

# XRS3

20V X-RAY GENERATOR

OPERATOR'S MANUAL



MARCH 2018

	PAGE
<b>1.0 INTRODUCTION</b>	2
<b>2.0 WARNINGS</b>	2
DUTY CYCLE	2
STORAGE	2
<b>3.0 PHYSICAL DESCRIPTION</b>	3
HIGH VOLTAGE PULSER/TUBEHEAD	3
BASE	3
BATTERY PACK	3
BATTERY CHARGER	3
<b>3.5 CONTROL MODULE</b>	4
CABLE CONNECTOR DIAGRAM	5
<b>4.0 DESCRIPTION OF OPERATION</b>	6
BLOCK DIAGRAM	6
<b>5.0 OPERATING INSTRUCTIONS</b>	7
OPERATING PRECAUTIONS	8
EXCLUSION ZONE	8
PULSE SETTINGS	8
<b>6.0 NAVIGATING THE MENU</b>	9
<b>7.0 MAINTENANCE</b>	11
DOSE MEASUREMENT	11
TUBE REPLACEMENT	11
<b>8.0 TROUBLE-SHOOTING</b>	11
<b>9.0 INSTRUCTIONS FOR SERVICE</b>	12
REMOVING BOARDS	12
BOARD INSTALLATION	12
HEAD REPLACEMENT	12
BATTERY DISPOSAL	13
<b>10.0 WARRANTY</b>	13
INSTRUCTIONS TO RETURN FOR SERVICE AND MAINTENANCE	13
<b>11.0 SPECIFICATIONS</b>	14
PHYSICAL DIMENSIONS	14
X-RAY OUTPUT	14
ELECTRICAL & THERMAL CHARACTERISTICS	14
<b>12.0 SPARE PARTS</b>	14

## 1.0 INTRODUCTION

**The XRS3 produces high levels of radiation and must be operated by qualified personnel who have read the WARNINGS and OPERATING INSTRUCTIONS sections of the manual before operating the device.**

The XRS3 is a small, lightweight X-ray generator that operates on its own removable battery pack. The XRS3 is a pulsed X-ray device that produces X-ray pulses of very short duration (25 nanoseconds). It produces a relatively low dose rate comparable to a 0.25 ma constant potential machine. The energy produced by the XRS3 is up to 270kVp, which makes it possible to radiograph up to one (1) inch (2.54 cm) of steel.

XRS3 standard accessories are two keys, two battery packs, and one battery charger. Remote cable and carrying case are also common accessories.

## 2.0 WARNINGS

The XRS3 is a pulsed X-ray generator that emits hazardous ionizing radiation when pulsing. The XRS3 should only be **operated** by **authorized personnel** who are properly trained to safely operate the generator. The XRS3 must be **registered** with proper authorities prior to use and should **not** be used to intentionally expose humans.

Develop and closely follow a safe operating system for using the XRS3. The safe operating system must ensure that no one is exposed to radiation above the permissible limits which are 2 mR (0.02 mSv) per hour for a member of the public. ***The safe operating system must ensure the XRS3 is used within federal and state guidelines.***

All operators and users of the XRS3 X-ray machine must wear a personal radiation monitoring device, such as a TLD (thermoluminescent dosimeter), film badge, and/or a pocket dosimeter **consistent with the appropriate federal, territorial or provincial standards** (note: an electronic dosimeter will not detect the XRS3 radiation pulses).

Due to the short pulse width of the XRS3, survey meters of the Geiger-Mueller and scintillator type do not accurately detect the radiation emitted from the x-ray source.

***Survey meters should be of the ionization type and should be used in the integration mode.*** Survey meters must not be used in the rate mode because the XRS3 does not produce constant radiation. The XRS3 produces very high rates of radiation for very short periods of time resulting in either unrealistically high readings or no readings for a survey meter in rate mode.

**The XRS3 has no explosion proof rating and should not be used in an explosive atmosphere. The Spark Gap is vented to the air and could be a source of ignition.**

**DUTY CYCLE WARNING.** *The XRS3 is a light duty machine that is not made to pulse continuously.* The maximum duty cycle for the XRS3 is 200 pulses every four minutes (3000 pulses per hour). Exceeding the duty cycle will shorten the life of the tube and head. In temperatures above 90 °F (32.22 °C) or continual use, rest 30 seconds after every 50 pulses and 4 minutes after every 200 pulses.

**STORAGE & USE:** Store and use the XRS3 in upright position. Upside down storage or use may cause premature failure including no output dose.

