GAMMA CAMERA and DATA PROCESSOR SYSTEM

TENDER QUESTIONNAIRE – PART B Gamma Camera and Data Acquisition

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Contents

The System

Please identify the gamma camera make and model to which the following specification applies. Include details of any options that are required in order to meet the stated performance.

Manufacturer	
Gamma camera model	
Acquisition system model	
Software version	
Options required	

Gamma Camera and accessories

1. Detector Performance

Please state the performance parameters of the gamma camera as determined according to the methods specified by the National Electrical Manufacturers' Standards Publication NU1-2001.

i)	What is the **intrinsic spatial resolution** of the detector? a) FWHM in CFOV (mm) b) FWHM in UFOV (mm) c) FWTM in CFOV (mm) d) FWTM in UFOV (mm)	
ii)	What is the **intrinsic flood field uniformity** of the detector *before application of sensitivity correction* (ie without scaling counts in inverse proportion to a previously acquired high count flood)? a) Integral uniformity in CFOV (%) b) Integral uniformity in UFOV (%)	

	c) Differential uniformity in CFOV (%) d) Differential uniformity in UFOV (%)	
iii)	What is the **intrinsic flood field uniformity** of the detector with all corrections (*including sensitivity correction*) applied? a) Integral uniformity in CFOV (%) b) Integral uniformity in UFOV (%) c) Differential uniformity in CFOV (%) d) Differential uniformity in UFOV (%)	
iv)	What is the **intrinsic spatial linearity** of the detector? a) Absolute linearity in CFOV (mm) b) Absolute linearity in UFOV (mm) c) Differential linearity in CFOV (mm) d) Differential linearity in UFOV (mm)	
v)	What is the intrinsic **energy resolution** of the detector (%)?	
vi)	What is the system sensitivity for 99mTc using the LEGP collimator (cps/MBq)?	
vii)	What is the **multiple window spatial registration** (mm)?	
viii)	What is the **intrinsic count rate performance**? a) Maximum observed count rate (kcps) b) Observed count rate at which 20% loss occurs (kcps)	
ix)	If the system is capable of SPET, what is the **resolution of reconstructed SPET images**? a) Tangential resolution (mm) b) Radial resolution (mm) c) Central resolution (mm) d) State the collimator that was used for the above measurements e) State the reconstruction method that was used for the above measurements	
x)	What is the detector **shield leakage**?	

	a) Maximum shield leakage at 140 keV (%) b) Maximum shield leakage at 360 keV (%) c) Maximum shield leakage at 511 keV (%)	
xi)	For multi-detector systems, do the figures stated in i) to x) apply to all detectors independently? If 'No' state any differences between detectors.	
xii)	For multi-detector systems, what is the maximum percentage difference between any two detectors in the following parameters? a) Intrinsic resolution (i)) b) Intrinsic uniformity with sensitivity correction applied (iii)) c) Intrinsic energy resolution (v)) d) System sensitivity (vi))	

2. Detector Head

i)	Does each detector head use a single NaI(Tl) crystal?	
ii)	Specify the thickness of the crystal (mm)	
iii)	Specify the number of photomultiplier (PM) tubes used in each detector.	
iv)	Specify the size and shape of each PM tube	
v)	Specify the shape of the field of view (eg rectangular, circular etc)	
vi)	Specify the size of the field of view (mm)	
vii)	Specify the distance between each edge of the useful field of view and the edge of the detector housing. (A diagram may be attached.)	
viii)	Which of the following correction systems are built into the detector? a) PM tube gain control b) Energy correction c) Linearity correction d) Sensitivity correction (count scaling) e) Other corrections (please specify)	
ix)	This question is no longer used	

x)	If periodic re-calibration of any of the correction systems in viii) is required, state the frequency with which the procedure needs to be performed, and how long it takes on each occasion a) PM tube gain control b) Energy correction c) Linearity correction d) Sensitivity correction e) Other corrections	
xi)	Would the above re-calibration procedures be routinely performed by your service personnel as part of a routine preventative maintenance visit?	
xii)	Could the re-calibration procedures be performed by the user, without the need for any special accessories or phantoms, other than those supplied as standard with the system?	
xiii)	This question is no longer used	
xiv)	Which of the correction systems specified in viii) can be temporarily switched off by the user, if required? a) PM tube gain control b) Energy correction c) Linearity correction d) Sensitivity correction e) Other corrections	
xv)	This question is no longer used	
xvi)	How many sets of correction maps are needed to cover different energy ranges, collimators etc? a) PM tube gain control maps b) Energy correction maps c) Linearity correction maps d) Sensitivity correction maps e) Other correction maps	
xvii)	This question is no longer used	
xviii)	At what point in the detector are signals converted from analogue to digital form? a) At the output of every individual PM tube	

	b) At the sum of each row and column of PM tubes c) After analogue calculation of X, Y and energy signals d) Other (specify)	
xix)	If the signals are subject to further re-conversion to analogue form at any point within the system, please give brief details of where and how this is done.	
xx)	Specify the variation in energy signal response to a point source at 140keV during a 360^0 rotation of the detector (keV)	
xxi)	Specify the variation in count-rate from a point source at 140keV during a 360^0 rotation of the detector (%)	
xxii)	Specify the method used to calculate X and Y position signals from the PM tube outputs, and the number of PM tubes that are included in the calculation (eg Anger arithmetic using all signals above threshold; local centroiding of 7 tubes etc).	
xxiii)	Specify the method used to calculate the energy signal from the PM tube outputs (eg weighted sum of all tubes; sum of highest 7 tubes etc)	
xxiv)	For multi-detector systems, do the responses in i) to xxiii) above apply independently to each detector? If not please specify any differences between detectors.	

1. Gantry Design

1.1 Detector Head Motion

i)	Please provide brief details regarding the method of gantry construction. Indicate how the construction ensures appropriate mechanical stability for both general and tomographic studies.	
ii)	How many independent detectors does the system have?	
iii)	If the system has more than one detector, what fixed detector positions can be used for patient imaging? (Angles are measured between radial lines which are perpendicular to a horizontal axis through the gantry and also perpendicular to the face of each detector)	

	a) Detectors 180° opposed b) Detectors 90° apart c) Detectors 120° apart d) Other (specify)	
iv)	For multiple detector systems, how long does it take to reconfigure the detectors between the different positions specified in iii) (sec)?	
v)	What is the angular accuracy with which the detector(s) may be returned to any of the positions specified in iii) prior to imaging (degrees)?	
vi)	For multi-detector systems, is it possible to acquire images with the detectors at intermediate angles between the fixed positions specified in iii)?	
vii)	For multi-detector systems in the 180° opposed configuration: a) Is it possible to vary the radial distance of each detector from the axis of rotation, independently of the other detectors? b) What is the minimum separation of the detectors between collimator faces (cm)? c) What is the maximum separation of the detectors between collimator faces (cm)?	
viii)	For multi-detector systems in the 90° opposed configuration: a) Is it possible to vary the radial distance of each detector from the axis of rotation, independently of the other detectors? b) What is the minimum distance between the collimator face of one detector and the axis of rotation (cm)? c) What is the maximum distance between the collimator face of one detector and the axis of rotation (cm)?	
ix)	Please provide one or more diagrams or photographs of the system annotated with arrows to show the directions in which it is possible to move the gantry and detector(s). If the system incorporates a built in imaging table please include table motions. For each available motion please specify the following:	

	a) The name by which this motion is known (eg gantry rotation, radial distance, head tilt, bed up) b) Which arrow on the diagram corresponds to this motion c) The range of motion possible (minimum and maximum values) d) Whether the motion is manual or motorised e) For motorised motions the speed, or range of speeds, that are available f) For motorised motions, whether it can be performed under operator control (ie the operator can move it by pressing one or more buttons such that motion stops as soon as the buttons are released) g) For motorised motions, whether it can be moved to predefined positions (ie the operator can move it to a preset position by a single command without having to hold a button pressed all the time) h) For motorised motions, whether it can be performed automatically (ie the system will move it under program control as and when required by the selected protocol)	
x)	Specify any limitations on any of the above motions that depend on the position of another motion.	
xi)	Are the full range of motions detailed in ix) available with all collimators? If 'No' specify any limitations with specific collimators.	
xii)	Are the full range of motions detailed in ix) available when the collimator(s) have been removed from the detector(s)? If 'No' specify any limitations.	
xiii)	Where are movement controls located? a) On the gantry b) On the detector head c) On the imaging table d) On a remote control unit e) On the acquisition computer	

