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600 Series Dual View and Single View Security X-ray Systems

Operator's Manual

For Models 618XR, 620XR, 620DV, 622XR, 624XR, 626XR, 627XR, 627DV, 628XR, 628DV, 632XR, 632DV, 638XR and 638DV

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1.0   Preface

A baggage type cabinet x-ray inspection system is a machine that is specifically designed to generate x-rays in the low-to-medium keV energy region (50-200 keV) for use in security screening operations. A cabinet x-ray inspection system means the x-ray source (i.e., x-ray tube, x-ray generator, x-ray tank) is installed inside an enclosure or cabinet which, independent of existing architectural structures except the floor on which it may be placed, is intended to contain at least that portion of a material being inspected, provide radiation attenuation and exclude personnel from the cabinet interior during the generation of x-ray radiation.

Baggage type cabinet x-ray inspection systems are regulated by applicable federal and state laws. These systems are equipped with warning lights, warning labels, safety controls, safety interlocks, E-Stops and shielding materials that must be maintained, inspected, and tested routinely.

It is important only trained and qualified individuals operate this x-ray radiation emitting machine. These individuals in turn must ensure the x-ray machine is maintained in excellent condition, that all operators and individual members of the public adhere to and obey all warning labels and that all safety features are maintained operational.

This manual provides safety precautions, basic radiation safety information and operational procedures necessary to safely operate the system and to ensure the risk associated with radiation emitted by the baggage type cabinet x-ray inspection system is maintained below regulatory limits and remains as low as reasonably achievable (ALARA).

1.1   Dual View vs. Single View

The main difference between Dual View and Single View machines is the addition of a second generator and associated boards and controller, to provide a second view of the scanned baggage. The difference in terms of an operator of these machines and specifically the GUI (Graphical User Interface) is negligible. In essence that difference is that on a dual view machine there are two monitors, the left monitor being the primary view, looking up through the bag in what is referred to as a vertical view. The right monitor is the secondary view looking horizontally at the bag. On a dual view machine the left or primary view is the view which will show the operator menu.

On a single view machine, there is only one monitor and it is basically the same as the left or primary view on a dual view machine. It shows the vertical view and will show the operator menu when called up (by clicking the left mouse button on the operator control panel).

Commands and the operator control panel for both machine models are identical. The screens shown in this manual are from the primary view of a dual view machine which is, as mentioned, identical to the view on a single view machine. Thus this one manual

irradiated into and out of the cabinet, or for partial insertion for irradiation of an object whose dimensions do not permit complete insertion into the cabinet.

9. **PRIMARY BEAM** means the x radiation emitted directly from the target and passing through the window of the x-ray tube.

10. **SAFETY INTERLOCK** means a device which is intended to prevent the generation of x radiation when access by any part of the human body to the interior of the cabinet x-ray system through a door or access panel is possible.

11. **X-RAY TUBE** means any electron tube which is designed for the conversion of electrical energy into x-ray energy.

2.0   Regulatory Standards and Responsibilities

2.1   Regulatory Standards

2.1.1   Manufacturers of cabinet x-ray systems sold in the United States (U.S.) are responsible **for** complying with the electronic product radiation control provisions of the Federal Food, Drug, and Cosmetic Act (Act), including radiation performance standards [21 U.S.C. 360hh-360ss].

2.1.2   The federal radiation safety performance standard for cabinet x-ray systems (performance standard) is found at 21 CFR 1020.40.

2.1.3   Individual State regulations must also be reviewed for additional registration and Standards for Protection against Radiation requirements. Go *www.crcpd.org* and click on Radiation Control Agencies, then locate the applicable State and review the registration requirements, reporting requirements, Standards for Protection Against Radiation and Notice, Reports and Instruction to Worker regulations for non-medical x-ray and/or radiation emitting devices.

2.1.4   Cabinet x-ray systems sold in the U.S. are required to comply with all applicable requirements of the performance standard. Before selling a cabinet x-ray system in the U.S., a manufacturer must certify that its product meets the applicable requirements of the performance standard. This certification must be based on a quality control and testing program that is in accordance with good manufacturing practices. Certification of compliance with a foreign radiation safety standard can not be substituted for certification of compliance with the U.S. performance standard.

2.1.5   All baggage x-ray inspection systems sold in Canada must conform to the Radiation Emitting Devices (RED) Regulations (Schedule II, Part IV), at the time of sale. These regulations are promulgated under the RED Act, and it is the responsibility of the manufacturer or distributor to ensure the x-ray system conforms to the regulatory requirements. Since the regulations are subject to amendments in order to reflect changes in technology, information on their current applicability may be obtained by contacting the X-Ray Section, Bureau of Radiation and Medical Devices, Health Protection Branch, National Health and Welfare, Ottawa, K1A 1C1. Any violation of the RED Act is a criminal offence.

2.1.6   Additional guidance and recommended safety procedures for the installation and use of baggage inspection x-ray equipment in Canada can be found in Safety Code 29 - Requirements for the Safe Use of Baggage X-Ray Inspection Systems.

2.1.7   When selecting or procuring a baggage x-ray inspection system, the owner (or designated representative) is advised to obtain a copy of the most recent regulations to become familiar with those requirements, and to inquire of the intended manufacturer or importer if the product complies with those current regulations. Provincial regulations

2.2.3.8   Conducting prompt investigations of all radiation accidents and unsafe events, and submitting reports to the system owner, if applicable and to the appropriate radiation protection regulatory authority within 5 calendar days.

2.2.3.9   Ensuring victims of radiation accidents receive specialized medical attention (e.g., consultation with a radiation oncologist, or a physician knowledgeable in the biological effects of ionizing radiation exposure to humans).

2.2.3.10   Determining the appropriate corrective measures following radiation accidents and unsafe events, and ensuring such measures are implemented effectively.

2.2.3.11   The designated facility Radiation Safety Officer, trained maintenance worker or senior operator shall be made available at the x-ray inspection system to assist **or** carry out operational and maintenance system functions unfamiliar to the radiation inspector during a radiation protection survey. A copy of the most recent radiation survey report specific **to** that system, including summaries of corrected measures recommended and instituted, shall be made available to the radiation inspector.

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3.0   Radiation Protection Fundamentals and Safety

This section of the manual is dedicated to providing basic radiation fundamentals information written specifically for facilities who own the Rapiscan Systems baggage x-ray inspection equipment and to those of you who will operate and maintain this radiation generating equipment.

NOTE: This section is not intended to be a substitute for a regulatory required radiation safety course required to be reviewed or administered by the appropriate radiation protection regulatory authority or their approved designee or system manufacturer.

The ultimate objective of this section is to increase your knowledge in basic radiation fundamentals and safety in order for you to perform your work safely by complying with proper radiation safety practices when working with or around radiation generating devices like the baggage x-ray inspection machine.

What is radiation? Where does it come from? What is the potential health protection problems associated with exposure to radiation? Is it safe to work with sources of radiation like a baggage x-ray inspection machine? How is radiation detected and measured? How can I minimize my dose to radiation? Do I need to wear a radiation monitoring badge? What safety features are required and incorporated into the design of a baggage x-ray inspection machine?

All non-medical x-ray inspection machines are regulated in accordance with the regulatory agency standards and regulations discussed in Section 2.1 above.

3.1   FUNDAMENTALS OF RADIATION

There have been few modern day discoveries which have had such an impact on our lives as did the discovery of X-rays by Dr. Wilhelm Roentgen on November 8, 1895. Today X-Ray machines are widely used in the medical industry, automotive industry, for circuit board inspections, the food packaging industry to detect foreign contaminants and they are used extensively in the security industry to detect contraband and deter terrorist and criminals at both private and public facilities such as courthouses, schools, sporting events, prisons, airports, shipping ports and border crossings.

In order for you to understand the characteristics of x-rays, how x-rays are produced and how x-ray machines actually work, it is important to first discuss basic radiological fundamentals and terminology.

Ionization is the process of "knocking" an electron from the orbit of a neutral atom, which is simply an atom that has the same number of positively charged protons as it does negatively charged electrons. Remember atoms are held together by a binding energy. In order to "knock" an electron from its parent atoms' orbit, it will take energy that is at least equal to or greater than the binding energy that holds the electron in orbit.

Radiation is energy in motion. When unstable or radioactive elements release their excess energy, this energy in motion will interact with other atoms in the air, material or our bodies as it travels.

Types of radiation which have enough energy to cause ionization are called Ionizing Radiation and those that do not have enough energy to cause ionization to occur are called Non-ionizing radiations.

Ionizing Radiation, like x-ray radiation can cause ionization in air, material or the atoms in the cells of our body as it passes through while some or all of the radiation energy is lost during this process. It is this process of ionization, caused by ionizing forms of radiation, which can cause damage to the atoms in the cells of our body and it's also the process which, in part, allows us to detect the presence of ionizing radiation.

UNITS OF RADIATION MEASURE

When radiation is measured, different terms are used based on whether we are measuring radiation emitted from a radioactive source, measuring the radiation dose absorbed by an individual, or measuring the risk an individual may suffer biological effects from exposure to radiation.

Exposure is a measure of the ability of photons, like x-rays to produce ionization in air.

Traditionally, the unit of exposure is the Roentgen (R). There is no System International (SI) unit defined for exposure. This was done to discourage further use of the quantity.

Absorbed Dose is a measure of the amount of energy absorbed or deposited per unit mass.

The unit Rad (R) can be applied to all types of radiation and is defined as the deposition of 100 ergs of energy in one gram of any material. The SI unit of absorbed dose is the Gray (Gy), equivalent to the deposition of one joule of energy per kilogram (1 J/kg). 1 Gy = 100 Rad.

Dose Equivalent is a measurement obtained by using the absorbed dose in Rad multiplied by a Quality Factor (QF), which relates the relative risk from the type of radiation absorbed to the risk from the same dose of X or gamma radiation. The QF

Radon is a decay product of uranium, which is relatively common in the earth's crust, but generally concentrated in ore-bearing rocks scattered around the world. Radon is a gas that seeps out of these ores into the atmosphere or into ground water and can accumulate within dwellings and expose humans to high concentrations. You receive approximately 2 mSv of dose per year (200 mRem per year). This is approximately 54% of your total annual dose to background sources of radiation.

Some of the essential elements that make up the human body, mainly potassium and carbon, have radioactive isotopes that add to our annual radiation dose. An average human contains about 30 milligrams of potassium-40 (40K) and about 8 grams of carbon-14 (14C). The largest component of internal radiation exposure from the human body is from potassium-40. The dose contribution is about 0.39 mSv per year (39 mRem per year).

MAN MADE SOURCES

The remaining twenty percent (20%) of your annual dose is from man-made radiation sources. The largest source of man-made dose is from medical procedures you may undergo during the course of any one year.

This could include a typical chest x-ray, a CT scan, radiopharmaceutical test, a dental examination or a mammogram, just to name a few examples. The average person receives an annual dose of about 0.54 mSv (54 mRem from medical procedures). This value is variable depending on the type and number of medical procedures an individual may receive during the course of a year.

For example, the dose from a chest x-ray procedure (two views) is approximately 0.20 – 0.26 mSv (20-26 mRem). The average dose from a mammography procedure (two views per breast) is 0.014 mSv (1.4 mRem), or 0.028 mSv (2.8 mRem) for both breasts. The average dose for a dental x-ray (one bitewing) is 0.015 mSv (1.5 mRem) per bitewing; however, a full mouth dental x-ray exam may include 21 views, which totals approximately 0.32 mSv (32 mRem) for the full mouth exam. Because these doses are only to localized portions of the body, the effective dose equivalent to the whole body is a fraction of these values.

Consumer products such TV's, older luminous radium dial watches, most smoke detectors contain a small quantity of Americium -241 in a sealed source, and older lantern mantles were tainted with Thorium. This dose is relatively small as compared to other naturally occurring sources of radiation and averages 0.10 mSv (10 mRem in a year.

Industrial uses include x-ray machines and radioactive sources (radiography) used to test pipe welds, bore-holes, etc. Most people receive little if any dose from these sources. Dose from coal fired plants and nuclear power plants are less than 0.03 mSv per year (3 mRem/yr).

All biological effects therefore begin with ionizing radiation interactions with the atoms forming the cells. Radiation causes ionization of the atoms which may affect molecules which may affect a cell which could impact tissue which may affect an organ which may ultimately have an impact on the whole body.

Ionizing radiation can interact with the atoms of any part of a cell. The two mechanisms by which radiation ultimately affects a cell are commonly referred to as direct and indirect effects.

If radiation interacts with the atoms of the DNA molecule, or some other cellular component critical to the survival of the cell, it is referred to as a <u>direct effect</u>. Such an interaction may affect the ability of the cell to reproduce. If enough atoms are affected and the chromosomes do not replicate properly during cell division, or if there is a substantial alteration in the information carried by the DNA molecule, then the cell may be destroyed by "direct" interference.

If a cell is exposed to radiation, the probability of the radiation interacting with the DNA molecule is very small since these critical components make up such a small part of the cell. Each cell, as is the case for the human body, primarily consist of water. Therefore, there is a much higher probability of radiation interacting with the water that makes up most of the cell's volume. This interaction is referred to as an <u>indirect effect</u>.
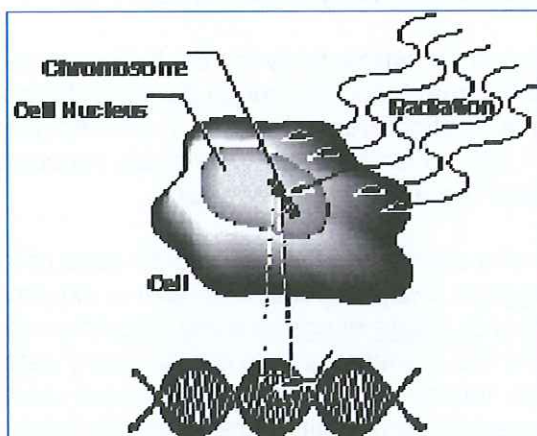
Not all living cells are equally sensitive to radiation. Those cells which are actively reproducing are more sensitive than those which are not. As a result, living cells can be classified according to their rate of reproduction, which also indicates their relative sensitivity to radiation.

When a cell is exposed to ionizing radiation, several things can happen. The following are possible effects of radiation on cells.

1. There is no damage.

2. Cells repair the damage and operate normally.

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individuals is generally less than 0.01 mSv (1 mRem) posing little risk to the exposed individual.

A chronic dose is a small amount of radiation dose received over a long period of time. An example of a chronic dose is the dose we receive from natural background every day of our lives, standard medical procedures involving radiation dose or the dose we receive from working with a source of radiation like a baggage x-ray inspection machine.

The body is better equipped to handle a chronic dose than an acute dose. The body has time to repair damage because a smaller percentage of the cells need repair at any given time. The body has time to replace dead or non-functioning cells with new healthy cells. It is only when the dose of radiation is high and is received very rapidly that the cellular repair mechanisms are overwhelmed and the cell dies before repair can occur.

RADIATION AND PREGNANCY

While the risks of cancer or genetic damage are statistically very low, it is important for women who are pregnant or who are considering pregnancy to be aware of the special needs of their situation.

The embryo/fetus is particularly radiosensitive during the first three months after conception when a woman may not be aware she is pregnant. Women who work with sources of radiation and are considering pregnancy should request additional published information and studies from the facility Radiation Safety Officer.

The degree and risk of radiation damage is extremely low and dependent on the state of development of the embryo. Most of the major organs in humans are developed during the period from the second to the sixth week post conception.

Dose limits have been established to protect the embryo/fetus from potential effects that may occur from a significant radiation dose.

RADIATION RISK

Exposure to radiation is not a guarantee of harm. However, because of the linear, no-threshold model, more exposure means more risk, and there is no dose of radiation so small it will not have some effect. It is a generally accepted practice to limit radiation exposure to levels which are as low as reasonably achievable or ALARA.

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reduce the radiation levels outside the access ports which transfer materials into and out of the x-ray machine.

Shielding material should <u>NEVER</u> be removed. Removing shielding from a baggage x-ray inspection machine can cause an increase in radiation leakage emissions above regulatory limits. Removing shielding materials like lead impregnated curtains, trimming curtains, taping the curtains to the sides of the machine or operating the x-ray machine with worn or missing curtains will cause an increase in radiation levels at the entry and exit points which will likely increase your individual dose. Radiation levels at unshielded access port openings generally measure approximately 0.6 – 0.8 mSv/hr (60-80 mR/hr).

It is important for your radiation protection program to include frequent inspections of the baggage x-ray inspection machine to ensure it remains safe and in excellent condition at all times.

REGULATORY DOSE LIMITS

Several scientific groups provide information and recommendations concerning radiation safety. These groups include the International Commission on Radiation Protection (ICRP) and the International Atomic Energy Agency (IAEA). Scientists have performed numerous experiments and studies and have determined acceptable dose limits for the worker so no clinical evidence of harm would be expected in an adult working within these limits for an entire lifetime.

A baggage x-ray inspection system is a machine that is specifically designed to generate x-rays in the low-to-medium keV energy region for use in security screening operations. Regulatory Agencies have established requirements for the safe use of baggage x-ray inspection systems to ensure the radiation risks associated with baggage x-ray systems remain negligibly low (i.e., the same as the risks from unavoidable, natural background radiation levels). This approach is in accordance with the 1990 International Commission on Radiological Protection (ICRP) objectives (1) to prevent the occurrence of deterministic effects (those for which the severity of a biological effect increases with dose and for which a threshold may occur) and to reduce the incidence of stochastic (random) biological effects to acceptable levels.

Regulatory Dose Limits vary from country to country but most are based on the 1990 ICRP Report 60 recommended average annual whole body dose equivalent limits of 20 mSv/yr (2 Rem/yr) for an occupational radiation worker (US Limit is 5 mSv/yr), 2 mSv/remainder of pregnancy once diagnosed (200 mRem/term) and 1 mSv/yr (100 mRem/yr) for a member of the public. These limits do not include medical and natural background radiation exposure contributions since they are judged to be beneficial and unavoidable. Rapiscan Systems encourages the facility owner and/or facility Radiation Safety Officer to verify the applicable regulatory dose limits.

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Radiation Protection

Figure 1: Ion Chamber Fluke Model 451P

RADIATION SURVEYS & MONITORING

Radiation surveys must be performed routinely or as needed to evaluate the radiation hazards. All personnel responsible for the maintenance of baggage x-ray inspection systems must use a properly functioning and appropriately calibrated survey meter to monitor radiation levels before and after maintenance activities, especially after the replacement of an x-ray tube (or its shielded housing) or the relocation of an x-ray inspection system and for other radiation safety checks when warranted.

A radiation protection survey is intended to establish the x-ray inspection system functions according to applicable performance standards and that it is used and maintained to provide maximum radiation safety to all individuals.

Baggage x-ray inspection systems must be surveyed regularly. While the frequency of surveys depends on the conditions of use, performance history and type of x-ray system, the appropriate radiation protection regulatory authority defines the required or recommended survey frequency. Rapiscan Systems recommends a minimum quarterly radiation leakage survey; however, the minimum survey frequency is annually.

A radiation survey must be performed when:

- Upon initial installation

- X-ray systems of uncommon or new designs are installed.

- In-house surveillance tests have failed to identify and correct any radiation emissions that exceed the regulatory limit and/or the operational values needed to establish image quality assurance criteria during normal use or following modifications or maintenance operations; or

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CHARACTERISTICS OF X-RAYS

In the late evening of November 8, 1895, Wilhelm Conrad Roentgen constructed a black cardboard covering to place over his Hittorf-Crookes tube (cathode ray tube). As he passed the Ruhmkorff coil charge through the tube, Roentgen noticed a faint glow from a bench a few meters away from the tube. He quickly recognized the illumination was originating from a barium platinocyanide screen he had intended to use in his experiment.

