Baba Farid University of Health Sciences, Faridkot

E-TENDER NOTICE FOR supply & installation of **High Energy Linear Accelerator Machine on turnkey basis for Tertiary Cancer Care Center Fazilka (Punjab).**

Annex I

REVISED TECHNICAL SPECIFICATION

General:

1.1. The Linear Accelerator proposed to be purchased must be procured from the original manufacturer. It should be one of the **latest Models** capable of delivering at least dual energy photon and multiple electron energy treatments. Equipment with superior technical features & technology will be preferred.

1.2. The vendor must be either the original manufacturer or its Indian counterpart possessing complete sales and service facility in India so as to give efficient servicing within 24 hours of a Telephone, Email or Fax communication from the Department of Radiotherapy & Oncology Guru Gobind Singh Medical Hospital, Faridkot (PUNJAB), India during the entire period the Linear Accelerator remains installed in the Tertiary Cancer Care Center, Fazilka (Punjab).

1.3. A competent service engineer must be positioned at the Tertiary Cancer Care Center, Fazilka, for one year from the date of commissioning of the Linear Accelerator at the Tertiary Cancer Care Center, Fazilka. The vendor will be solely responsible for ensuring that the Linear Accelerator is installed within the given time frame as a turnkey project.

1.4. The system should include and the basic platform must accommodate, besides conventional modes of radiotherapy comprehensive facilities for delivering the 3 Dimensional Conformal Radiotherapy (3DCRT),Intensity Modulated Radiotherapy (IMRT),Image Guided Radiotherapy (IGRT) consists of both 3D and 4D radiotherapy, Volumetric Modulated Arc Therapy (VMAT): Single and Multiple arc treatments, Stereotactic Radio surgery (SRS): Frameless & Frame based, Stereotactic Radiotherapy (SRT) : **Frameless/Frame based**, Flattening Filter Free (FFF) delivery mode for VMAT / SRS / SBRT. Note that treatment modes for above should be deliverable with or without the flattening filter on the same machine.

1.5. The Supplier must have sufficient experience in manufacturing, sale, installation, commissioning and reliable maintenance service of the Linear Accelerator both in India and developed Countries

1.6. The main equipment and accessories must have mandatory approval for sale and installation in India issued by National Competent Authority. It should have regulatory type approval from AERB. Any feature offered with NOC of AERB shall be made functional on installation and handing over of the unit. Otherwise, the EMD and Security deposit thereof will be forfeited.

1.7. Approval and clearance for actual commencement of treatment at CMC will be the main criteria for completion of installation for which the supplier must involve at every level in tandem with efforts of Department of Radiotherapy & Oncology Guru Gobind Singh Medical Hospital, Faridkot, Comprehensive warranty on all items without any exception for a minimum of 5 years.

1.8. Non pro rata warranty on Electron Gun, Magnetron, Klystrons, Thyratron, Bending Magnet, Vaccum Pump, In built monitor chambers, X-ray tube, cone beam CT and Electronic Portal Imaging system (including all robotics), Radiofrequency generator, pulse modulator, multi-leaf collimator system (includes multi-leaf collimator, motor and all electronics required to drive the MLC system), Optical Field System and **Optical Surface Mapping System**, couch top and complete couch control system **to be quoted as standard item**. This non pro rata warranty

should extend for a minimum period of **10 years** from the date of commissioning of the Linear Accelerator at Tertiary Cancer Care Centre, Fazilka, Punjab. The wave- guide should have non pro rata warranty for at least **10 years**.

1.9. The scope of work shall include supply, installation, commissioning, satisfactory demonstration and turnkey operations. This includes testing, packing, transportation, scheduling of transportation, transit insurance, delivery at site, loading, unloading, and lifting and storage services associated with delivery, Comprehensive warranty and comprehensive Maintenance contract (CMC). The successful bidder will assume full responsibility of the complete supply of equipments / stores until its final acceptance.

2	**Photon Beam Characteristics**
2.1	The following energies should be available without requiring extra cost: 6 MV, 10 MV, 15 MV. 2. Flattening Filter Free Energies: 6 MV and 10 MV Mention the spread of energies from the peak values. A difference of ± 2% in the depth dose data from the published values in the British Journal of Radiology is acceptable.
2.2	Variable Dose rate selection - specify the dose rates. Must be variable from 100 - 600 MU / min for treatments with flattening filters (10 x 10 cm field at 100 cm TSD). Without flattening filters dose rate must be at least 1400 MU/min for 6MV beams. Specify in detail. Also specify if higher dose rate is available as it is desirable for SRS/SRT
2.3	High Intensity Dose Rate - If flattening free mode is available then specify the maximum dose rate in MU/min for different energies available.
2.4	Specify range of dose rates available for all photon energies for field size of 10 x 10 cm at TSD of 100 cm.
2.5	Specify the D_{max} at 100 cm SSD **for all energies** in tissue equivalent material at field size of 10 x 10 cm.
2.6	Specify the %DD at 10 cm depth in tissue equivalent material for all the energies as per the BJR/AAPM protocol.
2.7	Specify the consistency of dose rate at 100 cm SSD with time Provide data.
2.8	Field Size : Minimum 0.5x 0.5 cm^2 Maximum 40 x 40 cm^2 at SAD of 100 cm
2.9	**Specifications as per AERB protocol**. 1. Field congruence for Field Size 5 x 5 to 30 x 30 cm^2 at different gantry angles at 100 cm to be ± 2 mm. 2. Digital and Mechanical field congruence to be within ± 2 mm. 3. Set optical field and measured optical field must agree within ± 1 mm for field sizes up to 10 x 10 cm and the same should not exceed 2 mm for larger fields. Specify in

	details. 4. Independent asymmetric collimators should be provided. Specify the range of travel with respect to the isocenter. 5. Field size resolution in digital display must be stated.
2.10	Collimator rotation - range should be specified. Dynamic rotation of collimator assembly should be possible during rotational / non rotational IMRT delivery.
2.11	Variation of mechanical and radiation isocenter during complete collimator rotation should not exceed 1 mm in diameter. Please specify the same for the system. This should hold true for all gantry positions.
2.12	Specify the following: 1. Isocenter to bottom of the collimator distance 2. Dimensions of the collimator 3. Collimator Jaw out travel in X and Y dimensions 4. Material of the Collimator 5. Percentage of transmission through collimator 6. State the accuracies of the display as in section 7.13
2.13	Must have mechanical and digital readout for collimator position. Digital display should be present in both treatment room as well as the console.
2.14	State the field flatness for all the photon energies (ratio of central value to that of 80% Isodoses) at 100 cm SSD at 10 cm depth at a plane perpendicular to the central axis.
2.15	Mention the field flatness for various gantry and collimator angles whiletreating with flattening filter.
2.16	Mention the field symmetry for the longitudinal and transverse axes at 100 cm SSD at 10 cm depth for different gantry angles.
2.17	The above parameters must agree with AERB specifications.
2.18	Penumbra : Measured as the width between 20 - 90% isodoses lines at a depth of 10 cm at 100 cm SSD must be below 10 mm. State the values.
2.19	In the flattening filter mode quote the above values for both states: with flattening filter and without flattening filter.
2.20	Asymmetric Jaws: All collimator jaws should have the capability for treatment asymmetric jaws. At least one set of jaws shall be capable of crossing the centre line by at least 10 cm as projected at 100 cm TSD. The collimators should re-centre automatically when the symmetrical mode of operation is re-selected. If the machine comes with independent X and

	Y jaws they should be capable of independent movement and have asymmetric capabilities as outlined above.

3	**Electron Beam Characteristics**
3.1	Electron energies available should be 6, 9, 12, 15 and 18 MeV
3.2	Dose rate should be variable up to 1000 MU / min. Specify the range.
3.3	HD TSE (High Dose Total Skin Electron) mode for total skin electron therapy should be available. The maximum dose rate for the HDTSE mode should be 2500 MU / min. The maximum energy available for HDTSE mode should be made specified.
3.4	A minimum of 5 applicators with variable sizes ranging from 4×4 cm^2 - 25×25 cm^2 in the step of 2 cm for all applicators should be available. The range of available field sizes should be specified.
3.5	Specify the dimensions and weight of each applicator
3.6	Each applicator should be able to support custom cerrobendcut-outs for field shaping. 10 trays for supporting these custom cerrobendcut-outs should be provided for each applicator size.
3.7	Field congruence for each electron beam must be with the optical field for various collimator and gantry positions must not be more than 2 mm at Isocenter.
3.8	Field flatness must be as defined by AERB. Please specify
3.9	Stability of field flatness during rotation of the gantry should be less than equal to 5%
3.10	The cross beam profile at D_{max} along X-Y & diagonal axes should be less than equal to 2% for 10x10 to 20x20 cm^2 fields for all electron energies at all gantry positions.
3.11	State the peak value of the dose in the plane perpendicular to the beam axis at Dmax depth for each electron energies and field sizes.
3.12	State the penumbra (between 20% to 90% isodose lines)
3.13	Provision for electron arc therapy and applicators for the same must be available. Specify details of: 1. Facility for delivery of preset dose over any preset arc 2. Specify the range of variable dose rates 3. CW and CCW delivery of preset dose must be available

3.14	The following should be available for High Dose skin electron therapy 1. **Rotating table marked with angular rotation on which patient can stand during therapy (more than 4m)**. 2. Lucite tray**/frame** of sufficient thickness to modulate the beam energy from 6 to 3.8 MeV across the entire height. 3. Accessory for attachment for High dose mode of electron therapy should be made available. 4. High Dose Rate exceeding 1000 MU/min should be quoted.

