C-ARM BUYERS GUIDE

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The C-Arm Buyers Guidebook

This C-Arms Guidebook, developed by Amber Diagnostics Inc., is designed to help you understand and address common concerns before you make your investment in purchasing a C-arm. With over twenty years in the medical imaging equipment industry, we have applied our knowledge and experience to compile all the information you need in regards to types of C-arms, radiation safety, pain management, reimbursements, and more. Our goal is to ensure you have a convenient reference at hand, giving you the wisdom and confidence to go forth in purchasing your next C-arm.

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Overview of C-Arm X-Ray Systems
A C-arm is an overhead x-ray image intensifier that provides real-time detailed viewing of anatomic structures using fluoroscopic dyes. The system is a non-invasive device that does not enter the patient's body, making it safe for screening before, during and after procedures. The minimal invasiveness also allows faster diagnosis and treatment, as well as increased comfort for patients.

These machines are mobile and easily transportable, and can be used in confined spaces. The unit's support structure is shaped like the letter “C”, and is capable of being adjusted to different settings based on the application. The special arced semi-circular design also permits the physician to rotate and angle an x-ray tube without moving the patient. Furthermore, using a moveable c-arm table also allows the physician the opportunity to “tilt” the patient while rotating the c-arm, maximizing the viewing capacity.

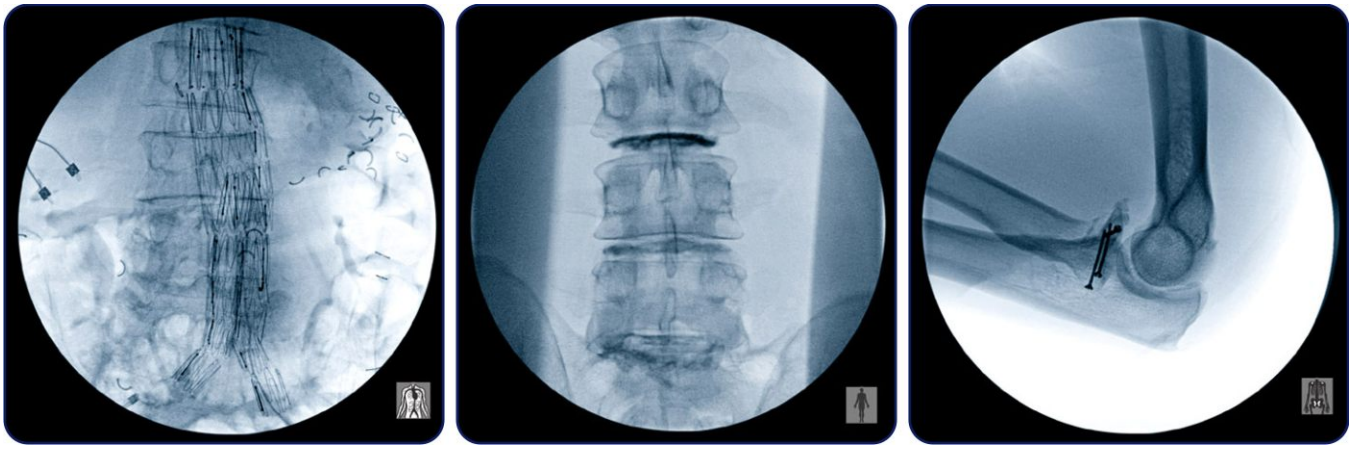
C-arms work in conjunction with patient tables and are specifically designed for X-ray imaging, allowing free positioning of the C-arm around the patient. Tables may even be designed to move and rotate to allow better patient access for procedures and to aid imaging angles. Keep in mind that tables also need to be X-ray translucent to avoid interference with imaging.

C-arms are very effective diagnostic tools used by many medical specialists such as radiologists, surgeons, cardiologists, orthopedists, urologists and gynecologists. Their flexibility allows the physician to quickly view and monitor the placement of devices such as pacemakers, catheters and prostheses. Though C-arms have radiographic capabilities, they are primarily used for fluoroscopic imaging during surgical, orthopedic, critical care, pain management, and emergency care procedures.

Outpatient studies
C-arm imaging is used for various studies including those of the digestive, reproductive, coronary and venous systems to help identify potential health problems such as stomach ulcers, infertility, and coronary artery occlusion.

