Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

Australian Clinical Dosimetry Service

Level II Audit – Fact Sheet

Definition

The ACDS Level II Audit determines absorbed dose to water delivered to selected points and planes within a 'slab' geometry phantom. This is an audit of the beam model within a treatment planning system, where the phantom CT is supplied to the Facility for treatment planning and delivery. The Level II audit includes a number of modalities, each with additional options. The facility can choose to complete as many options in the audit as deemed necessary for their clinical practice (see below). Note the 3DCRT 6X modality must be completed.

	3DCRT	IMRT	VMAT	3DCRT FFF	IMRT FFF	VMAT FFF
Optional Please select as relevant to clinical practice	10X	6X	6X	6FFF	6FFF	6FFF
	15X	10X	10X	10FFF	10FFF	10FFF
	18X					
	Wedges					

Facilities must indicate which components are to be completed prior to the day of the audit. Multiple cases are planned for all modalities of the audit. Fields are fully prescribed by the ACDS and link directly to the ACDS Level III Audit. CT datasets and RT Structures for planning are provided by the ACDS. Dosimetry measurements are made in a custom phantom of CIRS solid water, using a 2D ionisation chamber array as a primary detector and supporting measurements with CC13 ionisation chambers. The 2D array is calibrated against a Farmer type ionization chamber, which is traceable to the primary standard at ARPANSA.

Audit Coverage

The Level II Audit is available to all facilities as part of a scheduled 4 year program. The Level II Audit will be offered to facilities once during the 4 year program. Measurements are performed on a single representative Linac at each facility.

Audit Cases

For the 3DRT modality there are 8 cases in the audit, with the option of repeating these cases with multiple beam models. The 3DCRT modality consists of non-reference and wedged beams, measured with and without lung inhomogeneities. Figure 1 shows a schematic of some of the audit cases included in the 3DCRT modality.

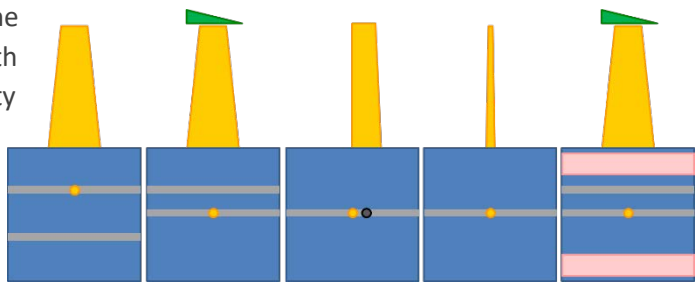

Figure 1. Selection of 3DCRT cases

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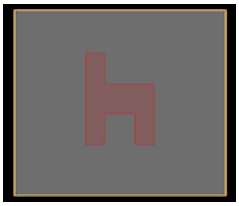
Cases 13-16 consist of complex target volumes and diagnostic tests for the IMRT and VMAT modalities. The facility has the option to include as many IMRT and/or VMAT beam models in the audit as applicable to their clinical practice. Cases 13-16 are repeated for the IMRT FFF and VMAT FFF modalities.



Case 13 – The 'Chair' Test

The chair test is an adaptation of the test described by Van Esch et al., where a chair-like fluence (Fig. 2) is delivered by dynamic MLC movement. The test aims to separate the effects of leaf transmission from dosimetric leaf separation in a single test.

Figure 2. 2D coronal plane of the Chair

Case 14 & 15 – The C-Shape

The C-Shape target volume has been adapted from AAPM: TG119, a horseshoe shaped target volume surrounding a central avoidance structure. Two treatment plans for the C-Shape are required; with and without inhomogeneities (Fig.3).

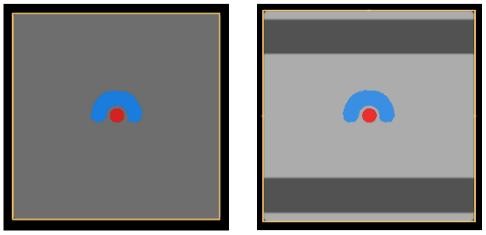


Figure 3. C-Shape with and without inhomogeneities

Case 16 – The 4L

The ACDS prescribed 4L test is an adaptation of a typical Monaco Treatment Planning System (IMPAC Medical Systems Inc., Elekta AB, Sweden) commissioning test, which consists of 4 nested 'L' shaped MLC patterns. The abutting regions of the MLCs between each 'L' shape allow assessment of the dosimetric leaf gap and inter leaf leakage, whilst the continuously blocked region shows the leaf transmission. An example of a 2D measured coronal plane of the 4L plan is shown in Figure 4.

