Waza-ari

-A web-based CT dose calculator-

WAZA-ARI version 3
USER MANUAL

Ver. 20260217

National Institutes for Quantum Science and Technology

National Institute of Radiological Sciences

Dept. of Radiation Regulatory Science Research

Contents

1. Preface

1.1. **Preface**

This manual is a user manual of WAZA-ARI, the web system for evaluating exposure dose from CT. The instruction, calculation algorithm and parameters for WAZA-ARI are summarized in this manual. And it was edited by the following members who developed WAZA-ARI.

National Institutes for Quantum Science and Technology
Yusuke Koba, Yuta Hirai, Yuzuki Saito

If you have any questions, please feel free to contact us at the below e-mail address.
WAZA-ARI Development group：ml-waza-ari@qst.go.jp

Contributors to the development of WAZA-ARI

National Institutes for Quantum Science and Technology
Nakada Yoshihiro, Akahane Keiichi,
Tokyo Metropolitan University
Chang Weishan, Matsumoto Shinnosuke

Japan Atomic Energy Agency
Takahashi Fumiaki, Satoh Kaoru

Tokyo Health Care University
Ono Koji

Oita University of Nursing and Health Sciences
Kai Michiaki

Shinbeppu hospital
Yoshitake Takayasu

Tokai University Oiso Hospital
Hasegawa Takayuki

Tokai University Hospital
Katsunuma Yasushi

Chiba University Hospital
Kasahara Tetsuharu

1.2. **Background of the development of WAZA-ARI**

Recently, CT scan has been widely used in medical institutions while exposure dose from CT scan is much higher than that from radiography. Therefore, the International Atomic Energy Agency IAEA has called for more attention to exposure dose by radiography in early childhood and repeated radiography for the same patients. Japanese medical-related societies have also begun to manage exposure doses caused by medical behavior during the patient's life in order to prevent excessive exposure. Japan had a relatively large number of CT scanners per million population. According to the survey in 2005, more than 20.7 million scans per year was recorded. Nevertheless, the system for managing total medical exposure of patients has not been constructed in Japan.

To solve the above-mentioned problems, Japan's National Institutes for Quantum and Radiological Science and Technology (QST), Japan Atomic Energy Development Agency (JAEA), and the Oita University of Nursing and Health Sciences (Oita Pref. Nursing) renewed the WAZA-ARI system which was developed in 2012. The renewal system WAZA-ARI can evaluate patient dose from CT scans and officially started to serve in January 2015 under the management of QST. [1][2]

WAZA-ARI version 2 was released on January 30, 2015, and WAZA-ARI version 3 was released on June 30, 2025.

1.3. **Features of WAZA-ARI**

WAZA-ARI is the second highest score a fighter can achieve in a Japanese martial arts ippon or waza-ari contest such as judo.

【Web-based system】

WAZA-ARI was developed to be a web-based system so that installation and maintenance will never be a burden to users. After accessing the web site, users can calculate dose from CT by entering information such as the model of CT scanner, the scanning range, the age, body shape, and gender of the patient. The result will display immediately after the scanning conditions are set.

WAZA-ARI has the following new functions

【Dose calculation for patients of various body shapes and ages】

The previous version of WAZA-ARI only calculates organ doses for the average Japanese adults. On the other hand, WAZA-ARI calculates not only standard body shape but also fat and thin people so that most Japanese can be covered. Besides, dose calculation is supported for underage patients with the age of 0, 1, 5, 10, or 15. Dose calculation was mainly performed by simulation code developed by JAEA, and the phantoms used for calculation include the newly developed Japanese adult phantoms and the child phantoms developed by the University of Florida and the National Cancer Institute of the US.

【Construction of registered dose data statistically for CT scanning condition optimization】

After registration, users can calculate organ dose by entering required information and register the data on the QST server. WAZA-ARI server, on the other hand, can collect dose data of each institution and estimate the distribution of dose from CT in Japan. Users can compare the dose level between their own institutions and the dose level of the registered data in WAZA-ARI and use it to optimize CT scanning conditions to prevent overexposure of patients.

Calculation results are modified to display on the right side of the window for setting the scanning conditions in WAZA-ARI. In addition, the layout has been changed so that users can see the scanning conditions and the calculation results at the same time. Functions of registering calculation results and frequently used scanning conditions are also added for convenience.

2.Dose calculation

2.1. **Setting of the condition for dose calculation**

Click "CT Dose Calculator" on the right banner to move to the dose calculation screen.

