

Faxitron Checklist

IACUC Approval date: 01/19/2017

Revised:

Authors: Chad B Walton, PhD, and Sylvia Kondo, DVM

IACUC considerations for FAXITRON CP-160 use

I. Purpose

This set of guidelines describes recommended points of consideration for IACUC review of protocols involving the irradiation of mice. It is meant to serve as a supplement to the "Checklist for IACUC Protocols".

This document is not intended to provide training on the use of the machine itself. Please contact JABSOM EHSO for proper instrument training and documentation.

II. Responsibility

Principal investigator (PI) and their research staff, and veterinary care staff.

III. Approval for use

This document does NOT cover the State of Hawaii and AVS Policies and Procedures requirements that pertain to the FAXITRON usage, namely;

- The instrument must have a current license with the State Department of Health
- The machine must undergo annual preventative maintenance and servicing
- Each user must undergo training that covers safe operation of the machine but also Hawaii Department of Health rules and policies relating to radiation use, as well as compliance with Hawaii Administrative Rules Chapter 11-45
- A user's log must be maintained at the machine

Please contact JABSOM ESHO to ensure that all personnel wanting to use the instrument, as well as the instrument itself, are in compliance with the points detailed above.

Failure to address these points will result in an automatic "nonapproval" of any protocols submitted to IACUC.

IV. Definitions

- IACUC: Institutional Animal Care and Use Committee
- Faxitron CP-160: The CP-160 cabinet x-ray system is a 160 kV unit with a 1000 Watt maximum. The unit's cabinet can accommodate specimens up to 40"H x 24"W x 24"D
- JABSOM: John A Burns School of Medicine
- EHSO: Environmental Health and Safety Office
- AVS: Animal and Veterinary Services
- Cu: Copper
- kv: kilovolt
- Gy: Gray. A Gy is a derived unit of ionizing radiation dose in terms of absorbed energy per unit mass of tissue in the International System of Units.
- CRI: Cutaneous Radiation Injury

V. Procedural considerations

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1. Dose calculation. See calculation chart in the Appendices for proper calculation of dose. Report dose as Gy's in your protocol submission.
Procedural tip: Use a 0.5 mm Cu filter to cut out the low dose energy, the 30kv energy. This will reduce possible cutaneous radiation injuries (CRI)
2. Mice exposed to whole body irradiation should be housed under sterile conditions (i.e., sterile feed, bedding, water, cages) until, if ever, they regain a functional immune system.
3. Cages of irradiated mice are identified with the following information:
 - a. Dose of irradiation
 - b. Date of irradiation
4. Irradiated mice should be monitored on the day following irradiation and then at least three times per week for two weeks thereafter, as applicable. Observations should be documented on a monitoring log.
5. Possible clinical signs following whole body irradiation:
 - a. Weight loss: due to inappetence and diarrhea
 - b. Lethargy
 - c. Hunched posture
 - d. Rough coat
 - e. Anemia: nose and paws appear pale
 - f. Infection
 - g. Intestinal bleeding: feces may appear dark
 - h. Transplant failure: Graft Versus Host Disease
 - i. Graying of the hair coat, particularly in black haired mice
 - j. Development of secondary neoplasias
 - k. Damage to incisors
6. In case of skin burns due to CRI (refer to Table 1 in the Appendices for more details of possible expectations, signs and monitoring of CRI's based on the calculated dose):
 - a. Refer to the IACUC Policy on Rodent and Rabbit Anesthesia and Analgesia for alternative analgesics to alleviate discomfort.
 - b. Apply antibiotic ointment (e.g. sulfadiazine ointment, BNP, etc) daily on the wound, until healed.
7. Humane intervention points

When immune reconstitution has been provided by bone marrow transplant, mice usually recover within 2-3 weeks. Animals that have not received a bone marrow transplant will not recover.

If the general condition of the animal does not improve after 21 days, irradiated mice should be considered for euthanasia.

