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Sub.: Procurement of Radiotherapy Equipment for Lady Hardinge Medical College & Hospital, New Delhi.

Final Amended Technical Specifications

Schedule 1: Technical Specification for a High-Energy Linear Accelerator

Sealed tenders (sealed separately as the "Technical Bid & the Price Bid-in duplicate) are invited directly from the manufacturers/principles for the supply of a state-of the-art **with latest platform** clinical Radiotherapy Linear Accelerator capable of producing 6MV and 15 MV dual photon energy for the routine and specialized treatment techniques. Linear Accelerator must have the latest **Flattening Filter Free (FFF) linear accelerator technology** and should be fully computer controlled with the latest state-of-art control system. The Linear accelerator system includes Medical Linear accelerator, Treatment Planning System, Record and Verification System. It should be capable of interfacing/integrating with standard networking and PACS systems available in the market. The offered equipment should have the following technical features.

1.0 Linear Accelerator

An Advanced, new generation of high-energy medical linear accelerator should be equipped with a multileaf collimator (MLC) and an electronic portal imaging device (EPID) and kV-cone-beam CT (CBCT) to perform conformal treatment techniques such as three dimensional conformal radiotherapy (3D-CRT), intensity modulated radiation therapy (IMRT), **VIMAT (Volumetric Intensity Modulated Arc Therapy)** and image-guided radiotherapy (IGRT) and **Flattening Filter Free (FFF) technology** through record and verification system. The system should have the capability for future upgradation in order to perform advanced treatments of stereotactic radiosurgery and radiotherapy (SRS/SRT), 4D-Radiotherapy and Adaptive Radiotherapy.

2.0 Photon Beam Characteristics

2.1 **Beam Energies**

The accelerator shall be capable of producing two clinically useful photon beams with energies of 15 MV as high energy and 6 MV as low energy.

2.2 **Dose Rate and Beam Stability**

2.2.1 The maximum dose rate for routine clinical applications shall equal at least **500** monitor units (MU)/min or more for **6MV & 600 MU/min for 15MV** for a 10 x 10 cm field at the depth of maximum buildup at a TSD of 100 cm for both photon beams. **Flattening filter free beams of minimum two energies (6MV and 10MV) shall be 1200 MU/min or more.**

2.2.2 Specify the maximum dose rate and number of intermediate dose rate available in the offered linac model

2.2.3 Specify the beam stability time in milliseconds.

2.3 **Field Size Specifications**

The field size is defined as the distance along the radial and transverse axes between the points of 50% density on an x-ray film taken at 100 cm TSD with minimum buildup. The digital display, light field size and mechanical display should be accurate to within $\pm$ 2 mm.

2.3.1 The accelerator shall provide a continuously variable rectangular, unclipped field size from 1 x 1 cm to 35 x 35 cm at 100 cm SSD. The maximum clipped field size should equal or exceed 40 x 40 cm at 100 cm SSD. Clipped corners are unacceptable for fields smaller than 35 x 35 cm.

2.3.2 A detachable block holder should be provided to accommodate 2 trays simultaneously for wedges and block trays. The size of the blocking trays should be at least 5 cm larger than the maximum field size at the lower position. Specify location and size of blocking trays.

2.3.3 Asymmetrical collimation for two sets of jaws shall be provided. One set of jaws shall be capable of crossing the center line by at least 10 cm as projected at 100 cm TSD. The collimators shall re-center automatically when the symmetrical mode of operation is re-selected.

2.4 **Beam Profile**

2.4.1 **Field Flatness Specification**

Variation of x-ray intensity relative to the central axis shall not exceed $\pm$ 4% at 100 cm SSD and 10 cm depth over the central 80% of the field for the longitudinal and transverse axes of all field sizes from 10 x 10 cm to 40 x 40 cm. State the maximum variations for the above field sizes at each energy.

2.4.2 **Field Symmetry Specifications**

The maximum percent differences of average doses shall not exceed $\pm$ 3.0% for the longitudinal and transverse halves of the field at 100 cm TSD and 10 cm depth, at gantry angles of 0, 90, 180 and 270 degrees. Field sizes shall be specified as 10 x 10 cm and 40 x 40 cm. Average dose is defined as the arithmetic average of minimum and maximum doses within the central 80% of the field for both axes.

2.4.3 **Radiation Field Penumbra**:

The width between the 20% and the 80% isodose lines measured for 10 X 10 cm^2 at depth of 10 cm at 100 cm SSD should not be more than 10mm. Specify the penumbra width.

2.5 **Beam Quality Index:**

The ratio of ionization measured at 20 cm and 10cm depth for a field size 10 X 10 cm2 at the detector level and with constant detector source distance = 100cm should be as given below:

Photon beam energy (MV)	Quality Index (QI)
6 MV	Specify
15 MV	Specify

2.6 **Radiation Leakage**

Radiation leakage limits shall be within appropriate regulatory agency guidelines as follows:

2.6.1 Photon leakage. The photon leakage rate at any point one meter from the target outside the cone defined by the primary x-ray collimator shall be less than 0.1% of the absorbed dose at the isocenter.

2.6.2 Collimator transmission. The movable collimators shall not permit transmission of radiation exceeding 0.5% of the central axis dose at Dmax measured in air for both photon energies.

2.6.3 Neutron leakage. The neutron leakage rate should not exceed 0.2% expressed in neutron dose equivalent (Sivert) when added to the photon leakage for a 10 x 10 cm field at the isocenter at any point one meter from the target when the jaws are closed.

2.6.4 In addition to meeting above specifications for radiation leakage, the linac should also meet all the mandatory safety and radiation leakage regulations as specified by Atomic Energy Regulatory Board (AERB), Mumbai, India for a medical linear accelerator.

2.7 **Rotational/ Arc Therapy**

2.7.1 The Linac must have photon arc therapy feature with gantry rotation in clockwise and counter clockwise directions.

2.7.2 The dose rate/range of dose rate should be specified MU per degree. The MU/degree shall automatically be computed.

2.7.3 A range of continuously variable dose rate should be available. A unit able to deliver high dose per degree will be preferred

2.8 **Maximal Dose**

For TBI procedures, maximum dose up should be specified for a single field

2.9 **Congruence Between Optical and Radiation Field:**

The congruence between optical and radiation fields for 5x5 cm^2, 10 cm x10 cm at 0, 90,180 and 270 degree gantry angles with SSD = 100 cm should be within 2 mm along X,Y axes.

3.0 Electron Beam Characteristics

3.1 **Electron Beam Energies**

Five clinically useful electron beam energies shall be provided. The lowest energy shall be 4 or 6 MeV and the highest energy shall be 15 MeV/16 MeV or above. Energy shall be specified as the most probable energy (E_p) of the electron energy spectrum at 100 cm from the accelerator exit window.

3.2 **Dose Rate**

The dose rate at the isocenter shall not be less than **600 MU/minute** for each electron energy.

3.3 **Field Size**

The electron beam size is defined by the inside dimensions of the electron beam applicators projected geometrically to a plane surface at 100 cm SSD. A range of field sizes from 4 x 4 cm to 25 x 25 cm is required. A method to obtain irregular field shapes shall be provided.

3.3.1 It shall be possible to visualize both the field defining light and the optical distance indicator with an electron applicator in place.

3.4 **Beam Profile**

3.4.1 Field Flatness

The maximum percent variation of the electron intensity at 100 cm SSD at D_{max} shall not exceed 5% (within the central 80% of the longitudinal and transverse axes relative to the central axis) for field sizes from 10 x 10 cm to 25 x 25 cm and for all the electron beam energies.

3.4.2 Beam Symmetry

The maximum percent variation in the average electron intensity to the longitudinal and transverse halves of the electron field at D_{max} for a 10 x 10 and 25 x 25 cm field at 100 cm SSD shall not exceed $\pm$ 2% at gantry angles of 0, 90, 180 and 270 degrees.

The average electron intensity is the average of the maximum and minimum points within the central 80% of the field for each of the axes.

3.5 **X-ray Contamination**

The x-ray contamination of the electron beam shall be less than 5% of the maximum dose for all energies specified previously.

3.6 **Deleted**

4. Accelerator System

4.1 The system must provide with either Magnetron or Klystron as the radiofrequency (RF) micro power source. The warranty should be at least for 5years. (Pro-rata guarantee is not acceptable).

4.2 Standing or travelling type of wave-guide along with the bending magnet, target assembly, vacuum ion-pump should be offered a warranty of 5 years. (Pro-rata guarantee is not acceptable).

4.3 Specify the target type and materials and also flattening filter materials in details

4.4 Electron gun should have warranty of minimum 5 years and the beam focal spot should be within 3 mm diameter.

5. Dose Monitoring System

5.1 Sealed/**Unsealed** type of dose monitoring chambers must be provided and should operate independent of ambient temperature and pressure. All dosimetry, patient and unit safety related interlocks must be sensed and controlled by hardware and software

5.2 The equipment shall provide two independent dose monitoring systems for primary and secondary dose monitoring as well dose distribution monitoring

5.3 The dose monitoring systems shall monitor the beam energy and shall terminate irradiation when the change of beam energy greater than ±3% of the nominal energy.

5.4 Provision of a controlling timer to protect against failure of dose monitoring systems shall comply with the requirements in accordance with respective IEC norms.

5.5 The reproducibility tolerance for the dose monitoring system shall be better than 1% or 1 MU.

5.6 The linearity tolerance of accumulated doses from 10 to 1000 MU for the dose monitoring system shall be ± 1% or 1 MU. Specify the linearity tolerance for less than 10MU in view of IMRT

5.7 The reproducibility tolerance at any gantry angles for the dose monitoring system shall be better than ± 1% or 1 MU.

6. Mechanical Features

6.1 Gantry

6.1.1 Gantry shall be motorized by local and remote controls. Automatic setup facility and in-room display of treatment parameters shall be provided.
6.1.2 The total range of gantry rotation shall not be less than 360°
6.1.3 Resolution and accuracy of digital readout shall be 0.1° and ± 0.5° or better
6.1.4 Resolution and accuracy of analog readout shall be 1° and ± 1° or better

6.2 Collimator

6.2.1 Collimator shall be motorized by local and remote controls
6.2.2 The cross-wire wander (rotation) shall not exceed 1mm diameter
6.2.3 The total range of collimator rotation shall not be less than ± 165°
6.2.4 Resolution and accuracy of digital readout shall be 0.1° and ± 0.5° or better
6.2.5 Resolution and accuracy of analog readout shall be 1° and ± 1° or better

6.3. Diaphragm (Jaws)

6.3.1 Each diaphragm shall be independently motorized by local and remote controls
6.3.2 One pair of diaphragm shall be traveled up to at least -10cm crossover the central axis in order to simulate the asymmetrical and offset fields.
6.3.3 Resolution and accuracy of digital readout shall be 1 mm and ± 1mm or better
6.3.4 Maximum angular deviation between the axes of opposing diaphragms shall be stated.

6.4 Multileaf Collimator

6.4.1 **The MLC System shall have all leaves of 5mm resolution or combination of 5mm or less and 10mm set to have maximum field size of 40 x 40 cm^2.**
6.4.2 **Deleted.**
6.4.3 Multileaf speed together with maximum possible dose rate for dynamic radiotherapy shall be stated
6.4.4 Maximum range of leaf speed and extension between leaves shall be stated.
6.4.5 Accuracy and repeatability of leaf position shall be within ± 1mm or better. Accuracy of leaf alignment perpendicular to leaf movement about isocenter shall be within 1mm or better.

6.4.6 Radiation parameters such as leaf penumbra, leaf transmission, inter-leaf transmission and coincidence of radiation field vs optical field shall be stated.

6.4.7 The MLC system shall incorporate a fast and efficient QA tools (compliance of AAPM-TG-50 guidelines) for checking and monitoring all leaves position in real time. Deviations from leaves position calibration shall be interlocked to prevent treatment.

6.4.8 Clearance from bottom of collimator to isocenter shall be specified.

6.4.9 Provision of treatment verification and record system with the necessary interface for static and dynamic operation of MLC prior to treatment delivery.

6.5 Treatment Table/Couch

6.5.1 Vendor shall provide the treatment couch and accessories used for accurate image guided radiation therapy.

6.5.2 Indexed carbon fiber tabletop shall be provided.

6.5.3 The tabletop shall comply with the deflection requirement of IEC norm.

6.5.4 Lifting capacity shall be at least 200kg

6.5.5 IEC scale convention shall be provided.

6.5.6 Treatment tabletop shall be capable of free manual movement in both lateral & longitudinal directions

6.5.7 Lateral & longitudinal couch displacement shall not exceed 1mm under braked condition

6.5.8 Range of vertical, longitudinal and lateral movement shall be stated

6.5.9 Range and accuracy of isocentric rotation shall be stated.

6.5.10 Vendor shall specify the accuracy of isocentric rotation angle.

6.5.11 Mechanical isocenter accuracy for couch rotation shall not 1mm radius sphere

6.5.12 Vendor shall specify the accuracy of couch rotation isocenter

6.5.13 Vendor shall specify the coincidence of couch isocenter with gantry and collimator isocenter.

6.5.14 Vendor shall provide any auto-setup / remote control couch motions capability

6.5.15 Precision of digital couch rotation readout +/- 0° or accuracy of digital couch rotation readout +/- 1 ° or better.

6.5.16 Precision of digital couch vertical, longitudinal and lateral position readout shall be +/- 1mm or better, accuracy of digital couch vertical, longitudinal and lateral position +/- 2mm or better.

6.5.17 Vendor is required to facilitate with all available accessories, inter-changeable tabletop materials, removable parts for treatment. Provision of patient immobilization accessories, preferably with indexing capability compatible with the couch. Detailed list of all accessories shall be stated and provided.