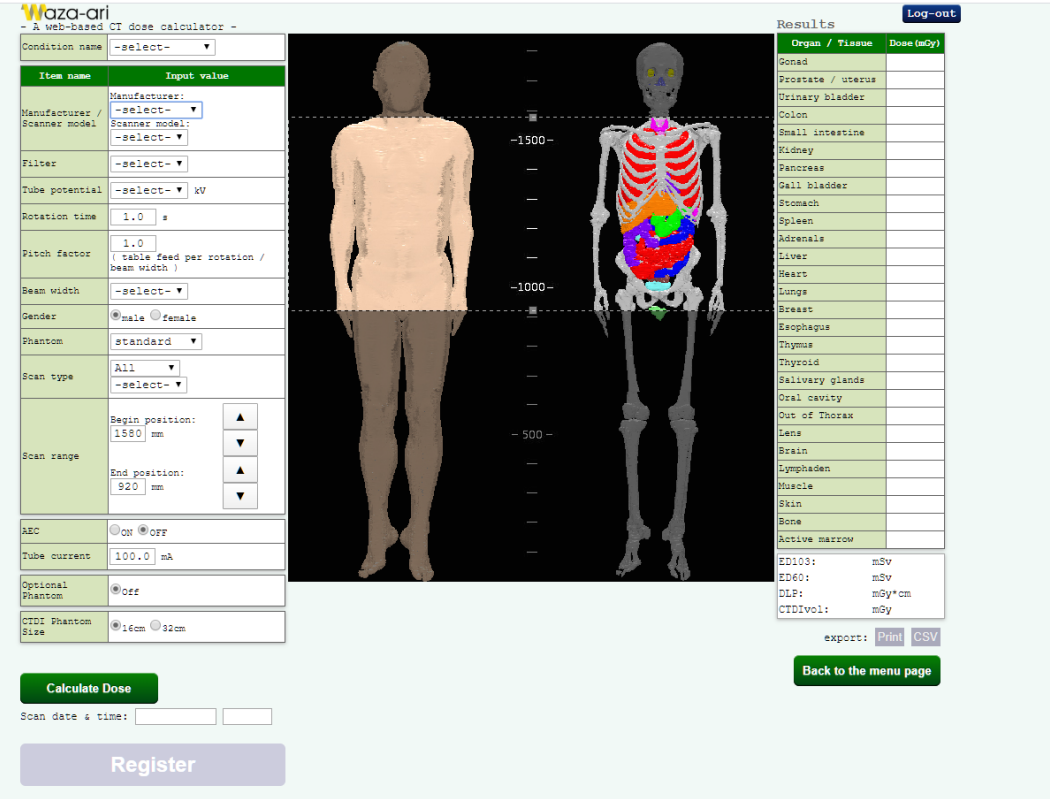


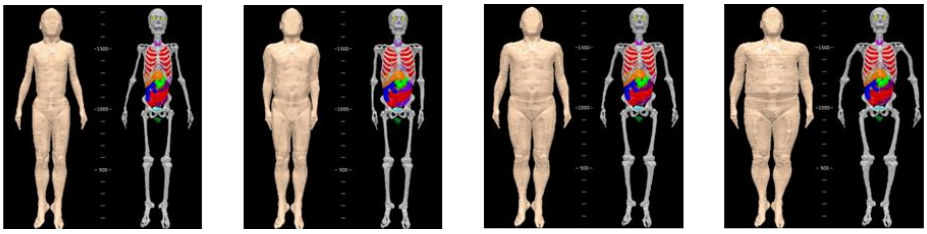
Fig. 2-1. Page for calculation of the X-ray CT exposures

Scanning conditions for dose calculation are set in the left column on dose calculation page. Detail of the scanning condition items are shown in Table 2-1 and detail of the available phantoms are shown in Table 2-2 and Fig. 2-2. Height, weight and BMI for each phantom are shown in Table 3-2.

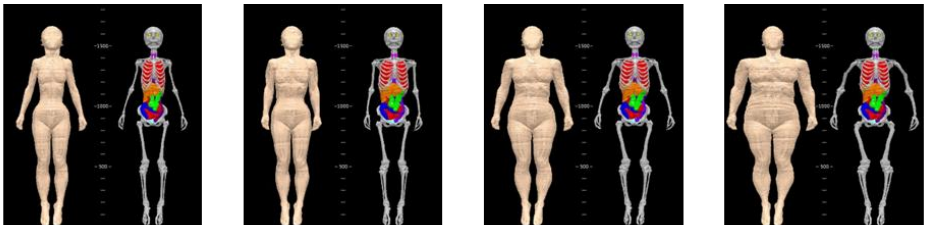
Two new functions of (1) BMI-based organ dose calculation and (2) SSDE calculation are added in Feb 2021. If you select Adult optional phantom in the phantom item, body shape correction function (optional phantom) will be turned on and columns of height and weight display (Fig. 2-3). Using BMI estimated by the entered height and weight, it has potential to calculate the organ dose closer to the body shape of the subject. Phantom displayed on the calculation screen does not change with the entered height and weight. In WAZA-ARI, SSDE is calculated using $CTDI_{vol}$ and the conversion factors proposed in AAPM TG 204, and the conversion factor is a function of effective diameter (AP: anterior-posterior dimension, LAT: lateral dimension). Fig. 2-4 shows the calculation screen when SSDE is turned on.

Table 2-1. Scanning condition item for dose calculation

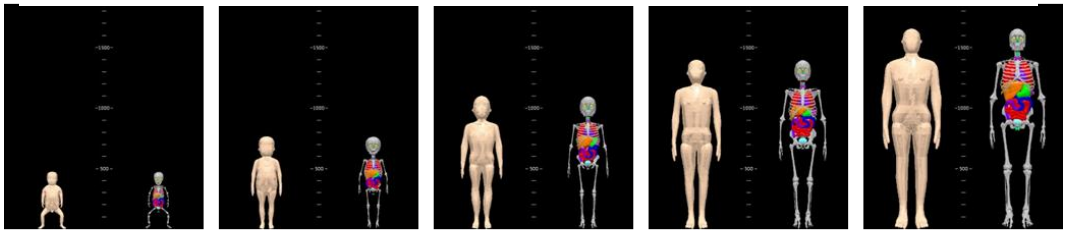
Item	Description
Manufacturer	Vender of CT machine
Scanner model	Name of the CT scanner model
Filter	Name of the Bow-tie filter that depends on the of FOV
Tube potential	Tube Voltage [kV]
Rotation time	Time required for one rotation of the tube [s]
Pitch factor	Pitch for helical scan mode. (Movement of the table for one rotation of tube) / (beam width)
Beam width	Collimation range in the direction of body axis
Gender	Gender
Phantom	Select a phantom according to the body type and age. Adult: Standard, Fat(+2SD), Fat(+5SD) and Thin(-2SD) Child: age:0～15 Adult optional phantom
Scan type	Scan type (region of body)
Scan range	Enter the scanning range. The scanning range can also be set by dragging the ☐ part on the center phantom image
AEC (Option)	"On" to enable dose calculation for the case of AEC (Auto Exposure Control) is applied. Setting the tube current for the specific slice is necessary.
Tube Current	Tube Current
Optional Phantom	The function of body shape correction is planned to be implemented in the future.
SSDE(Option)	"On" to enable calculation of SSDE (Size Specific Dose Estimates). P.S. Since SSDE is estimated using effective diameter, information of anterior-posterior dimension and lateral dimension are necessary.
CTDI phantom size	CTDI phantom size for calculating $CTDI_{vol}$ and DLP



