Diagnostic Imaging Specialists Corporation

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Instruction Manual for DISC CR Radchex Meter (Wired Version)

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KONFORMITAETSERKLAERUNG
DECLARATION OF CONFORMITY
DECLARATION DE CONFORMITE

WE,

DIAGNOSTIC IMAGING SPECIALISTS CORPORATION
163 ST. MALO STREET, ST. MALO, MANITOBA
CANADA R0A 1T0

- ***erklaren, dass die Produkte***
- ***declare, that the products***
- ***declarons, que les produits***

DISC CR RADCHEX SYSTEM consisting of the following:

Model AEC-IS-1 (Electronic Interface Module in combination with
Model AEC-CC-CR-RAD (CR Radiographic Cassette)

- ***auf die sich diese Erklarung bezieht, mit den folgenden Normen ubereinstimmt:***
- ***to which this declaration relates are in conformity with the following standard:***
- ***auquels se referent cette declaration sont conforme a la norme:***

EN61010-1 Safety requirements for electrical equipment for measurement control and laboratory use

Exigences de securite pour de l'equipement electronique afin de controller les mesures et pour l'utilization du laboratoire

- ***Gemass den Bestimmungen der Niederspannungsrichtlinie:***
- ***following the provisions of the low voltage Directive:***
- ***conformement aux dispositions de la Directive basse tension:***

73/23 EWG und 93/68 EWG

October 5, 2002

Theory of Operation
CR Radchex

FIGURE 1: Comparison of Energy Conversion Between CR System and CR Radchex

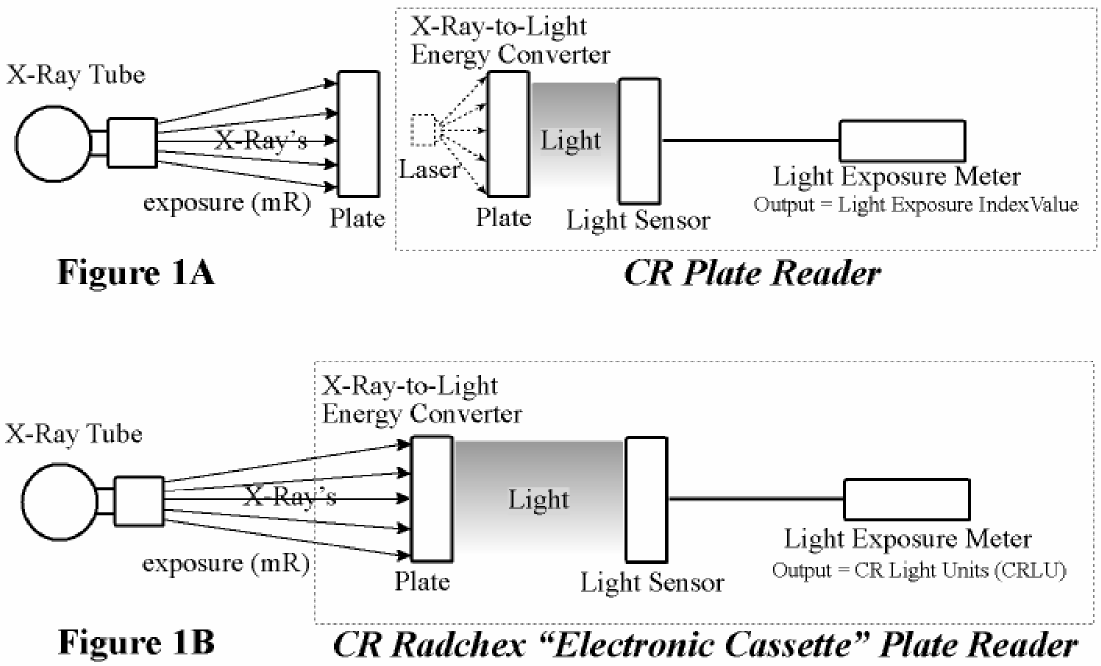


Figure 1A shows a typical CR system complete with CR imaging plate and plate reader while Figure 1B shows the CR Radchex meter complete with plate and reader. These diagrams point out the similarities and differences between the two systems:

1. First, the two systems are both 'X-ray-calibrated light meters', measuring X-ray-produced light from an 'X-ray-to-light energy converter' (plate).
2. The two systems have comparable plates, so they both produce the same amount of light when exposed to the same X-ray energies (kVp); same X-ray-to-light conversion efficiency.
3. For the CR Radchex, the X-ray-to-light conversion is immediate, taking place inside a light tight 'electronic cassette'; while for the CR system, the X-ray-produced energy is stored in the imaging plate and only released as light when 'stimulated' by a laser located inside the plate reader.
4. The CR plate reader measures and indicates the amount of X-ray-produced light from the plate as a 'light exposure index value'; while the CR Radchex measures and indicates the amount of radiation-produced light its plate produces as CR light units (CRLU).

Based on these similarities, it can be concluded, since the 'CRLU' and 'light exposure index value' are both X-ray-produced light measured values, that each value can be compared and 'matched' or 'balanced' to each other.

The manufacturers of CR systems provide algorithms in their software to convert light values to estimated X-ray exposure values in mR, Fig 1A. The CR Radchex software uses these same CR manufacturer defined conversion algorithms to convert its light measured values to estimated X-ray exposure values in mR, Fig 1B. Based on these similarities, it can be concluded that the CR Radchex provides identical light output and exposure values as a plate reader when both measure the same X-ray-light and calculate an X-ray exposure value. The practical application of this conclusion is that a CR Radchex meter can be used instead of a CR plate/reader when assessing and calibrating X-ray automatic exposure control systems (AEC); and assessing and 'balancing' plate readers in the field. The benefit is time savings and improved accuracy when doing these tasks.

