

CRES Memorization Sheet

Print this and keep it beside you. The CRES exam rewards recall of dose limits, the inverse square law, tube and generator relationships, QC tolerances, regulators and what each asks for, and the network tools of the imaging department. Every number on this sheet is fair game.

01 The exam itself

FACT	VALUE
Certifying body	AAMI Credentials Institute (ACI), the credentialing arm of AAMI
Questions and time	165 multiple-choice questions in 3 hours, closed book; on-screen calculator and notepad only
Delivery and windows	Computer-based at Kryterion centers, travel up to 100 miles; twice a year, May 1 to 15 and November 1 to 15
The six domains	Anatomy and Physiology 7 percent; Public Safety in the Healthcare Facility 8; Fundamentals of Electricity and Electronics 10; Healthcare Technology and Function 25; Healthcare Technology Problem Solving 25; Healthcare Information Technology 25
Passing	A criterion-referenced cut score set by the modified Angoff method; no cut score is published
Results	Pass or fail on screen and by email within 24 hours; those who do not pass also get a scaled score and an analysis of performance
Fee	\$410 member, \$460 non-member; retake \$355 member, \$405 non-member
Retakes and recertification	60 days between attempts, three attempts in two years, then a one-year wait; recertify every three years with continuing education
Where the points are	Function, problem solving, and informatics are 75 percent; the first three domains are 25 percent

ELIGIBILITY PATHWAY	WHAT IT REQUIRES
Pathway 1, education	An associate degree or higher in an electronics, technology, or science program plus two years of full-time BMET work
Pathway 2, military	A United States military biomedical equipment technology program plus two years of full-time BMET work
Pathway 3, experience	Four years of full-time BMET work
Radiology specialty clause	Full certification also requires at least 40 percent of work experience in the radiology specialty over the last two years, with 25 percent over the last five years
Candidate status	The degree alone, the military program alone, or two years of work alone earns candidate status, not full certification
Credential ladder	CABT entry associate, CBET general technician, CRES imaging specialist, CHTM manager; all four are ACI credentials inside HTM

This course's official-format test uses 70%, the same bar as our **CBET** course; **ACI** publishes no cut score.

02 Anatomy, positioning, and terminology

DIRECTION OR POSITION TERMS	PLAIN MEANING
Anterior (ventral), posterior (dorsal)	Toward the front; toward the back
Superior, inferior	Toward the head; toward the feet
Medial, lateral	Toward the midline; away from it

DIRECTION OR POSITION TERMS	PLAIN MEANING
Proximal, distal	Nearer the trunk or attachment; farther from it
Supine, prone, erect, recumbent	Face up; face down; upright; lying down in any position
Lateral decubitus	On a side, horizontal beam; right or left names the down side
Dorsal and ventral decubitus	On the back, or face down, horizontal beam crossing side to side

PROJECTION OR POSITION	BEAM PATH AND EQUIPMENT
AP	Enters the front, exits the back; patient supine or erect facing the tube
PA	Enters the back, exits the front; patient faces the receptor, so less magnification
Lateral	Crosses side to side; the named side is against the receptor
Oblique: RAO, LAO, RPO, LPO	Body rotated between frontal and lateral, tube and receptor square. RAO right front to the receptor, LAO left front, RPO right back, LPO left back
Axial, tangential	Along the long axis of the part; or skimming a surface to clear other anatomy
Decubitus	Lying down with a horizontal beam, so air and fluid levels show

PLANE, LINE, OR LANDMARK	HOW IT DIVIDES, OR WHERE IT RUNS
Sagittal, median (midsagittal)	Vertically into left and right; the median plane into equal halves
Midcoronal	Vertically into anterior and posterior parts
Transverse (axial)	Horizontally into superior and inferior parts; state the level
Orbitomeatal, infraorbitomeatal	Outer canthus of the eye, or just below the eye, to the auricular point (ear canal)
Glabellomeatal, acanthiomeatal	The glabella between the eyebrows, or the acanthion where nose meets upper lip, to the auricular point
T1	About 2 inches above the sternal notch
T2 to T3, then T4 to T5 disc spaces	The sternal notch at the jugular; then the sternal angle
T6 to T7 disc space, then T10	The lower end of the scapula; then the xiphoid tip
Column count	33 bones: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, coccyx of 4 fused

BODY HABITUS	SHARE	WHERE THE ORGANS SIT
Hypersthenic	About 5 percent	Massive, broad deep midsection, ribs nearly parallel to the floor; high diaphragm, short wide heart, high transverse medial stomach, high outside gallbladder, colon framing the abdomen; most exposure
Sthenic	About 50 percent	The average athletic build technique charts are based on; ribs sloping down, stomach high and left, colon evenly spread, gallbladder centered right
Hyposthenic	About 35 percent	More slender than sthenic; stomach and gallbladder high; less exposure
Asthenic	About 10 percent	Frail and slim, long shallow narrow midsection; heart nearly vertical at the midline, low medial stomach, low midline gallbladder, low colon; least exposure
Why it matters	6 to 8 inches	Habitus shifts the diaphragm, stomach, gallbladder, heart, and lungs that far, so centering and collimation change with build

SYSTEM	KEY ORGANS	WHAT IMAGING SHOWS	ONE PATHOLOGY
Circulatory	Heart, arteries, veins, capillaries	Angiographic and interventional runs; heart size on a chest image	Arterial stenosis

SYSTEM	KEY ORGANS	WHAT IMAGING SHOWS	ONE PATHOLOGY
Respiratory	Trachea, bronchi, lungs, diaphragm, pleura	Chest radiography: air, fluid, lung markings	Pneumonia, pneumothorax
Gastrointestinal	Esophagus, stomach, intestines, liver, gallbladder, pancreas	Contrast swallows and enemas, abdominal series, fluoroscopy of motion	Obstruction, ulcer
Urinary	Kidneys, ureters, bladder, urethra	Contrast studies of the collecting system	Stones
Musculoskeletal	Bones, joints, muscles, tendons	Most plain-film work: alignment, cortex, joint spaces	Fracture, arthritis
Nervous	Brain, spinal cord, peripheral nerves	Skull and spine positioning; cross-sectional for soft tissue	Disc herniation, bleed
Endocrine	Thyroid, parathyroid, adrenals, pancreas, pituitary	Thyroid uptake work, neck soft tissue	Thyroid nodule
Lymphatic	Nodes, spleen, thymus, tonsils	Node chains and spleen on cross-sectional work	Enlarged nodes

Word parts and the abdominal map

- Prefixes: brady- slow, tachy- fast, hyper- above normal, hypo- below normal, a- or an- without, dys- difficult, peri- around, endo- inside, retro- behind, sub- under
- Roots: cardi heart, pulmo or pneumo lung, nephro or reno kidney, hepat liver, gastro stomach, entero intestine, osteo bone, arthro joint, encephal brain, mammo breast, angio vessel
- Suffixes: -itis inflammation, -ectomy removal, -ostomy opening, -oscopy viewing, -graphy recording, -gram the record, -algia pain, -megaly enlargement, -oma tumor, -osis condition
- Map: the median and a transverse plane cross at the navel to give four quadrants; anatomically there are nine regions (hypochondrium, epigastrium, lumbar, umbilical, iliac, hypogastrum)
- Requisition words: bilateral both sides, unilateral one, ipsilateral same side, contralateral opposite, portable at the bedside, stat now

03 Radiation: quantities, limits, and protection

QUANTITY	UNIT AND CONVERSION
Exposure and air kerma	Roentgen (R), and 1 R = 2.58 x 10 to the minus 4 C/kg in SI units; air kerma in gray (Gy) is the SI replacement
Absorbed dose	Gray (Gy), or rad; 1 Gy = 100 rad
Equivalent dose	Sievert (Sv), or rem; 1 Sv = 100 rem
Effective dose	Sievert, weighted for radiation type and tissue sensitivity
Prefixes	milli a thousandth (mSv, mGy, mR), micro a millionth; 1 mSv = 1000 microsieverts