### 3.0 PHYSICAL DESCRIPTION

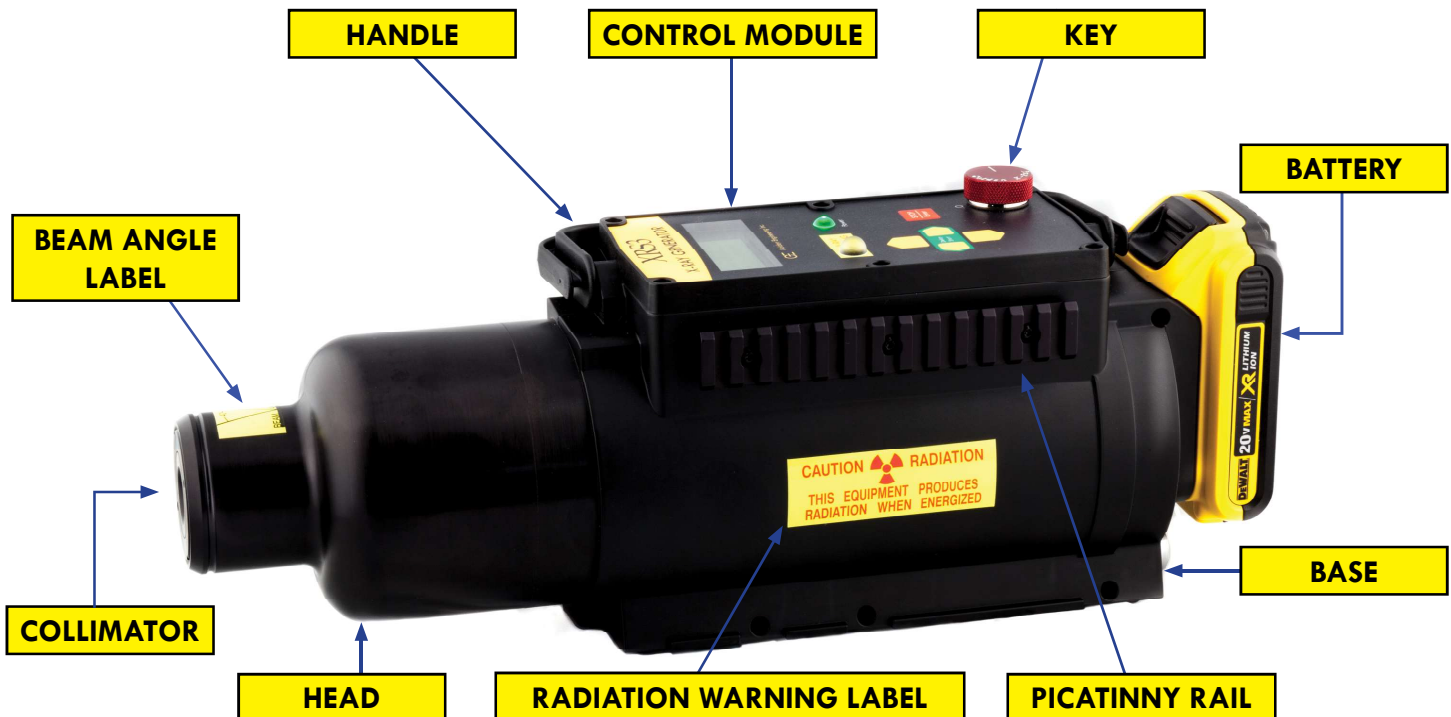


Figure 1: XRS3 X-ray Unit

**HIGH VOLTAGE PULSER/TUBEHEAD.** The main body of the XRS3 is the tube head which contains the tube cavity, cold cathode type X-ray tube, spark gap, high voltage capacitor, and transformer. The standard collimator located on the front of the head limits the X-ray beam to 40 degrees. Special order collimators up to 85 degrees are available.

**BASE.** The base of the XRS3 contains an identification label and a 1/4-20 brass insert compatible with standard camera tripods. The base also accommodates a quick release external tripod mount. The identification label located on the bottom of the generator lists the manufacturer's name and address, model number, serial number, weight, volt, amp, and production date.

**BATTERY PACK.** The standard battery pack is a DeWalt® 20V 2 amp hour Li Ion battery (DCB203).

**BATTERY CHARGER:** The standard battery charger is the DeWalt® DCB107 110V charger or DCB105 220V charger. (Note DeWalt part numbers may change). Battery charge time is less than one hour. See battery charger manual for additional instructions and warnings.



**PICATINNY RAIL:** The XRS3 has a 21 mm picatinny rail located on each side of the housing.

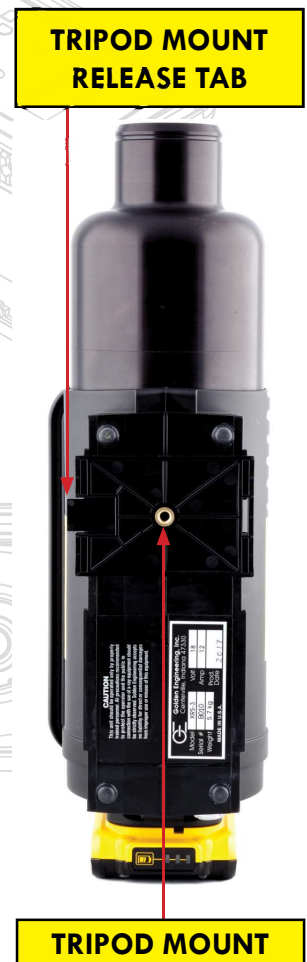


Figure 2: Base





Figure 3: Control Module

**POWER ON LIGHT:** Illuminates when battery voltage is applied to control module.

**RED X-RAY PULSING LIGHT:** Blinks after time delay button or remote cable button is pressed to warn that the XRS3 is going to pulse. The light stays on continuously while the XRS3 is pulsing. This is a failsafe warning light. If the light does not work the X-ray unit will not pulse. See settings menu for fail safe override in emergency situations.

**LIQUID CRYSTAL DISPLAY (LCD):** 80 digit LCD. Home displays number of pulses selected and delay time before the first pulse. Home will also indicate if multiple pulse trains have been entered. Arrows allow operator to scroll through various menu options.

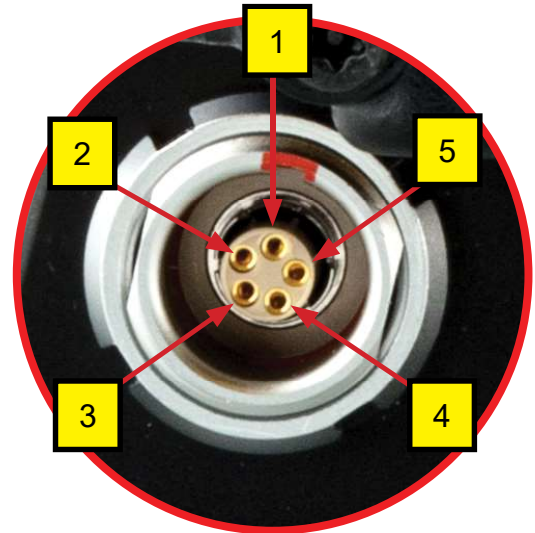
**DIRECTIONAL BUTTONS:** Used to maneuver through the menu.

**DELAY SWITCH:** Left and Right arrow buttons pressed simultaneously Initiates the delay mode.

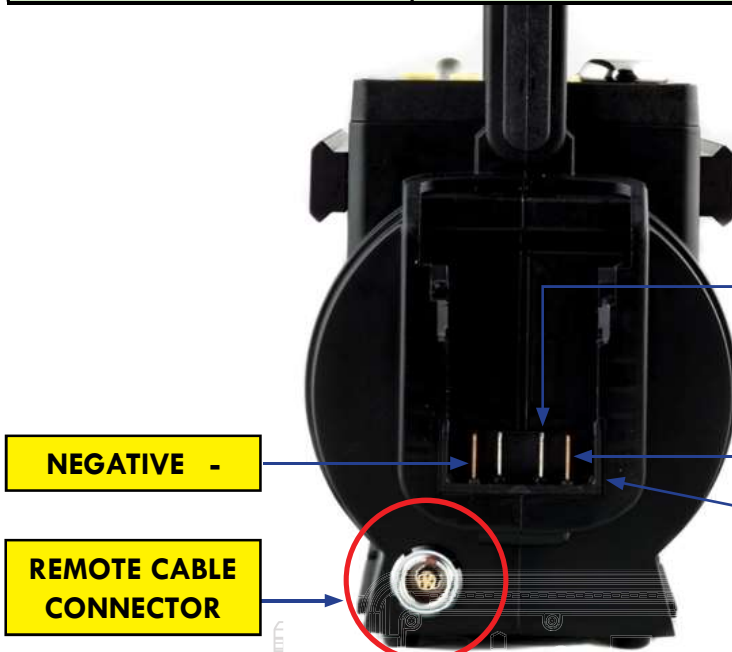
**EMERGENCY STOP/ENTER SWITCH:** Stops the unit before it begins pulsing or stops the unit in the middle of a pulse train. Also used as the enter button to select desired option.