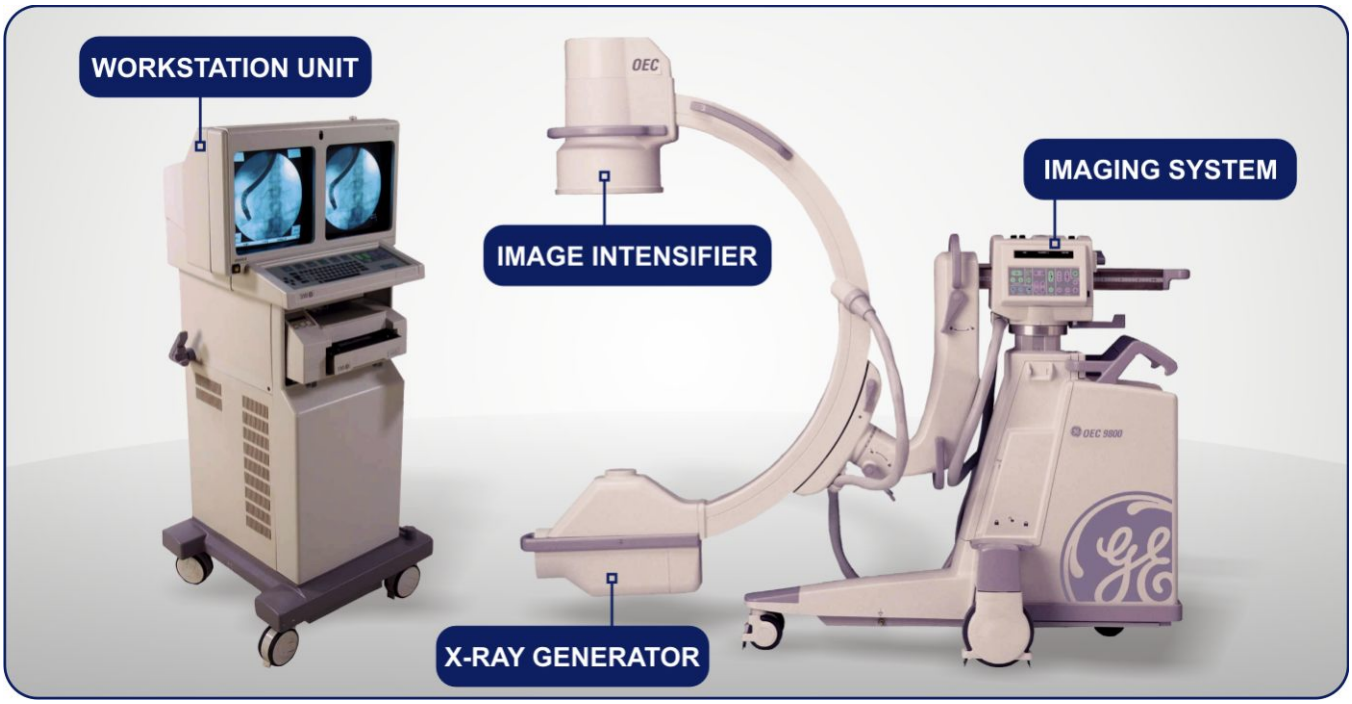
Line placement
C-arm fluoroscopes are ideal for use in visually guiding physicians to place needles, stents and catheters in specific areas.

Image Intensifiers
Image intensifiers are usually set up for two purposes: for plain fluoroscopy or digital subtraction angiography (DSA). All image intensifiers are set up with the capability of adjusting settings to fit different user requirements, based on the procedure and body part being imaged. For example, in simple fluoroscopy, imaging of the throat would not require the same amount of exposure as the abdomen. On DSA capable models, preset programs are available. This lets the user decide a rate of how many images or frames per second are acquired. Image intensifiers are frequently used in orthopedics to help put hardware needed to stabilize bones and joints; for vascular and neurological imaging to ensure surrounding tissues remain healthy; and to help guide surgeons operating on delicate areas such as the spine.



Surgery
C-arms have a number of surgical uses including real-time viewing of the gallbladder, liver, heart and bone structures. It can also provide viewing assistance to ensure accuracy during surgery. Some imaging systems are capable of taking images in multiple planes, which is useful for reconstructing a 3D volume of the patient anatomy. This is typically used for surgical navigation. Surgeons also find this helpful to check the placement of implanted devices in the patient.

Pain management
Image intensifiers are used to help direct needle placement into joints when injecting anesthetics. Pain-relieving medication can be inserted into shoulders and knees with little or no damage to the nearby structures.



C-Arm Components
The portable C-Arm generally consists of these main components: the x-ray generator, imaging system, and workstation unit.

X-Ray Generator
The X-ray generator, dose control system and collimator controls are usually housed in the frame on which the C-arm is mounted. All of the control systems are directed by the master controller (found in work station). User controls on the C-arm allow the operator to modify the operation of the system while in use.

Modern systems use a digital high frequency generator with typically 20,000 cycles per second. The range of kVp settings may be from 40kV to 120kV with a tube current of 0.1mA to 6mA for fluoroscopy examinations. For radiographic mode, the mA is fixed at approximately 20mA to 60mA, and mAs values also vary from 0.16 to 160 for radiographic applications. The electronic timer varies from 0.1sec to 4.0sec for radiographic exposures.

There are several benefits for increased x-ray power. For starters, it allows greater flexibility for imaging while reducing exposure times and the risk for error. These benefits may be very important for pediatric and obese patients who may find longer exposure times daunting.

Types of X-Ray Tubes
The two types of X-ray tubes are fixed anode or rotating anode. Typical features of fixed anode tubes include a heat capacity load 30,000 - 50,000 heat units; an angle on the anode target of about 12 degrees; and single or dual focused anode with 0.5 by 0.5 mm focal spot for fluoroscopic applications and 1.8 by 1.8 mm focal spot size for radiographic applications. Typical features of rotating anode tubes include a 0.3 mm focal spot for better image detail; longer tube life; typical anode heat rating of 300 000 heat units for longer exposure times; and housing with a heat storage limitation of about 1200-1250kHU.

Imaging System

The imaging system unit can perform a variety of movements that allow for use in a variety of surgical procedures such as cardiology, orthopedics and urology. This unit provides the correct structure to properly mount an image intensifier and an X-ray tube. The imaging system must be compact and lightweight to allow easy positioning with a wide range of motion and adequate space to work around, but must still remain firm enough to avoid misalignment.

Workstation unit

Much of the operation of the machine comes from the workstation unit. This unit is typically equipped with the following features: various handles for movement and positioning; power switch and exposure switch; cable hanger; brake pedal; controls for radiographic and fluoroscopic settings; assorted interconnect cables; hard disk and optical disk writer/rewriter, DVD R/RW, PACS system connection; advanced image quality enhancement software such as noise reduction and zoom control; ability to save and swap images; contrast and brightness controls; single or dual large monitors; and advanced image processing such as noise reduction.

