## Contents

**Chapter 1** Welcome ................................................................. 1

**Chapter 2** Important Safety Instructions .................................. 2

2.1 Safety Information .......................................................... 2

2.2 Safety Symbols ................................................................ 3

2.3 Instructions .................................................................. 3

Read, Retain, and Follow Instructions ..................................... 3

Heed Warnings .................................................................. 3

2.4 X-Ray Safety and Hazards: Regulations .............................. 4

2.5 Environmental Considerations for the System Components ... 5

Location for the IVIS Lumina XRMS Series III ....................... 5

Heat ............................................................................. 5

Water and Moisture ............................................................ 5

2.6 Cleaning or Moving the System Components ..................... 5

Cleaning/Liquid Entry ......................................................... 5

Moving the IVIS Lumina XRMS Series III .............................. 6

2.7 Power Considerations ....................................................... 6

Power Sources .................................................................. 6

Power Cord Protection ......................................................... 6

Lightning and Power Line Surges .......................................... 6

Power Outages .................................................................. 6

Overloading .................................................................... 7

2.8 Servicing ................................................................... 7

2.9 Other Equipment ............................................................ 7

**Chapter 3** Warnings ................................................................. 8

3.1 Electrical Safety ............................................................... 8

3.2 X-Ray Safety ................................................................. 8

3.3 Eye Safety and Burn Hazard ........................................... 9

3.4 Mechanical Safety ........................................................ 9

3.5 Chemical and Biological Safety ....................................... 10

3.6 Panels, Cover, and Modules ........................................... 10

**Chapter 4** Legal Notices ........................................................... 11

4.1 Introduction .................................................................. 11

4.2 Limited Warranty ........................................................ 11

4.3 Patents ..................................................................... 12

4.4 Trademarks ................................................................. 13

4.5 Disclaimers .................................................................. 13

**Chapter 5** X-ray Safety and Radiation Hazards .......................... 14

5.1 Introduction .................................................................. 14
Cabinet X-ray System .................................................. 14
Other Product Documentation ................................. 14

5.2 Radiation Theory and X-ray Generation  ................. 14
Types of Radiation: Ionizing and Non-ionizing .......... 14
X-rays: An Ionizing Radiation ............................. 15
X-rays: A Penetrating Radiation .......................... 15
X-rays: How They are Made .................................. 15
Lumina XRMS Series III X-ray Source Tube ............ 16

5.3 Biological Effects of Radiation ............................. 16
Ionization Process and the Cell .............................. 16
Deterministic Effects ............................................ 16
Stochastic Effects ................................................ 17
X-ray Dose Limits ................................................ 17

5.4 IVIS Lumina XRMS Series III Safety Systems .......... 17
Radiation Shielding ............................................. 17
IVIS Lumina XRMS Series III Control Panel .............. 18
Requirements for Turning on X-rays ....................... 18
Turning Off X-rays .............................................. 20
X-ray ON Indicators ............................................ 21
Safety Interlocks ................................................. 21
Safety Testing ..................................................... 22

5.5 Your Laboratory X-ray Safety Procedures ............... 22
Contact Your Radiation Protection Authorities .......... 22
Study Documentation ........................................... 22
Create Radiation Safety Plan ................................. 22
Create a Training Plan .......................................... 23
Safety Maintenance ............................................. 23
Regulatory Compliance ....................................... 24

5.6 Contact Information ............................................ 24
PerkinElmer Sales and Technical Support ................. 24
US State Radiation Authorities ............................ 24
Canadian Radiation Authorities ............................ 33

Chapter 6 Components and Specifications .................. 36
6.1 CCD Camera .................................................... 37
CCD Camera Features .......................................... 37
CCD Camera Specifications .................................. 37

6.2 X-Ray System and Components .......................... 37

6.3 X-Ray Scintillation Module ............................... 39

6.4 X-Ray System Control Panel ............................. 40

6.5 Key Selector Switch .......................................... 41

6.6 Imaging Chamber ............................................. 41
Imaging Chamber Features .................................. 42
Imaging Chamber Specifications .......................... 42

6.7 Optics .......................................................... 42

6.8 Optical Filter Wheel .......................................... 42
Chapter 7 Basic Operation ................................................. 45
  7.1 Starting the IVIS Lumina XRMS Series III ......................... 45
  7.2 Restarting the System After a Power Outage ...................... 46
  7.3 Gas Plumbing .......................................................... 46
  7.4 Door Operation .......................................................... 48
      Stage Curtain .......................................................... 48
  7.5 Changing the X-Ray Scintillation Plate Position .................. 49
      Moving the Scintillation Plate to the Upper Position ............. 49
      Moving the Scintillation Plate to the Lower Position ............ 52
  7.6 Imaging Basics .......................................................... 54
      Black Paper .......................................................... 54
      Centering a Subject .................................................. 54
      Glowing Materials .................................................... 55
  7.7 System Shut Down Procedure ......................................... 55

Chapter 8 Fluorescence Module ......................................... 56
  8.1 About the Fluorescence Module .................................... 56
  8.2 Installation Requirements .......................................... 57
  8.3 Specifications .......................................................... 57
      Electrical Power and Fuses .......................................... 57
      Environmental ......................................................... 57
      Lamp and Fuse ........................................................ 57
      Ventilation Requirements ............................................. 57
      Chemicals Required for Operation .................................. 58
      Weight and Dimensions of the Fluorescence Light Source Module ... 58
  8.4 Description and Theory of Operation .............................. 58
      System Components .................................................. 58
      Understanding Filter Spectra ....................................... 62
  8.5 Fluorescent Imaging ................................................... 63
      IVIS Acquisition Control Panel ..................................... 63
      Acquiring Fluorescent Images ....................................... 64
  8.6 Troubleshooting .......................................................... 64
      Hardware Problems ................................................... 64
      Fuse Replacement ..................................................... 65
      Lamp Replacement .................................................... 66
  8.7 Care and Maintenance of the Fluorescence Equipment .......... 67
      Cleaning the Fluorescence Light Source Module .................. 67
      Cleaning the IVIS Lumina XRMS Series III and Fluorescence Equipment .... 67
      Cleaning the Optical Components and Filter Replacement ........ 67

Chapter 9 Care and Maintenance ........................................ 68
  9.1 Surveying the IVIS Lumina XRMS Series III for Radiation Leakage .... 68
Conducting the X-Ray Radiation Survey ........................................ 68
9.2 Maintenance and Safety Checks ........................................... 68
   Daily Safety Checks .......................................................... 68
   Weekly Safety Checks ...................................................... 69
   Monthly Safety Checks ................................................... 69
   Annual Safety Checks ...................................................... 69
9.3 Cleaning the IVIS Lumina XRMS Series III ............................ 69
9.4 Cleaning the Scintillation Plate Window and Holder .............. 70

Chapter 10 Troubleshooting .................................................... 74
10.1 Measured Temperature Is Not Equal to Demand Temperature .... 74
10.2 Photographic Image Is Unacceptable ................................. 75
10.3 Luminescent Image Is Unacceptable ................................. 75
10.4 No Image Produced ....................................................... 76

Appendix A XWS-260 Workstation .......................................... 77
   A.1 Shutting Down the Imaging System ................................. 78
   A.2 Moving the Imaging System on the XWS-260 Workstation .. 78
   A.3 Starting the Imaging System ........................................ 78

Appendix B Options and Accessories ....................................... 80

Appendix C Scintillation Plate Holder ..................................... 81
   C.1 Removing the Scintillation Plate Holder .......................... 81
   C.2 Replacing the Scintillation Plate Holder .......................... 83

Index ...................................................................................... 84
1 Welcome

The IVIS® Lumina XRMS Series III is a high-sensitivity, low noise imaging system providing in vivo fluorescent and bioluminescent imaging together with X-ray capability (Figure 1.1).

![Figure 1.1 IVIS Lumina XRMS Series III](image)

The IVIS Lumina XRMS Series III Imaging System includes:

- A scientific grade, thermoelectrically-cooled CCD camera mounted on a light-tight imaging chamber with integrated optical modules.
- A module for X-ray imaging with a two-position scintillation plate that accommodates subjects up to 2.8 cm vertical height or larger subjects up to 5.3 cm vertical height.
- Fluorescence equipment:
  - 22-position excitation filter wheel with 19 equally spaced excitation filters covering the wavelength range from 410 to 790 nm
  - 8-position filter wheel with 7 emission filters spanning the wavelength range from 500 – 865 nm
- Living Image® Software for automated image acquisition, post-processing, and data analysis.
- A Windows®-based computer system for data acquisition and analysis.

This manual explains how to operate and maintain the equipment, and provides guidelines for obtaining optimal bioluminescent, fluorescent, and X-ray images. Before using the IVIS Lumina XRMS Series III, please read this manual carefully to obtain safe, optimum performance and a maximum service life from the unit. For instructions on using the Living Image software, please see the Living Image® Software User Manual for IVIS Lumina XRMS Series III (PN CLS137702RevB).

If you have questions regarding this manual or the IVIS Lumina XRMS Series III, please contact PerkinElmer Technical Support (see page 24).
2 Important Safety Instructions

Safety Information
Safety Symbols on page 3
Instructions on page 3
X-Ray Safety and Hazards: Regulations on page 4
Environmental Considerations for the System Components on page 5
Cleaning or Moving the System Components on page 5
Power Considerations on page 6
Servicing on page 7
Other Equipment on page 7

2.1 Safety Information

This manual provides safety information in the following formats:

⚠️ CAUTION: A caution note indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or mechanical damage. It is also used to alert you to unsafe practices. It reminds you that all safety instructions should be read and understood before installation, operation, maintenance, or repair of this instrument. When you see this symbol, pay particular attention to the safety information presented. Observance of safety precautions will help avoid actions that could damage or adversely affect the performance of the IVIS Lumina XRMS Series III. If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

⚠️ WARNING! Used when an action or condition may potentially cause serious personal injury or loss of life. Mechanical damage may also result.

⚠️ VOLTAGE! Provides safety information about high voltage or risk of electric shock.
2.2 Safety Symbols

Table 2.1 shows safety symbols that are found on the IVIS Lumina XRMS Series III and in this manual.

Table 2.1  Safety symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Warning: Hazardous voltage</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Warning: The equipment produces X-rays when energized.</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Warning (Canada): The equipment produces X-rays when energized.</td>
</tr>
</tbody>
</table>

2.3 Instructions

**WARNING!** The IVIS Lumina XRMS Series III should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. PerkinElmer also recommends that personnel who operate the equipment, or are close proximity to the equipment, use a radiation film badge or other type of appropriate personal dosimeter

Read, Retain, and Follow Instructions

Read and understand all the safety and operating instructions before you install, operate, or perform maintenance on the IVIS Lumina XRMS Series III. Make sure that you fully understand the following safety instructions, warnings, and disclaimers before proceeding to the rest of the manual.

Retain the safety and operating instructions for future reference.

Follow all operating and handling instructions. Failure to follow operating or handling instructions may void any warranty covering this product.

Heed Warnings

Abide by all warnings on the product and in the operating instructions. Failure to adhere to warnings or safety precautions may void any warranty covering the IVIS Lumina XRMS Series III.
2.4 X-Ray Safety and Hazards: Regulations

This equipment produces X-rays when energized. Before operating the equipment, read and understand the specific information in X-ray Safety and Radiation Hazards on page 14. DO NOT operate the IVIS Lumina XRMS Series III unless an X-ray safety survey has been performed within the last 12 months. Please contact PerkinElmer Technical Support for more information (see page 24).

An X-ray safety survey must be performed when the instrument is installed or after it has been moved, unless the instrument was moved on the XWS-260 Workstation cart and no abnormal mechanical shocks occurred. A survey is also to be performed when the IVIS Lumina XRMS Series III has undergone any form of service in which the electronics drawer has been opened, the safety interlocks have been adjusted or any of the shielding has been removed and re-installed.

After servicing, if the safety interlocks are not operating properly or if the X-ray shielding is not properly re-installed, serious injury can result when operating the system. Conducting an X-ray safety survey is the only way to confirm proper shielding and interlock operation.

---

**WARNING!** For radiation survey of the IVIS Lumina XRMS Series III, please comply with your own laboratory radiation regulations or contact PerkinElmer Technical Support for further assistance.

Owners and operators of the IVIS Lumina XRMS Series III are responsible for complying with all regulations in the country where the equipment is operated. This includes all local, state, and federal regulations. In some states of the US, it may be necessary to register radiation sources with the governing state and/or local public health agencies before operating the instrument. Equipment registration may be required immediately or within 30 days of acquiring the equipment.

Owners and operators of the IVIS Lumina XRMS Series III are responsible for contacting the appropriate public health agencies for registration information that pertains to installation of the IVIS Lumina XRMS Series III. If you need assistance with this requirement, contact PerkinElmer Technical Support (see page 24). For more details and contact information, see Safe Operating and Emergency Procedures for the Operation of the IVIS Lumina XRMS Series III Cabinet X-Ray System. This document was provided with the pre-installation instructions.

---

**WARNING!** A PerkinElmer representative will conduct a radiation leakage survey and safety tests when the IVIS Lumina XRMS Series III is installed. PerkinElmer representatives are trained in radiation safety. However, check with your local radiation control authority to determine the specific radiation survey requirements at your facility. If necessary, have a qualified expert other than a PerkinElmer representative survey the installation before operating the instrument.
2.5 Environmental Considerations for the System Components

Location for the IVIS Lumina XRMS Series III

Before the IVIS Lumina XRMS Series III is installed, consider the proper environment for the components. Install the equipment in an environment where:

- The temperature does not fluctuate widely and is maintained between 15-25 °C (59-77 °F).
- The humidity does not exceed 80%.
- No strong electric or magnetic fields exist.
- No vibrations are present.
- No corrosive gases are present.
- High amounts of dust are not present.
- No open flame is present.
- There is sufficient space behind the IVIS Lumina XRMS Series III equipment. A minimum space of four inches from the flat surface of the rear panel should be provided behind the IVIS Lumina XRMS Series III to provide unobstructed air flow and access to the main power on/off switch.
- The work space is level.

Heat

The system should be situated away from heat sources such as open flames, radiators, heat registers, stoves, and other heat-generating electrical equipment.

Water and Moisture

![VOLTAGE!] Do not use this product near water (for example, near a sink or wet room) due to risk of electric shock, electrical damage, and/or equipment failure.

2.6 Cleaning or Moving the System Components

Cleaning/Liquid Entry

![VOLTAGE!] Do not use liquid or aerosol cleaners and never spill liquid of any kind on any of the IVIS Lumina XRMS Series III components. Sprays and liquids that come into contact with the IVIS Lumina XRMS Series III hardware may result in damage to the system or electrocution. For more details on proper care of the system, see Care and Maintenance on page 68.
Moving the IVIS Lumina XRMS Series III

You can move the light source module on the laboratory bench within the extent of the fiber optic cable. Be careful not to bend the fiber optic cable (minimum radius of bending: 3 inches/7.6 cm).

**CAUTION**: The IVIS Lumina XRMS Series III is sensitive, scientific equipment and should not be moved by any user unless the system is located on the XWS-260 workstation. Due to the risk of potential damage, it is critical that only a trained PerkinElmer technician moves the IVIS Lumina XRMS Series III. If it is necessary to relocate the instrument, contact PerkinElmer Technical Support (see page 24). See Appendix A on page 77 for more details on moving the IVIS Lumina XRMS Series III on the XWS-260 workstation.

### 2.7 Power Considerations

**Power Sources**

The IVIS Lumina XRMS Series III is configured for the voltage requirements of the installation locality that was specified at the time of order. If the IVIS Lumina XRMS Series III is moved to another area, make sure that the same voltage requirements exist.

**VOLTAGE!** The IVIS Lumina XRMS Series III can operate at multiple voltages (100-240 VAC); however, you are not permitted to change the input voltage to any of the system components. Several internal modifications are required for voltage change. If the operating voltage must be changed, contact PerkinElmer Technical Support (see page 24).

**Power Cord Protection**

Power supply cords should be routed so that they are unlikely to be walked on or pinched by items placed upon or against them. Pay close attention to receptacles and to points of connection between cords and equipment.

**Lightning and Power Line Surges**

The IVIS Lumina XRMS Series III is supplied with a surge protector. All components should be connected to this device to protect against electrical transient events. Failure to isolate the camera from electrical transients may result in damage to the CCD camera.

