

XR150 X-RAY SOURCE



OPERATOR'S MANUAL

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1.0 INTRODUCTION

The XR150 produces high levels of radiation and must be operated by qualified personnel who have read the Warning and Operations section of the manual before operating the device.

The XR150 is a small, lightweight x-ray generator that operates on its own removable battery pack. The XR150 is a pulsed x-ray device that produces x-ray pulses of very short duration (30 nanoseconds). It produces a low dose rate comparable to a 0.1 ma constant potential machine. The energy produced by the XR150 is up to 150KVP, which makes it possible to radiograph up to one (1/2) inch (1 cm) of steel.

XR150 standard accessories are two keys, two battery packs, and one battery charger. Remote cable, carrying case, and film developing equipment are also common accessories.

2.0 WARNINGS

The XR150 is a pulsed X-ray generator that emits hazardous ionizing radiation when pulsing. The XR150 should only be **operated by authorized personnel** who are properly trained to safely operate the generator. The XR150 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 XR150. 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 XR150 is used within federal and state guidelines.***

All operators and users of the XR150 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 XR150 radiation pulses).

Due to the short pulse width of the XR150, 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 XR150 does not produce constant radiation. The XR150 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 XR150 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 XR150 is a light duty machine that is not made to pulse continuously.*** The maximum duty cycle for the XR150 is 100 **counts** every four minutes (1500 **counts** (4500 pulses) per hour). Exceeding the duty cycle will shorten the life of the tube and head.

3.0 PHYSICAL DESCRIPTION

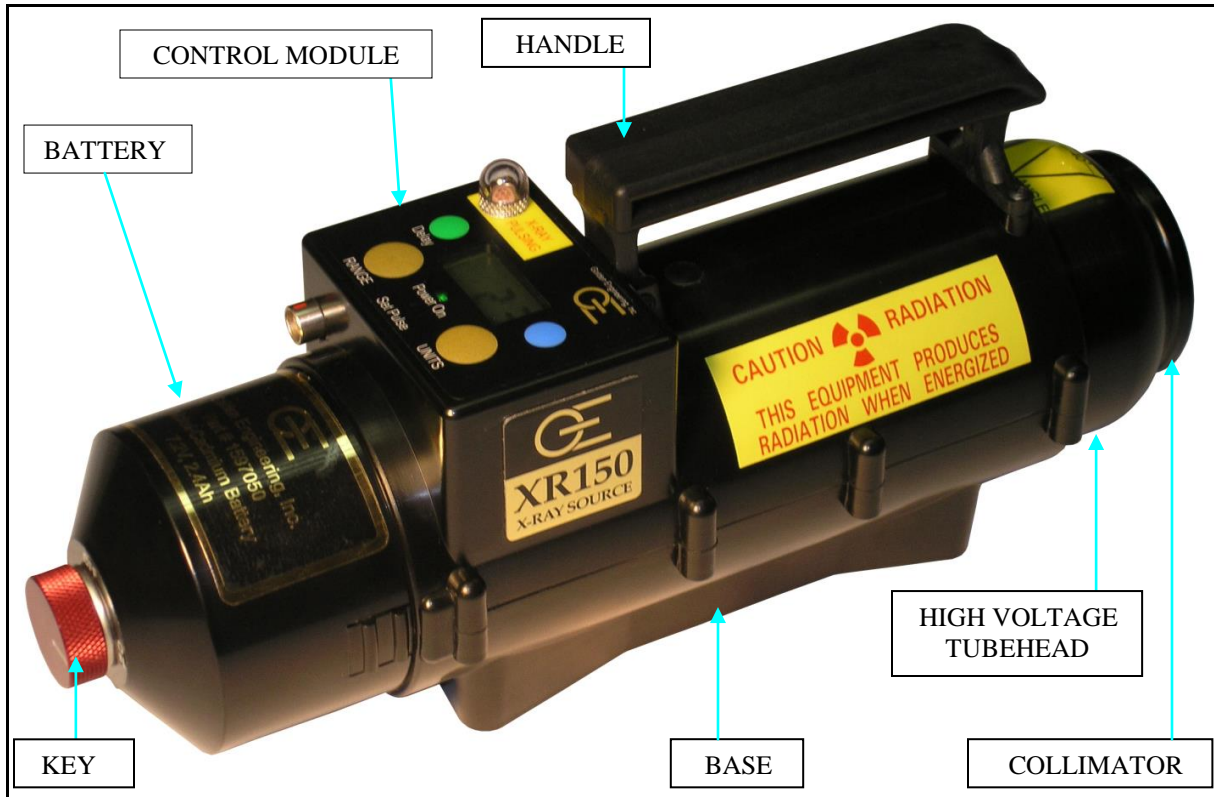


Figure 1: XR150 X-ray Unit

HIGH VOLTAGE PULSER/TUBEHEAD. The main body of the XR150 is the tube head which contains the 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.