Growing Market for C-Arms

According to a report conducted by the Global Industry Analysts, Inc. (GIA), minimally invasive procedures along with the evolution of new application areas is forecasted to drive the growth of mobile C-arms. Excluding mini C-arms, the global market for fluoroscopy and mobile C-arms was estimated at 9,403 units in 2011, and projected to grow to 11,486 units and $1.4 billion by 2017.

In developed markets such as Western Europe and the United States (which represents the largest market worldwide), business has been fairly steady. Meanwhile, in emerging markets including China, Brazil, Russia and the Middle East, business has been booming over the past year, and becoming more aligned with the larger markets.

“A shift from traditional open surgery to minimally invasive surgery often requires the use of visualization or imaging where the surgeon cannot see with direct line of sight,” says Joe Shrawder, president and CEO of GE Healthcare Surgery. “The developing world's [surgical teams are] becoming better at it, and more aware of it, and more conscious about providing patients with the best available surgical techniques.”

The evolution of new application areas, such as the capability to image the body's torso and head, is another area that will help the C-arm industry grow. Demographic trends toward a heavier, aging population may also drive procedure growth. “The population in general is getting older and the U.S. is getting heavier; those two factors coincide with some health issues that mobile C-arms are used for, including image guidance during spine surgery, orthopedic trauma surgery, joint replacements and vascular surgery,” says Mark Manum, director of marketing for Philips Healthcare's OR channel.

Minimally invasive surgery is becoming more widespread in emerging countries; these emerging markets are beginning to adopt newer technology as their economic growth cycle matures.

OEC 6800 Mini C-Arm

Ziehm Quantum Compact C-Arm

OEC 9600 Full Size C-Arm

OEC 9800 Super C C-Arm

Types of C-Arms

Mobile C-arm systems are used for a range of diagnostic imaging and minimally invasive surgical procedures. C-Arms come in different sizes including Mini C-Arms, Compact C-Arms, Full-Size C-Arms, and Super C C-Arms.

Mini C-Arms

Mini-C-Arms, which are smaller systems typically used in clinics for sports medicine, orthopedic and podiatric imaging, generally come with a 4”/6” image intensifier.

They are ideal for performing studies or scanning extremities such as hands, feet, ankles, knees, elbows, and even shoulders. These units can be especially helpful during external reduction and fixation of fractures since the bone alignment can also be visualized in a non-invasive manner via real time.

Compact C-Arms

Compact C-Arms are larger than a Mini-C-Arm, but not as big as a Full size C-Arm (almost like a hybrid of the two). These compact systems can come in either one-piece or two-piece systems, with the main benefit being its mobility.

Full Size C-Arms

Full size C-Arms tend to be the most sought after model because it allows you to perform just about any type of procedure. These C-Arms are usually used for swallow tests, spine and torso studies, cardiology, pain management and surgery. The open space in the regular full size C-arm is 26 inches, making it large enough to fit a table and patient between the image intensifier and the tube. They can come with a 6/9" Image Intensifier, and even a 12" image intensifier, which can be useful for cardiology.

Super C C-Arms

A Super C C-Arm gives more space from the middle of the C-arm to the outer edge. The extra open space in a Super C (33 inches), allows for additional room to accommodate larger or obese patients.

Recognized C-Arm Brands
The key players in the United States C-arm market include GE Healthcare/OEC, Philips, Siemens and the German-based Ziehm Imaging, which has made a strong push in the market over the past few years. Top sellers outside the US include Shimadzu and Hitachi.

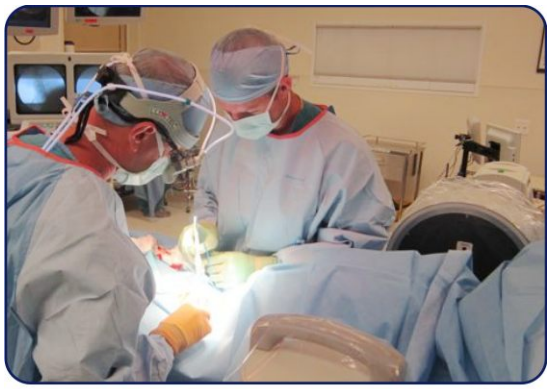
Notable features on newer mobile C-arm systems include 3-D navigation aids and image processing software to improve image quality and system capabilities. Some systems also offer technologies to reduce the radiation dose delivered to patients. Other features include a touch-screen interface, laser aiming guides, digital subtraction angiography (DSA) and procedure road mapping, allowing vascular procedures to be premeditated with minimum amounts of contrast media and shorter fluoroscopy times.

The new style OEC 9600 C-arms have a rotating handle on the C-arm for added ease of steering the rear wheels of the system, and allowing for lateral movement with less effort. Though both have the same scanning capabilities, the old style OEC 9600 required the user to put in quite a bit of strength and effort for the steering.



Clinical Applications for C-Arms
In the operating room, C-Arms help in visualizing kidney drainage, abdominal and thoracic aortic aneurysm repair, valve replacements, cardiac surgery, vascular surgery, pain management, orthopedics, gastroenterology, and neurology procedures. Below are some examples of general procedures that require C-Arms, and which particular system best fits those procedures. Remember, the correct table also makes all the difference for patient comfort and safety.

Pain Management.
The growing use and innovations of C-Arm fluoroscopic technology has certainly helped excel interventional therapies for pain management including spinal problems, joint pain and sports medicine. Pain management applications of C-Arms are the fastest growing utilization of this technology, often providing the greatest potential ROI for physicians. Equipment to consider for pain management include Ziehm Vista and Exoscop 7000; Philips BV Pulsera; Siemens Compact L; and the GE OEC 9900, 9800, 9600, 9400.



