**Australian Clinical Dosimetry Service**

**Level III Audit – Fact Sheet**

**Definition**
The ACDS Level III Audit determines absorbed dose to water delivered to selected points in an anthropomorphic phantom. This is an “end-to-end” audit where the phantom undergoes all steps in the treatment chain as normally experienced by a patient. The Level III 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. Note the 3DCRT 6X modality must be completed.

<table>
<thead>
<tr>
<th>Optional</th>
<th>3DCRT</th>
<th>IMRT</th>
<th>VMAT</th>
<th>3DCRT FFF</th>
<th>IMRT FFF</th>
<th>VMAT FFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please select as relevant to clinical practice</td>
<td>10X</td>
<td>6X</td>
<td>6X</td>
<td>6FFF</td>
<td>6FFF</td>
<td>6FFF</td>
</tr>
<tr>
<td>15X</td>
<td>10X</td>
<td>10X</td>
<td>10FFF</td>
<td>10FFF</td>
<td>10FFF</td>
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</tr>
<tr>
<td>18X</td>
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<tr>
<td>Wedges</td>
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</tbody>
</table>

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 II Audit. Dosimetry measurements are made with an electrometer and ionisation chambers in a CIRS thorax phantom. Ion chambers are calibrated by the national primary standards laboratory at ARPANSA. As recommended by TRS-398, the ACDS uses ion chamber calibration factors determined in high-energy beams of similar quality (referred to as “Directly measured”).

**Audit Coverage**
The Level III Audit is available to all facilities as part of a scheduled 4 year program. The Level III 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 3DCRT modality there are 4 cases in the audit, with the option of repeating these cases with multiple beam models. The 3DCRT modality consists of reference and wedged beams, measured with and without lung inhomogeneity. A schematic of the cases is shown in Figure 1.

![Figure 1. 3DCRT Cases 1-4](image-url)
Cases 5-8 consist of complex target volumes for inclusion in 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 5-8 are repeated for the IMRT FFF and VMAT FFF modalities.

**Case 5 – 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. The ‘Chair’ test](image)

**Case 6 & 7 – 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](image)

**Case 8 – The Complex Case**

The ACDS derived the ‘complex’ case from elements of IMRT/VMAT practice observed in the clinic. The complex case (Fig.4) consists of two adjacent target structures, with varying dose objectives, and an exclusion sphere fully encompassed by the higher dose target.

![Figure 4. The Complex Case](image)

**Audit Outcome**

The Audit results are determined for each case using the point dose variation between Facility Stated Dose (planned dose) and the ACDS Measured Dose. An overall Audit Outcome for each modality is determined, which is equal to the worst case outcome for each modality. All measured points must fall within the tolerance dose variation to achieve the level of audit outcome (i.e. the result is equal to the worst point).

<table>
<thead>
<tr>
<th>Audit Outcome</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pass (Optimal Level)</strong></td>
<td>≤ 3.3%*</td>
</tr>
<tr>
<td><strong>Pass (Action Level)</strong></td>
<td>&gt; 3.3% and ≤ 5%</td>
</tr>
<tr>
<td><strong>Out of Tolerance</strong></td>
<td>&gt; 5%</td>
</tr>
<tr>
<td><strong>Reported not scored (RNS)</strong></td>
<td>Any deliveries which are restricted for clinical use, repeated measurements, alternative scoring options and supporting measurements</td>
</tr>
</tbody>
</table>

*% dose variation = (Planned dose-ACDS measured dose) / ACDS measured dose

**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 days of the audit. Data collected is held confidentially by the ACDS and its oversight groups. Publicly reported outcomes are randomised and de-identified.
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 & 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

- 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, the Facility completes CT scanning and planning, 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, with the phantom shipped to the Facility ahead of time.

- At minimum, the Facility should book staff and equipment for 8 hours of treatment planning time and 4 hours of treatment delivery time. Additional beam models will increase planning and delivery time required. Bookings should be made during normal business hours except by prior arrangement.

- The Facility must ensure that (a) physics representative is available for the duration of the audit to provide supplemental information if required; (b) A radiation therapist representative/s are 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 and R&V QA modes.

- 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/VMAT plans (eg. patient specific QA).

- For pre-treatment verification, CBCT is recommended, due to the lack of anatomical structures within the phantom. Planar imaging (kV or MV) is also acceptable.