

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 must 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 (50 nanoseconds). It produces a relatively 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 1 cm (0.4 in) of steel.

The XR150 comes with 1 X-ray source, 2 battery packs, 2 keys, and 1 battery charger. Remote cable, carrying case, battery charger adapter, 1 hour charger, and film developing equipment are common accessories.



FIGURE 1 (XR150 w/accessories)

2.0 WARNINGS

2.1 The XR150 is an industrial type x-ray generator that produces hazardous radiation when energized.

2.2 It is unlawful to use this equipment to intentionally expose humans or to use it for medical radiography.

2.3 *The XR150 is subject to state regulation and registration. Contact your state board of health before operating equipment.*

2.4 The operator of the XR150 must be properly trained to safely operate the unit.

2.5 Unauthorized personnel should not have access to the XR150.

2.6 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 0.01 mR per hour for a member of the public and 1 mR per hour for a radiation worker (refer to section 10.0, Specifications, for information concerning x-ray output).

The system must ensure the XR150 is used within federal and state guidelines.

2.7 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, 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.

2.8 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.

3.0 DESCRIPTION OF OPERATION

3.1 The block diagram in *Figure 3* on page 12 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 about 150,000 volts and 60-70 nanoseconds in duration is applied across the x-ray tube generating x-rays.

3.2 The closing of the High Voltage Switch produces an audible snapping sound. The XR150 cannot produce x-rays without the snapping sound and conversely the snapping sound serves as a warning that the XR150 is functioning. The operator should become familiar with the characteristic sound.

3.3 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.

4.0 PHYSICAL DESCRIPTION

4.1 HIGH VOLTAGE PULSER/TUBEHEAD. The front half of the XR150 consists of a 3 inch diameter canister that is rounded at its end.

The canister contains the high voltage capacitor and the x-ray tube. A radiation warning label is located on each side of the canister. A beam angle label located on the front of the canister indicates the direction and angle the x-ray beam leaves the unit.

4.2 BASE. The base of the XR150 contains a threaded ¼-20 hole. This enables the XR150 to be mounted on a standard tripod.

A label identifying the model, manufacturer, and serial number is located on the bottom of the XR150 base.

4.3 CONTROL MODULE/REMOTE CONNECTOR. The control module contains the following indicators and switches.

4.3.1 Green LED: Illuminates when the battery voltage is applied to the control module. (Power on)

4.3.2 Red X-ray Warning Light: Blinks when the XR150 is about to pulse either in delay mode or when connected to the remote switch. Stays on continuously when the XR150 is pulsing.

4.3.3 Liquid Crystal Display (LCD): Displays 2 digits showing the number of counts selected. If the X-ray Warning Light is blinking, then the LCD displays the number of seconds remaining until the XR150 begins pulsing. The LCD is backlit so it can be viewed in the dark.

4.3.4 Input Switches: The two tan push button switches, Range Switch and Units Switch, are used to select the number of counts that will be generated when the unit is activated. The Units Switch is also used to alter the default count setting when the XR150 is first powered up.

4.3.5 Delay Switch : This green push button switch is used to initiate delay mode.

4.3.6 Blue Switch: This switch is used to alter the default count setting when the XR150 is first powered up.

4.3.7 Remote Connector this connector mates with the connector on the remote switch assembly. *Figure 4* on page 13 shows more details about the Remote Connector.



Figure 2 Control Module

4.4 BATTERY PACK. The battery pack contains five nickel-cadmium cells and nominally produces 7.2 volts. The battery connects to the XR150 and battery charger adapter after the key way in the battery is properly aligned with the key on the back of the XR150 or the key on top of the battery charger adapter.

4.4.1 The battery pack contains four electrical contacts.

- One contact is the negative.
- One contact supplies positive voltage to the oscillator block.
- The third contact supplies positive voltage to the control module. This contact is opened and closed by the key switch.
- The fourth electrical contact connects to the charger to indicate a full charge.

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

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

4.4.4 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 a month.

4.4.5 The battery pack does not have a memory, so it is not necessary to discharge before charging.

4.4.6 The key switch for the XR150 is located on the back of the battery pack.

4.5 BATTERY CHARGER: The standard battery charger to charge the XR150 batteries is our Model # BC150. This charger was designed specifically for this 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, test the capacity of the battery pack as well run the battery pack through several charge/discharge cycles to maximize the battery pack's life. The charge time using this battery charger is 5 hours.

