# Impact of the Processing Methods on the Performance of the X-Ray Film-Screen Combinations

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## Abstract

In ISO9236-1 there is no description of the processing method for the sensitometric determination of an x-ray film by the film-screen combination method. But it states that when the film-screen combination system is being determined, either manual processing or automatic processing can be adopted. The different processing procedures will result in wide different sensitivities and average gradients. This paper describes the sensitometric determination of the film-screen combination systems of four types of medical x-ray films by the bootstrap method with manual processing and automatic processing. Their sensitometric results show that there are certain difference in the performance of the film-screen combination systems between the manual processing and the automatic processing. With the manual processing, the resultant sensitivity is faster and average gradient steeper, and min. density and max. density almost same with the automatic processing. These results are identical with the results obtained in the sensitometric determination by visible light exposure.

## Introduction

It is known that the processing method influences the performance of an x-ray film when the performance of an x-ray film is being determined by visible light exposure. However, is the performance obtained with different processing procedure for the sensitometric determination of an x-ray film by the film-screen combination method the same? In ISO9236-1, there is point that screen-film-systems including either manual or automatic processing may be tested.[1] We tested photographic characteristics of the film-screen combination systems of four types of medical x-ray films by the Bootstrap method with manual and automatic processing.

## 1. Experimental

### 1.1 Device and Sensitive Material Used in the Experimental

(1) X-ray machine: TX-II type made by Tanaga of Japan. 500mA and focal length of 1.0mm (2) Aluminum step wedge. A 24 step wedge made by Zhejiange East Wind phosphrate corporation of China with an increment of 2mm in thickness between the neighboring steps. The width of the wedge is 5mm. (3) Intensifying screens: medium speed CaWO4 made in Shanghai Dental Machinery Factory of China (4) X-ray film: Shanghai GK-II, "Tian Jing", "Konica", "Aermei" (5) Densitometer: Type CMT Transparency Densitomer made by Shanghai Xianfeng Moving Picture Machinery Factory of China. (6) Processor: Hope Micro Max 1417 made in USA.

### 1.2 Testing Method

A double exposure was adopted to determine the performances of the above mentioned four x-ray films as film-screen combination.[2] The exposure conditions under 70 Kv and with the duration of time of exposure of 0.20 sec. and 0.40 sec. respectively, and FFD 100cm. The processing was conducted in the aforesaid processor with dry to dry time of 90 sec. And manual. The detailed procedures are as follows: (1) The magazine with each kind of film and same screen were loaded onto the platform of the x-ray machine. The aluminum step wedge was placed over a piece of copper with a thickness of 0.5mm. Then it was placed over the magazine. (2) The same wedge was used for the double exposures of the same film-screen combination, with the exposing time of the second exposure to be twice that of the first exposure. During the first exposure, half part of the film was covered with a piece of lead. Two pieces of each kind of film were exposed; (3) One set including four types of x-ray films were processed with manual, another set including four types of x-ray films were processed with automatic; (4) the densities were determined for the first and second exposure respectively, using the densitometer (5) Plotting the

curves of the densities against the thickness of the aluminum step wedge; (6) In accordance with the mathematical relationship of lg2 = 0.30, the characteristic curves were plotted using the "artificial plotting method".

## 2. Results and Discussion

### 2.1 The Testing Results

The calculation of the characteristic value of each film was yielded from the characteristic curve in accordance with the method specified in ISO5799.[3]

#### 2.1.1 The Performance of Film-Screen Combination of Four Types of an X-ray Film with Manual

**(1) Processing Procedure**

**Table 1. Manual Processing**

| | Time (min.) | Temperature | Note |
|---|---|---|---|
| Developing | 5 | 20°c | Agfa-30 |
| Fixing | 10 | Normal | F – 5 |
| Washing | 15 | Normal | Running water |
| Drying | | Normal | |

(2) With above-cited method, the performances of film-screen combination of four types of an x-ray film are shown in table 2.

**Table 2**

| Film | Dmin | S | G | Dmax |
|---|---|---|---|---|
| Konica | 0.25 | 3.33 | 2.40 | 2.24 |
| Shanghai GK-II | 0.33 | 1.11 | 1.60 | 2.26 |
| Tian Jing | 0.33 | 1.06 | 3.10 | 2.90 |
| Aermei | 0.25 | 2.50 | 1.78 | 2.22 |

#### 2.1.2 The Performances of Film-Screen Combination of Four Types of an X-Ray Film With Automatic

**(1) Processing procedure**

**Table 3 Automatic Processing**

| Procedure | Time (Sec) | Temperature | Note |
|---|---|---|---|
| Developing | 23 | 35°c | Shanghai SK-III |
| Fixing | 23 | 30°c | Shanghai HF-31 |
| Washing | 23 | Normal | |
| Drying | 23 | 55°c | |

(2) With above-cited method, the performances of film-screen combination of four types of an x-ray film are shown in table 4

**Table 4**

| Film | Dmin | S | G | Dmax |
|---|---|---|---|---|
| Konica | 0.22 | 2.50 | 2.08 | 2.30 |
| Shanghai GK-II | 0.33 | 1.10 | 1.48 | 2.24 |
| Tian Jing | 0.36 | 1.22 | 2.65 | 2.72 |
| aermei | 0.22 | 2.38 | 1.85 | 2.23 |

### 2.2 Discussion

With the manual processing, the resultant sensitivity is faster and average gradient steep. When the performance of an x-ray film is being determined by visible light exposure. For example, Shanghai GK-II. The characteristic value of the x-ray film obtained with manual processing and automatic processing by visible light exposure are shown in table 5.

**Table 5**

| Processing | Dmin | S | G |
|---|---|---|---|
| Manual | 0.11 | 59 | 2.16 |
| Automatic | 0.15 | 51 | 1.99 |

So is the import film. The results prove clearly that the performance of an x-ray film with automatic processing does not develop. According to the radiographic condition, the technician may compensate performances for under or over radiography using particularly manual processing and obtained the image satisfied diagnostic.

The performance of the film-screen combination of an x-ray film was tested by Bootstrap method, resultant sensitivity and average gradient was different between manual and automatic processing. Some was not very different. Because the x-ray radiated by an x-machine is not steady. The exposure is not identical one after another. There is the error of 7% of x-ray machine abroad. There is the error of 10% of domestic x-ray machine i.e. it is impossible for exposing value of the second exposure to be twice that of the first exposure. There is the error of 7% between two exposing value. The error of 7% plus the error of "artificial plotting method" equals error of 10%. The sensitivity obtained with manual processing faster than 30% that with automatic processing for Konica x-ray film, even though there is the error of 10%. The average gradient obtained with automatic processing general is smooth. Min. density is about the same with manual and automatic. It has proved that the performance of film-screen combination of an x-ray film can't thoroughly develop with automatic. It is difficult to get the high quality of x-ray picture with automatic processing. The same to black-and-white photography, manual processing better may be used, so that x-ray picture of a lot of information was obtained.

## 3. Conclusion

3.1 The performances of x-ray film-screen combination are different using different procedure when the performances of x-ray film-screen combination are being determined by Bootstrap method.

3.2 The performances of film-screen combination of an x-ray film can't thoroughly develop with automatic. Manual processing better may be used, so that the x-ray picture of a lot of information was obtained.

## References

1. International Standard ISO 9236-1
2. He Guang Qian etc. *Photographic Science and Photochemistry academia Sinica* 1986.8 p8-11
3. International Standard ISO 5799 – 19