6.5.18 Emergency down drive shall be provided to remove the patient in the case of power failure.

6.5.19 Two extra spare control pendants shall be provided

6.6 Electronic Portal Imaging System

6.6.1 The imager shall utilize amorphous silicon (a-Si) with higher resolution shall be provided

6.6.2 Vendor shall specify the maximum image field size at isocenter and at other distance achievable with a single exposure for the detector panel.

6.6.3 Specify details of all movements and positional accuracy of the imager.

6.6.4 Specify the details of pixel depth pitch of the imager.

6.6.5 Maximum image acquisition rate and minimum MU for full image resolution shall be stated

6.6.6 Spatial resolution (lp/mm) shall be stated if test object position is at isocenter and at detector

6.6.7 Accuracy of imager centre to beam isocenter shall be stated.

6.6.8 The EPID shall provide a suitable means to import & export images for verification and display on the same workstations; to acquire & transfer images through the existing oncology network; and to be capable of registration

6.6.9 Vendor shall provide features on image processing, image display, image analysis, image storage, image print and image enlargement. Details shall be stated.

6.6.10 Avoidance of irradiation of area outside sensitive detector panel and anti-collision device, vendor shall state and provide details including the usable life span of the EPID.

6.6.11 Vendor shall provide all accessories including necessary QA tools, maintenance tools etc. for EPID.

6.6.12 Provision of facilities for storage *I* archival of electronic portal images

6.6.13 Portal images can be exported to external facilities in a recognized format including BMP and TIFF.

6.6.14. Vendor state and provide any value-added features such as IMRT portal dosimetry and verification system of EPID (**it must be quoted as optional items separately**).

6.7 Patient Alignment system

6.7.1 Vendor is required to supply and install 4 sets green laser alignment systems. A separate back pointer laser alignment system shall be provided and installed onto

the linear accelerator on offer. All laser products shall comply with respective code of IEC safety of laser products.

6.7.2 Two spare sets of green lasers shall be provided.

6.7.3 Each laser beam shall be precisely adjustable vertically and horizontally by remote control to indicate the isocenter position within 1 mm and protected against accidental displacement

6.7.4 System should have 0.5mm line thickness at isocenter for patient alignment and set-up

6.8 Control Console and Treatment room display features

6.8.1 **Main control console:**

A computerized control console shall be located outside the treatment room. This console shall provide controls that must be activated in order for the accelerator to become operational in any of its various modes of operation and also provide displays of accelerator parameters. The following shall be present:

6.8.1.1 **Power Off**: Turns off all electrical power, including power to the computer, except for that power needed to maintain the accelerator in a "Stand By" condition

6.8.1.2 **Power On***:* Turns on electric power to the accelerator

6.8.1.3 **Total Dose:** Sets the desired total dose for patient's treatment

6.8.1.4 **Time:** Sets time for patient's treatment. Time shall be used as a back up in case of failure of total dose interlock. Backup time shall be calculated automatically with provision for manual reset.

6.8.1.5 **MU/Degrees:** Sets the desired MU/degree for rotational therapy. MU/degree shall be calculated automatically with provision for manual reset.

6.8.1.6 **Mode Selection:** Selects x-rays or electrons for treatment

6.8.1.7 **X-Ray Energy:** Selects photon beam energy

6.8.1.8 **Radiation On:** Turns on accelerator and radiation is produced

6.8.1.9 **Interrupt:** Immediately stops treatment.

6.8.1.10 **Treatment Complete***:* Indicates that desired dose has been delivered. In addition, the operator should be alerted if radiation terminates for any reason other than reaching the set integrated dose. In such cases, the dose remaining to be given shall be indicated

6.8.1.11 **Arc Therapy:** Enables the accelerator to perform arc therapy

6.8.1.12 **Wedge:** Requires that the presence, identification and orientation of a wedge must be confirmed at the control console.

6.8.1.13 **Port Film:** Opens jaws completely or partially, as selected by the operator, and limits the amount of radiation to be delivered to less than or equal to 20 cGy. This shall be operational in both the photon and electron modes but

allow only the production of low energy photons. Once the port film has been completed, it should be possible to return the collimators to their original setting automatically.

6.8.1.14 **Special Procedures:** Prohibits accidental selection of procedures such as electron arcs or high dose rate electron irradiation by providing an "extra step" in selection procedure

6.8.2 Control Console Display/Monitors:

The following monitors and displays should be available at the control console, and with the exception of a back-up dose counter, it should be possible continuously to visually observe the value being registered on these counters and displays from the position of the operator.

6.8.2.1 **Dose Rate Indicator:** Indicates the dose rate at maximum build-up for a 10 x 10 cm field at 100 cm SSD.

6.8.2.2 **Dose Counters***:* Two counters that count integral dose detected by each of the two dosimeters

6.8.2.3 **Total Time Counter:** Counts total treatment time in 0.01-minute increments up to 9.99 minutes.

6.8.2.4 **Angle***:* Indicates position of gantry in degrees with precision of ± 0.5 degrees

6.8.2.5 **Symmetry:** Indicates beam symmetry in both major axes

6.8.4 It should be possible to adjust the parameters at or near the control console:

6.8.5 **Accelerator Parameter Checks: I**t shall be possible to monitor different accelerator parameters via an oscilloscope at or near the control console.

6.8.6 **Treatment room pendent:**

Hand pendants shall be provided. The hand pendent must have the control of gantry rotation, collimator rotation, collimator jaw settings, treatment couch motions (vertical lateral, longitudinal and turntable rotation around isocentre and room light control. To prevent possible malfunctioning, when hand pendant is in operation, the computer system must prevent conflicting signals from being sent to the same mechanical device.

6.9 Essential Accessories

6.9.1 **Shielding Blocks and Shadow Tray**

An accessory set of pre-shaped, screw-on blocks and shadow trays shall be delivered with the machine. At least 10 shadow blocks, of at least 5 HVL, shall be included. A detachable accessory mount is highly preferable.

6.9.2 **SSD indicator**

A optical distance indicator (ODI) of SSD from 80cm to 130 cm with accuracy of ±1 mm at isocentre should be provided.

6.9.3 **Front and Side pointers**

A mechanical front pointer to locate isocentre of the unit within ±2mm and to apply to any orientation of the machine shall be provided

6.9.4 **A closed-circuit color TV system** with TV monitors and two cameras in the linac treatment room shall be supplied.

6.9.5 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.

6.9.6 **Field Illuminating light:** A field illuminating system should be provided for both photon and electron modes.

6.10 Wedge Systems

610.1 Provision of a set of standard physical wedge filters with wedge angles 15°, 30°, 45° and 60°

6.10.2 Provision of virtual or dynamic programmable wedge fields of generating variable wedge angles starting from 1 0° up to 60

6.10.3 The programmable wedge fields shall provide a range of wedged fields starting at least 4cm up to 30 cm at 100 cm TSD

6.10.4 Provision of a statistics log for tracking the accuracy of the programmable wedge fields' profiles

6.10.5 Must provide dosimetric and QA equipments for dynamic wedge dosimetry and QA tests

6.10.5 Provision for automatic, motorized, universal wedge system for variable wedge angles from 0° up to 60

7. Intensity Modulated Radiation Therapy System

7.1 The linear accelerator system shall be capable of delivering Intensity (fluence) modulated photon beam within and across the given field apertures in order to produce highly conforming dose distribution as per the physician prescription.

7.2 Inverse treatment planning system shall be capable of doing IMRT Planning for all vendor's of the linear accelerator available.

7.3 Support for "step and shoot" IMRT and/or dynamic sliding window" IMRT delivery

7.4 Specify the linac performance for small MU delivery

7.5 Capable of delivering high quality intensity modulated fields using fractions of MU (please state minimum MU per segment)

7.6 Extended intensity modulated field size shall be at least 30 cm x 30 cm

7.7 Capable of automated delivery of multiple co-planar fields in sequence from the console with remote control of gantry, collimator and jaws motions between co-planar treatment fields.

7.8 Capable of verifying every parameter of segments downloaded from treatment planning systems through network for IMRT treatment

7.9 **Deleted.**

8. Image-Guided Radiotherapy System

8.1 Kilovoltage-based 3D-Image-Guided Radiotherapy (kV-IGRT) shall be provided and it should have FDA clearance. The system shall have the capability of producing 2D radiography, 2D fluoroscopy and 3D (volume) cone beam CT imaging modalities for patient's interfraction and intrafraction daily setup verification.

8.2 A 3D volume CT image data is reconstructed from a series of 2D projection images acquired as the linear accelerator gantry is rotated. This image data can be used for verification of patient position and target motion. This shall have flexibility in providing full or partial gantry rotations, with the opportunity to select a choice of gantry rotation speeds.

8.3 The cone-beam CT technology should be of amorphous silicon (a-Si) based flat panel detector technology.

8.4 The system should be able to acquire and display on-board 2D and 3D volume images of the patient immediately prior to treatment. The images should be in DICOM 3 and DICOM RT format. The network provided should be able to transfer images to (from) EPID/CBCT from (to) TPS and simulator and additional workstations.

8.5 The quality of image, especially axial CT images from the CBCT should be sufficient to delineate target and critical structure volumes.

8.6 The image registration software supplied should be able to overlay original reference images from the TPS to the on-board images and calculate offset values

based on user defined reference points and structures. The software should then be able to move the table as per the offset values in 3D.

8.7 Based on the comparison of initial planning images and on-board images, change in treatment plan should be possible.

8.8 The system should have latest configuration of hardware (CPU, hard drive, RAM, min 21" square TFT monitor, color LASER printer)

8.9 There shall be a geometric calibration phantom for kV to MV isocenter alignment and other calibration.

8.10 Image quality phantom to determine the low contrast and spatial resolution shall be provided

8.11 Daily QA phantom for kV and MV projection imaging and kV CBCT checks and all other necessary IGRT QA tools shall be provided.

9. Optional Features (Price must be quoted separately)

9.1 **Deleted**

9.2 It should be possible to upgrade to perform the stereotactic radiosurgery and stereotactic radiotherapy (SRS/SRT) treatment. The SRS/SRT frames, localizers, table attachments, treatment planning system and all other necessary phantom and quality assurance tools should be provided.

9.3 It should be possible to upgrade to perform 4D-Radiation Therapy (4D Planning and 4DCBCT based verification system or equivalent technology) and Adaptive Radiotherapy treatment. The vendor should provide all necessary gadgets in detail.

10. Utility Requirements

10.1 Power Supply

10.1.1 Power conditioner shall be installed to provide precise voltage regulation and protection for the linear accelerator on offer.

10.1.2 Should work on three phase 400-440 V / 50 Hz Power

10.1.3 UPS of suitable rating with voltage regulation and spike protection for 60 minutes back up for whole Linear Accelerator Systems (including associated TPS, server etc.) should be provided.

10.1.4 Silent Generator of 75 kVA should be provided and must be quoted separately.

10.1.5 Resettable over current breaker shall be fitted for protection

10.2 Water Chiller System

10.2.1 The chiller system shall be provided along with the machine by the principals. No local system shall be accepted.

10.2.2 The chiller system shall incorporate an automatic back-up facilities, remote control and alarm panel with warning facilities

10.2.3 Vendor should provide a fully automatic water chiller system for sufficient cooling of the linear accelerator

10.3 Air conditioning and ventilation:

To be provided. Specify temperature, relative humidity and air changes**.**

10.4 Safety Systems: Patient, staff and machines safety interlocks, emergency switches and beam off interlocks to be provided.

10.5 Machine space: Details about the physical dimensions and weights of the machine and its accessories including control console to be provided.

11. Equipment Warranty and After-Sales Services

11.1 The vendor shall give mandatory on-site warranty for first five years from the date of commissioning of the entire Linac system (including for all locally supplied items including consumables like batteries of the UPS, printer cartridges etc) from the Principals, except for the wave-guide, beam-bending magnet assembly, electron gun, X-ray tube & RF system, which shall carry guarantee for 10 years. Pro-rata warranty is not acceptable.

11.2 Vendor should provide comprehensive maintenance contract (CMC) rate year-wise for quoted machine other accessories for next 5 years after warranty period.

11.3 98% uptime warranty/guarantee during warranty and CMC period.

11.4 Spare parts kit should be available for minimum of 10 years and price must be included in the offer

11.5 During the warranty period, all the software updates and upgradation should be provided without asking for free of cost.

11.6 Please quote the rates of necessary consumables recommended valid for 5 years block

11.7 Factory trained service Engineer/Application specialists should be available in Delhi to look after the installation and maintenance of the system without patient treatment interruption.

12. Equipment Compliance with Standards and Safety

12.1 Should be ISO, IEC, FDA and/or CE certified product.

12.2 Should comply with the national regulatory AERB/BARC guidelines

12.3 The offered linac model should have **AERB type approval or NOC**.

12.4 Dosimetry, QA and Safety protocols should adherence to ICRP/ICRU/IAEA and national regulatory AERB/BARC guidelines/reports

12.5 Interlock system should be provided to afford maximum protection for personal against high voltage hazards.

12.6 High voltage protection and warning lights/symbols to be provided.

12.7 **The mail equipment offered shall have AERB NOC/Type Approval. However, new functions viz. FFF shall have CE/FDA and AERB NOC/Type Approval. AERB NOC/Type Approval should be provided 8 months from the date of clinical start-up. Price of FFF to be indicated separately as part of the equipment which shall be released after submission of AERB Type Approval.**

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13. Staff Training and Documentation

13.1 The vendor should provide comprehensive training on Linear Accelerator, Treatment Planning in a well advanced center in any developed country for four

persons (two for Radiation Oncologist, two for Medical Physicist).The training period should be at least for two weeks.

13.2 On-site application training should be provided for minimum four weeks for all staff members in the department

13.3 Beam Data: Representative photon and electron central axis profile dose curves, as well as flatness and symmetry profiles measured on the accelerator to be installed shall be provided. These curves need not be warranted by the vendor for clinical use.

