DIRECT DIGITIZER

AeroDR SYSTEM
AeroDR SYSTEM 2

Technical Commentary/ Image Adjustment Manual

CE 0197 CE ⓘ

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Introduction

This technical commentary explains to users characteristics of AeroDR SYSTEM and image processing that are not explained in the user manual.

It is our hope that this manual will assist in understanding AeroDR SYSTEM operations and using the equipment more effectively.

* While this text primarily uses the roentgen as the unit for expressing X-ray dose, in light of integration with international units and trends, air kerma is also noted.
A conversion factor of 1mR=8.7μGy is used.

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Chapter 1 Outline

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1.1 Digital Conversion of X-ray Images

X-ray images are converted to digital data through a 2-step process of sampling and quantization.

Each of the 2 processes determines 2 basic properties of digital images: spatial resolution and density resolution.

1.1.1 Sampling and Spatial Resolution

Sampling refers to the discrete division of a spatially connected signal into pixels at set intervals, with sampling pitch referring to the interval between neighboring pixels.

Spatial resolution is used as an index to denote the degree of fineness to which space in the image can be resolved. Here the number of pixels per unit length of the image, which can be derived from the inverse of the sampling pitch, is used as the value.

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Pixel: The smallest element of a sampled image. Each pixel is located on a sampling coordinate point.

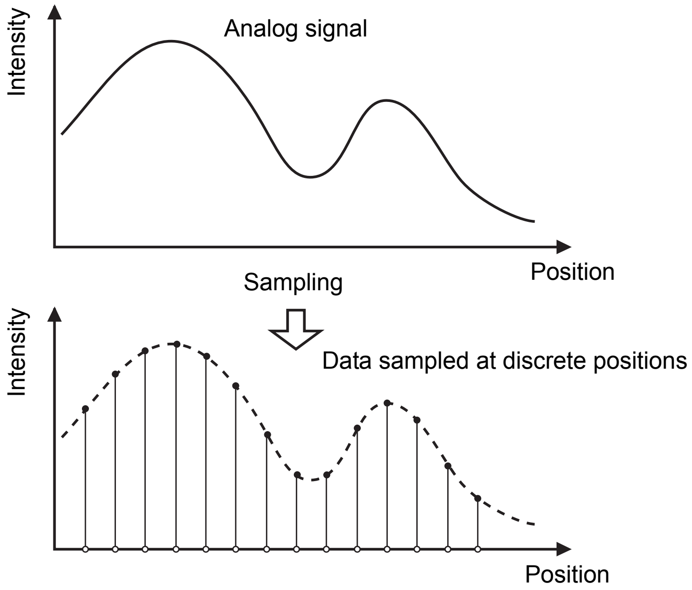

Figure1-1 Sampling

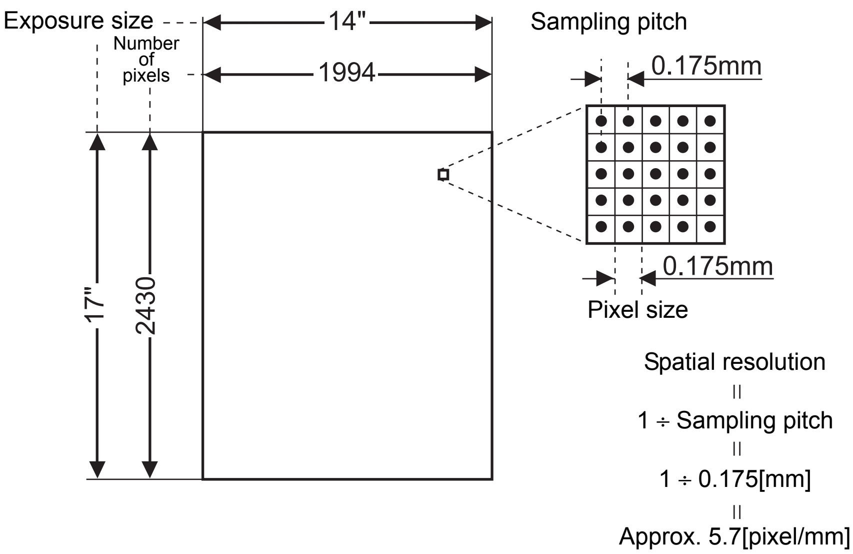

Figure1-2 Sampling pitch and pixel size

The following images show examples of an original image sampled at different resolutions.

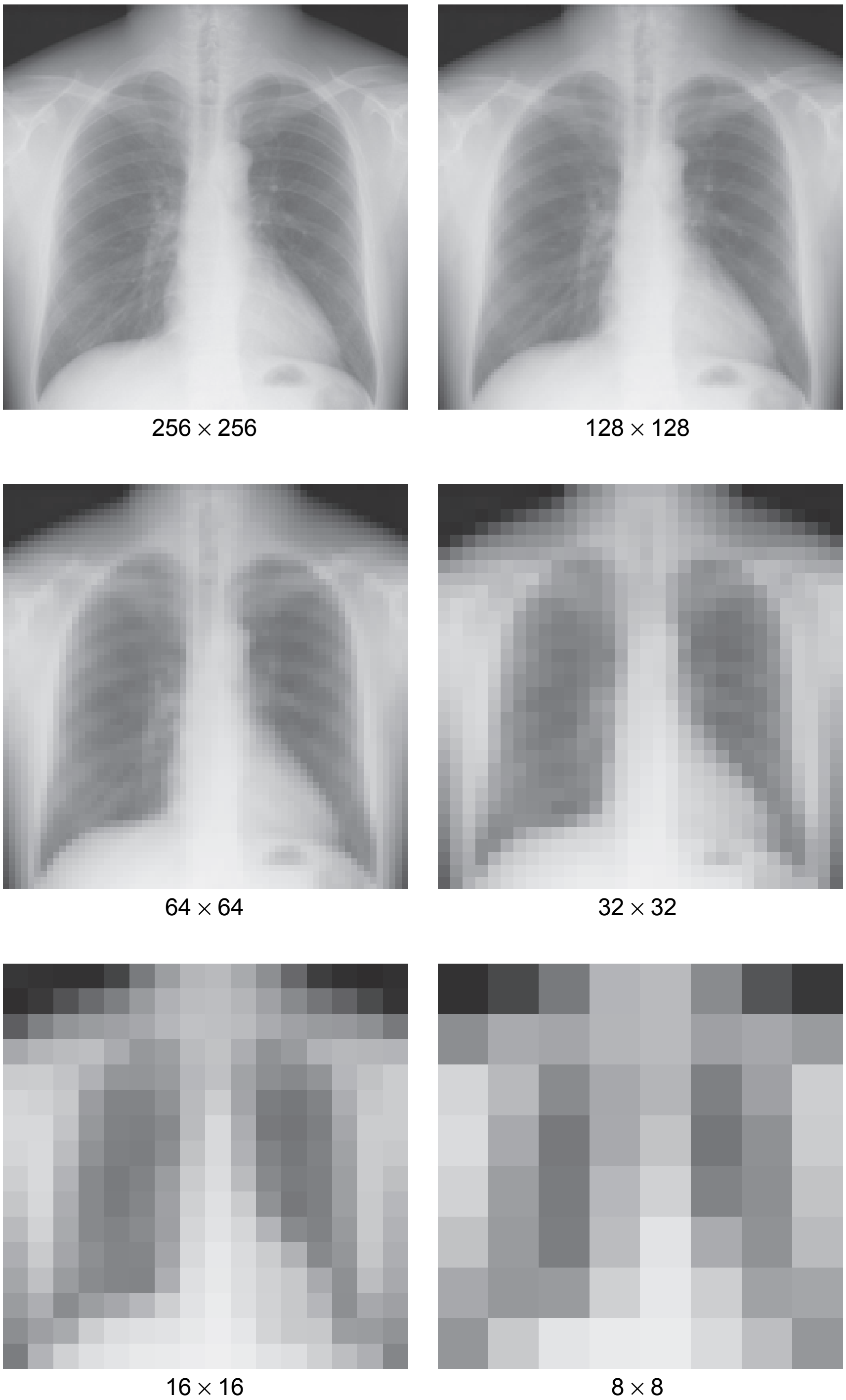

Figure1-3 Number of pixels and image quality

1.1.2 Quantization and Density Resolution

Quantization refers to the rounding and digitizing of the signals within the pixels spatially divided by sampling.

The values derived through digitization are known as pixel value, gray level, or quantization level, and the number of values that the digitized values may take is known as the number of gradations (also number of gray levels and number of quantization levels).

Density resolution is an expression used for the index denoting the degree of fineness to which shading in the image can be resolved, but is generally used as a synonym for number of gradations.

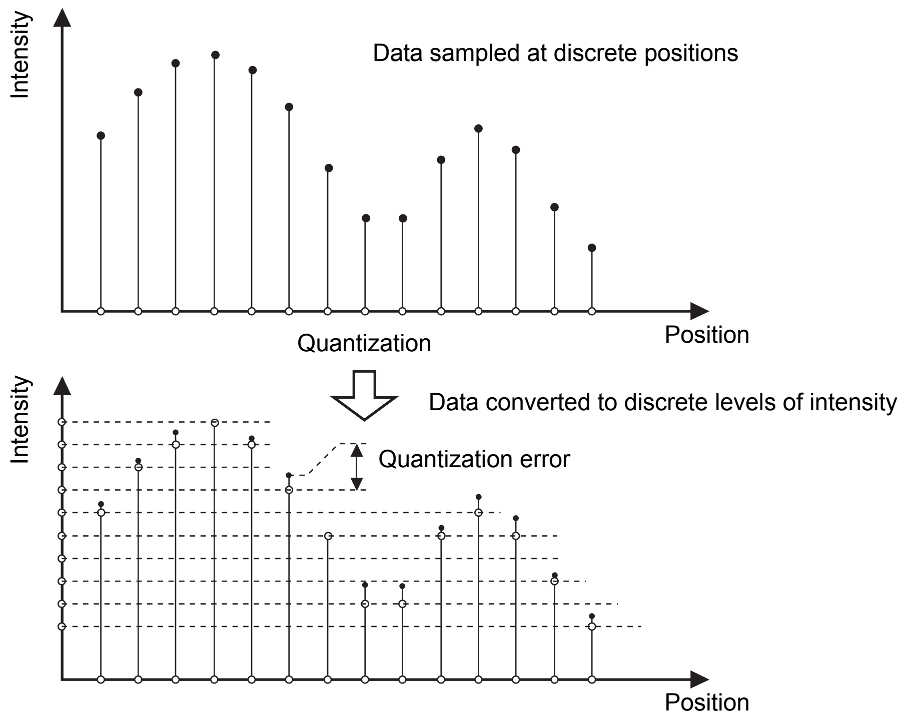

Figure1-4 Quantization

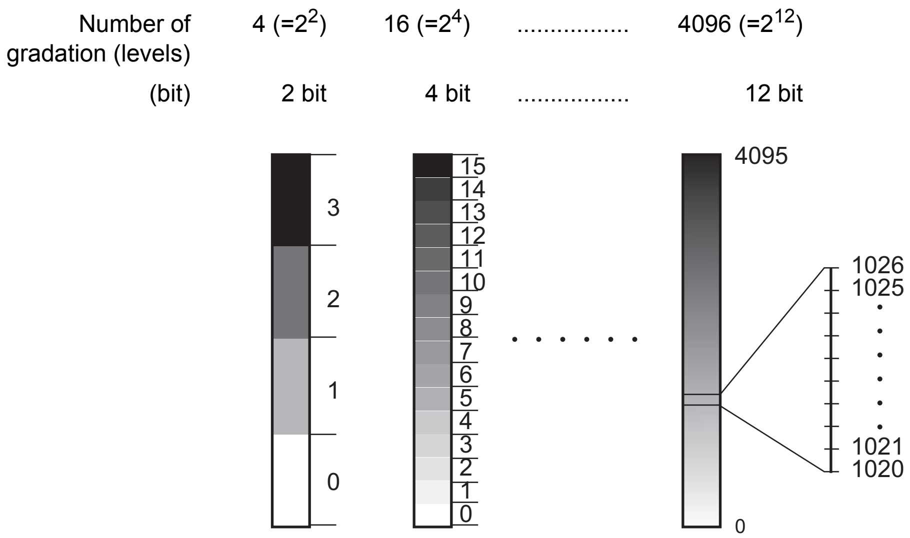

Figure1-5 Number of gradation levels

The lower the density resolution (i.e., the fewer the number of gradations), the worse the ability to express shading in the image, and the greater the likelihood of false contours appearing.

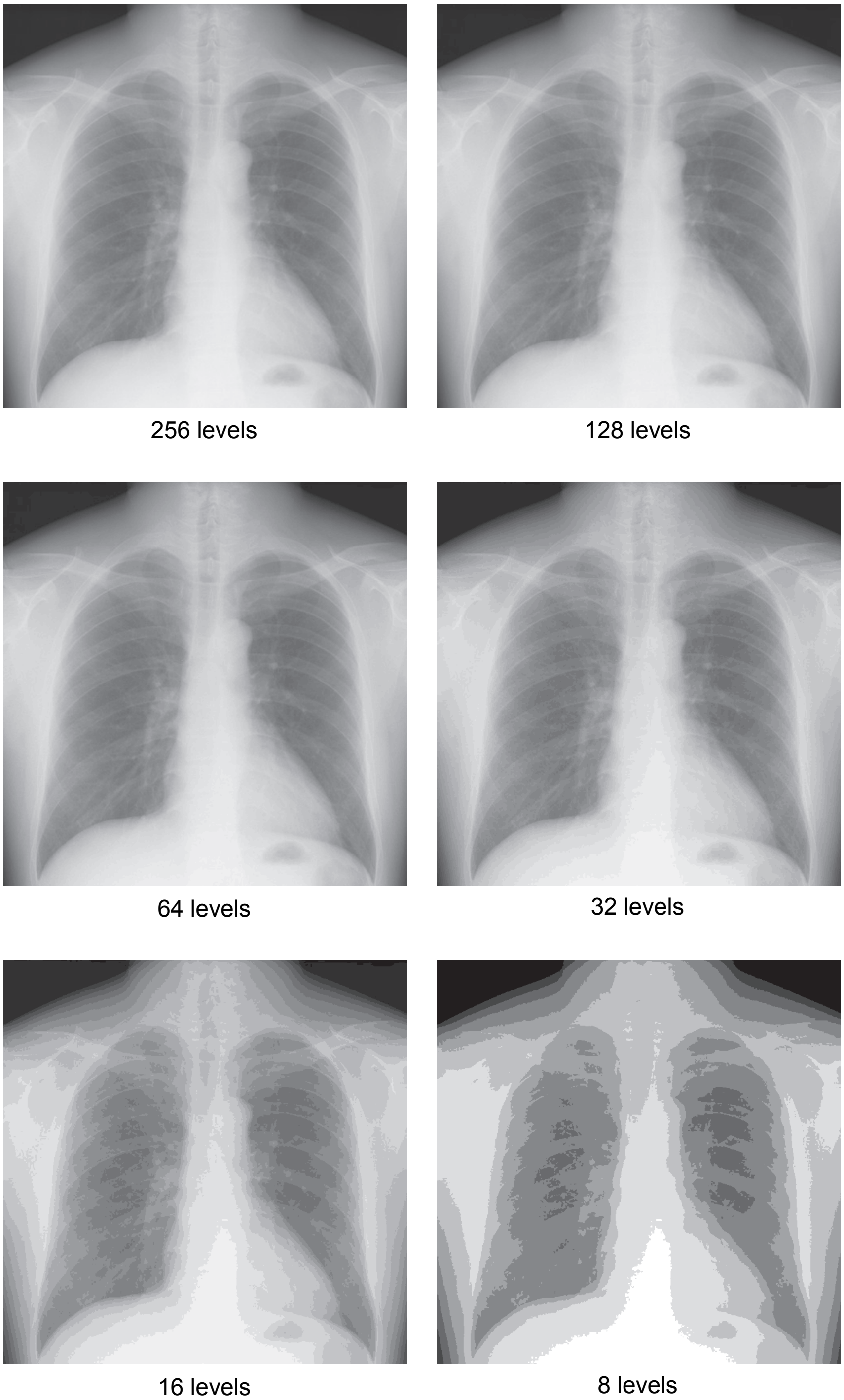

Figure1-6 Number of Gradation Levels and Image Quality

In X-ray images, a 10-bit (1024 gradations) to 12-bit (4096 gradations) number of gradations is generally considered sufficient to avoid deterioration of the image by quantization.

1.1.3 Image Data Size

When an X-ray image is digitized, the size of the image data (amount of data) can be derived through the following formula.

Image data size = Pixels in horizontal direction × Pixels in vertical direction × Bits per pixel

The AeroDR SYSTEM handles images using a 12-bit number of gradations, but as the data processed by standard computers is managed in 8-bit units, the system handles each pixel as 16-bit data.

The amount of data per single half-size AeroDR image is as follows.

1994 × 2430 × 16 = 77526720 [bit]
9690840 bytes [B]
Approx. 9464 kilobytes [kB] (9463.7109375 kB)
Approx. 9.2 megabytes [MB] (9.24190521240234375 MB)

Chapter 2

Indirect Conversion FPD Technology

The AeroDR SYSTEM is a DR SYSTEM using indirect conversion FPD.
While there are several methods of FPD in use, the indirect conversion method features a balance between image quality and ease of use.
The remainder of this chapter will introduce the features of the AeroDR SYSTEM directed at imaging.

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2.1 AeroDR SYSTEM Structure and Imaging Process

The primary image reception functions of the AeroDR SYSTEM are performed by the scintillator and the TFT sensor panel.
The scintillator and TFT sensor panel are positioned opposite each other, encased in sealing material to preserve contact while protecting the scintillator from moisture.

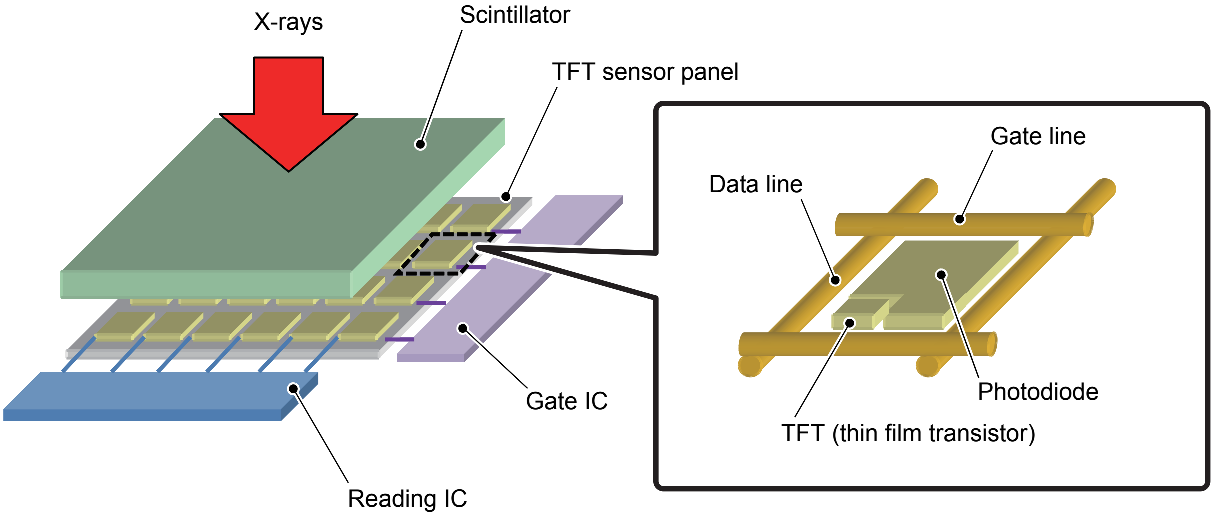


Figure2-1 Structure of the indirect conversion method X-ray plane sensor

The scintillator and TFT sensor panel, as an assembly, are affixed to a base along with the various control board and power source components, and are consolidated within the body.

X-rays reaching the detector surface are converted by the scintillator to light in the visible spectrum, and are extracted as electrical signals via the TFT sensor panel. While the electrical signals pass through the AD converter and become pixel distribution data converted to signal values, after subsequent image correction processing by the CS-7, the image is completed through the application of image processing suitable for the portion exposed.

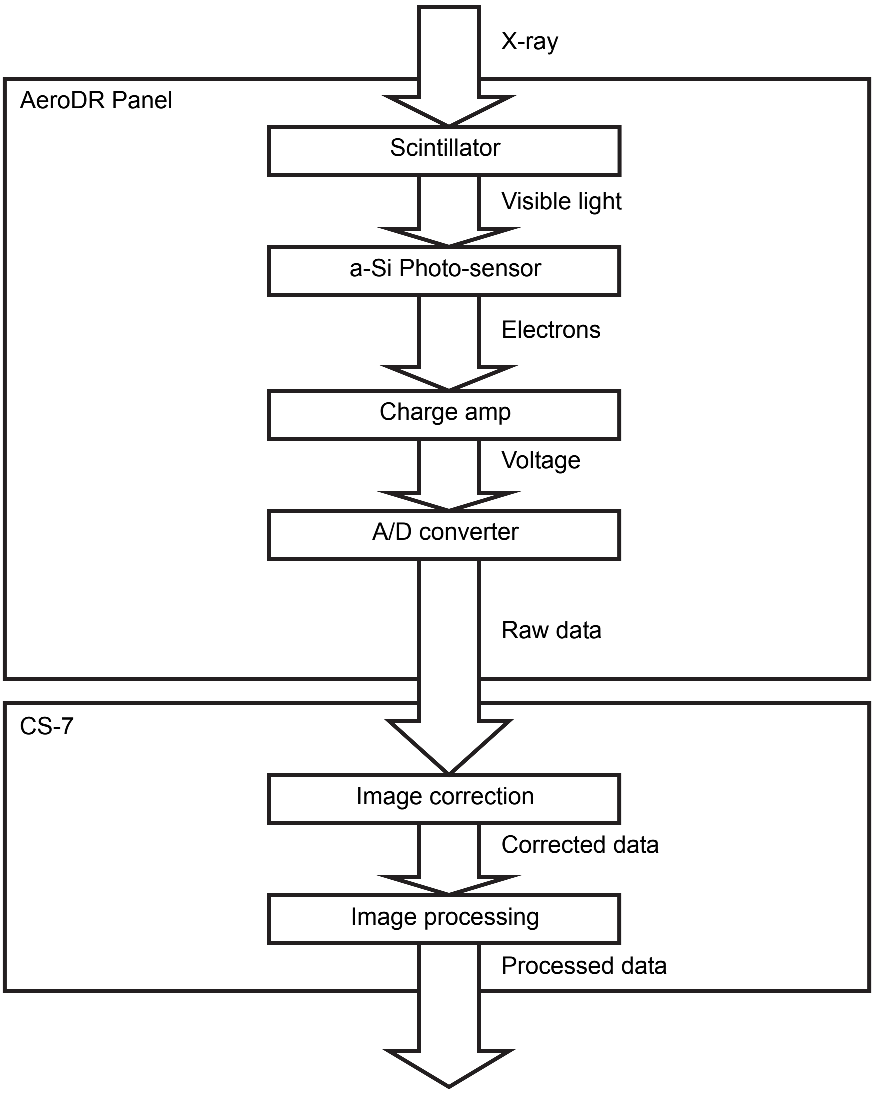


Figure2-2 Imaging Process

2.1.1 Scintillator

The scintillator uses CsI:Tl columnar crystals.

As these are highly reliable and widely used in X-ray I.I and other devices, and offer high sharpness through the light guide effect inherent in columnar crystals, they increase X-ray adsorption through thick film, and facilitate improvement in DQE.

An photostimulable phosphor plate photostimulated luminescence (emission generated by accumulation of X-ray irradiation information and subsequent photostimulation excitation) is used in CR, but FPD, like screen and film systems, uses an instantaneous emission (emission generated during X-ray irradiation).

2.1.2 TFT sensor panel

The TFT sensor senses and samples light emissions from the scintillator, and is composed of a photodiode that accumulates light emitted from the scintillator as an electric charge, and a TFT for reading the accumulated charges. It is manufactured in the same way as the TFT panels used in active matrix LCD displays.

2.1.3 Reading and AD Conversion of Electrical Charges

On the TFT sensor panel, each pixel generates an electric charge proportional to the amount of light emitted from the scintillator.

The electric charges are read via the TFT switching action controlled by the gate IC, and are converted to voltage signals by the reading IC. This is further quantized to 16 bits by the AD converter, by which a digital signal is obtained.

2.2 Image Correction

The AeroDR SYSTEM performs the correction processing discussed below to facilitate the use of the FPD's features in the clinic.

2.2.1 Offset/Gain Correction

The sensitivity and offset characteristics with respect to the dose differ by individual pixel. To compensate for these, offset/gain correction is performed, subtracting offset data and multiplying gain data.

2.2.2 Defect Correction

The FPD contains defective pixels (on which offset/gain correction cannot be performed) which result from the manufacturing process. Correction for these is performed using information for the normal surrounding pixels.

2.2.3 Logarithmic Conversion

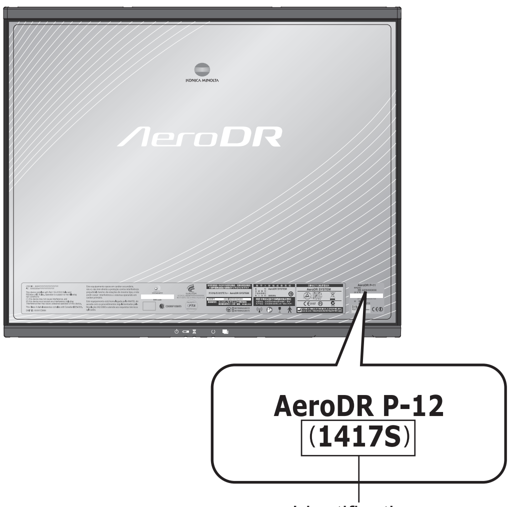
While the AeroDR SYSTEM can obtain output from the AD converter in proportion to the exposure dose, in order to make effective use of the image processing technology built up through REGIUS, the output pixel values are converted to logarithmic values, and are converted from 16-bit to 12-bit gradations.

2.2.4 Grid Moire Removal

In general radiography, a density of 34-60 lines/cm is commonly used. When these grids are combined with a FPD with pixel intervals of over 100 microns, the grid stripe structure is incorporated as a moire. Additionally, as the grid stripe structure is spatially rectangular, it has high level frequency components in addition to the frequency corresponding to the grid density. For this reason, these high level frequency components are also incorporated into the image as Nyquist frequency aliasing.

The AeroDR SYSTEM is compatible with the 40 lines/cm or 34 lines/cm grids commonly used in cassette exposure. Even if these grids are used, the moire pattern is detected and removed, lessening the moire while reducing the effect on subject information to the minimum.

* For an AeroDR 1417S without the "1417S" identification, only 34 lines/cm grids are supported.