DOSE LIMIT (ANNUAL UNLESS STATED)	VALUE
Occupational effective dose	50 mSv per year, and a cumulative limit of 10 mSv x age in years
Occupational organ limits	Lens of the eye 150 mSv per year; thyroid, skin, hands, and feet 500 mSv per year
Public	1 mSv per year frequent exposure, 5 mSv infrequent
Embryo or fetus	5 mSv over the gestation; 0.5 mSv in any month once declared
Education and training, under 18	1 mSv per year
Natural background	About 3 mSv per year, radon the largest part; one chest image about 0.02 mSv

CARDINAL RULE OR LAW	WHAT IT SAYS
Time, distance, shielding	Dose rises with beam-on time; distance is the strongest control, so one step back beats any apron; shielding is aprons, mobile shields, the booth barrier, and lead in the walls
Inverse square law	$I_1 / I_2 = (d_2 / d_1)^2$. Double the distance, one quarter the intensity. Halving a fluoroscope's skin distance from 40 cm to 20 cm raises entrance exposure about four times
ALARA	As low as reasonably achievable: lowest technique, smallest field, fewest exposures
PROTECTIVE APPAREL AND BARRIER	SPECIFICATION
Aprons and gloves	0.25, 0.5, and 1 mm lead equivalent; at least 0.25 mm Pb required, 0.5 mm Pb normal. At 75 kVp, 0.25 mm Pb attenuates about 66 percent and 1 mm Pb about 99 percent, but 1 mm can weigh 12 kg (25 lb)
Thyroid and gonadal shields	Used and inspected like an apron; read the lead equivalent marked on the garment
Inspection and retirement	Fluoroscope or radiograph every apron, glove, and shield at least yearly, or use 120 kVp at 10 mAs radiography; replace on cracks, tears, or holes; store on racks
Gonadal shielding practice	Cuts ovary dose about 50 percent, testicular about 95 percent; use within about 0.5 cm of the primary beam. Flat contact shields lie on the patient, shadow shields hang in the beam
Bucky slot cover and curtain	Each at least 0.25 mm Pb equivalent; the cover closes the roughly 5 cm gap at gonadal level
Barriers and mobile work	The fluoroscopic receptor assembly is a primary barrier of at least 2 mm Pb, interlocked so the tube cannot energize parked; the booth is about 1/16 inch lead equivalent; a mobile switch must reach 2 m from the tube
FLUOROSCOPY LIMIT	VALUE
Tabletop intensity	Not above 10 R/min (100 mGy/min) without high-level control, 20 R/min (200 mGy/min) with it, and not above 2.1 R/min (21 mGy/min) per mA at 80 kVp. No limit while recording
Cumulative timer	Audible signal at 5 minutes of beam-on time; record beam-on time every exam
Minimum source-to-skin distance (SSD)	Not less than 38 cm stationary, not less than 30 cm mobile
Control, filtration, collimation	Dead-man control stops the beam on release; total filtration at least 2.5 mm Al equivalent; an unexposed border must show with the input phosphor 35 cm above the tabletop
MRI SAFETY ITEM	WHAT TO KNOW
Zones	Zone I public, Zone II reception and screening, Zone III controlled and badged, Zone IV the magnet room
Field and the 5-gauss line	1 T = 10,000 gauss, a common magnet is 3 T, the field is never off. The posted 5-gauss line marks where an implant or pacemaker can be disturbed, so screening happens before it
Projectiles and screening	Any ferromagnetic tool, cylinder, or cart becomes a missile; screen every person and item every time. Labels are MR Safe, MR Conditional, or MR Unsafe
Quench and cryogenics	Loss of superconduction boils off the cryogen; the quench pipe vents outside, a room-side release displaces oxygen. Liquid helium boils at 4 K, nitrogen at 77 K
RF energy and EMI	Deposited RF heats tissue, so looped leads and damaged coils cause burns. The scanner also interferes with nearby monitors and pumps, and a noisy device spoils the image

Pregnancy and pediatrics: ask, then declare. Once declared, the 0.5 mSv monthly limit applies to the embryo or fetus. Shield what is not being imaged, collimate to the anatomy, use the lowest technique that answers the question, immobilize rather than repeat, and use a gonadal shield whenever it will not cover the region of interest. Children are more radiosensitive because dividing cells are the most sensitive cells there are.

04 Regulators, standards, and what each asks for

BODY	WHAT IT DOES AND WHAT IT ASKS YOU FOR				
FDA	Regulates devices and radiation-emitting products through CDRH , which carries the work the former BRH began; publishes the standards in 21 CFR 1020 and runs recalls and device reporting				
State radiation control programs	Register every tube, inspect rooms, set operator and posting rules; CRCPD is where those programs write their shared suggested regulations				
NRC	Licenses byproduct radioactive material, so nuclear medicine carries its own license, surveys, and records				
CMS and TJC	CMS sets the conditions of participation and may survey directly; The Joint Commission surveys environment of care, asking for the inventory, maintenance strategy, PM completion, test records, and inspection history				
MQSA and ACR	Federal mammography law under the FDA : accreditation, annual inspection, an annual medical physicist survey, personnel qualifications, a written QC program. ACR accredits facilities and publishes the phantoms				
OSHA	Worker safety: hazard communication, bloodborne pathogens, electrical practice, and the PPE the employer must supply				
ANSI and AAMI	The equipment-management standards a technology program is written against; ANSI accredits the process, AAMI writes the content				
NCRP and NEMA	NCRP publishes the dose limits and shielding reports barriers are designed from; NEMA carries manufacturer standards such as focal spot tolerances				
FEDERAL PERFORMANCE NUMBER	LIMIT				
Tube housing leakage radiation	Less than 100 mR/h (about 1 mGy/h) at 1 m from the housing				
AEC backup timer	Must end the exposure at 6 s or 600 mAs , whichever comes first				
Light field to x-ray field	Within 2 percent of the SID ; at a 100 cm SID that is 2 cm				
Console and geometry indicators	PBL within 2 percent of the SID , the SID indicator within 2 percent, and the console must show exposure conditions and that the tube is energized				
Minimum total filtration	At least 2.5 mm Al above 70 kVp , 1.5 mm Al from 50 to 70 kVp , 0.5 mm Al below 50 kVp				
MINIMUM HVL (MM AL) BY WAVEFORM	30 KVP	50 KVP	70 KVP	90 KVP	130 KVP
Single phase	0.3	1.2	1.6	2.6	3.6
Three phase or high frequency	0.4	1.5	2.0	3.1	4.2
CMMS RECORD	WHAT IT MUST HOLD				
Equipment inventory	Every device by control number, model, serial number, location, risk class, and interval; the first thing a surveyor asks for				
Work order	Who, what, when, the symptom in the caller's words, the finding, parts, labor, and readings after the repair				
PM due list	What is due, what is overdue, and the completion rate by area				
Service history and recalls	Every visit on a device, vendor reports included, so repeat failures show; plus which devices a notice touches and what was done				

Compliance and performance reports **PM** completion, failures, downtime, and cost per device for management review