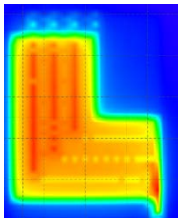


Figure 4. Measured 2D coronal plane of the 4L

Audit Outcome

The outcome for an individual case is determined using the measured 2D dose map. An overall Audit Outcome for each modality is determined, which is equal to the worst case outcome for each modality.

For 3DCRT, the audit results are determined for each case using the dose variation between the *Facility Stated Dose (planned dose)* and the *ACDS Measured Dose*. A measurement case/plane is considered passed at the Optimal Level if the maximum absolute variation of the Facility stated plan dose from the ACDS measured dose is within 3.3% for all assessed points. It is considered passed at the Action Level if the maximum absolute variation is between 3.3% and 5%. It is considered Out of Tolerance if the maximum absolute variation is outside 5%.

For IMRT/VMAT, gamma criteria of 3%/3mm relative to 2Gy, with dose <20% suppressed, are assessed across the entire measurement plane for each case.

	Pass (Optimal Level)	Pass (Action Level)	Out of Tolerance	Reported not scored (RNS)
3DCRT	≤ 3.3%*	> 3.3% and ≤ 5%	> 5%	Any deliveries which are restricted for clinical use, repeated measurements, alternative scoring options and supporting measurements
IMRT, VMAT & FFF	γ≤1 at 3%/3mm[+] for ≥97.5% points	γ≤1 at 3%/3mm for ≥90% and <97.5% points	γ≤1 at 3%/3mm <90% points	

Table 1. General audit pass criteria

[+] ***% dose variation = (Planned dose - ACDS measured dose) / ACDS measured dose**
Gamma criteria relative to 2Gy, across entire CT dataset, with dose < 20% suppressed

Outcome Reporting

All outcomes are reported in accordance with the ACDS Protocol for Audit outcomes (ACDS-SUP-9010). An individual report is created for each facility audited and is specific to the beam model(s) audited for a specified linac and TPS type. An ACDS representative will issue a provisional audit report to the Facility immediately following the audit. A formal report will be sent to the Facility within approximately 14 working days of the audit. Data collected is held confidentially by the ACDS and its oversight groups. Publicly reported outcomes are de-identified and randomised.

Audit Scope

The ACDS aims to ensure a high degree of independence from the Facility by providing external equipment and measurements whenever practicable. The ACDS will however assume that:

- The linac has been accepted from the supplier by the Facility.
- The linac has been commissioned by a certified ROMP (or equivalent) and performance (mechanical and radiation) is within Facility tolerance on the day of measurement

The ACDS will typically perform independent measurements of:

- Ionisation chamber charge collected per Monitor Unit under conditions of Facility treatment plan.
- Phantom temperature and ambient air pressure

Please note that this audit does not include independent measurement of:

- Beam Quality ($D_{20,10}$ / $TPR_{20,10}$ / $R_{50,dose}$)
- k_S, k_{Pol}, and k_Q in the Facility beam. These are pre-selected based on Facility provided beam data.

General Audit Procedures

- Where Facilities has previously indicated a willingness to participate in ACDS audits, the Facility will be placed on the Level II audit schedule.
- The initial audit documentation includes audit outcomes protocol, acknowledge of audit conditions form, audit instructions and data collection prior form. Please indicate which components of the audit are to be completed using data collection prior form.
- The standard procedure is for a two phase audit. In Phase 1, plans are completed on phantom CT data downloadable by the Facility from the ACDS website, followed by ACDS plan review off-site. In Phase 2, the ACDS is on-site for treatment delivery and dose measurements. These are normally performed with an extended interval in-between, subject to mutual agreement between the Facility and the ACDS.
- At minimum, the Facility should book staff and equipment for 12hrs of treatment planning time and 5 hours of treatment delivery time. Additional planning and Linac time will be required, as the number of beam models is increased. The ACDS suggests a start time no later than 1pm.
- The Facility must ensure that (a) A physics representative is available for the duration of the audit to provide supplemental information if required; (b) A radiation therapist is available for the duration of the audit to deliver the planned treatment and provide supplemental information if required.
- Measurements are required to be completed in clinical mode and R&V system QA mode.
- For the IMRT and VMAT modalities, the facility must confirm the plans are deliverable and pass all QA measures employed by the facility for clinical IMRT plans (e.g. patient specific QA)