XR200

20V X-RAY GENERATOR

OPERATOR'S MANUAL

JUNE 2017

Golden Engineering

Portable X-ray Technology

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1.0 INTRODUCTION

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The XR200 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 XR200 is a small, lightweight x-ray generator that operates on its own removable battery pack. The XR200 is a pulsed X-ray device that produces X-ray pulses of very short duration (50 nanoseconds). It produces a low dose rate comparable to a 0.5 ma constant potential machine. The energy produced by the XR200 is up to 150KVP, which makes it possible to radiograph up to one (1/2) inch (1.27 cm) of steel.

XR200 standard accessories are two keys, two battery packs, and one battery charger. Remote cable, carrying case, are also common accessories.

2.0 WARNINGS

The XR200 is a pulsed X-ray generator that emits hazardous ionizing radiation when pulsing. The XR200 should only be **operated** by **authorized personnel** who are properly trained to safely operate the generator. The XR200 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 XR200. 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 XR200 is used within federal and state guidelines.***

All operators and users of the XR200 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 XR200 radiation pulses).

Due to the short pulse width of the XR200, 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 XR200 does not produce constant radiation. The XR200 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 XR200 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 XR200 is a light duty machine that is not made to pulse continuously.*** The maximum duty cycle for the XR200 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 XR200 in upright position. Upside down storage or use may cause premature failure including no output dose.

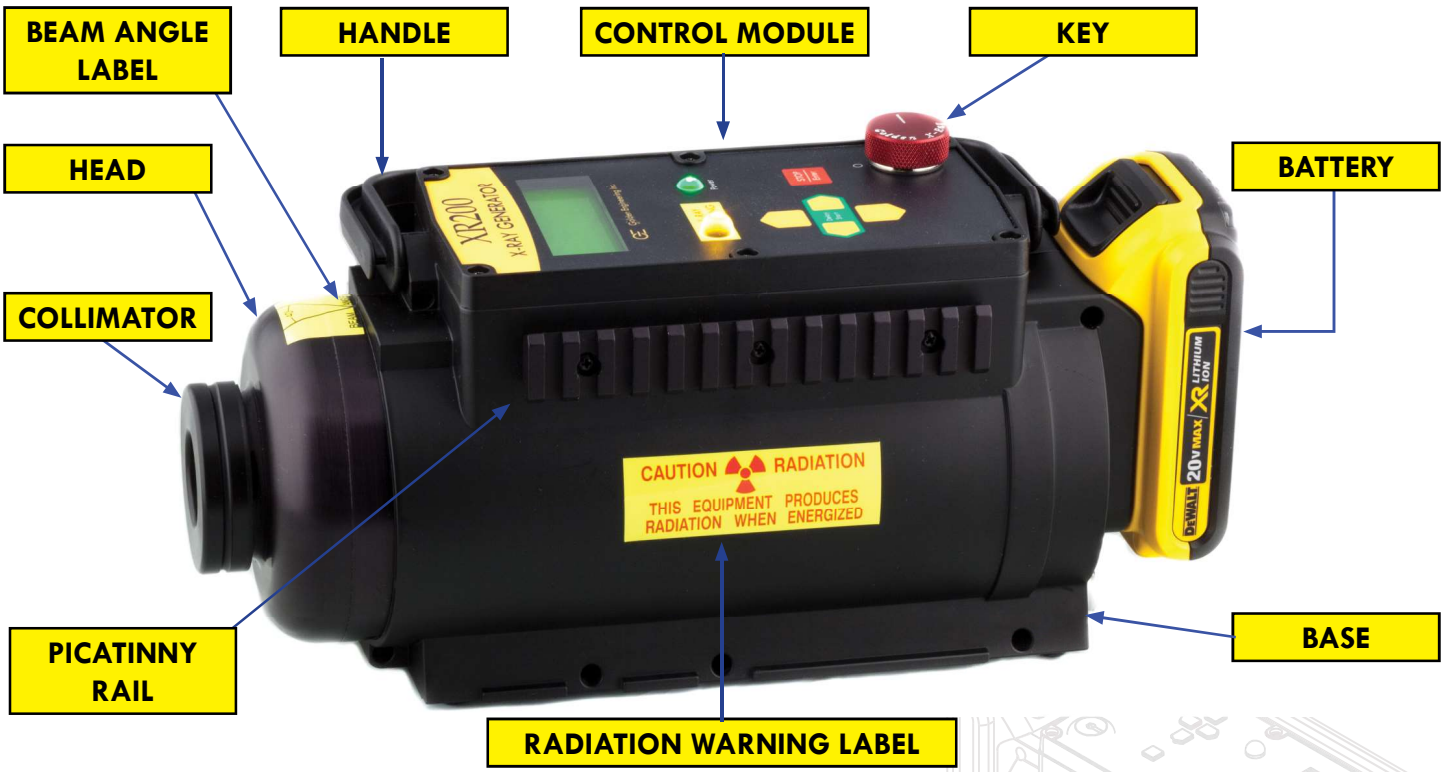
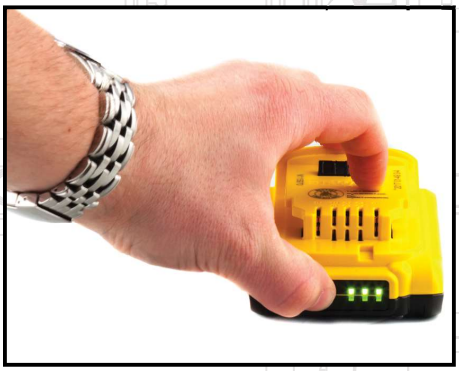