Identification

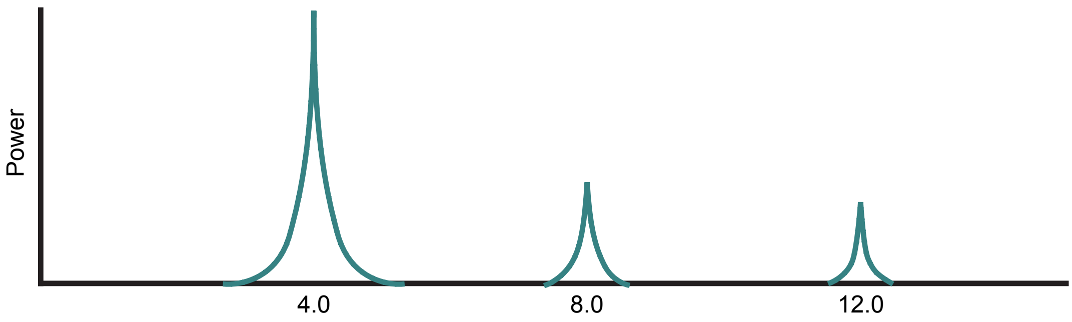


Figure 2-3a Grid Frequency Characteristics

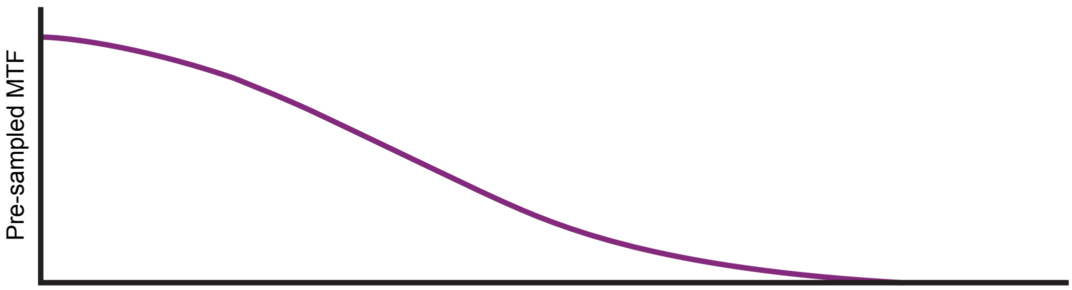


Figure 2-3b Detector Pre-sampled MTF (scintillator MTF × aperture MTF)

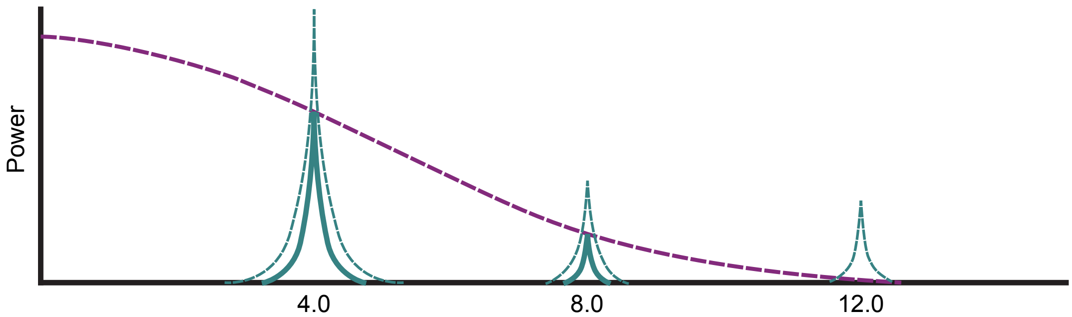


Figure 2-3c Frequency characteristics of grids modulated by MTF

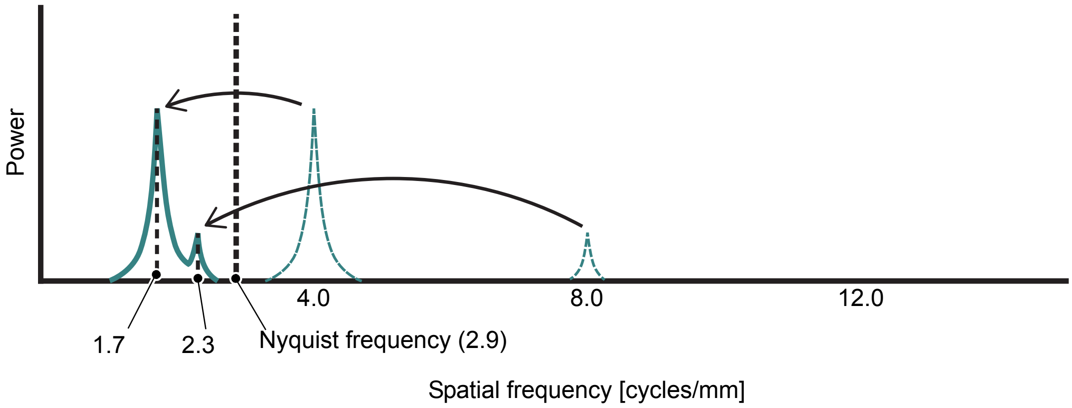
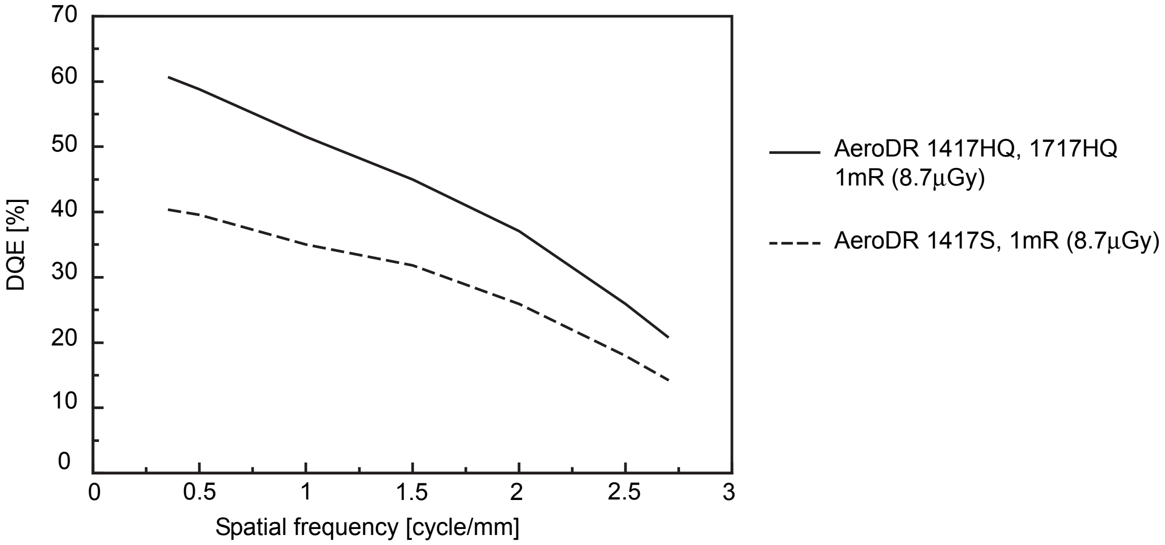
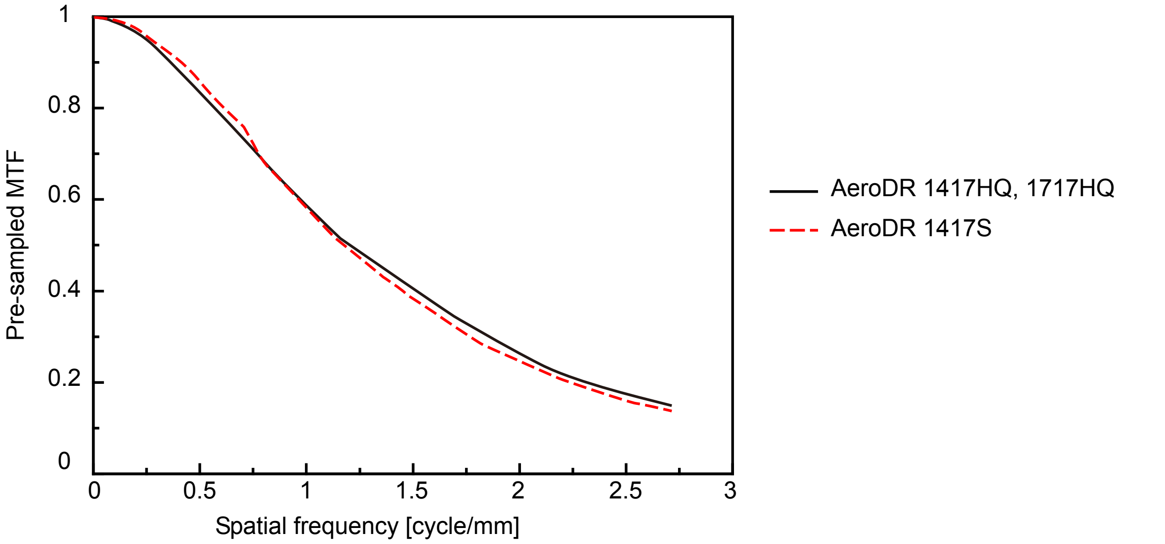


Figure 2-3d Grid frequency characteristics after sampling

2.3 Image Quality

The DQE and MTF graphs are shown below.





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3.1 Basics of Image Processing Technology

X-ray images read by the AeroDR SYSTEM are sent to the CS-7, after which image processing is performed on the CS-7 side according to the exposure parameter keys selected prior to exposure.

The CS-7 mainly has 4 types of image processing functionality: automatic gradation processing (G processing), and hybrid processing (H-F processing, H-E processing, and H-S processing).

Of these, automatic gradation processing is indispensable for the output of images suitable for diagnostic use.

Conversely, frequency enhancement, a basic form of frequency processing (F processing), and hybrid processing, which expands equalization processing (E processing), are additional forms of image processing applied according to the body part concerned, posture, diagnostic purpose, and the request from physicians. (F processing ang E processing can be used in CS-7.)

3.2 Automatic Gradation Processing

3.2.1 Explanation of Automatic Gradation Processing

Automatic gradation processing is a method of image processing in which the optimum gradation processing conditions are automatically determined for each separate image so that adjusting the gradation of the images in accordance with those conditions results in stable output of images with density and contrast suitable for diagnosis.

Automatic gradation processing serves two purposes as follows.

Obtain a constantly stable and complete image output regardless of the subject's physique and fluctuations in X-ray exposure dose

With earlier screen/film systems deviations from the proper exposure range (under exposure or over exposure) results in images unusable for diagnosis (Figure3-1a).

By contrast, the response from the AeroDR SYSTEM possesses excellent linearity over a wide range of X-ray exposures. Therefore, acquisition of image signals presents no issues even when there is some fluctuation in the arrived X-ray dose at the detector, due to variation in subject's physique or irradiation conditions (Figure3-1b).

However, in order to obtain good output images, it is necessary to compensate for the variations in the intensity of the incident X-rays so as to ensure that appropriate density and contrast are maintained at all times. For this reason for each image, the image data needs to be analyzed so that appropriate gradation processing conditions can be determined.

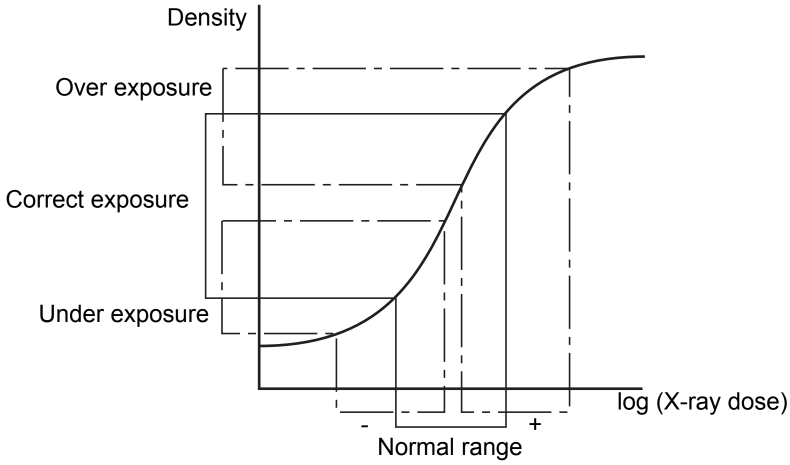


Figure3-1a Density characteristics of screen/film systems

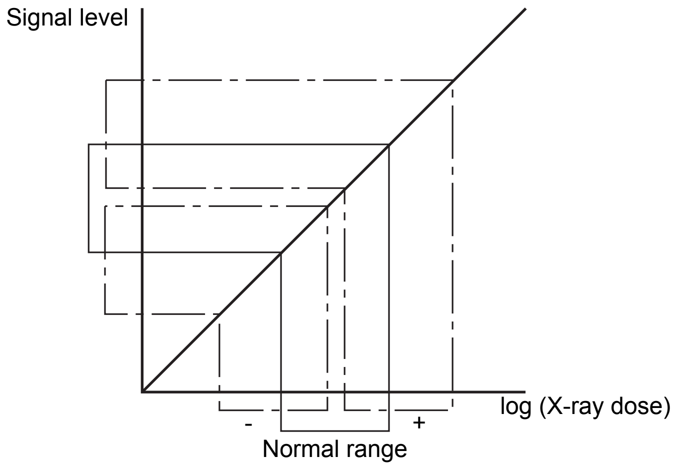


Figure3-1b AeroDR SYSTEM signal characteristics

The gradation characteristics of the image signal obtained from the AeroDR SYSTEM photostimulable fluorescent detector need to be converted to the non-linear characteristics of an X-ray image diagnostic system.

The image signal obtained by the AeroDR SYSTEM is proportional to the logarithmic value of the arrived X-ray dose as is shown in Figure3-2a.

In film terminology this is $\gamma = 1$ gradation characteristic and if this signal was to be output as is, it would result in an image which would be difficult to use for diagnosis due to insufficient overall contrast. As a countermeasure, to ensure sufficient contrast in the signal range important for diagnosis, the image signal is converted to the non-linear gradation characteristics shown in Figure3-2b.

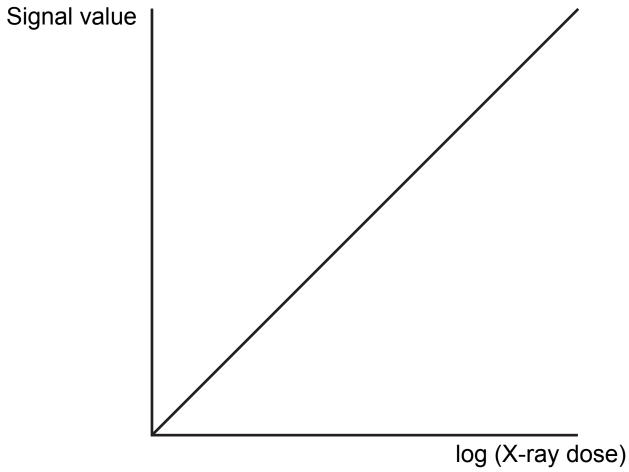


Figure3-2a AeroDR SYSTEM signal characteristics

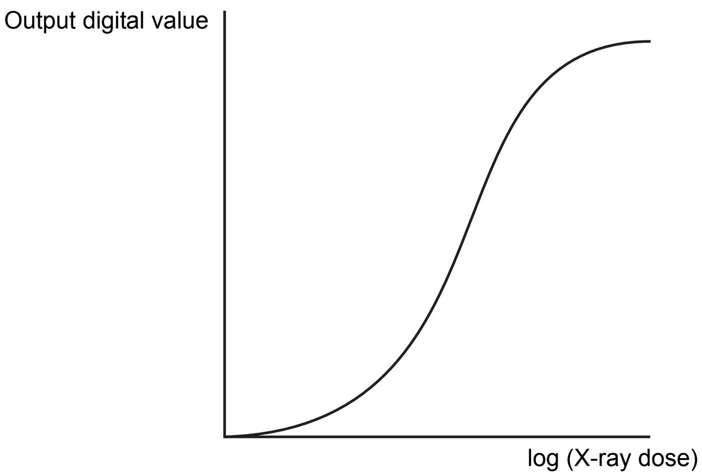


Figure3-2b AeroDR SYSTEM post-gradation processing characteristics

3.2.2 LUT

The AeroDR SYSTEM's automatic gradation processing converts the image signal using a LUT (Look Up Table) whose input and output signals have a relationship similar to that shown in Figure3-3.

As can be seen from the figure, the LUT has a characteristic curve resembling those of screen and film systems.

To allow appropriate automatic gradation processing to be performed for a wide variety of exam body parts and physiques, AeroDR SYSTEM has been provided with Look Up Tables with various curve shapes.

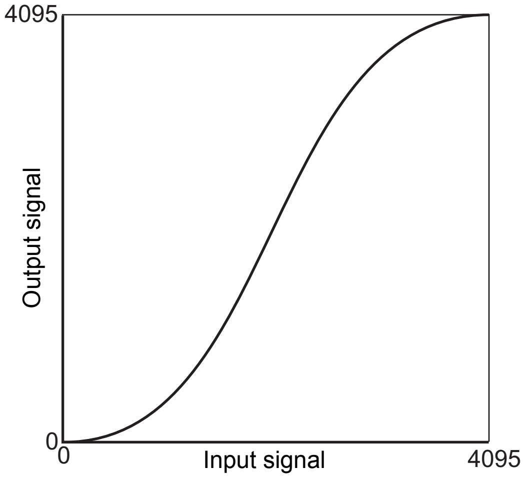


Figure3-3 Example of AeroDR SYSTEM LUT

3.2.3 Algorithm for Automatic Gradation

Figure3-4 shows the automatic gradation processing flow in the AeroDR SYSTEM.

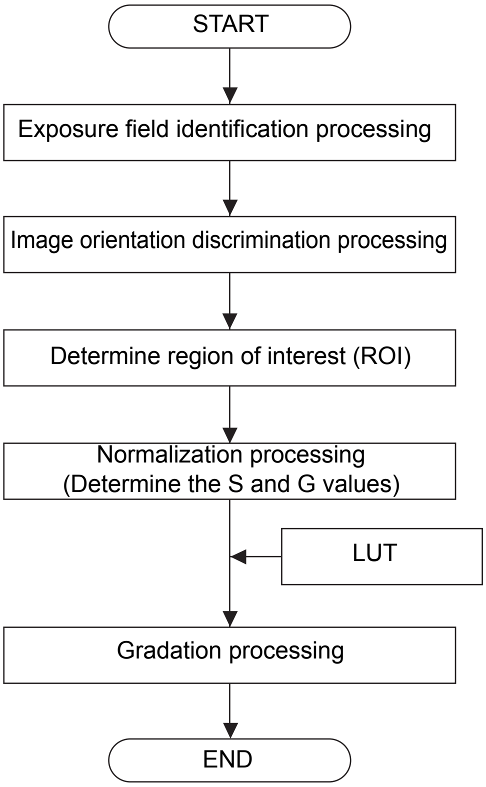


Figure3-4 Flow diagram for automatic gradation processing

In the AeroDR SYSTEM, even after automatic gradation processing, the raw image data (image data prior to processing) and the image processing parameters (normalization processing parameters and LUT parameters) are stored separately, allowing processing to be performed any number of times under differing image processing parameters.

Furthermore, the raw image data, image processing parameters, and processed image data etc., can be flexibly output to other environments.(Refer to "5.2.1 Online Output Function")

Exposure Field Identification

Exposure field identification is the processing that extracts and defines the range of the exposure field from the entire image data (or in the case of partition exposures, the region of the partition) obtained by the AeroDR SYSTEM.
The purpose of exposure field identification is the prevention of negative effects on the setting of image processing parameters for automatic gradation processing, due to signals that are outside the exposure field and that are unneeded for diagnosis.

The basic concepts behind the AeroDR SYSTEM's methods of exposure field identification are indicated in Figure3-5.

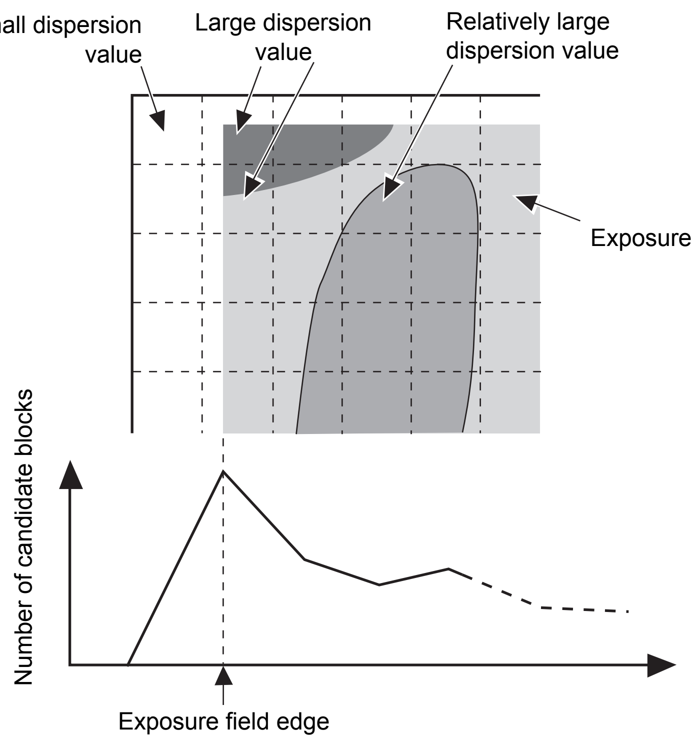


Figure3-5 Exposure field identification

(1) Divide the image into small blocks and compute a dispersion value for each block.
(2) Blocks containing the edges etc. of the exposure field will have large dispersion values.
Use this Characteristic to select blocks with large dispersions as candidate blocks.
(3) Find areas in which many candidate blocks form a straight line and take this to be an exposure field boundary.
(4) Take the rectangular area surrounded by the exposure field boundaries as the exposure field.

The AeroDR SYSTEM chooses from among multiple exposure field identification algorithms according to the body part set in the exposure parameter keys.

For the types of exposure field identification used by the AeroDR SYSTEM, refer to "Data 1 Exposure Field Identification Types" at the end of this chapter.

Image Orientation Discrimination Processing

Image orientation discrimination processing determines the orientation of the body part in the image and rotates the entire image as required by circumstances.
As an example, if the AeroDR detector is used in horizontal orientation as shown in Figure3-6b, the orientation of the body within the read image will be horizontal. This will be automatically detected, and the image will be rotated.

Figure3-6a Vertical exposure

Figure3-6b Horizontal exposure

As a result, images are displayed on the CS-7 console panel or external devices so that the parts nearer the head appear at the top, allowing easy image confirmation and diagnosis.
Discrimination of subject orientation is performed by dividing the image into nine blocks as shown in Figure3-7 and comparing the typical value for each of the shaded blocks determined by statistical methods.

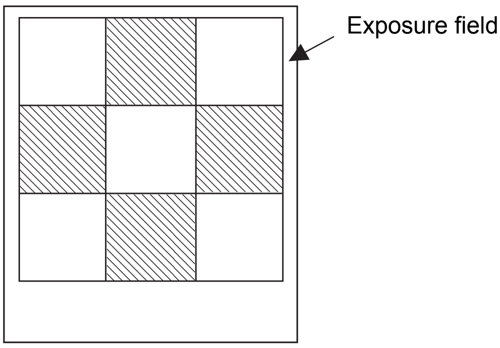


Figure3-7 Blocks used for image orientation discrimination processing

* However, this processing is limited to the following body parts:

- Chest PA/AP
- LAT chest
- New born/PED chest and abdomen
- Abdomen PA/AP
- Pelvis PA/AP
- Both hip joints

Setting the Region of Interest (ROI)

After identifying the exposure field range, the image data within the field is analyzed and the region of interest (ROI) is identified.

To ensure that the region of interest (ROI) matches the body part to be observed, the AeroDR SYSTEM selects from among different ROI identification algorithms according to the body part to be examined and patient physique.

For the types of ROI identification algorithms used by the AeroDR SYSTEM, refer to "Data 2 ROI Setting Algorithm" at the end of this chapter.

The different types of regions of interest (ROI) can be generally classified into two groups, each of which uses a different algorithm. Of the types shown in the table at the end of this chapter, types A to N other than M and N use algorithm (a) while types M and N use algorithm (b) as described below.

(a) Automatic extraction of a specific human anatomical structure.
(b) Selects a given area within the exposure field.

Setting Reference Signal Values

AeroDR SYSTEM analyzes the image data within the region of interest and determines one or two reference signal values.

If a chest PA/AP image is taken as an example, the maximum signal value for the lung area (H reference value) and the minimum signal value for the mediastinum area (L reference value) are selected as indices for densities in the final image. This allows achievement of densities considered desirable for the body part concerned.

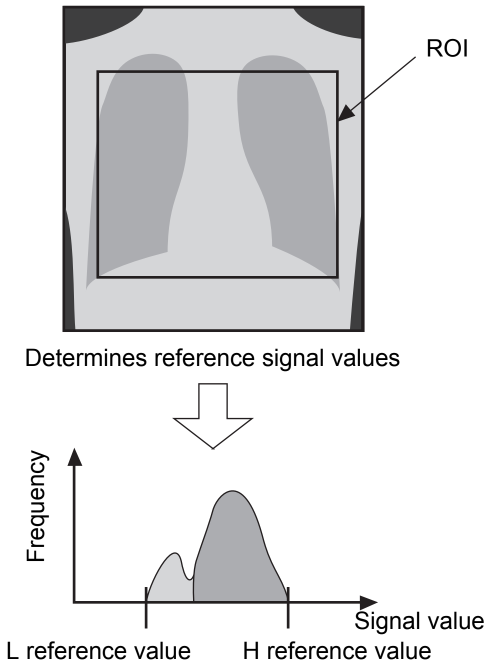


Figure3-8 Setting reference signal values (Example of Chest AP/PA)

The reference section "Data 2 ROI Setting Algorithm" at the end of this chapter, shows for each ROI type, reference signal values suitable for the body parts within the ROI.

These were found through statistical analysis.

Normalization Processing

Normalization processing is used to correct for variations in incident X-ray dose due to variations in subject's physique or X-ray exposure conditions etc.
To ensure that the reference signal values determined by the "Setting Reference Signal Values" match the signal values (SL, SH) determined previously, the image processing parameters (G value: contrast value, S value: density correction) are determined (calculated) and are then used to process (normalize) the image data.

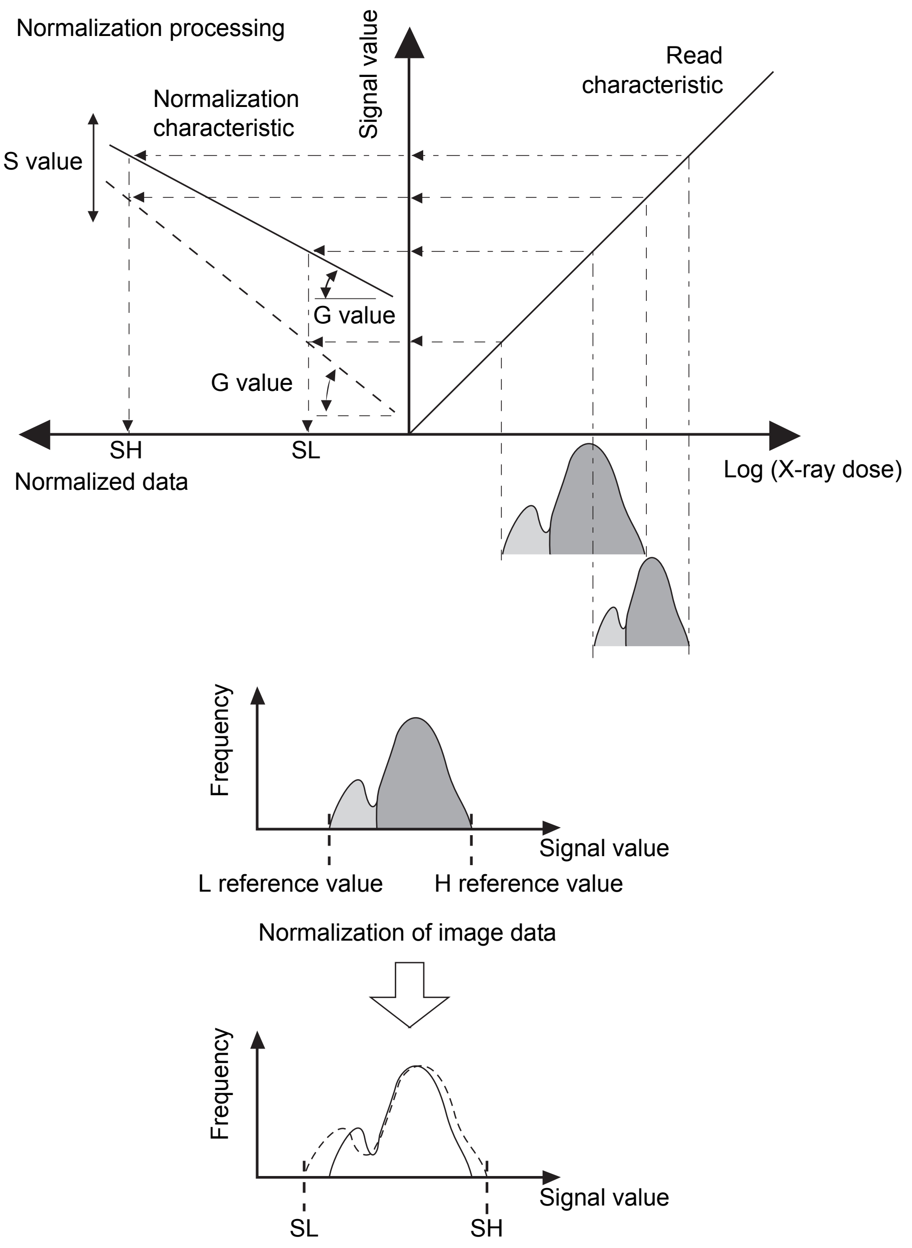


Figure3-9 Setting Reference Signal Values (Example of Chest AP/PA)

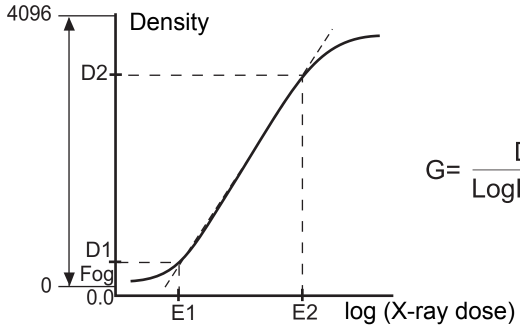
As shown in the top graph in Figure3-9, changing the value of G (the slope of the normalization characteristic) changes the range of the image data signal value which changes the contrast of the image. On the other hand, changing the value of S (the y intercept of the normalization characteristic) increases or decreases the image data signal value which changes the density of the image.

