GENERAL SPECIFICATIONS

A GENERAL

1. a. Linear Accelerator must have the latest technology and should be fully computer controlled with the latest state of art digital control system.
   b. Must provide Magnetron/Klystron as the RF power source. The warranty should be at least for 5 years. (Pro-rata guarantee is not acceptable)
   c. Standing 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).
   d. 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.
   e. Electron gun should have warranty of minimum 5 years and the beam focal spot should be within 3 mm diameter.
2. Machine shall be typed approved by A.E.R.B.
3. Machine shall be upgradable to higher version
4. The unit shall meet all the radiation safety standards & Quality Assurance of its mechanical, electrical and electronic provisions set by regulatory bodies (AERB).
5. System shall have all safety interlocks as per AERB guideline.
6. Equipment with a better specification than those mentioned will be preferred.
7. FDA and/or CE certificate must be provided.
8. Company shall provide certificate of trouble free operation of machine for five years from existing five users.
9. The supplier or its Indian national representative company should provide one certified service engineer permanently at Varanasi or nearby station to attend it immediately when required.
10. All the equipment/ accessories quoted and supplied should be of latest model (Proof should be enclosed in the form of press release/advertisement/certification by concerned bodies, etc.). If it is not latest, tender will not be accepted.
11. It shall be brand new machine. Supporting documents to be furnished.
12. Terms and conditions of the company will not be accepted.
13. Company should provide the certificate of life of machine.
14. Company should provide the list and cost of spares for five years after warranty period.
15. Company should give the undertaking for supply of spares till machine life.
16. Company should provide the list of 3rd party supply with manufacturer name, address and warranty period.
17. **Warranty/*Guarantee from the date of commissioning***
    Single Energy 6MV Linear accelerator Systems Including consumable, software, treatment planning systems and dosimetric equipments shall have warranty/guarantee of 24 months + extended warranty of another 36 months + 60 months of CMC from the date of commissioning approval, certificate against manufacturing defects of materials and workmanship.
18. **Insurance coverage should be F.O.R BHU, Varanasi up to commissioning.**
19. Software up-gradation with all added features should be provided free of cost for warranty period.
20. Company should be responsible for commissioning and handing over the machine to institute in fully running (proper working) condition.
21. Installation and commissioning will be carried out by the company/it's authorized agents at no additional cost (free of cost).
22. After expiry of guarantee/warranty period of 2 years, CMC and AMC charges will be quoted for eight years at the time of tender.
23. In CMC/AMC, number of routine preventive maintenance visit and all breakdown visits must be specified. 25% of CMC/AMC charges will be paid after each PMC visit. If Company fails to do AMC/CMC services in scheduled time, then penalty will be imposed @ 1% of AMC/CMC charge per day.
24. Company must specify the time period of uptime warranty in days/year during warranty and service contract. In case of failure, a compensation of Rs.15000.00/day or part thereof for the lost days will be payable to second party.
25. Training: 1 Doctor, 1 Physicist and 1 technologist for 2 week in India and 1 week abroad. Onsite Training for staff for 2 week.

26. Company shall specify the time period of replacement of damaged parts in days during warranty at no additional cost.
27. In case of any replacement during warranty/guarantee required documents would be provided by the BHU. However, the payment of clearing and transportation charges shall be borne by the supplier.
28. Company should make availability of spares for ten years.
29. If any items are required for proper functioning and running of the machine that is not quoted or mentioned by institution should be included and provided by vendor. Vendor should include the cost of those items in price bid. Inclusion of such items will be responsibility of vendor.
30. In case the Indian representative (agency/company) of company changes it shall be responsibility of company to run machine till it's full life. Original company should submit declaration for this.
31. Proof of all & every statement, certificates should be enclosed from the principle.
32. Networking and configuration with existing & procured equipment should be done by vendors at their own cost. No extra payment will be made to vendor for this work.
33. As per BHU Store purchase rules vendor will deposit 5% of purchase cost as security deposit or shall give bank guarantee of same amount till warranty is over.
34. The company should be responsible for installation, commissioning, maintenance and down time of the machine, software, accessories and networking which will help directly and indirectly in proper functioning of the machine.
35. Last five purchase prices of the same equipment should be provided along with supporting documents and complete address and telephone numbers of purchaser is to be provided.
36. Payment terms: Payment shall be made only after successful installation, commissioning and handing over of machine to Department of Radiotherapy & Radiation Medicine, IMS, BHU, Varanasi.
37. Quoted price should be on F.O.R. BHU, Varanasi
38. BHU purchase rules are applicable.
39. Company should provide the installation & commissioning time.
40. Prices including CMC charges should be quoted in Indian Rupees.
41. Prices quoted for optional items and future upgrade shall be valid for five years after installation.
42. In case of Indian engineer of company changes it shall be responsibility of original company to run machine till it's full life.
43. The company must specify the time period of whole turnkey project including installation and commissioning of machine. Any delay beyond that will be penalized as per mutually agreed amount.
44. All terms and conditions of institute will be final. Any terms and conditions of vendor will not be accounted.
45. Chiller room responsibility (installation, maintenance, off time etc.) should be of company.
46. Chiller room architectural drawing and other details should be provided by company.