Figure 1: XR200 X-ray Unit

HIGH VOLTAGE PULSER/TUBEHEAD. The main body of the XR200 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 XR200 contains an identification label and a ¼-20 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 instruction and warnings.

PICATINNY RAIL: The XR200 has a 21 mm picatinny rail located on each side of the housing.

Figure 2: Base

3.5 CONTROL MODULE

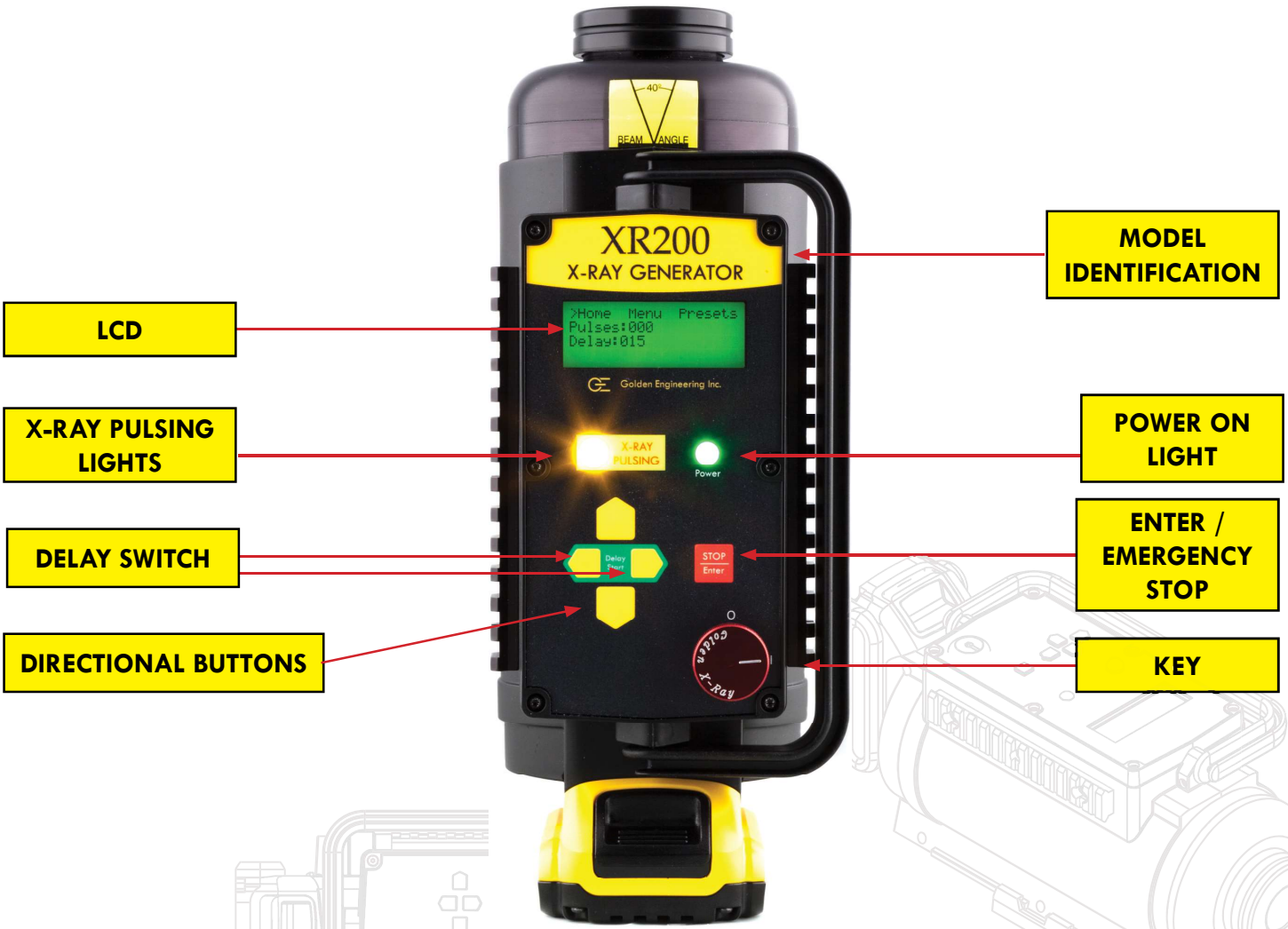


Figure 3: Control Module

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 XR200 is going to pulse. The light stays on continuously while the XR200 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.