G Value:

When the patient is X-rayed under particular exposure conditions, the G value indicates the contrast of the output image obtained as the result of normalization processing. Also, this corresponds to the film γ value required when matching the reference signal value set in the ROI to the contrast specified by density DL and DH.

MEMO

The G value is given by the following equation for the characteristic curve.



$$G = \frac{D2-D1}{LogE2-LogE1} \quad \begin{bmatrix} D1 = 0.25 + Fog \\ D2 = 2.0 + Fog \\ Fog = 0.2 \end{bmatrix}$$

S Value:

When the patient is X-rayed under particular exposure conditions, the S value indicates the density of the output image obtained as the result of normalization processing. Also, this corresponds to the film sensitivity required when matching the reference signal value set in the ROI to the density specified by density DL and DH.

MEMO

The AeroDR SYSTEM correlates an arriving dose of 1mR at the detector with a reference value of 200.

Furthermore, for images output to film after gradation processing, the system notes pixels with density expressed as 1.2, and sets the actual arriving dose detected by those pixels as D (mR).

S value is defined as the ratio of 1(mR) to this D(mR), multiplied by the reference value of 200.

$S=200 \times (1\ (mR)\ /D\ (mR)\ )$

However, when the same subject is imaged using the same irradiation qualities, same positioning, and same exposure parameter keys, if the mAs value is doubled then the S value will be roughly halved.

Since the S value after the scattered radiation correction is calculated from the image that the scattered radiation correction is applied, it will be a larger value compared with the S value of the image before the scattered radiation correction is performed.

Gradation Processing

The image data that has been normalized according to the S and G values, is subjected to gradation processing based on a pre-determined LUT so as to produce an image (output signal value) with the desired gradation.

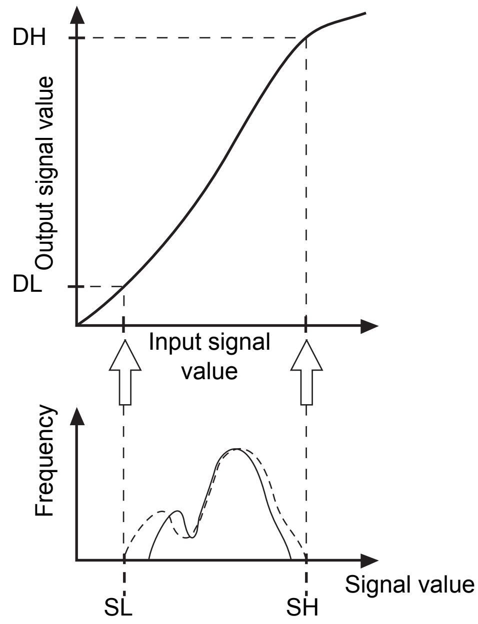


Figure3-10 Gradation processing using an LUT

As explained earlier in "3.2.2 LUT", the LUT has a characteristic curve that resembles that of screen/film systems so the output image is compatible with the output images produced by existing screen/film systems.
Figure3-11 indicates the relationship between AeroDR SYSTEM gradation processing parameters and output characteristics.

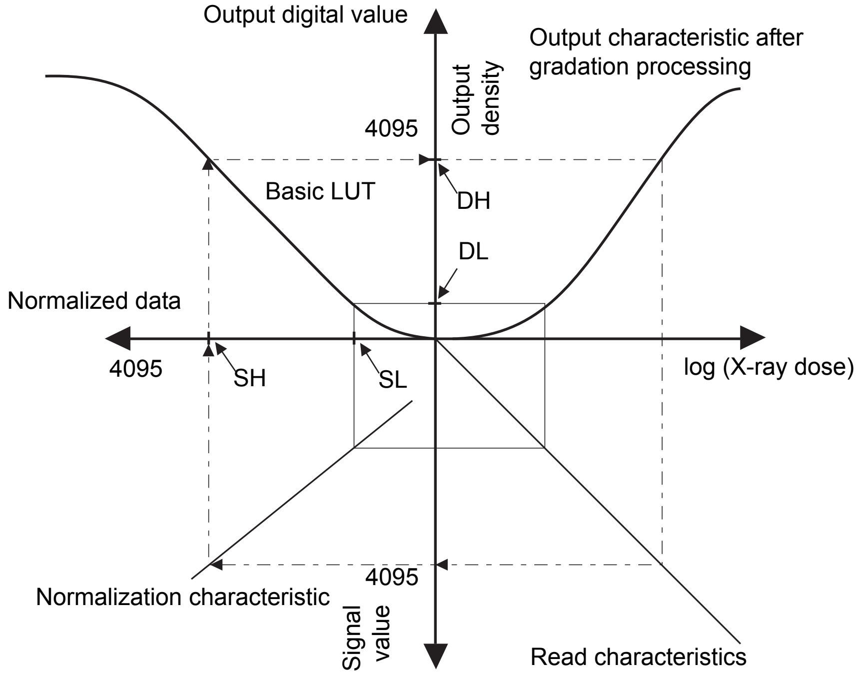


Figure3-11 Gradation processing parameters and output characteristics

3.2.4 Correcting Image Processing Parameters

The AeroDR SYSTEM has "image processing parameter edit" functions that allow the image processing parameters used with previously exposed images to be edited.

If the wrong exam tag has been selected or if the desired result is not achieved in the following automatic gradation processing or if you wish to apply a form of image processing that differs from the normal processing, you can freely change the image processing without the need to repeat the exposure.

Image processing parameters can be edited by changing the previously mentioned image processing parameters (ROI range, S value, G value, and applicable LUT) on the CS-7 console panel.

[G Value]

The value shows the contrast level, and the level increases as the G value increases. (The value represents the average gamma concentration between 0.45 and 2.20.)

- Purpose of G value adjustment: Change the value to adjust contrast levels.
  - For enhancing contrast: Increase the G value.
  - For decreasing contrast: Decrease the G value
- Notes (when G value is increased)
  - Latitude of image becomes narrower, and the low- and high-density areas may be darkened.
  - Changes in density increase with small changes in the S value (density), resulting in possible fluctuation in treatment.
  - When radiation dosage is less, image granularity is noticeable.
- General G value (reference value)
  - Chest AP/PA: 1.8 to 2.5
  - LAT lumbar vertebra: 2.6 to 3.1 (LUM - 01, BONE - 05, LUM - 02)

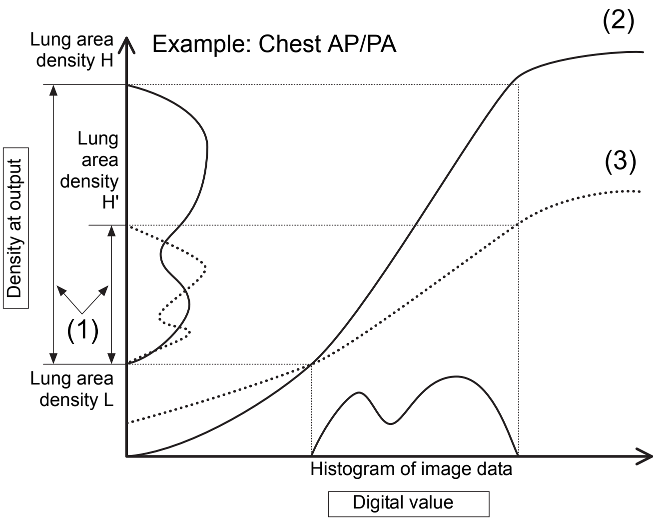
[S Value]

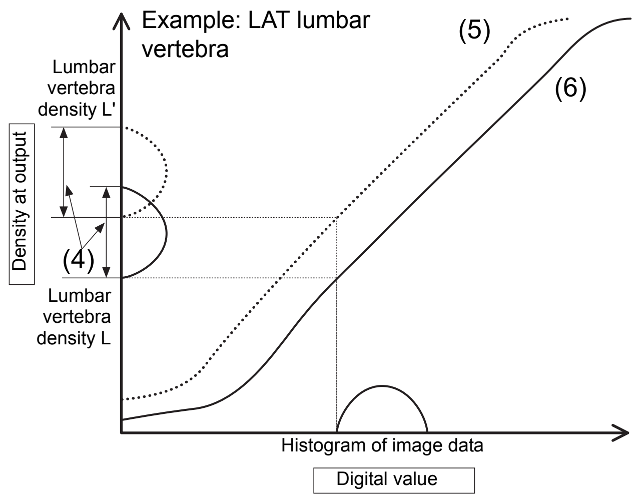
This value is equivalent to film sensitivity.

- Purpose of S value adjustment: Change the value to adjust final density.
  - For increasing the final density: Increase the S value.
  - For decreasing the final density: Decrease the S value.

Concept of Density Adjustment

Contrast-changing treatment (chest AP/PA, LAT lumber vertebra, etc)	Non contrast-changing treatment (LAT lumbar vertebra, etc)
An image that exhibits greater contrast can be obtained as the difference between the density L and the density H increases.	Because only the density changes and the contrast will not change, basic LUT or G value should be changed in order to change the contrast.





(1) When the density H is reduced to H', the contrast of the output image decreases.
(2) Output characteristics after gradation processing (not the basic LUT)
(3) Output characteristics when the density L does not change, and the density H is reduced to H'. (The higher density area of the image to output decreases and the contrast for the entire image decreases).
(4) The overall density will vary by changing the density L to L', but contrast remains at the same level.
(5) Output characteristics after changing the density to L'.
(6) Output characteristics at density L after gradation processing.

MEMO

G-value fixing processing: Processing to forcibly fix the G value of the finished image at the designated G value.

3.3 Basics of Frequency Processing

Frequency processing includes frequency enhancement processing and equalization processing.

Here, typical techniques employed in F processing (frequency enhancement processing) and E processing (equalization processing) will be explained.

3.3.1 Explanation of Frequency Enhancement Processing

Frequency enhancement processing is a form of image processing which modifies image spatial frequency characteristics, so that structures of body parts are displayed more sharply.

Since the spatial frequency components of an actual X-ray image are composed of patterns of various frequency, we can draw a graph in which spatial frequency is plotted along the horizontal axis, and signal strength (intensity) along the vertical axis. Doing this will generally result in a graph as shown in Figure3-12.

Spatial Frequency:

Spatial frequency is an index that expresses the degree of detail in a structure. For example if an image signal value had a repetitive pattern that varied sinusoidally in the form large → small → large → small...the spatial frequency would be the number of such cycles repeated within a length of one millimeter. This would be expressed in units of "c/mm" or "lp/mm".
While a coarsely repetitive pattern has a low spatial frequency, a fine pattern has a high frequency.

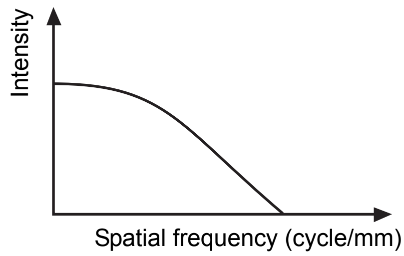


Figure3-12 Example of X-ray image spatial frequency characteristics

3.3.2 Basics of Frequency Enhancement Processing

"Smoothing mask processing" is one simple and fast processing method for spatial frequency enhancement.

"Smoothing mask processing" applies the following computations to the image data.

$$S = Sorg + \beta(Sorg - Sus)$$

S : Frequency processed image signal
Sorg : Original image signal
Sus : Smoothed image signal
β : Emphasis coefficient

First, a smoothed image signal (Sus) is derived from the original image to which one wishes to apply frequency processing as follows.

(1) As shown in Figure3-13, a square mask with sides of length (2N + 1) is centered over the pixel to be processed.

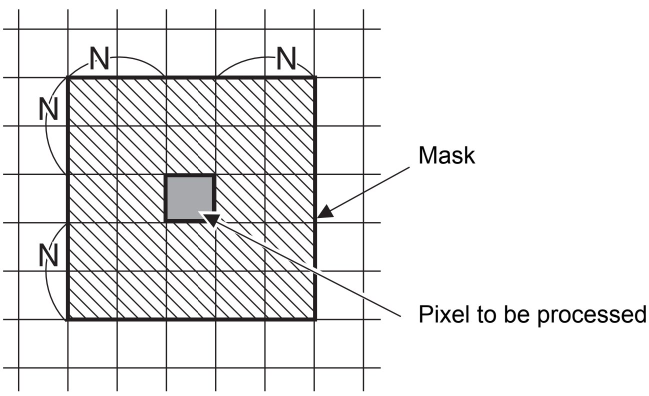


Figure3-13 Deriving a smoothed image

(2) The average value of the pixels within the mask is calculated and assigned to the central pixel as its smoothed image signal.
(3) Moving the mask one pixel at a time, step (2) is repeated for each pixel, so as to obtain the smoothed image signal for all pixels in the image.

The smoothed image obtained as a result of the above processing has a blurred appearance compared to the original image (Figure3-14a, Figure3-14b).

Next, for all pixels, the difference between the original image signal and the smoothed image signal, (Sorg - Sus) is computed. The image obtained as a result of this computation is equivalent to an image created by extracting from the original image, high frequency components of frequency higher than a certain value (Figure3-14c).

Finally (Sorg-Sus) multiplied by emphasis coefficient β, is added to the original image signal (Sorg). This produces the frequency processed image (S) (Figure3-14d).

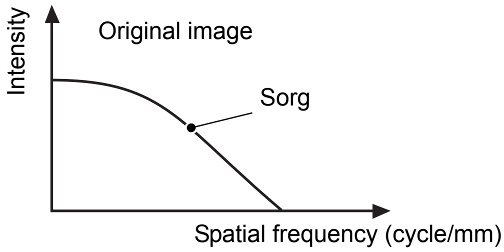


Figure3-14a

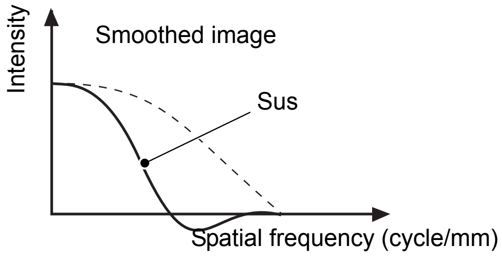


Figure3-14b

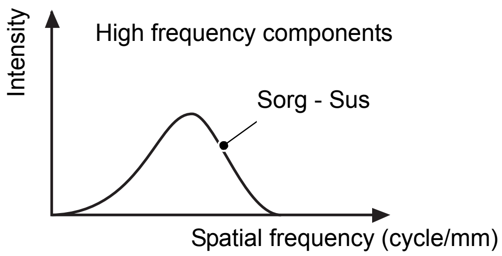


Figure3-14c

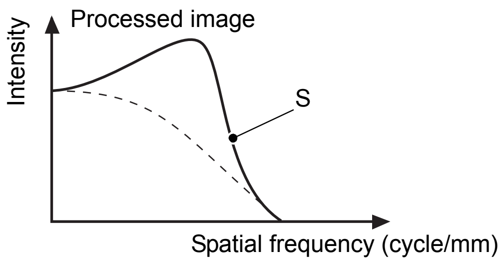


Figure3-14d

Figure3-15a to Figure3-15d below show the stages of frequency processing using a simple step pattern as an example.

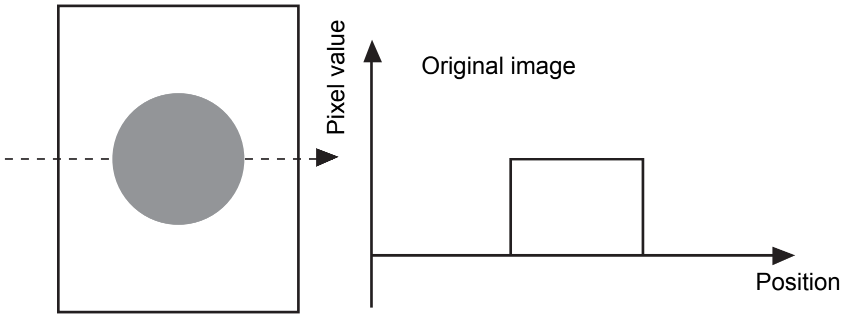


Figure3-15a

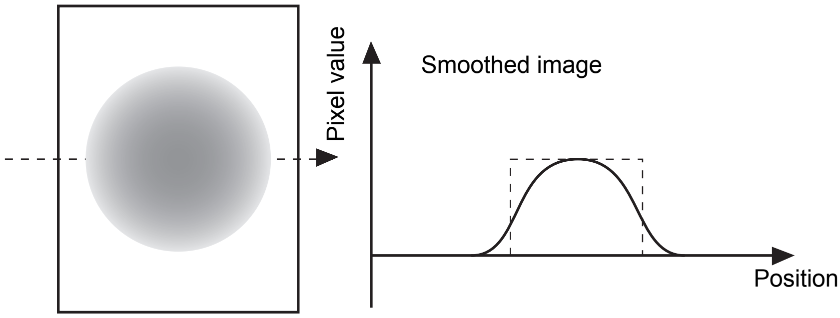


Figure3-15b

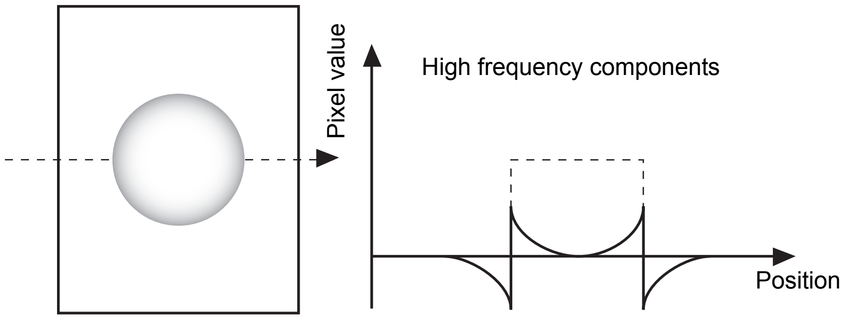


Figure3-15c

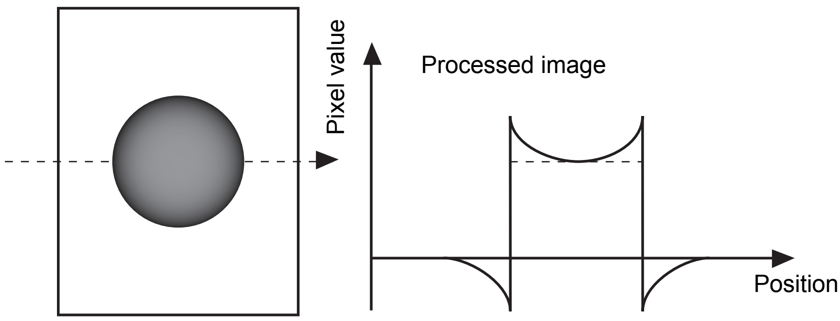


Figure3-15d

3.3.3 Explanation of Equalization Processing

During equalization processing, the dynamic range of an image signal based on a smooth image signal is reduced. This allows an image with a wide dynamic range to be converted to one with a smaller dynamic range which is easier to view.

In general, when an X-ray image is used for diagnosis, the image will contain an area of primary interest and an area of secondary interest. For example in chest PA/AP images the lung is of primary interest and the mediastinum of secondary interest. In this case, to display the lung area with good contrast the LUT needs to be set so that during gradation processing the medium to high signal levels are given a steep gradient.

However, if this is done, the mediastinum area which gives rise to a low signal level, is at the base of the characteristic curve (where the gradient is shallow) resulting in low contrast for this area.

In this way, for body parts with a wide dynamic range, it is difficult to ensure good contrast for both the area of primary interest and the area of secondary interest; even the CS-7 console would be unable to resolve this problem if it were to rely on gradation processing alone.

In this situation, equalization processing is used to bring the average density of the area of secondary interest close to that of the area of primary interest. This is similar to the role of sensitivity compensation filters used in screen/ film systems.

During equalization processing, compensation is applied to broad changes of the image signal based on the smoothed image signal of the original image, so that depictions of fine signal changes (due to structures such as bone edges etc.) within the secondary area of interest are preserved.

3.3.4 Basics of Equalization Processing

One method of equalization processing performs computations on the image per the following expressions.

$S = Sorg + f(Sus)$

$f(Sus) = \beta(A - Sus)$

However, $\beta = \beta L \ (Sus \leq A)$

$\beta H \ (Sus > A)$

S : Image signal after equalization processing

Sorg : Original image signal

Sus : Smoothed image signal

βL,β H : Correction coefficients

A : Constant

If compensation is applied to all signal values below a particular signal value (intensity) as a boundary, constant A is set equal to the boundary signal level, and βL is set equal to the correct value and βH to zero.

For this case, the relation between the correction signal (f) and the smoothed image signal (Sus) is shown in Figure3-16.

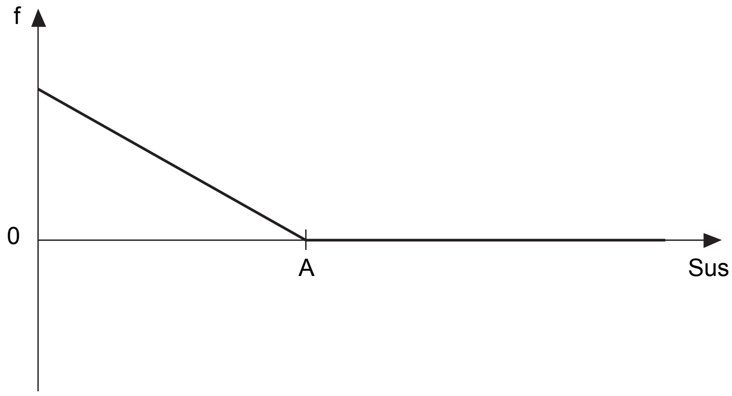


Figure3-16 Correction signal example (βL > 0, βH = 0)

The following explains the principles of equalization processing using a chest PA/AP image as an example.

(1) A smoothed image (Sus) is derived from the original image (Sorg) using the same method used in frequency processing.

(2) A correction function β (A - Sus) is sought.
Here, the aim is to compensate the mediastinum area signal without changing the appearance of the lung area, so the correction function shown in Figure3-16 is applied. The value of constant A will be set, for example, to the midpoint (50%) between the maximum value of the signal for the lung area and the minimum value of the signal for the mediastinum area.

(3) Adding the correction signal (f) to the original image signal (Sorg), will produce an equalization-processed image (S).
If the pixel values along a horizontal line through the image are graphed as shown in Figure3-17a, it will be seen that in the frequency processed graph (Figure3-17c), the average density for the mediastinum area has been increased so that it has been brought closer to the average density for the lung area, but that the local signal changes for bone edges and blood vessels within the mediastinum area have been preserved. This is because only low frequency components were used when the correction function was determined.

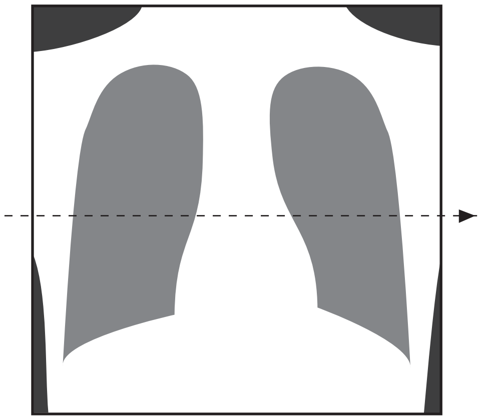


Figure3-17a

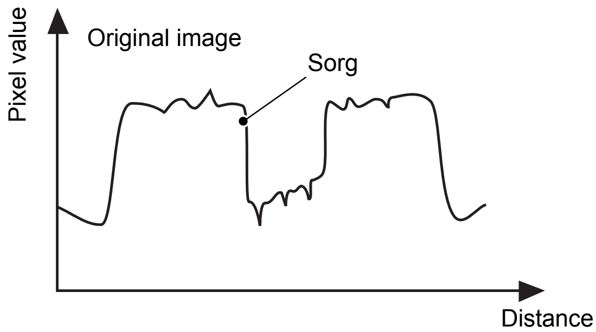


Figure3-17b

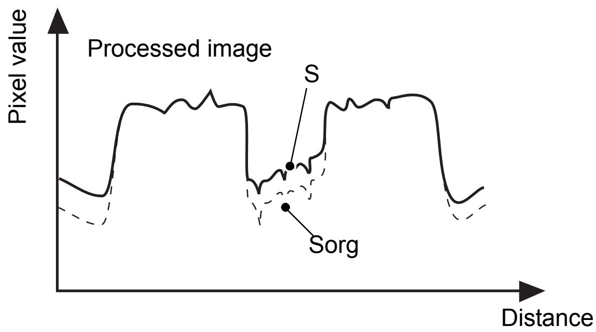


Figure3-17c

3.4 Hybrid Processing

3.4.1 Explanation of Hybrid Processing

In the CS-7, hybrid processing (H processing), which expands on the technique of frequency processing (F processing, E processing) that has been explained so far, is mainly used. This is a new frequency processing using analysis performed on the multi-resolution space of the image. It includes [H-F processing] to adjust the sharpness of the image, [H-E processing] to compress the dynamic range, and [H-S processing] to reduce the noise component.

Features of H processing

(1) Adjusting the sharpness depending on the parts and diagnostic purpose:
The conventional method only emphasizes the frequency that is most worthy of observation. But, H processing makes sufficient intensification possible from low frequency to high frequency, the former is from the soft parts or internal organs, and the latter is from bone trabeculae or blood capillaries.

(2) Enabling the diagnosis of the whole structure of the human body and lesion:
In the conventional method, overshooting or undershooting sometimes occurred in a high contrast area like artificial bone. H processing thus improves the overshooting and undershooting found in the conventional method.

(3) Compatibility of the image granularity control and intensification of human parts by frequency processing:
The conventional method slightly emphasizes the intensity in the low intensity zone in order to cope with the degradation of image granularity due to frequency processing. But, H processing is compatible with granularity control and frequency processing.

3.4.2 H-F PROCESSING

H-F processing Algorithm

Multiple images with reduced sharpness will be created from the original image. Next, they will be converted to intensity-dependent low sharpness images depending on the intensity.