B Other details:

1. Construction and electrifications of complete linear accelerator room & associated facility as per AERB norms will be sole responsibility of vendor.
2. Associated facility includes: T.P.S. room (5X5m^2), Patient waiting area (10X10m^2), Patient review room (5X5m^2), UPS, chiller and Air handling room. Vendor must visit the site/department for inspection of area, construction and scope for any modification
3. Cost of construction and modifications must be quoted separately and should not be clubbed with the cost of equipment.

C TECHNICAL SPECIFICATIONS LINEAR ACCELERATOR:

1. **Photon Beam Energy:**
   Single Photon energy – 6 MV
   The linear accelerator must be able to produce 6 MV photon beam with Dmax = 1.5±0.2 cm and% depth dose = 67 ±2% for 10x10 sq cm field at 100 cm SSD.
2. **Dose Rate & Beam Stability:**
   6 MV Photon should have dose rate of 300 or more MU/min at isocentre
   (with calibration setting of 1 MU-1cGy)
   Please indicate minimum and maximum dose rates and number of intermediate dose rates available.
   Specify the beam stability time in milliseconds.

3. **Field Size:**

Rectangular Field Size:

0.5X0.5 cm^2 to 35X35 cm^2 at 100cm SSD (unclipped field size)

0.5X0.5 cm^2 to 40 X 40 cm^2 at 100 cm SSD (clipped field size)

Clipped corners will not be acceptable for field size less than 35 X 35 cm.

a) The collimators must be motorized.

b) **Asymmetric Jaw movement**:

c) Asymmetrical collimation for both the sets of jaws shall be provided. At least one pair of jaws must be able to cross the central line by at least 10 cm to other side. The travel other set of jaws shall be specified.

d) **Tolerance**: The digital, mechanical display should be within 2mm, the optical field size and measured optical field size at 0^o, 90^o, 180^o and 270^o gantry angles must be less than 1mm for field size less than 10 X 10 cm and ≤ 2mm for fields size > 10 X 10 cm.

4. **Beam Flatness:**

a) Flatness: For photon beam intensity relative to the central axis over the central 80% of the field size at 100 cm SSD and 10cm depth perpendicular to the central axis. This should be less than or equal to±3% along X-Y axis and diagonal axis for all field sizes from 5 X 5cm^2 to 40 X 40 cm^2.

b) Stability of flatness with gantry rotation: The stability of the field flatness with gantry angle 0^o, 90^o, 180^o and 270^o at 10cm depth along X,Y and diagonal axis for all field sizes from 5 X 5 cm^2 to 40 cm x 40 cm should not be more than ±2%.

5. **Beam Symmetry:**

The ratio between values measured for each pair of symmetrical points along longitudinal and transverse axis with respect to the beam axis at 10 cm depth for 0^o, 90^o, 180^o and 270^o gantry angles for all fields sizes from 10 cm x 10 cm to 40 cm X 40 cm should not exceed ±2%.

6. **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 (MU)	Quality Index (QI)
a) 6MV	***Specify***

7. **Photon Beam Energy Stability:**

The quality index of a photon beam should not vary with time by more than ±1%. The nominal energy of the electron beam exit from the bending magnet shall be within ±3% of the nominal

8. **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.

9. **Congruence Between Optical and Radiation Field:**

The congruence between optical and radiation fields for 5x5 sq cm, 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.

10. **Rotational/Arc therapy:**

- The Linac must have photon arc therapy feature with gantry rotation in clockwise and counter clockwise directions.
- The dose rate/range of dose rate should be specified MU per degree. The MU/degree shall automatically be computed.
- A range of continuously variable dose rate should be available. A unit able to deliver high dose per degree will be preferred.

11. **Maximal Dose:**

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

12. **Radiation Leakage:**

1. X-ray absorbed dose due to leakage radiation (excluding neutrons) outside useful beam but inside a plane circular area of radius 2 m centered around and perpendicular to central axis at normal treatment distance. As per International Specifications (ICRP No 33)
2. Collimator transmission:As per International Specifications (ICRP No 33)
3. Neutron dose inside the treatment area and outside the treatment area: As per International Specifications (ICRP No 33)
4. High Voltage Protection

5. Should have anti collision system
6. Should have emergency cut-offs.
7. Should have all the interlocks & indicators.

D **Beam Data**:

1. The vendor must provide photon beams dose distribution data, such as percentage depth dose, tissue maximum ratio, collimator and phantom scatter factors, beam profiles at various depths, isodose curves, for all field sizes as well as flatness and symmetry profiles, for the unit which is to be installed in the department.

2. Field Dosimetry data should be provided from other existing setup with same machine and model.

E **Dosimetry System (Photons) :**Built-in chambers.