Currently, CR manufactures specify a method to calibrate a plate readers light exposure index in the field using any available X-ray machine and a dosimeter. The practical consequence of using a dosimeter to calibrate a 'light' meter is that each meter was originally designed to measure different types of energy and not necessarily to convert the measurement of one type of energy to another type. The CR Radchex has certain advantages over dosimeters when calibrating plate readers in the 'field'. Since the CR Radchex is a traceable, factory X-ray-calibrated 'light meter', it can be used instead of a dosimeter to 'balance' a field plate readers light exposure index value to a factory calibrated X-ray-light measurement value; this makes the plate reader traceable and balanced to an accurate and precise laboratory-defined X-ray-produced light source. The practical application of this methodology is that field plate readers that are balanced to the same CR Radchex light output value (CRLU) are balanced to each other and to the factory X-ray-light calibration condition. This methodology eliminates the need to use a dosimeter to balance readers to a radiation exposure in the field where the X-ray source has many variables such as the X-ray generator kVp, kV waveform, tube filtration, and beam geometry that can cause significant differences between and among dosimeter calibrated plate readers. The factory calibrated CR Radchex, when used in the field, is 'immune' to these field variables since the X-ray-produced light it measures is traceable back to only those accurate and precise conditions used during the factory calibration. The practical application is that the CR Radchex removes the dosimeter/X-ray source variations from the plate reader calibration providing a more accurate method of assessing and balancing a plate reader exposure index value.

A 1.5 mm thick copper reference filter is supplied with the CR Radchex, which when attached to the X-ray tube collimator, provides X-ray exposures to be made in the field that duplicate those X-ray calibration exposure conditions found at the factory. This filter provides a 'factory reference beam' that is used with the CR Radchex during field plate reader assessment and calibration. All that is needed when using the CR Radchex in the field is a reproducible X-ray source.

The issue of converting a light measurement to a radiation exposure value, or conversely, converting an exposure to a light value, is a delicate one. It is delicate because attempting to use a dosimeter to field calibrate plate readers involves 'knowing' the conversion efficiency of the 'X-ray-to- light' signal from a CR system/CR Radchex plate and the conversion efficiency of the 'X-ray-to-electrical' signal from a dosimeter; each device responding differently to the same X-ray beam.

The problem is that the relationship between a dosimeter determined X-ray exposure (mR) and plate reader determined light exposure (CRLU) changes continuously and significantly with beam condition. This relationship is shown in the following Table:

X-Ray-Light Energy Conversion Efficiency Values for the CR Radchex for Various Beam Conditions

Beam Condition	Conversion Efficiency (CRLU/mR)
Scatter-Free	14.10 CRLU/mR
Low Scatter	12.80 CRLU/mR
Medium Scatter (in bucky)	12.05 CRLU/mR
High Scatter	10.00 CRLU/mR
Air with 3mm total Al	8.06 CRLU/mR
Air with 4mm total Al	10.22 CRLU/mR
Air with 5mm total Al	11.65 CRLU/mR

Our research shows that at 80 kVp, a CR plate exposed to a 1 mR highly attenuated, scatter-free beam releases 75% more light than the same CR plate exposed to a 1 mR non-attenuated air filtered beam. Since each CR system manufacturer specifies a different X-ray beam condition to which their plate and reader must be exposed during calibration, using an air chamber dosimeter, the exposure calculated from the light measurement value from one manufacturer to another can vary by as much as 75% for the same 1 mR dosimeter reading. For this reason, it is difficult to use a dosimeter to convert the light measured value from a CR system to an exposure since the energy dependence of the two devices is very different and very dependent on having a well defined radiation beam condition and X-ray source during calibration! This is difficult to achieve in the field. To solve this problem, the CR Radchex software uses its scatter-free factory calibrated beam as a reference beam to which other CR manufacturers beams are compared. By experimentally determining the X-ray-to-light conversion efficiency values for all manufacturer beam conditions, the meters software simply applies the appropriate conversion efficiency correction factor to move from one manufacturers defined beam condition to another. The software provides 7 different user selectable beam conditions to which any plate reader can be calibrated, Figure 2 . These are directly linked back to 5 different manufacturers specified beam conditions including the currently proposed AAPM TG116 beam condition. The practical application is that the X-ray-to-light conversion efficiency between and among CR manufacturers can be compared.

The issue of converting a radiation exposure to a light value, and visa versa, for an air filtered beam condition (non-filtered beam) is especially delicate. Our research shows that at 80 kVp, a CR plate exposed to a 1 mR air filtered beam with 5 mm Al total equivalent filtration in the tube-head releases 45% more light than the same plate exposed to a 1 mR air filtered beam with 3 mm Al total equivalent filtration in the tube-head. It is critical for CR manufacturers who specify a non-filtered beam condition for dosimeter calibrated field plate readers to ensure an X-ray source with well defined beam and geometry conditions; this is difficult to achieve in the field where X-ray tube filtration has significant variations.

The following Table shows the relationship between CR Radchex light measurement values (CRLU) and various CR Manufacturers light measurement values (EI, LgM, S#):

CR Manufacturer Plate Reader Values Corresponding to CR Radchex values
(Assuming that the reader is calibrated using the manufacturers specifications)

CRLU	EI	LgM	S#	Imaging Speed (DISC)
5.00	1550	1.77	409	400
6.00	1629	1.85	341	333
7.00	1695	1.92	292	286
8.06	1757	1.98	253	248
10.00	1851	2.07	204	200
10.22	1860	2.08	200	196
11.65	1917	2.14	175	172
12.05	1932	2.15	170	166
12.80	1958	2.18	160	156
14.1	2000	2.22	145	142

When assessing the calibration of a plate reader, the 1.5 mm copper filter is ‘strapped’ to the exit side of the collimator to provide a reproducible ‘field reference X-ray beam’. The software compares and assesses the reader’s calibration according to the CR manufacturer’s specifications to the observed calibration and indicates the percentage difference between the expected and observed calibration.

