

# Elekta Compact™

IEC 60976/60977 PERFORMANCE VALUES



## Introduction

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The following functional performance values have been measured according to the methods specified in IEC 60976:1989. They are provided for the purpose of making comparisons between different manufacturers' equipment under standardised test conditions. They may also be used to provide an indication of the performance to be expected from the linear accelerator throughout its life when maintained according to the manufacturers' specifications. The values specified herein have been met under type test conditions. Care has been taken, in providing these values, to include tolerances for unit to unit variations and test measurement uncertainty; however, these values are not guaranteed specifications to be applied to individual units, and the test methods are in general unsuitable for acceptance testing. Equipment specifications are provided in a separate functional description. Tests suitable for product acceptance following installation are provided in the Customer Acceptance Test Schedule (CATS) supplied with the equipment. For many of the performance characteristics two values are provided. The former value under the heading 'declared', is that specified by Elekta for Elekta Compact™. The latter value under the heading 'suggested', is the value recommended by the IEC working committee as recorded in IEC 60977.

### 3.1 Available nominal energies and absorbed dose rates

| X-radiation mode   | Values Gy/min* |     |     |     |
|--------------------|----------------|-----|-----|-----|
| Nominal energy 6MV | 0.5            | 1.0 | 2.0 | 3.5 |

*\*The same absorbed dose rate applies for both 10 x 10cm and maximum radiation field in X-radiation mode.*

### 3.2 Available radiation fields (at normal treatment distance)

| X-radiation mode             | Values cm   |
|------------------------------|---|
| Minimum square               | 0.5 x 0.5   |
| Maximum square               | 35 x 35 (fully flattened radiation field, square corners) |
| Maximum with clipped corners | 40 x 40 (diagonals 50cm x 50cm)                           |

### 3.3 Normal treatment distance

| Normal treatment distance | Values |
|---------------------------|--------|
| X-radiation mode          | 100cm  |

### 3.4 Available filters

X-ray field flattening filters

| Designation | Nominal energy | Maximum square radiation field (square corners) |
|-------------|----------------|---|
|             | 6MV            | 35 x 35cm                                       |

X-ray wedge filters

| Nominal energy | Maximum radiation field | Wedge filter angle | Related isodose value | Wedge filter factor |
|----------------|-------------------------|--------------------|-----------------------|---------------------|
| 6MV            | 30 x 40cm               | 60°                | 67%                   | 27%                 |

### 3.5 Availability values

Time necessary to reach the ready state from the stand-by state      20 min.

### 3.6 Influencing qualities

| Environmental conditions               | Values              |
|--|---------------------|
| Ambient temperature                    | 15°C to 35°C        |
| Relative humidity                      | 30% to 70%          |
| Atmospheric pressure                   | 700 hPa to 1100 hPa |
| Maximum period of continuous operation | 6 hours             |

*(possibly influencing the functional performance characteristics)*

## 5. Dose monitoring system

| Dose monitoring system                                      | Values            |
|---|-------------------|
| Range of absorbed dose over which the standard is met       | 0.5 to 9.99Gy     |
| Range of absorbed dose rates over which the standard is met | 0.5 to 3.5Gy/min. |

### 5.1 Reproducibility

| Maximum co-efficients of variation of ratio R of                      | Values   |           |
|---|----------|-----------|
|   | Declared | Suggested |
| a) the number of dose monitor units and absorbed dose for X-radiation | 0.5%     | 0.5%      |

The average of a number of determinations of  $\bar{R}$  is defined as  $\bar{R}$  in the following clauses.

### 5.2 Proportionality

Maximum deviation of the measured absorbed dose from the value given by multiplying the measured value of U of dose monitor units by the proportionality factor S over the following range of absorbed dose and absorbed dose rates:

| X-radiation nominal energy: all MV            | Values   |           |
|---|----------|-----------|
| of 0.5Gy to 9.99Gy at 0.5Gy/min. to 3.5Gy/min | Declared | Suggested |
| Deviation                                     | ±1%      | 2%        |

### 5.3 Dependence on angular positions

Maximum difference between the maximum and minimum values of  $\bar{R}$  over the full angular ranges of the gantry and beam limiting system.

| X-radiation        | Values   |           |
|--------------------|----------|-----------|
|                    | Declared | Suggested |
| Maximum difference | 1%       | 3%        |

### 5.4 Dependence on gantry rotation

As the gantry moves, the maximum deviation of  $\bar{R}$  from the arithmetic mean of the maximum and minimum values of  $\bar{R}$  determined in Sub clause 5.3.