Specify the following
number of sealed chambers
Precision in percentage or MU
Linearity in percentage or MU
Reproducibility in percentage or MU
Dose Rate Dependence

F **MECHANICAL SPECIFICATIONS:**

1. **Gantry and collimator**

Gantry Rotation ±180° (360° total)

a) Read out - Digital and Mechanical
b) The digital display must be in room as well as at console. The digital display accuracy should be ±0.5deg., with resolution of 0.1 deg. while mechanical scale accuracy within ±1.0deg. with resolution of 1 deg.
c) Readout accuracy 0.5°
d) Control - Hand pendent and control-console
e) Target - Axis Distance. - 100 ± 0.2 cm
f) ODI Range- 75 cm to 150 cm
g) ODI Accuracy ± 0.1 cm
h) Mechanical front pointer must have the range from 60 cm to 120 cm with an accuracy of ± 0.1 cm at 100 cms SAD and resolution of 0.2 mm.
i) Gantry Rotation Isocentre ≤ 2 mm dia. Sphere
j) No Beam-stopper
k) Collimator:Rotation - ± 95° about mid position
l) Control - Hand pendant and control- console
m) Readout accuracy - ± 0.5°
n) Collimator Rotation Isocentre ≤ 2 mm dia. Sphere
o) Dynamic Wedge

2. **Target specification:**

Transmission type target with focal spot ≤3mm in diameter at x-ray target. (Material of the target to be specified)

3. **Treatment Couch:**

1. Isocentric indexed versatile extended range couch.
2. Longitudinal, Lateral, Vertical and Rotational movements
3. Electrical / Mechanical Control
4. Control-Local and/or Remote
5. Opening window - Tennis Racket / Mylar
6. Fully Carbon Fiber table top for better Quality Portal Images.

a) Minimum height from floor –approx. 60-65 cms
b) A mean shall be provided to lower couch in the event of power failure.
c) Table top dimensions: Width≥50cm, Length ≥200cm
d) Lift capacity ≥440 lb
e) All motions must have an accuracy of ± 1mm with 0.1 cm resolution in digital display must be in room and in control console area.

G CONTROL CONSOLE AND TREATMENT ROOM DISPLAY FEATURES:

1. **Main Control Console:**
   A computerised controlled console must be provided outside the treatment room. All the functions and modes of the accelerator must be software controlled. 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. In addition all the modes and functions of the accelerator must also be operated manually in case of any software malfunction.
   The accessories attached to the machine must be displayed on control console (with record and verification)
2. **Parameter Monitors:**
   The display of important parameters should be provided at the control console, and in the treatment room.
3. **Control Console Display:**
   The control console must have digital displays of gantry rotation, collimator rotation, collimator jaw setting (symmetric & asymmetric) treatment couch motions (lateral, vertical, longitudinal and turn table rotation about isocentre) and required display as mentioned earlier.
4. **Accelerator parameters check:**
   This facility must be available and details should be specified.
5. **Treatment room display:**
   This facility must be available and details should be specified.
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.

H ESSENTIAL ACCESSORIES:

1. **Shielding Block Holder:** A detachable set of screwed shielding blocks and tray must be provided to accommodate 2 trays simultaneously for wedges and block separately. Specify location and size of blocking trays.
2. **Shielding Blocks and Trays:**
   A complete set of screwed shielding blocks and tray must be provided.
3. **Wedge Filters:**
   Should provide a motorized wedge system for variable wedge angles. The hard wedges for 15,30,45 and 60 degree must also be provided.
   The unit must have special dosimetric and QA equipments for dynamic wedge dosimetry and QA tests**.**
4. Accessory for Patient set up - A mechanism to support the patient's hands may be provided.
5. **Laser Localizer lights:**
   Laser Alignment System (4 cross laser system) All lasers will be diode green lasers.

I ACCELERATOR SYSTEM CHARACTERISTICS:

1. **SSD Indicator:**
   A mechanical indicator of SSD from 60cm to 120 cm with accuracy of ±1 mm at isocentre should be provided.
2. **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.
3. Anti collision system shall be provided.
4. **MLC - Multileaf Collimator.**
   For maximum flexibility, the Multileaf Collimator must be used in conjunction with the primary collimators. To facilitate rapid setup of standard treatments, the conventional collimator system must not be replaced. Conventional therapy capabilities must be provided through an accessory mount for the attachment of shadow blocks, wedges, and electron applicators. The field sizes must range from at least 0.5 x 0.5 cm^2 to 40 x 40 cm^2. The mechanical and radiation isocenter accuracy must remain < .01 cm radius sphere. Separate MLC workstation provided if required.

i. Number of leaves shall be at least 80 (40 pairs). Better specification would be preferred.
ii. Clearance from bottom of collimator to isocenter shall be specified.
iii. X-ray transmission through leaf shall be specified
iv. Positional accuracy shall be specified.
v. Minimum step size shall be specified

a) Independent drives
b) Leaf width at isocentre <= 10 mm
c) Capable of performing Dynamic Conformal therapy procedures. Interface between MLC & Existing Network System should be provided.
d) Facility to treat patients conventionally, using blocks without MLC.
e) Work Station HW/SW – Specify details
f) Integration (full Networking) with Planning System, Simulator, CT, CT Simulator, MRI & RFA should be done.
g) IMRT delivery should be possible.
h) Two nos. of treatment parameter 21" TFT monitors to be provided.