Vascular.
With further research in the expanding field of vascular access, C-Arm use continues to grow for vascular surgeons, interventional radiologists and interventional nephrologists. C-Arm systems you can look into for vascular access include the GE OEC 9900, GE OEC 9800, OEC 9600; the Philips BV Pulsera; the Ziehm Exoscop 7000; and the Siemens Arcadis Avantic.

Urology.
C-Arms for urology procedures today include a variety of versatile machines with flexibility and performance features that can save time, and enhance patient comfort and satisfaction. C-Arms for urology include Ziehm Exoscop 7000; Philips BV Pulsera; Siemens Arcadis Avantic; and the GE OEC 9900, 9800, 9600, 9400.

Orthopedics.
C-Arm technology has truly revolutionized orthopedic care and surgical practices. For an orthopedic surgical center, the objective is to comfortably treat various instances of patient trauma, while providing the best image possible for the physician.

This can require a highly adjustable c-arm machine capable of maneuvering to focus on precise angles. Here are some options for C-Arms for orthopedic practices: Hologic Fluoroscan InSight Mini C-Arm; OrthoScan HD; Ziehm Vista and Exoscop 7000; Philips BV Pulsera; Siemens Compact L; and the GE OEC 9900, 9800, 9600, 9400, 6800 & 6600.

The chart below is designed to give you an idea on various features that C-Arm models may contain.

OEC Elite 9900 Vascular vs. Vision RFD

Both the OEC 9900 and Ziehm Vision can serve all your fluoroscopic VASCULAR needs. However, the Vision does offer a higher heat capacity tube along with a higher kW generator. The OEC 9900 offers a 30fps vascular package compared to Ziehm's 25 fps. Pricing for the systems are pretty much the same however parts seem to be more readily available for the OEC 9900.

C-Arm Model	> OEC Elite 9900 Vascular	> Vision RFD
Company	GE Healthcare	Ziehm Imaging
Used for	Interventional fluoroscopic imaging	Fluoroscopy
Noteworthy feature(s)	Advanced vascular I.Q. w/MTS, low dose	Liquid cooling; 7.5 or 20 kW generator; SmartVascular
Dose reduction features	Low dose, pulse, laser aimer	Low dose & pulsing generator
>> X-RAY TUBE ANODE		
Maximum output @ 120VAC	75 mA @ 120 kVp	40 – 120 kV 75/ 200 mA
Maximum output @ 220VAC	75 mA @ 120 kVp	40 – 120 kV 75/ 200 mA
Heat capacity	300,000	5,000,000 HU
Cooling, HU/min.	85,000	100,800
Cooling system/features	Passive cooling	Active liquid cooling
Focal spot size, mm	0.3 - 0.6	Dual focus: 0.3 / 0.6
Radiographic mode	0.3 - 0.6	0.6
Fluoroscopic mode	0.3	0.3 / 0.6
Tube power rating, kW @ 100 kVp	15	40 - 120 kV
>>X-RAY GENERATOR		
Type	High-frequency, 60kHz	Varian Monoblock
Power rating, kW@100kVp	15	40 – 120 kV
>>RADIOGRAPHIC MODE		
kV range	50 - 120	40 - 120
mA range	Up to 75	75 / 200
mAs range	Up to 300	N/A
AEC	N/A	N/A
Exposure time, sec.	0.1 – 4 , automatic computer control	N/A
>>FLUOROSCOPIC MODE		
kV range	40 - 120	40 - 120
mA	0.2 - 10	7.5kW: 1.5-75; 20kW: 1.5-200
Pulsed fluoroscopy	Yes	Yes
Pulses per sec.	1,2,4,8,15 / 30 DC	1 - 25
ABS control	kVp, mA, camera gain	kV, mA, gain, black level, TV iris, dual histogram multiregion control

So with all these various brands and types of C-Arms, how do you know which one is right for you? The following section is designed to help you find the best C-Arm, fit for your particular business and budget.

Which C-Arm is Right for Me?

Whether you are looking to open up a pain management center, or expanding your services to add surgical procedures, you are going to need a C-Arm system.

Deciding to purchase a C-Arm is easy enough, but choosing which one is appropriate for your practice can get a little complicated. We understand the search process can become an information overload with the different brands, sizes, and costs.

Ultimately, the answer comes down to what type of studies you intend to do at your facility. If you specialize in interventional pain management services, cardiac or orthopedic services, then we encourage you to go all out and get the full size C-arm.

To simplify things and help steer you in the right direction, keep these questions and ideas below in mind while you shop around.

1. How big?

Yes, size does matter. C-Arms come in different sizes, as we mentioned before. Knowing the size of the image intensifier you need is always a good initial step. You should also know whether the size of your power generator is strong enough for your procedures. For example, a 15 kW generator will penetrate deeper than a 7.5 kW generator. (Remember, a bigger sized “C” makes it easier to work with larger patients.). These mobile fluoroscopic units should be maneuverable around hospitals and provide positioning flexibility. While a great C-arm depth may be preferable, it can also make the maneuverability a bit more difficult.

2. Image Quality

The resolution of a C-Arm varies greatly, and the more lines per inch, the sharper the resolution will be. However, not all procedures require the highest resolution, so it is best to test out different types to see which C-Arm gives you the best quality based on the procedures you will be performing. Remember, taking great images won't mean anything unless you have the correct storage device for image capture; Printer, Medicapture or Dicom for PACS system are all great options available to add to your C-Arms purchase.

3. Warranty

A service plan with a warranty is a must; be sure the coverage includes parts and labor, as well as travel time. Keep in mind, some plans may exclude x-ray tube and image intensifiers (which happen to be the two most expensive parts to replace). At some point, be prepared to have service done to the system; whether it is routine maintenance or a larger repair issue, make sure there are reliable service engineers that can come out to work on your system immediately.