Roentgen concluded that a form of penetrating ray of energy was being emitted by the cathode ray tube and called the unknown ray, X-Rays since the mathematical symbol for unknown was X.

He continued his experiments and tests with this invisible ray and discovered x-rays travel in straight lines, the x-ray beam was not reflected or refracted by electrical or magnetic fields and this new x-ray has the ability to penetrate lower density materials and has less penetrating ability with higher density materials such as lead.

Like radio waves, microwaves, infrared light, visible light, ultraviolet light, gamma rays and cosmic rays; X-rays are a form of <u>electromagnetic radiation</u>. All electromagnetic radiation is characterized by the movement of waves of energy called photons.
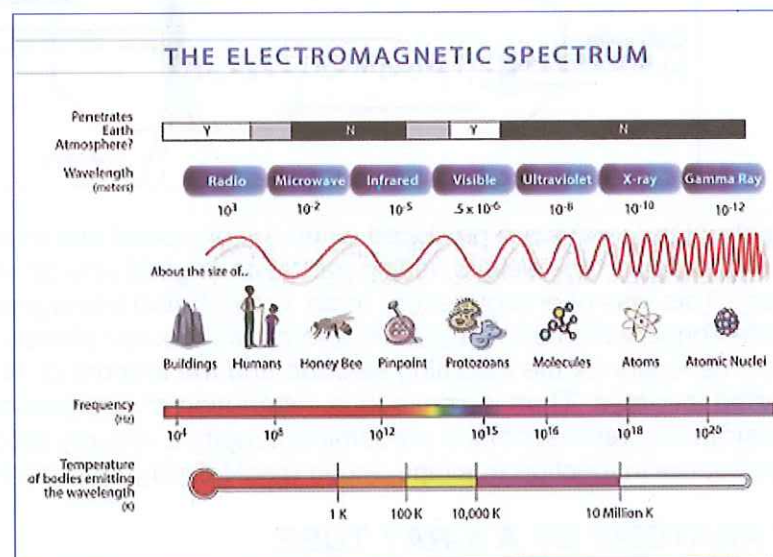
Photons have no mass and no charge and they travel at the speed of light. Photons move with a characteristic wavelength and frequency that defines the specific type of electromagnetic radiation. X-rays which have a relatively short wavelength and high frequency possess a great deal of energy. Because of their short wavelength, x-rays can penetrate materials that absorb or reflect visible light. Like light, x-rays can produce a visible image on photographic film. Because of these properties the use of x-rays has found wide applications in medicine and industry.

the focal spot. X-rays are directed out of the tube through a small window in the housing called a port.

HOW AN X-RAY MACHINE WORKS
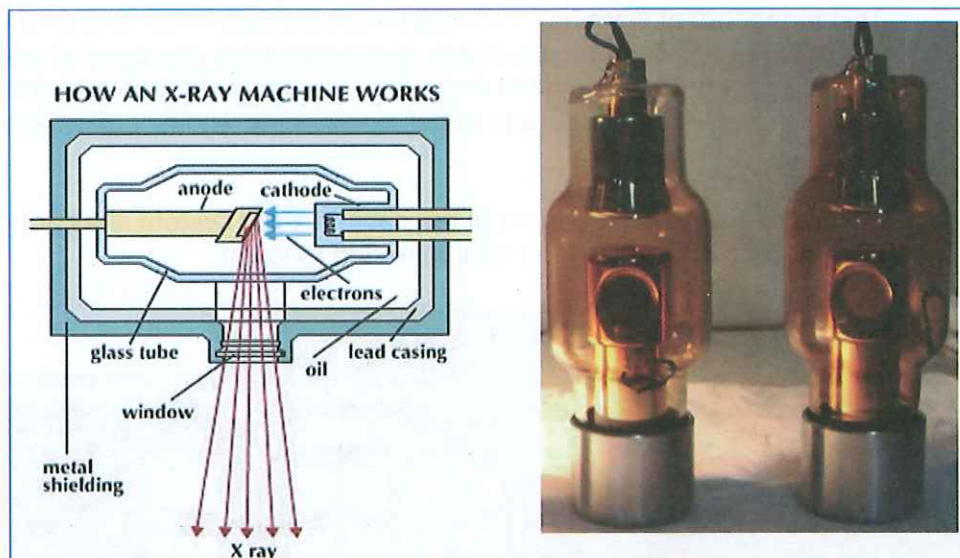
Electrons are produced at the cathode by heating the tungsten filament to incandescence just like a household light bulb is heated. The number of electrons is controlled by adjusting the temperature of the filament. The amount of charge flowing per second to the cathode is termed the current, expressed in mill amperage (mA).

Electrons are accelerated towards the positive anode by a high voltage potential. This potential difference is expressed in kilo voltage (kV). Since the voltage across the tube may fluctuate it is usually expressed as peak kilo voltage (kVp).

SAFETY CONTROLS AND INDICATORS

Shielding Materials

Shielding materials like stainless steel, carbon steel, lead sheet and lead impregnated curtains or drapes are used throughout the baggage x-ray inspection machine with the primary purpose of reducing the radiation levels on all external surfaces of the baggage x-ray device to as low as reasonably achievable and below the regulations stray radiation leakage limit of 0.5 milli roentgens/hr (5 uSv/hr) measured at 5 cm from all external surfaces of the cabinet, including the imaginary plane at the access port openings.

Controls and Indicators

A key-actuated control has been provided to insure x-ray generation is not possible with the key removed or positioned in the OFF position.
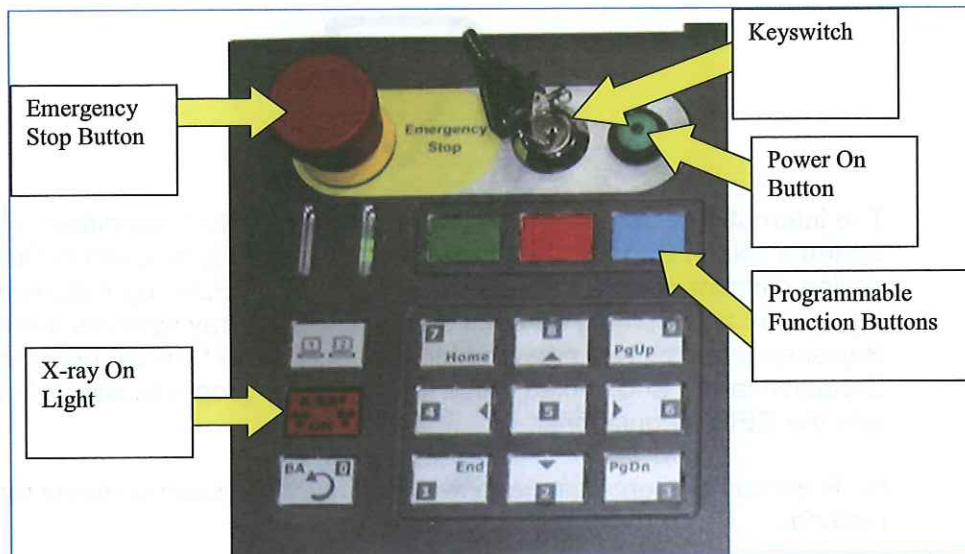
Warning Labels

Permanently affixed on the x-ray system at the location of the controls which can be used to initiate x-ray generation, there is a clearly legible and visible label bearing the statement:

Caution: X-Rays Produced When Energized

Permanently affixed on the x-ray system adjacent to each port there is a clearly legible and visible label bearing the statement:

Caution: Do Not Insert Any Part of the Body When System is Energized--X-ray Hazard

For all units sold in Canada, Health Canada Radiation Emitting Devices (RED) Act regulations require the X-radiation warning sign to:

- be shown in two contrasting colors;
- is clearly visible and identifiable from a distance of one meter;
- has no outer dimensions less than two centimeters;
- bears the words "CAUTION, X-RAYS" and "ATTENTION, RAYONS X"; and
- is designed in accordance with the following diagram:

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Radiation Protection

Maintenance department personnel MUST understand the importance of maintaining the safety interlocks in full working condition at all times. The facility RSO is strongly encouraged to test the safety interlock system and perform a full x-ray machine safety inspection frequently, Rapiscan Systems recommends a quarterly inspection.
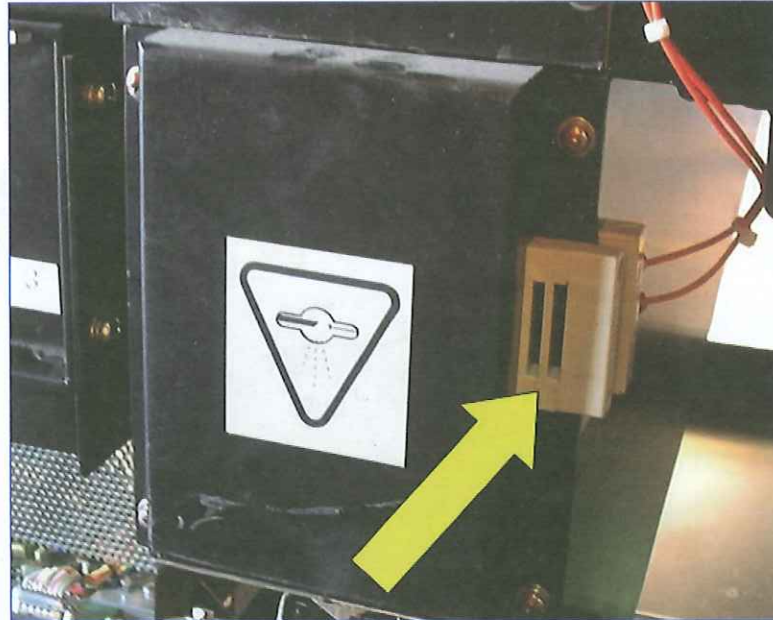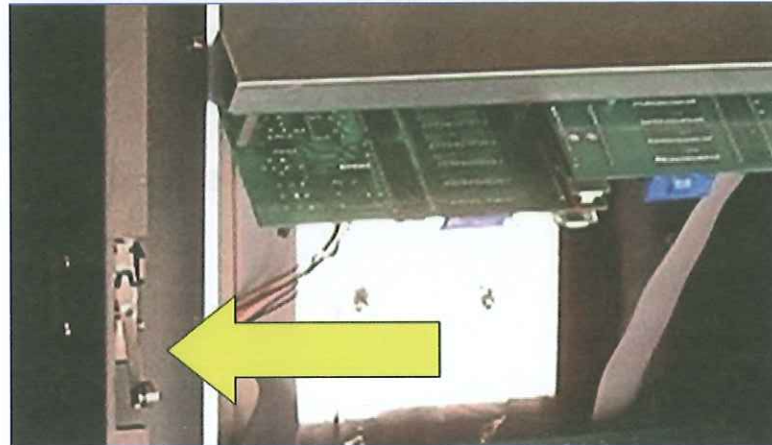

Figure 4: Collimator Interlock

Figure 5: Diode Array Box Interlock

Conveyor Covers/Shrouds

Baggage x-ray inspections systems are equipped with conveyor covers or conveyor shrouds (Figure 6) that serve as a protective cover to prevent operator and general public contact with the moving conveyor system.

4.0   Safety Instructions

4.1   Machine Labeling

	Radiation symbol (Optional) This symbol indicates the unit has components capable of emitting X-radiation.
	X-Ray Radiation symbol (Canada Only - Required) This symbol indicates the unit has components capable of emitting X-radiation.
	High Voltage symbol This symbol indicates that hazardous voltages are present.
	Book symbol This symbol indicates the operator manual should be consulted before proceeding.
	Warning symbol This symbol indicates a safety warning or alert.
	Earth symbol This symbol indicates this is the safety earth point for the system or a sub-system.
	Anti-Static symbol This symbol indicates that anti-static electricity precautions should be used to prevent damage occurring to components.
CE	The CE mark is the official marking required by the European Community for all Electric and Electronic equipment that will be sold, or put into service for the first time, anywhere in the European community.
UL	The UL mark is a mark showing compliance with the safety standards of Underwriters Laboratories Inc., an independent, not-for-profit product-safety testing and certification organization in the United States of America (USA).

WARNING: Moving and/or relocating the baggage x-ray inspection system can affect components critical to safety. If the baggage x-ray inspection system is moved and/or relocated, maintenance personnel and/or other suitably qualified person(s) must test and ensure all safety interlocks are functioning properly as intended by design; examine and ensure all radiation shielding is free from structural damage (i.e., puncture, hole, dent, missing part); examine and ensure the lead clamps that hold the anode and cathode terminals onto the chassis of the x-ray tube housing assembly are positioned correctly; conduct the normal in-beam quality imaging tests and, if discrepancies exist, investigate the x-ray tube assembly, the collimator setting, and the radiation exposure parameters (tube current, high voltage, filters, etc.) for possible causes; and ensure all problems are resolved satisfactorily before the x-ray inspection system is placed into operation.

WARNING: The baggage x-ray inspection system must be thoroughly tested and verified by trained and qualified personnel to ensure all radiation shielding components and safety devices, including warning lights are installed and functioning, *before* the x-ray system is placed into operation.

WARNING: No person must create a physical or mechanical condition that ultimately makes the x-ray inspection system unsafe to operate. Defeating safety devices, placing liquid-filled containers on the x-ray inspection system, positioning x-ray inspection systems in confined spaces for carrying out routine maintenance and operational test functions, and positioning x-ray inspection systems for use in areas exposed to rain or snow are examples of hazardous conditions.

WARNING: Do not remove any conveyor covers or shrouds at any time during x-ray inspection operations. These covers are intended to prevent the insertion of any part of the body into the primary x-ray beam and to maintain radiation levels at or near the entry and exit ports of the cabinet to as low as reasonably achievable and within regulatory radiation leakage limitations.

WARNING: Electric Shock Hazard: DO NOT touch electrical wire terminals by hand or with a conductive tool.

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4.3   Electrical Rating

MODEL	VOLTAGE	CURRENT	FREQUENCY
618XR	110/230V	7/3.5A	50/60Hz
620XR, 622XR, 624XR	110/230V	8/4A	50/60Hz
626XR, 627XR, 628XR	110/230V	13/6.5A	50/60Hz
632XR, 638XR	110/230V	15/7.5A	50/60Hz
620DV	110/230V	8/4A	50/60Hz
627DV, 628DV	110/230V	13/6.5A	50/60Hz
632DV, 638DV	110/230V	15/7.5A	50/60Hz

The machines are designed to function at 230V or 115V +/-10% to compensate for variations in supply voltage. Supply voltage fluctuations are not to exceed +/-10% of the nominal voltage

WARNING: When dangerous objects such as explosives, guns or other weapons are identified in the X-ray image, follow the procedure established at your facility to safely resolve such events.

WARNING: Modifications to this baggage x-ray inspection system are strictly prohibited. The system owner must contact the manufacturer.

"Over 300 films from all the major manufacturers were used in the tests. These films ranged from those typically used by holidaymakers and amateurs, such as ISO100 color negative film for prints, to high speed, high quality professional films. These ranged from ISO64 slide film to black and white film which was push processed to an exposure index of EI 3200."

"To test the effects of multiple exposures to X-rays, several rolls of each type of film were used. Each roll was passed through the X-ray machine a different number of times, ranging from zero to 32."

"The results showed that none of the films suffered any visible effects when viewed on a light box, even after multiple exposures to X-rays."

Dual View systems have not been tested for film safety.

4.6 Drugs and Food

There are no known adverse effects of radiation absorbed dose to food or pharmaceuticals which are conveyed and inspected by a baggage X-ray inspection system used for security screening. The radiation absorbed dose received by objects scanned by most systems, including the Rapiscan Systems baggage x-ray inspection system, is 1 millirad or less.

The minimum radiation dose used in food irradiation for food preservation or destruction of parasites or pathogens is 30,000,000 millirad. For further information on the limits on radiation used for food inspection or food irradiation see Title 21 CFR 179 and/or contact FDA's Center for Food Safety and Nutrition or the United States Department of Agriculture Food Safety Inspection Service.

An additional reputable resource is the World Health Organization (WHO). Below is a summary excerpt of their research on this subject of irradiation:

High-dose irradiation: wholesomeness of food irradiated with doses above 10 KGy, a joint FAO/IAEA/WHO study group. Geneva, Switzerland, 15-20 September 1997

"On the basis of the extensive scientific evidence reviewed, the report concludes that food irradiated to any dose appropriate to achieve the intended technological objective is both safe to consume and nutritionally adequate. The experts further conclude that no upper dose limit need be imposed and that irradiated foods are deemed wholesome throughout the technologically useful dose range from below 10 kGy to envisioned doses above 10 kGy".

5.0 Installation and Configuration

5.1 <u>General</u>

Rapiscan Systems does not accept liability for damage to this or any other equipment or materials or personal injury caused directly or indirectly by or as a result of either incorrect or poor quality termination of local power supply cables or unauthorized modifications to this equipment or tampering with this equipment by unauthorized personnel.

If the equipment provided is not used in the manner specified by Rapiscan Systems, the protection provided by the equipment may be impaired.

Hand Baggage Systems

A level floor site should be chosen with sufficient space to enable clear access to the conveyor system at both ends of the unit, and enough room to open the panels at the side of the machine. With the unit in its desired position, screw the feet down at each corner of the chassis to prevent further movement (a reduction in vibration effects when the feet are extended may result in an improvement in the quality of the image.)

Unpack the monitor, and place it on the console or on top of the machine. There are two connectors, power and signal. The signal connector plugs into the free D-type socket (15-way) that will be found near the monitor cable exit hole on the top of the machine. In the case of a console, the connector will be found underneath the desktop. Secure the plug to the socket by using a screwdriver to mate the jackscrews. The power connector will be found in the same place as the signal connector.

Unpack the control panel, and place it on the console (if supplied). The connector must be attached to the free D-type socket (9-way) that will be found in the same place as the monitor cables. The touchpad connector is a free D-type plug, located in the same place.

6.0   End Panel and IEC Socket

The supply power for the Rapiscan X-ray system enters the machine via the 3-pin IEC socket on the end panel (Figure 9 to Figure 13).