**Power Outages**

If the IVIS Lumina XRMS Series III experiences a loss of supply power, turn off the power switch for all components and do not restart the system until reliable power has been restored.
Overloading

WARNING! Do not overload wall outlets, extension cords, or integral convenience receptacles as this can result in a risk of fire or electric shock. See Components and Specifications on page 36 for more details on the power requirements of the equipment.

Facilities should be adequately wired according to local building codes.

2.8 Servicing

Refer all servicing to PerkinElmer Technical Support (see page 24). If the IVIS Lumina XRMS Series III is damaged and requires service, unplug the instrument from the outlet and contact PerkinElmer Technical Support. Servicing by anyone other than an authorized PerkinElmer representative voids the warranty covering the IVIS Lumina XRMS Series III.

2.9 Other Equipment

Use of any equipment other than that recommended by this manual has not been evaluated for safety and, therefore, is the sole responsibility of the user.

Do not modify the IVIS Lumina XRMS Series III in ANY manner by making any kind of hole or aperture in the instrument or removing any component of the radiation shielding.
### 3 Warnings

**Electrical Safety**

**X-Ray Safety**

**Eye Safety and Burn Hazard on page 9**

**Mechanical Safety on page 9**

**Chemical and Biological Safety on page 10**

**Panels, Cover, and Modules on page 10**

#### 3.1 Electrical Safety

⚠️ **VOLTAGE!** DO NOT attempt to service the IVIS Lumina XRMS Series III yourself. Although there are no voltages in excess of 24V inside the imaging chamber, local line voltages (110VAC or 230VAC) are present in the lower electronics tray. The light source module may be user-serviced for line fuse and lamp replacement only. There are no other user serviceable electrical parts in the light source module with the exception of the line fuse. See [Fuse Replacement on page 65](#) for instructions. Contact PerkinElmer Technical Support for other electrical service needs (see page 24).

⚠️ **WARNING!** If necessary, wipe exterior surfaces of the light source module with a soft cloth. DO NOT use fluids to clean the exterior of the module. Do not allow fluids of any kind to enter the light source module under any circumstances. See [Cleaning the IVIS Lumina XRMS Series III on page 69](#) for instructions.

⚠️ **WARNING!** When the power is on, DO NOT disconnect or reattach the electrical control cable that connects the fluorescence equipment (excitation filter assembly) to the light source module and the IVIS Lumina XRMS Series III (electronics tray). See [System Components, page 45](#) for photographs of these components. Disconnecting or reconnecting the control cable when the system has electrical power will damage the system. Always turn off the switch on the front panel of the light source module and the rear-mounted ON/OFF switch on the IVIS Lumina XRMS Series III before you connect or disconnect any of these cable connections.

#### 3.2 X-Ray Safety

⚠️ ⚠️ **WARNING!** This equipment produces X-rays when energized.

⚠️ ⚠️ **WARNING!** The IVIS Lumina XRMS Series III should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. PerkinElmer also recommends that personnel who operate the equipment, or are close proximity to the equipment, use a radiation film badge or other type of appropriate personal dosimeter.
3.3 Eye Safety and Burn Hazard
The light source module and the connecting fiber optic cables produce intense light that can cause eye damage. The module uses a tungsten halogen lamp bulb that operates at a high temperature, which if exposed to a user's skin, could cause a burn.

**WARNING!** DO NOT operate the light source module or the fluorescence equipment without all of the fiber optic cables connected at both of their end connections.

**WARNING!** Do not attempt to replace the tungsten halogen lamp or lamp assembly in the light source module. Lamp replacement requires PerkinElmer Technical Support (see page 24) because access to the lamp could expose the user to dangerous voltages and the IVIS Lumina XRMS Series III will require recalibration after replacement of the halogen lamp or lamp assembly.

3.4 Mechanical Safety
The imaging chamber of the IVIS Lumina XRMS Series III is heavy and weighs 160 lbs. (73 kg).

**IMPORTANT:** The IVIS Lumina XRMS Series III may only be moved on the XWS-260 Workstation. See Appendix A on page 77 for instructions.

The IVIS Lumina XRMS Series III has many internal motorized components that can move at any time. The imaging stage can move when the door is open. Care should be taken to keep hands and equipment away from the sides of the platform when it is moving. Never place anything underneath the platform.

Do not attempt to put anything into the lens opening of the camera as there are optical components that can be compromised or damaged.

If the imaging chamber makes an unusual noise or appears to be jammed, turn off the power switch located on the back of the instrument.

The X-ray scintillation plate is a delicate part and should not be handled with bare hands or sprayed with cleaning agents.

**WARNING!** If the gas hoses become caught, kinked, or disconnected, do not operate the instrument. Over exposure to anesthesia gas may occur.

**CAUTION:** DO NOT touch or expose the four diffusing reflectors and the exposed emission filter to contaminants (see Figure 8.2 on page 59), as this may impair imaging performance. The reflectors’ surfaces have been surface treated for optimum light diffusion.

**CAUTION:** The Living Image® software controls excitation filter selection. Do not manually turn the numbered knob on the Excitation Filter Wheel Assembly (see Figure 8.5 on page 60).
3.5 Chemical and Biological Safety

Normal operation may involve the use of test samples that are pathogenic, toxic, or radioactive. It is your responsibility to ensure that all necessary safety precautions are taken before such materials are used.

Dispose of all waste materials according to appropriate environmental health and safety guidelines.

It is your responsibility to decontaminate the IVIS Lumina XRMS Series III before requesting service by PerkinElmer Technical Support. Ask your laboratory safety officer to advise you about the level of containment required for your application and about the proper decontamination or sterilization procedures to follow.

Handle all infectious samples according to good laboratory procedures and methods to prevent the spread of disease.

3.6 Panels, Cover, and Modules

There are no user serviceable components in the lower electronics tray of the IVIS Lumina XRMS Series III. Do not remove the electronics tray from the IVIS Lumina XRMS Series III or the cover from the light source module unless you are instructed by and under the supervision of a PerkinElmer technical service representative.

Do not modify the IVIS Lumina XRMS Series III in ANY manner by making any kind of hole or aperture in the instrument or removing any component that is part of the radiation shielding.
4 Legal Notices

**Introduction**

**Limited Warranty**

**Patents on page 12**

**Trademarks on page 13**

**Disclaimers on page 13**

4.1 Introduction

This manual is provided to you by PerkinElmer Health Sciences, Inc. ("PEHS") on behalf of itself and its affiliates, Caliper Life Sciences, Inc. ("Caliper") and Xenogen Corporation ("Xenogen"). PEHS, Caliper and Xenogen are referred to collectively throughout this manual as "PerkinElmer". Section 4.2 below provides the standard limited warranty for the System and associated Living Image® Software.

4.2 Limited Warranty

a. PerkinElmer provides the following limited warranty for each new IVIS® Lumina XRMS Series III ("System") purchased from it as follows ("Limited Warranty"):

i. PerkinElmer warrants that This Limited Warranty for the System extends for a period of one (1) year following delivery to, and installation of, the System to the original customer, purchaser, or user ("Customer"), the System shall substantially conform to its published specifications existing at the time of purchase. This Limited Warranty and is not assignable or transferable to any successor, without the express written permission of PerkinElmer, which may be withheld in its sole discretion.

ii. During the Limited Warranty period, PerkinElmer will repair or replace, at PerkinElmer's sole option, any defective parts if such repair or replacement is needed because of System malfunction or failure during normal usage in accordance with the instructions in this manual. Repairs and replacements under the Limited Warranty will be made at PerkinElmer's expense. Parts replaced during this Limited Warranty period may be retained by PerkinElmer, at its sole option, and will be warranted for the longer of the remaining term of the original Limited Warranty period, or for thirty (30) days from the date of replacement. PerkinElmer's limit of liability under the Limited Warranty shall be the purchase price of the Imaging System. PerkinElmer shall not be liable for any other losses or damages. These remedies are the Customer's exclusive remedies for breach of warranty.

iii. If a problem develops during the Limited Warranty period, the Customer shall contact PerkinElmer Technical Support for assistance immediately following discovery of the problem.
b. The following Limited Warranty provided by PerkinElmer is the sole and exclusive warranty applicable to the Living Image® software ("Software"):

v. PerkinElmer warrants that such software will conform to PerkinElmer's program manuals current at the time of shipment to Customer when properly installed, provided, however, that PerkinElmer does not warrant that the operation of the software will be uninterrupted or error-free.

vi. Customer agrees that as PerkinElmer's sole liability and as Customer's sole remedy, PerkinElmer will provide services to correct documented and reproducible errors which PerkinElmer's diagnosis indicates are caused by a defect in an unaltered version of the Software.

c. THE FOREGOING LIMITED WARRANTY IS THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. PERKINELMER SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF ANTICIPATED BENEFITS OR PROFITS, LOSS OF SAVINGS OR REVENUE, PUNITIVE DAMAGES, LOSS OF USE OF THE SYSTEM OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF ANY SUBSTITUTE EQUIPMENT OR FACILITIES, DOWNTIME, THE CLAIMS OF ANY THIRD PARTIES, INCLUDING CUSTOMERS, AND INJURY TO PROPERTY, RESULTING FROM THE PURCHASE OR USE OF THE SYSTEM OR ARISING FROM BREACH OF THE WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT TORT, OR ANY OTHER LEGAL OR EQUITABLE THEORY, EVEN IF PERKINELMER KNEW OF THE LIKELIHOOD OF SUCH DAMAGES. PERKINELMER SHALL NOT BE LIABLE FOR DELAY IN RENDERING SERVICE UNDER THE LIMITED WARRANTY, OR LOSS OF USE DURING THE PERIOD THAT THE SYSTEM IS BEING REPAIRED. PERKINELMER DOES NOT REPRESENT OR WARRANT THAT THE EQUIPMENT OR SOFTWARE WILL BE FREE FROM DEFECTS, UNINTERRUPTED OR, ERROR-FREE.

d. Some countries, states or provinces do not allow the exclusion or limitation of implied warranties or the limitation of incidental or consequential damages for certain products or the limitation of liability for personal injury, so the above limitations and exclusions may be limited in their application to you. When any implied warranties are not allowed to be excluded in their entirety, they will be limited to the duration of the applicable written warranty. This Limited Warranty gives you specific legal rights which may vary depending on local law.

e. This Limited Warranty shall be governed by the laws of the Commonwealth of Massachusetts, U.S.A., excluding its conflicts of laws principles and excluding the United Nations Convention on Contracts for the International Sale of Goods.

4.3 Patents

The detection and imaging of light originating within mammals is the subject of several issued patents and pending patent applications in the United States and around the world, including U.S. Patent Numbers 5,650,135, 6,217,847, 6,649,143, 6,890,515, 6908605, 6916462, 6923951, 6939533, 7198774 and 7255851, and European Patent Commission Numbers EP0861093 and EP1016419, for which Xenogen Corporation is the exclusive licensor. The use of an IVIS® Imaging System for such applications requires a sublicense from Xenogen Corporation.

In addition, many of the hardware and software components of the Imaging System are the subject of various issued patents and pending patent applications owned by Xenogen, including: United States Patent Number 6,614,452 (Graphical User Interface for In Vivo Imaging); 6,775,567 (Improved Imaging Apparatus); 7113217 (Multi-view Imaging Systems), 7616985 (Method and Apparatus for 3-D Reconstruction of Light Emitting Sources), 7403812 (Method and Apparatus for Determining Target Depth, Brightness, and Size Within a Body Region), 6894289 (Fluorescence illumination assembly for an imaging apparatus), and 6919919 (Light calibration device for use in low level light imaging systems).
4.4 Trademarks

IVIS and Living Image are registered trademarks of PerkinElmer. The names of companies and products mentioned herein may be the trademarks of their respective owners. Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries. Pentium III is a registered trademark of Intel Corporation.

4.5 Disclaimers

a. **Use of the Software.** The Software and related documentation may be subject to clickwrap, shrink wrap, or other end user license agreements containing restrictions on use and disclosure and are protected by intellectual property laws. Except as expressly permitted in your license agreement or allowed by law, you may not use, copy, reproduce, translate, broadcast, modify, license, transmit, distribute, exhibit, perform, publish, or display any part, in any form, or by any means. Reverse engineering, disassembly, or decompilation of this software, unless required by law for interoperability, is expressly prohibited.

b. **Use of the System.** This manual has been developed for use by properly trained individuals only and use by individuals who have not received proper training is not advised. Any changes or modifications of the System, not expressly approved by PerkinElmer, will void the Limited Warranty and any repair thereafter shall be charged to the Customer. Any movement of the System not performed by authorized personnel of PerkinElmer may void the Limited Warranty. Failure to operate the System in accordance with this manual is likely to cause safety hazards, personal injury, property damage, and/or other damages.
5 X-ray Safety and Radiation Hazards

5.1 Introduction

Cabinet X-ray System

The IVIS® Lumina XRMS Series III produces X-rays when and only when the X-ray function has been energized and initiated. The instrument may also be operated in standard bioluminescence or fluorescence mode without X-ray generation. The IVIS Lumina XRMS Series III is defined by most regulatory agencies as a "Cabinet X-Ray System." A cabinet system is one that produces little or no X-ray exposure to the user and is safe to operate with the user in close proximity. This radiation is confined to the interior of the imaging chamber. PerkinElmer certifies the IVIS Lumina XRMS Series III to produce not more than 0.5 millirem per hour at a distance of 5 cm from the instrument surface. In addition, the instrument is certified to meet all international exposure requirements (typically, 0.1 millirem per hour at 10 cm) and other regulations for where it is sold. The IVIS Lumina XRMS Series III meets all US (FDA) regulations regarding a cabinet X-ray system. For information on international limits for X-ray doses see X-ray Dose Limits on page 17 later in this section.

Other Product Documentation

Users will receive pre-installation information to help prepare the laboratory for installation of the IVIS Lumina XRMS Series III. Included with this package of material is a document called 126198: Safe Operating and Emergency Procedures for the operation of the IVIS Lumina XRMS Cabinet X-ray System. This document includes a list of US and Canadian contacts for Radiation Protection. Those contacts have been repeated in this manual for your convenience.

Only individuals who have been trained to operate the equipment should be permitted to use it. In some locations, government regulations may require that the user have radiation training and be certified.

5.2 Radiation Theory and X-ray Generation

Types of Radiation: Ionizing and Non-ionizing

Radiation is everywhere. Our bodies are continuously bathed in radiation in the form of sunlight, radio and television waves as well as radiation produced by the earth's natural background radiation produced by radioactivity and cosmic rays. Radiation is distinguished by its ability to ionize chemical bonds, and is characterized as either ionizing or non-ionizing. Ionizing radiation has the ability to affect biological organisms including human beings by interacting with the cellular chemistry. Radiation such as sunlight, is usually considered non-ionizing radiation, although there is some
overlap when discussing ultra-violent radiation. X-rays are a form of electromagnetic radiation similar to light, but having much shorter wavelengths. X-rays have wavelengths from 10 to 0.01 nanometers, whereas visible light ranges from 700 to 400 nanometers. Non-visible ultraviolet light fills the gap between visible light and X-rays with wavelengths ranging from 400 to 10 nanometers. It too is considered an ionizing radiation, but it does not possess the penetrating capability of X-rays. In summary, X-ray radiation is an ionizing form of electromagnetic radiation that has sufficient energy to break chemical bonds.

The IVIS Lumina XRMS series III uses an X-ray generating tube to produce ionizing radiation, which if left unshielded could be harmful to people or animals. The IVIS Lumina XRMS Series III produces ionizing radiation in the energy range from 20 to 40 kilovolts (X-ray). The IVIS Lumina XRMS Series III has been shielded by design so that the X-rays are completely confined within the imaging chamber. Consequently, operation of the IVIS Lumina XRMS Series III poses no unsafe exposure to its operator. To verify the design, and to assure proper manufacturing and installation, at least two complete radiation surveys are conducted to make certain that there is no leakage from the instrument that exceeds US and international regulations. It is the user’s responsibility to minimize the total X-ray exposure to the individual mouse or other animal subject as part of the total amount of time spent imaging.

**X-rays: An Ionizing Radiation**

As noted above, X-rays are considered ionizing radiation capable of removing or rearranging the electronic bonds of chemical compounds. For this reason they are considered potentially hazardous to living organisms. X-rays can also interact with matter by scattering off of atoms in new directions. For this reason, the IVIS Lumina XRMS Series III has shielding that completely blocks scattered radiation in all possible directions, including the primary beam direction. Ionizing radiation can also be produced by radioactive materials, but IVIS Lumina XRMS Series III contains no radioactive materials. This is important because there is no possibility of transferring a radioactive contaminant into the laboratory during a procedure such as cleaning the imaging chamber.