4. Site planning

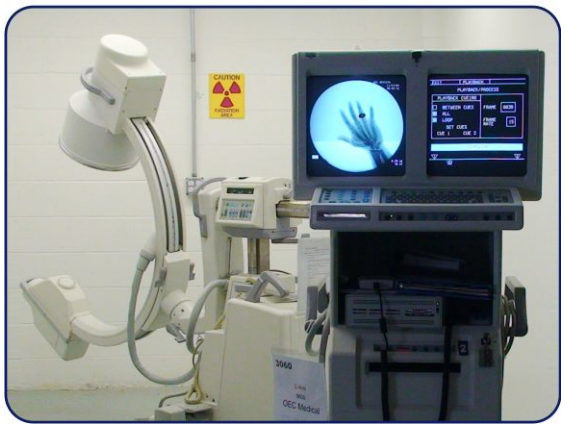
Make sure the C-arm is housed in a room that provides enough clearance so you can manipulate the C-arm to get a better view without having to move the patient. The room should accommodate the C-Arm system you select, with correct wall and ceiling clearance. You should also have plenty of space to maneuver around the system. The mobile C-arm's lower portion must be low enough to fit underneath the hospital's beds and operating room tables. If you plan to stow away the C-Arm during non-business hours, make sure there is proper clearance between hallways and doorways.

5. Free space
There should be a certain amount of free space for the area between the image intensifier and x-ray tube. You'll need to be able to adjust it for the best possible image output. If the system you are looking for is expected to be used on a high volume of patients, then you will need a rotating anode tube, which will help result in less time for cool-down.

6. Software for your hardware
You will need particular software packages based on the procedures you perform. For instance, if you are doing procedures that involve veins, you will need a vascular package. Try to aim for the most up to date version of the software, so you get the most out of usage and image quality. Crisp, clear image resolutions will help physicians better navigate the needle.

7. Last but not least…
Make sure you know everything that is covered and included with the system you purchase, including set up service, shipping, and warranty coverage. Do not spend more than your budget, a used or refurbished unit is just as capable and can cost 30-40% less than a brand new C-arm. If you're looking into a refurbished C-Arm, ask to get a full list of which parts were replaced and repaired, and the refurbishment process your particular unit went through.
After following this checklist, you'll realize that finding the most optimal C-Arm for your practice isn't so bad after all.

Now the next question you'll ask yourself is: **where do I buy a C-Arm?** Well, you can stop scratching your head, because at **Amber Diagnostics**, we have a great selection of C-Arms and C-Arm tables in stock! www.AmberUSA.com



Brand new always sounds like something bright and shiny, whereas when we hear the word “used”, often times we think of something old, worn out, and nonfunctional. While it may hold true in some cases, it is a different ball game with medical imaging equipment. Before you make any final purchasing decisions (or judgments), please continue reading so that you can fully understand the benefits and risks of buying C-Arms on the secondary market.

Used/Refurbished vs. New Imaging Equipment
There is no harm in questioning pre-owned medical equipment, especially when using it for a high volume of patients. Just bear in mind that because a piece of equipment is labeled as “used” or “refurbished” does not make it less effective or less functional.

For any reason, whether it is a surplus of machines or a decline in business, a medical company may decide to sell equipment that is perfectly functional. Even if the machine has barely been touched, it is no longer considered new, and becomes secondary. This also means a very good piece of equipment is now on the market for a low price.

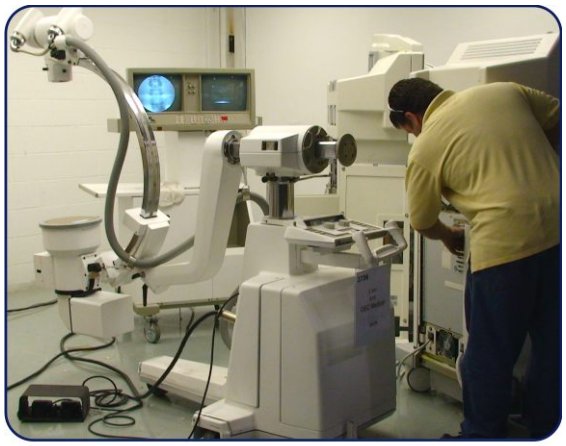
A used medical device generally refers to equipment that is sold “as-is”. There are no changes or fixes made to the product. When buying a used system, not only are you buying a very low-priced item, it does not typically come with warranty. Often times, buyers are responsible for any parts or labor that may be needed to complete the installation. In most cases these issues can be handled in a fair and ethical manner between both the buyer and seller.

A refurbished machine usually has some work done to it, be it cosmetic reconditioning, a quick replacement, or an extensive repair. Refurbished systems include a variety of warranty packages with delivery and installation included. Agreements made for refurbished equipment also depends on the budget of the buyer and the product itself. Keep in mind some plans for C-Arms may exclude x-ray tube and image intensifiers (which happen to be the two most expensive parts to replace).

Buying used or refurbished C-Arms is certainly a cost-effective strategy that can get the same job done on patients for a lower cost, than when buying new equipment. When buying second hand medical equipment, be sure to consider whether it will meet the quality standards and guidelines for the future.