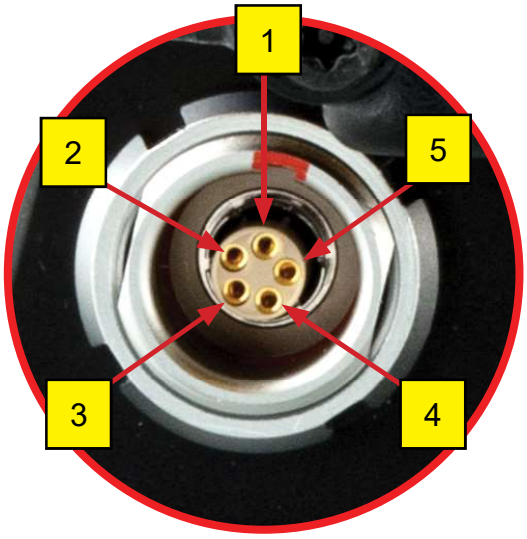
DIRECTIONAL BUTTONS: Used to maneuver through the menu.

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.

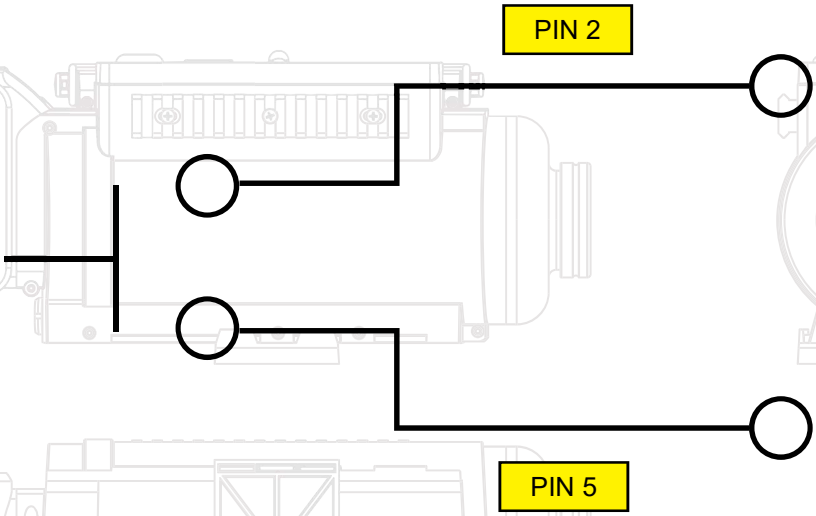
CABLE CONNECTOR: Lemo "K" series five pin connector located on the back of the control module beneath the battery receives the remote cable or imaging system cable.

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

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



Remote switch inputs are activated when grounded.

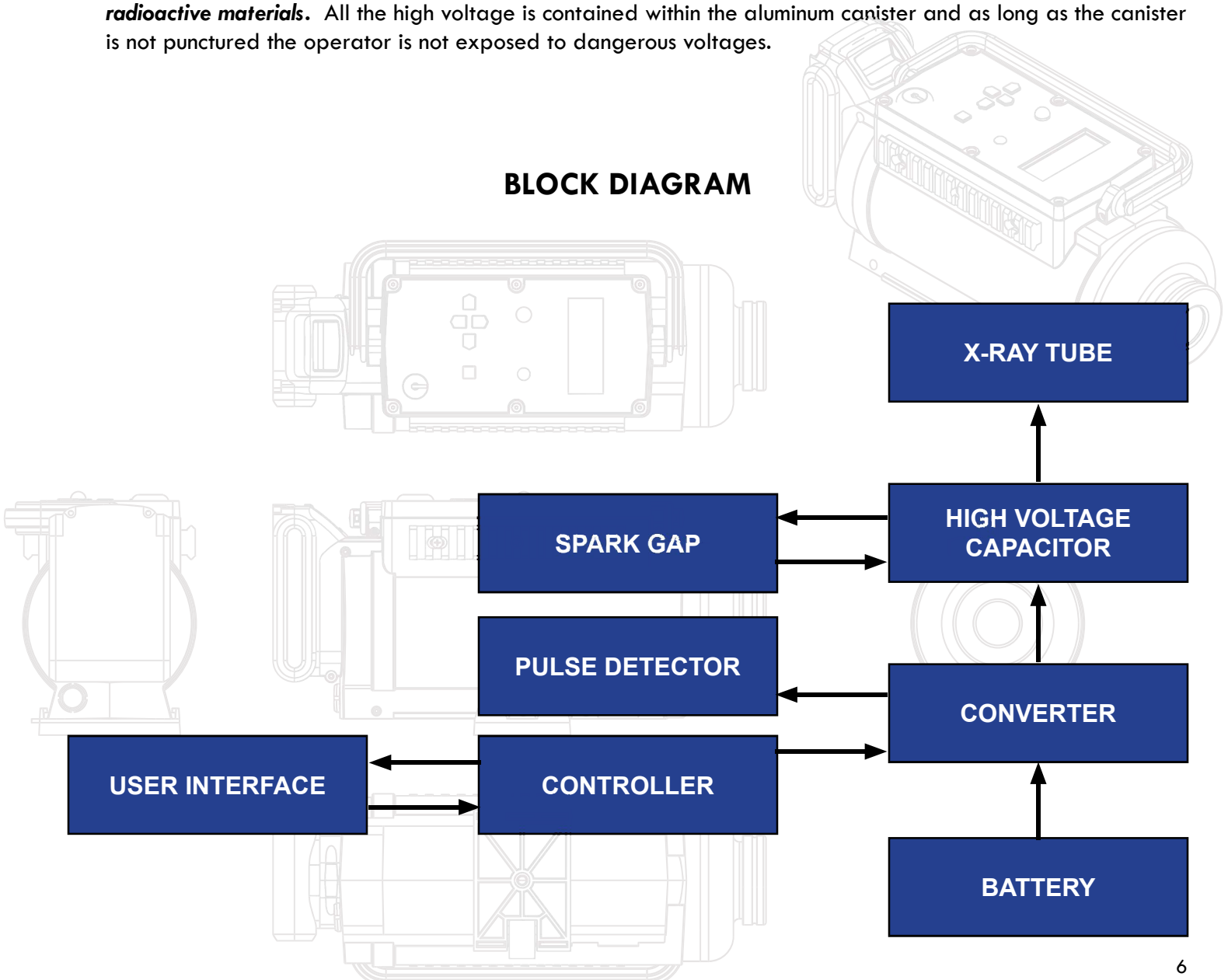
The block diagram below illustrates how the XR200 functions. The following sequence of events takes place each time the XR200 is fired:

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 8000 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 150,000 volts and 50 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 XR200 cannot produce X-rays without the pulsing sound so it serves as an additional warning the XR200 is functioning.**

This unit generates X-rays through high voltage bombardment of a tungsten target. ***The XR200 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

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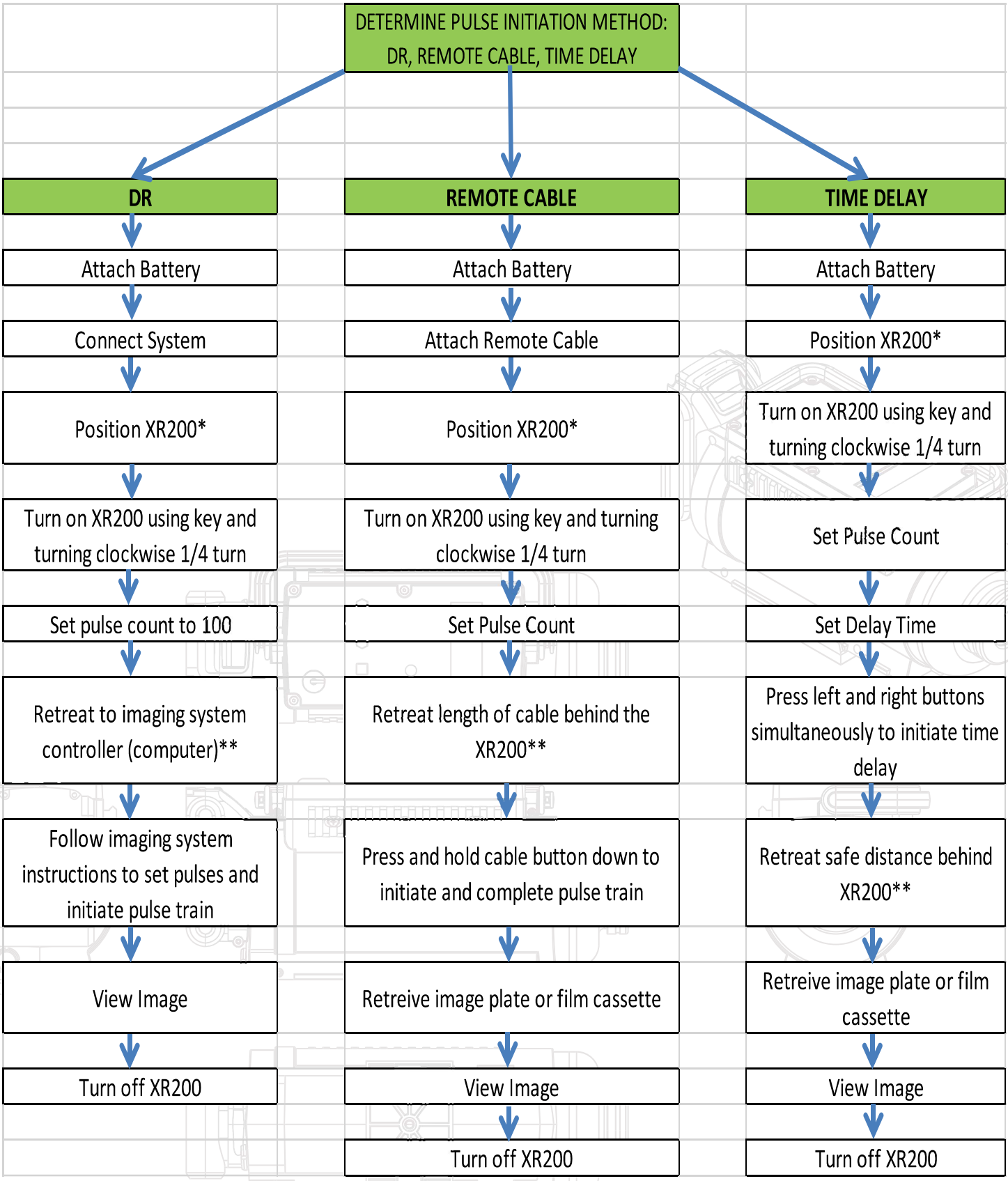
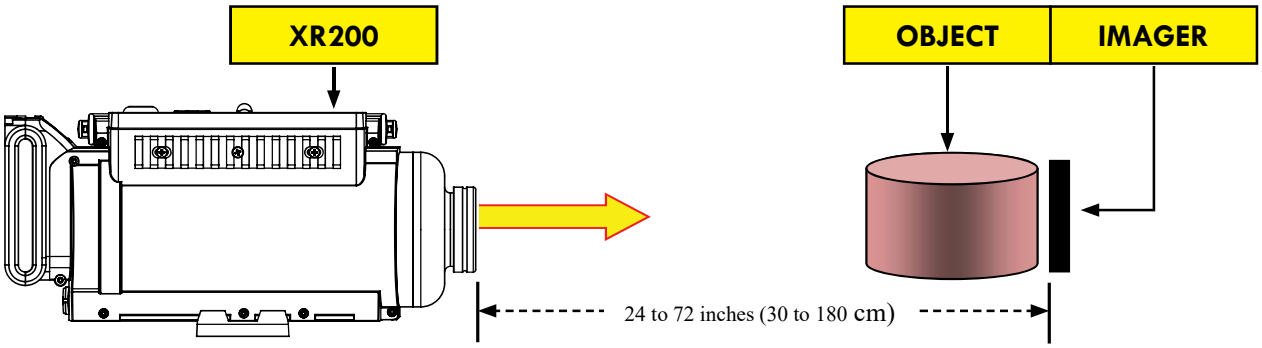
The following are basic operation instructions to take an X-ray image using the XR200. Certain applications may require modifications to these basic procedures.