	f) Other (specify)	
xiv)	Is there a numerical display of the current positions of the gantry, detector and imaging table a) On the gantry? b) On the detector head? c) On the imaging table? d) On the acquisition computer? e) Other (specify)	
xv)	Is the gantry and/or detector head equipped with appropriate sensors to detect contact with the patient or an obstruction?	
xvi)	Are there contact sensors on the face of every collimator?	
xvii)	Specify the location of any additional contact sensors	
xviii)	What happens if a contact sensor is activated during patient positioning?	
xix)	What happens if a contact sensor is activated during image acquisition? a) During static acquisition b) During dynamic acquisition c) During whole body acquisition d) During SPET acquisition	
xx)	If acquisition is stopped when a contact sensor is activated, can it be restarted without loss of any data?	
xxi)	Specify the number and location of any emergency stop buttons that can be used to stop all motorised motions.	
xxii)	If an emergency stop button is pressed during data acquisition is the data acquired so far preserved?	
xxiii)	Do all motions detailed in ix) have brakes that prevent the detector and/or gantry from moving by simply pushing against it?	
xxiv)	Do these brakes remain applied even in the event of a power failure?	
xxv)	Are manual controls available to move the detector head away from the patient in the event of a power failure?	
xxvi)	Specify how patients can be removed from the system in the event of a power failure	

xxvii)	With collimators removed, is it possible to position the detector so that a point source placed on the detector axis at a distance of 5 times the diameter of the field of view, gives a uniform illumination of the detector (eg for intrinsic uniformity measurement)?	
xxviii)	If the system has more than one detector, can all detectors be positioned, such that all detectors are uniformly illuminated simultaneously by the same source (e.g. for daily intrinsic uniformity measurement)?	
xxix)	If the distance of the source in 2.3.1.28 is less than 5 times the diameter of the field of view, is software provided to correct for this in intrinsic uniformity calculation?	

1.2 Whole-Body Imaging

This section has now been combined with section 3.6

1.3 Automatic patient-detector distance sensing

i)	Does the system provide an autocontouring device for automatically sensing the patient-detector distance and adjusting the detector to maintain this distance constant? a) As part of the basic system b) As an extra cost option (ECO)	
ii)	Which acquisition modes can the autocontouring device be used in? a) SPET mode b) Whole body mode c) Other (specify)	
iii)	Provide brief details of the method used for autocontouring	
iv)	What distance between collimator and patient does the autocontouring device achieve (mm)?	
v)	Which collimators can the autocontouring device be used with?	

1.4 Imaging patients in beds

i)	Is it possible to take an anterior image of a patient who is lying supine on a standard hospital bed without moving the patient off the bed?	

ii)	What is the maximum reach of the detector across the bed, measured from the edge of the bed to the centre of the detector field of view?	
iii)	In this imaging configuration, what is the width of the detector field of view in the lateral direction (from the patients left to right)	
iv)	In this configuration is it possible to adjust the height of the detector above the floor? If 'Yes', specify the range of available heights from the floor to the collimator face (with the detector facing down) (cm)	
v)	In this configuration, is it possible to move the detector horizontally a) longitudinally (from the patient's head to feet)? b) laterally (from the patient's left to right)?	
vi)	In this configuration is it possible to tilt the detector a) in the caudal/cephalic direction (towards the patient's feet/head)? b) in the lateral direction (towards the patient's left or right)?	

1.5 Imaging seated and standing patients

i)	Is it possible to take posterior, anterior and oblique images of a patient's chest (eg for a lung scan) a) whilst they are seated on a standard nuclear medicine imaging chair with a wheeled base? b) whilst they are seated on a stool or other special seat without wheels? c) whilst they are standing in front of the detector?	
ii)	Is it possible to take posterior images of a patient's abdomen (eg for a renogram) a) whilst they are seated on a standard nuclear medicine imaging chair with a wheeled base? b) whilst they are seated on a stool or other special seat without wheels?	
iii)	If the detector is rectangular, can the above imaging configuration be reached a) with the long axis of the detector field of view placed vertically? b) with the long axis of the detector field of view placed horizontally?	

iv)	In this imaging configuration, what is the range of detector height adjustment that is possible (measured as the distance from floor to lower edge of the detector field of view). If this is adjustable specify the range in cm (minimum to maximum); if not specify the distance and state 'fixed'. a) For a rectangular detector positioned so that the long axis of the detector field of view is vertical b) For a rectangular detector positioned so that the long axis of the detector field of view is horizontal c) For a circular, hexagonal or square detector	
v)	In this imaging configuration, is it possible to tilt the detector away from the patient (so that it forms an inclined back rest during renography on a seated patient)? a) For a rectangular detector positioned so that the long axis of the detector field of view is vertical b) For a rectangular detector positioned so that the long axis of the detector field of view is horizontal c) For a circular, hexagonal or square detector	
vi)	If a patient is seated with their chest vertical and thighs horizontal, and the detector is positioned for an anterior view of the chest (such as for an anterior lung image), what is the minimum distance between the patients thighs and the lower edge of the detector field of view (taking account of any detector supports that might interfere with the thighs)? a) For a rectangular detector positioned so that the long axis of the detector field of view is vertical b) For a rectangular detector positioned so that the long axis of the detector field of view is horizontal c) For a circular, hexagonal or square detector	

2. Collimators

i)	Please provide a list of all collimators available for the system. This may be done by attaching a separate data sheet, provided that all the following parameters are included for each collimator: a) system sensitivity (cps/MBq) b) system resolution at 0cm (mm) c) system resolution at 10cm (mm) d) useful energy range (keV) e) weight (kg) f) type (parallel, fanbeam etc) g) method of construction (foil or cast) Include methods of measurement for each parameter (eg radionuclide & energy window used)	
ii)	Which of the collimators listed in i) are included with the base system price?	
iii)	Do all parallel hole collimators have an effective hole angulation of less than 0.15°?	
iv)	Specify how collimators of different weights are provided for, if necessary	
v)	Are all necessary devices for changing collimators and for storing collimators not currently in use provided a) In the base system price? b) As an extra cost option (ECO)?	
vi)	Specify how the system uses collimator carts? a) Does not use collimator carts b) One collimator cart is used to change all collimators and move them into a separate collimator storage rack c) Several combined collimator change/storage carts are used to change collimators and store them on the carts themselves d) Other (specify)	
vii)	If the system uses collimator change cart(s) how many collimators are changed at once (this may be more than 1 for multi-detector systems)	

viii)	If the system stores collimators on the carts themselves, how many collimator sets can be stored on each cart (For a single detector system a collimator set is 1 collimator; for a dual detector system a set is 2 collimators and for a triple detector system a set is 3 collimators)	
ix)	What is the size of a collimator cart?	
x)	What is the weight of an unloaded collimator cart (kg)	
(1)	If the system uses a collimator storage rack e) How many collimator sets does each storage rack hold? (For a single detector system a collimator set is 1 collimator; for a dual detector system a set is 2 collimators and for a triple detector system a set is 3 collimators) f) How many storage racks can be installed? g) What is the size of a storage rack?	
xiii)	Is the method of changing collimators h) Completely manual (with no cart)? i) Manual, using a collimator change cart? j) Semi-automated by system movements of the detector and manual movement of the cart? k) Fully-automated without operator intervention?	
xiv)	If the system is fully automatic please, specify the method of operation and the size, weight and any electrical power requirements of the device.	
xv)	Is the collimator that is currently loaded on the detector recognised by the system and recorded with acquisition data?	
xvi)	For multi-detector systems is it possible to acquire images with different collimators on each head (eg LEGP on one head and MEGP on the other)? If 'Yes', specify what combinations are possible	