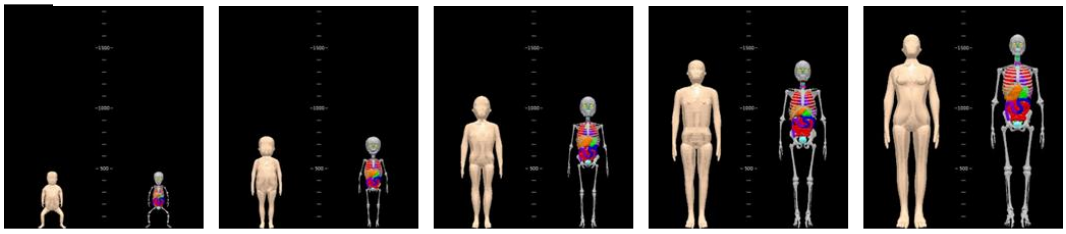
Adult Male (from left to right): thin (-2σ), standard, fat (+2σ), obese (+5σ)



Adult Female (from left to right): thin (-2σ), standard, fat (+2σ), obese (+5σ)



Boy (from left to right): 0-yr-old, 1-yr-old, 5-yr-old, 10-yr-old, 15-yr-old



Girl (from left to right): 0-yr-old, 1-yr-old, 5-yr-old, 10-yr-old, 15-yr-old

Fig. 2-2. Available phantom types

Optional Phantom	ON
Height	cm
Weight	kg

Fig. 2-3. Columns of Height and Weight display when Adult optional phantom is chosen.

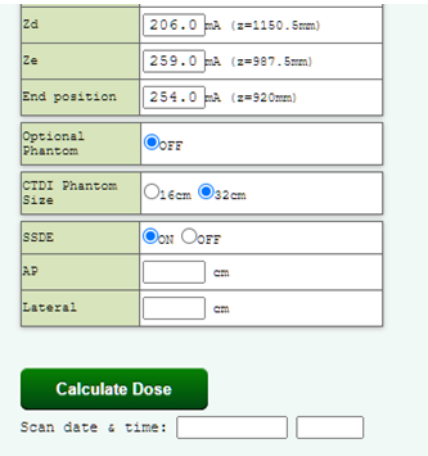


Fig. 2-4. Columns of AP and Lateral display when SSDE is set "on".

Table 2-2. Height, weight and BMI for each phantom used in WAZA-ARI[3][4]

	Male			Female		
	height[cm]	weight[kg]	BMI*	height[cm]	weight[kg]	BMI*
Standard	171	65.1	22.3	155	52	21.6
+2σ : Fat(+2SD)	171	82.2	28.1	155	66.9	27.8
+5σ : Fat(+5SD)	171	118.1	40.4	155	89.5	37.3
-2σ : Thin(-2SD)	171	54.1	18.5	155	43	17.9
age:0	47.5	3.5	15.5	47.5	3.5	15.5
age:1	76.4	10.2	17.5	76.4	10.3	17.6
age:5	110.2	19.7	16.2	110.2	19.7	16.2
age:10	139.8	34.3	17.6	139.8	34.3	17.6
age:15	165.7	59.9	21.8	161.1	56.6	21.8

* $\mathrm{BMI} = (\mathrm{Weight[kg]})/\mathrm{Height[m]})^2$

2.2. **Confirmation of dose calculation results**

After setting the appropriate conditions, press "Calculation dose" button to start dose calculation, and the dose calculation result will display. In addition to absorbed dose [mGy] to each organ, the effective dose (ED103, ED60) [mSv], DLP and CTDIvol are also displayed.

Absorbed dose · Equivalent dose · Effective dose

Equivalent dose H_T [mSv] of each organ is obtained by using the radiation weighting factor w_R and the absorbed dose D_{TR} [mGy] as follows.

$$H_T = w_R \times D_{TR}$$

Since w_R for X-ray is 1, D_{TR} [mGy] of each organ is equal to H_T [mSv]. Effective dose E is then calculated by summing the product of the tissue weighting factor w_T of each organ and [mSv] H_T for all organs.

$$E = \sum_T w_T H_T$$

Since the definition of w_T for each organ is different between ICRP103[5] and ICRP60[6], ED103 and ED60 are both displayed in the calculation result of WAZA-ARI.

It is worth to mention thatWAZA-ARI calculates *E* using Japanese phantom which is different from the phantom defined by ICRP. Therefore, strictly speaking, it is not proper to compare *E* calculated by WAZA-ARI with that by other calculation software.

