

WEK-0744 Multi-functional Comprehensive Test Board

>>> Instruction <<<

1. Product Introduction and Structure

A.1. Test Mold Introduction

The test mold used in the imaging and photography modes consists of an attenuating body and a multifunctional test card (see Figure A.1), which can be used for tests such as dynamic range, spatial resolution, and low contrast resolution.

The attenuating body is a 25 mm thick aluminum plate with a purity of no less than 99.5%, placed as close as possible to the beam stop outlet.

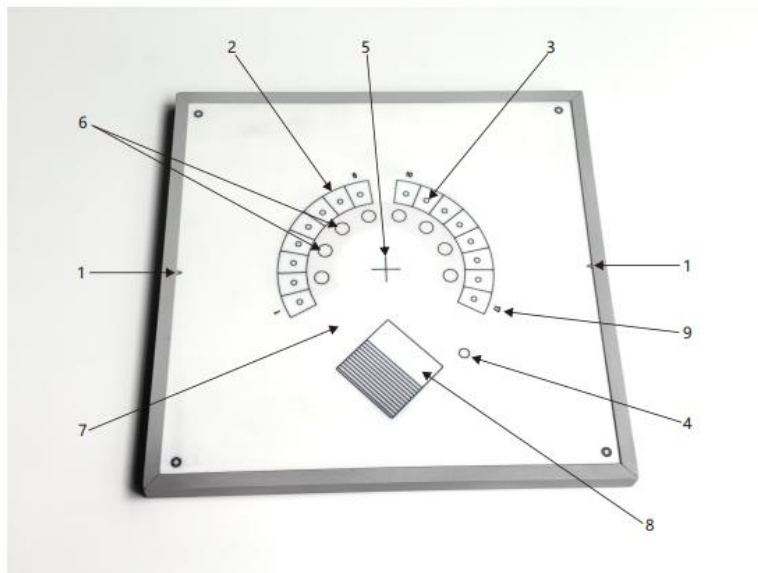


Figure A.1 Diagram of various structural components of the multi-functional test card

Explanation:

- 1 - X-ray tube axis;
- 2 - Dynamic wedge;
- 3 - 16 low-contrast apertures, 4 mm in diameter and 2.5 mm deep (PAMM);
- 4 - kV inspection area;
- 5 - Central crosshair marker;
- 6 - 8 groups of objects with 10 mm diameter high contrast detail;
- 7 - Unstructured central area;
- 8 - Spatial resolution test chart;
- 9 - Numbers that the dynamic wedge can display on the image.

A.2. Module Composition

The multi-functional test card is composed of the following components, with a total thickness of 18.5 mm:

a) The base copper plate, with a thickness of 1.5 mm and a size of 300 mm × 300 mm. However, the thickness of the copper plate in the spatial resolution detection area is 1.1 mm.

b) The measurement copper step wedge for the dynamic range (see No. 2 in Figure A.1), with an outer diameter of 150 mm and an inner diameter of 110 mm. It consists of 17 steps, and the copper thickness of each step is specified in Table A.1. In the table, the copper thickness includes the thickness of the base copper plate (1.5 mm), and steps 1 to 8 are thinner than the base copper plate, while steps 10 to 17 are thicker than the base copper plate.

Table A.1 Thickness of Dynamic Step Wedge and Its Tolerance

| Steps | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|----------------------------|-----|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Copper thickness | 0 | 0.18 | 0.36 | 0.54 | 0.74 | 0.95 | 1.16 | 1.38 | 1.50 | 1.73 | 1.96 | 2.21 | 2.45 | 2.70 | 2.96 | 3.22 | 3.48 |
| Copper thickness tolerance | - | +/- 0.02 | +/- 0.02 | +/- 0.02 | +/- 0.02 | +/- 0.03 | +/- 0.03 | +/- 0.03 | +/- 0.05 | +/- 0.05 | +/- 0.05 | +/- 0.05 | +/- 0.05 | +/- 0.05 | +/- 0.05 | +/- 0.05 | +/- 0.05 |
| PMMA thickness | 4.0 | | | | | | | | 17 | 12 | | | | | | | |

When the X-ray tube voltage is set at 75 kV and a 25 mm aluminum attenuator is used, the dynamic range reference values for each copper wedge relative to the 9th step are shown in Table A.2.

Table A.2 Reference Values for Dynamic Range

| Steps | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---------------|------|------|-----|------|------|------|------|------|------|--------|--------|--------|--------|--------|--------|--------|------|
| Dynamic range | 16.0 | 11.3 | 8.0 | 5.66 | 4.00 | 2.83 | 2.00 | 1.41 | 1.00 | 1/1.41 | 1/2.00 | 1/2.83 | 1/4.00 | 1/5.66 | 1/8.00 | 1/11.3 | 1/16 |

c) Spatial resolution test card: Composed of 100 μm thick lead foil and line pairs with spatial resolutions ranging from 0.6 lp/mm to 5 lp/mm. The measurable resolutions are: 0.6, 0.7, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.5, 2.8, 3.1, 3.4, 3.7, 4.0, 4.5, 4.6, 5.0 (lp/mm).

d) Eight low-contrast object components, with a diameter of 10 mm (see Figure A.1, item 6), are located in a uniform internal area (see Figure A.1, item 7), used to test low-contrast resolution. The depth of the holes is shown in Table A.3.

Table A.3 Depth of contrast details in PMMA

| Detail Number | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Detail Depth | 0.4 | 0.6 | 0.8 | 1.2 | 1.7 | 2.4 | 3.4 | 4.0 |

When the X-ray tube voltage is 75 kV and a 25 mm aluminum attenuator is used, the contrast values of each detail comparison area relative to the copper gradation wedge's 9th step are shown in Table A.4.

Table A. 4 Contrast Reference Values

| Detail Number | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|----------------|------|------|------|------|----|------|------|------|
| Contrast Ratio | 0.9% | 1.3% | 1.8% | 2.8% | 4% | 5.6% | 8.0% | 9.4% |

e) A group of 16 detail contrast objects with a diameter of 4 mm (see Figure A.1, item 3), with a depth of 2.5 mm in PMMA. These details are located on each step of the copper step wedge (see Figure A.1, item 2), and are used to test the contrast resolution in each step of the copper step wedge.

f) Tube voltage inspection area: A rough inspection of the radiation quality is conducted using a 0.78 mm thick metal ytterbium sheet (Ytterbium) (see Figure A.1, item 4). If a 25 mm aluminum attenuator is used, when the X-ray tube voltage is greater than approximately 75 kV, this area appears white in the image; when the X-ray tube voltage is less than approximately 70 kV, this area appears black in the image.