**CABLE CONNECTOR:** Lemo “K” series five pin connector located on the back of the control module beneath the battery receives the remote cable or imaging system cable.

PIN #	DESCRIPTION
1	+5 VOLTS 100 ma MAXIMUM
2	REMOTE SWITCH
3	REMOTE SWITCH - NO DELAY
4	X-RAY ON SIGNAL
5	COMMON 0 VOLTS



REMOTE CABLE CONNECTOR



NEGATIVE -

REMOTE CABLE  
CONNECTOR

TEMPERATURE  
SENSOR

POSITIVE +

BATTERY  
TERMINAL  
BLOCK

REMOTE CONNECTOR: LEMO EEG.0K.305.CLN  
MATING CABLE PLUG: LEMO FGG.305.CYCC50Z

PIN 2

PIN 5

Remote switch inputs are activated when grounded.

## 4.0 DESCRIPTION OF OPERATION

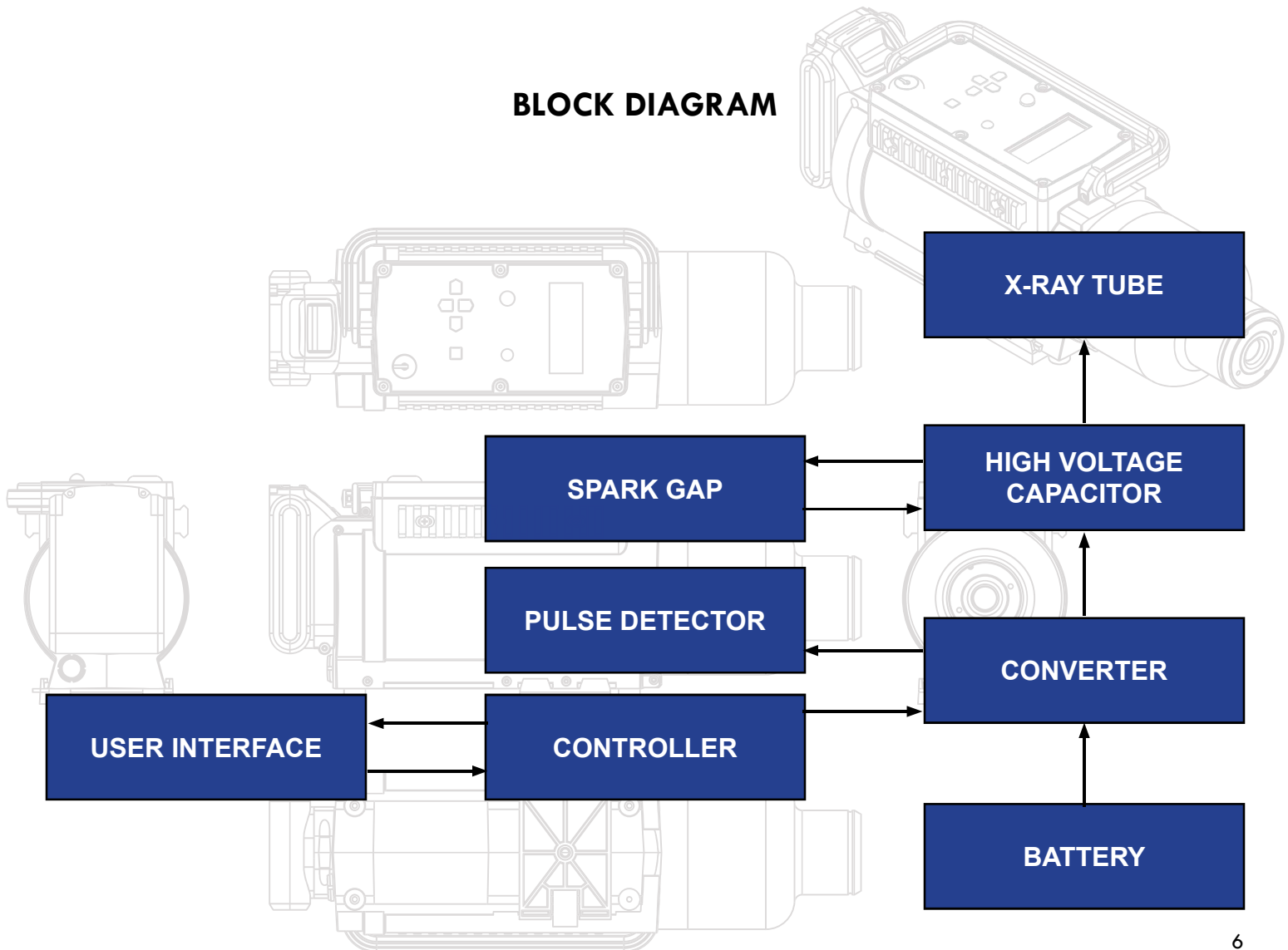
The block diagram below illustrates how the XRS3 functions. The following sequence of events takes place each time the XRS3 is fired:

1. User initiates operation of the machine.
2. The control section sends a signal to the converter section to begin oscillating.
3. Once oscillating, the converter section changes the 20 volts DC to 22Khz AC.
4. The transformer charges the High Voltage Capacitor to about 9000 volts.
5. The spark gap arcs after the High Voltage Capacitor reaches proper voltage.
6. The pulse detector signals the control block that the unit has pulsed.
7. As the High Voltage Switch is closed, a high voltage transient of approximately 270,000 volts and 25 nanoseconds in duration is applied across the x-ray tube generating x-rays.

