

# user manual

## MultiScan G-Arm System<sup>®</sup>

**XGB6-12-1026**

**B6**

**104**

**ENG This user manual includes detailed usage instructions for the G-Arm system. Please read this manual before using equipment. You can always use Ctrl + F1 to open or close this manual (PDF format).**

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## CHAPTER 1

# OVERVIEW AND SAFETY



## 1.1 Overview

This manual can also be used as a general guide for planning the pre-installation, installation and daily service of the G-Arm system.

This manual includes functional descriptions as well as operational instructions exclusively for the specific model of B6 (hereafter in this manual referred to as *the G-Arm system*). It is intended for qualified medical personnel who have been trained for operating the G-Arm system. It is not designed to be used as a substitute for certified training in the radiological or medical field.



*Potential hazards exist in the use of medical electronic devices and X-ray systems. X-ray equipment may cause injury if improperly used. Carefully read this manual and follow the instructions prior to operating this equipment.*

## 1.2 System Intended Use

The G-Arm system is a mobile digital X-ray diagnostic system, which is intended to generate X-ray fluoroscopic image of a patient. The application includes: real-time positioning and monitoring operations in trauma surgery, orthopedics, spine surgery, chest surgery, etc. It is not intended to be used in interventional procedures.

The G-Arm system permits a qualified doctor or technologist to take a range of diagnostic exposures of spinal column, chest, abdomen, extremities, and other body parts on the patients.



*The G-Arm system is prohibited for dental, mammography, and tomography.*



*The G-Arm system will not be in physical contact with patients and is supposed to be operated only in the operation room. It shall not be used in the environment with rich oxygen.*



*This unit is designed to rotate around the patient, minimizing any direct contact.*




*This equipment cannot be used for pregnant women, unless it is used as directed by physicians.*




## 1.3 Safety Classification

<b>Electric Shock Protection Type:</b>	Class I
<b>Operation Mode:</b>	Continuous Operation
<b>Liquid Ingress Protection Degree:</b>	IPX0
<b>Applied Part:</b>	NONE
<b>Quasi Applied Part:</b>	G-Arm, Image intensifier assembly, X-ray tube assembly (type B applied)
<b>MOP (Means of Protection):</b>	Control Unit: MOOP (Means of Operator Protection) G-Arm: MOPP (Means of Patient Protection)

## 1.4 Safety Hazard Alerts

Pay attention to all areas of this manual marked with this symbol . Four types of safety hazard alert words are included in this manual: Danger, Warning, Caution and Note.

**Table 1-1: Safety Hazard Alerts**

Alert	Circumstances for Use
 <b>DANGER</b>	Indicates an imminently hazardous situation that, if not avoided, could result in serious injury or death.
 <b>WARNING</b>	Indicates a potentially hazardous situation that, if not avoided, could result in serious injury or death.
 <b>CAUTION</b>	Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury, equipment damage or loss of data.
<b>Notes</b>	Indicates important information necessary for users to understand.

## 1.5 Safety Hazard Overview

Potential hazards exist in the use of medical electronic devices and X-ray systems. Operators using the equipment need to understand the safety issues,

emergency procedures, and the operating instructions provided in this manual.



*Do NOT use this unit in the presence of potentially flammable anesthetic gas or equivalent.*



*This unit shall NOT be operated at an altitude above 3000 meters (9842 feet).*

### **Protection against electric shock**

Be sure the protective earth cable is properly connected to the control unit prior to use.

Do not use the G-Arm system if the power cable is damaged.

Do not remove or open the casing or covers of the equipment. The internal circuits of the G-Arm system generate high voltages and can cause serious injury or death. To minimize the shock hazard, the power cable must be connected to a UL-approved power receptacle.

### **Radiation protection**

The G-Arm system is designed and manufactured with the highest safety standards. However, no design can guarantee absolute safety or complete protection. See "Radiation Protection" (s1.9, p16) for more information on this topic.

### **Explosion protection**

Do not operate the equipment in the presence of flammable or explosive liquids, vapors or gases.

If flammable substances are detected after the system has been turned on, do not attempt to turn the system off. Evacuate and ventilate the area before turning the system off.

### **Implosion protection**

Jarring or striking the system could lead to serious mechanical shocks, leading to explosion. This may result in injury from flying debris.

### **Electrical fire protection**

This equipment is not suitable for use in the presence of flammable gases. Conductive fluids that drain into the active circuit components of the system may cause short circuits that may result in electrical fire. Therefore, do not place fluids or food on any part of the system.

Make sure that the fire extinguisher at the site has been approved for use on electrical fires, to prevent electrical shock or burn.

## 1.6 Safety - Operation



WARNING

The appropriate X-ray imaging exposure parameters should be consistent with established Federal and Provincial/State radiation protection practices and medical imaging standards in the local institution.



CAUTION

Do not use the system in unsafe conditions (smoke, fire, etc.), which can lead to hardware failure.



CAUTION

To avoid damaging the unit, do not place anything, especially heavy objects or liquid contents on top of the unit.



DANGER

The unit should be placed on stable and level ground.

### Notes

- No user-serviceable parts are provided within the unit.
- None of electronic objects or parts of the unit (fuses, circuit breaker, etc.) shall be replaced or repaired by the hospital. Only service personnel authorized by Beijing East Whale Imaging Technology Co., Ltd. are allowed to perform these operations.

Only operate the control unit in a ventilated environment.

Do not operate the control unit near strong magnetic fields. Keep the G-Arm system away from devices that generate strong magnetic fields. Such devices include MRI unit, microwave oven, speaker, etc.

The additional equipment that is required to work with the G-Arm system must conform to Standard EN 60601-1.

In the event of system failure, immediately cease the operation of the G-Arm system and call the responsible service technician for help.

## 1.7 Safety - Power Supply

<b>Power Supply Requirement:</b>	220/230 VAC, 50/60 Hz, 15 A
<b>Power:</b>	2500 VA (Momentary), 800 VA (Long-time)
<b>Rated Line Voltage:</b>	220/230 VAC
<b>Line-voltage Regulation:</b>	2% in bi-plane imaging (120 kV, 15 mA)

<b>Max. line current and technique factors:</b>	11 A, 120 kV, 15 mA (bi-plane imaging)
<b>Highest electric power in high-voltage circuit:</b>	1.8 kW (120 kV, 15 mA)(bi-plane imaging, peak), 1.2 kW (120 kV, 15 mA) (bi-plane imaging, maximum average)
<b>Nominal electric power:</b>	2.3 kW (100 kV, 15 mA, 1 s)

Line-voltage regulation is based on measurements made at the input (primary winding) of the isolation transformer under standby conditions and at maximum fluoroscopic exposure.

$$\text{PERCENT LINE REGULATION} = 100 (V_N - V_1)/V_1$$

Where  $V_N$  stands for no-load line potential (standby), and  $V_1$  for load line potential for maximum radiographic exposure.



