Scanray Corporation

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OPERATION AND MAINTENANCE MANUAL

TORREX 120D/~~150D~~

PREPARED BY: SCANRAY CORPORATION
1526 W. 240TH ST.
HARBOR CITY, CA 90710

JULY 26, 1984

REGISTRATION NO.

TORREX 120D/150D OPERATION AND MAINTENANCE MANUAL

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.3 Specifications

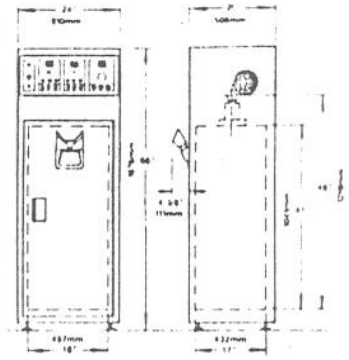
Radiation Safety. Meets or exceeds Federal Standard 21CFR Section 1020.40 for Cabinet X-Ray Systems

	TORREX 120	TORREX 150
Standard Line Voltage Requirements*	115.0 VAC — 50 or 60 Hz	115.0 VAC — 50 or 60 Hz
Power Requirements	625 V.A. Maximum	850 V.A. Maximum
Output Rating, Kilovolts (By Variac Control)	0-120	0-150
Tube Current Rating (By Thumbwheel Control)	1.0 to 5.0 Milliamperes	1.0 to 5.0 Milliamperes
X-Ray Tube Model	Astro 120	Astro 150
Focal Spot Size	.6mm ± .1mm	1.5mm ± .2mm
Source to Film Distance	24" or 48"	24" or 48"
Cooling	Forced Oil	Forced Oil
Duty Cycle	100%	100%
Beam Angle	46°	46°
Inherent Filtration	.6mm Beryllium Window	1.2 Beryllium Window
Timer Range	1 Second to 2.75 Hours	1 Second to 2.75 Hours
Cassette Capacity	Up to 14" × 17"	Up to 14" to 17"
Weight — Maximum — 24"	400 Pounds	400 Pounds
Weight — Maximum — 48"	800 Pounds	800 Pounds

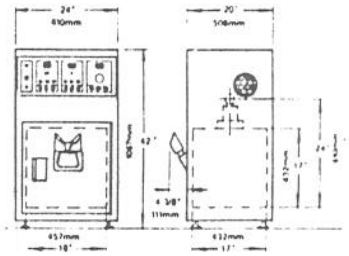
Specifications subject to change without notice