4	**Accessories for Dosimetry, Quality Assurance, Acceptance Testing and Immobilization of patients**
4.1	Accessories cited under dosimetry, QA systems, Acceptance testing and immobilization system are likely to be from third party. In such situation the Vendor for the LINAC must **provide** these devices/items.
4.2	Responsibility for warranty clause etc will rest with the main supplier
4.3	All bought out items are to be quoted and supplied if they are supplied by the successful vendor for the LINAC system.
4.4	The offers such items should be such that the physics and technical service for installation of these accessory items, dosimetry, QA and Acceptance testing procedures of the LINAC are to be carried out initially in the presence of the specialists from the actual supplier of these items.
4.5	The above specialists should work in tandem with the physics staff of Tertiary Cancer Care Centre, Fazilka, Punjab, during the acceptance testing and commissioning of the LINAC. Their physical presence at the hospital will be required during the entire duration of the acceptance testing and commissioning.
4.6	A consent letter obtained from the actual suppliers of these items and for the services as detailed above must be included in the offer document.

5	**The Linear Accelerator System**
5.1	The make and model number of the LINAC must be clearly stated.
5.2	The year of approval from CE or CDSCO, IMDRF, FDA, ISO certifications and AERB should be clearly stated. Year of Launch should not be older than 2010.
5.3	The year of 1st installation**/List of installations** of this model in India and abroad must be

	stated with details for verification.
5.4	Wave-Guide : Either Travelling wave or standing wave type (please specify type with name of the manufacturer with complete technical details)
5.5	Electron Gun: Specify the type with technical details - diode, triode etc, with consistency parameters regarding electron intensity and its control. Also mention if it is permanently fixed or demountable giving details.
5.6	RF power source: Specify if it's Klystron or Magnetron. Technical details regarding reliability and useful life to be provided with supporting scientific and technical documents.
5.7	Specify the components of the complete RF chain employed - couplings, driver, thyratron amplifier etc with technical details.
5.8	Bending Magnets: Specify the number, type of bending and electron energy spread
5.9	Vacuum System: Give details regarding the pump
5.10	Radiation Head: Details for shielding for radiological protection. State if depleted Uranium is being used in any part of LINAC. Characteristics of the design and materials of the head of the unit are to be detailed.
5.11	Special Chilling units if required must be included with technical details and requirements for housing of the same should be mentioned and both the CMC and AMC should include this item.
5.12	Specify the nature of Targets, Scattering Foils and their interlock system
5.13	Specify the details of flattening filter - material, dimension. Flattening filter free beam mode is required for high dose rate treatments in addition to regular treatment with flattening filters.
5.14	Specify the extent and speed of Gantry Rotation and accuracy of the same
5.15	Specify all safety interlocks offered for fail safe operation of all systems.
5.16	It should be a digital linear accelerator. Analog models are not acceptable.
5.17	The following accessories should be provided: 1. Collimator mount accessory 2. Accessory mount 3. Port film graticule 4. Spare parts kit 5. Stereotactic motion disable kit for treatment table and gantry

	6. Collision detection system for the Collimator, so that automatic field treatments can be carried out without any hindrance.

6	**Optical Field System**
6.1	The optical field defining system for both photon and electron modes should satisfy AERB criteria
6.2	Edge of the defining light field should coincide to within ± 2 mm of the 50% isodose line of an X-ray field taken with minimum build up for any field size at 100 cm^2 for any angulations of the gantry / collimator system
6.3	Optical Field and Radiation Field congruence should be better than or same as specified by AERB and must be in line with the requirements of all modes of treatment as defined in section 1.4
6.4	Congruence of the centres of the optical and radiation field must be in or better than AERB specifications.
6.5	Optical distance indicator indicating SSD between **70 cm - 150 cm, ±10**.
6.6	Bright Cross wire or similar facility should be provided to indicate field centre
6.7	Mechanical front pointer should be provided to locate isocenter of the unit within ± 1 mm in all orientations of the gantry and collimator.

7	**Laser System**
7.1	4 **Green** Lasers should be provided of LAP Laser System make.
7.2	Specify the luminous flux, adjustability with remote control, projection angle of the system.
7.3	Specify the dimensions of the Laser Display
7.4	Line width should be less than 0.5 mm
7.5	Straightness deviation of line should be less than 0.05 mm

8	**Couch System**
8.1	It should be suitable for all modes of treatment mentioned in section 1.4 above
8.2	Indexed Couch top should be completely made of carbon fibre.

8.3	It should have the capability for remote controlled robotic positional correction facility in three translational and rotational axes with respect to the 6D shifts derived from the integrated to KV cone beam CT and Orthogonal KV imagesacquisition system.
8.4	Specify the range of travel movements in the lateral and craniocaudal direction
8.5	Specify the dimensions of the table top.
8.6	It should have a free floating facility for the table top with simultaneous lateral and longitudinal motions.
8.7	Specify the range of vertical movements in terms of height above and below the isocenter and lowest position from floor.
8.8	Specify the range of rotation around the isocenter and directions
8.9	All motions of the couch should be displayed in the treatment room and the control console
8.10	The control system should have the capability to operate all motions simultaneously for the gantry, collimator and couch from the in room system as well as from the console.
8.11	Accuracy of all motions should be within ± 0.5 mm and 0.25 degrees.
8.12	Lift capacity of the table top and extent of sagging at maximum load to be specified
8.13	The couch top should have the capability to rotate simultaneously for a particular arc along with the arc rotation of the gantry. Complex synchronous orchestration of the couch and gantry rotations should be possible.
8.14	The system for robotic control of couch in **all 6** dimensions (all 3 cardinal translational and all 3 rotational). It is understood that this system will incorporate all specifications in8.3 above. If this system requires an additional couch system the same should be specified and provided. Specify the range of motion that is possible with the 6 D couch in the other dimensions.
8.15	Specify the positional and angular accuracy in all 6 dimensions and range of correction and movement for the additional couch as in section8.16 if required

9	**Safety**
9.1	Specify details for anti-collision mechanism for the gantry. Specify in details.
9.2	Specify the different situations of all beam off interlocks

10	**Rotational / Arc Therapy**

10.1	The system should be able to deliver a preset dose delivered over an arc of 360 degree or any fraction thereof. A range of variable dose rates must be available which must be specified. The system should be able to deliver 4D gated Volumetric Modulated Arc Radiotherapy plans with single, multiple and partial arcs in any combinations. Multi-isocentric arc planning and delivery should also be possible.
10.2	The maximum variation in the integrated dose over a 45 degree arc shall not exceed ± 3% or 1 MU whichever is greater. The maximum variation of integrated dose delivered over any arc of 90 degree or more should not exceed ± 2% or 1 MU whichever is greater.
10.3	Gantry motion shall be possible Clock wise and Counter clockwise for arc therapy. The MU/degree shall be computed automatically.
10.4	The system should be capable for continuous modulation of dose rate, gantry speed and MLC motion during rotational IMRT. In addition the possibility of collimator rotation and jaw tracking during rotational IMRT delivery should be available.
10.5	Jaw tracking and collimator rotation modulation of the LINAC should be made available.
11	**Leakage Radiation**
11.1	The radiation leakage through the beam limiting diaphragm should be less than 0.5%.
11.2	Leakage radiation outside the treatment area and averaged over 100 sq cm should be less than 0.1% of the maximum absorbed dose at the isocenter.
11.3	The ratio of neutron radiation outside the treatment area and within a radius of 1m to absorbed dose at isocenter shall be ± 0.05% Neutron contamination within the useful beam for 6 MV shall be negligible and for 15 MV beam it should not exceed 1% of the dose at Isocenter. This should be measured and demonstrated to the RSO of Tertiary Cancer Care Centre, Fazilka, Punjab by Vendor using a calibrated dosimeter.

12	**Electron Contamination**
12.1	The level of electron contamination must be specified and within AERB notified values.

13	**Beam ON and stabilization time**
13.1	Beam on and stabilization time should be minimum and actual value should be stated.

14	**Wedges**
14.1	A motorized / dynamic / virtual wedge that can introduce any wedge angle from 0 to 60

	degree must be provided.
14.2	State the maximum possible treatment field size at 100 cm SSD for all wedges clearly indicating the wedge dimensions and the wedge angle definitions.
14.3	QA equipment required to implement the dynamic / automatic / wedge if needed must be provided as an integral part of the main offer.
14.4	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.

15	**Multileaf Collimator System**
15.1	Should be high resolution of Multileafcollimatorequal to 5 mm at isocentre.
15.2	It should be capable for performing 3DCRT and all types of IMRT such as multiple static, step and shoot, dynamic MLC rotation and Volumetric Arc therapy.
15.3	State the number of leaves in the MLC.
15.4	State the leaf width at the Isocenter.
15.5	State the independent over travel range for each leaf beyond the beam axis.
15.6	Light leaf projection and X-ray leaf projection must be less than equal to 1 mm
15.7	Radiation transmitted through the leaves must be stated.
15.8	Radiation transmission outside the field must be less than 0.5%. State the actual value.
15.9	Mention the penumbra defined by the leaf ends.
15.10	Mention leaf motion speed
15.11	Mention leaf position accuracy.
15.12	State the maximum field dimension at SAD
15.13	State if the MLC is removable or not
15.14	The unit should be capable of being used conventionally if the MLC needs servicing.