Then, each frequency component will be extracted by taking the difference of neighboring frequency bands.

The extracted subtracted image will be added to the original image obtaining the intensified image for H-F processing.

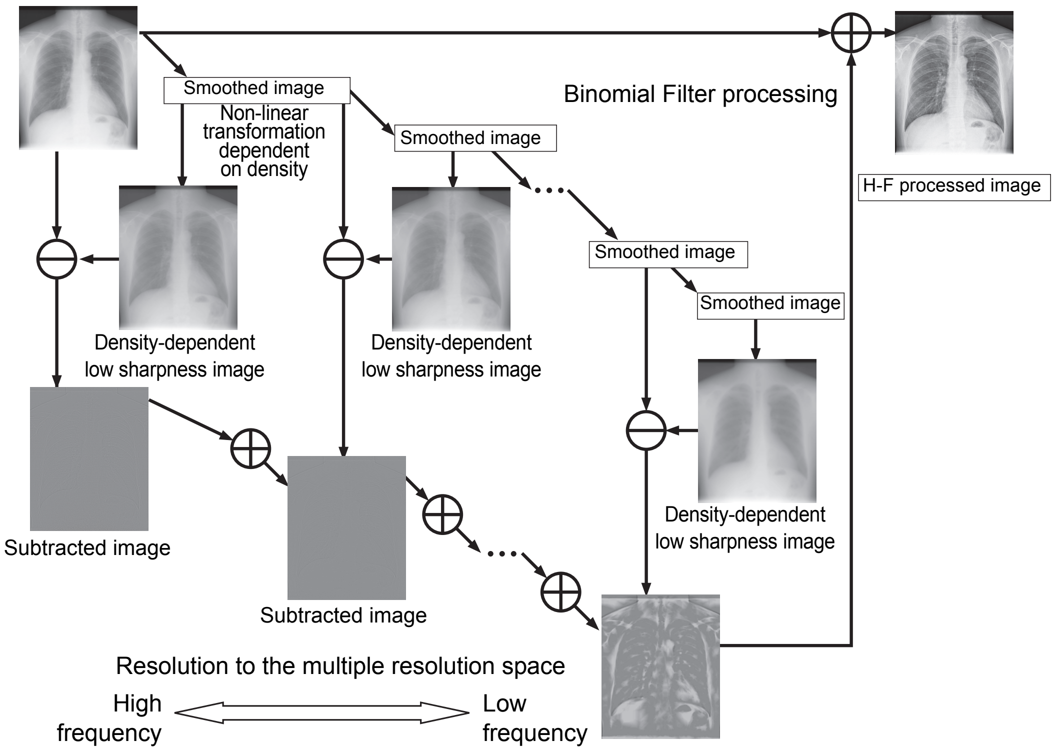


Figure3-18 Algorithm of H-F processing

H-F processing procedures

H-F Parameters (Intensified Band) :

There are six kinds of H-F parameters from HF-STANDARD 1 to HF-STANDARD 6, and they are used according to the size of the object to be emphasized.

Table3-1 H-F TYPE and its applicable parts

H-F TYPE	Major applicable area	Explanation
HF-STANDARD1 HF-STANDARD2	Abdomen Pelvis and other areas	Emphasizes the internal organs and soft organs and is effective for increasing the contrast for a whole image.
HF-STANDARD3 HF-STANDARD4	Vertebrae (backbone) of the hip joint Femur, lower leg bone, etc.	Effective in parts like the vertebrae where large bones, bone beams, and soft parts should be emphasized. Relatively general frequency characteristics.
HF-STANDARD5 HF-STANDARD6	Limb bones, cervical vertebrae (bone beams) Chest (blood vessels), head, mamma	Effective in parts like the bone beams or blood vessels where small structures or small parts should be emphasized.

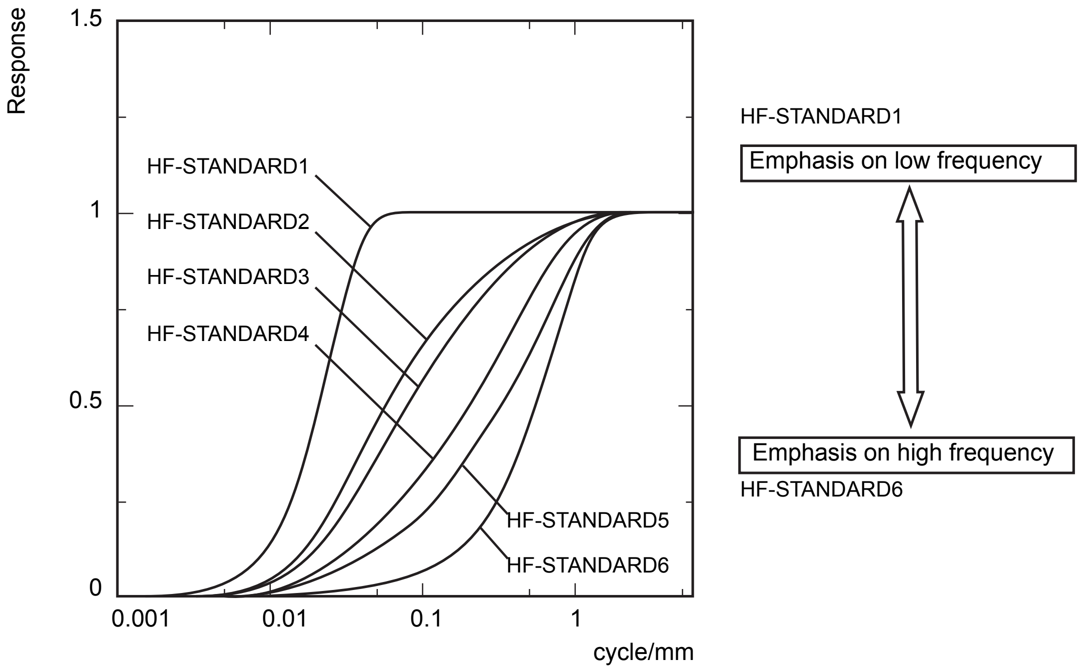


Figure3-19 H-F parameters

H-F Parameter (Enhancement Coefficient):

The emphasis coefficient β is the parameter that determines the degree of frequency emphasis, so the larger the emphasis coefficient the greater the degree of emphasis. However, if the emphasis coefficient is made large, the sharpness of the image is increased, but X-ray noise etc. is also emphasized and this may lead to observable speckling. For this reason, instead of keeping the emphasis coefficient β fixed, it is made to vary with density as shown in Figure3-20, that small values are for low densities where speckling tends to be noticeable, and larger values for higher densities where speckling is less noticeable.

Furthermore, if the emphasis coefficient is made too large, this may make an unnatural image that looks different from the one on the traditional screen/film.

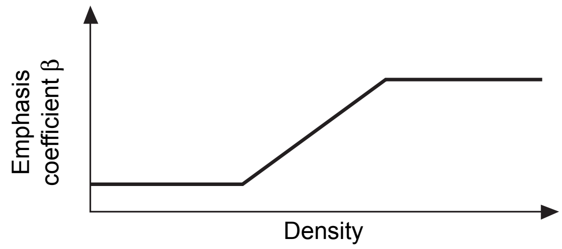


Figure3-20 Emphasis coefficient β and density

H processing adjustments

Contrast can be added to the image due to the strong intensification including low frequency.

Therefore, lower LUT than usual can be used, and it can stabilize the degradation.

- All the parts of human body can be diagnosed by controlling the degradation granularity.
- Multiple uses of H-E processing can be avoided making more natural processing possible.

3.4.3 H-E PROCESSING

Algorithm for H-E processing

Multiple images with reduced sharpness will be created from the original image. Next, they will be converted to intensity-dependent low sharpness images depending on the intensity.

Then, each frequency component will be extracted by taking the difference of neighboring frequency bands. (It is the same as H-F processing.) Extracted subtracted images are added, and it is subtracted from the original image in order to obtain low frequency components.

Then, compensation for intensity is performed, and the image is added to the original image. This is the image obtained by H-E processing.

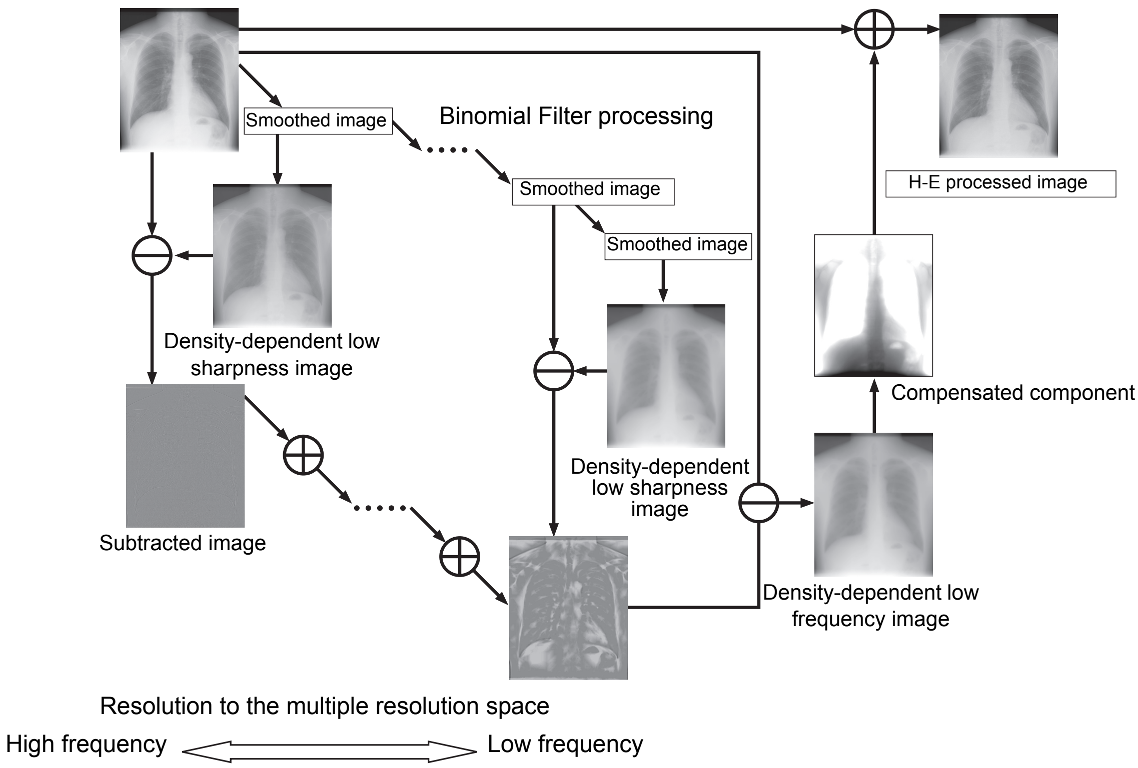


Figure3-21 H-E processing algorithm

H-E PROCESSING

H-E Parameters (Intensified Band) :

There are two kinds of H-E parameters from HE-STANDARD 1 to HE-STANDARD 2

Table3-2 H-E TYPE and applicable parts

H-F TYPE	Major applicable area	Explanation
HE-STANDARD1	Parts excluding Chest PA/ AP and LAT chest	A type that emphasizes the edge of low intensity parts. Effective in cases that focus on the description of fine structures like bone beams.
HE-STANDARD2	Chest PA/AP, LAT chest	A type that emphasizes granularity in low intensity parts. Suppresses the deterioration of granularity under the diaphragm, etc.

H-E Parameter (Correction Coefficient):

The correction coefficient β is the parameter that determines the degree of correction, and is usually set between 0 and 1. When the correction coefficient is made larger, the average density of the secondary area of interest becomes more even, producing an image with a flatter appearance.

The reference % value is the parameter which determines the signal value A, which forms the boundary between the signal range to which correction is added, and the signal range to which no correction is made. For example, in the case of chest PA/AP, if we refer to the two reference signal values found during automatic gradation processing described earlier as reference signal L and reference signal H, then A is given by,

A = [reference signal L] + ([reference signal H] - [reference signal L]) × [reference % value] / 100

Furthermore, when only one reference signal that is used for automatic gradation processing exists as in the case of LAT lumbar vertebra, if we refer to the reference signal value (the signal value for the lumbar vertebra) as L, and the maximum signal value for the body as H, then A is found using the same calculation.

3.4.4 H-S PROCESSING

H-S processing algorithm

Multiple images with reduced degrees of sharpness will be created from the original image, and subtracted images will be created by taking the difference between neighboring frequency bands. Then, edge information will be extracted from the image with reduced sharpness and the subtracted image for a particular frequency band.

By performing the processing while controlling the smoothing level according to the extracted edge information, a selectively smoothed image with retained edge and smoothed noise components will be obtained.

By taking the difference between this selectively smoothed image and an image with reduced sharpness compensated so that milder smoothing is applied to areas with higher density or contrast, the noise component will be obtained.

The H-S processing obtains an image where the noise component is subtracted from the original image.

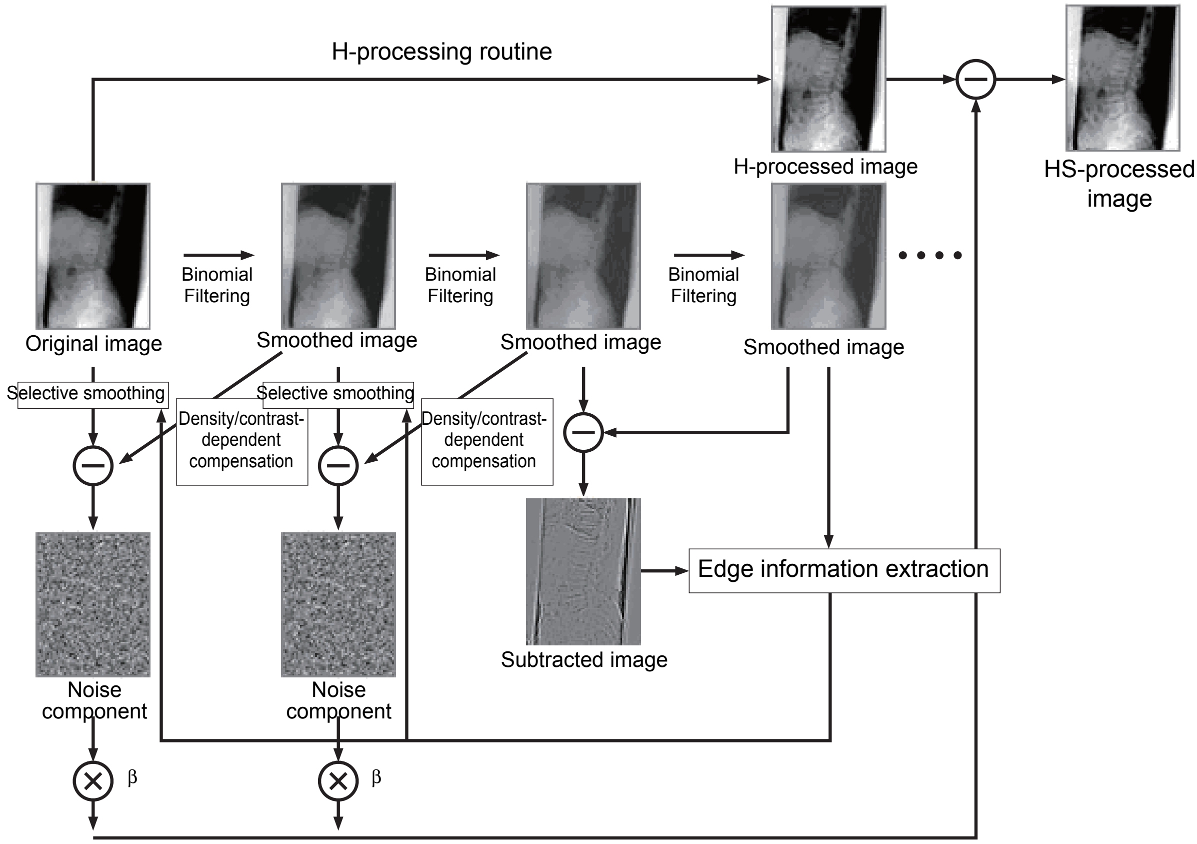


Figure3-22 H-S processing algorithm

H-S processing procedures

H-S parameter (HS Level, Dose-Dependent Characteristics, Density-Dependent Characteristics):

HS level is a parameter to determine the degree of noise suppression. Noise suppression is in effect to the extent that the HS level is high.

When the level of the HS processing is high, images sometimes might seem strange.

For this reason, the HS level upper limit is set to prevent the processing level from being too high, however, always check images when applying the processing.

2 types of H-S parameters are mainly used as dose-dependent characteristics, TYPE-2 and TYPE-3.

3 types of H-S parameters are mainly used as density-dependent parameters, TYPE-0 to TYPE-2.

Table3-3 Explanation of H-S TYPE

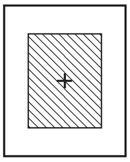
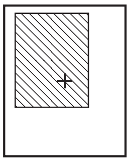
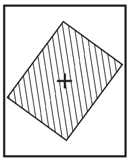
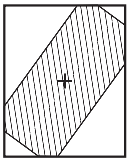
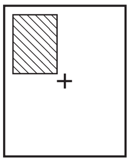
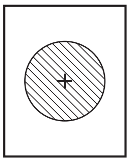
Dose-dependent characteristics	Explanation
TYPE-2	This type places importance on the balance between granularity and sharpness. The processing level is constant regardless of the dose.
TYPE-3	This type places importance on the balance between granularity and sharpness. The lower the dose, the higher the processing level becomes.

Density-dependent characteristics	Explanation
TYPE-0	The processing level is constant regardless of the density.
TYPE-1	The processing level changes depending on the image density. The lower the density of the area, the higher the processing level becomes for that area.
TYPE-2	The processing level changes depending on the image density. The higher the density of the area, the higher the processing level becomes for that area.

Data 1 Exposure Field Identification Types

The AeroDR SYSTEM chooses from among 3 types of exposure field identification algorithms according to the body part set in the exposure parameter keys.

Corresponding exposure field pattern

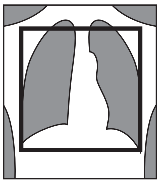
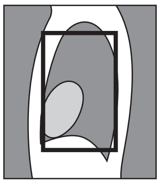
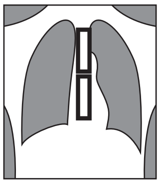
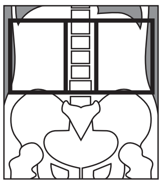
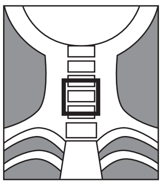
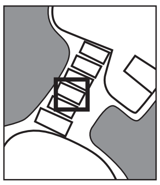
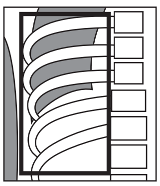
Type	Type1	Type3	Type5
	○	○	○
	○	○	○
	×	○	○
	×	○	○
	×	○	○
	×	×	○
Applicable body part	Chest PA/AP LAT Chest Abdomen simple Pelvis PA/AP etc.	Cervical vertebrae PA/AP LAT cervical vertebrae Thoracic vertebrae PA/AP LAT lumbar vertebrae etc.	Head Limb bones etc.

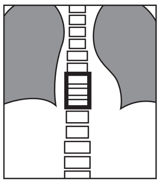
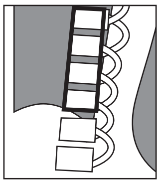
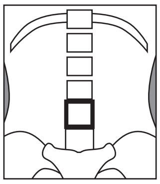
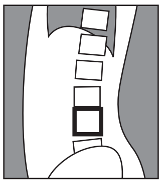
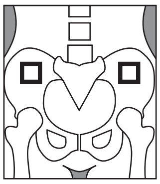
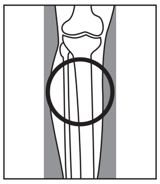
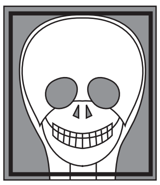
[Type 1]: Type 1 will be used to identify an exposure field that is quasi-parallel to the image end.
It is useful for detecting an exposure field whose edge is comparatively vague due to dispersion rays.

[Type 3]: Type 3 will be used to identify an exposure field that may be oblique at the image end.
It is useful when the edge of the exposure field overlaps the exposure subject as is the case with the core of the human body.

[Type 5]: Type 5 will be used to identify an exposure field that may be oblique at the image end or to identify a quasi-circular field.
It is useful for detecting an exposure field whose area is comparatively narrow.

Data 2 ROI Setting Algorithm

Type	Main processing name	ROI position		Reference signal value	Exposure field type
A	Chest PA/AP PED chest PA/AP	(ROI 1) Rectangle including the chest * If the transmission though one lung is exceptionally low, that lung is excluded. (ROI 2) None		(1) Minimum signal value for mediastinum area (2) Maximum signal value for lung area	1
B	LAT chest Chest oblique	(ROI 1) Rectangle including the chest (ROI 2) None		(1) Average signal value for lung area (2) None	1
C	Chest expiration observation	(ROI 1) Upper thoracic vertebrae (ROI 2) Lower thoracic vertebrae		(1) Average signal value for thoracic vertebrae (2) None	1
D	Abdomen simple	(ROI 1) The rectangle from the bottom of the lung area to the top of the ilium. (ROI 2) The vertebra within ROI 1		(1) Minimum signal value for soft abdomen area (2) The signal value near the flank stripe area	1
E	Cervical vertebrae PA/AP	(ROI 1) Fourth - sixth cervical vertebrae (ROI 2) None		(1) Signal value for the fourth - sixth cervical vertebrae (2) None	3
F	LAT cervical vertebrae Cervical vertebrae oblique	(ROI 1) Fourth - sixth cervical vertebrae (ROI 2) None		(1) Signal value for the fourth - sixth cervical vertebrae (2) None	3
G	Ribs	(ROI 1) Rectangle to flank excluding vertebra (ROI 2) None		(1) Signal value for low density area of ribs (2) Maximum signal value or lung area	1

Type	Main processing name	ROI position		Reference signal value	Exposure field type
H	Thoracic vertebrae PA/AP Thoracic lumbar vertebrae PA/AP	(ROI 1) Vertebra in center region of exposure field (ROI 2) None		(1) Signal value for the vertebra in center region of exposure field (2) None	3
I	LAT Thoracic vertebrae	(ROI 1) Thoracic vertebra in lung area (ROI2) None		(1) None (2) Signal value for the vertebra in lung area	3
J	Lumbar vertebra PA/AP Abdomen KUB	(ROI 1) Fourth lumbar vertebra (ROI 2) None		(1) Signal value for the fourth lumbar vertebra (2) None	1
K	LAT lumbar vertebra Lumber vertebra oblique	(ROI 1) Fourth lumbar vertebra (ROI2) None		(1) Signal value for the fourth lumbar vertebra (2) None	3
L	Pelvis PA/AP	(ROI 1) Center of right ilium (ROI 2) Center of left ilium		(1) Average signal value for center of ilium (2) None	1
M	Upper arm bone Elbow joint Knee joint PA/AP/LAT Lower leg bone * Also primarily processing of the extremities.	(ROI 1) Circular region in center of exposure field. * If the subject part is not located in the center of the field adjust its position. (ROI 2) None		(1) Signal value for the bone in the central area of the exposure field. (2) None	5
N	Head PA/AP Shoulder joint Hip joint PA/AP * Also primarily processing of parts including large bones.	(ROI 1) Whole of exposure area (ROI 2) None		(1) Minimum signal value in the exposed area of human body (2) None	5

Chapter 4 X-Rays and Images

4.1 Relationship between Dose and Image 4-2
4.1.1 Differences between Film Screen and AeroDR SYSTEM 4-2
4.1.2 Quantization Range 4-5
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4.1 Relationship between Dose and Image

4.1.1 Differences between Film Screen and AeroDR SYSTEM

In film screen, departure from a suitable dose leads to overexposure or underexposure of image density. Screen sensitivity may be modified to obtain suitable density, but this may result in changes to sharpness and granularity.

Conversely, as the AeroDR SYSTEM has a wide dynamic range, and as automatic gradation processing is applied after image acquisition, appropriate image density is maintained regardless of the exposure dose. However, as differing exposures do result in corresponding changes to quantum noise and to the degree of contribution of electrical noise in the system, granularity will vary.

Table4-1 Effect on images when exposure dose is varied from the dose suitable for base sensitivity

Modality	Precondition	Compared to suitable dose for base sensitivity: Low dose	Compared to suitable dose for base sensitivity: High dose
AeroDR SYSTEM	Application of automatic gradation processing only	Density : Suitable Granularity : Degraded Sharpness : No change	Density : Suitable Granularity : Improved Sharpness : No change
Film screen	Using high sensitivity screen	Density : Suitable Granularity : Somewhat degraded Sharpness : Degraded	
	Using base sensitivity screen	Density : Under exposed Granularity : Improved (low gamma) Sharpness : No change	Density : Over exposed Granularity : Improved (quantum noise improvement effect) Sharpness : No change
	Using base sensitivity screen		Density : Suitable Granularity : Somewhat improved Sharpness : Improved

Figure4-1 (1) indicates the change in image density when a base sensitivity screen is used as the film screen and dose is decreased without changing the screen.
When the dose is decreased, density is underexposed and quantum noise is increased, but as this corresponds to a low gamma film region, there is little notable effect on granularity.

Figure4-1 (2) indicates the change in image density when a high sensitivity screen is used and dose is decreased.
Density becomes suitable, but sharpness decreases under the effect of the greater screen thickness. Moreover, while quantum noise increases in the same manner as during use of the base sensitivity screen, due to sensitizing effects, the effect on granularity can be kept low.

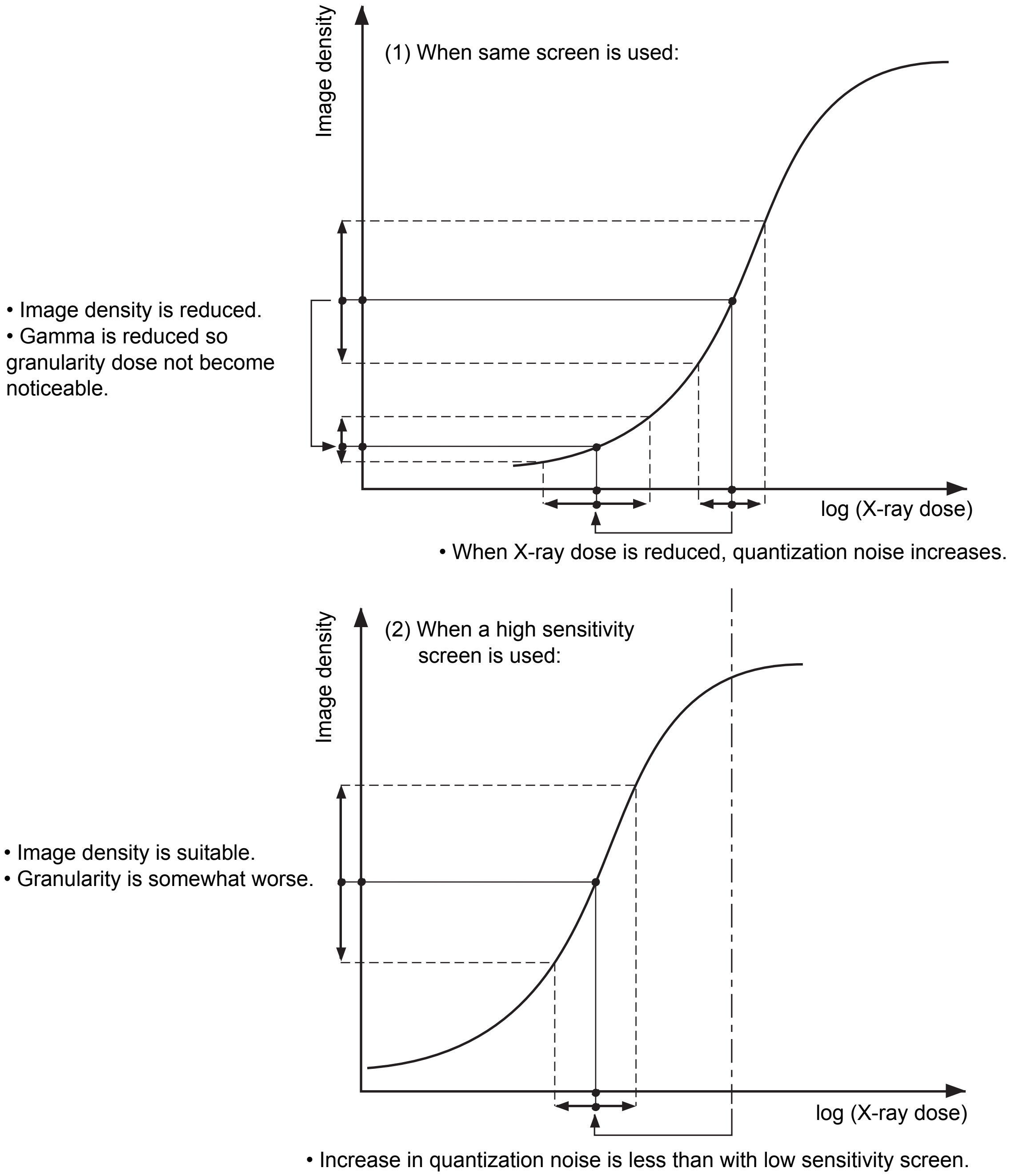

Figure4-1 Changes to images when X-ray dose is reduced (film screen)

Figure4-2 (1) and Figure4-2 (2) indicate image density when exposure dose is decreased in the AeroDR SYSTEM.