05 Electricity, electronics, and imaging power

FORMULA	STATEMENT
Ohm's law	$V = I \times R$; $I = V / R$; $R = V / I$
Power	$P = V \times I$; $P = I^2 \times R$; $P = V^2 / R$, in watts
Series and parallel	Series: one path, resistances add, same current, voltages add. Parallel: several paths, reciprocals add, same voltage, branch currents add
Imaging system power rating	$(\text{mA} \times \text{kVp}) / 1000 = \text{kW}$, so 1,000 mA at 120 kVp is 120 kW; multiply by 0.7 single phase
Transformer turns and AC values	Secondary voltage = primary voltage x turns ratio, so 120 V at 750:1 gives 90 kVp. RMS = 0.707 x peak, peak = 1.414 x RMS; mains is 120 V RMS at 60 Hz
PREFIX OR UNIT	MEANING ON AN IMAGING CONSOLE
kilo, milli, micro	A thousand, a thousandth, a millionth: kV and kW, mA and ms, and the microamps leakage limits use
kVp, mA, and mAs	Kilovolt peak is the highest voltage across the tube and sets quality; mA is tube current and sets quantity; mAs is mA x exposure time in seconds, the one number that sets how many x-rays are made
COMPONENT	WHAT IT DOES IN IMAGING EQUIPMENT
Resistor, capacitor, inductor	A resistor limits current and drops voltage, and sets mA in the filament circuit. A capacitor stores charge, smooths rectified voltage, passes AC and blocks DC. An inductor opposes a change in current: transformers, chokes, stator windings
Transformer	Changes AC voltage by turns ratio: autotransformer sets kVp, step-up makes kilovolts, step-down heats the filament
Diode and rectifier	A diode conducts one way, about 0.7 V forward drop in silicon; a rectifier set makes the one-way current the tube needs
Transistor and SCR	A transistor switches or amplifies on a small control current; an SCR is a gate-triggered AC switch used in primary circuits and rotor drives
Fuse, breaker, relay, contactor	Fuses and breakers open on overcurrent, and a repeat trip is a fault, not a nuisance; a relay or contactor lets a small coil current switch the rotor or exposure load
Interlock and indicators	An interlock sits in series with the exposure circuit: door, rotor ready, receptor parked, collimator, emergency stop. An unlit LED means the lamp or its drive is dead
FACILITY AND ROOM POWER	FACT
Three-phase distribution	Facility power distribution for imaging is three-phase, commonly 480 VAC, stepped down to what each room needs; three-phase service feeds the larger generators
Single-phase service	120/240 VAC at 60 Hz with a grounded center neutral; most imaging systems are designed for 220 V, some 110 V or 440 V
Dedicated feed, disconnect, ground	Each room has its own feeder and a lockable disconnect: tag it before opening a cabinet. A lifted ground gives a leakage failure and image noise at once
Line voltage compensation	Building power is never steady enough for repeatable exposures; the compensator corrects the supply ahead of the autotransformer

FACILITY AND ROOM POWER	FACT
Transformers in the generator	The autotransformer is a tapped winding the kVp selector picks taps on, read by a pre-reading voltmeter; the step-up secondary carries 500 to 1,000 turns per primary turn; the filament step-down supplies about 4 A or more
Low-voltage rails	Logic and interlock boards run on VDC rails from the cabinet supplies; measure each at the test point the manual names before condemning a board
WAVEFORM	RIPPLE AND WHAT IT MEANS
Single phase, half-wave and full-wave	Half-wave passes only the positive half of each cycle, the least efficient; full-wave uses both halves at twice the pulse rate. Ripple is 100 percent either way, and without rectification the negative half-cycle would destroy the tube
Three phase, six pulse	About 14 percent ripple, so voltage never drops below about 86 percent of peak
Three phase, twelve pulse	About 4 percent ripple, never below about 96 percent of peak
High frequency	About 1 percent ripple, nearly constant voltage: most efficient and now standard. Less ripple means more quantity and quality for the same settings, so one technique is not the same exposure on another generator
POWER PROTECTION	WHAT IT IS FOR
UPS types	Online double conversion always runs the load from the inverter, the cleanest protection for consoles and archives; line-interactive regulates and switches on loss; standby only switches. Batteries age out
Line conditioner	Regulates and filters without a battery: cures noise and sag, not a blackout
Isolation and surge protection	An isolation transformer clears ground loops and noise; surge devices clamp transients. A surge strip is not a UPS
Internal distribution and brownouts	One feed splits to generator, gantry, table, and computers, so one branch can look like total failure. Low line voltage makes a generator read kVp low, abort exposures, or throw a line-compensation fault
BATTERY-POWERED SYSTEMS	WHAT TO CHECK
Where they are and what is in them	Ultrasound carts and portable x-ray units, on sealed lead-acid or lithium-ion packs; never substitute a chemistry the unit was not built for
Charge before use	Leave the unit on the charger between cases; a lead-acid pack left discharged sulfates and will not come back
Capacity fade	Run time and exposures per charge fall with age; log them, because the trend is the warning
What a weak pack does	Low or aborted exposures, resets mid-exposure, or a rotor that will not spin; measure the pack under load
CURRENT THROUGH THE BODY (60 HZ, HAND TO HAND)	EFFECT
1 mA	Threshold of perception (tingle)
5 mA	Accepted maximum harmless current
10 to 20 mA	Let-go threshold: muscles contract and the person cannot release
50 mA	Pain, possible fainting, respiratory arrest
100 to 300 mA	Ventricular fibrillation likely
6 A and above	Sustained heart contraction, burns, respiratory paralysis
Microshock	As little as 10 microamps delivered directly to the heart (through a catheter or pacing wire) can cause fibrillation

IEC 60601-1 LIMIT	NORMAL CONDITION	SINGLE FAULT CONDITION
Earth (ground) leakage	5 mA	10 mA
Touch (enclosure, chassis) current	100 microamps	500 microamps
Patient leakage, type B and BF, AC	100 microamps	500 microamps
Patient leakage, type CF, AC	10 microamps	50 microamps
Patient leakage, DC (all types)	10 microamps	50 microamps

NFPA 99 AND FACILITY FACT	VALUE
Ground (chassis to plug ground pin) resistance	0.5 ohm maximum for patient-care equipment
Chassis (touch) leakage, cord-connected patient-care equipment	500 microamps in current editions (older editions used 300 or 100 microamps; know the limit your facility cites)
Patient care vicinity	About 6 feet (1.8 m) beyond the bed or chair and 7.5 feet (2.3 m) above the floor
GFCI trip	4 to 6 mA (nominal 5 mA)
Applied part types	Type B touches the body but not the heart; BF is body floating and isolated; CF is cardiac floating, safe for a direct heart connection

06 X-ray production, tubes, and generators

TUBE PART	FACTS WORTH MEMORIZING
Cathode	A thoriated tungsten filament, 1 to 2 percent thorium, coiled about 1 to 2 cm long and 2 mm across, in a negatively charged focusing cup; two filaments give the small and large spots
Anode	A tungsten-rhenium target disc backed by molybdenum or graphite. Tungsten is chosen for atomic number 74, conductivity close to copper, and a melting point of about 3,400 C
Rotor and stator	An induction motor spins the anode, about 3,400 rpm standard and about 10,000 rpm high-speed; reversing the stator field brakes it
Anode angle and line focus	Angles about 5 to 20 deg. Angling shortens a long focal track into a small effective spot, so a 10 mm by 1 mm line becomes about a 1 mm square; smaller angle, smaller spot, stronger heel effect
Heel effect	Intensity is lower on the anode side because those x-rays cross more target material; put thick anatomy under the cathode side
Focal spot sizes	Small stations about 0.3 to 0.6 mm, large about 1.0 to 1.2 mm, mammography down to 0.1 mm. Nominal sizes carry a variance, so a nominal 0.3 mm may measure 0.45 mm and pass
Envelope, oil, housing	A glass or metal vacuum envelope; tungsten plating glass causes arcing, so metal lasts longer. Oil carries heat to the lead-lined housing, which limits leakage and shock risk

PRODUCTION FACT	DETAIL
Efficiency	About 1 percent of the electrons' kinetic energy becomes x-rays, about 99 percent heat
Bremsstrahlung and characteristic radiation	Electrons braked by the nuclear field emit a continuous spread of energies, the bulk of the beam. An inner-shell vacancy filled from an outer shell instead emits a photon at exactly the difference in binding energies, and only K-shell transitions in tungsten are useful, above its K-shell energy of about 69.5 keV

EXPOSURE FACTOR	RULE
kVp	Sets penetrability (quality, measured as the HVL) and contrast; quantity is proportional to kVp squared
mA and time	Both linear with quantity; short times freeze motion