3. Pulse height analysis (PHA) – energy spectrum

i)	Are PHA windows calibrated in keV?	
ii)	Is the adjustment of PHA windows continuously variable?	
iii)	If No, specify the increment size (keV)	
iv)	Specify the calibration accuracy of PHA windows (keV)	
v)	Does the system permit the user to define preset energy windows?	
vi)	Can multiple energy windows be overlapping?	
vii)	Can the energy window used for acquisition be set: a) Manually in keV? b) From a spectrum display? c) From a system defined list of radionuclides? d) From a user defined list of radionuclides?	
viii)	Does the list of system defined radionuclides include: a) ^{99m}Tc b) ^{57}Co c) ^{67}Ga d) ^{75}Se e) ^{81m}Kr f) ^{201}Tl g) ^{133}Xe h) ^{111}In i) ^{123}I j) ^{131}I k) Others (specify)	
ix)	Can the energy window width be defined using: a) Width as percentage of centre-line value? b) Width specified in keV? c) Lower and upper levels in keV?	
x)	This question is no longer used	

xi)	Does the system permit the use of asymmetric or offset energy windows (ie window lower and upper levels are not equally spaced around the photopeak)? If 'Yes' indicate any limitations on this facility	
xii)	For multi-peak nuclides (eg ^{67}Ga) specify the maximum number of PHA windows which may be combined together into a single image. (Any limitations for static, dynamic, whole-body or SPET acquisitions must be described.)	
xiii)	For multiple isotope acquisition, specify the maximum number of PHA windows which may be used to simultaneously acquire separate images. (Any limitations for static, dynamic, whole-body or SPET acquisitions must be described.)	
xiv)	Are scatter correction techniques (using multiple energy windows) provided with the system? If 'Yes', specify the method of scatter correction, applicability and any limitations on usage within the system	
xv)	This question is no longer used	
xvi)	Is a real-time energy spectrum display provided with the system?	
xvii)	Can pre-set PHA windows be displayed superimposed on the energy spectrum?	
xviii)	Can PHA windows be adjusted by the user while being displayed?	
xix)	Can the spectrum display be stored as a data file to enable the measurement of energy resolution?	
xx)	Is it possible to view the spectrum display during acquisition?	
xxi)	For multi-detector systems, is the spectrum displayed separately for each detector?	

4. Imaging table(s) and attachments

i)	Is a suitable imaging table provided with the system for use with whole-body and tomographic imaging studies?	
ii)	For the imaging table, specify: a) Dimensions of the table (cm x cm)	

	b) Minimum height (cm) c) Maximum height (cm) d) Maximum weight loading (kg) e) Attenuation of 140keV gamma-rays (%)	
iii)	Does the system use the same patient table for both whole body imaging and SPET imaging?	
iv)	If Yes, does the table position have to be moved through 90° between whole body mode and SPET mode?	
v)	Is a patient head support (suitable for brain SPET) available? a) At no extra cost b) As an extra cost option (ECO)	
vi)	Are patient arm rests available (to support arms at the patients side for whole body scanning)? a) At no extra cost b) As an extra cost option (ECO)	
vii)	Are shoulder supports available (to support arms above the head for cardiac SPET studies)? a) At no extra cost b) As an extra cost option (ECO)	
viii)	Are patient restraint/immobilisation devices available? a) At no extra cost b) As an extra cost option (ECO)	
ix)	Give brief details regarding any such patient restraint or immobilisation devices	
x)	Does the imaging table require: a) Tracking rails on the floor? If Yes specify the location and size of the rails b) Attachment points to the floor? If Yes, specify the number and location of the attachment points	
xi)	What is the maximum height that the rails or attachment points protrude above floor level?	
xii)	Are there any areas on the imaging table reinforced with high gamma-ray attenuation materials?	
xiii)	Are these high attenuation areas visibly delineated to the operator?	

xiv)	Provide details of any such areas (preferably by diagram or labelled photograph)	
xv)	Is there an attachment point on the imaging table for drip stands?	
xvi)	Specify any other patient-connected equipment that can be attached to the imaging table	
xvii)	Is the imaging table motion motorised? a) Vertical motion b) Lateral motion c) Longitudinal motion	
xviii)	How long does it take to raise the table from the lowest to the highest position (sec)?	
xix)	What is the minimum force required to move the table in any horizontal position when the table is holding a 100kg patient (Newtons)	
xx)	What is the maximum sag in the imaging table when loaded with a 100kg patient (mm)?	
xxi)	Is the imaging table supported at both ends or only at one end?	
xxii)	If support is at both ends, is this support maintained at all table heights?	
xxiii)	Can the imaging table be completely detached from the camera and wheeled out of the room?	
xxiv)	If Yes, can this be done safely with the patient still on the table?	
xxv)	Can the head support detailed in v) be used with transmission attenuation correction (if available)	

Data acquisition

1. General Acquisition features

i)	Is it possible to start data acquisition a) From the camera gantry? b) From a remote control? c) From the acquisition computer?	
ii)	Specify how acquisitions are initiated in each case	
iii)	Can the system display images in 'persistence' mode for patient positioning prior to the start of acquisition?	

iv)	For multiple detector systems, is the persistence image from each detector displayed separately (so that the operator can view images from all detectors side by side)?	
v)	Can an operator standing next to the patient table a) Easily see the persistence image? b) Clear the persistence image? c) Change the persistence time of the image?	
vi)	Can the acquiring image be rotated in multiples of 90°? a) From the gantry b) From the remote control c) From the acquisition computer	
vii)	Is the angle of rotation that was applied stored with the acquired data?	
viii)	This question is no longer used	
ix)	Can the acquiring image be 'mirrored' about both vertical and horizontal axes?	
x)	Is the fact that mirroring was applied stored with the acquired data?	
xi)	Are the gantry and bed positions stored within the acquired data file?	
xii)	Can this information be used for patient re-positioning?	
xiii)	This question is no longer used	
xiv)	If an acquisition is halted prematurely, can the data acquired so far still be stored a) During static acquisition? b) During dynamic acquisition? c) During whole-body acquisition? d) During SPET acquisition?	
xv)	Can studies be paused and re-started during acquisitions without loss of data?	
xvi)	Is the fact that the acquisition was paused and restarted stored in the data file?	
xvii)	Can the acquiring image be zoomed?	
xviii)	Specify the range of magnification factor available for zoomed acquisitions.	

xix)	Specify the smallest step size for changes in magnification factor.	
xx)	Is it possible for the centre of the zoomed field to be placed anywhere within the useful field of view? If not specify any limitations	
xxi)	Can zoomed acquisitions be set to a pre-defined field of view size?	
xxii)	Can the position and magnification of a pre-defined zoom be changed interactively by the user while in persistence mode?	
xxiii)	Can the user create predefined acquisition protocols?	
xxiv)	Can a predefined acquisition protocol specify: e) Study name f) View name g) Energy window h) Matrix size i) Matrix depth j) Acquisition termination condition k) Image rotation l) Image mirror m) Image zoom n) Collimator to be used o) Gantry position p) Imaging table position For each of the above parameters, state whether they can be changed at the time of acquisition	
xxvi)	Does the acquisition system accept DICOM patient worklists?	
xxvii)	Is the detector count rate (separately in each head for multiple detector systems) visible to the operator before acquisition is started?	
xxviii)	For multiple detector systems, can images be acquired simultaneously from each head and be stored separately?	

