Camera Purchasing by Bid Specification

Frank Bloe, Daniel F. Kane and Ed Sims

Associates in Medical Physics, LLC, Cleveland, Ohio

Expensive equipment, such as gamma cameras, is purchased only infrequently. Some departments may not purchase a camera for 10 or more years. Occasionally turnover in personnel means new individuals become involved in the next purchase. Because of tighter budgets and the costs of equipment, the purchasing process involves more than nuclear medicine department personnel and may include purchasing agents, middle management and even upper management. Some of these individuals may not be familiar with gamma cameras. This article is intended to help those who are new to the purchasing process identify important specifications and provide guidelines on bid specification for those who are already familiar with the process.

Key Words: bid specifications; camera purchasing; acceptance testing; camera performance

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Consumers increasingly want to be assured that purchased equipment is delivered, installed and operates as promised by the vendor. In-house physics personnel or outside contractors are brought in to perform acceptance testing on the equipment. One element that is not adequately considered is the bid specification process that should have preceded the equipment acquisition. Unfortunately, the bid specification process is frequently ignored. The bid specification process goes hand-in-hand with camera acceptance testing as it identifies the criteria against which the acceptance testing results can be compared. This article reviews the bid specification process and is written from the perspective of a physicist involved in evaluating the equipment.

BID SPECIFICATION

When your hospital or clinic decides to purchase a camera, you usually request information on current models from several original equipment manufacturers (OEMs). In response, you usually receive a brochure by mail or delivered by a sales representative. The brochure contains pages of beautiful, glossy photographs and text expounding on the virtues of the manufacturer's equipment. The sales representative visits and determines your institution's needs and demonstrates which camera model is most suitable for your applications. A price quote soon follows. From the vendor's perspective, the recommended equipment is presented with the best of intentions to satisfy your needs. However, when you compare quotes from the various manufacturers, you will notice that a significant amount of information in the brochures is superfluous to making a decision on which camera to purchase. It becomes time consuming to filter through all the information to find the significant points. If an agent from materials management is involved in the process, there may be the added burden of explaining the significance of all the details to this individual.

The bid specification process is an excellent opportunity for you to reverse the process used in purchasing equipment. Rather than have a vendor tell your institution what it can purchase within budget, you specify the criteria desired and ask the vendor whether or not they can provide the product. A significant amount of work is involved in this process but it provides more control in the purchasing process and ensures that you focus on only those features that are important to your institution. This process requires the seller to state whether or not their company's product will meet your specifications. You must insist that the vendors' responses are specific to your requirements.

To prepare a bid specification, you should do a prerequisite study to become familiar with the product you are about to buy. A questionnaire can be developed requesting suppliers to respond to specific items. When you receive the responses from all vendors under consideration, you can compare the information for each of the equipment's features. Items that should be considered are discussed in the following sections.

HARDWARE

Detector Heads: One, Two or Three?

The intended use of the camera determines the number of heads needed. Be aware that the camera's cost is directly related to the number of detectors, which may be a limiting factor in the purchase decision. Three-headed SPECT units are dedicated for SPECT imaging. They usually have a smaller field of view, provide slightly faster patient throughput and are more expensive.

Two-headed cameras are more versatile and allow for both planar and SPECT imaging. Many also are capable of whole-body imaging. A feature offered by some manufacturers is a

For correspondence or reprints contact: Frank Bloe, Associates in Medical Physics, LLC, 883 N. Medina Line Rd., Akron, OH 44333.

dual-headed camera with variable angle ability (*1*). Historically, the dual-headed camera has had two fixed-angle parallel detectors. The new feature allows one head to move from a 180° position to a 90° angle compared to the other head. This camera has been promoted primarily for cardiology procedures.

Single-headed units are less expensive, may have SPECT capability and are often the starting point for a department. They may meet the department's need for a general-purpose camera and may have whole-body capabilities.

Crystal Size and Shape: Round, Square or Rectangle?

