RTR-4 Portable Digital X-Ray Imaging System

Operator's Manual

120300 Rev. D

15 February 2003

An Employee-Owned Company

SAIC
16701 W. Bernardo Dr.
San Diego, CA 92127-1903
U.S.A.

RTR-4 Portable Digital X-Ray Imaging System Operator's Manual
120300 Rev. D

FCC Declaration of Conformity

We **SAIC**
16701 W. Bernardo Dr.
San Diego, CA 92127-1903 U.S.A.

declare under our sole responsibility that the product

RTR-4 Portable Digital X-Ray Imaging System

complies with Part 15 of FCC Rules. Operation is subject to the following of two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. Changes or modifications not expressly approved by Science Applications International Corporation could void the user's authority to operate the equipment.

Declaration Of CE Conformity

We **SAIC**
16701 W. Bernardo Dr.
San Diego, CA 92127-1903 U.S.A.

declare under our sole responsibility that the product

RTR-4 Portable Digital X-Ray Imaging System

to which this declaration relates is in conformance with the applicable provisions of the following directives:

- 73/23;EEC governing product safety.
- 89/336/EEC governing electromagnetic compatibility.
- 99/5/EC governing radio and telecommunication terminal equipment.

Using the following standards:

- EN61010-1
- EN 61326:1997 +A1:1998 +A2:2001
- EN300 220-3:2000
- EN 301 489-3:2001

15 February 2003
San Diego, CA

Richard Amiton
Director of Engineering

Revision History

VERSION	COPY FREEZE DATE	NOTES
—	15 June 1999	Initial release.
A	16 April 1999	Minor revision.
B	28 February 2001	Wireless Option removed from Operator's Guide and transformed into a separate supplemental document.Battery Charger chapter and CU-4 Modem chapter deleted.
C	20 October 2001	Minor text changes.
D	15 February 2003	Incorporate information for Wireless operation and optional equipment; document new database software. Word count is 19,926.

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1 Introduction

About this Manual

This manual provides information on the setup and use of the various options and configurations of the Real Time Radioscopy (RTR-4) Imaging System and is comprised of the following chapters:

Chapter 1 - Introduction

Chapter 2 - Safety Summary

Chapter 3 - System Description, Setup, and Quick Start

Chapter 4 - System Operation

Chapter 5 - Ancillary Equipment

Purpose and Scope

This manual describes the RTR-4 hardware and software and provides instructions on its use, including setup of the equipment, acquisition and processing of X-ray images, and some troubleshooting. The information in this document is to be used only by technicians and operators who have been trained to use the RTR-4 system.

Document Revisions

This manual is revised periodically, based on the amount and substance of equipment changes and resulting changes to the manual. When changes to this manual are required, a new manual incorporating the changes is released.

RTR-4 Technical Support

Technical support is available using the following methods:

- By phone: 800-962-1632 (in the US) or 858-826-9831 (outside of the US) from 0730 to 1630 PDT.
- By fax: 858-826-9009.
- By e-mail: SecurityProducts@saic.com.

More information may be found on our website at http://www.saic.com.

Component Returns

Contact us at the above numbers or e-mail to receive a Return Material Authorization (RMA) number. Return damaged, failed, or defective systems or components to the address below. When shipping components, include a description of the problem and the RMA number.

SAIC

Attn: RTR-4 Manufacturing Mgr.

16701 W. Bernardo Dr.

San Diego, CA 92127-1903 USA

The Golden Engineering X-ray sources may be handled separately for customer convenience. Follow the instructions in the Golden operator's manual for repair of the Golden Engineering XR200 X-ray source or visit their website at http://www.goldenengineering.com.

Acronyms and Abbreviations

The acronyms and abbreviations listed in the table below are used throughout this manual.

TERM	DEFINITION
ALARA	As Low As Reasonably Achievable
CU-4	Control Unit 4 (original controller)
ESD	Electrostatic Discharge
GUI	Graphical User Interface
HERO	Hazards of Electromagnetic Radiation to Ordnance
LED	Light Emitting Diode
MB	Megabyte (one million bytes)
NCU	Notebook Control Unit
NIC	Network Interface Card
PC	Personal Computer
PCMCIA	Personal Computer Memory Card International Association
PIC	Pocket Ionization Chamber

TERM	DEFINITION
RF	Radio Frequency
RMA	Return Material Authorization
ROI	Region Of Interest
RTR	Real Time Radiography
SNR	Signal-to-Noise Ratio
.tif	Tagged Image Format (a filename extension)
TLD	Thermoluminescent Dosimeters
Vac	Volts alternating current
Vdc	Volts direct current
WiFi	Wireless Fidelity, a wireless ethernet communications standard.

2 Safety Summary

Introduction

This chapter lists and describes the safety issues applicable to the standard configurations of the RTR-4. The summaries listed here apply at all times and shall be strictly followed by all operators, technicians, and observers.

Follow all warnings and instructions

The equipment and the procedures in this manual have warning and caution labels and their relevant hazard type symbols. Observe all warnings, cautions, and instructions marked on the equipment and included in this manual and in all supporting manufacturer documentation at all times.

Qualified and Trained personnel only

The RTR-4 should only be operated by technically qualified and trained personnel. It is the responsibility of the RTR-4 user to ensure only trained personnel are permitted to configure, operate, and maintain RTR-4 equipment. It is the responsibility of the user to verify that all regulations have been met before operating this equipment.

Symbols

In procedural steps, specific warnings and cautions are placed immediately prior to the step(s) to which they apply. Specific warnings and cautions have three parts:

- The specific hazard is stated.
- The correct action to be followed or performed is given.
- The consequences if the correct action is *not* followed are stated.

The following warning symbols and the caution symbol are used in this manual when warnings and cautions are placed into procedural steps.

SYMBOL	DEFINITION OF USE
	The generic **Warning** symbol precedes a procedural step or process which could lead to personnel injury if not followed correctly. This symbol is used when multiple hazard conditions may be present or one of the symbols below does not specifically apply.
	The **Electrical**, **High Voltage**, or **High Current** hazard warning symbol is used where the potential for electrical shock may exist while performing a specific task.
	The **X-Ray Radiation** hazard warning symbol is used whenever emitted x-ray radiation may exceed background levels during a specific procedure or process.
	The **Microwave Radiation** hazard warning symbol is used whenever emitted microwave/rf radiation is present during a specific procedure or process.
	The generic **Caution** symbol precedes a procedural step or process which could lead to equipment damage if not followed correctly.
	The **ESD** caution symbol precedes a procedural step or process requiring use of standard approved ESD damage control procedures to avoid harming electronic components and circuit card assemblies.
	The **Note** symbol indicates where additional or clarifying information, commentary, sidelights, or points of interest have been added to a procedure either before or after the step to which it applies.

Safety Procedures

The X-ray source used with the RTR-4 system generates x-rays that can be harmful to personnel. It is the responsibility of the operator to ensure that the RTR-4 is properly used by trained personnel who follow recommended operating procedures and

applicable regulations, and the X-ray Source supplier guidelines, such as the Golden Engineering XR200 X-Ray Source Operator's Manual.

General Safety Procedures

The following are general safety precautions for using X-ray generating devices:

- As Low As Reasonably Achievable (ALARA) principles of radiation exposure are applicable whenever the RTR-4 system is being used. Personnel exposure to X-rays shall be kept to the absolute minimum possible.
- Users shall establish appropriate exclusion zones to limit access to the radiation field. This information can be found in the Users's Manual for the applicable X-ray source or on the manufacturer's webpage. When two or more exclusion zones apply, such as using the RTR-4 in the presence (or suspected presence) of explosives, the larger exclusion zone perimeter shall apply.
- Operating personnel shall review and follow applicable regulations.
- In order to meet the FCC RF safety regulations when using the wireless configuration, personnel shall maintain a distance of at least 20cm (8in) from the WiFi antennas when the system is operational.
- Personnel in the vicinity when the RTR-4 system is being operated may be required to wear an approved X-ray radiation monitoring device in accordance with local regulations or administrative procedures.
- Personnel shall remain at a safe distance from the X-ray source, and always remain outside the direct beam during image acquisition if possible.
- Personnel shall remain at a distance of at least 20cm (7.9in) from the antennas whenever the RTR-4 wireless option is being used.
- When using the optional Notebook Safety Lock, the controller key shall be turned to the **OFF** position when not acquiring images. The X-ray source cannot fire when its controller key is in the **OFF** position.
- The power key for the X-ray source should be turned to the **OFF** position when the system is not acquiring images. The X-ray Source cannot fire when its key is in the **OFF** position.

- The system operator shall remove the controller key and X-ray Source keys when not operating the system, to ensure that the system is not accidentally or improperly operated.
- All reasonable efforts shall be made to reduce doses to ALARA levels.

Safe Operating Environment

The following environmental conditions affect the safe operating conditions of the RTR-4:

- Maximum external voltage fluctuation of ± 10%.
- Maximum altitude 2000m (6562ft).
- Operating temperature range 5°C (41°F) to 40°C (104°F).
- Maximum relative humidity of 80%.

Outdoor Use

All parts of the RTR-4 system are intended for the outdoor use except for the external ac power adapters. If external power adapters must be used outdoors, ensure they are protected from adverse weather conditions such as rain or moisture. Failure to use adequate precautions may result in equipment damage or personnel hazard.

3 System Description, Setup, and Quick Start

Introduction

This chapter describes the standard configuration of the RTR-4 system and contains the following sections:

- Hardware Description.
- Setting up the RTR-4
- Quick Start

The basic system design of the RTR-4 consists of an imager unit, a controller unit, an X-ray source unit, and the interconnecting cables or optional wireless components. This chapter covers the standard wired configuration and the standard wireless configuration only. Alternate components are covered in later chapters.

Hardware Description

RTR-4 System Standard Wired Configuration Components

The standard wired RTR-4 configuration includes the following components:

- Portable Notebook Controller.
- Notebook ac power adapter.
- 30cm (1ft) Notebook to cable reel adapter.
- 50m (164ft) cable reel.
- Integrated Imager.
- Imager ac power adapter and spare battery.
- Imager battery external battery charger.
- RTR-4 Operating Software
- Golden Engineering XR200 X-Ray Source with operator's manual.
- 3m (10ft) imager to source cable.
- Source battery charger and spare battery.

- RTR-4 Portable Digital X-Ray Imaging Set Operator's Manual, SAIC document 120300 (this document).
- Transport case.

Portable Notebook Controller

The standard configuration of the RTR-4 system uses a standard commercial notebook Personal Computer (PC). Functioning as the controller, the notebook PC contains specific SAIC software that provides for operator interface with the RTR-4 system and displays images as they are captured. A special adapter cable is provided to connect the PC modem RJ45 connector to the RTR-4 system cable reel when the system is setup in the wired configuration. A WiFi Network Interface Card (NIC) is provided for connecting in the wireless configuration.

The notebook PC has the following current features:

- A Pentium- series processor.
- A 12.1 in (30.7cm) or larger active matrix color flat panel display.
- Custom SAIC software.
- A 30 GB or greater internal hard drive.
- A 1.44 MB floppy disk drive.
- DVD/CD-RW drive.
- Two CardBus slots.
- 56 kbaud internal modem.
- Internal rechargeable Lithium Ion battery with an external 100-240Vac power adapter and battery charger.
- Current Dimensions: 36.6cm x 25.9cm x 2.55cm (14.1in W x 10.2in D x 1.46in H).

- Weight: 2.9 kg (6.39lbs).

Storage Medium

Images are stored on disk in an industry-standard format, and may be manipulated and annotated with third-party software. The following list shows the RTR-4 Notebook options for storage, and their capacities. Some differences between notebook manufacturers will occur.

STORAGE MEDIUM	MAXIMUM CAPACITY
Internal hard disk drive.	Over 80,000 images, depending on size of disk drive.
1.44 MB floppy disk.	Four images per disk.
Optional CardBus disk drive.	System-defined; up to thousands of images.
Optional USB flash disk.	Up to thousands of images.
CD-ROM	Up to thousands of images.

RJ45 Cable Adapter

This adapter is provided to connect the modem connection on the controller PC to the 50m cable reel when the RTR-4 is setup in the wired configuration.

Controller AC Power Adapter

This adapter connects the notebook PC to ac power and provides 19Vdc to the PC for operation or internal battery charging.

Integrated Imager

The Integrated Imager uses a compact solid-state camera with a 20cm x 27cm (8.0in x 10.7in) field-of-view. An electro-optical system records images formed on the imager's X-ray conversion screen and transmits the images to the controller PC for display. Imager features include:

- Dimensions: 30cm x 34cm x 18cm (11.75in W x 13.25in H x 7.0in D).
- Weight: 4.5kg (10.0lbs).
- DR35S NiMH 10.8Vdc battery and an optimal ac power adapter.

- The imager may use other external power sources between 12Vdc and 24Vdc such as vehicle power.

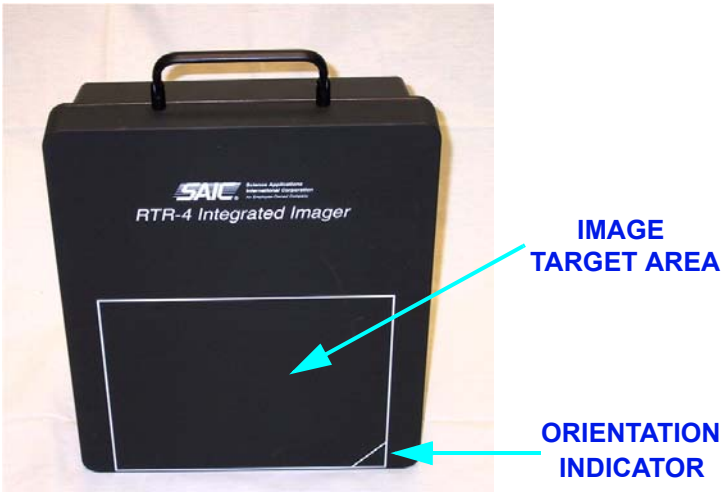
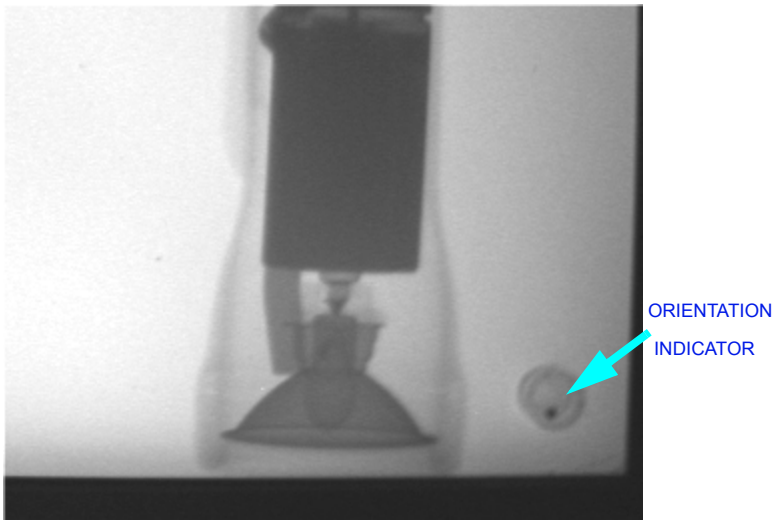


Image Target Area

The active image area is indicated on the face of the imager. This is the area that will be displayed on the controller PC.

Orientation Indicator

A triangle in one corner of the image target area is shown as a ball in a circle on the controller PC image and indicates the lower edge of the image. This ball is free floating and will always indicate the downward edge of the image as the imager is positioned on its sides or other orientations. Rubber feet and standard threaded tripod mounting holes are provided on three sides to permit placement of the imager in different orientations.



Power-on Delay Timer

The imager is equipped with a rotary switch that allows setting a 0 to 3 minute delay between turning on the imager power switch and the application of power to the imager. The switch positions provide 20 second interval settings up to the 3 minute limit. Use of this switch permits operating personnel to leave the immediate area before electromagnetic energy is applied near a suspect package.

Integrated Imager External Power Adapter

This adapter provides 18Vdc power to the imager when connected. If a battery is present, the adapter will charge the battery. The **Power On** LED will indicate when the adapter is connected and the **Battery Charge** LED will indicate battery charge status.

Integrated Imager External Battery Charger.

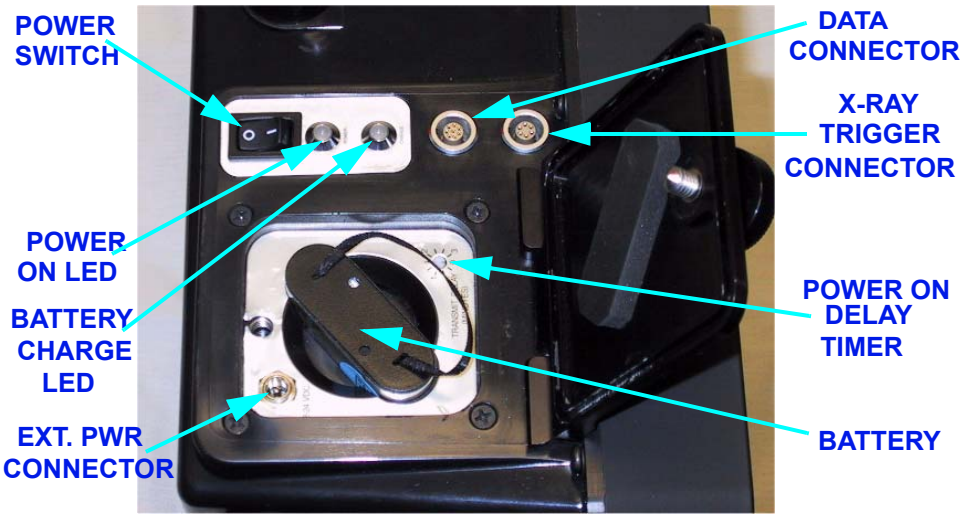
This unit provide for charging the DR35S NiMH 10.8Vdc battery while it is outside of the imager. It is connected to the local utility power and the battery to be charged is inserted. The charger is equipped with LEDs that indicate as follows:

LED	INDICATION
	IDLE, unit plugged in, no battery inserted.
Red	flashes once.
Green	flashes briefly, long dark pause.
	CHARGE, battery inserted.
Red	off.
Green	on steady, normal charging of smart battery.
	MAINTENANCE
Red	off.
Green	steady flashing, battery is fully charged.
	WAKEUP-CHARGE heavily discharged smart battery or not a smart battery.
Red	flashes on-off in equal amounts.
Green	flashes on-off in equal amounts.

LED	INDICATION
	TEMPERATURE FAILURE, battery is too hot or too cold for safe charging. The battery should be brought to operating temperature.
Red	On steady.
Green	Off.
	FAILURE, battery is physically damaged, do not use, discard battery.
Red	On.
Green	On.
Red	**FAILURE DURING INITIATION** If the red LED light up when the charger is plugged in, the charger is not ready for use. Contact your nearest dealer.

Imager Control Panel

Operation and interconnection of the imager with the rest of the RTR-4 system in the wired configuration is accomplished through a control panel at the side of the imager.



The functions located on the Imager control panel are as follows:

CONTROL OR INDICATOR	FUNCTION
Power On-Off Switch	Turns on the imager power for both internal battery and external power operation.
Power On LED	• Green and on steady when powered by battery. • Amber and on steady when powered by an external source. • Flashing green when power-up delay is selected, with last five seconds before power on rapid flashing green. • Flashing Amber when battery power is low.
Battery Charger LED	• Amber and flashing when testing battery. • Amber and on steady during battery charging. • Green and on steady when battery charging is complete.
Data Connector	Receptacle for the Extension Data Cable Spool. Color coded green to match the cable connector.
X-Ray Trigger Connector	Receptacle for the X-Ray Trigger Cable. Color coded yellow to match cable connector.
External Power Connector	Receptacle for an external 12Vdc to 24Vdc power source.
Battery Compartment	Receptacle for the NiMH 10.8Vdc battery. Insert battery with the "This side up" label towards the external power connector.
Power On Delay Timer	Provides for setting power-on delays from 0 to 3 minutes in 20 second intervals.

