

How to Use the RS-2000

In this section the basic operation of the RS-2000 will be discussed. The procedure for basic operation is posted on the unit and is also provided at the end of this section.

WARNING

Any use of the RS-2000 not for its intended use may result in an unsafe condition. Do NOT insert any flammable or potentially explosive materials into the unit, or apply toxic or corrosive chemicals.

If you have any questions about its use, please refer to the Operating Manual (located in irradiator room) or contact Rad Source Technologies.

Getting Started/Prerequisites

1. To use the RS-2000 an individual complete initial training which consists of completing this training module and perform a hands-on irradiation with Radiation Safety (contact Radiation Safety at ext. 9-6356 to set up a time).

2. Irradiations using RS-2000 must be reserved and are scheduled using the Research Support System (RSS);

RSS→Core Facilities → Instrument Schedules→ Biological Irradiator Core

Note 1: You can schedule use on the biological irradiator core (BIC) website at www.bic.unmc.edu which provides a link to the RSS.

Note 2: For the Animal Irradiator reservations are for 1 hour sessions.

3. Cell Irradiator BSC Use: If you need to use the biosafety cabinet or CO₂ incubators in this room you need to fill out the request form and submit to the facility supervisor (Dr. Mayumi Naramura). Please note that users must provide their own consumables (cultureware, culture medium, etc.) and dispose of them appropriately. Any items left in the room without authorization may be removed at the discretion of the facility supervisor.

4. Animal Irradiator Use:

Note: Irradiator use must be approved on your IACUC protocol.

- a. Must wear PPE (gloves and lab coat).
- b. Must NEVER leave animals unattended in this room.
- c. Animal cages must be opened within the Biosafety Cabinet (BSC).
 - i. Transfer animals into a sterilized Allentown Cage without bedding, food, or water.
 - ii. A maximum of five (5) mice per cage is recommended for accurate results.
 - iii. Transfer animals back to their home cages immediately after irradiation treatment.
 - iv. Target irradiation shields are stored in a sterile cage within the biosafety cabinet. In an effort to prevent potential contamination of your animals, please dip the shield in Clidox before and after use. When you are finished, please spray the shield with 70% ETOH and leave it in the biosafety cabinet to dry.
 - v. Prepare and anesthetize the animal inside the biosafety cabinet, position the animal and shield inside the Allentown cage. Place the cage at the appropriate level inside the irradiator. Do not place mice directly onto the stage in the irradiator.



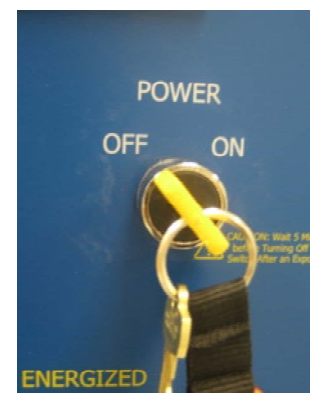
Target Radiation Shields

Performing an Irradiation

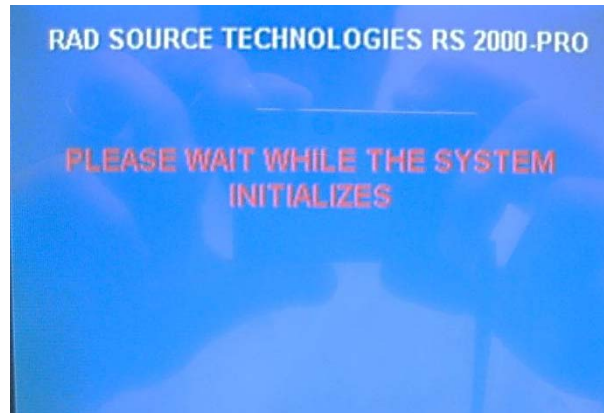
1. When you open up the chamber door there should be a **RAD+** reflector block (see picture) which is used to produce a more uniform dose distribution within the block. Do NOT remove this block unless cleaning is required.
2. To prepare for operation, close the front door and turn the handle clockwise until fully engaged (unit will not operate if not properly closed).
3. Use the key to turn the power on/off switch to on (the key to power on the unit should already be in the unit and should remain inserted).