*230 VAC — 50 Hz available

NOTE BOTH MODELS ARE AVAILABLE IN 120 OR 150 KILOVOLTS

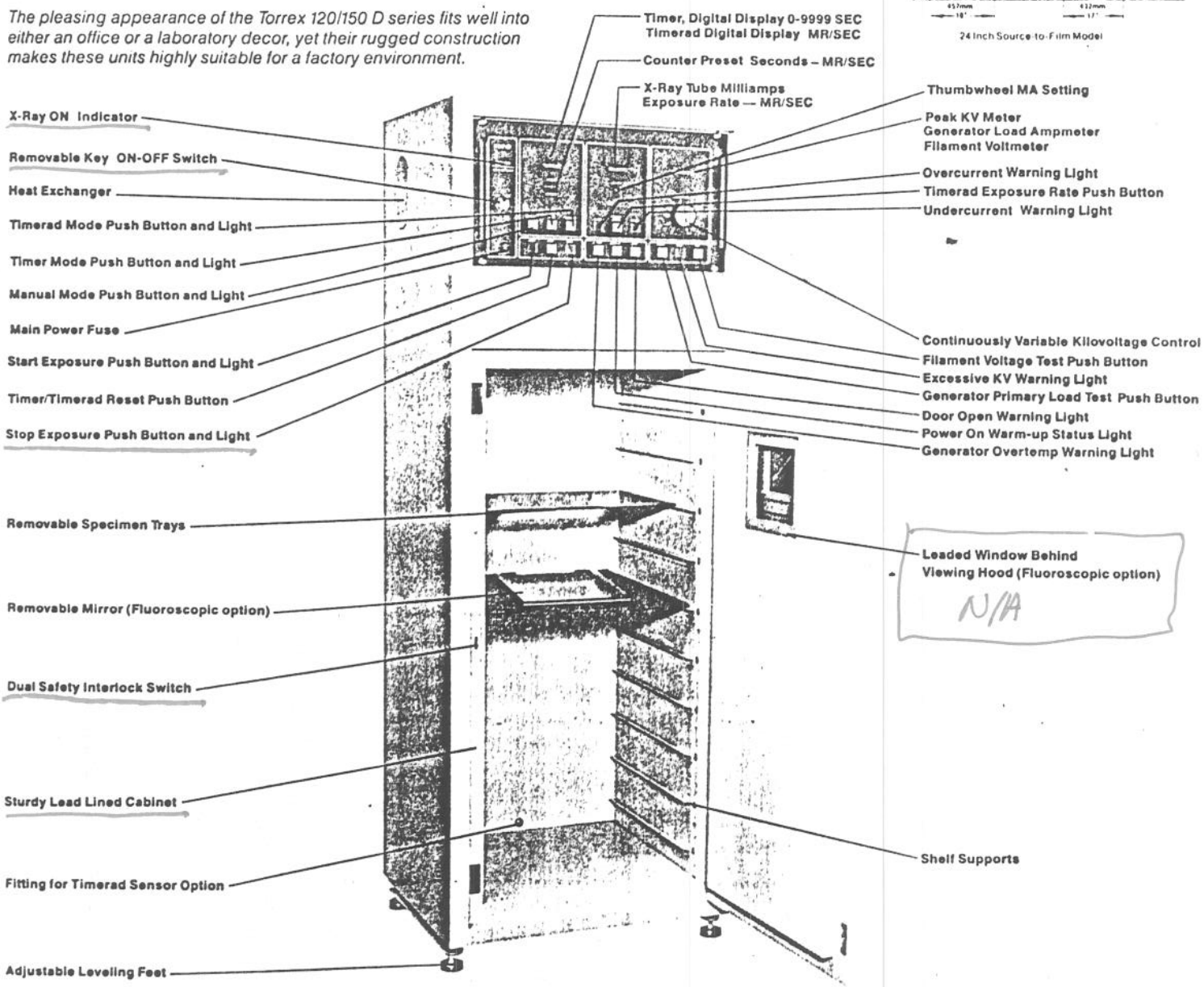


48 Inch Source-to-Film Model



24 Inch Source-to-Film Model

The pleasing appearance of the Torrex 120/150 D series fits well into either an office or a laboratory decor, yet their rugged construction makes these units highly suitable for a factory environment.



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Printed in U.S.A.

TORREX 120D/150D OPERATION AND MAINTENANCE MANUAL

SECTION 1

GENERAL DESCRIPTION

1.1 SCOPE OF THE MANUAL

This instruction manual for SCANRAY CORPORATIONS' X-RAY INSPECTION SYSTEM, includes a general description, specifications, operating instructions, circuit theory, adjustment and alignment procedures, part list, and pertinent drawing and schematic diagrams.

1.2 GENERAL DESCRIPTION

The X-Ray Inspection System is a completely self-contained X-Ray machine. This machine is an ideal instrument for non-destructive testing of materials and components by radiographic or fluoroscopic techniques. The system has great utility for examining metal castings, and electronic components and assemblies. It is an economical instrument for satisfying quality control requirements of small parts and assemblies. This equipment is also an indispensable tool for use in research, design and production. The system is a useful instrument to anyone in industry concerned with dependable production, low operating costs, and human safety.

The X-Ray Inspection System is equipped with a thin Beryllium window X-ray tube which makes the unit ideally-suited for low and high voltage radiography. A Ø.5mm focal spot provides a high degree of resolution. The high voltage is continuously variable from Ø to maximum system potential at currents of 1mA to 5mA. A unique current regulating circuit is employed. This circuit maintains the X-ray tube current constant within +/- 1% over the operating range of 125 VAC. The X-ray variations between 105VAC an 125VAC. The X-ray generator has a novel X-ray tube cooling system. The high voltage and filament transformers are immersed in forced into the anode cavity of the X-ray tube at approximately 1000 cc/minute. The heated oil then passes through an external heat exchanger. This heat exchanger is forced-air cooled with a high efficiency positive pressure blower. The oil temperature remains sufficiently low, even under continuous operation at maximum power, to increase X-ray tube life.

Operator protection against X-ray radiation hazards is afforded by the use of lead shielding. An interlock on the door of the radiation chamber prevents radiation hazards to operating personnel. This interlock cuts off the high voltage power from the emitting X-ray tube when the door to the radiation chamber is opened.

SECTION 2

OPERATING INSTRUCTIONS

2.1 GENERAL

Operation of the X-RAY INSPECTION SYSTEM is relatively simple and requires no special training; however prior to operation the operator should become familiar with the operating controls as well as observe all rules pertaining to radiation safety. The following paragraphs will ensure proper setup and checkup of the equipment to ensure radiation leakage levels are within specified limits and provide long trouble-free operation.

2.1.a It is essential that this unit remain upright at all times. It is not permissible to tilt the unit more than 5 degrees from vertical. To assure that the unit is not tilted, tip-n-tels should be attached to the outer wrap or the crate at the front and on the left side as viewed from the front. The attention of the carrier should be called to the requirement that the unit be transported vertically.