**X-rays: A Penetrating Radiation**

X-rays are able to penetrate matter. This is why they are useful in applications such as medical imaging and industrial inspection. The IVIS Lumina XRMS Series III uses an X-ray tube source of the minimal energy needed to penetrate and image mice. Even though X-rays are able to penetrate matter such as tissue or plastic, they are not able to make it radioactive.

**X-rays: How They are Made**

The source of X-rays used in the IVIS Lumina XRMS Series III is an X-ray tube located in the area under the imaging chamber. The characteristics of this tube are discussed in *Lumina XRMS Series III X-ray Source Tube on page 16*. The basic function of the X-ray tube is to generate X-rays of a maximum energy of 40000 electron volts. The X-rays are produced by the collision of high energy electrons with a tungsten metal target in a vacuum tube. When a high voltage is applied between a heated cathode and the tungsten anode, electrons are stripped from the cathode and are accelerated into the anode. The collision of those electrons produces X-rays. There are two atomic processes capable of producing X-rays from these collisions. One process, known as bremsstrahlung from the German "braking radiation", generates X-rays by the rapid deceleration of the high energy electrons as they interact with the repulsive electron field of the tungsten target metal. The second generating process results from the high energy free electrons interacting with the target metals atomic orbitals. The tube used in the IVIS Lumina XRMS Series III generates X-rays by means of both of these processes. The tube generates a spectrum of X-rays from approximately 5 keV to the maximum of 40 keV. The X-ray generating source assembly is equipped with a user-activated aluminum X-ray
filter. When the filter is engaged and intersects the X-ray beam, the range of transmitted radiation is from 5 to 40 keV with average intensity of approximately 25 keV and radiation from bremsstrahlung attenuated. When the filter has been moved out of the beam path, the range of energy remains from 5 to 40 keV, but with very strong bremsstrahlung intensity at the 10 keV energy level. The practical affect of having these two energy settings is to provide a reduced dose when animal imaging (filter in), but increased contrast when imaging tissue samples (filter out).

**Lumina XRMS Series III X-ray Source Tube**

The X-ray generating tube is located beneath the imaging chamber in a separate enclosure. The tube is neither accessible nor serviceable by the user. The separate enclosure, called an electronics tray, has a safety interlock switch design to make the X-ray tube inoperable if the tray is opened. The tube and its integrated high voltage power supply are manufactured to PerkinElmer’s specifications. The tube is rated at 40kV high voltage potential with a maximum beam current of 0.10 milliAmperes. Total power is 4.0 watts. The X-ray window is 0.127mm thick Beryllium and the X-ray target is tungsten. X-ray tube control such as ON/OFF, and beam power settings are carried out by Living Image® software commands acting through an electronic X-ray controller. The controller is mounted on the back of the IVIS Lumina XRMS Series III. Living Image also controls the IN-OUT status of the aluminum X-ray filter.

**5.3 Biological Effects of Radiation**

**Ionization Process and the Cell**

X-rays are a form of electromagnetic radiation that has enough penetrating energy to ionize atoms with in cell. Ionization occurs when an X-ray photon interacts with an orbital electron and transfers energy to it, causing the electron to be ejected from the atom. Such ionizations may disrupt cellular molecules such as DNA. A DNA molecule may be broken by the radiation and the cell may be severely damaged, resulting in cell death. With enough cell death, tissue and organs may be damaged. Injury to a living organism can also occur in indirect ways such as the creation of free radicals or other ions. The deleterious effects of radiation exposure are classified into two categories: deterministic effects and stochastic effects.

**Deterministic Effects**

Deterministic effects are effects in which a clear causal connection can be made between the exposure to radiation and the effect. Deterministic effects are the result of cell killing and tissue damage. This effect is dose related, and a certain threshold of radiation dose needs to occur so that a large enough number of cell deaths occur for the tissue to be damaged. After the dose threshold is exceeded, the severity of the effect is increased by the amount of the dose. Skin reddening is one example of a deterministic effect resulting from radiation exposure. Overexposure of skin to X-rays can result in changes to pigmentation, blistering and ulceration. Other examples of a deterministic effect are the formation of cataracts and fetal abnormalities.

The deterministic effects of radiation can be classified as either acute or delayed. An acute effect such as skin reddening results soon after the overexposure to radiation. A delayed effect such as cataracts may take some time, even years, to develop. Other delayed effects are cancer, genetic defects, shortened life span, and metal retardation in children exposed in utero.

Deterministic effects have clear connection between the individual exposure to radiation and the biological effect. The biological effect requires a minimum threshold dose and the severity of the effect increases with increased dose.
Stochastic Effects

Stochastic effects are biological effects that have a statistical probability of occurring based on the radiation dose. Unlike deterministic effects, stochastic effects have no dose threshold. Even for low radiation doses there is a small probability of a biological effect occurring. Also, the severity of the stochastic biological effect can be unrelated to the magnitude of the dose, but the probability of occurrence increases with increased dose or time of exposure. Since stochastic effects such as cancer or genetic defects often show up years after exposure, it is not certain that these effects can be linked to any specific event of radiation exposure. Since stochastic effects such as cancer can also afflict individuals who have not been exposed to radiation above background, it is not possible to determine that the cancer resulted from any specific exposure.

X-ray Dose Limits

A sample of PerkinElmer Model IVIS Lumina XRMS Series III has been tested at maximum operating conditions. PerkinElmer has determined the local x-ray dose rate at a distance of 5 cm from the surface of the equipment is less than 1.0 µSv/h. PerkinElmer declares that the Product IVIS Lumina XRMS Series III system conforms to:

- 1996/29/Euratom Directive (Dose rate of 1 µSv/h at 10 cm from any accessible surface under normal operating conditions).
- US CFR21 Part 1020.40 Regulation (Dose rate of 0.5mrem/h at 5cm outside of the external surface under maximum operating conditions) in accordance with the following standard: IEC 61010-1:2001 Standard (Dose limit of 1 µSv/h at 10 cm from the surface of the equipment under maximum operating conditions).

PerkinElmer certifies that IVIS Lumina XRMS Series III system has achieved the objectives of:

- ICRP 60 recommendations of annual public dose limit of 100mrem.
- ICRP 103 recommendations of annual public dose limit of 100mrem.
- US OSHA workplace annual public dose limits of 100mrem and other international public safety standards and regulations.

It is unlikely the trained individual using the IVIS Lumina XRMS Series III will receive an annual dose that exceeds these public dose limit levels.

5.4 IVIS Lumina XRMS Series III Safety Systems

The IVIS Lumina XRMS Series III has many different safety features intended to keep the operator safe from radiation exposure. Many of these features are discussed in the system hardware manual as well as the Safe Operating and Emergency Procedures for the operation of the IVIS Lumina XRMS Series III Cabinet X-ray System you received at time of ordering. No amount of engineering design or testing can keep you safe if the instrument is not maintained or is tampered with. Following the maintenance procedures in Chapter 9 on page 68 will prevent hazardous conditions from developing.

Radiation Shielding

The IVIS Lumina XRMS Series III is considered a cabinet X-ray system because all the radiation is confined to the inside of the metal structure. This is accomplished by using steel of a sufficient thickness to block X-rays of the energies produced by the tube described in Lumina XRMS Series III X-ray Source Tube on page 16. In some parts of the cabinet additional shielding has been added to prevent leakage. There are no ports, apertures, or other openings by which any part of the human body can be placed when X-rays are being generated. The IVIS Lumina XRMS Series III x-ray cabinet is defined as the portion of the console where the subjects are placed by opening the door and
also a separate radiation enclosure under the imaging chamber and within the electronics tray. The x-ray tube is contained within the electronics tray radiation enclosure.

**WARNING!** Do not modify this product in ANY way. Do not drill or modify the shielding panels in ANY way. Do not operate the instrument or turn on the source unless all shielding is in place and is in good repair. Do not attempt to access the electronics compartment below the imaging chamber. Operation of the instrument in a modified condition could result in exposure to X-rays. Exposure to X-rays can cause serious bodily injury or death. Refer all servicing to PerkinElmer Technical Support (see page 24).

It is important to not tamper with any of the steel shielding by either removing it or making any kind of modification. The steel shield that is attached to the inside of the cast aluminum door is held on by screws. It should be inspected frequently to make sure that it is not becoming detached. The frequent inspection should be applied to any of the exterior mounted components such the excitation filter wheel assembly.

**IVIS Lumina XRMS Series III Control Panel**

IVIS Lumina XRMS Series III is controlled primarily by software through a proprietary PerkinElmer program called Living Image® software. For the X-ray modality some of the control has been shifted to the main console electronics tray so as to confor to requirements for cabinet X-ray systems. However, the controls and indicators on the main module are "enablers" only. The initiation and termination of the X-ray imaging session is controlled from the computer through the Living Image software.

X-rays cannot be generated unless the main console has been armed for X-ray mode with the emergency off switch in the OFF position, the key switch is in the ON position, all safety interlocks are working, and the yellow "ARM X-RAY" switch/indicator is activated. X-rays can be terminated from the computer as an ordinary result of the programmed end of an imaging system or by stopping the X-rays from the computer control panel. The X-rays can be stopped abnormally by hitting the Emergency Stop switch, by turning OFF the Key switch, or by turning the door handle which activated the primary interlock switch.

Finally, a redundant interlock, as prescribed by the United States FDA, completely disconnects power to the X-ray source when the door is opened to a gap of 7 mm (0.28 inches). Because of the "knife edge" design of the light and X-ray leakage seal, no radiation could escape through this gap. Also, during X-ray operation, a solenoid-operated door lock prevents opening the door. This door lock stays engaged for a few seconds after X-ray power has been turned off, and is used to ensure that the radiation field has completely collapsed after the X-ray source voltage has been turn off.

**Requirements for Turning on X-rays**

The main ON/OFF enabling switch on the console control panel is the Keyed On/Off switch shown in Figure 5.1. Without key enabling, no X-rays can be generated. The second action required is for the yellow push button/indicator light "X-RAY ARMED" switch to be activated (see Figure 2).

**NOTE:** This procedure assumes that the Emergency OFF switch is in its normal ON position.

These three conditions are necessary but not sufficient to generate X-rays. For X-ray imaging to occur, the door must be closed and locked, thus engaging both the primary and redundant interlocks. Finally, the X-rays must be activated by the computer control software as shown in Figure 3. In normal operation, the yellow X-Ray Armed light will stay on while the user loads subjects into the
imaging chamber. If for some reason the emergency OFF switch has been pushed to the off position, it can be reset to ON by rotating the red knob in a counter-clockwise direction.

![Figure 5.1 Key Switch](image1)

![Figure 5.2 Arming Switch and Indicator](image2)

![Figure 5.3 Control Panel – Living Image Software](image3)
Turning Off X-rays

The normal procedure for turning off the x-ray source is to either let Living Image software finish the imaging session and turn the source off as part of the normal termination of the imaging sequence, or by terminating the program by stopping the session by "pushing" the computer stop button as shown in Figure 4. X-rays will be stopped if the Key switch is turned OFF or if the emergency OFF switch is pushed (see Figure 5). Finally, any attempt to open the door will activate the primary interlock thus turning off the X-rays. Abnormal turning off of the x-rays will require re-arming the yellow push button switch on the main console control panel.

Figure 5.4 Control Panel – Living Image Software

Figure 5.5 Emergency OFF Switch

Push in to turn off. Turn counterclockwise to reset.
X-ray ON Indicators

**WARNING! This product produces X-rays. Do not attempt to open the IVIS Lumina XRMS Series III door when X-rays are being generated as indicated by the "X-Ray On" lights.**

IVIS Lumina XRMS Series III is equipped with three (3) red indicator lights showing the status of X-ray generation:

- Indicator on the main console control panel that is labeled "X-RAY ON" (Figure 6.5 on page 41). This indicator operates independently. If it malfunctions, the remaining two indicators will operate.
- Indicator on the decorative camera top cover at the top of the main console (Figure 6.5 on page 41)
- Indicator on the rear of the instrument.

The Living Image control panel also indicates the status of X-ray generation (Figure 5.4).

Safety Interlocks

**WARNING! Do not, for any reason, attempt to defeat the built-in safety interlocks described in this section. Operating the IVIS Lumina XRMS Series III without the safety interlocks can result in exposure to X-rays. Exposure to X-rays may cause serious bodily injury or death. Refer all servicing to PerkinElmer Technical Support (see page 24.)**

IVIS Lumina XRMS Series III has several interlock switches. The primary interlock switch is activated as soon as you turn the door handle. It is a micro-switch that when OFF (handle turned to open position) prevents generation of X-rays or any image acquisition. Unless the door is completely closed and the handle locked, the CCD camera shutter will not open.

A second redundant door interlock prevents X-ray generation by physically removing part of the X-ray electrical circuit when the door is opened (Figure 5.6).

In addition to the two safety interlocks, the door has a solenoid-activated lock that prevents the door from being opened during an imaging session when X-rays could be generated. For reasons discussed in the warning above, it is important not to attempt defeat of any of these safety features.
Safety Testing

PerkinElmer will perform at least two safety tests on every system at time of installation:

- At time of manufacture.
- At the user’s laboratory or facility.

The safety test includes, but is not limited to, an X-ray radiation leakage test.

5.5 Your Laboratory X-ray Safety Procedures

In addition to what PerkinElmer has done to make a safe system, there are some things required of the user to make the instrument operate safely and within legal authority.

Contact Your Radiation Protection Authorities

Before operating the IVIS Lumina XRMS Series III, you need to contact your state or provincial radiological authorities. A list with contact information is provided in 126198: Safe Operating and Emergency Procedures for the operation of the IVIS Lumina XRMS Series III Cabinet X-ray System. This document was provided at the time of ordering; it is also included on the manual CD-ROM as well as the CD-ROM governing international documentation. In most cases, you will be required to register the IVIS Lumina XRMS Series III with the state or provincial radiation protection authority. This registration may need periodic renewal.

Study Documentation

Before operating the IVIS Lumina XRMS Series III, read this manual as well as the 126198: Safe Operating and Emergency Procedures for the operation of the IVIS Lumina XRMS Series III Cabinet X-ray System. Pay particular heed to the safety procedures described in document 126198. This document can help with preparing a radiation safety plan described in the next section. Also, the Living Image Software Manual for IVIS Lumina XRMS Series III provides the basic operating instructions for bioluminescence, fluorescence, and X-ray imaging modes.

Create Radiation Safety Plan

Your institution may require that you have a written radiation safety plan or a plan may already exist. Such a plan may also be a requirement of your registration with your provincial radiological authority. Here are some of the key points of such a plan.

- Persons using the IVIS Lumina XRMS Series III must read all documentation supplied with the instrument.
- Permit only trained and authorized individuals to operate the IVIS Lumina XRMS Series III. Wear personal radiation monitors if required. It is recommended to wear them even if they are not required.
- Designate a Master Key person who controls access to the IVIS Lumina XRMS Series III.
- If required, install the instrument in a controlled access or restricted access room.
- Post any required “Caution X-ray” signs required by your regulating authority.
- Designate a person who will be responsible for ensuring that specified safety and maintenance procedures described in this manual are performed.
- Frequently verify that all safety procedures are followed and that the IVIS Lumina XRMS Series III has not been modified or that any of the safety interlocks have been disabled.
Follow all guidance supplied by your local, state or provincial radiological authority. If that guidance conflicts with information supplied by PerkinElmer, either written or spoken, contact PerkinElmer Technical Support so that the conflicts can be resolved (see page 24).

Keep records of X-ray surveys, instrument repairs or other data required by radiological authorities or your institution. Some other records that should be kept are Registration Certificates, compliance or safety audit reports, instrument inspections, training records, a list of authorized users, accident or investigation reports, and worker complaints.

Create a Training Plan

- Use documentation supplied with the IVIS Lumina XRMS Series III for specific training instructions for the instrument. Use supplemental information for more in depth coverage of topics such as radiation safety.
- Identify radiation hazards associated with the use of the IVIS Lumina XRMS Series III.
- The training plan should include discussion of:
  - Characteristics of radiation and units of dose.
  - The warning and safety devices incorporated into the IVIS Lumina XRMS Series III. Point out the importance of having them in working condition.
  - Proper operating procedures for the equipment.
  - The operation, calibration and limitations of radiation survey instruments if the trainee will be conducting radiation surveys.
  - Proper survey techniques if surveys are not conducted by a PerkinElmer representative.
  - Methods of controlling radiation dose, such as time, distance and shielding.
  - The principles and practice of maintaining X-ray exposure to as Low As Reasonably Achievable (ALARA).
  - Personal monitoring of X-ray exposure. Symptoms of acute localized exposure, and proper reporting procedure for an actual or suspected exposure.
  - Applicable state, provincial, local and institutional regulation or policies.