Even when dose is reduced as in Figure4-2 (2) relative to suitable dose per Figure4-2 (1), density is kept constant through automatic gradation processing. Quantum noise increases as dose decreases, but as the detector does not change, there is no effect on sharpness.

However, even with the AeroDR SYSTEM, when Fix processing (image processing parameters under which normalization processing is not performed) is used, behavior tends to resemble the film screen case in which the screen is kept unchanged and only the dose is changed.

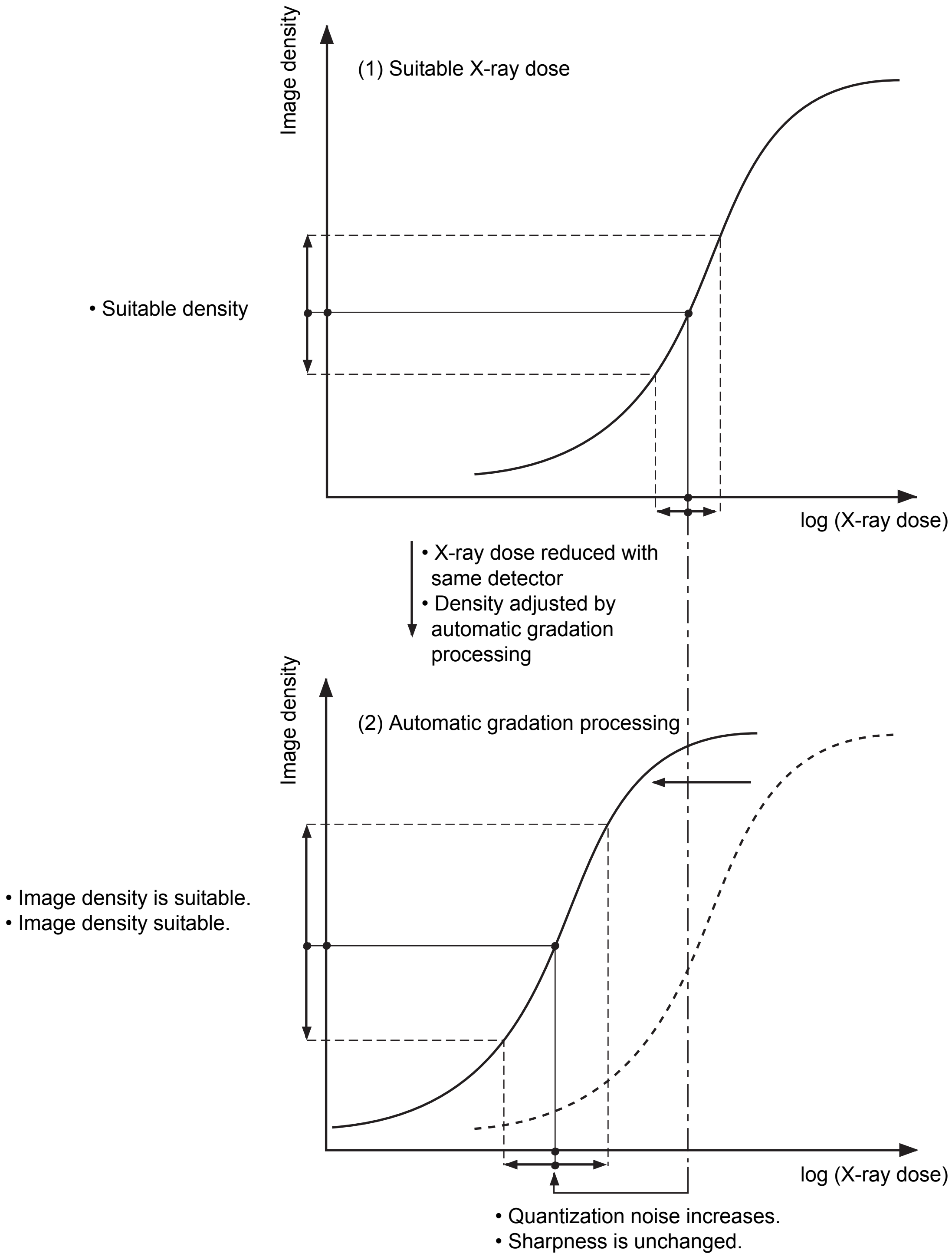

Figure4-2 Changes to images when X-ray dose is reduced (AeroDR SYSTEM)

4.1.2 Quantization Range

The AeroDR SYSTEM has about a 4-digit dynamic range. The range is equivalent to that of the REGIUS, but the AeroDR SYSTEM quantizes lower doses.

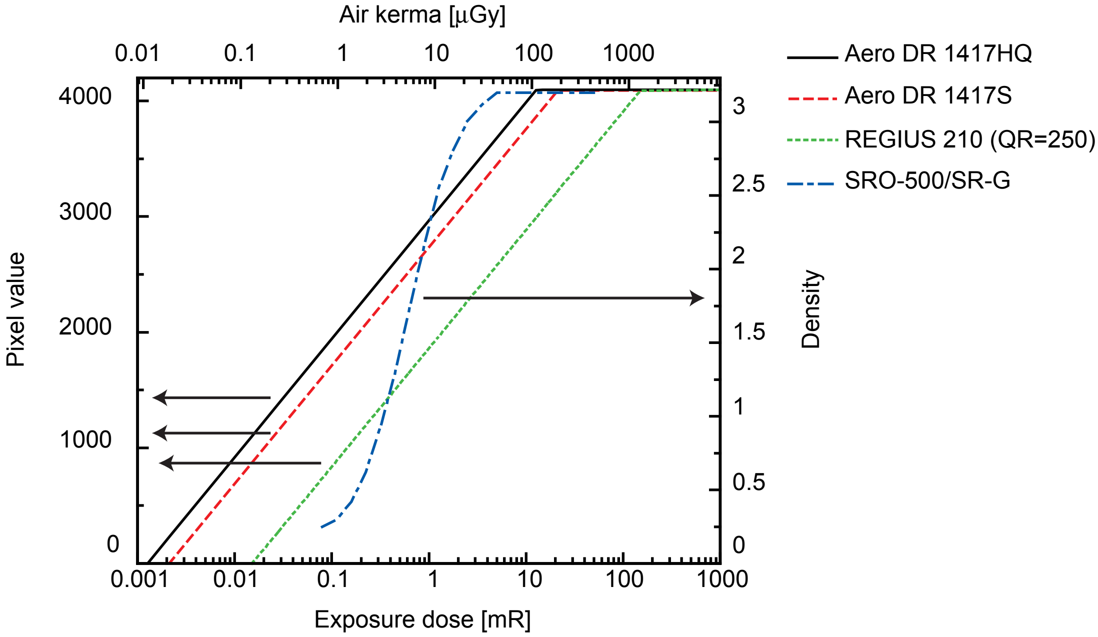

Figure4-3 Quantization range

4.1.3 Dose and Image Quality

The AeroDR SYSTEM has high DQE due to its CsI scintillator with high X-ray adsorption, but greatly reducing dose tends to decrease DQE. This is a characteristic specific to the FPD method, stemming from its high electrical noise compared to the CR method.

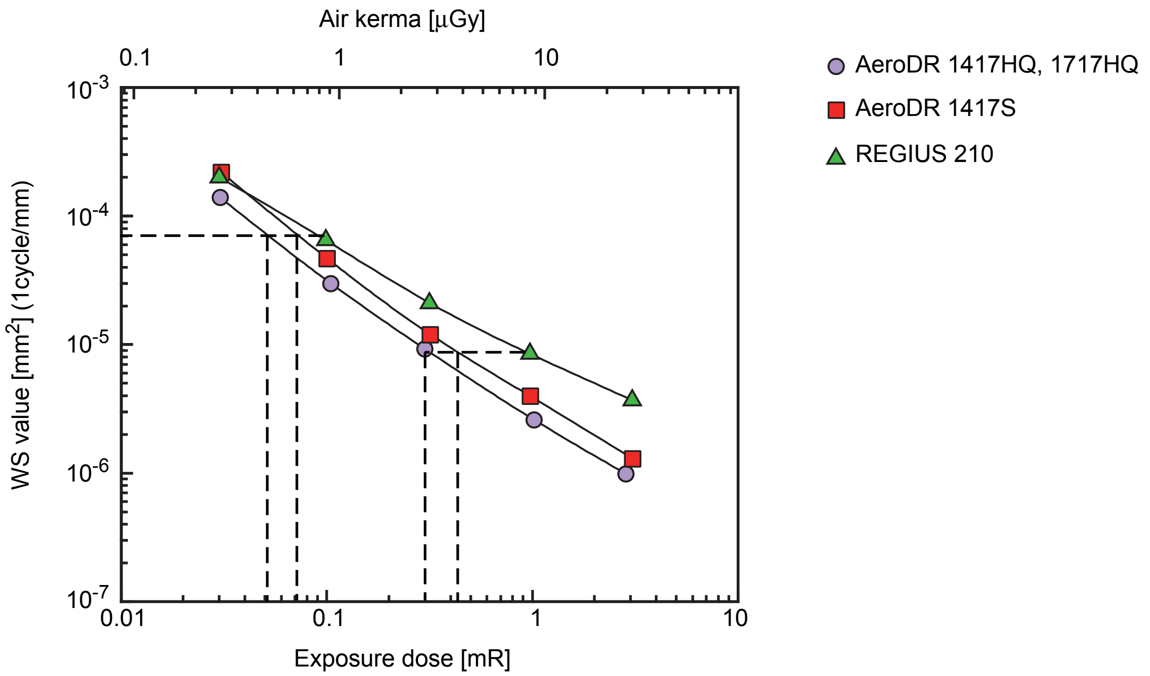

Figure4-4 Dose and WS Value

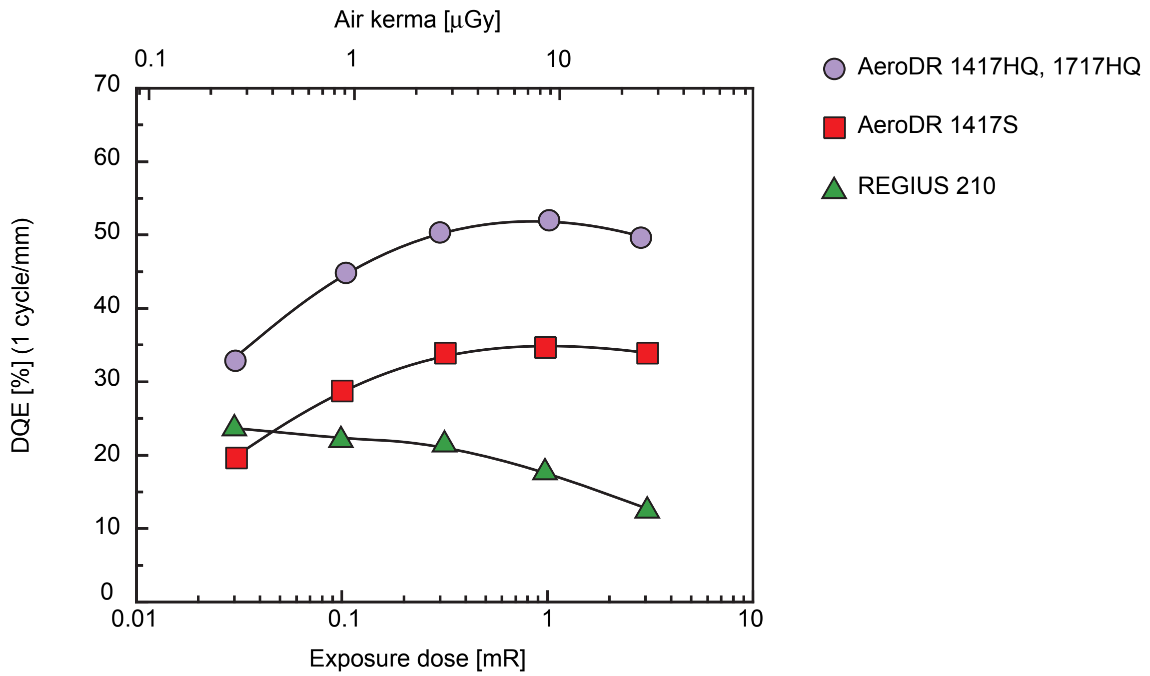

Figure4-5 Dose and DQE

MEMO

DQE is a measure expressing the ratio of SN output from the image receiver to the SN input.

When dose is decreased, the SN of the X-rays decreases in proportion to the square root of the dose. Therefore, in a system without noise other than "Noise originating with X-rays" (quantum noise), when dose is reduced, SN will decline in proportion to the square root of the dose. In other words, WS (the square of N/S) is inversely proportional to dose, while DQE (the square of SN output/input) is constant regardless of dose.

MEMO

As uncorrectable structural mottle exists under the CR method, DQE declines as the dose increases. However, in FPD, as unevenness in each pixel is corrected through offset/gain correction, structural mottle is also corrected through that effect, and DQE does not readily decline even in high dose regions.

Chapter 5 Image Output

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5.1 Hard Copy Output

The CS-7 can be connected in many ways to Konica Minolta imagers for hard copy output.

5.2 Online Output

As online output, the CS-7 implements the DX image storage service class and the CR image storage service class (C-STORE) of DICOM (Digital Imaging and Communication in Medicine: a standard for medical imaging and communication developed by the Radiation Research Society and National Electrical Manufacturers Association in the US). This enables transmission of image data to servers within a facility, such as storage and display devices etc. conforming to the DICOM standards.

5.2.1 Online Output Function

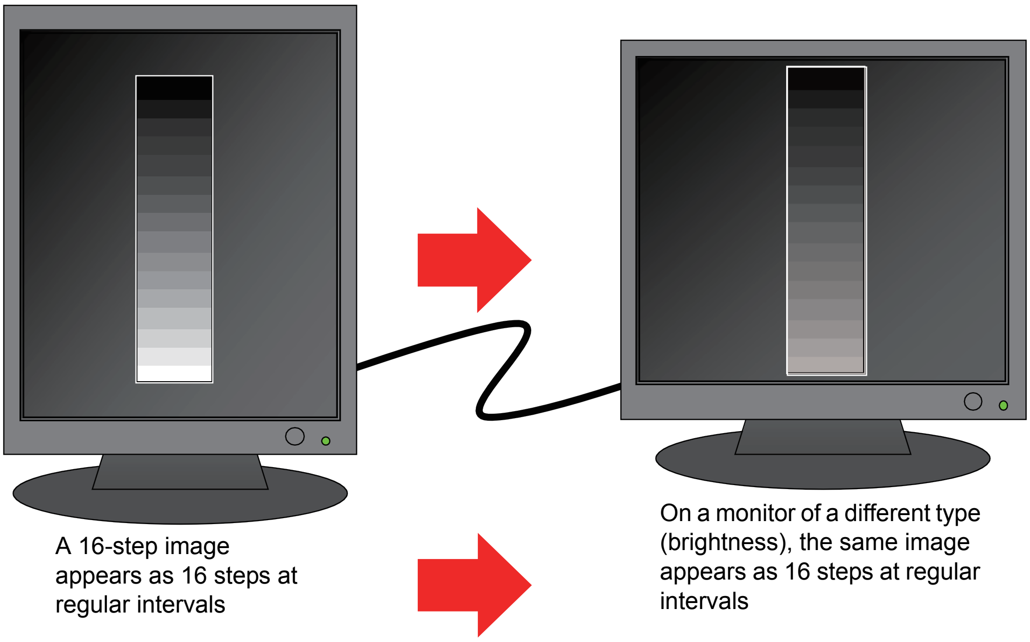
The CS-7 supports the following DICOM conformant functions.

Luminance Measurement Interpretation	:	Supports MONOCHROME 1 and MONOCHROME 2. MONOCHROME 1 is an image data format that requires the minimum value (0) to be displayed by the server as white. MONOCHROME 2 is an image data for-mat that requires the minimum value (0) to be displayed by the server as black.
JPEG Reversible Compression	:	This reversibly compresses image data using subtracted pulse code modulation (DPCM) so as to allow stable transmission of data with reduced network load.
Image Processing	:	Processed image data will be output in a linearly visible manner. The P value (Presentation Value) is the gradation defined in Part 14 of DICOM 3.0. It is a linear gradation based on the human vision model and is defined as equalizing the variation of the P value with the brightness change perceived by humans. If the monitors or imagers are calibrated by the GSDF (Grayscale Standard Display Function) curve defined by DICOM Part 14, similar gradation can be obtained when the P value image is output irrespective of the dynamic range of the output device.

5.2.2 Characteristics of DICOM Part 14 P-Value Images

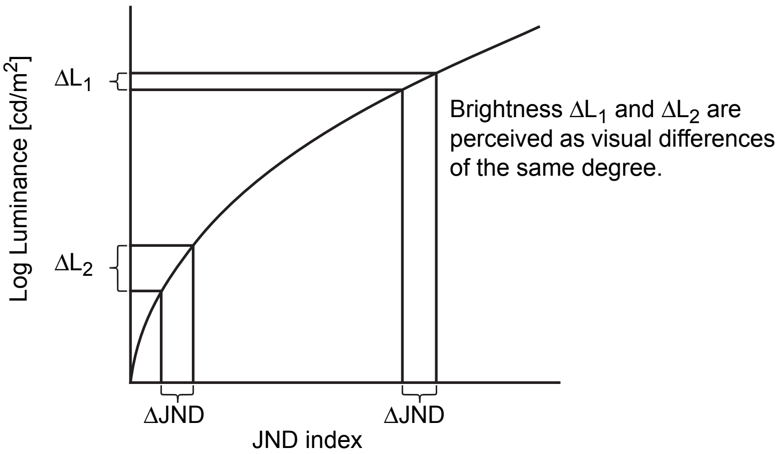
P-value images can be displayed on different types of monitors without difference in gradation, if the monitors are calibrated using GSDF curves.

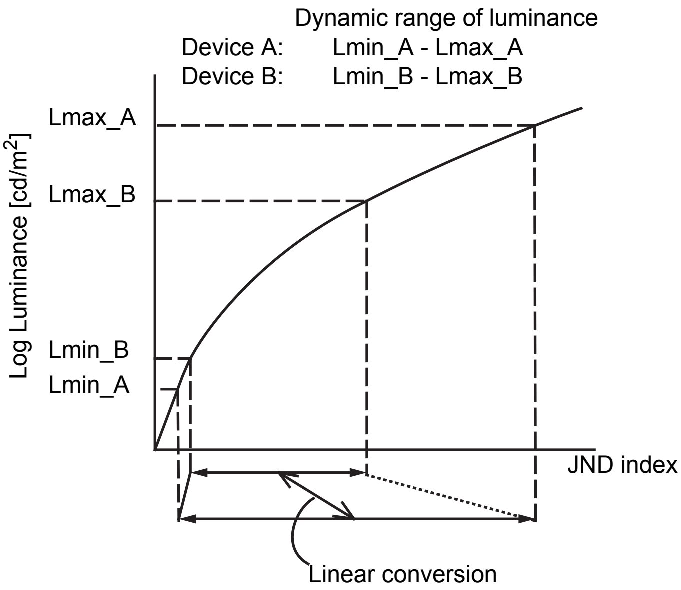
This means, for example, that if on a given monitor with a 16-step image the brightness appears to change at regular intervals, then on a different monitor the 16 steps will appear to change at regular intervals.



DICOM Part 14 defines a 1-step difference using the "JND index" scale that corresponds to the minimum difference in brightness perceptible to people.

The value of this "JND index" converted to linear form in accordance with the image's number of gradations becomes the "P value".





P-value images, when observed at different times and places, appear the same.

Conversely, when comparing monitors side-by-side at the same time and place, especially when the maximum brightness differs in 2 monitors, the images may not appear identical due to the difference in display brightness.

5.2.3 Image Adjustment in Online Output

Maximum brightness differs between monitors and schaukasten, as does the range of displayable brightness.

- Maximum brightness in typical schaukasten: 3000cd/m^2
- Maximum brightness in typical medical monitor: 400cd/m^2

As the displayable brightness range for images on a monitor is narrow, the delineation of light and dark areas may be insufficient, or the contrast (sharpness) lacking.

In these instances, image quality can be improved by performing the image adjustments below.

Details of Adjustments	Adjustment Items
Improving delineation of dark areas (soft tissues, etc.)	Apply H-E processing [high density side].
Improving delineation of bright areas	Apply H-E processing [low density side].
Raise visual contrast	Apply H-F processing. Prioritize low frequency types (H-F STANDARD2, etc.) for H-F processing.

Chapter 6 Atlas for Image Adjustment

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6.1 List of Atlases for Image Adjustment

List of Exposure Parameter (reference values)

Item No.	Part	AeroDR 1417HQ				AeroDR 1417S			
		Voltage (kVp)	mAs value (mAs)	SID (cm)	Grid	Voltage (kVp)	mAs value (mAs)	SID (cm)	Grid
6.2	Head AP	80	10	100	8:1	80	15	100	8:1
6.3	Chest PA	130	2	200	12:1	130	3	200	12:1
6.4	Chest LAT	135	6	200	12:1	135	9	200	12:1
6.5	Observation of Thoracic Progress	130	2	200	12:1	130	3	200	12:1
6.6	Abdomen AP (Upright)	80	13	120	8:1	80	20	120	8:1
	Abdomen AP (Supine)	75	18	120	8:1	75	28	120	8:1
6.7	Cervical Spine AP	65	10	150	8:1	65	15	150	8:1
6.8	Cervical Spine LAT	65	10	150	8:1	65	15	150	8:1
6.9	Lumbar Spine AP	75	25	120	8:1	75	38	120	8:1
6.10	Lumbar Spine LAT	90	50	120	8:1	90	75	120	8:1
6.11	Shoulder Joint AP/Axial	75	6	120	8:1	75	9	120	8:1
6.12	Ribs	70	6	120	8:1	70	9	120	8:1
6.13	Humerus AP	60	4	120	–	60	6	120	–
6.14	Pelvis AP	85	10	120	8:1	85	15	120	8:1
6.15	Hip Joint Axial	75	15	100	8:1	75	24	100	8:1
6.16	Femur AP	70	12	120	8:1	70	18	120	8:1
6.17	Knee AP	55	8	120	–	55	12	120	–
6.18	Larynx LAT	70	10	120	8:1	70	15	120	8:1

List of Processing Parameter for Online Output

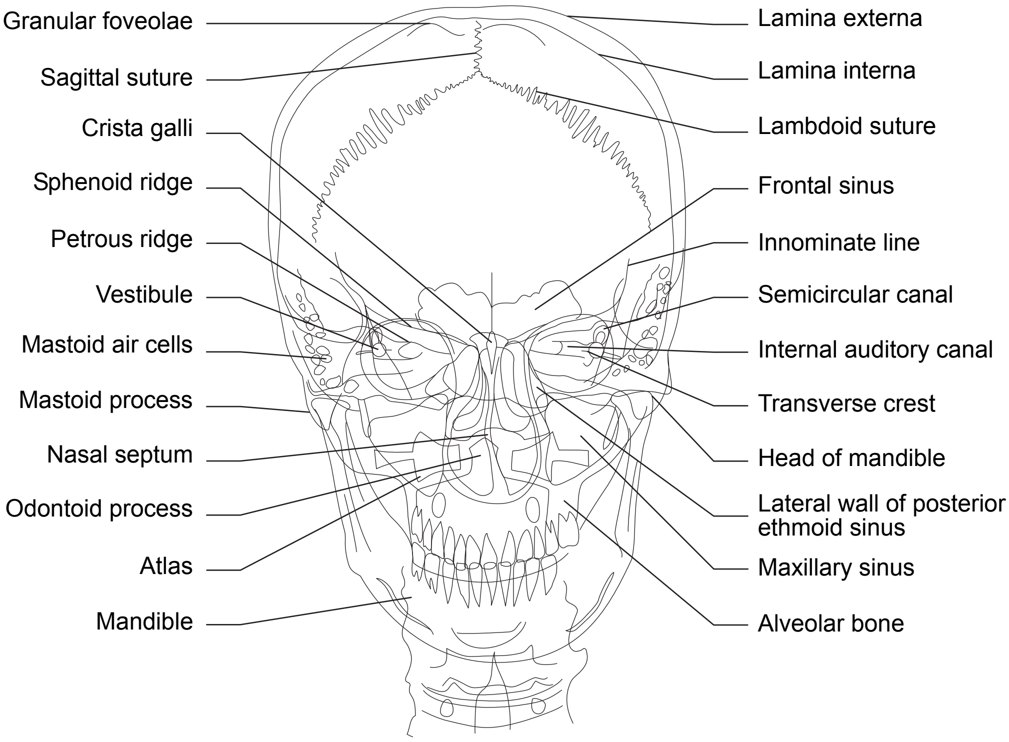
Item No.	Part	G processing				H-F processing			H-E processing		
		LUT	Reference signal value density		Fixed gradient	Enhancement Type	Low density side (H)	High density side (H)	Enhancement Type	Low density side (H)	High density side (H)
6.2	Head AP	BONE-01	Cranial Bone Density 0.5	–	2.24	HF-STANDARD3	0.1	0.7	HE-STANDARD1	0.0	0.5
6.3	Chest PA	LIN-03	Medias-tinum Density 0.21	Lung Field Density 2.5	–	HF-STANDARD3	0.2	0.5	HE-STANDARD2	0.6	0.5
6.4	Chest LAT	THX-04	Lung Field Density 1.07	–	2.20	HF-STANDARD3	0.2	0.8	HE-STANDARD2	0.3	0.5
6.5	Observation of Thoracic Progress	THX-01	Dorsal Vertebra Density 0.45	–	3.00	HF-STANDARD3	0.2	0.5	HE-STANDARD1	0.3	0.0
6.6	Abdomen AP (Upright) Abdomen AP (Supine)	THX-04	Abdomen Density 0.8	Flank Density 2.5	–	HF-STANDARD1	0.4	0.6	HE-STANDARD1	0.2	0.3
6.7	Cervical Spine AP	LUM-01	Cervical Spine Density 0.9	–	2.65	HF-STANDARD4	0.0	1.0	HE-STANDARD1	0.0	0.3
6.8	Cervical Spine LAT	LUM-01	Cervical Spine Density 0.8	–	2.65	HF-STANDARD4	0.0	1.0	HE-STANDARD1	0.0	0.3
6.9	Lumbar Spine AP	LUM-01	Lumbar Spine Density 0.95	–	2.65	HF-STANDARD2	0.5	1.0	HE-STANDARD1	0.4	0.0
6.10	Lumbar Spine LAT	LUM-01	Lumbar Spine Density 1.05	–	2.65	HF-STANDARD2	0.0	1.0	HE-STANDARD1	0.3	0.3
6.11	Shoulder Joint AP/Axial	BONE-02	Shoulder Joint Density 1.5	–	2.46	HF-STANDARD4	0.0	1.0	HE-STANDARD1	0.0	0.5
6.12	Ribs	BONE-02	Ribs Density 0.45	Lung Field Density 2.00	–	HF-STANDARD3	0.0	0.5	HE-STANDARD1	0.0	0.4
6.13	Humerus AP	BONE-03	Humerus Density 0.8	–	2.68	HF-STANDARD5	0.0	0.8	HE-STANDARD1	0.0	0.3
6.14	Pelvis AP	BONE-05	lium Density 1.1	–	2.93	HF-STANDARD4	0.0	0.5	HE-STANDARD1	0.0	0.3
6.15	Hip Joint Axial	BONE-05	Hip Joint Density 0.5	–	2.93	HF-STANDARD4	0.0	0.5	HE-STANDARD1	0.0	0.3
6.16	Femur AP	BONE-03	Femur Density 0.7	–	2.68	HF-STANDARD3	0.5	1.0	HE-STANDARD1	0.0	0.2
6.17	Knee AP	BONE-03	Knee Density 0.7	–	2.46	HF-STANDARD3	0.5	1.0	HE-STANDARD1	0.0	0.2
6.18	Larynx LAT	THX-04	Soft Tissue Density 2.3	–	2.65	HF-STANDARD3	0.0	0.7	HE-STANDARD1	0.0	0.3