2.2 UNPACKING INSTRUCTIONS

The X-RAY INSPECTION SYSTEM is packaged in a mechanically-insulated wooden crate to minimize shock and vibration during transit. Immediately inspect the exterior of the crate for physical evidence of poor handling such as dents, punctures and cracks. In the event that damage has occurred in transit, immediately notify the carrier at your end. To remove the system from the packing crate, proceed as follows:

2.2.a UNPACKING PRECAUTION: Before removing the outer wrap or crate, examine the TIP-N-TELL's to determine if the unit was tilted during transportation. If there is any indication that the unit was tilted, note this on the receiving record and refer to the set-up precaution below. Examine the unit for any other kinds of damage, dents, scratches, or other indications of mis-handling and note them on the receiving record. File a claim for damage if any is found.

SETUP PRECAUTION: If there is any evidence that the unit was tilted or damaged during transportation, it will be necessary to check the cooling system for proper operation. To do this remove the four screws securing the front panel and tilt it forward, securing it in a tilted position by the two projections on the side brackets. Disconnect the fan

by unplugging it from the master power board. Connect the unit to a source of suitable current and turn it on. If the pilot lights and meters illuminate, listen carefully to the pump. It should make only a quiet hum. It should NOT make a sound like fluid rushing thru pipes or gurgling noises. If any such noises are noted, DO NOT ENERGIZE the unit further until the entrapped air in the cooling system has been purged.

PURGING THE COOLING SYSTEM OF AIR: Proper operation of the cooling system of this unit demands that the impeller housing, hoses, and radiator be completely filled with the coolant, a highly refined petroleum based oil, with no air at all. Typically some air will tend to collect in the impeller housing of the pump if the unit has been tilted so that the lead protective box over the cooling outlet to the pump is above the level of the oil. The system can be purged in the field using this method:

1) Remove the power cord and the back panel.
2) Loosen and remove the four bolts securing the straps holding the tank in place.
3) Remove the straps.
4) Remove the fan and radiator from the cabinet wall and tie-wrap the two to the tank itself. Place a generous pad of absorptive material under the pump body.
5) Twist the tank clockwise horizontally so that the pump face can be accessed.
6) Loosen each of the three stainless steel screws securing the impeller housing to the pump body. The lower right 1/2 turn, the upper left 1 turn and upper right 1-1/2 turns, depress the impeller housing tilting it down at the outside and a bubble of air should escape and a little oil will leak out. Resecure the impeller housing and operate the pump. If the sound of rushing fluid disappears, re-orient the tank, resecure the fan, radiator and replace. Resecure the tank straps and replace the back cover.

   If the sound of rushing fluid does not go away, repeat the process until it does then continue with the process of reorienting the tank as noted above.

   (It may be noted that air in the impeller housing is lighter in color than the oil below it. It can often be determined that air is present by noting this color difference).

2.2.b. Remove the 10 hex head lag screws from the removable front panel of the packing crate and remove this panel. Remove the six (6) remaining lag screws around the bottom of the crate. Lift the crate up and to the rear, away from the system taking care not to scratch the cabinet.

-NOTE-

The best way to lift and move the system is with the use of a fork lift, supporting the system by its internal steel frame.

2.2.c. Remove the rear lower panel from the system. This will permit access to the frame.

2.2.d. Insert the forks of the fork lift just above the inner chamber and lift by the frame.

-CAUTION-

WHEN INSERTING THE FORKS, USE CARE TO BE CERTAIN THE FORKS CONTACT ONLY THE STEEL FRAME TO AVOID DAMAGE TO THE CABINET OR WIRING.

2.2.e. Remove the shipping platform and install the four feet into the threaded holes in the bottom of the system. The equipment can now be placed into position on its operating table.

2.2.f. Level the system by adjusting the front feet.

2.3 IMPORTANT SAFETY PRECAUTIONS

The X-RAY INSPECTION SYSTEM was inspected prior to shipment to ensure that radiation leakage levels comply with the requirements of Federal Standard 21 CFR 1020.40 published by the National Center for Devices and Radiological Health. THis equipment was packaged and shipped in a special create designed to absorb shock and vibration and to protect the equipment to the maximum extent possible. Despite these safeguards, damage may occur in shipping. It is therefore imperative that the radiation emission level for the system be established prior to placing this equipment in operation.

-NOTICE-

REGISTRATION OF RADIATION SOURCES WITH COGNIZANT STATE AND/OR LOCAL PUBLIC HEALTH AGENCIES. REGISTRATION NORMALLY MUST BE MADE WITHIN 30 DAYS OF ACQUIRING EACH SUCH SOURCE. CONTACT YOUR STATE OR LOCAL HEALTH AGENCY FOR REGISTRATION

INFORMATION PERTINENT TO THIS EQUIPMENT.

