

# Equipment Specifications for Linear Accelerator High Energy

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UNSPSC Code:

ECRI Code:

## 1 Description of Function

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|-----|---|--|--|
| 1.1 | Dual Energy Medical linacs utilise photons of 6 MV and 15MV & electron beams from 4-20MeV to treat both benign and malignant disease. |  |  |
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## 2 Operational Requirements

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| 2.1 | High Energy Linear Accelerator complete with Treatment Planning System and Working Consoles is required. |  |  |
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## 3 Technical Specifications

### 3.1 A.STANDARD EQUIPMENT

1. **Photon Energy:**6 MV for Low Energy and 15 MeV and above for High Energy

2. **Electron Energy:**6 Beam energies between 4-20 MeV.

3. **RF Source:**Magnetron / Klystron

4. **Waveguide Type:** Standing / Travelling wave

5. **Electron Gun:** Sealed / Unsealed

6. **Treatment Modes** Normal - TSD / TAD

Rotation - CW / CCW

ARC - CW / CCW

Dose rate - MU/degree

7. **Dose-Rate for Photon energy:** 200 MU/min and above in steps or higher dose rates for both photon beams

8. **Dose-Rate for electron energy:** 100-1000 MU/min in steps or higher dose rates.

9. **Field Size(Unclipped)**

For Photons:Max- 35 x 35 cm<sup>2</sup> or more Min - 1 x 1 cm<sup>2</sup>

Penumbra 10mm for 10 x 10 cm<sup>2</sup> field at 10 cm depth

10. **Field Size(Unclipped)**

For Electrons:Max - 25 x 25 cm<sup>2</sup> or more;Min - 4 x 4 cm<sup>2</sup>

A method to obtain irregular field shapes shall be provided

11. **Beam Flatness( PHOTONS)** Variation of x-ray intensity relative to the central axis shall not exceed  $\pm 4$  % over central 80% of radial and transverse axes for photons field sizes 10 x 10 cm<sup>2</sup> to 40x40 cm<sup>2</sup> at 10 cm depth

12. **Beam Flatness( Electrons)** Variation of electron intensity relative to the central axis shall not exceed  $\pm 5$  % over central 80% of radial and transverse axes for photons field sizes 10 x 10 cm<sup>2</sup> to 40x40 cm<sup>2</sup> at 10 cm depth

13. **Focal Spot size**

14. **Photon Arc Therapy** Bi-directional arc therapy should be included with Automatic calculation of Dose per Degree based on the Dose Rate selected and the Arc angle set

15. **Beam Symmetry** The maximum percent difference of average doses shall not exceed  $\pm 2\%$  for Electrons and  $\pm 3\%$  for Photons

16. **Gantry Rotation**  $\pm 180^\circ$  (360° total)

- a) Read out - Digital and Mechanical
- b) Accuracy dig-readout  $0.5^\circ$
- c) Control - Hand pendent and control-console
- d) Target - Axis Distance. -  $100 \pm 0.2$  cm
- e) ODI Range- 75 cm to 150 cm
- f) ODI Accuracy  $\pm 0.1$  cm
- g) Gantry Rotation Isocentre  $\pm 2$  mm dia. Sphere
- h) No Beam-stopper

17. **Collimator:** Rotation -  $\pm 95^\circ$  about mid position

Control - Hand pendent and control- console

Readout accuracy -  $\pm 0.5^\circ$

Collimator Rotation Isocentre  $\pm 2$  mm dia. Sphere

Dynamic Wedge/motorized wedge.

18. **Asymmetric Collimators** X & Y both Asymmetrical  
Specify travel ranges & over travel range.

19. **Multi-leaf collimator** (MLC) No. of Physical Leaves- 50 and above,

- a) Independent drives
- b) Leaf width at isocentre  $\leq 10$  mm
- c) Capable of performing Dynamic Conformal therapy procedures. Interface between MLC & Existing Network System should be provided.
- d) Facility to treat patients conventionally, using blocks without MLC.
- e) Work Station HW/SW – Specify details
- f) Integration (full Networking) with Planning System, Simulator, CT, CT Simulator, MRI & RFA should be done.
- g) IMRT delivery should be possible.
- h) Max. leaf retracting position
- i) High over center travel of MLC leaves ( $> 10$  cm) for IMRT treatments.
- j) Max. field length
- k) Leaf height & material
- l) Coincidence of light & x-ray field
- m) Penumbra
- n) Transmission
- o) Interleaf leakage
- p) Leaf position accuracy
- q) Max. carriage speed
- r) Max. leaf speed
- s) Positional accuracy of the leaves during treatment.
- t) Inter-digitation of leaves if available
- u) Two nos. of treatment parameter monitors 21" TFT to be provided.

