XSTRAHL 150 X-ray Therapy System

Technical Description

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1. X-ray Beam Specifications

The XSTRAHL 150 system uses a metal ceramic MXR 161 X-ray tube designed for medical applications.
The assembly consists of an end grounded metal ceramic X-ray tube of advanced design with an integral high voltage receptacle and cooling system. It is enclosed in a ray-proof housing with fittings for water hose connections.

X-ray Tube Output Limits:

Voltage	10 - 150 kV
Current	0 - 30 mA
Power	400 – 3000W for designated stability

X-ray Tube Specification:

Focal spot size	7.5 mm (largest dimension)
Target material	Tungsten
Inherent filtration	0.8 ± 0.1 mm Be
Tube power continuous max	3000W
Rating continuous max	160kV/19.0mA
Radiation coverage total	40°
Target angle	30°
Weight	8kg

Focal Spot Alignment
The alignment of the focal spot with the central axis of the applicator is within ± 0.5mm

Operating Energies
The XSTRAHL 150 system can have a HVL of up to 8.00 mm of aluminium.
The nine clinical filters are manufactured to customer specifications.

Summary of Half Value Layer Data

kV	30	40	50	80	100	120	120	140	150
HVL 1 (mm)	0.2 Al	0.5 Al	1.0 Al	2.0 Al	3.0 Al	4.0 Al	5.0 Al	8.0 Al	0.5 Cu
Added Filtration (mm)	0.10Al	0.40 Al	0.80 Al	1.70 Al	2.00 Al	0.90 Al 0.05 Cu	0.50 Al 0.10 Cu	1.15 Al 0.20Cu	1.00 Al 0.20 Cu

An example of HVL's used clinically on the XSTRAHL 150 system.

Percentage depth dose data is available upon request.

2. The Control Console

The XSTRAHL 150 X-ray control console is a TP1 microprocessor controller. The TP1 controller has a time based control system. Dual microprocessor architecture enables independent backup timer safety.

Beam Start up Characteristics
The TP1 controller increases the kV before the mA at the start of an exposure. The mA value does not increase until the kV is within 90% of the required value this eliminates any treatment “ramp up” errors.

Automatic Run up Procedure
In order to maximise the X-ray tube life two run up procedures are stored within the control system. The controller automatically displays the required run up procedure when the system is powered on.

Daily run-up	10kV per minute to max kV value from 100kV
Monthly run-up	2kV per minute to max kV value from 100kV

In an emergency the daily run up procedure can be bypassed.

Operating Modes
The TP1 controller has two modes of operation, a set-up (physics/engineering) mode and a treatment mode.

- Physics Mode

The physics/engineering mode is only accessible with a key.
In the physics/engineering mode data relating to the system settings, filters and applicators can be entered.
A maximum treatment time limit for all exposures can be specified; this will inhibit an exposure greater than the limit from being entered.

- Treatment Mode

Treatment mode allows clinical treatments to be prescribed and delivered.
In this mode the physics/engineering data can only be viewed.

Power Failure LCD Display
A complete treatment status report can be viewed on the LCD battery powered display in the event of a power failure.

Data Format
The controller data is available in an asci file format for export to a third party record and verify system.

3. The Time Control Mode

The TP1 Controller
The TP1 controller contains a dual channel (channel 1 and channel 2) monitoring system in accordance with IEC601-2-8.

1. Channel 1 is a timer and the treatment exposure is entered in decimal minutes up to a limit of 99.99. The decimal minute limit may be less depending on the maximum treatment time limit specified for the system. If the set time exceeds the configured maximum time limit the exposure will be inhibited.

2. Channel 2 is a backup timer, runs 0.02 decimal minutes behind the channel 1 timer.

Dose Rate Stability
The system continuously monitors the kV and mA actual values if these deviate by more than ±3% the system will automatically turn off.

- Reproducibility (as IEC 601-2-8)

The reproducibility of the time system for each energy is less than or equal to 1%.

- Reproducibility, dependence on equipment position (as IEC 601-2-8)

For any X-ray tube position the reproducibility of the time system is ± 2% or 1cGy, whichever is greater.

- Linearity (as IEC 601-2-8)

The linearity of time system is better than ± 1% or 1cGy whichever is greater.

4. Radiation Safety

Leakage Radiation
Leakage from the X-ray tube assembly complies with IEC601-2-8

<1m Gy h^{-1} averaged over 100cm^2

Safety Interlocks

Hardware Interlocks
Emergency Stop button
Treatment room door interlock
Filters are interlocked in the filter storage unit.
Confirmation of the filter and exposure is required before X-rays can be emitted.

Visual Interlocks
The following interlocks are visible on the TP1 controller screen.

Interlock	**Comment**
Filter Data	Defined by department
Treatment Time	Limited value entry
Backup Timer	0.02mins behind channel 1 timer, cumulative time of treatment
Tube Voltage	±3% interlock on actual kV
Tube Current	±3% interlock on actual mA
X-rays On	Only available once key is in the enable position
X-rays Ready	Only displayed when filter, applicator & exposure confirmed
X-ray warning lights	Lights and audible alarm signifying X-rays On

Other Interlocks

Interlock	**Comment**
Physics Key Interlock	Prevents unauthorised access to physics mode
Low Tube Coolant Flow	
Excess Tube Coolant Temperature	
Two filters removed	
No Filter Fitted	
Maximum Exposure Time Exceeded	User configurable
Un initialised Filter	
Backup Timer Termination	

5. Filters & Applicators

Filters
The XSTRAHL 150 system uses an encoding system to detect treatment filters within the filter storage unit. Each system can have up to ten filters, nine clinical filter and one “warm-up” filter. The warm-up filter is constructed of 2mm of lead. The nine clinical filters can be constructed in accordance with the half value layers defined by the department.
Each filter can be constructed from a maximum of three materials, up to a maximum physical thickness of 2mm.
Each filter has a unique place in the filter storage unit due to mechanical shaping of the storage unit and the filter holders.
The filter selection must be confirmed prior to treatment delivery.