-CAUTION-

All warnings, cautions, directions, and recommendations contained in this manual and in the NBS Handbooks must be closely followed. The safety of operating personnel cannot otherwise be assured. No modification of the system, particularly the radiation chamber, should be attempted without written concurrence from the manufacturer. Should it be necessary to move the system after initial operation, extreme care should be exercised to ensure proper handling. The user must be aware that excessive radiation leakage could develop due to mishandling. A radiation leakage survey, conducted by highly qualified personnel, must be conducted after any relocation of this equipment or after modification to the equipment. This procedure will prevent radiation health hazards to operating personnel. The lead shield cover for the x-ray generator tank may be removed for servicing. In the event that this cover is removed, maintenance and operating personnel, ensure the presence and proper installation of this cover before beginning normal operating procedure.

The radiation safety features built into the system conform to the radiation requirements as outlined in NBS Handbooks, Numbers 76 and 93. Copies of these handbooks may be obtained from the Superintendent of Documents, Washington 25, D.C.

2.4 INITIAL OPERATING PROCEDURES

The procedures which follow must be strictly adhered to in order to validate the warranty for the X-RAY INSPECTION SYSTEM. Adherence to these procedures will also obtain maximum operating life from the X-ray tube and the high voltage components. Similar procedures are required after installation of a new X-ray tube or high voltage transformer.

-WARNING-

RADIATION LEAKAGE CHECKS SHOULD BE MADE DURING THE FOLLOWING INITIAL OPERATING PROCEDURES. THESE CHECKS WILL ENSURE FUTURE OPERATOR SAFETY DURING NORMAL USE OF THE EQUIPMENT.

Perform the initial operating procedures as follows:

a. Insert power cable into a 3-wire, grounded receptacle of the proper voltage and frequency as stated on the nameplates on the rear of the cabinet.

b. Insert the key into the keylock provided on the control panel. Turn the key to ON. The blower on the right side of the machine will start and the filament of the X-ray tube will heat.

c. Permit the system to operate ten (10) minutes in this condition.

d. Turn the MA SET thumbwheel on the control panel to 3mA.

e. Press the PRESET pushbutton and rotate the high voltage control (PERCENTAGE) clockwise until the kilovolt meter reads 80 KV.

f. Press the TIMER mode button and set the PRESET thumbwheel to 270 seconds (4.5 minutes).

g. With the door to the radiation chamber closed, depress the red EXPOSE pushbutton. Allow timer to count down to zero. When this occurs, the amber START pushbutton will extinguish and the green STOP pushbutton will illuminate.

h. The timer will automatically reset to 4.5 minutes.

i. Press PRESET pushbutton and rotate the high voltage control clockwise until the meter reads 95KV.

j. Depress the START pushbutton. Allow timer to count down to zero.

k. Repeat steps g. and j. for KV meter readings of 80KV, 100KV, 120KV for TORR 120D Control Panel or 110KV, 130KV and 150KV for TORR 150D.

l. With a KV meter readings of 150KV, repeat step j. for three or four complete cycles.

-NOTE-

The X-ray tube is now properly aged. The system can be operated at 1 mA to 5 mA, at power ratings up to ~~150KV~~ 120KV. Subsequent use of this equipment will not require this aging procedure; merely turn the key to ON, wait approximately 60 seconds for the warm-up timer light to time out and proceed with either radiographic or fluoroscopic inspection. When operating above 120KV, begin the exposure at 120KV, then immediately increase the KV to the desired level.

2.5 NORMAL OPERATING INSTRUCTIONS

To energize the X-RAY INSPECTION SYSTEM and place it in an operating condition, proceed as follows:

a. Insert power cable into a 3-wire, grounded receptacle of the proper voltage and frequency as stated on the nameplate on the rear of the cabinet.

b. Turn key switch to ON. Warmup timer light will automatically come on and prevent operation for 60 seconds to allow the equipment to warmup.

c. Select the desired operating current of 1mA to 5mA.

d. Select the desired operating voltage by rotating the high voltage control knob on control panel while monitoring output voltage level on control panel voltage meter. The voltage can be aired between zero and maximum KV output.

-NOTE-

The Hi KV light will come on and prevent operation if operation above 150KV is attempted. When operating at settings greater than 120KV, it is good practice to start at 120KV and then immediately increase the KV output to the desired setting.

e. Set timer for desired length of exposure time. The maximum exposure time possible is 9999 seconds or 166 minutes.

f. Verify that door to radiation chamber is securely closed. If it is not closed, the interlock circuit will prevent the high voltage from being applied to the X-ray tube. The red DOOR light will light and it will be impossible to begin exposure.

g. Depress START pushbutton. This applies high voltage to the X-ray tube and starts exposure. The timer will automatically terminate the exposure after the preset time interval. If desired, the exposure may be terminated manually by depressing the STOP then the RESET button.