Your institution may prefer a square over a round crystal shape, but the more important issue is whether the size of the field of view is adequate to cover the area being imaged. Crystal sizes range from 11 in. to 20 in. Sometimes a small field-of-view camera is useful for imaging small areas, such as a unit dedicated to imaging children or small organs such as the heart. A larger field of view is more appropriate for dedicated whole-body imaging. Most commonly, the camera must satisfy a wide range of imaging procedures and the larger field-of-view cameras are more popular.

Crystal Thickness: 1/4 Inch, 3/8 Inch or 1/2 Inch?

Some vendors offer a choice of two or three typical crystal thicknesses. Frequently, the crystal is available in only one thickness per model of camera, usually 3/8 in. or 1/2 in. Thicker crystals are more efficient for detecting higher energies such as that from ^{67}Ga, ^{131}I or ^{18}F. Thinner crystals are more efficient for lower energies such as that from ^{99m}Tc, ^{201}Tl or ^{133}Xe. However, manufacturers have already determined crystal thickness based on these criteria. If only one crystal thickness is available on the camera, review the specifications for spatial resolution to ensure the performance is comparable with other cameras. If the performance is similar, crystal thickness is not as critical an issue.

Number of Pulse-Height Analyzer Windows

Most current cameras come with four pulse-height analyzer windows that can be used to acquire counts for imaging. Older cameras that have been refurbished may have three, two or, occasionally, a single window. The important issue is to determine if the availability of multiple windows is significant in your imaging program and how many photopeak windows would be desirable today. Some imaging protocols use two photopeaks (^{201}Tl, ^{111}In), or, at most, three (^{67}Ga). The number of analyzers available for a given camera usually is not an option. Be certain that the number of windows available is sufficient for your intended use.

Energy Range

Camera pulse-height analyzers can typically process photopeaks from approximately 50 to 500 keV. If there is a choice, greater crystal thickness may be a factor if the higher energy nuclides are of interest. If the camera's upper limit of energy analysis is 450 keV, then 511-keV imaging might not be able to be performed.

Imaging with 511 keV

Some vendors offer options for 511-keV imaging. The efficacy of this option has not yet been determined. A primary consideration is timely and reliable delivery of ^{18}F-labeled compounds. In the absence of a reliable supply of ^{18}F, this imaging option may not be a concern. However, the upgrading of cameras, after initial purchase, to perform 511-keV imaging may be expensive.

Planar versus SPECT

The current interest is in SPECT cameras because most nuclear medicine departments already have planar capability. SPECT cameras have an advantage because they allow the operator to slice through an organ at a given depth and display the slice. This produces a clearer view at a desired depth and eliminates the overlay of scattered radiation from structures above and below the region of interest. SPECT cameras require the use of computers and sophisticated software and are, therefore, expensive. SPECT capability is the imaging modality of choice today for most applications.

Gantry Dimensions

Gantry size is a frequently overlooked parameter. Camera gantry designs vary from those with camera heads positioned within the gantry to those with detectors extending from a gantry. Cameras positioned within the gantry may have limitations of radius and require that all patients be placed on a narrow imaging pallet where patients are passed through the gantry. Cameras designed with detector heads placed outside the gantry usually allow for a larger radius of rotation. This is important if the department routinely images large patients. The design also allows planar imaging of patients outside the gantry on a wider imaging table and possibly on a hospital stretcher. This latter capability usually is available with many single-headed systems. Depending on the model and manufacturer, whole-body imaging may be performed by passing the patient through the gantry or having the patient lie lateral to the gantry. SPECT imaging can be performed by passing the patient through the gantry or passing the gantry over the patient.

Some SPECT units require the camera heads to return to a home position before performing the next procedure. Others have a slip-ring design that allows continuous unidirectional rotation of the camera heads without the need to return to a home position. The intended use of the camera affects gantry dimension and design.