XR200 X-Ray Source

The RTR-4 system uses the Golden Engineering XR200 X-ray source. This is a pulsed 150kV unit with a 40° beam angle. This unit produces extremely short bursts of X-rays capable of penetrating several centimeters of most materials. The source is equipped with a keyed power switch to prevent the uncontrolled emission of X-rays. The source is battery powered using a rechargeable battery. The manufacturer states that 4000 pulses may be obtained with a fully charged battery. However, this will vary with temperature, battery age, and source condition.

Standard features include:

- Tube life: 100,000 pulses.
- X-ray Source Power Key and spare.
- 14.4Vdc removable, rechargeable nickel-cadmium (NiCd) battery pack and spare.
- Battery charger.
- Dimensions: 11.5cm x 19cm x 32cm (4.5in W x 7.5in H x 12.5in D). The front half is a canister with a diameter of 4.0cm (1.6in).
- Weight: 5.5kg (12.0lbs) including battery.

Additional information is available in the provided Golden Engineering Operator's Manual.

Interconnecting Cables

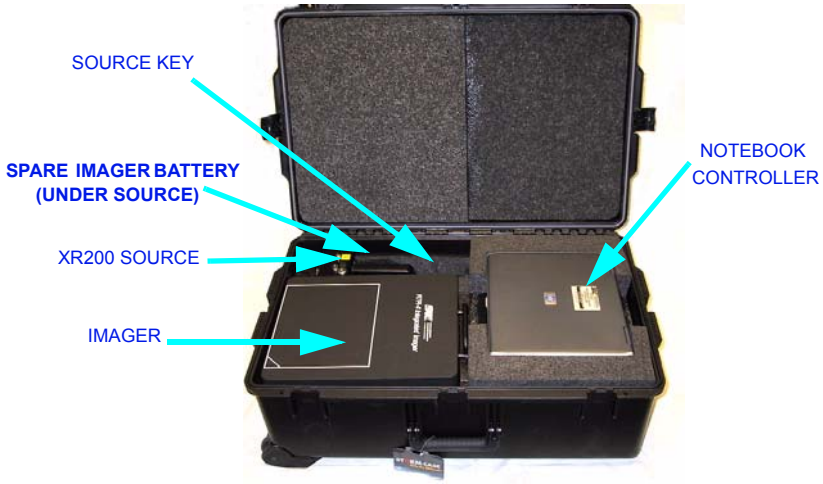
The RTR-4 system when setup in the wired configuration requires the following cables:

- 30cm (1ft) adapter cable that allows connection between the controller communications port and the 50m (164ft) signal cable.

- 50m (164ft) cable on a reel, passes communications and image data signals between the controller and the imager.
- 3m (10ft) X-ray source control cable connects the X-ray source to the imager.

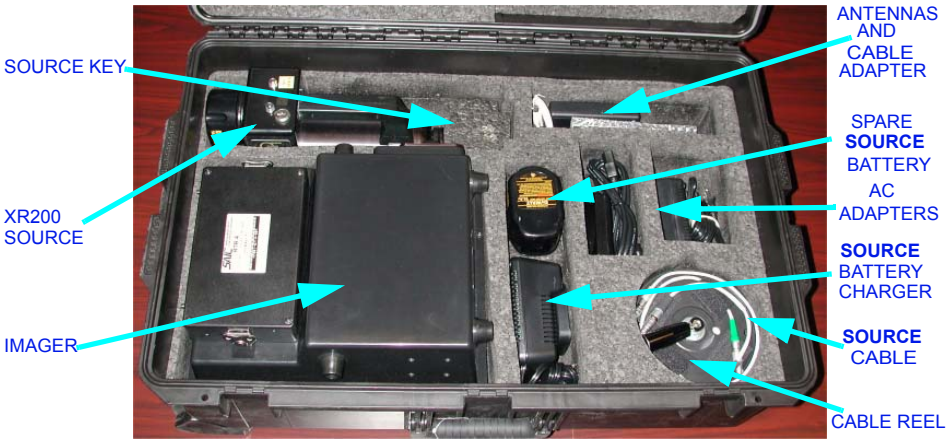
Transport Case

The RTR-4 is protected during transport and storage by a rugged impact-resistant plastic transport case with fitted foam inserts.



Key features are:

- A single watertight, crushproof, foam-lined case.
- Dimensions: 67.3cm x 27.9cm x 44.4cm (26.5in W x 11.0in H x 17.5in D)
- Weight: 11.8kg (26.0lb)



RTR-4 Standard Wireless Configuration

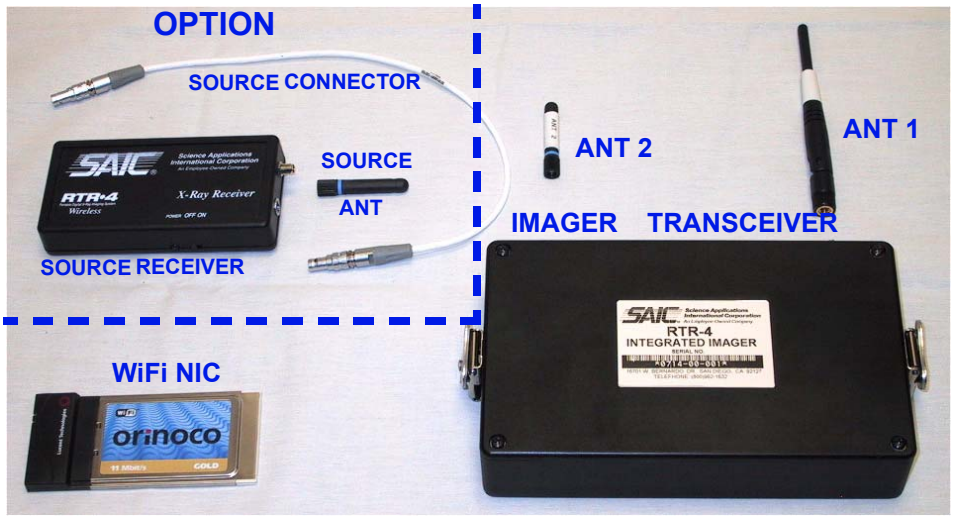
Wireless Option

The RTR-4 Wireless Option is an alternative to connecting the controller, X-Ray imager, and XR200 X-ray source with cables. Wireless operation simplifies system setup and use by eliminating the signal cables and provides greater controller to target distances. The Wireless systems adhere to the frequencies and protocols of the WiFi, IEEE-802.11b standard.

Radio-frequency energy between the imager and the controller combined with the radio-frequency energy to the X-ray receiver is at a very low intensity. When the Integrated Imager is more than 50cm (1.5ft) away from a target device, the RTR-4 Wireless operation complies with the Hazards of Electromagnetic Radiation to Ordnance (HERO) specifications. This consideration is only relevant if the RTR-4 is being used with potentially explosive devices.

The data transmission frequency of the Imager radio module and the controller is between 2.4000 and 2.4835GHz, and is spread-spectrum and frequency-hopping, according to the IEEE-802.11b-1999 standard, and is further encrypted to minimize snooping or spoofing. The frequency used when transmitting to the X-ray source receiver is about 418MHz for US usage and about 433MHz for European usage, which is very low power. The frequency is coded with a sequencing 64-bit security code to minimize the possibility of unintended source firing.

The wireless option adds the following components to the RTR-4 standard configuration:



- WiFi NIC.
- Imager transceiver.

- 2.4GHz screw-on transceiver antenna (ANT 1) for the imager transceiver provides signals for communication with the controller.
- 418MHz or 433MHz screw-on transmitter antenna (ANT 2) for the imager transceiver provides signals to the X-ray Receiver.
- Optional source transceiver with short antenna and connector cable for alternate X-Ray sources.

WiFi NIC

The Wifi NIC is a PC interface transceiver card that fits into the notebook Personal Computer Memory Card International Association (PCMCIA) slot. This card transmits and receives data to the Imager Transceiver radio module attached to the RTR-4 Imager.

Imager Transceiver Radio Module

The Image Transceiver radio module is affixed to the RTR-4 Imager with quarter turn clamps.This module transmits and receives data to the controller PC and transmits a trigger signal to the X-Ray receiver unit. A 3m (10ft) cable is available to permit placement of the Imager Transceiver radio module remotely from the imager to remove radio frequency energy from the immediate area of the suspect package. This cable connects from the radio module connector to the Imager at the receptacle located to the left of the radio module bulkhead connector.

Internal Source Receiver

A receiver within the X-ray source receives the trigger signal from the Imager radio module to fire the X-ray pulses. A label on the XR200 source indicates that the source is equipped with an internal receiver. All other sources use the externally mounted source receiver.

Optional Source Receiver (Externally Mounted)

An optional source receiver is affixed to the X-ray source by a velcro strip and connected to the source by a short cable. The externally mounted source receiver is not used on the current model XR200 source equipped with the internal receiver. All other sources require the external receiver to be used in the wireless configuration. The X-ray receiver unit receives a signal from the Image Transceiver radio module and fires the X-ray source. It has three components, the body, antenna, and connecting cable. Cables are available that can accommodate any of the four X-ray sources manufactured by Golden Engineering. The externally mounted X-ray receiver unit is powered by a standard 9-volt alkaline battery and has a power switch with an indicating LED.

Setting up the RTR-4

There are two setup configurations for the standard RTR-4, the wired configuration and the wireless configuration. There are some positioning related issues that apply to all setups that the operator must be aware of during the setup process.

Distance Adjustments

The distance between the source and the imager determines the target X-ray illumination. Although a distance of approximately 50-100cm (20in-40in) between the X-ray source and imager is recommended to provide a flat field image without sacrificing penetrating power. This separation distance can be decreased to penetrate thicker or denser materials, or increased to provide a flatter field for very thin objects. Regardless of the distance between the X-ray source and imager, it is usually better to place the suspect object as close to the center of the imager as possible to make the edges of objects sharper.

The further the suspect object is away from the imager and the closer to the source, the larger its projected image, and the larger its features appear in the acquired image. This can be used to magnify small features, but will result in fuzzier edges. Objects that are closer to the imager more closely reflect their true dimensions.

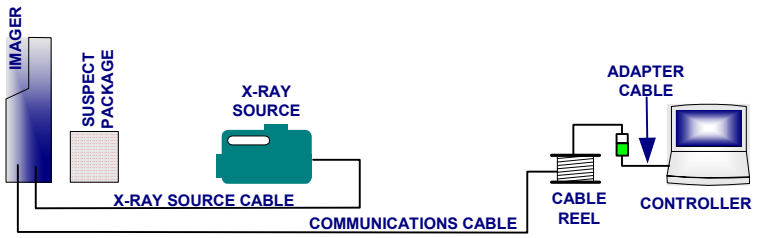
Position Adjustments

The imager's active area, denoted by the white rectangular outline on the flat side of the imager (the face), should be positioned as close as possible to the target object. The X-ray source should be positioned approximately 50cm-100cm (20in-40in) from the imager with its beam centered on and perpendicular to the imager face. The imager is oriented so that it is located as close to the ground as possible. The X-ray source is set on the ground or in a slightly elevated position so the source's beam is centered on the imager's face.

If needed, the imager can be used in an inverted position, such as suspended from a rope or wire, placed on a tripod, or on its side for imaging tall, narrow objects. An Image Orientation Indicator in the marked corner of the image shows the orientation of the object when the image was acquired. Regardless of the orientation, the image appears on the controller screen as though the imager was positioned with the handle on top. The image can be rotated to the actual orientation using the RTR-4 software.

Standard Wired Configuration

In the wired configuration of the RTR-4 Imaging System, cabling is used to interconnect the various components. The basic wired configuration is shown here.



Setting Up the Wired Configuration

Description

Use this procedure to setup the standard RTR-4 Imaging System in the wired configuration.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 components have been removed from their transport cases.
- All needed batteries have sufficient charge or have been recharged or replaced with new ones.
- A cleared, level workplace is available for setup and an appropriate exclusion zone has been established.

Procedure RTR0001

Setup the wired configuration of the RTR-4 system as follows:

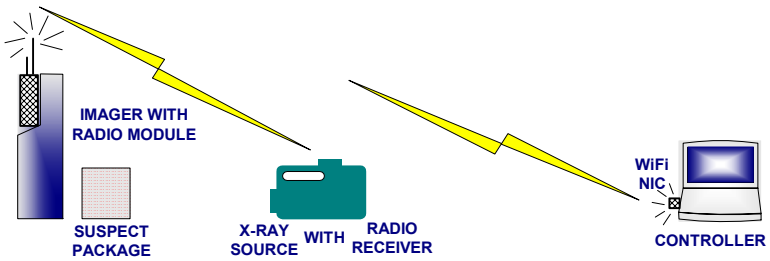
STEP	ACTION
1	Place the imager screen as close to the object to be imaged as possible.
2	Place the X-ray source approximately 1m in front of the imager, perpendicular to and level with the imager screen.
3	Connect the yellow connector of the 3m (10ft) X-ray Source cable to the imager and connect the other end to the X-ray source.

STEP	ACTION
4	Place the controller notebook in the selected area as far from the imaging area as is appropriate to adhere to exclusion zone requirements and other safety regulations.
	**CAUTION** When unreeling the cable, be sure to grasp the cable rather than the connector and unreel the cable rather than let the Imager pull the cable off the reel. This will extend cable life and reduce the likelihood of moving the suspect object. Failure to comply may damage equipment.
5	Connect the green connector of the 50m (164ft) communications cable to the appropriate connection on the Imager then unreel and extend the cable to the controller setup location. Use optional extension cabling if needed and available.
6	Connect the 30cm (1ft) adapter cable between the controller and the 50m (164ft) cable reel.
7	If 110/220Vac power is to be used for imager power, connect the supplied external power adapter directly to a 110/220Vac outlet and connect the adapter output to the external power connector on the Imager control panel.
8	If a power-on time delay is desired, use a small screwdriver to set the desired delay at the time delay rotary switch in the Imager battery compartment.
9	Turn on the Imager power switch.
10	Using the key, turn on the X-ray source. Verify that the X-ray source's Exposure Selector (display at the back of the X-ray source handle) is set to 99 pulses. Do not change this setting during operation of the RTR-4.
11	If 110/220Vac power is to be used for the controller, connect the supplied external power adapter directly to a 110/220Vac outlet and connect the adapter output to the controller.
12	Turn on the controller.

STEP	ACTION
	**WARNING** When the RTR-4 has been set up and is standing by for imaging, ensure all personnel follow applicable X-ray radiation safety distance recommendations for field operation. Failure to comply may result in personnel injury.

Standard Wireless Configuration

In the Wireless configuration of the RTR-4 Imaging System, radio components are used to interconnect the various components. The basic wireless configuration is shown here.



Setting Up the Wireless Configuration

Description

Verify the following prerequisites are completed before doing this procedure:

Use this procedure to setup the standard RTR-4 Imaging System in the wireless configuration.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 components have been removed from their transport cases.
- All needed batteries have sufficient charge or have been recharged or replaced with new ones.
- A cleared, level workplace is available for setup and applicable exclusion zone has been established.

Procedure RTR0002

Set up the wireless configuration of the RTR-4 system as follows:

STEP	ACTION
1	If not already mounted to the Imager, place the Imager radio module in the imager mounting bracket ensuring that the bulkhead connector is aligned and secure the module with the quarter-turn clamps.
2	If the Imager radio module is to be used remotely from the Imager, do the following: • Connect the 3m (10ft) cable to the female connector on the rear of the Imager. • Place the Imager radio module in desired location. • Connect other end of the 3m (10ft) cable to the Imager radio module.
	**CAUTION** Antenna connectors are not keyed. Ensure antennas are mated to the proper connector and correctly aligned before tightening. Do not force antennas onto connectors. Failure to comply may damage equipment.
3	Attach **ANT 1** and **ANT 2** to their respective connectors on the imager radio module.
4	Place the imager screen as close to the object to be imaged as possible.
5	Place the X-ray source approximately 1m in front of the imager, perpendicular to and level with the imager screen.
	**NOTE** If it is desired to reduce the radio energy in the vicinity of the object being X-Rayed, the X-Ray Source Cable can be connected between the imager and the source. This overrides the Imager radio module control of the source by permitting the source to be fired by signals sent through the cable.
6	Place the controller notebook in the selected area as far from the imaging area as is appropriate to adhere to exclusion zone requirements and other safety regulations.

STEP	ACTION
7	Insert the WiFi NIC into the PCMCIA slot on the controller notebook.
8	If 110/220Vac power is to be used for the imager, connect the supplied Imager external power adapter directly to a 110/220Vac outlet and connect the adapter output to the external power connector on the Imager control panel.
9	If a power-on time delay is desired, use a small screwdriver to set the desired delay at the time delay rotary switch on the Imager control panel.
10	Turn on the Imager power switch.
11	Using the key, turn on the X-ray source. Verify that the X-ray source's Exposure Selector (display at the back of the X-ray source handle) is set to 99 pulses. Do not change this setting during operation of the RTR-4.
12	If 110/220Vac power is to be used for the controller, connect the supplied controller external power adapter directly to a 110/220Vac outlet and connect the adapter output to the controller.
13	Turn on the controller.
	**WARNING** When the RTR-4 has been set up and is standing by for imaging, ensure all personnel follow applicable X-Ray radiation and RF safety distance recommendations for field operation. Failure to comply may result in personnel injury.

Quick Start

System Initialization

Description

Use this procedure to prepare the RTR-4 for X-raying an object.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The appropriate setup procedure has been completed.
- The source and imager are correctly positioned by the object to be X-rayed and the source, imager, and controller have been turned on.

Procedure RTR0003

Initialize the RTR-4 as follows:

STEP	ACTION
1	At the controller screen, select either Wired *or* Wireless mode.
2	The controller will then load Windows. The splash screen will appear followed by the main menu screen.
3	To use the software database function, verify that **Enable Database** is checked on the **Preferences** menu.

Acquiring an X-Ray Image

Description

Follow this procedure to X-ray an object.

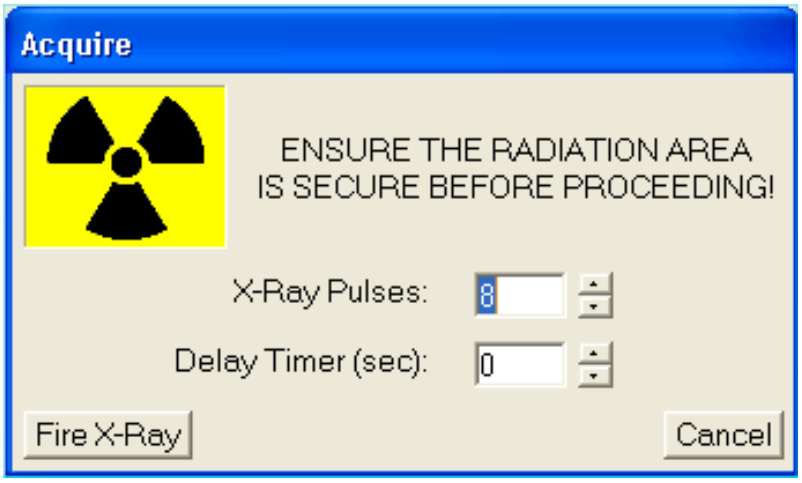
Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 is fully configured in accordance with the applicable setup procedure.
- The Source and Imager units are correctly positioned around the item to be X-rayed and the source Safety Keyswitch has been turned 90° clockwise.
- The RTR-4 imaging software has been properly initiated and is running.

Procedure RTR0004

X-Ray an object as follows:

STEP	ACTION
	**WARNING** Excessive exposure to X-ray radiation is harmful. Verify the exclusion zone is clear of all personnel. Failure to comply may result in personnel injury.
1	Press the **F1** key or click the **Acquire**  button on the toolbar. The **Acquire** dialog box appears.
2	Enter the number of pulses desired and the desired time delay. 
3	Press the **Enter** key or click on the **Fire X-Ray** button. The source fires and an image appears on the screen.
	**NOTE** The X-ray source fires and an image is produced. Examine image to determine if the image shall be saved or discarded. Press **F2** to **QuickSave or F4** to **Save As** or if the image is too dark, discard it and take another image, either with a higher pulse settings or use the Sum feature. If the image is too light, discard it and take another image with a lower pulse setting. Proceed to the appropriate procedure in the operations chapter.