Safety Maintenance

PerkinElmer recommends, and some local government agencies may require, an X-ray leakage safety test be performed under the following conditions:

- Every 12 months.
- When the system is installed at a new site unless it has been moved to the new location on the XWS-260 workbench and no jarring shocks have occurred during transport.
- After a PerkinElmer representative performs maintenance or service, in which case the safety survey will be conducted by PerkinElmer.
- After any abnormal condition that could impair any of the safety systems, for example, the light box door becomes difficult to open or close.

WARNING! A PerkinElmer representative will conduct a radiation leakage survey and safety tests after the IVIS Lumina XRMS Series III is serviced by PerkinElmer. PerkinElmer representatives are trained in radiation safety. However, check with your local radiation control authority to determine the specific radiation survey requirements at your facility. It necessary, have a qualified expert other than a PerkinElmer representative survey the installation before operating the instrument.

See Conducting the X-Ray Radiation Survey on page 68 for more information.
Additionally, it is recommended to perform a daily or weekly light leak check as described in Table 10.1 on page 76. Using the High Reflectance Hemisphere to look for possible light leaks into the imaging chamber may help detect potential radiation leaks out of the chamber. Performing this check DOES NOT invalidate the requirement for the 12 month TOTAL radiation survey. It is possible for X-rays to leak from areas outside of the imaging chamber, for example from the electronics enclosure.

**Regulatory Compliance**

Customers in the US are directed to check with their state radiation control program director for registration requirements. See the Safe Operating and Emergency Procedures for the Operation of the IVIS Lumina XRMS Cabinet X-Ray System for a list of US state and Canadian Province agencies. This document was provided as part of the pre-installation instructions and is also included on the same CD-ROM as this manual. International customers should check with their governing bodies about possible registration or other requirements. PerkinElmer certifies that the IVIS Lumina XRMS Series III meets the Japanese standard JAISOS0101- 2001 with respect to X-ray containment. PerkinElmer certifies that the IVIS Lumina XRMS Series III complies with FDA regulation CFR 1020.40 after installation at the customer's site. PerkinElmer also certifies that the instrument meets all of the international regulations of the country where it is installed.

**5.6 Contact Information**

**PerkinElmer Sales and Technical Support**

PerkinElmer Health Sciences  
940 Winter Street, Waltham, Massachusetts 02451 USA  
Telephone: 800.762.4000 (US) or +1.203.925.4602  
Fax: +1.203.944.4904  
For sales: CustomerCareUS@perkinelmer.com  
For Technical Support: tech.support@caliperLS.com  
877.522.497.3302 (US) or +1.508.435.9500  
www.PerkinElmer.com

**US State Radiation Authorities**

**ALABAMA**  
Office of Radiation Control  
State Dept. of Public Health  
201 Monroe St/PO Box 303017  
Montgomery, AL 36130-3017  
334-206-5391  
http://www.adph.org/radiation/
ALASKA
Radiologic Health Program
4500 Boniface Parkway
Anchorage, AK 99507-1270
907-334-2107
http://www.hss.state.ak.us/dph/labs/radiological/

ARIZONA
Arizona Radiation Regulatory Agency
4814 South 40th St.
Phoenix, AZ 85040-2940
602-255-4845 Ext. 222
http://www.arra.state.az.us/

ARKANSAS
Arkansas Department of Health
Radiation Control Section
4815 W. Markham St., Slot H-30
Little Rock, AR 72205-3867
Phone: 501-661-2301
www.healthyarkansas.com/rtl

CALIFORNIA
Radiologic Health Branch
Division of Food and Radiation Safety
PO Box 997414, MS-7610
Sacramento, CA 95899-7414
916- 440-7899
http://www.cdph.ca.gov/programs/Pages/RadiologicHealthBranch.aspx

COLORADO
X-Ray and Mammography Compliance
Registration and Certification
4300 Cherry Creek Drive South
Denver, CO 80246-1530
303-692-3446
http://www.cdphe.state.co.us/hm/rad/xray/

CONNECTICUT
Dept. of Public Health
Division of Radiation
79 Elm Street
Hartford, CT 06106-5127
860-424-3029
http://www.dep.state.ct.us

DELAWARE
Office of Radiation Control
Division of Public Health
417 Federal Street
Dover, DE 19903
302-744-4546
http://www.dhss.delaware.gov/dph/hsp/orc.html
**DISTRICT OF COLUMBIA**
Department of Health
HRLA/Radiation Protection Div.
717 14th Street NW, Room 639
Washington, DC 20005
202-724-8800
http://hrla.doh.dc.gov/hrla/site/default.asp

**FLORIDA**
Dept. of Health/Bureau of Radiation Control
4052 Bald Cypress Way, Bin C21
Tallahassee, FL 32399-1741
850-245-4266
Radiologic Technology Program
4052 Bald Cypress Way
Tallahassee, FL 32399-1741
850-245-4540
www.doh.state.fl.us/environment/radiation

**GEORGIA**
Department of Human Resources
2 Peachtree Street NW, 33rd Floor
Atlanta, GA 30303-3142
404-657-5400
http://ors.dhr.georgia.gov/portal/site/DHR-ORS/

**HAWAII**
Dept. of Health./Noise and Radiation Branch
591 Ala Moana Blvd.
Honolulu, HI 96813-4921
808-586-4700
Radiation Section
Radiological Response/Radiologic
Technology/Mammography
808-586-4700
http://hawaii.gov/health/environmental/noise/radiationsection/radiation.html

**IDAHO**
Dept. of Health and Welfare
Idaho Bureau of Laboratories
2220 Old Penitentiary Rd.
Boise, ID 83712-8299
208-334-2235 ext.245
http://healthandwelfare.idaho.gov/Health/Labs/Certification/tabid/186/Default.aspx
ILLINOIS
IL Emergency Management Agency
Division of Nuclear Safety
1035 Outer Park Dr.
Springfield, IL 62704
217-785-9868
Registration and Certification Section
217-785-6982/Fax 217-785-9946
http://www.iema.illinois.gov/iema/dns.asp

INDIANA
State Department of Health
Epidemiology Resource Center/
Indoor and Radiological Health
2525 North Shadeland Avenue, E3
Indianapolis, IN 46219
317-351-7190, Ext. 257
http://www.in.gov/isdh/23279.htm

IOWA
Bureau of Radiological Health
Lucas State Office Bldg., 5th Fl
321 E. 12th St.
Des Moines, IA 50309-4611
515-281-3478
http://www.idph.state.ia.us/eh/radiological_health.asp

KANSAS
Radiation Section
1000 SW Jackson St, Suite 310
Topeka, KS 66612-1366
785-296-1565
http://www.kdheks.gov/radiation/indexXray.html

KENTUCKY
Radiation Control Program
Cabinet for Health and Family Services
275 East Main Street, HS1C-A
Frankfort, KY 40621-0001
502-564-3700 Ext. 3695
http://chfs.ky.gov/dph/radiation.htm

LOUISIANA
Emergency and Radiologic Services Division
PO Box 4312
Baton Rouge, LA 70821
225-219-3041
www.deq.louisiana.gov/portal/tabid/2283/Default.aspx
MAINE
Division of Environmental Health
Radiation Control Program
286 Water Street, 4th Floor
Augusta, ME 04333
Telephone: 207-287-5677
http://www.maine.gov/dhhs/eng/rad/

MARYLAND
Radiologic Health Program
Maryland Dept of the Environment
1800 Washington Blvd., Suite 750
Baltimore, MD 21230-1724
410-537-3300
http://www.mde.maryland.gov/Programs/AirPrograms/Radiological_Health/

MASSACHUSETTS
Radiation Control Program
Department of Public Health
Schrafft Center, Suite 1M2A
529 Main Street
Charlestown, MA 02129
617-242-3035
www.mass.gov/dph/rcp

MICHIGAN
Radiation Safety Section
Div. of Health Facilities and Services
Bureau of Health Systems
MI Dept. of Community Health
PO Box 30664
Lansing, MI 48909
517-241-1993
www.michigan.gov/rss

MINNESOTA
Section of Indoor Environments and Radiation
Division of Environmental Health
Department of Health
625 Robert Street N.
P.O. Box 64975
St. Paul, MN 55164-0975
651-201-4602
http://www.health.state.mn.us/divs/eh/radiation/xray/

MISSISSIPPI
Division of Radiological Health
State Department of Health
3150 Lawson Street
Jackson, MS 39215-1700
601-987-6893
http://www.msdh.state.ms.us/msdhsite/_static/30,0,102.html
MISSOURI
Medical Radiation Control Program
Health Services Regulation
Division of Regulation and Licensure
PO Box 570
Jefferson City, MO 65102-0570
573-751-6083
http://www.dhss.mo.gov/RadProtection/

MONTANA
Radiological Health Program
MT Dept. of Public Health and Human Services
Licensure Bureau
P. O. Box 202953
Helena, MT 59620-2953
406-444-2868
https://app.mt.gov/radio/

NEBRASKA
Office of Radiological Health
Dept. of Health and Human Services
P. O. Box 95026
Lincoln, NE 68509-5026
402-471-0528
www.dhhs.ne.gov/rad

NEVADA
Radiological Health Section
Bureau of Health Protection Services
Nevada State Health Division
4510 Technology Way, Suite 300
Carson City, NV 89706
775-687-7540
http://health.nv.gov/HCQC_Radiological.htm

NEW HAMPSHIRE
Radiological Health Section
Division of Public Health Services
Dept. of Health and Human Services
29 Hazen Drive
Concord, NH 03301-6504
603-271-4585
http://www.dhhs.nh.gov/DHHS/RADHEALTH/default.htm

NEW JERSEY
Radiation Protection Programs and
Release Prevention Element
Dept. of Environmental Protection
P. O. Box 415
Trenton, NJ 08625-0415
609-984-5636
http://www.state.nj.us/dep/rpp/index.htm
NEW MEXICO
Radiologic Technologist Cert. Program
New Mexico Environment Department
1190 St. Francis Drive
Santa Fe, NM 87502-0110
505-476-3264
http://www.nmenv.state.nm.us/nmrcb/radserv.html

NEW YORK
Office of Radiologic Health
2 Lafayette Street, 11th Floor
New York, NY 10007
212-676-1550
http://www.health.state.ny.us/environmental/radiological/radon/registration.htm

NORTH CAROLINA
North Carolina Radiation Protection Section
3825 Barrett Drive
Raleigh, NC 27609-7221
919-571-4141, Ext.232
http://www.ncradiation.net

NORTH DAKOTA
Division of Air Quality
North Dakota Dept. of Health
918 E. Divide Avenue
Bismarck, ND 58501-1947
701-328-5188
www.ndhealth.gov/aq/rad

OHIO
Bureau of Radiation Protection
Ohio Dept. of Health
246 North High Street
Columbus, OH 43215
614-644-2727
http://www.odh.ohio.gov/odhPrograms/rp/radprot/radprot1.aspx

OKLAHOMA
Consumer Protection Services
State Department of Health
1000 Northeast Tenth Street
Oklahoma City, OK 73117-1299
405-271-5243

OREGON
Radiation Protection Services
Oregon Health Services,
Department of Human Services
800 NE Oregon Street, Suite 640
Portland, OR 97232-2162
971-673-0499
http://public.health.oregon.gov/Pages/Home.aspx
PENNSYLVANIA
Bureau of Radiation Protection
Rachel Carson State Office Bldg.
P.O. Box 8469
Harrisburg, PA 17105-8469
717-787-2480
http://www.dep.state.pa.us/brp/default.htm

PUERTO RICO
Radiological Health Division
Department of Health
P.O. Box 70184
San Juan, PR 00936-8184
787-274-7802
http://www.salud.gov.pr

RHODE ISLAND
Office of Facilities Regulation
Division of Environmental and Health Services
3 Capitol Hill, Room 206
Providence, RI 02908-5097
401-222-4520
http://www.health.ri.gov/hsr/facilities/radiological/index.php

SOUTH CAROLINA
Bureau of Radiological Health
Dept. of Health and Environment Control
2600 Bull Street
Columbia, SC 29201
803-545-4420
http://www.scdhec.gov/health/radhlth/x-ray.htm

SOUTH DAKOTA
Office of Health Care Facilities
Licensure and Certification
615 East 4th St.
Pierre, SD 57501-1700
605-773-3356
http://doh.sd.gov/Licensure/Default.aspx

TENNESSEE
Division of Radiological Health
37911 Middlebrook Pike
Knoxville, TN 37921
Telephone: 865/594-5577
http://www.state.tn.us/environment/rad/

TEXAS
Bureau of Radiation Control
State Dept of Health Services
PO Box 14937
Austin, TX 78714-9347
512-834-6679
http://www.dshs.state.tx.us/radiation/
UTAH
Division of Radiation Control
168 North 1950 West
PO Box 144850
Salt Lake City, UT 84114-4850
801-536-4257
http://www.radiationcontrol.utah.gov/XRAY/reginspc.htm

VERMONT
Office of Radiologic Health
Department of Health
108 Cherry Street
PO Box 70
Burlington, VT 05402
802-865-7730
http://healthvermont.gov/enviro/rad/rad_health.aspx

VIRGINIA
Division of Radiological Health
Department of Health
James Madison Bldg.
109 Governor Street, Room 730
Richmond, VA 23219
804-864-8170
http://www.vdh.state.va.us/epidemiology/RadiologicalHealth/

WASHINGTON
Office of Radiation Protection
Department of Health
PO Box 47827
Olympia, WA 98504-7827
360-236-3210
http://www.doh.wa.gov/ehp/rp/xray/reg.htm

WEST VIRGINIA
Radiological Health Program
Office of Environmental Health Services
DHHB Bureau for Public Health
1 Davis Square, Suite 200
Charleston, WV 25301-1798
304-558-6721
http://www.wvdhhb.org/rtia/radiological_health.asp

WISCONSIN
Radiation Protection Section
Dept. of Health and Family Services
PO Box 2659
Madison, WI 53701-2659
608-267-4792
dhfs.wisconsin.gov/dph_beh/RadiatioP/Index.htm
**Canadian Radiation Authorities**

Canadian Provincial/Territorial/Federal Radiation Protection Contacts (Non-medical X-rays).

**Alberta**  
Radiation Health and Safety Specialist  
Alberta Human Resources and Employment  
10808-99th Ave, 8th Floor  
Edmonton, AB T5K 0G5  
Tel: (780) 415-0612  
Fax: (780) 422-0014

**British Columbia**  
Radiation Protection Services  
BC Centre for Disease Control  
655 - 12th Avenue West  
Vancouver BC V5Z 4R4  
Tel: (604) 660-6630  
Fax: (604) 660-6628

**Department of National Defence**  
Director General Nuclear Safety  
Department of National Defence  
Rm 1702 Standard Life Building  
280 Slater Street  
Ottawa, ON K1A 0K2  
Tel: (613) 995-8253  
Fax: (613) 992-5537

**Federal**  
Health Canada  
H.P. (Harri) Maharaj  
Physicist and Head,  
Nonmedical X-Rays, CCRPB  
Health Canada  
775 Brookfield Rd  
Postal Locator 6301A  
Ottawa, ON K1A 1C1  
Tel: (613) 954-0318  
Fax: (613) 941-1734  
Email: H_P_Maharaj@hc-sc.gc.ca
Manitoba
Head of Radiation Protection
Medical Physics Division
Cancer Care Manitoba
675 McDermot Ave
Winnipeg, MB R3E 0V9
Tel: (204) 787-2213
Fax: (204) 775-1684

New Brunswick
Health Protection Branch
Department of Health
PO Box 5100
Fredericton, NB E3B 5G8
Tel: (506) 453-2424
Fax: (506) 453-8702

Newfoundland and Labrador
Department of Government Services
West Block, 4th Fl, Confederation Bldg
PO Box 8700
St. John’s, NL A1B 4J6
Tel: (709) 729-0218
Fax: (709) 729-3445

Northwest Territories
Workers’ Safety and Compensation Commission
Northwest Territories and Nunavut
PO Box 8888
Yellowknife, NT X1A 2R3
Tel: (867) 669-4407 or 1-800-661-0792
Fax: (867) 873-0262

Nova Scotia
Occupational Health and Safety Division
Department of Labour and Workforce Development
PO Box 697.
Halifax, NS B3J 2T8
Tel: (902) 424-7115
Fax: (902) 424-5640

Ontario
Radiation Protection Service
Occupational Health and Safety
Ontario Ministry of Labour
81A Resources Road
Weston, ON M9P 3T1
Tel: (416) 235-5765
Fax: (416) 235-5926
Prince Edward Island
Environmental Health
Dept. of Health and Social Services
16 Garfield Street
PO Box 2000 Charlottetown,
PE C1A 2N8
Tel: (902) 368-4792
Fax: (902 368-6468

Quebec
CSST Quebec
Direction de la prevention-Inspection
Commission de la sante et de la securite du travail
524, rue Bourdages, local 250
CP 1200, succursale Terminus
Quebec, QC, G1K 7E2
Contact: Mrs. Candide Fournier
Tél: (418) 266-4699 ext. 2005

Saskatchewan
Radiation Safety Unit
Department of Labour
400 - 1870 Albert St
Regina, SK S4P 4W1
Tel: (306) 787-4538
Fax: (306) 787-2208

Yukon
Workers' Compensation Health and Safety
401 Strickland St.
Whitehorse, YT Y1A 5N8
Tel: (867) 667-5376
Fax: (867) 393-6279
The IVIS® Lumina XRMS Series III is an imaging system that consists of a charged coupled device (CCD) camera which can image animal subjects using three modalities: bioluminescence, fluorescence, and X-ray. IVIS Lumina XRMS Series III includes:

- A camera.
- An imaging chamber with controlling electronics.
- An X-ray source and detector, including controls and safety systems.
- A Fluorescence Module, including excitation and emission filters.