16	**Dosimetry**

16.1	State the arrangement of the dose monitoring transmission chambers
16.2	Are the transmission chambers open or sealed? State advantages if any.
16.3	Free replacement of all chambers required during first **10 years**.
16.4	Give details of the accuracy of the chambers in measuring dose and dose symmetry.
16.5	Specify details of hardware and software interlocks for dosimetry control and patient & unit safety.
16.6	Should have two independent channels for monitoring accumulated dose.
16.7	Treatment shall be terminated by the dual channel system when: 1. Dose set and dose delivered coincide 2. Reading in 2nd channel exceeds 1st by 2 - 10 MU 3. Two channels read differently exceeding 5% of the set dose per treatment 4. Backup timer preset time is elapsed.
16.8	Reproducibility of the dose monitoring system should be within 2% at any fixed gantry angle from 0 - 360 degree
16.9	Linearity of dose monitoring system must be within 1% or 1 MU whichever less for all photon and electron energies is.
16.10	Back-up counter must be available to take care of unexpected disruption of treatment.
16.11	The monitoring system must be independent of dose rate within 2%.

17	**Main Control Console**
17.1	Fully computerized control console should be provided outside the treatment room.
17.2	All functions and modes of the LINAC should be capable of being controlled through software in the console.
17.3	Displays must include power on/off, status, total dose, time, mode selection, energy selection, interruption mode, radiation on/off, rotation / arc mode, jaw movement mode, port film mode etc.
17.4	There should be separate indicators for accumulated dose and dose rate.
17.5	Warning for exceeding a preset maximum value of dose determined by the user
17.6	Option should be available for system calibration and servicing

17.7	Separate mode operation should be present for monitoring and adjusting the accelerator parameters.
17.8	Dose, Dose Rate, All angles, High dose rate electron mode and all accelerator parameters to be displayed on flat monitors for the entire system both inside and outside the treatment room.
17.9	Give full details of the number of displays required for the complete system including that for imaging and respiratory motion management. Lesser the number will be better.
17.10	Networking for communication with TPS, saving the treatment history, portal images, KV images and cone beam CT. The entire networking is the responsibility of the vendor.
17.11	The portal imaging system, KV imaging system and treatment delivery should be integrated uniquely for every patient in the console. Both the Integration, fluoroscopy and radiography mode should be provided. These modes should be integrated uniquely for every patient in the console even with 4D gating system.
17.12	Accuracy of collimator and gantry angle displays shall be $\pm$ 0.5, with a resolution of 0.1. Accuracy of collimator jaw position displays shall be $\pm$ 1 mm with a resolution of 1 mm. Accuracy of the couch vertical, lateral and longitudinal displays shall be $\pm$ 2 mm with a resolution of 1 mm

18	**Event Logging**
18.1	The system must record all relevant equipment parameters during clinical operation for later review
18.2	The system must provide an extra step to ensure that accidental wrong selection of parameters is not done. That is there must be a fail and safemechanism for execution of treatment.
18.3	Auto sequence and such procedures for sequencing and transmission of fields to the machine should be available.

19	**Treatment Room Hand Pendant**
19.1	Two hand pendants should be provided in the treatment room.
19.2	All operations to control the gantry, collimator, jaw setting, couch movements, EPID, Cone beam CT system must be functional from the pendants
19.3	To prevent possible errors software must ensure that conflicting signals are not sent to same

	device at the same time.
19.4	Remote hand control should be included.

20	**Remote Servicing**
20.1	Facility for remote diagnostics and servicing should be provided. Please provide details and requirements for the system.
20.2	**Representative** beam data set in hard and soft copies for all beams, wedge beams, wedge profiles etc for reference must be included.

21	**Portal Imaging System**
21.1	Solid state amorphous silicon Electronic Portal imaging device (EPID) - Field Size at least 40 x 40 cm
21.2	Specify the size of the display matrix and resolution
21.3	EPID should be mounted on a retractable arm which is robotically controlled and fixed to the LINAC capable of imaging at any gantry angle.
21.4	Entire system should have a non pro rata warranty for minimum of **10 years**
21.5	Large capacity and high speed PC with 21 inch display flat panel color monitor for acquisition and viewing.
21.6	Specify the following for the EPID: 1. FOV at Isocenter 2. Sag of the EPID at extended arm positions at 90 & 180 degrees less than or equal to 1 mm. 3. Extent of vertical, lateral and longitudinal movements 4. Image acquisition rate 5. Useful sensitive energy range 6. MU required per frame 7. Image acquisition before during and after the treatment - specify all modes.
21.7	Portal images must be integrated with the main console
21.8	The EPID must have integrated software for verification with simulation images and TPS-DRR images and evaluation tools to determine systematic and random setup errors.
21.9	EPID must be able to give real time / fluoro mode images.

21.10	Images acquired to be saved automatically with the patient record in the Oncology Information System. The same should be available for review in an integrated fashion which should allow the operator to review the setup accuracy across the entire treatment history. This should provide an integrated view of other imaging modes like KV imaging and CBCT.
21.11	The EPID should be able to do portal dosimetry.
21.12	KV and MV detectors must deliver acceptable image quality at the time of initial acceptance and **for the entire period of warranty and CMC period**.
21.13	Image deterioration as certified by a radiologist / oncologist will be a valid cause for replacement of the detectors or the entire EPID system as per terms of warranty (section 21.4)

22	**Treatment Planning System**
22.1	The treatment Planning system provided must be the latest version as available with the company on the date of purchase. The vendor must agree to keep the software **updated** to the latest available version for the entire AMC and CMC period after commissioning in the Tertiary Cancer Care Centre, Fazilka, Punjab, India without extra charges.
22.2	The treatment planning system should have the capability to plan all modalities of treatment as outlined in 1.4 above.
22.3	It should have the facility to import CT/MRI/PET/PET CT and other images taken at or outside the Tertiary Cancer Care Centre, Fazilka, Punjab, India when available in standard DICOM format.
22.4	It should automatically create 3D image from the supplied axial images and should make the body structure though auto segmentation.
22.5	The TPS should be integrated with the existing virtual simulation software available in the Tertiary Cancer Care Centre, Fazilka, Punjab, India for importing CT images, 4D CT image datasets, Contoured structures and treatment field including position of isocenter, gantry, collimator and couch angles as well as field sizes along with Multileafcollimator. Configuration of these in the Virtual Simulation workstation is the responsibility of the vendor. **More detail would be share of virtual simulation workstation.**

23	**TPS Hardware**
23.1	All specifications given below for TPS hardware are subject to the condition that they represent the basic minimum and better configuration would be preferred.

23.2	The TPS system software should run on a very powerful graphics intensive workstation. Two such systems should be provided. This should be capable of fast VMAT/IMRT optimization and calculation using the latest algorithms.
23.3	Processor : Intel Dual Quad Core Xeon® Processors E5520, 2.26 GHz, 8M L3, 5.8 GT/s, turbo or better
23.4	RAM: 12GB or higher
23.5	**4 such workstations** to be supplied for calculation of VMAT and other forms of treatment as in para1.4.
23.6	All systems should come with keyboard, 3 Button Optical Scroll Mouse, 1280 x 1024 (minimum), 32-bit color, 21-inch screen display, 1 x 10/100/1000 Mbit/s Ethernet card, DVD Writer/Reader. All systems should be equipped with Windows XP SP3 or better.
23.7	In addition to above a database server, Information exchange server and an image server should be quoted for housing the **Oncology Information Network**. This should link in with the existing OIS present in the Tertiary Cancer Care Centre, Fazilka, Punjab, India to ensure seamless transfer of images, structures sets, plans, dose, MLC movement files, QA plans, Portal Imaging and KV imaging files across the department. The database server and the image servers should be separate but fully integrated (in RAID configuration) with backup of at least 2 TB per server.
23.8	Please give detailed hardware specifications regarding all the above items.
23.9	All workstations and servers should be seamlessly connected via networking and the Oncology Information System Software. The system should provide connectivity for the LINAC with all its electronic systems, Treatment planning system, MLC, Portal Imaging and On Board Imaging system, Remote couch correction, Planned motions for non-coplanar fields, respiratory gating system including gating hardware, portal dosimetry for pre-treatment QA and all software packages required for functionality of IGRT. The networking should be done with the latest CAT 6 cables and the vendor is responsible for cable laying for the complete network.
23.10	Any additional hardware / software licenses required for the smooth functioning of all modalities as mentioned earlier should be included with details even if not explicitly described in the specifications above.

