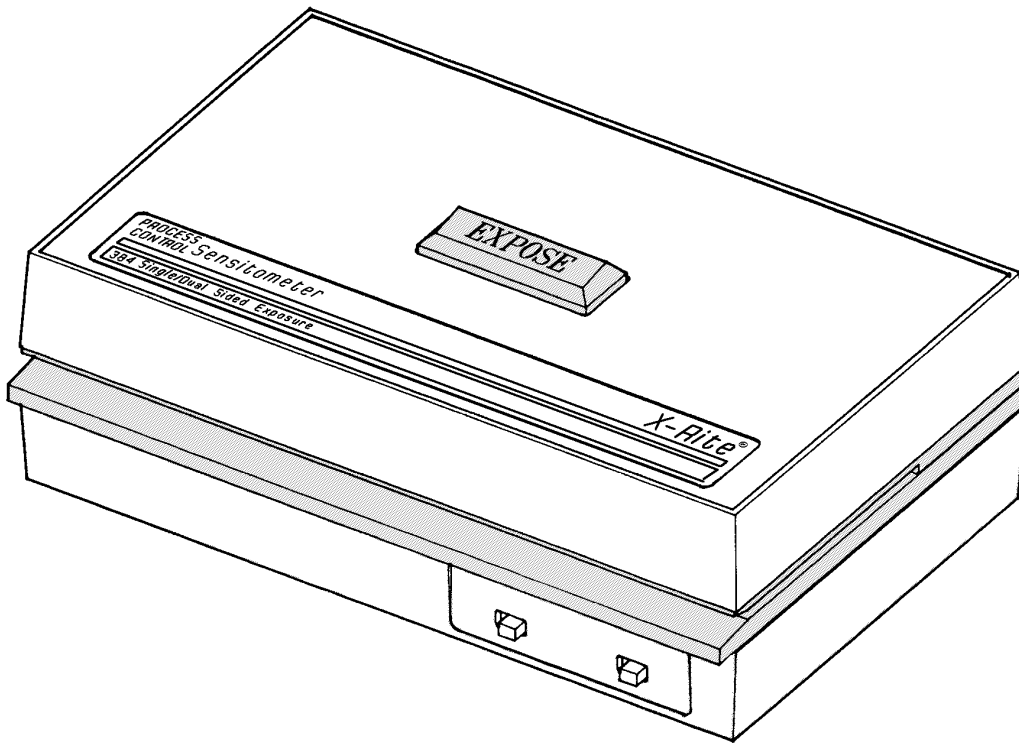


X-Rite® 384

Single/Dual Sided Exposure Process Control Sensitometer



Operation Manual



X-Rite, Incorporated—World Headquarters
3100 44th Street, S.W. • Grandville, Michigan 49418 • U.S.A
Tel: (616) 534-7663 • Order Administration Fax: (616) 534-0723
Instrument Services Fax: (616) 534-7722

X-Rite GmbH
Charlottenstraße 61 • 51149 Köln • Deutschland
Tel: (49) 2203-91450 • Fax: (49) 2203-914519

X-Rite Asia Pacific Ltd.
Room 1004-05 • Kornhill Metro Tower • 1 Kornhill Road
Hong Kong • Tel: (852) 2-568-6283 • Fax: (852) 2-8858610

X-Rite Ltd.
Lower Washford Mill • Mill Street • Buglawton
Congleton, Cheshire CW12 2AD • U.K.
Tel: (44) 1260-279988 • Fax: (44) 1260-270696

CAUTION: Reverse connection of battery may cause damage to circuit. Use only 9 volt alkaline batteries.

VORSICHT: Eine Umkehrung der Akkuverbindung wird möglicherweise Schäden in der Schaltung verursachen. Verwenden Sie nur Alkalibatterien von 9 Volt.

ADVERTENCIA: Conexión inversa de las pilas causaría daño al circuito. Use solamente las pilas alcalinas de 9 voltios.

ATTENTION: Un raccordement inversé des piles peut endommager le circuit. Utiliser seulement des piles fer-nickel de 9 volts.

AVVERTIMENTO: Connessione inversa delle pile può causare danno al circuito. Usare solamente le pile alcaline di 9 volt.

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Dear Customer:

Congratulations! We at X-Rite, Incorporated are proud to present you with the X-Rite 384 Sensitometer. This instrument represents the very latest in low power integrated circuit design. As a result, your 384 is a rugged and reliable instrument whose performance and design exhibit the qualities of a finely engineered instrument, which is not surpassed.

To fully appreciate and protect your investment, we suggest that you take the necessary time to read and fully understand this manual. As always, X-Rite stands behind your 384 with a full one year limited warranty and a dedicated service organization. If the need arises, please don't hesitate to call us.

Thank you for your trust and confidence.

X-Rite, Incorporated

General Description

The 384 Sensitometer is a battery operated, dual color, single/dual sided exposure sensitometer designed for quality control of cine and x-ray processing systems.

Advanced low power circuitry allows a long battery life without sacrificing performance. Replacement batteries are 9V alkaline type.

The 384 Sensitometer produces a repeatable stepped exposure on applicable film. This is done by exposing a piece of film in the Sensitometer, processing it, and comparing it with a reference film prepared when processing conditions were known to be satisfactory.

Sensitometry information will enable operators to consistently maintain the upper limits of informational content in their radiographic processing, establish relative film processing quality standards within the department, and achieve total system control of quality between other x-ray departments.

The unique "calibration monitor" circuit of the unit provides repeatable exposures from month to month and from instrument to instrument. Its ease of operation enables anyone with little instruction to expose repeatable sensitometry strips with either blue or green exposing light, simulating the light from blue and green intensifying screens.