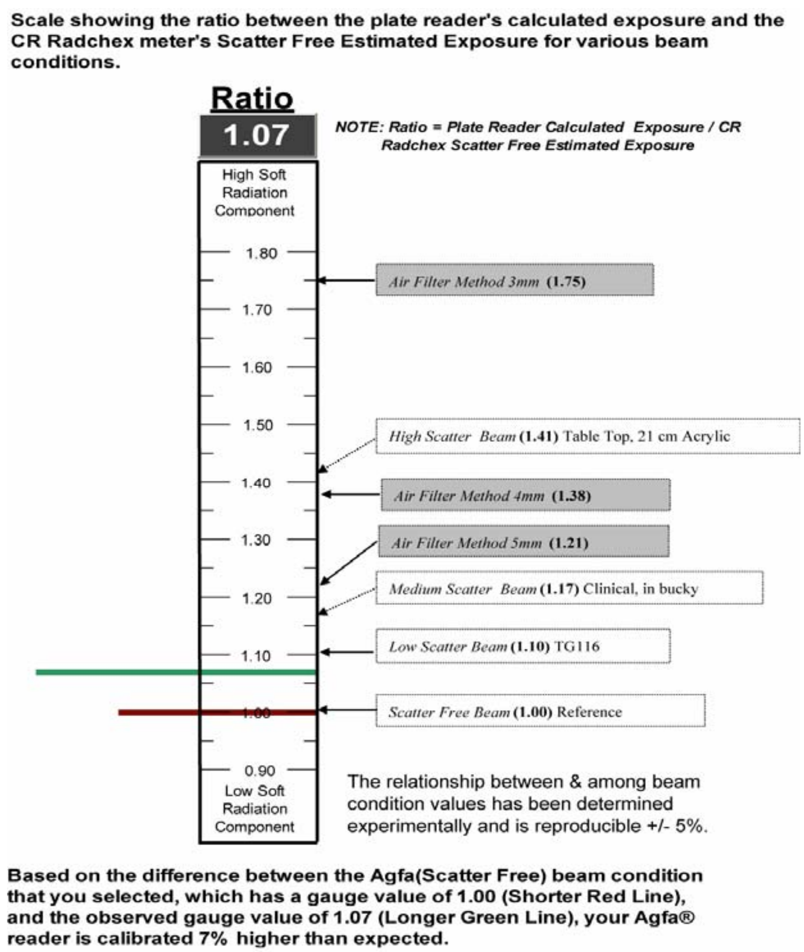
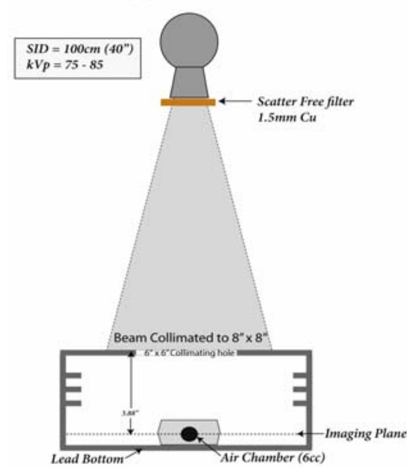
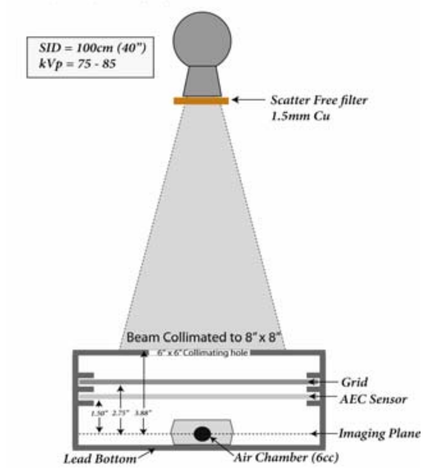


FIGURE 2 – Choices of Beam Conditions for Plate Reader Calibration

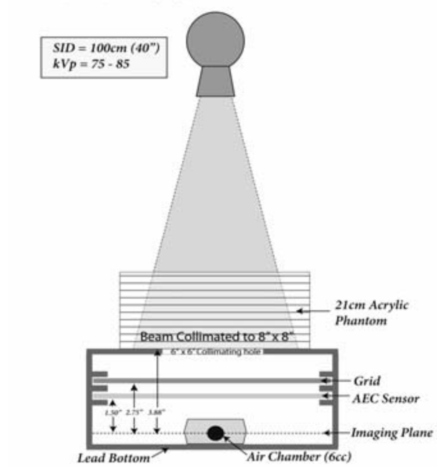
GAIN#1 - Scatter Free Beam Condition
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (SFEE)



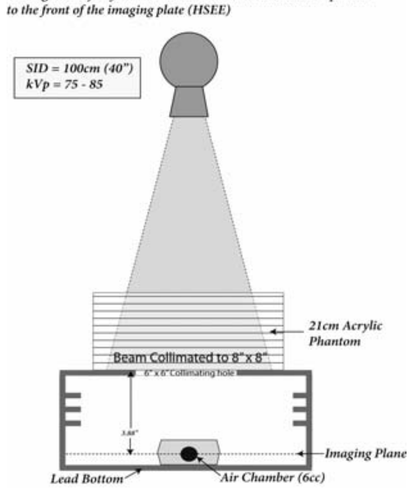
GAIN#2 - Low Scatter Beam Condition (TG116)
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (LSEE)



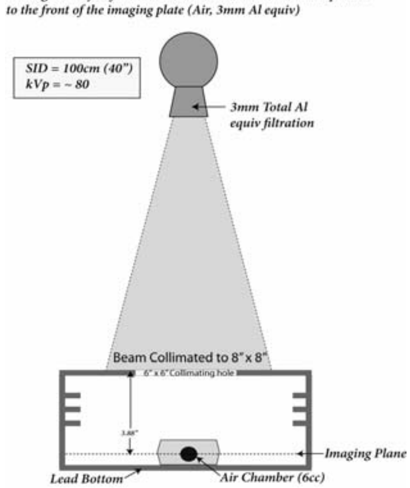
GAIN#3 - Medium Scatter Beam Condition (Clinical)
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (MSEE)



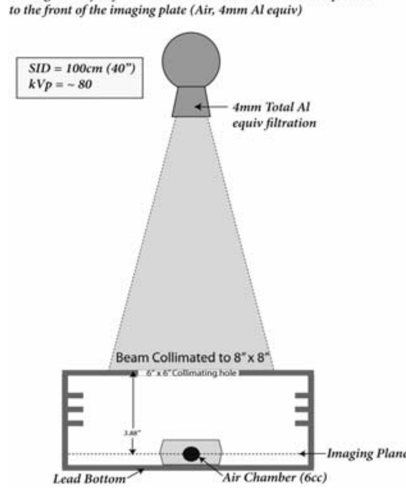
GAIN#4 - High Scatter Beam Condition
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (HSEE)