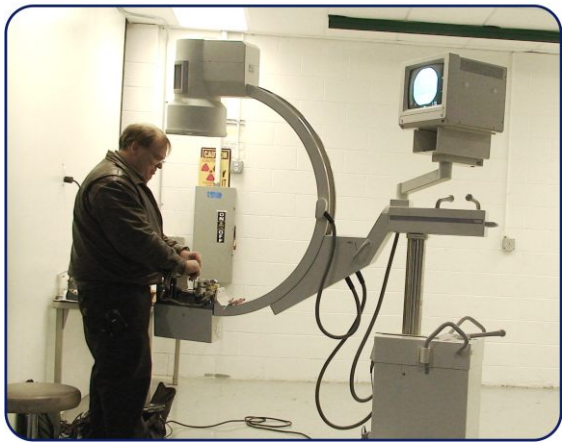
There Must Be Some Risk Involved

As with any investment, new, used or refurbished, you always want to buy with a trusted source that guarantees quality. Also, know exactly what's included in the terms; get a copy from your provider listing the refurbishments and the coverage of the warranty (if applicable).



Since there is very limited or no warranty at all with used medical equipment, asking to perform an inspection prior to the purchase and getting opinions from other buyers could also be helpful.

Also, ask about service plans available because at some point you'll need to be prepared to have service done to the system-whether it is routine maintenance or a larger repair issue. As long as you are working with a reliable seller, the benefits will certainly outweigh the financial risks of buying used or refurbished medical equipment.



Remember, don't be afraid to ask any questions. If your seller is well-experienced and knowledgeable, they will have no problem in answering your questions or directing you to those who will know.

C-Arm Refurbishment Process and Service at Amber Diagnostics

Amber Diagnostics has extensive experience in the refurbishment of all major imaging modalities from the industries most respected manufacturers. Our refurbished and reassembled products are guaranteed to deliver performance and safety features that meet or exceed original manufacturer's specifications. Below is an overview of the refurbishing steps at Amber.

Selection: Each piece of mid-life equipment is carefully selected, avoiding any equipment that has experienced high usage or has been poorly maintained.

Mechanical: The extensive refurbishing process includes complete refurbishment and reassembling of all mechanical, electrical, and computer systems.

Electrical: Amber's experienced engineers completely refurbish and reassemble the system, insuring compliance with FDA laws and OEM equipment specifications.

Cosmetic: Equipment is cosmetically reconditioned to make it look good as new.

Staging Process & Testing: Once the refurbishing is complete, each system is pre-staged in our state of the art staging bays. Performance tests are conducted to meet FDA and OEM specifications before it leaves our facility.

Installation: Once the equipment has passed all the testing, we will deliver and install the system at your facility. Following installation, engineers will guide you through the functions of the equipment and train technicians, if required.

Applications: All systems sold and installed by Amber come with a Complete Applications and Training course to allow clients to become familiar with their new system.

Warranty: Every refurbished and reassembled system comes with a Comprehensive Warranty including all glassware, parts and labor. Amber Diagnostics guarantees fast response time and after sale support for all your warranty needs anywhere throughout the United States.

C-Arm Costs

More often than not, buying decisions are finalized based on cost and cost alone. Why shouldn't it be? Times are tough, and if you find a system that fits your budget, you should jump on it.

But before you do, know this: purchasing a C-Arm machine is not always cheap. While you can find great deals on used and refurbished medical equipment, it is an investment when you add up the overall costs of the equipment itself, delivery, accessories (printer, table, and DICOM boxes), proper gear for the operator (lead aprons, radiation goggles, and gloves), service packages, inspections by a certified physicist, and other regulations such as lead shielding (refer to the last section of this document for state by state requirements).

It is almost impossible to put a definite price tag on any one system. Brand new C-Arms can cost well over $200K; of course that price is cut significantly when buying on the secondary market or with refurbished equipment. Other factors that play a key impact on price include the year equipment was manufactured, the specific model you desire, number of features in the model, and the general condition of the system.

Let us reiterate that purchasing a C-Arm is an investment, so more than just the cost itself, it is wise to think about the overall value in terms of what you will be getting out of it, and most importantly, what you will be using it for. Buying the latest and greatest full-size C-Arm is not always the best decision as it can essentially become a financial burden if it doesn't fit your business standard as a whole. If you are still unsure of purchasing equipment, look for options to rent radiology equipment.

Renting/Financing Options

Like buying a home, some customers are better fit to lease or rent, rather than actually buying long-term. With C-Arms, there are plenty of leasing, financing, or rental solutions for hospitals, clinics and physician offices. Renting a C-Arm is an ideal option for those who are unsure of their scan volumes, or duration of a physician's job at your facility. Regardless of your circumstances, at Amber Diagnostics, equipment financing is available based on your facility needs and budget. The flexible finance options include affordable equipment purchase plans to help you acquire healthcare equipment, without hindering your financial flexibility.

Financing Programs at Amber include:

- Full service contracts
- Parts coverage (based on usage)
- Site planning and drawings
- Delivery to site
- Standard rig-in
- Installation
- Application training and support

With times (and reimbursements) changing, users are looking more into renting and leasing medical equipment.

A Brief Look at Reimbursements
Reimbursement figures differ based on insurance carrier and site of care. Generally speaking, fluoroscopy codes provide two times the reimbursement amount over regular x-ray codes, but this estimate is not static.

While a multitude of studies indicate that medical imaging exams are directly linked to greater life expectancy, declines in mortality rates, and are generally safer and less expensive than invasive procedures, cuts to funding for medical imaging scans in the Medicare fee schedule has been proposed for 2013. As reimbursement rates vary from state to state, it is beneficial to understand the rules and regulations of the particular site your practice is located in. This will better educate and prepare you for any impact this will have on your services.

Tips Before Finalizing Your C-Arm Purchase
As with any investment you make, you want to do your research and homework beforehand. Let the seller know that you know what to look for in all aspects of purchasing a pre-owned C-Arm.

Prior to your C-Arm purchase, be sure to ask:
- What are the specifics in the warranty and application packages?
- Is the software installed?
- Do you offer tables?
- Is it ACR certified?
- Does the system include a printer?