Step-and-Shoot versus Continuous Acquisitions

Stopping the camera every 3° or 6° to acquire data is probably more time consuming than continuous acquisition. If this is an important issue, make sure that image resolution is not degraded and that computer memory is adequate for multiple procedures.

Circular versus Elliptical Orbit

A SPECT image is better if the camera head can be kept close to the patient during data acquisition. Noncircular orbits usually provide better images. Confirm if the track is user selectable or preprogrammed. More flexibility is better. Maintaining distance from the patient, so that the camera head clears the patient's shoulders, potentially degrades image resolution.

PERFORMANCE

Energy Resolution

This item is an essential feature. The better the energy resolution, the better the overall image performance. Energy resolution is determined by dividing the full width at half maximum (FWHM) value of a photopeak by the nuclide's energy, both in keV units and expressing it as a percent. The smaller the numerical value, the better the energy resolution. Energy resolution on contemporary cameras for ^{99m}Tc is about 9%–11%. Make sure the comparison between each camera model is made using the same nuclide. Sometimes specifications are given for ^{57}Co as well as ^{99m}Tc. A comparison between cameras using different nuclides is not valid.

Spatial Resolution

Spatial resolution is also specified as a FWHM value. It is, however, different from energy resolution. This parameter is usually referenced as an intrinsic (without collimator) performance standard, but there are also specifications given for total system resolution (with collimator) expressed as FWHM.

Spatial resolution is derived from a line spread function (count profile), often one pixel wide, taken through a point source or actual line source. These may be obtained using a lead mask placed on the crystal containing a 1-mm slit for intrinsic studies or a capillary tube placed above a collimated camera for total system resolution. The counts in each of a line of pixels are plotted. The FWHM is determined in pixels and converted to millimeters or may be displayed directly in millimeters, depending on the software. Current cameras show intrinsic FWHM figures of 3.0 to 3.5 mm.

Uniformity

Uniformity, linearity and optimal energy resolution across the field of view are usually produced with correction circuits and protocols dedicated for this purpose. In older camera systems, some count addition or subtraction was used to produce the desired results. The correction circuits on today's cameras are excellent and little count addition or subtraction is needed. Often, the user can access the computer software and turn the correction circuits off or on, but this typically is not done for patient imaging procedures. It is very useful during camera acceptance testing and periodic camera evaluation testing to compare test results with and without the correction circuits.

Count Rate Capability

Previously, there was a horsepower race to see how many counts per second the camera could handle. Figures went up to the hundreds of thousands. Capabilities of 180 kcps, 240 kcps or higher were achievable. Most clinical images, however, were generated with 500 to 800 kcps over several minutes, which meant that images were collected at a rate of 5 to 10 kcps. Only first-pass cardiac studies, or other bolus flow studies, required high count rate capability. Even then, a collimated detector with a sensitivity of 300 cpm/μCi (5 μCi) only received about 125 kcps. High count rate capability was not necessary for most users and few facilities performed first-pass studies without specialized equipment.

Multihead cameras now require more data processing than single-headed units. Therefore, count rate capability has been reduced in current specifications to 80 to 150 kcps. Also, a 20% count rate loss parameter is specified by the manufacturer for each camera. This is probably the more important measure of count rate performance. The higher the value of this parameter, the better the count rate capability.

Imaging Table

Attenuation, maximum patient weight and flexibility of use are the most important imaging table parameters. Carbon fiber is used to strengthen small configurations. The heavier the weight that the table can handle, the more flexible is the camera for patient selection. A second table may be necessary for non-SPECT imaging. Make sure these tables are part of the purchase. The proper alignment and leveling of the table and gantry may require a small bed of epoxy that is laid down on the floor. When poured, it flows out to a uniform and flat surface. Some camera manufacturers no longer use this leveling process. Whatever method is used, leveling and aligning the gantry and table are critical for proper center of rotation of the detector head and is required specifically for SPECT imaging.