Limits/range for following shall be specified

a) Max. leaf retracting position
b) High over center travel of MLC leaves (>10 cm) for IMRT treatments.
c) Max. field length
d) Leaf height & material
e) Coincidence of light & x-ray field
f) Penumbra
g) Transmission
h) Interleaf leakage
i) Leaf position accuracy
j) Max. carriage speed
k) Max. leaf speed
l) Positional accuracy of the leaves during treatment.
m) Inter-digitation of leaves if available

5. **Intensity Modulated Radiotherapy System**

The system shall be capable of improving target dose homogeneity and sparing irradiation of healthy tissue.

- IMRT techniques available shall be specified.
- Treatment (including imaging) should be possible in conventional 10 to 15 minutes time slots
- The treatment planning software to calculate IMRT treatment plans should be included:

a. Describe in detail the optimization and calculation algorithm.
b. System must provide inverse planning dose optimization.
c. System must support Dose Volume constraints
d. System can support any number of dose volume constraints
e. User can draw arbitrary line to represent the desired DVH
f. Dose optimization must have an interactive user interface
g. User must be able to modify dose constraints without having to stop the iteration process
h. Final dose calculation must be based on a deliverable a MLC sequence
i. MU calculation accuracy should be specified.
j. System must support both multiple static segment and "step and shoot" IMRT
k. System can optimize using a base-dose from a previous 3D external plan.
l. A most precise two dimensional array detector system with all essential accessories (like hardware, plastic Phantom, software etc.) shall be supplied for fluence verification of IMRT plans. The number of ion chamber needs to be specified. Active area shall be at least 20X20cm^2. Chamber volume shall be less than 0.1cc. It shall be capable to import planned data from **TPS** being quoted. Gantry angle verification shall be possible.

J PORTAL IMAGING SYSTEM- TECHNICAL SPECIFICATION

1. It should be fully integrated with the accelerator
2. It should give real time image.
3. It should be integrated with arm fixed along with the linear accelerator and capable to take, image at any gantry angles. The arm should be of robotic type and remote controlled.
4. The system should be based on latest technology with high-resolution imaging.
5. The system should have image detection unit, image acquisition and processing system. Portal vision visualization system workstation and workspace with 21" display color monitor.
6. Portal imaging system should be retractable to get movement space when EPID is not in use.
7. In portal imaging system:(following should be specified)
    a) Size of detector panel
    b) Image matrix
    c) Resolution
    d) Spatial resolution
    e) Possibility of double exposures.
    f) Printing of multiple images.
    g) Number of multiple viewing stations.
    h) Energy range.
    i) Feasibility of grid overlay.
    j) Image annotation.
    k) Storage of patient information with image.
    l) Facility for sending and receiving RT images.
    m) Imaging technique/detectors
    n) Connectivity with Record and verification system.
    o) Facility of transferring images with DICOM RT.
    p) Feasibility for upgradability.
    q) Calibration and set-up: Describe briefly the calibration technique, set-up time and preventative maintenance procedures for the system, including a statement of the frequency with which these tests and procedures must be performed and any tools which are required shall be supplied.

K TREATMENT PLANNING SYSTEM - TECHNICAL SPECIFICATION

1. Provide a latest comprehensive Radiotherapy Treatment Planning (RTP) system for conventional, 3D Conformal Radiotherapy, Inverse Planned IMRT and Brachytherapy.
2. At least two work stations shall be provided. The Treatment Planning System shall be linked to Accelerator console through record and verification system. Required Server and software shall be supplied.
3. Appropriate port Hub W/BNC connector for network connection should be provided.
4. Power strip with push-to-reset circuit breaker to provide single power connection for computer, monitor and accessory and peripherals.
5. The TPS shall be based on modern workstation technology and permit the linking of several client workstations to a central server workstation. Two calculation engine and two contouring station (with floating licence).
   Hardware requirements: Latest configuration of hardware (CPU, hard drive, RAM, Min 21" square TFT monitor, color LASER printer)
   DICOM-3RT INTERFACE to network with simulator, CT scanner, dosimetry system, 3-D TPS etc. System shall be with Digital film scanner
6. **Required softwares:**
   6.1 User Interface
    a) 3D view displays anatomical volumes (translucent surfaces or wire-frames), fields, field accessories and dose distribution
    b) 3D view indicates patient orientation using an anthropomorphic symbol
    c) 3D view can be used to define beam parameters (field size, collimator rotation), beam position (lateral and longitudinal rotation, movements), shielding blocks and MLC settings
    d) Can project field outlines onto the patient surface in the 3D view
    e) Can display DRR attached to field in the 3D view
    f) Can compare DRR image with portal image or digitized simulator image inside BEV
    g) Beam's-Eye-View (BEV) with anatomy and DRR display
    h) Ability to create digitally enhanced DRR to suppress bone, enhance soft tissue, use partial volumes, etc.

i) DRR automatically recalculated in real time when the field is moved
j) BEV can be used to define beam parameters (field size, collimator rotation), beam position (lateral and longitudinal rotation, movements), shielding blocks and MLC settings
k) Layer window that provides a quick and interactive method to display and select fields and accessories
l) Property display function that groups information into logical combinations for easy access and change.
m) Toolbar for frequently used operations
n) Hot-keys for frequently used operations.
o) Printing and plotting is done in the background thus system is free for planning the next patient.