-NOTE-

For standby operation, simply energize the system by turning ON the key switch.

2.6 RADIOGRAPHIC TECHNIQUES

A radiograph is a permanent visible record on a sensitive

film of the absorption characteristics of a specimen. The film exposure radiation emanates from a small area in the X-ray tube called the focal spot. The smaller the focal spot, the higher the degree of resolution and detail in the radiograph. The radiation proceeds in straight lines to the object being irradiated. A portion passes through. The amount of radiation which passes through the specimen depends upon the density and thickness of the specimen. For example; if the specimen is an aluminum casting having a void formed by a gas bubble, more radiation will pass through the void area. The void results in a reduction in the total thickness of the specimen. Therefore, a corresponding dark spot will appear on the developed film. Film radiography thus provides a permanent, visible record of the internal condition of a product. Film radiography also furnishes fundamental information in judging the soundness and subsequent reliability of materials.

In getting acquainted with the radiographic capabilities of the X-RAY INSPECTION SYSTEM, it is desirable to work with familiar components of low densities. A good example to use for this purpose is a plastic molded circuit breaker, or microswitch. The technique for items of this type using Polaroid type 52 film is as follows:

a. Engergize system.

b. Select 3mA current position and allow equipment to warmup.

c. Rotate high voltage control for a reading of 70KV.

d. Set timer for 30 seconds exposure.

e. Place film support on shelf No. 1. Be certain that the film support is pushed all the way to the rear.

f. Place the film in the center of the film support.

g. Place specimen to be examined in the center of the active portion of the film.

h. Close door to the radiation chamber.

i. Depress START control. The specimen will be irradiated for 30 seconds, at which time the START indicator will extinguish.

j. Remove the specimen and film.

k. Process the film in accordance with the manufacturers instructions.

-NOTES-

Proper film density and maximum definition are the direct product of KV setting and exposure time. As a general rule, the KV level should be as low as possible while maintaining adequate specimen penetration. The exposure time is then adjusted for the film density desired. This instrument incorporates an optional Timerad mode which produces an automatic exposure and provides the operator with the relative exposure level by automatically controlling the exposure time. High quality films can be produced without the need of costly experimentation or highly trained personnel.

The minimum beam size for each shelf is shown on the film plate. For the optimum resolution, it is good practice to keep the film to source distance (FSD) as long as possible. Shelf No. 1 provides the highest degree of resolution. However, for denser specimens, a long FSD may require increased exposure time. In such instances, select another shelf where the beam diameter is comparable to the specimen size, or area, to be inspected. Reducing the FSD to one-half, reduces the exposure time to one-fourth. The resolution will be as good as with the longer FSD. In most instances, however, this will not be apparent because of the fine focal spot of the systems X-ray tube. It is possible to perform radiography at the maximum KV setting and 5mA of current. This high radiation level is generally not required, however.

Exposure time is directly proportional to the current rating chosen. For example, an exposure time at 5 mA will be 3/5 of the required exposure time at 3 mA, if all other conditions remain constant.

2.7 FLUOROSCOPIC TECHNIQUES N/A

Fluoroscopy is the process of examining a specimen by direct observation. X-radiation penetrating through a specimen will illuminate a special, fluorescent screen. The physical arrangement of the X-ray source, the specimen, and the imaging plane is identical to that used in radiography. The basic advantage of fluoroscopy over radiography is in economy. Film and film processing time are saved by the fluoroscopic technique. There is no permanent documentation with fluoroscopy. Further, the image quality is slightly degraded, as compared to radiography. However, many items and situations lend themselves well to fluoroscopy. These can be generally categorized as large size, low density exteriors, and high density interiors. Fluoroscopy is

useful for rapid examination of gross defects, internal parts placement, alignment, broken wires, etc. Radiography can then be employed to determine the more elusive failures. To examine equipment by fluoroscopy, proceed as follows:

a. Energize the system.

b. Remove the film support from the radiation chamber and insert the mirror on shelf No. 1.

c. Insert Bakelite holder with fluoroscopic screen on shelf No. 5.

d. Place specimen to be observed over crossmark on the Bakelite holder.

e. Close door of radiation chamber.

f. Set timer to 4.5 minutes.

g. Select 1mA to 5mA of current.

h. Depress START pushbutton. Look into the viewing hood. Press face firmly against hood to exclude ambient light.

i. Vary KV setting and current selection for optimum fluoroscopic quality. Examine specimen.

j. Press STOP pushbutton, open door to radiation chamber, and remove specimen.