Safety Features

Contact pads on the collimator surface and in some cases, on the sides of the camera heads, prevent equipment damage as well as patient injury. They are common on state-of-the-art cameras. Ease of removal when changing collimators or ease of camera operation without them is a plus. A kill switch is still recommended for emergencies.

Motion Controls

Ease of controlling the camera heads for patient positioning or collimator exchange is important in day-to-day use of the camera. Ask about this capability and any known problems. Easy positioning of the imaging tables also is beneficial.

Collimators

Collimator options are usually quite extensive. Low/medium/high-energy and low/medium/high-resolution units are usually available. Fanbeam collimators are another option. Converging, diverging and pinhole collimators still are used sometimes. Usually multiple combinations of collimators are offered by all manufacturers. You should understand the clinical utility of each to determine the proper need. Carefully evaluate the number of collimators that will be used or needed. Collimators are expensive and camera costs are difficult to compare if comparable collimators are not considered. Storage space for the collimators must also be considered in your room design. For some cameras, collimator storage must be located adjacent to the gantry for more automatic exchanges.

You should review storage racks and the mounting/removing mechanism for collimators. Some systems are easier to use and better designed that others. The positioning of the heads for collimator exchange may be more robotic and less operator-assisted on certain units. Ask about any known problems with the mechanism.

Collimators are made by three techniques: cast, etched and pressed. Cast collimators are made by pouring hot lead around multiple pins that are set in a vertical pattern. By necessity, the pins have a slight bevel to free them from the lead when it has cooled. Therefore, the final shape of the collimator holes also has a slight bevel. Etched collimators have straight pins that are used to cast the holes. The pins are removed by chemically dissolving the material away from the collimator holes. Pressed collimators are produced with an appearance of corrugated cardboard. They can be made as squares, rectangles, triangles and so on.

Each vendor believes their collimators are the best design, but each design has advantages and disadvantages. Cast collimators are rugged but have a slight bevel and the hole is not perfectly straight. Etched collimators have straight holes but may contain residual material not cleaned out after the etching process. Pressed collimators are satisfactory, less expensive and lighter in their design but are more susceptible to linear stress fractures. The important thing is that the selected collimators must be solid and not have any construction defects (*2,3*). Almost perfectly aligned holes (less than 0.6° error) (*4*) are paramount for good SPECT imaging. Aftermarket collimators also are available from a variety of sources. Check the specifications and prices for comparison but realize that the OEM may not warrant the camera's performance with another vendor's collimators.

Many collimators produce similar resolution at the surface. Resolution degrades quickly at distance. The important performance specifications for collimators are the field of view and the sensitivity and resolution at 10 cm from the face of the collimator. Manufacturer's specifications for total system resolution document the camera/collimator performance expressed as FWHM. These can be compared among cameras, remembering that improved resolution has an inverse effect on sensitivity. That is, improved resolution usually means reduced sensitivity and vice versa.

SOFTWARE

Computer System

Review of the variations in a camera system's computing capability should be an integral part in your evaluation process. Many cameras come with a manufacturer-selected system. Hard drive storage of ≥1 gigabyte allows storage of up to approximately 40 patient studies. Removable or external storage probably is needed if exams are to be archived on disk. Features such as a 32-bit microprocessor, ram ≥24 Mbytes, CD-ROM, mouse/trackball, tape or optical backup, monitor resolution of 1024 × 1024 on a 19/20-in. screen should be checked to see if there is any choice among the options, or even if they are options. You should confirm that simultaneous acquisition and processing are currently available and are not a work-in-progress. You should explore connecting the camera to a currently-installed color laser or multiformatting imaging device. You should strongly consider purchasing a reading station. Even home transmission of patient data should be discussed to allow on-call physicians this flexibility, if desired.