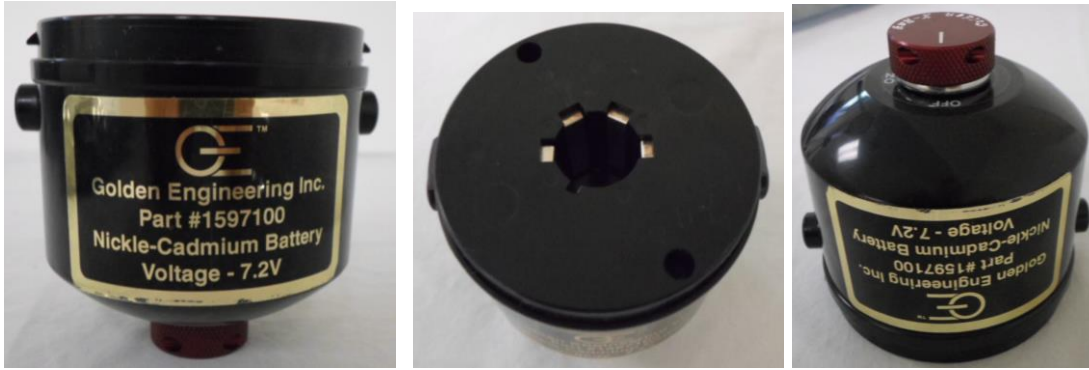
BASE. The base of the XR150 contains an identification label and threaded ¼-20 insert that can be attached to any standard camera tripod.

BATTERY PACK. The battery pack contains six nickel-cadmium or NIMH cells, key switch, identification label, terminal cavity, and two release buttons. The battery nominally produces 7.2 volts. The battery cavity contains four electrical contacts and a key notch that must align correctly on the XR150 unit and battery charger. The four contacts are negative, positive charge to oscillator block, key switch positive, and charge indicator.

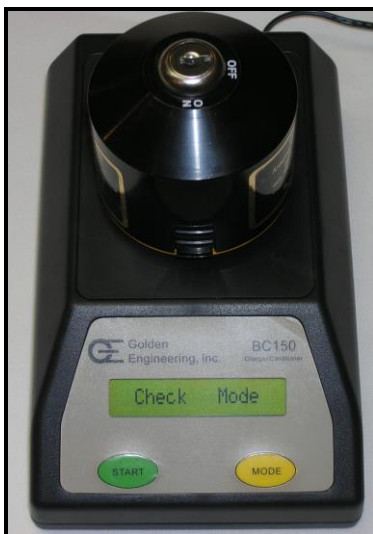
To completely remove power from the XR150 the battery must be removed.

Placing keys or other metal objects in the battery cavity may short the battery.

The battery pack loses 1% charge per day when not in use. To keep the XR150 ready for operation the battery should be charged at least once every two weeks.



BATTERY CHARGER: There are three possible battery chargers for the XR150 - BC150 battery charger conditioner and two Makita one hour chargers (110V and 220V versions). BC150 charger was designed specifically for the XR150 battery pack. It comes with a universal power supply that accepts input voltage of 100 – 240 volts 50 – 60 Hz and can be connected to the AC power sockets of most countries in the world. The BC150 can test the state of charge of the battery pack, charge a battery pack, and run the battery pack through several charge/discharge cycles to maximize the battery pack’s life. The charge time using this battery charger is five hours.



BC150 battery charger



Makita Charger and adapter

The battery can be tested on the BC150 by inserting a battery pack onto the charger and then depressing the START key while the LCD indicates CHECK MODE. The BC150 LCD will then return state: HIGH CHARGE, MEDIUM CHARGE, or LOW CHARGE depending on the condition of the battery. The battery pack has sufficient power to operate the XR150 as long as the message HIGH CHARGE or MEDIUM CHARGE are displayed. The battery will need to be charged if the message is LOW CHARGE.