RAD+ Reflector



The Operator Touch Panel Control Screen will illuminate, control power is applied to the high voltage power supply and the following screen should be displayed:



After approximately 30 seconds, the system is initialized and the main menu, shown below, is displayed (Note: if at any time after the system is initialized a fault is detected the ALARM SCREEN will be displayed).



Main Menu

The main menu enables the operator to access all the features of the RS-2000. The white rectangular system status box is used to display the machine status. Possible machine statuses include:

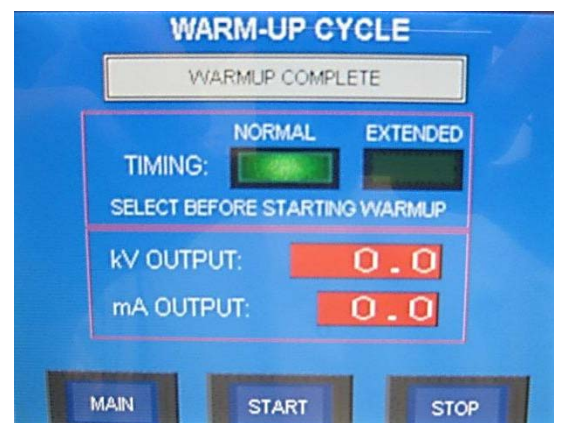
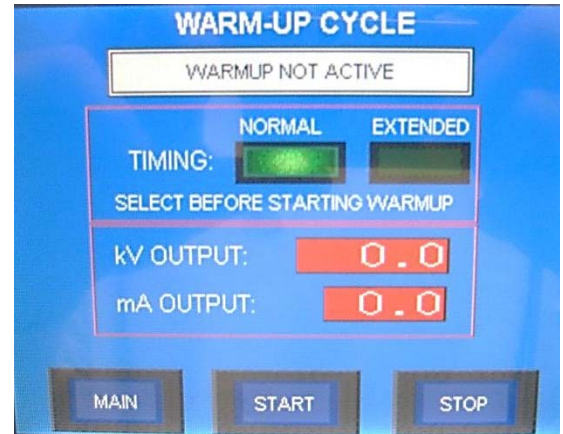
- WARMUP REQUIRED
- WARMUP IN PROGRESS
- X-RAY ON
- X-RAY OFF

The WARMUP cycle will be discussed in the next section.

Warm-Up Cycle

When you first power on the unit, the x-ray tube may or may not need to be properly warmed up (a warm-up is required every 40 hours). If the x-ray tube needs to be warmed up the system status box will say **WARMUP REQUIRED**. **It is important to perform the warmup message appears.** If the tube doesn't need to be warmed up, the status box will say X-RAY OFF. To initiate a warm-up;

1. Press Warm Up on the main menu
2. The WARM-UP CYCLE menu will appear (see figure at the right).
3. There are two pre-programmed warm-up cycles labeled **NORMAL** and **EXTENDED**. Unless you know that the unit hasn't been used for a couple of months, select **NORMAL**.
4. Press **START** (at the bottom of the screen).
5. The message in the system status box will indicate **WARMUP IN PROGRESS**. The flashing indicator lights on the unit will flash on and off indicating that x-rays are being produced.
6. After the warmup is completed (the NORMAL warm-up cycle takes approximately 10 minutes), that system status block will indicate **WARMUP COMPLETE**. Press **MAIN** to take you back to the main menu. You are now ready to perform an irradiation which is discussed in the next section.



Determining Irradiation Time

Before performing an irradiation, you obviously need to first determine how long to irradiate, which corresponds to what level inside the irradiator chamber you will be placing the specimens. So what do we mean by levels?

