

NERO[®] mAx X-ray Test Device

Victoreen[®] Model 8000



- **Non-invasive evaluator of radiation outputs**
- **100 kHz sampling speed captures data from the most difficult machines**
- **0.5 kV or 1% accuracy from 22 to 160 kV**
- **Measures kVp average, kV effective, kV peak, time, exposure or rate, mA or mAs, HVL, exposure/frame, and mAs/frame**
- **Displays R or Gy**
- **Excel Add-in includes MQSA, Rad, and Fluoro templates**
- **RS-232 computer interface**
- **Enhanced dental capabilities**

Introduction

The Victoreen[®] NERO[®] mAx, Non-invasive Evaluator of Radiation Outputs, evaluates the widest range of x-ray machines on the market today. Evaluation of pulsed fluoro, cine, computed tomography (CT), portable, mammographic, dental, radiographic, fluoroscopic, low, medium, and high frequency machines is finally made possible with a single instrument. This fifth generation instrument features 100 kHz sampling speed and direct mA/mAs measurements. The NERO mAx's innovative Easy Flow Menu (EFM) system and flexible softkeys provide an intuitive, user friendly operating environment for quick, accurate, and easy measurements. All measurement modes and functions are displayed on the NERO mAx's super bright LCD and are controlled by the five softkeys directly below the display and three hard keys to the right.

Seven user selectable measurement modes and three system control modes are available and clearly displayed on the control console screen for easy access and selection.

Applications

The NERO mAx consists of the control console, detector, detector cable, two filter cards, mAs leads, Excel Add-in, AC adapter, HVL plates, instruction manual, and carrying case.

The compact control console houses the rechargeable battery, super bright easy to read backlit display, eight control buttons, and the sophisticated electronics necessary for accurate, reproducible measurements. Connectors for power input, RS-232, printer, scope output and the NERO mAx detector are located on the control console's rear panel.

The NERO mAx detector contains sensors for simultaneously measuring kV, exposure or rate and mA or mAs. Solid state detectors are used to measure kV. An ion chamber, located in the top of the detector, is used for exposure/rate measurements. Connectors for external ion chambers and the NERO mAx detector interface are located on the rear panel of the detector. The front panel has a keyed opening for the NERO mAx filter cards and a connector for mAs leads.

The filter cards contain the various filters needed to accurately measure kilovoltage. Each filter card is coded so that the NERO mAx "knows" which filter is in use and its position. The NERO mAx also verifies that the filter card is valid for the selected measurement mode. The two filter cards are keyed so that they may only be inserted properly. The W/AI filter card and the Mammo filter card are clearly labeled as to the x-ray tube targets for which they are calibrated.

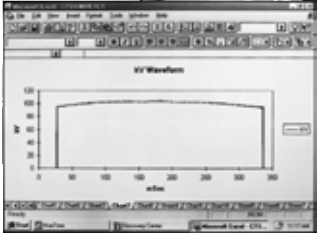
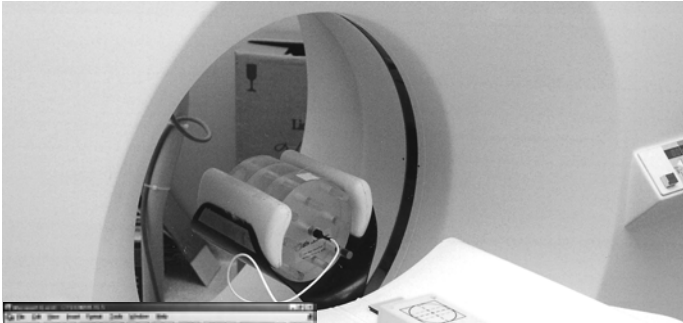
External chambers

External ion chambers for CT, mammographic, image intensifier tube, and special radiographic applications are available.

Chamber calibration factors can be stored in the NERO mAx for direct readout of measurements.

The Excel Add-in acquires measured data and waveforms directly into an Excel spreadsheet to maximize flexibility for report generation.