The system is controlled by a pre-configured computer that runs Living Image® software. There are no user-serviceable parts in the IVIS Lumina XRMS Series III. See Chapter 8 on page 56 for more details on the fluorescence equipment.
If you have any questions, please contact PerkinElmer Technical Support (see page 24).

6.1 CCD Camera

The camera is a scientific grade, back-thinned, back-illuminated, large format CCD manufactured by Andor Technologies (Figure 6.2).

CCD Camera Features

- Low dark current
- Thermoelectrically cooled
- 16 bit CCD digitization
- Low-noise electronic readout for extremely low-background images

CCD Camera Specifications

<table>
<thead>
<tr>
<th>CCD Camera</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Type</td>
<td>Back-illuminated</td>
</tr>
<tr>
<td>CCD Format</td>
<td>1024 x 1024</td>
</tr>
<tr>
<td>Pixel Dimensions</td>
<td>13 x 13 µm</td>
</tr>
<tr>
<td>Quantum Efficiency</td>
<td>&gt;90% at 500 - 700 nm</td>
</tr>
<tr>
<td></td>
<td>&gt;65% at 700 - 850 nm</td>
</tr>
<tr>
<td></td>
<td>92% at 600 nm</td>
</tr>
<tr>
<td>Readout Noise - bin 1</td>
<td>&lt;2 e-RMS</td>
</tr>
<tr>
<td>Dark Charge</td>
<td>&lt;0.0015 e-/pixel/sec</td>
</tr>
</tbody>
</table>

6.2 X-Ray System and Components

The X-ray modality of the IVIS Lumina XRMS operates as a separate capability within the Living Image operating environment. The instrument can operate in the following modes:

- Bioluminescence
- Fluorescence
- White light/photographic
- X-ray
- Any combination of bioluminescence, fluorescence, and/or X-ray mode

Operating in X-ray mode requires activation with a key-operated selector switch on the imaging chamber front panel. See *Key Selector Switch on page 41* for more details.

The X-ray source is located underneath the imaging chamber in a separate, shielded enclosure in the electronics drawer. The X-ray beam cone is directed upward through a "transparent" (radiolucent) plate in the imaging chamber floor. The beam passes through the movable shelf, through the subject animal, and finally impinges on the scintillation plate. The CCD camera captures the scintillation image produced in the plate. When not in X-ray mode, the scintillation plate moves out of the way during other imaging modalities, including photographic imaging. Specific information including care of the scintillation plate is given in the next section.

The X-ray system schematic is shown in *Figure 6.2*.

![Figure 6.2 IVIS Lumina XRMS Series III – X-ray Schematic](image)

A solenoid-driven X-ray filter is located near the X-ray source. The filter screens out unwanted X-ray energies from the total radiation spectrum. The filter's normal position is over the source, but it can be moved out of the way for X-ray imaging requiring the full radiation spectrum. The Living Image software controls the filter. The X-ray filter is part of the X-ray source enclosed within the electronics drawer and is not accessible or serviceable by the user.

**WARNING! DO NOT attempt to access the interior of the electronics compartment underneath the imaging chamber. Improper reassembly could result in disruption of radiation shielding.**
6.3 X-Ray Scintillation Module

The main component of the X-Ray scintillation module is a cesium iodide (CsI) screen (scintillation plate) that is used to convert the image shadow produced by the X-rays into visible light which can be imaged by the camera. The scintillation plate is composed of a structured layer of CsI salt on a substrate and is housed in a plastic retainer with a protective glass cover.

The scintillation plate has two positions:
- Lower position – For subject height up to 2.8 cm
- Upper position – For subject height up to 5.3 cm

See page 49 for instructions on changing the scintillation plate position.

### Table 6.1 X-ray Source Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage Potential</td>
<td>20 to 40 kV</td>
</tr>
<tr>
<td>Maximum Current</td>
<td>100 mA</td>
</tr>
<tr>
<td>Anode Type</td>
<td>Tungsten</td>
</tr>
<tr>
<td>Window</td>
<td>Beryllium</td>
</tr>
<tr>
<td>Spot Size</td>
<td>~300 mm</td>
</tr>
<tr>
<td>Cone Angle</td>
<td>46 degrees</td>
</tr>
<tr>
<td>Field of View</td>
<td>5, 7.5, 10 cm</td>
</tr>
<tr>
<td>Filter</td>
<td>Aluminum, 0.4 mm thick</td>
</tr>
</tbody>
</table>

After X-ray imaging, the screen rotates out the way under a protective cover (Figure 6.3). The cover prevents incidental afterglow from interfering with other imaging modalities, and protects the screen window from contamination (for example, cleaning liquids).
6.4 X-Ray System Control Panel

The front panel located under the door of the imaging chamber has two switches and two indicator lights associated with the X-ray function of the instrument (Figure 6.4). The main ON/OFF switch that controls the electrical power to the full instrument is on the rear of the IVIS Lumina XRMS Series III (see Figure 7.3 on page 47). Activation of this switch provides power to the instrument, but does not permit energizing the X-ray source unless the following conditions have been met:

1. The imaging chamber door is completely closed and the door handle is in the completely locked position.
2. The Emergency OFF switch is in the ON (out) position. See the note below.
3. The key selector switch is turned ON.
4. The amber switch has been pushed and the light is ON, indicating that all safety interlocks are functioning properly.

The X-ray source cannot be energized from the Living Image software until these conditions have been fulfilled.

NOTE: The Emergency OFF switch is not intended as a main X-ray source control and should not be used to turn the X-ray function ON or OFF on a routine basis. It should only be used in the unlikely situation where the X-ray source must be immediately turned OFF. Under normal circumstances, it should be left in the ON position and left as is.


6.5 Key Selector Switch

X-ray safety regulations require controlled access to the IVIS Lumina XRMS Series III. The objective of this requirement is to prevent untrained and unauthorized personnel from operating the X-ray functionality of the instrument. The key-operated switch on the IVIS Lumina XRMS Series III fulfills this requirement when used in conjunction with the user's own written radiation safety procedures.

The control of the key is typically managed by a Master Key person. The switch is designed so that the key cannot be removed except in the OFF position. When the authorized user is finished using the instrument, the key is removed from the switch. Two keys are provided with the instrument, and it is a good practice to archive the spare key. If the keys are lost, contact PerkinElmer Technical Support (see page 24).

6.6 Imaging Chamber

The imaging chamber is a highly specialized device consisting of the imaging chamber housing, a heated, movable platform, an auto focusing lens system with F/Stop control, a filter wheel, and sample illumination LEDs (Figure 6.5). All adjustable components are motorized and computer-controlled, including the scintillation module.

The imaging chamber is **light tight**, so that no light penetrates from the outside. The interior of the imaging chamber is constructed from materials that are non-phosphorescent and non-fluorescent to prevent internal light contamination that could compromise sample measurements. In addition to being light tight, the imaging chamber is shielded to prevent X-ray radiation from escaping.

**WARNING! Under no circumstances should you attempt to make any mechanical modifications to the imaging chamber.**
Imaging Chamber Features

- Custom zero-background imaging chamber
- Eight position optical filter emission wheel with seven filters (Table 6.2 on page 43)
- 22-position excitation filter wheel with 19 narrow band pass filters (see Table 6.2 on page 43 for excitation filter specifications)
- High-efficiency lens assembly
- Sample illumination system
- F/Stop control
- Heated and regulated sample shelf temperature to reduce stress on an animal under anesthesia
- Gas anesthesia manifold, including gas delivery and exhaust plumbing
- Software-controlled field of view, F/Stop, focus, and optical filter wheels

Imaging Chamber Specifications

<table>
<thead>
<tr>
<th>IVIS Lumina XRMS Series III Imaging Chamber</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power requirements</td>
<td>4.0 A max at 120 V, 2.0 A max at 240 V, 50-60 Hz</td>
</tr>
<tr>
<td>Dimensions</td>
<td>19” x 28” x 39”, 48 cm x 71 cm x 100 cm</td>
</tr>
<tr>
<td>Door opening dimensions</td>
<td>15” x 20.25”, 38 cm x 51 cm</td>
</tr>
<tr>
<td>Weight</td>
<td>160 lbs, 73 Kg</td>
</tr>
</tbody>
</table>

6.7 Optics

<table>
<thead>
<tr>
<th>Optics</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens F/Stop</td>
<td>f/0.95-f/16</td>
</tr>
<tr>
<td>Field of View</td>
<td>Fluorescence or bioluminescence mode: A (5cm²), B (7.5cm²), C (10cm²) and D (12.5cm²)</td>
</tr>
<tr>
<td></td>
<td>X-ray mode: A, B, and C</td>
</tr>
</tbody>
</table>

6.8 Optical Filter Wheel

A 22-position excitation filter wheel with 19 equally spaced narrow band filters is attached to the back of the imaging chamber (Table 6.2). An 8-position, computer-controlled optical filter wheel is located at the top of the imaging chamber in front of the imaging lens.

The filter wheel settings are selected in the Living Image software. See the Living Image® Software Manual for IVIS Lumina XRMS Series III for instructions.
6.9 Acquisition Computer

The computer contains an Intel family processor and Windows® operating system. Microsoft® Office is installed as well as the Living Image software that controls the IVIS Lumina XRMS Series III.

The computer controls the IVIS Lumina XRMS Series III hardware, including the CCD camera. A printer can be connected to the computer.

Computer Features

- High speed Windows-based PC
- Microsoft Windows family operating system
- Living Image software installed. This software controls the IVIS Lumina XRMS, and displays and analyzes image data.
- CD-burner installed for data storage and transport
- Network ready
- 24” high-resolution flat screen monitor for image viewing
- Microsoft® Office installed

Table 6.2  IVIS® Lumina XRMS Series III Filters

<table>
<thead>
<tr>
<th>Excitation Filters</th>
<th>Emission Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center (nm)</td>
<td>Passband (nm)</td>
</tr>
<tr>
<td>420</td>
<td>20</td>
</tr>
<tr>
<td>440</td>
<td>20</td>
</tr>
<tr>
<td>460</td>
<td>20</td>
</tr>
<tr>
<td>480</td>
<td>20</td>
</tr>
<tr>
<td>500</td>
<td>20</td>
</tr>
<tr>
<td>520</td>
<td>20</td>
</tr>
<tr>
<td>540</td>
<td>20</td>
</tr>
<tr>
<td>560</td>
<td>20</td>
</tr>
<tr>
<td>580</td>
<td>20</td>
</tr>
<tr>
<td>600</td>
<td>20</td>
</tr>
<tr>
<td>620</td>
<td>20</td>
</tr>
<tr>
<td>640</td>
<td>20</td>
</tr>
<tr>
<td>660</td>
<td>20</td>
</tr>
<tr>
<td>680</td>
<td>20</td>
</tr>
<tr>
<td>700</td>
<td>20</td>
</tr>
<tr>
<td>720</td>
<td>20</td>
</tr>
<tr>
<td>740</td>
<td>20</td>
</tr>
<tr>
<td>760</td>
<td>20</td>
</tr>
<tr>
<td>780</td>
<td>20</td>
</tr>
</tbody>
</table>
Computer Specifications

<table>
<thead>
<tr>
<th>Computer Description</th>
<th>Power requirements</th>
<th>Dimensions</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0 A at 120 V</td>
<td>17.0” D x 16.7” H x 6.9” W</td>
<td>27.56 lbs</td>
</tr>
<tr>
<td></td>
<td>0.5 A at 240 V</td>
<td>43.4 cm D x 42.5 cm H x 17.5 cm W</td>
<td>12.5 Kg</td>
</tr>
<tr>
<td></td>
<td>50-60 Hz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Computer Monitor Specifications

<table>
<thead>
<tr>
<th>Computer Monitor (Flat screen)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power requirements</td>
<td>0.6 A at 120 V</td>
</tr>
<tr>
<td>Dimensions with stand</td>
<td>10.13” D x 15.5” H x 22.03” W</td>
</tr>
<tr>
<td>Weight with stand</td>
<td>14.7 lbs</td>
</tr>
</tbody>
</table>

6.10 Environmental Requirements

<table>
<thead>
<tr>
<th>Environmental Requirements</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>15 °C to 25 °C (50 °F to 78 °F)</td>
</tr>
<tr>
<td>Humidity</td>
<td>0% to 80% non-condensing</td>
</tr>
<tr>
<td>Type of use</td>
<td>Indoor</td>
</tr>
<tr>
<td>Imaging chamber shelf temperature</td>
<td>Ambient to 37° C</td>
</tr>
<tr>
<td>Altitude rating</td>
<td>&lt;2000 meters (6560 ft.)</td>
</tr>
<tr>
<td>Pollution degree</td>
<td>2</td>
</tr>
<tr>
<td>Installation category</td>
<td>II</td>
</tr>
</tbody>
</table>
7 Basic Operation

Starting the IVIS Lumina XRMS Series III

7.1 Starting the IVIS Lumina XRMS Series III

NOTE: All components of the IVIS Lumina XRMS Series III should be left on at all times. Periodically rebooting the computer is permissible and does not affect camera operation.

1. Plug the devices into the wall sockets in the new location.
2. Turn on the power surge protection devices.
3. Turn on the computer and monitor.
4. Turn on the IVIS Lumina XRMS Series III imaging chamber (the power switch is located on the back of the unit) and verify that the other components such as the camera power supply, X-ray controller (both on the back of the unit) and fluorescence lamp are also turned to the On position.
5. Start the Living Image® software after the desktop screen is displayed.
6. Enter a User ID (up to three letters) when prompted, then click Done.
7. Click Initialize in the IVIS Acquisition Control Panel (Figure 7.2).

Allow the system to initialize. You will hear the motors move. The System Status box displays the current changes.
The temperature square in the IVIS Acquisition Control Panel is red at startup and turns green when the operating temperature is reached. The control panel displays the current temperature (Figure 7.2).
When the temperature is locked at -90°C, as indicated by the green light in the control panel, the instrument is ready for operation. (For operating instructions, see the Living Image® Software Manual for IVIS Lumina XRMS Series III, PN CLS137702RevB.)

8. To use the X-ray modality:
   a. Verify that the Emergency OFF switch is in the ON position.
   b. Turn the key selector switch to the ON position.
   c. Confirm that the amber arming switch has been pushed and the light is ON.
   d. Verify that the X-ray source is armed.
   e. Use the Control panel in the Living Imaging software to turn on the X-ray source during an imaging sequence or session.

7.2 Restarting the System After a Power Outage

If the IVIS Lumina XRMS Series III experiences a loss of supply power, turn off the power switch on each component. Do not restart the system until reliable line power has been restored.

1. Turn on the computer
2. Turn on the imaging chamber.
3. Start the Living Image® software and click Initialize IVIS System in the IVIS Acquisition Control Panel.
4. For X-ray mode, the system will need to be re-armed by pressing the amber arming switch on the front panel.