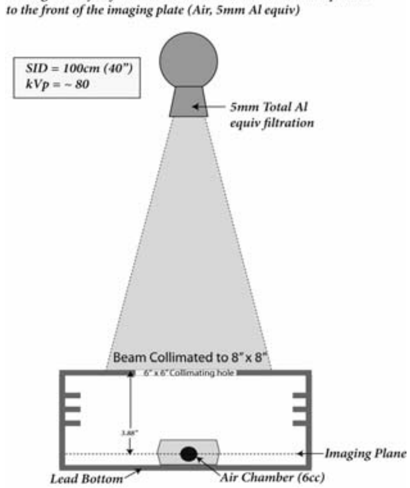
GAIN#5 - Air, 3mm Al equiv Beam Condition
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (Air, 3mm Al equiv)



GAIN#6 - Air, 4mm Al equiv Beam Condition
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (Air, 4mm Al equiv)



GAIN#7 - Air, 5mm Al equiv Beam Condition
Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (Air, 5mm Al equiv)



Advantages of Using the CR Radchex Versus a Dosimeter for Plate Reader Calibration

1. The factory, radiation-calibrated and traceable CR Radchex light meter can be used to calibrate (balance) another radiation-calibrated light meter, CR plate reader in the field. The plate reader in the field will hence be calibrated and traceable to the reliable factory radiation-calibrated and traceable X-ray-produced light exposure.

2. Since the CR Radchex has the same X-ray energy response as a CR system, (same X-ray-to-light conversion efficiency for various beam conditions) the CR Radchex can be used as an accurate and reliable replacement for the plate readers light measurement value (exposure index value) when assessing or calibrating the X-ray AEC system.

3. Since each CR Radchex is factory calibrated to the same traceable radiation-produced light condition, the radiation exposure (mR) to the front of the plate is 'linked' accurately and reliably to the light measurement value.

4. The CR Radchex software applies 7 different 'X-ray-to-light' conversion efficiency factors corresponding to 7 different traceable radiation beam conditions to provide the user with 7 beam conditions to which field plate readers can be assessed and calibrated; these beam conditions include 5 specified by different CR companies and the currently proposed AAPM TG116 beam condition.

5. The CR Radchex provides a reliable and reproducible method for accurately maintaining a CR manufacturers specified factory calibration even when using an X-ray machine in the field of unknown calibration status as the X-ray source.

6. The CR Radchex software provides three different tube-head filtration choices for users who desire a non-filtered beam condition for field plate reader calibration. The 3, 4, and 5 mm total Al filtration choices are provided to most closely match those filtration conditions currently found in tube-heads in the field.

System Components

1. Electronic CR Imaging Plate: This component has the same dimensions as the 24 x 30 cm CR imaging plate and produces an electrical output signal when exposed to radiation. The electronic IP responds to radiation beam quality the same as the response of the CR imaging plate. **The electronic IP output signal is also directly proportional to the light output from a laser stimulated exposed imaging plate.** The electronic signal is "conditioned" by a microprocessor located in the cassette before being sent to the interface box (hard-wired version) or directly to the LCD display (QA version).

2. Excel Software: The digital signal from the electronic IP is diplayed on the interface box (hard-wired version) or on the built in LCD display (QA version). The PC software algorithm analyzes the CRLU and leads the operator through the calibration and or assessment procedures for the CR AEC system, density control, plate reader gain, or quality control.

3. X-ray beam filter: A 1.5mm thick copper filter, 6 inches by 6 inches, with two Velcro straps is provided to attach to the X-ray tube collimator housing. When attached, the X-ray beam is highly attenuated and mostly scatter-free. The filter provides mAs exposures similar to those encountered clinically and provides an easily reproducible X-ray beam in the 'field'.

Running the Excel Software Templates

Note: The excel templates included use macros. The security settings in Excel should be set to Medium for the program to operate properly. Follow the instructions below to set security level.

1. **Open Excel on your computer.**
2. **Click on the Tools / Macro / Security.**
3. **Select the Medium setting in the security level tab.**

Note: Software is best viewed in a screen resolution of at least 1024 x 768 or higher.

There are several template files to choose from and you may initiate them directly from the CD or copy the contents of the CD to a location of your choice, ex: My documents. Choose the one that matches the system you are operating(Agfa, Fuji, Kodak, etc…) and initiate it by clicking on it.

If the Macros are set to medium there should be a prompt that comes up about Macros or ActiveX controls. Click on the "Enable Macros" button to allow macros.

You should now be in the software and ready to start.

Software Application Notes:

Choosing a Template:

<u>Manufacturer Specific CR Radchex Template:</u>

Once you have initiated the desired manufacturer's template(Refer to Running the Excel Software Template for instructions to initiate the templates), you will then have a drop down menu to choose the beam condition . The default Beam condition is the one that best reflects that of the Manufacturer's Factory CR Reader Gain calibration. You can accept this gain value or you can pick any of Disc's other Beam conditions.

Note: *If you are using an Agfa system there will be a 2nd drop down list box for Speed Class. You may choose one of the values in the list or simply type in the speed class in the box.*

Click on the "Confirm Settings" button and you should now see Step 2 appear which has 3 boxes labeled CRLU(AEC#), Disc Relative Speed, and Plate Reader Exposure indicator value. You are now ready to use the Disc CR Radchex Wireless meter.

When you are ready to expose, simply click on the Reset button and wait until the LCD display says "Ready for Exposure". Make the exposure and enter the CRLU in the appropriate box and press enter.

The Disc Relative Speed, and Plate Reader Exposure indicator values will appear in their respective boxes.

You may also notice that there are three buttons on the bottom of the screen under the heading labeled Step 3: Select a Function by clicking on a box. These buttons are links to protocol driven spreadsheets. There are 3 of them to choose from.

Reader Calibration: Select this option to accurately gain balance CR Readers in the field.

Reader Assessment: Select this option to accurately assess the gain balance of CR Readers in the field.

AEC Calibration: Select this option to accurately calibrate X-Ray generator's AEC system to match the CR System's X-Ray energy dependence.

Note: The instructions are provided onscreen for the 3 protocol driven spreadsheets.

Specifications:

X-ray energy dependence: Simulates relative light output of Photostimulatable Phosphor Plate (PSP) within +/- 3% over kVp range of 60 to 120 kVp and a patient equivalent thickness range of 5 to 35 cm (within specified operating rates).

Digital range: Computed Radiography Light Units; CRLU (AEC#); 0 to 655.35

Minimum CRLU Rate: 1.50/sec (approx 0.15 mR/sec entrance exposure rate)

Maximum CRLU Rate: 2500/sec (approx 250 mR/sec entrance exposure rate)

Power On/Off: Manual switch

Controls: Manually using the Power/Reset button.