2. Static acquisition

i)	Can static acquisitions be terminated: a) manually? b) on preset time? c) on preset count? d) by preset counts or time (whichever occurs first)? e) by count density within a user-defined region of interest?	
ii)	Specify any limitations on these parameters	
iii)	Can the system acquire and store static image data with the following matrix sizes: a) 32 x 32 b) 64 x 64 c) 128 x 128 d) 256 x 256 e) 512 x 512 f) 1024 x 1024 g) Other (specify)	
iv)	What is the maximum number of counts that may be acquired in each pixel? If the user may choose between several acquisition modes (eg byte mode and word mode) please specify the maximum count per pixel for each mode and indicate in question iii) which modes are available for each matrix size.	
v)	Specify any limitations with respect to static acquisitions that apply to any of these matrix sizes (eg no dual isotope for 1024x1024).	
vi)	This question is no longer used	
vii)	What is the maximum total count that may be stored within a single static image.	
viii)	What happens to the acquiring image when any pixel reaches its maximum value (pixel overflow)? a) Pixel saturates at maximum value and acquisition continues b) Pixel recycles back to zero and acquisition continues c) Acquisition stops	

	d) Other (specify)	

3. Dynamic acquisition

i)	For dynamic acquisition sequences what are the limits on frame time: a) Minimum time per frame (s) b) Maximum time per frame (s) c) Increment of frame time (s)	
ii)	Can the system acquire and store dynamic study data with the following matrix sizes? a) 32 x 32 b) 64 x 64 c) 128 x 128 d) 256 x 256 e) Other (specify)	
iii)	What is the maximum number of counts that may be acquired in each pixel? If the user may choose between several acquisition modes (eg byte mode and word mode) please specify the maximum count per pixel for each mode and indicate in question ii) which modes are available for each matrix size.	
iv)	What is the maximum acquisition frame rate for each matrix size (frames/sec): a) 32 x 32 b) 64 x 64 c) 128 x 128 d) 256 x 256 e) Other (specify)	
v)	Specify any limitations with respect to any of these matrix sizes	
vi)	This question is no longer used	
vii)	Specify the maximum length of any dynamic study with respect to: a) Total number of frames b) Total acquisition time c) Total number of counts	

viii)	What happens to the acquiring image when any pixel reaches its maximum value (pixel overflow)? a) Pixel saturates at maximum value and acquisition continues b) Pixel recycles back to zero and acquisition continues c) Acquisition stops d) Other (specify)	
ix)	This question is no longer used	
x)	Specify the maximum number of different framing rates (phases) which is possible to use during a single dynamic acquisition.	
xi)	Specify any limitations on these acquisition phases.	
xii)	Can data processing of an acquiring dynamic study begin prior to the termination of that study?	
xiii)	Does the system provide real-time curve display of an acquiring study from a user-defined region or regions of interest (eg for Renography)?	
xiv)	Specify any limitations regarding ROIs used for this purpose (e.g. number, size, shape)	

4. List-mode acquisition

i)	Is list-mode acquisition available as a user-selectable acquisition mode: a) As part of the basic system? b) As an extra cost option (ECO)?	
ii)	Can list-mode acquisition be used with: a) Dynamic studies? b) Physiologically-gated dynamic studies? c) SPET studies? d) Physiologically-gated SPET studies?	
iii)	Specify the resolution limits at which list-mode data is stored	
iv)	Specify the maximum number of PHA energy windows which may be independently stored in list-mode data	

v)	Specify the timing resolution used by list mode data. If this may be changed by the user specify all possible values.	
vi)	This question is no longer used	
vii)	Can physiological signals (such as ECG R-wave triggers) be stored as markers in list-mode acquisitions?	
viii)	Specify the maximum count-rate for list-mode acquisitions	

5. Gated cardiac acquisition (planar)

i)	Can the system acquire and store planar ECG gated cardiac studies using the following matrix sizes? a) 32 x 32 b) 64 x 64 c) 128 x 128 d) Other (specify)	
ii)	For each matrix size specify the maximum number of frames that may be acquired during a cardiac cycle a) 32 x 32 b) 64 x 64 c) 128 x 128 d) Other (specify)	
iii)	Specify any limitations with respect to any of these matrix sizes.	
iv)	Is it possible for the user to define a window of acceptable beat lengths and for the acquisition to reject data from all cardiac cycles that fall outside this window (on-the-fly bad beat rejection)?	

v)	Please describe how the acceptable beat length window is defined (for example whether this is done by positioning cursors on a displayed beat length histogram, whether the users enters a heart rate and acceptable variation, or an acceptable range of R-R intervals)	
vi)	How many separate beat length windows may be defined and acquired simultaneously	
vii)	Can gated cardiac acquisitions be terminated : a) Manually? b) On preset acquisition time? c) On preset total acquired counts? d) On preset counts or time (whichever occurs first)? e) On count density within a user-defined region of interest? f) On total number of accepted cardiac cycles? g) On total counts acquired in the first frame?	
viii)	Specify any limitations on these parameters	
ix)	If a cardiac cycle falls within the acceptable beat length window, how is the data from this cycle framed up? a) By adjusting the time per frame to divide the actual beat length into a fixed number of frames b) Using a fixed time per frame regardless of the actual beat length, and framing forwards from the start of the cycle c) Using a fixed time per frame regardless of the actual beat length, and framing backwards from the end of the cycle d) Combination of (b) and (c) e) Other (please specify)	
x)	If the patient's heart rate gradually changes during a gated cardiac acquisition, what options does the user have for dealing with this? a) Make the acquisition software keep a fixed beat length window and therefore reject all beats until the heart rate returns to within the window.	

	b) Let the software automatically adjust the beat length window to keep track of gradual changes in heart rate, but keep the same time per frame for framing up accepted beats. c) Let the software automatically adjust the beat length window to keep track of gradual changes in heart rate, and also adjust the time per frame to keep the same number of frames per cycle. d) Other (please specify)	
xi)	With the patient positioned on the imaging table for a planar gated cardiac study in the LAO projection, can the detector be inclined to give caudal tilt (towards the patient's feet).	

6. Whole-body imaging

i)	Is whole body imaging available a) As part of the basic system? b) As an extra cost option (ECO)?	
ii)	Can the system acquire and store whole body images in the following matrix sizes? a) 512 x 128 b) 512 x 256 c) 1024 x 256 d) 1024 x 512 e) 2048 x 512	
iii)	How are whole body scans acquired? f) Continuous scanning motion g) Step & shoot sequence h) Other (specify)	
iv)	What is the maximum scan length that can be imaged (cm)?	
v)	What is the width of the usable detector field of view perpendicular to the scan direction (cm)? (For circular or hexagonal detectors this dimension should be the width of the inscribed rectangle that defines the acquired image)	
vi)	What is the range of scanning speeds available (cm/min)?	
vii)	When performing whole body imaging does the system provide body contouring:	

	a) Manually, by allowing the operator to move the detector up and down during the scan? b) Semi-automatically, by letting the operator define the patient profile before the scan starts? c) Fully automatically, by sensing the detector to patient distance during the scan? d) Other (specify)?	
viii)	When scanning with the detector underneath the imaging table, what is the minimum usable distance between the detector and the underside of the table?	
ix)	When scanning with the detector above the imaging table, what is the minimum distance between the detector and the table (ie the thinnest patient that could be scanned whilst still keeping close)?	
x)	When scanning with the detector above the imaging table, what is the maximum distance between the detector and the table (ie the fattest patient that could be scanned)?	
xi)	For multiple detector systems, can anterior and posterior images be acquired simultaneously?	
xii)	For single detector systems, can anterior and posterior images be acquired sequentially without repositioning the patient?	
xiii)	Which collimators can be used for whole body scanning?	

7. Single photon emission tomography (SPET)

i)	Is SPET imaging available a) As part of the basic system? b) As an extra cost option (ECO)?	
ii)	Can the system acquire and store SPET data using the following matrix sizes? a) 64 x 64 b) 128 x 128 c) Other (specify)	

iii)	What is the maximum number of counts that may be acquired in each pixel? If the user may choose between several acquisition modes (eg byte mode and word mode) please specify the maximum count per pixel for each mode and indicate in question ii) which modes are available for each matrix size.	
iv)	Can the system acquire SPET data using: a) Continuous rotation? b) 'Step-and-shoot' mode? c) Other (specify)?	
v)	Can the operator set the required SPET acquisition time as: a) Time per rotation? b) Time per frame? c) Other?	
vi)	Specify the minimum and maximum acquisition times for a full 360^0 rotation?	
vii)	Specify the minimum and maximum number of images that may be acquired in a full 360° acquisition. (For multiple head systems give the total number of images from all heads combined)	
viii)	Can SPET data be acquired using the following acquisition arcs? (For multiple head systems the angle specified is the total acquired angle for all heads combined, not the angle through which the gantry rotates; ie two heads each rotating through 90° is a 180° acquisition arc): a) 180° acquisition arc? b) 360° acquisition arc? c) Other (specify)?	
ix)	For multi-detector systems, what relative detector positions can be used for SPET acquisition? a) Detectors 180° opposed	

	b) Detectors 90° apart c) Detectors 120° apart d) Other (specify)	
x)	For a patient lying supine on the imaging table with their feet into the gantry, which of the following SPET acquisition arcs are possible? a) 360° arc starting and ending at the posterior position b) 360° arc starting and ending at the anterior position c) 180° arc centred on the posterior position d) 180° arc centred on the anterior position e) 180° arc centred on the left anterior oblique position f) 180° arc centred on the right anterior oblique position g) 180° arc centred on the left posterior oblique position h) 180° arc centred on the right posterior oblique position	
xi)	Can the system acquire SPET data in both clockwise and counter-clockwise directions?	
xii)	Can the system acquire SPET data using multiple rotation acquisitions without the need to restart the acquisition a) With successive rotations in the same direction? b) With successive rotations in opposite directions?	
xiii)	What is the maximum number of successive rotations that may be acquired without the need to restart the acquisition?	
xiv)	How can multiple rotation acquisitions be processed? a) By reconstructing each rotation separately b) By reconstructing the sum of all rotations c) By reconstructing the sum of a user selected number of rotations	
xv)	Can SPET data be acquired using circular orbits?	