1.3.4 User/Technical/Maintenance manual to be supplied in English

14. General Terms & Condition

14.1 All optional items to be quoted separately with separate prices in price bid.

14.2 A list of installations existing in the county with 'satisfactory service certificate', if available from the user, may be submitted to support the claim of a good performance of the equipment. The supplier shall mention the number of installations in India and worldwide, for the quoted model only. Such installations should have been supplied directly by the quoting firm itself. Current performance and status report from the user departments for the model quoted shall be provided.

14.3 All claims regarding meeting the specification should be duly supported by appropriate, latest technical catalogues/brochures from the manufacturer. The vendors shall submit point-wise compliance statement in regard to the specifications asked for in the tender and should mention corresponding page numbers matching with the technical details in the compliance statement**.**

14.4 **Penalty clause**: Penalty at the rate of RS.10, 000 per day for short falling of 95% uptime guarantee. If the machine lies non-functional for a period of more than two weeks continuously, the same penalty will be imposed even if 95% uptime clause is met with for the given calendar year.

14.5 **Price Guarantee**: The supplier shall also give a commitment that the price quoted for the equipments in the tender is the minimum price quoted to any institution in the country for similar terms & conditions; whether Government, semi-Government, autonomous or non-Government; in the recent times (preceding six months) and shall remain so for at least the next six months subject to variations in the foreign exchange rates, if applicable.

II. Technical Specification for Advanced Treatment Planning System

1. General Specifications

1.1 Quotations are invited for an advanced, state-of-the-art radiotherapy treatment planning system capable of performing for conventional, 3D conformal and inverse treatment planning of Intensity Modulated Radiotherapy (IMRT) and Volumatric Modulated Arc Therapy using coplanar and non-coplanar beams.

1.2 The TPS system should have the capability of integration with Simulators, CT simulators/MR/PET and linear accelerator of any vendor.

1.3 The system should have latest technology of hardware and software features.

1.4 Two treatment planning workstation with calculation licenses and additional **Two workstations** enabling simultaneous contouring with licenses for contouring, registration, image infusion, virtual simulation software in each workstation shall be provided.

1.5 Virtual simulation using the software and licenses for virtual simulation features and for controlling moving laser shall be provided

1.6 The TPS should include Clarkson, 3D Pencil Beam, anisotropic, convolution and superposition/collapsed cone algorithms or any other algorithms for dose calculations in 2D and 3D external beam applications with electron and photon beams. Monte Carlo calculations algorithms, if available, should be quoted (price indicated separately).

1.7 Advanced tools for automatic and manual contouring/segmentation of normal structures and target volumes on arbitrary axial, coronal and sagittal planes. Non-uniform automatic and manual margining for CTV and PTV in 3D with exclusion barriers should be possible

1.8 Manual and fully automatic image alignment using mutual registration information modes for image fusion among CT, MRI, PET and USG should be provided. The fusion results should be qualitatively and quantitatively verifiable with checkered board and in vertical and horizontal split screens spyglass and image overlaying options.

1.9 3D visualization of anatomical structures, beams eye view (BEV), rooms-eye view (REV) and dose distributions shown in 2D and 3D solid, wired and transparent multiplanar views including colour wash mode.

1.10 Multiplan viewing for comparing dose distribution of at least three rival plans including interactive DVH (qualitative and quantitative) comparison. Summation and subtraction of dose plans should also be possible.

1.11 Creation of DRRs in any desired plane including the beam cross-sectional plane should be possible for export to EPID and virtual simulation console.

1.12 TCP and NTCP calculations option should be provided

1.13 A complete DICOM-RT import/export license must be provided along with the DICOM-3 image import/export license

2. 3D-Treatment Planning

2.1 Patient registration, record and file management should be user friendly.

2.2 Patient data acquisition through film scanners, digitizer, DICOM 3.0 import facility from CT Scanners/ MRI & Simulator of any vendor.

2.3 Advanced Contouring tools with patient identity information should be available. Auto segmentation/contouring based on electron density values for different organs should be included & follow ICRU-50 & 62 Volume definitions.

2.4 System should also be capable of showing the combined dose distribution to the target volume resulting from whole treatment received by teletherapy (photon, electron, photon + electron) and brachytherapy.

2.5 System must have facility of treatment planning for Photon & Electron beam of all energies in the therapeutic range.

2.6 The system must be capable of calculating mixed beam treatment with photon and electron radiation.

2.7 System must have facility of machine data acquisition through RFA/scanner, etc.

2.8 The system must support regular & irregular fields for all types of beam modifiers such as Bolus, Blocks, MLCs, tissue compensator, wedges, dynamic wedge, asymmetric beams, etc.

2.9 System must be capable of conformal radiotherapy planning and multiple isocentre calculations.

2.10 System should be capable of making tissue inhomogeneity correction (as per electron density), irregular point dose calculations and auto-contouring as per CT data. Accuracy of dose calculations must be as per TG-23 Bench Mark Tests.

3. Inverse Treatment Planning for IMRT and VMAT

Inverse planning algorithms should be incorporated in the TPS for IMRT Planning with the following facilities:

3.1 Inverse planning system should be used to determine fluence pattern or beamlet intensities for each field and translate it to delivery instructions.

3.2 System should be capable of handling unlimited target and normal structure volume objectives and dose-volume constraints.

3.3 The dose optimization should be fast and interactive. Optimization algorithms namely deterministic/stochastic methods should be provided. Specify physical and biological optimization methods available in the offered system.

3.4 The system should support for both step-and-shoot and/or dynamic sliding window IMRT delivery.

3.5 Specify the leaf sequencing algorithms used in the offered system

3.6 The system should be capable of modeling/incorporating MLC head scatter, penumbra, physical limitation of motion, rounded leaf ends and tongue-and groove effects.

3.7 Specify the final dose calculation algorithms used in the offered inverse planning.

3.8 The dose grid should be finer than the size of the beamlet or incidence fluence

3.9 System should be capable of calculating doses in the build-up region using bolus

3.10 System should be capable of calculating doses in the region of flash and also in the mobile target like breast target.

3.11 System should be capable of incorporating 3DCRT base dose along with IMRT dose volume constraints.

3.12 In addition to fluence map optimization, if direct aperture optimization or its equivalent is available, it should also be quoted with price indicated separately. Optimization techniques should also be specified

3.13 Advanced inverse planning features should be included to follow ICRU-83 & Volume definitions and dose reporting and recording the treatment.

3.14 Comparison of planning images with images received via network from EPID system for necessary changes in treatment plan should be possible

3.15 Vendor should provide the necessary QA tools/gadgets for commissioning of the inverse planning system for dosimetric accuracy

4. Hardware configuration

4.1 The latest configuration of the computer/PC available at the time of shipping should be the basic platform for the TPS. The display system should be high performance 21” or above LCD monitor

.

4.2 A high quality film scanner (Vidar) suitable for 17" X 14" film size should be provided.

4.3 A device such as a DVD system for archiving of the patient data and plan

4.4 Two colour laser or equivalent printer suitable for dose plan printing

4.5 Suitable UPS for TPS computer and additional contouring workstation computer back-up of at least 30 minutes should be provided.

5. Optional features to be quoted

5.1. **Deleted**

5.2 The Monte-Carlo based IMRT system and biological optimization algorithms should be quoted.

5.3 4D Treatment Planning and Adaptive Planning capability should be quoted, if commercially available in the market

III. Oncology Information & Image Management / Treatment Record and Verify system

1. General Specifications

1.1 The vendor shall provide a comprehensive oncology information & image management and treatment record & verify system.

1.2 It shall also record and verify treatment parameters of patients undergoing treatment on the linac(s).

1.3 The system shall be based on one comprehensive database, thereby eliminating the need for redundant entry of data used in different applications.

1.4 The system shall provide the following functions: Record and Review Patient Diagnoses; Plan a course of treatment in advance so that treatments are readily delivered when the patient arrives; Write RT prescriptions that detail treatment techniques, fractions, and dose; Define treatment fields; Link setup fields and notes to treatment fields; Setup notes can include photos that show how to set up the patient; Track dose to specific sites; Define site breakpoints with instructions that appear when the breakpoint will be exceeded; Store treatment plan information to avoid redundant and time-consuming data entry.

1.5 MLC user operation shall be accomplished entirely through the Oncology Information System (OIS), thereby eliminating the need for a separate control

station for the MLC. Planned leaf shapes shall be incorporated directly into a patient's planned treatment field(s) in the electronic Chart.

1.6 The MLC shape shall automatically appear on the OIS treatment screen during the setup and treatment of any patient with a planned MLC shape. The shape shall be displayed simultaneously with all other pertinent treatment parameters.

1.7 The system shall have the capability of storing patient photos facilitating correct treatment. The digital patient photographs should upload to the database. After treatment of the first field, all subsequent fields shall be automatically and sequentially downloaded to start auto-setup of the next field without requiring operator interaction at either the OIS console or In-Room Monitor.

1.8 Port Films shall be capable of being planned ahead for appropriate treatment sessions, completed with prompting from the system, and automatically recorded in the electronic chart. Port Film dose shall be capable of being accumulated, if desired. The system shall permit override of individual treatment parameters (couch longitudinal for example) and require a password and appropriate user rights to successfully complete the override.

1.9 The record and verification station shall accept and store demographic data, notes or comments and diagnostic information for each radiotherapy patient. When the patient proceeds with tumor localization, treatment planning and simulation, the treatment parameters will also be entered into the patient's file automatically or manually.

1.10 A daily patient schedule and time management schedule must be capable of being displayed on the computer monitor at the record and verify workstation. This schedule shall include, at a minimum, the scheduled treatment time for each patient, the patient's identification number and the patient's name. The schedule shall be used to select a patient for treatment on the accelerator.

1.11 The system shall be capable of maintaining a record of field-specific and treatment-specific daily and cumulative doses for the target site and additional sites of interest. It shall be possible to specify a prescribed dose for each treatment site for every patient. The system shall prevent treatment if this dose will be exceeded upon completion of the treatment. A manual override shall be provided. Overriding prescribed dose limits by unauthorized personnel shall not be permitted. After the daily irradiation of a patient, the therapy history will be updated and the given target doses, or doses calculated to other sites, shall be accumulated.

1.12 The Operating System shall provide a convenient and efficient means for the user to generate and to print hard copy reports of information contained in the database.

1.13 The scheduler of the OIS should be capable of maintaining schedules for multiple departments and scheduling any resource desired by the site. It should have a graphical user interface for ease of customizing schedule views, changing appointment times and minimizing keystrokes.

1.14 The OIS shall provide the capability to integrate simulation, CT, MRI, PET and electronic portal imaging system images into the OIS database to provide a readily available reference during the patient's course of treatment. Reviewing images immediately after acquisition from a remote location shall be permitted.

1.15 The Hardware should consist of the following: Two separate, but fully integrated servers, one each for data management and image management with back up with 500 GB capacity or more to handle our department workload; 6 additional Image Workstations for Review and Approval; a latest 5 mega pixel digital camera (lithium ion battery with at least 10 GB memory card) for acquiring patient photos; a networked color image DICOM laser printer; capability for high speed internet connectivity for Online Service support. A camera having capable of taking both still as well as motion picture having latest configurations should be supplied.

1.16 It should integrate the following (with suitable software and hardware) to transfer and store patient data, treatment parameters & images for automatic treatment delivery along with 05 workstations): (i) Linear Accelerator (ii) Treatment Planning System (iii) Existing CT scanner, MRI and PET (iv) Virtual Simulator Workstation and/or conventional simulator and (v) **with required dosimetry systems.**

1.17 It should support full DICOM connectivity for import and export of data with query retrieve support, DICOM CT, MR, PET image support, and DICOM RT structures set support.

Turnkey for Site Preparation at LHMC : For High Energy Linear Accelerator is as follows:

INSTALLATION:

Installation of all these equipments/accessories shall be free of cost and should be completed in the specified time-frame manner. The vendor shall demonstrate all the acceptance and calibration tests, to the satisfaction of the user as well as of the Regulatory Authorities, as required for the safe use of the equipments.

TURNKEY:

Room, complete with all the civil/electrical/air-conditioning modification along with the accessories as required for safe *(including radiation dosimetry, calibration,beam quality assurance and radiation safety aspects)*, proper and smooth functioning of the equipment shall be the responsibility of the supplier, on turnkey basis from the state existing at the site at the time of finalizing the tender. Time frame for this work shall be specified and strictly adhered to, with penalty clause for delays in the work. The vendors shall inspect the site in detail before quoting for the turnkey job. All the materials and workmanship for the turnkey shall conform to the ISI/CPWD standards and shall be carried out under the overall supervision of the client. The vendor shall coordinate the shipment of the equipments with the pace of work at site. Scope of the turnkey shall consist of the following salient components:

i) The rooms for the proposed LINAC (Low Energy as well as High Energy) along with other supporting systems viz. rooms for TPSs etc. shall be provided in raw, unfinished state to the vendor. The vendor shall complete the job, as per the AERB requirements, from 'as is where is' basis at the time of finalizing the tender. It shall be the responsibility of the vendor to facilitate LHMC for the necessary requirements for this purpose and obtain the AERB/BARC clearance for these rooms for installing/operating the proposed equipments in these rooms.

ii) The vendor shall finish the rooms according to the international standards of aesthetics and functional requirements and matching with the existing décor at LHMC, as detailed below:

a) Flooring of the rooms shall have first quality vitrified tiles of reputed firms in matching colour, in size of at least 900mmx900mm or any other similarly suitable substitute. The walls should have wall panelling and cupboards of suitably matching material with granite workbenches, to keep the accessories as required for patient treatment and equipment maintenance. Handrails should be provided in the maize corridor.

b) False ceiling *(preferably with acoustic lining –without perforations)* in the equipment rooms consisting of removable 2'x2' panels of powder coated aluminium sheet panels. Electrical work including copper wiring, lighting, switches and fixtures, keeping in view the needs and ambience in the mentioned areas. Decorative wall panels (paintings) with light effect matching with the decor of the equipment should be provided.

iii) PA *(patient call)* system from the console area to the patient waiting area and between the console area & the equipment room.

iv) CCTV with cameras in the equipment room, the console and other area with additional monitors installed in the rooms of the HOD, Oncology, LHMC and Head Physicist.

v) Internal telephone systems between various equipment rooms, doctors'/physicists' rooms and other services.

vi) On-line UPS for the entire system with at least thirty minutes back up supply. In addition to this main UPS, additional UPS systems shall be supplied along with all other computer terminals/workstations/ accessories, wherever applicable. The batteries for the UPS systems shall be maintenance free and shall be looked after/replaced *(whenever required)* by the linear accelerator vendor throughout the warranty period of the main equipments.

vii) All safety and warning gadgets like voltage stabilisers, fire fighting systems, smoke detectors, fire alarms, electrical safety devices, radiation alarms, glow signs, signages, air/fumes exhaust, waterproofing, waterlogging protection *etc*, as may be necessary for the safety of the equipment, patients and personnel handling the equipment shall be provided.

viii) The vendor shall ensure the radiation safety aspect of the room, as per the AERB guidelines and shall get the necessary 'NOC' from AERB for operating the unit after installation.

ix) Water-cooling system for the linear accelerator should be compact, effective and supplied from the country of origin of the main equipment. Local units shall not be accepted.

x) Air-conditioning system and ducts for energy and temperature requirements shall be provided and installed and maintained by the vendor.

xi) A closed-circuit color TV system with 3 TV monitors and 2 cameras each in the LINAC and TPSs rooms shall be supplied.