If you open the door and look inside the irradiation chamber of the RS-2000 you will see various levels indicated along each side. Although you can't see it, because the **RAD+** reflector is covering it, the bottom level is labeled "1". The levels increase in number as you go up higher in the chamber (although not labeled, the level above 5 is level 6).



Levels inside the Chamber

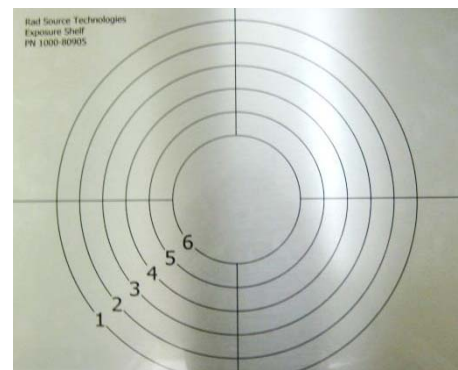
Because the x-ray tube is located above the chamber in the RS-2000, the higher numbered levels correspond to higher dose rates (& shorter irradiation times).

Animals:

Small animals must be placed in a filtered cage filtered cage and are typically irradiated on Level 1 (i.e., within the black **RAD+** reflective chamber on the floor of the chamber).

Non-Animals (e.g., cells, well plates, flasks):

These specimens are typically irradiated on Levels 3, 4, 5, or 6 using the Aluminum Specimen Shelf ("shelf plate").



Aluminum Specimen Shelf

A couple of points regarding using levels and the shelf-plate:

- To ensure relative dose uniformity; if you are using the shelf plate, the specimen(s) should fit within the circular area of the level you are irradiating at (85% dose uniformity within the circle). For the animal cage inside the **RAD+** reflector block, the uniformity is 95%.
- The radiation dose rate is highly dependent upon the distance from the radiation source (x-ray tube). Therefore, for certain specimens (e.g., test tube) you may achieve more uniform irradiation by laying it horizontal.

- Although Level 6 provides the highest dose rate, caution should be used at this level since it is close to the x-ray tube and the dose rate can vary if the specimen is not small.

The dose rates and corresponding irradiation times are given on a “Dose Chart” which is posted on the side of each irradiator. An example is shown below:

RAD SOURCE RS 2000 X-RAY IRRADIATOR DOSE CHART

UNMC Animal Facility (SN 3196) Machine Settings: 160 KV 25mA 0.3 mm Cu

LEVEL 1 Dose Rate: 1.2 Gy/min (Inside the RAD+)					LEVEL 3 Dose Rate: 2.0 Gy/min					LEVEL 4 Dose Rate: 2.9 Gy/min					LEVEL 5 Dose Rate: 4.5 Gy/min					LEVEL 6 Dose Rate: 8.5 Gy/min NOTE: ESTIMATED DOSE RATE				
rad	Gray	Min	Sec		rad	Gray	Min	Sec		rad	Gray	Min	Sec		rad	Gray	Min	Sec		rad	Gray	Min	Sec	
200	2.0	1	40		200	2.0	1	0		200	2.0	0	41		2000	20.0	4	27		2000	20.0	2	21	
250	2.5	2	5		250	2.5	1	15		250	2.5	0	52		2500	25.0	5	33		2500	25.0	2	56	
300	3.0	2	30		300	3.0	1	30		300	3.0	1	2		3000	30.0	6	40		3000	30.0	3	32	
350	3.5	2	55		350	3.5	1	45		350	3.5	1	12		3500	35.0	7	47		3500	35.0	4	7	
400	4.0	3	20		400	4.0	2	0		400	4.0	1	23		4000	40.0	8	53		4000	40.0	4	42	
450	4.5	3	45		450	4.5	2	15		450	4.5	1	33		4500	45.0	10	0		4500	45.0	5	18	
500	5.0	4	10		500	5.0	2	30		500	5.0	1	43		5000	50.0	11	7		5000	50.0	5	53	
550	5.5	4	35		550	5.5	2	45		550	5.5	1	54		5500	55.0	12	13		5500	55.0	6	28	
600	6.0	5	0		600	6.0	3	0		600	6.0	2	4		6000	60.0	13	20		6000	60.0	7	4	
650	6.5	5	25		650	6.5	3	15		650	6.5	2	14		6500	65.0	14	27		6500	65.0	7	39	
700	7.0	5	50		700	7.0	3	30		700	7.0	2	25		7000	70.0	15	33		7000	70.0	8	14	
750	7.5	6	15		750	7.5	3	45		750	7.5	2	35		7500	75.0	16	40		7500	75.0	8	49	
800	8.0	6	40		800	8.0	4	0		800	8.0	2	46		8000	80.0	17	47		8000	80.0	9	25	
850	8.5	7	5		850	8.5	4	15		850	8.5	2	56		8500	85.0	18	53		8500	85.0	10	0	
900	9.0	7	30		900	9.0	4	30		900	9.0	3	6		9000	90.0	20	0		9000	90.0	10	35	
950	9.5	7	55		950	9.5	4	45		950	9.5	3	17		9500	95.0	21	7		9500	95.0	11	11	
1000	10.0	8	20		1000	10.0	5	0		1000	10.0	3	27		10000	100.0	22	13		10000	100.0	11	46	
1050	10.5	8	45		1500	15.0	7	30																
1100	11.0	9	10		2000	20.0	10	0																
1150	11.5	9	35		2500	25.0	12	30																
1200	12.0	10	0		3000	30.0	15	0																
1250	12.5	10	25		3500	35.0	17	30																
1300	13.0	10	50		4000	40.0	20	0																
1350	13.5	11	15		4500	45.0	22	30																
1400	14.0	11	40		5000	50.0	25	0																
1450	14.5	12	5		5500	55.0	27	30																
1500	15.0	12	30		6000	60.0	30	0																
					6500	65.0	32	30																
					7000	70.0	35	0																
					7500	75.0	37	30																
					8000	80.0	40	0																
					8500	85.0	42	30																
					9000	90.0	45	0																
					9500	95.0	47	30																
					10000	100.0	50	0																

For Doses NOT Listed in the Above Tables

Divide the desired dose (Gy) by Dose Rate for the Level being used to get the minutes of irradiation needed.

Convert irradiation time into minutes and seconds

EXAMPLE:
Your target dose is 45 Gy using Level 3

Dose rate for Level 3 = 2 Gy/min

Irradiation time = 45 Gy ÷ 2 Gy/min = 22.5 minutes

Convert to minutes & seconds format (multiply the decimal remainder by 60 to get seconds) - for this example 0.5 minutes = 0.5 X 60 = 30 sec

Irradiation Time (min sec) = 22 minutes 30 seconds

In most cases, the Dose Chart will provide the irradiation time needed. However, if a dose is not provided you can use the dose rate to calculate the irradiation time, as shown in the example below:

Example: Calculating Irradiation Time If Dose is NOT listed on Dose Chart

Suppose you wish to give a specimen a dose of 3.7 Gy on Level 3. Looking at the Dose Chart, the dose rate at Level 3 is 2.0 Gy/minute. Dividing dose by the dose rate (3.7 ÷ 2) gives a total irradiation time of 1.85 minutes.

Because the RS-2000 requires minutes, seconds input, the 0.85 must be converted to seconds by multiplying by 60 which converts to 51 seconds.

Therefore, 3.7 Gy on Level 3 corresponds to an irradiation time of 1 minute 51 sec

Once you have determined the irradiation time you are ready to enter in the time and perform the irradiation as follows:

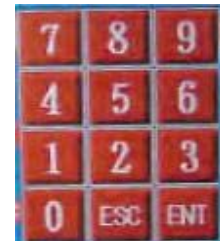
1. Place the specimen in the chamber. For small animals, place the HEPA filtered cage within the **RAD+** block. For non-animal specimens, place the shelf plate at the level desired and place the specimen on the plate.