24	**Treatment Planning System Contouring Software** **(Contouring station – 4 no.)**
24.1	Contouring tools for 3D auto margin and 3D variable margin

24.2	Automatically create margins in all six directions. Both positive and negative margins should be possible and individual expansions should be possible in all dimensions
24.3	Edit/Draw all contours, contour names, CT densities and colour for each structure. Facility for selection of colour for DVH display is available should be specified.
24.4	Continuous trace, point to point and auto contour via MR and CT threshold
24.5	Auto-segmentation and auto-search for body for given volumetric image
24.6	Contour on primary image (CT) or secondary study images (MRI / PET) after image fusion. Also should be feasible to contour on fused images send after image registration in other systems
24.7	Outline tumor volumes and critical structures on transverse planes with visualization in any 3 axes including real time 3D visualization.
24.8	Contour interpolation facility
24.9	Asymmetric stretch and resize facility should be available
24.10	Rapid copy to superior and inferior slices
24.11	Atlas based auto-segmentation for all body sites should be provided. This system should be capable of storing and retrieving contours from a library of contours of similar patients. Both expert drawn library and facility to use own contours as atlas should be present. The auto-segmentation process should be capable of contouring the major organs at risk along with CTV for a patient from stage and site matched patients in the library.
24.12	Separate licences should not be required for site or organ specific atlas based auto-segmentation. Atlas based auto-segmentation along with deformable image registration should be available on all new and existing workstations on the network. The number of licences required for simultaneous use in two or more workstations should be specified.
24.13	Advanced editing tools like facility to give negative margins, crop structures with arbitrary margins, remove structures extending outside or inside other structures; wall extraction from a solid structure with positive or negative margin, auto-segmentation based on CT numbers and limiting contours by the Volume of Interest tool should be provided.
24.14	It should be possible to add / subtract / join one or more contours of drawn structures as well as that of isodoses converted into dummy structures.
24.15	It should have the capability for interpolation of contiguous and non-contiguous contours between one or more image planes. It should be able to copy and extend the contours in arbitrary lengths along the cranio caudal direction.

24.16	Facility for both deformable and rigid image registration should be available. The result of registration of both types should be editable and exportable. The system should be capable of registering arbitrary images like CT/MRI/PET/ PETCT and Cone Beam CT.

25	**Treatment Planning System Radiation Planning software**
25.1	The system should auto-compute isocentre placement from AP and lateral DRRs and also with respect to the centre of mass of the target volume
25.2	There should be a facility to place multiple isocentre for the same plan.
25.3	The system should allow planning using the SAD technique or the SSD technique depending on requirement.
25.4	It should be possible to edit the placement of isocentre manually by dragging on any plane as well as by entering numerical position with respect to the origin.
25.5	The system should recognize the DICOM origin of image acquisition and allow setting of arbitrary centres of origin with respect to external fiducial.
25.6	The system should be able to place multiple points and marker point definitions. It should be able to import marker point and field isocentre as well as field details from the existing virtual simulation workstation.
25.7	Planning of various combination of beams should be possible viz. photon - photon, photon - electron and electron – electron
25.8	The system should allow computed isodoses to be exported as structures.
25.9	The system should allow the dose calculation of each field, all fields and combination of fields across plans for the same CT dataset. It should allow computation of dose in a single plane and across an arbitrary volume of interest.
25.10	The system should fully integrate with the Record and Verify system that ensures seamless connectivity to the LINAC.
25.11	It should be possible to use Bolus of various thicknesses and various materials in the treatment planning system to use during the dose calculation. The system should have a list of commonly used bolus material with respective electron density available for use.
25.12	The system should have the capability of copying fields with all accessories, plans and contours across image sets and in the same image set. It should be possible to generate an opposing pair of fields with all accessories and collimator configuration reversed.

25.13	The system should allow auto conformation of MLC and blocks to various structures and shapes. It should support the capability to export the block shape to computerized automatic block cutter.There should be the option of selecting multiple MLCs at a single time.
25.14	The system should be capable of allowing manual entry of gantry, collimator, couch and Multileaf collimator positions values. In addition to a keyboard based entry interface it should be possible to modify these parameters via mouse on the Graphical user interface directly.

26	**Treatment Planning System Imaging System**
26.1	The treatment planning should have the capability to display real time Digitally Reconstructed Radiographs.
26.2	It should be possible to have adjustable Window and Length for display of DRR.
26.3	Various pre-set DRR modes should be available especially to display the bone, soft tissue, muscle, air cavity and lung.
26.4	The DRR generation method should include normal summed, Maximum Intensity Projection (MIP) 3Dimage data set and volume rendered.
26.5	The system should have the capability to display the Beams Eye View in various orientations as well as a model view. It should be capable of rotating the entire room's eye view in various orientations so as to visualize any potential collisions. There should be facility for real time rotation of wire frame, solid and transparent structures and dose clouds.
26.6	It should have interactive DRR and BEV control.

27	**Treatment Planning System : Intensity Modulated Radiotherapy**
27.1	The system should be capable of planning, optimizing and calculating IMRT plans using static, dynamic and rotational IMRT (VMAT).
27.2	It should support co-planar and non-coplanar beam arrangements.
27.3	It should be capable for synchronous IMRT optimization using the already optimized plan as a base plan.
27.4	The MLC segmentation algorithm should automatically account for tongue and groove effect in the MLC.

27.5	It should have the facility for user selectable intensity levels.
27.6	Per beam and per plan QA data generation tools should be available.
27.7	The dose should be exportable for external QA software for verification while doing QA.
27.8	The system should display Intensity maps in BEV with facility to edit or modify the intensity profile in the display graphically.
27.9	It should be capable of generating DRR with widest MLC position of segments at a particular beam angle.
27.10	The system should be capable of planning IMRT for large fields without requiring field splitting. If field splitting is required automatic carriage shifts and jaws tracking should be done in the same field so as to minimize treatment interruptions (Large Field IMRT). Software license if required for same is required.
27.11	Should be able to import CBCT images from treatment machines and compute dose on the imported images to evaluate the dose to critical structures of the patient during treatment.
27.12	If IMRT is delivered as a boost dose after delivery of partial treatment by conventional 3DCRT plan then it must be possible to incorporate the delivered plan to optimize the IMRT treatment plan.

28	**Treatment Planning System : Data Import & Export**
28.1	CT/MRI/PET import and export with existing and proposed units in the Tertiary Cancer Care Centre, Fazilka, Punjab, India
28.2	The planning system must be completely integrated with the proposed 4D RT CT as well as the CT scanner and MRI in the hospital via Local Area Network. Seamless connectivity with existing treatment planning and virtual simulation workstations is required for data import and export (image/ contours/ beam data/ dose / verification images / Cone Beam CT images/ KV images / MV port images etc). It should have the capability to integrate with any future imaging equipment acquired by the hospital for imaging and treatment delivery. If necessary, **any** software licenses required for such **future updates** will be provided free of cost by the vendor.
28.3	DICOM and DICOM -RT import and export facility for **import as well as export** of all DICOM RT objects viz. RT Image, RT Structure Set, RT Plan, RT Dose, RT Beams Treatment Record, RT Image Registration, RT Brachy Treatment Record, and RT Treatment Summary Record. Any extra licences required for any specific DICOM RT object should be mentioned clearly and provided as a part of the standard purchase.

28.4	The system should be capable of importing or exporting the above (28.3) through the LAN / CD or the Internet.
28.5	Seamless connectivity should be present to facilitate data exchange of all DICOM - RT objects between the existing treatments planning system in the Tertiary Cancer Care Centre, Fazilka, Punjab, India. The responsibility for such networking including network switches/ routers will borne by the vendor.
28.6	The new network should be constructed using the latest CAT-6 cables. One or more network switches should be provided with Level 3 switching facility.
28.7	The treatment planning system should be able to import/export the capable export of the images, structures, image registration data, field configuration, dose, verification images, CBCT in the RTOG data exchange format (RDE).
28.8	The vendor should submit their compliance sheet showing their compatibility with both DICOM-RT and RDE standards.
28.9	The entire TPS should be IHE-RO (Integrating the Healthcare Enterprise-Radiation Oncology) compliant. **All IHE-RO integration profiles** supported by the latest version of the treatment planning system should be specified and same supported in the TPS supplied in the hospital. The system should support at least the BRTO, ARTI & TDW profiles.MMRO, ECSI and DCOM profile support is desirable(Please visit aapm.org/IHERO/?od1n for more information). Note that the vendor requires additional licenses for any of the profiles the same should be clearly indicated and provided.
28.10	Export of DRR in DICOM secondary capture format.

29	**Treatment Planning System Treatment Parameter Configuration**
29.1	The TPS should support beam data entry via keyboard, digitizer and water phantom.
29.2	It should be able to accept data from Iba, PTW or other dosimetry system.
29.3	General beam parameters: Gantry, Collimator, Couch, conventions, single and dual asymmetric jaw limits, PDD, OAR, TAR, TPR, BSF, Phantom Scatter correction factor, wedges, blocks and compensators.
29.4	Should accept physical/motorized or dynamic/enhanced dynamic wedge parameters
29.5	Multi window overlay of measured vs generated depth dose and profiles.
29.6	Multi Tray factor definition for each treatment machine.