<u>TURN KEY FOR SITE PREPARATION</u>

The prospective bidders for the main equipment shall inspect the site before submission of tender and give the certificate to the effect that the site is suitable for the installation of the installation of equipment to be procured for Radiotherapy. Linac room, Chiller room, Server Room, CT Simulator room and the whole radiation area.

1. CIVIL WORK :

1.1 The civil work need to be undertaken in a skeleton structure built by hospital contractor after AERB certification and approval.

1.2 Flooring – High density Vitrified tiles only in all the areas.

1.3 Walls – High density vitrified tiles only all the walls up to false ceiling in all the areas.

1.4 All the doors should be aluminium glazed door of thickness 10 gauge with 20 micron anodizing and with 5.5 thick wired glass / 12mm thick pre-laminated board wherever specified.

1.5 All the door should be provided with Hydraulic type door closures.

1.6 All the doors should be provided with mortise locks of GODREJ/LINK/Harrison make except that of the main doors, which should be provided with link locks.

1.7 False ceiling – Powder quoted Armstrong Metallic.

2. PLUMBING WORK

Plumbing work has to be carried out as per the requirement. The waste pipes and accessories should be of centrifugally cost iron and the connection of existing main hole in the public shafts shall be done. All water pits and fitting shall be galvanized iron of Tata make. The gratings shall be brass chrome plates.

3. ELECTRICAL WORK

The firms shall be required to specify the total load requirement for the entire equipment the air-conditioning units, room lighting and for the accessories, if an. The institute up to the distribution panel will provide the load. The distribution panel should give switchgear of SIEMENS/ l & T makes and shall be provided by the vendor. The electrical work will include wring, lighting and main switch fittings. Special roof light will be required particularly in the machine room which should have long life and should not be affected by frequent to on the off.

THE ELECTRICAL WORK SHALL INCLUDE THE FOLLOWING:

3.1 Wring the wire shall be of copper of different capacity as per the load and should be renowned make like: FINOLEX, BATRA, HENELEY, HAVELUS.

3.2 SWITCHES, Light and power point should be modular type of MK, North West ACHORE (Roma) / CCIPSL/SSK brands.

3.3 General Lights: Mirror optic type 1x40 w or 2x40 w PHILIPS/CROMPTON/KESSELECSCHREDER/ WIPRA/BAJAJ Brands.

3.4 The underground cables: supplying the electricity load should be of CCI/FORT GLOSTER, HAVELLS and ECKO Brands.

3.5 MCBs/ACBs/MCCBs should be MBS/SIEMENS/GE/ABB.

3.6 Roof light ; CFL down lighters of PHILIPS/OSRAM/WIPRO.

3.7 Main switchgears, fuse units should be L &T / SIEMENS/ GE.

3.8 Telephone cables should be of FINOLEX, HAVELLS & ECKO Brands.

3.9 Electrical load of the linear accelerator machine to be added as per the tender / brand of the equipment.

3.10 Main Electrical panel should be supplied.

3.11 Appropriate cable from substation to main panel is also to be provided.

4. AIR CONDITIONING

Whole area needed to be air-conditioned. Use of fresh air system and no recycling system. Head exchanger to save energy will be preferred. Six air changes per hour are required, as per the size of the area and circulation efficiency. Ventilation of remove air dissipated from the room as per requirement.

4.1 Environmental Specification Humidity range: 40% to 80% relative humidity, non – condensing. Temperature Ranges 19 deg. C to 27 deg. C through the year. Detail for the ducting diffuser, grills etc to be supplied by Engg. Deptt.

4.2 Provide ventilation sufficient for removal of equipment air heal load as per requirement of the accelerator.

4.3 Provide ventilation sufficient for removal of equipment air heat load as per requirement of the accelerator.

4.4 Air-conditioning load : Air conditioning load for the new liner accelerator area shall be 30 TR. To provide HVAC system 4x TR of air cool package units are to provided (3 nos. working & 1 no stand by) of the following approved makes.

(i) VOLTAS

(ii) BLUSTAR

(iii) ETA

(iv) CARRIER

However, the halting load calculation and maintenance temperature and humidity shall be the responsibility of the agency and offered as option.

4.5 Double earthling with copper plate is to provide separately for the air conditioning equipment as per (S) specifications in addition to the double earthling of the medical equipment

5. FIRE PROTECTION

The fire protection is to be integrated as per the requirement heat deflector / Hooters/ Photoelectric smoke deflector shall be provided as per the requirements of IS/BIS code. The ionization detector should not be used. The fire alarm panel shall be linked the main panel of the institute.

6. ELECTRIC PROTECTION OF THE INSTALLATION:

The use of earth leakage circuit breaker will be required. Emergency switches interlock devices and warning lights have to be integrated into the planning.

7. EMERGENCY LIGHT

Provide a battery backup emergency lights both in machine room and console control area.

7. FURNITURE:

7.1 Control console and computer plate forms should include:

-Key board drawer – 3nos.

-Self or base for computer table – 6nos.

-Wall side board in machine rooms:

a). For Block storage, wedges storage, applicators storage and compensators storage – 6nos.

b).For storage of patient position accessories and mask etc. – 4nos.

8. Time period and payment for turnkey:

Turnkey work, installation & commissioning should be completed strictly as per the schedule.

NOTE:

1. Irrespective of specification mentioned, it is the responsibility of the firm quoting for STATE-OF-THE-ART EQUIPMENT to physically inspect in detail, the pending job to be done at the site where above systems are to be Installed as per regulatory guide lines. It is also the responsibility of the same vendor, to avoid duplication of work as the construction of the bunkers have already reached near completion.

2. In case the successful bidder proposes to use material other than specified brand then approval of the client is mandatory.
3. It shall be the sole responsibility of the bidder to interact with LHMC, New Delhi for optimal utilization of resources without any duplicacy of work.

Bidders are requested to collect the required AERB approved drawings from Director, LHMC, NewDelhi.

Schedule 2: Technical Specification for a Low-Energy Linear Accelerator

Sealed tenders (sealed separately as the "Technical Bid & the Price Bid-in duplicate) are invited directly from the manufacturers/ principles for the supply of a state-of the-art clinical Radiotherapy Linear Accelerator capable of producing 6MV single photon energy for the routine and specialized treatment techniques. Linear Accelerator must have the latest technology **viz. Amorphous (Si) based EPID, IMRT & Volumetric Modulated Arc Therapy (VIMAT) along with 5 or more electron energies** and should be fully computer controlled system. It should be capable of integrating with standard networking and PACS systems available in the market. **KVCBCT based IGRT system as optional, price to be quoted separately.**

1. Linear Accelerator

An Advanced, new generation of low-energy medical linear accelerator should be equipped with a multileaf collimator (MLC) and an electronic portal imaging device (EPID) to perform conformal treatment techniques such as three dimensional conformal radiotherapy (3D-CRT) **IMRT & Volumetric Modulated Arc Therapy (VIMAT)** through record and verification system. The system should have the capability for future upgradation in order to perform advanced treatments.

2.0 Photon Beam Characteristics

2.1 Beam Energy

The accelerator shall be capable of producing one clinically useful photon beam with energy of 6 MV as low energy.

2.2 Dose Rate and Beam Stability

2.2.1 The maximum dose rate for routine clinical applications shall equal at least **500** monitor units (MU)/min or more for a 10 x 10 cm field at the depth of maximum buildup at a TSD of 100 cm for both photon beam.

2.2.2 Specify the maximum dose rate and number of intermediate dose rate available in the offered linac model

2.2.3 Specify the beam stability time in milliseconds.

2.3 Field Size Specifications

The field size is defined as the distance along the radial and transverse axes between the points of 50% density on an x-ray film taken at 100 cm TSD with minimum buildup. The digital display, light field size and mechanical display should be accurate to within $\pm$ 2 mm.

2.3.1 The accelerator shall provide a continuously variable rectangular, unclipped field size from 1 x 1 cm to 35 x 35 cm at 100 cm SSD. The maximum clipped field size should equal or exceed 40 x 40 cm at 100 cm SSD. Clipped corners are unacceptable for fields smaller than 35 x 35 cm.

2.3.2 A detachable block holder should be provided to accommodate 2 trays simultaneously for wedges and block trays. The size of the blocking trays should be at least 5 cm larger than the maximum field size at the lower position. Specify location and size of blocking trays.

2.3.3 Asymmetrical collimation for two sets of jaws shall be provided. One set of jaws shall be capable of crossing the center line by at least 10 cm as projected at 100 cm TSD. The collimators shall re-center automatically when the symmetrical mode of operation is re-selected.

2.4 Beam Profile

2.4.1 Field Flatness Specification

Variation of x-ray intensity relative to the central axis shall not exceed $\pm$ 4% at 100 cm SSD and 10 cm depth over the central 80% of the field for the longitudinal and transverse axes of all field sizes from 10 x 10 cm to 40 x 40 cm. State the maximum variations for the above field sizes at each energy.

2.4.2 Field Symmetry Specifications

The maximum percent differences of average doses shall not exceed $\pm$ 3.0% for the longitudinal and transverse halves of the field at 100 cm TSD and 10 cm depth, at gantry angles of 0, 90, 180 and 270 degrees. Field sizes shall be specified as 10 x 10 cm and 40 x 40 cm. Average dose is defined as the arithmetic average of minimum and maximum doses within the central 80% of the field for both axes.

2.4.3 Radiation Field Penumbra:

The width between the 20% and the 80% isodose lines measured for 10 X 10 cm^2 at depth of 10 cm at 100 cm SSD should not be more than 10mm. Specify the penumbra width.

2.5 **Beam Quality Index:**

The ratio of ionization measured at 20 cm and 10cm depth for a field size 10 X 10 cm^2 at the detector level and with constant detector source distance = 100cm should be as given below:

Photon beam energy (MV)	Quality Index (QI)
6 MV	Specify

Electron Beam Characteristics

1 **Electron Beam Energies**

Five clinically useful electron beam energies shall be provided. The lowest energy shall be 4 or 6 MeV and the highest energy shall be 15 MeV/16 MeV or above. Energy shall be specified as the most probable energy (E_p) of the electron energy spectrum at 100 cm from the accelerator exit window.

2 **Dose Rate**

The dose rate at the isocenter shall not be less than **500 MU/minute** for each electron energy.

3 **Field Size**

The electron beam size is defined by the inside dimensions of the electron beam applicators projected geometrically to a plane surface at 100 cm SSD. A range of field sizes from 4 x 4 cm to 25 x 25 cm is required. A method to obtain irregular field shapes shall be provided.

3.1 It shall be possible to visualize both the field defining light and the optical distance indicator with an electron applicator in place.

4 **Beam Profile**

4.1 Field Flatness

The maximum percent variation of the electron intensity at 100 cm SSD at D_{max} shall not exceed 5% (within the central 80% of the longitudinal and transverse axes relative to the central axis) for field sizes from 10 x 10 cm to 25 x 25 cm and for all the electron beam energies.

4.2 Beam Symmetry

The maximum percent variation in the average electron intensity to the longitudinal and transverse halves of the electron field at D_{max} for a 10 x 10 and 25 x 25 cm field at 100 cm SSD shall not exceed $\pm$ 2% at gantry angles of 0, 90, 180 and 270 degrees.

The average electron intensity is the average of the maximum and minimum points within the central 80% of the field for each of the axes.

5 **X-ray Contamination**

The x-ray contamination of the electron beam shall be less than 5% of the maximum dose for all energies specified previously.

2.6 **Radiation Leakage**

Radiation leakage limits shall be within appropriate regulatory agency guidelines as follows:

2.6.1 Photon leakage. The photon leakage rate at any point one meter from the target outside the cone defined by the primary x-ray collimator shall be less than 0.1% of the absorbed dose at the isocenter.

2.6.2 Collimator transmission. The movable collimators shall not permit transmission of radiation exceeding 0.5% of the central axis dose at Dmax measured in air for both photon energies.

2.6.3 Neutron leakage. The neutron leakage rate should not exceed 0.2% expressed in neutron dose equivalent (Sivert) when added to the photon leakage for a 10 x 10 cm field at the isocenter at any point one meter from the target when the jaws are closed.

2.6.4 In addition to meeting above specifications for radiation leakage, the linac should also meet all the mandatory safety and radiation leakage regulations as specified by Atomic Energy Regulatory Board (AERB), Mumbai, India for a medical linear accelerator.