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"ALL RIGHTS RESERVED"

1. Getting Started

1.1. Packaging Check List

Remove the instrument from the shipping carton. Inspect for possible damage. If any damage is noted, contact the transportation company immediately. Do nothing more until the carrier's agent has inspected the damage.

If damage is not evident, check to make sure that the following items are included:

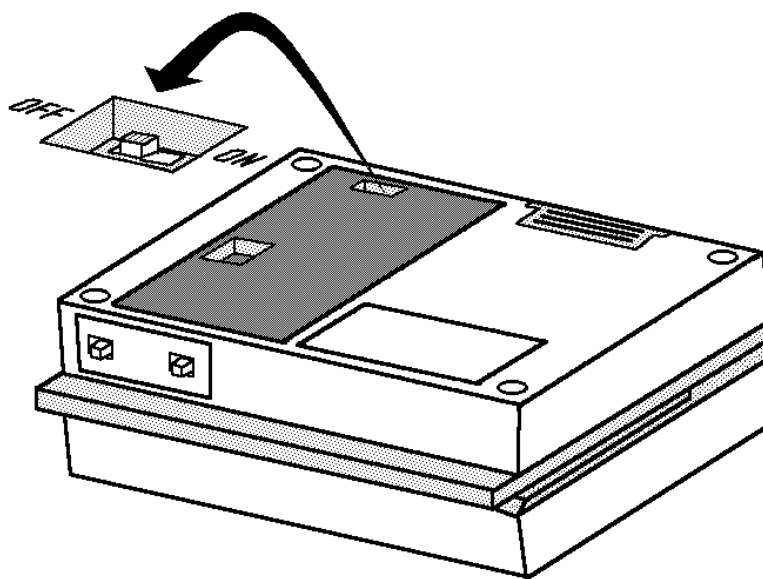
- Important Notice
- Registration Card
- Operation Manual
- Sensitometer

Your sensitometer was packaged and shipped in a specially designed carton to assure against damage. If reshipment is necessary, the instrument should be repackaged in the original carton. If the original carton is not available, a new one can be obtained from X-Rite, Incorporated.

1.2. Applying Power

The sensitometer is shipped with the battery installed and the power switch in the "OFF" position (power switch is located on the bottom of the unit). Slide the switch to the "ON" position. Because there is no current drain on the battery during nonuse periods, the power switch can remain in the ON position. The only time that the power switch must be turned OFF is when the unit is transported or the battery is replaced.

Your Sensitometer is designed to operate from its 9v alkaline battery for approximately one year. When the battery is low the circuit will not allow any exposures to occur. Should your unit become inoperative, REPLACE THE BATTERY FIRST (see Section 3.2). If this does not rectify the problem, then refer the instrument to X-Rite or an authorized service center for proper servicing. There are no user serviceable components in the sensitometer.



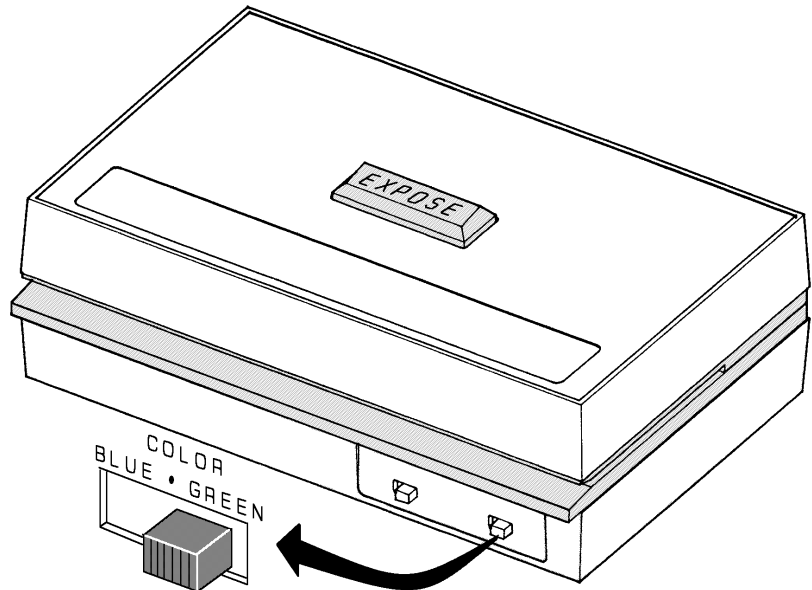
2. Operation

2.1. Color Selection

Optimum sensitometric control occurs when the proper color light exposes the film. Expose with the same color emitted from the intensifying screen recommended by the film manufacturer for the film being exposed.

EXAMPLE: When using blue emitting intensifying screen - expose in BLUE position.

Slide the color switch on the front of the unit to the left for "BLUE" or to the right for "GREEN".