WARNING

*To avoid the risk of electric shock, this equipment shall only be connected to the power supply with protective earth.*

*When another device is used together with this unit, the combination as a whole shall conform to the standard EN 60601-1.*



WARNING

*It is required to have the G-Arm connected to the Control Unit before applying power to the G-Arm system.*

## 1.8 Required Work Space

Figure 1-1 (p16) demonstrate the work space required for the operator to operate the G-Arm system in any particular area.

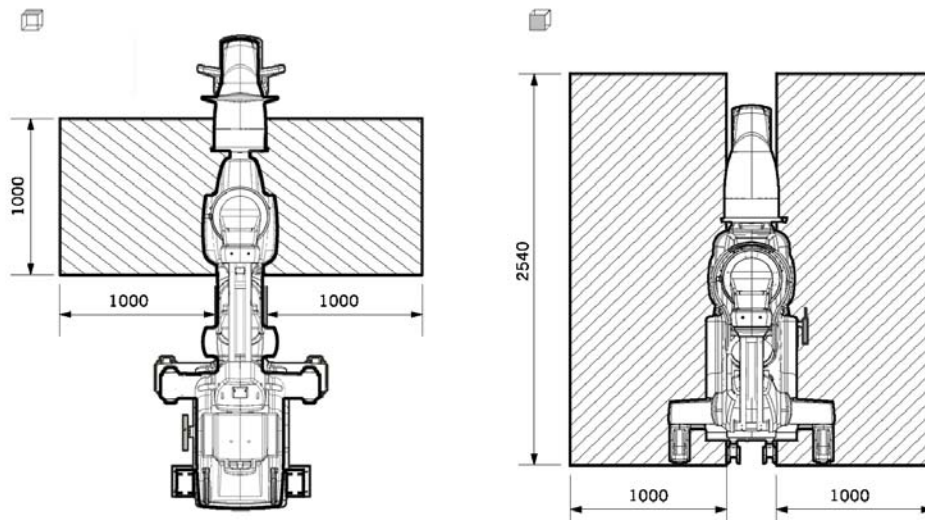


Figure 1-1: Required work space (mm (inch))



CAUTION

Be sure to leave sufficient room to maneuver the G-Arm, and take the required work space into consideration.

## 1.9 Radiation Protection

X-ray radiation exposure can be harmful to the human body. The cumulative effect it creates may last for months or years. Operators and service personnel should avoid direct exposure to the X-ray beam and take protective measures to avoid scattered radiation.

No design can guarantee absolute safety or complete protection for those who fail to take adequate safety precautions. Only properly trained operators or authorized service personnel are allowed to operate this unit. Both the operators and service personnel should be aware of the risk of X-ray radiation during routine operation and the risk of high-voltage electric shock during equipment maintenance.



### 1.9.1 **General Protection**

The owner of the G-Arm system must designate areas suitable for safe operations and maintenance of the equipment and ensure the G-Arm system are only used in those areas. For example, allocate a room exclusively to the equipment, where protective precautions like lead shields and lead screens are provided to separate the X-ray radiation field from the human bodies irrelevant to the purpose of the clinical procedure.

While using the equipment, the owner must ensure that all personnel wear radiation monitoring devices (operator dosimeter) and appropriate protective clothing, helmet, apron, goggles, shield, etc.

Remain alert for visual indicators and audible alarms that are activated when ionizing radiation is being generated by the equipment in the work area.

Additionally, the G-Arm system uses grids to reduce the amount of scattered radiation.

### 1.9.2 **Keeping Distance**

Maintaining a safe distance from the source is another effective protective method. Locations more than 2 meters away from the X-ray focus is considered to be safe when equipped with protective devices and protective clothing.

### 1.9.3 **Reducing Dosage**

The collimator are carefully configured so that it regulates itself more precisely upon SID changes. Better precision in collimator movements boosts the image quality and minimizes the dosage, and greatly reduces the amount of scattered radiation.

### 1.9.4 **Exposure Alert**

The G-Arm system triggers a warning alarm when **5 minutes** of fluoroscopic imaging time is accumulated during a single study.

#### **Related Topics**

- "Fluoroscopy time summary" (s8.1.2, p90)
- "Exposure Lamps and Audible Signals" (s3.6, p41)

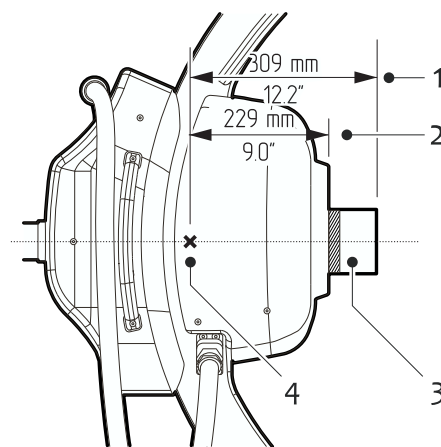
### 1.9.5 **Source-to-skin Distance**

The X-ray radiation value varies in proportion to the product of the kV value and mA value.

International regulations specify that a minimum source-skin distance (SSD) of 300 mm shall be maintained. However, for specific surgical applications, a minimum SSD of 200 mm is required.

The cover of the hole where the X-ray is emitted is the nearest position to the X-ray source that the patient body can reach during normal use, which mechanically preserves the minimum SSD.

The G-Arm system may come with an optional accessory - skin spacer - to create additional space between the focal spot and the patient body. The minimum SSDs that the G-Arm system can reach, with or without the skin spacer installed, are illustrated as in the figure below:



**Figure 1-2: Minimum Source-skin Distance (SSD)**

- |                      |                       |
|----------------------|-----------------------|
| 1 SSD w/ Skin Spacer | 2 SSD w/o Skin Spacer |
| 3 Skin Spacer        | 4 Focal spot          |

In normal conditions, the SSD shall be far enough to keep the dosage as low as possible.



DANGER

Exposing the eyes or the skin to the primary X-ray beam may result in severe radiation burns in the event of repetitive or prolonged exposures. The hazards are most often associated with exposure to X-ray radiation including increased risks of cancer and genetic effects in exposed populations.

## 1.9.6 Penetration of Fluids

**DANGER**

*The G-Arm system is not waterproof. If liquids drip into the equipment, disconnect the power cord. Do NOT operate the system until it has been cleaned and inspected by a qualified service engineer.*

Excessive amount of fluids such as antiseptics, cleaning solutions or body fluids may damage the internal components if seeped through. Use drapes, if necessary, to protect the equipment during clinical procedures. Do not apply excessive amounts of fluids when cleaning.

## 1.10 Acronyms and Abbreviations

The acronyms and abbreviations used in this manual are explained in the following table:

AE Title	Application Entity Title
AEC	Automatic Exposure Control
AKR	Air Kerma Rate
AP	Anteroposterior
Auto	Automatic
Cont	Continuous
C-Unit	Control Unit
DICOM	Digital Imaging and Communications in Medicine
DAP	Dose Area Product
Fluo	Fluoroscopy
DR	Digital Radiation
I.I.	Image Intensifier
LT	Lateral
LIH	Last Image Hold
Mfr.	Manufacturer
SR	Structured Report
PACS	Picture Archiving and Communication Systems
PMMA	Polymethyl-methacrylate
ROI	Region of Interest
SID	Source to Image Distance



The terms of AP and LT used on the G-Arm system and in this manual are only to indicate the X-ray plane on which the images are generated. They are not identical to the clinical terms of AP and LT.