4 System Operation

Introduction

This chapter describes how to operate the Standard RTR-4 system in both wired and wireless modes and contains the following sections:

- Operating the RTR-4.
- Image Processing.
- Image Preservation.
- Software Description.
- Shutting Down and Stowing the RTR-4.
- Operator Maintenance.

Operating the RTR-4

Acquiring an X-Ray Image

Description

Follow this procedure to X-Ray an object.

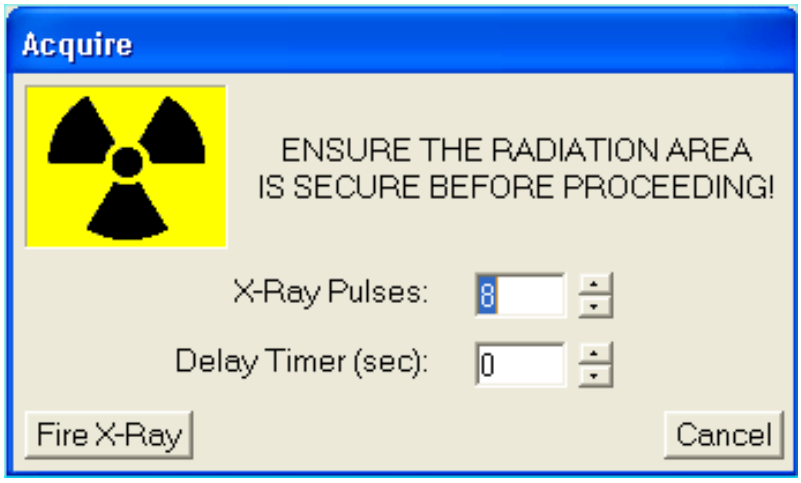
Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 is configured in accordance with the applicable setup procedure in the previous chapter.
- The Source and Imager units are correctly positioned around the item to be X-Rayed and the source Safety Keyswitch has been turned 90° clockwise.
- The RTR-4 imaging software has been properly configured and is initiated and running.

Procedure RTR0004

X-Ray an object as follows:

STEP	ACTION
	**WARNING** Excessive exposure to X-Ray radiation is harmful. Verify the exclusion zone is clear of all personnel. Failure to comply may result in personnel injury.
1'	Press the **F1** key or click the **Acquire**  button on the toolbar. The **Acquire** dialog box appears.
2	Enter the number of pulses desired and the desired time delay. 
3	Press the **Enter** key or click on the **Fire X-Ray** button. The source fires and an image appears on the screen in the Original buffer.
	**NOTE** The X-Ray source fires and an image is produced. Examine image to determine if the image shall be saved or discarded. Press **F2** to **QuickSave or F4** to **Save As** or if the image is too dark, discard it and take another image, either with a higher pulse settings or use the Sum feature. If the image is too light, discard it and take another image with a lower pulse setting. Proceed to the appropriate procedure.

Using the Sum Command

Description

If an image appears too dark after using 99 pulses to acquire it, you can use the **Sum** command to accumulate more that 99 pulses per image. The **Sum** command allows the operator to acquire an initial image then acquire subsequent images that are automatically added (summed) to the initial image. Follow this procedure to obtain an X-Ray using the **Sum** command.

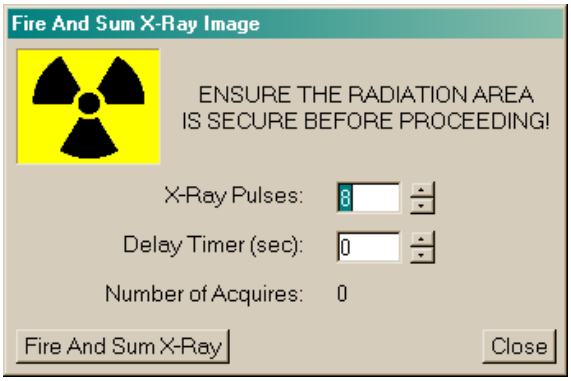
Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 is configured in accordance with the applicable setup procedure in the previous chapter.
- The source and imager units are correctly positioned by the object to be X-rayed and the source Safety Keyswitch has been turned 90° clockwise.
- The RTR-4 imaging software has been properly configured and is initiated and running.

Procedure RTR0005

Obtain a summed X-Ray image as follows:

STEP	ACTION
1	Close all images currently open.
2	Select **Sum** from the **Acquire** menu. The **Fire and Sum X-Ray Image** dialog box appears. 
3	Enter the number of pulses desired up to 99 and enter the desired time delay up to 300 seconds.

STEP	ACTION
	**WARNING** Excessive exposure to X-Ray radiation is harmful. Verify the exclusion zone is clear of all personnel. Failure to comply may result in personnel injury.
4	Click the **Fire and Sum X-Ray** button. After the source fires, an image appears on the screen along with the **Fire and Sum X-Ray** dialog box.
5	If the image is satisfactory, click the **Close** button in the dialog box and proceed to step 8. If the image is unsatisfactory, continue to next step.
	**CAUTION** If the source is set to fire more than 99 pulses, wait five minutes before firing the source again. This permits the source to cool down properly. Failure to comply may damage the source.
6	Enter the number of pulses desired up to 99 and enter the desired time delay up to 300 seconds.
7	Click the **Fire and Sum X-Ray** button. The newly acquired image is added to the previous image. Repeat steps 5 through 7 until a satisfactory image is obtained.
8	When a satisfactory image is obtained, save the image using **QuickSave** or **Save As**.

Using the Add Images Feature

Description

The **Add Images** feature allows the operator to accumulate more than 99 pulses per image by adding the pixels from a second image. The images can either be newly acquired or retrieved from the image file folder. Follow this procedure to obtain an X-Ray using the **Add Images** feature.

Prerequisites

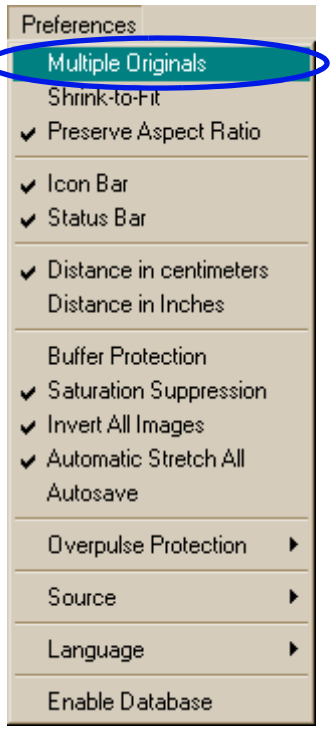
Verify the following prerequisites are completed before beginning this procedure:

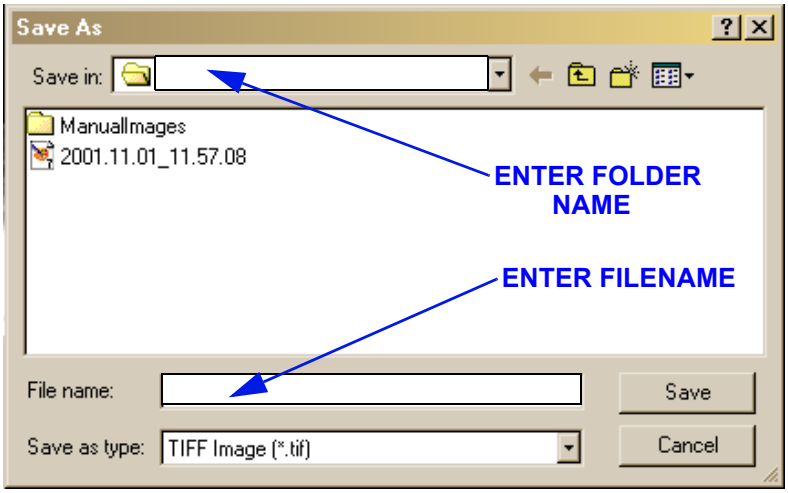
- The RTR-4 is configured in accordance with the applicable setup procedures in the previous chapter.
- The Safety Keyswitch has been turned 90° clockwise.

- The RTR-4 imaging software has been properly configured and is initiated and running.

Procedure RTR0006

Obtain a Added image as follows:

STEP	ACTION
1	Close all images currently open.
2	Click on the **Preferences** pull-down menu.
3	Verify the **Multiple Originals** command is disabled (unchecked.) 
	**WARNING** Excessive exposure to X-Ray radiation is harmful. Verify the exclusion zone is clear of all personnel. Failure to comply may result in personnel injury.
4	Acquire the first image and save it.
	**CAUTION** If the source is set to fire more than 99 pulses, wait five minutes before firing the source again. This permits the source to cool properly and allow the battery to recover. Failure to comply may damage the source unit.

STEP	ACTION
5	Acquire the second image and save it. Do not close the image.
6	Press the **F7** key to display the **Modified** buffer. **Modified** appears in the status bar at the bottom of the screen.
7	Open the first image from step 4. It appears in the **Modified** buffer.
8	Press the **F7** key to display the **Original** buffer. **Original** appears in the status bar.
9	Select **Add Images** from the **Modify** menu. The images are added together and the result appears in the **Modified** buffer.
10	To make the image more visible, click the **Auto Contrast**  button on the toolbar.
11	Save the new image by pressing **F4** or clicking the **Save As**  button on the toolbar. The **Save As** dialog box appears.
12	Use the browse feature to ensure the correct folder appears in the Save in field. 
13	Type the desired filename into the **File name** field.
14	Press the **Enter** key or click on the **Save** button.

STEP	ACTION
15	If equipped, turn the Controller Safety Keyswitch 90° counterclockwise to disable the source.

Using the Subtract Images Command

Description

The **Subtract Images** command contrasts two identical-looking images to see if there are any differences between them. Follow this procedure to use the **Subtract Images** command.

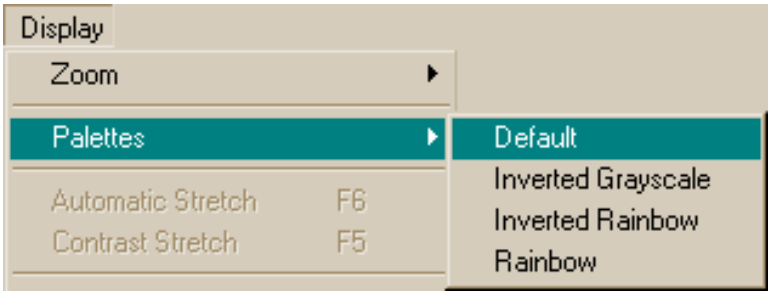
Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 is configured in accordance with the applicable setup procedures in the previous chapter.
- The Safety Keyswitch has been turned 90° clockwise.
- The RTR-4 imaging software has been properly configured and is initiated and running.

Procedure RTR0007

Use the **Subtract Images** command as follow:

STEP	ACTION
1	Close all images currently open.
2	Verify the Default palette is selected. 
3	Press the **F5** key or click the **Contrast Stretch**  button on the toolbar. The **Contrast Stretch** dialog box appears.

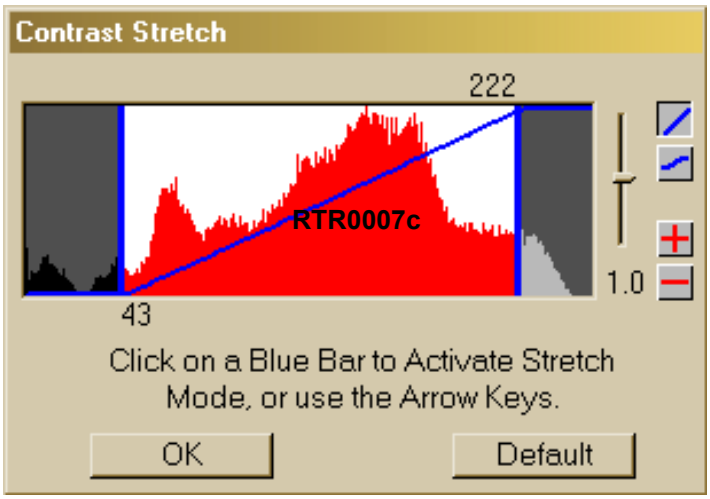
STEP	ACTION
4	Click the **Default** button then click on the **OK** button. 
5	Acquire an image of a unknown object and save it.
6	Acquire an image of the known object and save it. Do not close the image.
7	Press the **F7** key to display the Modified buffer. **Modified** appears in the status bar.
8	Open the unknown image file. The image appears in the **Modified** buffer.
9	Press the **F7** key to display the **Original Buffer**. **Original** appears in the status bar.
10	Select **Subtract Images** for the **Modify** menu. The resulting subtracted image appears in the **Modified** buffer.
11	To make the image more visible, click the **Auto Contrast**  button on the toolbar.
12	Save the new image by pressing the **F4** key or clicking the **Save As**  button on the toolbar. The **Save As** dialog box appears.
13	Enter a descriptive filename and click the **Save** button.

Image Processing

The following procedures provide the RTR-4 operator with various options to manipulate images after they have been acquired. The purpose of these manipulations is to improve the visualization of acquired images and to annotate them for future reference.

Retrieving an Image

Description

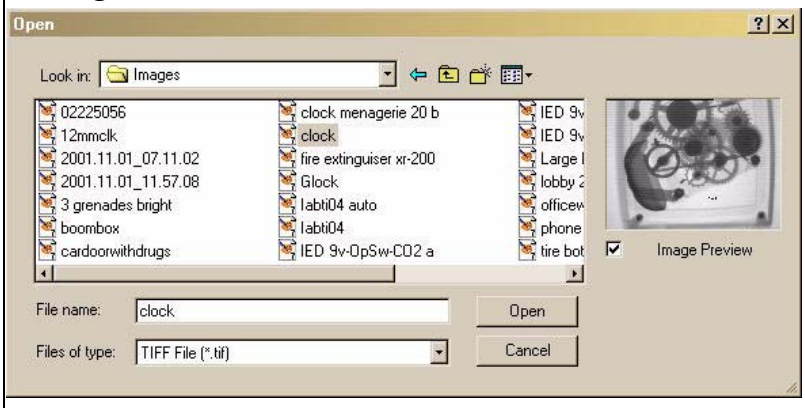
Follow this procedure to open an image file from the images folder.

Prerequisites

The RTR-4 imaging software has been properly configured and is loaded and running.

Procedure RTR0008

Retrieve an existing image as follows:

STEP	ACTION
1	Press the **F3** key or click the **Open File** button  on the toolbar. The open dialog box appears.
2	Verify the **Images** folder is displayed in the Look in: dialog box. 
3	Select the file to be opened.
4	Click on the **Open** button.

Showing Image Information

Description

Follow this procedure to obtain information such as the date and time the image was acquired and the number of pulses used to acquire the image.

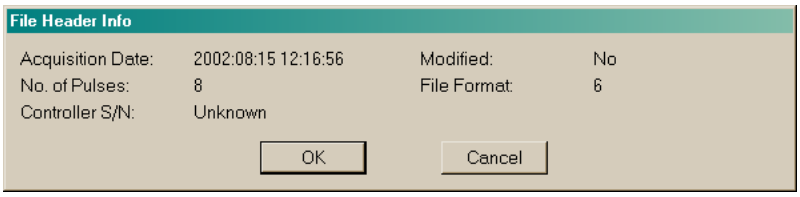
Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0009

Obtain image information as follows:

STEP	ACTION
1	Select **Image Header** from the **Display > Show** pull-down menu. The **File Header Info** dialog box appears. 
2	Click the **OK** or **Cancel** button to close the dialog box.

Using Multiple Image Display

Description

It is often useful to present images next to each other for comparison purposes. Follow this procedure to set the display to show multiple images.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the Original Buffer and one is displayed in the Modified Buffer.

Procedure RTR0010

Display multiple images as follows:

STEP	ACTION
1	Select **Multiple Original** from the **Preferences** pull-down menu.
	**NOTE** Once selected, **Multiple Original** will remain in effect until cleared or the software program is closed.
2	At the **Window** pull down menu, select either: • **Tile Horizontal** • **Tile Vertical** Depending upon selection, images will be displayed one above the other or side by side.

Using the Grid Overlay

Description

The RTR-4 imaging software has a **Grid Overlay** feature to assist the operator in determining the position and dimension of components in an image. Follow this procedure to enable and disable the **Grid Overlay** feature.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the Original Buffer.

Procedure RTR 0011

Use the Grid Overlay feature as follows:

STEP	ACTION
1	Select **Grid Overlay** from the **Display** menu. A grid appears over the displayed image.
2	Select **Distance in Centimeters** or **Distance in Inches** from the **Preferences** pull-down menu.

STEP	ACTION
	**NOTE** Once selected, the **Grid Overlay** remains in place until cleared. Complete step 3 to clear the **Grid Overlay**.
3	Select **Grid Overlay** from the **Display** menu. The grid disappears.

Measuring Distance in an Image

Description

Follow this procedure to measure the distance between two points in an image, either in centimeters or inches, depending upon the Preferences setting.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0012

Measure distance as follows:

STEP	ACTION
1	Select **Distance Measurement** from the **Display** pull-down menu or press **Ctrl+d** on the keyboard. The cursor symbol changes to crosshair.
2	Move the crosshair cursor to the initial measuring point and click.
3	Move the crosshair cursor to the final measuring point and click. A dialog box appears with the distance indicated in centimeters or inches depending upon **Preferences** setting.
4	Click on the **OK** button to close the dialog box.

Adding Lines and Text

Description

The RTR-4 imaging software has provisions to allow the operator to place lines and text on an image to highlight or point out certain areas. Follow this procedure to add lines and text to an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0013

Add lines and text to an image as follows:

STEP	ACTION
1	To add text, select **Annotate>Text>Black** (or **White**) from the **Modify** pull-down menu.  The cursor changes to the text I-beam.
2	Move the cursor to where the text is to be added and click. A text box appears.
3	Type in the desired text and then press **Enter**.
4	To add a line to the image, select **Annotate>Lines>Black (or White)** from the **Modify** pull-down menu.  The cursor changes to the crosshair symbol.

STEP	ACTION
5	Move cursor to the beginning point of the line and click the mouse button.
6	Move the cursor to the end point of the line and click the mouse button.

Using Contrast Stretch

Description

Contrast Stretch provides the operator with the most useful tool to analyze images. This function allows the operator to make graduated changes in the brightness and contrast of an image. Doing this often reveals objects of very slight differences in density from their surroundings.

Follow this procedure to adjust the brightness, darkness, and contrast of an image.

Prerequisites

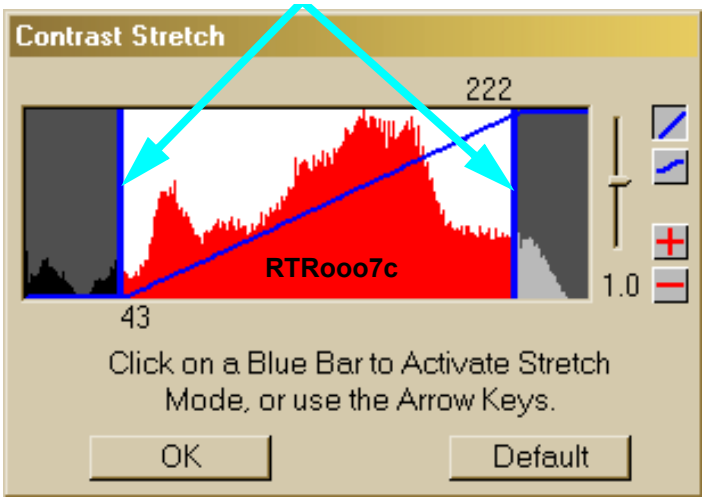
Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0014

Use **Contrast Stretch** as follows:

STEP	ACTION
1	Press the **F5** key or click the **Contrast Stretch**  button on the toolbar. The **Contrast Stretch** dialog box appears.