Assessing software applications may be bewildering when many programs now allow tomographic, circular and elliptical orbiting, gated 64 × 64 and 128 × 128 acquisitions, image processing with orientation/sizing/ROI, text overlay, frame algebra (+, -, x, ÷) images, curve generation/profile analysis, transverse, sagittal, coronal, oblique, 120°, 180°, 360° reconstruction, attenuation correction, transmission/emission protocols, whole-body, three-dimensional cardiac imaging and EKG triggering. These may be standard with the computer and there may be little choice in the selection. Hopefully, you have a computer expert within your ranks to help evaluate both hardware and software options. One key point to remember: if you do not have a choice in the software selection, there is little point in listing item after item on the bid specification other than to confirm that each item is provided and is fully operational.

It would be helpful if acceptance testing software and associated equipment were available, at least on loan, with the camera at the time of purchase to facilitate camera acceptance testing. However, most vendors disclaim field testing, often because it does require special equipment or computer capabilities. You can still perform several tests, and if special equipment or software is provided by the seller it is a definite plus.

You should evaluate a number of other considerations, such as quality control, maintenance and technical support, before deciding which camera to purchase. We recommend including these items in the purchase agreement because you will have more leverage in obtaining these items before, rather than after, the purchase. Some suggestions follow.

QUALITY CONTROL EQUIPMENT

As the bid specifications are being written, determine the number and type of quality control phantoms that will be supplied by the camera manufacturer to monitor ongoing camera performance. This may consist of a resolution bar phantom, a fillable flood source and, if SPECT capability is purchased, a SPECT phantom (Carlson, Jaszczak or equivalent). Incorporate these into the purchase agreement. A ^{57}Co flood source, if recommended or desired, may also be included. These items actually represent a small cost compared to the camera and will eliminate the need to get approval later. The ^{57}Co flood source must be ordered from a licensed supplier or manufacturer.

Although not used for quality control, some manufacturers are receiving FDA and NRC approval for the use of sealed sources for attenuation correction for dual- and triple-head SPECT systems. These include ^{153}Gd, which may have an activity of up to 1 Ci, and ^{57}Co with an activity up to 300 mCi. These activities vary among manufacturers and may depend on whether the unit is dual- or triple-headed. As with most flood sources, these also need to be replaced periodically. You should consider the cost and expected useful life. A specially-designed ^{99m}Tc line source also may be an option for attenuation correction.

Please note that your NRC, agreement state or state license must be amended for the use of attenuation correction sources. Also, an amendment to your license is probably necessary for using a large source of ^{99m}Tc for this purpose. State registrations also may need to be amended to allow for the increased activity.

TRADE-IN

Typically, used cameras have little residual value. Trade-in value as low as a few thousand dollars may be offered for the existing camera. Sometimes the trade-in value can be increased if a camera from the same vendor is purchased for an upgrade. Occasionally, an OEM will assist in finding a buyer for your equipment, but they usually are not interested in taking your camera on trade.

An alternate avenue for selling used cameras is through independent service companies. These companies will remove the used camera from your premises, sometimes rebuild it to more current specifications and sell it. The seller and buyer usually have to be known ahead of time by the third-party vendor in order for the transaction to be completed. This arrangement may bring a little more money for the used equipment, but it will not be significant for the seller.

Another option is to use one of the increasing number of brokerage type services that may buy your existing camera and have it disassembled and removed. The unit may be taken to a warehouse to await future resale by the broker. It may or may not be reconditioned before resale. Computers may also be sold this way. Sales and service representatives are good sources to find out who may have this type of service in your area.

Conversely, purchasing refurbished equipment can provide your hospital or clinic with a relatively inexpensive camera (approximately $50,000 to $120,000). The used camera market is evolving and refurbished cameras can provide quite satisfactory performance for routine imaging purposes. You can find out about the used camera market by asking independent service representatives and checking trade journals.

USERS LISTS AND SITE VISITS

Ask the camera manufacturer to provide a list of users within a reasonable radius of your location. If they offer an extensive list, you may find some users who are not completely satisfied with their camera purchase. Insight on any difficulties they may have encountered with the purchase may aid your decision. You must understand, however, that not all individuals will be happy with the equipment that was purchased. Expressions of dissatisfaction should be tempered with the circumstances at a given location.