List of Processing Parameter for Hard Copy Output

Item No.	Part	G processing				H-F processing			H-E processing		
		LUT	Reference signal value density		Fixed gradient	Enhancement Type	Low density side (H)	High density side (H)	Enhancement Type	Low density side (H)	High density side (H)
6.2	Head AP	BONE-03	Cranial Bone Density 0.5	–	2.68	HF-STANDARD6	0.0	0.5	HE-STANDARD1	0.0	0.3
6.3	Chest PA	THX-01	Mediastinum Density 0.22	Lung Field Density 1.9	–	HF-STANDARD5	0.0	0.3	HE-STANDARD2	0.3	0.0
6.4	Chest LAT	THX-04	Lung Field Density 1.07	–	2.20	HF-STANDARD5	0.0	0.5	HE-STANDARD2	0.1	0.0
6.5	Observation of Thoracic Progress	THX-01	Dorsal Vertebra Density 0.45	–	3.00	HF-STANDARD5	0.0	0.3	HE-STANDARD1	0.3	0.0
6.6	Abdomen AP (Upright) Abdomen AP (Supine)	THX-04	Abdomen Density 0.8	Flank Density 2.4	–	HF-STANDARD3	0.0	0.5	HE-STANDARD1	0.0	0.3
6.7	Cervical Spine AP	LUM-01	Cervical Spine Density 0.9	–	2.65	HF-STANDARD5	0.0	0.5	HE-STANDARD1	0.0	0.3
6.8	Cervical Spine LAT	LUM-01	Cervical Spine Density 0.8	–	2.65	HF-STANDARD5	0.0	0.5	HE-STANDARD1	0.0	0.3
6.9	Lumbar Spine AP	LUM-01	Lumbar Spine Density 0.95	–	2.65	HF-STANDARD3	0.0	0.7	HE-STANDARD1	0.4	0.0
6.10	Lumbar Spine LAT	LUM-01	Lumbar Spine Density 1.05	–	2.65	HF-STANDARD3	0.0	0.7	HE-STANDARD1	0.4	0.0
6.11	Shoulder Joint AP/Axial	BONE-02	Shoulder Joint Density 1.5	–	2.46	HF-STANDARD5	0.0	0.7	HE-STANDARD1	0.0	0.3
6.12	Ribs	BONE-02	Ribs Density 0.45	Lung Field Density 2.00	–	HF-STANDARD5	0.0	0.5	HE-STANDARD1	0.0	0.4
6.13	Humerus AP	BONE-03	Humerus Density 0.8	–	2.68	HF-STANDARD5	0.0	0.5	HE-STANDARD1	0.0	0.3
6.14	Pelvis AP	BONE-02	Iium Density 1.1	–	2.46	HF-STANDARD4	0.0	0.5	HE-STANDARD1	0.0	0.3
6.15	Hip Joint Axial	BONE-03	Hip Joint Density 0.5	–	2.68	HF-STANDARD4	0.0	0.5	HE-STANDARD1	0.0	0.3
6.16	Femur AP	BONE-03	Femur Density 0.7	–	2.68	HF-STANDARD4	0.0	0.5	HE-STANDARD1	0.0	0.3
6.17	Knee AP	BONE-03	Knee Density 0.6	–	2.68	HF-STANDARD5	0.0	0.5	HE-STANDARD1	0.0	0.3
6.18	Larynx LAT	THX-04	Soft Tissue Density 2.3	–	2.65	HF-STANDARD3	0.0	0.5	HE-STANDARD1	0.0	0.3

6.2 Head AP

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The parietal region, cranial border of the temporal region (imaging of the outer and inner tables,) and the mandible and the accessory nasal sinus (cavity) are not displayed at excessive density; at the same time, the petrous region of the temporal bone of the eye socket (auditory organ in petrous part) is not displayed at the low density.	Adjust [Density of Cranial Bone] so as not to whiteout the low density region. If necessary use H-E Processing to show the cranial border.
The substance of the frontal bone and the parietal bone shall be displayed with a concave/convex web structure pattern.	Raise the contrast by changing LUT to High-Contrast LUT.
The structural details of the bony wall or the internal septal wall of the accessory nasal sinus and the fine structure of the internal auditory canal and semicircular canal of the temporal bone are clearly displayed.	Apply H-F Processing to raise the sharpness.
The trabecula of the alveolar bone in which the teeth are rooted is clearly shown.	Same as above
When there are external injuries, it is necessary to display other soft tissue (structure up to skin surface) as well as bone structure.	Apply H-E Processing.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	80 kVp	80 kVp
mAs value	10 mAs	15 mAs
Distance	1.0 m	1.0 m
Grid	8:1	8:1

[Examples of Processing Parameter]

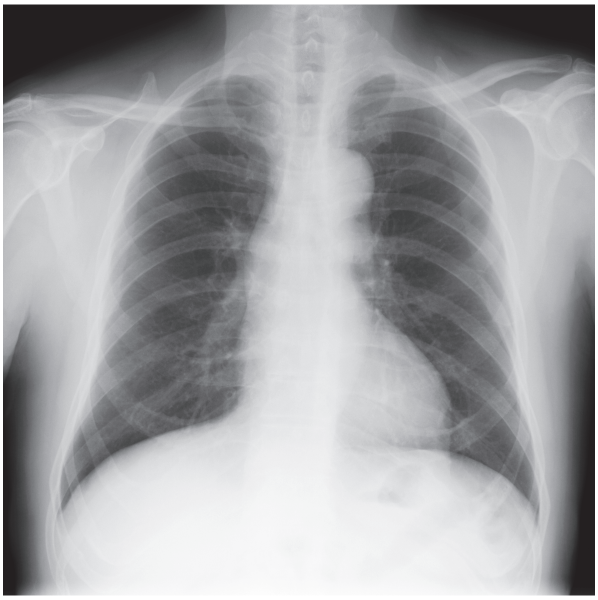
Processing Parameters	Head AP	(For online output)	(For hard copy output)
G-processing	LUT	BONE-01	BONE-03
	Reference signal value density	Cranial bone density 0.5	Cranial bone density 0.5
	Fixed gradient	2.24	2.68
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD6
	Low density side (H)	0.1	0.0
	High density side (H)	0.7	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.5	0.3

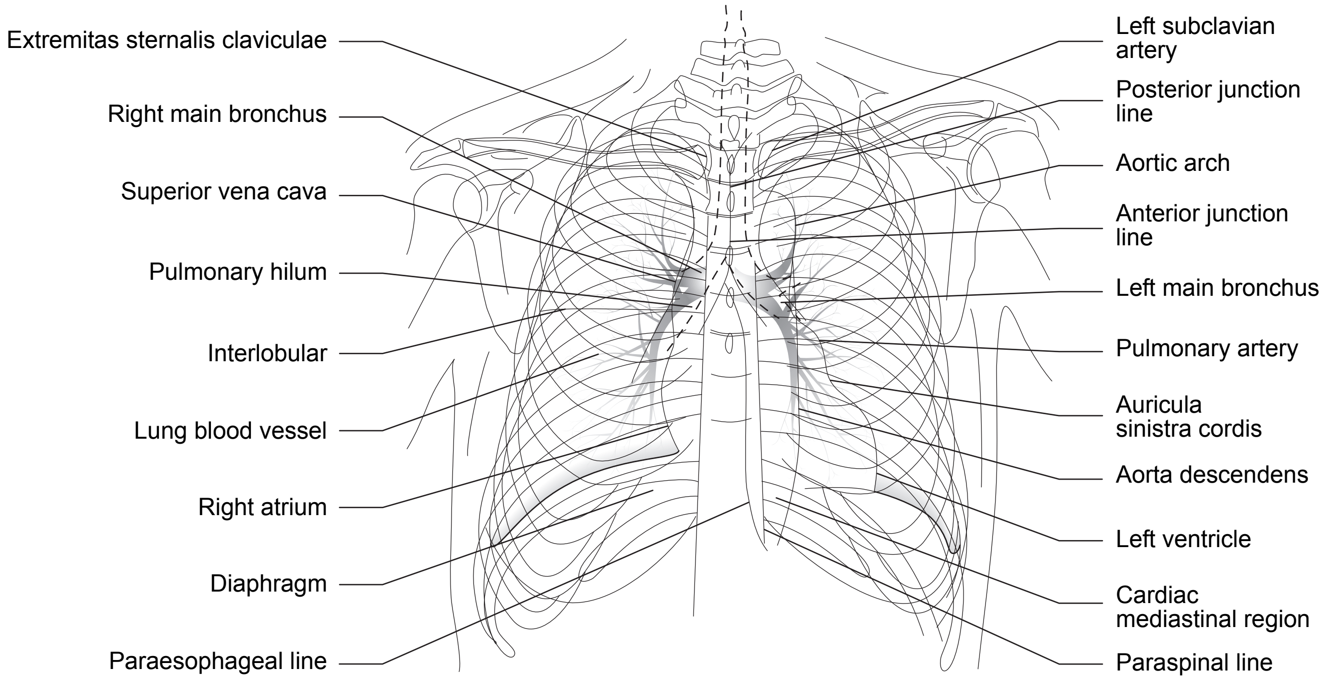
[Items and requirements of Adjustment]

	Requirements	Items of Adjustment	Remarks
Head AP	Improvement of graininess	Change to Low Contrast LUT, or weaken H-F Processing.	
	Increase contrast	Change LUT to High-Contrast LUT.	It is necessary to raise contrast with care regarding graininess.
	Improvement in imaging near skin.	Lower [cranial bone density]. (Depict the high density regions)	Too low [cranial bone density] will whiteout the low density region.
		Apply H-E Processing.	
	Improvement in imaging of trabecula.	Apply H-F Processing.	It is necessary to apply H-F Processing with care regarding graininess.

6.3 Chest PA

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The lung field is not displayed at excessive density; at the same time, the density of mediastinal region is not too low with the result that the entire chest area is within the suitable density range for diagnosis.	Drag [Density ADJ.] slider to adjust the density of the image. Target for density adjustment (influenced by the brightness of the room or schaukasten, etc.) [Mediastinum density]:0.22-0.25[Lung field density]: 1.8-2.20 To raise the contrast of lung field, change to LUT: THX-02, THX-07.
There should be no difference in density between left and right lung fields.	Review photographic alignment, etc.
Absorption should not cause an extreme loss of density in the lung field or in the areas of the female breast.	Adjust the density ([mediastinum density], in particular).
The blood vessels under the diaphragm area (fairly thick) are visible.	Same as above. Or, apply H-E Processing ([The low density side]). (Same for depicting mediastinum)
The periphery of the dorsal vertebra in the mediastinal region is visible to a discernable degree.	Same as above.
The vertical line on the right side of the dorsal vertebra in the mediastinal area. (paravertebral line) is visible.	Same as above.
A contrast exists that allows a certain degree of continuous tracing of the shadows of the fine blood vessels (lung marking) to the periphery. (located approximately 1.5-2 cm from the chest wall)	Apply H-F Processing ([The high density side]). It is necessary to adjust with care regarding graininess.
The trabecula of the clavicle and ribs are clearly visible.	Same as above.
The left and right bronchia are visible as far as the hilar region.	Optimize the density at bronchial tube and raise the contrast. (Make the adjustment with priority on the overall contrast, especially in the lung field.)
The periphery of a small lesion (the shadow of a tumor larger than 10 mm) is clearly visible (plane or spur type pattern), with a certain degree of contrast.	Apply H-F Processing ([The high density side]) Too high a contrast, or too strong an H-F Processing will prevent normal imaging of the ragged edge (size).

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	130 kVp	130 kVp
mAs value	2 mAs	3 mAs
Distance	2.0 m	2.0 m
Grid	12:1	12:1

[Examples of Processing Parameter]

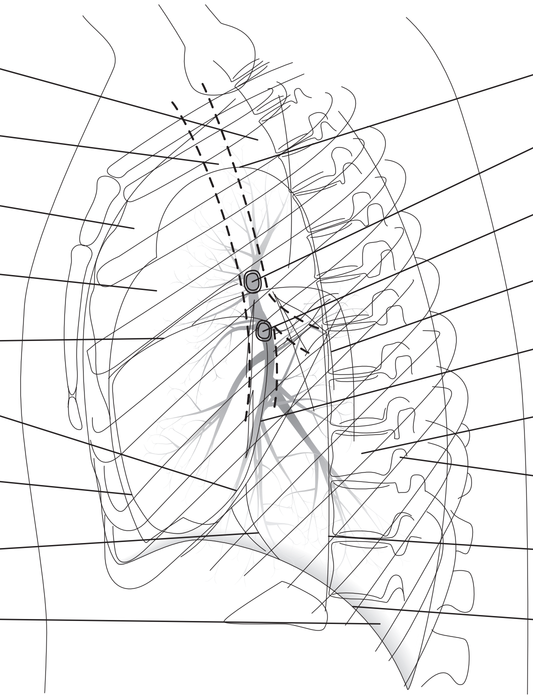
Processing Parameters	Chest PA	(For online output)	(For hard copy output)
G-Processing	LUT	LIN-01	THX-01
	Reference signal value density	Mediastinum density 0.21	Mediastinum density 0.22
		Lung field density 2.5	Lung field density 1.9
	Fixed gradient	–	–
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD5
	Low density side (H)	0.2	0.0
	High density side (H)	0.5	0.3
H-E Processing	Enhancement Type	HE-STANDARD2	HE-STANDARD2
	Low density side (H)	0.6	0.3
	High density side (H)	0.5	0.0

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Chest PA/AP	Improvement of graininess	Control H-F processing enhancement.	
	Raise contrast	Decrease [Mediastinum density]. Or increase [Lung field density]	The lung field contrast improves while the mediastinum area's depiction degrades.
	Improvement in imaging of peripheral vessels.	Raise the degree of H-F processing enhancement.	It is necessary make adjustments carefully regarding graininess.
	Decrease the quality of imaging of pale shadows.	Decrease [Mediastinum density]. Or increase [Lung field density]	Increased contrast will be available, but be careful of the density of lung field and mediastinum.
	Improvement in imaging of blood vessels behind the heart and under the diaphragm.	Increase [Mediastinum density].	[Mediastinum density] that is too high will result in poor graininessand will result in an over-exposure.
		Apply H-E Processing.	Graininess at mediastinum will be emphasized.
	Imaging of the mediastinum.	Apply H-E Processing.	Graininess at mediastinum will be emphasized. Processing that is too strong will result in an over-exposure and scattered radiation.

6.4 Chest LAT

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The upper lung field is not visible at the low density; while the lung field behind the sternum and the lower lung field at the backside do not show too high a density, resulting in imaging of the blood vessel in each.	Adjust with the [Lung field density]. Or, Change LUT.
The periphery of the dorsal vertebra body, the intervertebral foramen, and intervertebral joints are clearly visible.	Adjust with the [Lung field density]. Apply H-F processing. ([The high density side])
The trachea in the mediastinal region and the bronchial branching in the pulmonary hilum are visible, and the lymphatic node in the pulmonary hilum is visible with clear contrast as a large mass.	Same as above.
The aortic arch, the aorta descendens, as well as the inferior vena cava are visible with clear contrast.	Same as above.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	135 kVp	135 kVp
mAs value	6 mAs	3 mAs
Distance	2.0 m	2.0 m
Grid	12:1	12:1

[Examples of Processing Parameter]

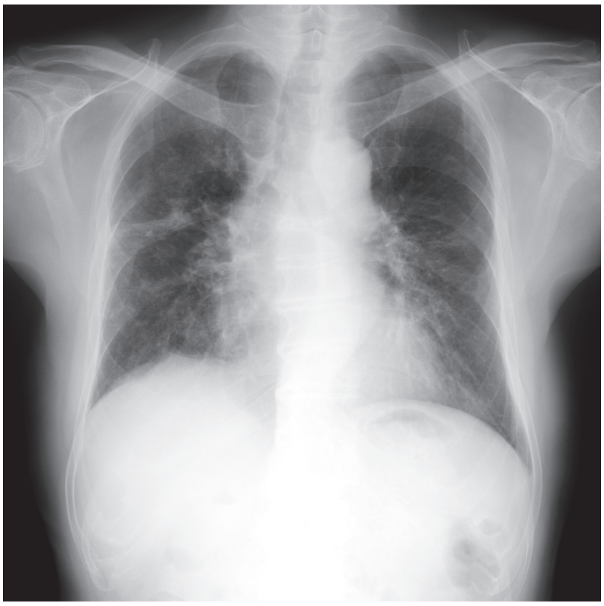
Processing Parameters	Chest LAT	(For online output)	(For hard copy output)
G-Processing	LUT	THX-04	THX-04
	Reference signal value density	Lung field density 1.07	Lung field density 1.07
	Fixed gradient	2.20	2.20
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD5
	Low density side (H)	0.2	0.0
	High density side (H)	0.8	0.5
H-E Processing	Enhancement Type	HE-STANDARD2	HE-STANDARD2
	Low density side (H)	0.3	0.1
	High density side (H)	0.5	0.0

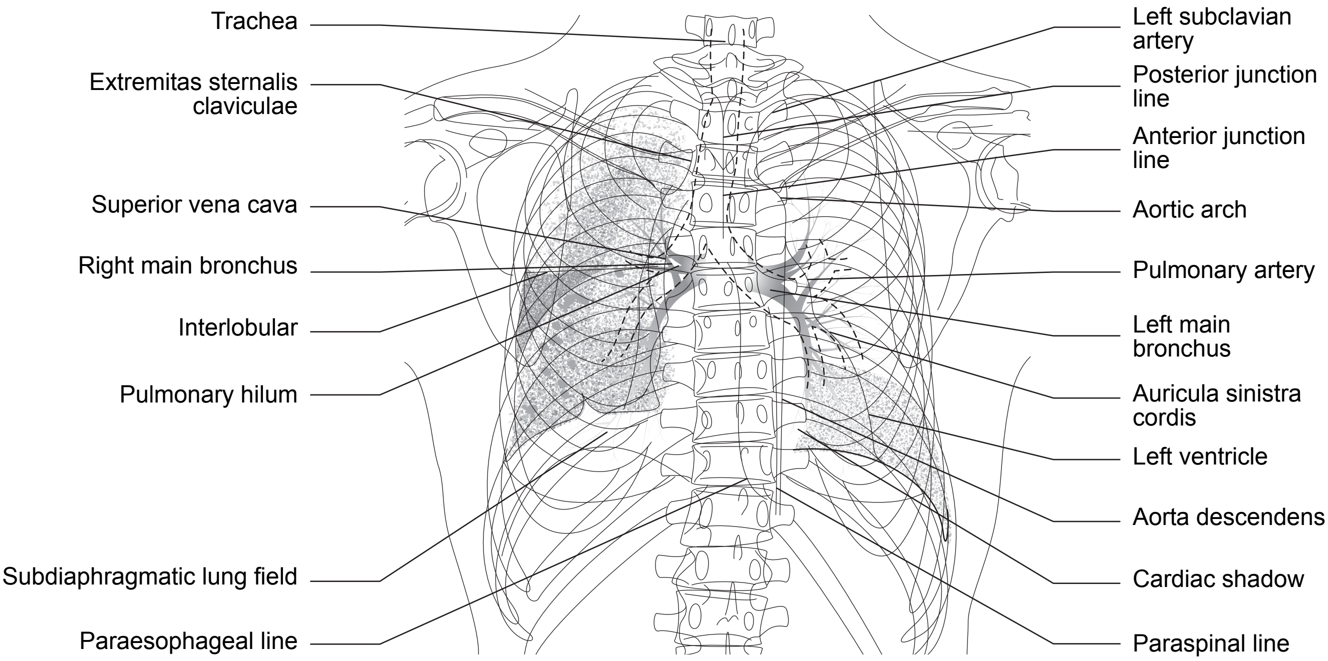
[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Chest LAT	Improvement in imaging of peripheral vessels	Raise the degree of H-F processing enhancement.	
	Improvement in quality of imaging of pale shadows.	Increase [Fixed gradient].	[Fixed gradient] that is too high may result in uneven finished density.
	Improvement in imaging of blood vessels behind heart.	Increase [Lung field density].	[Lung field density] that is too high will result in an over-exposure.
		Adjust the degree of H-F processing enhancement.	When applying H-F Processing, be especially careful about graininess.
	Improvement in quality of imaging of the region under diaphragm and shoulder region.	Raise the degree of H-E processing enhancement.	When applying strong H-E Processing, be careful about graininess. Enhancement that is too high will result in an image that is overexposed.

6.5 Observation of Thoracic Progress

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
A previously obtained chest radiograph of sound regions (with no lesion) and the current radiograph (sound lung legion, mediastinum, and diaphragm) shall be visible with the same density, contrast, and sharpness.	Apply progress-observation processing. The basic image quality shall be identical to the chest AP.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	130 kVp	130 kVp
mAs value	2 mAs	3 mAs
Distance	2.0 m	2.0 m
Distance	12:1	12:1

[Examples of Processing Parameter]

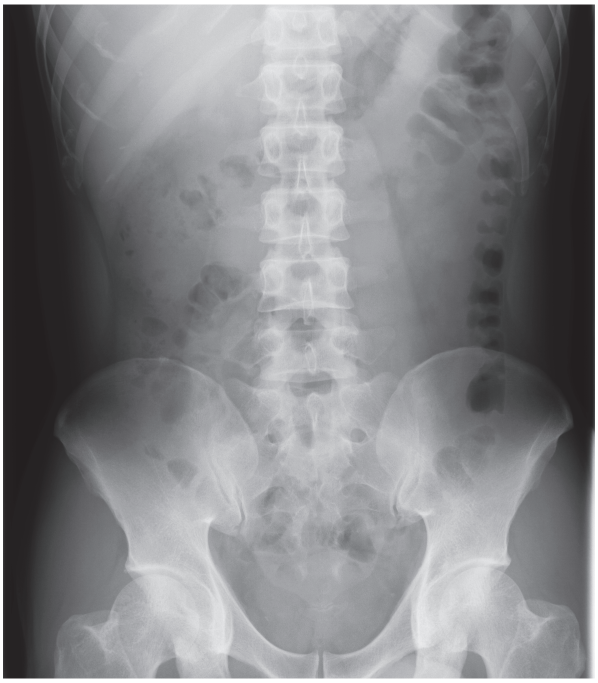
Processing Parameters	Progress Observation / Infant Progress Observation	(For online output)	(For hard copy output)
G-Processing	LUT	THX-01	THX-01
	Reference signal value density	Dorsal vertebra density 0.45	Dorsal vertebra density 0.45
	Fixed gradient	3.00	3.00
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD5
	Low density side (H)	0.2	0.0
	High density side (H)	0.5	0.3
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.3	0.3
	High density side (H)	0.0	0.0

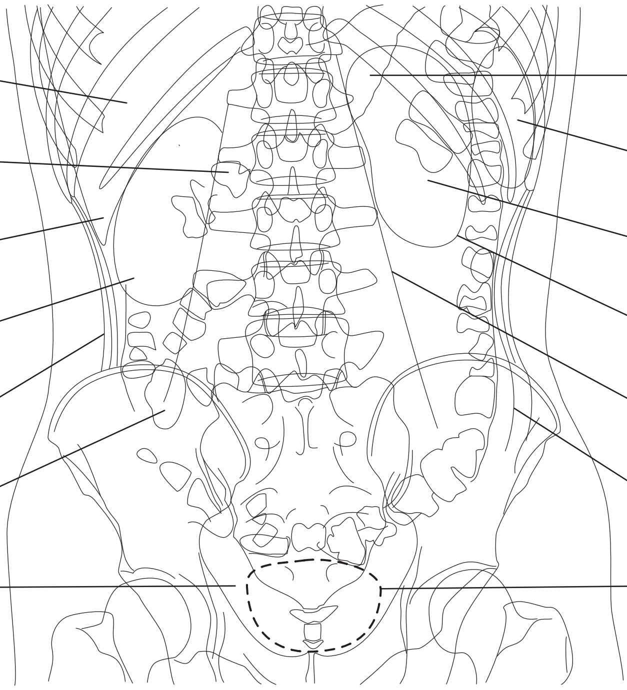
[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Progress Observation	Increase image contrast.	Increase [Fixed gradient].	The [fixed gradient]'s default value is the portable image's average value. It must be adjusted for each facility. In practice, compare the images of over-weighted and under-weighted patients and adopt the intermediate [Fixed gradient].
Infant Progress Observation	Increase image contrast.	Increase [Fixed gradient]. However, the fixed gradient for an infant is usually lower than that for an adult.	