Refer to the IACUC Policy on Euthanasia and consider euthanasia when:

- a. Weight loss exceeding 20% of pre-irradiation weight.
- b. Body condition score of less than 2.
- c. No or weak response to external stimuli.

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- d. Hunched posture, lethargy and lack of grooming.
- e. Pale eyes and/or extremities.

VI. Appendices

1. Chart of radiation dosage calculations.
Both the Gray (Gy) and the rad are units of absorbed dose and reflect the amount of energy deposited in a mass of tissue (1 Gy = 100 rads). The referenced absorbed dose levels in this document are assumed to be from x-radiation.
2. Table 1. Grades of cutaneous radiation injury; Cutaneous Radiation Injury Chart.
(In general in humans; 200 rads leads to erythema, 25 -100 rads induce wbc effects, and 400-500 rads is the LD50 for human acute radiation syndrome.)

VII. References

1. McGill University Veterinary Care SOP 615 Post-Irradiation Care
(https://www.mcgill.ca/research/files/research/615_-_post-irradiation_care_-_sept2015.pdf)
2. National Center for Environmental Health (NCEH) /Agency for Toxic Substances and Disease Registry (ATSDR), National Center for Injury Prevention and Control (NCIPC)
3. Faxitron X-Ray Corp Manual No. 5081-9520, revised Spet 15, 1999)

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Appendix I

Table 1. Grades of cutaneous radiation injury

Grade	Skin dose	Prodromal stage	Latent stage	Manifest illness stage	Third wave of erythema	Recovery
I	> 2 Gy (200 rads) ‡	1–2 days postexposure or not seen	no injury evident for 2–5 weeks postexposure §	<ul style="list-style-type: none"> • 2–5 weeks postexposure, lasting 20–30 days: redness of skin, slight edema, possible increased pigmentation • 6–7 weeks postexposure, dry desquamation 	not seen	complete healing expected 28–40 days after dry desquamation (3–6 months postexposure)
II	> 15 Gy (1500 rads)	6–24 hours postexposure with immediate sensation of heat lasting 1–2 days	no injury evident for 1–3 weeks postexposure	<ul style="list-style-type: none"> • 1–3 weeks postexposure; redness of skin, sense of heat, edema, skin may turn brown • 5–6 weeks postexposure, edema of subcutaneous tissues and blisters with moist desquamation • possible epithelialization later 	<ul style="list-style-type: none"> • 10–16 weeks postexposure, injury of blood vessels, edema, and increasing pain • epilation may subside, but new ulcers and necrotic changes are possible 	healing depends on size of injury and the possibility of more cycles of erythema
III	> 40 Gy (4000 rads)	4–24 hours postexposure, with immediate pain or tingling lasting 1–2 days	none or less than 2 weeks	<ul style="list-style-type: none"> • 1–2 weeks postexposure: redness of skin, blisters, sense of heat, slight edema, possible increased pigmentation • followed by erosions and ulceration as well as severe pain 	<ul style="list-style-type: none"> • 10–16 weeks postexposure: injury of blood vessels, edema, new ulcers, and increasing pain • possible necrosis 	can involve ulcers that are extremely difficult to treat and that can require months to years to heal fully
IV	> 550 Gy (55,000 rads)	occurs minutes to hours postexposure, with immediate pain or tingling, accompanied by swelling	none	<ul style="list-style-type: none"> • 1–4 days postexposure accompanied by blisters • early ischemia (tissue turns white, then dark blue or black with substantial pain) in most severe cases • tissue becomes necrotic within 2 weeks following exposure, accompanied by substantial pain 	does not occur due to necrosis of skin in the affected area	recovery possible following amputation of severely affected areas and possible skin grafts

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4385 - CP160 Option - Typical Dosimetry Results

Faxitron X-ray Corporation

13" SID, Shelf position 7, Beam Center, No filtration, values are in R/min.