*XR200 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 XR200 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) XR200.



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.*

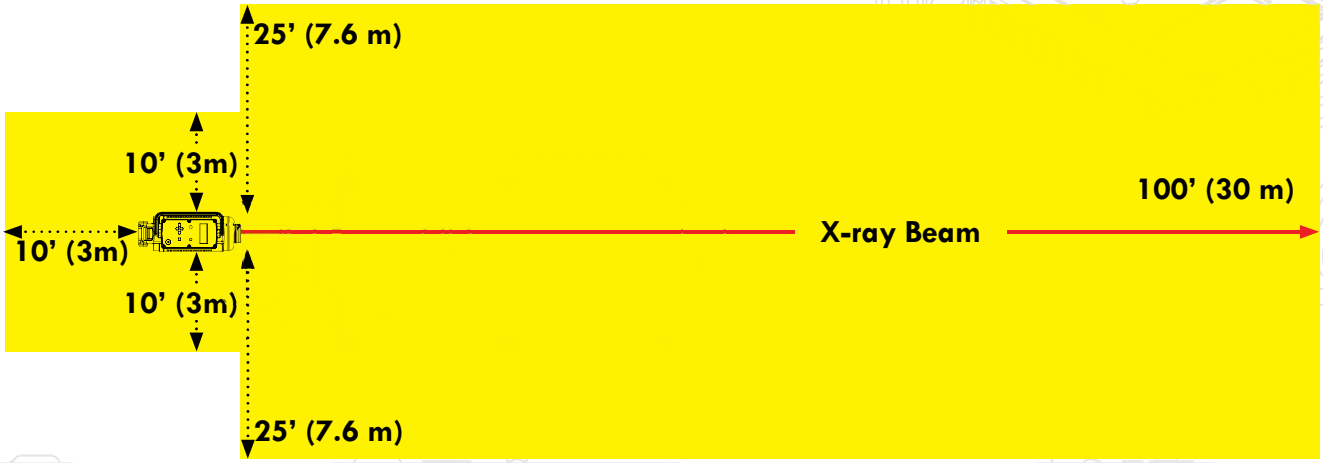


Figure 4: Exclusion Zone

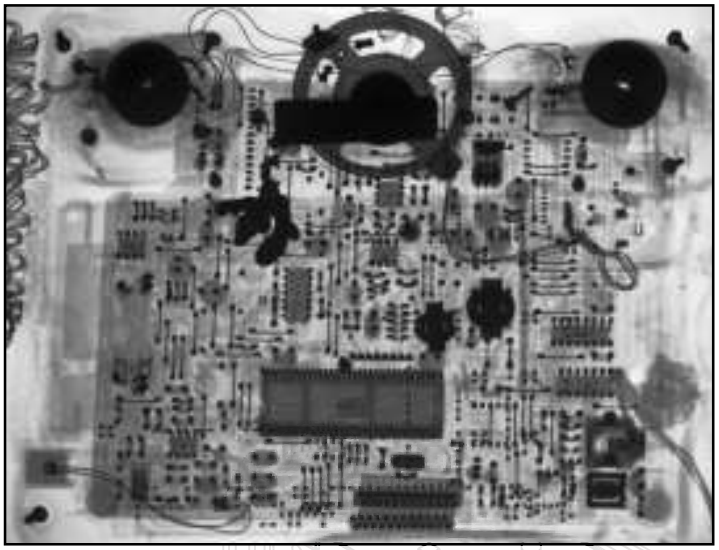
SUGGESTED PULSE SETTINGS

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.

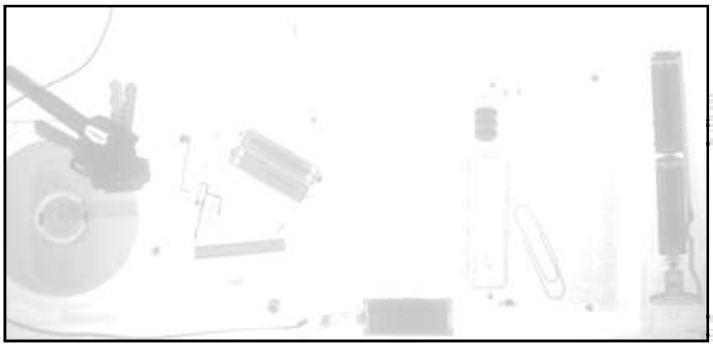
MATERIAL	PULSE SETTING (24" BETWEEN X-RAY & IMAGER)
CARDBOARD / LIGHT WOOD / PLASTIC	2-5
LIGHT METAL	10
STEEL 1/4"	25
STEEL ½"	50

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 XR200. **Overexposure** can be corrected by reducing the number of pulses and/or increasing the distance between the imaging medium and XR200.

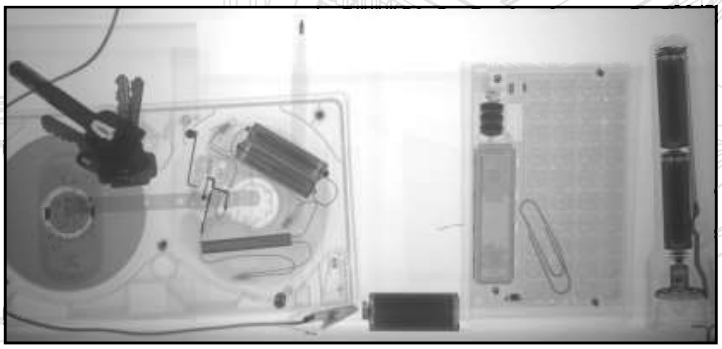
Underexposed



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 XR200. Charge the battery.
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              LIFE PC
SET DELAY               RESET PC
TRAINS                  SETTINGS
```

→

```
SET PULSE COUNT
_ _ _ PULSES
BACK                    SAVE
```

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

→

```
SET DELAY TIME
_ _ _ SECONDS
BACK                    SAVE
```

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

→

```
SET PULSE TRAINS
_ _ _ PULSE TRAINS:
_ _ _ SECONDS BETWEEN:
BACK                    SAVE
```

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

→

```
LIFETIME PULSE COUNT