3. Dose calculation using local API

Under construction

4. Dose calculation method

4.1. **Construction of organ dose database for each CT source data**

WAZA-ARI calculates exposure dose using organ dose database for each CT model, tube voltage, Bow-tie filter, and phantom. This organ dose database is constructed using general-purpose particle / heavy ion transport calculation codes PHITS developed by the JAEA and various human Voxel phantoms.

After measuring source data (such as HVL and dose distribution) for each CT model, tube voltage, Bow-tie filter and collimation X-ray energy spectrum and generation distribution are modeled based on the measurement, and the model is implemented into PHITS as an X-ray source. Accordingly, using PHITS and the human body voxel phantom to calculate dose to each organ for each slice of phantom. [1,2]

In PHITS, absorbed dose to organ T per generated photon at slice k $qD(T,k)$ [mGy / photon] and air kerma at the center of rotation per generated photon qK_{air} [mGy / photon] (=$CTDI_{free\ air}$ per generated photon) are calculated for each CT model, tube voltage, Bow-tie filter, and phantom and implemented in WAZA-ARI system as described above. Absorbed dose to organ T at k-th slice ${}_nD(T,k)$ [mGy / mGy] per $CTDI_{free\ air}$ is then calculated by

$$ {}_nD(T,k) = \frac{qD(T,k)}{qK_{air}}. $$

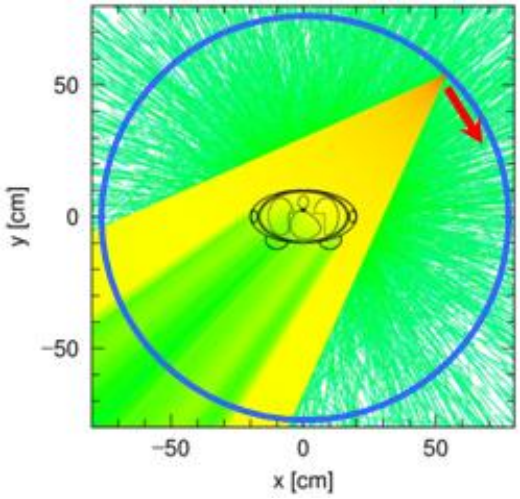


Fig. 4-1. Example of how X-ray emitted from CT device using PHITS

In WAZA-ARI, CT models with similar beam quality and dose distribution are calculated using the same source data while dose information such as $CTDI_w$ and $CTDI_{free\ air}$ are referring the nominal values of each model.

4.2. **Organ dose database and the computable range**

Organ dose database is the calculated radiation dose data for each organ within an interval of 5 mm (= 1 slice). Table 4-1 shows the content of organ dose database.

Table 4-1 Content of organ dose database

Phantom	Male	Female
standard **Fat(+2SD)** **Fat(+5SD)** **Thin(-2SD)**	0 – 1835 (367 slice)	0 – 1666 (334 slice)
age:0	0 - 475 mm (95 slice)	0 - 475 mm (95 slice)
age:1	0 - 765 mm (153 slice)	0 - 765 mm (153 slice)
age:5	0 - 1105 mm (221 slice)	0 - 1105 mm (221 slice)
age:10	0 – 1400 mm (280 slice)	0 – 1400 mm (280 slice)
age:15	0 – 1660 mm (332 slice)	0 – 1615 mm (323 slice)

4.3. **Parameter and data for dose calculation**

Organ dose calculation for each scanning condition needs the following parameter.

Beginning position z_{start} [mm] and the end position z_{end} [mm] of scan

Tube current I [mA]

Rotation time t [s]

Beam pitch pit [-]

normalized CTDI free air $_nCTDI_{free\,air}$ [mGy/mAs]

$_nCTDI_{free\,air}$ means CTDI free air per mAs which varies with tube current, Bow-tie filter and beam width.

normalized Weighted CTDI $_nCTDI_w$ [mGy/mAs]

$CTDI_w$ is the summation of weighted central dose in CTDI phantom (16 cm ϕ for head and 32 cm ϕ for body) $CTDI_{center}$ and the peripheral dose in CTDI phantom $CTDI_{peripheral}$.

$$CTDI_w = \frac{1}{3}CTDI_{center} + \frac{2}{3}CTDI_{peripherl} \quad (1)$$

$_nCTDI_w$ is $CTDI_w$ per mAs and it varies with tube voltage and beam width.

4.4. **Calculation of organ dose**

AEC（Auto Exposure Control）: off

Couch movement during one rotation of the beam is $w \cdot pit$, and irradiated area is equal to the beam width w during one rotation. Therefore, percentage of the body surface with incident of primary X-rays can be expressed as follows.

$$\frac{w}{w \cdot pit} = \frac{1}{pit}$$

$\frac{1}{pit} > 1$ means that this part is multiple irradiations.

Irradiation of *k*th slice results in dose for the organ T$D(T,k)$ [mGy] is as follows

$$D(T,k)[\mathrm{mGy}] = {}_nD(T,k)[\mathrm{mGy/mGy}] \cdot {}_nCTDI_{free\ air}[\mathrm{mGy/mAs}] \cdot \frac{I \cdot t}{pit}[\mathrm{mAs}] \qquad (2)$$

${}_nD(T,k)$ is pre-calculated for different CT scanner, tube voltage, Bow-tie filter and phantom with an interval $\Delta s = 5\ \mathrm{mm}$.