xvi)	What is the minimum orbit radius (cm)?	
xvii)	What is the maximum orbit radius (cm)?	
xviii)	Can SPET data be acquired using non-circular orbits (where the orbit radius is varied as the detector rotates in order to keep an optimal distance between the detector and the patient)?	
xix)	Can non-circular orbits be achieved by selection from a list of predefined orbits suitable for typical body profiles?	
xx)	How many such predefined orbits are available?	
xxi)	Can non-circular orbits be achieved by allowing the operator to define multiple points around the patient and thus generating a patient specific orbit?	
xxii)	How many points around the orbit can be defined?	
xxiii)	Can non-circular orbits be achieved fully automatically without any operator intervention, by sensing the distance between the detector and the patient throughout the orbit (auto-contouring)?	
xxiv)	Can auto-contouring be used for brain SPET?	
xxv)	Can auto-contouring be used for myocardial SPET (with two heads at 90° for dual detector systems)?	
xxvi)	Which collimators can be used with autocontouring?	
xxvii)	Can an image zoom be applied during SPET acquisitions?	
xxviii)	What range of zoom factors can be used?	
xxix)	Can the centre of the zoomed area be positioned anywhere within the field of view in the longitudinal (Y) direction?	
xxx)	Can the centre of the zoomed area be made to move automatically in the transverse (X) direction to follow an organ of interest (such as the heart) if it is positioned off-centre?	
xxxi)	Does the system store SPET projection data that has been corrected for the following effects? (Note that suppliers should respond 'No' here if the corrections will be applied by the processing system – see part C question 3.5.2) a) Corrected for centre of rotation b) Corrected for offsets due to non-circular orbits c) Corrected for camera non-uniformity d) Corrected for radionuclide decay	

	e) Data from multiple detectors combined f) Data from multiple rotations combined	
xxxii)	State the maximum tolerable COR offset which may be corrected by software	
xxxiii)	Can the corrected data described in xxxi) be transferred to an independent processing workstation using DICOM protocols?	
xxxiv)	During SPET imaging, what is the size of the usable detector field of view?(For circular or hexagonal detectors these dimensions should specify the inscribed rectangle that can actually be reconstructed) a) The usable width in the transverse direction (from the patients left to right) (cm) b) The usable length in the axial direction (from patients head to feet) (cm)	
xxxv)	Can brain SPET studies be acquired with the detector orbiting inside the patients shoulders?	
xxxvi)	During brain SPET, what is the distance from the outer edge of the detector housing to the edge of the usable field of view where the base of the brain is imaged (brain reach)?	
xxxvii)	Can myocardial SPET studies be acquired with the patient positioned a) Feet first into the gantry? b) Head first into the gantry?	
xxxviii)	For a dual detector system with the two heads positioned 90° apart for myocardial SPET, how wide is the dead space in the corner between the detectors (cm)? Please specify the distance from the face of one detector to the edge of the field of view of the other detector.	
xxxix)	Can SPET acquisitions be performed using the full range of available parallel hole collimators? If not specify any limitations.	
xxxx)	Is the system capable of acquiring and reconstructing SPET data from the following non-parallel hole collimators? a) Fan-beam collimators b) Slant-hole collimators c) Pinhole collimators d) Other special collimators (specify)	

8. Physiological triggering

i)	Is the system provided with a trigger input and appropriate software to enable acquired data to be gated with the following physiological signals: a) ECG gating b) Respiratory gating c) Other (specify)	
ii)	Is ECG gating controlled by: a) An independent ECG monitor providing a digital signal into the gamma camera when an R-wave is detected. b) An independent ECG monitor providing an analogue signal into the gamma camera and R-wave detection built into the gamma camera c) An ECG monitor built into the gamma camera	
iii)	If an independent ECG monitor is required, is the cost of this included in the system price or is it an extra cost item?	
iv)	During ECG gated acquisition is the patient's ECG displayed a) On an independent ECG monitor b) On the screen of the acquisition computer	

9. Anatomical Landmarking

i)	Is the system capable of electronically adding anatomical landmarks to acquired images, through the use of a point source placed within the field of view? If 'Yes', briefly indicate how this is achieved	

10. Gated SPET

i)	Can the system perform ECG gated SPET a) As part of the basic system? b) As an extra cost option?	
ii)	Can the system acquire and store ECG gated SPET data using the following matrix sizes? a) 64 x 64	

	b) 128 x 128 c) Other (specify)	
iii)	Can gated SPET use all the same detector configurations and acquisition arcs that are possible for ungated cardiac SPET? If 'No' specify any limitations	
iv)	Specify the minimum and maximum number of angular stops that may be used in a 180° acquisition arc. (For multiple head systems give the total number of stops from all heads combined)	
v)	Specify the minimum and maximum number of frames into which each cardiac cycle may be divided.	
vi)	Is it possible for the user to define a window of acceptable beat lengths and for the acquisition to reject data from cardiac cycles that fall outside this window?	
vii)	Please describe how the acceptable beat length window is defined.	
viii)	Please describe what happens to data from accepted beats.	
ix)	Please describe what happens to data from rejected beats.	
x)	Can the acquisition time at each stop be defined by a) Fixed time per stop regardless of any bad beats b) Fixed number of beats at each stop c) Fixed number of accepted beats at each stop d) Other (specify)	
xi)	Can the gated SPET data be reformatted into an equivalent ungated study?	
xii)	Describe any methods that are used to ensure that bad beat rejection does not compromise the quality of the ungated data.	

11. Transmission Imaging

This section is concerned with transmission imaging that can be used with SPET studies, either for non-uniform attenuation correction or for anatomical localisation by fusion of emission and transmission images. Transmission imaging for use with PET studies is covered in Part D.

i)	Does the system have an option for transmission imaging that can be used with SPET studies? a) Included in the basic system b) As an extra cost option that must be specified at the time of initial purchase c) As an extra cost option that can be purchased at a later date	
ii)	What radiation source does the transmission imaging use? a) External radionuclide source b) X-ray source	
iii)	If a radionuclide source is used, specify the following: a) The radionuclide used b) The number of sources c) The total activity in all sources (MBq) d) The physical form (solid or liquid) e) The shape of the source (eg point or line) f) Whether the source is fixed or scanning g) What shielding is provided around the source	
iv)	If an X-ray source is used, specify the following: a) The range of kVp available b) The range of mAs available c) Electrical power requirements of the source d) X-ray slice thickness e) X-ray detectors used	
v)	Can the transmission scan be acquired a) Before the emission scan b) Simultaneously with the emission scan c) After the emission scan	
vi)	Does the imaging table have to move between acquisition of the emission and transmission scans?	

vii)	How much extra time does the transmission scan add to the total imaging time of SPET study?	
viii)	Describe any calibration or QC procedures that need to be performed for the transmission device	
ix)	How long do these calibration procedures take and how often should they be performed?	
x)	Can the transmission scan be used for a) Non-uniform attenuation correction of myocardial SPET studies using ^{99m}Tc b) Non-uniform attenuation correction of myocardial SPET studies using ^{201}Tl c) Non-uniform attenuation correction of SPET studies of other organs using ^{99m}Tc d) Non-uniform attenuation correction of SPET studies using ^{123}I e) Non-uniform attenuation correction of SPET studies using ^{131}I f) Non-uniform attenuation correction of SPET studies using ^{111}In g) Non-uniform attenuation correction of SPET studies using other radionuclides (specify which) h) Anatomical localisation by fusion of emission and transmission images for SPET studies	
xi)	Is the raw transmission data (rebinned into parallel projections if necessary) available as a separate image file?	
xii)	How is the transmission data corrected for any crosstalk from emission in the patient?	
xiii)	Does the system produce attenuation maps based on broad beam or narrow beam attenuation coefficients?	
xiv)	If broad beam attenuation maps are used, how are these generated from the narrow beam data?	
xv)	If narrow beam attenuation maps are used, what alternative means of scatter correction is available?	
xvi)	How are the attenuation maps extrapolated from the energy of the transmission source to the energy required for attenuation correction?	