## 1.11 ***Symbols and Nameplates***

Various symbols, labels, and signs are fixed to or printed on the surface of this product to provide you with additional information including warnings and/or safety information.

For descriptions of these symbols, labels, signs and nameplates, see Appendix I: "Symbols & Nameplates" (p163).

## 1.12 ***Equipment Malfunction***

In the event that the system circuit breaker trips, which may indicate a system malfunction, do not attempt to operate the equipment and contact the manufacturer or the service engineer authorized by the manufacturer.

## 1.13 ***Responsibility***

Regardless of the particular requirements set by the relevant liability standards, WHALE can be considered liable only when the following conditions apply:

- Assembly, installation, adjustment, maintenance and modifications are performed only by WHALE personnel or by persons authorized by Beijing East Whale Imaging Technology Co., Ltd.
- Operations of this unit is in accordance with the instructions depicted in the user manual with a proper version.

WHALE assumes no responsibility when the patient, the operating staff or the third party are exposed to excessive X-ray radiation.

## CHAPTER 2

# START-UP



## 2.1 Connecting Cables

The G-Arm system has four cables, as shown below:

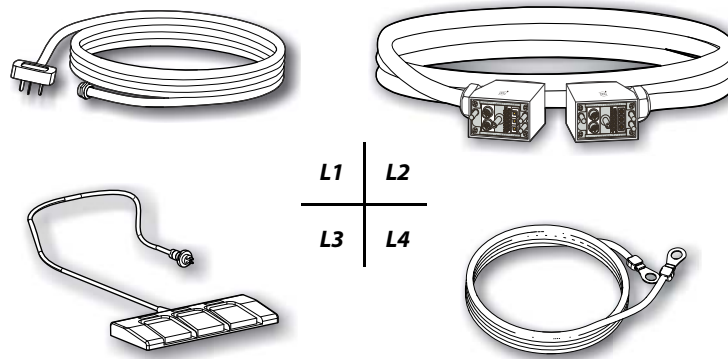


Figure 2-1: Cable list

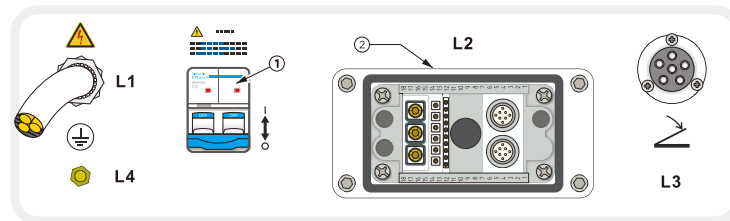


Figure 2-2: Ports & sockets on Control Unit

1 Circuit breaker 2 Terminal catch lock of Interconnect cable (L2)

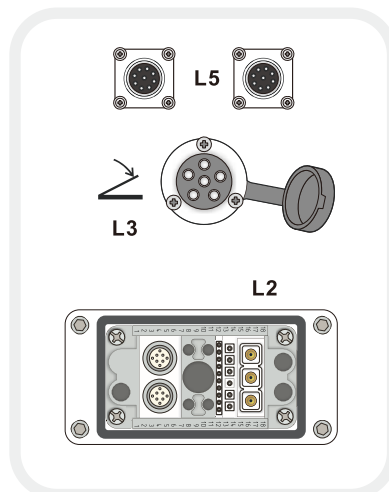


Figure 2-3: Ports & sockets on G-Arm

#	Cable	From	To	Length	Qty.
L1	Power cord	C-Unit	AC receptacle	7 m	1
L2	Interconnect cable	C-Unit	G-Arm	7 m	1
L3	Footswitch cable	C-Unit/G-Arm	Footswitch	7 m	1
L4	Protective earth cable	C-Unit	Protective earth	5 m	1
L5	Line control cord	G-Arm	Line control	3 m (9.8 ft.)	2



**IMPORTANT** - Do not attempt to connect or disconnect any cable when the equipment is powered on.



The power cord (L1) is not detachable and can only be replaced by the service personnel authorized by WHALE to make sure it conforms to relevant standards.

### Connect the power cord to AC receptacle

Make sure the circuit breaker is in the Off state, and then plug the power cord (L1) to a suitable AC receptacle, which conforms to the following specifications:

<b>Voltage:</b>	220/230 VAC $\pm$ 10%
<b>Frequency:</b>	50/60 Hz $\pm$ 1 Hz
<b>Current:</b>	15 A
<b>Apparent Resistance:</b>	$\leq 0.36 \Omega$



Before connecting to the mains, make sure its specifications conform to the power supply requirements of the G-Arm system.

If you want to connect the G-Arm system to the mains with different specifications, please contact the manufacturer.

### Connect Control Unit and G-Arm with the interconnect cable

**STEP 1** Connect one end of the interconnect cable (L2) marked with the Control Unit symbol (1) to the L2 socket (as shown in *Figure 2-2* (p29)) on the back cover of the Control Unit.

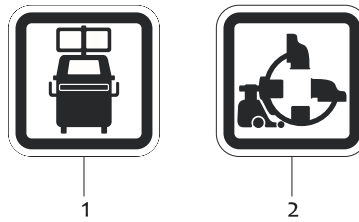
**STEP 2** Connect the other end that is marked with the G-Arm (2) symbol to the G-Arm L2 socket.



STEP 3 Lock both connectors in place by securely applying the catch locks (2 in Figure 2-2 (p29) and 13 in Figure 3-2 (p38)).



*If the connectors are not securely locked in place, unreliable system operation may result.*



**Figure 2-4: Use these symbols to connect to the correct unit**

- 1 Connect the end with this symbol to the Control Unit
- 2 Connect the end with this symbol to the G-Arm

### **Connect the footswitch cable to the Control Unit**

Plug the footswitch cable (L3) connector in the L3 socket (as shown in Figure 2-2 (p29)) on the back cover of the Control Unit.

### **Connect the protective earth cable**

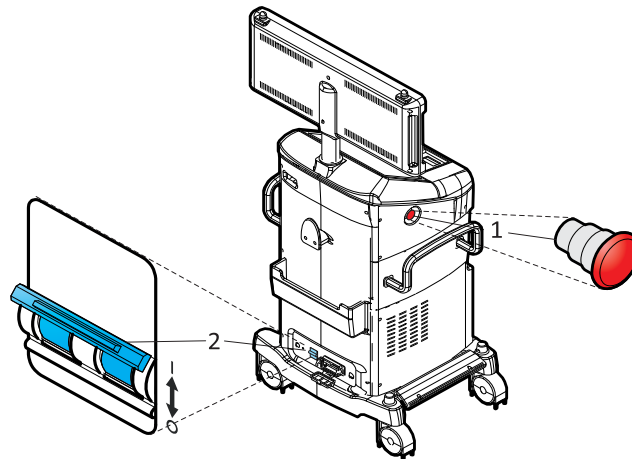
The AC power receptacle must provide protective earth connection.