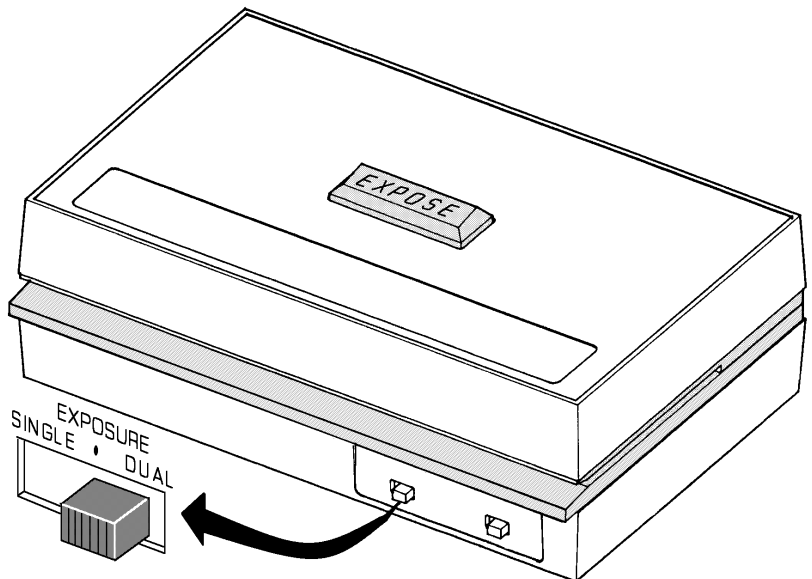


The exposure time should be set in accordance with the manufacturers requirements. See section 2.2 for exposure settings.

2.2. Single or Dual Exposure Selection

Depending on the type of film that is to be exposed, the sensitometer can have either single sided or double sided exposure selected.

If the film being exposed is a single emulsion type, slide the exposure switch to the "SINGLE" position, and EXPOSE FILM EMULSION SIDE DOWN. If the film being exposed is a double emulsion type, slide the switch to the "DUAL" position.

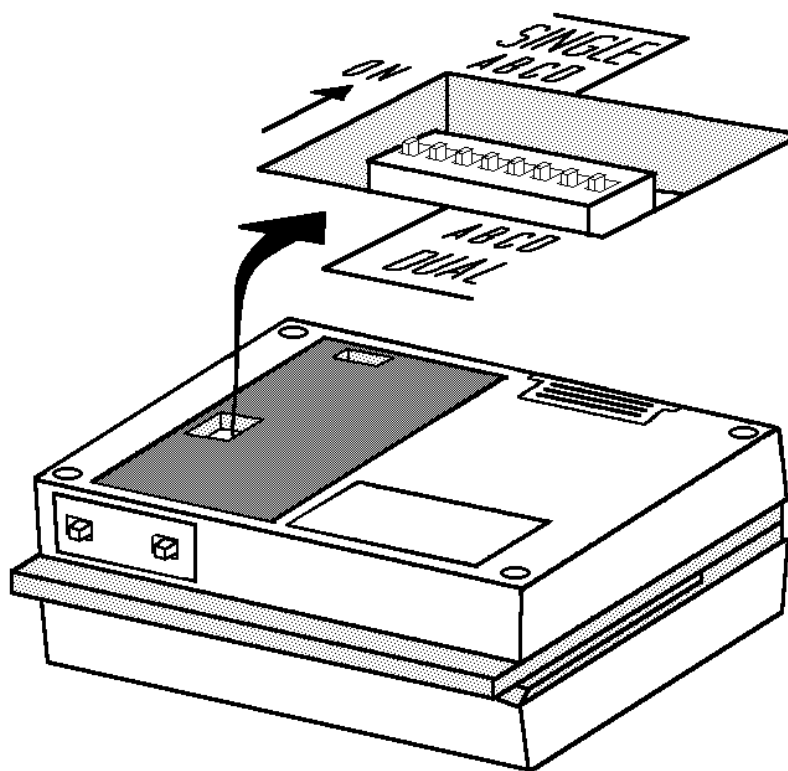


2.3. Exposure Setting

The sensitometer has the capability of seven different exposure times for both single and dual. The factory preset exposure setting for single and dual is #3. If different exposure times are required, refer to the chart below (or bottom of unit) for the settings. Each exposure setting will move the speed index on the film one step.

The dip switch used to change the exposure time is located on the bottom of the unit. When the single color is selected, switches A,B,C,D bracketed as single are activated. When the dual color is selected, switches A,B,C,D bracketed as dual are activated.

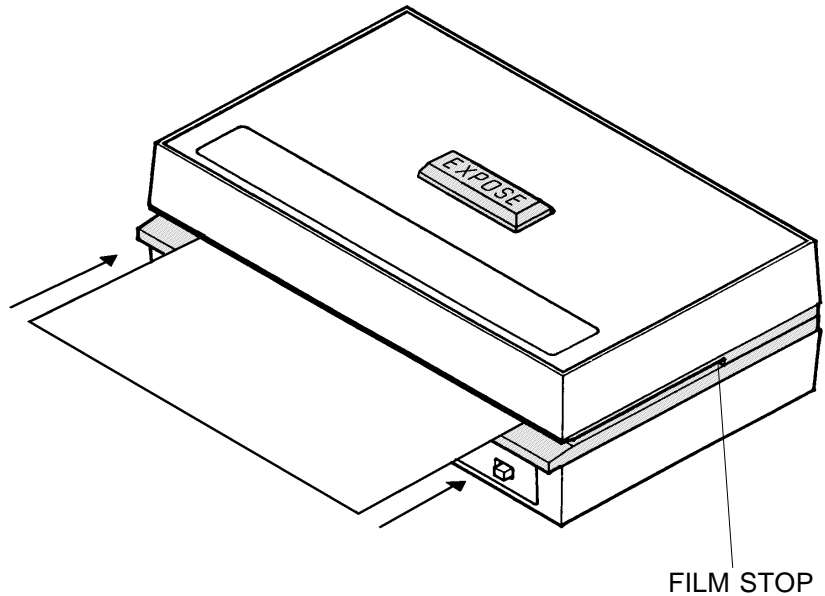
Exp. Setting	Dip Switch Setting			
	A	B	C	D
#1 (Min)	OFF	OFF	OFF	OFF
#2	ON	OFF	OFF	OFF
#3 (Normal)	OFF	ON	OFF	OFF
#4	OFF	OFF	ON	OFF
#5	ON	ON	ON	OFF
#6	OFF	OFF	OFF	ON
#7 (Max)	OFF	OFF	ON	ON



