

## QUALITY ASSURANCE PROCEDURES FOR LOCOREGIONAL HYPERTHERMIA EQUIPMENT IN AMSTERDAM

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### Introduction

Quality assurance (QA) is essential for reliable clinical application of hyperthermia, and involves both guidelines for treatment delivery and test procedures to check the system operation. Purpose: This study reports on the development of QA procedures to characterise the performance and stability of the AMC-4 regional heating device, elaborating on existing ESHO QA guidelines.

### Methods

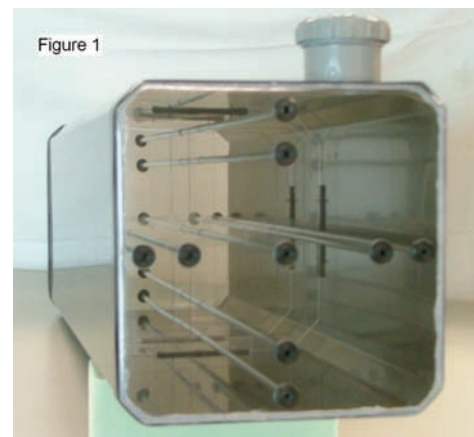
The AMC-4 phased array hyperthermia system consists of a ring of 4 waveguides (aperture 33 x 21 cm) operating at 70 MHz and is used for treatment of tumours in thorax and pelvis. Three aspects of the Specific Absorption Rate (SAR) distribution of the AMC-4 are tested in various phantom models:

1. *SAR focus size and shape*, quantified by the Full Width Half Maximum of the focus and the  $S_{ratio}$ , the ratio between maximum power deposition at the surface and at the centre of the phantom. The  $S_{ratio}$  is a measure for preferential tumour heating.
2. *SAR steering*, quantified by the displacement of the SAR focus in the aperture midplane at different phase settings.
3. *Efficiency*, quantified by the amount of power effectively absorbed in the phantom in relation to the input power.

Two types of QA procedures were developed: The first acceptance requires extensive measurements, periodical repeat tests can be limited to simpler measurements. Action is taken when large deviations are detected.

*SAR focus size:* The initial test was performed by measuring the E-field distribution in the transversal midplane of a tissue equivalent phantom with a square cross section with all antennas at equal phase and amplitude, creating a central SAR focus. The repeat test focuses on the stability of this distribution by measuring the E-field at nine characteristic points in the aperture midplane of a square tissue equivalent phantom fitted with 9 measurement channels (Fig 1).

*SAR steering:* The initial test was performed by measuring E-field distributions in the transversal midplane of a tissue equivalent phantom with a square cross section with all antennas at equal amplitude, but with variable phase settings. The repeat tests focus on the stability of phase steering by optimising the phase settings to yield a maximum field at four characteristic points in the aperture midplane of the square tissue equivalent phantom fitted with 9 measurement channels (Fig 1).



*Efficiency* was established in both the acceptance and repeat test by measuring the temperature rise distribution in an elliptical tissue equivalent phantom after a short power pulse at standard phase and amplitude settings creating a central SAR focus, and comparison with computational results.

### **Results**

Repeat tests are fast and easy to conduct. The use of a square phantom is favourable because of the symmetry of the AMC-4 system, resulting in simple standard settings. The procedures provide an excellent method to monitor the stability of the AMC-4 system. Some parameters have been tracked over a sufficiently long period to monitor long term trends.

### **Conclusion**

The AMC-4 QA procedures are easy to perform and give an accurate impression of the performance of the AMC-4 regional hyperthermia system. The presented procedures have been added to well established equipment stability monitoring procedures to further improve QA. With minor modifications the approach is applicable for loco-regional hyperthermia equipment in general, e.g. for the AMC-8 system.