| X-radiation        | Values   |           |
|--------------------|----------|-----------|
|                    | Declared | Suggested |
| Maximum difference | 1%       | 2%        |

### 5.5 Dependence on the shape of the radiation field

Maximum difference of  $\bar{R}$  between 5 x 20cm and 20 x 5cm fields.

| X-radiation                 | Values   |
|-----------------------------|----------|
|                             | Declared |
| Declared maximum difference | 1%       |

### 5.6 Stability of calibration

#### 5.6.1 Stability after high absorbed dose delivered

X-radiation

| Values  | Declared | Suggested |
|---|----------|-----------|
| Maximum difference of $\bar{R}$ between beginning and end of a period of 30 minutes at maximum nominal absorbed dose rate | 1%       | 2%        |

### 5.6.2 Stability throughout the day

X-radiation

| Values  | Declared | Suggested |
|---|----------|-----------|
| Maximum difference of $\bar{R}$ between beginning and end of 8 hours of successive 4Gy irradiations followed by 10 minutes without irradiation. | 1%       | 2%        |

### 5.6.3 Stability throughout the week

X-radiation

| Values   | Declared | Suggested |
|--|----------|-----------|
| Maximum difference between the highest and lowest values of $\bar{R}$ measured immediately following switch-on on five consecutive days. | 1%       | 2%        |

### 5.7 Stability in moving beam radiotherapy

X-radiation

| Values  | Declared | Suggested |
|---|----------|-----------|
| Where the dose monitor system terminates irradiation the maximum difference in degrees between the gantry rotation angular range traversed and the angular range calculated by dividing preset dose monitor units by the value of preset dose monitor units per unit angle. | 3%       | 3%        |

## 6 Depth absorbed dose characteristics

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### 6.1 X-radiation

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| Nominal X-ray energy   | 6MV      | MV        |
| Depth of dose max for 10 x 10cm radiation field                              | 1.5cm    | cm        |
| Depth of dose max for max radiation field                                    | 1.4cm    | cm        |
| Penetrative quality (10 x 10cm radiation field)                              | 6.1cm    | cm        |
| Maximum deviation of actual value from declared value of penetrative quality | 2mm      | 3mm       |
| Quality index  | 0.67     |           |
| Relative surface dose for 10 x 10cm radiation field                          | 37 %     | %         |
| Relative surface dose for max radiation field                                | 58 %     | %         |

## 7 Uniformity of radiation fields

### 7.1 X-radiation

#### 7.1.1 Flatness of square X-ray fields

Nominal energy ALL MV. Maximum ratio of maximum absorbed dose anywhere in the radiation field to minimum absorbed dose in flattened area of radiation field both at standard measurement depth.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| 5 x 5cm to 30 x 30cm                       | 106%     | 106%      |
| Greater than 30cm x 30cm to maximum square | 110%     | 110%      |

#### 7.1.2 Deviation of dose distribution of square X-ray fields with angular positions

Maximum variation in the ratio of absorbed dose at a point in the flattened area to absorbed dose on the radiation beam axis both at standard measurement depth for all angular positions of the gantry and beam limiting system.

|                               | Values   |           |
|-------------------------------|----------|-----------|
|                               | Declared | Suggested |
| Nominal energy less than 30MV | 2%       | 3%        |

#### 7.1.3 Symmetry of square X-ray fields

Maximum ratio of absorbed doses at points symmetrically displaced from the axis of the beam and within the flattened area at standard measurement depth.

| Values   |           |
|----------|-----------|
| Declared | Suggested |
| 103%     | 103%      |

#### 7.1.4 Maximum ratio of absorbed dose

Nominal energy 6MV. Maximum ratio of absorbed dose in the radiation field to absorbed dose on the radiation beam axis in the plane at the depth of dose maximum.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| 5 x 5cm to 30 x 30cm                     | 107%     | 107%      |
| Greater than 30 x 30cm to maximum square | 109%     | 109%      |

#### 7.1.5 X-ray fields with wedge filters (see sub-clause 3.4)

Nominal energy ALL MV

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| Maximum deviation of wedge filter factor | 2%       | 2%        |
| Maximum deviation of wedge filter angle  | 2°       | 2°        |

### 7.3 Penumbra of radiation fields

Maximum distance along major axes between points of 80% and 20% of the absorbed dose on the radiation beam axis, all measurements being in the plane at standard measurement depth.