The closing of the High Voltage Switch produces an audible pulsing sound. **The XRS3 cannot produce x-rays without the pulsing sound so it serves as an additional warning the XRS3 is functioning.**

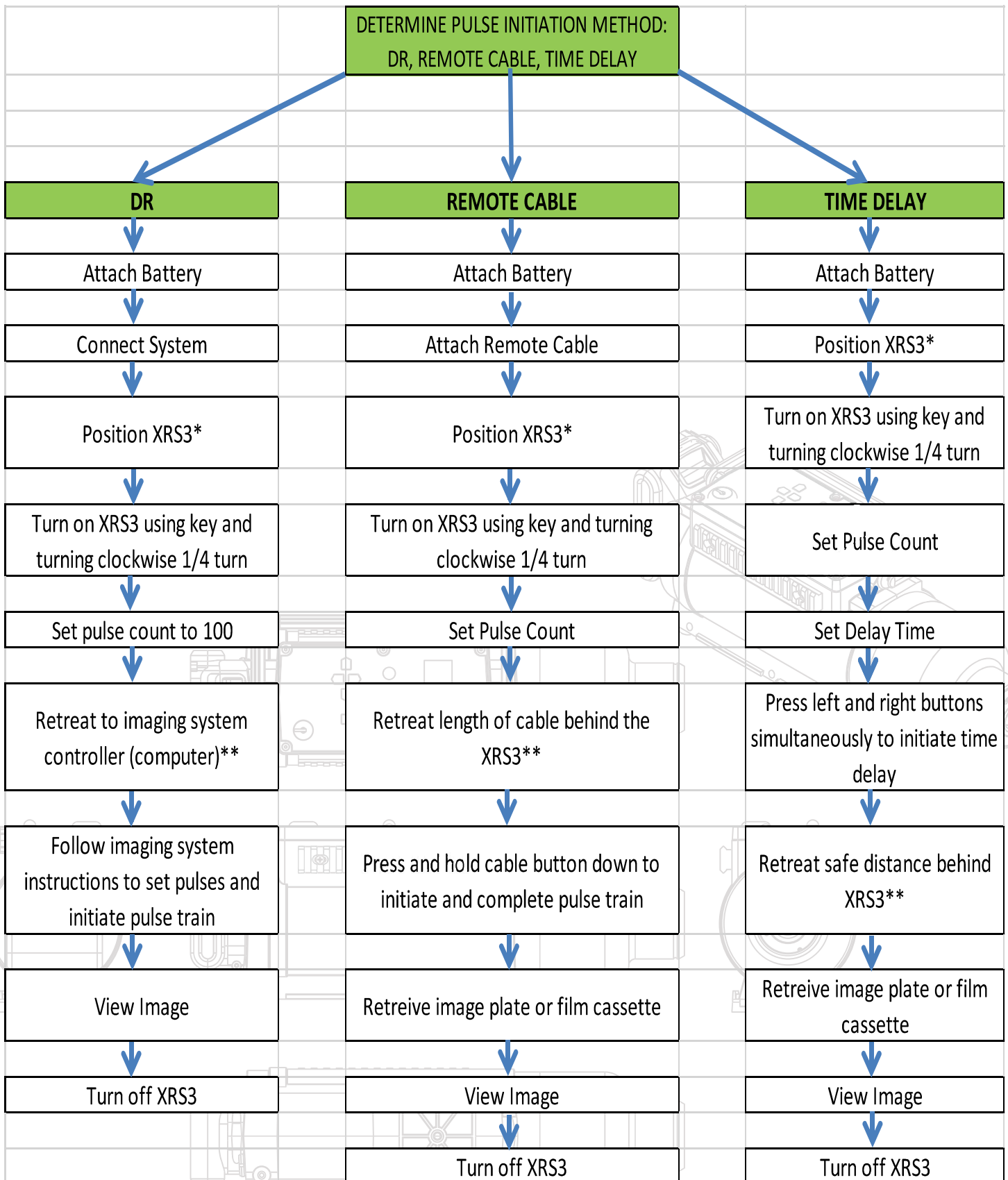
This unit generates X-rays through high voltage bombardment of a tungsten target. **The XRS3 does not contain radioactive materials.** All the high voltage is contained within the aluminum canister and as long as the canister is not punctured the operator is not exposed to dangerous voltages.

### BLOCK DIAGRAM



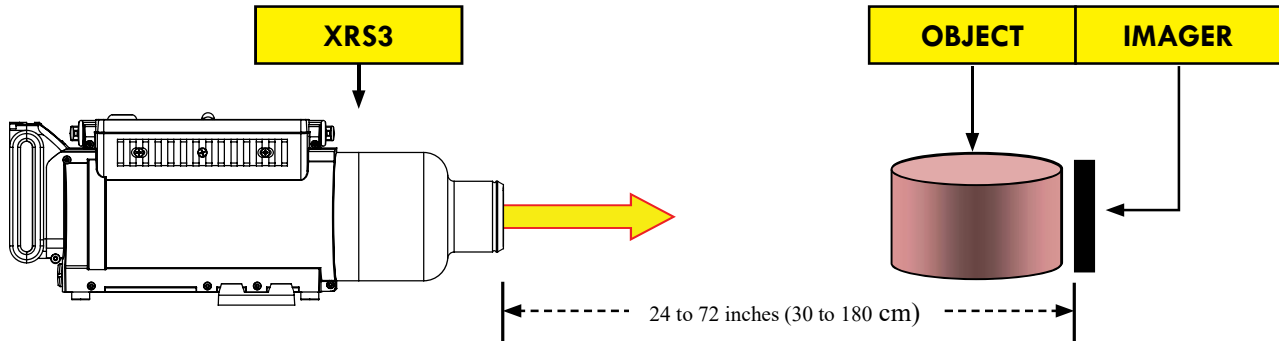
## 5.0 OPERATING INSTRUCTIONS

The following are basic operation instructions to take an X-ray image using the XRS3. Certain applications may require modifications to these basic procedures.





\*XRS3 should be positioned directly in front of the object to be X-rayed and the imager placed directly behind the object to be X-rayed. Imager should be placed as close to the object as possible. Distance between XRS3 and imager is usually 24 to 72 inches (30 to 180 cm). During operation XR200 should be stabilized on a flat surface, a tripod, or a custom fixture suitable for holding the 11 pound (5 Kg) XRS3.



**OPERATING PRECAUTIONS:** The operator should always stand at least 10 feet (3m) behind the X-ray unit and clear all personnel at least 10 feet (3m) behind the unit or at least 100 feet (30m) from the front of the unit before pulsing. The exclusion zone (below) should be a controlled area free of all personnel while X-ray pulses.