EXPOSURE FACTOR	RULE	
mAs and reciprocity	mAs = mA x seconds, and any pair giving the same product should give the same receptor exposure, which is what the linearity test checks	
The 15 percent rule	Raising kVp 15 percent equals doubling the mAs ; to hold receptor exposure, raise kVp 15 percent and halve the mAs , accepting lower contrast	
Filtration	Removes low-energy photons that only dose the patient: average energy and HVL rise, quantity falls	
Distance and magnification	Receptor exposure falls with the square of the SID . MF = SID / SOD , about 1.1 at a 100 cm SID and 1.05 at 180 cm	
HEAT FACT	VALUE	
Heat units	Single phase HU = kVp x mA x s, so 98 kVp at 120 mAs is 11,760 HU ; three phase or high frequency HU = 1.4 x kVp x mA x s, because lower ripple makes more heat. 1 HU = 1.4 joules	
Rating and cooling charts	The rating chart says whether one exposure is safe; anode and housing cooling curves say how long to wait before the next series	
How heat leaves	Radiation from the anode, conduction into envelope and oil, convection in the oil to the housing, then the room. The anode is hottest for only about 1 to 3 seconds per exposure	
TUBE FAILURE MODE	CAUSE AND WHAT YOU SEE	
Filament evaporation	Tungsten boils off, thins the coil, and plates the envelope; output drifts low, then the filament opens	
Anode pitting and melting	Repeated overload roughens the target; output falls and becomes unpredictable across stations	
Cracked anode	A cold anode loaded hard cracks or wobbles and fails at once, which is why the warm-up series exists	
Arcing	Tungsten plated inside a glass envelope conducts, so tube current jumps the vacuum and the generator throws an overcurrent or tube-arc fault	
Bearing wear	Heat into the rotor ruins the bearings: a noisy or slow rotor, then a rotor-fault lockout. Long fluoroscopic runs are hardest on them	
Overheating	The most common cause of early failure. Lowest technique that works, fewest repeats, never exceed the rating chart; a well-used tube gives at least about 50,000 exposures	
GENERATOR CONTROL	WHAT IT DOES	
kVp and mA selectors	kVp picks autotransformer taps, mA sets filament heating; verify with a meter, not the display, and keep adjacent mA stations within 10 percent	
Time and mAs	Timer types: synchronous (multiples of 1/60 s), electronic (common and most accurate), mechanical (portables and dental), mAs , and automatic	
AEC and backup timer	Ionization chambers in front of the receptor end the exposure when enough radiation arrives; cell selection and density steps tune it, and the backup must end at 6 s or 600 mAs	
Line compensation	Holds the supply steady so one technique gives the same exposure all day	
Rotor, ready, and interlocks	First stage spins the anode and heats the filament, and the ready light means the interlock chain is satisfied. A two-stage dead-man switch sits in series with those interlocks, so an open link gives no exposure and no fault code	
IMAGE QUALITY FACTOR	RAISED BY	LOWERED BY
Density (overall blackening)	More mAs , higher kVp , shorter distance, faster receptor	Less mAs , lower kVp , longer distance, a grid without compensation; too little exposure also shows as noise

IMAGE QUALITY FACTOR	RAISED BY	LOWERED BY
Contrast	Lower kVp , a grid, collimation, compression	Higher kVp , scatter, fog, a large field
Recorded detail	Small focal spot, long SID , short OID , no motion	Large focal spot, short SID , long OID , motion
Distortion	Correct alignment and centering	Angled parts, off-center anatomy, uneven OID across a thick part
BEAM CONTROL DEVICE	FACTS	
Collimator and PBL	Two pairs of lead shutters at right angles plus lamp and mirror, with cones and aperture diaphragms to restrict further. Light field and x-ray field must match within 2 percent of the SID , and positive beam limitation must hold the same 2 percent	
Grid ratio, frequency, types	Ratio is strip height over gap, usually 4:1 to 16:1; frequency is strips per inch, usually 60 to 150; higher ratio removes more scatter and costs more dose. Linear grids are parallel, focused grids are angled with the labeled side to the tube, crossed grids are two at right angles	
Bucky factor	The mAs increase a grid costs, also called the grid conversion factor; it rises with ratio and with kVp . Contrast improvement factors run 1.5 to 2.5	
Air gap and compensating filters	A long OID lets scatter miss the receptor instead of using a grid, at the cost of magnification; wedge and trough filters even out a part that changes thickness	

07 Receptors, fluoroscopy, mammography, CT, ultrasound, nuclear medicine, MRI

RECEPTOR	HOW IT WORKS AND WHAT FAILS
CR, and the film it replaced	A PSP plate stores the latent image, a laser scanner reads the glow, a bright lamp erases it for reuse. Dust and scratches print on every image, an incomplete erase leaves a ghost, a worn plate loses speed. Film vocabulary survives in questions: optical density, screen speed, screen-film contact
DR, indirect and direct	Indirect panels use a CsI scintillator over an amorphous silicon TFT array; direct panels use amorphous selenium, with no light step
DQE, EI, and DI	Detective quantum efficiency is how much of the radiation reaching the detector becomes usable signal, so higher means the same image at less dose. The exposure index reports what the detector received, and the deviation index compares it with the target for that exam
Calibration and care	Offset (dark), gain (flat-field), and defective pixel map; skipping them shows as banding, shading, or stuck pixels. Inspect portable panel cases and cables, and handle boards with ESD precautions
FLUOROSCOPY ITEM	FACTS
Image intensifier chain	Input phosphor, photocathode, electrostatic focusing lenses, anode, output phosphor; output phosphors about 2.5 or 5 cm, input phosphors 10 to 40 cm
Gains	Flux gain is the 50 to 75 light photons each photoelectron makes at the output phosphor; minification gain is the square of input over output diameter; brightness gain = minification gain x flux gain
ABC and magnification	Automatic brightness control holds brightness by raising mA , kVp , or pulse width as the patient thickens, so dose rate climbs on a large patient. A magnification mode uses less of the phosphor, so dose rate rises again
Flat-panel fluoroscopy	A dynamic flat detector instead of an intensifier tube: even brightness, no vignetting or S-distortion
Pulsed mode and last-image hold	Short pulses at a chosen rate are the biggest dose saving the operator has; last-image hold freezes the final frame with the beam off

FLUOROSCOPY ITEM	FACTS
DSA	A mask image taken before contrast is subtracted from the contrast run so only vessels remain; any motion ruins it
C-arm and the suite	A mobile or fixed C-arm adds its own collimator, laser aimers, brakes, detents, cables, and foot switches to the PM list
MAMMOGRAPHY ITEM	FACTS
Targets, filters, technique	Molybdenum, rhodium, or tungsten targets with matching molybdenum or rhodium filters shift the spectrum into the useful range for soft tissue. About 23 to 28 kVp , with total filtration at least 0.5 mm Al equivalent through a beryllium window
Focal spot and geometry	Focal spots down to about 0.1 mm for microcalcifications; the cathode faces the chest wall so the heel effect evens out thicker tissue, at an SID of about 60 to 80 cm
Compression	Power and manual modes must both reach 25 to 40 lb and hold at least 15 seconds, and 40 lb must never be exceeded automatically. Thinner even tissue means less scatter, less motion, a shorter OID , lower dose
Grids and AEC	Grids of 4:1 or 5:1 at 30 to 50 lines per cm; the AEC detector sits behind the receptor and reads intensity and quality
Digital detectors and DBT	TFT arrays with thallium-activated cesium iodide, or a CCD ; film-screen still edges them on spatial resolution. Digital breast tomosynthesis sweeps the tube through an arc and reconstructs slices, adding gantry motion and arc calibration to QC
QC schedule	Processor or detector daily, phantom image weekly, visual checklist monthly, repeat analysis quarterly or every 250 patients, compression at least semiannually, medical physicist survey annually or after a major component change
ACR phantom scoring	Count largest to smallest; the minimum to pass accreditation is four fibers, three speck groups, and three masses, and a score must not fall more than 0.5 from the last image
CT ITEM	FACTS
Gantry and slip ring	Tube and detector array rotate together; the slip ring carries power and signals so rotation never stops
Helical scanning and pitch	The couch moves while the gantry turns, tracing a spiral. Pitch is couch travel per rotation over beam width, such as 1.0:1; above 1 the spiral stretches and dose falls, below 1 it overlaps and dose rises
HU scale	Hounsfield units run from -1000 to +3000: air -1000, water exactly 0 by continuous calibration, dense bone about +3000. A water-phantom drift is why numbers go wrong
Cooling and reconstruction	CT tubes carry huge heat loads, so cooling and the heat-unit budget govern how fast a schedule runs; raw data is reconstructed then windowed for display
What the technician services	Table motion and alignment, laser lights, slip-ring brushes, detector and air calibrations, chillers and filters, console and reconstruction computers, and the network link
ULTRASOUND ITEM	FACTS
How it works	A probe's piezoelectric elements turn an electrical pulse into sound and the echo back into a voltage; no ionizing radiation
Frequency and depth	Higher frequency gives finer detail but less penetration; sound also weakens with depth and is blocked by bone and gas, so gel and window matter
Probe types	Linear for superficial work, curved for abdomen and obstetrics, phased array for cardiac, TEE down the esophagus, plus intracavity probes
Doppler	Measures motion and flow from the frequency shift of the echo; noise and poor contact ruin it first
HLD	Probes touching mucous membranes need high-level disinfection between patients; the wrong chemical or a soaked connector destroys a probe
Dropout and service	A dead element or broken cable wire leaves a dark stripe down the image that does not move with the probe. Service covers probes and connectors, cart power and batteries, display and controls, and the network link