As shown in Fig 4-2, absorbed dose D to tissue T $D(T)$ that located in scanning range of z_{start}~z_{end} $(z_{start} < z_{end})$ [mm] is calculated as follows.

$$D(T) = \int_{z_{start}}^{z_{end}} \frac{D(T,k)}{\Delta s} dz = \frac{z_{i+1} - z_{start}}{\Delta s} D(T,i) + \sum_{k=i+1}^{j-1} D(T,k) + \frac{z_{end} - z_j}{\Delta s} D(T,i) \qquad (3)$$

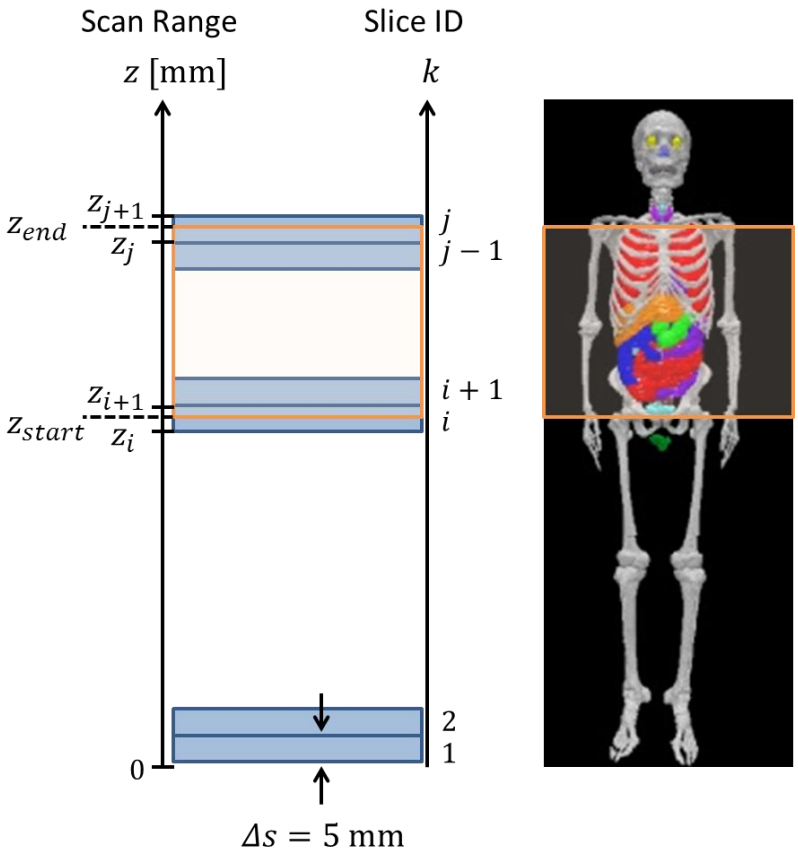


Fig 4-2. Relationship between the scanning range of z_{start}~z_{end} and organ dose data for *k*th slice

AEC（Auto Exposure Control）: on

When AEC function is on, it is assumed that tube current I [mA] changes according to z-coordinate of the irradiation position as shown in Fig. 4-3. Tube current values $I_{start}, I_{end}, I_a, I_b, I_{c'}(=I_b), I_c, I_d, I_e$ corresponding to the beginning/end position of scanning z_{start}, z_{end} and boundary position $z_a, z_b, z_{c'}, z_c, z_d, z_e$ can be specified by the user. Tube current at the center of each slice I_k ($\Delta s = 5$ mm) within the scanning range is calculated based on the tube voltage. Boundary positions are shown in Table 4-2 and Table 4-3.

When the coordinates $z_k + \frac{\Delta s}{2}$ of the center of the k-th slice are between adjacent boundary positions z_l, z_m, tube current I_k is expressed by linear interpolation as shown in the following formula.

$$I_k = I_l + \frac{I_m - I_l}{z_m - z_l}\left(z_k + \frac{\Delta s}{2} - z_l\right) \quad \left(z_l < z_k + \frac{\Delta s}{2} < z_m\right) \tag{4}$$

On the assumption that I_k is constant within each slice, absorbed dose *D* to organ T from the irradiation of the *k*th slice $D(T,k)$ is calculated as follows.

$$D(T,k)[\mathrm{mGy}] = {}_nD(T,k)[\mathrm{mGy/mGy}] \cdot {}_nCTDI_{free\ air}[\mathrm{mGy/mAs}] \cdot \frac{I_k \cdot t}{pit}[\mathrm{mAs}] \tag{5}$$

Absorbed dose to tissue T $D(T)$ within the scan area is calculated by Eq. (6).

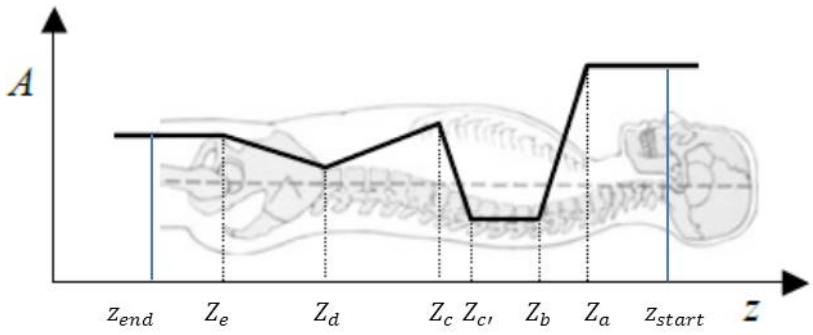


Fig. 4-3. Change of tube current when AEC is on

Table 4-2 Boundary for male phantom when using AEC calculation

z	Anatomical definition	Adult male [mm]	0-year-old boy [mm]	1-year-old boy [mm]	5-year-old boy [mm]	10-year-old boy [mm]	15-year-old boy [mm]
Z_a	First slice of lung apex	1542.5	337.5	575.5	885.5	1156.5	1394.5
Z_b	Trachea	1452.5	319.5	550.5	843.5	1100.5	1324.5
$Z_{c'}$ $(Z_{c'} - Z_c)$		1322.5 (50)	297.5 (20)	493.5 (20)	774.5 (20)	1019.5 (20)	1190.5 (20)
Z_c	Hepatic portal section (Last slice for left lung field)	1272.5	277.5	473.5	754.5	999.5	1170.5
Z_d	Upper margin of iliac	1150.5	200.5	377.5	614.5	823.5	1010.5
Z_e	Upper margin of pubis	987.5	164.5	306.5	517.5	686.5	849.5

