TOR CDR

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Description

Test object TOR [CDR] is intended for routine quality control of radiographic screen-film combinations, and may also be used for non-subtractive digital radiography. Testing should be done on a regular basis, keeping an ongoing record of the test results, which will indicate any deterioration in the imaging performance. In addition to checking imaging consistency, the test object can be used to assess the relative performance of different screen-film combinations.

Figure 1 shows the layout of the test details, which enable the following tests to be carried out:

- Film density measurements (base+fog, speed index, contrast index)
- Low-contrast sensitivity (large details)
- High-contrast sensitivity (small details)
- Spatial resolution limit

Specifications of the X-ray contrasts and spatial frequencies in the test object are given on pages 5 and 6.

Positioning the Test Object

Place the test object in contact with the tube side of the loaded cassette, which should be positioned at an appropriate FFD. The orientation of the test object is not important, but is good practice to use a standard position each time, to reduce any possible variability when making subjective measurements.

X-ray Beam Conditions

The recommended beam conditions are 70 kVp with a primary filter of 1 mm copper. Place the supplied filter as close as possible to the tube head, normally at the diaphragm housing. Set the diaphragms to the required positions, and expose the film to a background density of about 1.5 above the base+fog level (ideally, this should be the mid-point of the linear portion of the characteristic curve). This is Film No1.

Next, remove the copper filter and use a lower tube voltage, about 50 kVp. Expose a second film, again obtaining a density of about 1.5 above base+fog. This is Film No2.

The exposure conditions (FFD, kVp, mAs) should be recorded; the same conditions must be used each time (for a particular screen-film combination), otherwise the test results can not be compared. If Automatic Exposure Control is used, the consistency of AEC function will be included in the test.

Film Density Measurements

On Film No1, the 5.6 mm discs at the bottom of the test pattern form a 10-point grey-scale, which can be measured using a densiometer. For routine testing, only three measurements need be made, as follows;

- Base+fog level, given by the extreme left hand disc
- Speed index, the density of the disc closest to 1.0 above base+fog (N.B. the same disc must be measured each time)
- Contrast index, the difference between the speed index and the background density, measured adjacent to the disc.

A Control chart, plotting the three densities as a function of time, will indicate the consistency of radiographic exposure, and of the film processing conditions (the film processor must be monitored independently by a standard sensiometric programme). The control chart should indicate the permitted tolerance levels for each measurement, e.g. base+fog should have an upper limit (say 0.22), the speed index may vary between 0.9 and 1.1 (above base+fog) and the contrast may also vary accordingly.

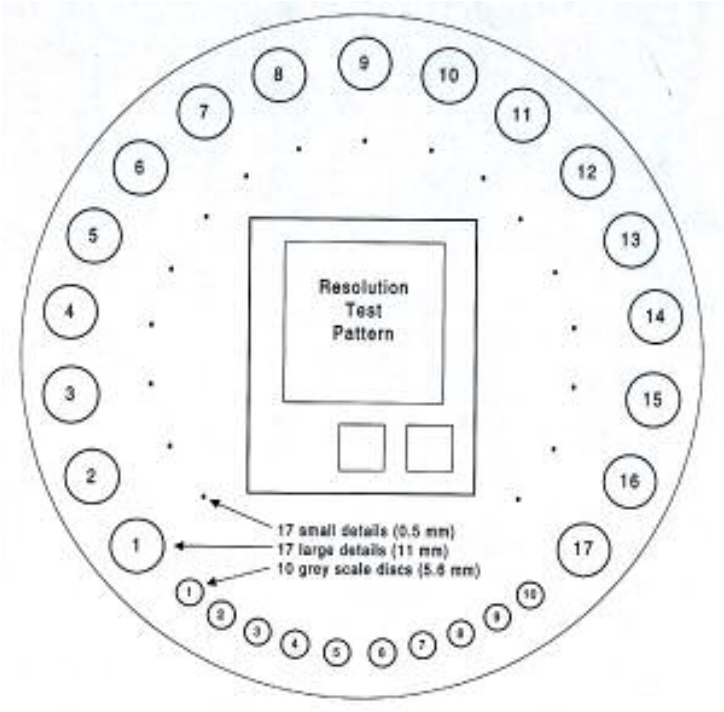

Figure 1: Layout of test details (not to scale)

Measuring The Low-Contrast Sensitivity

View Film No1 on a light box, and count the number of large circular details that can be detected against the background. This will depend upon the shape of the characteristic curve, especially its gradient, and also upon the level of radiographic noise. The value of the threshold contrast can be found from the table of page 5. N.B. when the image has a relatively high noise level (as with fast rare-earth screens) it may be necessary to view more than one sample image and find a mean value.