Although Amber Diagnostics covers the refurbishment process in detail, it is always good to double check key factors when your system has been refurbished, especially if purchasing from another seller.

• Examine the C-Arm entirely to ensure proper functioning, cosmetic reconditioning, and calibration. (Check cables, connections, brake pads, workstation software, electronics, monitor, printer, keyboard, etc.)

• Make sure damaged components have been repaired and replaced, and system has been cleaned internally and externally.

• Following installation, inspect and start up the unit one more time when it's in your own facility. Do some inventory to ensure all specified parts included in the contract are not missing.

• If you are unable to be onsite when the unit is transported, ask your seller to send you some pictures of the finished system.

Remember, at Amber Diagnostics, every refurbished system comes with a Comprehensive Warranty, and we guarantee fast response time for all your warranty needs!

Fluoroscopy & Radiation

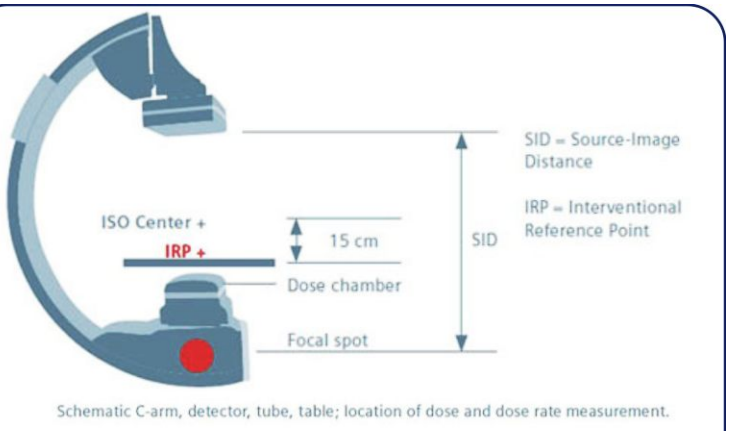
An estimated 4-10 million interventional pain procedures are performed annually in the United States, where at least 50% of those are performed under fluoroscopy. The major purpose of fluoroscopy is for correct needle placement to ensure target specificity and accurate delivery of the injected drug.

However, this interventional technique of fluoroscopic guidance does result in radiation exposure with risks posed to patients, physicians, and other personnel. Federal regulations do limit the maximum output for C-Arms, and there are a range of techniques to reduce the risk in private practice settings.

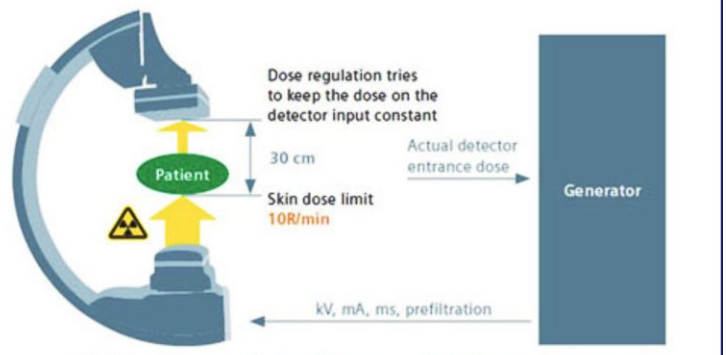
Radiation Exposure

Fear over patient radiation doses is a valid concern. Nonetheless, it is important to understand that the goal of all interventional radiology procedures is to treat (not harm) patients and improve their well-being. As a physician, radiation risks associated with interventional procedures should be discussed with patients, particularly when the expected dose of radiation may be high.

In general, fluoroscopy delivers a dose of approximately 5 rads per minute in the direct beam. The thickness of the patient also determines the exposure rate: the thicker the patient, the higher the exposure. Even small doses of radiation (1 rad = approximately one chance in 100,000) can damage DNA, which can essentially cause acute health effects.



Schematic C-arm, detector, tube, table; location of dose and dose rate measurement.



Principle of dose regulation with constant input dose at the detector and 10 R/min dose rate limit 30 cm in front of the detector.

Since shielding the patient is not usually possible, time and distance are key in helping reducing their exposure. Time: shorter fluoro times can be achieved when the physician uses intermittent fluoroscopy (as opposed to continuous), and utilizes the image hold capacity. Distance: the patient's exposure increases exponentially the closer he/she is positioned to the x-ray tube.

Positioning the patient as far as possible from the x-ray tube (maybe 12 to 15 inches away from body) and as close to possible to the image intensifier can reduce exposure. (Decreasing x-ray field size can also reduce patient exposure).

With C-Arms, education is a must for properly monitoring and reducing exposure levels for patients and staff. Receive training from a qualified expert (radiologist or radiological health physicist) in safety procedures and proper imaging techniques. Good safety practices, such as the ones below, can also keep radiation doses As Low As Reasonably Achievable (ALARA).



Radiation Safety
Time, distance, and shielding are the three basic guides that could and should be taken for radiation safety. First and foremost, do not allow any unauthorized visitors during x-ray exams. Only individuals required for the radiographic procedure should be present in the radiographic room during exposures.

Timing. As we mentioned before, with timing, shorter fluoro times can be achieved when the physician uses intermittent fluoroscopy. Also, analyze original radiographs before performing a fluoroscopic examination. Viewing original radiographs, especially for orthopedic studies, can dramatically reduce the repeat rate for the time required for procedures.

Distance. Observers should stand on the image intensifier side of the C-arm if possible, to avoid radiation leakage from the x-ray tube. When not assisting, step away from the patient during fluoro, as feasible. Stepping even one foot further back can significantly reduce a person's dose.