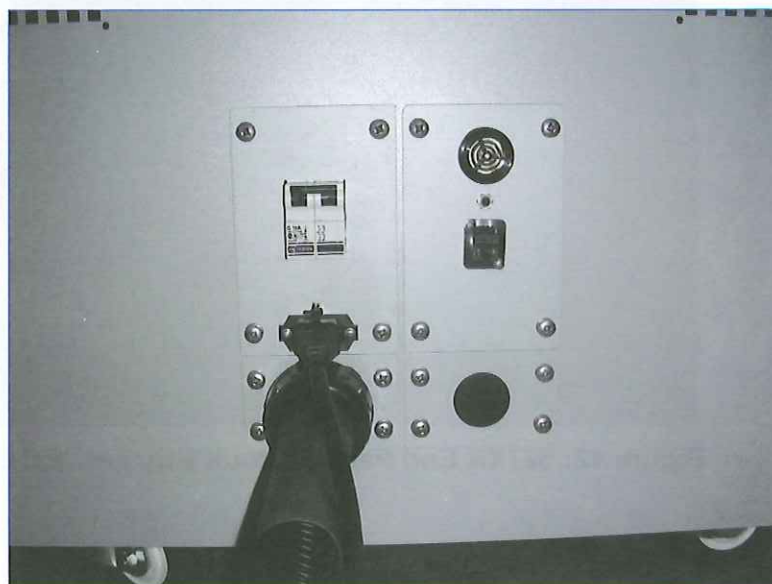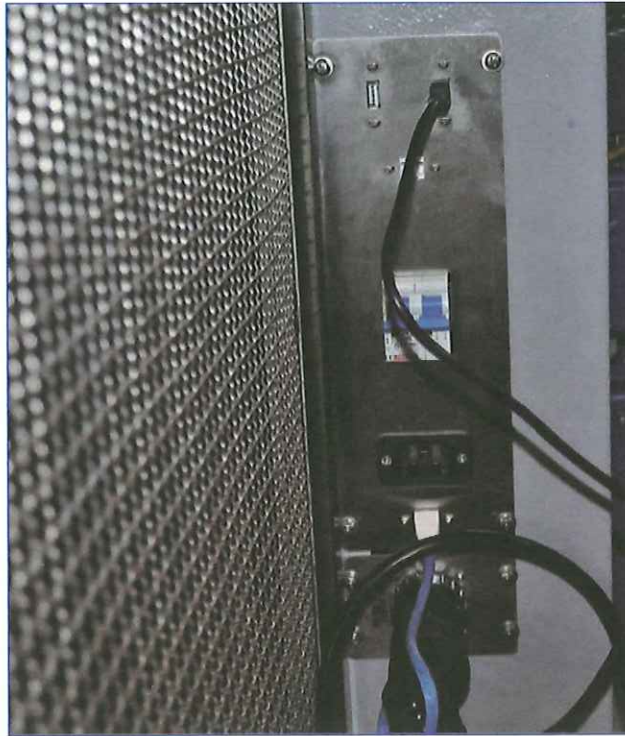**Figure 9: 620XR End Panel, Circuit Breaker, IEC Socket**

Figure 10: 620DV End Panel, Circuit Breaker, IEC Socket

Figure 13: 632DV End Panel, Circuit Breaker, IEC Socket

Figure 9 to Figure 13 show the end panel with a circuit breaker, IEC socket, and an optional High Speed Conveyor Terminal.

⚠️ **WARNING:** Voltage is present in the high speed conveyor terminal, handle with caution.

CAUTION: Do not block this side of the machine, because access to it is needed to plug in the power cable and to access the circuit breaker.

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7.0   Operational Instructions

7.1   Scope

This section covers the operation of the Rapiscan Systems Model 600 Series Single View (XR) and Dual View (DV) machines. As mentioned before, the only difference between the two types of machine (XR vs DV) in terms of operation is that the DV has an extra screen that shows a horizontal view of the bag. The menus and screens are exactly the same for both machines, as is the Operator Control Panel (Figure 14).

7.2   Windows-Based Software: New Features

The new Windows-based operating system features a new graphic interface that includes Programmable Function Buttons, and features real time image manipulation, allowing an operator to enhance an image while it is scrolling across the screen without having to stop that image.

The new Windows-based software also includes additional hardware in the security X-ray machines that the new operating system runs on. This manual, however, will concentrate on the software and those aspects of it that are of concern to an operator.

Figure 14 shows the Icon Operator Control Panel.

Figure 14: Operator Control Panel

The following sections describe the general layout, operating principles and safety measures of the Rapiscan Systems' 600 series security X-ray machine that Rapiscan Systems' proprietary Windows-based operating system runs on. These systems consist of the following components:

- X-ray generator (two generators for DV machines)

- Detector system (diode array)

- Frame and tunnel assembly

- Leaded curtains

- Conveyor assembly

- Photo sensors to detect the presence of baggage in the system

- Power distribution system

- Signal distribution system

- Operator Control panel

- Computers and monitor (two monitors for DV machines)

- A mobile operator control station (optional) (Figure 17) or a remote workstation/desk.

- Stringent safety measures including X-ray tunnels covered by conveyor shrouds that prevent passenger access to the tunnel.

- Advanced detector circuits using minimal X-ray energy to protect photographic film.

- A dual-energy type machine configured to display images with different colors according to the density and material type of the objects being scanned.

- Emergency Stop switches

- Proprietary Rapiscan software that controls the entire system and allows the operator to view images in various modes, enhancing the Operator's detection abilities.

Again, the main difference between the machines is the dual monitors on the DV and the single monitor and single view on the XR/Single View machines. Following are photos with remote workstations with single and dual monitors.

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Figure 19: 627DV with Remote Workstation and Dual Monitors
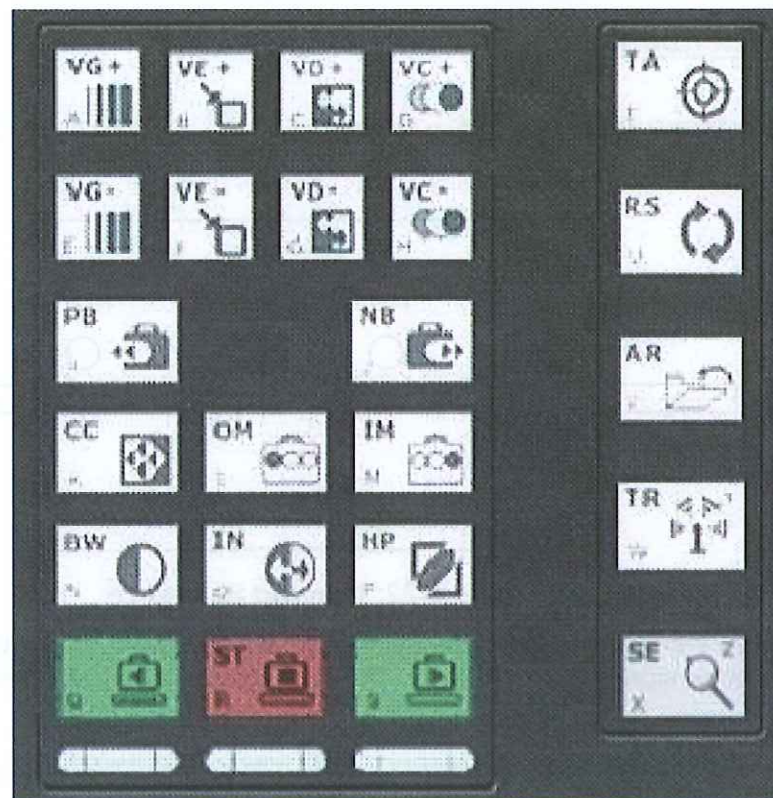
Figure 20: Operator Control Panel (close-up)

See "Control Panel Operation" on page 9-1 for a full description of each button and function of the control panel. NOTE: The SE button is used to indicate that an additional search (either manual or via further scanning) should be carried out on a particular bag. On some models, the SE (SEARCH) button is labeled as SUSPECT.

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6. When baggage reaches PS2, the system begins to make an image. If Calibration is incomplete, the system will use the results of the previous calibration. The system will then continue the Light Current collection.

7. While the system is creating an image, pressing STOP on the control panel will STOP the conveyor. Clicking FW (Forward) after this will result in a small movement in reverse by the conveyor; the system will then energize the X-rays and move the conveyor forward. This is done to compensate for X-ray and conveyor ramping time in order to create a "cut-free" image.

8. After baggage travels a certain distance past PS2, the software will stop generating an image but will still keep X-rays ON.

9. If, during the time X-rays are still ON, new baggage reaches PS1, the system will continue image processing without re-calibration. This is done to prevent repeatedly turning the X-ray generator ON and OFF, and thus will prolong the life of the generator.

10. After a delay, if no other baggage enters the tunnel, the system turns off X-rays. After further delay, to ensure X-rays are fully off, the system will begin Dark Current collection.

Dual View Imagine Sequence

The Rapiscan Dual View option allows the use of two monitors and X-ray generators to provide a secondary view of the object being scanned. Full image processing functions are available for the images. Another advantage of the system is that objects that may normally be lost in clutter in the traditional single view can be seen clearly in the second view.
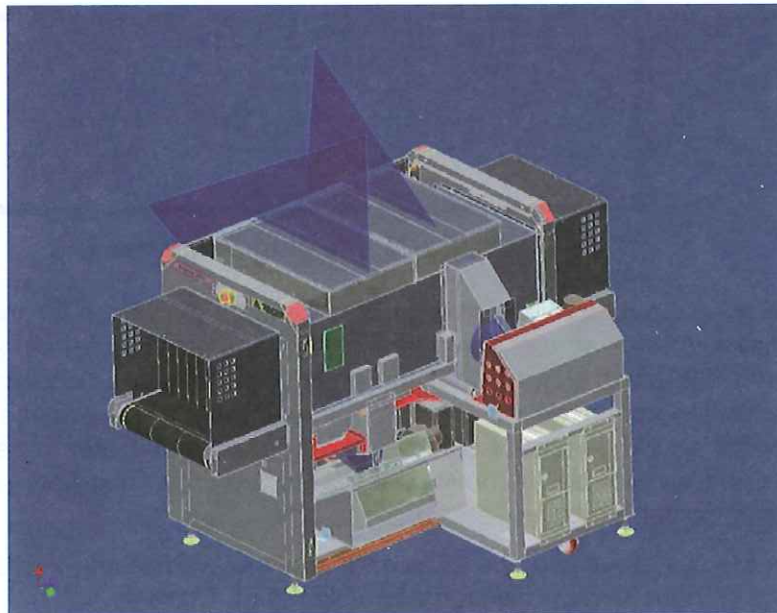
Figure 23: Dual X-rays from Front

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2. When the conveyor starts moving and a bag reaches PS1, blocking it, both generators are turned on and a short period ensues during which the generators ramp up to the point at which they are ready to capture an image of the bag

3. When the front of the bag reaches and blocks PS2, the "first" generator begins actually capturing an X-ray image of the bag

4. When the back of the bag passes and stops blocking PS3, the "first" generator shuts off

5. When the front of the bag reaches and blocks PS4, the "second" generator begins to capture an X-ray image of the bag (but from a different angle than the "first" generator)

7. Once the trailing end of the bag passes and stops blocking PS5, the "second" generator shuts down

8. PS6 does not come into operation unless the conveyor reverses direction and it becomes the entrance photo sensor (in effect it becomes PS1) and PS1 becomes non-operational

9. If, during the time X-rays are still ON, new baggage reaches PS1, the system will continue image processing without re-calibration. This is done to prevent turning the X-ray generator ON and OFF frequently to prolong its life

10. After some extra delay, if no other baggage enters the tunnel, the system turns off X-rays. After a delay, to ensure X-rays are fully off, the system will begin Dark Current collection again

7.5 Accessories

Rapiscan Systems has made available a wide range of accessories for use with X-ray machines to assist airport security staff with baggage handling- from simple off-load devices to fully integrated transfer tables and search bench systems. Choose from standard items available, or contact Rapiscan Systems for custom-designed solutions.

For questions concerning options and accessories, please contact our sales department (See Sales Offices on page 15-4). For questions concerning servicing and maintenance of Rapiscan systems, please contact the Service department nearest you:

8.0   Starting the X-ray System

8.1   System Check

Before switch-on:

- Check that the power cord is connected.
- Check that the power switch is activated on the monitor.
- Check the functionality of all warning lights.
- Check that all service panels are closed and locked.
- Check that no lead curtains are torn or missing.
- Check that all emergency switches are in their released or out position.
- Check that there are no objects in the inspection tunnel.
- Check that the circuit breaker switch is set to the ON position (see Figure 9 to Figure 13).

8.2   Power Connection

Every Rapiscan X-ray system has a rating plate or label which is located near the power inlet. Ensure the voltage and frequency marked on the plate or label is appropriate for your power supply before connecting (see End Panel and IEC Socket on page 6-1).

Warning: The apparatus must have an earth connection. This is normally supplied through the power cord.

8.3   Switching On

1. Connect the power lead to your supply, and turn the supply on.

2. Rotate the key switch on the power control panel and push the "Power On" button (Figure 26)

3. The X-ray system will begin its power-up sequence. The Power On light at the end of the machine should also light. If no lamps illuminate, check your electricity supply, the power lead and circuit breaker

4. The X-rays will be turned on briefly, to calibrate the system.

Figure 27: Log On Screen (Dual View)

The Log-on screen contains fields for User ID and Password, both of which must be correctly filled in order for the operator to access the main operator screen.

The Log-on screen also contains information in the lower right-hand corner about the software version, machine serial number and model number of the Rapiscan X-ray machine that the software is running on.

Finally, the Log-on screen contains two buttons in the lower left hand corner of the left screen, one green, one red. The green button toggles between W and Y on the TR (Transmit) key on the Operator Control Panel, and between X and Z on the SEARCH (SE) key. The red button acts as a backspace key when users are typing in their user ID and passwords. See page 9-2 for information on these function buttons.

The operator should type in his or her User ID and Password.

8.5   Main Operator's Screen

Once the Operator has entered his or her ID and Password, the main operation screen will appear as shown in. Notice that the function buttons have changed and now represent HP (High Penetration), BW (Black and White) and Manual Scan.

Figure 29: Forward / Thumbnail Window
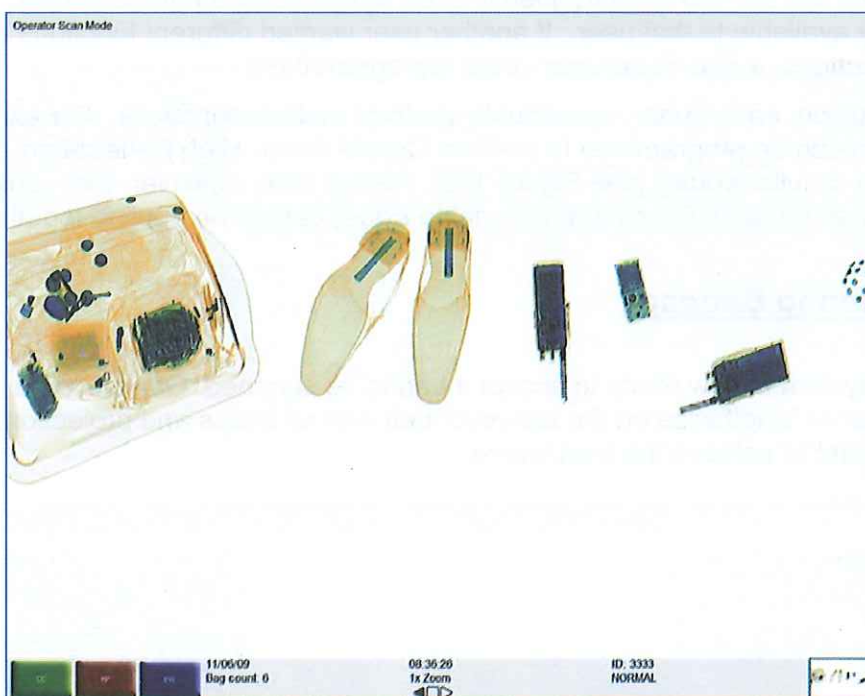
Figure 30: Reverse
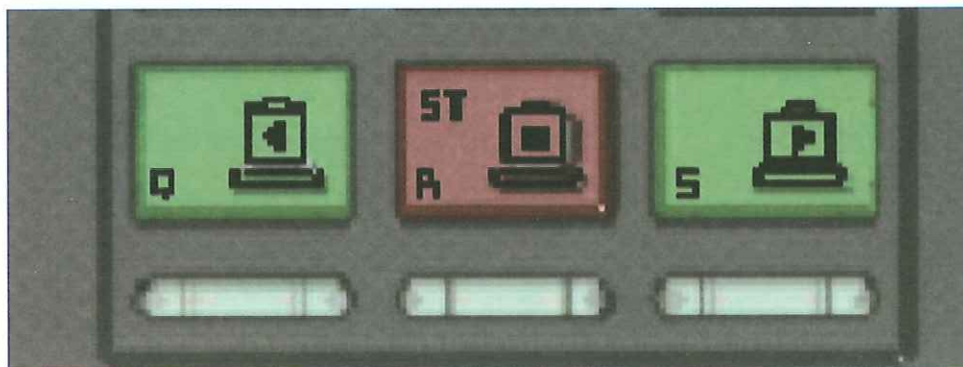
Figure 32: Conveyor Control Buttons

Press the green "S" button (Forward) on the operator control panel (Figure 32). The conveyor will run forward until the R button (Stop, Figure 32) is pressed. When the bag reaches the center of the tunnel, the X-rays will be turned on, and an image of the bag will be displayed on the screen. When the bag has emerged from the output end of the system, you may press the R/ST button to stop the conveyor. A typical image is shown Figure 33.

Figure 33: Typical Scanned Image

9.0   Control Panel Operation

Figure 34: Operator Control Panel

9.3   Conveyor Controls
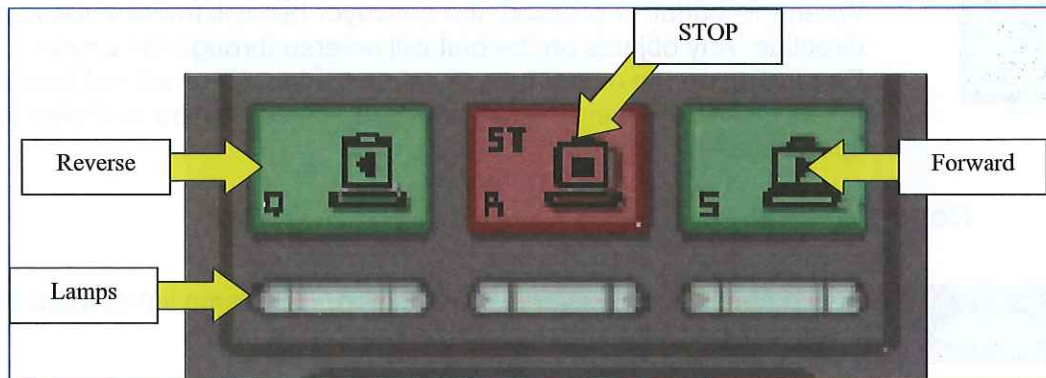
Figure 36: Conveyor Controls

Forward button

When this button is pressed, the conveyor will move objects on the belt to the inspection tunnel for scanning.

Forward lamp

Located beneath the Forward ("S") Button. This lamp lights when the conveyor is traveling in the forward direction.

Stop button

When this button is pressed, the conveyor belt will halt. Note: If this button is pressed during scanning of an object, the belt will stop then reverse a few centimeters. This is to ensure that when 'forward' is selected again, no part of the object is missing from the image. If the X-rayed image is being viewed with an image processing function, the ST button will cancel the function.

Stop lamp

Located beneath the Stop ("R") Button. This lamp lights when the conveyor belt is stationary.

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9.4   Image Processing Keypad

Figure 38 shows the image processing keypad on the Operator Control Panel. These keys are described in the following paragraphs.

> **NOTE:** All image processing functions can be applied to images whether the bags have been stopped on the belt and the images are stopped on the operator's screen, or when the bags are still moving through the X-ray tunnel, the images scrolling across the operator's screen.
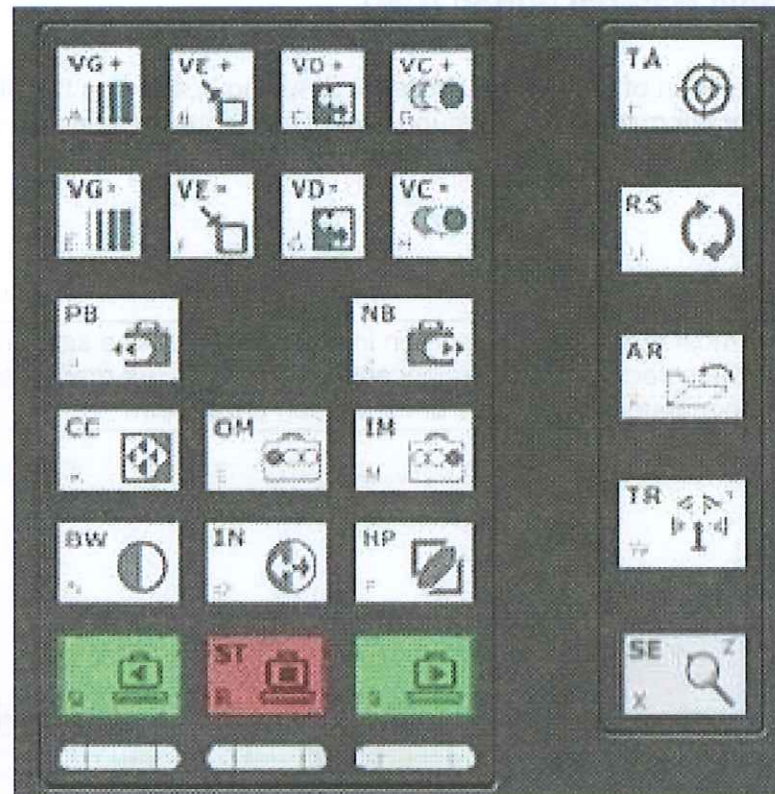
Figure 38: Image Processing Buttons

Material Groups

Organic substances composed of light chemical elements that have an atomic weight of less than ten (irrespective of their molecular structure) are displayed in orange on the operator's screen. The most important elements in this category are hydrogen, carbon, nitrogen and oxygen.