kV	1 mA-R/min	2 mA-R/min.	4 mA-R/min.	Max. mA- R/min.	(mA)
10					7.9
20					16
30					16
40					16
50					16
60					16
70					14.3
80					12.5
90					11.1
100	215	470	978	2440	10
110	218	478	1000	2230	9.1
120	219	481	1019	2070	8.3
130	220	484	1030	1920	7.7
140	218	484	1035	1810	7.1
150	215	481	1037	1700	6.6
160	213	478	1032	1570	6.3

13" SID, Shelf position 7, Beam Center, 0.5 mm. Al filtration, values are in R/min.

kV	1 mA-R/min	2 mA-R/min.	4 mA-R/min.	Max. mA- R/min.	(mA)
10					8
20					16
30					16
40					16
50					16
60					16
70					14.3
80					12.5
90					11.1
100	24.15	52.75	108.5	278	10
110	26.2	58	118.1	279	9.1
120	28.5	64.3	129.5	280	8.3
130	30.4	70.1	139.2	280	7.7
140	32.4	74.5	148	279	7.1
150	35.5	79.8	160	279	6.6
160	37.2	85	168.9	277	6.3

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438. - CP160 Option - Typical Dosimetry Results

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13" SID, Shelf position 7, Beam Center, 0.5 mm. Cu filtration, values are in R/min.						
kV	1 mA-R/min	2 mA-R/min.	4 mA-R/min.	Max. mA- R/min.		(mA)
10						8
20						16
30						16
40						16
50						16
60						16
70						14.3
80						12.6
90						11.2
100	2.86	5.9	12.5	32.4		10
110	3.78	7.8	16.4	39.2		9.1
120	4.89	10.1	21.8	46		8.4
130	5.98	12.2	26	53.1		7.7
140	7.16	14.8	31.4	59.1		7.2
150	8.24	18.3	37	65.2		6.7
160	9.71	21.5	44.1	72		6.3
17" SID, Shelf position 6, Beam Center, No filtration, values are in R/min.						
kV	1 mA-R/min	2 mA-R/min.	4 mA-R/min.	Max. mA- R/min.		(mA)
10						8.3
20						16
30						16
40						16
50						16
60						16
70						14.3
80						12.4
90						11.1
100	112	249	510	1312		10
110	114.1	254	521	1225		9.1
120	115.3	256	530	1141		8.3
130	115.1	258	533	1063		7.7
140	114.5	258	536	990		7.1
150	113	257	534	922		6.7
160	112	256	532	815		6.2

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4385... - CP160 Option - Typical Dosimetry Results

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5" SID, Shelf Position 9, Beam Center, 4" Beam Coverage, R/min at various technique factors (Max. Power) and depths of water.

Technique Factors		1 cm. H2O	2 cm. H2O	3 cm. H2O	4 cm. H2O
kV	mA	R/min	R/min	R/min	R/min
50	16				
60	16				
70	14.3				
80	12.4				
90	11.1				
100	10	1640	1140	766	580
110	9.1	1660	1175	813	626
120	8.3	1625	1210	850	665
130	7.7	1640	1240	882	700
140	7.1	1630	1268	924	734
150	6.7	1628	1308	964	768
160	6.2	1644	1330	1001	807

13" SID, Shelf Position 7, Beam Center, 10.5" Beam Coverage, R/min at various technique factors (Max. Power) and depths of water.

Technique Factors		1 cm. H2O	2 cm. H2O	3 cm. H2O	4 cm. H2O
kV	mA	R/min	R/min	R/min	R/min
50	16				
60	16				
70	14.3				
80	12.4				
90	11.1				
100	10	212	145	106.4	84
110	9.1	215	151	112.8	90
120	8.3	217	115.1	118.3	96
130	7.7	219	158.8	122.4	101.6
140	7.1	220	162	127	107
150	6.7	221	165	131.1	110.9
160	6.2	221	170.4	134	114