Functions: Measures CRLU (AEC#); Converts CRLU to CR manufacturers specific CR plate reader light exposure index value (EI); user selectable. Calculates cassette input exposure values for various X-ray beam conditions (exposure in mR plus backscatter)

Power requirements: 2 x 9Volt Batteries in Interface box.

Typical battery life: Greater than 8 hrs.

Operating environment: 59 degrees to 95 degrees F (15 to 35 degrees C)

X-ray beam filter: 1.5 mm copper (B152-110); 6 inches by 6 inches complete with velcro straps to attach to X-ray tube collimator housing

Electronic Cassette:

Dimensions: 10 x 12 x 0.5 inches (24 x 30 x 1.3 cm)
Weight: 3.9 lb (1.8 kg)

Software: Microsoft Excel Template and Instruction Manual on included CD.

Definition of Terms

The specifications provide a relationship between the Computed Radiography Light Units, CRLU (AEC#) a light measurement, and the X-ray entrance exposure (mR), to the front of the CR Radchex electronic cassette. These specifications apply only to the X-ray beam condition described below. The relationship between the CRLU and exposure (mR), changes significantly (as much as 75%) as the beam condition changes. The CR Radchex software provides relationships between CRLU and mR for several different beam conditions, among these are all CR manufacturers specified beam conditions.

X-ray Beam Condition: A highly attenuated, scatter-free X-ray beam at approximately 80 kVp using a 1.5 mm copper filter attached to the collimator. The cassette focal spot distance is approximately 40 inches (100 cm).

Relationships:

A CRLU of 10.00 = 0.71 mR (includes backscatter from lead positioned under the air chamber dosimeter)

A CRLU of 10.00 = 0.63 mR (without backscatter and air chamber free-in-air)

CR Relative Speed Relationship: Based on CRLU (light measurement not an X-ray exposure)

2000/CRLU = CR Relative Speed; A CR Relative Speed of 200 = 10 CRLU (AEC#)

Appendix

General Information on CRLU(AEC#)(200 Speed Class CR)

Target AEC# of **"7.00"**. Based on our experience, choosing a target AEC# of **7.00** is a good balance between Image Quality and Patient Dose.

Suggested Baseline Calibration for 200 Speed Class CR Systems

1. X-ray machine *Center Chamber, kVp(variable), pep phantom thickness(variable), Density Selector at "0", Collimation ~ 25 x 25 cm. Adjust AEC circuit for a constant Target CRLU(AEC#) of ~ 7.00 over the clinical range of kVp and Phantom Thickness*.

2. Balance the right and left chambers to the center chamber.

3. Adjust the Density Selector to 15% incremental value between steps.

Results of Baseline Calibration

The AEC System will now be adjusted to match the relative energy response of CR Imaging Systems (constant plate reader Exposure Indicator value over the clinical kVp range and Phantom thickness range).

Density Selector setting of "0": At the mid kVp Range (75 to 85kVp), the in bucky exposure to the CR Cassette will be about the same as the required input exposure to a 250 speed Green rare earth film screen cassette in order to produce a 1.20 film O.D.(0.58mR).

Density Selector / Speed Selector: The relative operating speed of the AEC system will increase by 15% per step as the density selector is reduced.

This method of calibrating AEC Systems will result in the AEC Systems not only matching the CR Systems, but also matching each other.

The CR user can now use the Density Selector / Speed Selector to choose the relative speed required for each specific exam type.

DISC CRLU(AEC#) Information

The Disc CRLU(AEC#) has been calibrated and is traceable to an Air Chamber at 80kVp in a high scatter environment(Figure4). The relationship is as follows: **CRLU(AEC#) = mR x 10.** As with plate readers, the Disc CR Radchex can only estimate the plate entrance exposure and will be most accurate at the beam condition at which it was calibrated to a dosimeter.

Energy Dependence

The Disc CR Radchex's energy conversion system(converts x-rays to electrical digital signal) has the same energy dependence as CR imaging plates, therefore the CRLU(AEC#) will have the same relative gain shift to various beam conditions as plate reader exposure indicator values.

Converting the CRLU(AEC#) to plate entrance exposure (mR) at various beam conditions

Figure 4 - High Scatter: *CRLU(AEC#) / 10 = mR (High Scatter)*

Figure 3 – Medium Scatter: *CRLU(AEC#) / 12 = mR (Medium Scatter)*

Figure 2–Low Scatter: *CRLU(AEC#) / 12.8 = mR (Low Scatter)*

Figure 1 – Scatter Free: *CRLU(AEC#) / 14.1 = mR (Scatter Free)*

Relating CRLU(AEC#) to green rare earth film screen speeds

This information is based on measured cassette entrance exposures to a typical 200 speed class green rare earth film screen system. The table below shows the entrance exposure required to produce a film O.D. of 1.20 at four reference beam conditions.

Figure 4 - High Scatter: *1.00mR = 1.20 O.D.*

Figure 3 – Medium Scatter: *0.72mR = 1.20 O.D.*

Figure 2–Low Scatter: *0.62mR = 1.20 O.D.*

Figure 1 – Scatter Free: *0.54mR = 1.20 O.D.*

As one can see from the table above, although this system is called a 200 speed system, at 80kVp the actual entrance exposure required to produce a 1.20 film O.D. can vary anywhere from 0.54mR to 1.00 mR depending on beam condition.

The commonly used formula 1mR = 200 speed only reflects the green rare earth film/screen relative speed when the X-ray beam has a high soft radiation component such as the high scatter method or the air method where the tube head has about 4mm Al equivalent total filtration.

The table below shows beam condition specific speed formulas to reflect green rare earth speed based on entrance exposures (mR).

Figure 4 - High Scatter: *200 / mR = Speed (1mR = 200 speed).*

Figure 3 – Medium Scatter: *144 / mR = Speed (0.72mR = 200 speed)*

Figure 2–Low Scatter: *124 / mR = Speed (0.62mR = 200 speed)*

Figure 1 – Scatter Free: *108 / mR = Speed (0.54mR = 200 speed)*

In order to convert the CRLU(AEC#) to reflect green rare earth speeds, one first converts the CRLU(AEC#) to an exposure at the appropriate beam condition, and then using the appropriate beam condition formula, one calculates the green rare earth film screen clinical speed.