STEP	ACTION
2	Click on a vertical blue bar to change the image brightness. The bar will flash a different color when properly selected. 
3	Move the cursor to the left or right to vary the brightness of the image. Notice the selected blue bar moves as the cursor moves, adjusting the brightness of the image in the active buffer.
4	Click the blue bar again to stop the bar from moving.
	**NOTE** Selecting and moving either the left or right vertical blue bar will vary the brightness of the image. Depending on the distribution of the density graph, one may have more affect than the other. The operator should try both until satisfied with the image display. To change the contrast of the image, continue this procedure.
5	Place the cursor in the space between the vertical bars and click. Both bars will flash.
6	Move the cursor left or right to adjust the contrast.
7	When satisfied with the contrast setting, click between the vertical bars again.
8	To close the dialog box either click the **OK** button to keep the changed settings or click the **Default** button to return to the original settings.

Using Automatic Stretch

Description

Follow this procedure to automatically adjust the brightness and contrast of an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the Original Buffer.

Procedure RTR0015

Use Automatic Stretch as follows:

STEP	ACTION
1	Press the **F6** key or click the **Auto Stretch**  button on the toolbar. The image contrast and brightness adjust to optimum levels.
	**NOTE** If not satisfied with the auto-adjusted image, follow the **Contrast Stretch** procedure. To return the image to the original settings, continue this procedure.
2	Press the **F5** key or press the **Contrast Stretch**  button on the toolbar. The **Contrast Stretch** dialog box appears.
3	Click the **Default** button to return to the original settings.

Using the Color Palettes

Description

The default palette is grayscale. Some images are easier to interpret if color is used to show density differences. Follow this procedure to select the color palette or an inverted palette.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0016

Change the image palette as follows:

STEP	ACTION
1	Select **Palettes** from the **Display** menu.
2	Select one of the following commands from the **Palettes** pull-down menu. • **Default** • **Inverted Grayscale** • **Inverted Rainbow** • **Rainbow**
3	To return to default settings, select **Default** from the **Palettes** drop menu.

Using Saturation Suppression

Description

Image saturation occurs when a dense object surrounded by less dense material is X-rayed using a high number of pulses. The image will have bright white areas surrounding the denser object.

These bright areas make it difficult to see the contents of the denser area. **Saturation Suppression** changes the white pixels to black allowing better interpretation of detail in the denser area. Follow this procedure to enable the saturation suppression feature.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0017

Use **Saturation Suppression** as follows:

STEP	ACTION
1	Select **Saturation Suppression** from the **Display** pull-down menu.
	**NOTE** Once enabled, Saturation Suppression will remain in effect until disabled. The Saturation Suppression will be applied on all subsequent images. Complete step 2 to disable the Saturation Suppression feature.
2	Select **Saturation Suppression** from the **Display** menu.

Sharpening an Image

Description

Image sharpening defines the lines and edges in an image and improve an image's resolution. Follow this procedure to sharpen an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0018

Sharpen an image as follows:

STEP	ACTION
1	Press the **F8** key or click on the **Sharpen Image** button  on the toolbar. The sharpened image appears in the **Modified** buffer.

STEP	ACTION
2	Or select: • **Sharpen>Fine** • **Sharpen>Moderate** • **Sharpen>Extreme** from the **Modify** pull-down menu.
	**NOTE** An image may be sharpened several times before distortion become severe. Use the **Ctrl+Z** key combination or click the **Undo** button  on the toolbar to undo a sharpen. Also, you may return to the **Original** buffer.

Smoothing an Image

Description

Image smoothing softens edges, softens image, and reduces image resolution. Follow this procedure to soften an image.

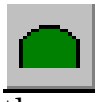
Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0019

Smooth an image as follows:

STEP	ACTION
1	Press the **F9** key or click the **Smooth** button  on the toolbar. A smoothed image appears in the **Modified** buffer.

STEP	ACTION
2	Select one of the following commands: • **Smooth>Fine** • **Smooth>Moderate** • **Smooth>Extreme** from the **Modify** pull-down menu.
	**NOTE** An image may be smoothed several times before distortion become severe. Use **Ctrl+Z** key combination or click the **Undo** button  on the toolbar to undo a smooth. Also, you may return to the **Original** buffer.

Reducing Image Noise

Description

Noise is randomly colored and scattered pixels within an image that give the image a cluttered and unclear appearance. Follow this procedure to reduce noise in an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0020

Reduce image noise as follows:

STEP	ACTION
1	Select one of the following commands from the **Modify** pull-down menu. • **Noise Reduction>Average** • **Noise Reduction>Median** • **Noise Reduction>Despeckle**
2	The noise reduced image appears in the **Modified** buffer.

STEP	ACTION
	**NOTE** Noise reduction may be used several times before distortion become severe. Use **Ctrl+Z** key combination or click the **Undo** button  on the toolbar to undo. Also, you may return to the **Original** buffer.

Using Edge Detection

Description

Edge detection displays white lines on a dark background where the edge of objects appear. **Invert Grayscale** can be used to show a reverse image-black lines on a white background. Follow this procedure to edge detect an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0021

Edge detect an image as follows:

STEP	ACTION
1	Select one of the following commands: • **Edge Detect>Horizontal** • **Edge Detect>Vertical** • **Edge Detect>General** from the **Modify** pull-down menu.
2	The Edge Detected image appears in the **Modified** buffer.

STEP	ACTION
	**NOTE** Edge Detect may only be used a few times before distortion become severe. Use **Ctrl+Z** key combination or click the **Undo** button  on the toolbar to undo. Also, you may return to the **Original** buffer.

Embossing an Image

Description

Embossing suppresses color and makes an image appear raised or stamped in a "high relief" pattern. This is useful if the pattern or density appears uniform throughout the image making it difficult to pick out specific objects. Follow this procedure to emboss an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.

Procedure RTR0022

Emboss an image as follows:

STEP	ACTION
1	Select **Emboss** from the **Modify** menu.
2	The embossed image appears in the **Modified** buffer.
	**NOTE** Emboss may only be used a few times before distortion become severe. Use **Ctrl+Z** key combination or click the **Undo** button  on the toolbar to undo. Also, you may return to the **Original** buffer.

Using Histogram Equalization

Description

The **Histogram Equalize** command moves the density scale of an image slightly causing the lighter areas to darken slightly and the darker areas to lighten slightly. Follow this procedure to perform a **Histogram Equalize**.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software is on and software preferences have been set.
- An image is displayed in the **Original** buffer.

Procedure RTR0023

Use Histogram Equalize as follows:

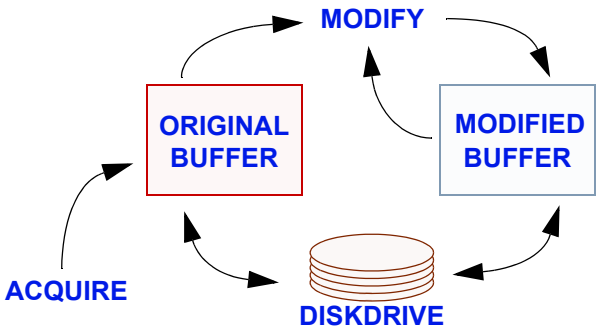
STEP	ACTION
1	Select **Histogram Equalize** from the **Modify** pull-down menu.
2	The equalized image appears in the **Modified** buffer.
	**NOTE** **Histogram Equalize** only slightly affects an image. More than one use is unlikely to produce any useful results. Use the **Ctrl+Z** key combination or click the **Undo** button  on the toolbar to undo. Also, you may return to the **Original** buffer.

Image Preservation

The operator must be aware of the following regarding image preservation:

- A newly acquired image is displayed in the **Original** buffer.
- A newly acquired image remains unchanged in the **Original** buffer until another image is acquired or a saved image is opened with the **File Open** command while the **Original** buffer is active.

- Modifications made to an image in the **Original** or the **Modified** buffers will overwrite the image in the **Modified** buffer.
- Immediately save a newly acquired image to prevent its loss.



QuickSaving an Image

Description

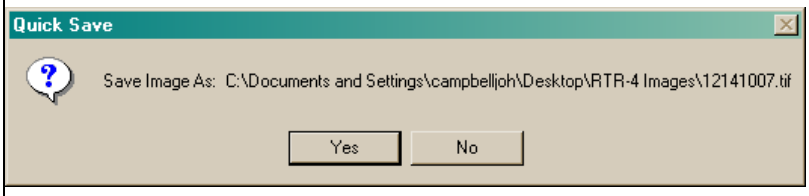
Follow this procedure to "quick save" an image to the default **C:\Images** folder with a default file name.

Prerequisites

Verify an unsaved image is present in the active buffer.

Procedure RTR0024

QuickSave an image as follows:

STEP	ACTION
1	Press the **F2** key or click the **QuickSave!** button  on the toolbar. The **QuickSave!** dialog box appears.
2	Click on the **Yes** button. 
	**NOTE** The displayed image is saved to the **C:\Images** folder with a default file name. DD.HH.MM.SS.tif The day date, hour, minutes, and seconds and the image file type.

Saving an Image

Description

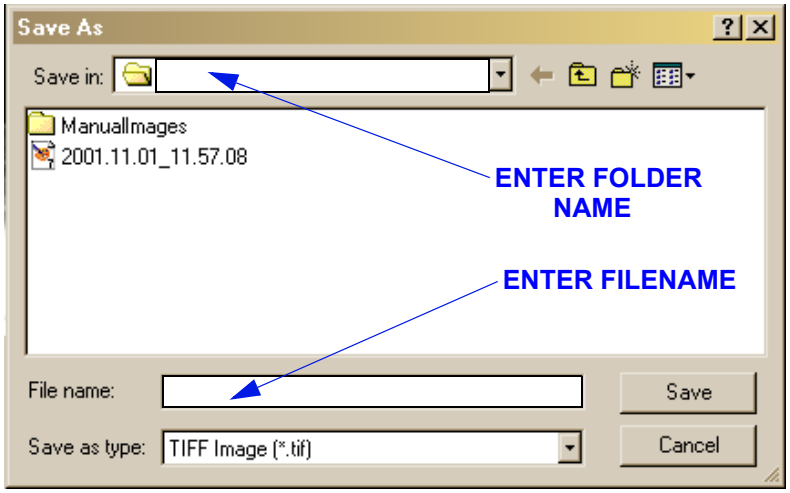
Follow this procedure to save an image with a specific filename to a location other than the default folder.

Prerequisites

Verify an unsaved image is present in the active buffer.

Procedure RTR0025

QuickSave an image as follows:

STEP	ACTION
1	Press the **F4** key or click the **Save As**  button on the toolbar. The **Save As** dialog box appears.
2	Use the browse feature to ensure the correct folder appears in the Save in field. 
3	Type the desired filename into the **File name** field.
4	Press the **Enter** key or click on the **Save** button.

Print an Image

Description

Follow this procedure to print an image.

Prerequisites

Verify the following prerequisites are completed before beginning this procedure:

- The RTR-4 imaging software has been properly configured and is loaded and running.
- An image is displayed in the **Original** buffer.
- Verify a printer is connected to the printer port, is loaded with paper, and is powered up.

Procedure RTR0026

Print an image as follows:

STEP	ACTION
1	Select **Print** from the **File** pull-down menu to print the image in the active buffer.
2	Select **Print Window** from the **File** pull-down menu to print the entire Main Menu screen.

Software Description

The RTR-4 imaging software has many unique operating features differing from the MS Windows® OS installed on the controller notebooks. RTR-4 operators must be familiar with the Windows® OS. This manual does not cover Windows® operation. Information and training on Windows® may be located at http://www.microsoft.com. RTR-4 application-specific features and commands are listed and described in the following paragraphs.

RTR-4 Functions

In most cases the RTR-4 commands can be accessed by:

- The pull-down menus listed in the Main Menu bar at the top of the screen.
- A button on the toolbar displayed under the Main Menu bar.
- The Function Keys (F1-F12) located at the top row of the keyboard.
- Various keys or key combinations (refer to the **Key Map** selection under the **Help** pull-down menu for more information).
- The RTR-4 application may be operated using the keyboard in the advent of a mouse or pointing device failure.

Once the RTR-4 is set up and configured, the operator shall launch the imaging software and verify that it is running normally and properly configured.

Images are acquired with the RTR-4 using an imaging and modification software program installed on the RTR-4 system. The RTR-4 Main Menu screen is a standard Windows-based Graphical User Interface (GUI) activated through onscreen pull-down menus and toolbar buttons as well as keyboard commands.

The RTR-4 software includes a database feature that lets the user record information about an image such as operator name, date of acquisition, location, project, type of image, X-Ray source and serial number, and any comments about the image. This information can then be retrieved, viewed, sorted by category, and changed as needed to provide an accurate record of acquisitions and modifications, and assist the user in locating and organizing images. The database function is enabled in the Preferences menu, and accessed through the File menu.

The operator must be familiar with the RTR-4 software pull-down menus, dialog boxes, and toolbar buttons. The figure below shows the Main Menu screen as it appears at startup.

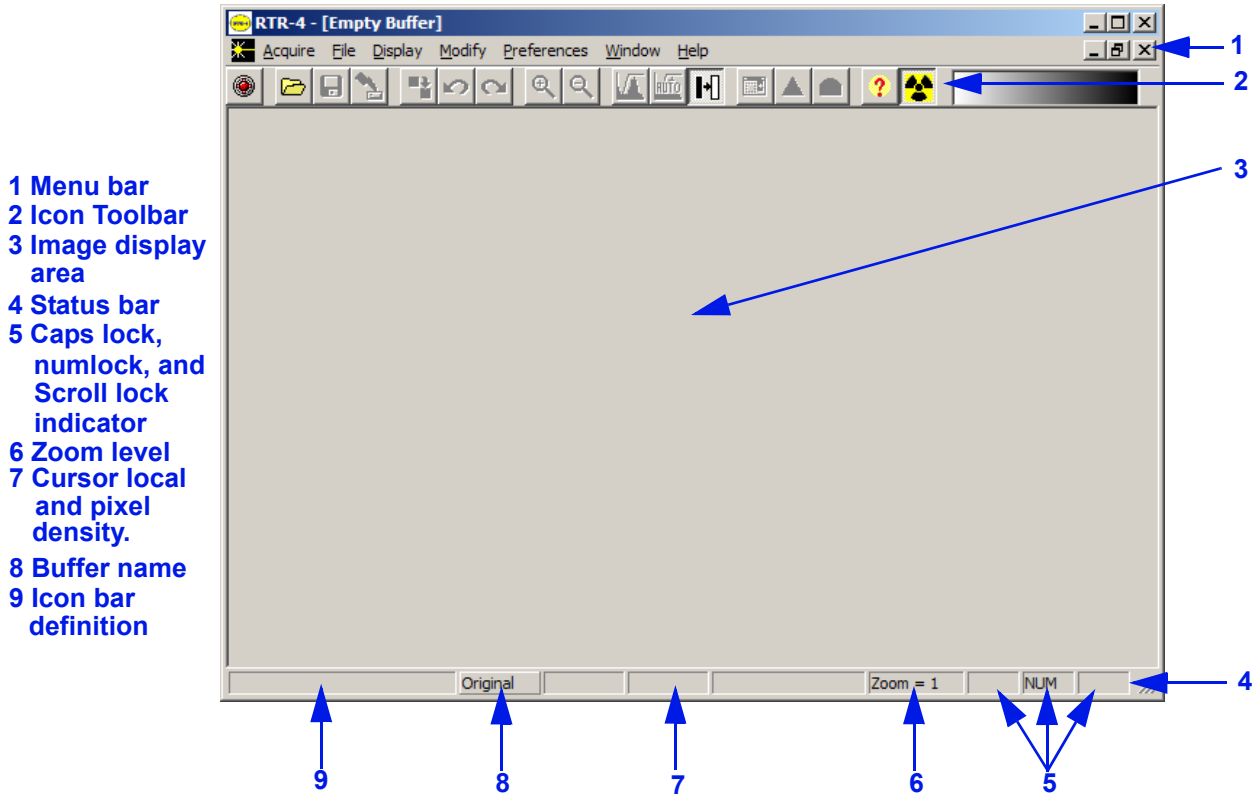
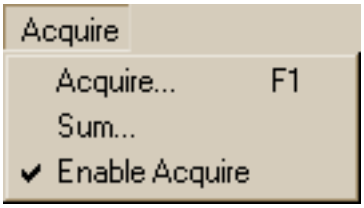


Figure 4-1: Main Menu Screen

The Acquire Menu

The **Acquire** menu contains the **Acquire..., Sum**, and **Enable Acquire** commands.



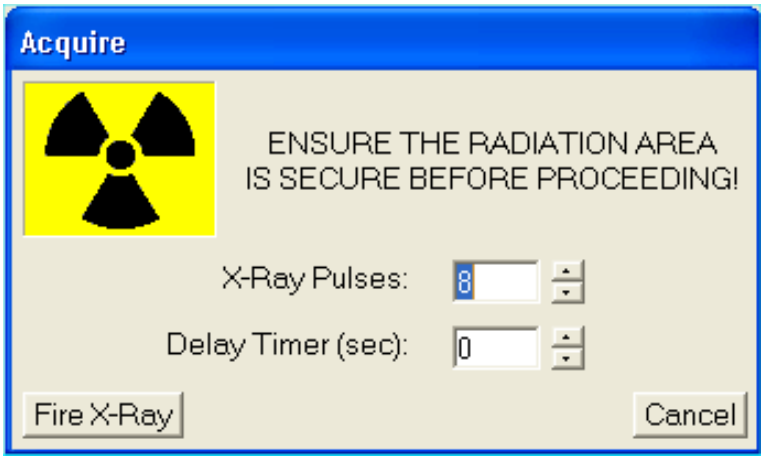
COMMAND	DESCRIPTION
Acquire... (F1)	When selected, the system waits the number of seconds specified in the **Delay Timer** field, then the X-Ray source fires for the specified number of pulses and an image is acquired.
Sum...	Used to collect an initial image, then subsequent acquired images are added to the existing image. This operation may be repeated as often as the operator desires. This command is useful when the target object is thick or made of a dense material.
Enable Acquire	When enabled (checkmark present), the Acquire command is enabled and the source can fire. When disabled (no checkmark), the Acquire command is disabled and the source will not fire. A password will be required to re-enable this function.

During image acquisition, a progress bar is displayed, showing progress as the image is transferred the **Original** buffer. When finished, the system returns to the main screen and the image is displayed.

An **Acquire** request can be canceled at any point by selecting **Cancel** or pressing **Esc** twice. The **Cancel** or **Esc** commands return the user to the Main Menu.

Acquire Dialog Box

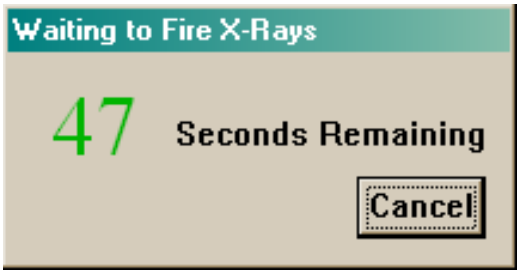
The two **Acquire** dialog box settings and their respective ranges are:



COMMAND	DESCRIPTION	TYPICAL INPUT RANGE	DEFAULT
X-Ray pulses	Sets the number of times the source pulses on firing	5-99 pulses	Eight pulses
Delay Timer	Sets the time delay before the source fires	0-300 seconds	Zero seconds

Delay Dialog Box

When a **Delay Timer** value other than zero seconds has been set, a message box appears on the display with a counter that counts

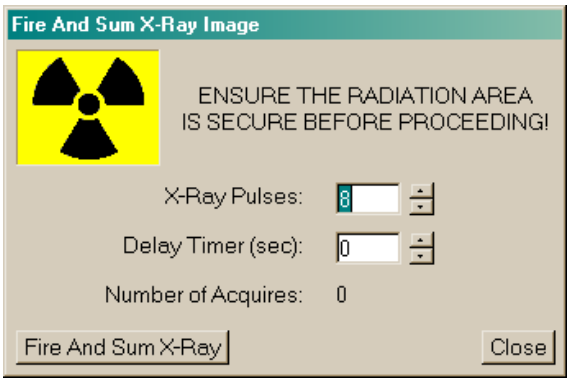


down the preset number of seconds.**Cancel** may be selected to abort image acquisition at any point during the countdown.