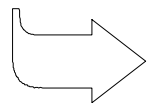
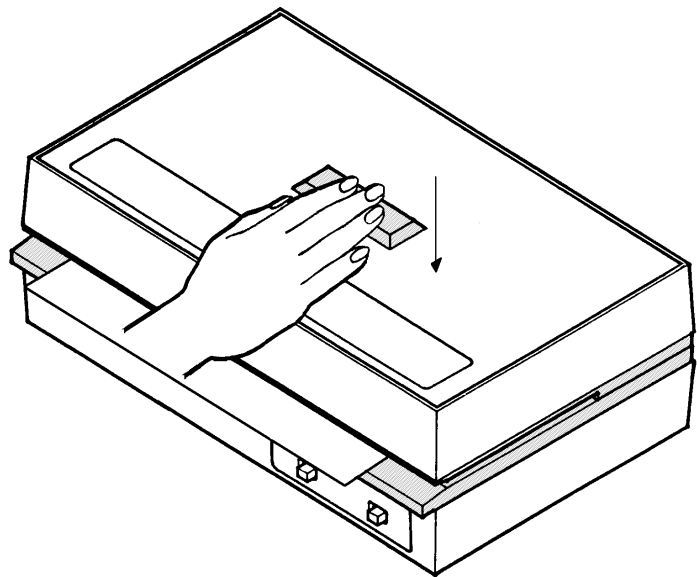
2.4. Exposing Film

Expose the film selected as follows:

1. Select exposing color (see Section 2.1).
2. Select single or dual exposure (see Section 2.2).
3. Adjust exposure setting if required (see Section 2.3).
4. Insert the film (emulsion side down if single emulsion) with the back edge against the stop, and the film centered in the unit.

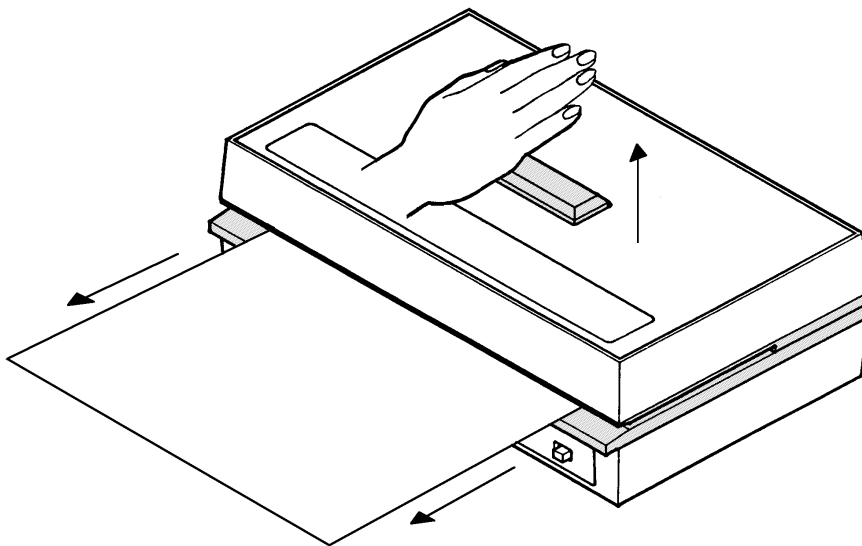


5. Press the expose button down and hold until the buzzer has sounded. Always press straight down in center of expose button.



2.3 Exposing Film - continued

6. Release the expose button and remove the film immediately.
7. Develop the film in the processor to be monitored (see Section 4).
8. Record data on the film immediately after development (see Section 4).



IMPORTANT NOTES:

1. Film must be inserted all the way to the back of the unit in order to be exposed properly.
2. The sensitometer is calibrated to expose screen-type films normally used for general radiography to an approximate density of 1.0D+ Base+Fog on Step No. 11.
3. If the X-Rite 380 or 381 Densitometer is used to measure film strips (see Sec. 4.3.3), the sensitometric exposure must meet the following criteria:
 - The exposure must have a gamma of .7 or greater on steps 7 through 15. There must be a visible density difference between each step (density increment of at least .11D).
 - The film must have at least 1.1 inch of clear leader at both ends of the exposure. The use of 8" x 10" or 18cm x 24cm film is recommended.

3. Maintenance

3.1. General

The X-Rite 384 is covered by a one-year limited warranty (excluding battery) and should be referred to the

factory or authorized service center for repairs within the warranty period. Attempts to make repairs within this time frame may void the warranty.

3.2. Factory Repair

X-Rite provides a factory repair service to their customers. Because of the complexity of the circuitry all circuit repairs should be referred to the factory or an authorized service center. X-Rite will repair any 384 past warranty.

Shipping costs to the factory or an authorized service center shall be paid by the customer and the instrument shall be submitted in its original carton, as a complete unaltered unit.