To charge battery plug in the charger, connect the battery, and press the MODE key. The LCD charger will display CHARGE MODE. The LCD will alternately display “CHARGING XXXX maH” and CHARGE MODE while charging the battery. The LCD will display “CYCLE COMPLETE” when it is finished charging.

EXERCISE Mode will discharge the battery one time then charge it to full capacity. It is recommended to run each battery through the exercise mode once every three weeks. After the Exercise mode is complete the battery should have at least 1700 mAh.

CONDITION MODE will discharge the battery, charge the battery, then discharge a second time and charge a second time to full capacity. If a battery does not come up to at least 1700 mAh on the exercise mode then it needs to be run through the condition mode. If the battery does not come up to 1700 after it has been conditioned then it needs to be discarded.

OPTIONAL CHARGERS: The one-hour Makita battery chargers are optional chargers. These chargers may be used in addition to the BC150 custom charger or instead of the custom charger. The Makita battery chargers must be used with a battery charger adapter to interface with the XR150 battery.

CONTROL MODULE



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 XR150 is going to pulse. The light stays on continuously while the XR150 is pulsing.

LIQUID CRYSTAL DISPLAY (LCD): Two digit LCD displays selected pulse, time before unit pulses, software version, and total number of pulses on the unit.

RANGE SWITCH: Used to alternate LCD between tens digit and one's digit.

UNITS SWITCH: Used to change the value of the tens digit or ones digit from 0 to 9. The UNITS SWITCH is also used with the EMERGENCY STOP SWITCH to alter the default pulse setting.

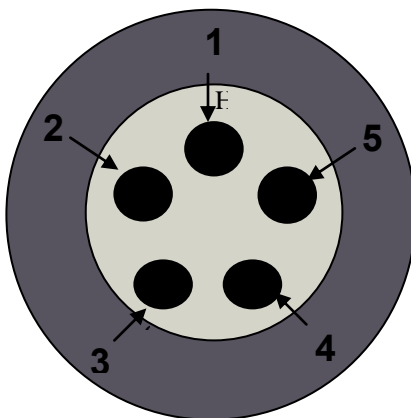
DELAY SWITCH: Initiates 60 second or 15 second delay mode.

PULSE DEFAULT SWITCH: When this switch is pressed simultaneously **with** the UNITS SWITCH the pulse reading on the LCD will be locked in as the new pulse default setting.

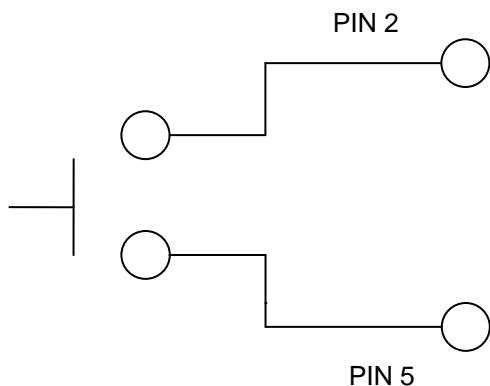
CABLE CONNECTOR: Lemo connector located on the back of the control module above the battery. Diagram below details the pin configuration.

XR150 CABLE CONNECTOR

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 CONNECTOR: LEMO EPG.0B.305.HLN
 MATING CABLE PLUG: LEMO FGG.0B.305.CLAD 56Z



Remote switch inputs are activated when grounded.