6.2 Patient anatomical data transfer:

a) The patient data must be transferred from CT/MRI, Simulator (in the form of flouroscopic image and CT/MRI slices) via DICOM, CD & DVD's.
b) Data from CT/MRI slices must be transferred via film scanner, digitizer & direct from CT/MRI Scanners, Simulators & RFA.
c) The system must select more than or equal to 200 images per patient and to do real time multi-planer reconstructions from original CT/MRI image data sets.
d) 4. The system must have autocontouring of external and internal organs from CT/MRI images either taken from CT/MRI film or via other mode of data transfer as mentioned above.

6.3 Image handling

a) Support of patient prone or supine, and head-first or feet-first patient orientation.
b) Image processing tools including mean filter, median filter, threshold, and adaptive histogram.
c) Window/level facilities for gray scale images.
d) Image Utilities include distance, area and volume measurements and statistical calculation of CT values within a user-defined region.
e) Zooming of high-resolution image and screen dumps to a color printer is possible in any stage of the planning program.
f) Each image contains information of the imaging equipment (scaling, orientation); the images can be in arbitrary order and arbitrarily spaced.
g) Real-time frontal and sagittal section reconstruction from original transversal CT-images
h) It shall read X-ray films digitized via Video Digitizer or film scanner

6.4 Contouring

a) Supports contouring templates that list structures of interest and define structure display properties, etc.
b) Automatic contouring of patient outlines and internal structures through all CT-images
c) Post-processing tools that smooth, reshape, connect, disconnect structures, etc.
d) 3D automargin function (e.g. CTV to PTV) with independent margins in 6 directions
e) 3D manual contouring tools that work in the transversal, sagittal and frontal images
f) Interpolation of contours
g) Manual contour entry and editing
h) Display of frontal and sagittal images for reference
i) Boolean operations (AND, OR, XOR, AND NOT) with structures to create complex structure definitions
j) Edge detection tool
k) Contour optimization tool

6.5 Dose Planning

a) Supports Planning library that define field orientation, name, margins, isocenter location, and dose prescription
b) The field can be centered automatically to the center of any volume
c) Different energies (photons and electrons) as well as external beam, intracavitary and interstitial plans can be combined in a single plan
d) Each field can have separate isocenter
e) Import of image, isocenter and plan data from CT scanner

f) Entire group of fields can be moved together
g) Auto-blocking with a user-defined margin around target volume
h) Block outlines can be modified graphically
i) Ability to copy, move and mirror blocks
j) Auto-MLC with a user-defined margin around target volume
k) MLC aperture can be modified graphically
l) Ability to copy and mirror MLC settings
m) Automatic optimization of compensators.
n) User-defined density for bolus
o) User-defined CT numbers within specified regions (remove contrast medium) in any plane

6.6 Dose Calculation, Photons

a) Photon energy range from telecoblat to 25 MV X-rays and multiple electrons.
b) 3D dose calculations with coplanar and non-coplanar photon and electron beams
c) Calculation of Monitor Units separates the phantom and head scatter component
d) Calculation of Monitor Units for linear accelerators and treatment times for Cobalt units (decay factor included)
e) 3D dose calculations can be performed simultaneously with multiple patient planning
f) Normalization of dose distributions to minimum, maximum, any arbitrary % value or to any dose point value
g) User-definable transmission factors for blocks etc.
h) Beam hardening in metallic wedges is included in the calculation
i) Support for Enhanced Dynamic Wedge
j) Support for motorized wedge
k) Batho Power law and Equivalent TAR heterogeneity correction

6.7 Dose Calculation, Accuracy

For following, accuracy must be specified:
a) Photon fields in typical clinical setup
b) Photon beam reconstruction model
c) Oblique correction
d) DVH sampling
e) 3D margin
f) Automargin for blocks in BEV
g) Dose calculation grid user-selectable specify range
h) Dose calculation matrix (specify accuracy)

6.8 Plan Analysis

a) Side-by-side plan comparison such that images are linked to display the same image planes (frontal, sagittal and transversal) simultaneously
b) DVH for any multiple structure volumes in one plot
c) DVH for multiple plans in one plot
d) Differential or cumulative dose volume histogram
e) Absolute or relative scale for the structure volume axis of DVH plot
f) Dose volume histogram supports Boolean combination (AND, OR, XOR, AND NOT) of several volumes
g) Export of DVH data into other formats(ASCII file/Excel file, etc.)
h) Printout of DVH graphs on paper
i) Point dose display
j) Display and plotting of any arbitrary dose line profiles
k) Multiple plan summation
l) Can store summed plans
m) Plan subtraction
n) Can map, dose distribution to the surface of any structure

6.9 Supported Treatment Techniques

a) Isocentric and fixed SSD fields

b) Photons, electrons
c) Irregular
d) Coplanar and non-coplanar fields
e) Asymmetrical collimators with field central axis over-travel
f) Shielding blocks (number should be specified)
g) Standard wedges
h) Motorized wedges
i) Dynamic and Enhanced Dynamic Wedges based on open field dosimetric beam data and STT files (no additional beam data measurements to configure)
j) Compensators
k) Bolus