6.6 Abdomen AP

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
When the density of the upper right abdominal region (in the region of the liver) is set to 0.7-1.0, flank stripe is visible in a density that enables diagnosis.	Adjust using [Abdomen density], [Flank density]
On the KUB image, the kidney line as well as the psoas major muscle line and renal interior are visible at a density of approximately 1.0. At the same time, the pelvic area and the cavity of the lesser pelvis are visible without being shown at low density.	Since the KUB contrast cannot be adjusted (Adjusted only by [Abdomen density]), the contrast shall be adjusted using LUT.
The edges of lumbar spine or pelvis are clear with the bone trabecula visible.	Apply H-F Processing ([The high density side])

[Examples of Exposure Parameter]

	AeroDR 1417HQ		AeroDR 1417S	
	Erect Position	Recumbent Position	Erect Position	Recumbent Position
Tube Voltage	80 kVp	75 kVp	80 kVp	75 kVp
mAs value	13 mAs	18 mAs	20 mAs	28 mAs
Distance	1.2 m	1.2 m	1.2 m	1.2 m
Grid	8:1	8:1	8:1	8:1

[Examples of Processing Parameter]

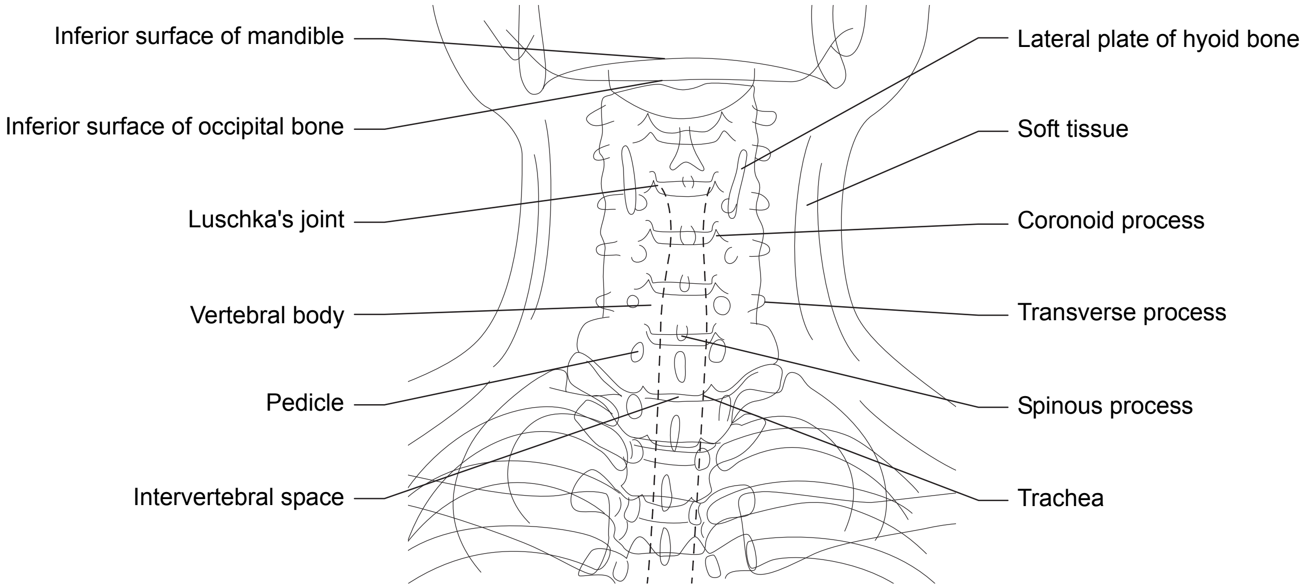
Processing Parameters	Abdomen AP	(For online output)	(For hard copy output)
G-Processing	LUT	THX-04	THX-04
	Reference signal value density	Abdomen density 0.8	Abdomen density 0.8
		Flank density 2.5	Flank density 2.4
	Fixed gradient	–	–
H-F Processing	Enhancement Type	HF-STANDARD1	HF-STANDARD3
	Low density side (H)	0.4	0.0
	High density side (H)	0.6	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.2	0.0
	High density side (H)	0.3	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Abdomen AP	Raise Contrast	Allow for a greater difference between [Abdomen density] and [Flank density].	Too great a difference between [Abdomen density] and [Flank density] may result in unstable finished density.
	Imaging of region near skin.	Adjust the degree of H-E processing enhancement.	
	Matching of the density in erect and recumbent positions.	Application of KUB processing eliminates the contrast subtracted.	Contrast subtracted due to the difference between the subjects still remains, but the tendency of contrast will be identical to that of S/F.
		Reduce the difference between [abdomen density] and [flank density]. Adjust the degree of H-F processing enhancement to prevent the lack of sharpness due to a decrease in contrast.	Too small a subtracted between [Abdomen density] and [Flank density] will lose contrast.
	Imaging of the kidneys.	Adjust the degree of H-F processing enhancement.	In the case of excessive H-F processing, graininess is degraded.

6.7 Cervical Spine AP

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The density of the cervical spine below the mandible is suitable for bone diagnosis (0.6-1.2) and the soft tissue on the exterior of the cervical spine is visible with clear contrast without being shown at the high density.	Use LUT to adjust contrast, and [Cervical spine density] to adjust density. Apply H-E Processing for soft tissue. ([The high density side])
The upper and lower edges of the vertebral body (the region between these is the intervertebral space), and the joint of Luschka is clearly visible with good contrast.	Use LUT to adjust the contrast, and apply H-F Processing. ([The high density side])
The pedicle and spinous process are visible.	Same as above.
The trachea overlapping the cervical spine or the lateral plate of the thyroid gland bone are visible.	Same as above.
The X-ray absorption subtracted in regions of soft tissue is visible with good contrast.	Adjust using H-E Processing.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	65 kVp	65 kVp
mAs value	10 mAs	15 mAs
Distance	1.5 m	1.5 m
Grid	8:1	8:1

[Examples of Processing Parameter]

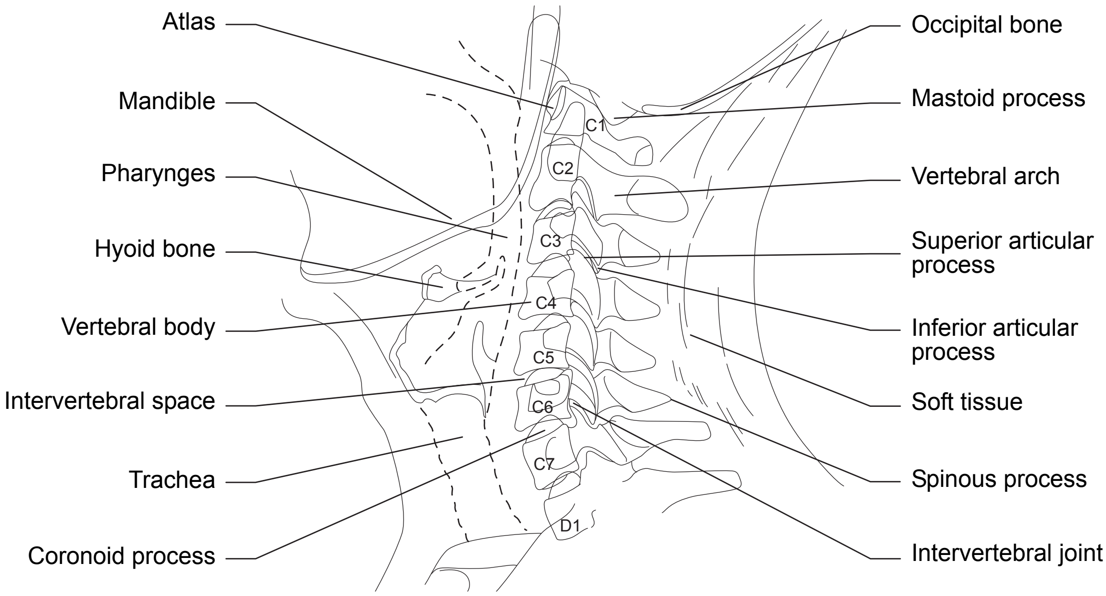
Processing Parameters	Cervical Spine AP	(For online output)	(For hard copy output)
G-Processing	LUT	LUM-01	LUM-01
	Reference signal value density	Cervical Spine Density 0.9	Cervical Spine Density 0.9
	Fixed gradient	2.65	2.65
H-F Processing	Enhancement Type	HF-STANDARD4	HF-STANDARD5
	Low density side (H)	0.0	0.0
	High density side (H)	1.0	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.3	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Cervical Spine AP	Clear imaging of the vertebral body.	Adjust the degree of H-F processing enhancement.	When applying strong [H-F Processing], be careful of graininess.
		Change the basic LUT to High-Contrast LUT.	When increasing contrast, be careful of graininess.
	Imaging of region near skin.	Adjust the degree of H-E processing enhancement.	

6.8 Cervical Spine LAT

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The region from the spinal body between the odontoid process on the second cervical vertebra and the sixth cervical vertebra to the spinous process is visible within a density suitable for bone diagnoses.	Make the adjustment using the LUT and [Cervical spine density].
The spinal periphery in the region from the spinal body to the spinous process and the internal bone structure are visible with a good degree of sharpness and with a fairly high degree of contrast.	Same as above. If necessary, apply H-F Processing.
The soft tissue behind the spine is visible with a contrast without the high density.	Apply H-E Processing. ([The high density side])

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	65 kVp	65 kVp
mAs value	10 mAs	15 mAs
Distance	1.5 m	1.5 m
Grid	8:1	8:1

[Examples of Processing Parameter]

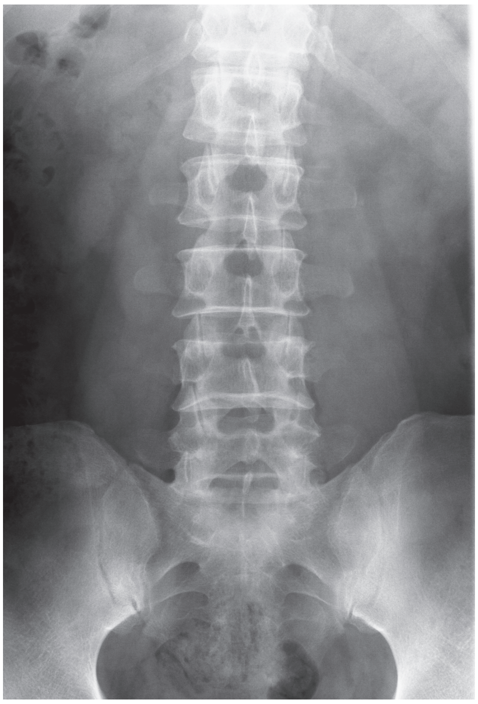
Processing Parameters	Cervical Spine LAT	(For online output)	(For hard copy output)
G-Processing	LUT	LUM-01	LUM-01
	Reference signal value density	Cervical Spine Density 0.8	Cervical Spine Density 0.8
	Fixed gradient	2.65	2.65
H-F Processing	Enhancement Type	HF-STANDARD4	HF-STANDARD5
	Low density side (H)	0.0	0.0
	High density side (H)	1.0	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.3	0.3

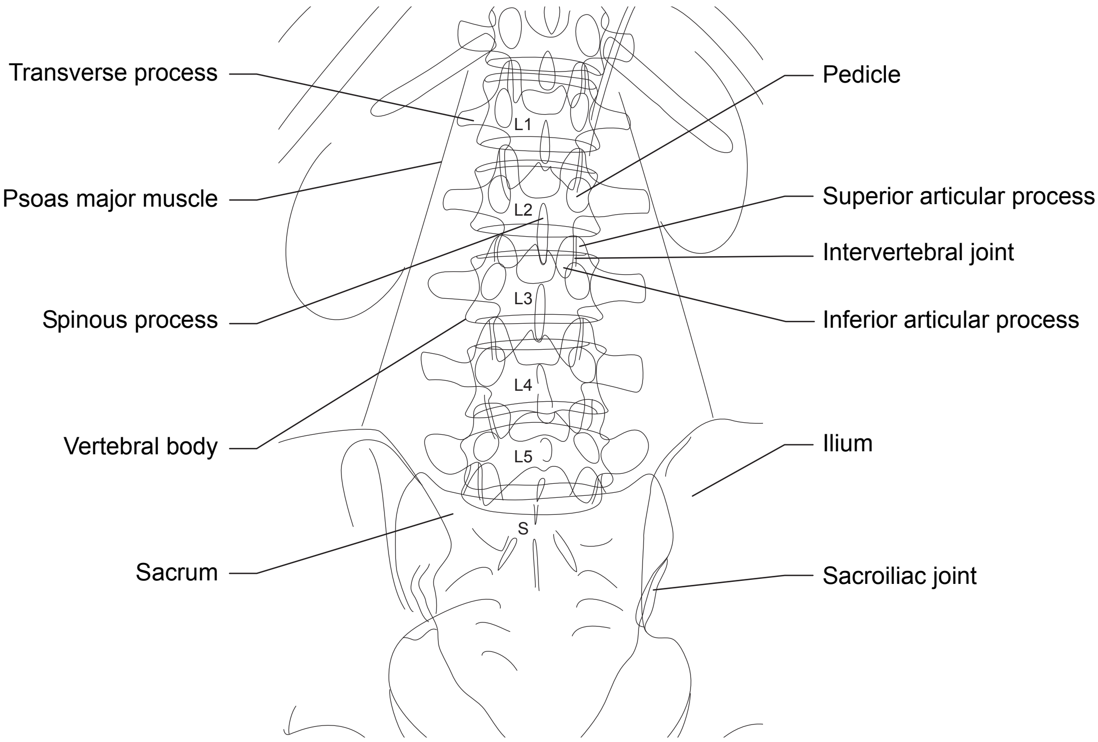
[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Cervical Spine LAT	Clear imaging of the vertebral body.	Adjust the degree of H-F processing enhancement.	When applying strong [H-F Processing], be careful of graininess.
		Change the basic LUT to High-Contrast LUT.	When increasing contrast, be careful of graininess.
	Imaging of the spinous process and soft tissue.	Adjust the degree of H-E processing enhancement.	

6.9 Lumbar Spine AP

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The vertebral body of the whole lumbar spine is within the range of density suitable for bone diagnosis. At the same time, the costal process and the psoas major muscle are not visible at too the high density. In particular, when the region from third to fifth lumbar vertebra are visible at suitable density, the first and second lumbar vertebra are not shown at the low density. At the same time, the costal process and the psoas major muscle are not visible at excessive density.	Make the adjustment with the LUT and [Cervical spine density]. If necessary, apply H-E Processing.
The terminal plate periphery is clearly visible and the trabecula is visible with a fair degree of sharpness and contrast (not possible with younger subjects).	Use LUT to adjust. If necessary, apply H-F Processing.
The vertebral arch and the pedicle overlapping the vertebral body and the spinous process are visible with clear contrast. The vertebral arch, excluding the vertebral body, describes a pattern throughout the entire lumbar spine.	Same as above.
The vertebral arch except the vertebral body is visible as one pattern over entire lumber vertebral.	Same as above.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	75 kVp	75 kVp
mAs value	25 mAs	38 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

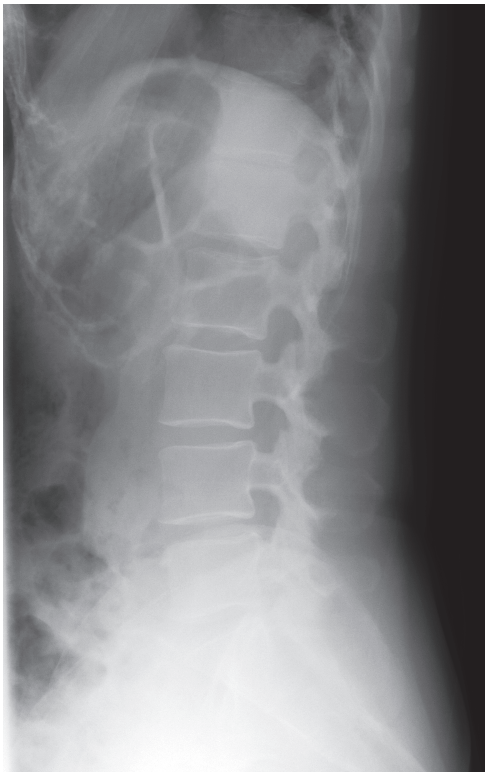
Processing Parameters	Lumbar Spine AP	(For online output)	(For hard copy output)
G-Processing	LUT	LUM-01	LUM-01
	Reference signal value density	Lumbar Spine Density 0.95	Lumbar Spine Density 0.95
	Fixed gradient	2.65	2.65
H-F Processing	Enhancement Type	HF-STANDARD2	HF-STANDARD3
	Low density side (H)	0.5	0.0
	High density side (H)	1.0	0.7
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.4	0.4
	High density side (H)	0.0	0.0

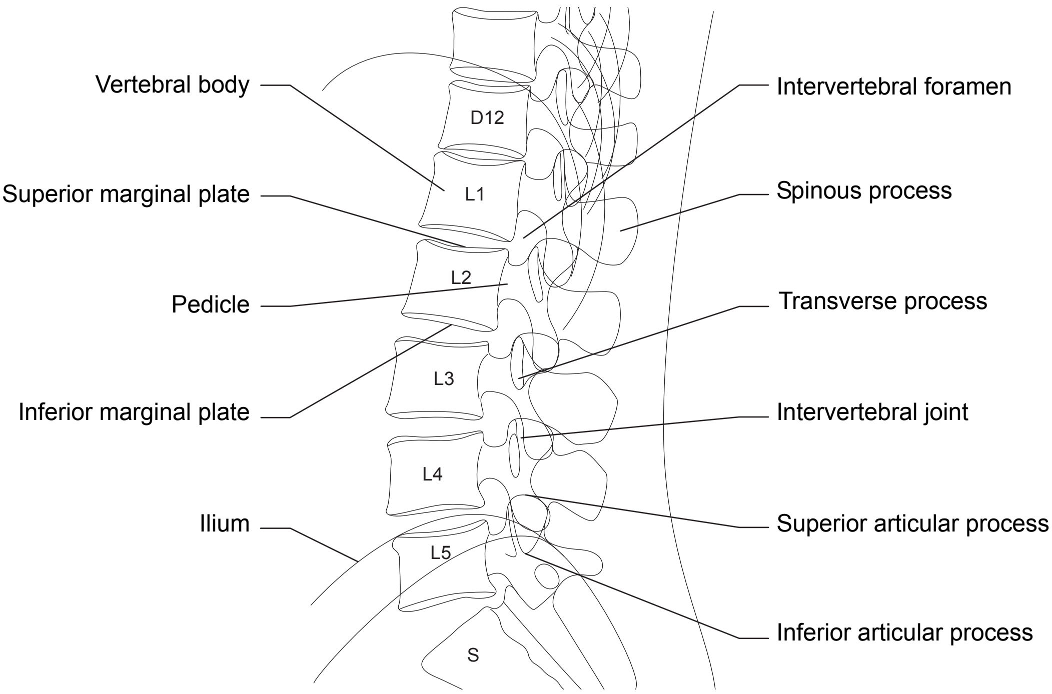
[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Lumbar Spine AP	Improve imaging of muscle (psoas major muscle) and the costal process.	When increasing the contrast using LUT change, change to high contrast LUT.	Be careful at degradation of graininess and stability of finish density influenced by the change in contrast. Also note that inflammation may produce an unclear muscle line (psoas major muscle).
	Improve imaging of transverse process.	Change the standard type of H-F Process parameter to low frequency side, and increase the high density side enhancement. In this case, change LUT to low contrast LUT.	Be careful at degradation of graininess.
	Improvement in imaging of the trabecula of bone.	Adjust H-F Processing parameter (the high density side) to improve imaging. If it is desirable to clearly show the bone quantity of the vertebral body (region of the low density) near the pelvis, input a value also in the low density side. In this case the value input for the low density side shall be less than that for the high density side.	When inputting a value for the low density side, be careful of degradation from graininess.

6.10 Lumbar Spine LAT

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The fourth lumbar spine and the upper edge of the sacred bone, which overlaps left and right iliac bones, is visible at a discernable density (approx. 0.6). At the same time, the spinous process and the sacral crest are visible without excessive density.	Adjust using [Lumbar density]. For the spinous process, apply H-E Processing. (The high density side)
The entire lumbar spine region is visible in clear contrast to the surrounding region.	Change LUT to high contrast LUT. According to the above, adjust [Lumbar spine density].
The periphery of the vertebral body is sharply visible while the area between the periphery and the vertebral body interior are shown in contrast. There are cases where the trabecula other than those on the spinous process are not visible.	Same as above. Apply H-F Processing.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	90 kVp	90 kVp
mAs value	50 mAs	75 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

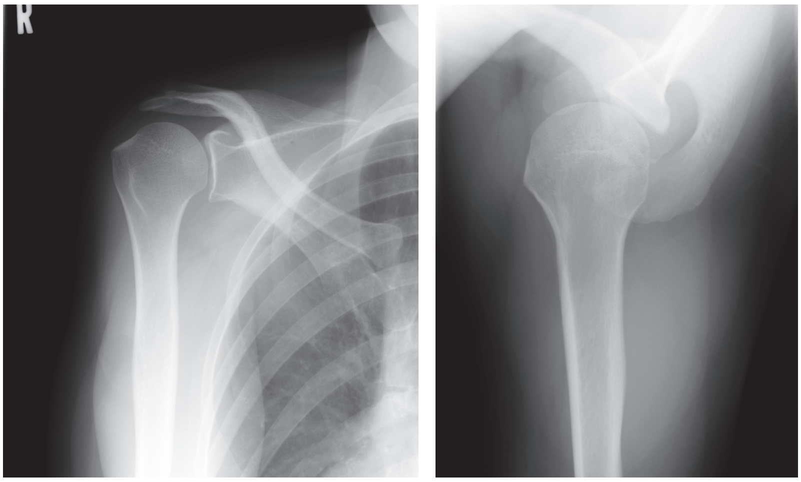
Processing Parameters	Lumbar Spine LAT	(For online output)	(For hard copy output)
G-Processing	LUT	LUM-01	LUM-01
	Reference signal value density	Lumbar Spine Density 1.05	Lumbar Spine Density 1.05
	Fixed gradient	2.65	2.65
H-F Processing	Enhancement Type	HF-STANDARD2	HF-STANDARD3
	Low density side (H)	0.0	0.0
	High density side (H)	1.0	0.7
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.3	0.4
	High density side (H)	0.3	0.0

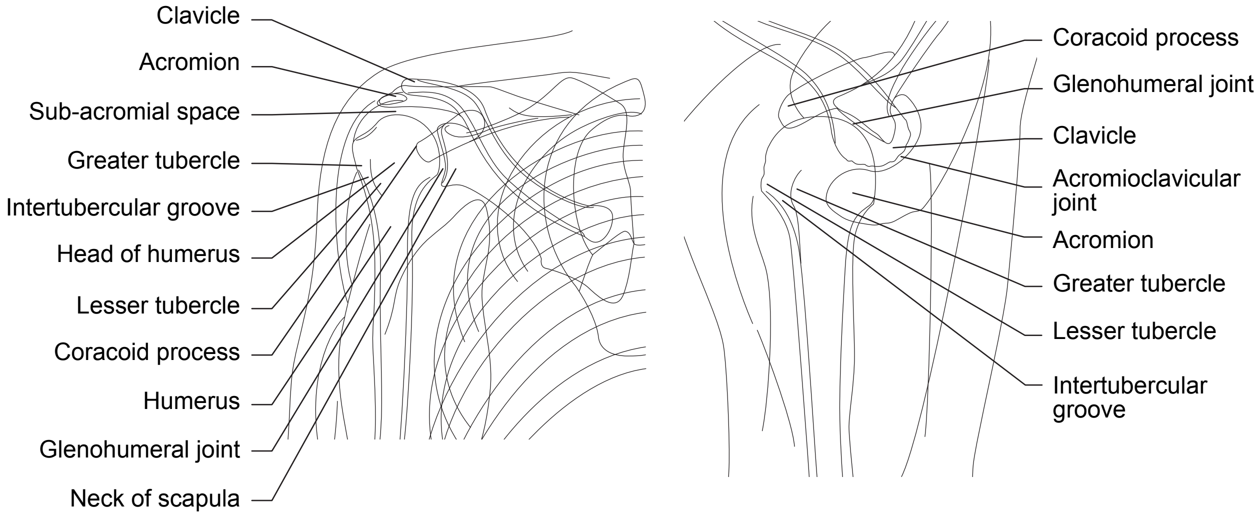
[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Lumbar Spine LAT	The spinous process is "blacked-out"	If the overall density is high, decrease [Lumbar spine].	By decreasing [Lumbar spinal density], the overall density can be lowered.
		Adjust the value of the high density side of the H-E processing parameter.	
		Change to low contrast LUT and at the same time select the low frequency side of H-F Standard, and apply H-F Processing with high enhancement.	
	Improvement in contrast	Change LUT to high contrast LUT.	
		Confirm adjustment of the aperture.	When exposing, it is important to use the aperture. Proper aperture adjustment will result in overall improvement of the quality of the image.
	Clear imaging of the trabecula	Adjust the high density side value for enhancement for H-F Processing. For the vertebral region near the pelvic region (region of the low density), input a value for the low density side to adjust.	Be careful of degradation from graininess.

6.11 Shoulder Joint AP/Axial

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The acromion and sub-acromial space is not visible at excessive density (imaging of the skin surface is also necessary), while the shoulder joint (the glenohumeral joint) is not visible at the low density. There is sufficient contrast to allow the coracoid process to be discerned.	Make the adjustment with the [Shoulder joint density] and LUT. [Shoulder density] will vary depending on the presence of the spine in the image. For the skin surface and the coracoid process, apply H-E Processing. (The high density side)
The trabecula of the head of the humerus is visible and sharp.	Apply H-F Processing.
The greater and lesser tubercles are visible and the intertubercular groove can be discerned.	Adjust using LUT. Apply H-F Processing.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	75 kVp	75 kVp
mAs value	6 mAs	9 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

Processing Parameters	Shoulder Joint (Shoulder Joint AP, Axial)	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-02	BONE-02
	Reference signal value density	Shoulder Joint Density 1.5	Shoulder Joint Density 1.5
	Fixed gradient	2.46	2.46
H-F Processing	Enhancement Type	HF-STANDARD4	HF-STANDARD5
	Low density side (H)	0.0	0.0
	High density side (H)	1.0	0.7
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.5	0.3

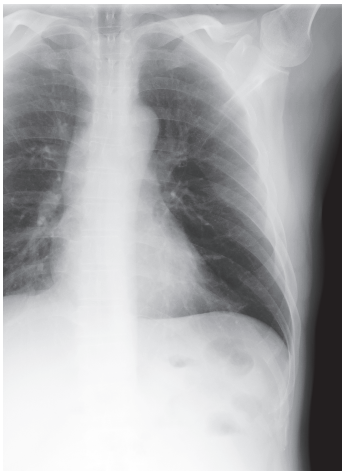
[Items and requirements of Adjustment]

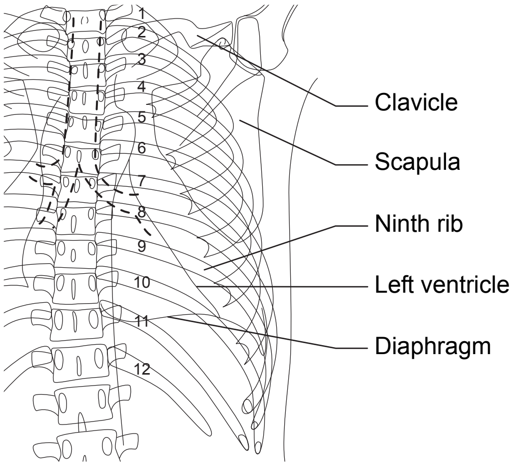
	Requirements	Items for Adjustment	Remarks
Shoulder Joint AP	Increased contrast	Adjust using [Shoulder Joint density] and LUT. Caution should be taken since the dynamic range of the shoulder joint image is comparatively broad.	The contrast of shoulder joint image is high, and often blackouts around joint region, or whiteout around the edge of the upper arm (near elbow). Additionally, on an axial image, the shoulder region is often lost in white; basically, H-E Processing is considered to be effective for the shoulder joint. While it is recommended to limit the field of exposure, in cases where the field is to be widened so that the image of spinal region is included, [Shoulder joint density] shall be lowered.
	Improved imaging of the trabecula.	H-F Processing: Increase the high density side.	
	Imaging including soft tissue in the region of the joint.	H-E Processing: Increase the high density side. Excessive increase will decrease the contrast on the overall image.	
Shoulder Joint Axial	Increased contrast	Adjust using [Shoulder Joint density] and LUT. Caution should be taken since the dynamic range of the shoulder joint image is comparatively broad.	
	Improved imaging of the trabecula.	H-F Processing: Increase the high density side. If necessary the standard type shall be changed to the high frequency side.	
	Imaging including soft tissue in the region of the joint.	H-E Processing: Increase the high density side. Excessive increase will decrease the contrast of the overall image.	