2.7 **Rotational/ Arc Therapy**

2.7.1 The Linac must have photon arc therapy feature with gantry rotation in clockwise and counter clockwise directions.

2.7.2 The dose rate/range of dose rate should be specified MU per degree. The MU/degree shall automatically be computed.

2.7.3 A range of continuously variable dose rate should be available. A unit able to deliver high dose per degree will be preferred

2.8 **Congruence Between Optical and Radiation Field:**

The congruence between optical and radiation fields for 5x5 cm^2, 10 cm x10 cm at 0, 90,180 and 270 degree gantry angles with SSD = 100 cm should be within 2 mm along X,Y axes.

3. Accelerator System

3.1 The system must provide with either Magnetron or Klystron as the radiofrequency (RF) micro power source. The warranty should be at least for 5years. (Pro-rata guarantee is not acceptable).

3.2 Standing or travelling type of wave-guide along with the bending magnet, target assembly, vacuum ion-pump should be offered a warranty of 5 years. (Pro-rata guarantee is not acceptable).

3.3 Specify the target type and materials and also flattening filter materials in details

3.4 Electron gun should have warranty of minimum 5 years and the beam focal spot should be within 3 mm diameter.

4. Dose Monitoring System

4.1 Sealed type of dose monitoring chambers must be provided and should operate independent of ambient temperature and pressure. All dosimetry, patient and unit safety related interlocks must be sensed and controlled by hardware and software

4.2 The equipment shall provide two independent dose monitoring systems for primary and secondary dose monitoring as well dose distribution monitoring

4.3 The dose monitoring systems shall monitor the beam energy and shall terminate irradiation when the change of beam energy greater than ±3% of the nominal energy.

4.4 Provision of a controlling timer to protect against failure of dose monitoring systems shall comply with the requirements in accordance with respective IEC norms.

4.5 The reproducibility tolerance for the dose monitoring system shall be better than 1% or 1 MU.

4.6 The linearity tolerance of accumulated doses from 10 to 1000 MU for the dose monitoring system shall be ± 1% or 1 MU. Specify the linearity tolerance for less than 10MU in view of IMRT

4.7 The reproducibility tolerance at any gantry angles for the dose monitoring system shall be better than ± 1% or 1 MU.

5. Mechanical Features

5.1 Gantry

5.1.1 Gantry shall be motorized by local and remote controls. Automatic setup facility and in-room display of treatment parameters shall be provided.

5.1.2 The total range of gantry rotation shall not be less than 360°

5.1.3 Resolution and accuracy of digital readout shall be 0.1° and ± 0.5° or better

5.1.4 Resolution and accuracy of analog readout shall be 1° and ± 1° or better

5.2 Collimator

5.2.1 Collimator shall be motorized by local and remote controls

5.2.2 The cross-wire wander (rotation) shall not exceed 1mm diameter

5.2.3 The total range of collimator rotation shall not be less than ± 165°

5.2.4 Resolution and accuracy of digital readout shall be 0.1° and ± 0.5° or better

5.2.5 Resolution and accuracy of analog readout shall be 1° and ± 1° or better

5.3. Diaphragm (Jaws)

5.3.1 Each diaphragm shall be independently motorized by local and remote controls

5.3.2 One pair of diaphragm shall be traveled up to at least -10cm crossover the central axis in order to simulate the asymmetrical and offset fields.

5.3.3 Resolution and accuracy of digital readout shall be 1 mm and ± 1mm or better

5.3.4 Maximum angular deviation between the axes of opposing diaphragms shall be stated.

5.4 Multileaf Collimator

5.4.1 Number of multileaf collimator (MLC) leaves shall be of **80 leaves or more** and should cover the maximum field size of 40x40cm^2

5.4.2 MLC leaf width projected at 100 cm TSD isocenter, shall be 10 mm or less

5.4.3 Multileaf speed together with maximum possible dose rate for dynamic radiotherapy shall be stated

5.4.4 Maximum range of leaf speed and extension between leaves shall be stated.

5.4.5 Accuracy and repeatability of leaf position shall be within ± 1mm or better. Accuracy of leaf alignment perpendicular to leaf movement about isocenter shall be within 1mm or better.

5.4.6 Radiation parameters such as leaf penumbra, leaf transmission, inter-leaf transmission and coincidence of radiation field vs optical field shall be stated.

5.4.7 The MLC system shall incorporate a fast and efficient QA tools (compliance of AAPM-TG-50 guidelines) for checking and monitoring all leaves position in real time. Deviations from leaves position calibration shall be interlocked to prevent treatment.

5.4.8 Clearance from bottom of collimator to isocenter shall be specified.

5.4.9 Provision of treatment verification and record system with the necessary interface for static and dynamic operation of MLC prior to treatment delivery.

5.5 Treatment Table/Couch

5.5.1 Vendor shall provide the treatment couch and accessories used for accurate 3D conformal radiotherapy

5.5.2 Indexed carbon fiber tabletop shall be provided.

5.5.3 The tabletop shall comply with the deflection requirement of IEC norm.

5.5.4 Lifting capacity shall be at least 200kg

5.5.5 IEC scale convention shall be provided.

5.5.6 Treatment tabletop shall be capable of free manual movement in both lateral & longitudinal directions

5.5.7 Lateral & longitudinal couch displacement shall not exceed 1mm under braked condition

5.5.8 Range of vertical, longitudinal and lateral movement shall be stated

5.5.9 Range and accuracy of isocentric rotation shall be stated.

5.5.10 Vendor shall specify the accuracy of isocentric rotation angle.

5.5.11 Mechanical isocenter accuracy for couch rotation shall not 1mm radius sphere

5.5.12 Vendor shall specify the accuracy of couch rotation isocenter

5.5.13 Vendor shall specify the coincidence of couch isocenter with gantry and collimator isocenter.

5.5.14 Vendor shall provide any auto-setup / remote control couch motions capability

5.5.15 Precision of digital couch rotation readout +/- 0° or accuracy of digital couch rotation readout +/- 1 ° or better.

5.5.16 Precision of digital couch vertical, longitudinal and lateral position readout shall be +/- 1mm or better, accuracy of digital couch vertical, longitudinal and lateral position +/- 2mm or better.

5.5.17 Vendor is required to facilitate with all available accessories, inter-changeable tabletop materials, removable parts for treatment. Provision of patient immobilization accessories, preferably with indexing capability compatible with the couch. Detailed list of all accessories shall be stated and provided.

5.5.18 Emergency down drive shall be provided to remove the patient in the case of power failure.

5.5.19 Two extra spare control pendants shall be provided

5.6 Electronic Portal Imaging System

5.6.1 6MV Low Energy Linear Accelerator having features and capability of amorphous silicon (a-Si) based high resolution EPID

5.6.2 Vendor shall specify the maximum image field size at isocenter and at other distance achievable with a single exposure for the detector panel.

5.6.3 Specify details of all movements and positional accuracy of the imager.

5.6.4 Specify the details of pixel depth pitch of the imager.

5.6.5 Maximum image acquisition rate and minimum MU for full image resolution shall be stated

5.6.6 Spatial resolution (lp/mm) shall be stated if test object position is at isocenter and at detector

5.6.7 Accuracy of imager centre to beam isocenter shall be stated.

5.6.8 The EPID shall provide a suitable means to import & export images for verification and display on the same workstations; to acquire & transfer images through the existing oncology network; and to be capable of registration

5.6.9 Vendor shall provide features on image processing, image display, image analysis, image storage, image print and image enlargement. Details shall be stated.

5.6.10 Avoidance of irradiation of area outside sensitive detector panel and anti-collision device, vendor shall state and provide details including the usable life span of the EPID.

5.6.11 Vendor shall provide all accessories including necessary QA tools, maintenance tools etc. for EPID.

5.6.12 Provision of facilities for storage *I* archival of electronic portal images

5.6.13 Portal images can be exported to external facilities in a recognized format including BMP and TIFF.

5.6.14 **Deleted.**

5.7 Patient Alignment system

5.7.1 Vendor is required to supply and install 4 sets green laser alignment systems. A separate back pointer laser alignment system shall be provided and installed onto the linear accelerator on offer. All laser products shall comply with respective code of IEC safety of laser products.

5.7.2 Two spare sets of green lasers shall be provided.

5.7.3 Each laser beam shall be precisely adjustable vertically and horizontally by remote control to indicate the isocenter position within 1 mm and protected against accidental displacement

5.7.4 System should have 0.5mm line thickness at isocenter for patient alignment and set-up

5.8 Control Console and Treatment room display features

5.8.1 **Main control console:**

A computerized control console shall be located outside the treatment room. This console shall provide controls that must be activated in order for the accelerator to become operational in any of its various modes of operation and also provide displays of accelerator parameters. The following shall be present:

5.8.1.1 **Power Off**: Turns off all electrical power, including power to the computer, except for that power needed to maintain the accelerator in a "Stand By" condition

5.8.1.2 **Power On***:* Turns on electric power to the accelerator

5.8.1.3 **Total Dose:** Sets the desired total dose for patient's treatment

5.8.1.4 **Time:** Sets time for patient's treatment. Time shall be used as a back up in case of failure of total dose interlock. Backup time shall be calculated automatically with provision for manual reset.

5.8.1.5 **MU/Degrees:** Sets the desired MU/degree for rotational therapy. MU/degree shall be calculated automatically with provision for manual reset.

5.8.1.6 **Mode Selection:** Selects x-rays or electrons for treatment

58.1.7 **X-Ray Energy:** Selects photon beam energy

5.8.1.8 **Radiation On:** Turns on accelerator and radiation is produced

5.8.1.9 **Interrupt:** Immediately stops treatment.

5.8.1.10**Treatment Complete***:* Indicates that desired dose has been delivered. In addition, the operator should be alerted if radiation terminates for any reason other than reaching the set integrated dose. In such cases, the dose remaining to be given shall be indicated

5.8.1.11 **Arc Therapy:** Enables the accelerator to perform arc therapy

5.8.1.12 **Wedge:** Requires that the presence, identification and orientation of a wedge must be confirmed at the control console.

5.8.1.13 **Port Film:** Opens jaws completely or partially, as selected by the operator, and limits the amount of radiation to be delivered to less than or equal to 20 cGy. This shall be operational in both the photon and electron modes but allow only the production of low energy photons. Once the port film has been completed, it should be possible to return the collimators to their original setting automatically.

5.8.1.14 **Special Procedures:** Prohibits accidental selection of procedures such as electron arcs or high dose rate electron irradiation by providing an "extra step" in selection procedure

5.8.2 Control Console Display/Monitors:

The following monitors and displays should be available at the control console, and with the exception of a back-up dose counter, it should be possible continuously to visually observe the value being registered on these counters and displays from the position of the operator.

5.8.2.1 **Dose Rate Indicator:** Indicates the dose rate at maximum build-up for a 10 x 10 cm field at 100 cm SSD.

5.8.2.2 **Dose Counters***:* Two counters that count integral dose detected by each of the two dosimeters

5.8.2.3 **Total Time Counter:** Counts total treatment time in 0.01-minute increments up to 9.99 minutes.

5.8.2.4 **Angle***:* Indicates position of gantry in degrees with precision of ± 0.5 degrees

5.8.2.5 **Symmetry:** Indicates beam symmetry in both major axes

5.8.4 It should be possible to adjust the parameters at or near the control console:

5.8.5 **Accelerator Parameter Checks: I**t shall be possible to monitor different accelerator parameters via an oscilloscope at or near the control console.

5.8.6 **Treatment room pendent:**

Hand pendants shall be provided. The hand pendent must have the control of gantry rotation, collimator rotation, collimator jaw settings, treatment couch motions (vertical lateral, longitudinal and turntable rotation around isocentre and room light control. To prevent possible malfunctioning, when hand pendant is in operation, the computer system must prevent conflicting signals from being sent to the same mechanical device.

5.9 Essential Accessories

5.9.1 **Shielding Blocks and Shadow Tray**

An accessory set of pre-shaped, screw-on blocks and shadow trays shall be delivered with the machine. At least 10 shadow blocks, of at least 5 HVL, shall be included. A detachable accessory mount is highly preferable.

5.9.2 **SSD indicator**

A optical distance indicator (ODI) of SSD from 80cm to 130 cm with accuracy of ±1 mm at isocentre should be provided.

5.9.3 **Front and Side pointers**

A mechanical front pointer to locate isocentre of the unit within ±2mm and to apply to any orientation of the machine shall be provided

5.9.4 **A closed-circuit color TV system** with TV monitors and two cameras in the linac treatment room shall be supplied.

5.9.5 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.

5.9.6 **Field Illuminating light:** A field illuminating system should be provided for both photon and electron modes.

5.10 Wedge Systems

5.10.1 Provision of a set of standard physical wedge filters with wedge angles 15°, 30°, 45° and 60°

5.10.2 Provision of virtual or dynamic programmable wedge fields of generating variable wedge angles starting from 1 0° up to 60

5.10.3 The programmable wedge fields shall provide a range of wedged fields starting at least 4cm up to 30 cm at 100 cm TSD

5.10.4 Provision of a statistics log for tracking the accuracy of the programmable wedge fields' profiles

5.10.5 Must provide dosimetric and QA equipments for dynamic wedge dosimetry and QA tests

5.10.5 Provision for automatic, motorized, universal wedge system for variable wedge angles from 0° up to 60

6. Optional Features (Price must be quoted separately)

6.1 The linear accelerator offered model should be a ready platform for upgradation to techniques without any design/functional constraints for newer radiotherapy techniques. **KVCBCT based IGRT system as optional, price to be quoted separately.**

6.2 Deleted.

7. Utility Requirements

7.1 Power Supply

7.1.1 Power conditioner shall be installed to provide precise voltage regulation and protection for the linear accelerator on offer.

7.1.2 Should work on three phase 400-440 V / 50 Hz Power

7.1.3 UPS of suitable rating with voltage regulation and spike protection for 60 minutes back up for whole Linear Accelerator Systems (including associated TPS, server etc.) should be provided.

