FLUORO ACTION LEVELS

JCAHO Reviewable Sentinel Events; Radiation overdose involving prolonged fluoroscopy with a cumulative dose of more than 15 Gy (1,500 rads) to a single field. To ensure compliance with this JCAHO standard the following fluoro action levels are proposed.

1. The **imaging procedure action level** measured in minutes of fluoroscopic "ON" time, dose area product (DAP), commonly presented in units of cGy•cm^2 or air kerma (Gy) is intended to warn the physician that the patient radiation dose levels may be at 50 percent of values expected to produce a visible skin effect. At this point, the operator should consider and utilize techniques to reduce the single field skin dose such as, changing beam orientation and further reducing any unneeded overall exposure.

2. The **patient follow up action level** sets a threshold for the potential to create a radiation dose to the skin that could be visible. The threshold represents a skin dose of approximately half of the Sentinel Event limit. These patients should be contacted to determine if they have experienced any unusual or unexpected reddening or other effect to their skin. If the patient indicates an unusual reaction, they should be scheduled to return for follow-up and any recommended medical treatment, if required.

These two action levels are an attempt to approach a generally complex problem in a relatively simple manner. However, certain patient and procedure dependent factors must be considered. For this purpose, **action level modifiers** are introduced. As a guideline, any of up to two modifiers may be applied to reduce the action levels as shown in the following table.

The action level modifiers are listed below, however, the last two (i) apply only to action levels specified in minutes and do not apply for dose area product or air kerma values.

- □ a patient weighing over 100 kilograms (220 pounds)
- □ imaging performed with poor geometry where the patient is closer to the x-ray tube than normal
- □ imaging time concentrated in one orientation, that is, more than half of the fluoroscopic time with the x-ray beam entering the patient at approximately the same location
- i the significant use of high output mode (e.g. High Level Mode, High Detail Mode, HLF, Boost)
- i significant use of serial image recording during the procedure

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	Procedure Action Level			Follow Up Action Level		
Modifiers	**(minutes)**	**(cGy ¢ cm^2)**	**(mGy)**	**(minutes)**	**(cGy ¢ cm^2)**	**(mGy)**
None	50	52,500	4,250	100	105,000	8,500
1	25	26,250	2,125	50	52,500	4,250
2	13	13,125	1,063	25	26,250	2,125

BASIC ASSUMPTIONS

1. Action levels should be set in relation to the potential for visible effects on the patient's skin that are well under 1500 rad. A 600-rad value has been used.
2. For time limits, it was assumed that it was usual to use different orientations of the x-ray bean and that only 50 percent of the total time would use the same orientation with the x-ray beam entering the patient at approximately the same location [Relative Time at Skin Location (RTSL)].
3. Serial image recording could produce an additional radiation dose equivalent to the fluoroscopic dose [Image Recording Factor (IRF)].
4. The image intensifier is at 40 inches (D_{II}).
5. The beam entrance point is at 22 inches (D).
6. The fluoroscopic output is in roentgens per minute at 12 inches in front of the image intensifier entrance surface (R/min).
7. For Air Kerma a correction factor of 0.88 must be include to cover to rads in tissue.
8. A backscatter factor (BSF) of 1.2 is used to include radiation backscatter from the body to the skin.

$$\textbf{Dose} = \textbf{Time} * \textbf{R/min} * \textbf{BSF} * [(D_{II} - 12)/D]^2 * [\textbf{RTSL}] * [\textbf{IRF}]$$

Dose (rad)	Time (minutes)	R/min	DII (inches)	D (inches)	$(D_{II}-12)/D$	RTSL	IRF
583	100.0	3.0	40.0	22.0	1.27	0.5	2.0
700	120.0	3.0	40.0	22.0	1.27	0.5	2.0

9. Assuming the air kerma dose reference D_{ref} is at 22.65 inches from the tube focal spot and the dose entrance point is at 22 inches (D), dose to a single entrance port would be:

$$\textbf{Dose} = \textbf{Air Kerma} * \textbf{BSF} * (D_{ref}/D)^2 * [\textbf{RTSL}] / 8.8$$

Dose (rad)	Air Kerma (mGy)	D	D_{ref}	RTSL
606	8,500	22.0	22.5	0.5
713	10,000	22.0	22.5	0.5

10. Assuming the DAP in cGy ▯ cm^2 with a field size of 7.9 x 7.9 inches (20 x 20 cm) at the image intensifier distance (D_{II}) and the entrance point at 22 inches (D), the dose to a single entrance port would be:

$$\textbf{Dose} = (\textbf{DAP} * \textbf{BSF} * \textbf{RTSL} / [(D/D_{II})^2 * (\textbf{Field Area})]) / 0.88$$

Dose (rad)	DAP (cGy • cm^2)	D	D_{II}	RTSL	Field Size @ D_{II}
592	105,000	22.0	40.0	0.5	400.0
733	130,000	22.0	40.0	0.5	400.0