Once the **Delay Timer** value has been changed, it remains at the changed setting until the program is shut down. The **Delay Timer** value automatically resets to zero when the application is restarted.

Fire and Sum X-Ray Dialog Box

Selecting **Fire and Sum X-Ray** command captures the first image. The Acquire dialog box appears again automatically. If the first image is adequate, select **Cancel**. If not, set the option values and select **Fire and Sum X-Ray** again. This adds the newly-acquired image to the sum of the previous images.



Using the **Sum** command can help produce images with superior signal-to-noise ratios (SNR), by adding multiple acquisitions, thus achieving higher grayscale values in the resulting image. Be sure the Contrast Stretch is set to Default before starting so the image does not wash out prematurely.

Disable Acquire

The **Disable Acquire** command is depicted by  button at the end of the toolbar. This button is only visible on those systems which do not have the optional **Interlock Safety Key**. When the button is depressed (the default state) **Acquire** is enabled and the system responds as normal. When this icon is enabled, the user is prompted to enter a password. This password will be required to

re-enable the **Acquire** command. The password is not retained for future use; a new password is requested each time the function is activated. This function acts as a software safety interlock, and can be used to prevent another user from accidentally firing the X-Ray source.

The File Menu

The **File** pull-down menu contains file management commands. These commands allow the opening, closing, printing, and saving of files and the option to exit the RTR-4 application.

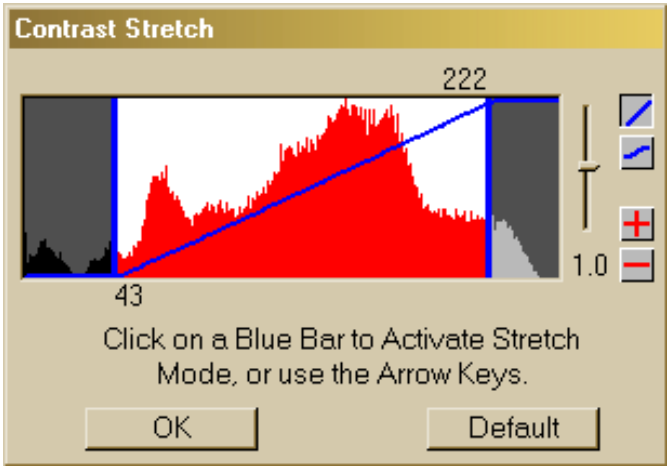
COMMAND	DESCRIPTION
Quick Save (F2)	When selected, a dialog box appears with a computer-generated filename and the option to save or cancel by selecting **Yes** or **No**.
Open (F3)	Select to retrieve an image from the hard disk drive or a floppy disk.
Save As (F4)	Select to store an image on the hard disk drive or a floppy disk under a user-specified filename. A dialog box is displayed on the screen, select the desired location for the file and provide an appropriate name. Then select **OK** or **Cancel**.
Database	Select to access the seven database functions, allowing image query, modification of image data, importing data, and exporting image data.
Print (Ctrl+P)	Select to activate the **Print** dialog box for print options. The **Print Setup** dialog box commands allow selection of print options (window or image), paper orientation (portrait or landscape) and number of copies to print.
Print Window	Select to print the border icons and data along with the displayed fraction of the image.

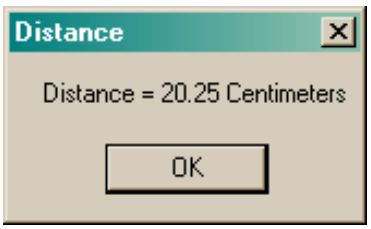
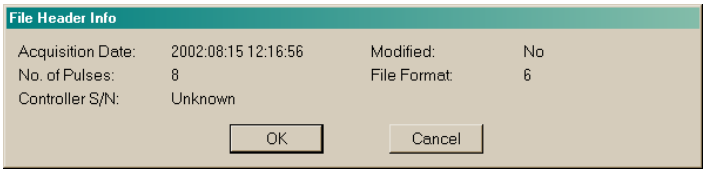
COMMAND	DESCRIPTION
Exit (Alt+X)	When selected, the RTR-4 imaging application is shut down. All unsaved images are discarded from the buffers.

The Display Menu

The commands provided in the **Display** pull-down menu allow the images to be modified to aid in analysis. Adjustments done using the commands in the **Display** menu do not alter the data in the image, they merely change the way the data is presented.

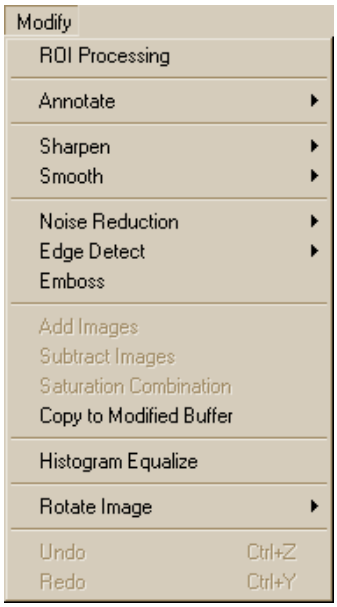
COMMAND	DESCRIPTION
Zoom	When selected, a dialog box appears with four sizing options. Selecting the options x1, x2, x4 or x8 enlarges the image by a factor of one, two, four or eight respectively.

COMMAND	DESCRIPTION
Palettes	Selecting **Palette** options changes the displayed colors of the images. Applying different palettes (also called "color mapping") may improve the appearance of some details • The **Default** option shows a positive grayscale image view. • The **Inverted Grayscale** option displays a negative grayscale image view, similar in appearance to an X-Ray film negative. • The **Rainbow** option applies different colors to objects in the image, based on the varying density levels of the objects • The **Inverted Rainbow** option reverses the colors of the rainbow option.
Automatic Stretch (F6)	Select to adjust the brightness and contrast of the image automatically. It selects settings that frequently maximize image clarity and improve image interpretation.
Contrast Stretch (F5)	Select to allow manual change to the distribution of the color or gray-levels of the image. A dialog box containing a histogram appears over the image. 
Grid Overlay	Select to overlay a square grid over the image. This allows the user to quickly estimate device dimensions and determine the positioning of device components within a package. This feature remains in effect until selected again or until the program is exited.

COMMAND	DESCRIPTION
Distance Measurement (Ctrl+D)	Select to place a measuring crosshair cursor on the image. Move the cursor to the desired first location, then click to set the base position. Move to the second location, a mobile line is displayed with another crosshair at the new end. Click to set the endpoint and the distance between the two set points is displayed in a dialog box. 
Show	Select to show a dialog box displaying the date and time that the selected image was acquired. Also shows the serial number of the Control Unit used to capture the image, the number of pulses used to acquire the image, and whether the image has been modified.  Selecting the **Show > Cumulative Pulse Count** command displays the total number of pulses requested of the X-Ray source since the last reset. 
Switch Buffers (F7)	Select to switch between the Original Buffer and the Modified Buffer. The current buffer on the display is highlighted in the Status Bar.
Clear Buffer	Select to erase the image located in the displayed buffer, clearing the display.

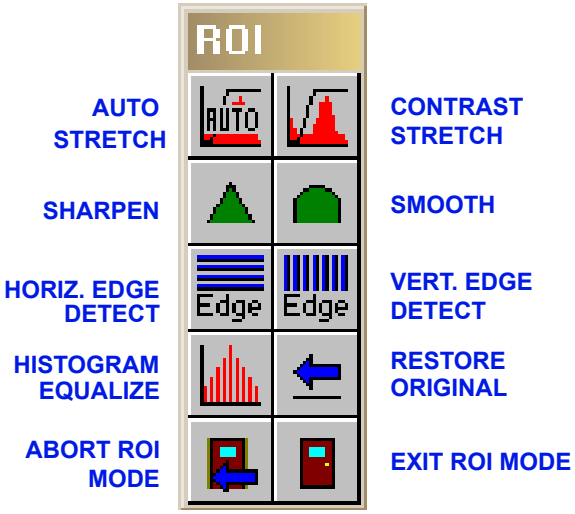
The Modify Menu

The commands in the **Modify** pull-down menu alter the displayed image to produce a modified image in the **Modified** buffer. If the modifications are not satisfactory, press the **F7** key to switch back to the **Original** buffer, where the unmodified image may be changed in a different way. If the displayed buffer was the **Modified** buffer, then this reversal is not available.



Save the original image before any modifications are made. When making modifications to an image, RTR-4 displays only the most

recently saved modifications unless **Multiple Originals** is enabled.

COMMAND	DESCRIPTION
ROI Processing	Select this command to modify a specific area of an image. When selected, the cursor changes to a crosshair. Click at one corner of the area to be modified and drag to the opposite corner and click again. The **ROI** toolbar then appears.  Click on the desired toolbar button to modify the selected area.
Annotate	Select this command to place lines or text on an image. Select any of the following: • **Text>Black** • **Text>White** • **Line>Black** • **Line>White**

COMMAND	DESCRIPTION
Sharpen	Select this command to sharpen an image. • **Fine** slightly sharpens the image, use for subtle adjustments. • **Moderate** improves image clarity without significantly increasing the image noise level. • **Extreme** dramatically increase the sharpness of the image, but increases the noise, producing a "grainy" effect.
Smooth	Select this command to soften the lines, edges, and noise in an image. Using this function will slightly reduce the image resolution. • **Fine** slightly smooths noise, edges and lines and is used for subtle adjustment. • **Moderate** smooths the image to a higher degree. • **Extreme** causes more smoothing, for noisier images or more subtly changing areas of interest.
Noise Reduction	Select this command to filter out pixels with randomly distributed brightness or color levels. • **Average** replaces the center pixel of a three-by-three array with the average of those nine pixels. • **Median** replaces the center pixel of the three-by-three array with the median value of those nine pixels • **Despeckle** removes one-pixel speckles (white dots) from the image and shrinks some larger speckles.

COMMAND	DESCRIPTION
Edge Detect	Select this command to highlight edges in the image as white lines on a black background. This may aid in locating specific shapes in a cluttered image. • **Horizontal** highlights the horizontal lines. • **Vertical** highlights the vertical lines. • **General** highlights both horizontal and vertical lines.
Emboss	Select this command to make an image appear raised or stamped by replacing shading with a uniform gray. This may aid in locating specific shapes in a cluttered image.
Add Images	Select this command to add images together to discern objects within dense containers or housings. This feature is useful when the highest pulse rate setting (99) provides a dim image. This feature allows the user to add several 99-pulse images together.
Subtract Images	Select this command to subtract images from one another. This feature can be used to remove objects in images by taking a background image and subtracting the image of the object.
Saturation Combination	Select this command to compare a low-pulse image and a high-pulse image of the same object, taken in the same position. The combined image shows the details of both the low- and high-pulse images.
Copy to Modified Buffer	Select this command to copy the image in the original buffer into the modified buffer.

COMMAND	DESCRIPTION
Histogram Equalize	Select this command to make a nonlinear change to enhance subtle details in a different way than **Auto Contrast**. It automatically adjusts the brightness of pixels to balance the number of pixels across the range of possible brightness values. This can improve visual interpretation
Rotate Image	Select this command to rotate the image as follows: • **+180 Degrees.** • **Flip Left-Right.** • **Flip Top-Bottom.**
Undo	Select this command to step backwards through previously created images. If a modification is performed which does not provide the desired effect the user can step backward one image by selecting the **Undo** item.
Redo	Select this command to step forward through previously generated images. If the user decides that a previously "undone" modification is desirable after all, they may return to this image by selecting the **Redo** item.

The Preferences Menu

Description

The **Preferences** pull-down menu commands allow operators to customize the various operating interfaces. A checkmark next to a pull-down menu item indicates that the command is enabled.

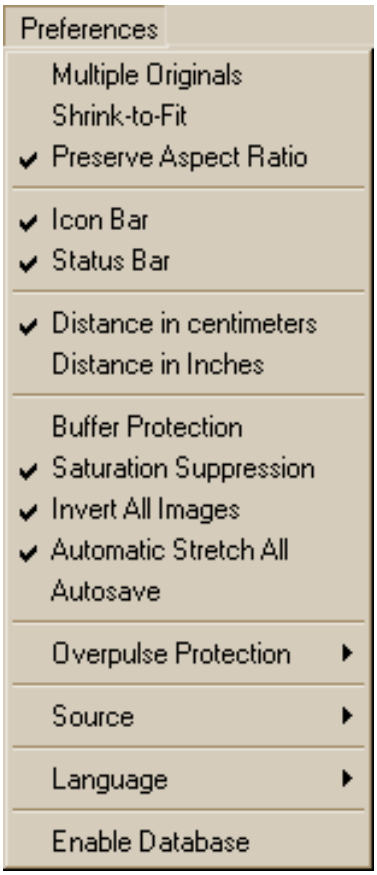
Except for default settings and unless otherwise noted, preference commands do not remain enabled after the RTR-4 imaging application is exited. Preferences should usually be checked and set before acquiring images.

Prerequisites

Ensure the RTR-4 imaging application is loaded and running.

Set Preferences Procedure RTR0027

The items listed and described below are available in the Preferences pull-down menu. Set each item for the desired RTR-4 operation.

STEP	ACTION
1	Select the **Preferences** pull-down menu located at the top of the Main Screen.
2	The **Preferences** pull-down menu appears. 
3	**Multiple Originals** Select this command to utilize more buffers than the system default of two (Original and Modified). Enabling multiple buffers allows the operator to open, display, and modify several images.
4	**Shrink-To-Fit** Select this command to shrink the image to fit within the viewable area of the window.

STEP	ACTION
5	**Preserve Aspect Ratio** Select this command to retain the width to height ratio of an image on the display screen when the **Shrink-to-Fit** command is used.
6	**Iconbar** Select this command to show the Toolbar at the top of the screen, just below the Main Menu bar. This selection remains enabled after the RTR-4 imaging application is exited.
7	**Status Bar** Select this command to show the status information across the bottom of the screen. This selection remains enabled after the RTR-4 imaging application is exited.
8	**Distance in Centimeters** Select this command to display units in centimeters. This selection remains enabled after the RTR-4 imaging application is exited.
9	**Distance in Inches** Select this command to display units in inches. This selection remains enabled after the RTR-4 imaging application is exited.
10	**Buffer Protection** Select this command to turn buffer protection on. When on, the system warns the system operator when a buffer's contents are about to be discarded, unless the image in the buffer has already been saved. When off, no warnings are given. This selection remains enabled after the RTR-4 imaging application is exited.
11	**Saturation Suppression** Select this command to reduce glare that may be created in images containing large areas of bright white pixels. When enabled, pure white pixels are changed to black, allowing subtle details to be more easily seen. When activated this function remains in affect until it is disabled.

STEP	ACTION
12	**Invert All Images** Select this command to view the display as a negative (a positive image is normally displayed). This setting disables itself when the RTR-4 imaging application is exited.
13	**Automatic Stretch All** Select this command to automatically optimize the contrast of images that are opened or captured.
14	**Autosave** Select this command to be prompted immediately after each acquired image to save the image. The Save As dialog box will appear.
15	**Overpulse Protection** Use this command to select one of the following: • No overpulse protection. (Ignores the duty cycle constraint.) • Warn about overpulsing. (Warns the operator prior to firing the source.) • Delay to prevent overpulsing.(Add an appropriate delay to prevent overpulsing.) **NOTE:** Overpulse protection is required to prevent overheating of the source and stressing the source battery.
16	**Source** Use this command to select one of the four RTR-4 radiation sources: • XR-200 • XR-150 • XRS-3 • Inspector

STEP	ACTION
17	**Language** Use this command to select the desired display language. This item changes only the menu items, not the OS. The name of the language is always displayed in that language. Available foreign languages may vary, depending on the particular controller's OS.
18	**Enable Database** Select this command to enable the database function and allow recording of ancillary data. This option remains enabled after the RTR-4 imaging application is exited.

The Window Menu

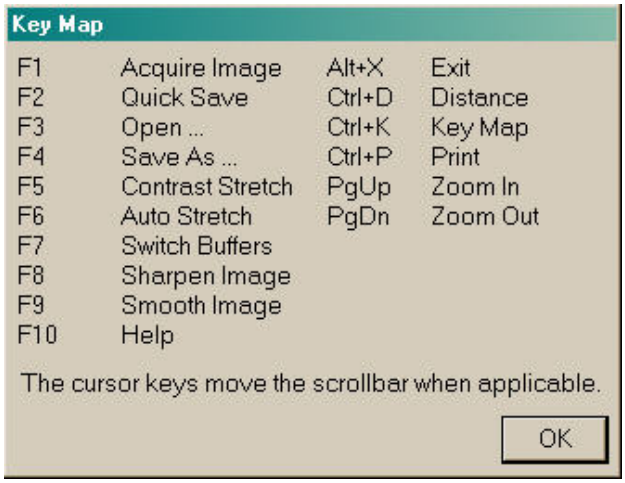
The **Window** pull-down menu commands allow the user to arrange or select image windows. This option is not available if the **Multiple Originals** command is disabled.

COMMAND	DESCRIPTION
Cascade	If **Multiple Originals** is enabled in the **Preferences** pull-down menu, selecting this command rearranges the displayed images on the screen in a cascade pattern. Clicking on any image brings that image to the front of the screen. If Multiple Originals is not selected, only the images from the Original and Modified buffers may be cascaded.

COMMAND	DESCRIPTION
Tile Horizontal	Selecting this command displays images in a horizontal layout pattern. The **Multiple Originals** function under the Preferences menu must be selected in order for more than two images to be displayed.
Tile Vertical	Selecting this command displays images in a vertical layout pattern. The Multiple Originals option under the Preferences menu must be enabled in order for more than two images to be displayed.
Arrange Icons	Selecting this command reorganizes icons for each of the minimized open files neatly on the display screen above the Status Line.
Minimize All	Selecting this command collapses all open display to icons arranged at the bottom of the screen just above the status bar. Double clicking the image header of the icon expands the image to full size.
Empty Buffer	The words **Empty Buffer** are replaced by the file name of the image once an image is opened and read into the buffer.

The Help Menu

The **Help** pull-down menu offers information and assistance on RTR-4 operation.

COMMAND	DESCRIPTION
Help (F10)	When selected, a help window containing the RTR-4 Operator Manual appears. The first image is the index to chapters, with hypertext links where the text is underlined. Clicking on the links retrieves and displays the indicated chapter. Clicking on the **Index** button returns to the index. **Close** exits this display.
Key Map (Crtl+K)	Selecting this commands provides a list of the various keyboard commands and their corresponding functions. 
About	Selecting this command provides release data on the RTR-4 imaging software. 

The Icon Toolbar

The icon toolbar is located directly under the main menu bar at the top of the screen. Many of the Menu Bar and pull-down menu commands have corresponding buttons located in the toolbar. The commands and their corresponding options for accessing that

particular command are listed together. The **Esc** key can be used to cancel any command request.

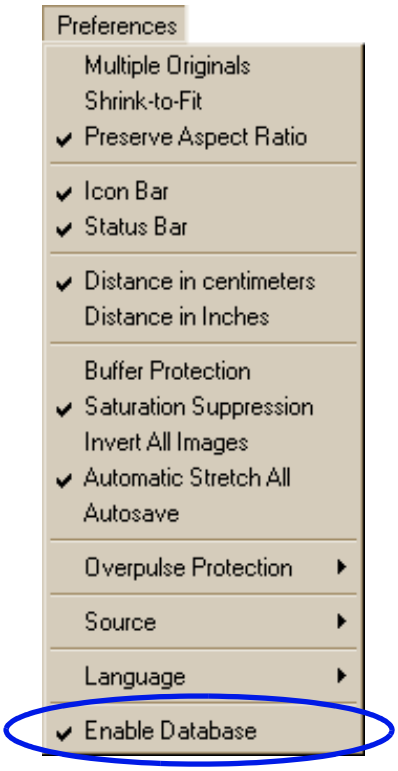
MENU COMMAND	FUNCTION KEY	TOOLBAR BUTTON
Acquire	**F1**	
Quick Save	**F2**	
Open	**F3**	
Save As...	**F4**	
Print	**Ctrl+P**	n/a
Exit	**Alt+X**	n/a
Zoom In	**PageUp**	
Zoom Out	**PageDown**	
Grayscale Invert	**n/a**	
Contrast Stretch	**F5**	
Automatic Stretch	**F6**	

MENU COMMAND	FUNCTION KEY	TOOLBAR BUTTON
Distance Measurement	Ctrl+D	n/a
Switch Buffers	F7	
Undo	Ctrl+ Z	
Redo	Ctrl+Y	
ROI Processing	n/a	
Sharpen Moderate	F8	
Smooth Moderate	F9	
Help	F10	
Acquire Disable	n/a	
Key Map	Ctrl+K	n/a

The Database Function

Enable Database Description

The RTR-4 software contains a database function that can be used to collect, track, analyze, import and export images and related information conveniently and efficiently. Use of the database functions is optional and is enabled by checking **Enable Database** on the **Preferences** menu.