Table 4-3 Boundary for male phantom when using AEC calculation

z	Anatomical definition	Adult female [mm]	0-year-old girl [mm]	1-year-old girl [mm]	5-year-old girl [mm]	10-year-old girl [mm]	15-year-old girl [mm]
Z_a	First slice of lung apex	1404.5	337.5	575.5	885.5	1156.5	1345.5
Z_b	Trachea	1311.5	319.5	550.5	843.5	1100.5	1269.5
$Z_{c'}$ $(Z_{c'} - Z_c)$		1181.5 (50)	297.5 (20)	493.5 (20)	774.5 (20)	1019.5 (20)	1164.5 (20)
Z_c	Hepatic portal section (Last slice for left lung field)	1131.5	277.5	473.5	754.5	999.5	1144.5
Z_d	Upper margin of iliac	1028.5	200.5	377.5	614.5	823.5	975.5
Z_e	Upper margin of pubis	861.5	164.5	306.5	517.5	686.5	818.5

4.5. **Calculation of dose index**

WAZA-ARI calculates DLP (Dose Length Product) and averaged $CTDI_{vol}$ for the scanning area as dose indexes.

AEC（Auto Exposure Control）: off

$$CTDI_{vol}[\mathrm{mGy}] = {}_nCTDI_w \cdot \frac{I \cdot t}{pit}$$

$$DLP[\mathrm{mGy \cdot cm}] = CTDI_{vol}[\mathrm{mGy}] \cdot (z_{end} - z_{start})\ [\mathrm{mm}] \cdot \frac{1}{10}[\frac{\mathrm{cm}}{\mathrm{mm}}]$$

AEC（Auto Exposure Control）: on

$CTDI_{vol}$ for *k*th slice $CTDI_{vol}(k)$ is expressed as:

$$CTDI_{vol}(k)[\mathrm{mGy}] = Rel\_CTDI \cdot {}_nCTDI_w \cdot \frac{I_k \cdot t}{pit}$$

When the scanning range is between z_{start}~z_{end} $(z_{start} < z_{end})$ shown in Fig 4-2, DLP [mGy・cm] can be expressed as

$$DLP[\mathrm{mGy \cdot cm}] = \left\{ (z_{i+1} - z_{start}) \cdot CTDI_{vol}(i) + \Delta s \cdot \sum_{k=i+1}^{j-1} CTDI_{vol}(k) + \left(z_{end} - z_j\right) \cdot CTDI_{vol}(j) \right\} [\mathrm{mGy}$$

$$\cdot \mathrm{mm}] \cdot \frac{1}{10}[\mathrm{cm/mm}]$$

Averaged $CTDI_{vol}$ [mGy] can be expressed as:

$$CTDI_{vol}[\mathrm{mGy}] = \frac{DLP[\mathrm{mGy \cdot cm}]}{(z_{end} - z_{start})[\mathrm{mm}]} \cdot 10[\mathrm{mm/cm}]$$

SSDE（Size-specific Dose Estimates）: on

SSDE is a dose index proposed to correct the uncertainty of $CTDI_{vol}$. WAZA-ARI calculates SSDE by using the conversion factors, i.e. f_{size}^{16} or f_{size}^{32}, and the following formula proposed in AAPM report TG204 [7].

If $CTDI_{vol}$ was calculated based on a 32 cm CTDI phantom:

$$SSDE = f_{size}^{32} \times CTDI_{vol}^{32}\ [\mathrm{mGy}]$$

If $CTDI_{vol}$ was calculated based on a 16 cm CTDI phantom:

$$SSDE = f_{size}^{16} \times CTDI_{vol}^{16}\ [\mathrm{mGy}]$$

Table 4-4 Conversion factor f_{size}^{32} as a function of effective diameter

Effective diameter	Conversion factor	Effective diameter	Conversion factor	Effective diameter	Conversion factor
8	2.76	21	1.71	34	1.06
9	2.66	22	1.65	35	1.02
10	2.57	23	1.59	36	0.99
11	2.47	24	1.53	37	0.95
12	2.38	25	1.48	38	0.92
13	2.30	26	1.43	39	0.88
14	2.22	27	1.37	40	0.85
15	2.14	28	1.32	41	0.82
16	2.06	29	1.28	42	0.79
17	1.98	30	1.23	43	0.76
18	1.91	31	1.19	44	0.74
19	1.84	32	1.14	45	0.71
20	1.78	33	1.10		