Real-time CT



UNIT ID	SETUP	CAL	HVL
EXP	CT EXP	10PULSE	
AMSE	ZERO		
FLUORO	75%		
MAMMO	80%	LOW	
RADIO	90%	HIGH	10 mS
MODE	%kV	SENS	DELAY

Easy Flow menu, Mode Select screen

80.0	kVp Avg	100	msec
79.2	kV Eff	392	mR
81.1	kV Peak	0.0	mAs
RADIO	75%	LOW	10 mS
MODE	%kV	SENS	DELAY
			MAKE EXPOSURE

Easy Flow menu, Radio screen

24.8	kVp Avg	226.1	msec
24.3	kV Eff	240	mR
27.3	kV Peak	19.9	mAs
MAMMO	HIGH	MOLY	Mo 30 μ
MODE	SENS	TARGET	FILTER
			MAKE EXPOSURE

Easy Flow menu, Mammo screen

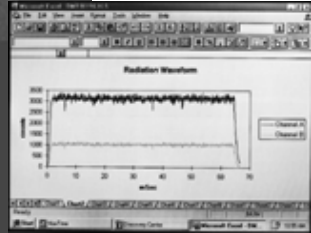
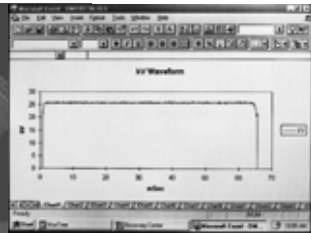
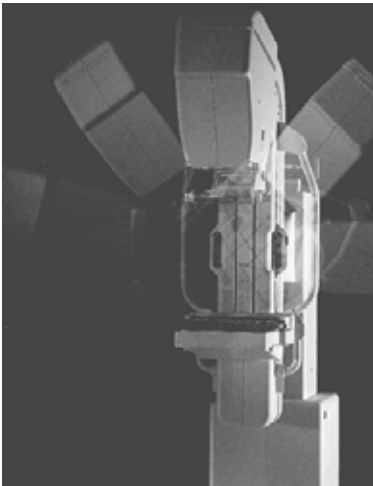
75.4	kVp Avg	0.159	R/min
71.1	kV Eff	0	mAs/pulse
80.8	kV Peak	177	μ R/pulse
FLUORO	PULSED	LOW	
MODE	TYPE	SENS	
			MAKE EXPOSURE

Easy Flow menu, Pulsed Fluoro display

74.1	kVp Avg	102.1	mSec/frame
72.7	kV Eff	359.3	mR/frame
74.8	kV Peak	30.5	mAs/frame
AMSE	LOW		
MODE	SENS		
			MAKE EXPOSURE

Easy Flow menu, AMSE screen

High frequency mammography



3.65 R			
CT EXP	LOW	10 mm	
MODE	SENS	BEAM	RESET

Easy Flow menu, CT EXP screen

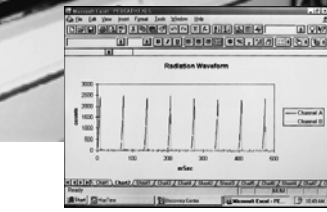
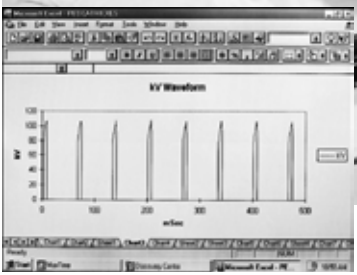
1.23 mR				
EXP	FLUORO	INTEG	HIGH	
MODE	CHAMBER	MODE	SENS	RESET

Easy Flow menu, EXP screen

6.2 R		HVL 3.76 mmAl	
		r = 1.000	
Please wait...			
HVL	CT	LOW	10 mm
MODE	CHAMBER	SENS	BEAM

Easy Flow menu, HVL screen

Pulsed fluoro/AMSE



NERO mAx operating modes

Radio mode Radio mode is used to make measurements on tungsten target, aluminum filtered radiographic x-ray generators

Selections are available for % kV peak for the type of generator being tested. For example, Zero Crossing, Single Phase Pulse, 75%, 80%, or 90% of kVp modes are available for accurate exposure measurements on difficult x-ray machines

Radio mode simultaneously measures:

- kVp Avg
- exposure
- kV Eff
- exposure time
- kV Peak
- mAs

Mammo mode Mammo mode is used to make measurements on mammographic x-ray generators

Mammo mode simultaneously measures:

- kVp Avg
- exposure
- kV Eff
- exposure time
- kV Peak
- mAs

Fluoro mode Fluoro mode is used to make measurements on fluoroscopic x-ray generators. Fluoro mode supports both continuous fluoro and pulsed fluoro measurements

In the continuous fluoro mode, the NERO mAx measures:

- kVp Avg
- exposure rate (R/min)
- kV Eff
- mA
- kV Peak

In the pulsed fluoro mode, the NERO mAx measures:

- kVp Avg
- exposure rate (R/min and mR/pulse)
- kV Eff
- mAs/pulse
- kV Peak

AMSE mode AMSE mode is used for Automated Measurement of Sequential Exposures. This mode is used to measure the output of CINE generators

In AMSE mode, the NERO mAx measures:

- kVp Avg
- exposure rate (mR/frame)
- kV Eff
- mAs/frame
- kV Peak
- time/frame (ms/frame)

CT Exposure mode CT Exposure mode is used to make CT exposure measurements using the Victoreen Model 6000-100 CT ion chamber. The CT probe must be connected to the NERO mAx detector's external ion chamber input in this mode

Exposure mode Exposure mode is used to make exposure and rate measurements using the NERO mAx's internal ion chamber or an external ion chamber

HVL mode In the HVL mode, the NERO mAx calculates half value layer based upon a series of exposure or rate measurements made with varying thicknesses of aluminum absorbers placed in the x-ray beam. A minimum of two exposures are required and up to ten exposures may be used

Calibrate mode Calibrate mode is used to enter and store calibration factors for ion chambers used with the NERO mAx

Setup mode Setup mode is used to setup various features of the NERO mAx. From the setup screen the user can set the instrument's parameters such as the real time clock, temperature and pressure

Unit ID Displays the NERO mAx's serial number, firmware part number and level

Specifications

Kilovoltage Measured during the first 480 ms of exposure

Measured quantity kVp Avg, kV Eff, kV Peak

Accuracy 0.5 kV or $\pm 1\%$

Reproducibility 0.5 kV or $\pm 1\%$

Range

Target/Filter	Range	Filtration
W/Al	30 - 60 kV	
	50 - 100 kV	
	80 - 160 kV	1.2 mm of Al
Mo/Mo	22 - 35 kV	30 μ of Mo
Mo/Rh	22 - 40 kV	25 μ of Rh
Mo/Al	22 - 49 kV	1 mm of Al
Rh/Rh	25 - 49 kV	25 μ of Rh
Rh/Al	25 - 49 kV	1 mm of Al
<i>All calibrations performed with NIST traceable calibration beam.</i>		

Analyze/Display cycle time

Radio & mammo 3 seconds for 0.1 second exposure, 1 second for each 32 ms of exposure time

Fluoro & AMSE 15 seconds for all exposures

Time

Radio mode Measured during entire exposure at 90, 80, 75% rise/fall of waveform, zero crossing, or pulse count

Mammo mode Measured during entire exposure at 90% rise/fall of waveform

Accuracy 1 ms

Resolution 0.1 ms

Range All diagnostic exposures from 1 ms to 60 seconds

Exposure & rate Measured during entire exposure with automatic energy, temperature, and pressure correction

Measured quantity Roentgens or Grays

Accuracy $\pm 5\%$

Reproducibility Radio and mammo modes: $\pm 2\%$ or 2 mR

Resolution 0.1 mR

Range All diagnostic exposure and rate measurements from 1 mR to 9999 R

Fluoro rate 0.1 R/min to 999 R/min

mAs and mA Measured invasively during entire exposure

Accuracy 2%

Reproducibility $\pm 1\%$ or 0.2 mAs

Range 0.1 mAs to 9999 mAs, 0 to 1000 mA

HVL

Accuracy $\pm 5\%$

Range 0.1 to 99.9 mmAl

Physical

Display Super bright 240 x 60 pixel, super twist LCD with cold cathode fluorescent backlight