_ _ _ _ _ _ PULSES
```

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

→

```
RESETTABLE COUNTERS
#1: _ _ _ _             >RESET
#2: _ _ _ _             RESET
BACK
```

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

→

```
SETTINGS
>BACKLIGHT              FEEDBACK
X-RAY INFO
BACK
```

→

```
BACKLIGHT
ON                      OFF
```

→

```
SETTINGS
BACKLIGHT               >FEEDBACK
BACK
```

→

```
FEEDBACK
INDIVIDUAL PULSE
X-RAY ON / X-RAY OFF
BACK
```

→

```
SETTINGS
BACKLIGHT               FEEDBACK
>E-RAY INFO
BACK
```

→

```
X-RAY INFO
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 #2
  PRESET #3
```

→

```
PRESET #1
PULSES: _ _ _ _         DELAY: _ _ _ _
TRAINS: _ _ _ _         BTWN: _ _ _ _
BACK        RECALL      >SAVE
```

→

```
PRESET #1
PULSES: _ 50            DELAY: 15
TRAINS: 05              BTWN: 45
BACK        RECALL      >SAVE
```

To Recall Presets

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

```
HOME        MENU        - PRESETS
> PRESET #1
  PRESET #2
  PRESET #3
```

→

```
PRESET #1
PULSES: _ 50            DELAY: 15
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 26 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: The XR200 tube should last at least 100,000 pulses. Under normal conditions the tube's output will decrease slowly with use. If the tube is broken or glass cracks the tube output will cease immediately. The following are tube replacement instructions.