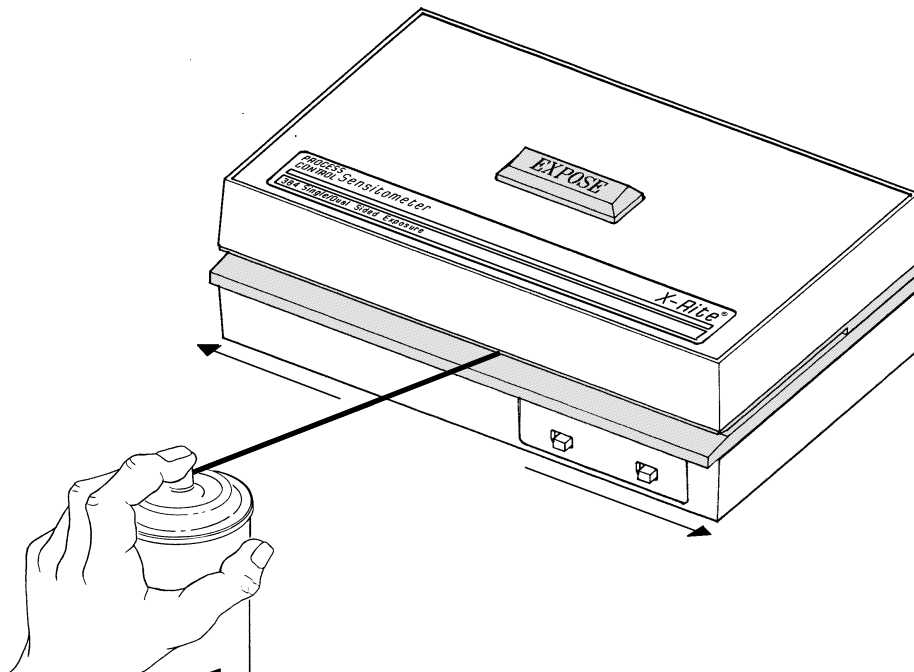
A 383/384 Subassembly Troubleshooting Manual is available from X-Rite: order P/N 383-505

3.3. Cleaning Step Tablet

To remove any dust and lint from the exposure area, follow the procedure below periodically.

1. Holding can in upright position, insert tube from canned air into exposure slot. Make sure the air is clean and free of moisture.

2. With back and forth motion spray air into exposure slot from one end to the other. Do this several times. This should remove any dust and lint that may have collected.



3.4. Battery Replacement

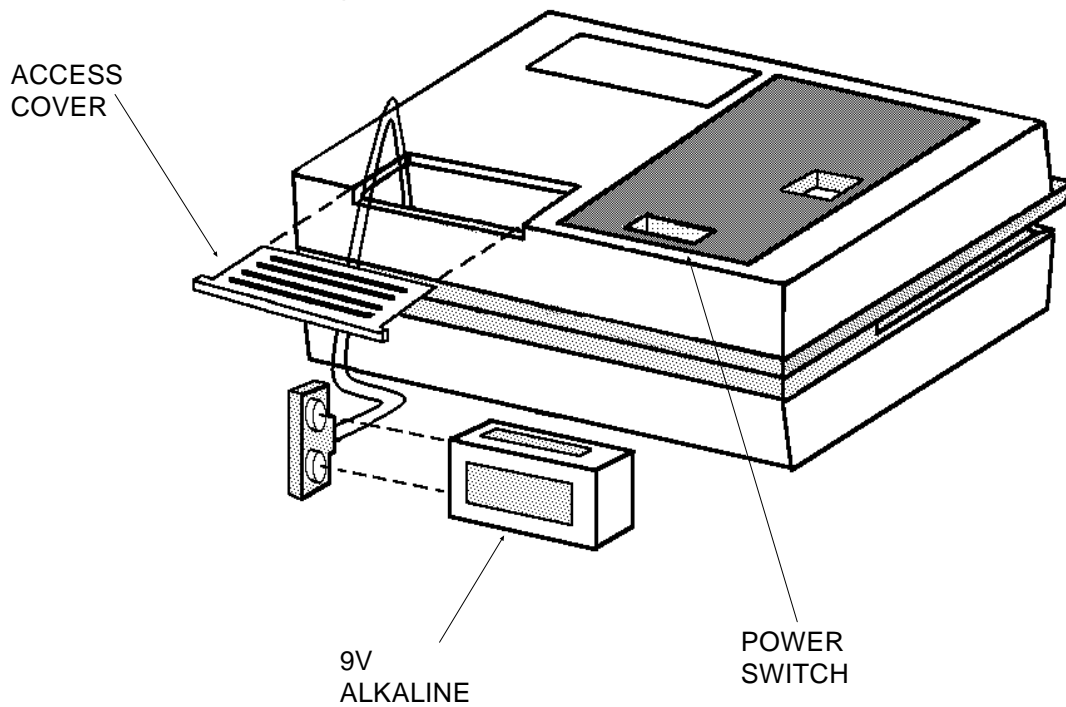


A low battery condition prevents exposures from occurring. **ALWAYS REPLACE THE BATTERY FIRST** before referring the unit to the factory for repairs.

Replace the battery as follows:

1. **Turn Power Off**, and remove battery access cover on bottom of unit by sliding outward.
2. Disconnect old 9V battery from the circuit and discard.
3. Connect a replacement 9V alkaline battery to the circuit and insert it into the battery compartment.
4. Reinstall battery access cover and turn power On.

CAUTION: Connection of the battery leads backwards may cause circuit failure.



4. Applications

4.1. Sensitometer Monitoring for Processor Control

4.1.1. Film Response to Exposure

The sensitometer exposes film with a known quantity of light through two 21-step light modulators. The maximum light is emitted from Step No. 21. Each successive step emits 70.7% of the light emitted from the step adjacent to it (.15 log exposure). The film exposed responds to this exposure in a predictable way called the D-Log E Curve, (Density-Log Exposure Curve). Figure One shows the response of a typical radiographic film to exposure with the sensitometer. The portion of the curve that changes most with variations in processing is called the "straight line portion" of the curve.