20. **Treatment Couch:**

1. Versatile extended range couch with indexed immobilization Movements:
2. Longitudinal, Lateral, Vertical and Rotation
3. Electrical / Mechanical Control
4. Control-Local and/or Remote
5. Opening window - Tennis Racket / Mylar

6. Fully Carbon Fiber table top for better Quality Portal Images.
7. Minimum height from floor –app 60-65

## 21. Treatment Planning System

1. The TPS software shall run on a very powerful, graphics intensive computer system with adequate, latest backup technology. The system shall have high capacity hard disks and a DVD writer.
2. Capable of performing conventional, 3D-CRT and as well as intensity modulated radiotherapy (IMRT) treatment planning for coplanar and non-coplanar beams in the same system.
3. Supports multiple dose calculation algorithms such as anisotropic analytical algorithm, **convolutional algorithm & pencil beam algorithm**, Monte-Carlo etc
4. At least two calculation algorithms for photons and two for electron beams shall be quoted.
5. Virtual simulation using the software and licenses for virtual simulation feature and for controlling moving lasers shall be provided.
6. DICOM READY Image Networking
7. **Two** workstations enabling simultaneous contouring with licenses & additional **two treatment planning workstations with calculation licenses** should be provided.

### Software Specifications for IMRT :

#### A. Beam Data

1. Dosimetric data for IMRT fields must be transferred from RFA.
2. Conventional standard beam data for electrons and photons must be stored and modification of it for IMRT and conformal treatment must be done.

#### B. Patient anatomical data transfer :

1. The patient data must be transferred from CT/MRI, Simulator (in the form of fluoroscopic image and CT/MRI slices) via DICOM, CD & DVD's.
2. Data from CT/MRI slices must be transferred via film scanner, digitizer & direct from CT/MRI Scanners, Simulators & RFA.
3. The system must select more than or equal to 100 images per patient and to do real time multi-planer reconstructions from original CT/MRI image data sets.
4. The system must have autocontouring of external and internal organs from CT/MRI images either taken from CT/MRI film or via other mode of data transfer as mentioned above.

#### C. Planning :

1. **Geometric Planning:** System must have auto contouring of organs. After dose prescription and fractionation scheme system must create geometric treatment plan with 3-D visualization and virtual simulation.
2. **Dose optimization:** System should have provision to generate the treatment plans from templates that satisfy the organ dose constraints. Following steps should be taken :
  - 1) Define dose volume constraints
  - 2) Set optimization parameters.
  - 3) Evaluate optimization.
3. **Dose Calculation:** System should be able to provide dynamic/Step and shoot IMRT treatment planning & licenses for Fluence map to be exported on DICOM-RT format. **The necessary interfaces for transfer of treatment plans to**

**any Linear Accelerator** should be provided. The final dose distribution is calculated as per selected dose delivery technique.

4. **Plan, Review & Evaluation:** It must provide 3-D dose visualization and differential & cumulative DVH analysis tools to review the plan.
5. **Plan Export:** The IMRT plans can be exported directly after approval to linear accelerator for dose delivery.

D.: The **inverse planning system** should be complete in all respects and be able to perform static/ dynamic MLC plans. The system should be able to generate multiple plans for selection. The accuracy of forward dose calculation using intensity modulated beams should be less than 2%. The IMRT planning and treatment should be based on step & shoot and /or sliding window MLC techniques as per the user's choice.

The total time for inverse planning should be less than 20 minutes.

A complete QA kit for the system must be supplied. Necessary software for linking RFA to the planning system must be supplied.

## **22. Oncology Information System complete with Networking**

Record & Verify System

Transfer of all parameters from Simulator & Treatment Planning System, Cadplan to the Accelerator for Automatic treatment setup & delivery should be provided.

Transfer of Fluoroscopy images from Simulator to Portal Imaging System for Comparison should be provided.

Transfer & Execution of MLC Position Parameters for normal treatment & IMRT treatment including step & shoot & Sliding Window (Dynamic) techniques from Treatment Planning System should be provided.

Should be Networked with Existing Network System all required interfaces should be provided.

## **23. Accessories:**

1. Wedges – Stationary 15°,30°,45° and 60° wedge Angle
2. Front pointer - mechanical
3. Accessory mount - shadow block tray
4. Blocks – divergent / non-divergent
  
5. Universal Clamps
  
6. Side Rails on both sides of Couch for Mounting Accessories.
  
7. CCTV / Camera Two Nos. One wide angle & one remote control with remote zoom & focus facility.
  
8. In-Room Colour Monitor 20" or higher
9. Laser Alignment System (4 cross laser system)
10. Interface Mount to be provided for the Simulator to simulate accessories like Shadow Block Tray etc. of the quoted Accelerator model.

**24. Dosimetry System (Photons) :**Built-in chambers. Two separate sealed chambers

Precision  $\pm 1\%$  or 1 MU

Linearity  $\pm 1\%$  or 1 MU

Reproducibility  $\pm 2\%$  or 1 MU

Dose Rate Dependence

**B. Portal Imaging & Dosimetry Accessories**

1. **Portal Imaging** : Should fully integrate with Accelerator  
Should be able to take images at any Gantry angles with variable X-Y-Z movements, Robotics Arm with remote control.