xvii)	Are attenuation maps available as a separate image file? If 'Yes' specify the units in which they are stored.	
xviii)	Can transmission data be acquired using all detector configurations which are available for SPET? If 'No' specify any limitations	
xix)	Is the transmission image acquired using fan-beam or parallel geometry?	
xx)	If transmission data is acquired using fan-beam geometry, does this cause any truncation of the field of view?	
xxi)	Does the transmission image cover the same transaxial field of view as the emission image? If 'No' specify the transaxial field of view of the transmission data	
xxii)	Does the transmission image cover the full axial field of view of the emission image? If 'No' specify the axial field of view of the transmission data	
xxiii)	How frequently would the source detailed in ii) need replacing	
xxiv)	Please provide an estimate of the cost of replacing the source and indicate whether this can be incorporated into annual maintenance costs.	
xxv)	What is the additional effective dose to the patient from use of the transmission source to acquire an attenuation map (mSv)?	
xxvi)	When the transmission source is not in use (source in its shielded position), what is the radiation dose rate due to the source (microSv/hr) a) At the closest point that an operator might stand to the source? b) At a point where an operator might stand at the foot of the patient bed?	
xxvii)	When the transmission source is in use, what is the radiation dose rate due to the source (microSv/hr) a) At the closest point that an operator might stand to the source? b) At a point where an operator might stand at the foot of the patient bed?	
xxviii)	Is a lead-glass screen recommended around the operators' workstation?	

xxix)	Is additional shielding recommended in the walls of the room?	

Data acquisition system

This section covers the basic facilities available on the workstation that controls data acquisition from the gamma camera. If the workstation also includes data processing facilities then part C of the questionnaire should also be completed.

1. Hardware

i)	What hardware platform does the data acquisition workstation run on (eg PC, Mac, Sun)?	
ii)	What is the CPU speed?	
iii)	How much memory is installed?	
iv)	What type of monitor is supplied (eg CRT or flat panel LCD)?	
v)	What is the size of the display monitor?	
vi)	What is the resolution of the display?	
vii)	What is the capacity of the hard disc drive?	
viii)	What other storage devices are included: a) Floppy disc drive b) ZIP disc drive c) CD-ROM drive d) Recordable CD drive e) DVD drive f) Recordable DVD drive g) WORM optical disc drive (state capacity) h) Erasable optical disc drive (state capacity) i) Tape cartridge (state capacity) j) Other (specify)	
ix)	What input devices are included? a) Keyboard b) Mouse c) Trackball d) Joystick e) Other (specify)	

2. Software

i)	What operating system does the system use (eg Windows, MacOS, Unix)? State the version number of the operating system which will be installed	
ii)	Does the acquisition workstation include software to display previously acquired images? a) Static images b) Dynamic images c) Whole body images d) Gated images e) SPET projection images f) Reconstructed SPET images	
iii)	Does the acquisition workstation include software to reconstruct previously acquired SPET data? If yes, please give details or refer to relevant sections of Part C.	
iv)	Does the acquisition workstation include any software for processing data that is not covered in this part of the questionnaire? If yes then please also complete Part C of the questionnaire	
v)	If the workstation includes processing or display software can this be run at the same time as data acquisition is in progress? If 'Yes', please specify any limitations or effect on processing speed that use of simultaneous acquisition and processing imposes	

3. Data Display

In order to clarify terminology the following definitions will apply to questions in this section:
Screen means the part of the system display that is used for displaying images. This may be less than the full size of the display monitor.
Colour scale means the translation table used to convert image counts into intensity (for a monochrome display) or into colours (for a colour display).
Display levels means the lower (background) and upper (saturation) count thresholds that correspond to pixels which are displayed at the minimum and maximum steps of the colour scale.
Cine display means a sequential display of consecutive frames of a dynamic sequence of images at the same position on the screen so as to give the impression of a moving image.

i)	What is the maximum resolution of the screen (pixels)?	
ii)	What is the maximum number of distinct steps in a colour scale?	

iii)	How many different colour scales are supplied as standard?	
iv)	Is a linear monochrome colour scale (grey scale) included?	
v)	Can the user create additional colour scales?	
vi)	What is the maximum number of images that can be shown simultaneously on one screen?	
vii)	Can each displayed image use a different colour scale, independently of the colour scales used for other images?	
viii)	If 'Yes', what is the maximum number of different colour scales that can be used on one screen at the same time?	
ix)	Can the display levels be adjusted independently for each image on the screen (so that each image can have different display levels)?	
x)	What is the maximum cine display rate for a dynamic study acquired on a 128x128 matrix (frames per second)?	
xi)	Is the cine display rate continuously variable?	
xii)	Can ROIs be superimposed on a cine display of a dynamic study?	
xiii)	What is the maximum number of images that can be displayed in a cine loop?	
xiv)	What is the maximum cine display rate for a gated cardiac study acquired on a 64x64 matrix?	
xv)	Can gated cardiac cines be displayed: a) In a window? b) Full screen?	
xvi)	Can ROIs be superimposed on a cine display of a gated cardiac study?	
xvii)	What is the maximum number of independent cine displays that can be shown on the screen at once?	
xviii)	Can two separate cine displays of gated cardiac data (eg stress and rest) be displayed synchronised - so that corresponding frames display at the same time ?	
xix)	Can user specified free text be displayed on the screen: a) At any position b) With control over font c) With control over point size	

xx)	Can the user control which patient and study details (eg name, date etc) are displayed on the screen?	
xxi)	Are there independent controls for lower and upper display level, so that the upper level can easily be adjusted without changing the lower level and vice-versa?	
xxii)	Can lower and upper display levels be specified as: a) Actual counts? b) Percent of maximum in the current image? c) Percent of maximum in the complete dynamic sequence?	
xxiii)	If display levels can be specified as actual counts, state the permitted values for lower and upper display levels. a) Range available (eg 0 to max in image) b) Smallest increment (eg 1 count)	
xxiv)	If display levels can be specified as percent, state the permitted values for lower and upper display levels. a) Range available (eg 0 to 200%) b) Smallest increment (eg 0.1%)	

4. Patient database management software

i)	Does the system include patient database management software for indexing all patient studies that are stored on the system?	
ii)	Can a list of available patient studies include the following fields? c) Patient name d) Patient ID e) Patient date of birth f) Patient sex g) Study name h) Study type (eg bone, renal etc) i) Study date j) Study status (eg processed, archived etc) k) Acquisition mode (static, dynamic, whole body, SPET etc)	

iii)	Can the operator choose to display the list of available studies sorted in order by the following fields? a) Patient name b) Patient ID c) Patient date of birth d) Patient sex e) Study name f) Study type (eg bone, renal etc) g) Study date h) Study status (eg processed, archived etc)	
iv)	Can the operator search for studies that match the following criteria? a) Exact patient name b) Patient name including wild cards c) Patient ID d) Date of birth or age e) Date of birth range or approximate age f) Patient sex g) Study name h) Study type (eg bone, renal etc) i) Range of study dates	
v)	Can the searches of iv) be made for a) Studies currently on this computer? b) Current studies plus archived studies? c) All studies on this and other computers on the network?	
vi)	Can the user edit the following details in the patient database? a) Patient details (specify whether none, all or some) b) Study details (specify whether none, all or some)	

	c) Acquisition parameters (specify whether none, all or some)	
vii)	What methods are available for deleting old studies that have been processed and archived? a) Manual deletion of individual selected studies b) Manual deletion of a range of selected studies c) Automatic deletion of studies after a given time provided that they have been archived	
viii)	Can individual studies be marked as protected so that they cannot be deleted?	
ix)	Describe any other mechanisms that exist to prevent accidental deletion of studies before they have been processed and archived	
x)	Does the system have an HL7 HIS/RIS interface?	