Connect one end of the protective earth cable (L4) to the L4 port of the Control Unit (as shown in Figure 2-2 (p29)), and connect the other end to a protective earth terminal.



*Make sure the protective earth connection is undamaged.*

## 2.2 Turning the System On



**Figure 2-5: Turning the system on**

- 1 Emergency stop
- 2 Circuit Breaker



**WARNING**

At initial setup or when removing from storage, stabilize the equipment at ambient temperature and humidity for 4 hours before applying power. Failure to observe this warning might damage the equipment.


If the equipment has not been used for an extended amount of time (over 30 days), turn it on and leave it idle without taking any exposures for 2~3 hours in order to maintain the required vacuum in the image intensifier.



**CAUTION**

When the G-Arm system is in the Off state, the G-Arm will not respond to any control commands even with the circuit breaker being switched on.


To turn the system on:

- STEP 1 Turn the emergency stop (1) clockwise. The button will be released if it has been previously activated.
- STEP 2 Flip up the circuit breaker (2).
- STEP 3 Press the **Power On** button  above the control panel. The system begins the power up sequence.

## 2.3 Turning the System Off

When the Control Unit is turned off, neither the Control Unit nor the G-Arm can be operated.

To turn the system off:

STEP ► When the equipment is on, press the **Power On** button  above the control panel.



*When you turn the equipment off, always wait at least 10 seconds before powering it back on. This helps to prevent operational problems.*

## 2.4 Power-off Protection

The G-Arm system offers a power-off protection mechanism to prevent data loss in the event of unexpected power cut. The G-Arm system always saves the last two images (generated on separate X-ray imaging plane) in a temporary location on the disk right after they have been generated, regardless of the auto-saving settings.

If such abnormal shut-downs do happen, and if at that time the images have not been saved yet, when you restart the equipment and try registering the same patient (with the same patient MRN) again, those two temporarily saved images will be displayed at the top-right corner of the control screen (i.e., frozen image refreshing area where the last images are displayed). You can then save them in the study.



## CHAPTER 3

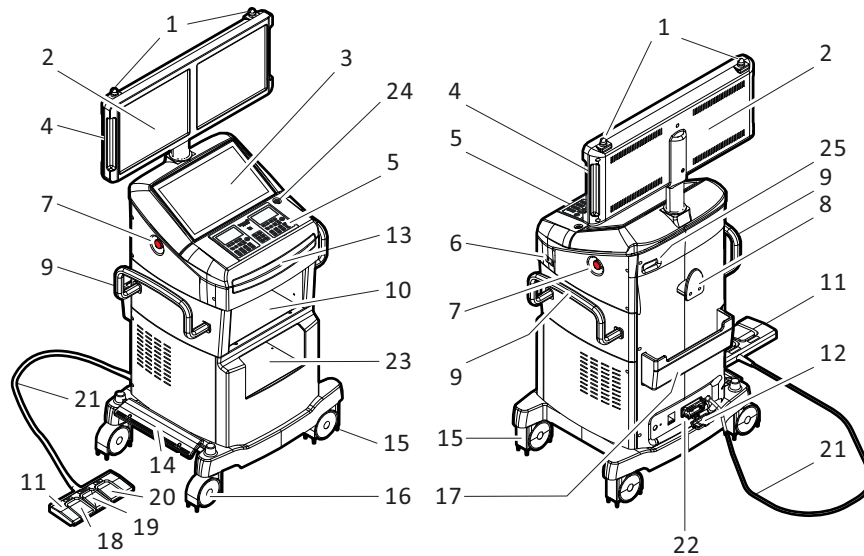
# SYSTEM COMPONENTS



### 3.1 Control Unit Components

The G-Arm system consists of two main units - the Control Unit and the G-Arm.

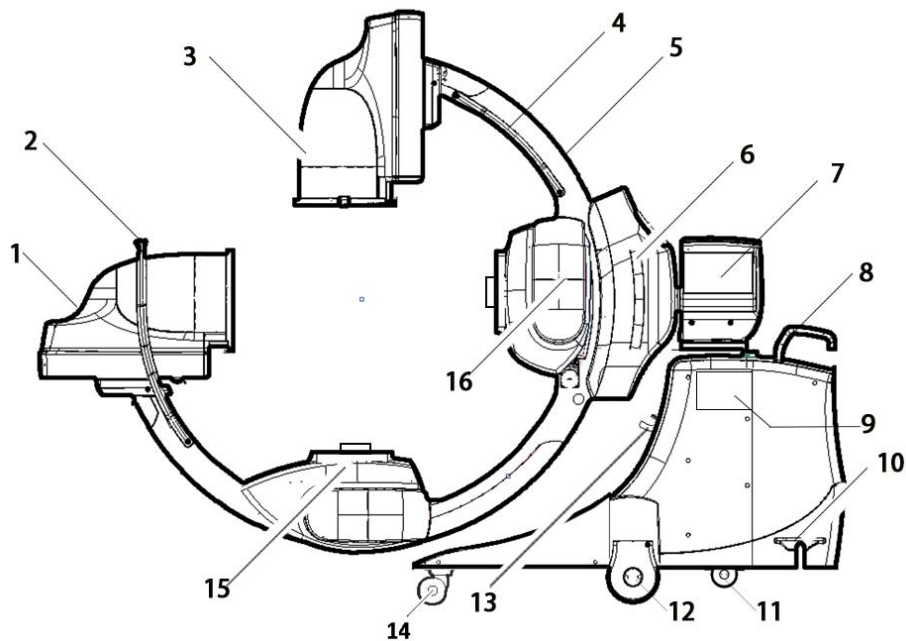
The Control Unit is connected to the G-Arm through the interconnect cable. The G-Arm is powered and controlled by the Control Unit.



**Figure 3-1: Components of Control Unit**

- |  |   |
|--|---|
| 1 Exposure lamp                          | 2 Viewing monitor (left: AP, right: LT) |
| 3 Control monitor                        | 4 Monitor handle (one on each side)     |
| 5 Control Panel                          | 6 USB ports                             |
| 7 Emergency Stop (one on each side)      | 8 Cord hook                             |
| 9 Control Unit handle (one on each side) | 10 Printer compartment                  |
| 11 Footswitch                            | 12 Interconnect cable connector (L2)    |
| 13 Keyboard drawer                       | 14 Wheel lock pedal                     |
| 15 Baffle plate                          | 16 Locking wheel                        |
| 17 Footswitch holder                     | 18 X-ray switch (AP)                    |
| 19 X-ray switch (AP & LT)                | 20 X-ray switch (LT)                    |
| 21 Footswitch cable (L3)                 | 22 Port panel                           |
| 23 Storage compartment                   | 24 Power Switch                         |
| 25 Network port                          |   |

## 3.2 G-Arm Components



**Figure 3-2: The G-Arm**

- |                                    |                                   |
|------------------------------------|-----------------------------------|
| 1 Image intensifier (LT plane)     | 2 G-Arm handle                    |
| 3 Image intensifier (AP plane)     | 4 G-Arm handle (one on each side) |
| 5 Curved arm                       | 6 G-Arm handle (one on each side) |
| 7 Control Panel (one on each side) | 8 Steering handles                |
| 9 G-Arm Movement Line Control      | 10 Brake pedal                    |
| 11 Swivel wheels                   | 12 Locking wheels                 |
| 13 Interconnect cable socket       | 14 Swivel wheel                   |
| 15 X-ray tube assembly (AP plane)  | 16 X-ray tube assembly (LT plane) |

## 3.3 Component Configuration

Table 3-1 (p38) and Table 3-2 (p39) lists all the major components that the G-Arm system contains.