7.3 Gas Plumbing

Anesthesia gas tubing is built into the IVIS Lumina XRMS Series III imaging chamber. On the back of the imaging chamber are 0.25" hose barbs that are marked "GAS IN" and "GAS OUT" (Figure 7.3).
"GAS IN" means the direction of flow is into that port. Similarly, the port labeled "GAS OUT" means that flow can be exhausted out of this port.

**WARNING!** Use only isoflurane with the IVIS Lumina XRMS Series III. DO NOT USE FLAMMABLE ANESTHESIA GAS.

**CAUTION:** It is recommended to use the XGI-8 Gas Anesthesia System when imaging small animals (Figure 7.4). The system supplies a controlled amount of isoflurane to the imaging chamber and continuously reduces the build-up of isoflurane in the chamber. If you want to use a gas other than the recommended isoflurane/oxygen gas mixture or pure air, contact PerkinElmer Technical Support (see page 24).
7.4 Door Operation

The IVIS Lumina XRMS Series III imaging chamber door has custom designed hinges, seals, and a four-point closure mechanism. The door is designed to provide a light-tight seal over numerous opening/closing cycles and should close easily without excessive handle turning resistance.

The door has shielding to prevent the escape of X-ray radiation and should not be tampered with or modified in any way. The door also contains part of the X-ray safety interlock system. This component is a copper plug attached to, but insulated from, the door. When the door is open, this plug removes part of the electrical circuit powering the X-ray source. If the copper plug becomes damaged in any way, do not operate the X-ray function of the system, and contact PerkinElmer Technical Support (see page 24). Never try to defeat its function by defeating its purpose or modifying the mating safety interlock. This safety interlock should be visually inspected daily for signs of malfunction.

Stage Curtain

The stage curtain attached to the IVIS imaging chamber platform covers the empty space beneath the platform (Figure 7.5). The stage curtain serves as a reminder to not place anything below the platform. The curtain attaches to the platform by a bar that is held in place by clips at two locations. If it is necessary to access this area, the curtain can be easily removed and replaced.

To release the rod and curtain from the clips, pull the stage rod slightly forward. Do not allow the curtain to retract around the roller. To reattach the rod, push the rod back into the clips.
7.5 Changing the X-Ray Scintillation Plate Position

The X-ray scintillation module contains a scintillation plate which has two imaging positions (Figure 7.6).

Set the scintillation plate position based on the subject vertical height (Table 7.1).

![Figure 7.6 Scintillation Plate in Lower Position](image)

NOTE: Changing the scintillation plate position is a manual process.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Scintillation Plate Position</th>
<th>To Move the Scintillation Plate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat</td>
<td>Upper position – for vertical subject height up to 5.3 cm.</td>
<td>Put a check mark next to &quot;Large Animal&quot; option in the control panel. Follow the instructions for Moving the Scintillation Plate to the Upper Position, page 49.</td>
</tr>
<tr>
<td>Mouse</td>
<td>Lower position – for vertical subject height up to 2.8 cm.</td>
<td>Uncheck the &quot;Large Animal&quot; option in the control Panel. Follow the instructions for Moving the Scintillation Plate to the Lower Position, page 52.</td>
</tr>
</tbody>
</table>

IMPORTANT: Ensure that the scintillation plate position and control panel are synchronized as shown in Table 7.1. For example, if the "Large Animal" option is selected by check mark in the control panel, the scintillation plate must be in the upper position for best image resolution.

Moving the Scintillation Plate to the Upper Position

Put the scintillation plate and cover in the upper position when imaging large subjects such as rats (5.3 cm vertical height maximum).

1. Select the "Large Animal" option in the control panel (Figure 7.7).

   The scintillator assembly moves to the service position. The software prompts you to manually move the scintillator assembly to the upper position.
2. Remove the locking screw using the hex wrench provided with the imaging system (Figure 7.8).

3. Slide the scintillation plate out by pulling the plate toward you. The magnets and alignment pins on the scintillation plate are visible after the plate is removed from the scintillation assembly. The scintillation assembly has matching magnets and pin receptacles (Figure 7.9).
4. Place the scintillation plate in the upper position using the alignment pins and magnets as guides (Figure 7.10).

5. Reinstall the locking screw.

6. Move the scintillation plate cover to the upper position.
   a. Loosen the thumb screw (Figure 7.11).
   b. Remove the cover by pulling the alignment pins of the cover out of the scintillation assembly.
   c. Place the cover in the upper position using the alignment pins as guides.
   d. Tighten the thumb screw.
7. Click **OK** in the software prompt (Figure 7.7 on page 50).

**Moving the Scintillation Plate to the Lower Position**

Put the scintillation plate and cover in the lower position when imaging small subjects such as mice (2.8 cm vertical height maximum).

**To move the scintillation plate to the lower position:**

1. Remove the check mark next to "Large Animal" in the control panel (Figure 7.7).
   The scintillator assembly moves to the service position. The software prompts you to move the
   scintillator assembly to the lower position.

2. Remove the locking screw using the hex wrench provided with the imaging system (Figure 7.7).
3. Slide the scintillation plate out by pulling the plate toward you. After the plate is removed from the scintillation assembly, magnets and alignment pins on the scintillation plate are visible. The scintillation assembly has matching magnets and pin receptacles (see Figure 7.9 on page 51).

4. Place the scintillation plate in the lower position using the alignment pins and magnets as guides (Figure 7.14).

5. Reinstall the locking screw.

6. Move the scintillation plate cover to the lower position.
   a. Loosen the thumb screw (Figure 7.15).
   b. Remove the cover by pulling it off the alignment pins.
   c. Place the cover in the lower position using the alignment pins as guides.
   d. Tighten the thumb screw.
7. Click **OK** in the software prompt (Figure 7.12 on page 52).

### 7.6 Imaging Basics

#### Black Paper

The imaging platform is a black anodized aluminum shelf with a special radiolucent insert. To protect this surface and to minimize the need to clean it, PerkinElmer recommends performing bioluminescence imaging on a high quality black paper. PerkinElmer has surveyed many types of paper and recommends Swarthmore, Artagain, Black, part no. 445-109, size 8.5 inch x 11 inch. This paper prevents illumination reflections and helps keep the stage clean.

Cleanable Lexan sheets are provided for use with fluorescent imaging as they produce less background than the black paper. The actual field of view pattern is provided on several of the Lexan sheets to aid in placing the subject in the center of the image. Instructions for mounting the field of view mats are provided with the mats and installation hardware.

PerkinElmer recommends not using the FOV mat (supplied as an accessory to the Lumina XRMS) during imaging in the X-ray mode where high resolution is desired. The FOV mat material permits more X-ray scatter. Some compromise may be necessary, however, if the X-ray acquisition is coupled with fluorescence imaging. In this case, the low auto-fluorescence image produced with the FOV mat material may be preferred to the X-ray image with scattering.

#### Centering a Subject

It is recommended to confirm that the subject is centered on the stage before acquiring an image. Manual Focus adjusts the stage position to yield the optimal focus, but can also be used as a centering tool.

1. Place the subject on the center of the imaging stage and close the imaging chamber door.
2. Select the Manual Focus option from the Focus drop down menu of the Living Image control panel.
   The software displays a Manual Focus Window of the subject.
3. If the subject is not centered, open the door and reposition the subject. Click the Update button to refresh the image. Repeat this step until the subject is properly centered.
4. When the subject is centered properly, click the Done button on the Manual Focus Window to close the window. See Living Image® Software User Manual for IVIS Lumina XRMS Series III (PN CLS137702RevB) for detailed instructions.

Glowing Materials

Always keep in mind that nearly EVERYTHING glows (that is, has the potential to phosphoresce and contaminate the image). Most plastics, almost all tape, plants, paint, rodent food (mostly plants), mouse urine, and animal bedding have been found to glow.

Use caution when introducing materials into the IVIS Lumina XRMS Series III. It is advisable to pre-screen all items by imaging them alone, before imaging them with samples under study. PerkinElmer recommends using non-powdered gloves when working with IVIS Lumina XRMS Series III equipment.

7.7 System Shut Down Procedure

It is not recommended to power cycle the IVIS Lumina XRMS Series III (turning the system components on and off). If it is necessary to shut down the imaging system for any reason, it is important to follow the procedure below.

1. Close the Living Image software and save any information of interest at the prompt.
2. Return the X-ray ON key selector switch to the OFF position and remove the key.
3. Turn off the IVIS Lumina XRMS Series III imaging chamber using the power switch on the back of the unit.
4. Turn off the computer using the standard Windows® shut down procedure.
5. Turn off the power to the other system components and power surge protection devices.
6. If moving the system, unplug the devices from the wall.

If you have any problems during the shut down or start up procedure, please contact PerkinElmer Technical Support for assistance (see page 24).

NOTE: The Emergency OFF switch is not intended as a main X-ray source control and should not be used to turn the X-ray function ON or OFF on a routine basis. It should only be used in the unlikely situation where the X-ray source must be immediately turned OFF. Under normal circumstances, it should be left in the ON position and left as is.
8 Fluorescence Module

About the Fluorescence Module

Installation Requirements on page 57
Specifications on page 57
Description and Theory of Operation on page 58
Fluorescent Imaging on page 63
Troubleshooting on page 64
Care and Maintenance of the Fluorescence Equipment on page 67

8.1 About the Fluorescence Module

The Fluorescence Module provides IVIS Lumina XRMS Series III with fluorescent imaging capability. The fluorescence equipment can be used for in vitro or in vivo applications. The sensitive range of the IVIS Lumina XRMS Series III CCD camera sets the wavelength range for fluorescence applications, which is approximately 400-950 nm. As with bioluminescent imaging, wavelengths greater than 600 nm are preferred for in vivo fluorescent applications due to lower absorption in tissue. The Living Image software controls fluorescent image acquisition, including lamp power, level, and filter selection.

The IVIS Lumina Series III includes an extended Range (ER) illumination source which yields increased brightness in the near infrared (NIR) region, especially at wavelengths greater than 700nm. The excitation filter wheel has 22 positions that are filled with 19 narrow band filters spanning the range from 410 to 790 nm. The emission filter wheel has 8 positions with 7 broad band emission filters covering the range from 500 to 865 nm. A high service temperature fiber optic cable connects the illumination source to the input of the excitation filter wheel.

CAUTION: Only use the fiber optic cable that is provided with the IVIS Lumina XRMS Series III. Other fiber optic cables may be damaged by the heat from the lamp.

This chapter explains how to operate the fluorescence equipment with the IVIS Lumina XRMS Series III. It also provides important safety and maintenance information.

IMPORTANT: To ensure optimum and safe performance of the Fluorescence Module with maximum service life, read this chapter carefully before you use IVIS Lumina XRMS Series III with the Fluorescence Module.

You should also be familiar with and refer to the other chapters of this manual for the IVIS Lumina XRMS Series III.

For instructions on how to use the Living Image software that controls fluorescent image acquisition, see the Living Image® Software Manual for IVIS Lumina XRMS Series III that is provided with the software.

The Schott Fostec DCR® III Direct Current Regulated Light Source User’s Manual and Technical Reference is a separate manual for the light source module. It provides additional useful information on the light source module and its safe operation.
8.2 Installation Requirements

The fluorescence equipment requires 90 - 260 VAC 50/60 Hz electrical power. The system automatically accepts the required voltage.

⚠️ IMPORTANT: The fluorescence equipment operates at the same voltage as the IVIS Lumina XRMS Series III chamber and must not be used at other than its labeled voltage.

8.3 Specifications

Electrical Power and Fuses

<table>
<thead>
<tr>
<th>Voltage Available</th>
<th>90 – 260 VAC, 50/60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Consumption</td>
<td>150 W</td>
</tr>
</tbody>
</table>

NOTE: See Chapter 6 on page 36 for more information on additional electrical power requirements of the IVIS Lumina XRMS Series III.

Environmental

<table>
<thead>
<tr>
<th>Temperature</th>
<th>15-25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td>0% to 80% Non-Condensing</td>
</tr>
<tr>
<td>Type of Use</td>
<td>Indoor (Pollution Degree 2)</td>
</tr>
<tr>
<td>Sound Level</td>
<td>61 dB &lt;500 Hz</td>
</tr>
<tr>
<td>Altitude Ratio</td>
<td>&lt;2000 meters (6560 feet)</td>
</tr>
</tbody>
</table>

Lamp and Fuse

| Lamp                   | 150 W tungsten halogen EKE bulb with an Extended Range (ER) coating to for increased brightness in the near infrared (NIR). |
|                        | Lamp voltage: 20V       |
|                        | Color temperature: 2856 K°|
| Fuse                   | 2.0 A, 5x20 mm, 250 VAC Slow Blow |

Ventilation Requirements

Provide sufficient space (minimum 6 inches or 15 cm) behind the fan of the light source module so that airflow is unobstructed. Provide a similar minimum distance behind the IVIS Lumina XRMS Series III to enable fan cooling as well as adequate room for fiber optic cable routing.
Chemicals Required for Operation

No chemicals are required for the operation of the IVIS Lumina XRMS Series III or the fluorescence equipment. Other user supplied chemicals or materials may be required for your specific biological testing procedures.

Weight and Dimensions of the Fluorescence Light Source Module

<table>
<thead>
<tr>
<th>Weight</th>
<th>4.94 lbs (2.24 kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>8.61 inches (21.9 cm)</td>
</tr>
<tr>
<td>Width</td>
<td>7.27 inches (18.5 cm)</td>
</tr>
<tr>
<td>Height</td>
<td>4.6 inches (17.7 cm)</td>
</tr>
</tbody>
</table>

8.4 Description and Theory of Operation

System Components

The Fluorescence Module provides fluorescent imaging capability. You can conveniently switch between bioluminescent and fluorescent imaging applications.

Figure 8.1 shows the fluorescence equipment and Figure 8.2 depicts the interior of the imaging chamber (green indicates the excitation light).
The fluorescence light source module (Figure 8.3) provides the fluorescence excitation light. This light source consists of a 150-watt quartz tungsten halogen lamp with a dichroic reflector. Figure 8.4 shows the relative spectral radiance output of the lamp/reflector combination and indicates emission throughout the IVIS Lumina XRMS wavelength range of 400-950 nm. The EKE-ER lamp provides improved light output in the 400-950 pm range compared to the standard EKE lamp. Because of the higher temperature of the ER lamps, a high temperature fiber optic is used to deliver the light to the excitation filter wheel.
The lamp intensity level is computer-controlled by the Living Image® software. The user can adjust the lamp output intensity by means of software to a low or high setting. The fluorescence light source module operates under software control; therefore manual adjustment of the front panel lamp potentiometer is disabled.

The illumination system of the IVIS Lumina XRMS Series III is optimized for NIR imaging. The Extended NIR range (EKE-ER) 150W tungsten excitation light source allows increased power at wavelengths greater than 700 nm (red curve in Figure 8.4) compared to the previous illumination system (blue curve in Figure 8.4).

The lamp output is delivered to the excitation filter wheel assembly (Figure 8.5) on the back of the IVIS Lumina XRMS Series III imaging chamber. Figure 8.6 shows a cross section of the excitation filter wheel assembly. Light from the input fiber optic bundle passes through a collimating lens then travels through a 25 mm diameter excitation filter. Twenty-two (22) position filter wheel locations allow you to choose up to nineteen excitation filters. Light blocks are provided in the three unused filter slots. One of these positions is used during bioluminescent imaging to prevent external light from entering the imaging chamber. The 22 position excitation filter wheel is motor-controlled through the Living Image software.
Following the excitation filter, a second lens focuses light into a one quarter inch fused silica fiber optic bundle inside the IVIS Lumina XRMS Series III imaging chamber. Fused silica (core and clad) fibers are used in this bundle to avoid the generation of auto-fluorescence in the fiber, as is the case with ordinary glass fibers.