NUCLEAR MEDICINE ITEM	FACTS
Gamma camera chain	Collimator, NaI scintillation crystal, light guide, PMT array, position and energy circuits, then the computer
Technetium-99m (Tc-99m)	The workhorse tracer; it decays to technetium-99 emitting a 140 keV gamma ray, the window the camera is peaked for
PET and hybrids	Positron emitters annihilate with electrons and send out a pair of photons of about 0.51 MeV in opposite directions, and the ring counts coincidences. SPECT/CT and PET/CT add a CT gantry for attenuation correction and anatomy
Instruments and service	Doses are assayed in a dose calibrator and contamination found with survey meters, both calibrated and logged. The technician handles detectors and collimators, PMT tuning and uniformity, gantry motion, computers and links
MRI ITEM	FACTS
Magnet	A superconducting coil in a liquid-helium bath, measured in tesla, commonly 3 T, always on
Gradients and RF coils	Gradient coils bend the field to encode position and make the banging noise; RF coils transmit and receive the signal
Cold chain	Compressor, cold head, and chiller keep the helium cold; a helium level alarm or a warm cold head is an emergency
Shielded room and service	Copper shielding and a filter panel keep outside RF out, and a propped door shows as zipper artifacts. The technician services chillers and compressors, coils and cables, table motion, rated peripherals, and the console side

08 PM, QC, and test equipment

PM AREA	WHAT THE VISIT MUST COVER
Mechanical	Locks, brakes, detents, counterweights, cables and chains, bearing play, tube stand and rails, table travel, collision sensors; plus filters, fans, dust, and room temperature, because heat kills generators and detectors
Electrical safety	Ground resistance 0.5 ohm maximum and chassis leakage within the limit your facility cites, with an analyzer, at incoming inspection, after repair, and on schedule
Interlocks	Door, rotor ready, receptor parked, collimator, emergency stops: prove each one blocks the exposure
Radiation output	kVp accuracy, timer, linearity, reproducibility, HVL , and leakage on the schedule the state and the manufacturer set
Logs and documentation	Read the error log every visit, note firmware versions, record before clearing, patch only on the vendor's validated schedule, and close the work order with the measured value, the tolerance, and pass or fail
RADIOGRAPHIC QC TEST	TOLERANCE
kVp accuracy	Measured kVp within 10 percent of the indicated kVp
Exposure timer accuracy	Within 5 percent of the indicated time above 10 ms; 20 percent at 10 ms or less
Linearity and reproducibility	No more than 10 percent variation in output per mAs between adjacent mA stations, and no more than plus or minus 5 percent over repeated identical exposures
Collimation and beam alignment	Light field and x-ray field within 2 percent of the SID , with PBL and the SID indicator held to the same 2 percent
HVL	Measure and compare with the minimum for that kVp and waveform; meeting it proves the filtration is adequate
Focal spot size	Pinhole camera, star pattern, or slit camera against the nominal size and its variance
AEC performance	Constant density through varying thicknesses of aluminum or acrylic, plus a backup timer test at 6 s or 600 mAs
When to retest	Annually, after major repair to the console or high-voltage generator, and whenever output looks wrong

FLUOROSCOPY QC TEST	WHAT TO MEASURE
Tabletop exposure rate and timer	A chamber at the tabletop against the 10 R/min and 20 R/min limits, and the audible signal at 5 minutes
Geometry	SSD at least 38 cm stationary or 30 cm mobile with the spacer in place, and an unexposed border with the input phosphor 35 cm above the tabletop
Image quality	A resolution and low-contrast phantom at fixed geometry against the baseline on file
MAMMOGRAPHY QC SCHEDULE	TASKS
Daily and weekly	Processor or detector check and cleanliness daily; phantom image, screen cleanliness, viewing conditions weekly
Monthly and quarterly	Visual checklist monthly; repeat analysis quarterly or every 250 patients
Semiannual and annual	Compression force at least semiannually; medical physicist survey annually or after a major component change
ULTRASOUND QC TASK	WHAT TO DO
Phantom scan	Depth of penetration, resolution, and uniformity at fixed settings against the baseline
Probe, display, and controls	Cracks in the lens, kinked cables, bent connector pins, and chemical damage; brightness and contrast against the test pattern, with every control and footswitch working
TEST INSTRUMENT	WHAT IT IS FOR
Non-invasive kVp meter	Reads kVp, time, dose, dose rate, and HVL from outside the beam path, and verifies time and mAs independently of the console
Ionization chamber and solid-state detector	The reference dose and dose-rate detectors for output, fluoroscopic rate, and leakage
DAP meter	Measures dose area product under the collimator, tracking dose and the volume of tissue irradiated
Phantoms, filters, test tools	Calibrated aluminum sheets added until intensity halves give the HVL; plus resolution and contrast phantoms, the beam-alignment tool, pinhole and star patterns, and the mammography and CT accreditation phantoms
Staff dosimeters	TLD and OSL badges read by a service, plus direct-reading electronic dosimeters; worn at the collar outside the apron
DMM or DVM	Voltage, current, and resistance at the test points the manual names; on continuity an OL reading means the path is open
Electrical safety analyzer	Ground resistance and leakage against the NFPA 99 and IEC 60601-1 limits, in normal, reversed-polarity, and open-ground conditions
Dose calibrator	Assays activity in nuclear medicine before a dose is given, with its own constancy, accuracy, linearity, and geometry tests
WHAT A SURVEYOR ASKS FOR	WHERE IT COMES FROM
Inventory and PM record	The CMMS: complete, current, risk-classified, with completion rates and reasons for anything overdue
QC logs	Signed, dated records with readings and tolerances, technologist daily checks included
Physicist and safety reports	Annual surveys with findings and closure dates, dosimetry reports, committee minutes, shielding designs
Recalls and training	Each notice with the devices affected and what was done, and who is competent on what, contractors included

The method, every time

- Symptom and history: get it in the user's own words with the exam, the room, and the step where it happens, then ask what changed and read the error log and service history. Not working is not a symptom
- Isolate: split the chain into power, control, generation, geometry, receptor, and network, and prove which side of each split is good. Measure resistance and continuity only with the equipment OFF and capacitors discharged
- Verify: after the fix, run the test that would have caught the fault and record the number
- Device error versus use error: reproduce it yourself. A fault nobody else can reproduce is often workflow or training, and the fix is a demonstration, not a part
- Repair, replace, or escalate: weigh downtime, parts cost against replacement value, your own calibration ability, and the limits of your service access
- Exam wording: a problem-solving stem asks for the FIRST step or the MOST likely cause, so pick the check that is safest, simplest, and soonest. Read what the stem says is NOT true; BEST means the complete safe action, while LEAST likely wants the three plausible ones eliminated