4.5.1 To charge battery, first connect AC power to the BC150.

4.5.2 With the battery connected, press the MODE key. The LCD of the charger will display CHARGE MODE.

4.5.3 The LCD will alternately display "CHARGING XXXX maH" and CHARGE MODE while charging the battery.

4.5.4 The LCD will display "CYCLE COMPLETE" when it is finished charging.

4.5.5 The state of charge of the battery can be tested on the BC150 by inserting a battery pack onto the

charger and then depressing the START key.

4.5.6 The BC150 LCD will then return either HIGH CHARGE, MEDIUM CHARGE, or LOW CHARGE. The battery pack has sufficient power to operate the XR150 as long as the message HIGH CHARGE or MEDIUM CHARGE is returned.

4.6 OPTIONAL CHARGER: The one hour Makita battery charger is an optional accessory. The Makita battery charger must be used with a battery charger adapter to interface with the XR150 battery.

5.0 OPERATING INSTRUCTIONS

5.1 OPERATING PRECAUTIONS

The operator should always stand at least 10 feet behind the X-ray unit while it is pulsing. All other personnel should stand at least 50 feet behind the X-ray unit while it is in use.

Closely follow all procedures in the safe operating system.

5.2 OPERATING PROCEDURES

The XR150 X-ray source may be used with different imaging systems. Operating procedures depend on the type of imaging system. This section explains three different operating procedures.

5.3 REMOTE CABLE OPTION

This option is used with any system that does not have direct interface between the X-ray unit and imager. (Polaroid film and Phosphor imaging plates).

5.3.1. Attach fully charged battery pack to the XR150.

5.3.2. Plug the remote cable into XR150.

5.3.3. Place cassette or imaging plate directly behind the object to be X-rayed. Make sure the cassette or imaging plate are as close as possible to the object. Distance between object and cassette will cause distortion to the X-ray image.

5.3.4. Place the XR150 two to four feet in front of the object with the front of the XR150 pointing directly at the object.

5.3.5. Insert key into key switch located on the back of the battery pack. Turn on the XR150 by gently turning the key clockwise 1/4 turn.

5.3.6. In order to select the desired number of counts for the XR150 first depress the RANGE SWITCH. The units digit of the LCD will blink twice and then go blank. The UNITS SWITCH can then be used to adjust the units digit of the LCD to the desired value.

-Next, press the RANGE SWITCH again and the tens digit of the LCD will blink twice and the UNITS SWITCH can be used to adjust the tens digit to the desired value.

-After 6 seconds of inactivity, both the units and tens digit will blink twice and the counts will have been set on the XR150.

5.3.7. Retreat behind the XR150 the length of the cable.

5.3.8. Fire the XR150 by depressing the button on the remote cable.

-The XR150 **delays 5 seconds** before it begins pulsing.

-The X-ray Warning Light blinks and the LCD displays how many seconds remain before the XR150 start pulsing.

-The XR150 will stop pulsing when the pulse count reaches "00".

-The operator may stop the pulsing immediately by releasing the button on the remote cable. The LCD will then display how many pulses remain on the original count setting.

5.3.9. Check the XR150 to see that original pulse count is on LCD.

5.3.10. Turn off key switch.

5.4 DELAY MODE OPTION

This option is also used with any system that does not have direct interface between the X-ray unit and imager. (Polaroid film and Phosphor imaging plates).

5.4.1. Attach fully charged battery pack to the XR150.

5.4.2. Place cassette or imaging plate directly behind the object to be X-rayed. Make sure the cassette or imaging plate is as close as possible to the object. Distance between object and cassette will cause distortion to the X-ray image.

5.4.3. Place the XR150 two to four feet in front of the object with the front of the XR150 pointing directly at the object.

5.4.4. Insert key into key switch located on the back of the battery pack. Turn on the XR150 by gently turning the key clockwise 1/4 turn.

5.4.5. See section 5.3.6 for pulse setting instructions.

5.4.6. Push the delay button and the red light starts to blink.

- The LCD starts at 60 seconds.
- If the operator holds the button down for 1.5 seconds the unit goes to 15 second delay.
- The red light continues to blink until the XR150 begins to pulse.