Example with CRLU(AEC#) = 10.00

Figure 4 - High Scatter: *10.00 / 10 = 1.00mR.*
High Scatter Speed = 200 / 1.00 = 200 speed

Figure 3 – Medium Scatter: *10.00 / 12 = 0.833mR*
Medium Scatter Speed = 144 / 0.833 = 173 speed

Figure 2–Low Scatter: *10.00 / 12.8 = 0.781mR*
Low Scatter Speed = 124 / 0.781 = 158 speed

Figure 1 – Scatter Free: *10.00 / 14.1 = 0.709mR*
Scatter Free Speed = 108 / 0.709 = 152 speed

Condensed formulas to relate CRLU(AEC#) to green rare earth film screen relative clinical speed would be as follows:

Figure 4 - High Scatter: *2000 / CRLU(AEC#) = Green Film Screen Clinical Speed*

Figure 3 – Medium Scatter: *1728 / CRLU(AEC#) = Green Film Screen Clinical speed*

Figure 2 – Low Scatter: *1587 / CRLU(AEC#) = Green Film Screen Clinical Speed*

Figure 1 – Scatter Free: *1523 / CRLU(AEC#) = Green Film Screen Clinical Speed*

Since most exams are done in bucky, perhaps the most clinically relevant useful formula is the Medium Scatter.

When exposing the CR Radchex cassette in bucky in the mid kVp range(75 to 85 kVp) with phantom thicknesses of 15cm to 30cm, the Medium Scatter formula most accurately reflects the relative green rare earth clinical speed (operating speed).

Perhaps another beam condition of interest is the Low Scatter. This is the beam condition currently proposed by the AAPM’s Task Group 116 as a common beam condition at which to compare all digital imaging systems.

Figure 1 - Scatter Free Beam Condition

Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (LSEE)

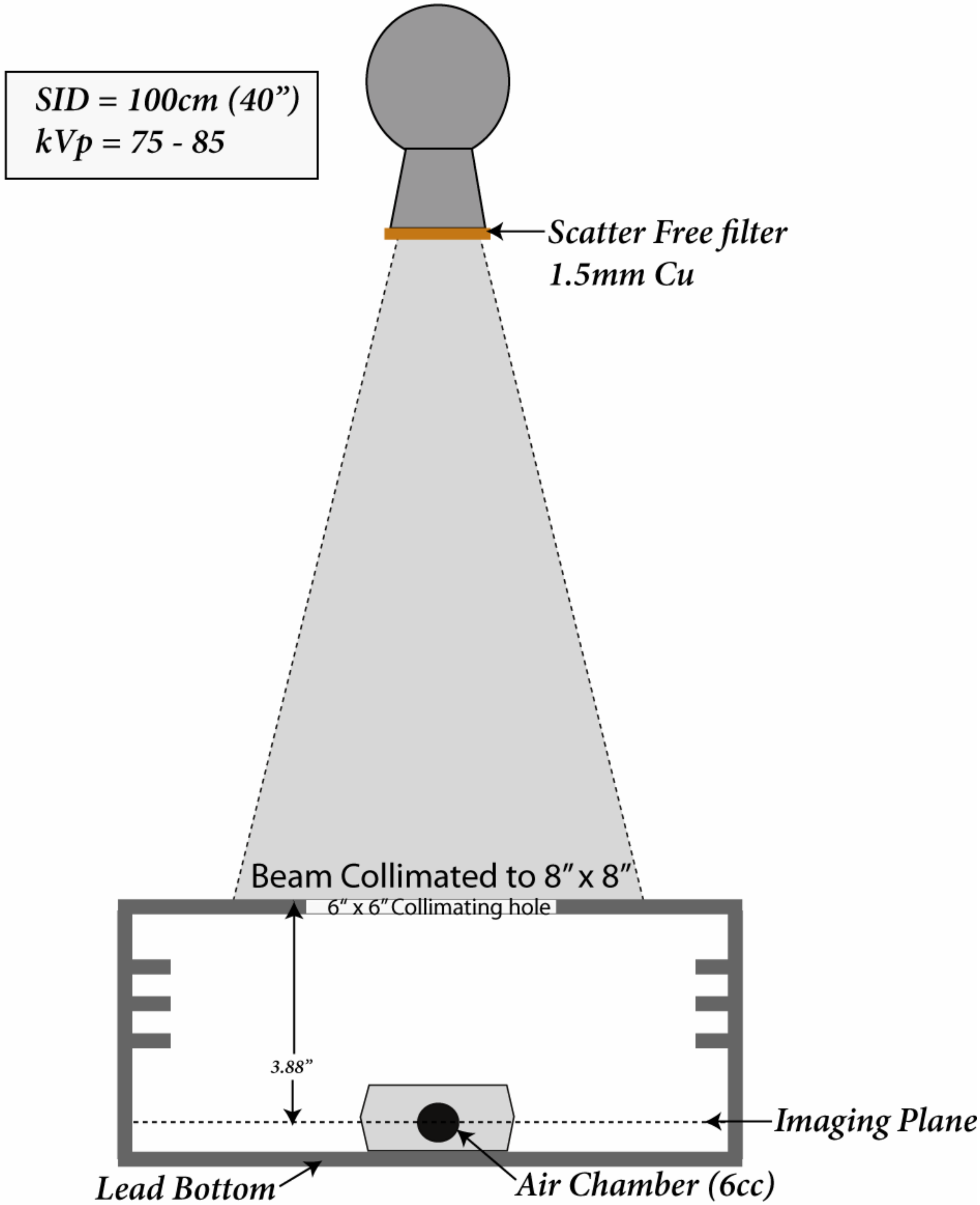


Figure 2 - Low Scatter Beam Condition

Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (LSEE)