7.1.4 Silent Generator of 75 kVA should be provided and must be quoted separately.

7.1.5 Resettable over current breaker shall be fitted for protection

7.2 Water Chiller System

7.2.1 The chiller system shall be provided along with the machine by the principals. No local system shall be accepted.

7.2.2 The chiller system shall incorporate an automatic back-up facilities, remote control and alarm panel with warning facilities

7.2.3 Vendor should provide a fully automatic water chiller system for sufficient cooling of the linear accelerator

7.3 Air conditioning and ventilation:

To be provided. Specify temperature, relative humidity and air changes**.**

7.4 Safety Systems: Patient, staff and machines safety interlocks, emergency switches and beam off interlocks to be provided.

7.5 Machine space: Details about the physical dimensions and weights of the machine and its accessories including control console to be provided.

8. Equipment Warranty and After-Sales Services

8.1 The vendor shall give mandatory on-site warranty for first five years from the date of commissioning of the entire Linac system (including for all locally supplied items including consumables like batteries of the UPS, printer cartridges etc) from the Principals, **including** for the wave-guide, beam-bending magnet assembly, electron gun, X-ray tube & RF system, which shall carry guarantee for 10 years. Pro-rata warranty is not acceptable.

8.2 Vendor should provide comprehensive maintenance contract (CMC) rate year-wise for quoted machine other accessories for next 5 years after warranty period.

8.3 98% uptime warranty/guarantee during warranty and CMC period.

8.4 Spare parts kit should be available for minimum of 10 years and price must be included in the offer

8.5 During the warranty period, all the software updates and upgradation should be provided without asking for free of cost.

8.6 Please quote the rates of necessary consumables recommended valid for 5 years block

8.7 Factory trained service Engineer/Application specialists should be available in Delhi to look after the installation and maintenance of the system without patient treatment interruption.

9. Equipment Compliance with Standards and Safety

9.1 Should be ISO, IEC, FDA and/or CE certified product.

9.2 Should comply with the national regulatory AERB/BARC guidelines

9.3 The offered linac model should have **AERB type approval or NOC**.

9.4 Dosimetry, QA and Safety protocols should adherence to ICRP/ICRU/IAEA and national regulatory AERB/BARC guidelines/reports

9.5 Interlock system should be provided to afford maximum protection for personal against high voltage hazards.

9.6 High voltage protection and warning lights/symbols to be provided.

10. Staff Training and Documentation

10.1 The vendor should provide comprehensive training on Linear Accelerator, Treatment Planning in a well advanced center in any developed country for four persons (two for Radiation Oncologist, two for Medical Physicist).The training period should be at least for two weeks.

10.2 On-site application training should be provided for minimum **two** weeks for all staff members in the department

10.3 Beam Data: Representative photon and electron central axis profile dose curves, as well as flatness and symmetry profiles measured on the accelerator to be installed shall be provided. These curves need not be warranted by the vendor for clinical use.

10.4 User/Technical/Maintenance manual to be supplied in English

11. General Terms & Condition

11.1 All optional items to be quoted separately with separate prices in price bid.

11.2 A list of installations existing in the county with ‘satisfactory service certificate’, if available from the user, may be submitted to support the claim of a good performance of the equipment. The supplier shall mention the number of installations in India and worldwide, for the quoted model only. Such installations should have been supplied directly by the quoting firm itself. Current performance and status report from the user departments for the model quoted shall be provided.

11.3 All claims regarding meeting the specification should be duly supported by appropriate, latest technical catalogues/brochures from the manufacturer. The vendors shall submit point-wise compliance statement in regard to the specifications asked for in the tender and should mention corresponding page numbers matching with the technical details in the compliance statement**.**

11.4 **Penalty clause**: Penalty at the rate of RS.10,000 per day for short falling of 95% uptime guarantee. If the machine lies non-functional for a period of more than two weeks continuously, the same penalty will be imposed even if 95% uptime clause is met with for the given calendar year.

11.5 **Price Guarantee**: The supplier shall also give a commitment that the price quoted for the equipments in the tender is the minimum price quoted to any institution in the country for similar terms & conditions; whether Government, semi-Government, autonomous or non-Government; in the recent times (preceding six months) and shall remain so for at least the next six months subject to variations in the foreign exchange rates, if applicable.

Turnkey for Site Preparation at LHMC : For Low Energy Linear Accelerator is as follows:

INSTALLATION:

Installation of all these equipments/accessories shall be free of cost and should be completed in the specified time-frame manner. The vendor shall demonstrate all the acceptance and calibration tests, to the satisfaction of the user as well as of the Regulatory Authorities, as required for the safe use of the equipments.

TURNKEY:

Room, complete with all the civil/electrical/air-conditioning modification along with the accessories as required for safe *(including radiation dosimetry, calibration,beam quality assurance and radiation safety aspects)*, proper and smooth functioning of the equipment shall be the responsibility of the supplier, on turnkey basis from the state existing at the site at the time of finalizing the tender. Time frame for this work shall be specified and strictly adhered to, with penalty clause for delays in the work. The vendors shall inspect the site in detail before quoting for the turnkey job. All the materials and workmanship for the turnkey shall conform to the ISI/CPWD standards and shall be carried out under the overall supervision of the client. The vendor shall coordinate the shipment of the equipments with the pace of work at site. Scope of the turnkey shall consist of the following salient components:

i) The rooms for the proposed LINAC (Low Energy as well as High Energy) along with other supporting systems viz. rooms for TPSs etc. shall be provided in raw, unfinished state to the vendor. The vendor shall complete the job, as per the AERB requirements, from 'as is where is' basis at the time of finalizing the tender. It shall be the responsibility of the vendor to facilitate LHMC for the necessary requirements for this purpose and obtain the AERB/BARC clearance for these rooms for installing/operating the proposed equipments in these rooms.

ii) The vendor shall finish the rooms according to the international standards of aesthetics and functional requirements and matching with the existing décor at LHMC, as detailed below:

a) Flooring of the rooms shall have first quality vitrified tiles of reputed firms in matching colour, in size of at least 900mmx900mm or any other similarly suitable substitute. The walls should have wall panelling and cupboards of suitably matching material with granite workbenches, to keep the accessories as required for patient treatment and equipment maintenance. Handrails should be provided in the maize corridor.

b) False ceiling *(preferably with acoustic lining –without perforations)* in the equipment rooms consisting of removable 2'x2' panels of powder coated aluminium sheet panels. Electrical work including copper wiring, lighting, switches and fixtures, keeping in view the needs and ambience in the mentioned areas. Decorative wall panels (paintings) with light effect matching with the decor of the equipment should be provided.

iii) PA *(patient call)* system from the console area to the patient waiting area and between the console area & the equipment room.

iv) CCTV with cameras in the equipment room, the console and other area with additional monitors installed in the rooms of the HOD, Oncology, LHMC and Head Physicist.

v) Internal telephone systems between various equipment rooms, doctors'/physicists' rooms and other services.

vi) On-line UPS for the entire system with at least thirty minutes back up supply. In addition to this main UPS, additional UPS systems shall be supplied along with all other computer terminals/workstations/ accessories, wherever applicable. The batteries for the UPS systems shall be maintenance free and shall be looked after/replaced *(whenever required)* by the linear accelerator vendor throughout the warranty period of the main equipments.

vii) All safety and warning gadgets like voltage stabilisers, fire fighting systems, smoke detectors, fire alarms, electrical safety devices, radiation alarms, glow signs, signages, air/fumes exhaust, waterproofing, waterlogging protection *etc*, as may be necessary for the safety of the equipment, patients and personnel handling the equipment shall be provided.

viii) The vendor shall ensure the radiation safety aspect of the room, as per the AERB guidelines and shall get the necessary 'NOC' from AERB for operating the unit after installation.

ix) Water-cooling system for the linear accelerator should be compact, effective and supplied from the country of origin of the main equipment. Local units shall not be accepted.

x) Air-conditioning system and ducts for energy and temperature requirements shall be provided and installed and maintained by the vendor.

xi) A closed-circuit color TV system with 3 TV monitors and 2 cameras each in the LINAC and TPSs rooms shall be supplied.

<u>TURN KEY FOR SITE PREPARATION</u>

The prospective bidders for the main equipment shall inspect the site before submission of tender and give the certificate to the effect that the site is suitable for the installation of the installation of equipment to be procured for Radiotherapy. Linac room, Chiller room, Server Room, CT Simulator room and the whole radiation area.

1. CIVIL WORK :

1.1 The civil work need to be undertaken in a skeleton structure built by hospital contractor after AERB certification and approval.

1.2 Flooring – High density Vitrified tiles only in all the areas.

1.3 Walls – High density vitrified tiles only all the walls up to false ceiling in all the areas.

1.4 All the doors should be aluminium glazed door of thickness 10 gauge with 20 micron anodizing and with 5.5 thick wired glass / 12mm thick pre-laminated board wherever specified.

1.5 All the door should be provided with Hydraulic type door closures.

1.6 All the doors should be provided with mortise locks of GODREJ/LINK/Harrison make except that of the main doors, which should be provided with link locks.

1.7 False ceiling – Powder quoted Armstrong Metallic.

2. PLUMBING WORK

Plumbing work has to be carried out as per the requirement. The waste pipes and accessories should be of centrifugally cost iron and the connection of existing main hole in the public shafts shall be done. All water pits and fitting shall be galvanized iron of Tata make. The gratings shall be brass chrome plates.

3. ELECTRICAL WORK

The firms shall be required to specify the total load requirement for the entire equipment the air-conditioning units, room lighting and for the accessories, if an. The institute up to the distribution panel will provide the load. The distribution panel should give switchgear of SIEMENS/ l & T makes and shall be provided by the vendor. The electrical work will include wring, lighting and main switch fittings. Special roof light will be required particularly in the machine room which should have long life and should not be affected by frequent to on the off.

THE ELECTRICAL WORK SHALL INCLUDE THE FOLLOWING:

3.1 Wring the wire shall be of copper of different capacity as per the load and should be renowned make like: FINOLEX, BATRA, HENELEY, HAVELUS.

3.2 SWITCHES, Light and power point should be modular type of MK, North West ACHORE (Roma) / CCIPSL/SSK brands.

3.3 General Lights: Mirror optic type 1x40 w or 2x40 w PHILIPS/CROMPTON/KESSELECSCHREDER/ WIPRA/BAJAJ Brands.

3.4 The underground cables: supplying the electricity load should be of CCI/FORT GLOSTER, HAVELLS and ECKO Brands.

3.5 MCBs/ACBs/MCCBs should be MBS/SIEMENS/GE/ABB.

3.6 Roof light ; CFL down lighters of PHILIPS/OSRAM/WIPRO.

3.7 Main switchgears, fuse units should be L &T / SIEMENS/ GE.

3.8 Telephone cables should be of FINOLEX, HAVELLS & ECKO Brands.

3.9 Electrical load of the linear accelerator machine to be added as per the tender / brand of the equipment.

3.10 Main Electrical panel should be supplied.

3.11 Appropriate cable from substation to main panel is also to be provided.

4. AIR CONDITIONING

Whole area needed to be air-conditioned. Use of fresh air system and no recycling system. Head exchanger to save energy will be preferred. Six air changes per hour are required, as per the size of the area and circulation efficiency. Ventilation of remove air dissipated from the room as per requirement.

4.1 Environmental Specification Humidity range: 40% to 80% relative humidity, non – condensing. Temperature Ranges 19 deg. C to 27 deg. C through the year. Detail for the ducting diffuser, grills etc to be supplied by Engg. Deptt.

4.2 Provide ventilation sufficient for removal of equipment air heal load as per requirement of the accelerator.

4.3 Provide ventilation sufficient for removal of equipment air heat load as per requirement of the accelerator.

4.4 Air-conditioning load : Air conditioning load for the new liner accelerator area shall be 30 TR. To provide HVAC system 4x TR of air cool package units are to provided (3 nos. working & 1 no stand by) of the following approved makes.

(i) VOLTAS

(ii) BLUSTAR

(iii) ETA

(iv) CARRIER

However, the halting load calculation and maintenance temperature and humidity shall be the responsibility of the agency and offered as option.

4.5 Double earthling with copper plate is to provide separately for the air conditioning equipment as per (S) specifications in addition to the double earthling of the medical equipment

5. FIRE PROTECTION

The fire protection is to be integrated as per the requirement heat deflector / Hooters/ Photoelectric smoke deflector shall be provided as per the requirements of IS/BIS code. The ionization detector should not be used. The fire alarm panel shall be linked the main panel of the institute.

6. ELECTRIC PROTECTION OF THE INSTALLATION:

The use of earth leakage circuit breaker will be required. Emergency switches interlock devices and warning lights have to be integrated into the planning.

7. EMERGENCY LIGHT

Provide a battery backup emergency lights both in machine room and console control area.

7. FURNITURE:

7.1 Control console and computer plate forms should include:

-Key board drawer – 3nos.

-Self or base for computer table – 6nos.

-Wall side board in machine rooms:

a). For Block storage, wedges storage, applicators storage and compensators storage – 6nos.

b).For storage of patient position accessories and mask etc. – 4nos.

8. Time period and payment for turnkey:

Turnkey work, installation & commissioning should be completed strictly as per the schedule.

NOTE:

1. Irrespective of specification mentioned, it is the responsibility of the firm quoting for STATE-OF-THE-ART EQUIPMENT to physically inspect in detail, the pending job to be done at the site where above systems are to be Installed as per regulatory guide lines. It is also the responsibility of the same vendor, to avoid duplication of work as the construction of the bunkers have already reached near completion.

2. In case the successful bidder proposes to use material other than specified brand then approval of the client is mandatory.
3. It shall be the sole responsibility of the bidder to interact with LHMC, New Delhi for optimal utilization of resources without any duplicacy of work.

Bidders are requested to collect the required AERB approved drawings from Director, LHMC, NewDelhi.