6.10 Plan Output

a) The plans can be exported directly after approval to linear accelerator for dose delivery.
b) User-definable print layouts
c) On-screen graphics can be dumped to a color graphics printer
d) Plotting of plan in a user selected scale on A3, A4, letter or tabloid size paper
e) Printouts include patient administration data, time stamp, field parameters (treatment unit, gantry, collimator and couch rotations, field position coordinates, field size, wedge, weight, Monitor Units), dose parameters (target maximum, minimum and mean, maximum dose), patient orientation and plotting scale
f) DRR printed with cross-hairs to identify isocenter
g) DRR printed with graticules to identify scale
h) DRR printed with structure outline projections
i) Scaleable DRR printouts
j) Plotting of BEV image at any distance.
k) Block outlines can be plotted in a user-defined scale with internal structures and field edges
l) Compensator shapes as equivalent thickness curves or profiles can be plotted at user defined scale
m) Plotting of compensators as iso-thickness curves or thickness profiles at any distance.
n) Direct data transfer to compensator milling machines.

6.11 Connectivity

a) Multiple 3D workstations can be connected to RTP network.
b) Multiple 3D workstations can import image and plan data
c) Support for different image modalities (fluoroscopy, C-arm,CT, MR and PET) for target and critical organ delineation.
d) Supports DICOM-RT import/export of
    I. At least DICOM 3.0 images (any better specification preferred)
    II. Radiotherapy Images (DRR, simulator image, etc.)
    III. Radiotherapy Structures
    IV. Radiotherapy Plans
    V. Radiotherapy Dose Matrix
    VI. Radiotherapy Dose points
    VII. Radiotherapy Fluence
    VIII. Radiotherapy dMLC for IMRT
    IX. Radiotherapy Blocks
    X. Radiotherapy Compensators

e) Integrated planning, virtual simulation, simulation, patient management (RV system) and treatment delivery
f) Local Area Network (LAN)
g) Network Files System (NFS).
h) TCP/IP
i) Ethernet/IEEE802.2/3.

6.12 Import Filters

a) DICOM-RT

b) DICOM 3.0 or higher
c) Image transfer via Local Area Network
d) Image transfer via CD-ROM
e) Digitizer for non-CT based patients (brachytherapy films and irregular fields)
f) Film scanner
g) Dosimetric beam data from all brand name water phantoms (Wellhofer, RFA, and PTW, etc)

6.13 Output Filters

a) DICOM RT.
b) DICOM 3.0 or higher
c) Block and compensator data via DICOM

6.14 **The Treatment planning system shall be integrated to Linear Accelerator console through record and verification system. Required Server and software shall be supplied**.

L THE RECORD & VERIFICATION SYSTEM MUST BE BASED ON CLIENT/SERVER ARCHITECTURE TO PROVIDE:

- A common relational database management system that integrates medical and business records
- A common user interface for data entry and viewing in a variety of applications
- A standard communication path for interfacing to other database systems.
- Considering the critical nature and volume of procedures, the software must provide high reliability, and should offer the highest quality performance.
- The Oncology information management/record and verify system shall assist in the integration of radiotherapy patient data throughout the entire department. It shall also record and verify treatment parameters of patients undergoing treatment on the Linac.

M ONCOLOGY INFORMATION SYSTEM COMPLETE WITH NETWORKING, RECORD & VERIFY SYSTEM

a) Transfer of all parameters from Simulator & Treatment Planning System to the Linear Accelerator for automatic treatment setup & delivery should be provided.
b) Transfer of Fluoroscopy images from Simulator to Portal Imaging System for comparison should be provided.
c) Transfer & Execution of MLC Position Parameters for normal treatment & IMRT treatment including Step & Shoot & Dynamic techniques from Treatment Planning System should be provided.
d) Should be Networked with Existing Network System and all required interfaces should be provided.

N DOSIMETRIC AND QUALITY ASSURANCE TOOLS

1. **Absolute Dose Calibration :**
   A compact water phantom for routine absolute dosimetry (30X30X30cm^3) with water drains system. Phantom shall have provision to hold 0.6 cc Farmer type Chamber. Required chamber adopter shall be supplied.
2. 0.6/0.65 cc Farmer type cylindrical chamber (2 nos) with water proof sleeve shall be supplied with valid calibration certificate.
3. Portable, single channel, high precision reference class electrometer (2 nos.) for measurements of absorbed dose shall be supplied. Electrometer has provision to measure dose, dose rate, average dose rate, charge, current and dose per monitor unit. Detectors details should be stored in electrometer.
4. A solid water equivalent phantom made up of slabs of different thickness shall be provided for Linear Accelerator dosimetry. It should be possible to use this phantom for both electrons and photons dosimetry. The phantom must be free of contaminants and air buffers. Guarantees must be provided for electron density and homogeneity and shall be certified to be within 0.5% of water at photon energies. The slabs shall be of 40 cmx40 cm, Size totaling thickness of 40 cm. Different slabs of 2 cm thickness with appropriate cavities to accommodate NE 2571, NE 2581 type Farmer chambers, the pin-point ion-chamber, markus type and roos type parallel plate chambers must be provided in addition to the 40 cm thick slabs. The phantom should be rigid type and should not show any kind of charge build up effects. It shall not be affected by any change in ambient temperature and humidity. Film cassettes made of the same material should also be quoted.
5. **Relative dose measurement system:** 3-D Radiation Field Analyzer **(RFA)** for beam data measurement and QC & QA should be provided with real time software control with integrated workstation based decision support option for treatment planning. RFA System shall have following features:

a. Water phantom to have scanning volume (LxWxH): 450mm x 450mm x 410mm or higher. Higher values will be preferred.
b. Electrical lift table with four points for level alignment.
c. It shall have provision for step-by-step as well as continuous measurement.
d. Position resolution: 0.1 mm or better
e. Position accuracy: ± 0.1 mm or better
f. Position reproducibility: ± 0.1 mm.
g. Sensor shall be ion chamber with about 0.1cc volume.
h. Water reservoirs shall be Bi-directional with more than 210 L capacity.
i. Common control unit (CCU) [leakage current and time constant should be specified] and Ethernet common interface.
j. TMR & TPR probe with required accessories and software licenses.
k. Software shall be provided to convert measured data in the format required for beam data configuration of supplied TPS.
l. Chamber adapter for 0.6cc cylindrical chamber shall be supplied compatible with RFA phantom to perform absolute dosimetry.

O QUALITY ASSURANCE TOOLS:

a) One most precise and reliable Iso-alignment device with provision for holding ready pack film for radiation field congruence test and digital leveling system shall be supplied.
b) One flat bed films scanner with appropriate software shall be provided to check flatness and symmetry of beams at gantry angles 90^{o},180^{o} and 270^{o}.
c) Appropriate buildup caps for nominal energy available in supplied linear accelerator for in air measurement.
d) A reliable and precise D20/D10 phantom for Quality Index verification.
e) A digital barometer with valid calibration certificate shall be supplied.
f) A digital thermometer with valid calibration certificate shall be supplied.
g) One latest, most precise and reliable Ionisation Chamber based surveymeter shall be supplied. The surveymeter should have following features:

- It shall be sensitive to gamma and X-ray of energy from 20keV to 20MeV
- It shall have micro resolution.
- Operating range shall be at least 0.0 µR/hr to 5R/hr.
- It shall have digital readout and indication for Low Battery, Mode and peak hold.
- It shall be capable to measure dose rate and dose simultaneously with capability to record peak dose rate.
- It shall have provision for auto ranging and auto zeroing.
- Case shall be light weight and made up of high strength material and shall be sealed against moisture.

h) Quality Assurance Test: A list of daily weekly, monthly and yearly QA test must be provided. Each test must be described in detail. The critical accelerator operational parameters shall be recorded for each of the QA test run and a report of these parameters can be printed at the end of the completion of QA procedure. A required test kit for QA test must be provided.

P IMMOBILIZATION DEVICES

Standard supine base plate of carbon fiber material (head & neck) - 2 sets
Lateral base plate 2 sets
Head and neck prone base plate of carbon fiber Material (adjustable) - 2 sets
Head & neck supports of low radiation attenuation A ,B,C,D, & E.- 3 sets
Knee crutch and arm position with hand grip - 2 sets
Overhead arm positioner – 3 numbers
Shoulder retractor – 4 sets
Universal tissue equivalent bolus 30X30 cm^2 of appropriate thickness –10 numbers
Breast Board, Pituitary Board, pelvic base plate (all in carbon fiber),
One large water bath.

Q ENVIRONMENTAL FACTORS

Complete installation should include:

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

Power Supply

a) Should work on three phase 400-440 V / 50 Hz Power
b) 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.)
c) Silent Generator of 75 kVA should be provided and must be quoted separately.
d) Resettable overcurrent breaker shall be fitted for protection

R CIVIL CONSTRUCTION AND ELECTRIFICATION: TURNKEY WILL INCLUDE WHOLE AS UNDER MENTIONED

Construction of Linear accelerator room according to approved layout and as per guide line of AERB. Construction of adequate size electrical substation, generator room and UPS room TPS room (5X5m^2), Patient waiting area (10X10m^2), Patient review room (5X5m^2), Chiller and Air handling room. Vendor must visit the site/department for inspection of area, construction and scope for any modification

The construction work of the LA room must be as per AERB norms. Any radiation leak or related uneventful happening will be responsibility of vendor.

Electrification and centralize air conditioning of Linear Accelerator room shall be as per machine requirement.

a) All electrical fittings/ wiring to be done by the vendor.
b) Cable for 3 Phase Power to be provided by vendor.
c) Air-conditioners to be provided as per the system requirements
d) All Electrical Switchgear (MCCB/MCB.DB/Bus bar) should be used from reputed company like L&T ,Siemens, ABB only.
e) All wires used must be FRLS(Fire Retardant with Low Smoke) type only.