Table 4-5 Conversion factor f_{size}^{16} as a function of effective diameter

Effective diameter [cm]	Conversion factor	Effective diameter [cm]	Conversion factor	Effective diameter [cm]	Conversion factor
6	1.49	23	0.77	40	0.40
7	1.43	24	0.74	41	0.38
8	1.38	25	0.71	42	0.37
9	1.32	26	0.69	43	0.35
10	1.27	27	0.66	44	0.34
11	1.22	28	0.63	45	0.33
12	1.18	29	0.61	46	0.32
13	1.13	30	0.59	47	0.30
14	1.09	31	0.56	48	0.29
15	1.05	32	0.54	49	0.28
16	1.01	33	0.52	50	0.27
17	0.97	34	0.50	51	0.26
18	0.93	35	0.48	52	0.25
19	0.90	36	0.47	53	0.24
20	0.86	37	0.45	54	0.23
21	0.83	38	0.43	55	0.22
22	0.80	39	0.41		

5. Registered parameters

Table 5-1 Scan position and range for each scan type: Age-0 M/F

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	475	390	85
	Routine Head (helical)	475	390	85
	Head-Neck (1-phase)	475	330	145
	Head CTA	475	355	120
	Head-Neck CTA	475	330	145
	Face/Orbits/Sinus	440	355	85
Neck	Routine Neck (1-phase)	390	345	45
	Neck-Chest (1-phase)	390	260	130
	Neck-Abdomen (1-phase)	390	220	170
	Neck-Pelvis (1-phase)	390	140	250
Chest	Routine Chest (1-Phase)	370	260	110
	HRCT	370	260	110
	Chest-upper Abdomen (1-phase)	370	220	150
	Chest-Pelvis (1-phase)	370	140	230
	Lung nodule (1-phase)	370	260	110
Abdomen	Upper Abdomen (1-phase)	300	220	80
	Abdomen-Pelvis (1-phase)	300	140	160
	Multi-phase Liver	300	215	85
Pelvis	Pelvis	240	140	100
	Lower Abdomen	240	140	100
	Hip	195	145	50
Spine	C-spine	395	345	50
	T-spine	370	240	130
	L-spine	280	190	90
Cardiac	Coronary CTA	330	280	50

Table 5-2 Scan position and range for each scan type: Age-1 M/F

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	765	650	115
	Routine Head (helical)	765	650	115
	Head-Neck (1-phase)	765	555	210
	Head CTA	765	600	165
	Head-Neck CTA	765	555	210
	Face/Orbits/Sinus	720	600	120
Neck	Routine Neck (1-phase)	650	565	85
	Neck-Chest (1-phase)	650	425	225
	Neck-Abdomen (1-phase)	650	380	270
	Neck-Pelvis (1-phase)	650	280	370
Chest	Routine Chest (1-Phase)	600	425	175
	HRCT	600	425	175
	Chest-upper Abdomen (1-phase)	600	380	220
	Chest-Pelvis (1-phase)	600	280	320
	Lung nodule (1-phase)	600	425	175
Abdomen	Upper Abdomen (1-phase)	495	380	115
	Abdomen-Pelvis (1-phase)	495	280	215
	Multi-phase Liver	495	375	120
Pelvis	Pelvis	405	280	125
	Lower Abdomen	405	280	125
	Hip	345	285	60
Spine	C-spine	655	565	90
	T-spine	600	410	190
	L-spine	470	350	120
Cardiac	Coronary CTA	550	470	80

Table 5-3 Scan position and range for each scan type: Age-5 M/F

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	1100	975	125
	Routine Head (helical)	1400	1270	130
	Head-Neck (1-phase)	1400	1135	265
	Head CTA	1400	1200	200
	Head-Neck CTA	1400	1135	265
	Face/Orbits/Sinus	1350	1200	150
Neck	Routine Neck (1-phase)	1270	1140	130
	Neck-Chest (1-phase)	1270	920	350
	Neck-Abdomen (1-phase)	1270	860	410
	Neck-Pelvis (1-phase)	1270	635	635
Chest	Routine Chest (1-Phase)	1180	920	260
	HRCT	1180	920	260
	Chest-upper Abdomen (1-phase)	1180	860	320
	Chest-Pelvis (1-phase)	1180	635	545
	Lung nodule (1-phase)	1180	920	260
Abdomen	Upper Abdomen (1-phase)	1020	860	160
	Abdomen-Pelvis (1-phase)	1020	635	385
	Multi-phase Liver	1020	865	155
Pelvis	Pelvis	860	635	225
	Lower Abdomen	860	635	225
	Hip	740	650	90
Spine	C-spine	1280	1140	140
	T-spine	1180	900	280
	L-spine	950	745	205
Cardiac	Coronary CTA	1120	990	130

Table 5-4 Scan position and range for each scan type: Age-10 M/F

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	1400	1270	130
	Routine Head (helical)	1400	1270	130
	Head-Neck (1-phase)	1400	1135	265
	Head CTA	1400	1200	200
	Head-Neck CTA	1400	1135	265
	Face/Orbits/Sinus	1350	1200	150
Neck	Routine Neck (1-phase)	1270	1140	130
	Neck-Chest (1-phase)	1270	920	350
	Neck-Abdomen (1-phase)	1270	860	410
	Neck-Pelvis (1-phase)	1270	635	635
Chest	Routine Chest (1-Phase)	1180	920	260
	HRCT	1180	920	260
	Chest-upper Abdomen (1-phase)	1180	860	320
	Chest-Pelvis (1-phase)	1180	635	545
	Lung nodule (1-phase)	1180	920	260
Abdomen	Upper Abdomen (1-phase)	1020	860	160
	Abdomen-Pelvis (1-phase)	1020	635	385
	Multi-phase Liver	1020	865	155
Pelvis	Pelvis	860	635	225
	Lower Abdomen	860	635	225
	Hip	740	650	90
Spine	C-spine	1280	1140	140
	T-spine	1180	900	280
	L-spine	950	745	205
Cardiac	Coronary CTA	1120	990	130