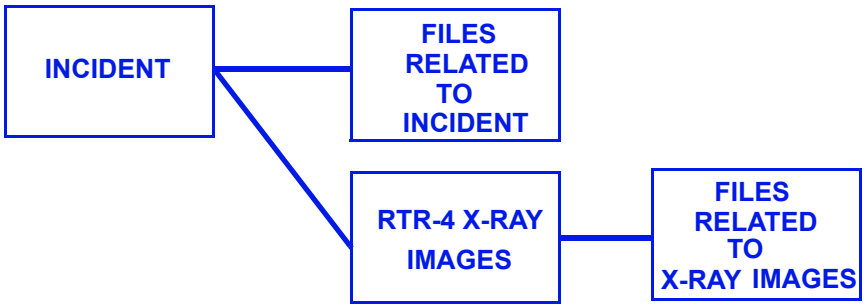


When the **Enable Database** option is unchecked, the software operates without the ability to append related data to displayed images. When the **Enable Database** option is checked, the operator has the opportunity to enter various details about an image, to append related data to the image, and to append several X-ray images to the active incident.

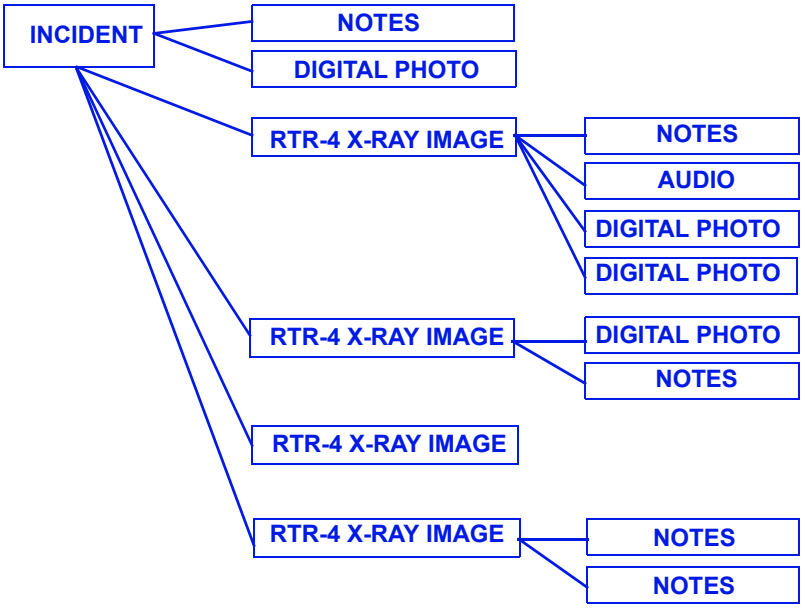
Database Structure

The database organizes and collects data related to an "Incident." An identified incident can have many X-Ray images, digital

photos, audio, video, and other files appended to it. The general relation ship is:



A more specific example shows one possible arrangement of files that can be appended to an incident. In this case, the incident has some notes, a digital photo and four X-ray images appended to it. The X-ray images have from zero to four files appended to them which include notes, digital photos, and in one case an audio file.



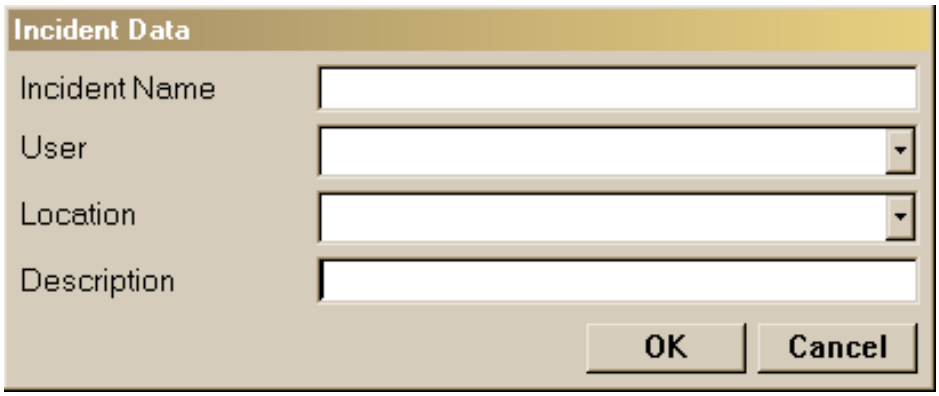
The database function allows for many incidents to be recorded. Each incident can have many associated files and images appended to it. Each image appended to an incident can additionally have many associated files appended to the image. Incidents and their associated files can be exported to archive the data outside of the RTR-4 system. Pre-existing incident files can be imported to add to data and images in an existing database. This facilitates backup and data management.

All data related to an incident can be imported and exported to a central point or database allowing the collection of incident data for legal use, statistic trending, and intelligence analysis. An entire incident, along with the associated RTR-4 images and all appended files may be saved to disk or CD by selecting

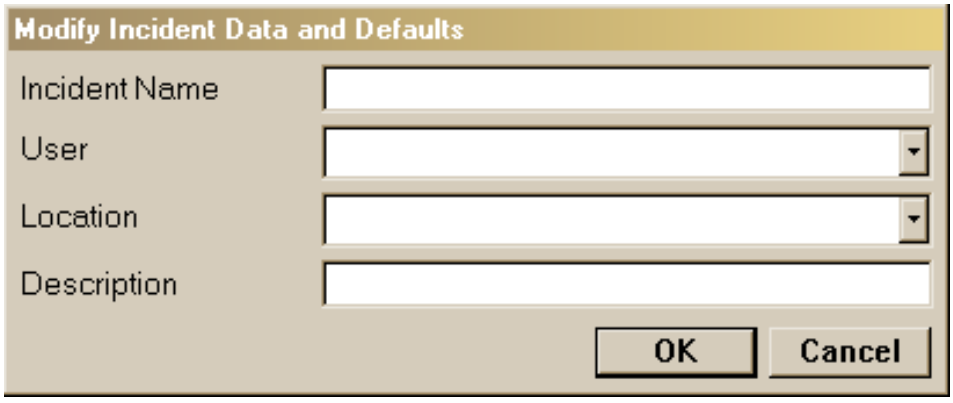
File>Database> Administer Database>Export when the database function is enabled. Saved incidents may be combined by selecting **File> Database>Administer Database>Import** when the database function is enabled.

Entering Incident Identification

When **Enable Database** is checked, the **Incident Data** dialog box is displayed when the RTR-4 program is started.



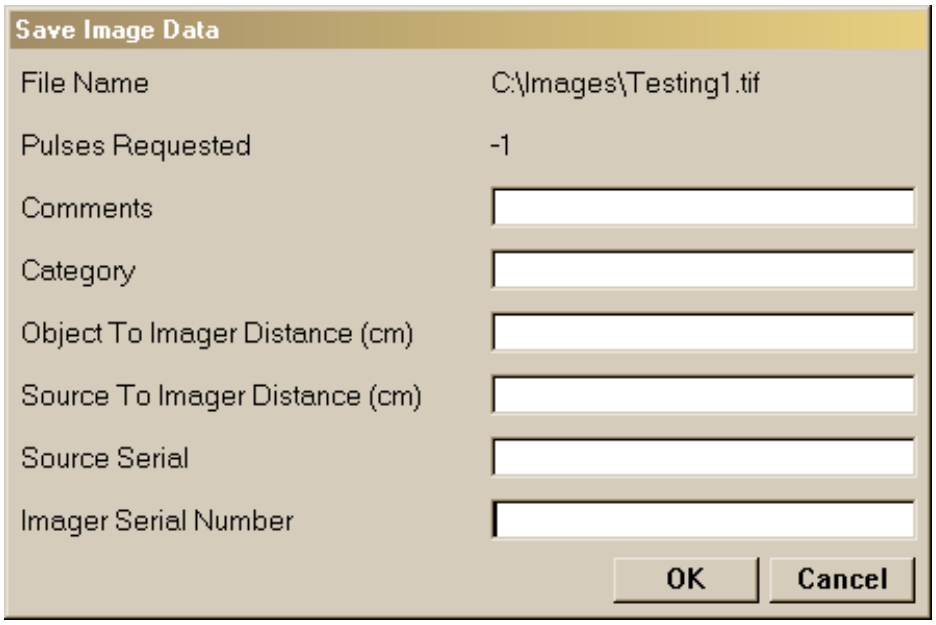
This dialog box shows the active **Incident Name** and the default **User, Location**, and **Description**. Changing any of the entries will create a new incident. The incident name and description fields accept typed input from the operator. The user and location fields will accept typed in data or the operator can select from the drop down lists. The **Incident Data** fields may be entered before arriving at an incident or input by the RTR-4 user at the scene. Once incident data has been entered, it can only be changed by using the **Modify Incident Data and Defaults** dialog box which is accessed by selecting **File>Database>Modify Incident Data and Defaults.**



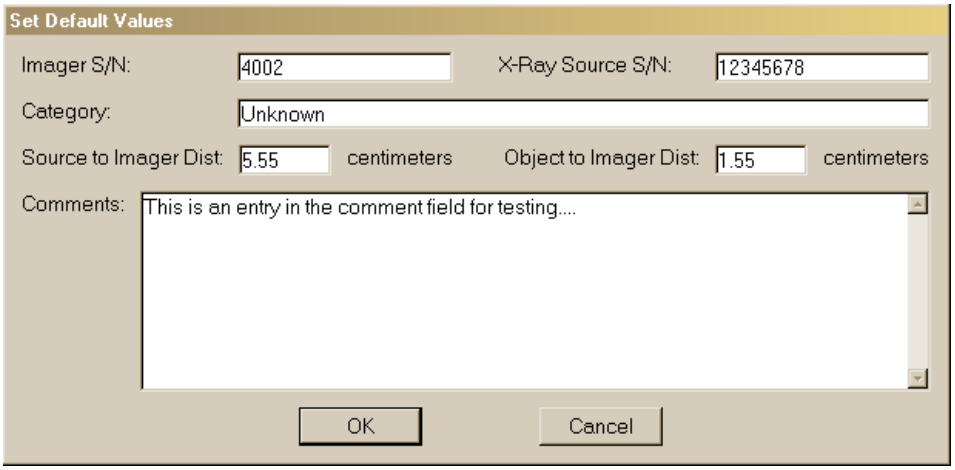
Saving Image Data

When an image is acquired and saved, after entering the filename, the **Save Image Data** dialog box is displayed. The operator enters the appropriate data into the fields provided and

clicks on OK to save the image. These values are provided by the system or the user-specified defaults.



The user can specify the defaults for the Save Image Data dialog box by using the **Set Default Values** option from the **Files>Database** menu.



Attaching Associated Data

Select **File>Database>Attach Associated Data** to link a file on the computer with the active image. The **Attach Associated Data** window displays (figure 4-2).

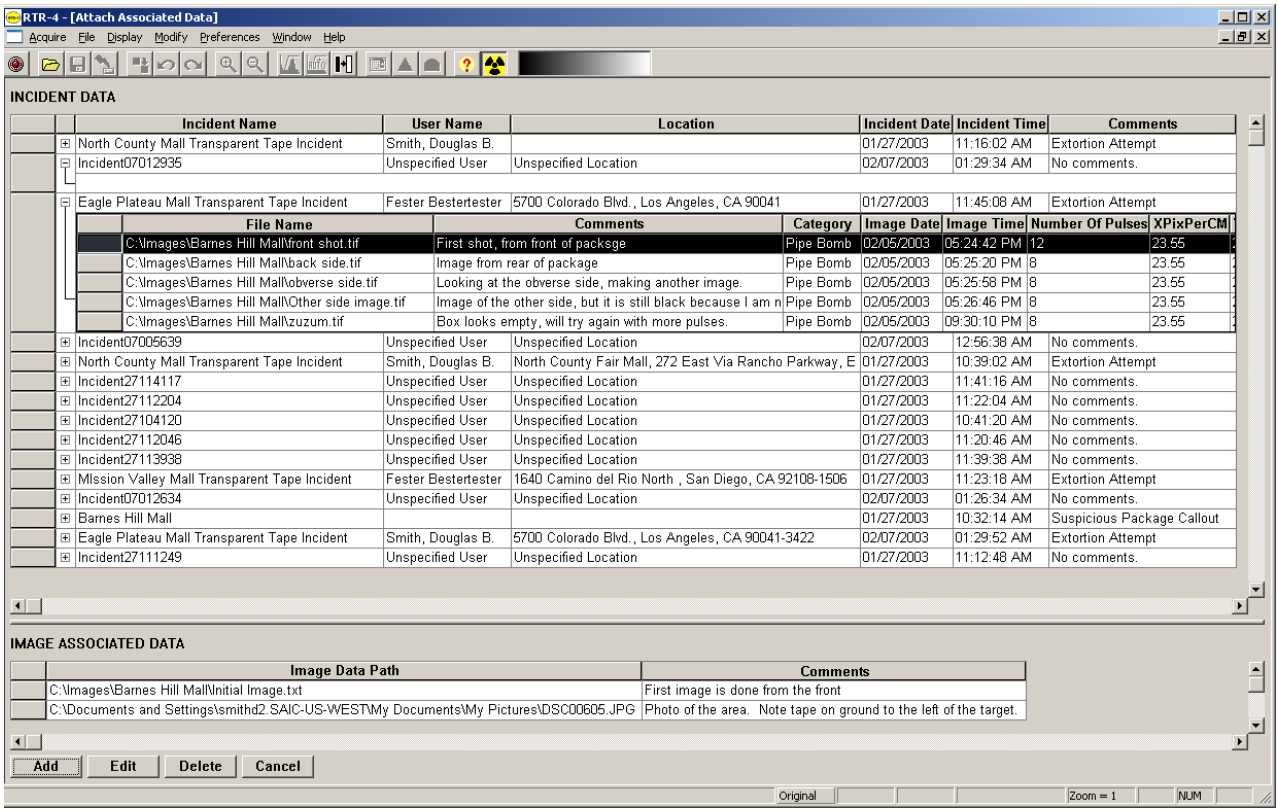
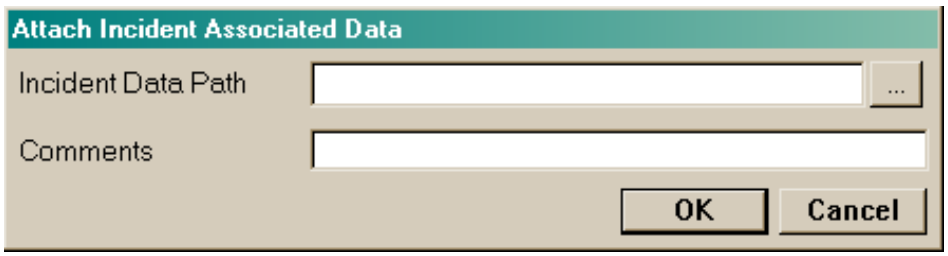


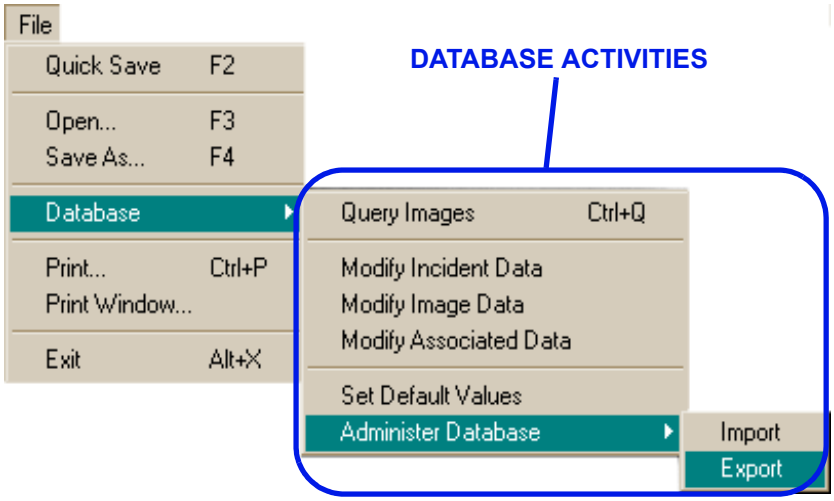
Figure 4-2: Attach Associated Data Window

This window displays a list of the incidents contained in the database with a + sign by each incident name. Clicking on this + sign expands the entry showing the RTR-4 X-ray images appended to that incident. The appended files are displayed in a smaller window below the selected incident. The operator appends files (images) to an incident by selecting the incident and clicking the **Add** button. A dialog box appears where the operator can enter the file location and a descriptive comment. After appending the desired files, the operator returns to the main menu screen by closing the **Attach Associated Data** window.

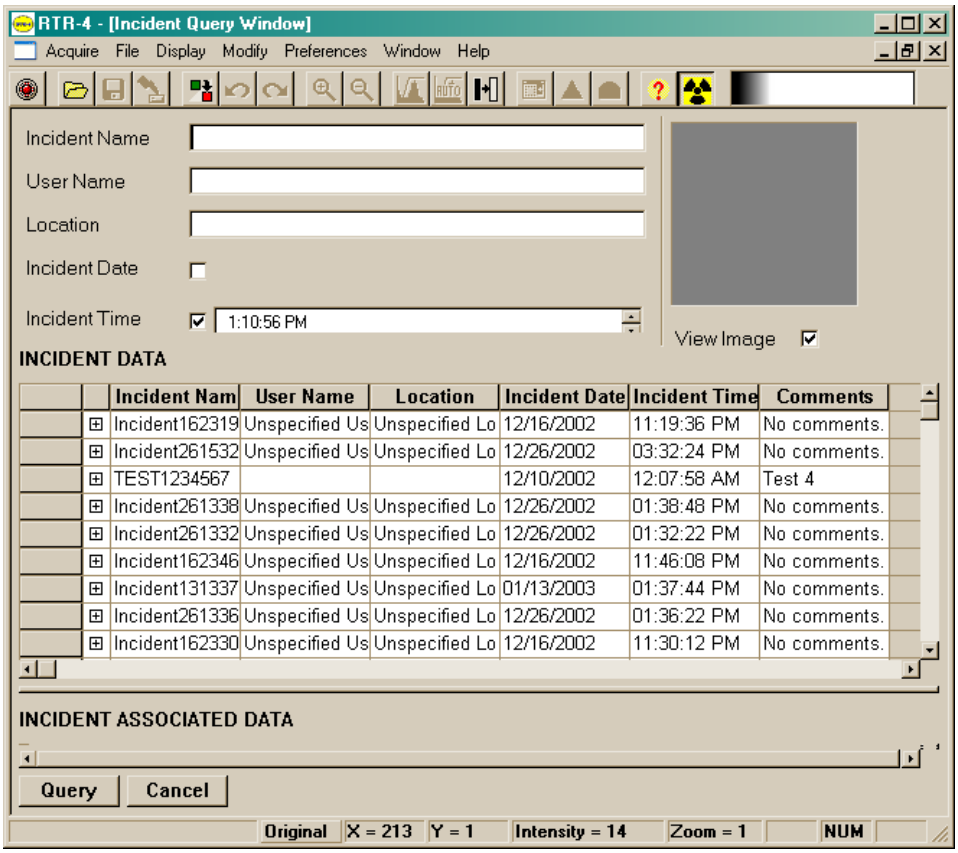


Query Image

Selecting this function displays a window where the operator can enter search data for specific incidents and related data.