Animal cage placed in RAD+

2. On the Main Menu you will select **PROGRAM SETUP** if you have not already programmed an irradiation time in for one programs (A, B, C, or D). If you have already programmed in an irradiation time go to Step 3.

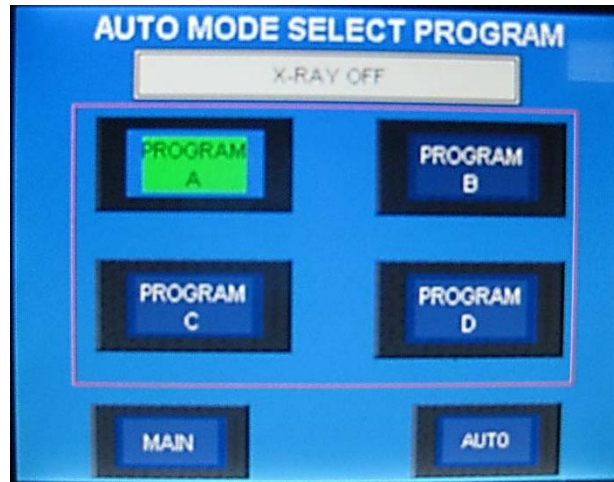
After selecting PROGRAM SETUP, the following screen (AUTO PROGRAM SETUP) will appear (Programs C and D can be seen by pressing **NEXT**);



Keypad; ESC = Escape
ENT = Enter

For the Program you wish to program an irradiation time for, press MIN or SEC and a keypad will appear on the display which allows entry of the irradiation time. Once the time has been entered, press **MAIN** to return to the main menu.

3. On the Main Menu, choose **PROGRAM SELECT** and the following window will appear:



4. Select the program (A, B, C, or D) you wish to run and then press **AUTO**.
5. Press **START** and the irradiation will begin (flashing lights on the front of the irradiator will flash on and off indicating that x-rays are being produced).
6. After the irradiation is completed, open chamber and remove specimen.

IMPORTANT NOTE: After the last irradiation has been completed, wait 5 minutes before turning the key to the OFF position. This is an extremely important step to ensure that the tube cools down properly (the tube costs \$25,000 to replace).

7. Complete the User's Log (located in the room) to document your irradiator usage.
8. Post Procedure Cleaning: After you have completed using irradiator, perform the following;
 - a. Irradiator: Spray a paper towel with Clidox solution and wipe the inside of the irradiator chamber including the shelf plate (if used). Repeat with 70% ETOH.
 - b. Biosafety Cabinet: If the BSC is used spray and wipe down all surfaces inside the BSC. Repeat with 70% ETOH.
 - c. Please dispose of all debris and waste in the waste basket provided.

- d. Allentown Caging must be left on a cage return cart by the exit. Comparative Medicine will wash, sterilize and return cages to the irradiator room for the next user.
- e. For the Animal Irradiator, Comparative Medicine will provide routine room sanitation. Additional room cleaning may result in additional charges.

As indicated earlier, the procedure for basic operation of the RS-2000 is posted on the door of each of the irradiators.

Irradiator Use Charge will be billed at the end of each month.

Faults & Possible Causes

If during normal operation of the machine a fault condition is detected an ALARM SCREEN will be displayed. Please contact Radiation Safety immediately if a fault or alarm is indicated. Table 3 in the operating manual lists possible faults and the corrective actions for the RS-2000.

Other Pertinent Information

On the Rad Source website (www.radsource.com) information pertaining to the RS-2000 irradiator can be found. The website also provides contact information should you wish to contact a technical representative directly.



This concludes the Initial Operator Training for the RS-2000 X-Ray Irradiator. After successful completion of the test, contact Radiation Safety to set up a practical training session operating the unit.