The fused silica fiber bundle splits into four separate legs that deliver filtered light to four reflectors located on the ceiling of the imaging chamber (Figure 8.2 on page 59). Typical illumination profiles for stage locations A-D (fields of view 5-12 cm respectively) are shown in Figure 8.7. Note that the profiles for all the stage locations are peaked near their center. The non-uniformity of the illumination pattern is compensated for when units of efficiency are selected in the Living Image software (for more details, see the Living Image® Software User's Manual). When imaging 96-well plates, the lower stage positions (C and D) are recommended to minimize shadowing effects due to the off-axis illumination. Fluorescent emission from the target fluorophore is collected through an emission filter wheel located at the top of the imaging chamber and then focused into the CCD camera. The emission filter wheel contains eight openings. Users have the ability to choose up to seven emission filters (60 mm diameter), leaving one position open for bioluminescent imaging.
Understanding Filter Spectra

The use of high quality filters is essential for obtaining good signal-to-background levels (contrast) in fluorescence measurements, particularly in a high sensitivity instrument such as the IVIS Lumina XRMS Series III. Figure 8.8 shows typical excitation and emission fluorophore spectra, along with idealized excitation and emission filter transmission curves shown as rectangles. The excitation and emission filters are called bandpass filters; ideally they transmit all the wavelengths within the bandpass region and block (absorb or reflect) all wavelengths outside the bandpass. This spectral band is like a window, characterized by its central wavelength and its width at 50% peak transmission (full width half maximum, FWHM).

- **Bandgap** – Spacing between the transmission regions of the excitation and emission filters.
- **Transmission** – Fraction of light that passes through the filter bandpass region.
- **Blockage** – Light rejection in the non-transmitting region (or the region outside the band) of the filter spectrum.
- **Leakage** – Undesirable light that is not blocked properly by the filter and is detected by the camera.

Real filters have some leakage outside of the bandpass region and can also exhibit autofluorescence, depending on the materials used in the filter construction. More realistic filter transmission curves are shown in Figure 8.9.
The vertical axis in Figure 8.9 is optical density, defined as OD = -log(T) where T is the transmission. An optical density of 0 indicates 100% transmission, whereas OD7 indicates a reduction of the transmission to 1x10^-7. Typical transmission of a filter in the bandpass region is about 0.7 (OD0.15) and typical blocking outside of the bandpass region is about OD7. The band gap between the two filters is usually defined as the gap at 50% transmission (OD0.3). There is a slope in the transition region from bandpass to blocking, as indicated in Figure 8.9. A steep slope is required to avoid overlap between the two filters.

The fluorescence filters are high quality interference filters, constructed from alternating layers of dielectric films on a substrate of low auto-fluorescent glass. Care has been taken to minimize filter auto-fluorescence so that its level is below OD7. Filter passbands for the standard set are listed in Table 6.2 on page 43.

### 8.5 Fluorescent Imaging

**NOTE:** This chapter provides a quick start guide to acquiring fluorescent images. See the Living Image® Software User Manual for IVIS Lumina XRMS Series III for complete details.

#### IVIS Acquisition Control Panel

Acquiring fluorescent images using Living Image software is controlled through the IVIS Acquisition Control Panel (Figure 8.10). To acquire a fluorescent image, the user must check the **Fluorescent** box on the left side of the panel. Once selected, controls for the illumination lamp – **Fluor Lamp Level**, and **Filter Lock** – will appear in the top half of the panel. Checking the **Filter Lock** box ensures that the excitation and emission filters are properly paired. During image acquisition, the lamp is computer-controlled through Living Image software. The **Lamp Level** dropdown list controls the illumination intensity level of the lamp with options – **Off**, **Low**, **High**, and **Inspect**. The **Low** setting is approximately 18% of the **High** setting. **Inspect** turns on the illumination lamp, allowing the user to manually inspect the excitation lamp.

**NOTE:** Ensure that the correct filters selected from the Excitation Filter and Emission Filter dropdown lists before you select Inspect. The inspect operation automatically positions the filters that are selected from the drop-down lists before turning on the lamp. Changing the filter selection in the drop-down lists will have no effect until another inspect operation is performed.
Acquiring Fluorescent Images

1. If it is not already on, start the acquisition computer and Living Image® software. The control panel appears (Figure 8.10).

2. Click Initialize IVIS system.
   After initialization, the Temperature box in the center of the panel should be green, indicating that the CCD camera is adequately cooled. (Allow 10 to 15 minutes for the camera to reach the proper temperature.) The Temperature box changes from red to green when the CCD camera has reached the proper operating temperature.

3. Place the sample to be imaged in the center of the stage in the imaging chamber and close the door.

4. Select the Fluorescent check box.

5. Make a selection from the Field of View drop-down menu on the left side of the Control Panel.

6. Enter the approximate (0.5 cm) Subject Height (height) in the lower left entry box (or focus manually).

7. Select the Emission Filter and Excitation Filter. If the Filter Lock box is checked, select the excitation or emission filter of interest. Select only one, as the other filter will be selected automatically.

8. Select High or Low from the Fluor Lamp Level drop-down menu. High is the recommended setting.

9. Set the Exposure Time, Binning, and F/Stop.
   Fluorescence is generally brighter than bioluminescence, so the exposure time is shorter and F/Stop higher (smaller lens opening). Typical fluorescence image camera settings might be 1 sec exposure time, Binning = Medium, and F/Stop = 2.

10. Click Acquire.
    After the exposure is completed, the overlay image is displayed.

   **NOTE:** During the fluorescent image acquisition, the Acquire button becomes a Stop button, which can be used to terminate the exposure if necessary.

11. To save the data, select Living Image ➞ Save Living Image Data from the main menu bar.
    This completes the data acquisition. To obtain additional images, repeat the process, beginning with step 3.
    The image window that displays the fluorescent image includes annotations specific to fluorescence (including emission filter, excitation filter, and fluorescence level) as well as standard annotations such as exposure time, F/Stop, FOV, and acquisition date/time.

8.6 Troubleshooting

Hardware Problems

If you have difficulty during fluorescent imaging, it may be due to the lack of excitation light. Loss of excitation light can result from either a burned out quartz tungsten halogen lamp or a blown line fuse. The following procedure describes a troubleshooting process for determining the problem. Figure 8.3 on page 59 shows the fluorescence light source module.

1. Verify that the fiber optic cables are not loosened or disconnected from their proper connectors.

2. Adjust "Fluor Light Level" (excitation lamp) to a value of high in the IVIS Acquisition Control Panel.
3. Take a fluorescent image and check for light and fan operation by looking through the fan guard on the rear panel of the light source module. If there is neither, a blown fuse is the probable cause for light loss. See Fuse Replacement below.

4. Observe the operation of the system by selecting "Inspect" in the Fluorescent Lamp Level drop down list. This causes the selected filter to move into place and the lamp to turn on. Open the chamber and visually inspect to see if the excitation light is incident on the sample stage. If no light is detected, try a different filter. If there is still no excitation light on the sample stage, contact PerkinElmer Technical Support (see page 24).

**Fuse Replacement**

---

**WARNING!** DO NOT disconnect or reattach the electrical control cable that connects the fluorescence equipment (excitation filter assembly) to the light source module and IVIS Lumina XRMS Series III (electronics tray) when the power is on. See Figure 8.1 on page 58 and Figure 8.2 on page 59 for photographs of these components. Disconnecting or reconnecting the control cable when the system has electrical power will damage the system. Always turn off the rear-mounted ON/OFF switch on the IVIS Lumina XRMS Series III before making or breaking any of these cable connections.

**WARNING!** The following procedure can expose the user to hazardous voltages unless the electrical power to the fluorescence light source module is completely eliminated. As instructed in the procedure, turn off the lamp from the module front panel ON/OFF switch and remove the electrical power to the module by disconnecting the plug from the surge protector and the back of the module.

---

1. Before starting this procedure, save any important data in Living Image, and then exit the program. Next, turn off the main power at the rear of the Lumina XRMS.

2. Press the light source module ON(1)/OFF(0) switch to the OFF(0) position.

3. Remove AC line cord from the AC power receptacle on the surge protector.

4. Remove the AC line cord from the power entry module on the rear panel of the light source module.

5. Open the fuse holder door.

   The fuse holder is part of the power entry module, and is located directly below where the AC line cord plugs in (Figure 8.11). Use a thin bladed screwdriver or penknife blade if necessary. Be careful not to damage the drawer.
6. Examine the replacement spare fuses and verify that they are the correct rating: Fuse value: 2.0A, 5 x 20, 250V SLOW BLOW.

7. Remove fuse cassette and remove the two blown fuses (Figure 8.11). If only one is blown, it may be a good idea to replace both. Place the replacement fuses into the fuse cassette. The fuses will work in either direction.

8. Push the fuse cassette into the fuse holder and shut the fuse door. The door should click shut.

9. Reattach the AC line cord to the power entry module, then to the AC receptacle on the surge protector.

10. Return the ON/OFF switch to the ON(1) position (the red indicator will be visible on the switch).

11. Turn on the main power switch at the rear of the IVIS Lumina XRMS Series III and start the Living Image software.

**NOTE:** The power switch on the back of the light source module (Figure 8.11) must be in the ON position in order for Living Image software to control lamp functions.

12. Resume normal operation.

**Lamp Replacement**

Contact PerkinElmer Technical Service (see page 24) for lamp replacement. Replacing the lamp requires re-calibration of the IVIS Lumina XRMS Series III. The procedure also requires removing the lamp module cover, which potentially exposes the user to hazardous voltages. Removing the lamp module cover will void the warranty.
8.7 Care and Maintenance of the Fluorescence Equipment

Cleaning the Fluorescence Light Source Module

If necessary, wipe the exterior surfaces of the light source module with a soft cloth.

**WARNING!** DO NOT use fluids to clean the exterior or interior of the IVIS Lumina XRMS Series III. Do not allow fluids of any kind to enter the light source module under any circumstances. Sprays and liquids that come into contact with the light source module or the instrument may result in damage to the system or electrocution.

If the fluorescence light source module requires more aggressive cleaning or sterilization, contact PerkinElmer Technical Support (see page 24).

Cleaning the IVIS Lumina XRMS Series III and Fluorescence Equipment

**WARNING!** DO NOT use fluids or moistened towels to clean any part of the IVIS Lumina XRMS Series III where electrical or fiber optic cables make connections. Do not use fluids of any kind in the vicinity of the Excitation Filter Wheel Assembly (mounted on the rear of the imaging chamber). Turn off electrical power to the instrument before engaging in cleaning operations using fluids. The Imaging Chamber power switch is located in the rear on the electronics tray.

See *Cleaning the IVIS Lumina XRMS Series III* on page 69 for instructions on cleaning the imaging chamber.

Cleaning the Optical Components and Filter Replacement

Contact PerkinElmer Technical Support for information about cleaning or sterilizing any of the optical components or the optical filter replacement (see page 24).
9 Care and Maintenance

Surveying the IVIS Lumina XRMS Series III for Radiation Leakage

Maintenance and Safety Checks

Cleaning the IVIS Lumina XRMS Series III on page 69

Cleaning the Scintillation Plate Window and Holder on page 70

9.1 Surveying the IVIS Lumina XRMS Series III for Radiation Leakage

PerkinElmer recommends, and some local government agencies may require, an X-ray leakage safety test be performed:

- Every 12 months.
- When the system is installed at a new site, unless the instrument was moved using the XWS-260 workbench and no abnormal mechanical shocks occurred.
- After PerkinElmer performs maintenance or service.
- After any abnormal condition that could impair any of the safety systems. For example, the light box door becomes difficult to open or close.

Conducting the X-Ray Radiation Survey

A radiation leakage test is complex and requires sensitive equipment. Some states or localities may require special training and certification to perform the test. Contact PerkinElmer Technical Support (see page 24) for information regarding these tests or for scheduling a PerkinElmer representative to conduct the survey as part of an overall safety check.

9.2 Maintenance and Safety Checks

Daily Safety Checks

The following safety checks should be performed on a *daily* basis.

1. Verify that the door interlock in good repair (see *Door Operation* on page 48).
2. Verify that the key switch functions properly.
3. Verify that the "X-Ray On" red indicator lights are functioning properly when the X-ray modality is used. The lights are located:
   - On the lower electronics panel.
   - In the camera cover.
   - On the rear of the instrument (only visible from the rear of the instrument and is intended to warn service personnel).
4. Verify that the amber "X-ray armed" indicator is working.
5. Light leak check described in *Table 10.1* on page 76.
Weekly Safety Checks

The following safety checks should be performed on a weekly basis.

1. All checks performed on a daily basis.
2. Inspect all screws holding the door shield and make sure that none are loose.
3. Inspect the metal knife edges on the door and the light box for damage such as bending. The knife edges keep X-rays in the light box and prevent light from entering.

Monthly Safety Checks

The following safety checks should be performed every month.

1. All safety checks performed on a daily basis.
2. All safety checks performed on a weekly basis.
3. Activate the "X-Ray Emergency Off" switch to verify operation.
   All indication of X-ray generation should cease when the switch is pushed in.

   NOTE: X-rays will need to be generated when performing this test.

4. Reset the X-Ray Emergency Off switch by turning the red knob clockwise.
   The knob should pop out.
5. Re-arm the X-ray source and restart X-ray generation from the Living Image software.

Annual Safety Checks

Perform the following safety checks every 12 months.

- All safety checks performed on a daily, weekly, and monthly basis.
- A full radiation survey performed by a qualified person.

9.3 Cleaning the IVIS Lumina XRMS Series III

The compounds shown in Table 9.1 do not damage the internal finish of the IVIS Lumina XRMS Series III imaging chamber and are suitable for use as cleaners, if required. Do not use any solution not included in this list. In particular, avoid strong bases, bleach, or acids that may potentially damage the unit and compromise its operation.

IMPORTANT: Do not spray cleaning solutions in the imaging chamber.

Table 9.1 Acceptable Cleaning Solutions for the IVIS Lumina XRMS Series III Imaging Chamber

<table>
<thead>
<tr>
<th>Cleaning Solution</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cidexplus® Solution (3.4% glutaraldehyde)</td>
<td>Johnson and Johnson Medical</td>
</tr>
<tr>
<td>Sporicidin® Sterilizing Solution (1.56% phenol)</td>
<td>Sporicidin International</td>
</tr>
<tr>
<td>Clidox-s® Disinfectant</td>
<td>Pharmacal Research Laboratories, Inc.</td>
</tr>
</tbody>
</table>
It is recommended to use a lint-free wipe, such as Scott Pure® wipe or a Kaydry EX-L® wipe to minimize the presence of particulate matter in the imaging chamber. After saturating a lint-free wipe, clean the internal surfaces using a gentle circular motion. Use extra care when cleaning the radiolucent insert since it is a delicate assembly. Do not pour or spray the solution directly onto internal surfaces, especially the garage housing the scintillation sensor assembly. Rinse surfaces using a wipe saturated with sterile deionized water. Do not allow puddles of water to remain on the surfaces. To avoid any phosphorescence from the cleaner, be sure that the surfaces are dry before using the imaging chamber. Be careful not to smudge the camera lens and optical filters.

The anti-reflective coated glass window on the scintillation module may be cleaned using an Optical Cleaning solution (PerkinElmer PN 123495) and lint-free wipes (PerkinElmer PN 123740). Extreme care should be exercised because the window is very thin and fragile.

Consider dedicating an IVIS Lumina XRMS Series III for immunodeficient animals to remove the risk of cross-contamination.

### 9.4 Cleaning the Scintillation Plate Window and Holder

The scintillation plate is protected by a glass window with anti-reflection coating. This window may be cleaned using the optical cleaner and soft absorbent wipes provided in the Scintillation Plate Maintenance Kit. Window cleaning may be accomplished without removing the scintillation plate holder, but rotating it to the center of the stage enables access. Plate rotation is performed using the service utility in the Living Image control panel. No tools are required for simple window cleaning other than the optical cleaner and soft wipes.

1. Optional: Disconnect the manifold gas hose at the right side of the stage and move the manifold out of the way. The gas tube can be removed either from the barbed fitting on the stage or from the right hand barbed elbow on the manifold (Figure 9.1). This may make it more convenient to clean the plate holder.

### Table 9.1 Acceptable Cleaning Solutions for the IVIS Lumina XRMS Series III Imaging Chamber (continued)

<table>
<thead>
<tr>
<th>Cleaning Solution</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>70% methyl alcohol/30% deionized water solution</td>
<td></td>
</tr>
<tr>
<td>70% ethyl alcohol/30% deionized water solution</td>
<td></td>
</tr>
<tr>
<td>3 - 5% bleach (in deionized water)</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** PerkinElmer makes no claims as to the sterility of the IVIS Lumina XRMS Series III imaging chamber after using the solutions in Table 9.1. Please refer to the manufacturer’s literature for information as to the applicability of the compound for the organism of interest.
2. Using the Living Image software service software commands, move the scintillation plate to the center of the stage (Figure 9.2).

3. Wet a small portion of the soft, lint-free wipe (PerkinElmer part no. 126291) with the optical cleaner (PerkinElmer part no. 123495) (Figure 9.3).
4. Starting at the middle of the plate, wipe the window surface using a gentle circular motion to remove dirt or smudges (Figure 9.4).