Most explosives are made of a combination of these elements. Explosives like nitro-glycerin and Semite belong to this group.

Inorganic Material button (IM)

Operation of the Inorganic Material Stripping button has the effect of removing the color information of all groups except for Group 3 (inorganic). See "Material Groups" on 9-5.

Figure 40: Inorganic Material (IM)

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Black and White button (BW)

All color information in the image is removed.

Figure 42: Black and White (BW)

High Penetration button (HP)

When this button is pressed, the presentation of high-density objects is enhanced.

Figure 44: High Penetration (HP)

Variable Gamma (VG)
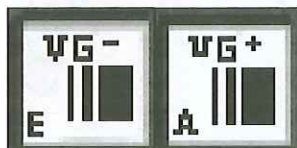
The Variable Gamma function allows the operator to alter the brightness of the image. Use buttons VG+ and VG-.

Multiple keystrokes on the VG- or VG+ button will either increase or decrease image brightness. Figure 45 shows an image with VG+ applied. Note the variable slider pointed out by the yellow arrow. This indicates that the user pressed the VG+ key several times in order to apply a near-maximum amount of VG+. Figure 46, conversely, shows an image with heavy VG- applied as indicated by the variable slider.

Variable Edge Enhancement

The Variable Edge Enhancement buttons (VE- and VE+) cause objects' boundaries to become sharper and easier to see.

Multiple keystrokes on the VE- or VE+ button will either increase or decrease the sharpness of different boundaries within the objects being scanned. Figure 47 and Figure 48 show images with heavy VE+ and VE- applied.

Figure 47: VE+

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Figure 49: VD+

Figure 50: VD-

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Figure 52: VC-

Previous Bag and Next Bag

In this mode the operator is able to scroll in reverse to view previous bags or to scroll forward to get back to the latest bag. Note that the Mode Indicator Panel reads: "Scanned Image Review Mode" which is the mode the system enters when allowing review of previous and next bags.

Next Bag

This mode is accessed by pressing the "NB" key on the Operator Control Panel. When "NB" is pressed, the Next bag will scroll on screen.

Figure 54: Next Bag

Figure 54 shows how the screen looks when Next Bag key ("NB") is pressed. Note that the next bag is outlined in red once it is chosen, and moves onto the screen from left to right.

A message reading "End of image review buffer. Press the PJ/I button to clear this message box" will appear on screen once the operator has reached the end of the image review buffer when in Next Bag mode. As indicated in that message, the operator can press the "J" or "NB" key on the operator control board to clear the message, but the message will disappear automatically after 5 seconds. The "R" or Stop button can be used to exit the Previous Bag or Next Bag mode (i.e. the Scanned Image Review Mode) and back to the Normal mode.

NOTE: Each bag in Previous Bag or Next Bag mode has a date/stamp indicator above the bag's image on screen.

Everything gets reversed, of course, if the conveyor belt is traveling in Reverse. In that case the "previous" bag now becomes the "next" bag and vice versa.

Transmit

This function is applicable when the X-ray machine is part of a network and allows images to be transmitted to other machines in the network.

Reset

This button allows the operator to return to "normal" mode from image enhancement and Zoom modes.

Combined Function

The system software also allows the operator to use more than one image enhancement feature simultaneously. Figure 56, for example, shows an image that is being enhanced with Crystal Clear, Black and White and Organic Material
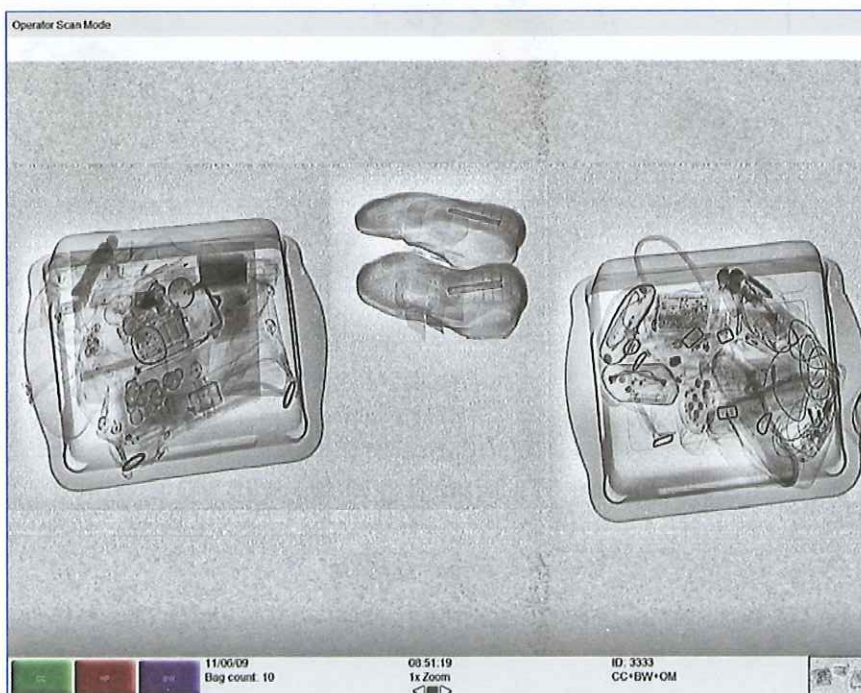
Figure 56: CC+ BW + OM

NOTE: Applying too many image enhancement functions to an image can actually have the opposite effect and distort the image beyond the operator's ability to spot possible threats

9.5   Zoom Keypad

Figure 58 shows a typical scanned image, which has divided by non-existent dashed lines into nine segments, each corresponding to a button on the Operator Control Panel zoom/numerical keypad (Figure 59).

> **NOTE:** These nine segments actually overlap somewhat rather than being evenly divided. This ensures complete coverage of all the objects on screen.
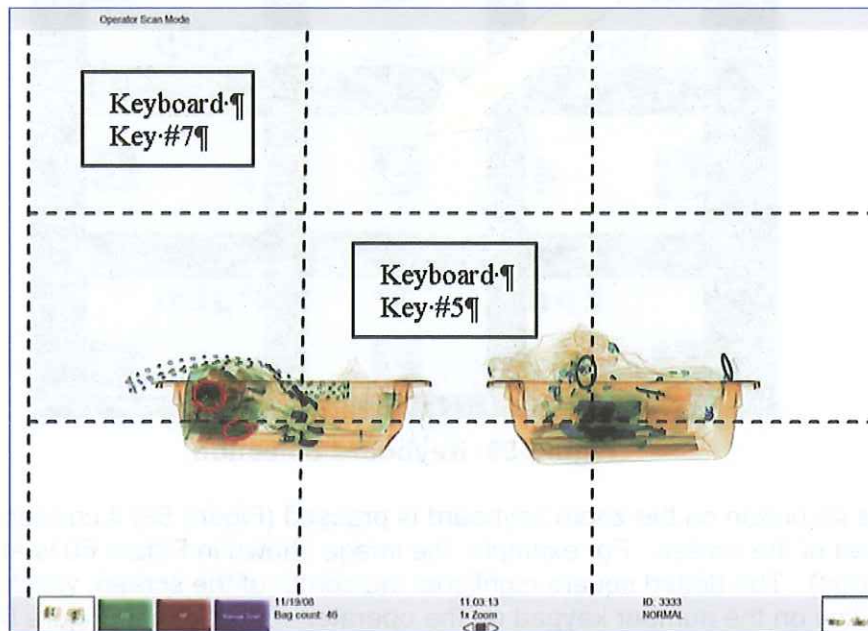
Figure 58: Screen Divided into Nine Segments

For example, the top left corner of the horizontal view corresponds to #7 on the Control Panel Numeric Keypad; the center square corresponds to #5 on the Control Panel Numeric Keypad (Figure 58).
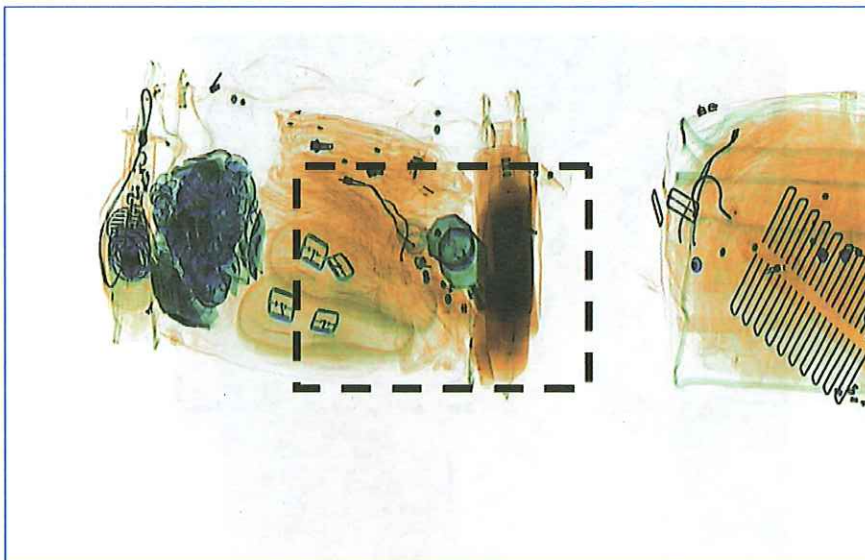
Figure 60: Center Selected (Button #5 on Operator Control Panel)
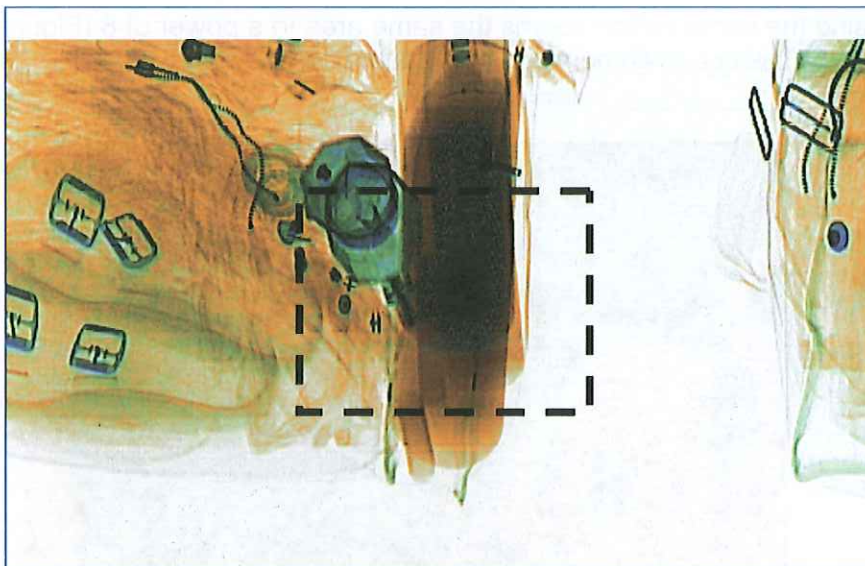
Figure 61: 2 x zoom

Press #5 on the zoom keypad again, the same area of the screen is increased to 4X Zoom (Figure 62).

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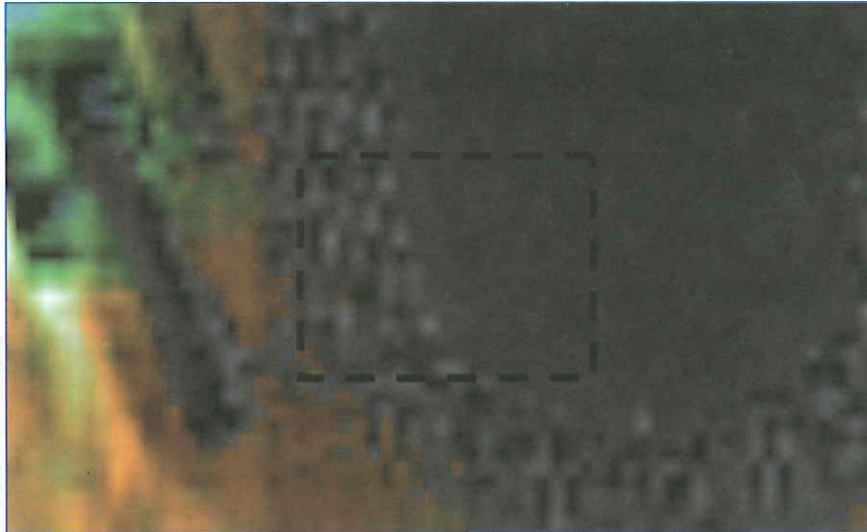
Figure 64: 16 x zoom

The Back to Normal button returns the image to a normal size (Figure 65).
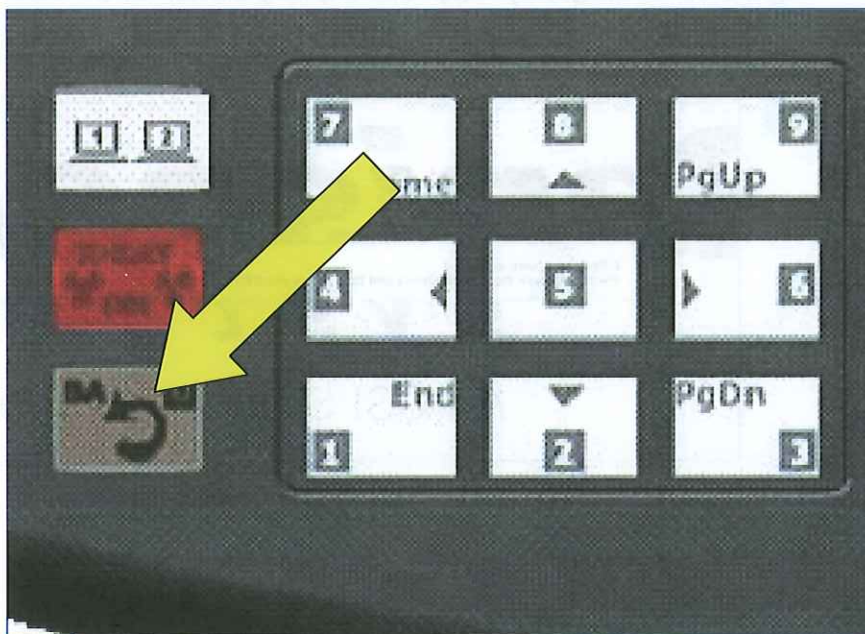
Figure 65: Back-to-Normal and Zero Button

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Please release the E-Stop button and then press the STOP button to continue.

Figure 68: E-Stop Release Message

The operator must release the E-stop and then press the Operator Control Panel STOP button again. At that point the following message will appear:

Please wait for system to resume normal operation.
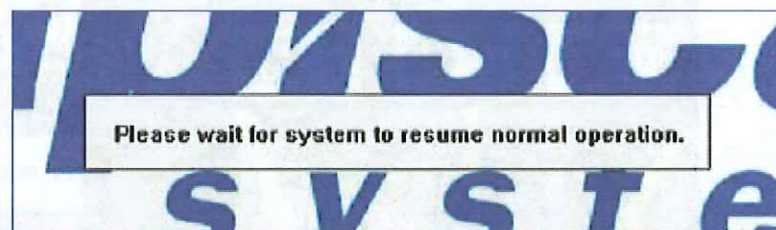
Figure 69: E-Stop "Wait for System" Message

Indicator Lights

The Operator Control Panel features five indicator lights. Figure 70 shows two of those lights: X-rays On and System On. Figure 71 shows the indicator lights at the base of the Image Processing Keypad (NOTE the SE button. These lights are for the Reverse (RE), Stop (ST) and Forward (FW) conveyor buttons and indicate when the respective buttons have been pushed.

X-Rays ON

Figure 70: X-rays On Light

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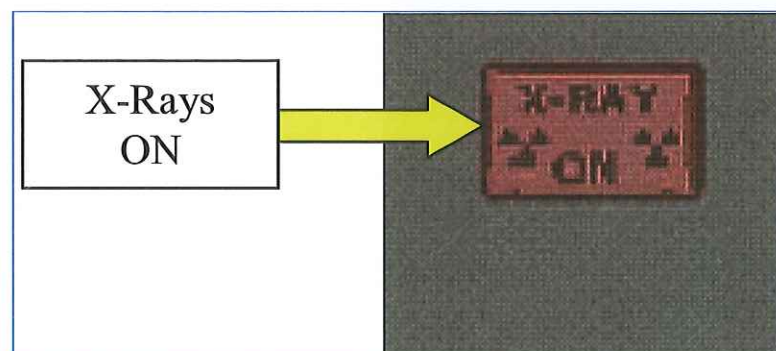
10.0 Operator Mode

To enter the Operator Mode, type in your User ID and Password on the Log-On screen (Figure 72) then left-click the mouse button. This will cause the main screen to appear, as shown in Figure 73.

> **NOTE:** For most of the manual, screen images will be of one side or view (Horizontal or vertical) of the screen only, simply because the print on the menus are too small to be legible in the manual if both sides of the screen are shown as in Figure 72.