4.0 DESCRIPTION OF OPERATION

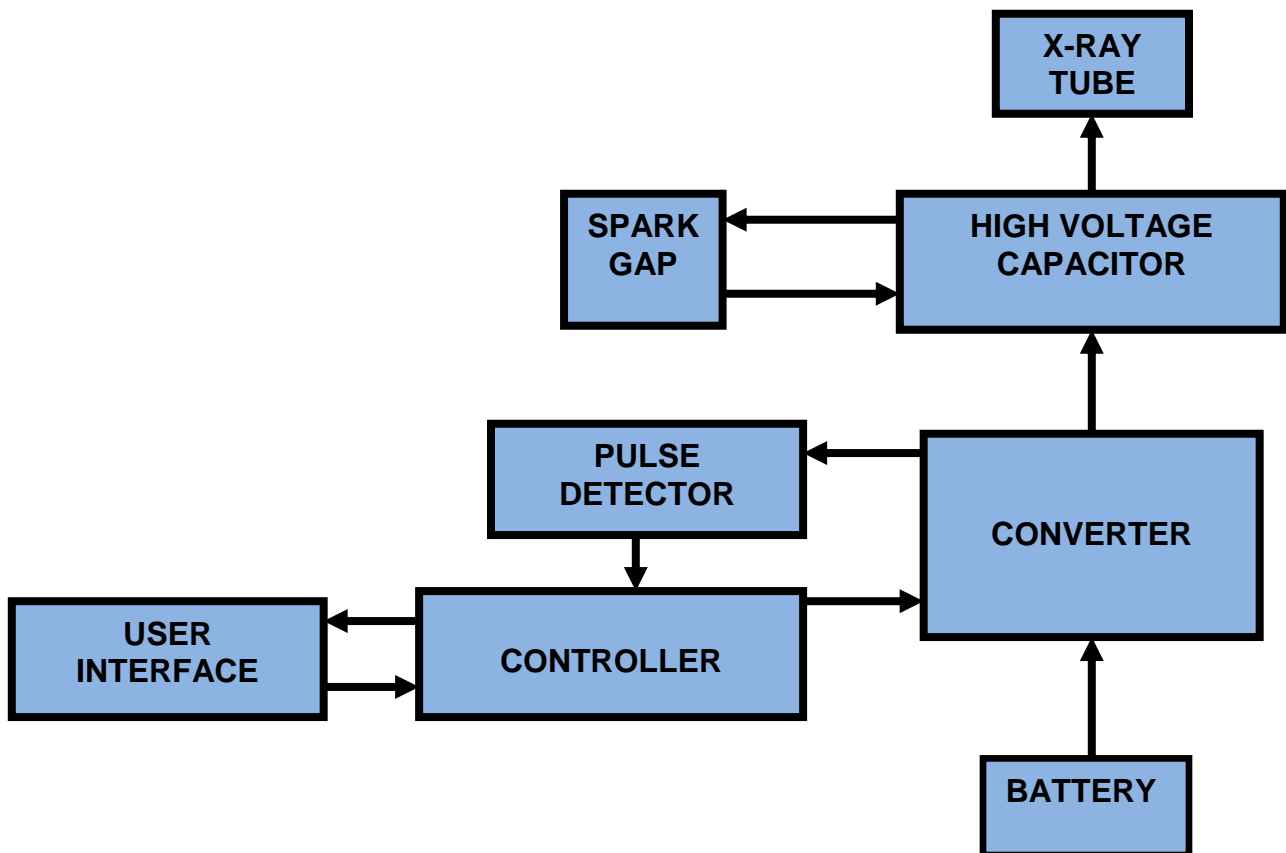
The block diagram below illustrates how the XR150 functions. The following sequence of events takes place each time the XR150 is fired:

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 7.2 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 30 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 XR150 cannot produce x-rays without the pulsing sound so it serves as an additional warning the XR150 is functioning.**

This unit generates x-rays through high voltage bombardment of a tungsten target. **The XR150 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

OPERATING PRECAUTIONS: *The operator should always stand at least 10 feet behind the X-ray unit and clear all personnel at least 10 feet behind the unit or at least 100 ft. 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.*