29.7	Output factors editors

30	**Treatment Planning System Utilities**
30.1	Template / plan storage / recall including graphics layout
30.2	Single / Dual Asymmetric Jaws
30.3	Manual Divergent Blocking
30.4	Automatic blocking with margin
30.5	MLC planning
30.6	Automatic MLC shaping with changes in machine parameters
30.7	Enhanced Dynamic Wedge, Virtual Wedge and Motorized Wedges
30.8	Arbitrary weight point location.
30.9	Relative dose, absolute dose or MU weighting.
30.10	Bolus
30.11	Real time display of dose in sagittal, coronal and arbitrary planes
30.12	Global and local hot spot display.
30.13	MU / Time calculation for both photons and electrons.
30.14	Dose profile generator
30.15	DVH: Differential and cumulative. Should have capability for multiple plan and plan sum DVH comparison with all curves over laid. User selectable DVH dose and volume grid. It should have the capability for displaying dose in percent or in cGy and volume in relative and absolute volumes. The DVH should be exportable in a txt / spread sheet format.
30.16	Preset DVH criteria to be available as a tabular or color coded display to ensure that critical volumetric DVH goals are met.
30.17	Facility for storage of DVH in the database for the final approved plan if the user desires. This database storage should not be in the form of attachment of the DVH data as a text/csv/ spreadsheet file but as discreet volume versus dose data for each selected structure set.
30.18	Facility for adding / subtracting or joining structures in the DVH for generating composite

	DVH curves.
30.19	The DVH curves should have editable color, shape and thickness for future presentations and publications.

31	**Treatment Planning System : Calculation Algorithms**
31.1	Monte Carlo or Monte Carlo equivalent algorithm (ACCUROS XB) for fast IMRT/VMAT dose calculations.
31.2	Time taken to calculate single arc and dual arc VMAT plans for head neck and prostate sample cases by the latest and most accurate dose calculation algorithm should be **faster**.

32	**Treatment Planning IMRT/VMAT optimization**
32.1	Specify the latest algorithm available with the vendor along with the version for VMAT and IMRT optimization algorithms with details.
32.2	Optimization algorithm should be capable of inverse planning optimal beam directions for the given objectives.
32.3	The above optimization algorithm should be capable of optimization for both coplanar and non-coplanar beam geometries.
32.4	**IMRT / VMAT Optimization based on EUD, TCP and NTCP criteria (biological optimization) should be available for VMAT /IMRT.** Separate license if required for Biological **optimization/evaluation** (as per **TCP / NTCP/EUD/gEUD**) should be provided. **Tools** for Adaptive Radiotherapy (ART) planning should be included.

33	**Oncology Information System – 2 no.**
33.1	The vendor should supply a state of the art software and hardware system for online treatment control, verification, recording and abstraction of data pertaining to each individual patient as well as all patients undergoing radiotherapy. The vendor should specify the version of the software being provided (which should be the latest available with the vendor)
33.2	The system should be able to record and review the patient diagnosis, stage, clinical history and examination findings. The system should be capable of recording the diagnosis as per the ICD C and ICD 10 system. The complete ICD C and ICD 10 codes should be available in the system without requiring extra input. It should also assign automatic AJCC staging for the

	disease.
33.3	The system should have a flexible system for recording the clinical details and stage of the patient. The system should be modifiable by a simple mechanism so as to allow the hospital to record the history, examination findings, diagnostic test reporting as per the system in the hospital.
33.4	The system should be able to register new patients with the hospital ID system available in the Tertiary Cancer Care Centre, Fazilka, Punjab, India. It should be capable of recording the age, gender, address, phone numbers, email id etc. for a given patient and should be capable of filtering and searching patients in the database for a given patient ID/name/ gender and date of birth.
33.5	It should be able to schedule the entire course of treatment in advance in the scheduling system in order to ensure hassle free treatment of the patient.
33.6	It should be capable of storing and retrieving and displaying RT prescription, treatment technique, fractions, dose, Monitor Units, treatment fields, MLC leaf motion files, treatment accessories etc.
33.7	It should be able to link setup fields to the treatment fields. Show setup notes of treatment position and accessories with ability to display the patient photographs.
33.8	It should be capable of tracking dose to specific sites along the course of treatment, define treatment breaks along with instructions.
33.9	The system should provide radiation safety related alerts for each setup
33.10	It should prepare the treatment chart for the patient for display as well as printed output at all stages of the progress of the treatment.
33.11	The system should be capable of electronic recording of treatment toxicity and management of the same during the course of treatment for each patient. The toxicities recorded should be according to the CTCAE system. The treatment progress (toxicity and management of the same) should be capable of being recorded longitudinally during the course of the treatment.
33.12	The system should be able to store patient photographs.
33.13	It should be able to auto setup all subsequent fields during a treatment.
33.14	It should support digital recording, archiving and retrieval of all verification images (e.g. EPID, KV x-rays and Cone Beam CT). This should be integrated with all images taken for treatment planning including registered image sets.
33.15	It should be capable of accumulating port film doses.

33.16	The system should allow override of individual treatment parameters under password protection for specific personnel groups only.
33.17	The system should have complete scheduling software which should be able to schedule patients on the treatment machine according to the time. The scheduling software should be able to do the scheduling for other machines in the department including the simulator, 4D CT simulator, existing CT simulator. In addition, the scheduling software should allow scheduling for personnel in the department. It should be capable of displaying individual and group schedules for the machines and personnel.
33.18	The system should be networked such that it is able to integrate simulation, CT/MRI/ PET/ 4D CT/ CBCT/ EPID/ KV imaging to the database. It should be a complete image archival, retrieval, display and export system. Reviewing of all images immediately from a remote location should be possible.
33.19	The software should be capable of retaining all records and images for future individual patient or group statistical analysis as well as transmission to the other centres.
33.20	The system should seamlessly integrate with the existing record and verify system. The existing system should be **completely updated** to the latest version. Any additional licenses required for supporting clinical data recording as mentioned above should be available both the new as well as the existing upgraded system.
33.21	The Oncology Information System should be **upgraded/updated** to the latest version for the entire period of AMC and CMC from the date of installation without requiring additional payment. The **up gradation** should be made available for both minor as well as major version upgrades.
33.22	**The equipments of Radiotherapy** department should also be included in the network and all software and hardware should be quoted as part of the tender.

34	**Image Guidance for Image Guided Radiotherapy**
34.1	The system shall be based on Four dimensional KV cone beam and CT imaging (4D KVCBCT).
34.2	The KV X-ray, Flat Panel Detector, MV Flat Panel Detector should be mounted on three motorized arms that can be moved together or independently using hand pendant in the treatment room /remotely from the control console.
34.3	The entire system should have remote robotic control.
34.4	The entire system should be provide with collision detector switches that when activated should stop all major motor functions.

34.5	The point of intersection of the KV detector source axis and gantry rotational axis should move within a sphere of radius 1 mm or less for full 360 degrees.
34.6	It should be possible to apply the calculated lateral, longitudinal and vertical corrections along with the rotational corrections (pitch, yaw and roll) remotely from the control console for the 6 D robotic couch (see section 7.16 above).

35	**On Board Imaging**
35.1	The KV detector should be flat panel amorphous silicon with field size of at least 39 x 29 $cm^2$and display matrix of the highest resolution available with the vendor.
35.2	Mention the spatial resolution in line pairs per cm.
35.3	Mention the KV range and KV step if it continuously variable in radiographic, fluoroscopic and cone beam CT modes.
35.4	Provide details of X-ray tube and its housing.
35.5	Specify the rating of the X-ray tube and its power supply.
35.6	Specify the focal spot dimensions, anode heat storage capacity and total heat storage capacity.
35.7	Mention the required cooling time between two successive volume scans.
35.8	The complete KV imaging system including the x-ray tube, detector system and robotic arms should have a non pro rata warranty for **10 years**.
35.9	It should be feasible to combine various modes of imaging e.g. KV-KV pairs, KV-MV pairs, Fluoroscopic KV imaging, Cine MV imaging etc. for image guidance during treatment. Mention all combinations available.

36	**Respiratory Gating for management of tumor motion**
36.1	A respiratory gating system**/Surface guided radiation therapy system for patient setup and tumor motion management (tracking and gating) for both CT and linac** should be provided to cancel patient and organ motion and should be provided with necessary accessories.
36.2	The respiratory gating system should be available on the LINAC room and on CT room.
36.3	It should seamlessly integrate with the oncology information system.
36.4	Both prospective and retrospective gating as well as amplitude / phase based gating should

	be available.
36.5	The gating system should integrate with the LINAC and should be control the beam ON/OFF without interference from the operator.
36.6	The gating system should be provided with all required hardware and software for allowing respiratory gated radiotherapy including respiratory gated VMAT.
36.7	The Respiratory Gating Interface should seamlessly integrate with the treatment interface.

37	**IGRT Software**
37.1	Matching of the arbitrary KV and MV image pairs should be possible.
37.2	The software should be able to compute the required couch correction in all 6 axes (translational and rotational) based on the comparison of the KV / MV / CBCT images to the reference image.
37.3	The computed couch correction should be sent to the LINAC for automatic shifts in all 6 axes as mentioned in section 6
37.4	It should be possible to acquire gated images in both **KV/MV** modes
37.5	Cone Beam CT images should be transferred to the OIS and TPS for adaptive radiotherapy planning. Both **rigid and deformable image registration** of Cone Beam CT data sets with the reference image set is required.
37.8	The system should support digital fluoroscopy in both KV and MV imaging system to visualize respiratory gating.
37.9	Image verification tools e.g. Blend image, split window, moving window and complimentary colour blending.
37.10	Calibrated Hounsfield units must be available for CBCT images to be used for RT planning. Obtaining the data for the calibration curve is the responsibility of the vendor.
37.11	The system should be fully DICOM compliant with CT Import / Export, RT plan import, RT structures import and RT image import.
37.12	Calibration and Flex Map Phantoms should be provided. In addition, all necessary phantoms for QA of IGRT, Gating, KV imaging and SRS/SRT should be provided. Winston Lutz Test tool and Isocal phantom for isocentre verification should be provided. Any other phantom required for Quality Assurance of the On Board Imaging System should be provided even if not mentioned explicitly.