It is useful to schedule a site visit at a location that uses the camera under consideration. Site visits are expensive and time consuming for all parties involved and should be reserved for the final stages of the decision-making process. Choose a site that is performing procedures similar to those planned at your facility. Site visits are most productive when you make them unaccompanied by the vendor representative and at locations that you have selected.

RELIABILITY

This is a difficult area to evaluate. Every manufacturer has had one camera that has been difficult to service. It is probably more valuable to get information about the average downtime on equipment and the nature of the most commonly identified problem(s).

SERVICE RESPONSE TIME AND FOLLOW-UP

You should discuss response time for service before you make the purchase. Availability of the same brand equipment in the nearby area probably indicates that service is available more readily. Telephone calls to other users in the area may give some insight into service history and reliability of service. If the service representative travels from a distant location, then travel time must be factored into the response time. Telephone response to a call for service can be as important as on-site visits in some instances. More manufacturers are installing modems into the camera/computer systems to allow service engineers to diagnose a problem before the visit. Repairs may be instituted at that time via modem or parts can be ordered for more efficient repair and reduced downtime. A guaranteed response to a service call can be established in the negotiation process. The purchase agreement can be negotiated to include a percentage reduction in the service charge if response time is not adequate. This provides a strong stimulus for the vendor to respond promptly to service calls.

Other factors that affect your service are the type of service, the speed of service response, the individuals involved in providing the service (if they are known and respected), and other equipment within your facility that was manufactured by the same vendor. Sometimes on-site service representatives can repair radiographic, fluoroscopic and CT x-ray units, as well as your new gamma camera.

TRAINING: NOW AND LATER

Applications training of technical personnel who will work with the camera is an important consideration. Installation of new equipment comes with a flurry of activity and exposure to many unfamiliar things. Site training given immediately after installation is useful for start-up, but technologists often have many additional questions weeks or months after the installation. Arrange a follow-up training session, in advance, to allow personnel to develop questions and understand the proper operation of the equipment so that these issues can be resolved. Also specify the amount of training that is given (i.e., the number of days), as well as the number of technologists that may participate in the training sessions.

Operation manuals are usually standard with a camera purchase. Some manufacturers are beginning to offer this information on computer disk to conserve storage space in the department and give technologists ready access to the information.

Hot-lines for technical assistance are usually provided by OEMs, but this may not be the case if refurbished equipment is installed. An alternative source of training may be a cooperating hospital that has comparable equipment and is willing to allow your personnel to visit for a day or two to observe and work with the equipment at that location.

WARRANTY

Most new equipment is warranted for one year on parts, labor and travel. You should discuss extension warranty contracts and/or maintenance contracts before your purchase. Service contracts are not inexpensive and you have a good opportunity to negotiate a lower price for the service contract before the purchase is made. The warranty period should not begin until the camera has been accepted (following acceptance testing) for routine use and after any problems have been rectified.

SERVICE MANUALS

Be sure to ask and receive a set of service manuals for the equipment. When the equipment is no longer under warranty or service contract or if budget reductions mandate that service be provided by a third party, these books will be necessary. The manufacturer may charge you for the manuals after you have purchased the camera. You can avoid this additional cost by incorporating the manuals into the original purchase agreement.

UPGRADABILITY

You also should discuss equipment upgrades provided by the seller during your purchase discussions. Although equipment technology changes dramatically over time, some manufacturers build more upgradability into their equipment than others. Inquire whether single-headed cameras can be upgraded to dual-headed systems or if planar cameras can be updated to SPECT. Ask if the computer's processing speed can be enhanced with new technology. Ask for estimated costs. The figures will probably change due to inflation, but at least it will give you an idea of what to expect.