Figure 72: Log On Screen (Dual View)
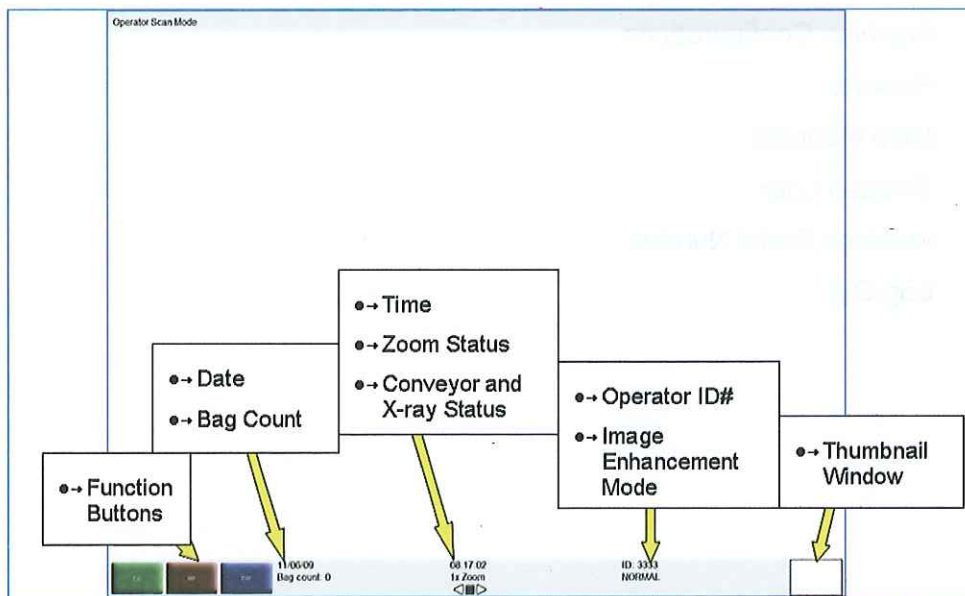
Figure 73: Main Screen

The Main Operator's Screen displays:
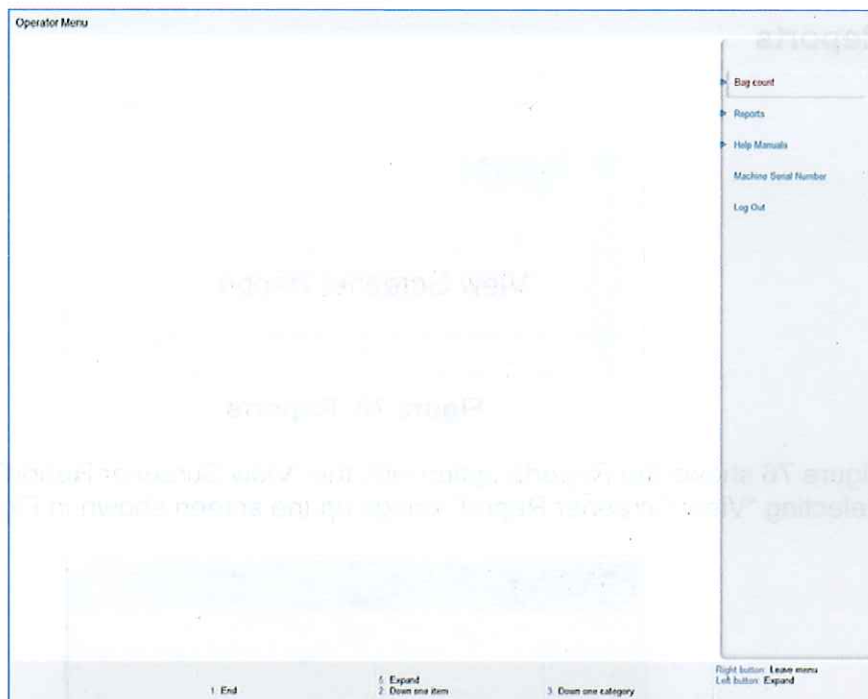
Figure 74: Operator's Main Menu

Figure 74 shows the Operator's Main menu, which is accessed by clicking the left mouse button. Clicking the right mouse button reverses that choice, making the menu slide back out of sight. The left/right mouse button works all through this menu: left click will bring up a sub-menu; right click will slide that submenu out of sight.

Bag Count

Figure 75: Bag Count

Selecting "Bag Count" and then "Total Number" brings up the sub-screen shown in Figure 75 which displays the number of bags scanned since the machine first operated at the factory. This number cannot be changed.

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Figure 78: Screener Log Report

Figure 79: Individual Screener Performance Report

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Operator Mode

Figure 82: Access History Report
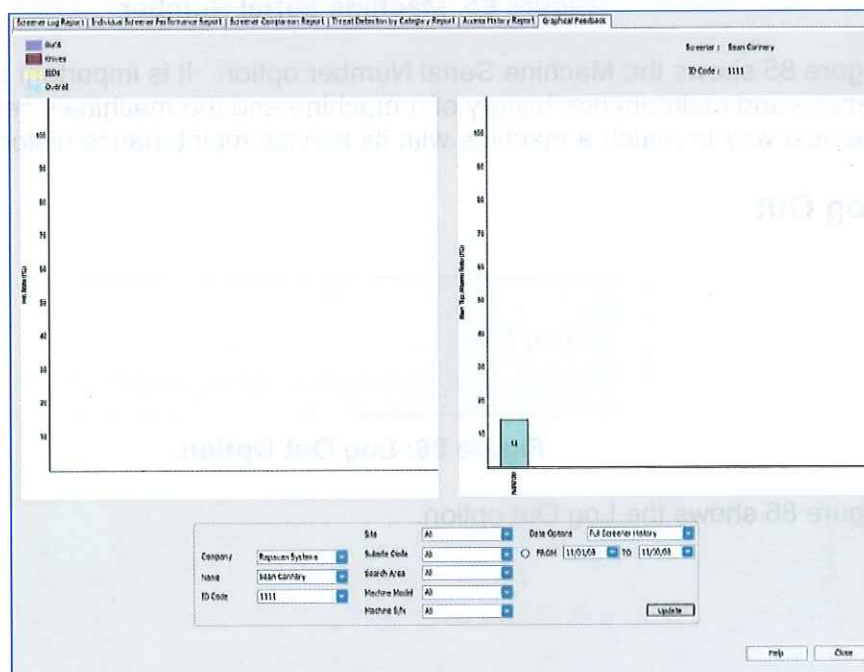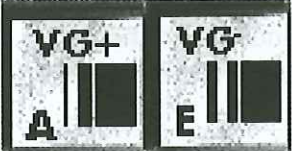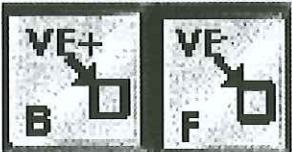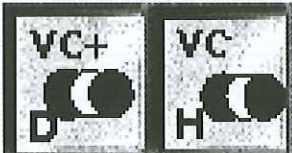
Figure 83: Graphical Feedback

Following is a table of describing the Image Enhancement functions.

BUTTON	NAME OF FUNCTION	BRIEF DESCRIPTION
VG+ (A) / VG (E)	**VARIABLE GAMMA** (ON and OFF)	These buttons alter the brightness of the image. This remains active until ST button is pressed.
VE+ (B) / VE (F)	**VARIABLE EDGE ENHANCEMENT** (ON and OFF)	These buttons show the centre of enhancement, which causes objects boundaries to become sharper and easier to see. This remains active until ST is pressed.
VD+ (C) / VD (G)	**VARIABLE DENSITY ZOOM** (ON and OFF)	These buttons place correlate an image's brightness with the scanned object's density.
VC+ (D) / VC (H)	**VARIABLE COLOR STRIPPING** (ON and OFF	These buttons progressively strip away color from inorganic matter in an image, defining the shape of objects within the blue/black color scheme. Blue shades represent inorganic materials namely metals, while the green shades the low-density materials.
PB (I)	**PREVIOUS BAG**	This button allows the Operator to go back to a previous bag stored in the buffer.
NB (J)	**NEXT BAG**	This button allows an Operator to view the next bag in line stored in the buffer.
CC (K)	**CRYSTAL CLEAR**	Crystal Clear brings out the detail in both light and dark areas simultaneously. This remains active until ST or F button is pressed.
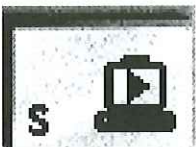
	FORWARD	Moves the conveyor belt forward, allowing X-ray scanning to take place.
	TARGET	This button causes an ellipse to be drawn around a suspected threat or contraband, if Target is installed.
	HIGH PENETRATION	When this button is pressed, the presentation of high-density object is enhanced. This remains active until ST or H button is pressed.
	ARCHIVE	Allows the scanned image to be stored on the computer. The image can be recalled later but only in Supervisor mode.
	TRANSMIT	This function is applicable when the X-ray machine is part of a network and allows images to be transmitted to other machines in the network.
	SE/SUSPECT	An Operator, who suspects that there may be a threat or contraband in a particular bag, should press the "SE/SUSPECT" button, and then follow the security procedures used at his place of employment.

Figure 87: Image Enhancement Functions

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Administrator Mode

11.0 Administrator Scan Mode

To enter the Administrator Scan Mode, type in your User ID and Password on the Log-On screen (Figure 88). This will cause the main screen to appear, as shown in Figure 89.

> **NOTE:** For most of the manual, screen images will be of one side or view (Horizontal or vertical) of the screen only, simply because the print on the menus are too small to be legible in the manual if both sides of the screen are shown as in Figure 88.

Figure 88: Login Screen
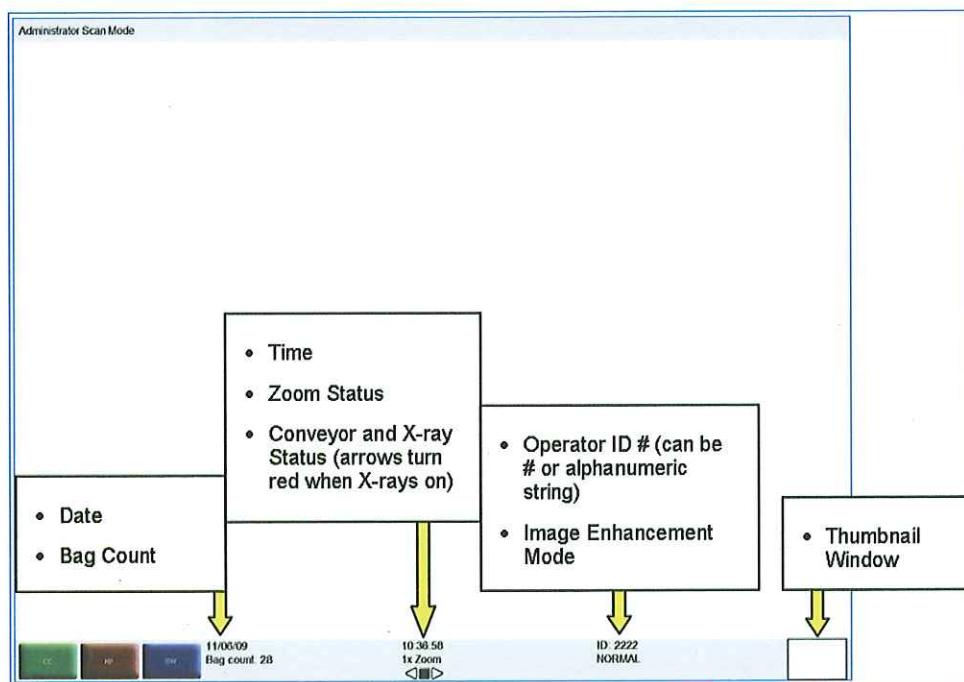
Figure 89: Main Screen

11.1   Main Menu

Left-clicking on the screen brings up the Maintenance Management menu (Figure 90). This menu allows the supervisor to change specific settings for the 600DV. Right-clicking on the screen will collapse a menu one step at a time.

▶ Image Processing

▶ Bag count

▶ On-Screen Display

▶ Image Archives

▶ Location Setup

User Management

View System Logs

▶ Reports

Screen Saver

▶ Help Manuals

Machine Serial Number

Log Out

Figure 90: Administrator Menu

11.2   Image Processing

High Penetration	Black and White	Crystal Clear	Mode
Real-Time Mode	Real-Time Mode	Real-Time Mode	
Inorganic Material	Organic Material	Inverse Color	Bind Processing Function
Real-Time Mode	Real-Time Mode	Real-Time Mode	
Edge Enhancement	Gamma	Color Stripping	Auto Reset on Scan
Real-Time Mode	Real-Time Mode	Real-Time Mode	
Density Zoom			▶ Bag count
Real-Time Mode			▶ On-Screen Display

Figure 91: Image Processing - Mode

1. To make use of the Bind Processing Functions function, obtain a scanned image

Figure 93: Scanned Image

2. Apply one or more image processing functions to the image. In Figure 93, for example, the operator has applied CC, BW and OM to the image

3. Click the right touchpad button, which brings up the Administrator Menu (Figure 90)

4. Using the touchpad, move down to highlight Image Processing

5. Left click on "Image Processing." The full Image Processing menu will be revealed, including the Bind Processing Functions button

6. Using the touchpad, move down to highlight the Bind Processing Functions button and left-click on the button. The Bind Processing Functions drop down menu will appear (Figure 94)

NOTE: Assigning too many functions may prove counterproductive to the quality of the actual image the operator's ability to discern possible threats in the image.
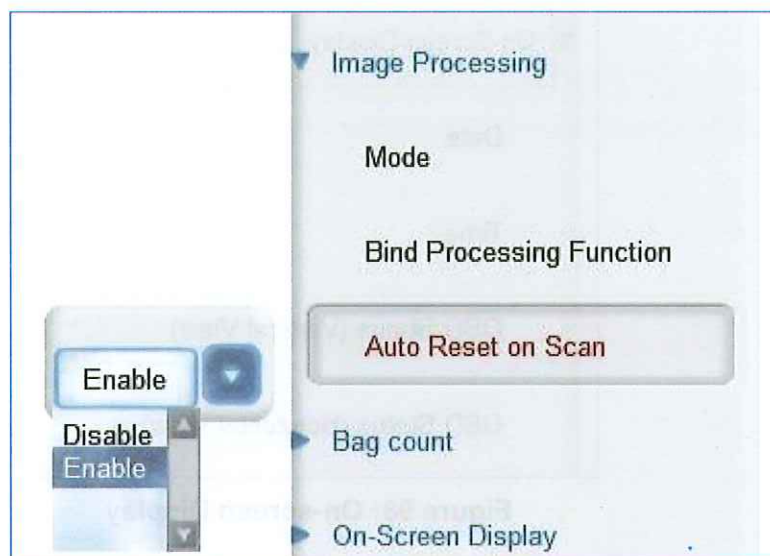
Figure 96: Image Processing – Auto Reset on Scan

Figure 96 shows the third and final item under "Image Processing," the Auto Reset on Scan function. When enabled, this function resets the image processing functions to normal each time a new item is scanned. Note the Enable and Disable options.

11.3 Bag Count
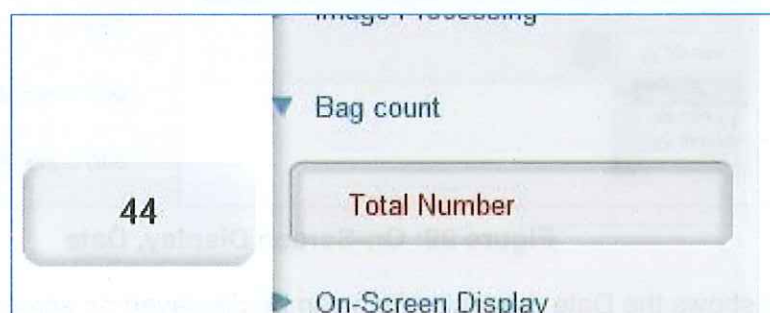
Figure 97: Bag Count – Total Number

Bag Count (Figure 97) includes the Total Number sub-option. Total Bag Count displays the number of bags scanned since the Machine first operated at the factory. This number cannot be changed.
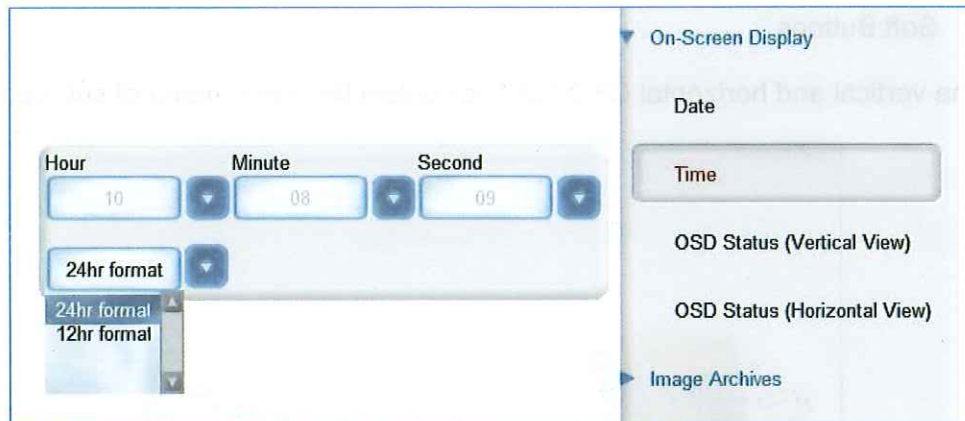
Figure 100: On-Screen Display, Time

Figure 100 shows On-Screen Display: Time. The time can be displayed in 12 hour or 24 hour format.
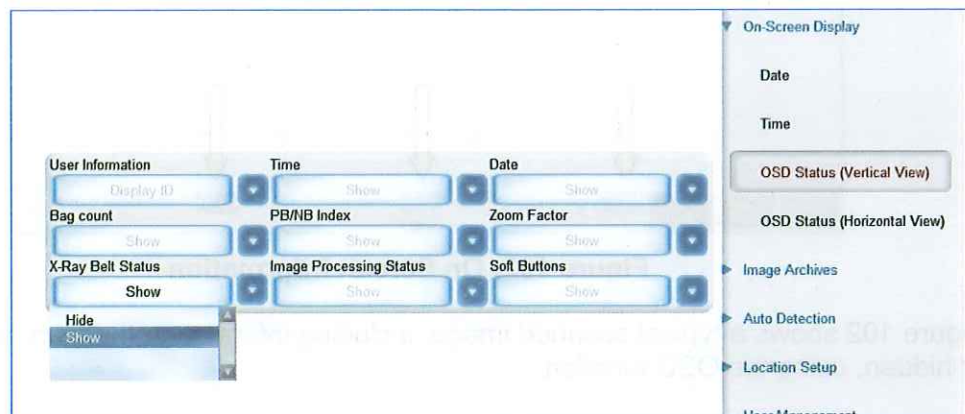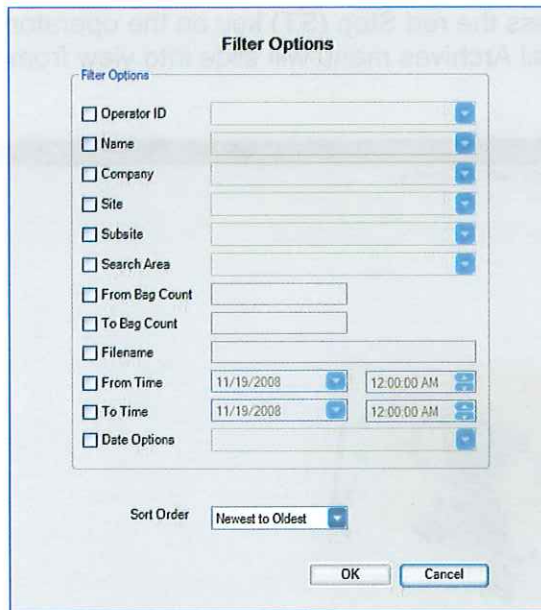
Figure 101: OSD (On Screen Display) Status

Figure 101 shows the OSD (On Screen Display) Status button for the vertical view, with the accompanying slide-out/drop down menu, which allows control over a number of types of information that can be shown or not shown on screen:

- User Information
- Time
- Date
- Bag Count
- PB/NB Index
- Zoom Factor
- X-ray Belt Status
- Image Processing Status

Figure 104: Filter Options

Selecting "OK" on the Filter Options screen brings you to the Review Manual Archives Mode (Figure 105).

Figure 105: Review Manual Archives mode

Within a few moments of entering the Review Manual Archives mode, archived images will begin to scroll across the screen from left to right. These images can be

Image Information

Operator ID:	1111
Name:	Sean Connery
Company:	Rapiscan Systems
Site:	Rapiscan
Subsite:	Building 1
Search Area:	Area
Machine S/N:	rtobin
Bag Count:	26
Date Time:	11/19/2008, 06:58:26
Filename:	image1.RCF
Description:	N/A

OK

Figure 109: Image Information screen

Figure 110 shows the Machine Serial Number option.

Figure 110: Machine Serial Number

Selecting Filter Options (Figure 111) brings up the Filter Options screen (Figure 104).

Figure 111: Filter Options

Selecting Export Images (Figure 112) brings up the screen shown in Figure 113.