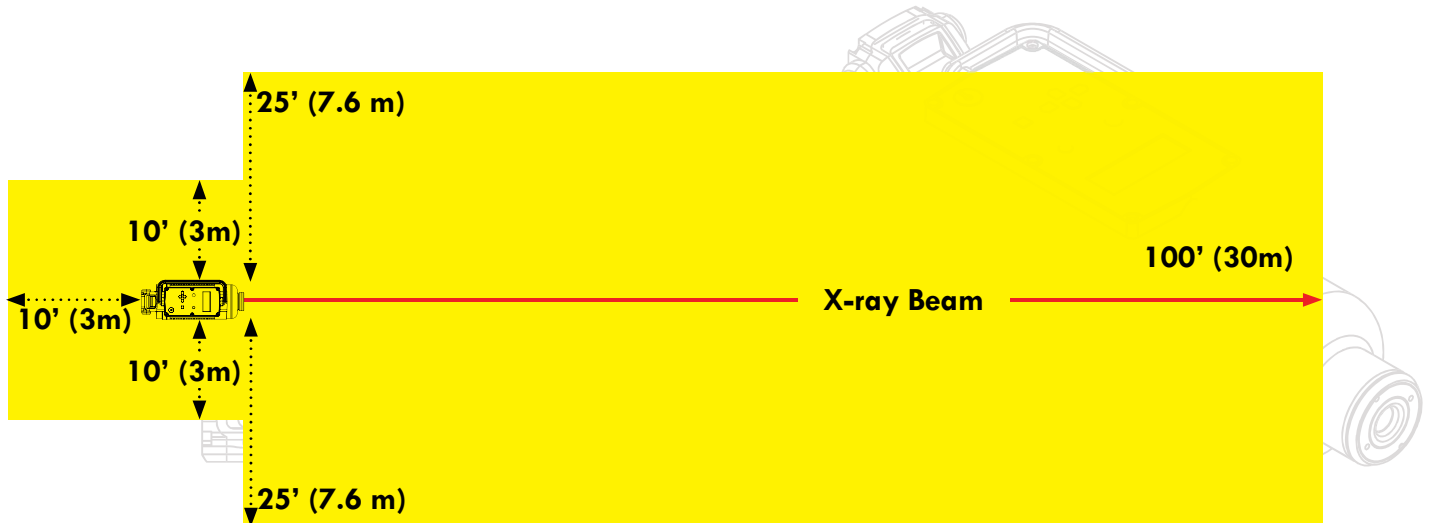


Figure 4: Exclusion Zone

### SUGGESTED PULSE SETTINGS

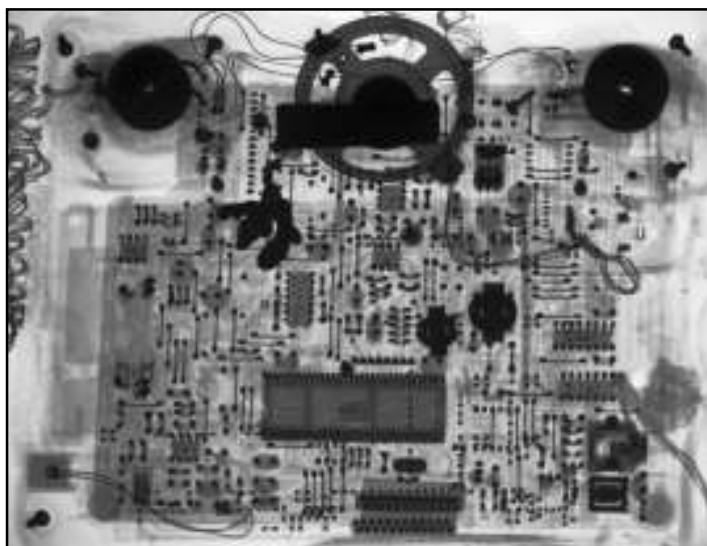
The chart below lists **approximate** pulses necessary to penetrate various materials. Settings vary greatly depending on imaging system used. Refer to imaging system instructions for more information.

MATERIAL	PULSE SETTING (24" BETWEEN X-RAY & IMAGER)
CARDBOARD / LIGHT WOOD / PLASTIC	2-5
LIGHT METAL	10
STEEL 1/4"	25
STEEL 1/2"	50
STEEL 1"	99

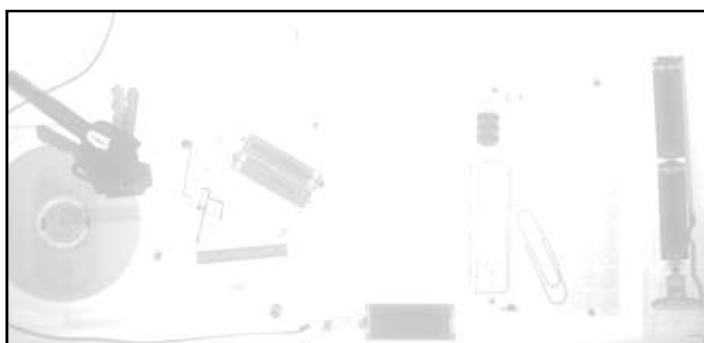
The following is true when using film or digital systems that generate a positive image. If the radiograph is too dark, the film is underexposed. If the radiograph is too light the film is overexposed. **Underexposure** can be corrected by increasing the number of pulses and/or decreasing the distance between the imaging medium and the XRS3. **Overexposure** can be corrected by reducing the number of pulses and/or increasing the distance between the imaging medium and XRS3.