Measuring The High-Contrast Sensitivity

Still viewing Film No1, count the number of small (0.5 mm) details that can be detected. A magnifying lens (x4 to x8) may be found useful. The detectability of these small details will depend upon radiographic noise and unsharpness. The threshold contrast value can be found from page 5.

Measuring The Resolution Limit

The resolution limit is a simple indicator of radiographic unsharpness, which is fully specified by the MTF of the screen-film combination. Radiographic unsharpness is caused almost entirely by the screen, but may deteriorate due to poor screen-film contact. Measurement of the resolution limit requires the test pattern to be imaged under optimum conditions, with high contrast and low noise, and these are provided by film No2. View this film on the light box, and note the resolution groups where the bars and spaces are all visible, using the magnifier if necessary. From the specification table, determine the highest spatial frequency that can be resolved.

Interpretation of Results

The results obtained from these measurements should be recorded in a way which allows any trend towards deterioration (over a period of time) to be detected. However, even without deterioration, it is unlikely that exactly the same values will be obtained for each routine test, and it is useful to establish tolerances in respect of the maximum and minimum values that are acceptable for each type of screen-film combination. This can be done after several sets of measurements have been obtained, using several cassettes. The best results may be taken as the standard to be expected of that particular combination. The worst results (depending how much worse) may define the lower limit of acceptability.

When deciding these values, there are several sources of variability which should be taken into account;

- The variability of subjective measurements, including inter-observer variability
- The variability of exposure conditions, including the AEC system (if used)
- The variability of film processing conditions, which must be monitored separately.

Reference Films

A set of reference films of the test pattern, for different types of screen-film combination, will allow differences in image quality to be observed directly, showing the effects of different radiographic noise, unsharpness and contrast. Such films can be used to train new observers and to monitor their performance, ensuring that their psycho-physical judgement of threshold contrasts remains stable. Also, they can be used as control images while investigating new radiographic products or techniques (e.g. when considering changes to current clinical procedures).

Specifications of the Test Details

X-ray contrast values are given for beam conditions of 70 kVp (constant potential) with 1 mm copper filtration. These should be regarded as nominal values; actual contrasts will depend on the shape of the kV waveform etc. They are also subject to manufacturing tolerances of ±5%.

- **Grey scale:**

  10 discs, diameter 5.6 mm, with nominal X-ray contrasts as follows;

  1.0, 0.91, 0.82, 0.73, 0.64, 0.50, 0.41, 0.30, 0.20, 0.11 (background 0.0)

- **Low-contrast sensitivity:**

  17 circular details, diameter 11 mm;

Disc Number	Contrast	Disc Number	Contrast
1	0.075	10	0.015
2	0.067	11	0.013
3	0.053	12	0.011
4	0.045	13	0.009
5	0.039	14	0.007
6	0.032	15	0.005
7	0.027	16	0.003
8	0.022	17	0.002
9	0.017	-	-

- **High-contrast sensitivity:**

  17 circular details, diameter 0.5 mm;

Disc Number	Contrast	Disc Number	Contrast
1	0.954	10	0.167
2	0.820	11	0.128
3	0.726	12	0.117
4	0.573	13	0.088
5	0.496	14	0.067
6	0.360	15	0.061
7	0.302	16	0.045
8	0.238	17	0.039
9	0.203	-	-

- **Resolution test patterns:**

  There are 30 separate groups of bar patterns, each group comprising 5 bars and 4 spaces, giving 4½ line-pairs. The following table gives the spatial frequencies in line-pairs per mm.

Group Number	Spatial Freq.	Group Number	Spatial Freq.
1	0.50	16	2.80
2	0.56	17	3.15
3	0.63	18	3.55
4	0.71	19	4.00
5	0.80	20	4.50
6	0.90	21	5.00
7	1.00	22	5.60
8	1.12	23	6.30
9	1.25	24	7.10
10	1.40	25	8.00
11	1.60	26	8.90
12	1.80	27	10.0
13	2.00	28	11.1
14	2.24	29	12.5
15	2.50	30	14.3