Shielding. In interventional fluoroscopy procedures the tissue of concern is the skin. The skin that is at the site where radiation enters the body receives the highest dose than any other body tissue. All workers in the x-ray room during studies must have a lead apron, and other appropriate shielding wear.

• **Lead Apron and Thyroid Shields.** Verify that the apron is 0.5 mm lead equivalent, and be sure aprons and shields are in good condition (remove any damaged ones). Insist on well fitting protective gear with a weight your body can handle. Hang aprons and shields on racks. Do not bend or fold them as this can cause cracks and tears in the protective material, making exposed body parts susceptible to radiation.

• **Wrap-around Apron.** When wearing lead aprons, it is imperative to keep the lead between you and the x-ray tube. Meaning, do not turn your unshielded back to the x-ray tube. If you do need to move about the room where exposing your back may be likely, insist on using a wrap around style apron.

• **Leaded Eyeglasses.** Those who routinely fluoro for long or interventional procedures, lead glasses with side shields can provide additional protection to the lens of the eyes. Remember, you may need to look sideways from the C-arm x-ray tube to see the image on the monitor, which will leave the lens unprotected if glasses do not have side shields.

• **Leaded Gloves.** Lead gloves are required if hands are potentially close to or in the primary beam.

• **Radiation Badges.** Requirements on how many and where radiation badges should be worn varies by state. Some may recommend a whole body badge under the lead apron, and some may add to that with a second badge outside the thyroid shield and/or a ring badge or wrist badge to avoid extremity exposures.

Additional Safety Tips

• For needles, try using just one hand so you can keep your other hand away from the needle, and any potential exposure. Be sure there is ample lighting for accuracy. Properly dispose of used needles immediately after use.

• If possible, structural shielding (such as ceiling-mounted lead acrylic shield and an under-the-table shield) should be implemented.

• Always check for damages. If the c-arm or fittings are damaged, the X-ray tube and intensifier may become misaligned, resulting in image degradation or loss, as well as presenting a potential injury to the staff and patient.

• The fluoroscopy beam-on time and x-ray field size should be reduced as much as possible, and the x-ray beam kept well collimated. Failure of the x-ray beam collimation may lead to primary beam x-ray exposure outside of the selected image intensifier input area. This would result in image degradation and additional exposure for the patient.

• Pulsed fluoroscopy, single pulse fluoroscopy mode, manual mode, fluoroscopy timer warning, and last image hold (“freezing the screen”) are also good safety practices.

There are ways radiation exposure can be fine-tuned to help lower radiation levels. Those who use radiology equipment must be adequately trained in equipment operation and radiation safety principles to protect the patients and personnel that are subject to exposure.

Additional Resources for Radiology Regulations

As you purchase your next C-Arm, the question of regulations for lead shielding may arise. To know what type of shielding is needed, if any, you should research radiation protection policies for your state, where in the building your C-Arm will be located, and whether your C-Arm unit will be moving or remain stationary. It is a good idea to have a physicist evaluate your site and make knowledgeable recommendations.

Below are radiology health department links for each state, which is a good starting point to attain information and documents. Do note that not all states require shielding, and not all states provide specific information about shielding on their website.

Alabama – Department of Public Health Radiation Rules

Alaska – Radiological Health

Arizona – Radiation Regulatory Agency (ARRA)

Arkansas – Department of Health Radiation Control

California – Radiologic Health Branch

Colorado – Public Health & Environment Radiation Control

Connecticut – Radiation Division

Delaware – Office of Radiation Control

Florida – Bureau of Radiation Control

Georgia – Environmental Protection Division

Hawaii – Indoor and Radiological Health Branch (IRH)

Idaho – Lab and X-Ray Certification

Illinois – IEMA Radiation Safety and X-Ray Registration

Indiana – Medical Radiology Services Program

Iowa – Bureau of Radiological Health

Kansas – Department of Health & Environment-Radiation

Kentucky – Radiation Health Branch of KY

Louisiana – Radiological Services

Maine – Division of Environmental Health-X Ray Program

Maryland – Radiation Health Program

Massachusetts – Radiation Control Program

Michigan – Radiation Safety

Minnesota – Department of Heath Radiation Control

Mississippi – MS Division of Radiological Health

Missouri – Radiation Control

Montana – Radiographic Machine Registration

Nebraska – X-Ray Programs

Nevada – Radiation Control Program

New Hampshire – NH Radiological Health

New Jersey – Radiation Protection & Release Prevention

New Mexico – Radiation Control Bureau

New York – Radiological Preparedness

North Carolina – Health & Human Services Radiation

North Dakota – Radiation Control X-Ray Machines

Ohio – ODH Radiological Licensure

Oklahoma – Protective Health X-Ray Tubes

Oregon – Radiation Protection

Pennsylvania – Bureau of Radiation Protection

Rhode Island – Radiation Control License and Registration

South Carolina – Radiological Health

South Dakota – Health X-Ray Facility Inspections

Tennessee – Division of Radiological Health

Texas – Radiation Control Program

Utah – Division of Radiation Control X-Ray Section

Vermont – Radiological Health

Virginia – Health X-Ray Machine Program

Washington – Department of Health Radiation

West Virginia – Radiological Health

Wisconsin – Radiation Protection

Wyoming – Department of Health

Still Have Questions?

Though this guide book is intended to inform you on the foundations of buying and safely utilizing a C-Arm system, we're pretty certain it must have raised some questions along the way.

Our knowledgeable and attentive team at Amber Diagnostics is here to help you find the perfect C-Arm system for your business. If the time is not right for you to purchase radiology equipment just yet, give us a call anyway! We will be happy to address all your questions and concerns.

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Be sure to subscribe to our Amber Blog as well for tips and trends in the imaging industry.

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C-ARM BUYERS GUIDE

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