The query window provides the operator with several methods to locate specific incident information. The operator can search on Incident Name, User Name, Category, Location, or a date range. The first four search methods use the key word search method to locate data.



Modify Incident Data

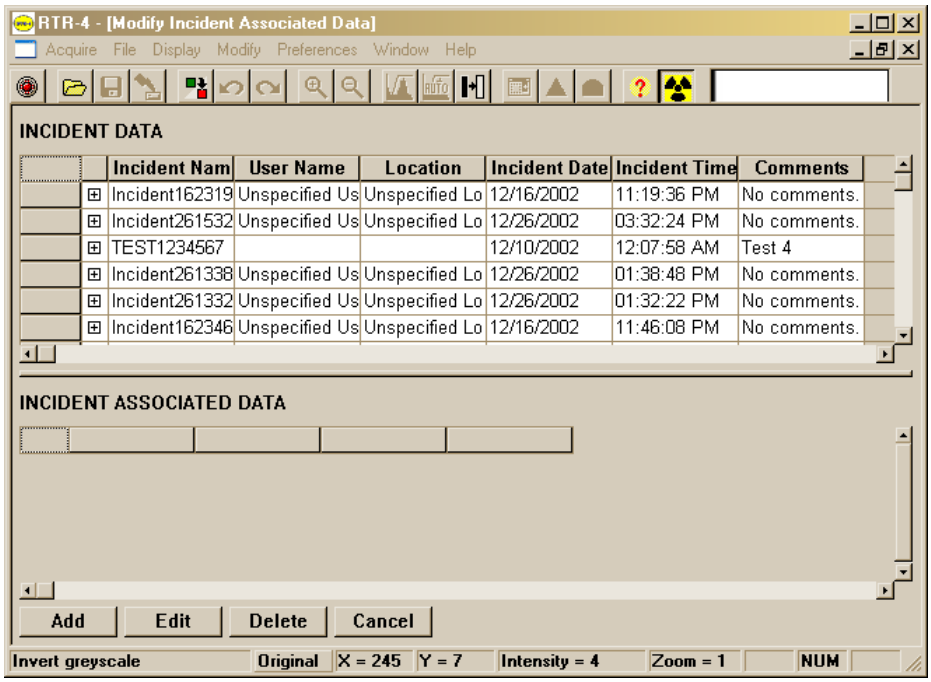
Selecting **Modify Incident Data** allows the operator to change the default entries in the **Session Data** dialog box. This is the window that is displayed when the software is started and the database option is checked.

Modify Image Data

Selecting Modify Image Data permits the operator to change the entries for the **Save Image Data** dialog box. This is the window that is displayed when saving an image.

Modify Associated Data

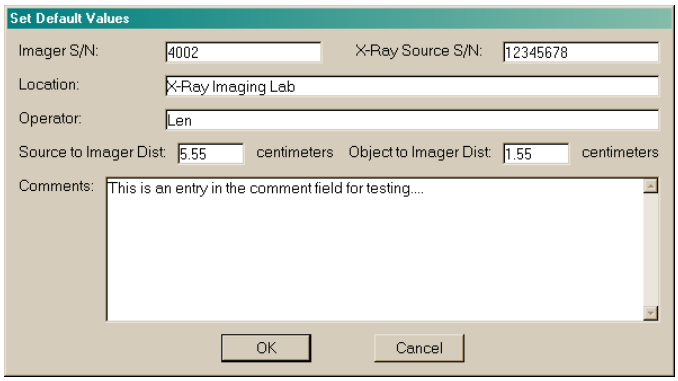
The Modify Associated Data Screen allows the operator to add, delete, or edit files associated with images and incidents. This screen is only displayed when **Modify Associated Data** is selected from the **File>Database** menu.



Selecting an image allows a file to be associated with this incident. Selecting an Incident and then an incident-associated file permits deletion of that connection or editing the comments or filename.

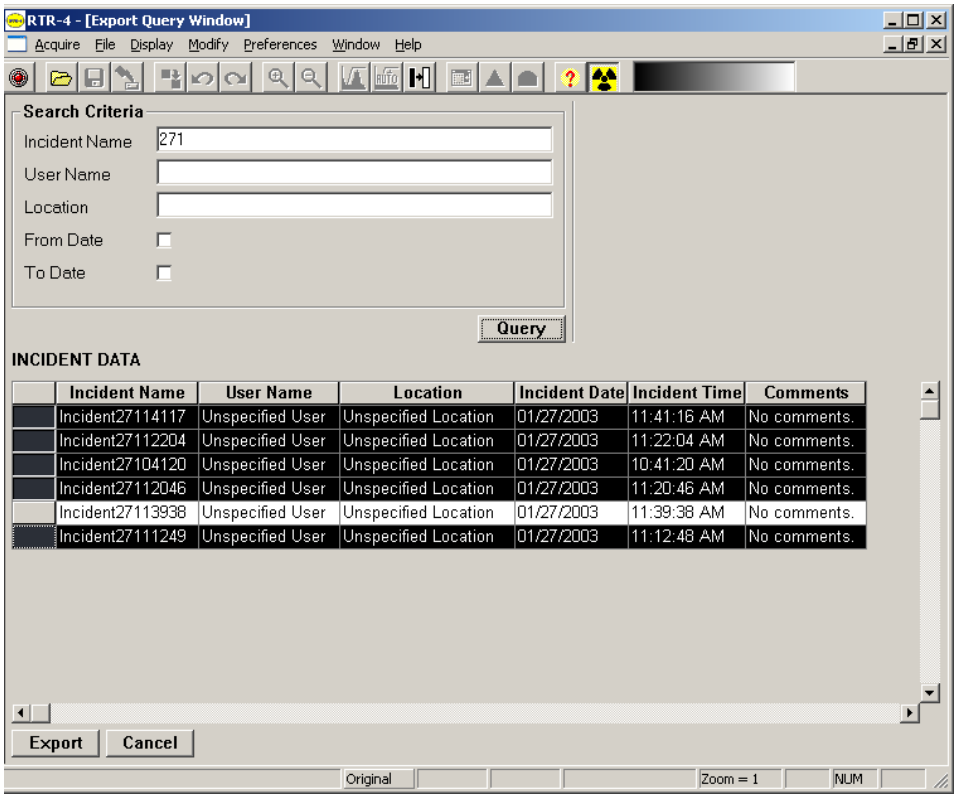
Set Default Values

The **Set Default Values** dialog box allows the operator to set the default values for the **Save Image Data** screen.



Administer Database

The **Administer Database** menu option has two choices, either **Import or Export**. This allows the operator to save or combine incidents. Selecting the **Export** option causes a query-style window to appear. The operator selects an incident by clicking on the box to the left of the incident name. More than one incident may be selected by using the Ctrl key or selecting a range by using the Shift key. Here is an example of five incidents selected for export.



This operation saves all the incident data, including the images, text files, spreadsheets, audio, video, and digital camera files that

were associated with the incidents. The exported incidents are not deleted from the initial system.

The import operation merges external database incidents into the existing database. Duplicate files are not copied.

Shutting Down and Stowing the RTR-4

Shutdown and Stow the RTR-4 (Wired or Wireless Configurations)

Description

Follow this procedure to shut down the RTR-4. Step numbers with the letter "a" apply to the wireless configuration only. Step numbers with the letter "b" apply to the wired configuration only.

Prerequisites

There are no prerequisites for this procedure.

Procedure RTR0028

Shutdown and stow the RTR-4 as follows:

STEP	ACTION
1	Exit the RTR-4 imaging software.
2	At the Windows desktop, select **Shut Down** from the **Start** menu.
3a	Remove the WiFi NIC and place it into its protective cover.
3b	Disconnect the 30cm (1ft) communications adapter cable from the controller and the communications cable reel.
4	If the controller external ac adapter was used, unplug it from both the controller and the 110Vac source.
5	Close the controller cover and place the following components (as applicable) into the transport case: • Notebook controller. • External ac adapter. • WiFi NIC • 30cm (1ft) communications cable adapter.
6	At the imager, set the **POWER** switch to the off position.

STEP	ACTION
7	At the X-ray source, turn the keyswitch counterclockwise 90° to the off position.
8b	At the imager, disconnect the communications and X-ray source cables.
9b	Coil up the communications cable and the extension cable, if used onto the cable reel(s). Use care to avoid dragging the connector on the ground.
10b	Place the communications cable reels into the transport case ensuring that the knob is in the pocket provided and the handle is folded to the stowed position.
11b	Disconnect the X-ray source cable from the X-ray source.
12b	Coil the X-ray source cable and place it into the transport case.
13	Remove the key from the X-ray source keyswitch and place the source and key into the transport case.
14a	Unscrew **ANT1** and **ANT2** from the imager radio unit and place the imager and the antennas into the transport case.
14b	Place the imager into the transportation case.

Operator Maintenance

RTR-4 owners, custodians and operators may perform limited maintenance activities as indicated in this section. Contact technical support as indicated in Chapter 1 for any required maintenance beyond that is listed here. Refer to the Golden Engineering XR200 X-ray source Operator's Manual for X-ray source care, maintenance and troubleshooting.

RTR-4 Care and Cleaning

The RTR-4 should be stored and transported in the transport case provided with the equipment. The RTR-4 has no special periodic maintenance requirements other than battery charging and routine image quality checking. The RTR-4 external surfaces may be cleaned carefully using a damp cloth and mild detergent, but care must be taken to prevent water from seeping inside any of

the units and damaging any electronic components. The flat panel display may be wiped off using a damp, lint-free cloth while the power is off.

Disk Space

Hard disk drive and floppy disk file space can be recovered by deleting old images that are no longer needed, or those that have been backed up to an external hard drive, ZIP disk or CD-R. Use the **Delete** option in Windows Explorer for this purpose.

Charging Batteries

It is recommended that unused and spare batteries be recharged every month while in storage. The Imager and controller batteries can be recharged by connecting the external power adapters when they are not in use. There are two different battery chargers for the DeWalt XR200 battery. One will only work on 110 Vac, 60 Hz, and the other will only work on 220 Vac/50 Hz. Attempting to use the battery charger with the wrong AC supply is very likely to damage the battery charger and possibly the battery. Please verify compatibility before connecting the charger to a power source. Batteries should be disconnected from the charging once they are fully charged.

Charging the Source Battery

The source battery is charged on an external battery charger. Remove the battery from the source and plug it into the charger to charge. A fully discharged battery can be charged in approximately one hour. However, observe the LED indicator on the charger to monitor battery charging progress. Be sure to remove the battery when it is fully charged.

Charging the Imager Battery

The battery in the imager can be charged while it is in the imager unit. Connecting the external power adapter to the Imager, whether in use or not, will charge the battery. Observe the LED indicator to monitor battery charging progress.

Imager batteries may also be charged using the external imager-battery charger provided. The red and green LEDs on the charger unit will indicate the condition and charge of the battery.

Replacement Integrated Imager batteries must meet or exceed the specifications for a DR-35S 10.8Vdc 3800 mA/hr battery. Nickel metal-hydrate (NiMH) is the only acceptable battery type.

Charging the Notebook Controller Battery

The RTR-4 Controller internal battery must remain charged to ensure that the set is always ready for deployment. Connecting

the supplied external power adapter to the notebook while it is not in use will recharge a discharged battery. Using the external power adapter while the notebook is in use will also charge a discharged battery, but at a slower rate. Check with appropriate notebook manufacturer documentation for recharge times.

Imager Battery Replacement

Description

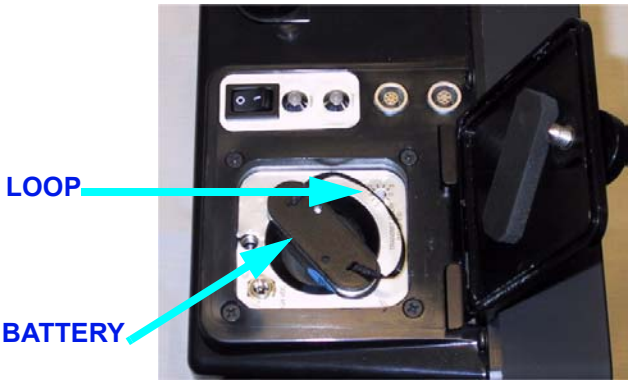
Follow this procedure to replace the DR-35S battery in the Integrated Imager unit.

Prerequisites

Verify all power is off and the Imager is not connected to other RTR-4 components or to external power.

Procedure RTR0029

Replace the battery as follows:

STEP	ACTION
1	Unscrew the cover screw and open the battery compartment cover. 
2	Pulling on the string loop in the battery end, remove the discharged battery.
	**WARNING** Substituting batteries is dangerous. Use only the 10.8Vdc, 9 cell NiMH provided. Use of any other battery may cause explosion or fire. Failure to comply may result in personnel injury.
3	Position replacement battery so that the "This side Up" label is facing the rear of the Imager, and insert into battery compartment.

STEP	ACTION
	**NOTE** The battery compartment cover will not close properly if the battery was replaced facing the wrong way. If cover doesn't close, repeat step 3 to place the battery correctly.
4	Close battery compartment cover and finger tighten cover screw.

Optional External X-Ray Receiver Battery Replacement

Description

Follow this procedure to replace the standard 9V transistor radio battery only if your system is equipped with the optional externally-mounted X-Ray Receiver unit.

Prerequisites

Verify the external X-Ray Receiver is turned off.

Procedure RTR0030

Replace the 9V battery as follows:

STEP	ACTION
1	Using the thumb, press and slide the battery cover off the opposite end of the X-Ray Receiver from the Velcro strip. 
2	Remove the discharged battery from the battery connector.

STEP	ACTION
3	Connect the replacement battery and position in the battery compartment.
4	Position and slide the battery cover inward until it snaps into place.

Wireless Signal Strength Test Utility

Description

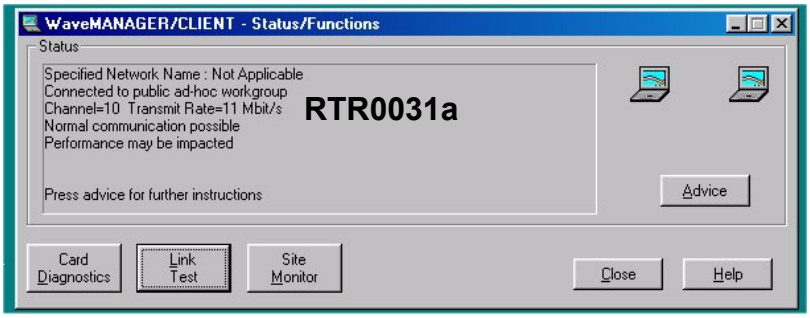
The RTR-4 Wireless Option features a signal strength test utility called "WaveManager Client" which is launched by clicking on an icon on the Windows desktop. This utility shows the signal strength in the connection between the WiFi NIC and Integrated Imager radio module. Follow this procedure to determine the set's signal-to-noise ratio (SNR) when deployed in the field.

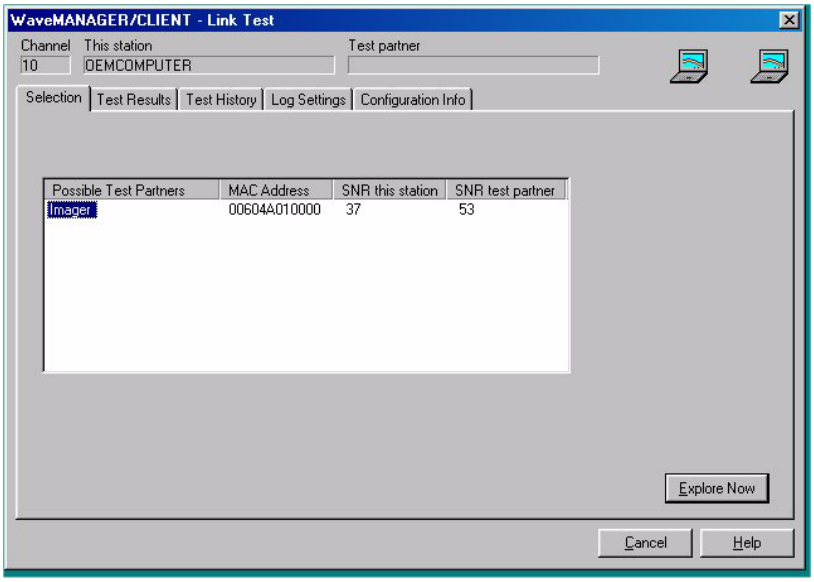
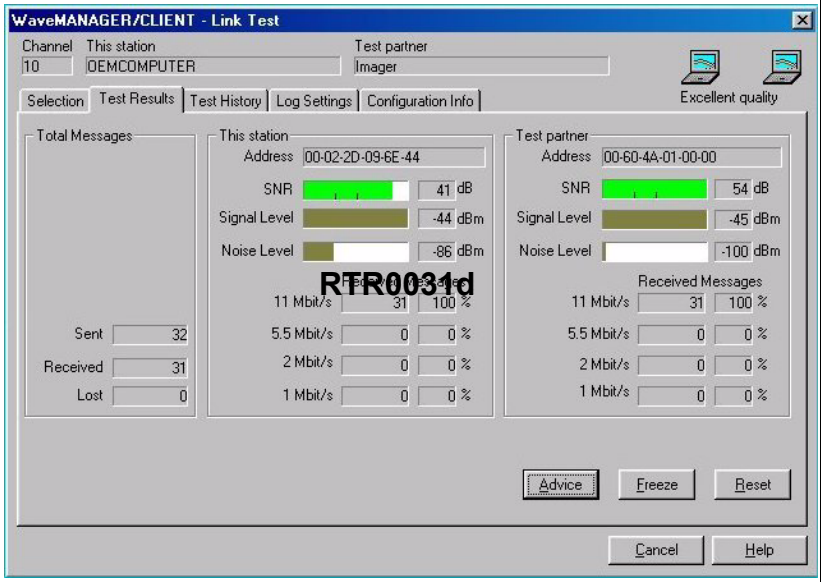
Prerequisites

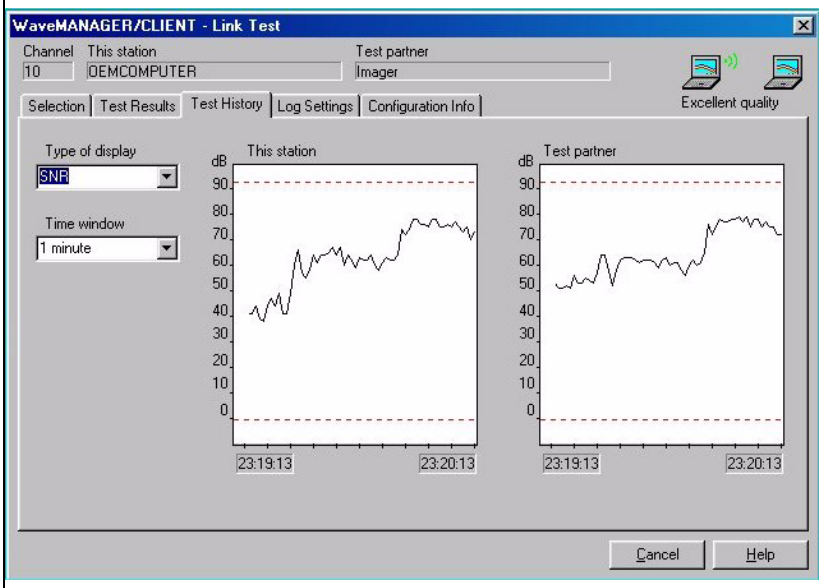
- Ensure the RTR-4 Wireless configuration properly set up, connected, and powered up.
- The controller must be booted up and running Windows.