|                        | Values   |           |                      |
|------------------------|----------|-----------|----------------------|
|                        | Declared |           |                      |
| <b>Radiation field</b> | 5 x 5cm  | 10 x 10cm | Maximum square field |
| <b>X-radiation</b>     | 7        | 7         | 8mm                  |

## 8 Indication of radiation fields

### 8.1 X-radiation

#### 8.1.1 Numerical field-indication

Maximum difference between the numerical radiation field-indication and the dimensions of the radiation field at normal treatment distance.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| 5 x 5cm to 20 x 20cm                     | 2mm      | 3mm       |
| Greater than 20 x 20cm to maximum square | 1%       | 1.5%      |

#### 8.1.2 Light field indicator

Maximum distance along the major axes between the light field edge and the radiation field edge at normal treatment distance in mm or % of dimensions of the radiation field.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| 5 x 5cm to 20 x 20cm                     | 1mm      | 2mm       |
| Greater than 20 x 20cm to maximum square | 1%       | 1%        |

Maximum distance along the major axes between the light field edge and the radiation field edge at 1.5 times nominal treatment distance.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| 5 x 5cm to 20 x 20cm                     | 3mm      | 4mm       |
| Greater than 20 x 20cm to maximum square | 1.5%     | 2%        |

Maximum distance between the centres of the radiation field and light field.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| At normal treatment distance           | 2mm      | 2mm       |
| At 1.5 times normal treatment distance | 4mm      | 4mm       |

#### 8.1.3 Reproducibility

Difference between the maximum and the minimum X-ray field for repeated settings of the same numerical field indication.

| Values   |           |
|----------|-----------|
| Declared | Suggested |
| 2mm      | 2mm       |

Maximum distance between any light field edge and the X-ray field edge for repeated settings of the same numerical field-indication.

| Values   |           |
|----------|-----------|
| Declared | Suggested |
| 2mm      | 2mm       |

### 8.3 Geometry of the beam limiting system for X-radiation

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| Maximum deviation from parallelity of opposing edges   | 0.5°     | 0.5°      |
| Maximum deviation from orthogonality of adjacent edges | 0.5°     | 0.5°      |

### 8.4 Illuminance and penumbra of the light field

|   | Values   |           |
|---|----------|-----------|
|   | Declared | Suggested |
| Average illuminance at normal treatment distance $\geq$ | 40 lx    | 40 lx     |
| Edge contrast ratio at points 3mm apart $\geq$          | 4:1      | 4:1       |

## 9 Indication of the radiation beam axis and isocentre

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### 9.1 + 9.2 Indication of the radiation beam axis

Maximum deviation of the indication of the radiation beam axis from the radiation beam axis.

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| Over NTD $\pm 25$ cm or working range entry X-ray beam | 2mm      | 2mm       |
| Over NTD to NTD +50cm or working range exit X-ray beam | 3mm      | 3mm       |

## 10 Isocentre

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### 10.1 Displacement of the radiation beam axis from the isocentre

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| Maximum displacement of the radiation beam axis from the isocentre | 2mm      | 2mm       |

### 10.2 Indication of the isocentre

Maximum displacement from the isocentre of any device for indicating the position of the isocentre

|                                    | Values   |           |
|------------------------------------|----------|-----------|
|                                    | Declared | Suggested |
| device a) crosswires               | 1mm      | 2mm       |
| device b) mechanical front pointer | 1mm      | 2mm       |
| device c) laser back pointer       | 2mm      | 2mm       |

## 11 Indication of distance along the radiation beam axis

### 11.1 Maximum difference between the indicated distance and the actual distance from a reference point

|   | Values   |           |
|---|----------|-----------|
|   | Declared | Suggested |
| For isocentric equipment the reference point shall be the isocentre | 2mm      | 2mm       |

## 12 Zero position of rotational scales

### 12.1 Maximum difference between the zero position indicated by the rotational scale and the zero position defined by clause 12

|   | Values   |           |
|---|----------|-----------|
|   | Declared | Suggested |
| Rotation of gantry (axis 1)               | 0.5°     | 0.5°      |
| Rotation of beam limiting system (axis 4) | 0.5°     | 0.5°      |

## 13 Congruence of the opposed radiation fields

|  | Values   |           |
|--|----------|-----------|
|  | Declared | Suggested |
| Maximum displacement at isocentre between axes of opposed radiation fields | 1mm      | 1mm       |

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