Schedule 3 - Technical Specification for High Dose-Rate Brachytherapy Remote-After Loading System

General Specification

The High Dose-Rate (HDR) Brachytherapy Remote After-Loading System includes Treatment Unit, Control Unit, Treatment Planning System and applicators and other required accessories for clinical application. The HDR system should be capable for the treatment of intracavitary, intraluminal, interstitial and surface mould brachytherapy.

1. Brachytherapy Treatment Unit:

1.1 The system should be capable for the treatment of intracavitary, intraluminal, interstitial and surface mould brachytherapy

1.2 The HDR system should be latest microprocessor and PC controlled and it must have latest hardware and advanced software.

1.3 The system should have minimum **18** channels or more for all types of brachytherapy treatments.

1.4 The system should be on wheels for easy mobility in the treatment area and provided with storage safe of lead/ tungsten alloy to guarantee and compatible with guidelines of international safety regulations especially AERB.

1.5 Specify the in-built radiation safety measures provided in the unit including power failure, emergencies, channels indexer, activity of the source and dose rate, verification system for channel number and connectivity of the applicator etc.

1.6 Specify the surface dose rate of the system source container when full strength of the source is loaded

1.7 The treatment unit should have an in-built integrated radiation detector to check the safe return of the source (GM Type tube).

1.8 The source must be retractable and reach in the safe position in the events of an emergency/ power failure etc specifies the source retraction methods.

1.9 Refurnished / reconditioned unit should not be offered. The vender shall quote month and year of the fabrication of the unit and provide the certificate of the same & of its being original.

1.10 The Source head should have adequate shielding and its height should be adjustable.

1.11 The system should have the dummy cable to check the treatment parameters prior to treatment.

2. Radioactive Source

2.1 The system should use either radioactive sources of Ir-192 or Co-60.

2.2 Activity should be capable of using at least 10Ci Ir-192 or 2Ci Co-60 source.

2.2 Please specify the activity, physical characteristics and dimensions of the source being supplied with the unit. Specify the number of source offered and usability period of the each source quoted. Please specify the following:

(i) Specify the maximum source extension

(ii) Specify the step size (minimum two or more are preferred

(iii) Specify the dwell position per catheter

(iv) Specify the maximum dwell time per position in the catheter

(v) Specify the maximum treatable length in cm

(vi) Specify the accuracy in position in mm.

(vii) Specify the active diameter and length of the source.

(viii) Specify the mode of source movement in each channel of the unit

(ix) Source cable must be able to pass through catheters of curvature 2 cm or less

3. Treatment Control Console:

3.1 Stand alone and independent PC based control unit should be provided with flat panel 21" or larger plasma color monitor, keyboard, mouse build in audio card, network card, backup media, printer etc and direct link with 3D-TPS to be supplied.

3.2 It should have protection circuit inbuilt to prevent treatment without proper applicator connection, door closing and proper index locking.

3.3 It should have all self-testing provision necessary for the treatment

3.4 Control unit software should run on window application

3.5 Access must be limited to authorized users with password protection

3.6 The treatment times must be automatically corrected for the decay of the radioactive source

3.7 There should be higher dwell position for the source in each channel

3.8 On-line extensive display of status codes with an indication of the action required

3.9 Large patient's database should be provided with a backup option to an external storage device

3.10 The system should provide real-time information during treatment.

3.11 Provision for checking of complete operation of the system prior to actual treatment including electronic and radiation safety checks should be available.

4. Brachytherapy Treatment Planning System (TPS)

4.1 A state-of-the-art brachytherapy planning system capable for performing conventional 2D and advanced 3D-treatment planning with dose-volume histogram analysis methods and different methods of optimization of the treatment plan and also inverse planning module, for planning of all treatment techniques like intracavitary, interstitial, intraluminal, and surface mould.

4.2 System should have input capability of receiving patient information i.e patient data through scanner, digitizer, and directly from CT, MRI, C-Arm X-ray unit through DICOM 3.0 or Radiotherapy compatible interface

4.2 The system should be capable of doing multimodality image registration and also should have the features of auto-contouring of the organs and applicator etc.

4.3 The 3D planning and viewing of dose distribution in coronal and sagital cuts and any other possible cuts should be provided.

4.4 The system should include the plan library, source and applicator library, optimization and isodose sharper tools and reporting tools etc. specify the features.

4.5 The treatment times must be automatically corrected for the decay of the radioactive source

4.6 The system should be cabable of summation of brachytherapy and external beam dose distribution and 3D viewing.

4.7 The Networking (on-line) between HDR treatment unit and TPS should be provided and it should be connected with C-arm X-ray machine and simulator and other imaging modalities.

4.8 Any other specific advantage of the system may be mentioned.

4.9 Hardware: Treatment planning system should have a latest computer with high speed with most modern graphics workstation, fast processor with RAM of maximum latest availability and should have a Hard Disk with large storing capacity of maximum available memory, Key Board, Mouse of latest configuration.

4.10 The system should have at least 21" TFT LCD Screen with high resolution for good visualization

4.11 For patient data input FILM SCANNER should be provided (offer for Flat bed & High Resolution Vider scanner should be quoted separately)

4.12 One color printer A3/A4 size for printing the treatment planning and plotting of isodose should be provided.

5. Applicators for HDR Unit

5.1 Supply the standard accessories for the application of intracavitary, intraluminal, interstitial brachytherapy of cervix, vagina, rectum and head and neck esophagus and bronchial, breast and prostate applications. Applicators to be provided for;

5.2 Gynecological **Fletchers** applicator – 6 sets

5.3 CT / MRI compatible gynecological **Fletchers** applicators – 2 sets

5.4 Vaginal / Rectal applicator – 2 sets

5.5 Esophagus applicator – 5 sets

5.6 Nasopharyngeal applicator – 5 sets

5.7 Breast and Prostate templates – 2 sets

5.8 Surface mould – 5 sets

5.9 All kinds of x-ray markers (two sets) for the applicators supplied (wherever relevant) Interstitial implant needles – Total 300 numbers of needles in three different lengths

5.10 Provide the catalogues of the all the applicators. All the guide-tubes must be functional for 10 years.

6. Radiation Dosimetric, Quality Assurance (QA) and Safety System/Tools

6.1 Quote all the QA tools and radiation monitoring and measuring instrument being supplied with the unit. The detailed should be furnished.

6.2 Emergency container/ source container as per AERB norms

6.3 Brachy treatment table with all accessories

6.4 Gamma zone monitor with audio alarm

6.5 Beta, Gamma irradiation chamber survey meter

6.6 Calibrated Well-Type chamber, electrometer and phantom (attach with valid calibration certificate).

6.7 Source position simulator and source check ruler

6.8 Two online UPS with 30 min backup for total system (HDR machine and TPS)

6.9 Closed Circuit TV system along with standby camera

6.10 X-ray reconstruction jig.

6.11 X-ray marker wire for all applicators.

7. Equipment Warranty and Service:

7.1 Five years warranty to be commenced from first patient treated as per AERB norms.

7.2 CMC year-wise for all quoted machines, UPS, Battery and other accessories for next 5 years after warranty

7.3 Spare parts should be available for minimum of 10 years.

7.4 Source: (i) If Ir-192 sources is offered in that case minimum **20** sources should be supplied in 10 years. Every four months or as and when required to maintain HDR treatment delivery. (ii) If Co-60 sources is offered in that case minimum two sources to be supplied free of charge in 10 years, first with machine and second after 5 years or as and when required. Loading of new source and unloading of the decayed source, source transportation, source export and disposal will be part of the offer.

7.5 Quote the rates of consumables recommended valid for 5 years block.

7.6 Factory trained service engineer/Applications specialists should be available in Delhi to look after the installation and maintainace of the system without patient treatment interruption.

8. Training and documentations

8.1 The treatment planning system and treatment unit's operational training should be provided to one Radiation Oncologist and one Medical Physicist at a centre of repute for 1 week in the country of manufacturer and also on-site training of 1 week to staff of dept.

8.2 User / Technical / Maintenance manuals to be supplied in English

8.3 Certificate of calibration and service inspection should be provided.

Schedule 4 - Technical Specification for a CT-Simulator

Sealed tenders (Sealed separately as the "Technical Bid & the Price Bid-in duplicate) are invited directly from the manufacturers/principles for the supply of a state-of the-art and latest technology based CT-Simulator. The CT-simulator includes CT scanner, laser system and virtual simulation system. The CT **simulator** should be of **spiral multislice, large-bore 16 slices per rotation** model. It should be capable of integrating with standard networking and PACS systems available in the hospital**.** The offered equipment should have the following technical features.

1. CT Scanner system

1.1 The system should be of latest slip-ring technology allowing acquisition of 16 slices per rotation with true isotropic volume acquisition and sub millimeter resolution of an at least 0.4mm **or more**.

2. X-ray Generator

2.1 High frequency x-ray generator with an output of at least 50 KW or more to support continous and sustained operation. Please give details.

3. X-ray Tube

3.1 Tube current: 30-400mA or more. The mA rating at peak generator power must be mention.

3.2 The system should have mechanism for real time mA modulation for both Z axis and angular dose modulation

3.3 Tube voltage should be in the range of 90-140kV

3.4 The x-ray tube should have anode heat storage capacity of 5 MHU or more.

3.5 The anode peak heat dissipation rate should be 700 KHU/min or more angular dose modulation.

3.6 The x-ray tube should have dual focal spot (please specify the size of each focal spot). The automatic selection of focal spot should be possible.

3.7 Filter and beam limiting device: Their Al equivalent (at least 5mm) and other specific features to reduce radiation dose to the patient must be specified.

4. Gantry

4.1 Gantry aperture should be minimum 80 cm or more
4.2 Gantry tilt should be at least ±30 degree
4.4 Entire range of rotation times for full 360 degree should be specified.
4.5 Remote controlled tilt from operator table should be possible.

4.7 Laser alignment lights should define accurately actual scan of plane. It should operate over full range of gantry tilt.

4.8 Green laser patient alignment system with (gantry and external wall /ceiling mounted) stationary and mobile for radiotherapy planning should be provided.

5. Patient Table

5.1 The scanning table should be universally flat with flat table top and should be compatible with tables of linear accelerators installed. The table should have patient positioning index system on carbon fiber table top.

5.2 The table should be able to bear weight up to 200 Kg or more.

5.3 Table should have the metal free scanable range should be at least 150 cm.

5.4 Horizontal accuracy should be ±0.50 mm or less

5.5 Vertical table travel range should be specified. Minimum at least 55cm height.

5.6 Table should support the immobilization accessories for conformal and stereotactic procedures. QA phantom holder, water level phantom and laser calibration bar should be provided.

5.7 The table should have total free floating facility

5.8 All patients positioning accessories including tilt should have control both form gantry and control console

6. CT scanning parameters

6.1 The slice thickness should be users selectable which range from 1 mm to 10 mm.

6.2 Minimum scan time for full 360 degree rotation should be 0.5 seconds or less for whole body applications.

6.3 Maximum true scan field of view should be at least 50 cm or more

6.4 Extended reconstruction FOV of at least **65**cm should be possible.

6.5 Gapless spiral length should be 150cm or more.

6.6 Specify single continuous spiral-on-time should be minimum 100 seconds or more.

6.7 The system should automatically optimize radiation dose and resolution for each selection.

6.8 Bolus triggered spiral acquisition should be possible. Give detail of sub millimeter resolution.

6.9 Both spiral and sequential mode acquisition should be possible for all scanning protocols.

6.10 Prospective and Retrospective respiratory compensated/gated CT to generate 4D datasets must be compatible with all commercially available hardware and software for motion management to localize the tumor in motion. Specify the details.

7. Scannograms/Topogram

7.1 Length and width: specify the range

7.2 Scan times: specify the range

7.3 Views: should be feasible in frontal and lateral views

7.4 Should be possible to interrupt acquisition manually once the desired anatomy is obtained.

8. Data Acquisition system

8.1 Detector: Please specify the number of detectors, detector design and type of detector.
8.2 Number of rows with their thickness, number of elements in each row
8.3 Mention the channels per row and number of projections
8.4 In-built mechanism for adapting the tube current during each scan. This should enable radiation dose reduction where body part thickness is less. Specify the mechanism used in the offered system.
8.5 There should be in-built pediatric protocols adapted to weight and/or age.
8.6 Specify available mechanisms to reduce the effective patient dose.

9. Image Reconstruction:

9.1 Real-time reconstruction speed: 10 images per second or more at 512x512 matrixes.
9.2 Display matrix should be minimum 1024 x 1024 or more.
9.3 Freely selectable window width and centre with organ specific preset windows be possible
9.4 Retrospective reconstruction with variable slice thickness should be possible.

10. Image Quality

10.1 High Contrast Spatial Resolution: It should be 15 lines pair per cm or better (for 50 cm FOV) maximum at 0% MTF for a slice of 1 cm thickness. Clearly specify the phantom used, scan time, mA, filter for image reconstruction, scan field, dose and MTF.
10.2 Low Contrast Detectability: The low contrast resolution for CATPHAN should be at least 5mm or less at 0.3% using 20cm CATPHAN phantom on 10mm slice thickness.
10.3 Spiral parameters: Different selection of pitch should be possible, from 0.5 to **1.5 or more** in 0.1 increments. Inter scan delay in different group of spiral should not be more than 5 seconds.
10.4 CT number accuracy must be better than $\pm$ 4HU for water and $\pm$10 HU for air. All necessary phantoms to check the spatial resolution of the scanner should be provided. A phantom to check the electron density to HU relationship for different body tissues must be provided.