-NOTE-

For fluoroscopic examination the 3mA setting is generally satisfactory, however for large or dense specimens, the equipment should be operated at the 5mA level. The operator will quickly learn the best voltage and current combinations to use in order to achieve optimum images. Whenever practical, it is good practice to operate this equipment at the 3mA level, achieving proper fluoroscopic images by increasing the KV setting. The X-ray tube life is extended by this technique.

2.8 DESCRIPTION

The TORR TIMERAD is a completely automatic X-RAY EXPOSURE CONTROLLER. With it's use, even inexperienced operators can obtain good quality radiographs on the first try. It automatically shuts off the x-rays when the film has received the optimum exposure.

2.8.1 Timerad Operation

Determine mA and KV settings - Press MANUAL mode button. Place sensor in X-ray chamber. Place specimen to be radiographed over the sensor with no film in place. Close door and start exposure. Pressing the TIMERAD SENSOR button under the mA meter causes it to read the exposure level in approximate counts per second.

The counter will be decremented at this rate. The exposure will extremely accurate at rates between 10 and 200 milliroentgens per second if the total exposure time of 5 seconds or more is obtained. This time can be estimated by dividing the total milliroentgens dose required by the exposure rate obtained from the meter. Total exposure is dependent on the film type and density required. This setting can be obtained from TABLE 1 or an actual sample strip. The count down to 2 mR/SECOND and exposure times down to 2 seconds will still produce reasonable results.

Set Mode - to Timerad by pressing the Timerad Button.

Enter Required Dose - on the Timerad Preset Thumbwheel.

Place Film - between sensor and specimen.

Press Start - button to initiate exposure. Timerad will now begin to count down and will automatically terminate the exposure at the required dose.

Adjustments to the exposure may be made by increasing or decreasing the thumbwheel setting by the required percentage. The Timerad is automatically reset on completion of exposure. If the display is not blanked and a new exposure is required, press the RESET button between the START and STOP buttons, while in stop mode to clear the display. The thumbwheel preset value is then loaded into the counter when the START button is pressed.

TABLE 1 - FILM EXPOSURE IN APPROXIMATE MILLIROENTGENS TOTAL DOSE

BRAND	FILM TYPE	FILM SETTING	Density 1.0	2.0	3.0	4.0
KODAK	R (single coated)	2	1400	2500	3500	4600
	R	3	1100	2100	3100	4000
	M	5	290	560	850	1200
	T	6	170	340	540	790
	AA	8	90	190	320	480
	Royal Blue	9	50	170	---	---
POLARIOD						
	55 p/n	1	---	---	---	---
	52	6	170	340	540	790
	57	8	90	190	320	480
DUPONT						
	NDT 45	4	---	---	---	---
	NDT 55	6	170	340	540	790
	NDT 75	8	90	190	320	480
GAF	HD	4	---	---	---	---
	B	5	290	560	850	1200
	A	7	---	---	---	---
GAVERT	D2	2	1400	2500	3500	4600
	D4	5	290	560	850	1200
	D7	7	---	---	---	---

SECTION 3

OPERATION

3.1 GENERAL

The following paragraphs are intended to provide the owner/user of this equipment with a thorough understanding of the X-RAY INSPECTION SYSTEM. Familiarity with the equipment may well suggest methods for extending the usefulness of this equipment.

3.2 DESCRIPTION

The X-RAY INSPECTION SYSTEM is a completely self-contained X-RAY Machine. The system was primarily designed for non-destructive testing of materials and components by radiography or fluoroscopic techniques. The system features an X-ray tube with a fixed aperture and an extremely fine focal spot, resulting in excellent resolution. The film to source distance is adjustable to any one of eight (8) positions within the radiation chamber. A filter holder is provided in the radiation chamber to provide the user with the means of adding either copper or aluminum filters to achieve even higher resolution radiography results. The system employs an inherent filtration of .6mm Beryllium for the 120D or 1.2mm Beryllium for the 150D. During the discussion of the various circuitry in the following paragraphs, refer to the system block diagram and schematic diagram contained in the appendix.

3.3 X-RAY TUBE

X-rays are generated in the X-ray tube V1. High voltage of zero to maximum KV is supplied for the cathode and anode of V1 by the high voltage transformer, T-4. Filament voltage for the X-ray tube is supplied by transformer T-5. V1 conducts during each half-cycle in which the anode is positive with respect to the cathode. Conduction by V1 results in half-wave self-rectification by the X-ray tube.

3.4 CONTROL PANEL

The Control Panel is the control center of the X-RAY INSPECTION SYSTEM. Incorporated in it are the power circuitry, Timing Section, MA Regulator, KV Control, the System Control Logic, Fault and Status Indicators. It is the latest state of the art design which allows an order of magnitude increase in reliability and repeatability.

3.4.1 Power Section

Keyswitch - Turns power to the entire system on and off. Some indicators and meters will be lit when keyswitch is on. The entire panel will be extinguished when the keyswitch is off.