1. Remove the battery before unscrewing the collimator. **WARNING! There is a potential of electric shock if the battery is not removed before unscrewing the collimator.**
2. To replace the tube unscrew the collimator.
3. Using needle nose pliers or your fingers grab the front of the tube and pull straight out.

Unscrew the collimator

Grab the front of the tube and pull straight out

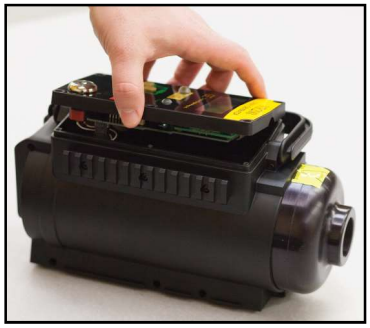
8.0 TROUBLESHOOTING

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.		- **Stop immediately and return for repair.**
Oil leaking from unit.		Return for repair.

INSTRUCTIONS TO REMOVE THE BOARDS AND THE HEAD.

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

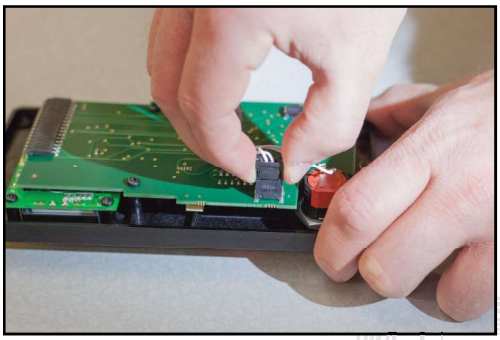
1



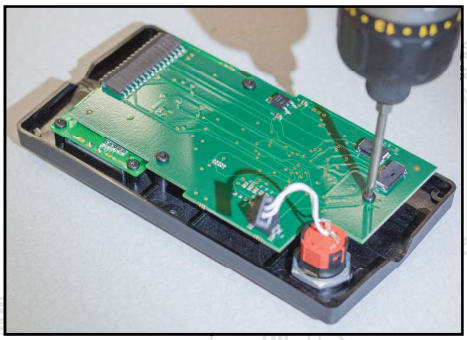
2

3

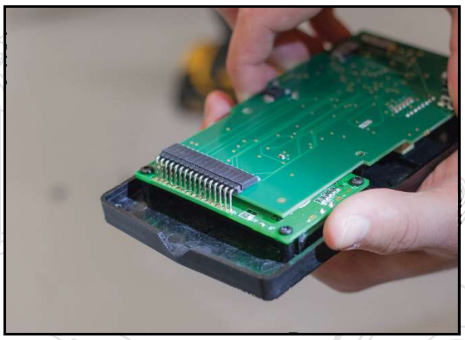
4



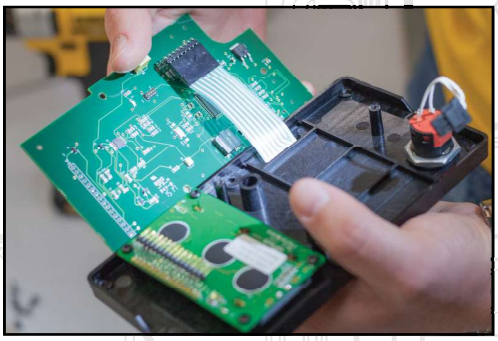
Remove keyswitch connector



Remove 3 screws holding processor board to top

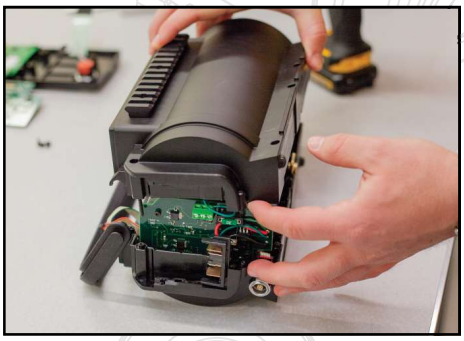


Remove processor board.

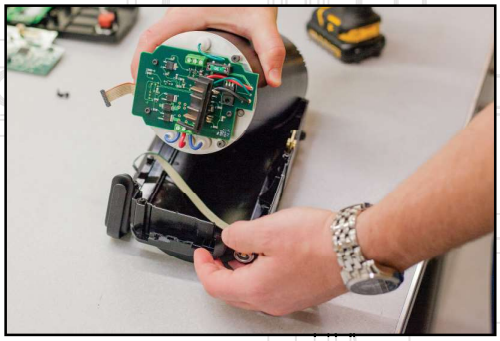


Disconnect ribbon cable.