**Table 3-1: Control Unit**

Major Component	Qty.
Viewing monitor	2
Control monitor	1
Keyboard	1



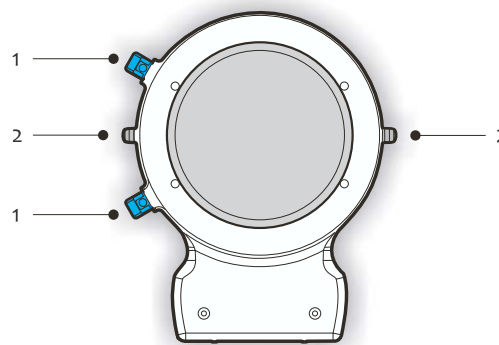
**Table 3-1: Control Unit**

Major Component	Qty.
Footswitch (3- or 2-pedal)	1
Printer (optional)	1

**Table 3-2: G-Arm**

Major Component	Qty.
Image intensifier assembly	2
X-ray tube assembly	2
Laser light indicator	2

## 3.4 Laser Light Indicator

**Figure 3-3: Laser Light Indicator**

- 1 Laser Light (two on each I.I.)
- 2 Laser Light Indicator Power Switch

The G-Arm system is outfitted with two sets of laser light indicators to facilitate clinical operations. Each set (AP or LT) uses two laser lights to illuminate two cross lines on the inspection target, i.e., the body surface of patient body to indicate the center of the image that is to be generated. Operators can take advantage of these cross marks as visual aids during patient positioning.

The laser light is off by default at system start-up.

To position the G-Arm correctly in the area of interest with the help of the laser light indicators:

- STEP 1 Press the power switch (2) to turn on either set of the laser lights. A pair of luminous cross lines are projected on the body surface of the patient.

**Note:** The two cross lines do not meet at right angles.

- STEP 2 Turn on the other set of laser lights if necessary.
- STEP 3 Adjust the G-Arm or the operating table until the cross marks are located over the desired region of interest.
- STEP 4 Press the power switch(es) again to turn off the laser light indicators.



CAUTION

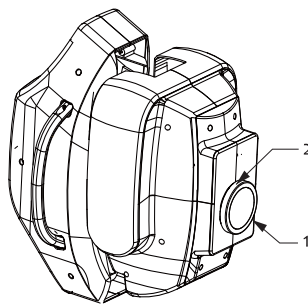
*The laser light indicator is class 2 laser product. Beware of laser radiation. Do not stare into beam.*

*Maximum Output:  $\leq 1$  mW*

*Wave Length: 635 nm*

## 3.5 Skin Spacer (Optional)

A skin spacer component may come with the G-Arm system to keep the body surface of the patient far enough from the X-ray emitting window of the LT tube assembly.



**Figure 3-4: Skin Spacer**

1 Skin Spacer    2 Screw

To install the skin spacer:

- STEP ► Fasten the skin spacer onto the X-ray emitting window of the LT tube assembly using the 4 plastic screws with your fingers.



CAUTION

*Do not use screw drivers to fasten these screws. Use your fingers only.*

### 3.6 Exposure Lamps and Audible Signals

The exposure lamp (yellow lamps on top of the viewing monitors, 1) will illuminate when a footswitch pedal (or Exposure key on the control panel) is pressed.

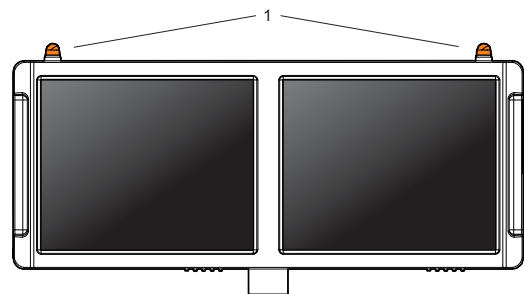


Figure 3-5: Exposure Lamps

- Continuous Fluoroscopy  
In this mode, the exposure lamps constantly light up.
- Pulse Fluoroscopy  
In this mode, the exposure lamps flash on and off.

There are three types of warning sounds during an exposure. The ringing patterns of the warning sounds are described below:

When	The G-Arm system sounds
in normal conditions,	two beeps per second
the dose rate exceeds 88 mGy/min,	four beeps per second
accumulated fluoroscopy time in a single study reaches 5 min,	eight beeps per second

**Related Topic:** "Fluoroscopy time summary" (s8.1.2, p90)

### 3.7 USB & Network Ports

The ports that are supported by the G-Arm system are shown in the figure below:

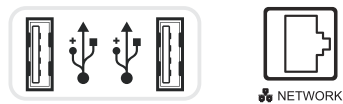


Figure 3-6: USB & Network Port

**Notes**

- *Personal USB flash disks are not allowed to be used in order to prevent or reduce the risk of computer virus infection.*
- *Use exclusive USB flash disks for the G-Arm system and perform virus checking periodically.*

Each USB interface can provide up to 500 mA current for a peripheral device.

The selected study can be transmitted from the network port to the PACS workstations, DICOM printer, etc. The G-Arm system supports DICOM 3.0 DX Modality and provides DICOM services.