38	**Dosimetry Equipment's**
38.1	All measuring systems selected must be supplied with calibration certificates from designated laboratories approved for this purpose by international agencies and AERB (of the time of commissioning).
38.2	All Dosimetry connections must be TNC. All Detectors and holders must be water proof and completely guarded.
38.3	All systems should be supplied with connecting cables, caps and chains of sufficient length to access the measuring system kept at the console room around the maze wall.
38.4	Cylindrical Ion Chamber 0.6 cc - three such.
38.5	Parallel Plate Chamber - **two** such
38.6	Pocket Dosimeter - four such
38.7	Precision Electrometer for above - 2
38.8	Long term stable micro ionization chamber (0.007 cc), small volume (1 mm diameter × 3 mm long) **scintillation detectors/diamond detectors** (radiation degradation ≈ 2% for dose greater than 2KGy) with requisite electrometer -1 no each
38.9	Gafchromic Films – 100 no.
38.10	Digital Barometer and Thermometer -4
38.11	Film Scanner which is possible to scan the film size 14×17 $inch^2$-1
38.14	Bar Code Scanners – 2
38.15	Gamma zone monitors – 2
38.16	Survey meter – 2
38.17	TPR 20/10 – 1 Mini Water Phantom -1 Absolute Water phantom 1D – 1 no. (30cm x 30cm x30cm)
38.18	**Omitted**
38.19	**LMOS – 2**

38.20	Dedicated desktop Bar Code printer capable of printing single and multiple sticky labels for a given patient.
38.21	Communication system with the OIS with the Bar Code Scanner and Bar Code Printer should be seamless and any necessary software packages should be provided.
38.22	Radiation Therapy Beam Analyser (**Latest Launched model is mandatory to offer**): 1. Require a full-fledged three dimensional water phantom & dosimetery system and therapy beam analyser for performing Off-axis profiles, PDD, point dose measurement, beam symmetry turning, Dose rate constancy check, vector scan and TG51 lead foil measurement for low and high energy photon, electrons. All measurements should be computer controlled and user friendly. 2. All components comply with national and international regulations and safety rules. All components of the system; all available options are controlled by the same software that runs under Microsoft Windows of latest version of Windows 2000 and Windows XP. The system should suitable to measure pulsed radiation with fluctuation dose rate ion chamber. The necessary holding devices extension cables for the above chambers must be included. The positional accuracy should be better than +/- 0.1mm.
	3. The positioning tool should be there to allow easy and exact position of the chamber's geometric centre in the central beam and at the water surface. Apart from this the exact position of the chamber the radiation beam should be possible via software.
	4. The detector unit should be driven by stepper motor and step length should be adjustable in steps of **1mm** or better. The scanning speed should be adjustable between **3mm/s and 25mm/s in 1mm/s** steps. Further the delay times for each step movement should also be changed as and when required.
	5. The system should allow simultaneous movement in available direction for any vector scan.
	6. The zero point, reference point and limit of the different detector units should be stored separately and permanently in the control unit.
	7. The control pendant should display the actual position of the chamber position at any given measuring time.
38.23	**Water Phantom/Radiation Field Analyser(Latest Launched model is mandatory to offer):**

	1. The scanning volume should be large enough to scan and should not be less than **48x48x40** cm to avoid bending of the tank's walls by water pressure and water pressure and water absorption of the acrylic material 1 wall thickness should be not less than **1.5 cm, +/-0.2 cm**. **It should be possible to set and validate the water level faster without need of software adjustment and revalidation**.
	2. The motor of the moving mechanism should not touch nor dip to the water to avoid mechanical stress to the acrylic tank.
	3. The reproducibility of a position should be +/- 0.1 mm throughout the whole phantom.
	4. The digitally driven stepper motors should provide hysteresis free movements (stick and slip free).
	5. The lift table should be electrically as well as manually operable.
	6. The velocity of the vertical motion should be quoted and preferably should have two vertical velocities. The water tank must be rotatable into positions 0 degree, +/- 45 degrees and +/-90 degrees
	7. A highly accurate positioning device directly supplied by the principals must be included.
38.24	**Water Reservoir:** 1. The water reservoir should be large enough to store the water and can be pump and drain to the water phantom as quick as possible. The water reservoir must be able to hold the entire weight of the water without any change. 2. The weight of the whole assembly can be push or pull though the wheel with polyethylene or equivalent. The lifting carriage should be electromechanical/elevating screw mechanism that keeps the height absolutely accurate. 3. The lifting carriage and water reservoir must be imported and directly from the suppliers and must complete with all facilities including TPR and TMR measurements. Completely **integrated/separate** lifting carriage and water reservoir. 4. The water reservoir must be compatible for TPR measurements 1 pump of the reservoir should drive automatically and electromagnetic valves make

	sure that no water can flow the phantom tank to the reservoir during automatic TPR measurement. 5. The water reservoir should have a safety circuit that avoids the dry pump running Control Unit/ Electrometer.
38.25	**Control Unit:** 1. A separate control unit for controlling the movement of the detector in any three directions should possible. 2. A separate electrometer to collect the ions/dose from the chamber/detector should be there the voltage to the chamber should be adjusted in the electrometer in steps of 50V. The polarity of the chamber should be able to measure absolute doses for low and high energy photon and electron. 3. The gain of the electrometer should be automatic depending upon the signal collected by the field and reference detector. Further the user should also be given an option to change the gain to field an reference separately. 4. Necessary software to use the electrometer for absolute measurements should be provided. 5. The time constant should allow 10ms measurement times. 6. The external dosimeter should also be connecting to the water phantom. 7. The control unit should permanently store zero point, reference point and limit points for water phantom, air scanner and mechanical film densitometer separately. 8. These different sets of limits, zero and reference points can be retrieved independently. 9. The coordinates of the probe should display for all directions, simultaneously on a control pendant. 10. The control pendant can be attached either to the water tank or to the control unit. 11. The communication between the control unit and the computer should perform by a standard **RS23/Ethernet/USB**. 12. The high voltage for the probe should be switchable independently for each decreased in different voltage and sign of the measuring signal can be reversed.
38.26	A solid, water equivalent phantom made up of slabs of different thicknesses (0.2cm, 0.5cm, 1cm) shall be provided by the vendor for external beam teletherapy dosimetry. It shall be possible to use this phantom for both photon and electron beam dosimetry. The phantom shall be free of contaminants and air

	bubbles. The slab shall be of 30x30x30 cm or more size totalling a thickness of 30 cm.
38.27	Additional One pressurised ION Chamber to be supplied.
38.28	**Control Computer:** The latest version of windows computer**/laptop** should have all the latest features with colour monitor and with 2 color printer **and** plotter and branded UPS (45 min. backup).
38.29	**The software:** 1. Measurements can be done against time, against a monitor signal or against chamber. 2. Within the moving range arbitrary points can be measured. 3. An arbitrary vector scan measurement should be possible. 4. Point dose measurement, Beam symmetry tuning and TG51 foil measurement should also be possible. 5. 2D planes can be measured at any solid angle. 6. Isodose can be displayed and plotted that can constructed out of profiles and depth dose curves or measured matrices. The isodose level should be freely closable warning before unsaved date in the RAM should be overwritten. 7. The isodose lines and hot spots should be detected automatically. 8. Single measuring points, complete curves and parts of curves should be re-measured from a user definable point. 9. During the measurement the measuring curve should be displayed graphically and online on the screen. 10. A special measuring program should allow a dose rate constancy check including a statistical evaluation. 11. Any kind of open, regular shaped, blocked or wedged field should be able to measure. 12. Fields from asymmetric collimators should easily be measured. A special measuring routine for service purposes should allow easily checking of beam with respect to symmetry, flatness, homogeneity and energy. 13. Implemented routines should allow the measurement, formatting and transferring of basic date to all important therapy planning systems. 14. Comprehensive documentation of the measured data by automatic saving of the used measuring environment should simplify the interpretation of data even a long time.