Detectors Ion chamber and solid state (kV detectors)

Ion chamber volume 45 cc nominal

Window area/density 38 mg/cm² Polycarbonate

HVL set 2.30 mm, 1.0 mm, 0.3 mm Al

Power requirements 12 VDC 1 A external supply. Rechargeable internal batteries supply more than 4 hours of continuous service with overnight charge

Physical (cont)

Size Volume is 3960 in³ (0.065 m³)

Console 9.00 x 9.12 x 3.25 in (22.86 x 23.17 x 8.26 cm)

Detector 6.56 x 3.70 x 2.58 in (16.66 x 9.4 x 6.55 cm)

Filter cards 2.4 x 6.25 x 0.31 in (6.1 x 15.88 x 0.8 cm)

Weight

Shipping 23 lb (10.43 kg)

Console 4.56 lb (2.067 kg)

Detector (with card) 1.65 lb (0.747 kg)

Filter cards 2.9 and 3.2 oz (0.090 and 0.094 kg)

External chamber accessories

Radiographic Ion Chamber, 30 cm³ (Victoreen Model 6000-528): energy response: within 7% from 30 to 150 kVp (15 to 65 keV); cable: 15 ft (4.5 m); chamber dimensions: 4 x 4 x 0.54 in thick (10.2 x 10.2 x 1.4 cm)

Mammographic Ion Chamber, 3.3 cm³ (Victoreen Model 6000-529): energy response: within 5% from 0.2 to 5.0 mm Al HVL (16 to 90 kVp); cable: 15 ft (4.5 m); chamber dimensions: 4 cm \varnothing x 1.5 cm thick. This chamber meets the needs of the MQSA for an external transparent chamber. Option: Probe Holder (Model 6000-529-95) for BRH2 test stand

Image Intensifier Ion Chamber, 150 cm³ (Victoreen Model 6000-530B): energy response: $\pm 10\%$ from 1.8 to 10 mm Al HVL; cable: 10 ft (3.0 m); chamber dimensions: 6.26 x 8 x 0.63 in (15.9 x 20.6 x 1.6 cm)

Scatter Ion Chamber, 400 cm³ (Victoreen Model 6000-532B): energy response: $\pm 5\%$ from 32 to 662 keV; cable 10 ft (3.0 m); chamber dimensions: 6.26 x 8 x 0.63 in (15.9 x 20.6 x 1.6 cm)

CT Ion Chamber, 3.2 cm³ (Victoreen Models 6000-100 and 500-100): energy response: $\pm 5\%$ from 1 to 10 mm Al HVL; cable: 3 ft (0.9 m); sensitive length: 4 in (10.0 cm); chamber inside \varnothing : 0.25 in (6.4 mm)

CT High Sensitivity Ion Chamber, 10 cm³, for multislice CT (Victoreen Models 6000-200 and 500-200): energy response: $\pm 5\%$ from 1 to 10 mm Al HVL; cable: 3 ft (0.9 m); sensitive length: 4 in (10.0 cm); chamber inside \varnothing : 0.45 in (11.44 mm)

Optional accessories

Ultra-High Purity HVL Attenuators (Model 07-434): for mammo, set of 6

Available model(s)

8000 NERO mAx X-Ray Test Device, consists of a control console, detector, detector cable, two filter cards, mAs leads, Excel Add-in, HVL plates, instruction manual, and carrying case

Available AC adapters (specify with order)

Model	Description	Typical geo. region
14-328	110 V AC 12 VDC 1000 mA	USA, Japan
14-401	230 V AC 12 VDC 1000 mA	Europe
14-414	230 V AC 12 VDC 1000 mA	UK
14-414 and 14-416 adapter	230 V AC 12 VDC 1000 mA	Australia

CE Tested. Meets applicable standards.

For more information, receive our full product catalog, or order online, contact **Radiation Management Services** business of **Fluke Biomedical**: 440.248.9300 or www.flukebiomedical.com/rms.

Specifications are subject to change without notice.

©2005 Fluke Biomedical. All rights reserved. Victoreen and NERO are trademarks of Fluke Corporation. Printed in USA.
8000-ds rev 4 12 may 05