chamber (IC) Model No. TN30013 (PTW, Freiburg, Germany) was placed in different media using the different inserts in the CIRS phantom, the CT images were imported to Eclipse and the IC was contoured and assigned to water equivalent material (HU=0). The dose was measured by the IC, after applying all the required correction factors to convert the reading to dose. The level of dose complexity varied gradually per test, tests 1-6 were using SSD setup, and tests 7-15 were using SAD setup. Test can be summarized as follows: T1&T2, dose evaluated for all energies in tissue (4X4 and 10X10 cm<sup>2</sup>, respectively); T3, open field (20x20 cm<sup>2</sup>) dose evaluated for all energies in bone; T4- T6, MLC static tests (T4 & T5) with different collimator angles and dynamic field-in-field MLC test (T6), dose evaluated for all energies in tissue; T7, four field box with enhanced dynamic wedge (EDW), dose evaluated for all energies in tissue; T8, oblique field with EDW, dose evaluated for all energies in tissue; T9 & T10, IMRT and VMAT plans, respectively, dose evaluated for 6X & 10X beams in tissue (PTV); T11 & T12, IMRT and VMAT plans, respectively, dose evaluated for 6X & 10X beams in bone (spine); T13-T15, 10x10 and 4x4 cm<sup>2</sup> off-axis (T13 & T14) and oblique MLC off-axis field (T15), dose evaluated for all energies in lung.

**Results:** For all the 15 test cases included in this study calculated and measured using different clinical beams (6, 10, and 15 X), the dose calculated by AXB, both the Dw and Dm, regardless of the medium (tissue, lung, or bone), the maximum detected percentage differences was less than 2% when comparing planned and measured dose values. Whereas for AAA the calculated dose deviated from the measured ones by -5.36% for T1 (6X beam), -5.1% & -4.73% for T3 (10X and 15X, respectively), 4.93% for T8 (6X beam), and -4.31% for T15 (10X beam). The detailed analysis of the data is presented in table (1) and figure 2.

**Conclusions:** AXB-Dw and AXB-Dm showed better match than AAA when calculated dose values were compared with the measured ones for different media, energies, beam arrangement, and plan complexity level. AXB-Dw calculated dose mostly had less deviation from the measured dose compared to the dose obtained from the AXB-Dm, this may be due to the water assignment of the IC contour in all CTs of the CIRS phantom.

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