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Validation of Dosimetric and Non-Dosimetric Stability In Varian Eclipse TPS Following a Version 18 Upgrade: Establishing an Annual Quality Assurance Protocol

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INTRODUCTION

Annual treatment planning system (TPS) quality assurance is recommended following major software upgrades and as part of routine QA. Following an institutional upgrade of the Varian Eclipse TPS from v15 to v18.01, including the Enhanced Leaf Model (ELM), we developed and validated a comprehensive annual QA protocol to verify that dosimetric performance and non-dosimetric system integrity remained consistent with commissioning benchmarks and clinically acceptable tolerances.

METHODS AND MATERIALS

Dosimetric stability was evaluated for AAA, AcurosXB, and Electron Monte Carlo algorithms using reference condition plans, commissioned simple and complex test plans, and independent secondary dose verification with ClearCalc. Tolerances were ≤1% (reference plans), ≤2% (commissioned plans), and ≤5% (independent verification). Non-dosimetric QA assessed DICOM image transfer, image geometry, and HU-density table association using a CT phantom.

Table 1. Dosimetric QA Results

Test Type	Maximum Observed Difference	Assessment
Reference Condition Plans (vs. Measurement)	0.8%	PASS
Commissioned Simple Test Plans (vs. 2025)	0.1%	PASS
Commissioned Complex Test Plans (vs. 2025)	1.5%	PASS
Independent Check (ClearCalc) – Reference Condition Plans	1.0%	PASS
Independent Check (ClearCalc) – Complex Plans	3.9%	PASS

Table 2. Non-dosimetric QA Results

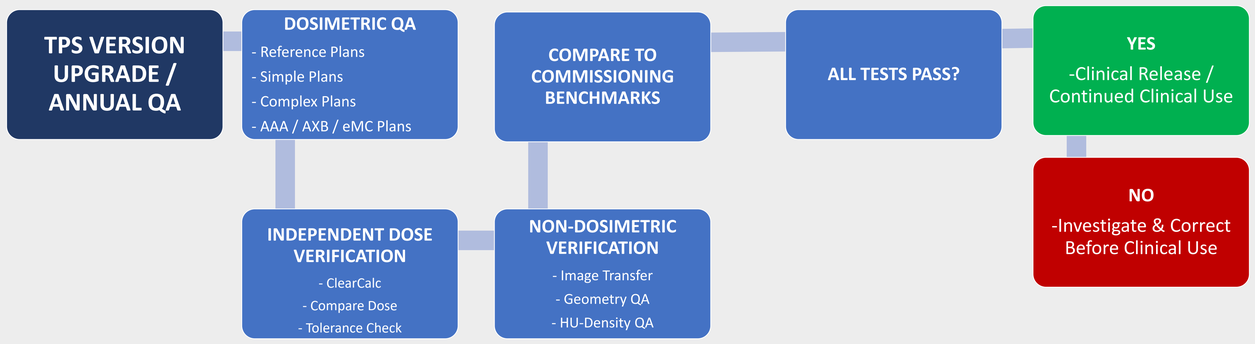
Parameter	CT Scanner Value	TPS Value	Assessment
Number of Slices (#)	71	71	PASS
Slice Thickness (mm)	2.0	2.0	PASS

Table 3. Image Geometry QA Results

Parameter	Known Physical Dimension	Measured TPS Value	Difference	Assessment
Width	150 mm	148.4 mm	1.6 mm	PASS
Height	130 mm	129.6 mm	0.4 mm	PASS
Orientation	N/A	N/A	N/A	PASS

RESULTS

All dosimetric tests passed established tolerances. Maximum observed differences were: Reference plans 0.8%; Simple commissioned plans 0.1%; Complex commissioned plans 1.5%; Independent verification: 1.0% (reference) and 3.9% (complex). Non-dosimetric testing confirmed correct image transfer (71 slices, 2.0 mm thickness), correct HU-density association, and geometric accuracy within 1.6 mm.



DISCUSSION

The protocol combines internal commissioning benchmarks, independent dose verification, and non-dosimetric integrity testing into a practical annual QA workflow. Agreement across all algorithms and test plans demonstrates that major TPS upgrades can be monitored using reproducible institutional benchmarks while providing confidence in continued clinical performance.

CONCLUSIONS

Eclipse TPS v18.01 demonstrated stable dosimetric and non-dosimetric performance following software upgrade. All evaluated metrics remained within clinical tolerances, supporting continued clinical use. The methodology has been adopted as the institution's annual TPS QA protocol.

REFERENCES

1. Varian Eclipse v18 documentation.
2. AAPM TG-53.
3. Radformation ClearCalc documentation.

KEY FINDINGS

- **Annual dosimetric verification of Eclipse v18.01 demonstrated agreement within all institutional tolerances for AAA, AcurosXB, and eMC algorithms.**
- **Independent secondary dose calculations (ClearCalc) confirmed the accuracy of both reference and complex treatment plans.**
- **Non-dosimetric QA verified DICOM image transfer integrity, HU-to-density table association, and geometric accuracy following the software upgrade.**
- **No clinically significant changes were identified compared with established commissioning benchmarks, supporting continued clinical use.**

IMPLICATIONS

- **A comprehensive annual TPS QA program can verify both dose calculation accuracy and system integrity following major software upgrades.**
- **Combining commissioned benchmark comparisons, independent secondary dose verification, and non-dosimetric validation provides a robust framework for annual TPS surveillance.**
- **This protocol has been adopted as the institutional annual QA procedure and can serve as a practical model for other clinics implementing Eclipse version upgrades.**

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