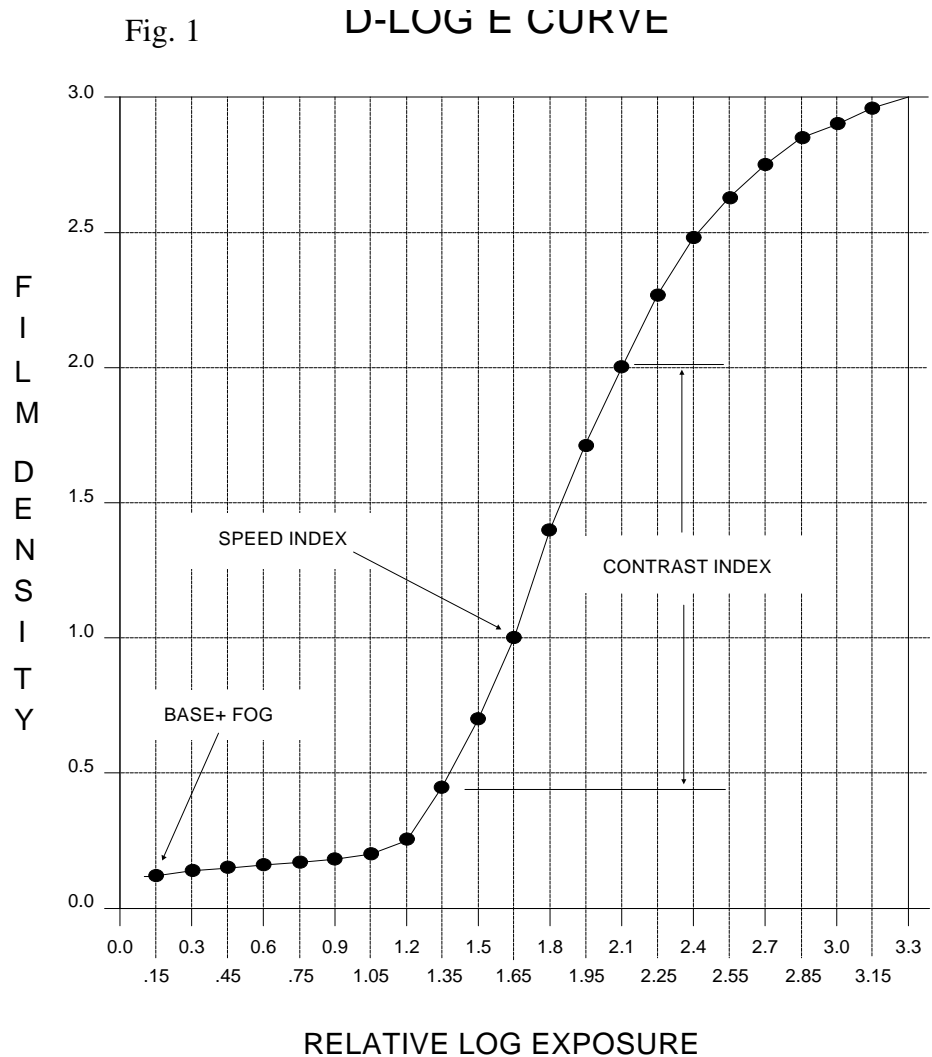
It is not necessary to plot D-Log E Curves to monitor automatic processors in normal laboratory environments. A simpler method is to record the three points on the D-Log E Curve which contain most of the data.

The following three points on the curve should be monitored to give pertinent processing data.

1. **Base+Fog:** Step No. 1 on the D-Log E Curve is called Base+Fog the least exposed portion of the film. It is the base support density plus any silver emulsion density developed in the area where negligible exposure should occur.

2. **Speed Index:** The step on the exposed film with a density nearest 1.0D+ Base+Fog is called Speed Index. This step is a direct indicator of film speed. Variations in processor conditions are monitored on this step.

3. **Contrast Index:** The slope of the straight-line portion of the D-Log E Curve is called Contrast Index. Select the step closest to but not larger than 2.20D. Subtract from this step the step closest to but not lower than 0.45D. Contrast Index is used to monitor processor variations in conjunction with the Speed Index.



4.1.2. Selection and Use of Film

The film selected to monitor a given processor should be representative of the film used with that processor.

4.1.3 Scheduling Sensitometric Control

Every processor in use should have a separate control chart plotted to monitor its behavior. The more frequent the data points, the better the control feedback. A control film should be run at start-up of the processor and at least once a day. Use sensitometry whenever trouble is suspected, or a change has been made to the process.

4.2. Processing Procedure

1. Allow the processor temperature and chemistry to reach equilibrium when starting up the processor before processing film.
2. Run a full width film for cleanup at start-up.
3. Orient the film into the processor in a consistent manner - making sure the film is inserted per processor manufacturer's specification.
4. After processing of film is complete, record the date, time, and processor identification number on the film in the designated areas.

X-Rite [®]	
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TIME: DATE: ID NO:	

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4.3. Data Recording Procedure

4.3.1. Establishing Normal Speed Index, Contrast Index, and Base+Fog

The normal speed index, contrast index, and base+fog values are established on a representative film, when the processor is considered to be operating in an optimum fashion.

Run several film samples and determine the average values for speed index, contrast index, and base+fog, using a transmission densitometer. Step wedge areas are as uniform as is possible to produce. There are, however, some errors at the edges of the step area. Therefore, always measure density at the center of the step. Use a 2mm aperture to give best repeatability.

Record the following data on the process control record (available from X-Rite, P/N 306-00):

Developer
Temperature.....Temperature of developer solution in processor during processing

Normal
Base+Fog.....Step number one density, the least exposed step on the wedge.