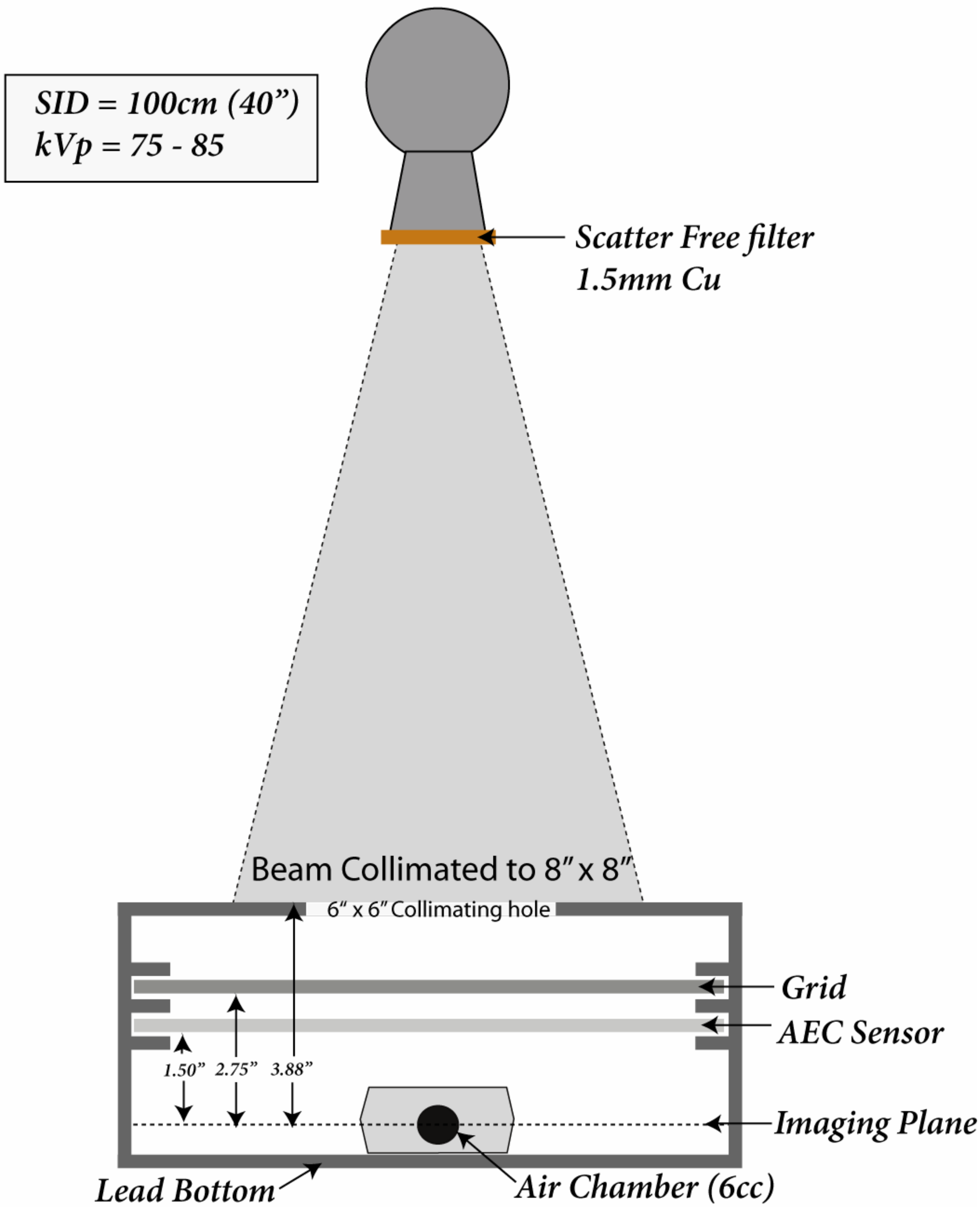


Figure 3 - Medium Scatter Beam Condition

Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (MSEE)

