Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

Australian Clinical Dosimetry Service

Level Ib Audit Instructions

Definition

The ACDS Level Ib Audit determines absorbed dose to water per monitor unit, for mega-voltage photon and electron beams, under the Radiation Oncology Facility's (Facility) reference conditions. Reference class electrometer and ionisation chambers are used with a water phantom. The determination is made using the IAEA TRS-398 Code of Practice. The ACDS uses ion chamber calibration factors determined in high-energy beams of similar quality (referred to as "Directly measured"), as recommended by the code. This audit is conducted by ACDS representatives, on-site at the Facility. The audit will require 5-7 hours of Linac time on the day of the audit.

The Level Ib audit consists of the following modalities:

- Reference beams (photons and electrons)
- Reference beams (photons FFF)
- Small field beams (field trial)

Audit Coverage

The Level Ib audit is typically offered for new linear accelerator installations. This audit is designed to measure static beams on Conventional Linacs, Halcyon™, Tomotherapy® and Cyberknife® systems.

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 Facility reference conditions
- Ionisation chamber specific corrections for polarity (k_{POL}) and recombination (k_S)
- Water phantom temperature
- Ambient air pressure and relative humidity
- Water phantom depth positioning accuracy – at selected points over the range of interest
- Spot check of PDD at z_{ref}

In the Small Field field trial, the ACDS will typically perform independent measurements of:

- Small field lateral profiles for field centre and width
- Small field output factors

- Small fields will only be measured for a selection of:
  - Conventional Linac, Halcyon, Tomotherapy and Cyberknife systems,
  - 6 MV, 10 MV, 6FFF and 10FFF photon beams,
  - square or circular fields with nominal size of 0.5 cm to 4 cm (typically 1, 2, 3, 4 cm),
  - the most clinically relevant collimation method (jaws, MLC, cone, iris).
- The ACDS calculates the output factors relative to the machine-specific reference field (10 cm square field for conventional linacs).
- The ACDS output factors are compared to a set of Facility-stated output factors determined using either a single detector or using an average of several detectors.

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

- Beam Quality ($D_{20,10}$, $TPR_{20,10}$ or $R_{50,dose}$)
- Percentage Depth Doses or Tissue Phantom Ratios
- Output Factors or Applicator Factors for Reference fields

Audit Outcome

The Audit results are determined by the percentage deviation of the *Facility-Stated Dose Output* from the *ACDS-Determined Dose Output*, for each clinical beam. Result Levels are given in Table 1. An overall Audit Outcome is determined, which is equal to the lowest result recorded for an individual beam.

Result	Level	% Deviation (Facility-Stated Dose / ACDS-Determined Dose)	
		Photons	Electrons
Pass	Optimal	≤ 1.4	≤ 2.2
	Action	> 1.4 and ≤ 2.1	> 2.2 and ≤ 3.3
Out of Tolerance		> 2.1	> 3.3

Table 1. General audit pass criteria

Small field output factors

The ACDS performs small field output factor measurements using a PTW 60019 microDiamond. Published field size specific corrections from the 'IAEA/AAPM TRS-483 Dosimetry of Small Static Field Used in External Beam Radiotherapy' Code of Practice are applied to the ACDS Output Factor measurements. A scanning water tank is required to measure profiles to determine the true centre and irradiated field size (FWHM) of the small field. The small field component of this audit is reported but not scored (RNS) against the overall audit outcome.

Outcome Reporting

A Level Ib audit report is created for each individual Linac audited. 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 two working weeks of the audit.

On the day checklist

- Ensure the dose outputs for photon, photon FFF and electron beams (the absorbed dose per MU at DOSP, under reference conditions) are available for the day of the audit.
    - The dose output should be measured according to the Facility's routine physics output check (NOT Daily QA device).
    - DOSP = Dose Output Specification Point, the point at which the nominal linac dose calibration is specified by the Facility e.g. 1cGy/MU at d_{max}.
- Ensure a physics representative is available for the duration of the audit to operate all Facility equipment and provide supplemental information if required
- Please have the scanning water tank set up prior to ACDS arrival. Ensure the tank can measure at varying depths for reference dosimetry and scan profiles for small field measurements.
- Reference dosimetry measurements may be performed in service mode, with a clinical mode verification measurement performed once for each reference beam through the R&V system (QA mode is acceptable).
    - Ensure each reference field is prepared in the R&V system QA mode

      e.g. *6X beam, Gantry = 0^o, Coll = 0^o, 10 cm x 10 cmfield size, 200 MU*

      9e beam, Gantry = 0^o, Coll = 0^o, 10 cm x 10 cm Applicator, 200 MU, etc.
- Small field output factors require lateral profiles to be scanned to determine the irradiated field size and place the detector at the radiation field centre.
    - Please create a measurement queue in the water tank driving software for **the smallest** small field to be measured. The following settings are preferred:

      Step-by-Step mode, 0.2 mm step size

      Lowest speed both during scanning and moving between scans

      Scan width to ± 10 mm beyond the 50% field edge

      Prepare: 2 x inline scans (G→T, T→G) in sequence

      2 x crossline scans (A→B, B→A) in sequence

      These four scans will be used to assess the tank performance, set the final (0,0) position, and choose a preferred scanning direction for the subsequent scans for which the queue will be modified during the audit.