Figure 112: Export Images

Figure 116: Location Setup - Site

The Site screen shown in Figure 117 allows you to modify site information and to list all the current sites.
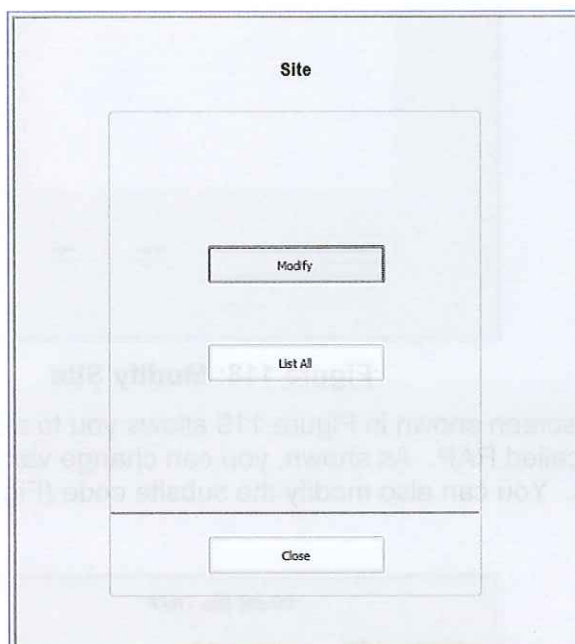
Figure 117: Site

Figure 118 shows the Modify Site screen. To actually modify an entry, select a site from those listed on the screen, then click on "Modify."

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Figure 120: Modify Sub-Site

Figure 121: Modify Search Area

Choosing List All from the Site screen shown in Figure 117 brings you to the screen shown in Figure 122 which lists all current sites. You can also view more detail about any particular site by selecting that site from the list and clicking View which brings you to the screen shown in Figure 123.

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Figure 124: Station option

The Station screen (Figure 125) allows you to modify and/or list all current stations.
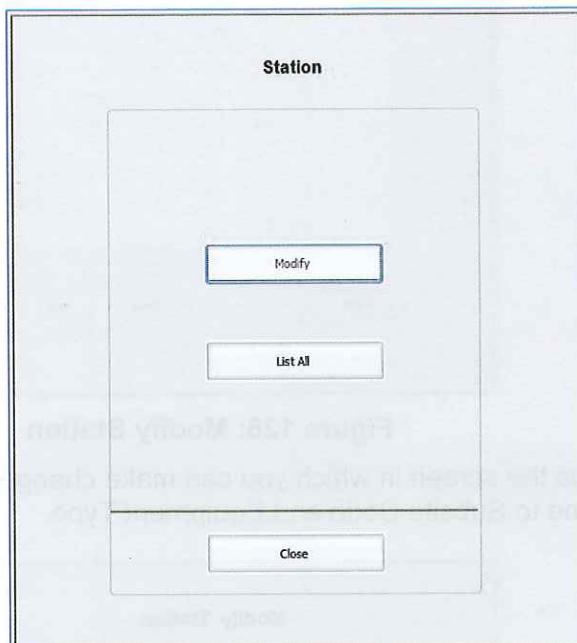
Figure 125: Station

Choosing Modify from the Station screen brings up the Modify Station screen shown in Figure 126. Select the desired station from the list of stations, then click "Modify."

Choosing List All from the Station screen (Figure 125) brings up the List All Stations screen (Figure 128). Select the station from the list of Stations and click View to see more detail (Figure 129).

Figure 128: List All Stations

Figure 129: View Station

Figure 132: Add User

Selecting Add Company brings up the Add Company screen:

Figure 133: Add Company
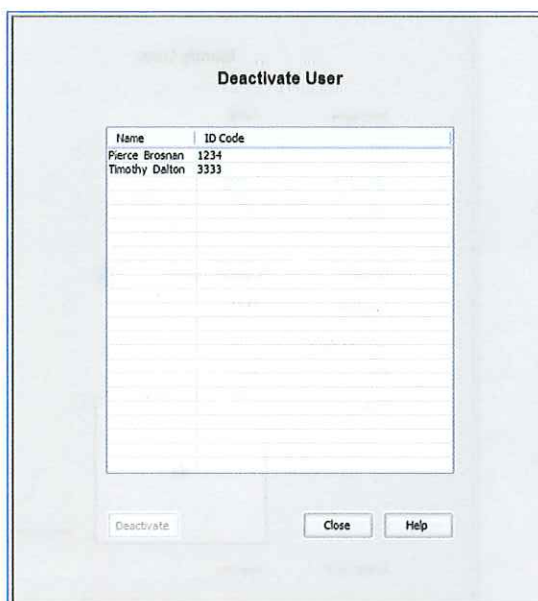
Figure 136: Deactivated user

Figure 137: Modify User

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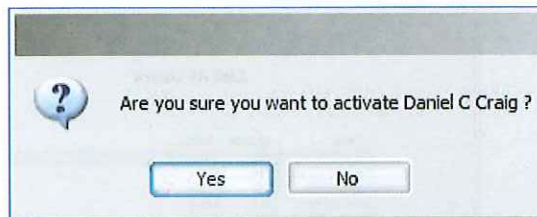
Figure 140: Activate User message
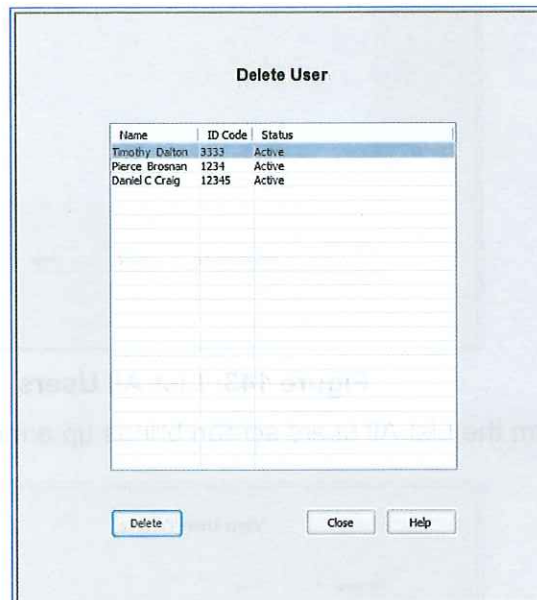
Figure 141: Delete User

Selecting Delete from the Delete User screen brings up a warning message:
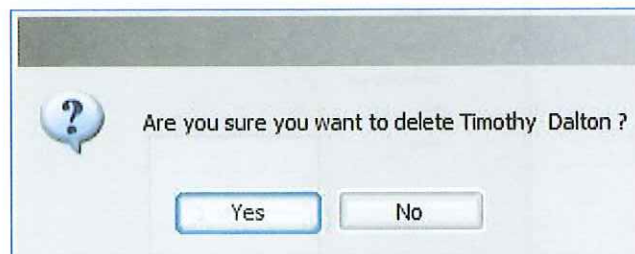
Figure 142: Delete User message

11.8 View System Logs

Figure 145: View System Logs

Figure 145 shows the View System Logs button. Selecting this button brings you to the screen shown in Figure 146.
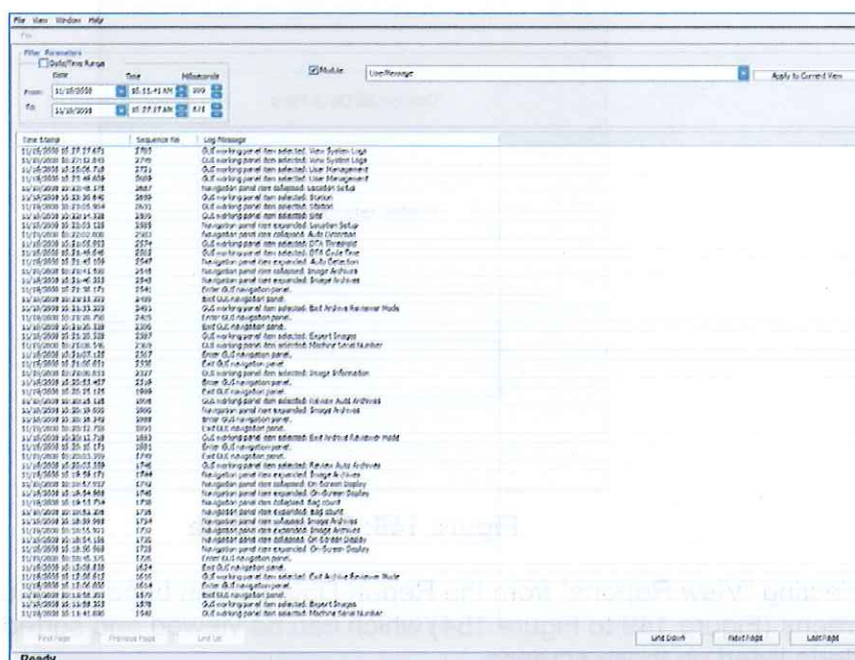
Figure 146: System Logs

To exit System Logs, select File in the upper left corner, then choose Exit from the pull-down File menu.

11.9 Reports

Figure 147 shows the Reports/Manage Report Data option.

Figure 147: Manage Report Data

Figure 149: Screener Log Report

Figure 150: Individual Screener Performance Report

Figure 153: Access History Report
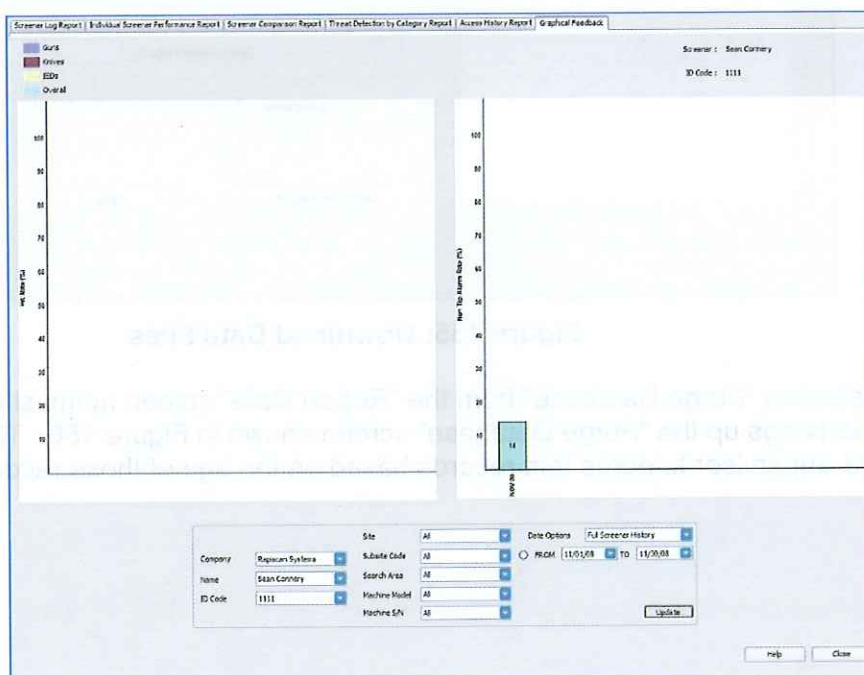
Figure 154: Graphical Feedback

Selecting "Download Data Files" from the "Report Data" screen menu shown in Figure 148 brings up the "Download Data Files" screen shown in Figure 155. This screen allows a Supervisor to download reports from:

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Administrator Mode

Figure 156: Purge Database

11.10 Screen Saver

Figure 157shows the Screen Saver option which allows you to set the wait time and/or to disable the function, and also whether or not to require a login.

Figure 157: Screen Saver

11.11 Help Manuals

Figure 158 shows the Help Manuals button and the Operator and Supervisor Manual option. When selected, this brings up online versions of the Operator and Supervisor manuals (Figure 159).

Figure 158: Help Manuals

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11.13 Log Out

Figure 161 shows the Log Out option. When selected, it brings the user back to the Login screen.
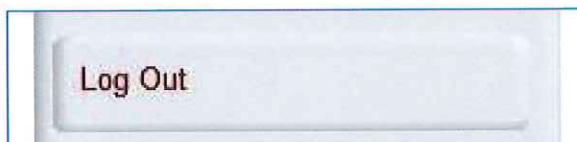
Log Out

Figure 161: Log Out Option

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Technician Mode

12.0 Technician Mode

Log into technician mode. This brings up the technician mode operating screen (Figure 162). The left side is the vertical view; the right side is the horizontal view.

> **NOTE:** For readability the images shown in this section will mostly be of one side of the screen only – either the horizontal or vertical view.

Technician Scan Mode

11/06/09
Bag count: 20

09.06.00
1x Zoom

ID. 1111
NORMAL

Figure 162: Operating Screen

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"Mode" includes a number of menu items that control the appearance of a scanned image:

- High Penetration
- Black & White
- Crystal Clear
- Inorganic Material
- Organic Material
- Inverse Color
- Edge Enhancement
- Gamma
- Color Stripping
- Density Zoom

Each of these menu items, when selected, offer three choices:

- Stop mode
- Disable/Enable
- Real-Time Mode

This determines whether a particular image enhancement, such as High Penetration, operates only in stop mode or in both stop mode and "real-time" mode and also whether the enhancement is enabled or disabled altogether.

Figure 164: Image Processing – Mode

The Bind Processing Functions button (Figure 165) allows the Operator to assign multiple image processing functions to individual function keys.

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6. Using the touchpad, move down to highlight the Bind Processing Functions button and left-click on the button. The Bind Processing Functions drop down menu will appear (Figure 167)

Figure 167: Image Processing – Bind Processing Functions

8. Choose the colored button to which you want to assign the image functions you've just applied to the scanned image (green or red)

9. Right-click until you return to the main screen (without the main menu showing) where you'll see that the functions you chose have been assigned to the function button you selected (Figure 168)
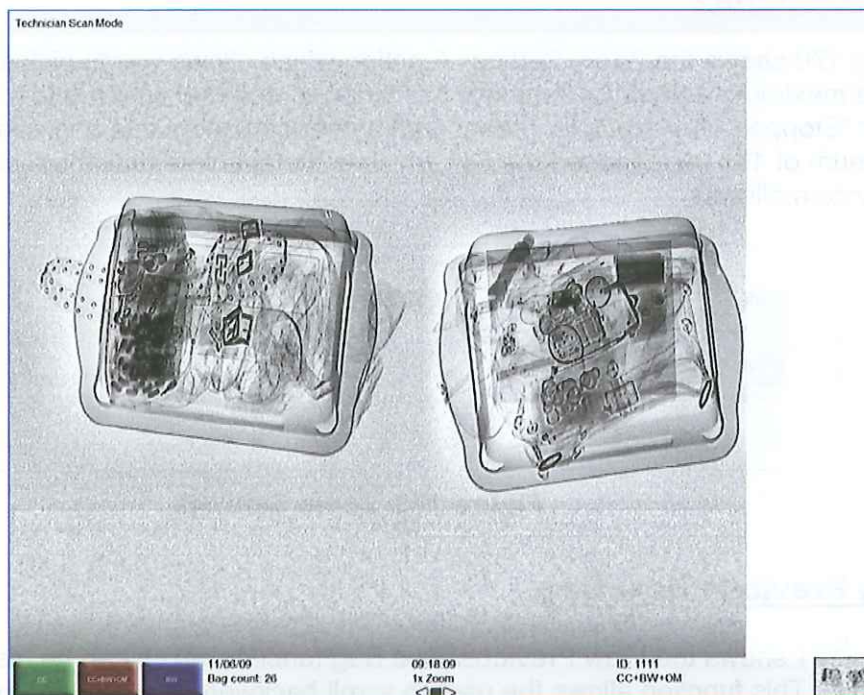
Figure 168: Multiple Image Processing Functions

Figure 168 shows the red button now representing the CC, B&W and HP functions. Now each time that button is selected, all three of those functions will be applied to the scanned image whenever the blue button is selected. Of course an operator may choose any number of functions to assign to any one of these buttons.

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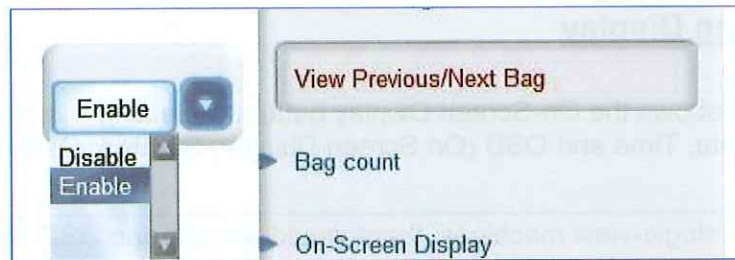
Figure 171: View Previous/Next Bag

12.5 Bag Count

Figure 172 shows the Bag Count function and its two sub-functions, Total Number and Reset Bag Count. Total Number displays the number of bags scanned since the Machine first operated at the factory. This number cannot be changed.

Figure 172: Bag Count - Total Number

Reset Bag Count (Figure 173) displays the number of bags scanned since the last time the count was reset.
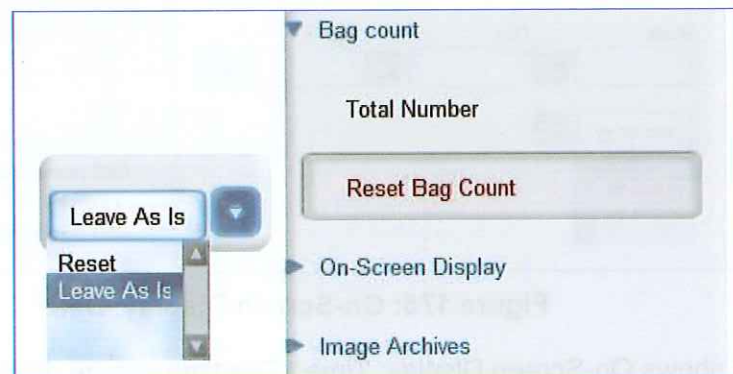
Figure 173: Reset Bag Count
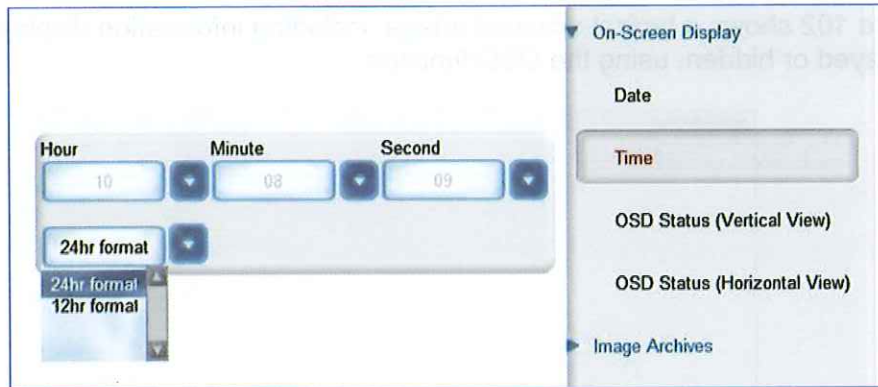
Figure 176: On-Screen Display, Time

Figure 177 shows the OSD (On Screen Display) Status button for the vertical view, with the accompanying slide-out/drop down menu, which allows control over a number of types of information that can be shown or not shown on screen:

- User Information
- Time
- Date
- Bag Count
- PB/NB Index
- Zoom Factor
- X-ray Belt Status
- Image Processing Status
- Soft Buttons

The vertical and horizontal OSD buttons contain the same menu of sub-options.
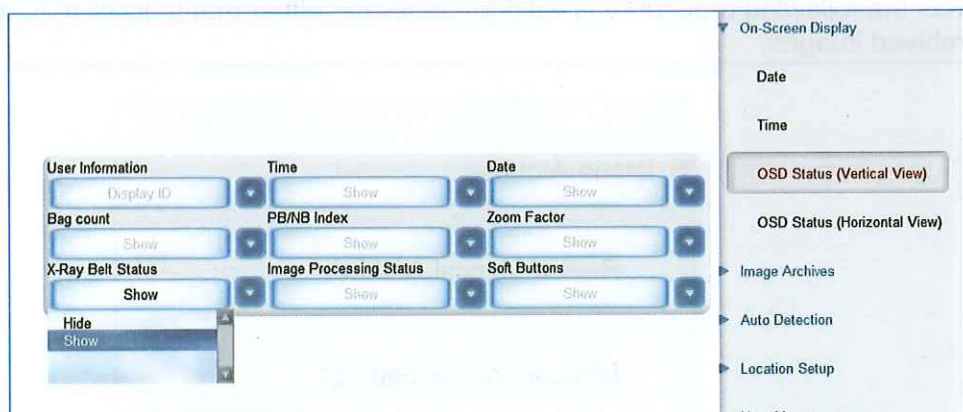
Figure 177: OSD (On Screen Display) Status

Selecting Review Manual Archives (Figure 180) brings up the Filter Options screen (Figure 181). The Filter Options screen allows you to determine the criteria that can be used to search the manually or automatically archived imaged, criteria such as Operator ID, Site, Bag Count and Date options.