Normal
Speed Index.....The density of the step exposed and developed closest to 1.0D + base+fog. The step number should remain the same for a given process and film type.

Normal
Contrast Index.....Select the step closest to but not larger than 2.20D. Subtract from this step the step closest to but not lower than 0.45D.
NOTE: Monitor subsequent films on the same steps selected for normal contrast index.

DateMonth - Day - Year.

Processor Number...Processor identification.

Emulsion Number....Film batch identification.

Developer Type.....Developer vendor identification.

Fixer Type.....Fixer vendor identification.

Film Type.....Film vendor identification.

Exposure Color.....Exposure light (blue or green).

Single/Double.....Single or Double sided exposure.

Developer
Replenisher Rate.....The rate of developer replenishment.

Fixer Replenisher
Rate.....The rate of fixer replenishment.

Processing Time.....Film process time, input-to-output.

A box of film should be set aside from regular stock for exclusive sensitometer use. New film stock will require reestablishment of normal values because small density changes are possible between film batches.

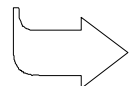
4.3.2. Daily Plotting of Data on Process Control Record

Plot the results on the process control record each time a control film is developed. Record data immediately so that it is not lost or changed. The following processor data will be plotted:

- Speed Index
- Contrast Index
- Base+Fog
- Developer Temperature

4.3.3. Using the X-Rite 381 Densitometer to Measure and Record Film Data

When the X-Rite 381 densitometer is used to measure process film, it will automatically calculate and store the values for, speed index, contrast index, and base+fog. The unit will also store up to 32 measurements of film data. And, when interfaced with a printer, it will print-out the process control record. The following page shows a sample process control record printed by the densitometer.

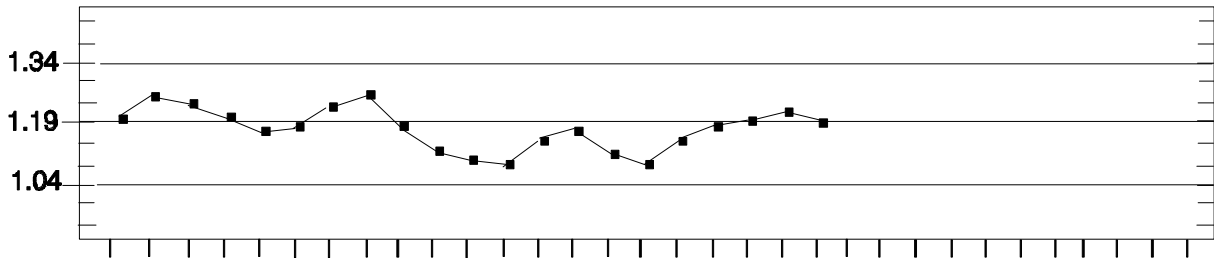


Sample Print-out from the 381 Densitometer

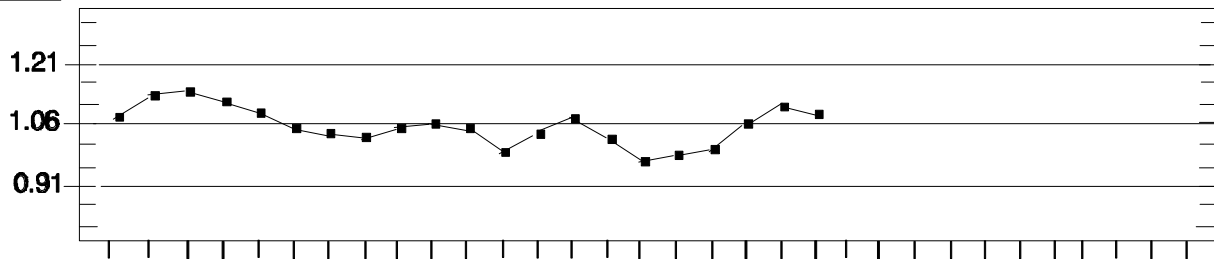
X-RITE Process Control Densitometer
METROPOLITAN
HOSPITAL

LOCATION: <u>Xray lab A</u>	BEGIN DATE: <u>XX/XX/XX</u>	GRAPH DATE: <u>XX/XX/XX</u>
TYPE OF FILM: _____	EMULSION NUMBER: _____	EXPIRATION: _____
PROCESSOR: _____	PROCESSING TIME: _____	
DEVELOPER: _____	REPLENISHMENT: _____	
FIXER: _____	REPLENISHMENT: _____	
EXP. COLOR: <u>BLUE</u> or <u>GREEN</u>	EXP. TYPE: <u>DUAL</u> or <u>SINGLE</u>	