*The device connected to DICOM interface shall conform to Standard EN 60601-1.*

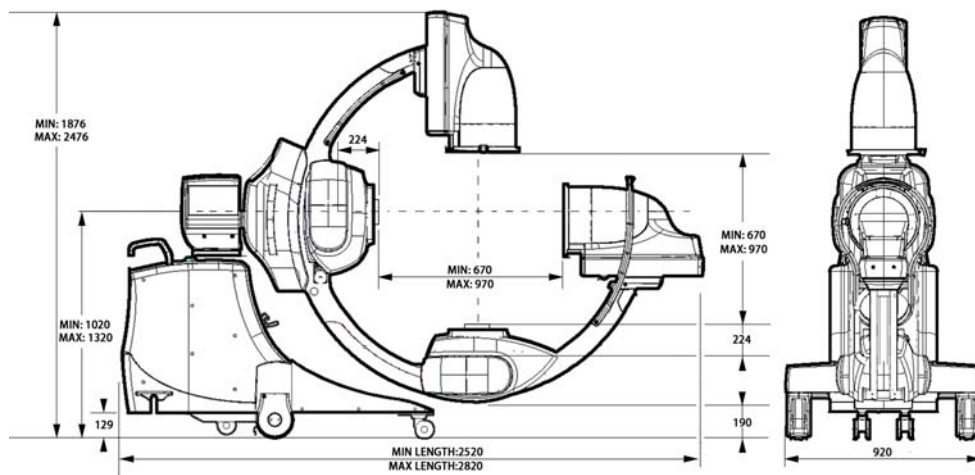
## CHAPTER 4

# MECHANICAL POSITIONING



## 4.1 Dimensions & Weights

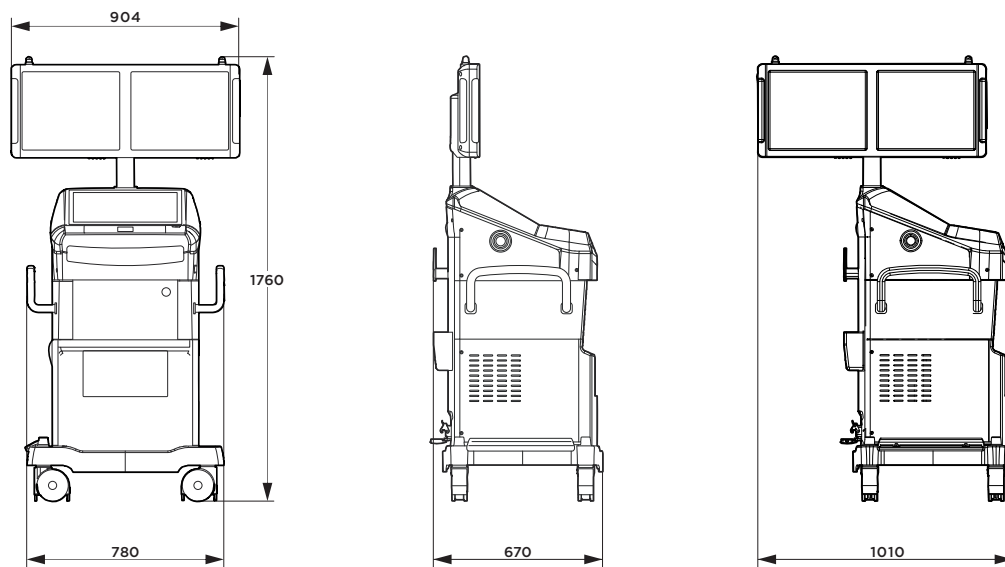
### 4.1.1 G-Arm Dimensions



**Note:** The deviation of the focal spot is 3 mm.

**Figure 4-1: G-Arm dimensions**

### 4.1.2 Control Unit Dimensions



**Figure 4-2: Dimensions of the control unit**

### 4.1.3 Equipment Weights

Whole Product Gross Weight:	≈ 670 kg
Weight of G-Arm:	≈ 520 kg
Weight of Control Unit:	≈ 150 kg

### 4.1.4 Operation Table Dimensions

Before starting the installation process of the G-Arm system, make sure the room allocated for using the G-Arm system meets the technical, safety and radiation protective requirements by the local rules.

The recommended dimensions of the operation table that matches the requirement of the G-Arm system are described as below:

Height:	≥ 605 mm
Width:	≤ 850 mm

## 4.2 Movement Controls



WARNING

*When positioning the G-Arm, observe the warning symbols attached to the equipment and observe the moving assemblies to ensure the safety of the patients and hospital personnel.*



CAUTION

*When the G-Arm system is in the Off state, the G-Arm will not respond to any control commands even with the circuit breaker being switched on.*

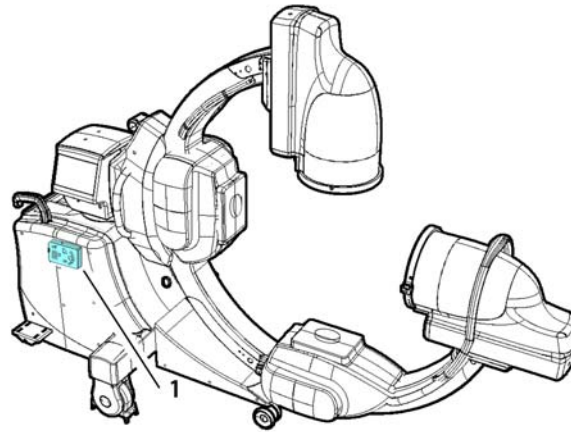
The G-Arm system offers a group of motor-driven positioning features, including:

- "G-Arm Orbital Rotation" (p48)
- "G-Arm Radial Rotation" (p49)
- "Image Intensifier Adjustment" (p49)
- "G-Arm Height Adjustment" (p50)

The equipment comes with a lined movement control board for the control of the G-Arm movements.

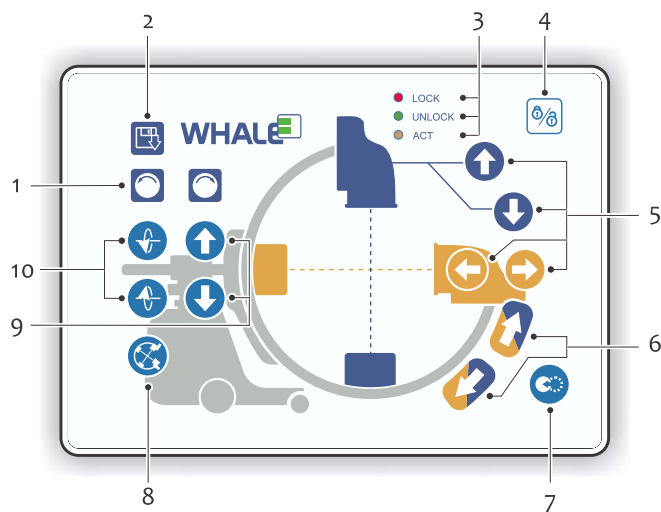


These movement controls are located on the movement control board (line control), as shown in Figure 4-4 (p47):



**Figure 4-3: Movement line control**

**Note:** Put the line control back to its original location as indicated in the Figure 4-3 (p47) after each use.



**Figure 4-4: Movement control keys**

- |   |   |   |             |
|---|---|---|-------------|
| 1 | Image rotation keys   | 2 | Save images |
| 3 | Key lock status indicator                                     | 4 | Key lock    |
| 5 | Image intensifier movement keys (AP: up/down; LT: left/right) |   |             |
| 6 | Orbital rotation keys (clock-wise and counter-clockwise)      |   |             |
| 7 | Reset combination key (press key 7 & 8 together)              |   |             |
| 8 | G-Arm compact position reset key (press key 7 & 8 together)   |   |             |