Applicators
Applicators are manufactured from stainless steel or copper with a clear perspex-viewing end.
The applicator concentricity is ± 1mm.

The standard range of applicators supplied with the XSTRAHL 150, have the following aperture sizes and are supplied at two FSD’s:

15 cm FSD Open applicators

- 1.5 cm diameter
- 2 cm diameter
- 2.5cm diameter
- 3 cm diameter
- 4 cm diameter
- 5 cm diameter

25 cm FSD Open applicators

- 10 cm diameter
- 15 cm diameter

Additional applicators are available.

6. Treatment Head Movements

The XSTRAHL 150 X-ray tube can be mounted on a ceiling support system or a floor mounted support system. Each option is designed to be versatile, to allow accurate treatment positioning with minimal operator effort.

Movement Controls
The support system is fully counter balanced with tensator springs and counterweights,
Movement brakes are electro-magnetic. Manual axial rotational movements are controlled via a gearbox mechanism.

Power Failure Conditions
In the event of a power loss to the system, the vertical brake will remain on but the other brakes will release allowing the system to be moved safely away from the patient.
If the power is removed from the tube support system the brakes are applied, the degree of movement is less than 3mm.

Ceiling Mounted Support System

Degrees of Rotation:	
Tube assembly around telescopic column	180° ± 90°
Tube assembly tilt	100° (+40° to -60°)
Rotational positioning detents every	90°
Degree of rotation of tube assembly (axial)	270° ± 135°

Specifications for the Ceiling Mounted System	
Telescopic sections	4
Maximum weight supported	75kgs
Vertical travel	1500mm or 1800mm
Ceiling Rail to Focal spot	897mm minimum
X-ray beam centre to vertical column axis	380mm
Longitudinal rails	4400mm
Longitudinal travel	3600mm
Transverse rails	3000mm
Transverse travel	2280mm

Floor Mounted Support System

Degrees of Rotation	
Tube assembly around vertical column	180° ± 90°
Tube assembly tilt	100° (+40° to -60°)
Rotational positioning detents every	90°
Degree of rotation of tube assembly (axial)	270° ±135°

Specifications for the Floor Mounted System	
Maximum weight supported	36kgs
Vertical travel	1500mm max
Minimum distance tube axis to floor	500mm
Ceiling height for fixing of support rail	2.5 to 3m
Longitudinal rails	3000mm max
Longitudinal travel	2800mm max
Transverse travel	200mm max

7. The X-Ray Generator & Heat Exchange Equipment

The X-ray Generator
The XSTRAHL 150 system includes a CP 160, 3kW high voltage generator.

Specifications

Output Power	3200W maximum
Ripple	High frequency and line frequency total ripple envelope is 300 V pk to pk at full rated output
Voltage & Current Stability	short term – 0.05% / hour of set value long term – 0.1% / hour of set value
Voltage & Current Reproducibility	0.1%
Voltage & Current Accuracy	2% & 1%

Reproducibility and Linearity of the generator is assured by direct output measurement with independent mA and kV control circuitry.

Heat Exchange Equipment
There are two types of closed circuit water cooler that maybe used with the XSTRAHL 150 system.

1. A water to air cooler, the water is cooled via a heat exchanged / radiator system in which the water-cooling is assisted by a thermostatically controlled fan.

Electrical supply	230 volts ± 10%, 2.5A 1phase 50/60Hz.
Enclosure	Width 398 mm
	Length 479 mm
	Height 481 mm
Noise Level	55dBA (50hz)
	59dBA (60hz)

2. Water-cooled cooler whereby the water is cooled through a heat exchanger by a thermostatically controlled ‘lost water ‘ system or a hospital chilled water loop.

Electrical supply	230 volts ± 10%, 1.8A 1 phase 50/60Hz
Enclosure	Length 450 mm
	Width 270 mm
	Height 400 mm
Noise level	47dBA (50hz)

Systems should be mounted behind soundproof panels if they are to be housed in the treatment room and ventilation extraction supplied locally to cooler, if required.

8. Optional Features

The Patient Data System.

The Patient Data system provides a record of all treatments delivered on the XSTRAHL 150. The Patient Data system contains the following modules.

- System Administration

The Patient Data system can be configured with the department and hospital name, which will be printed on hardcopy records. The patient database can be stored on disk, archived or exported. The data can be exported into other windows based databases.

- Treatment Module

The Patient Data system is interlocked to the control system and requires filter, applicator and exposure to be confirmed before allowing X-rays to be emitted. Each treatment is recorded in the database under the patient's unique identification. All the patient's previous treatment fields can be viewed; details about the filter, applicator, exposure and the operator who administered the treatment are displayed. Previous treatment field settings can be copied to reduce the time required entering data for subsequent treatments. The operator must enter their initials before treatment delivery can commence.

- Print Options

Printouts of an individual treatment, a patient's course of treatment, a daily system log or full system log can be acquired. All reports can be previewed electronically prior to printing or be saved on the hard disk.