PRIORITY	WHY IT COMES FIRST
Patient and staff safety	Stop the exposure, lock out the room, remove the device from service; an unsafe machine never stays in use to protect a schedule
Clinical downtime	A down room reroutes patients; say when it will be back and give radiology a workaround
Compliance	The repair is not done until the test, the record, and the sign-off are done
Convenience	Cosmetic items wait, but write them down so they are not lost
RADIOGRAPHIC ROOM SYMPTOM	LIKELY CAUSES AND THE FIRST CHECKS
No exposure	With no error code it is an interlock: door, rotor not ready, receptor not parked or wrong size, collimator, emergency stop. Follow the series chain until a contact is open. With a fault code, read the code and the log: tube arc, overcurrent, line voltage, thermal cutout, failed contactor
Output low or high	Verify kVp and timer with a meter, check mA linearity and filtration, then the AEC cell and density setting. Burnt-out images point at a timer or AEC failure or calibration lost after a board swap; density differing between stations is a linearity fault
Rotor will not spin or runs noisy	Stator drive, capacitor, or bearing wear; a noisy rotor with a slow run-up means the tube is near its end
Artifacts	Grid lines mean a stationary grid or a Bucky not moving. Cutoff names the error: upside down fades the edges, off level drops density everywhere, off center drops it at the sides. On digital, stripes mean a stale gain or pixel map, a ghost means an incomplete CR erase, moire means grid frequency beating against detector sampling, repeating marks mean a scored plate
Mechanical drift, drop, collision	Locks and detents out of adjustment, worn cable or counterweight, failed collision sensor; a safety fault, not a comfort item
FLUOROSCOPY SYMPTOM	LIKELY CAUSES AND THE FIRST CHECKS
Dim or noisy image	ABC at its limit, an aging intensifier losing gain, a camera or flat-panel fault, or a very large patient; compare dose rate with the baseline first. Image rotation or edge distortion is intensifier aging, which flat panels do not do
Dose rate too high	ABC calibration, a magnification mode left engaged, continuous instead of pulsed mode, or a missing filter; measure at the tabletop against the 10 R/min and 20 R/min limits

MAMMOGRAPHY SYMPTOM	LIKELY CAUSES AND THE FIRST CHECKS
Compression will not reach or hold	Paddle, drive, or force calibration; verify 25 to 40 lb in both modes with a scale and that 40 lb cannot be exceeded automatically
Images too light or dark, or the phantom score falls	AEC detector position, cell selection, or detector calibration; confirm with a phantom image before touching technique. A drop of more than 0.5 means stop and investigate calibration, target and filter selection, compression, or processing
Filter wheel fault or repeating artifacts	The wheel motor, position sensor, or interlock behind a target or filter error; a mark in the same place every image is a detector or plate defect, dust in the beam path, or a damaged paddle
ULTRASOUND SYMPTOM	LIKELY CAUSES AND THE FIRST CHECKS
Dark stripe down the image	Element dropout or a broken cable conductor; confirm on a phantom, then swap the probe to prove it
Weak or noisy image, or absent Doppler	Wrong preset, poor contact and gel, lens or connector damage, or a failing channel; try a known good probe first. A dead display or control is cart power, battery, cable, or the panel
Probe damage after cleaning	A disinfectant not approved for that probe, soaking past the immersion line, or a soaked connector; retrain and relabel
PORTABLE AND C-ARM SYMPTOM	LIKELY CAUSES AND THE FIRST CHECKS
Will not expose away from mains, or dies within a shift	Battery capacity under load, charger fault, a charge interlock, or a unit stored discharged; measure the pack under load and log run time
Drive, brakes, or faults that follow movement	Brake pads, drive belt, wheel bearings, or dead-man drive switch; faults that follow arm movement are cable flex failures, found with a wiggle test on continuity
Collimator lamp or laser out	Lamp, timer circuit, or mirror alignment; a dark lamp invites an uncollimated field, so it is a dose issue

The service report is part of the repair: the symptom as reported, what you found, what you did, the parts used, the readings with their tolerances, and the time the room went back into use. Tell radiology what works now, what does not, what to avoid, and when you will be back. When you call the manufacturer, have the model, serial number, software version, exact error text, and readings ready.

10 Imaging informatics

NETWORKING ITEM	WHAT TO KNOW
IP address, subnet mask, gateway	Four numbers 0 to 255 name the device; the mask splits that into network and host, and two devices must share a subnet to talk without a router. The default gateway is the way out, and a wrong one looks like the whole network is down from that device
DHCP and DNS	DHCP hands out addresses, and a self-assigned 169.254 address means it could not be reached. DNS turns names into addresses: if the address works and the name does not, it is DNS
Switch versus router	A switch connects devices inside one LAN; a router connects networks and usually carries the access rules
VLAN	A logical network on shared switches. Imaging gear often sits on its own VLAN, which is why a good cable in the wrong port gets nowhere
LAN, WAN, and wireless	The LAN is the building and the WAN joins sites, where slow prior retrievals live. Fixed modalities are wired; portables roam, so coverage gaps leave studies stuck in the local queue
Cabling and NIC	Cat 5e for 1 Gbps, Cat 6A for 10 Gbps, 100 m per run, RJ45 connectors, fiber for long runs. No link light on the network card is a layer 1 problem, cable or port

TOOL	WHAT IT PROVES
PING and traceroute	PING sends ICMP echoes, and a reply proves the path and host are alive: work outward from own address to gateway to archive by address to archive by name. traceroute shows each router hop and where the path stops, which matters across a WAN before blaming the modality
ipconfig or ifconfig	Reads the device's own address, mask, gateway, and DNS : the fastest way to spot a bad address
Cable tester, tracer, port lights	Prove the pairs end to end and find which jack is which; lights on both ends settle the physical layer
DICOM echo	A C-ECHO verifies the association, AE titles, address, and port: the DICOM ping, and the first test when images will not move
DICOM ITEM	WHAT TO KNOW
Association, AE title, host, port	Two application entities negotiate an association and must agree on who they are and what services they support. Each node answers to a case-sensitive AE title plus address and port, commonly 104 or 11112; a typo here is the most common reason a new room cannot send
SOP class	The service and object pair that says what a node can do, such as store a CT image or query a worklist
C-ECHO and C-STORE	Verification, then the push that sends images to the archive. A node that verifies but cannot store usually has a class mismatch, or a disk, license, or permission limit at the receiver
C-FIND and C-MOVE	Query for matching studies, then ask a node to send them somewhere; retrieving priors needs the destination configured on the sending node
MWL and MPPS	The modality worklist query pulls scheduled patients and accession numbers to the console; performed procedure step reports started, completed, or discontinued, which drives status boards and billing
Storage commitment and GSDF	Storage commitment is the archive confirming permanent responsibility, which makes local deletion safe; the grayscale standard display function is the calibration curve that makes an image look the same on every reading station
SYSTEM	ITS JOB AND THE PATH THROUGH IT
PACS and VNA	The archive plus reading workstations store, retrieve, distribute, and display. A vendor neutral archive holds studies from many systems in a standard form, so a vendor can be replaced without migrating the data again
RIS	Schedules exams, holds the worklist, tracks status, routes reports
HL7	The messaging standard joining those systems: ADT for admit, discharge, and transfer, ORM for orders, ORU for results and reports
Order to report	Ordered in the EMR , scheduled in the RIS , shown on the modality as a worklist entry, images to PACS , read and dictated, report back to the EMR and the EHR clinicians read
Interface engine or broker	Translates and routes HL7 and DICOM traffic between systems; its queue is where stuck messages pile up
SECURITY ITEM	WHAT IT MEANS FOR IMAGING EQUIPMENT
HIPAA, HITECH, and PHI	HIPAA protects PHI through its privacy, security, and breach rules; HITECH strengthened enforcement, added breach notification, and bound service vendors. Identifiers sit in consoles, caches, dose reports, and service logs, so sanitize or document before a device leaves the building
MDS2	The manufacturer disclosure statement for medical device security: what a device stores, how it authenticates, and what it can be patched with
IEC 80001	Risk management for IT networks carrying medical devices: the framework behind joint reviews with the IT department
Least privilege and remote access	Separate service and clinical accounts, no shared logins, vendor access through the hospital VPN with a controlled account, logged and time-limited, never an always-on modem

SECURITY ITEM	WHAT IT MEANS FOR IMAGING EQUIPMENT
Patching, segmentation, encryption	Patch only on the vendor's validated schedule; a modality that cannot be patched is segmented onto its own VLAN with only the ports it needs; encrypt anything leaving the building
Backups	Archives and databases backed up and restore-tested; a backup nobody has restored is a hope, not a plan

Imaging applications depend on each other, so the first question is how wide the fault is. One modality that cannot send is a node problem: **AE** title, address, port, or cable. Every modality losing its worklist at once is upstream, at the **RIS** or the interface engine. A down archive fails every reading station while the modalities keep scanning into their local queues, so the clock is running on local disk. Escalate with the device, the test you ran, the result, and the time it started.