Should have Digital technology with High Resolution **1024 x 1024 pixels or more Imaging (Amorphous Silicon Flat Panel Based Technology).**

2. **Auto Field Sequencing**

3. **Dosimetry Accessories:**

1. **3D Servo controlled** Radiation Field Analyzer (RFA) Having compact Water Phantom of minimum dimensions **60 X 60 X 60 cms or more** with reservoir, Buildup Caps, TNC Connectors, & Latest PC control System with TPS interface Program
2. dual channel electrometer
3. ionization Chambers (Signal, Reference & Pinpoint)
4. Diode detectors (Photons, Electrons & Stereotactic)
5. Parallel Plate Chambers
6. 2D Arrays of either semiconductor/ionization based dosimetry system for measurement of Fluence alongwith computer hardware and software.
7. **Solid water phantom- universal tissue equivalent along with necessary adaptors for the chamber, of size 30 x 30 x 30 cms should be provided.**

4. **Stereotactic Treatment System** including frames, table attachments, micro MLC, TPS & other required accessories. **(Optional and quote separately)**

**4 System Configuration Accessories, spares and consumables**

4.1	System as specified		
4.2	All consumables required for installation and standardization of system to be given free of cost.		
4.3	The Chiller system shall be provided along with the machine by the principals.		
4.4	A closed-circuit color TV system with TV monitors and two cameras in the linac treatment room shall be supplied. A patient calling system with 6 channels shall be supplied. Internet broad band connectivity for remote servicing shall be provided. A LCD Projector should be supplied.		
4.5	<b>Patient Immobilization Accessories</b>		
4.5.1	Standard supine base plate (head & neck)	2	sets
4.5.2	Lateral base plate	2	sets
4.5.3	Head and neck prone base plate (adjustable)	2	sets
4.5.4	Head & neck supports A ,B,C,D, & E.	3	sets
4.5.5	Knee crutch and arm position with hand grip	2	sets
4.5.6	Overhead arm positioner	3	
4.5.7	Shoulder retractor	4	
4.5.8	Universal tissue equivalent bolus30X30X0.5 cms	10	

## 5 Environmental factors

5.1	Complete installation should include: 1.Room Planning and designing and construction. Space requirements to be spelt out in advance. 2. Electrical Requirements to be specified and substation to be made. 3. All AERB Clearances and Environmental clearances to be arranged with local authorities. Institute will provide all the documentations. 4. Cooling water temperature, flow and pressure monitoring to be installed. 5. Air Conditioning and monitoring of Temperature;Relative Humidity and Air changes (To specify no. per hour) to be installed.		
5.2	The unit shall be capable of being stored continuously in ambient temperature of 0-50deg C and relative humidity of 15-90%		
5.3	The unit shall be capable of operating in ambient temperature of 20-30 deg C and relative humidity of less than 70%		
5.4	Shall meet IEC-60601-1-2:2001(Or Equivalent BIS) General Requirements of Safety for Electromagnetic Compatibility. or should comply with 89/366/EEC; EMC-directive.		

## 6 Power Supply

6.1	Should work on three phase 400-440 V / 50 Hz Power		
6.2	UPS of suitable rating with voltage regulation and spike protection for <b>60 minutes</b> back up <b>for whole Linear Accelerator Systems.</b>		
6.3	Resettable overcurrent breaker shall be fitted for protection		

## 7 Standards, Safety and Training

7.1	Leakage Radiation Safety: 1.X-ray absorbed dose due to leakage radiation (excluding neutrons) outside useful beam but inside a plane circular area of radius 2 m centered around and perpendicular to central axis at normal treatment distance. As per International Specifications (ICRP No 33) 2.Collimator transmission: As per International Specifications (ICRP No 33) 3.Neutron dose Inside the treatment area and Outside the treatment area:As per International Specifications (ICRP No 33)		
7.2	Comprehensive warranty for 5 years and 5 years CMC after warranty period.		
7.3	Warranty for 5 years for the entire Linac with accessories, UPS & Chiller including the following major components such as: Accelerator Guide including Target, Bending Magnet, Electron Gun, Vacuum Pumps, RF Source -Magnetron/Klystron.		
7.4	Shall comply with AERB guidelines & type approved.		
7.5	Should be FDA , CE,UL or BIS approved product		
7.6	Training to be imparted on the equipments as follows: 1.For two oncologists and one Physicist for one week on applications in a developed facility where the Linac is being extensively used. 2. One Biomedical Engineer to be trained in the factory on Preventive and Corrective Maintenance for one week. 3. One department technician to be trained on operating procedures on the system for one week. In all the cases certificates has to be provided to the trained persons and a copy to be attached while claiming balance payment.		

## 8 Documentation

8.1	User/Technical/Maintenance manuals to be supplied in English.		
8.2	Certificate of calibration and inspection.		
8.3	List of Equipments available for providing calibration and routine Preventive Maintenance Support. as per manufacturer documentation in service/technical manual.		
8.4	List of important spare parts and accessories with their part number and costing.		
8.5	Log book with instruction for daily, weekly, monthly and quarterly maintenance checklist. The job description of the hospital technician and company service engineer should be clearly spelt out		
8.6	Additional Documents to be enclosed with Quotation: 1.No. of similar models: India / World (enclose list of institutions) 2.No. of certified engineers in India (enclose list of names) 3.Remote Diagnosis Facility (India / Abroad) availability details.		