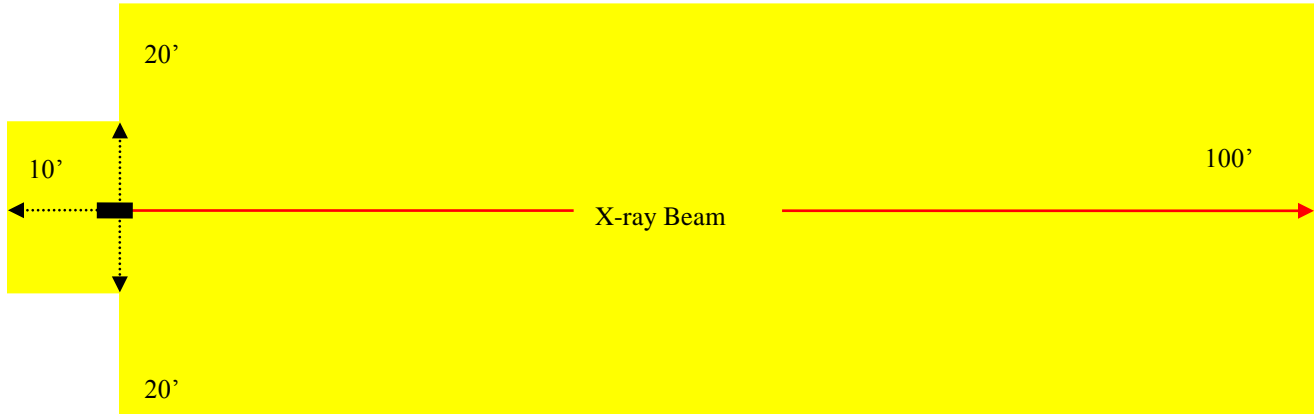


Figure 4: Exclusion Zone

PULSE SELECTION

The numbers entered on the LCD are **counts**. The XR150 **pulses** three times for each count.

1. **Attach** a charged battery and **turn on** the X-ray generator.
2. **Press** the RANGE BUTTON. The one's digit of the LCD will blink twice and then go blank.
3. **Press** the UNITS BUTTON to adjust the ones digit from 0 to 9.
4. **Press** the RANGE BUTTON again and the tens digit of the LCD will blink twice and go blank.
5. **Press** the UNITS BUTTON to change the tens digit from 0 to 9.
6. **Press** the RANGE or UNITS BUTTON again to accept the new count setting.
7. Both tens digit and units digit will blink to indicate acceptance of the new pulse setting. (If RANGE or UNITS BUTTON is not selected after entering the pulse count the generator will automatically accept the entered pulse setting after six seconds).
8. **Press** the UNITS BUTTON and EMERGENCY STOP BUTTON simultaneously to **lock in** pulse setting. If XR150 is turned off and back on new pulse setting will appear on LCD.



Select ones digit



Enter ones value (0-9)



Select tens digit



Enter tens value (0-9)



Change pulse default (optional)

DELAY MODE OPTION

1. **Press** Green DELAY BUTTON on top of the control module.
2. LCD displays 60 and X-ray begins 60 second time delay.
3. **Hold** DELAY BUTTON down for 1.5 seconds and time delay goes from 60 to 15 seconds.
4. X-ray makes audible beep and red pulsing light blinks as generator counts down to pulse.
5. Audible warning and red warning light stay on while X-ray pulses.

REMOTE CABLE OPTION

1. **Attach** remote cable to back of control module.
2. **Retreat** distance of the cable behind the unit.
3. **Press and hold down** remote cable firing button until X-ray generator completes pulse train.
4. There are audible beeps and red pulsing light blinks during a **5 second safety delay**.
5. Audible warning and red pulsing light stay on while X-ray pulses.

REAL TIME IMAGING OPTION

1. **Change** pulse setting default to 99 pulses if it is not already set to 99 pulses.
2. **Attach** imager cable to back of the control module unless using wireless option.
3. **Refer** to imaging system instructions for details on pulse setting and pulsing the generator.
4. There is **no** delay in this mode so the X-ray generator will pulse immediately unless there is a time delay on the imaging system.

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.

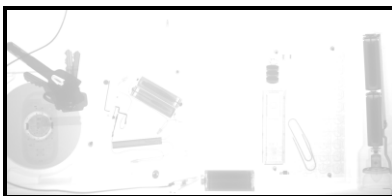
MATERIAL	COUNT (PULSE) SETTING 24 inches between x-ray & imager
CARDBOARD / LIGHT WOOD / PLASTIC	2-5
LIGHT METAL	10
STEEL 1/4"	25
STEEL 1/2"	50

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.

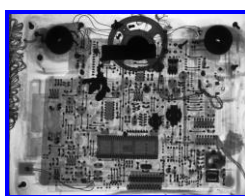
Underexposure can be corrected by increasing the number of pulses and/or decreasing the distance between the imaging medium and the XR150. **Overexposure** can be corrected by reducing the number of pulses and/or increasing the distance between the imaging medium and XR150.



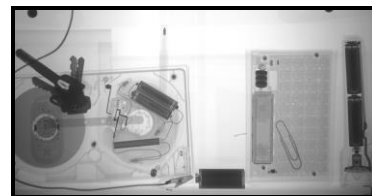
Underexposed



Overexposed



Correct exposures (pulse setting)



6.0 SOFTWARE

The software program that controls the microcontroller can be identified by turning the key switch on while both push button switches (RANGE & UNITS) below the LCD are depressed. The LCD displays the software version “53”. After “53” is displayed the total number of pulses on the XR150 will be displayed in the LCD. Each digit represents 10,000 counts. Example: If the LCD reads “04” the total number of pulses on the XR150 is between 40,000 and 50,000 pulses. After the total number of pulses is displayed the LCD will read “00” or the default pulse setting that was last stored on the unit.