11 Acronyms

Every acronym used in this course, 146 in all. In lessons and on this sheet, hover over an acronym for the short version; click it, or click one below, for the longer explanation.

ACRONYM	STANDS FOR	MEANING
AAMI	Association for the Advancement of Medical Instrumentation	The standards body for medical equipment and the sponsor of the technician credentials.
AAPM	American Association of Physicists in Medicine	The physicists' professional body, whose task group reports set the display and equipment test patterns a quality control program uses.
ABC	Automatic brightness control	The fluoroscopic feedback loop that holds image brightness by raising mA, kVp, or pulse width as the patient thickens.
AC	Alternating current	Mains power that reverses direction, 60 Hz in the United States and 50 Hz in much of the world.
ACI	AAMI Credentials Institute	The body inside AAMI that writes and administers the certification exams.
ACR	American College of Radiology	The body that accredits imaging facilities and publishes the phantoms and scoring that accreditation uses.
ADC	Analog-to-digital converter	The stage that turns a detector's analog charge or voltage into the numbers an imaging computer can work with.
ADT	Admit, discharge, transfer	The messages that tell every system who the patient is and where they are.
AE	Application entity	A DICOM node, identified by its application entity title, address, and port.
AEC	Automatic exposure control	Ionization chambers in front of the receptor that end the exposure once enough radiation has arrived.
ALARA	As low as reasonably achievable	The radiation safety principle: the least dose that still answers the clinical question.
ANSI	American National Standards Institute	The United States body that accredits standards developers such as AAMI.
AP	Anteroposterior	A projection in which the beam enters the front of the body and exits the back.
ARP	Address Resolution Protocol	The mapping between a logical address and the hardware address of a device on the same local network.
BF	Body floating (applied part)	An applied part that touches the patient but not the heart, isolated from ground.
BMET	Biomedical equipment technician	The job title for the technician who inspects, maintains, and repairs clinical equipment.
BRH	Bureau of Radiological Health	The former federal office whose radiation-emitting product work now sits inside the FDA device center.
C-ECHO	DICOM verification service	The DICOM ping; it proves two nodes can open an association and talk.
C-FIND	DICOM query service	A query that asks another node which studies match given criteria.
C-MOVE	DICOM retrieve service	A request asking a node to send matching studies to a named destination.
C-STORE	DICOM storage service	The push that sends an image or series from a modality or workstation to another node.
CABT	Certified Associate in Biomedical Technology	The entry-level credential on the certification ladder, below the technician credential.
CBET	Certified Biomedical Equipment Technician	The general technician credential, the usual step before specializing in imaging.
CCD	Charge-coupled device	A solid-state sensor that turns light into charge, used in some digital mammography and camera chains.
CDRH	Center for Devices and Radiological Health	The FDA center that regulates medical devices and radiation-emitting products.
CF	Cardiac floating (applied part)	An applied part isolated well enough for a direct connection to the heart.
CFR	Code of Federal Regulations	The published body of United States federal rules; imaging performance standards sit in title 21, part 1020.
CHTM	Certified Healthcare Technology Manager	The management credential at the top of the technician certification ladder.

ACRONYM	STANDS FOR	MEANING
CMMS	Computerized maintenance management system	The database of record for the equipment inventory, work orders, and maintenance history.
CMS	Centers for Medicare and Medicaid Services	The federal agency whose conditions of participation a hospital must meet to be paid.
CPU	Central processing unit	The processor that does the arithmetic of reconstruction and image processing on a console or workstation.
CR	Computed radiography	Cassette-based digital imaging: a storage phosphor plate is exposed, read by a laser scanner, then erased and reused.
CRCPD	Conference of Radiation Control Program Directors	Where state radiation control programs write their shared suggested regulations.
CRES	Certified Radiology Equipment Specialist	The ACI credential for technicians who service imaging equipment: 165 questions, 3 hours, offered in May and November.
CsI	Cesium iodide	The scintillator that converts x-rays to light in indirect digital detectors and image intensifier inputs.
CT	Computed tomography	Cross-sectional imaging made by rotating a tube and detector array around the patient and reconstructing slices.
CTDI	Computed tomography dose index	The dose in one slice spread over a defined 10 cm length, so radiation delivered outside the chosen slice is counted.
DAP	Dose area product	Dose multiplied by the area of the beam, measured by a meter under the collimator.
DBT	Digital breast tomosynthesis	Mammography that sweeps the tube through an arc and reconstructs thin slices.
DC	Direct current	Current in one direction only; what an x-ray tube needs across its cathode and anode.
DHCP	Dynamic Host Configuration Protocol	The service that hands out addresses automatically; a 169.254 address means it could not be reached.
DI	Deviation index	How far an exposure landed from the target for that exam: the technologist's dose feedback number.
DICOM	Digital Imaging and Communications in Medicine	The standard for medical image formats and for the network services that move them.
DLP	Dose length product	The computed tomography dose index multiplied by the length scanned, so it grows with how much of the patient was covered.
DMM	Digital multimeter	The bench meter for voltage, current, and resistance at the test points a service manual names.
DNA	Deoxyribonucleic acid	The molecule carrying a cell's instructions, and the target that makes ionizing radiation dangerous.
DNS	Domain Name System	Turns names into addresses; if the address works and the name does not, it is this.
DQE	Detective quantum efficiency	How much of the radiation reaching a detector becomes usable signal.
DR	Digital radiography	Direct-capture digital imaging: the detector reads out electronically with no plate to carry to a reader.
DSA	Digital subtraction angiography	A mask image taken before contrast is subtracted from the contrast run so only vessels remain.
DVM	Digital voltmeter	A meter dedicated to voltage measurement; the pre-reading voltmeter on a console is one.
EHR	Electronic health record	The longitudinal patient record shared across an organization, which the imaging report lands in.
EI	Exposure index	The number a digital detector reports to say how much radiation it actually received.
EMI	Electromagnetic interference	Unwanted energy coupling between equipment; it works in both directions in an imaging suite.
EMR	Electronic medical record	The clinical chart inside one organization, where orders begin and reports arrive.
ESD	Electrostatic discharge	A static spark that destroys or weakens electronic parts without leaving a mark.
FDA	Food and Drug Administration	The United States agency that regulates medical devices, including every radiation-emitting imaging system.
GFCI	Ground fault circuit interrupter	A device that opens the circuit on a small imbalance between hot and neutral, tripping at 4 to 6 mA.
GI	Gastrointestinal	The digestive tract, from mouth and esophagus through stomach and intestines to the rectum and anus.
GSDF	Grayscale standard display function	The DICOM display calibration curve that makes the same image look the same on every monitor.
HIPAA	Health Insurance Portability and Accountability Act	The United States law protecting patient information, with privacy, security, and breach rules.
HITECH	Health Information Technology for Economic and Clinical Health Act	The law that strengthened privacy enforcement and added breach notification.
HL7	Health Level Seven	The text messaging standard that joins scheduling, chart, and imaging systems.
HLD	High-level disinfection	The level of reprocessing required for a probe that touches mucous membranes.
HTM	Healthcare technology management	The department and the discipline that manage clinical equipment across its life.
HU	Heat unit, and Hounsfield unit	Two different units with one abbreviation: thermal loading on a tube, and density in a computed tomography image.
HVL	Half-value layer	The thickness of aluminum that cuts beam intensity in half; the practical measure of beam quality.
ICMP	Internet Control Message Protocol	The protocol that carries the echo requests and replies a ping uses.
ID	Identification	A patient identifier, a device identifier, or the photo identification a test center asks to see.
IEC	International Electrotechnical Commission	The body behind IEC 60601-1, the safety standard for medical electrical equipment.
IP	Internet Protocol	The addressing scheme that identifies every device on a network.
IT	Information technology	The department that owns the network, servers, and security an imaging department depends on.