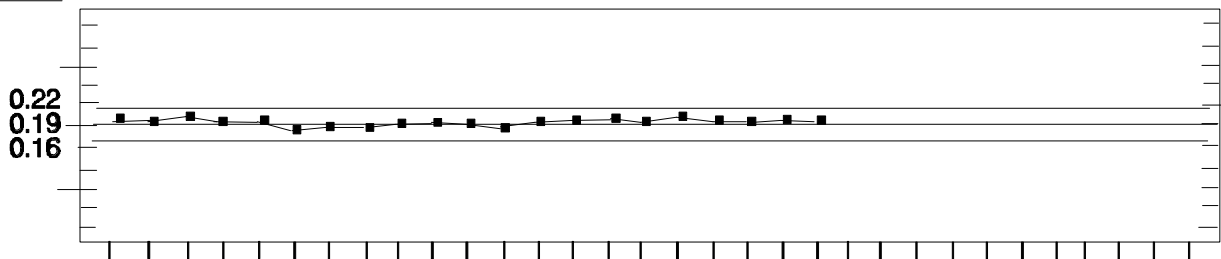
S. Indx



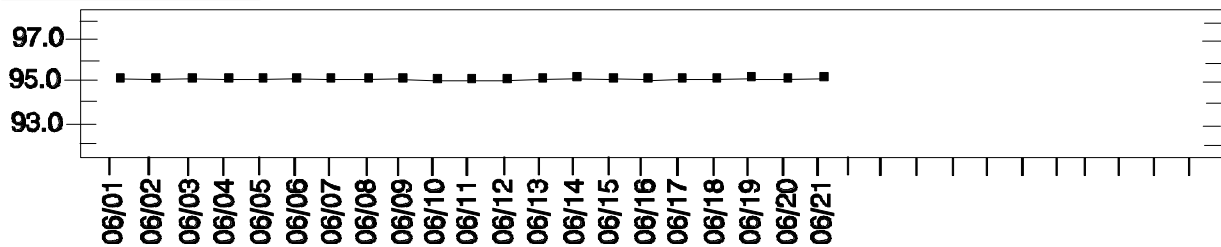
C. Indx



B+fog



Developer Temperature



4.4. Processor Troubleshooting

When troubleshooting out of tolerance processor conditions, use Speed Index as the primary guide. Speed Index is the most predictable indicator for all film types. Base+Fog is predictable, but is the least sensitive. Contrast Index reacts predictably for a given set of film conditions but may vary from film to film.

Listed below is a chart showing Speed Index and Base+Fog reactions to common processor problem conditions.

As Control Records become more complete for a given film, the relationships between Contrast Index and Processor Conditions will become apparent. Always note the reason for out-of-tolerance processor condition - preferably on the Control Record.



When out-of-tolerance conditions are noticed, always verify readings with another test film.

Speed Index	Base+Fog	Possible Cause
High	High or Normal	Developer temperature too high. Developer over replenished. Improper safe lighting. Improper solution mix.
Low	Low or Normal	Developer temperature too low. Developer underreplenished. Contaminated developer. Inadequate developer circulation. Improper solution mix.

5. Appendix

5.1. Proprietary Notice

The information contained in this manual is derived from patent and proprietary data from X-Rite, Incorporated. This manual has been prepared expressly for the purpose of assisting operation and maintenance personnel in their use and general maintenance of the X-Rite 384.

Publication of this information does not imply any rights to reproduce or use it for purposes other than installing, operating, or maintaining the equipment described herein. No part of this manual may be reproduced, transcribed, transmitted, stored in a retrieval system, or translated into any language or computer language, in any form or by any means, electronic, magnetic, mechanical, optical, manual, or otherwise, without the prior written permission of an authorized officer of X-Rite, Incorporated.

This instrument is covered by the following U.S. and foreign patents:

U.S. patent #4,235,537 and other patents pending.

THESE PROVISIONS ARE INTENDED TO STATE ALL OF THE RIGHTS AND RESPONSIBILITIES BETWEEN X-RITE, INCORPORATED AND CUSTOMER. THEY TAKE PLACE OF AND SUPERSEDE ALL WARRANTIES, EXPRESSED OR IMPLIED, AND WHETHER OF MERCHANTABILITY, FITNESS OR OTHERWISE. THE REMEDIES CONTAINED IN THIS OPERATION AND INSTALLATION MANUAL ARE EXCLUSIVE.

CUSTOMER AND X-RITE, INCORPORATED WAIVE ALL OTHER REMEDIES, INCLUDING BUT NOT LIMITED TO, CONSEQUENTIAL DAMAGES.

5.2. Limited Warranty

X-Rite, Incorporated warrants each instrument manufactured by them to be free of defects in material and workmanship for a period of 12 months. THERE ARE NO WARRANTIES OF MERCHANTABILITY OR FITNESS. THIS WARRANTY OBLIGATION IS LIMITED TO SERVICING THE UNIT RETURNED TO THE FACTORY FOR THAT PURPOSE AND EXCLUDES THE BATTERY.

The instrument shall be returned with transportation charges prepaid. If the fault has been caused by misuse or abnormal operating conditions, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

A Warranty Registration Card is enclosed with each instrument. The purchaser should fill in the warranty registration card completely and return it to X-Rite, Incorporated

postmarked no later than ten (10) days from the date of receipt. This card registers your system with us for warranty coverage. Once your unit is registered, we are able to maintain a file to help expedite service in case it is needed. Always include serial number and place of purchase in any correspondence concerning your instrument. The serial number is located on the bottom of the instrument.

X-Rite, Incorporated offers a repair program for instruments out of warranty. For more information, contact X-Rite Instrument Services Department.

This agreement shall be interpreted in accordance with the laws of the State of Michigan and jurisdiction and venue shall lie with the courts of Michigan as selected by X-Rite, Incorporated.

5.3. Specifications

Design Conformance:	A.N.S.I. PH2.9-1974*
Unit to Unit Repeatability:	±.02 Log Exposure
Exposure Stability:	±.02 Log Exposure per year
Temperature Sensitivity:	±.02 Log Exposure from 59°F - 86°F
Electrical Requirement:	9V Alkaline battery
Light Modulation:	21-Step Wedge, 0.15D per step
Blue Color Peak Wavelength:	460 nm ±10nm
Green Color Peak Wavelength:	510nm ±10nm
Warm-up Time:	Instantaneous
Recycle Time:	2 Seconds
Size:	8.5"W x 5.25"D x 3.0"D
Weight:	2-1/2 lbs.

*American National Standards Institute compliance except as noted.