Table 5-5 Scan position and range for each scan type: Age-15 Male

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	1660	1530	130
	Routine Head (helical)	1660	1530	130
	Head-Neck (1-phase)	1660	1370	290
	Head CTA	1660	1445	215
	Head-Neck CTA	1660	1370	290
	Face/Orbits/Sinus	1620	1445	175
Neck	Routine Neck (1-phase)	1525	1365	160
	Neck-Chest (1-phase)	1525	1140	385
	Neck-Abdomen (1-phase)	1525	1010	515
	Neck-Pelvis (1-phase)	1525	790	735
Chest	Routine Chest (1-Phase)	1420	1140	280
	HRCT	1420	1140	280
	Chest-upper Abdomen (1-phase)	1420	1010	410
	Chest-Pelvis (1-phase)	1420	790	630
	Lung nodule (1-phase)	1420	1140	280
Abdomen	Upper Abdomen (1-phase)	1215	1010	205
	Abdomen-Pelvis (1-phase)	1215	790	425
	Multi-phase Liver	1215	1015	200
Pelvis	Pelvis	1050	790	260
	Lower Abdomen	1050	790	260
	Hip	910	790	120
Spine	C-spine	1540	1365	175
	T-spine	1420	1100	320
	L-spine	1200	920	280
Cardiac	Coronary CTA	1360	1185	175

Table 5-6 Scan position and range for each scan type: Age-15 Female

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	1600	1485	115
	Routine Head (helical)	1600	1485	115
	Head-Neck (1-phase)	1600	1320	280
	Head CTA	1600	1405	195
	Head-Neck CTA	1600	1320	280
	Face/Orbits/Sinus	1550	1405	145
Neck	Routine Neck (1-phase)	1480	1325	155
	Neck-Chest (1-phase)	1480	1080	400
	Neck-Abdomen (1-phase)	1480	1015	465
	Neck-Pelvis (1-phase)	1480	770	710
Chest	Routine Chest (1-Phase)	1370	1080	290
	HRCT	1370	1080	290
	Chest-upper Abdomen (1-phase)	1370	1015	355
	Chest-Pelvis (1-phase)	1370	770	600
	Lung nodule (1-phase)	1370	1080	290
Abdomen	Upper Abdomen (1-phase)	1190	1015	175
	Abdomen-Pelvis (1-phase)	1190	770	420
	Multi-phase Liver	1190	800	390
Pelvis	Pelvis	1000	770	230
	Lower Abdomen	1000	770	230
	Hip	880	770	110
Spine	C-spine	1490	1325	165
	T-spine	1370	1050	320
	L-spine	1160	900	260
Cardiac	Coronary CTA	1310	1145	165

Table 5-7 Scan position and range for each scan type: Adult Male

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	1835	1700	135
	Routine Head (helical)	1835	1700	135
	Head-Neck (1-phase)	1835	1510	325
	Head CTA	1835	1600	235
	Head-Neck CTA	1835	1510	325
	Face/Orbits/Sinus	1785	1600	185
Neck	Routine Neck (1-phase)	1700	1525	175
	Neck-Chest (1-phase)	1700	1230	470
	Neck-Abdomen (1-phase)	1700	1150	550
	Neck-Pelvis (1-phase)	1700	920	780
Chest	Routine Chest (1-Phase)	1580	1230	350
	HRCT	1580	1230	350
	Chest-upper Abdomen (1-phase)	1580	1150	430
	Chest-Pelvis (1-phase)	1580	920	660
	Lung nodule (1-phase)	1580	1230	350
Abdomen	Upper Abdomen (1-phase)	1350	1150	200
	Abdomen-Pelvis (1-phase)	1350	920	430
	Multi-phase Liver	1350	1165	185
Pelvis	Pelvis	1180	920	260
	Lower Abdomen	1180	920	260
	Hip	1080	910	170
Spine	C-spine	1700	1525	175
	T-spine	1580	1190	390
	L-spine	1340	1060	280
Cardiac	Coronary CTA	1450	1265	185

Table 5-8 Scan position and range for each scan type: Adult Female

Body region	Scan parameter	Begin	End	Range (mm)
Head	Routine Head (non-helical)	1665	1550	115
	Routine Head (helical)	1665	1550	115
	Head-Neck (1-phase)	1665	1380	285
	Head CTA	1665	1445	220
	Head-Neck CTA	1665	1380	285
	Face/Orbits/Sinus	1625	1455	170
Neck	Routine Neck (1-phase)	1540	1370	170
	Neck-Chest (1-phase)	1540	1110	430
	Neck-Abdomen (1-phase)	1540	1010	530
	Neck-Pelvis (1-phase)	1540	820	720
Chest	Routine Chest (1-Phase)	1435	1110	325
	HRCT	1435	1110	325
	Chest-upper Abdomen (1-phase)	1435	1010	425
	Chest-Pelvis (1-phase)	1435	820	615
	Lung nodule (1-phase)	1435	1110	325
Abdomen	Upper Abdomen (1-phase)	1200	1010	190
	Abdomen-Pelvis (1-phase)	1200	820	380
	Multi-phase Liver	1200	1015	185
Pelvis	Pelvis	1050	820	230
	Lower Abdomen	1050	820	230
	Hip	930	810	120
Spine	C-spine	1545	1370	175
	T-spine	1435	1090	345
	L-spine	1200	930	270
Cardiac	Coronary CTA	1300	1140	160

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