Fuse - Main power fuse to the system. Its rating is 10A. 220VAC systems also have a 5AMP breaker adjacent to the power cord located on the rear panel.

X-Ray On - This lamp is lit whenever there is enough voltage applied to the X-ray Tube to cause generation of X-rays.

3.4.2 Control Section

Start PB - Clears all resetable fault lights and starts X-ray exposure. This PB is lit amber during exposure.

Stop PB - Stops X-ray exposure. This PB is lit green when exposure is completed or stopped. The X-ray system is automatically switched into standby mode to keep the X-ray tube and filament warm.

Reset PB - Resets the Timerad or Timer display to zero (blanked). This can only be done during stop mode.

3.4.3 Timerad Digital Display - Is a two function, 4 decade display of the remaining count. When activated from a blank (zero) state, the counter loads the preset valve of the thumbwheel switches and counts down to zero. The exposure is terminated and the counter is blanked out when the count reaches zero.

Preset Thumbwheel - Is a 4 decade thumbwheel switch which is used to preset the exposure count. In the timer mode the thumbwheel setting represents seconds of exposure. The maximum preset of 9999 seconds is equivalent to an exposure time in excess of 2-1/2 hours.

In the Timerad mode the thumbwheel setting represents approximate milliroentgens of total dose at the x-ray sensor. When the sensor is placed under the film, the dose is equal to the dose exposure of the film less the absorption of the film cassette. The maximum preset dose is about 10 roentgens. Less than 5 roentgens is required

to expose the slowest available film to a density of 4. Exposures as low as 5 milliroentgens may be accurately preset.

Manual Mode PB - Sets the timing mode to manual. This PB is lit green when active. The operator may then start and stop the exposure manually. No automatic functions are in effect.

Timer Mode PB - Sets the counter to count down seconds from a preset number. This PB is lit green when active. The operator starts the exposure and the timer terminates exposure when the count reaches zero.

Timerad Mode PB - Sets the counter to count down in approximate milliroentgens total exposure from a preset number. This PB is lit green when active. Exposure is terminated when the counter reaches zero. This PB is inactive if the Timerad option is not installed.

*** CAUTION ***

DO NOT CHANGE MODE DURING OPERATION AS THIS WILL STOP EXPOSURE AND RESET THE COUNTER

3.4.4 Milliamp Section

Milliamp Digital Meter - Normally indicates X-ray tube current. This reading should agree to within Ø.1MA of the MA set Thumbwheel position when X-rays are ON. This meter switches to counts per second when the Timerad Sensor PB is pressed.

MA Set Thumbwheel - Allows setting of X-ray milliamps between 1.ØMA and 5.ØMA in 1MA increments.

MAX

*** CAUTION ***

DO NOT CHANGE MA SETTING DURING OPERATION AS THIS MA RESULT IN A FAULT CONDITION AND EXPOSURE WILL BE HALTED.

Timerad Sensor PB - Switches the milliamp meter to read counts per second from the timerad sensor preamp. This is the rate at which the timerad counter will be decremented from its preset count. The operator may estimate the approximate length of an automatic exposure by dividing the total count by the rate. If we obtain a reading of

100.0 from the sensor and the timerad is preset to 1000, our exposure interval will be approximately 10 seconds.

HI MA Light - Lights when either the MA SETPOINT has been set above 5MA or in a fault condition when the X-ray tube current exceeds the Setpoint by more than 20%. Once lit, the X-ray exposure is stopped and fault relay contacts are opened to remove power from the high voltage primary. This light and the fault relay are reset by the start pushbutton.

An occasional severe line transient may trip the high MA light, but successive repeated faults indicate that a service problem exists.

LO MA Light - Lights when either the MA SETPOINT has erroneously been set to zero or if there is a condition which causes the X-ray tube current indication to drop more than 20% below the MA setpoint. This can occur when the KV control is set too low to maintain the required MA setting. In this case either the MA setting can be reduced, or the KV can be increased until the regulator can sustain the required current. This fault condition also stops the exposure after a delay of several seconds and opens the fault relay removing high voltage from the X-ray tube. The start PB clears this fault. If MA setpoint of KV corrections do not prevent reoccurance of this fault condition, a service problem may exist.

3.4.5 Status Indicators

HI Temp - Is a warning indicator signaling a high temperature condition in the X-ray Generator. It lights red at 70 degrees C and will also terminate exposure and open the fault relay. This condition may occur during operation at high voltage and current levels together with high ambient temperatures. Check for proper operation of the oil cooling system (i.e. pump and fan). Check and clean the fan air filter. Let the system cool off and restart the exposure. If the fault reoccurs a service problem may exist.