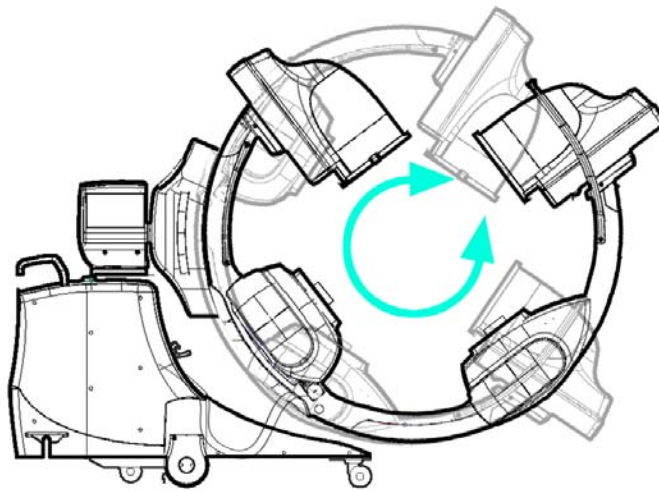
- 9 Vertical column lifting keys (up/down)
- 10 G-Arm radial rotation keys (clock-wise and counter-clockwise)

**Related Topic:** "G-Arm Attitude Restoration" (p50)

## 4.3 G-Arm Orbital Rotation

The G-Arm can rotate orbitally a total of 70° (35° clockwise and 35° counter-clockwise). The G-Arm is marked with a scale to aid in positioning.

G-Arm orbital rotation is motor-driven. Use the control keys on the line control to rotate the G-Arm.



**Figure 4-5: G-Arm orbital rotation**

## 4.4 G-Arm Radial Rotation

The G-Arm can be rotated radially a totally of 90° around the G-Arm support axis (45° on each direction).

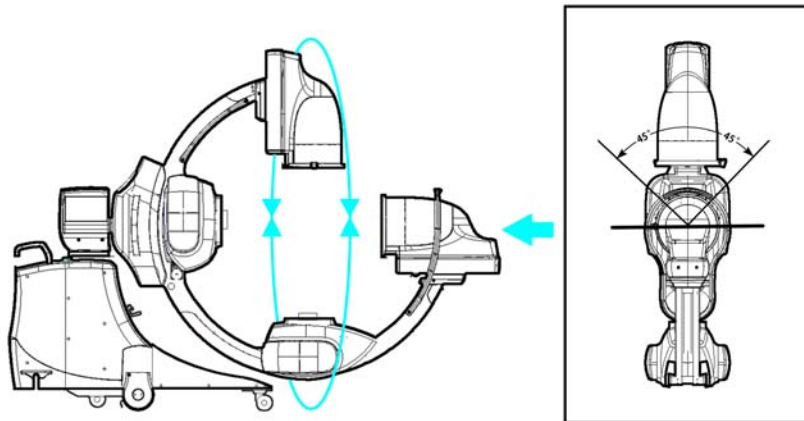


Figure 4-6: G-Arm radial rotation

## 4.5 Image Intensifier Adjustment

Each image intensifier provides a 300 mm of travel distance. Each side of the image intensifier is marked with a ruler to aid in positioning.

The movement of the image intensifier is motor-driven. You can use the control keys on the line control to move the image intensifiers.

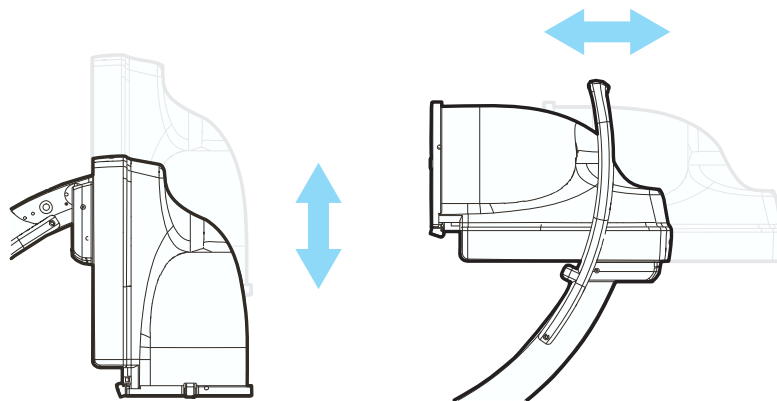


Figure 4-7: Positioning the image intensifiers

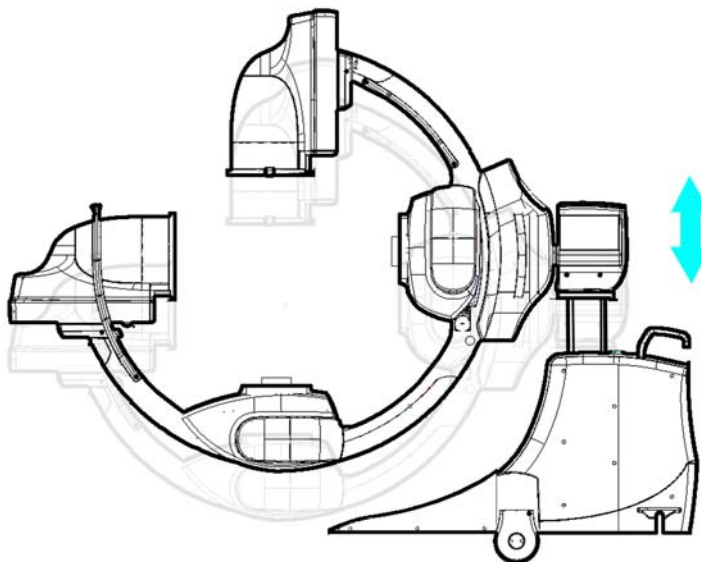
## 4.6 G-Arm Height Adjustment

**WARNING**

When positioning the vertical columns of the G-Arm, observe the moving assemblies to ensure the safety of the patients and hospital personnel.

The G-Arm as a whole can lift itself up by at most 300 mm by means of vertically extending and retracting the main support beam that prop the G-shaped arm.

The elevation of the G-Arm is motor-driven. You can use the control keys on the line control increase or decrease the height of the G-Arm.



**Figure 4-8: Elevating or lowering the G-Arm**

### Anticollision device

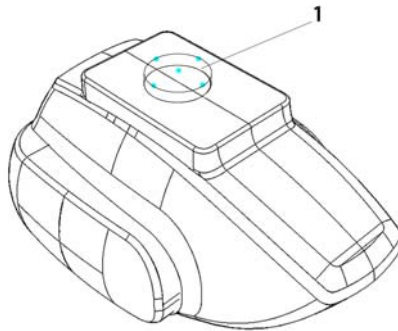
Top of X ray tube assembly in AP direction and LT direction. There are anti-collision devices installed. In the process of G-arm elevation, if the anti-collision flip-flop (Fig. 1 below) mounted in the position of X-ray emission circular hole touches the operating table or other objects, the anti-collision flip-

flop will trigger the collision signal after being squeezed, and the system will immediately terminate the movement of G-arm.



CAUTION

Keep the space around the anti-collision device clear during normal operation to avoid accidental activation or damage to the anti-collision device.