	15. The used measuring routine data can be reused either unchanged or with some of the parameter changed data can be printed and plotted in numerical and graphical form on all printers and plotters that art supported by windows. 16. The administrative data can be changed after saving the measuring data. All measuring data should be furnished automatically with their administrative information and comprehensive filter function should allow easy selection of specific data. 17. The necessary software to network the 3D **RFA** system with the 3D TPS in the department of radiotherapy must be offered.
38.30	**Data Analysis:** **1.** Various normalization should possible viz. normalization to maximum for depth dose curves normalization to maximum or centre for profiles and normalization to maximum, enter, position and value for dose isodose lines. **2.** Homogenity and symmetry should be calculated automatically and various national and international protocols can be selected. **3.** Depth dose curves can be analysed according to the protocols DIN 6800/2 IAEA TR277, ICRU 35 CRMI no. 2, AAPM TH21/TG25 and NACP **and AERB**.
38.31	**Data transfer and data representation:** 1. Modules should allow automatic formatting and transferring of measured data to treatment planning system available in the department. 2. The measured data can be stored in two different ASCII formats (with selectable separation characters). 3. ASCII – data can be sent from external computers and be imported into the water phantom software image date for the film dosimetry. Data can be displayed graphically on the screen. 4. Crosshairs should allow the easy manual evaluation of a curve. 5. Plotting/printing of the measured data and correction functions can be printed (alphanumerically) and plotted (graphically).
38.32	**Array Detector:** 1. One Array device must be based on **ionchamber/diode** array resulting in an effective measuring of **25cm x 25cm** or above and giving the facility to use with slab phantom for measurements. The chamber must be vented plane parallel square shaped ion chambers with at least 5mm x 5mm x 5mm size **or diodes with 0.48mm x 0.48mm** and centre to centre spacing must be **10 mm or less**.

	2. It should be able to use for the dose verification of IMRT beams and routine quality control of high energy photon and electron beams by using the software and also it should be able to check the MLC leaf positioning. It should be able to measure the dose from dynamic and static fields in one run and display the readings in both dose rate absorbed dose mode. 3. It should be able to perform the QA for high energy beams and dose verification for IMRT, IMAT, ARC beam techniques. It should be capable of doing complete pre-treatment patient plan verification with on measurement.
38.33	Patient specific QA tool (Cylindrical & Rotational Phantom and complete drive assembly with related software module for VMAT dynamic IMRT techniques. The detector inside the phantom should always be perpendicular to the beam **or Gantry Angle Sensor** & thus removing the angular dependence. The software should have the functionality **like global and local 2D gamma analysis**. **An additional phantom should be provided such that there should be a lsot and providion to insert the 2D array inside the phantom with this arrangement. This system should be capable of doing IMRT & VMAT measurement by apply Gantry Angle corrections.**
38.34	**Daily Machine AQ device** (2 numbers): It is a real time daily radiation beam output, energy, symmetry and flatness checking dosimetry systems based on air vented ion-chambers with essential software with TG 142 protocol.
38.35	Dynamic movement platform for respiratory gating technique which can carry a phantom of weight more than 25 Kg. Should incorporate a software application which allows you to display, edit, and run respiratory waveforms. . The Software Application is compatible with the latest Windows operating system. Motion Software application you can import, create, edit and save respiratory waveforms. Edit functions include adjusting the amplitude, stretching or compressing the timeline and filtering out high frequency noise, low frequency drift and cardiac signals. In Oscillation Mode (programmable), Rotation Mode and Position Mode the Platform operates under software control. It can also run in Rotation Mode and Position Mode without a computer, under local control.
38.36	Transparent Reference detector of size 23×23 cm^2 to be fit at the position of wedge so that it will serve as the reference detector **for small field (SRS) dosimetry for Beam Data Meausrement**.

38.37	Atom phantoms: It is a cross sectional phantom that can investigate organ dose, whole body effective dose as well as verification of radiation dose delivery from different radiation beam. This phantom should have the ability to simulate the mechanism of absorbed dose deposition, attenuation and radio diagnostic imaging properties as that of human tissues of different organs in a wide range of radiation beam energy. The composition of this phantom should be a tissue equivalent materials in terms of effective atomic number, physical and electron density so that the scattering, absorption and attenuation mechanism in this range of radiation beam energy. The complete shape of human body must be supplied along with different organs made of the simulated tissue equivalent materials. The thickness of the transverse slices must be ≤ 25 mm. The sectional surfaces are to be extremely flat and smooth and do not require any special coating so that the air-interfaced between the sections is minimized. This sectional slices shall not produce any visualization of interface in between the two sections in CT scout view or projection x-ray. All the bones and lung organs must be made of a homogeneous tissue equivalent material for easy comparison of calculated and measured doses. The size of the phantom must be comparable to the available anatomical reference data, based on ICRP 23 and ICRU 48. The tissue simulating materials of each model phantom are also formulated based on the appropriate body composition typical of each age and/ or gender. This is especially significant importance in the bone of each model. Linear attenuation and mass attenuation of the simulated tissue must be within 1 % of actual water and bone and within 3 % for lung tissue for the photon beam energy ranges from 50 KeV to 25 MeV. Lung tissue must simulate both inhalation (0.0033 to 0.53 cm^{-1} respectively for 40 KeV photon to 30 MeV photon beam) and exhalation condition in terms of linear attenuation within 3 % accuracy. Absolute absorbed dose measurement in this phantom and calculated dose in the same CT image phantom acquired with KV x-ray must be within 3 % in all organs and tissues. This phantom should simulate all the imaging characteristics of different organs and tissues of human body.Reinforcement tools of phantom positioning must be supplied. This reinforcement tools should not affect dosimetry greater than 0.1 %.It must be possible to do both radio chromic and radiographic film dosimetry in this phantom. Tissue equivalent holders and plugs of different organs for different type of detectors like farmer type ionization chambers of 0.66 cc, 0.13 cc and 0.012 cc, TLD chips of 0.3cm×0.3cm×0.1cm and TLD disks of 1 cm diameter×0.1 cm thick, MOSFET must be supplied. Holder grid size must 1.5cm×1.5 cm to 3.0cm× 3.0cm. There should be slot and insert in this phantom for this different type of holders for routine dosimetry. Transport / storage of this phantom must be supplied for safety point of view.

	Both Adult Female and Male Phantom 5 different breast sizes greater than or equal to190 cc and less than or equal to 350 cc should be supplied. Height of 900 mm or more excluding leg, weight of 33 Kg or more and 20 cm×25 cm thorax dimension or more.
38.38	One QA tool for optical and radiation field congruence check and laser beam alignment.

39	**Accessory System**
39.1	Two cameras should be provided inside the room. These cameras should be completely integrated with the LINAC console.
39.2	The real time images of the camera should be viewable on the console in an integrated fashion through special flat screens.
39.3	An efficient patient communication system should be provided. This communication system includes microphones, speakers etc. should be integrated with the control console.
39.4	The patient communication system should allow bidirectional communication.
39.5	High quality public address cum music system should be provided for communication with the patient waiting area.
39.6	UPS of sufficiently high rating should be provided to ensure adequate backup for minimum **30 minutes**. This UPS should be capable of covering the LINAC equipment, Lasers, Cameras, All displays, Servers and all provided workstations provided as a part of the treatment planning system. Note that separate UPS for each workstation is not acceptable.
39.7	The vendor should procure, install and maintain the air conditioning and humidity control systems as needed for the perfect functioning of the LINAC and its subsystems for the entire warranty period.
39.8	Complete details of such units must be furnished.
39.9	After completion of the warranty period the actual supplier of the A/C must enter into a comprehensive AMC with CMC for all those units. The details and rates for the same should be quoted.
39.10	Separate chillers required for the LINAC and same shall be an integral part of the whole system for the purpose of various conditions of warranty, servicing, AMC etc.

39.11	The following immobilization devices are required: 1. Vac Lock 80 x 100 cm - 10 no's 2. Vac Lock 80 x 120 cm - 10 no's 3. Vac Lock 80 x 150 cm - 10 no's
39.12	**Omitted**

40	**Warranty / CAMC**
40.1	Comprehensive warranty (non pro rata) for 5 years **from the date of license for operation obtained from AERB** of the system at the Tertiary Cancer Care Centre, Fazilka, Punjab, India.
49.2	This is irrespective of the warranty conditions mentioned for waveguide and other systems as stated in sections above. In case any of the warranty clauses above mention higher periods of time for specific items the higher period shall be applicable.
40.3	If any spare is to be imported or procured locally during the warranty period the cost of the part, transport, freight, insurance, clearance, excise, octroi, customs and other duties as applicable will be paid by the vendor. This warranty is comprehensive and on site.
40.4	**Upto 02 years** of the warranty period no expenses towards the cost of the spares or service for proper functioning of the entire system will be payable by Tertiary Cancer Care Centre, Fazilka, Punjab, India. This includes cost of the workstations, hardware, printers, networking and networking peripherals.
40.5	**State CMC** with or without spares for 5 years after expiry of the warranty period.
40.6	A service engineer must be stationed at Tertiary Cancer Care Centre, Fazilka, Punjab, India **till** the completion of commissioning at Tertiary Cancer Care Centre, Fazilka, Punjab, India.
40.7	During the **warranty period and CMC period** the vendor should provide a service uptime guarantee of 95% on a 12 hour per workday basis. The number of workdays in a year will be calculated as the number of weekdays excluding Sundays and Saturdays and 10 government mandated holidays (total of 250 days). The minimum period of downtime more than or equal to 30 minute will be counted in the annual downtime hours calculation. Downtime will include **any and all the time** in which treatment on the machine was **not possible** due to **machine (including all accessories like Chillers, Pump and all internal hardware e.g. MLC), workstation, hardware, software or network related issue**. In other words no more than **cumulative** 150 hours downtime is acceptable in a calendar year. The duration of the CAMC would be extended by a term of double the downtime without additional cost. Note that treatment as defined above will be the planned treatment which may be in the form of any of the treatment techniques described in section 1.6. In this regard it is noteworthy that partial availability for only few forms of treatment will also be taken as downtime.