5. To clean the bottom surface of the scintillation plate holder, soak a soft wipe in ethyl alcohol and rub the underside of the holder. It may be convenient to use a foam paint applicator to support the alcohol-soaked wipe (Figure 9.5). Support the applicator with the wipe as shown in Figure 9.5 to prevent bending the plate holder.

A solution of 3 to 5% bleach may be used on the underside of the plate holder if care is used not to get it on the AR-coated window.
**NOTE:** If this method does not completely clean the plate holder, it may be necessary to remove the plate holder from the drive mechanism for cleaning. See Appendix C, *Scintillation Plate Holder on page 81* for instructions.
10 Troubleshooting

Measured Temperature Is Not Equal to Demand Temperature
Photographic Image Is Unacceptable on page 75
Luminescent Image Is Unacceptable on page 75
No Image Produced on page 76

10.1 Measured Temperature Is Not Equal to Demand Temperature

At start up, the Living Image® software programs the CCD camera to maintain the CCD at -90° C. If the camera power supply remains on (IVIS Lumina XRMS Series III box), the system maintains this temperature regardless of whether the Living Image software is open or the computer is turned on.

To check the temperature of the CCD, click the Temperature square (red or green) in the control panel in the Living Image software.

Figure 10.1 IVIS Acquisition Control Panel – Living Image Software

Table 10.1 Troubleshooting – Measured Temperature Does Not Equal the Demand Temperature

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured temperature is warmer</td>
<td>Ambient temperature may be too high, camera air vents may be blocked, or system needs service. A problem may exist with the camera.</td>
<td>Verify that the room temperature is within operational limits. Check air vents in the camera head by removing protective cover and inspecting. Contact PerkinElmer Technical Support for assistance (see page 24).</td>
</tr>
<tr>
<td>Something is obstructing the stage.</td>
<td>1. Open the door to the imaging chamber and visually inspect the stage.</td>
<td>2. Remove anything that is physically obstructing the stage. If there is no obstruction and/or the stage still does not move, contact PerkinElmer Technical Support for assistance.</td>
</tr>
</tbody>
</table>
10.2 Photographic Image Is Unacceptable

Photograph imaging parameters are automatically controlled and generally produce a good quality photo. If shiny objects are imaged, creating specular reflections, the automatic algorithm may get confused and produce an underexposed image.

Also, refer to the Living Image Software® Manual for IVIS Lumina XRMS Series III for further details on acquiring images.

Table 10.2 Troubleshooting – Unacceptable Photographic Image

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image is streaked.</td>
<td>Subject moved during the exposure.</td>
<td>Check to see if the subject may have moved. If the subject is not on the sample stage, it is probably on the floor of the imaging chamber. If the subject has moved, locate and re-anesthetize it. If gas anesthesia is being used, confirm that the anesthesia is turned on and the flow rate is appropriate.</td>
</tr>
<tr>
<td>Image is blurry.</td>
<td>Subject height is significantly less than or greater than 1.5 cm.</td>
<td>The focus is set for a sample height of 1.5 cm. Significant deviation from this height results in an out-of-focus photograph.</td>
</tr>
<tr>
<td></td>
<td>Incorrect F/Stop setting.</td>
<td>The F/Stop for photographs should be set to F/Stop 8 or F/Stop 6. An F/Stop smaller than 8 reduces the depth of field in the photograph.</td>
</tr>
<tr>
<td>A white spot appears in the center of the field of view.</td>
<td>An excessively moist environment in the imaging chamber can result in condensation on the CCD window (Figure 10.2.)</td>
<td>Turn off the entire system and remove excess moisture in the imaging chamber. Allow the chamber to thoroughly dry. If the problem persists, contact PerkinElmer Technical Support for assistance (see page 24).</td>
</tr>
</tbody>
</table>

Figure 10.2 Example of Condensation

10.3 Luminescent Image Is Unacceptable

Binning, F/Stop, and exposure time affect the appearance of a luminescent image. Please refer to the Living Image Software Manual for IVIS Lumina XRMS Series III for instructions on setting binning, exposure time, and F/Stop values.

In order to function properly and reduce camera noise, the CCD camera must be cooled to the demand temperature before acquiring an image. If the camera is not cooled to the demand temperature, imaging may result in false positive signals.
10.4 No Image Produced

If no image is produced, there may be an error in the Living Image software, a problem with the physical connections to the camera, or a hardware failure.

1. Close the Living Image® software and restart the computer.
2. Restart the Living Image software and try to acquire an image.
3. If after restarting the computer, you are still unable to produce an image, contact PerkinElmer Technical Support for assistance (see page 24).
Appendix A  XWS-260 Workstation

Shutting Down the Imaging System on page 78
Moving the Imaging System on the XWS-260 Workstation on page 78
Starting the Imaging System on page 78

This appendix explains how to move the IVIS Lumina XRMS Series III configured with the XWS-260 workstation (Figure A.1).

⚠️ **CAUTION:** PerkinElmer recommends that you do not move an IVIS Lumina XRMS Series III that is not located on the XWS-260 workstation. If you need to move an imaging system not on the workstation, contact PerkinElmer Technical Support for assistance (see page 24).

The procedural steps include:

- Shut down the system components and unplug them from the line power.
- Move the workstation with the components.
- Restart the system components after the power is restored.

⚠️ **CAUTION:** The IVIS Lumina XRMS Series III has many cables and lines. It is very important to closely follow all directions to avoid damaging the system components.
A.1 Shutting Down the Imaging System

1. Close the Living Image® software and save any information at the prompt.
2. Return the X-ray ON key selector switch to the OFF position and remove the key.
3. Turn off the IVIS Lumina XRMS Series III imaging chamber.
4. Turn off the computer using the standard Windows® shut down procedure.
5. Turn off the power to the other system components and power surge protection devices.
6. Unplug the devices from the wall.

If you have any problems during the shut down procedure, please contact PerkinElmer Technical Support for assistance (see page 24).

**NOTE:** The Emergency OFF switch is not intended as a main X-ray source control and should not be used to turn the X-ray function ON or OFF on a routine basis. It should only be used in the unlikely situation where the X-ray source must be immediately turned OFF. Under normal circumstances, it should be left in the ON position and left as is.

A.2 Moving the Imaging System on the XWS-260 Workstation

1. Unlock the wheels on the XWS-260 workstation and carefully roll the workstation to the new location.

**CAUTION:** When moving the imaging system on the XWS-260 workstation, be sure to grasp and push the workstation from as low as comfortably possible. PerkinElmer recommends having two people present during any major move to minimize the risk of damage to the imaging system. If the IVIS Lumina XRMS Series III is damaged during movement, PerkinElmer cannot be held responsible and any warranty will be voided.

2. Lock the wheels when you are finished moving the workstation. Verify that the power outlets at the new location meet the power requirements for the system. See Chapter 6 on page 36 for equipment power requirements.

A.3 Starting the Imaging System

1. Plug the devices into the wall sockets in the new location.
2. Turn on the power surge protection devices.
3. Turn on the computer and monitor.
4. Turn on the IVIS Lumina XRMS Series III imaging chamber (the power switch is located on the back of the unit) and verify that the other components such as the camera power supply, X-ray controller (both on the back of the unit), and fluorescence lamp are also turned to the On position.
5. Start the Living Image® software after the desktop screen is displayed.
6. Enter a User ID (up to three letters) when prompted, then click **Done**.
7. To initialize the system, click **Initialize IVIS System** in the IVIS Acquisition Control panel (Figure A.2).
8. Allow the system to initialize.
   You will hear the motors move. The System Status box displays the current changes. The temperature square in the IVIS Acquisition Control Panel is red at startup and turns green when the operating temperature is reached. The control panel displays the current temperature (Figure A.2).
   The instrument is ready for operation after the temperature is locked at -90°C, as indicated by the green light in the control panel (Figure A.2. For operating instructions, see the Living Image® Software Manual for IVIS Lumina XRMS Series III.)

9. To use the X-ray modality:
   a. Verify that the Emergency OFF switch is in the ON position.
   b. Turn the key selector switch to the ON position.
   c. Confirm that the amber arming switch has been pushed and the light is ON.
   d. Verify that the X-ray source is armed.
   e. Use the IVIS Acquisition Control Panel in the Living Imaging software to turn on the X-ray source during an imaging sequence or session.
### Table B.1 Optional Equipment and Accessories for IVIS Lumina XRMS Series III

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>XBP-24 Black Paper (1 tablet of 24 sheets)</td>
<td>117837</td>
</tr>
<tr>
<td>XLS-4 Calibrated Light Source</td>
<td>118897</td>
</tr>
<tr>
<td>XGI-8 Anesthesia System, 120V</td>
<td>118918</td>
</tr>
<tr>
<td>XGI-8 Anesthesia System, 230V</td>
<td>118919</td>
</tr>
<tr>
<td>XGI-8 Anesthesia System, 100V</td>
<td>118957</td>
</tr>
<tr>
<td>Kit, 3 Port Manifold, X-Ray Compatible, plus Accessories</td>
<td>125698</td>
</tr>
<tr>
<td>XRH-2 Reflective Hemisphere</td>
<td>118937</td>
</tr>
<tr>
<td>XPP-1 Plate Positioner</td>
<td>118949</td>
</tr>
<tr>
<td>XPM-2 Bioluminescent Phantom Mouse</td>
<td>118993</td>
</tr>
<tr>
<td>XFM-2 Fluorescent Phantom Mouse</td>
<td>121365</td>
</tr>
<tr>
<td>XAF-8 Anesthesia System Filters</td>
<td>118999</td>
</tr>
<tr>
<td>XFM-1 Low Fluorescence Mat, set of 10</td>
<td>119000</td>
</tr>
<tr>
<td>XNC-2 Mouse Nose Cones, set of 10</td>
<td>119001</td>
</tr>
<tr>
<td>XRS-10 Rubber Stoppers for Anesthesia Manifold</td>
<td>119006</td>
</tr>
<tr>
<td>XWS-260 Workbench</td>
<td>123325</td>
</tr>
<tr>
<td>XWS-248 Workbench</td>
<td>123326</td>
</tr>
<tr>
<td>XWS-272 Workbench</td>
<td>126138</td>
</tr>
<tr>
<td>Optical Lens Cleaner</td>
<td>123495</td>
</tr>
<tr>
<td>Wipe, Lint Free (50/pk)</td>
<td>126291</td>
</tr>
<tr>
<td>FOV Targeting Mat (each)</td>
<td>121313</td>
</tr>
<tr>
<td>Looped T-handle Hex Key</td>
<td>CLS138501</td>
</tr>
<tr>
<td>Scintillation Maintenance Kit</td>
<td>126373</td>
</tr>
</tbody>
</table>
Appendix C   Scintillation Plate Holder

Removing the Scintillation Plate Holder
Replacing the Scintillation Plate Holder on page 83

There may be occasions when the scintillation plate holder has to be removed for replacement or for a more thorough cleaning than can be accomplished in situ. This appendix explains how to remove the holder.

For this procedure, you will need the 9/64” Hex screw driver from the Scintillation Maintenance Kit (PN 126373) or a looped T-handle Hex key (CLS138501) that was provided with the IVIS Lumina XRMS Series III Imaging System. This kit also contains some additional screws in case some are lost when conducting this procedure. If screws are lost inside the imaging chamber, you should try to recover them to prevent damage to the mechanisms under the stage.

C.1 Removing the Scintillation Plate Holder

1. Close the Living Image® software and turn off the power to the IVIS Lumina XRMS Series III at the main power switch that is located at the rear of the instrument near the power cord.
2. Disconnect the manifold gas hose on the right hand side of the stage and move the manifold out of the way. The gas hose can be removed from the barbed fitting on the stage or from the right hand barbed elbow on the manifold (Figure C.1).

Figure C.1   Gas Manifold Connections

Gas tubing connected at the barbed fitting on stage  Gas tubing connected at the right-hand elbow on the gas manifold  Manifold gas hose disconnected from the right-hand elbow
3. Move the scintillation plate holder out from under the scintillator cover by horizontally rotating the plate holder 90 degrees counter-clockwise.

4. To remove the scintillation plate holder:
   a. Remove the 9/16" Hex screw (Figure C.2).
      Two pins will hold the scintillator in position after the Hex screw is removed.
   b. Pull the scintillator out.

   ! **CAUTION:** Avoid putting fingerprints on the window. Pull straight forward without bending the plate holder up or down.

   The scintillation plate holder and its window can now be cleaned. See Section 9.4 on page 70 for cleaning instructions.
C.2 Replacing the Scintillation Plate Holder

1. Insert the two pins on the scintillation plate holder into the L-bracket (Figure C.3).
2. Tighten the 9/16” Hex screw.

3. Move the scintillation plate holder under the scintillator cover by horizontally rotating the plate holder 90 degrees clockwise (Figure C.4).

4. Close the imaging chamber door and turn on the power to the Lumina XRMS at the rear main power switch.
5. Re-initialize the instrument through the Living Image® software.
   This moves the plate holder to the home position by locating the limit sensors.
Index

A
accessories 80
acquiring fluorescent images 63–64
anesthesia
  gas plumbing 46

B
bandpass filter 62
black paper 54
burn hazard 9

C
camera noise 76
CCD camera 37
centering a subject 54
chemical & biological safety 10
cleaning
  imaging system 5
cleaning the system 69–70
computer 43
  specifications 44
color monitor
  specifications 44
cover 10

D
door operation 48

E
electrical power 57
electrical safety 8
emission filter
  transmission curve 62
emission filter wheel 61
emission fluorophore spectra 62
environmental considerations
  heat 5
  water and moisture 5
environmental requirements 44
excitation
  filter transmission curve 62
  filter wheel 60, 61
  fluorophore spectra 62
eye and burn hazard 9

F
filter lock 63
filter replacement 67
filter spectra 62
fluorescence equipment
  See Fluorescence Module.
fluorescence module
installation requirements 57
  system components 58
fluorescent imaging 63–64
fuse 57
fuse replacement 65–66

G
gas plumbing 46
  glowing materials 55

H
hardware problems 64
hazardous voltage symbol 3
hazards 9
heat safety 5
humidity 57

I
imaging chamber 41–42
  door 48
  stage curtain 48
imaging system
  cleaning 5
  servicing 7
installation requirements 57
IVIS Acquisition Control panel 63

L
lamp 57
lamp replacement 66
light block 60
Light Source Module 59
  dimensions 58
  weight 58
lightning 6
Living Image software 60
Lumina options and accessories 80
luminescent image unacceptable 75

M
maintenance & safety checks 68–69
manual information 3
mechanical safety 9
modules 10
moving the system 77–79

N
no image produced 76

O
optic specifications 42
optical density 63
optical filter wheel 42
options 80
other equipment 7

P
panels 10
photographic image unacceptable 75
power cord 6
power line surges 6
power outage
  restarting the system 46
power outages 6
power overloading 7
power sources 6

R
radiation
  survey for leakage 68
replace
  filter 67
  fuse 65–66
  lamp 66
requirements
  installation 57
  voltage 57
restarting after power outage 46

S
safety
  chemical & biological 10
  electrical 8
  electrical safety 8
  eye hazard 9
  mechanical 9
  panels, cover, and modules 10
safety instructions 2–7
safety symbols
  hazardous voltage 3
  X-ray warning 3
  X-ray warning (Canada) 3
scintillation module 39
scintillation plate 49
scintillation plate
  lower position 54
  upper position 52
scintillation plate
  lower position 52
  upper position 49
servicing 7
servicing the equipment 8
shut down procedure 55
specifications
  computer 44
  computer monitor 44
electrical power 57
environmental 57
fuse 57
humidity 57
imaging chamber 42
lamp 57
optics 42
temperature 57
stage curtain 48
start up 78–79
  restarting after power outage 46
subject placement 54

system
  cleaning 69–70
  environmental requirements 44
  moving with XWS-260 workstation 77–79
  restarting after power outage 46
  shut down 55
  start up 78–79
system components
  Fluorescence Module 58
  X-ray system 37–39

temperature 57
  measured unequal to demand 74
troubleshooting
  camera noise 76
  measured and demand unequal 74
  no image produced 76
  unacceptable luminescent image 75
  unacceptable photographic image 75

ventilation requirements 57
voltage requirements 57

water and moisture safety 5

X-ray
  hazard regulations 4
  safety symbol 3
  safety symbol (Canada) 3
  system & components 37–39
  system control panel 40
X-ray modality 46, 79
XWS-260 workstation 77–79