Warmup - Lights red for the first 60 seconds after the equipment is turned on. When lit the system is forced into stop and manual mode and operation is inhibited, allowing the X-ray tube ample time to come up to operating temperature, before being

put into operation.

Door - Lights red when the door to the X-ray Chamber is opened. Opening the door will stop exposure, as well as halt the counter. Last count is maintained and exposure may be continued by closing the door and pressing the start button.

3.4.6 Kilovolt Section

Kilovolt Digital Display - Is a four digit, four function display which normally displays peak KV applied to the X-ray tube. Pressing the two buttons below the KV control allows three other functions to be displayed, actual HV primary voltage, RMS filament primary voltage, and RMS neutral current. The later two are useful for troubleshooting and calibration purposes only.

KV Percentage Control - Is an adjustment which allows KV to the X-ray tube to be varied from zero to above the rating of the X-ray tube. There is an internal HV sense circuit which will not allow operation above the rating of the tube.

HI KV Warning Light - Lights red when the Kilovoltage rating of the tube is about to be exceeded. This can be caused by the operator setting the variac too high, by shifts on line voltage or short duration line transients. When lit exposure is halted and the genfault relay opens to remove Hi voltage from the x-ray tube. This fault is also reset by the START PB.

HVP Test PB - When pressed allows the operator to read the voltage which applied to the hi voltage primary during exposure. This allows the operator to verify the presence of voltage at the high voltage primary. The actual KV under operation may drop significantly depending on the MA setting and the length, gauge and loading factor of the feeder run that this equipment is plugged into. A drop of 5 volts RMS in line voltage when x-rays are energized translates to a 7KV drop at the tube. It is recommended that this equipment be provided it's own 20A feeder circuit to minimize line fluctuation.

FIL Test PB - Is used primarily for troublshooting and calibration. When pressed it causes the peak KV meter to read the RMS voltage input into the filament transformer primary.

FIL Test PB + Preset PB - Is used primarily for troubleshooting. When both buttons are pressed simultaneously. The KVP meter switches to read neutral current to the X-ray Generator. In the standby mode only the current to the X-ray filament transformer is read. During exposure the reading is the sum of the filament and HV primary currents.

3.5 OPERATING PROCEDURE

3.5.1 Turn Power On - Insert the key into the power keyswitch. Turn clockwise to the ON position. Observe that the red WARM UP indicator and the green MANUAL and STOP pushbuttons are lit.

The system is held inoperative for 60 seconds by the warmup timer. This allows sufficient time for the x-ray tube to come up to temperature. Normal operation will resume when the warmup light is extinguished.

3.5.2 Set MA Level - Select an x-ray tube current between 1 and 5MA. Dial this level in on the MA Set thumbwheel.

3.5.3 Set KV Level - Adjust the KV knob and set the desired KV level on the KILOVOLTS display. Readjust the KV immediately after the first exposure is started and leave this setting for further exposures at the same KV and MA settings.

The red Hi KV light will come on if the rating of the tube is exceeded during preset or exposure. The Genfault circuitry inactivated with the indicator. This will halt operation and remove light voltage power from the x-ray generator until the fault light is reset. Reset is accomplished by simply pressing the start button to continue the exposure. Reset without starting an exposure can be accomplished by holding down the stop button while pressing the start button of operation. This is the time required for the x-ray tube to come up to full operation. At high mA levels the actual operating voltage due to poor voltage stability at the power outlet. It is recommended that this equipment be operated on an independent 20 or 30 AMP line because changing load factors on the feeder line can also have a significant impact on the operating KV during an exposure. No compensation factor was built into

the preset, because operation at the maximum KV and MA levels under poor line conditions would require that the tube start at KVP ratings in excess it's maximum design rating causing eventual catastrophic failure of the tube.

3.5.4 Select Operating Mode - select mode by pressing, MANUAL, TIMER, TIMERAD pushbuttons. The appropriate switch will light green when depressed.

3.5.5 Manual Operation - Press MANUAL button and x-ray chamber. Close the door and observe that the door light goes out. Press the START button to start exposure. The START button and X-RAY ON indicator will light amber and the MA display and KILO VOLTS display will indicate generator current and voltage levels during exposure. Press the STOP button to terminate exposure. Opening the door which under operation will physically disconnect the high voltage from the generator and cause the stop light to come on. To restart simply close the door and press the START button.

3.5.6 Timer Operation - Press TIMER button and enter the exposure time in seconds on the timer preset thumbwheels. If the timer is not blanked press the RESET button to clear the timer.

NOTE: The timer will not load the preset value unless its display has been cleared, and display can only be cleared while in STOP mode.

Start the exposure by pressing the START button. The timer will start counting down. Stopping exposure by any means will halt the timer without causing loss of time.

Exposure can be restarted by simply pressing the START button again. A fault condition will prevent continued operation.