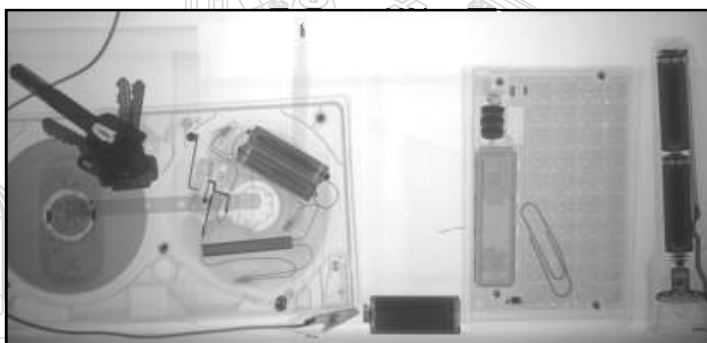
*Underexposed*



*Correct exposures (pulse setting)*



*Overexposed*



*Correct exposures (pulse setting)*

## 6.0 NAVIGATING THE MENU

LCD ERROR MESSAGE	
Low Battery	Battery voltage is too low to pulse the XRS3. Charge the battery.
PWM not running	Could occur at the start of a pulse train or during a pulse train. Power unit off and back on. If error message continues there is a problem with electronics.
Slow Pulsing	More than one second between pulses in a pulse train. Either low battery, problem with transformer, or electronics. Charge battery or replace oscillator board.
No Feedback	Current not detected. No current flow going to the head. Occurs at the beginning of pulse train. Check 20 amp fuse on the oscillator board. If fuse is ok problem could be in head or electronics. Replace board or send back for repair.
Cycle Reached	Displayed if duty cycle is reached (200 pulses in 4 minutes).

>HOME MENU PRESETS  
PULSES: \_\_\_\_  
DELAY: \_\_\_\_

HOME >MENU PRESETS  
SET PULSE LIFE PC  
SET DELAY RESET PC  
TRAINS SETTINGS

HOME - MENU PRESETS  
>SET PULSE SET PULSE COUNT  
SET DELAY \_\_\_\_ PULSES  
TRAINS BACK SAVE

HOME - MENU PRESETS  
SET PULSE SET DELAY TIME  
>SET DELAY \_\_\_\_ SECONDS  
TRAINS BACK SAVE

HOME - MENU PRESETS  
SET PULSE SET PULSE TRAINS  
SET DELAY PULSE TRAINS:  
>TRAINS SECONDS BETWEEN:  
BACK SAVE

HOME - MENU PRESETS  
SET PULSE LIFETIME PULSE COUNT  
SET DELAY \_\_\_\_ PULSES  
TRAINS >LIFE PC  
SETTINGS RESET PC

HOME - MENU PRESETS  
SET PULSE RESETTABLE COUNTERS  
SET DELAY #1: \_\_\_\_ >RESET  
TRAINS #2: \_\_\_\_ RESET  
BACK

HOME - MENU PRESETS  
SET PULSE SETTINGS FEEDBACK  
SET DELAY >BACKLIGHT ON BACKLIGHT OFF  
TRAINS X-RAY INFO BACK

SETTINGS FEEDBACK  
BACKLIGHT >FEEDBACK  
BACK FEEDBACK  
INDIVIDUAL PULSE  
X-RAY ON / X-RAY OFF  
BACK

SETTINGS FEEDBACK  
BACKLIGHT >E-RAY INFO X-RAY INFO  
BACK SOFTWARE SERIAL # HEAD #  
BACK

## To Enter/Save Presets

1. Enter desired settings (Pulse, Delay Time, Pulse Trains) from main menu as shown above
2. Go to Preset Menu
3. Select Preset #
4. Select SAVE

HOME MENU - PRESETS  
>PRESET #1 PRESET #1  
PRESET #2 PULSES: \_\_\_\_ DELAY: \_\_\_\_  
PRESET #3 TRAINS: \_\_\_\_ BTWN: \_\_\_\_  
BACK RECALL >SAVE

## To Recall Presets

1. Go to Preset Menu
2. Select Preset #
3. Select Recall

HOME MENU - PRESETS  
>PRESET #1 PRESET #1  
PRESET #2 PULSES: 50 DELAY: 15  
PRESET #3 TRAINS: 05 BTWN: 45  
BACK >RECALL SAVE

## 7.0 MAINTENANCE

**X-RAY DOSE MEASUREMENT** Using a dosimeter, the average X-ray dose for new tube can be established.

- With the dosimeter located 1 foot from the front of the case and in line with the center of the beam angle label, the reading for 10 pulses should be at least 20 mR to 36 mR.
- The leakage sheet illustrates the X-ray dose and maximum allowable radiation leakage levels for each X-ray unit. A completed copy of this form accompanies each X-ray.

**TUBE REPLACEMENT:** If you have a tube replacement kit refer to instructional disk included with the kit. If you do not have a kit the unit must be sent back to Golden Engineering or an Authorized Distributor for tube replacement. Tube life is approximately 100,000 pulses. Under normal conditions the tube's output will decrease slowly with use. If the tube is broken or the glass cracks the tube output will cease immediately.

## 8.0 TROUBLESHOOTING

SYMPTOM	TEST	ACTION
No "power on" light	-Check battery voltage -Check battery connection	- Replace or charge battery - Make sure battery is securely attached and battery clips are not bent or broken.
Power on lights, X-ray pulsing light does not illuminate, X-ray does not pulse		- Go to settings menu failsafe disable - To fix light replace processor board
X-ray pulses, but no image or black image.	-Test X-ray output.	-Replace the tube.
Unit stops pulsing in the middle of a pulse train and LCD displays 00.	-Check the battery voltage. -Check 15 amp fuse. -Check feedback line connection.	- Charge battery if necessary. - Replace the fuse if blown. - Make sure the screw holding wire to the oscillator board.
Unit makes loud popping noise while pulsing.		- <b>Stop immediately and return for repair.</b>
Oil leaking from unit.		Return for repair.



### INSTRUCTIONS TO REMOVE THE BOARDS AND THE HEAD.

1. Use T10 Torx driver to remove 6 screws holding control module in place.
2. Remove the control module.
3. Remove cable connecting the boards.
4. Control Module Removed