5.4.7. Retreat at least 10 feet behind the XR150.

5.4.8. Red light stays on and XR150 makes snapping sound while it is pulsing.

5.4.9. Check XR150 to see that original count setting is on LCD.

5.4.10. Turn off key switch.

5.5 REAL TIME IMAGING OPTION

This option is for the PC based imaging systems that have a control interface between the imaging system and X-ray unit. Interface may be hard wired from imager to X-ray or remote interface.

5.5.1. Attach fully charged battery pack to the XR150.

5.5.2 Attach imaging system cable or wireless option. See imaging system instructions for more details.

5.5.3. Insert key into key switch located on the back of the battery pack. turn on the XR150 by gently turning the key clockwise 1/4 turn.

5.5.4. Select 99 pulses. See section 5.3.6 for pulse setting instructions.

5.5.5. Change default setting to 99. See section 5.6 for detailed instructions.

5.5.6. Place imager behind object to be X-rayed and X-ray unit in front of object to be X-rayed.

5.5.7. Refer to your imaging system operating instructions for specific details on setting pulses and firing the unit.

5.5.8. There is no built in delay when used in this mode. The X-ray will fire immediately unless there is a time delay in the imaging system.

5.5.9. After the X-ray unit has pulsed the pulse setting should be read the original defaulted value. (99).

5.6 DEFAULT COUNT SETTING

The count setting displayed on the LCD immediately after applying power to the XR150 can be altered by the user.

5.6.1 First, set the count setting to the desired DEFAULT COUNT SETTING as described in paragraph 5.2.7.

5.6.2 Next depress the UNITS SWITCH followed by the BLUE SWITCH. Hold both switches down for 1.5 seconds.

5.3.3 Both digits of the LCD will blink indicating that the DEFAULT COUNT SETTING has been changed.

5.3.4 Verify the new DEFAULT COUNT SETTING by turning the power to the XR150 on and off and observing the LCD.

5.7 SUGGESTED PULSE SETTINGS

The XR150 is designed to pulse 3 times for each count entered on the LCD. If the operator enters 5 counts on the LCD the XR150 pulses 15 times. The XR150 pulses times for each count because it produces 1/3 as much energy per pulse as THE INSPECTOR X-ray source Model 200. Therefore, the operator can enter the same number of counts on the XR150 as he would enter pulses for THE INSPECTOR -ray source Model 200.

The chart below lists approximate counts necessary to penetrate various materials. The counts are APPROXIMATE because all XR150 units vary depending on tube output and imaging medium. The settings are based on a distance of 24 inches between the front of the XR150 and the front of the film cassette.

<u>MATERIAL</u>	<u>XR150 COUNT SETTINGS</u>
Envelope	1-2
Cardboard box	2-3
Light wood container	2-4
Heavy wood container	5-6
Plastic box	4-6
Light metal container	9-14
Steel Pipe	50-60

When using Polaroid positive film the following conditions are true. If the radiograph is too dark, the film is underdeveloped. If the radiograph is too light or washed out, the film is overexposed.

5.8 DUTY CYCLE WARNING. *Up to 200 counts (600 pulses) may be used without resting the XR150. The XR150 should then be rested for eight minutes. After every subsequent 200 counts the operator should allow a rest period of eight minutes. The XR150 is a light duty machine. It is not made to pulse continuously.*

6.0 SOFTWARE

The software program that controls the microcontroller can be identified by turning the key switch on while both push button switches below the LCD are depressed. The LCD displays the software version "21". When the push button switches are released, the LCD will display "00" and the XR150 is ready for operation.

The software program in the control module is capable of indicating 2 conditions:

The first condition is detected if there are more than .33 seconds between two consecutive pulses.

- The XR150 continues the current pulse train to "00".

- After the XR150 stops pulsing, the LCD will go back to the original pulse setting, but the left and right digits will 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.

The second condition is detected if there is more than 1 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 MAINTENANCE

The following procedures will help maintain top performance.

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

7.1.1 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 counts should be 30 mR +/- 5 mR.

7.1.2 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.