5. Data transfer

i)	Is the acquisition workstation capable of connecting to other systems using standard Ethernet protocols?	
ii)	What is the speed of the network interface?	
iii)	Does the network system support the following protocols? a) TCP/IP b) OSI c) NFS d) DICOM e) Other (specify)	
iv)	Can the system be connected to remote networks via a dial-up modem?	
v)	Can the system be connected to remote networks via ISDN link?	
vi)	Can acquired images be exported to a remote system in the following formats? a) The systems own internal format b) DICOM c) Interfile d) Other (specify)	
vii)	Do these export functions work with all image types? If no, specify any limitations of format and image type	

viii)	Do you hold an Interfile 3.3 Conformance Claim (ref: COST B2)?	
ix)	Have you included a DICOM 3.0 Conformance Statement for your equipment, structured in accordance with Part 2 of the DICOM standard (NEMA standards publication PS 3.2 - 1993)?	
x)	Can image files be transferred automatically to another computer system on completion of acquisition?	
xi)	Can an operator sitting at the acquisition workstation send selected image files to another workstation (Push function)?	
xii)	Can an operator sitting at another workstation transfer selected image files from the acquisition workstation (Pull function)?	

6. Archiving and backup

i)	Is software supplied to enable acquired data to be archived for long term storage using any of the following media? a) Floppy disk b) ZIP disc c) CD d) DVD e) WORM optical disc f) Re-writable optical disk g) Tape cartridge h) Other (specify)	
ii)	What format is used for the above data archive? a) Interfile b) DICOM c) Other public format (specify) d) Manufacturer's proprietary format	
iii)	If the archive uses data compression please state a typical compression ratio, otherwise state 1:1	

	a) For loss-less compression b) For lossy compression	
iv)	What data can be archived? a) Patient and study details b) Acquired images c) Processed images d) Regions of interest e) Curves	
v)	How can archiving be initiated? a) Manually using operator selected data b) Manually using all non-archived data c) Automatically at a given time of day	
vi)	If an archive process fails for any reason (eg a file is already in use, or the medium is full) what information is provided for the operator about which data has been archived and which has not, and the reason for the failure?	
vii)	Is it easy for the operator to identify from a listing of acquired data on the main hard disc, which studies have already been archived? (eg by means of a flag)	
viii)	If studies have been archived more than once (eg to two different media) can this be determined from the main patient listing?	
ix)	Is there an indexing system on the main hard disk which can be used to locate the appropriate disc or tape on which any given study has been archived?	
x)	Does the above index allow archived studies to be located by the following criteria? a) Patient name b) Patient ID c) Study name d) Study type e) Study date	
xi)	Is there a restore function to enable fast restoration of selected archived studies to the main system (hard disk) with appropriate updating of patient indexes, etc.?	
xii)	Is it possible for the user to make a backup of system software (other than acquired study data) using any of the following media?	

	a) Floppy disk b) ZIP disc c) CD d) DVD e) WORM optical disc f) Re-writable optical disk g) Tape cartridge h) Other (specify)	
xiii)	What files can be included in this backup? a) Complete software b) Changed files only c) All files modified by the user d) Camera calibration files e) Acquisition protocols f) Study data archive index	

7. Quality Control Software and test data

i)	Is software provided to measure the following parameters of gamma camera performance according to NEMA standards? a) Uniformity b) Energy resolution c) Spatial resolution d) Spatial non-linearity e) Count rate capability	
ii)	If special phantoms or source holders are necessary in order to acquire data for any of the above tests, please indicate whether these are supplied as standard (Standard), whether they may be purchased by the user as an extra cost option (ECO) or whether they are only available to the manufacturer's service engineers (Engineer). a) Uniformity b) Energy resolution c) Spatial resolution d) Spatial non-linearity e) Count rate capability	

iii)	Is software provided to measure camera uniformity on a regular basis (ie daily or weekly)?	
iv)	If 'Yes' to iii) does the software include a graphical representation of the trend of uniformity over time?	
v)	If 'Yes' to iii) does the software include a warning if uniformity parameters fall outside an appropriate action level?	
vi)	Is software provided to measure any other aspects of gamma camera performance? If 'Yes', provide brief details of the software supplied	
vii)	Is software provided to enable testing any of the computer hardware (eg camera interface, memory, ADC)? If 'Yes', provide brief details of the software supplied	
viii)	Are software phantoms or test data provided to test the clinical software supplied? If 'Yes', provide brief details of the software / data supplied	

8. Data Security

i)	Does the system provide log-on/log-off facilities with appropriate password protection? a) No passwords required b) One login name and password shared by all users c) Separate login name and password for administrators and service personnel, but all other users share the same password d) Individual login name and password for every user	
ii)	Are there at least three levels of authorisation to make sure that certain tasks (such as deletion of data, software installation, changing of passwords, etc) can only be performed by authorised users?	
iii)	Can the highest level user ('administrator') define access rights for individual users?	
iv)	Can security of unattended workstations be provided without actually logging-off (eg by use of a password-protected screensaver)?	

v)	Does the system provide facilities for the encryption of data for transmission over public networks?	

Hard Copy

The next four sections request information about hard copy devices that are available with the system. These may be manufactured by the supplier or by a third party. However, suppliers should only include hard copy devices that they are able to supply and support. Four different categories of device are included; monochrome film, colour film, colour prints and paper prints. If suppliers are able to offer more than one device in any category then they should include an additional copy of the relevant section.

1. Monochrome film

Please specify here details of the hard copy device that you recommend for producing high resolution monochrome images on transparent film. The image quality should be suitable for reporting from a viewing box.

i)	Specify the make and model of the device?	
ii)	What is the capital cost of the device (if not included with the system)?	
iii)	What is the cost of consumables (expressed as cost per film)?	
iv)	What printing method is used by the device? Specify whether this is a ‘dry’ or ‘wet’ process. (eg direct thermal transfer dry process)	
v)	What is the print resolution (expressed as pixels/image or dpi)?	
vi)	How many distinct grey levels can it reproduce?	
vii)	What is the size of each film?	
viii)	What output media is available (eg blue base film, clear base film)?	
ix)	What image format options are available (e.g. 1, 4, 9, images per film)?	
x)	How long does it take to print a typical film (seconds)?	
xi)	How is the device physically connected (eg analogue video, network)?	
xii)	What data input formats are supported (eg monochrome video, DICOM, Postscript etc)?	
xiii)	Does the device include user accessible adjustment of image brightness and contrast?	
xiv)	Does the device include user accessible adjustment of the film response curve?	

2. Colour film

Please specify here details of the hard copy device that you recommend for producing high resolution colour images on transparent film. The image quality should be suitable for reporting from a viewing box.

i)	Specify the make and model of the device?	
ii)	What is the capital cost of the device (if not included with the system)?	
iii)	What is the cost of consumables (expressed as cost per film)?	
iv)	What printing method is used by the device? Specify whether this is a ‘dry’ or ‘wet’ process. (eg direct thermal transfer dry process)	
v)	What is the print resolution (expressed as pixels/image or dpi)?	
vi)	How many different colour tones can it reproduce?	
vii)	What is the size of each film?	
viii)	What output media is used?	
ix)	What image format options are available (e.g. 1, 4, 9, images per film)?	
x)	How long does it take to print a typical film (seconds)?	
xi)	How is the device physically connected (eg analogue video, network)?	
xii)	What data input formats are supported (eg RGB video, DICOM, Postscript etc)?	
xiii)	Does the device include user accessible adjustment of image brightness and contrast?	
xiv)	Does the device include user accessible adjustment of the film response curve?	