The software program is capable of determining the state of battery charge based on the time between each pulse. As the battery loses charge the XR150 pulse rate slows, with more time between each pulse. If there is more than 0.33 seconds between two consecutive pulses the following will occur:

- The XR150 continues the current pulse train to “00”.
- After the XR150 stops pulsing. The LCD goes back to the original pulse setting. The left and right digits blink alternately.
- The condition indicates a low battery.
- The XR150 will be inoperable until the key switch is turned off and on, or the battery is replaced.

If there is more than one second between two consecutive pulses.

- The XR150 stops pulsing immediately and the LCD displays 00.
- This function prevents XR150 from pulsing continuously if there is a failure in detecting circuitry.
- This condition may indicate a low battery, electrical noise, or failure in detecting circuitry.
- The operator may need to replace the battery pack, turn key switch off and on, or send the XR150 back for repair.

7.0 TROUBLESHOOTING

SYMPTOM	TEST	ACTION
No “power on” light	-Check battery voltage -Check battery connection	- Replace or charge battery - Make sure battery is securely attached.
Power on lights, but X-ray does not pulse.	-Check the battery voltage.	-Charge or replace the battery.
X-ray pulses, but no image or black image.	-Test X-ray output.	-Send back for tube replacement.
Unit stops pulsing in the middle of a pulse train and LCD displays 00.	-Check the battery voltage.	- Charge battery if necessary.
Oil leaking from unit.		Return for repair.

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

8.0 WARRANTY

Golden Engineering, Inc. warrants XR150 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 return 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.

THE XR150 X-Ray Source is manufactured by:

GOLDEN ENGINEERING, INC.

PO BOX 185

CENTERVILLE, IN 47330 USA

Phone: 1-765/855-3493

Fax: 1-765/855-3492

WEB: www.goldenengineering.com

RETURNING UNIT FOR REPAIR

- **Complete the repair form** at www.goldenengineering.com/technical.html and include a copy of the printed form with the repair. If you do not have internet access prior to sending repair then 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 wrap in plastic bag if there is an oil leak.
- Ship to address:

Golden Engineering

6364 Means Road,

Centerville, IN 47330 USA

Phone: 1-765-855-3493

EMAIL: service@goldenengineering.com

9.0 SPECIFICATIONS

PHYSICAL DIMNSIONS INCLUDING BATTERY PACK	
LENGTH	10.5 inches (26.5 cm)
WIDTH	3 inches (8 cm)
HEIGHT	4 inches (10 cm)
WEIGHT	4 lbs. 5 oz. (2 Kg) with battery
X-RAY OUTPUT	
X-ray dose per count (3 pulses per count)	2.3 mR to 4.0 mR (12 inches in front of unit)
Counts per battery charge	1000
Counts per second	3 (Nominal)
Expected tube life (glass tube)	35,000 counts
X-ray source size	1/8 in. (3mm)
Maximum Photon Energy	150 KVP
X-ray pulse width	30 nanoseconds FWHM
ELECTRICAL AND THERMAL CHARACTERISTICS	
Battery voltage	7.2 volts
Battery type	Nickel Cadmium sub C sells
Battery recharge time	One Hour or Five hours depending on charger
Current draw	9 amps @ 7.2 volts
Current flow	0.1 mA
Temperature range	-10 to 120 degrees F (-23 to 50 degrees C)
Maximum duty cycle	100 counts every 4 minutes (1500 counts per hour)
Warm-up	None required

10.0 SPARE PARTS AND ACCESSORIES FOR THE XR150

IITEM	PART NUMBER
Thumbwheel Key	5951070
Battery Ni Cad	1597100
Battery NiMH	1597150
Battery Charger / Conditioner 110V/220V Model BC150	4100025
Makita One Hour Battery Charger (110V)	4100010
Makita One Hour Battery Charger (220V)	4100020
Battery charger adapter (interface between battery/Makita charger)	1597060
Handle	1504080
Remote Cable	1596110
Carrying case (holds X-ray, 2 batteries, charger, cable)	4008030