Procedure RTR0031

Run the Wireless Signal Strength Test Utility as follows:

STEP	ACTION
1	**For Windows 98 or 98SE OS:** Double-check on the WaveManager Client icon on the Windows desktop, or select **Programs>Orinoco>WaveMANAGER CLIENT** from the **Start** menu. A dialog box entitled **WaveManager/Client - Status/Functions** appears.  **For Windows XP OS:** Select **Programs>Orinoco>Client Manager** from the Start menu. A dialog box entitled **Orinoco Client Manager** appears. 
2	**For Windows 98 or 98SE OS:** Click on the "Link Test" button. **For Windows XP OS:** Select **Link Test** from the **Advanced** menu.

STEP	ACTION
3	A dialog box entitled **WaveManager/Client-Link Test** appears. From the tabs at the top, select the **Test Results** tab. (The Windows 98 and Windows XP Operating System dialog boxes are slightly different, but their functionality is identical.) 
3	Select the **Test Results** tab to display a horizontal real-time connectivity bar graph. The **WaveMANAGER/CLIENT Link Test** dialog box appears.  The presence of a high SNR (high signal value, low noise value) verifies a good quality connection.

STEP	ACTION
4	Select the Test History tab to display a real-time signal-to-noise ratio (SNR) figure and corresponding line graphs. 
5	Click the **Cancel** button on either the Test Results or Test History dialog boxes to exit the tests.
6	Click the **Close** button on the WaveManager/Client - Status/Functions dialog box to exit the WaveManager Test Utility.

5 Ancillary Equipment

Introduction

This chapter describes various ancillary equipment that has been used with or may be with the RTR-4 in place of or in addition to the equipment described earlier in this manual. This chapter consists of the following sections:

- Previous Model Wireless Option.
- Previous Model Controllers.
- Previous Model Imagers.
- Alternate X-ray Sources.
- Miscellaneous Accessories.

Previous Model Wireless Option

Prior to the current Wireless configuration a typical RTR-4 Wireless Option consisted of the hardware items shown below.

1. Carrying case with removable foam lining.
2. Optional medium-range antenna unit.

3. X-ray Receiver unit and Receiver-to-Source cable.
4. Power Transceiver unit.
5. Adapter cable for optional medium-range antenna unit.
6. Tall screw-on transceiver antenna.
7. Short screw-on transmitter antenna.
8. Two Power Transceiver-to-Imager cables.
9. Orinoco WiFi NIC PCMCIA card.

Power Transceiver

The Power Transceiver unit has three functions:

- Provides power to the imager previously supplied by the controller (in the CU-4 case) or the external power supply (in the notebook case).
- Facilitates wireless communication between the controller and the imager.
- Sends the wireless signal from the imager to the x-ray source for firing x-rays.

The Power Transceiver unit has five assemblies:

- The black chassis
- Antenna 1 (tall, transceiver antenna)
- Antenna 2 (short, transmitting antenna)
- The blue Power Transceiver-to-Imager cable for controller-and-imager communications

- The gray Power Transceiver-to-Imager cable for imager-to-x-ray-source communications

The chassis houses all the active components, the battery, the imager-to-controller transceiver, and the x-ray transmitter. Antenna 1 provides signals for communication with the controller; Antenna 2 provides signals to the X-ray Source Receiver. The blue cable provides communication to the imager, and the gray cable (with one red strain relief and one yellow) provides communication from the imager for x-ray firing purposes.

The Power Transceiver has a convenient briefcase-style handle and contains a 10.8-Volt smart battery that is the same type as provided with the CU-4 controllers. This battery can be recharged using either the single-slot or the dual-slot charger sometimes provided with the RTR-4 controllers, or in the RTR-4 CU-4 controller's battery compartment. The Power Transceiver also has a power switch and a power-indication LED as shown in Figure 5-2. The battery is in use whenever the power switch is on and the LED is illuminated. (Early versions have a red LED; later versions have a green LED.)

Radio-frequency communications between the Imager and the Controller combined with the radio-frequency communications with the X-ray Source Receiver are very low intensity. When the Power Transceiver is more than 50cm (1.5 feet) away from a target device, then the RTR-4 Wireless Option complies with HERO specifications. (If the RTR-4 is not being used with potentially-explosive devices, then this specification is irrelevant.)

The transmission frequency of the Power Transceiver when communicating with the imager is near 2.4GHz. This communication is done between 2.4000 and 2.4835GHz, is spread-spectrum and frequency-hopping, according to the IEEE-802.11b-1999 standard, and is further encrypted to minimize snooping or spoofing. The frequency used when transmitting to the X-ray Receiver is about 418MHz, is very low power and is coded with a sequencing 64-bit security code to minimize the possibility of unintended source firing.

Externally Mounted X-ray Source Receiver Unit

The X-ray Source Receiver unit receives a signal from the Power Transceiver and fires the x-ray source. A detachable cable can connect to any of the four x-ray sources manufactured by Golden Engineering. A strip of velcro is used to attach the receiver unit to the X-ray source unit.

The Externally Mounted X-ray-Source Receiver unit is powered by a standard 9-volt alkaline battery and has a power switch with an indicating LED.

Previous Model Controllers

Introduction

This section describes various controllers available for use with the RTR-4. These are:

- CU-4 Controller
- Notebook Controller with Battery Box.

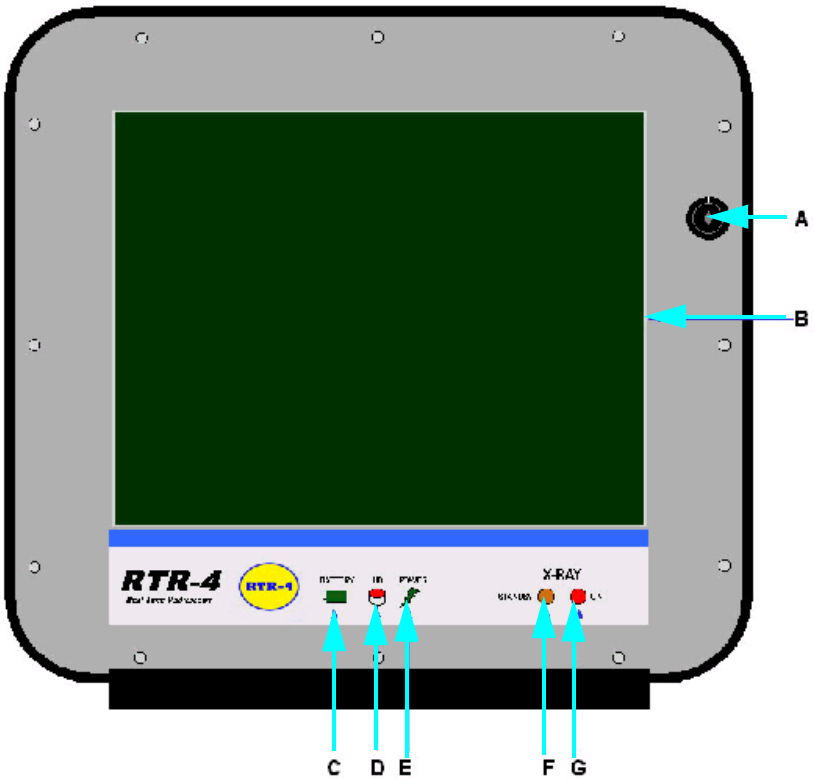
Standard CU-4 Components

The standard CU-4 controller unit is a fully integrated computer comprised of the following components:

- Pentium-series processor
- Flat panel display with power-save feature
- Internal hard disk drive
- 1.44MB floppy disk drive
- Modem

The cable spool supplied with the CU-4 controller contains 50 m of combined power and digital data delivery capability. Imager power is supplied directly from the CU-4 controller; the Notebook battery box component is not used in this configuration.

The CU-4 controller internal display panel features are shown below.



A Safety key switch

B Color display

C Battery charge indicator light

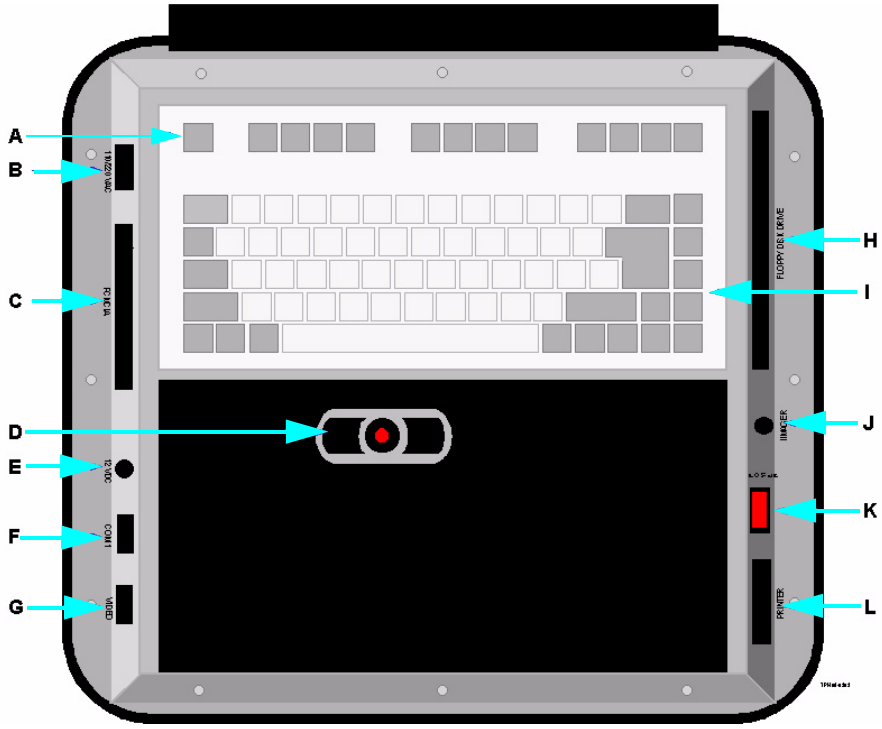
D Hard drive LED– indicates that the hard disk drive is in use

E Power LED – indicates that controller power is on

F Standby LED – indicates that the controller's safety key is in the "Standby" position

G Source LED – indicates that power is being supplied to the imager by the controller

The CU-4 controller operator panel features are shown below.



A Keyboard Function keys

B Power cord receptacle for AC line voltage operation

C PCMCIA slots

D Mouse

E Power cable receptacle for external DC power (9.5 to 28 Vdc)

F Serial Port (COM1 for external mouse, keypad, X-ray source control, etc.)

G External monitor connector (AUX VGA– for use with an external monitor to display images in parallel with the RTR-4 display, or for connection to some printing devices

H 1.4 Mbyte Floppy disk drive

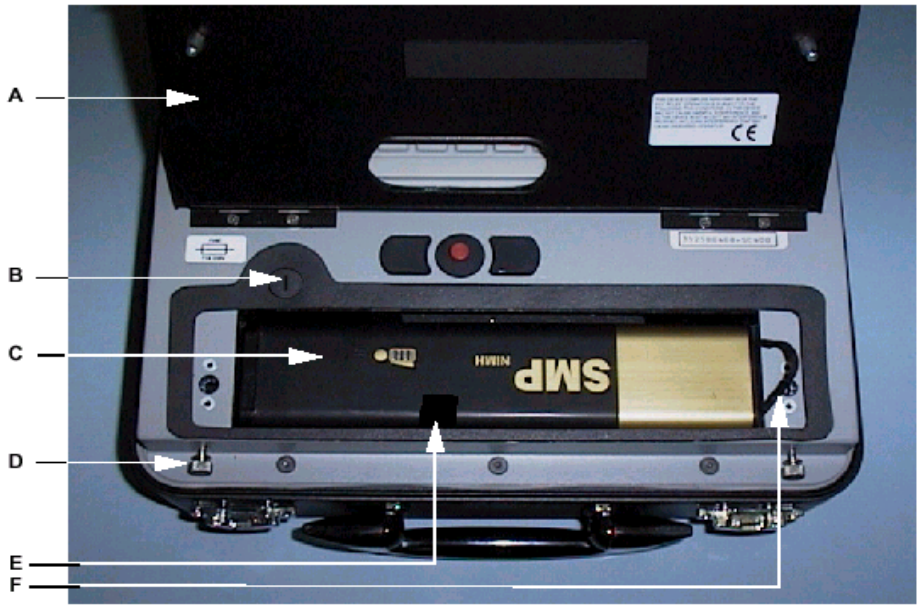
I Standard keyboard with membrane cover

J Imager cable receptacle

K Power ON/OFF switch

L Standard parallel printer port (LPT1)

Controller's battery and battery compartment features.



A Battery receptacle cover/wrist pads

B AC fuse

C Battery

D Thumbscrews for securing the battery receptacle cover

E Battery strap (center vinyl strip connected to battery housing underneath battery), used to extract battery.

F Battery strap (small cloth ribbon connected to non-conductor end of battery), used to lift battery

Power Supply Options

The CU-4 controller has a power-saving feature that darkens the computer screen if not used for two to four minutes. Pressing the shift key or moving the mouse reactivates the screen from the power-saver mode. **Do not** press any other key as it may perform an undesirable function.

The CU-4 controller automatically switches between internal battery, US standard 110Vac, and international standard 220Vac line power. The system is frequency-insensitive between 45 and 65Hz. The controller also powers the RTR-4 imager, so no special power consideration is required for the imager.

The list below shows the power options for the Controllers for the CU-4 and Notebook systems. Appropriate cables are provided for each option.

- 110-220Vac 50-60Hz connection to local power grid (standard operation).
- External DC power from an automobile cigarette lighter receptacle (option)
- External battery power (option).

Battery Power

A 10.8Vdc rechargeable battery is located in the hinged compartment below the keyboard of the controller. A fully charged battery allows about 60 minutes of continuous operation. The battery in the controller automatically begins recharging as soon as the unit is plugged into a line power outlet, and takes approximately eight hours to completely recharge. The controller does not need to be powered up for recharge, but it does need to be connected to a standard line power source.

An optional external battery charger can charge optional spare batteries. Fully recharging a discharged battery with an external charger takes about three hours.

A red LED on the CU-4 controller display panel will begin to flash when battery power is low. When this occurs, images should be saved and the system should be shut down as soon as possible, or the controller should be connected to a standard line power source.

Notebook Controller with Battery Box

The Notebook configuration uses a standard notebook PC as the Control Unit. The Notebook Controller has the following components:

- Pentium-series processor.
- Color flat panel display of at least a 12.1in (31cm) viewing area, internal hard disk drive.
- 1.44 MB floppy disk drive.
- CD-ROM drive.
- Modem.
- Communications port.

The communications port provides connection between the controller and the X-ray Imager. This port includes an internal

rechargeable battery and an external power supply which can be used to power the unit and also to recharge the internal battery.

Note that the adapter cable connects between the communications port of the Notebook and the 50m reel cable.

Notebook Battery Box

The notebook controller has a Battery Box that is necessary to power the Standard-View Imager and also routes communication and image data signals between the Imager and the Notebook Control Unit. This unit houses a rechargeable battery, which provides several hours of operation for the Imager.

A green light indicates when the power is being supplied, this requires that the Battery Box switch be in the ON position and that the communications cable is properly plugged in. An external

battery-charging unit is provided, and the battery is easily removed and replaced in the unit.

Optional Safety Interlock Key Box

The RTR-4 Notebook system offers an optional Interlock Key Box which enhances the operators control of x-ray firing. This safety feature is connected between the Control Unit pigtail cable and the main 50-m signal wire, and makes use of the existing connectors on these cables.

A serial communications cable is also required for this configuration. This extra cable is a standard RS-232 cable terminated with 9-pin plugs on either end. One side connects to the Interlock Key Box, and the other is plugged into the COM port on the rear panel of the Notebook Controller. This connection is required so that the RTR-4 software can detect the orientation of the key.

Previous Model Imagers

Introduction

This chapter describes the Standard-View Imager available for use with the RTR-4 system.

Standard-View Imager

Description

The standard-view imager uses a compact solid-state camera. Electro-optical signal processing circuitry records images captured by the Imager unit's X-ray signal acquisition screen and transmits the acquired images to the Controller (CU-4 or Notebook.)

- Dimensions: 30cm x 34cm x 18cm (11.75in W x 13.25in H x 7.0in D)
- Field of View: 20 x 27cm (8in x 10.7in)
- Weight: 4.5kg (10lb)

- Power: 12Vdc (supplied by CU-4 Controller's Control Unit or the Notebook Controller's Battery Box.)

X-Ray Source & Imager Relationship

When acquiring an image, the target object must be positioned so that it is as close as possible to the Imager's signal acquisition screen (face) which is denoted by the white rectangular outline on the flat side of the Imager unit.

The X-ray source unit should be positioned approximately 60-90cm (24-35in) from the Imager with its beam centered on and perpendicular to the Imager face.

The two large knobs on the side of the Imager unit must be loosened prior to adjusting the imager's handle. If the knobs are not sufficiently loosened before adjusting or moving the handle, the Imager may be damaged.

When scanning objects on the ground that cannot or shouldn't be moved, the Imager is oriented so that its face is as close to the ground or working surface as possible.

The Imager handle is used to support the Imager so that its face is nearly vertical. The X-ray Source is level with the Imager (or slightly elevated) so that the X-ray Source's beam is centered on the Imager's signal acquisition screen. The object being imaged *may* need to be elevated and the X-ray source *must* be elevated for the X-ray Source unit's beam to be properly centered on the screen Imager Unit with Elevated Source

Alternate X-Ray Sources

Introduction

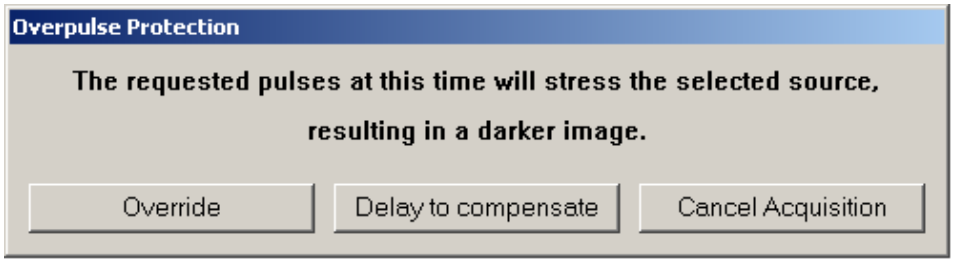
The RTR-4 can currently be used with the following Golden Engineering X-Ray sources:

- Inspector 200
- XR150
- XRS3
- XR200

Although the Inspector 200 has been discontinued, it still can be used with the RTR-4. For more information on setup and operation of these sources, see the respective Golden Engineering user's manual. These manuals are in Adobe PDF format and can be downloaded from www.goldenengineering.com.

Over Pulse Protection

Each Golden Engineering source has a duty cycle that sets the maximum number of pulses that can be produced in a given time. This is to prevent overheating in the source and stressing the battery. The RTR-4 software will prompt the operator should a selection be made that would overpulse the selected X-ray source.



Miscellaneous Accessories

Introduction

Miscellaneous accessories currently available for use with the RTR-4 are the:

- Wireless Option Backpack.
- Notebook PC Configuration Accessories

Wireless Option Backpack

The RTR-4 wireless option backpack provides a compact, convenient way of moving and operating the RTR-4 Wireless Option configuration.

The backpack holds the following items:

- the imager unit
- the X-ray source unit
- the controller unit
- the wireless option equipment (including the power/transceiver unit)

The backpack accessory uses the same imaging procedure as would be used in a standard work space. The case with the components inside can be worn as a backpack to carry the system to another location.

The RTR-4 backpack is used in conjunction with the normal transport cases. The items above are removed from their transport case and put into the RTR-4 backpack. The equipment is placed in the backpack for easy removal of the PC controller and X-ray source, while the imager is left in the backpack connected

and ready to power on. The backpack can be placed near the target object for imaging through the pack without removal of the imager or the need for further setup.

Notebook PC Configuration Accessories

The following table lists and describes the optional accessories for the standard RTR-4 Notebook configuration.

ITEM	DESCRIPTION
Notebook Safety Lock	An optional safety lock in a small box can be connected between the pigtail cable from the Notebook PC and the end of the 50m cable. A connection is also made to a serial port of the controller. When the key is in the OFF position, the X-ray source cannot be fired.
Extension Cable	50m (164ft) cable extension to connect to the 50m cable reel.

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