41	**All in One Immobilization Solution - Three such should be provided.**
41.1	All in One **(3 nos.)** immobilization Solution from renowned/Branded industries is only acceptable **(carbon fiber, clamp/pushpin)**.
41.2	The system should come with all cushions and Long Board carbon fibre base plate
41.3	**3 no**. Complete set of Head Supports
41.4	**3 no.** Complete Knee and Leg positioning set
41.4	**3 no.** Complete Breast Lung Board Solution
41.5	2 no. Complete AIO prone Breast Board Solution
41.6	Complete AIO Pelvic / Belly Board Solution - 2
41.7	AIO Storage Cabinet - Two such.
41.8	**4/5** Clamp base plate - 8
41.9	Hot water baths – 2
41.10	The same base plate shall be upgraded to adopt for frameless SBRT and also for SRS/SRT frameless and there shall be 2 set of each to be provided. For SRS/SRT, there shall be at least 50 cast with fixation accuracy of 0.3mm, which is mandatory.
41.11	**Body calliper – 1** **Heat gun – 1** **Alloy Melting pot – 1** **Melting Alloy – 15 KG** **Styrofoam Foam 30 x 30 x 1.5 cm – 25 nos.** **Electron Foam cutter digital** **Suitable Vacuum pump with connecting tube - 1**

42	**Licences**
42.1	Existing Licences should be usable and shared in the new system (TPS/OIS/Server). If necessary the licences should be **upgraded/updated** as necessary so that all features are available in both machines at no additional costs.

42.2	4Dose Calculation Licences for external beam dose calculation using photons and electrons.
42.3	4 Dose Volume Optimizer Licences available site wide in addition to the existing site wide licence
42.4	4 licences for Rapidarc Optimization, Rapidarc Multiarcs and Rapidarc Avoidance Selection (in addition to the existing licence for each)
42.5	4 External Beam Planning Advanced Licence
42.6	4 Licences for Photon Optimizer (PO).
42.7	4 License for Leaf Motion Calculator
42.8	Site wide Licences should be provided for all the features mentioned above viz. Oncology Information System (Section 33), Treatment Planning System (22 -32). The licences should allow deformable image registration, atlas based auto segmentation, Large Field IMRT, Biological Optimization, Biological Evaluation, Smart Staging etc.
42.9	Please provide **complete itemized list** of licences that will be provided along with the number, version and detailed descriptions of the facilities available with said licence.

44	**Special Conditions**
44.1	The tenderer should furnish item wise technical compliance of every point in the specification. The deviations if any should be clearly mentioned with clarifications. All relevant technical information must be included with reference to each clause of the specifications. They must be clearly indexed in the technical sheets attached.
44.2	State the requirement for electrical power supply for the unit, accessories, OIS server and all workstations being provided. Cooling system / chilling system must be supplied and installed by vendor.
44.3	Give full details of Air Conditioning and air handling requirements. The vendor has to specify the required ambient temperature, humidity conditions in the LINAC and console as well as in the server room. The vendor may offer this on a turnkey basis. **One stand by AC unit for each room wherever AC is required and CMC for AC/AHU should be included during warranty as well as CMC Period by vendor**.
44.4	Machine installation includes necessary Rigging, Grouting the base frame onto the floor, conduit runs, attaching utilities to the unit etc.
44.5	Any items not explicitly mentioned in the specifications but if the vendor and customer find the same an essential part for effecting smooth operation of the all systems must be

	included with all details.
44.6	The tenderer must clearly mention the make and model number of all equipment's being quoted and version numbers of the software and licences. Submit full detailed specifications, leaflet/catalogue for the offered model failing which offer is likely to be ignored without any further reference to the firm. Such incomplete offers will not be considered for further scrutiny.
44.7	In case the tenderer is not the original manufacturer valid authorization letter must be submitted with offer, otherwise the bid is likely to be rejected.
44.8	The tenderer should provide break up rates of the individual items of separate relevance for assessment by Departmental Committee
44.9	All expenses towards supply of equipment at the Tertiary Cancer Care Centre, Fazilka, Punjab, India, installation and commissioning will have to be met by the supplier. **However the customs duty shall be paid by the Baba Farid Univeristy of Health Sciences, Faridkot.** Customs clearance, transportation, insurance etc. are to be done solely by the supplier.
44.10	Turnkey work is to be done by the successful vendor under the directions of the UWD Department of Baba Farid University of Health Sciences, Faridkot, Punjab, India
44.11	All civil, engineering, mechanical work related to the actual installation of the LINAC, server, workstations and accessories including laying the entire network including cabling. Wall finishing up to the ceiling level with glazed tiles matching the colour scheme and design of the existing Machines. Trench covering with solid heavy duty material as in rest of floor. False ceiling with 12.5 mm gypsum sheet - plain with curved shape and fluorescence sky pattern painted there in. **Furniture like chairs & tables for staff, Almiras, cupboard and tables for contouring workstations, TPS Room, mould room. Good quality Racks for QA tools, for patient immobilisation cast etc. should be provided**.

45	**Others**
45.1	**Training of Staff** In order to fully and optimally utilize the equipment free training shall be provided as noted below: Clinical training for, **4** Radiation Oncologists, 4 physicists and **4** Technologists in two phases for 10 days in a **developed** clinical training center in India where the latest radiotherapy techniques are being routinely practiced. The supplier should also arrange for on-site training for Radiation Oncologists, Physicists and Radiation Technologists of the Department by trained personnel for the functioning of the entire LINAC system.

45.2	**General conditions and requirements:-** 1) The cost of the CMC shall be quoted only in Indian rupees. 2) The price should be quoted separately for following items in the equipment for proper comparison. Single price will not be acceptable. i) Linear accelerator – basic machine for doing 3-D CRT, IMRT and IGRT. ii) Multileaf collimator iii) Portal vision iv) 4DKV cone beam CT system v) Respiratory Gating System vi) Optical surface Mapping system vii) Treatment Planning System (TPS) viii) VMAT facility ix) Dynamic Adaptive Radiotherapy (DART) x) Networking xi) SBRT System xii) Dosimetry Accessories except 3-D RFA xiii) Mould Room Accessories xiv) U.P.S., Chiller, CCTV etc. xv) Turn Key (**<u>In Indian Rupees</u>**) 3) All claims regarding meeting of the specifications shall be duly supported by appropriate, latest technical catalogues / brochures from the manufacturer. Simply stating that the equipment meets the specifications is not sufficient and any such quotations will be summarily rejected. Computer printed documents or laser printouts will not be accepted as technical catalogues/brochures. 4) During the warranty and CMC period, software up gradation/mandatory software update shall be provided free of cost. 5) The vendor shall submit a compliance statement point wise in regard to the specifications asked for in the tender. It will be responsibility of the vendor to go through all the tender requirements carefully and accordingly address each and every point in clear terms about their compliance. The yes or no statement mentioned in the compliance statement shall not be contradicted in the tender document. 6) The company shall supply all the items required for running the entire Linear Accelerator system (including all parts consumables and non-consumables, imported or local). This assurance will remain valid **<u>upto 02 years of warranty period</u>** of the Linear Accelerator system. This assurance includes supply of all the parts required for proper functioning of the entire unit even if those have not been mentioned in the tender specifications advertised and the supply order /tripartite agreement. 7) **<u>Double distilled water should be provided for the entire life of Machine</u>**. 8) The Company **<u>would support</u>** all the regulatory clearance required for installation, commissioning proper clinical use of the entire Linear Accelerator till the time the machine is made functional for patient treatment.

	9) Supplier **would support** the complete acceptance test, QA procedures and formalities in presence of our physicists to secure the commissioning clearance from AERB. The actual supplier of the physics accessories like RFA and dosimetry systems must undertake to work along with the staff of the LINAC supplier to do the entire Quality Assurance and Acceptance Testing Procedure in compliance with the AERB guidelines. The offer must include such an undertaking also.

When quoting the price, the company can inspect the site wherever turnkey is involved

GENERAL TERMS AND CONDITIONS

Sr. No.	As per tender document	Amendment
1.	Delivery and installation period should be 160 days and it should be linked with opening of confirmed and irrevocable letter of credit.	Delivery and installation period should be 220 days and it should be linked with opening of confirmed and irrevocable letter of credit/power available/site readiness from the date of license obtained from AERB.
2.	Delivery period is 60 days from the confirmation of opening of LC.	Delivery period is 180 days from the confirmation of opening of LC.
3.	5 year comprehensive warranty Free of Cost. After the expiry of the 5 years warranty, CMC will be for 5 years.	5 year comprehensive warranty Free of Cost. Free Comprehensive warranty for 5 years will be started from the date of license for operation obtained from AERB. After the expiry of the 5 years warranty, CMC will be for 5 years.
4.	Further, 0.1% of FOB as penalty per week till the warranty period, if the instrument remains in non working condition for more than 18 days in a year.	If the instrument remains in non working condition for more than 18 days in a year, the duration of the CMC/warranty period would be extended by a term of double the downtime without additional cost.
5.	Turnkey Payment	1. 50% payment on completion of at least half of the jobs under turnkey project. 2. 50% after satisfactory completion certificate from the HOD, Radiotherapy, GGSMCH, Faridkot.
6.	-	The firm will provide 2 Radiotherapy Technologist & 1 RSO/Medical Physicist for 2 years.