3. Colour prints

Please specify here details of the hard copy device that you recommend for producing photographic quality colour images on opaque film. The image quality should be suitable for journal publication.

i)	Specify the make and model of the device?	
ii)	What is the capital cost of the device?	
iii)	What is the cost of consumables (expressed as cost per print)?	
iv)	What printing method is used by the device (eg dye-sublimation)?	
v)	What is the print resolution (expressed as pixels/image or dpi)?	

vi)	How many different colour tones can it reproduce?	
vii)	What is the size of each print?	
viii)	What output media is used (eg glossy paper)?	
ix)	What image format options are available (e.g. 1, 4, 9, images per film)?	
x)	How long does it take to print a typical film (seconds)?	
xi)	How is the device physically connected (eg analogue video, network)?	
xii)	What data input formats are supported (eg RGB video, DICOM, Postscript etc)?	
xiii)	Does the device include user accessible adjustment of image brightness and contrast?	
xiv)	Does the device include user accessible adjustment of the film response curve?	

4. Paper prints

Please specify here details of the hard copy device that you recommend for producing general purpose colour and monochrome images. The image quality should be suitable for inclusion in patient notes but need not be reporting quality.

i)	Specify the make and model of the device?	
ii)	What is the capital cost of the device?	
iii)	What is the cost of consumables (expressed as cost per print)?	
iv)	What printing method is used by the device (eg laser, ink-jet)?	
v)	What is the print resolution (expressed as pixels/image or dpi)?	
vi)	Can the device print true monochrome (black ink), colour or both?	
vii)	What is the size of each print?	
viii)	What output media is used (eg plain paper)?	
ix)	What image format options are available (e.g. 1, 4, 9, images per film)?	

x)	How long does it take to print a typical film (seconds)?	
xi)	How is the device physically connected (eg network)?	
xii)	What data input formats are supported (eg DICOM, Postscript etc)?	
xiii)	Does the device include user accessible adjustment of image brightness and contrast?	
xiv)	Does the device include user accessible adjustment of the film response curve?	

5. General printing features

i)	Can the full screen display be printed exactly as shown on the monitor, including all text annotation?	
ii)	Can individual screen images be printed on their own without displaying the required image full screen?	
iii)	How long does it take for the workstation to become re-usable once printing has been initiated?	
iv)	Can the system print to a local printer connected directly to the computer?	
v)	Can the system print to a networked printer connected elsewhere on the network?	
vi)	Can the system be interfaced to a radiology department laser imager? If yes, specify the models which can be interfaced.	
vii)	Can grey level correction (gamma correction) be applied by the system before data is sent to the printer so that monochrome hard copy images can be corrected for non-linear film response?	
viii)	Can colour correction be applied by the system before data is sent to the printer, so that the colours of hard copy images can be adjusted to closely match the image displayed on screen?	
ix)	Can the screen display be captured to a disc file in the following formats? a) JPEG b) GIF c) AVI (for cine displays) d) Other (specify)	

Maintenance and reliability

NHS Supplies have produced short questionnaires (‘6.2: Summary and Pricing Schedule: Maintenance’ and ‘6.3: Maintenance Questionnaire’) designed to elicit information about maintenance arrangements (contract prices, conditions, non-contract call-outs, etc.) for this type of equipment, which, if used, would mean some overlap with the section below. The authors consider that the section below is sufficient, but use of the NHS Supplies’ Maintenance documents may be a mandatory requirement, in which case Suppliers would effectively need to answer some questions twice.

i)	Assuming average use, indicate the anticipated useful life expectancy of the camera (years.)	
ii)	Assuming average use, indicate the anticipated useful life expectancy of the data acquisition system (years).	
iii)	Specify the guaranteed up-time of the system within a normal working week, excluding any planned preventative maintenance, provided the system is on a maintenance contract (%).	
iv)	Specify the type of compensation offered by the company if this guarantee is not achieved.	
v)	How many service inspections will take place during the 12 month warrantee period?	
vi)	Is a service report submitted to the user following each service visit?	
vii)	Specify the frequency and duration of such service inspection visits.	
viii)	Is there a guarantee that sufficient spares will be kept to ensure the operation of the system for a full 10 years from the date of purchase?	
ix)	Provide details of the geographical bases and relevant training of service engineers who will be responsible for the emergency and routine maintenance of the system.	
x)	Provide details of any alternative arrangements, including geography and training, in the event of the above engineer(s) not being available.	
xi)	Have you enclosed details of the full range of service contracts available (hardware and software), including prices?	
xii)	Specify the guaranteed response time to hardware emergency breakdown calls for all types of service contract and for non-contract holders. Details must include a description of what that 'response' entails.	
xiii)	Is some type of on-line diagnostic tool for hardware fault detection available?	

xiv)	If Yes, specify how this system operates (e.g. usable by the operator or just the engineer?), together with any additional costs involved or site requirements.	
xv)	Are additional discounts available if service contracts are paid for in advance (i.e. at time of equipment purchase).	
xvi)	If so, have you included details of these additional discount offers?	
xvii)	What is the hourly charge (excl. VAT) for non-contract call-outs?	
xviii)	Is travelling time charged for (for non-contract work)?	
xix)	If so, at what rate (excl. VAT) is travelling time charged?	
xx)	Is there a minimum call-out charge?	
xxi)	If so, what is the minimum charge (excl. VAT)?	

1. Room layout

Suppliers should provide a typical layout for the enclosed room plan, showing the placement (with dimensions) of all specified hardware, including camera, consoles, data acquisition workstation, collimator cart(s) and any imaging table(s) and rails.

2. Pre-installation work/requirements

Suppliers should note that it is their responsibility to check access in order to ensure that all equipment can be delivered to the installation site.

i)	Specify the weight and packed size of the camera and all major hardware components to be installed.	
ii)	Specify any room environment requirements, including: a) The maximum and minimum temperatures for normal working (^{0}C) b) The maximum rate of change of temperature (^{0}C/hr) c) The maximum and minimum relative humidity (%)	
iii)	Specify the total heat dissipation of the system (kW/hr) a) Typical b) Maximum	
iv)	Specify the electrical power requirements of all hardware to be installed	

v)	Specify any necessary pre-installation work, with particular emphasis on the floor material, support and floor surface covering	
vi)	If the installation requires floor levelling, specify: a) Exactly what is to be done b) Who is responsible for carrying out and quality assuring the work c) Any additional costs involved in carrying out the work d) Time scales for completion of the work.	

4. Purchase, installation and training

i)	Specify the guaranteed delivery time from placement of order (weeks)	
ii)	Specify the time required on site to install the system to the point where it can be handed over for acceptance testing (working days).	
iii)	Specify the standard provision for on-site operator training post-installation.	
iv)	Can a full on-site NEMA test programme be provided?	
v)	Specify any additional cost for such a test programme.	

5. Electrical and mechanical safety

i)	Does the system fully comply with UK legislation and recommendations on electrical and mechanical safety, including BS5724: Part 1 (IEC601-1), and the Department of Health's document TRS89 - 'Technical requirements for the supply and installation of equipment for diagnostic imaging and radiotherapy'?	
ii)	Please quote any safety standards used in the design, manufacture or supply of the system.	
iii)	Is there an emergency stop button provided so that all electrical power to the gamma camera head gantry can be cut immediately?	
iv)	If so, state the location(s) of the button(s)	

6. Quality management

i)	Is your company accredited under BS EN ISO 9000 (formerly BS 5750)?	
ii)	If 'Yes', give the certificate number and date achieved.	
iii)	Does your company employ a recognised software development methodology?	
iv)	If 'Yes', please state name of the method.	
v)	Is your company accredited under the UK TickIT scheme for software quality?	
vi)	If 'Yes', give certificate number and date achieved.	
vii)	Is your company accredited to any other IT-specific standards?	
viii)	If 'Yes', please name them and the date they were achieved	
ix)	Does your gamma camera system have certification of compliance under Annex II of the EC Medical Devices Directive (for a Class IIa medical device)?	

7. Supporting documentation

i)	Is the system supplied with an Operator's Manual that includes the following: a) A basic description of system operation? b) A detailed description of utility software? c) A detailed description of the operating system, including file structures / formats? d) A detailed description of clinical software, including intended application(s) and references to scientific papers? e) A detailed description of data backup procedures?	
ii)	Is the system supplied with a Service Manual that includes the following: a) Comprehensive block and circuit diagrams? b) Fault-finding procedures? c) Preventative maintenance procedures and schedules? d) List of spares, with part numbers? e) Calibration and adjustment procedures?	

iii)	Are all software upgrades fully documented, including the ways in which changes to subroutines, etc, may affect user protocols and programs?	