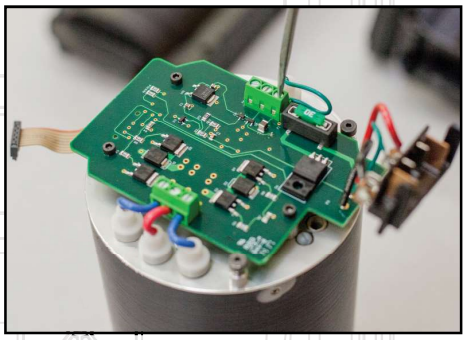
Remove the 8 screws that hold the housing together

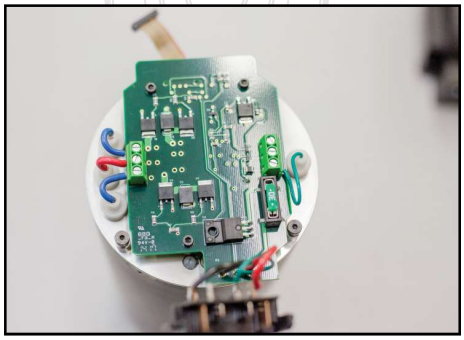


Remove half the housing.

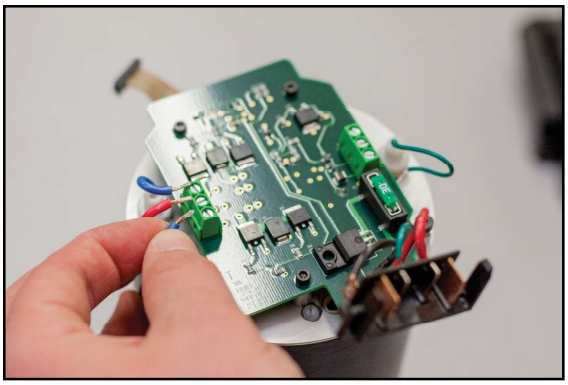


Remove the head.

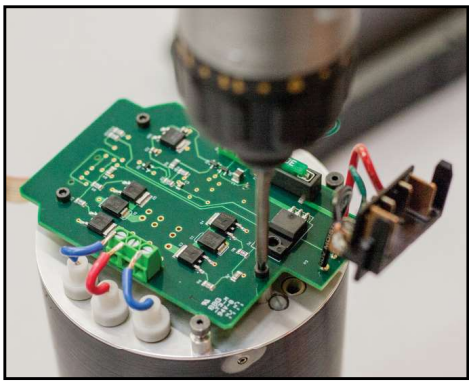




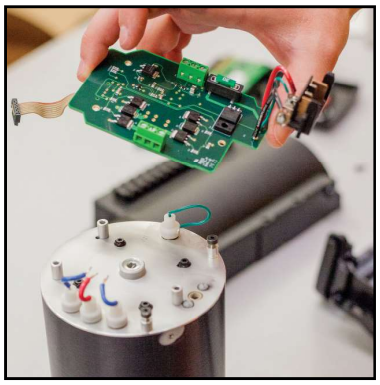
Loosen the four screws that hold the feedback wires in place.



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 XR200 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.

XR200 Manufacturer	European Representative
Golden Engineering, Inc.	Certification Experts Europe
6364 Means Road, Box 185	Nieuwstad 100
Centerville, IN 47330 USA	1381 CE Weesp
Phone: 1-765-855-3493	The Netherlands
Fax: 1-765-855-3492	Web: www.goldenengineering.com

Serial Number:_____ **Delivery Date:**_____

11.0 SPECIFICATIONS

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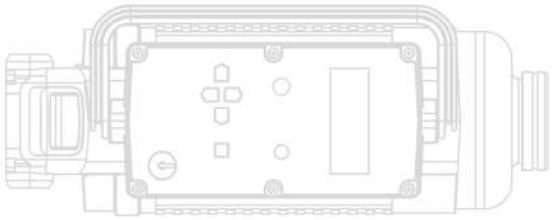
PHYSICAL DIMENSIONS INCLUDING BATTERY PACK	
LENGTH	11.95 inches (30.35 cm) with battery
WIDTH	4.26 inches (10.82 cm)
HEIGHT	5.83 inches (14.81 cm)
WEIGHT	11 pounds (5 Kg) with battery
X-RAY OUTPUT	
X-ray dose per pulse	2.6 mR to 4.0 mR (12 inches in front of unit)
Pulses per battery charge	6000
Pulses per second	10 (Nominal)
Expected tube life (glass tube)	100,000 pulses
X-ray source size	1/8 in. (3mm)
Maximum Photon Energy	150 KVP
X-ray pulse width	50 nanoseconds
ELECTRICAL AND THERMAL CHARACTERISTICS	
Battery voltage	18-20 volts
Battery type	Li Ion
Battery recharge time	One Hour
Current draw	9 amps @ 20 volts
Average X-ray Tube Current	0.5 mA
Temperature range	0 to 120 degrees F (-18 to 50 degrees C)
Airborne Noise Emissions	80 dB at 10 cm
Maximum duty cycle	200 pulses every 4 minutes (3000 pulses per hour)
High temperature / High use duty cycle	Above 90 degrees OR continual use rest 30 seconds every 50 pulses and 4 minutes every 200 pulses
Warm-up	None required

12.0 SPARE PARTS AND ACCESSORIES FOR THE XR200

IITEM	PART NUMBER
Thumbwheel Key	2002000
Flat key	5951020
Tube	2200020
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)	1701641



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