6.12 Ribs

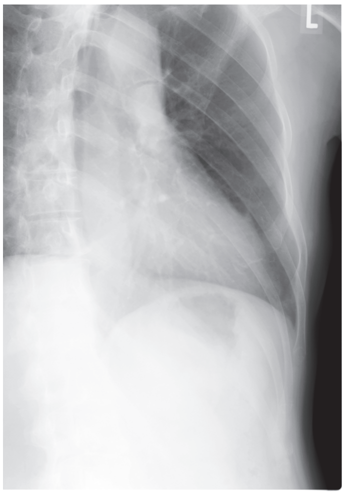
Image and Parts Names

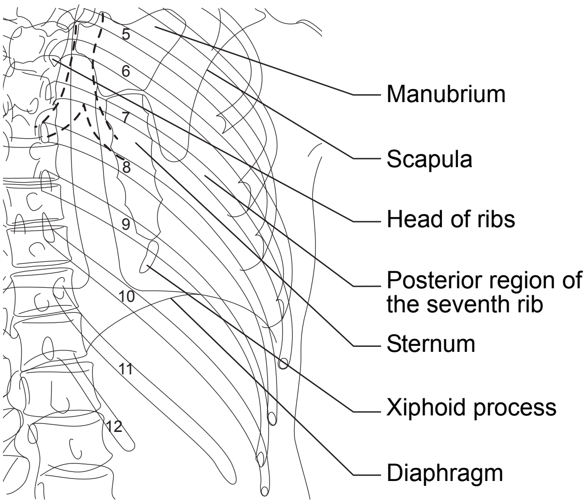
PA/AP



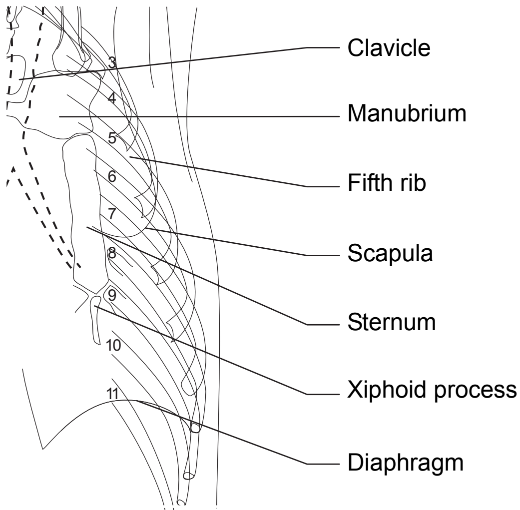


Oblique





Tangent



[Points for interpretation of radiogram]

	Points for interpretation of radiogram	Points for Adjustment
Ribs PA	Ribs in the lung region are visible sharply and with good contrast.	Adjust using [Rib density] [Lung field]. Apply H-F Processing.
	There is no significant subtracted in density between the ribs in the side thoracic wall and those in the lung field.	Same as above.
	The image is adjusted with imaging of the affected part (bone fracture) as the focus.	Setting shall be made to ensure that the rib density is not too light.
	Density of the ribs in the lung field and below the diaphragm is brought as close as possible without losing contrast between individual ribs and the background.	Depict the ribs in the lung field by applying H-E Processing (The high density side) matching the density of the ribs below diaphragm.
	The trabecula of the ribs is clearly visible regardless of whether the ribs are in the lung field or below the diaphragm.	Same as above.
Ribs Oblique	While keeping the ribs in the lung field within a range of density suitable to diagnosis, the ribs below the diaphragm are visible with density raised to within a range suitable to diagnosis.	Depict the ribs in the lung region by applying H-E Processing (the high density side) matching the density of the ribs below diaphragm. The contrast depends on the ratio occupied by the lung field. Fix the contrast by setting lung field = 0 (Fixed G-value), and apply H-E Processing to minimize variations in density.
	At this time, the density of ribs in the side thoracic wall shall not be excessive.	Same as above.
	Depict the trabecula of the ribs below the diaphragm.	Apply H-F Processing.
	Density of the ribs in the lung field and below the diaphragm as well as those spanning the mediastinal region shall be brought as close as possible without losing contrast between individual ribs and the background.	Same as those for Ribs PA.
	The trabecula of the ribs shall be clearly visible regardless of whether the ribs are in the lung field, below the diaphragm or in mediastinal region.	Same as above.
Ribs Tangent	Ribs on the periphery shall be visible within the range of density suitable for diagnosing and contrast with the background. Additionally, trabecula shall also be visible.	Same as Ribs PA.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	70 kVp	70 kVp
mAs value	6 mAs	9 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

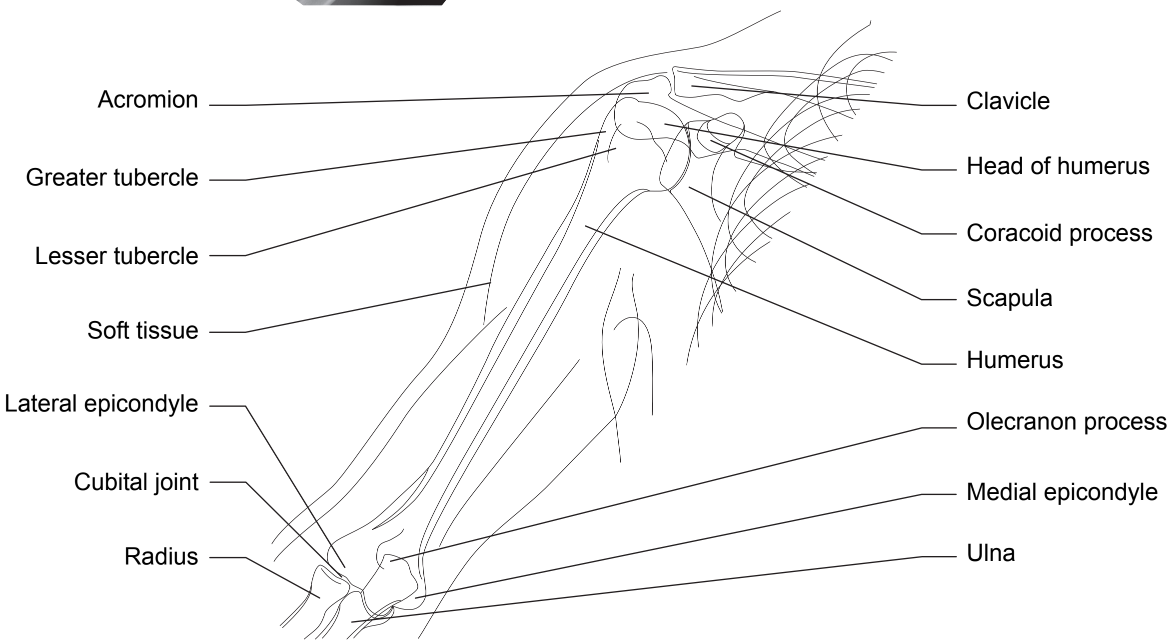
Processing Parameters	Ribs	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-02	BONE-02
	Reference signal value density	Shoulder Joint Density 0.45	Shoulder Joint Density 0.45
		Lung Field Density 2.00	Lung Field Density 2.00
	Fixed gradient	–	–
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD5
	Low density side (H)	0.0	0.0
	High density side (H)	0.5	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.4	0.4

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Upper Ribs	To show the ribs in the lung field.	H-E Processing: Increase the high density side.	There are various positioning such as upper ribs, lower ribs, oblique and tangent. Additionally, ribs in both the lung field and below the diaphragm with a wide dynamic range are present in the view. Thus, H-E Processing is considered the most effective tool for acquiring stable gradations for this region.
	Improved imaging of the trabecula.	H-F Processing: Increase the high density side.	
Middle Ribs	To stabilize gradation processing.	H-E Processing: Increase either the high density side or the low density side. When the high density side is increased, [Rib density] [Lung field] shall be increased a little, and when the low density side is increased, [Rib density] [Lung field] shall be lowered a little.	
	Improvement of imaging of the trabecula.	H-F Processing: Increase the high density side.	
Lower Ribs	To show the ribs below the diaphragm.	H-E Processing: Increase the low density side.	
	Improvement of imaging of the trabecula.	H-F Processing: Increase the high density side.	
Oblique Ribs Tangent	Improvement of the image contrast.	Decrease [Rib density]. Or, increase [Lung density]. In tangent or oblique images there is a tendency of emphasizing the contrast of the human body overlapping the ribs.	

6.13 Humerus AP

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The head of the humerus is visible without the low density while the cubital joint is visible without the high density.	Adjust using [Humerus density] and LUT. If imaging of the cubital joint is lost due to the high density, apply H-E Processing. (The high density side)
The trabecula of the humerus and the cubital joint are sharply visible.	Apply H-F Processing.
Depict soft tissue without the high density but give good contrast to the inside of it. (Sharpness is not required for soft tissues.)	Same as above.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	60 kVp	60 kVp
mAs value	4 mAs	6 mAs
Distance	1.2 m	1.2 m
Grid	-	-

[Examples of Processing Parameter]

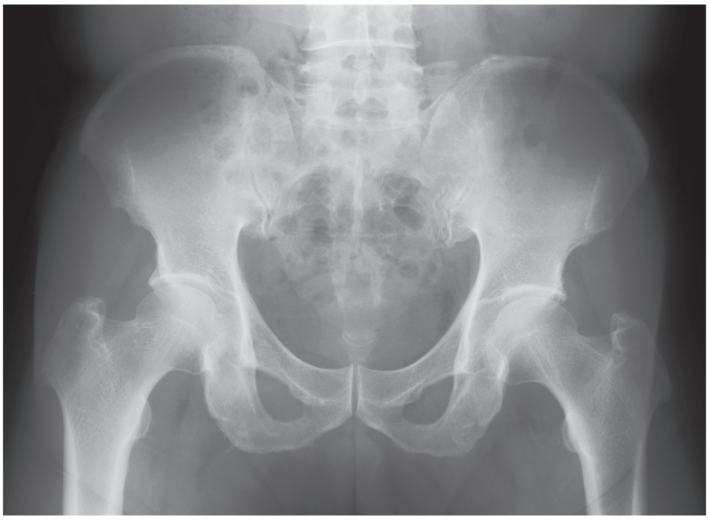
Processing Parameters	Humerus AP	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-03	BONE-03
	Reference signal value density	Humerus Density 0.8	Humerus Density 0.8
	Fixed gradient	2.68	2.68
H-F Processing	Enhancement Type	HF-STANDARD5	HF-STANDARD5
	Low density side (H)	0.0	0.0
	High density side (H)	0.8	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.3	0.3

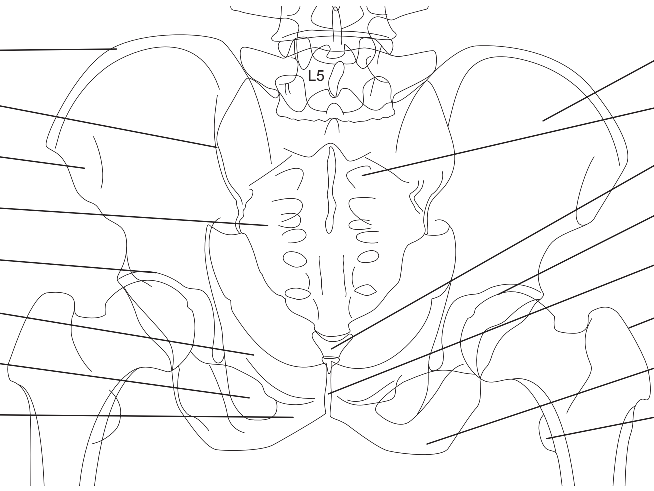
[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Humerus	Improvement of contrast, sharpness.	Apply H-F Processing.	Graininess will deteriorate.
		Change LUT to high contrast LUT.	Graininess will deteriorate. Density may become unstable.
	Match the density and the contrast for near and far regions of humerus.	Apply H-E Processing.	
	Imaging of the area near the skin.	Apply H-E Processing.	

6.14 Pelvis AP

Image and Parts Names





[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
The density of the iliac crest (greater trochanter of the femur as well for older and thin patients) shall not be excessive, and the hip joint and the head of the femur shall be visible without low density.	Adjust using [Ilium density] and LUT. Apply H-E Processing for ilium. (The high density side)
The acetabulum and the head of the femur as well as the trabecula of the greater trochanter region shall be clearly visible.	Same as above.
The sacrum, coccygeal bone and the ischiadic spine shown in the cavity of the lesser pelvis are visible with good contrast.	Same as above.
No subtracted between the left and right ilium.	Check photographic system alignments, etc.
Depict the soft tissue in the femur region.	Apply H-E Processing. (The high density side)

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	85 kVp	85 kVp
mAs value	10 mAs	15 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

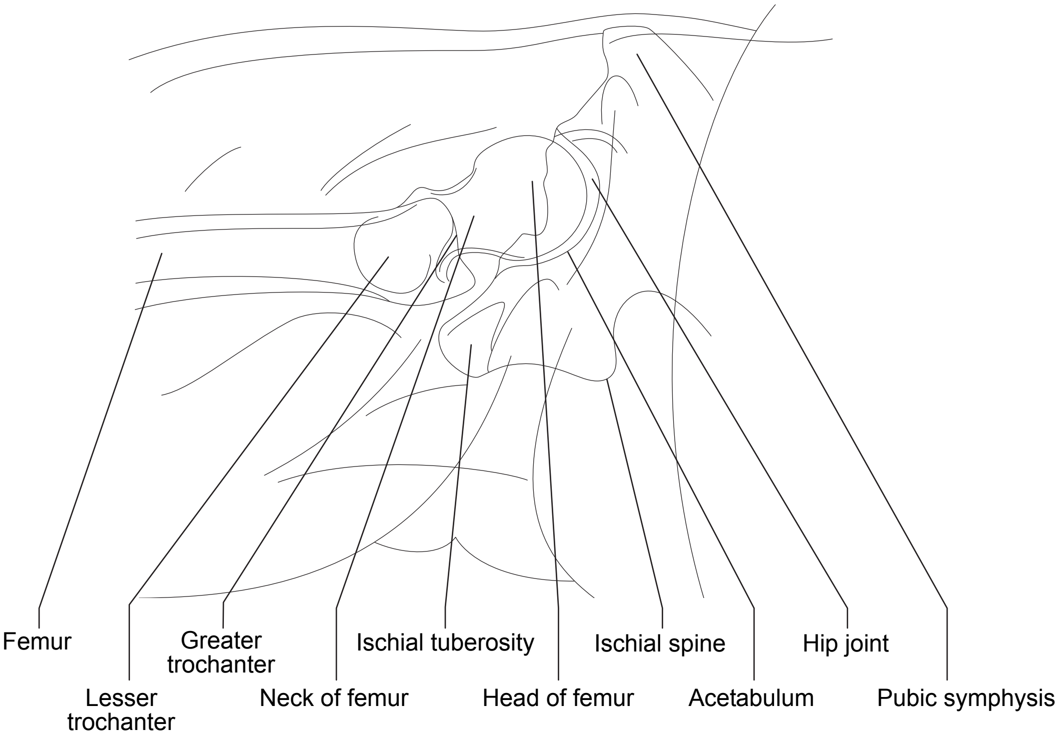
Processing Parameters	Pelvis AP	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-05	BONE-02
	Reference signal value density	Ilium Density 1.1	Ilium Density 1.1
	Fixed gradient	2.93	2.46
H-F Processing	Enhancement Type	HF-STANDARD4	HF-STANDARD4
	Low density side (H)	0.0	0.0
	High density side (H)	0.5	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.3	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Pelvis AP	Imaging of head of femur.	To get overall contrast, change to high contrast LUT.	When using higher contrast LUT, be careful of a drop in graininess.
		Enhancement of H-F Processing parameter: Increase the low density side and the high density side value.	When increasing the low density side, be careful of a drop in graininess.
		Request to expose with lower tube voltage condition than the current one.	When lowering the voltage, it is necessary to increase the mAs value.
	The pelvic region is "blacked-out"	Decrease [Ilium density] lowering overall density.	Be careful to avoid "whiteout" of the low density areas.
		Apply H-E Processing parameter. Lower the high density side.	
	Left and right ilium density is different.	Expose at pelvis AP exposing position and conditions, to check the alignment. And check whether the grid has proper focus distance.	

6.15 Hip Joint Axial

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment (simplified adjustment)
Depict the acetabulum (articular space) and the head of the femur without low density while the femur, pubic symphysis, and the ischial bone without excessive density.	Adjust using [Hip joint density] and LUT.
Depict the details of trabecula of the greater trochanter of the femur, the lesser trochanter region, and the head of the femur as much as possible.	Apply H-F Processing.
Depict the soft tissue in the area of the femur.	Apply H-E Processing. (The high density side)

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	75 kVp	75 kVp
mAs value	15 mAs	24 mAs
Distance	1.0 m	1.0 m
Grid	8:1	8:1

[Examples of Processing Parameter]

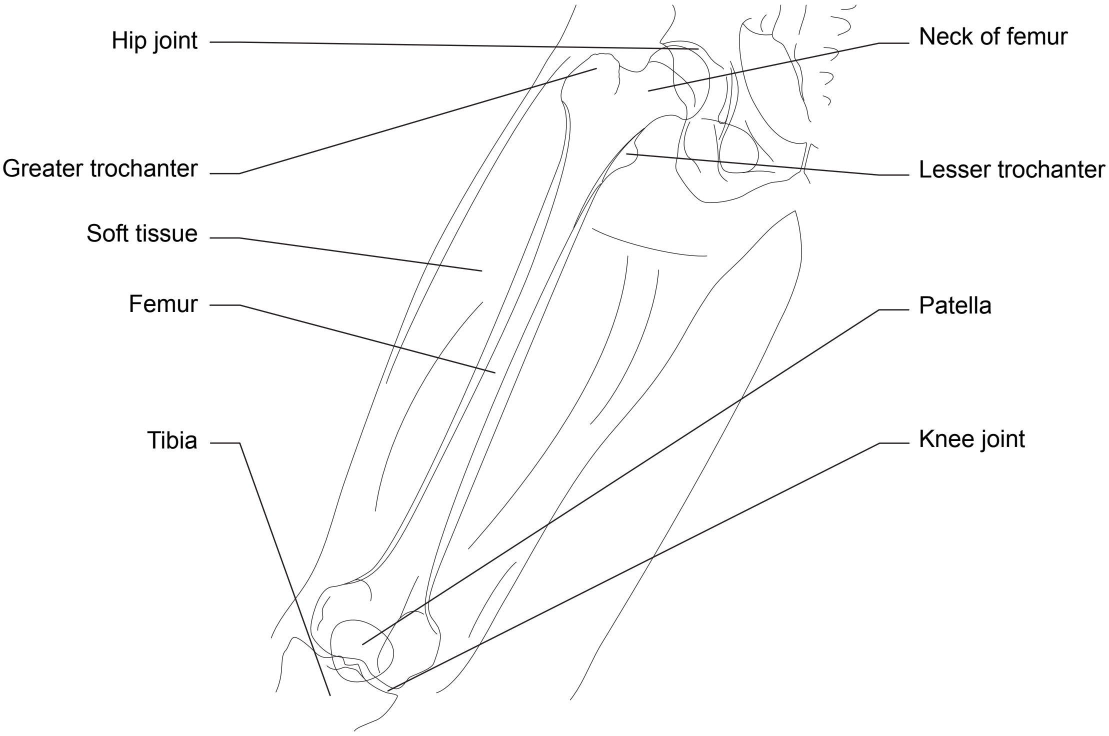
Processing Parameters	Hip Joint	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-05	BONE-03
	Reference signal value density	Hip Joint Density 0.5	Hip Joint Density 0.5
	Fixed gradient	2.93	2.68
H-F Processing	Enhancement Type	HF-STANDARD4	HF-STANDARD4
	Low density side (H)	0.0	0.0
	High density side (H)	0.5	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.3	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Hip Joint Axial	Imaging of head of femur.	For overall contrast, change to high contrast LUT.	When using higher contrast LUT, be careful of a drop in graininess.
		Request exposure with lower tube voltage condition than the current one.	When lowering the voltage, it is necessary to increase the mAs value.
	The pelvic region is "whitened-out"	Increase [Hip joint density] raising overall density.	Be careful to avoid "whiteout" of the low density areas.
		Change to low contrast LUT.	This adjustment is not suitable when the head of bone is not clear.
		Input a value for the low density side of H-E Processing parameter, and increase the density of the low density side.	
	The femur is "Blacked-out"	Decrease [Hip joint density] to decrease overall density.	
		Change to low contrast LUT.	This adjustment is not suitable when the head of bone is not clear.
		Apply H-E Processing to decrease the density of the high density side.	

6.16 Femur AP

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
Depict the head of the femur with not the low density while the knee joint region with not excessive density.	Adjust using [Femur density] and LUT. If necessary, apply [H-E Processing] to knee joint. (The high density side)
Clearly depict the details of trabecula of the lesser trochanter and the knee joint region.	Apply H-F Processing.
Depict the soft tissue without high density, while maintaining good contrast to the inside. (Sharpness is not required.)	Apply H-E Processing.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	70 kVp	70 kVp
mAs value	12 mAs	18 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

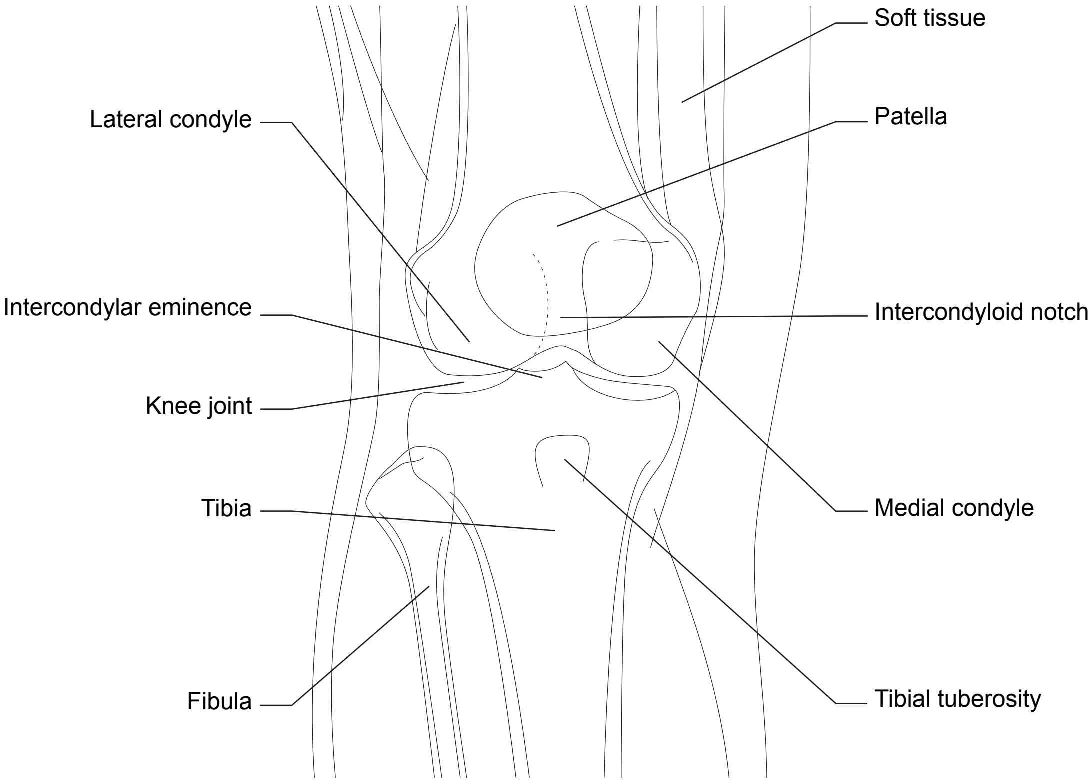
Processing Parameters	Femur AP	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-03	BONE-03
	Reference signal value density	Femur Density 0.7	Femur Density 0.7
	Fixed gradient	2.68	2.68
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD4
	Low density side (H)	0.5	0.0
	High density side (H)	1.0	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.2	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Femur	Improvement in contrast and sharpness.	Apply H-F Processing.	When increasing the value, be careful of a drop in graininess.
		Change LUT to high contrast LUT.	
	Matching of the density and contrast of the femur and knee joint.	Apply H-E Processing.	
	Imaging of the region near skin.	Apply H-E Processing.	

6.17 Knee AP

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
Depict the medial and lateral condyles of the femur without high density while clearly depicting the periphery of the patella and the interior trabecula.	Adjust using [Knee joint density] and LUT. If the external condyle is lost, apply [H-E Processing]. (The high density side)
Depict knee joint cavity and surrounding soft tissue without too high a density.	Apply H-E Processing.
Clearly depict the trabecula of the femur and the tibia.	Apply H-F Processing.
Depict the soft tissue in the vicinity of the bone with good contrast.	Adjust using LUT, and apply H-E Processing to depict the soft region.
Depict surface of skin.	Same as above.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	55 kVp	55 kVp
mAs value	8 mAs	12 mAs
Distance	1.2 m	1.2 m
Grid	-	-

[Examples of Processing Parameter]

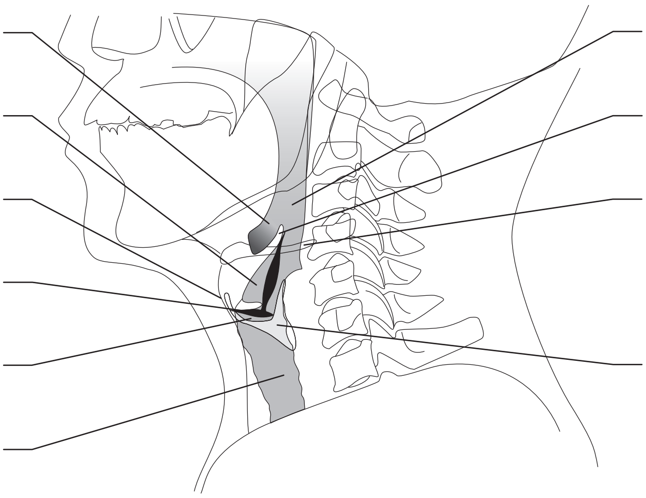
Processing Parameters	Knee AP	(For online output)	(For hard copy output)
G-Processing	LUT	BONE-03	BONE-03
	Reference signal value density	Knee Joint Density 0.7	Knee Joint Density 0.6
	Fixed gradient	2.46	2.68
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD5
	Low density side (H)	0.5	0.0
	High density side (H)	1.0	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.2	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Knee Joint AP	Improvement in contrast and sharpness.	Apply H-F Processing.	When increasing the value, be careful of a drop in graininess.
		Change LUT to high contrast LUT.	
	Imaging of joint cavity and soft tissue.	Apply H-E Processing.	

6.18 Larynx LAT

Image and Parts Names



[Points for interpretation of radiogram]

Points for Interpretation of Radiogram	Points for Adjustment
Depict the area from skin surface of spinal region to the front edge of spine, and depict laryngeal ventricle, piriform sinus and epiglottis shown in the air space, without too high a density.	Adjust using [Larynx density] and LUT. (The high density side)
Depict hyoid bone, the cartilage and the cricoid cartilage with sharpness and good contrast.	Same as above. Apply H-F Processing.

[Examples of Exposure Parameter]

	AeroDR 1417HQ	AeroDR 1417S
Tube Voltage	70 kVp	70 kVp
mAs value	10 mAs	15 mAs
Distance	1.2 m	1.2 m
Grid	8:1	8:1

[Examples of Processing Parameter]

Processing Parameters	Larynx LAT	(For online output)	(For hard copy output)
G-Processing	LUT	THX-04	THX-04
	Reference signal value density	Soft Tissue Density 2.3	Soft Tissue Density 2.3
	Fixed gradient	2.65	2.65
H-F Processing	Enhancement Type	HF-STANDARD3	HF-STANDARD3
	Low density side (H)	0.0	0.0
	High density side (H)	0.7	0.5
H-E Processing	Enhancement Type	HE-STANDARD1	HE-STANDARD1
	Low density side (H)	0.0	0.0
	High density side (H)	0.3	0.3

[Items and requirements of Adjustment]

	Requirements	Items for Adjustment	Remarks
Larynx LAT	Improvement in sharpness.	Apply H-F Processing.	When increasing the value, be careful of a drop in graininess.
	Improvement in contrast	Change LUT to high contrast LUT.	
	Imaging of skin periphery and soft tissue.	Decrease the value for [Soft Tissue density] to lower overall density. If it is desirable to avoid "whiteout" of the spinal region, apply [H-E Processing].	H-F Processing may be applied to supplement contrast. However H-F Processing that is too intense will cause a drop in graininess.

KONICA MINOLTA

A45YMA01EN03

2015-09-18

(JD)