7.1.3 The leakage and dose of the tube should be measured every 20,000 counts or every 2 years.

8.0 TROUBLESHOOTING

SYMPTOM	TEST	ACTION
No "power on" light	Check battery voltage, Check connection	-Charge/replace battery -Make sure battery is on securely
X-ray "ON" lights, but X-ray doesn't fire	Check battery voltage	Charge/replace battery
Black picture, but X-ray operating correctly	-Check if paper envelope removed -In dark place, fire X-ray at opened cassette. Greenish light will show on cassette screen.	-Remove envelop from film negative -Return for tube replacement if no green light
Oil leaking from unit		Return for repair
LCD displays "00" after unit fires	Turn key switch off and on	If problem occurs often return for repair

8.1 INSTRUCTIONS FOR REPAIR

8.1.1 In most cases we offer a three day turn-around for repair.

8.1.2 When returning a unit for repair, include a brief description of problem incurred.

8.2.3 Remove battery before shipping the unit. Battery may be returned in same package with XR150.

8.1.4 Be sure the unit is securely packaged for shipment.

8.1.5 Return address: Golden Engineering, Inc., 6364 Means Road, Centerville, IN 47330.

8.2 INSTRUCTIONS FOR BATTERY DISPOSAL

8.2.1 Users disposing of old battery packs should follow all federal, state, and local laws for disposal of nickel-cadmium batteries.

8.2.2 Users may send their old battery packs to Golden Engineering for disposal.

9.0 WARRANTY

Certification of Warranty

XR150 Serial Number	_____
Battery Charger Serial Number	_____
150P Processor Serial Number	_____
4"x5" Cassette/Developer Serial Number	_____
Date Delivered	_____

Unit Warranty

Golden Engineering, Inc. warrants THE INSPECTOR X-ray Source Model XR150 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. 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, Inc. assumes no liability for units or components shipped until they are actually in the custody of Golden Engineering, Inc. Provided Golden Engineering, Inc. in its sole discretion, is satisfied that the defect is not the result of abuse, misuse, accident, modification or improper disassembly or repair, Golden Engineering, Inc. 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

10.0 SPECIFICATIONS

10.1 PHYSICAL DIMENSIONS INCLUDING BATTERY PACK:

Length..... 10.5 in. (26.5 cm)
Width..... 3 in. (8 cm)
Height..... 4 in. (10 cm)
Weight..... 4 lbs. 5 oz. (2 Kg)

10.2 X-RAY OUTPUT.

X-ray dose per pulse..... 1.0 milliroentgens at 12 inches from
the front of the unit. (.093 mR at 1 meter)
Number of pulses per exposure..... 3 to 297.
Visual counts per pulse..... 3.
Number of pulses per battery charge. 2500.
Number of pulses per second..... 10 (nominal).
Expected life of XR150..... 50,000 pulses minimum.
X-ray source size..... 1/8 in. (3 mm)
Maximum photon energy..... 150 KEV.
X-ray pulse width..... 60 nanoseconds. (.00000006 seconds)

10.3 ELECTRICAL AND THERMAL CHARACTERISTICS.

Battery Voltage..... 7.2 volts.
Battery Type..... Nickel Cadmium sub C cells. (6)
Battery recharge time..... 1 hour.
Battery Charger..... Makita 7.2 /9.6 volt 1 hour charger.
(May be purchased in the user's country for proper AC voltage interface.)
Temperature range..... -10 to 120 degrees F.
(-23 to 50 degrees C)
Maximum duty cycle..... 300 pulses every 4 minutes.
(3600 pulses per hour)
Warm-up..... None required.

10.4 X-RAY LEAKAGE

X-ray leakage 10 mR per 300 pulses maximum
on the side of the unit, 3 inches from the center of the unit. 3 mR per 300
pulses 2 inches behind the unit.

SPARE PARTS AND ACCESSORIES FOR THE XR150

ITEM	PART#
Tube head.....	1502900
Control Module.....	1502990
Battery.....	1504900
Key.....	1507026
Makita battery charger (110V).....	DC9700A
Makita battery charger (220V).....	DC9700
Remote cable.....	1504090
Tripod mount.....	1508010
Battery charger adapter.....	1507094
Handle.....	1508020
Small carrying case.....	1508030
Large carrying case.....	1508035