1



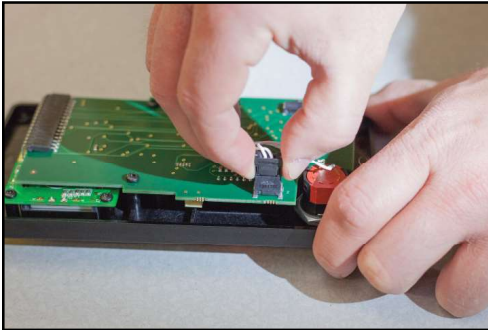
2



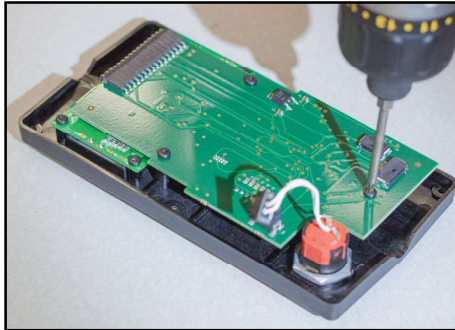
3



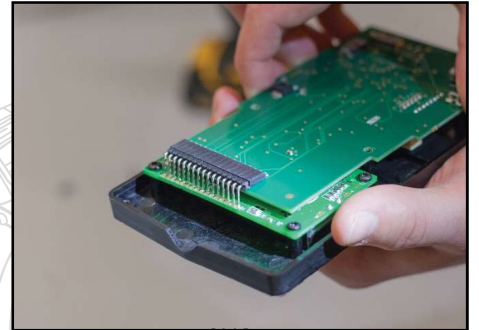
4



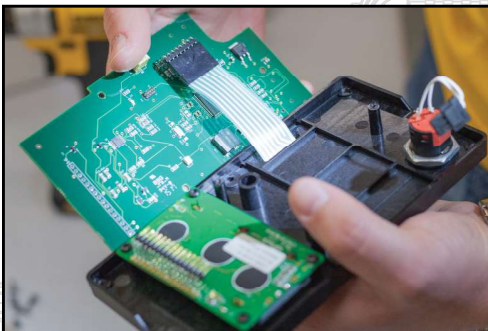
Remove keyswitch connector



Remove 3 screws holding processor board to top



Remove processor board.



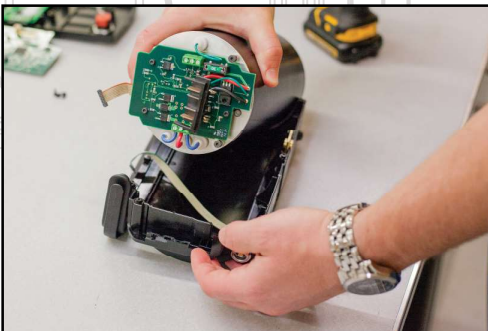
Disconnect ribbon cable.



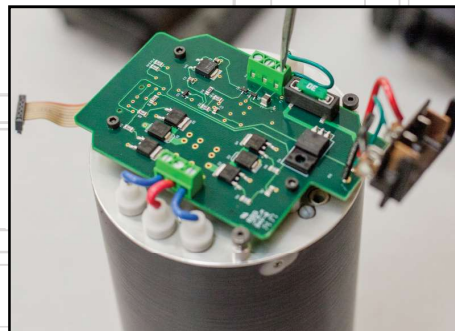
Remove the 8 screws that hold the housing together



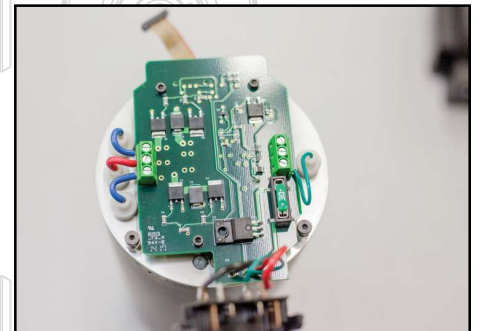
Remove half the housing.



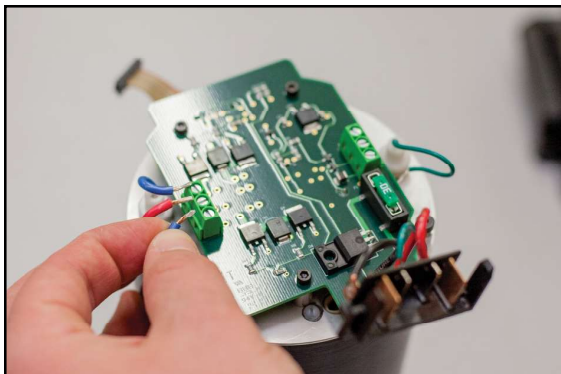
Remove the head.



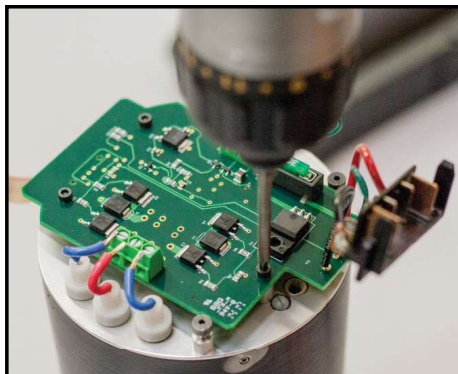
Loosen the four screws that hold the feedback wires in place.



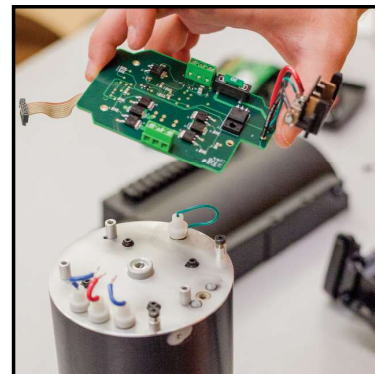




*Remove feedback wires.*



*Remove the screws that connect the oscillator board to the head.*



*Remove the oscillator board.*

**INSTRUCTIONS FOR BATTERY DISPOSAL** Follow all federal, state, and local laws for disposal of lithium-ion batteries. Batteries may be returned to Golden Engineering.

#### RETURNING UNIT FOR SERVICE AND MAINTENANCE

- **Complete the support form** at <http://www.goldenengineering.com/home/support> and include a copy of the printed form with the repair. If you do not have internet access prior to sending generator, include a letter containing a brief description of the problem, contact name, phone number, and return address.
- Remove battery before shipping the unit.
- Accessories are not required.
- Be sure the unit is securely packaged for shipment and wrapped in plastic bag if there is an oil leak.
- Ship to address: Golden Engineering, Inc., 6364 Means Road, Centerville, In 47330 USA

## 10.0 WARRANTY

Golden Engineering, Inc. warrants XRS3 X-ray unit made and sold by it or its authorized representatives to be free of **defects in materials and workmanship** for a period of twelve (12) months from the date of shipment to the end user. **Warranty does not cover maintenance required due to life.** To make a claim under this limited warranty, customer must ship the entire unit (or the component believed to be defective) to Golden Engineering, post-paid. Golden Engineering assumes no liability for units or components shipped until they are actually in the custody of Golden Engineering, Inc. Provided Golden Engineering, in its sole discretion, is satisfied that the failure is not the result of excessive use, abuse, misuse, accident, modification or improper disassembly or repair, Golden Engineering will provide parts and labor required for the repair. Golden Engineering reserves the right to use reconditioned and remanufactured components that meet original specifications. The unit or component will be shipped to customer at customer's expense. THIS EXPRESS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES AND GUARANTEES, EITHER EXPRESS OR IMPLIED OR CREATED BY OPERATION OF LAW.