DELIVERY, SETUP AND INSTALLATION DATE

Select a target delivery date for the equipment when you make the purchase. The production of your camera may not begin until the sale is made final. Therefore, delivery must be scheduled. Occasionally a camera system meeting your specifications may be available and delivery can be moved up. Conversely, delivery of your camera may be bumped if another customer is viewed as being more important. Negotiate a commitment on the delivery date and the amount of time needed for installation before you make the purchase final. Remember also to schedule the applications training to be delivered at a specific time after installation.

LIABILITY INSURANCE FOR INSTALLERS

Check that the company has adequate liability insurance in the event a worker is injured on your property.

FLOOR LOADING, ELEVATORS AND DOORS

Review with the seller the architectural requirements of the system. Ensure that your floors will support the weight of the equipment that you plan to install. It is also important to determine whether or not elevators, if needed, can support the load of the equipment or whether the equipment can be dismantled into sufficiently smaller components so that weight is not a problem. Similarly, door sizes, hallway widths and turning radii need to be adequate to move in the equipment for installation. Confirm whether or not moving the equipment from the loading dock to the nuclear medicine department must be performed by in-house personnel, outside contractors or the vendor's service representatives. Confirm that labor union restrictions do not pose any problems.

ELECTRICAL REQUIREMENTS

Most nuclear medicine cameras require a dedicated power line. This reduces voltage surges and electrical noise on the circuit that may be generated by other equipment, such as elevator motors, air conditioning units, radiology units or food service equipment. It may be advantageous to monitor outlets to be used for the new equipment with a voltage strip chart recorder for a few days. You can identify trends in voltage stability and spikes before installation and take corrective action to avoid problems after installation.

PAYMENT

You should agree upon your payment schedule in advance. Sellers usually want final payment when the equipment is installed and operational for the first patient study. We recommend that you modify this agreement to withhold final payment of some monies (approximately 10%) until the equipment is performing, as specified, and has been acceptance tested. Payment is usually requested in the form of a large deposit (60%–80%) upon placement of the order, followed by a second payment (approximately 10%) upon delivery of the equipment, with final payment upon first use of the equipment.

RIGHT TO REFUSE OR REMOVE EQUIPMENT

Write into the purchase agreement your right of refusal of the equipment and your option to have it removed from the premises at no cost to the purchaser if the equipment does not function as promised. If this point is not clarified before the purchase, there is a remote possibility you may end up with a lemon and little or no recourse.

ACCEPTANCE TESTING

Acceptance testing confirms whether or not the camera meets your stated specifications. Therefore, you must know the expected performance for energy resolution, spatial resolution, spatial linearity, uniformity, total system resolution, system sensitivity with different collimators, pixel sizing, useful field of view, multiple-window registration errors, potential detector head leakage, collimator hole angularity evaluation, SPECT resolution, SPECT uniformity and evaluation of any of the other specifications that you requested or the seller promised. Many of these specifications have been determined by the manufacturer in conjunction with the National Electrical Manufacturers Associations (NEMA) uniform criterion for the measurement and reporting of scintillation camera performance parameters (*6*). Typically, the manufacturer reserves the right to change published specifications, however. The value of the bid specification purchase process becomes obvious. The camera is tested against bid specifications that the seller committed to and the buyer has more resolve to expect satisfactory performance from the equipment.

You should have the camera acceptance tested upon delivery. Too often acceptance testing is an afterthought, especially when the camera is not functioning properly.

Acceptance testing is usually performed by a physicist or physics service, by in-house personnel or outside contractor, to determine whether you actually received the equipment that you ordered. There is not a uniform protocol for acceptance testing, but it generally consists of testing all the variable parameters of the gamma camera (*5*). The complexity of the acceptance test is probably an indication of the quality of the evaluation. If performed by an in-house physicist, scheduling may be more casual, as adequate time is available to test the equipment and then retest it, as necessary, to confirm or correct deficiencies in performance. If done by an outside contractor, you must set aside a designated period of time when the equipment will be completely available. Outside contractors generally have tighter schedules.