ACRONYM	STANDS FOR	MEANING
kVA	Kilovolt-ampere	A thousand volt-amperes: the apparent power a supply must be able to deliver.
kVp	Kilovolt peak	The highest voltage across the tube during an exposure; it sets beam quality and strongly affects quantity.
LAN	Local area network	The network inside one building or campus, where modalities and archives usually sit together.
LAO	Left anterior oblique	An oblique position with the left front of the body against the receptor.
LED	Light-emitting diode	A diode that emits light; the indicator and display backlight of almost every console and panel.
LPO	Left posterior oblique	An oblique position with the left back of the body against the receptor.
mA	Milliampere	Tube current: the number of electrons crossing from filament to target each second.
MAC	Media access control address	The hardware address built into a network interface, which a switch learns for each of its ports.
mA_s	Milliampere seconds	Tube current multiplied by exposure time: the single number that sets how many x-rays are made.
MDS2	Manufacturer Disclosure Statement for Medical Device Security	The standard form that says what a device stores, how it authenticates, and how it can be patched.
MF	Magnification factor	Image size divided by object size, equal to the source-to-image distance divided by the source-to-object distance.
MPPS	Modality performed procedure step	The DICOM service by which a modality reports that an exam started, finished, or was discontinued.
MQSA	Mammography Quality Standards Act	The federal law that sets mammography accreditation, inspection, personnel, and quality control requirements.
MR	Magnetic resonance	Imaging from the magnetic behavior of tissue in a strong field; also the labeling scheme for magnet room safety.
MRI	Magnetic resonance imaging	A superconducting magnet, gradient coils, and radiofrequency coils; no ionizing radiation and the field is always on.
MTBF	Mean time between failures	The average interval between one failure of a device and the next; the headline number of a performance report.
MWL	Modality worklist	The DICOM query that pulls scheduled patients and accession numbers onto the modality console.
NaI	Sodium iodide	The scintillation crystal in a gamma camera, which flashes light when a gamma ray is absorbed.
NCRP	National Council on Radiation Protection and Measurements	The body whose recommended dose limits and shielding reports are adopted into law and used by physicists.
NEMA	National Electrical Manufacturers Association	The manufacturers' standards association behind focal spot tolerances and the home of the imaging communications standard.
NFPA	National Fire Protection Association	The source of NFPA 99 for health care facilities and NFPA 70, the national electrical code.
NIC	Network interface card	The network adapter and its link light, the first physical check in any connection fault.
NRC	Nuclear Regulatory Commission	The agency that licenses byproduct radioactive material, which is why nuclear medicine has its own rules.
OID	Object-to-image receptor distance	The gap between the anatomy and the receptor; the main driver of magnification and blur.
ORM	Order message	The message type that carries a clinical order from the chart to the scheduling and imaging systems.
ORU	Observation result message	The message type that returns a result or report to the chart.
OSHA	Occupational Safety and Health Administration	The United States agency for worker safety: hazard communication, bloodborne pathogens, electrical practice, and PPE.
OSL	Optically stimulated luminescence	A personal dosimeter type read out by stimulating the detector with light.
PA	Posteroanterior	A projection in which the beam enters the back of the body and exits the front.
PACS	Picture archiving and communication system	The archive plus the reading workstations: it stores, retrieves, distributes, and displays images.
PBL	Positive beam limitation	Automatic collimation that sizes the shutters to the receptor in use.
PDU	Power distribution unit	The panel inside a system that takes the incoming feed and splits it to the subsystems.
PET	Positron emission tomography	Imaging that counts pairs of photons emitted in opposite directions when a positron annihilates with an electron.
PHI	Protected health information	Patient-identifiable information in any form, including what sits in consoles, caches, and service logs.
PING	Packet internet groper	The command that sends echo requests to an address to prove the path and the host are alive.
PM	Preventive maintenance	Scheduled inspection, testing, and service meant to find problems before a patient or a schedule does.
PMT	Photomultiplier tube	A tube that turns a faint light flash into a measurable electrical pulse.
PPE	Personal protective equipment	The gowns, gloves, eye protection, and respirators a task requires, plus the lead a radiation task requires.
PSP	Photostimulable phosphor	The storage phosphor in a computed radiography plate that holds a latent image until a laser releases it.
QC	Quality control	The scheduled measurements that prove an imaging system still performs within tolerance.
RAID	Redundant array of independent disks	Several drives working as one set so the storage survives a drive failure and raises an alert.

ACRONYM	STANDS FOR	MEANING
RAM	Random access memory	Working memory, lost at power off, holding the study a workstation is reconstructing or displaying.
RAO	Right anterior oblique	An oblique position with the right front of the body against the receptor.
RC	Resistor-capacitor (circuit)	A resistor and a capacitor together, whose time constant is the resistance times the capacitance.
RF	Radiofrequency	The radio part of the spectrum: the transmit and receive energy of magnetic resonance and a common source of interference.
RIS	Radiology information system	The department system that schedules exams, holds the worklist, tracks status, and routes reports.
RJ45	Eight-position modular connector	The familiar eight-pin plug on a twisted pair network cable.
RMS	Root mean square	The effective value of an alternating voltage: 0.707 times the peak.
RPO	Right posterior oblique	An oblique position with the right back of the body against the receptor.
RSO	Radiation safety officer	The person who owns a facility's radiation safety program and can stop unsafe practice.
SCR	Silicon controlled rectifier	A gate-triggered solid-state switch used to control alternating current power.
SDS	Safety data sheet	The standard document for a chemical: its hazards, handling, protective equipment, and first aid.
SI	International System of Units	The metric system the modern radiation units belong to: gray, sievert, and becquerel.
SID	Source-to-image receptor distance	The distance from focal spot to receptor; standard distances are 100 cm and 180 cm.
SMPTE	Society of Motion Picture and Television Engineers	The broadcast engineering body whose test pattern is the long-standing visual check for a diagnostic display.
SOD	Source-to-object distance	The distance from focal spot to the anatomy being imaged.
SOP	Service-object pair	The DICOM pairing of a service with an information object, which says what a node can actually do.
SPECT	Single photon emission computed tomography	Nuclear imaging that rotates a gamma camera around the patient to reconstruct slices.
SSD	Source-to-skin distance	The distance from focal spot to the patient's skin; the fluoroscopic minimum is a federal limit.
Tc	Technetium	The element behind technetium-99m, the workhorse tracer of nuclear medicine.
TCP	Transmission Control Protocol	The connection-oriented transport that carries imaging and messaging traffic reliably and in order.
TEE	Transesophageal echocardiography (probe)	An ultrasound probe passed down the esophagus to image the heart from behind it.
TFT	Thin-film transistor	The transistor array on a flat panel detector that reads out each pixel's charge.
TJC	The Joint Commission	An accrediting organization that surveys hospitals on behalf of the federal payer.
TLD	Thermoluminescent dosimeter	A personal dosimeter read out by heating the crystal and measuring the light it gives off.
TLS	Transport Layer Security	The encryption that protects data while it crosses the network, used on interfaces that support it.
UPS	Uninterruptible power supply	A battery-backed supply that carries a load through a power failure.
USB	Universal serial bus	The common port for keyboards, scanners, card readers, and removable media on an imaging console.
VAC	Volts alternating current	A voltage reading on the alternating supply side of equipment.
VDC	Volts direct current	A voltage reading on a direct current rail inside equipment.
VLAN	Virtual local area network	A logical network carved out of shared switches, often used to separate imaging equipment.
VNA	Vendor neutral archive	An archive that stores studies from many systems in a standard form.
VPN	Virtual private network	An encrypted tunnel; the controlled way a vendor reaches equipment from outside.
WAN	Wide area network	The network joining sites, usually over links leased from a carrier.