The institution will be providing land for construction LA room and vendor has to construct the LA room as per all requirements of AERB approved LA room for complete and successful working of machine in view of total radiation protection.

The walls will be cement plastered with Plaster of Paris finish.

The exterior walls and the façade will be in harmony with the existing buildings in the complex.

Flooring will be flat and stable.
The flooring shall be done with 600 x 600 high density mat finish vitrified ceramic tiles.

In the toilets glazed tiles will be used for Dado up to the ceiling.

The walls will be painted with washable plastic emulsion paint.

Floor trenches with block board covers will be provided for the cables in the LA and Equipment rooms.
Complete plumbing operations including laying of sanitary lines, manholes, wash basins, geysers, white vitreous EWC etc. will be provided.
Furniture should be of high quality (branded/superbrand)

Arrangement of water supply lines for drinking and general use including hot water will be made. Quality of water supply GI pipes should be high quality. The sanitary fixtures/ fittings should be of superior quality. The toilet seats should be of porcelain material .

The washing units and drainage lines should be resistant to chemicals.

The entrances to the Centre to be felt padded at the junction of both the doors to avoid dust and provide insulation.
False ceiling in all the areas will comprise of metal suspension system, perforated fireproof aluminium panels with integrated acoustic lining.

All fluorescent lights and smoke detectors to be accommodated/ integrated in the false ceiling.

All the internal wiring including that of telephone, LAN, DICOM & PACS etc. will be of concealed variety. Modular Cabinets should be provided..

Fire Safety measures: A fire alarm system of reputed make with smoke/heat detectors, indicator panels, call boxes, electronic sirens and wiring will be installed.
Audio call bell system, with intercom and remote locking/ unlocking facility, to be provided at the main door of the complex.
A security grill/shutters to be put at the main entrance. It will be wide enough to permit easy entry of patients on trolleys and wheel chairs.

The surrounding area to be illuminated for security reasons.
Music system for all the rooms and waiting areas in the centre.

Closed circuit cameras of reputed company should be provided in the examination room, console room, Linear Accelerator and waiting areas to be provided.

Metallic signboard is to be provided.(8 x 4) feet
All the rooms in the complex will be signposted. Sun-film and Venetian blinds will be put up in all windows.

The entire complex will be made rodent/pest proof.

All windows should have MS grill, Aluminium frame and glass, sliding window type.

Pop/ plaster / paint also to be mentioned in each rooms

RF Interiors on LA are to be specified

Scope of AC also needs to be clear in the form of ductable / units

Doors specification should be provided by the Vendor (followed by AERB guidelines wherever required)
Construction and all material should be of top quality (ISI Mark) and work should be completed within prescribed period.
All specifications should be as available in tertiary level teaching hospital/institute.

Electrical Services:
The LA and all connected/required equipment for treatment planning, scanning, post-processing and filming are to be connected to the supplied UPS.
All the equipments/computers along with peripherals, light points, fire alarm system, EPABX and view boxes are to be supplied power through the common or a separate UPS with suitable capacity or more with 60 minutes back up.

Dimmer controlled incandescent light fixtures are to be provided in the gantry room, console room.
All the electric wiring (Copper), switches, sockets, plugs, MCBs etc. are to be of reputed make and as per ISI standards.
Different parts of the complex will have separate wiring for light and power circuits through MCBs of suitable capacity.

Adequate safety measures will be incorporated in the electrical power supply system.

Dedicated isolated earthling is to be provided for the complex.

Electrical fitting, switches in all above rooms should be provided by Vendor for various purposes.

Ductable Central A.C. for gantry and console and Split A.C. of reputed Company in other rooms.

The complete area is to air-conditioned optimally except for Toilets/Services with split type of Acs.

All weather AC with cooling and humidity control capabilities is to be provided.
Air flow in various rooms should be adjustable to have some degree of control over temperature in different rooms of the complex.

The AC unit(s) should be microprocessor controlled for adequate temperature control.

The entire turnkey project (building and the supplied items) should have an underlying colour scheme so that it gives a homogenous, aesthetically pleasant and patient friendly appearance.

Any addition and alteration as and when required during turnkey work will be done by mutual discussion between the supplier and technical committee. The whole turn key work has to be done to the fullest satisfaction of the technical committee and University Works Department of BHU In case of any difference of opinion the decision of the technical committee shall be final and binding on the supplier.

S FURNITURE

Console, Gantry room

Modular furniture of branded company for console equipment and staff.

Modular Cupboard and cabinet with lock and key.

Equipment Room

Modular Cupboard with lock and key to keep spares and user manual

Modular Cupboard for stationary and record.

Receptionist Chamber

Plywood sunmica table for writing purpose , drawers cupboard to keep film. Folders , record and provision for PC, CPU, UPS and Printer.

Revolving chair, Illumination System, Fans, Provision for glass counter, Microphone and Speakers for giving instructions to patients,

Patients Waiting Hall

Sitting arrangement (steel waiting chairs fixed to the ground) for at least 25 patients/as per the space available.

Fans

Provision of 42" size flat screen Colour television with close cabinet and DTH disc with set top box and CD/DVD/ Player

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