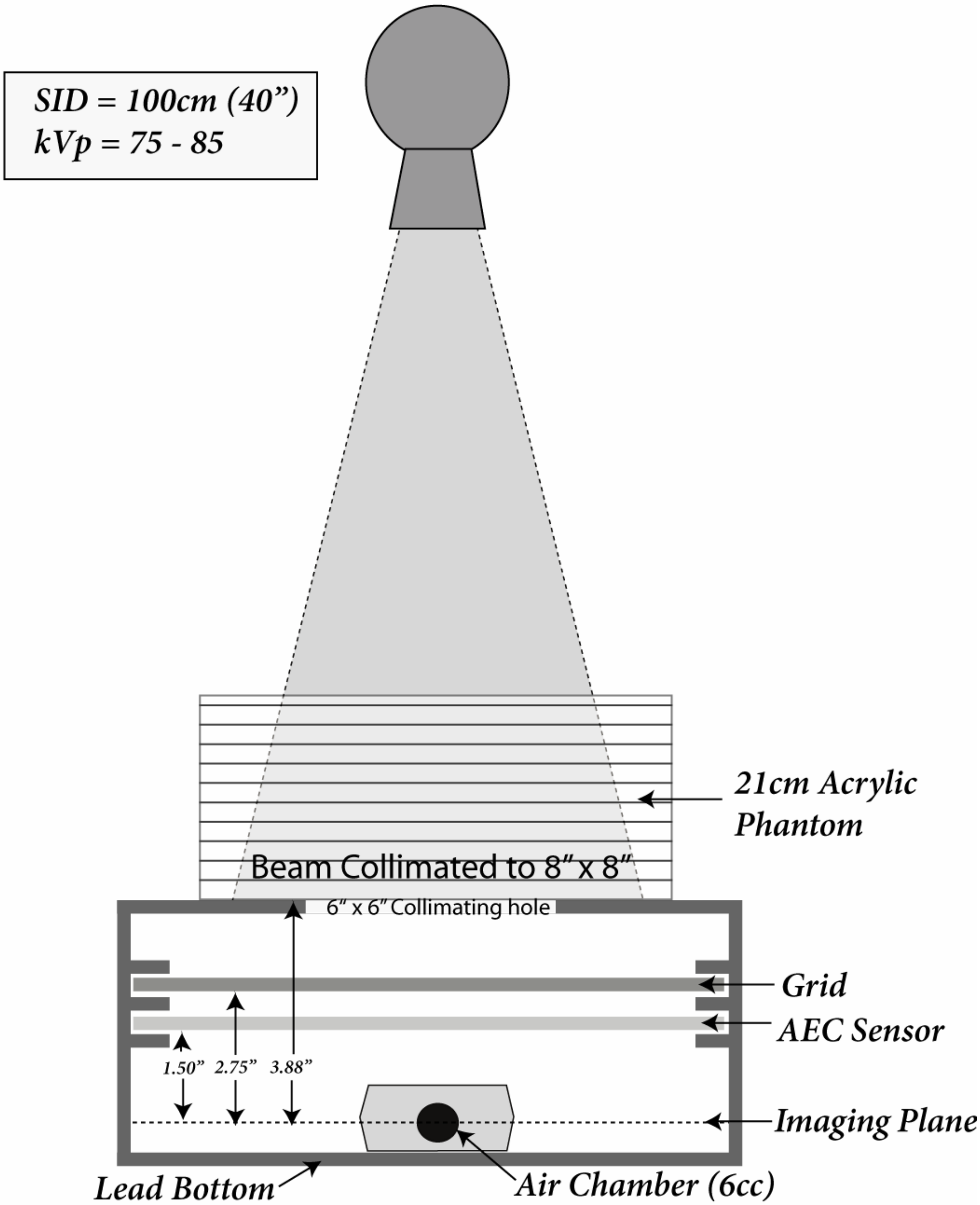
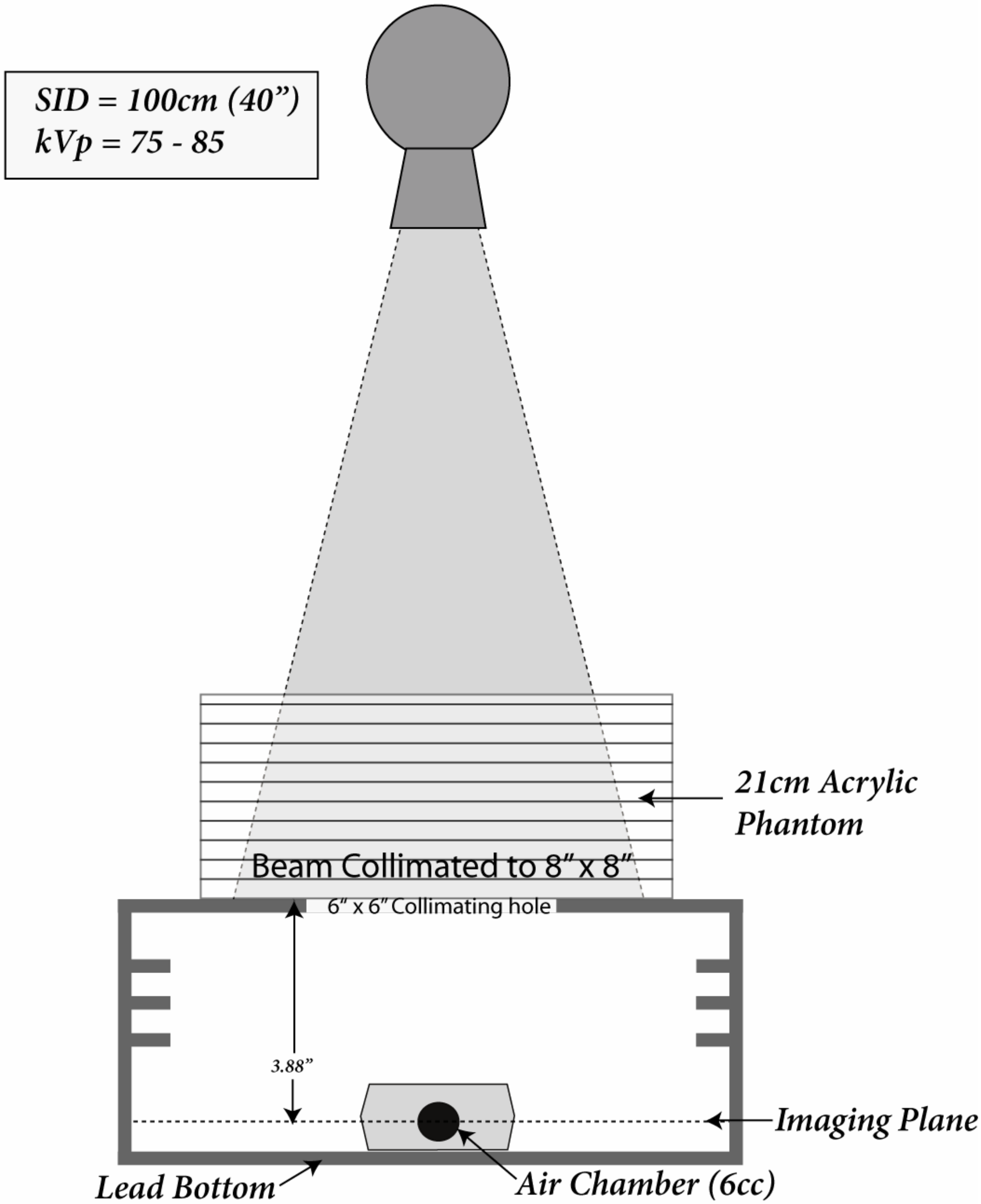


Figure 4 - High Scatter Beam Condition

Beam geometry & filtration used to estimate dosimeter exposure to the front of the imaging plate (HSEE)



LIMITED WARRANTY

CR Radchex System

This product, except the use, is warranted by Diagnostic Imaging Specialists Corporation (DISC), to the original purchaser to be free from defects in material and workmanship under normal use for a period of one (1) year from the date of purchase. During the warranty period, and upon proof of purchase, the product will be repaired or replaced (with the same or similar model) at our option, without charge for either parts or labor at the DISC factory. The purchaser shall bear all shipping, packing, and insurance costs to the DISC factory. The warranty will not apply to this product if the product has been misused, abused, or altered. Without limiting the foregoing, bending or dropping of unit, broken electrical wires, visible cracking of the product components and/or enclosures are presumed to be defects resulting from misuse or abuse.

NEITHER THIS WARRANTY NOR ANY OTHER WARRANTY EXPRESS OR IMPLIED, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, SHALL EXTEND BEYOND THE WARRANTY PERIOD. NO RESPONSIBILITY IS ASSUMED FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITING THE SAME TO MATHEMATICAL ACCURACY OR PRECISION OF THE PRODUCT. SOME PROVINCES AND OR STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS AND SOME PROVINCES AND OR STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THAT THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY.

This warranty gives the product owner specific legal rights, and the owner may also have other rights which vary from province to province or state to state.