XRS3 Manufacturer	European Representative
Golden Engineering, Inc.	Certification Experts Europe
6364 Means Road, Box 185	Nieuwstad 100
Centerville, IN 47330 USA	1381 CE Weesp
<b>Phone: 1-765-855-3493</b>	The Netherlands
<b>Fax: 1-765-855-3492</b>	Web: <a href="http://www.goldenengineering.com">www.goldenengineering.com</a>

Serial Number: \_\_\_\_\_

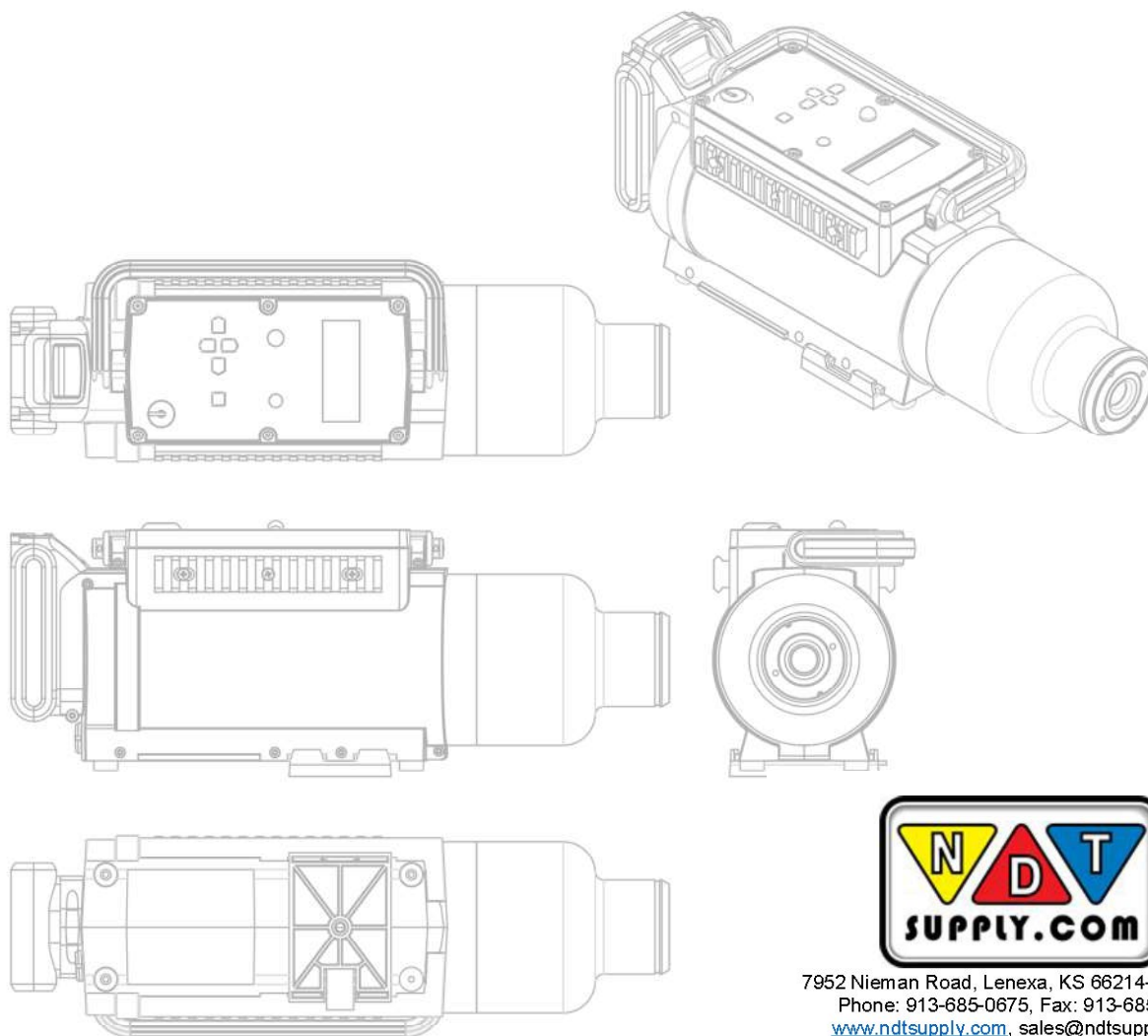
Delivery Date: \_\_\_\_\_

## 11.0 SPECIFICATIONS

PHYSICAL DIMENSIONS INCLUDING BATTERY PACK	
LENGTH	14.20 inches (36.07 cm)
WIDTH	4.26 inches (10.82 cm)
HEIGHT	7.44 inches (18.90 cm)
WEIGHT	11.8 pounds (5.4 Kg) with battery
X-RAY OUTPUT	
X-ray dose per pulse	2 mR/pulse min,(12 inches in front of unit)
Pulses per battery charge	4000
Pulses per second	15 (Nominal)
Expected tube life (glass tube)	100,000 pulses
X-ray source size	1/8 in. (3mm)
Maximum Photon Energy	270 kVp
X-ray pulse width	25 nanoseconds
ELECTRICAL AND THERMAL CHARACTERISTICS	
Battery voltage	18 volts - 20 volts
Battery type	Li Ion
Battery recharge time	One Hour
Current draw	20 amps @ 18/20 volt battery
Current flow	0.25 mA
Temperature range	-10 to 120 degrees F (-23 to 50 degrees C)
Airborne Noise Emissions	80 dB at 10 cm
Maximum duty cycle	200 pulses every 4 minutes (3000 pulses per hour)
Warm-up	None required

## 12.0 SPARE PARTS AND ACCESSORIES FOR THE XRS3

IITEM	PART NUMBER
Thumbwheel Key	2002000
Flat key	5951020
DeWalt® Battery 20V (2 Amp Hour / 40 Watt Hours) DCB105	1800106
DeWalt® Battery Charger (110V) DCB107	1800152
DeWalt® Battery Charger (220V) DCB105 or DCB115	1800164
Remote Cable	1809022
Tripod Mount	4000352
Handle	4000153
Carrying case (holds X-ray, 2 batteries, charger, cable)	1701656



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