Figure 180: Review Manual Archives

Figure 181: Filter Options

Selecting "OK" on the Filter Options screen brings you to the Review Manual Archives Mode (Figure 182). Within a few moments of entering the Review Manual Archives mode, archived images will begin to scroll across the screen from left to right. These archived images can be manipulated by using image enhancement functions such as Crystal Clear, Organic Material or Black and White.

Selecting Help Manuals will bring up the option to see the Operator and Supervisor manuals.

Help Manuals

Operator & Supervisor Manual
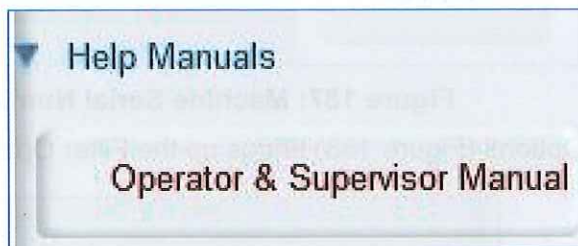
Figure 184: Help Manuals

Selecting Image Information (Figure 185) brings up the screen shown in Figure 186.

Image Information

Figure 185: Image Information button
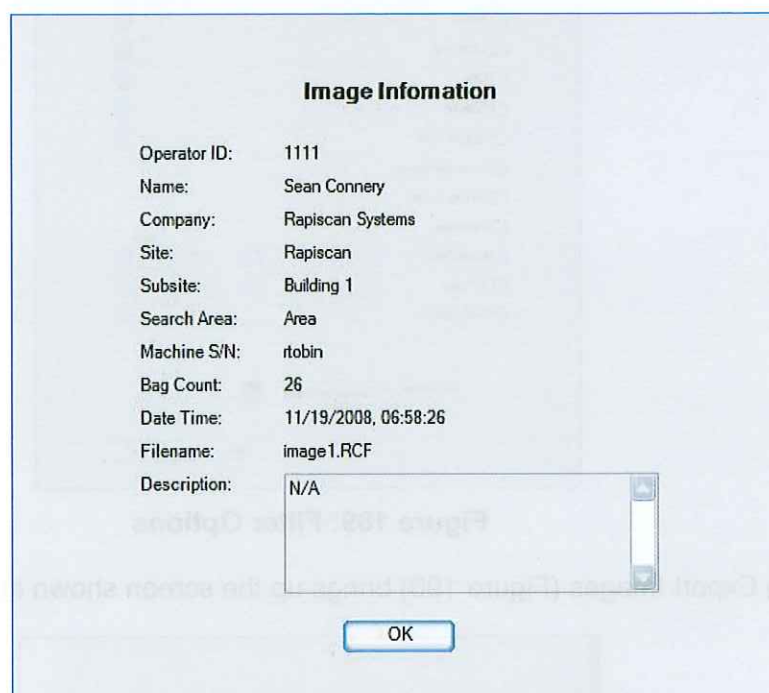
Image Information

Operator ID:	1111
Name:	Sean Connery
Company:	Rapiscan Systems
Site:	Rapiscan
Subsite:	Building 1
Search Area:	Area
Machine S/N:	rtobin
Bag Count:	26
Date Time:	11/19/2008, 06:58:26
Filename:	image1.RCF
Description:	N/A

OK

Figure 186: Image Information screen

Figure 187 shows the Machine Serial Number option.

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Figure 191 shows the Export Images screen with options for Image Selection, File Format, Output Files and Destination Path.


Figure 191: Export Image(s) screen

Selecting Exit Archive Reviewer Mode (Figure 192) takes you out of the Review Manual Archives mode.

Figure 192: Exit Archive Reviewer Mode

Figure 193 shows the Manual Archive Settings which allows you to decide: whether to enable or disable the function; the format in which to archive the images and; whether to enable or disable the "archive with DTA" feature.
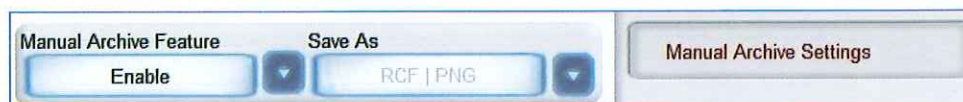
Figure 193: Manual Archive Settings

12.8   Location Setup

Figure 194 shows Location Setup and its three sub-options: Site, Station and Station Settings.
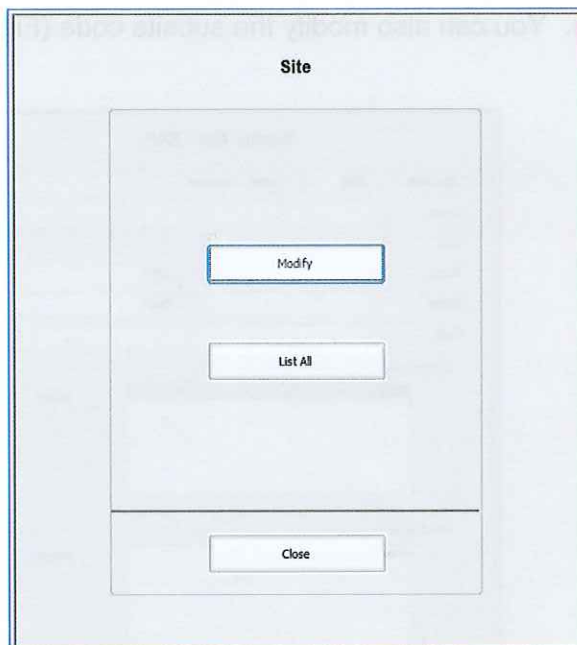
Figure 196: Site

Figure 197 shows the Modify Site screen. To actually modify an entry, select a site from those listed on the screen, then click on "Modify."
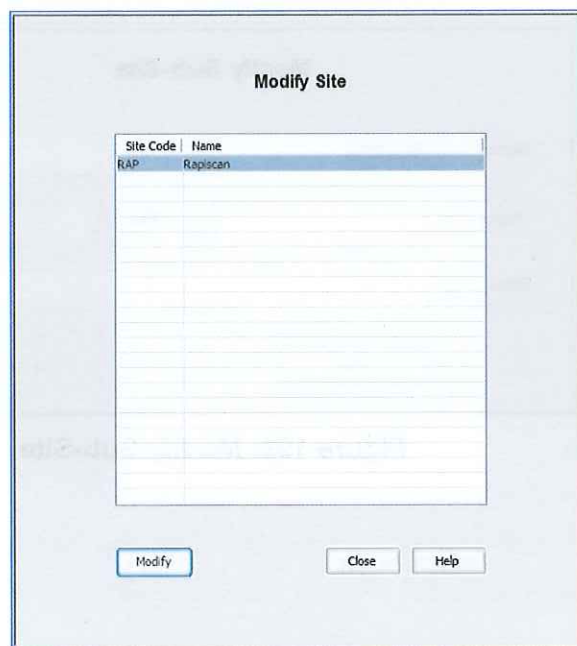
Figure 197: Modify Site

The Modify Site screen shown in Figure 198 allows you to modify an particular entry, in this case a Site called RAP. As shown, you can change various data, from street name

Figure 200: Modify Search Area

Choosing List All from the Site screen shown in Figure 196 brings you to the screen shown in Figure 122 which lists all current sites. You can also view more detail about any particular site by selecting that site from the list and clicking View which brings you to the screen shown in Figure 201.

Figure 201: List All Sites
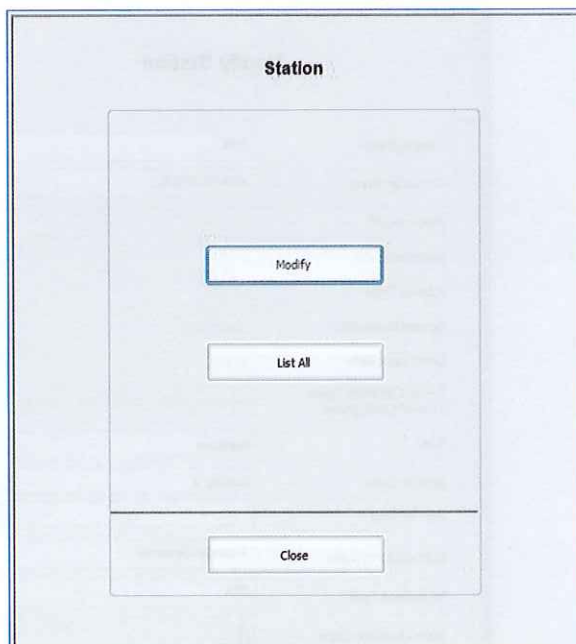
Figure 204: Station

Choosing Modify from the Station screen brings up the Modify Station screen shown in Figure 205. Select the desired station from the list of stations, then click "Modify."
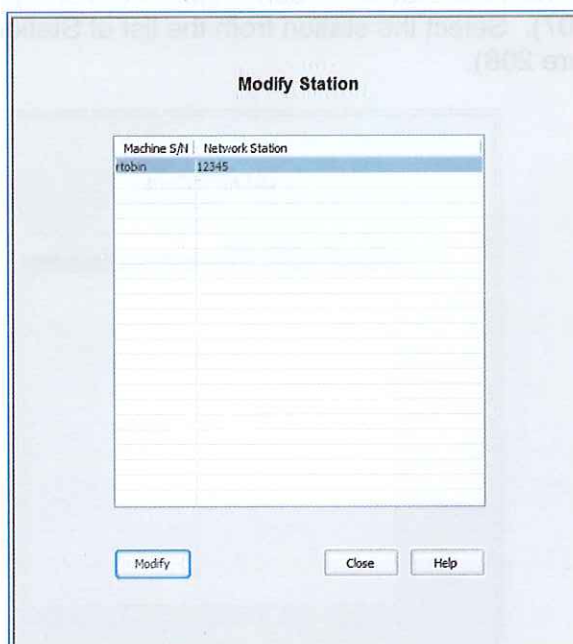
Figure 205: Modify Station

Figure 206 shows the screen in which you can make changes to the Station information, from Station name to Subsite Code and Equipment Type.

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Figure 208: View Station

Figure 209 shows the Station Settings screen which allows for the adjustment of: "Enable Idle Timers;" "Enable Session Timers;" "Session Review Time" and; "User Lockout Period."
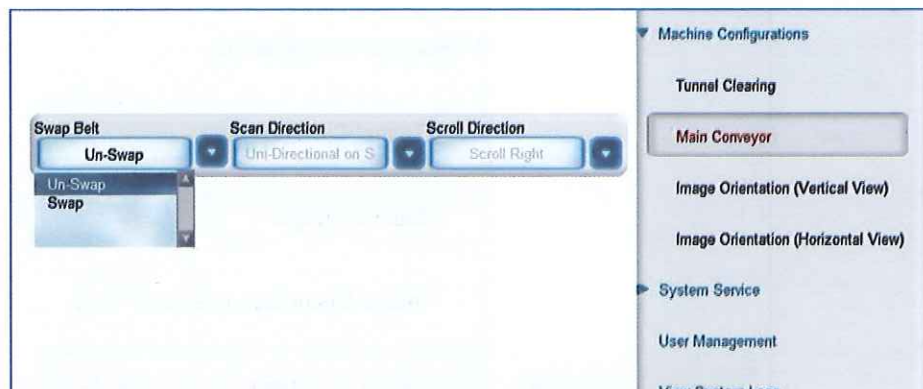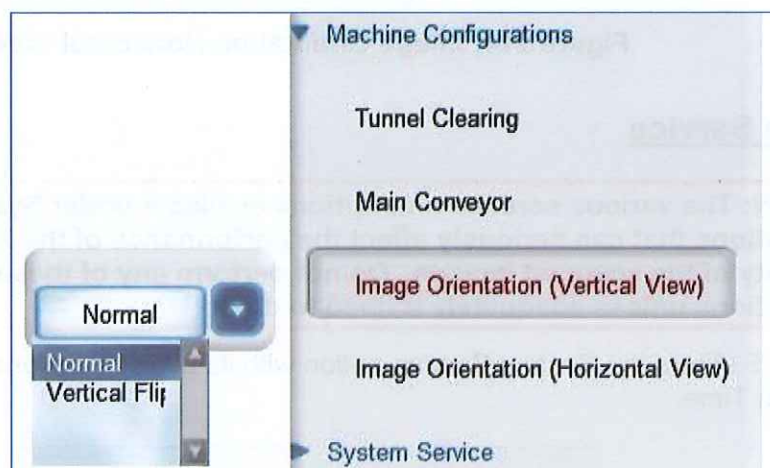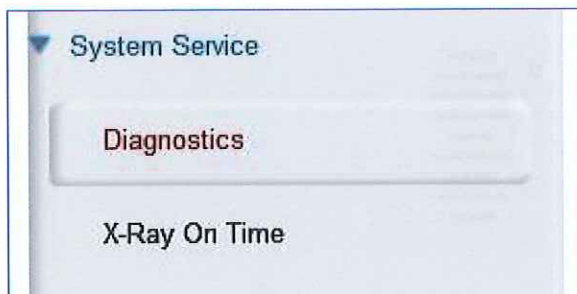

Figure 209: Station Settings

Figure 212: Main Conveyor

Figure 213 and Figure 214 shows the Image Orientation function for the vertical and horizontal views. This function allows you to have the image appear normal or to have it vertically flipped for easier viewing.


Figure 213: Image Orientation Vertical View

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Figure 216: Diagnostics

Selecting Diagnostics does not bring the user to the main Diagnostics screen but rather to the Radiation Survey screen shown in Figure 217. This is because the Radiation Survey screen is the most frequently accessed screen. The Radiation Survey screen contains a simple set of instructions for carrying out such a survey.

Selecting Exit Radiation Survey brings up the main Diagnostics screen (Figure 218).
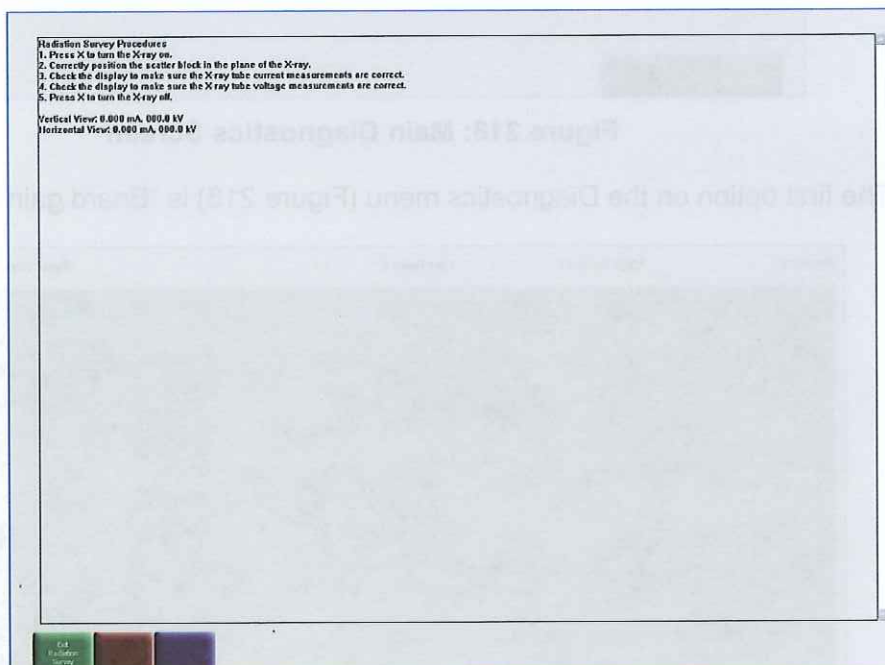
Figure 217: Radiation Survey

To set gain:

1. Select "board gain" from the top left corner of the Diagnostics Menu (Figure 218).

2. Once in the board gain mode:

   a. Use "P" key on the control panel to select the energy (high or low energy). Only data from the selected energy will be displayed.

   b. Use the "2" or "8" key on the control panel to select the appropriate DAB for gain adjustment. The signal of the selected DAB will be highlighted in light green.

   c. Use the "4" key to lower the gain of the selected DAB.

   d. Use the "6" key to increase the gain of the selected DAB.

   e. Use the "Save Gain" (green) button to save the current setting of the DAB's gain.

   f. Use "Cancel Gain" (red button) to discard current changes.

   g. It is suggested to set gain of the DAB to shift its signal to the right side without making saturation. The recommended setting is 85% of full screen signal.

If a line is observed on the screen while scanning an object, this can indicate a faulty channel. It is possible that the auto map-out software does not detect the problem, but a manual map-out can be performed (Figure 220).
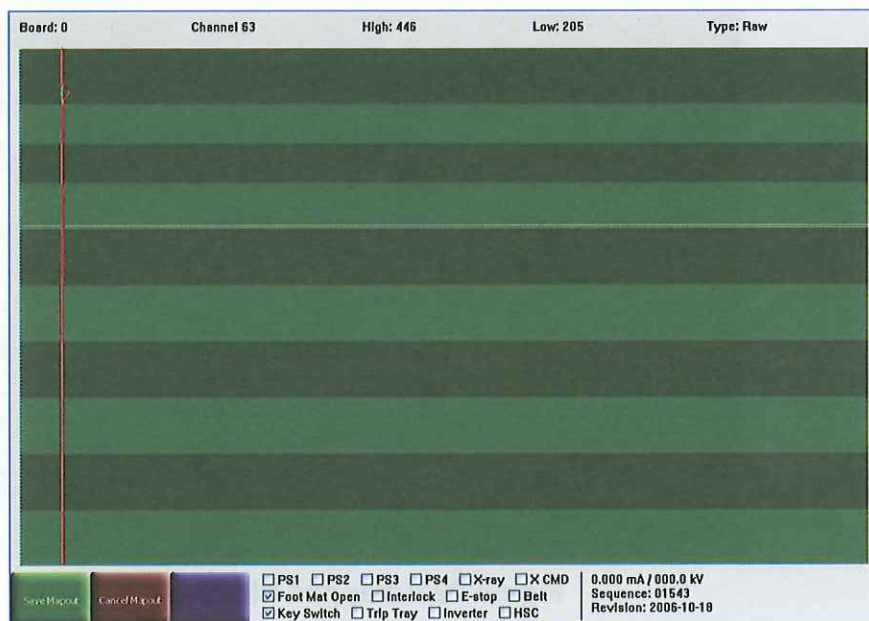

Figure 220: Mapout

There is a very thin yellow line at the top of the channel mapout screen (Figure 220).