11. CT Control Console

11.1 It should have **19"** or more TFT flat screen LCD colour monitor for display of 1024 x 1024 matrix or more.
11.2 Computer CPU systems should be running on a high-end workstation platform with UNIX/Window of latest configuration. RAM size must be atleast 8GB or better.
11.3 All functions viz. registration, scheduling, scanning, image reconstruction, image evaluation tools, post processing tools, film documentation and transfer of images, MPR, CT, maximum intensity projection, 3D with SSD etc should be possible from main console and workstation
11.4 Image storage of 500 GB or more for at least 2, 50,000 or more images in 512 x 512 matrixes uncompressed or better (quote the latest configuration)

11.5 At least one **imported high resolution 1200dpi or more (Canon/HP/EPSON/Techtronix)** laser color printer with latest model should be provided.
11.6 CD/DVD facility for archiving must be available.
11.7 The image reconstruction time should be less than 1.5 second for any mode.
11.8 An on-line juke-box with total storage capacity of 1.5 Terra bytes with fully loaded media for data storage should be provided.
11.9 The system should have fully DICOM complaint. DICOM compliance statement should be provided.
11.10 An integrated intercom for bi-directional speaker communication between operator and patient and also automated patient instruction (API) system should be provided.

12. Laser System

12.1 The CT-Simulator laser systems should have at least **three** computer controlled moving lasers for marking the isocenter without moving the table top. Following the isocenter localization in the CT-Simulation workstation, the isocenter coordinate will be sent directly to the computer system that is controlling the movements of the lasers. This computer in turn should drive all the lasers, so that without moving table, the laser point to the isocenter. The laser must be GREEN LASER system. Complete quality assurance tools must be provided.
12.2 In addition to the moving laser, the CT -Scanner should have conventional in-built lasers for positioning the patient
12.3 The vendor should give a complete description about the laser marking system offered and how the CT-Simulation software integrates with it.

13. CT-Simulation/Virtual Simulation System

13.1 The CT-Simulation/Virtual Simulation System should be possible to simulate all kinds of teletherapy machines in the simulation workstations without any kind of restrictions. It should support IEC, Varian, Elekta and other user defined linear accelerator conventions.
13.2 It should be possible to visualize interactively reference views in axial, coronal, sagittal, isocenter image planes and in any oblique direction with overlay of beams on digitally reconstructed radiograph (DRR).
13.3 DRR must provide fully divergent beam's eye view (BEV) 512x512 images.
13.4 The DRR and BEV/Room-eye view image should display the machine diagram to allow real-time checking of machine and patient geometry.
13.5 The system should be possible to support and define the asymmetric features in the Simulation software.
13.6 The system should be possible to support and define the multileaf collimator placement of 40 or more pairs of MLC leaves in the simulation software.
13.7 **Two** CT simulation workstation must be provided in addition to the CT workstation.
13.8 System should incorporate CT, MRI, PET and SPECT into localization, image fusion and registration

14. Contouring

14.1 Volume definition should be possible using volume segmentation using threshold, free hand contour tracing, contour editing, 3D anisotropic margins etc and any other advanced tools

14.2 System must be able to contour in axial, sagittal, coronal and oblique projections.

14.3 It should be possible to do manual, semi-automated, fully-automated contouring in the images by defining volume of interest.

14.4 The software should have facility for automated uniform/non-uniform margins. For example it should be possible to expand the clinical target volume (CTV) on all three dimensions by same magnitude or by different magnitude to define the planning target volume (PTV).

14.5 It should be possible to copy one organ to another with margin, and margins on a single slice, a range of slice or all slices.

14.6 Interpolate algorithm should be available to provide interactive, shape and interpolation i.e. after contouring only in selected slices. The algorithm should automatically interpolate the closely fitting contour in other slices. Interpolated contour may be edited; accepted or rejected.

14.7 Tracking of source to skin distance and contouring/extracting of wall should be possible

14.8 System should have the capability of 3D viewing and volume rendering should be possible.

14.9 The software should provide the density value (in Hounsfield Unit) of a particular point on an image. It should compute distances along straight line and curved line, angles between lines, and radius of the curvatures for curves.

14.10 Any other advanced features which may be of standard or optional, should be specified.

15. Isocenter Management

15.1 The software should support separate isocenters for multiple target volumes or general regions

15.2 Marked and final isocenters should be reported and displayed in the localization package for easy confirmation of a physical simulation session.

15.3 Hardcopy of the isocenter coordination should be possible for record of the simulation.

15.4 Isocenter positioning should be automatic.

15.5 No limit on number of isocenters per target.

16. Beam Placement and Definition

16.1 If should support extensive beam shapers (shielding blocks etc) and beam definition methods.

16.2 Manual or automatic beam placement tool.

16.3 Beam shaping should be possible in multiple ways like automatic shielding block, definition conforming to selected volume, definitions aperture or shielding manual free hand definition, automatic collimator jaw or multi leaf position definition.

16.4 It should be possible to define this asymmetric collimator feature, where both the X and Y axis are asymmetric, in the CT simulation software. Similarly the software should allow multi-leaf-collimator placement up to 40 pairs or more.

17. DRR Features

17.1 Interactive DRR calculation mode must be available.
17.2 Automatic window width/level selection for DRR.
17.3 DRR should be interactively updated when the isocenter position is modified.
17.4 Should be possible to highlight or suppress different density region in the DRR.
17.5 Printing of DRR images should be possible.DRR presets should be user defined.
17.6 Reconstruction of DRRs should be real-time or sub-second.
17.7 Real-time display of DRR as beam parameter changed should be possible.
17.8 Differential tissue weighting in DRR calculation should be possible.
17.9 Facility to display BEV on MPR with fields and blocks displayed divergently.
17.10 Any other advanced features available should be specified.

18. Data Import/Export and Connectivity

18.1 System should be able to export image, volume and plan data in DICOM 3.0 standard along with all Radiotherapy specific data and private objects, DICOM RT plans and data sets.
18.2 System should be able to import DICOM RT data to the linear accelerator of any vendor.
18.3 CT simulator system should be fully integrated with the existing TPS. The vendor should inspect and will be responsible for complete integration.
18.4 Specify clearly the DICOM-RT import and export licenses that are being offered.
18.5 The entire CT-Simulation system must be interconnected (all the workstations, laser systems, printers, etc) must be integrated to treatment machines available in the department for smooth transferring of images and DICOM-RT structures.

19. Archiving and Documentation

19.1 Should be on a Color dye sublimation printer to be supplied along with system. DICOM print should be possible.
19.2 Adobe PostScript Printing should be possible.
19.3 Archiving should be on a CD in DICOM format.
19.4 User / Technical / Maintenance manuals to be supplied in English.
19.5 Certificate of calibration and inspection
19.6 List of Equipments available for providing calibration and routine preventive maintenance support as per manufacturer documentation in service / technical manual.

19.7 List of important spare parts and accessories with their part number and costing.

19.8 Log book with instruction for daily, weekly, monthly and quarterly maintenance checklist.

20. Equipment Warranty and Service Facilities

20.1 Five years warranty to be commenced from first patient treated as per AERB norms.

20.2 CMC year-wise for quoted machine, UPS, Battery and other accessories for next 5 years after warranty period.

20.3 **95%** uptime warranty/guarantee during warranty and CMC period.

20.4 Spare parts should be available for minimum of 10 years.

20.5 During the warranty period, all the software updates and upgradation should be provided without asking for free of charge.

20.6 Please quote the rates of consumables recommended as well as other necessary consumables valid for 5 years block

20.7 Factory trained service engineer/Applications specialists should be available in Delhi to look after the installation and maintenance of the system without patient treatment interruption.

21. Standards, Safety and Training

21.1 Equipment standard and safety should comply with the national regulatory AERB guidelines and offered model should have AERB type approval or NOC.

21.2 Should be FDA and/or CE certified product.

21.3 The vendor should provide comprehensive training on CT-Simulator in a well advanced center in any developed country for two persons (one for Radiation Oncologist, one for Medical Physicist).The training period should be at least for two weeks.

21.4 On-site Application training should be provided for minimum two weeks for all staff members in the department.

22. General Terms & Condition

22.1 Any optional items to be quoted separately with separate prices in price bid.

22.2 The vendor shall list the number of their CT-Simulator installation/user in India.

22.3 All claims regarding meeting the specification should be duly supported by appropriate, latest technical catalogues/brochures from the manufacturer.

22.4 Penalty clause: Penalty at the rate of RS.10, 000 per day for short falling of 95% uptime guarantee. If the machine lies non-functional for a period of more than two weeks continuously, the same penalty will be imposed even if 95% uptime clause is me with.

Scope of work for turnkey CT Simulator-

The supplier should inspect the proposed site and submit all the detailed structural and architectural drawings and BOQ for the proposed CT Scan Centres along with technical bid of the tender.

The CT SCAN CENTRE shall consist of the following rooms:

a. CT Gantry Room

b. Console room

c. Equipment room

d. Patient preparation room

e. Reporting room

f. Patient waiting area

g. Radiologist room

The actual area of turnkey works done will be considered for payment, based on the site measurements.

Civil work

a) Civil construction work including construction of brick wall if any, plastering, flooring as per the approved plan and equipment layout plan.

b) Concrete bed at CT equipment area.

c) Platform for unloading and shifting the CT should be provided if necessary.

d) Cable tray, trench & channel – necessary trenches, cable tray and channels at required location would be provided.

e) All the construction work to be done as per the final plan approved by the Consignee.

f) Active and passive room shielding for magnetic, fringe field should be provided as per the requirement of the equipment.

a) Flooring

1. 600 x 600 mm vitrified tiles with 100mm tile skirting to match in console room, lobby and patient preparation areas, Radiologist room etc.

2. 50 mm thick cement concrete flooring with Vinyl flooring in CT equipment / UPS room.

b) Painting

1. Two coats Plastic Emulsion Paint over 2 coats of wall putty including primer in patient preparation area, Lobby area, console room, CT Gantry & Equipment room etc.

c) False Ceiling

1. Acoustical tile for ceiling with light weight insulating material of high quality supported on grid or finished seamless with support above ceiling. Finished with white paint or powder coated with white paint, if metallic.Ceiling height to suit the equipment mount and clearances.

Plumbing work

1. All water pipes and fittings shall be of high density polythene of approved and standard make. The gratings shall be brass chrome plated. All plumbing accessories should be of standard make.

2. Hot water service to be provided if required.

Electrical work

1. The supplier shall be required to specify the total load requirements for the CT scan centre including the load of air conditioning , room lighting and for the accessories if any. The supply line will be provided by the Institute up to one point within the CT Scan centre area. The distribution panel shall be provided by the vendor. Few lights in each room shall be connected to the UPS to provide emergency lighting.

2. The electrical work shall include the following:

a. Wiring – All interior electrical wiring- with main distribution panel board, necessary MCBs, DB, joint box, switch box etc. the wires shall be of copper of different capacity as per the load and should be renowned make as listed below.

b. Switches light and power points should be of modular type and of standard make as listed below.

c. General lights – Mirror optical type 1X28 W or 2X28 W/CFL fittings 2X36, 3X36 W with electronic ballasts

2.AIR CONDITIONING:

Ductable package air conditioners and split AC units may be used according to room requirement and suitability. Humidity control should be effective to eliminate moisture condensation on equipment surface. The Air conditioning should be designed with standby provision to function 24 hours a day.

The outdoor units of AC should have grill coverings to prevent theft and damage.

Ventilation is required in toilet.

2. Environment specifications:

a) a) Humidity range: Relative humidity 60% and 80% in all areas except equipment room which shall be as per requirement of the equipment.

b) b) Temperature ranges: 22± 2° C in all areas except equipment room which shall be as per requirement of the equipment.

c) Air conditioning load: The heat load calculations and maintaining the desired temperature and humidity shall be the responsibility of the bidder.

Furniture:

a) Revolving chairs height adjustable, medium-back with hand-rest in the Control room, Radiologist room and viewing area. – 4 NO.S

b) Chairs for patient waiting area – Three seater (chrome plated). - 10 NO.S

c) Cupboard with laminate door shutters for storage of spare parts and accessories and records as per requirement. – 3 NO.S

d) Drug trolleys 1 numbers for patient preparation area.

e) Patient trolley with rubber foam mattress to be kept in the patient preparation room.

f) Name boards for all rooms

g) Tables for Workstation and Radiologist in reporting room.- 2 NO.S

h) Changing rooms should have change lockers and dressing table.

i) Dustbins (plastic with lid) to be provided as required.

j) Any other furniture item as per requirement.

All furniture items should be of standard make as mentioned in the table below.

Miscellaneous:

1. Reporting room should have LED X-ray Film viewer with adjustable brightness ; capable of holding 3 films of 14”x17” size. – 2 no.s

2. Cabling of Network (LAN) connectivity for camera system, console system, workstation and computers etc.

3. Broadband connection: for REMOTE SERVICE of CT system.
4. Fire extinguisher Dry CO2 type as required for the building safety.

Items & Makes

Flooring-Vitrified Tiles- Somany, Kajaria, H&R Johnson, RAK India

Electrical-

Cables-Finolex, Havells, V-Guard

Switches-Legrand, L&T, Crabtree, Roma

Distribution Box, MCB-Legrand, L&T, Siemens, Havels

Light Switches-Philips, Crompton, Wipro, Kesselec-Schreder

Air-conditioning-Daikin, Hitachi, Blue Star, Voltas
Furniture-Herman Miler, Godrej, Featherlite

Accessories

a). Multi size Dry Laser Imager of any reputed make with 600 dpi or more.

b). Color Laser Printer.

c). Lead Glass of recommended size & thickness

d). UPS with half an hour back-up of suitable capacity to handle CT Scanner System.

e). Laser Color Printer.

f). Dual Head Pressure Injector of reputed make with 100 no. syringes & tubings.
g). Suitable ECG Monitor.

Suppliers of both High Energy Linear Accelerator and Dosimetry Systems shall be responsible to co-ordinate with each other at site for their integration and their satisfactory installation and commissioning, training and hand-over.

Note: It is the responsibility of the bidders to quote in conjunction with Bid Document and all earlier Amendments issued so far against this Tender.

In view of the above Amendments, the due date is extended from 21.10.2014 to 29.10.2014. This is the final amendment being issued.

Rest all remains unchanged.

Director
LHMC, New Delhi