The type of camera determines how much time it takes to perform acceptance testing, which can take from one to four days on site. An equivalent amount of time is needed afterward for statistical analysis and report generation.

There is an advantage to having the seller's service and/or applications representative present during acceptance testing. Frequently, the equipment is the most recent configuration or release of a camera model and computer, and your technologist or physicist may not be familiar enough with its operation to get the desired results without the assistance of an OEM representative. Determine if the OEM will charge for the time of their personnel during acceptance testing. Agree on this point during your purchase negotiations. You may withhold final payment based on the testing results.

You should consider the cost of acceptance testing as part of the purchase process. The fee for acceptance testing is approximately 1%–2% of the cost of the camera. However, this cost varies depending on the individual(s) conducting the testing and on the extent to which testing is performed. Retesting the equipment should be considered if it is needed. The possibility of this expense as well as the party responsible for payment should be clearly noted in the purchase agreement. You also should determine if the seller can provide specialized slit phantoms, other test objects or software needed to conduct acceptance testing.

At this point, you have reviewed the essential specifications that you want vendors to address. Organize your list of questions and demands on a form and send it to each vendor. Ask the vendor to respond with a price quote and to state whether or not they can provide the requested product within the specifications outlined in the attached document.

Your price quote request should contain sufficient latitude to allow the vendor to provide additional supporting information, if necessary, on a specific part of its product or on the product in general. This can be in the form of general product literature or a specific comment from the company's spokesman. If a vendor does not respond to some of the items in the bid specification, you should ask again for a complete quotation. If you still receive an unsatisfactory response, you may suspect the quality or performance of the product you are considering from that vendor, at least in relation to that specification.

In addition to price quotes, the vendor probably will provide you with an executable contract to purchase their equipment. You should review this document carefully, including the fine print on the backside of the paper. We recommend that you have your institution's legal counsel review the quotation to ensure that it is equitable for all parties involved. Be wary of standard terminology in the fine print that conflicts with the agreement terms that you are negotiating.

Once you receive the price quote from each vendor, you can generate a table that displays, item by item, what each vendor is offering. You can easily compare the vendors as to whether or not your criteria are met. The vendor who meets the most criteria, however, does not usually win the sale. Some aspects of the camera are more important than others to various users. If this is the case, you can develop weighting factors and assign points according to the relative importance of the features. For example, if spatial resolution carries more weight than the number of collimators included, then assign that parameter a higher numerical value. However, the camera with the highest overall score may not include those characteristics you prefer.

It is important for you to review films that have been generated from the camera at other sites during routine clinical use. Physician involvement in selection of the equipment is absolutely necessary, since this person ultimately is responsible for interpreting patient examinations. Images presented to you by the vendor from the same model camera are usually of optimal quality. Obtain a more realistic perspective of the camera's ability by having the physician review a variety of studies from another facility during a site visit. The physician may get a better feel for the day-to-day performance of the equipment on various patients. You must confirm imaging parameters (such as counts, time delays postadministration of radiopharmaceuticals) at the other facility to obtain an objective evaluation.

You also should consider technologists' preferences since they must use the equipment daily. You should heed any well-founded concerns as these could affect whether or not the camera is used to full advantage.

CONCLUSION

When you devote the required time and effort to the bid specification process, all personnel involved become more familiar with the product and their expectations of the level of performance are more realistic. Although, in many instances, buyers select equipment that was not indicated by their comparison checklist, the bid specification process provides objective criteria for the knowledgeable purchase of gamma cameras, which are a major investment. Also, the bid specifications are an excellent framework with which the camera acceptance testing results can be compared. If acceptance testing is an afterthought, the results cannot be used for comparison against any performance standards other than those published by the manufacturer. Keep in mind that the manufacturer reserves the right to change performance standards at any time. If the vendor commits to the standards in your bid specifications and quotation, your camera must meet your performance standards or you have grounds for corrective action that cannot easily be refuted.

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