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Figure 222 shows the control panel test screen. To test the control panel and the panel's individual keys, press each key on the control panel one at a time, each time checking to see if that key flashes on the control panel test screen. The flashing of the corresponding key on the screen indicates that that key and its associated function are operative.
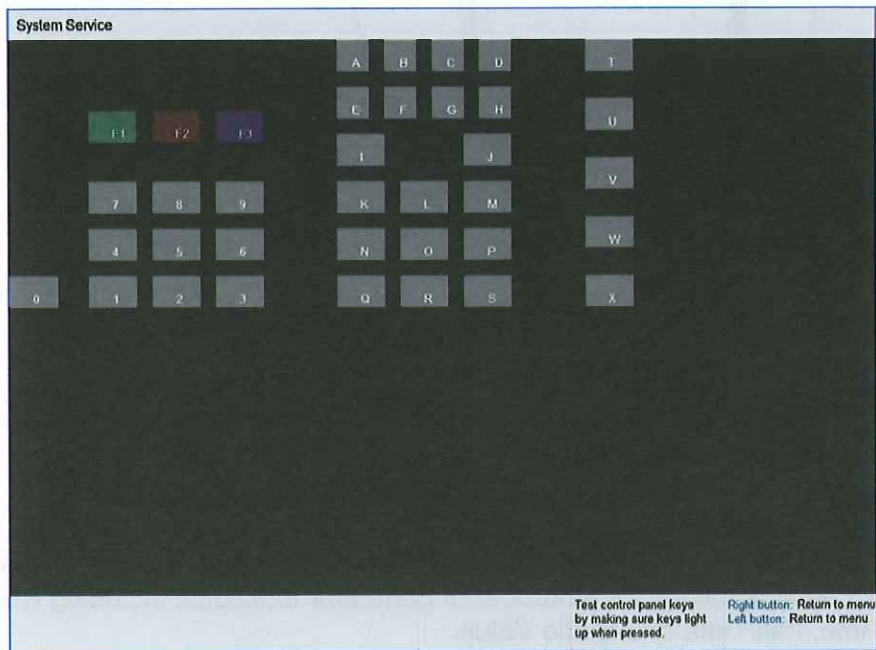
Figure 222: Control Panel Test Screen

Figure 223 shows the Generator Ramp screen. This screen measures the ramp up time for the X-ray generator's kV and mA when the generator begins generating X-rays. Most Rapiscan 600 series X-ray machines use 140kV generators. If a customer requests it, a 160kV generator is used instead. If a 140kV generator takes significantly longer than .5 seconds to ramp up, this is an indication of a problem with the generator. If a 160kV generator takes significantly longer than .75 seconds to ramp up, this is also an indication of a problem with the generator.

CAUTION: This screen is for use by only Rapiscan-trained engineers.

Figure 217 shows the Radiation Survey which is a simple set of instructions for carrying out such a survey.

Figure 225 shows the Self Test screen. This shows the actual and acceptable X-ray Generator kV and ma values while the generator is on and when it's off. It also lists a pass/fail report for various components such as inverter motor, channels (with x-rays off), x-ray controller and conveyor.
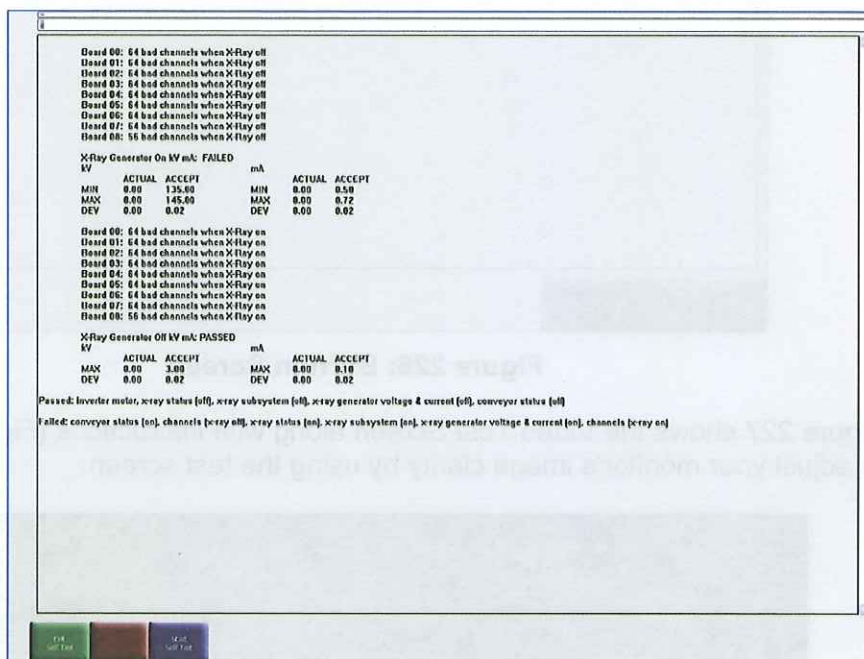

Figure 225: Self Test

Figure 226 shows the System Burn-in screen. Selecting the "Start Burn-in" button will cause the system to begin the burn-in process. The burn-in process lasts 24 hours once it is started, although it is possible to terminate the burn-in at anytime and obtain a partial burn-in report.

Monitor Calibration Instructions
1. Set the monitor's brightness to its minimum.
2. Increase the monitor's brightness till you reach the threshold where the calibration rectangle is visible.
3. Press any key to exit.

Figure 228: Video Test screen text

Press any key to exit the Video Test screen. Figure 229 shows the X-ray On time function which is not available in this mode at the time of writing this manual (Figure 229).
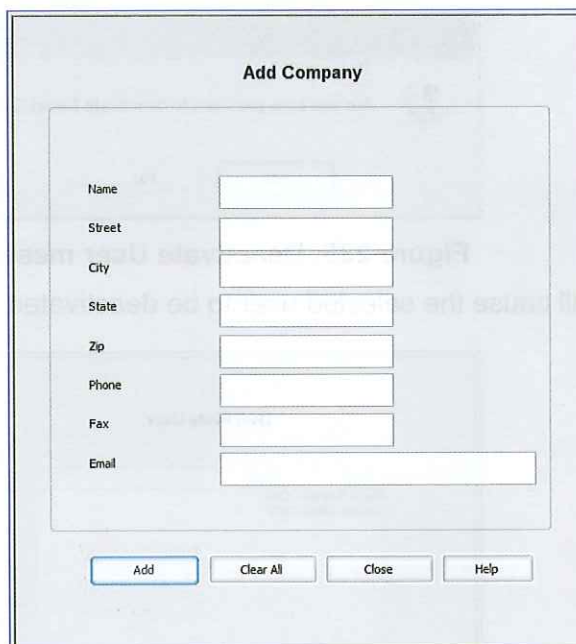
System Service

Diagnostics

Vertical View: N/A Horizontal View: N/A   X-Ray On Time
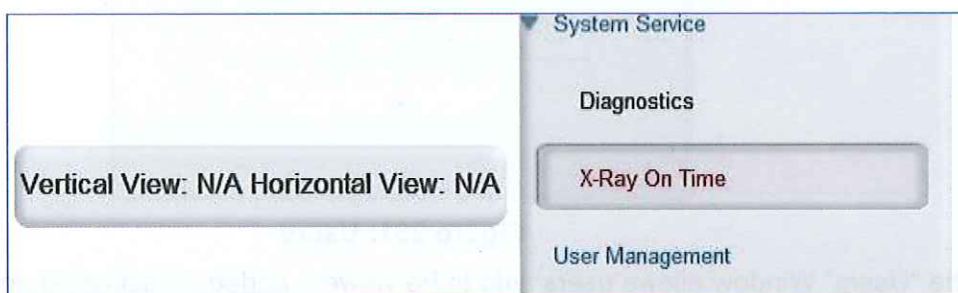
User Management

Figure 229: X-ray On Time

12.11 User Management

Figure 230 shows the User Management option.

User Management

View System Logs
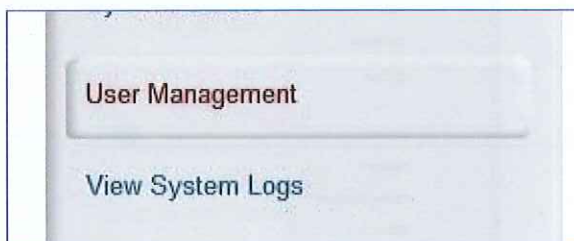
Figure 230: User Management

Selecting the "User Management" option brings you to the "Users" screen shown in Figure 231.

Figure 233: Add Company

Selecting Deactivate brings up the following screen:

Figure 234: Deactivate User

Selecting Deactivate from the Deactivate User screen brings up a warning message:
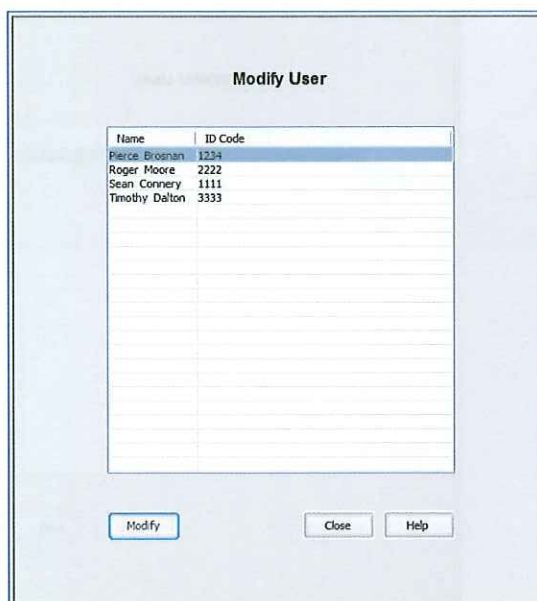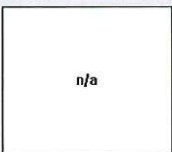
Figure 237: Modify User

Select the desired user and click on Modify where information on the user can be modified:

Figure 238: Modify User screen

Selecting Activate brings up the Activate User screen:
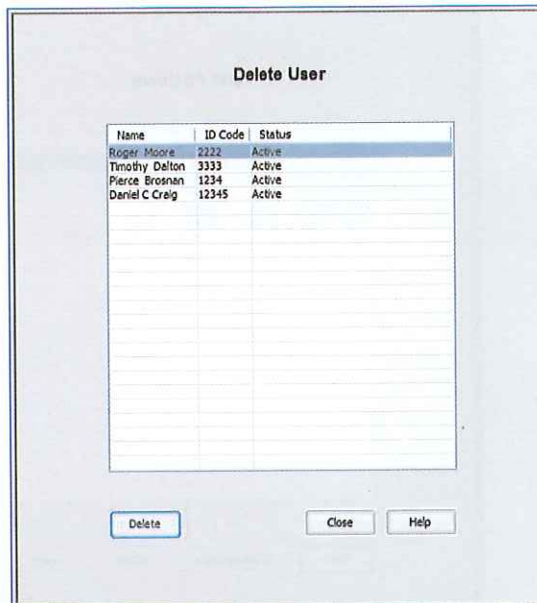
Figure 241: Delete User screen

Selecting Delete from the Delete User screen brings up a warning message:
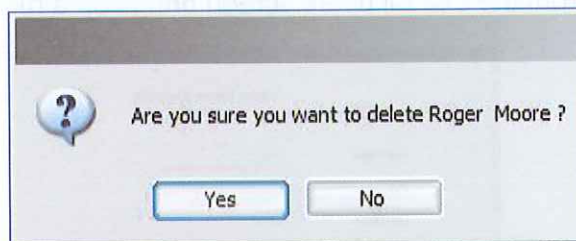
Figure 242: Delete User message

Selecting List All brings up the List All Users screen:
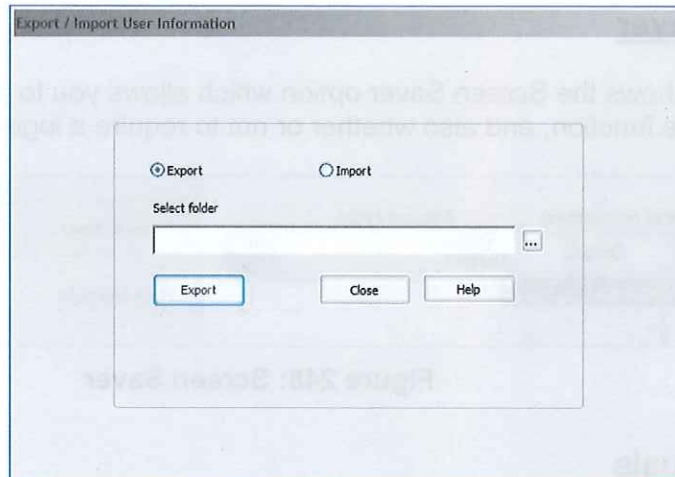
Figure 245: Export/Import User Information

Figure 246 shows the View System Logs button. Selecting this button brings you to the screen shown in Figure 247.

Figure 246: View System Logs

To exit System Logs, select File in the upper left corner, then choose Exit from the pull-down File menu (Figure 247).
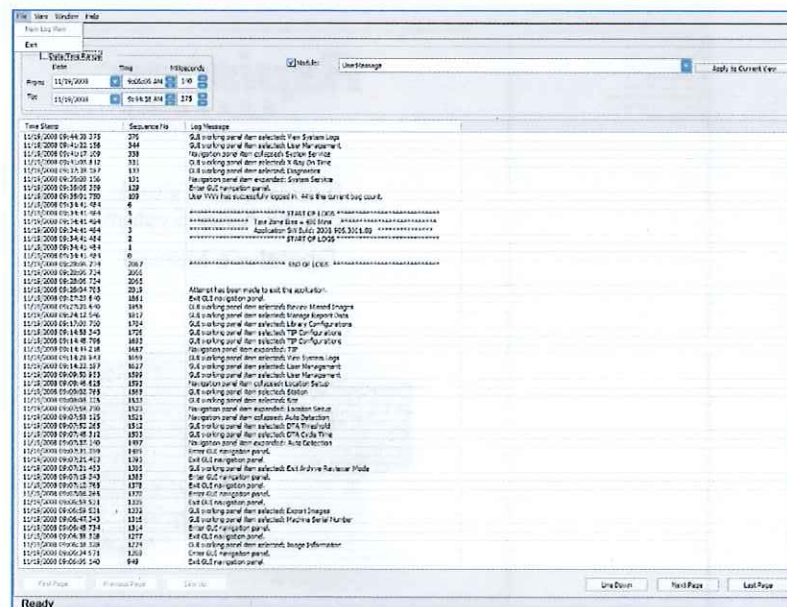
Figure 247: System Logs

12.14 Language Selection

The Language Selection option allows you to show the various menus and screens in a number of languages.
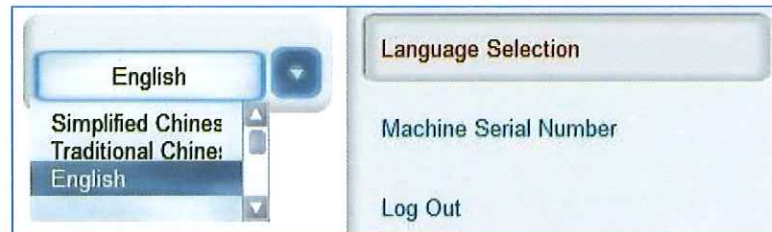
Figure 251: Language Selection

Machine Serial Number

Figure 252: Machine Serial Number

Figure 246 shows the Machine Serial Number option. It is important to know the service and maintenance history of a machine and the machine's serial number is the best way to match a machine with its service/maintenance history.

Log Out

Figure 253 shows the Log Out function that returns you to the Log In screen.

Figure 253: Log Out

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13.0 Planned Preventive Maintenance

⚠️ **WARNING:** Care must be taken to prevent water or any other liquid entering the system. Make sure any cleaning cloth is wrung out before use.

If the system is to be dismantled in any way, or if an internal inspection of the tunnel is necessary, then the system must be switched off and disconnected from the mains supply. The keyboard key is to be in the possession of the maintenance engineer.

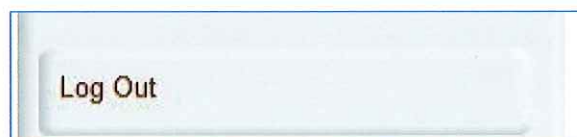Some parts of the X-ray system are heavy and require two persons during removal.

13.1 Weekly Maintenance

The weekly maintenance routines consists of visual inspection and cleanliness of the system; they are detailed in sequential order. If the operating environment warrants it, they should be performed more regularly. This is usually performed by the system's operators.

Preparation

- Read the warnings at the beginning of this chapter before proceeding.
- Switch off the system and remove the keyboard key.
- Remove the mains supply to the system.

CAUTION: Care must be taken to prevent water or any other liquid entering the system. Make sure any cleaning cloth is wrung out before use.

Visual Inspection

Visually inspect all the covers and panels for damage and security- damaged covers and panels and any missing fasteners must be replaced.

Conveyor Belt and Video Monitor casing

Using a damp lint-free cloth (soap suds may be used if required) wipe clean the surface of the conveyor belt and the casing of the monitor. Dry all surfaces that have been cleaned with a dry lint free cloth.

Video Monitor Screen

Clean the screen with an anti-static spray or liquid and a lint-free cloth.

14.0 Troubleshooting

14.1 Limitation on Liability and Warranty

Rapiscan Systems will not accept liability for damage or personal injury caused directly or indirectly by either incorrect or poor quality termination of the local main power supply or power cables. Rapiscan Systems is not responsible for damage or injury caused by unauthorized modification, maintenance, operation or tampering with this equipment.

Service of Rapiscan machines shall be performed only by Rapiscan Systems authorized service personnel. Any modification/alteration made to the system after purchase, by the customers or their agents without written authorization from Rapiscan Systems Management will void any warranty issued to the customer. Additionally Rapiscan Systems is not liable for any damage that might be caused by any unapproved changes."

Rapiscan Systems is an ISO9001: 2000 compliant company and adheres to the guidelines for inspection and testing for all materials prior to assembly. Rapiscan 600 series X-ray machines meet stringent quality control and testing criteria at both the component and system level.

Rapiscan Systems maintains sales and service offices worldwide. If you have questions or need assistance with any product manufactured by Rapiscan Systems, feel free to contact one of the offices listed under "Service Departments" or "Sales Offices."

⚠️ **WARNING:** The following checks are to be carried out by a trained and qualified maintenance technician only. No maintenance panel is to be opened while the system is connected to the power supply since hazardous voltages exist on circuit boards inside the system. Remove the power lead from the wall socket before opening any panel.

14.2 System Does Not Switch On

Check:

- Power-On key on the input end of the system (or on the console) is turned clockwise.
- Power cable is connected firmly to power inlet, and other end is connected to a live power socket.
- Trip indicator on circuit breaker is set correctly.
- The fuse in the power plug is O.K. (if fitted)
- All emergency stop switches are not activated i.e. rotated to the 'out' position.

15.0 Options

The following features are optional features available on Rapiscan 600 XR machines upon customer request and at additional cost.

15.1 TIP (Threat Image Projection)

Threat Image Projection is a software program that will, according to pre-selected preferences, percentages and rates, project fictional threat images onto real bags, for the purpose of training and/or testing operators, exposing them to threats they might not regularly have a chance to see or react to.

15.2 DTA (Density Threat Alert)

The Density Threat Alert (DTA) highlights any areas that exceed a set density by coloring them purple. A setting of 0 turns the DTA off. The setting for the DTA varies according to machine type and items to be scanned. A typical value to highlight areas of non-penetration would be 20.

15.3 Auto Archive

An optional program that automatically archives scanned images of baggage, allowing those images to be recalled using criteria such as date, station and operator.

15.4 Operator Training Program (OTP)

OTP (Operator Training Program) is a software program that creates a virtual scanning environment for training purposes. Scanned images are "scanned" and scroll onto the user's screen as if the conveyor belt is moving baggage through the security X-ray machine's tunnels, but it is completely virtual without conveyors moving or X-rays being generated.

Figure 254 shows a screen shot of an OTP session, the two bags in the image having just scrolled onto the user's screen as if scanned images of bags actually being moved into and through the X-ray tunnel.

15.6   Service Departments

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