**Figure 4-9: Collision avoidance mechanism protects patients and equipment**

1 Collision avoidance trigger

## 4.7 G-Arm Attitude Restoration

The G-Arm can be restored to a compact where the G-shaped arm is rotated by 35° to save up some space for packaging.

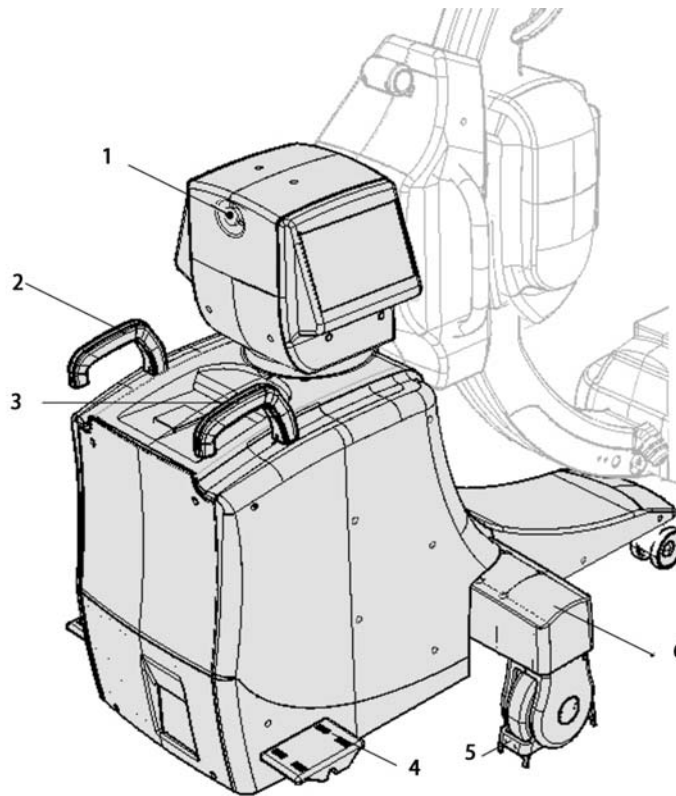
The specific setup of the compact position is described as follows:

Movement	Compact Position Settings
Orbital Rotation	35°
Radial Rotation	0°
SID	910 mm
Vertical Movement	0 mm

To restore the G-Arm to the compact position:

**STEP ►** On the line control, press and hold the **Reset** combination key (7 in Figure 4-4 (p47)) and **Compact Position Reset** key (8 in Figure 4-4 (p47)) together until the G-Arm stops moving.

## 4.8 Maneuvering the G-Arm



**Figure 4-10: The G-Arm Base**

- |                   |                   |
|-------------------|-------------------|
| 1 Emergency Stop  | 2 Steering handle |
| 3 Steering handle | 4 Brake pedal     |
| 5 Buffer          | 6 G-Arm Base      |

The G-Arm can be moved and positioned with less effort and more accuracy with the steering handles.

The G-Arm has two handles that can be swiveled to control the moving direction. Use these handles to turn the rear wheels from 0° to 90° to the right or left. Use this feature to position the G-Arm during clinical applications or to negotiate sharp turns during transport. The rear wheels turn at approximately the same angle as the right steering handle.



CAUTION

*To avoid losing control of the G-Arm, always reduce transport speed before moving the steering handle out of the 0° position.*

## 4.9 Moving the Control Unit



CAUTION

Familiarize yourself with the mechanical operations of all controls prior to moving the equipment.



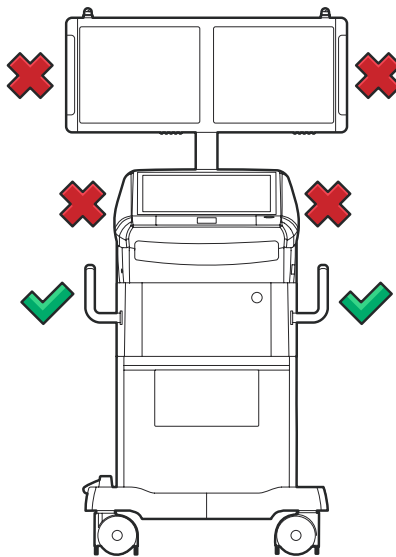
CAUTION

It takes two people to maintain control of either unit (Control Unit or G-Arm) when moving up or down an incline. Do NOT move the unit up or down stairs or steps. Do NOT lock the unit in place on an incline.




WARNING

Keep the Control Unit at least 3 meters away from the G-Arm. Leave enough space for maneuvering.



**Figure 4-11: Use only the handles to move the Control Unit**

To move the Control Unit:

- STEP 1 Press the **Power On** button  above the control panel to turn off the equipment, and then switch off the **circuit breaker** (2 in Figure 2-5 (p32)).
- STEP 2 Unplug the power cord (L1). Disconnect the interconnect cable (L2) from the G-arm assembly. Disconnect any other external connections like footswitch cable (L3), protective earth cable (L4), etc.
- STEP 3 Pull the monitor handles to make the viewing monitors face front.

- STEP 4 Unlock the wheel brakes on the locking wheels on the Control Unit.
- STEP 5 Guide the Control Unit to the destination using the handles indicated in Figure 4-10 (p53).
- STEP 6 When you reach your destination, apply the wheel brakes.

## 4.10 Moving the G-Arm



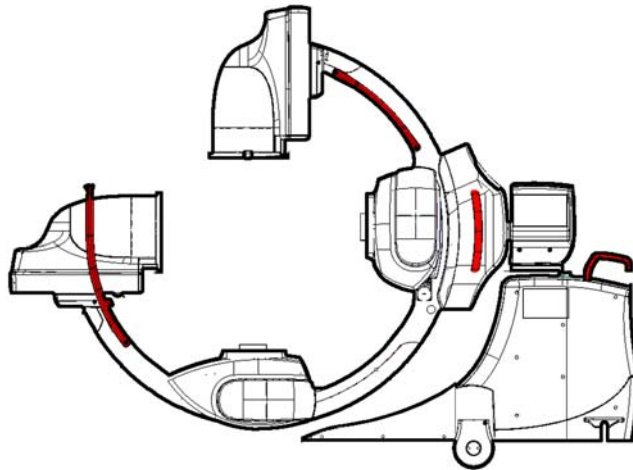
CAUTION

Familiarize yourself with the mechanical operations of all controls prior to moving the equipment.




CAUTION

It takes two people to maintain control of either unit (Control Unit or G-Arm) when moving up or down an incline. Do NOT move the unit up or down stairs or steps. Do NOT lock the unit in place on an incline.



**Figure 4-12: Use only the handles to move the G-Arm**

To move the G-Arm:

- STEP 1 Use the movement line control to minimize the G-Arm height, and then reset the radial rotation angle of the G-Arm to 0°.
- STEP 2 Press the **Power On** button  above the control pane of Control Unit to turn off the equipment, and then switch off the **circuit breaker** (2 in Figure 2-5 (p32)).



- STEP 3 Unplug the power cord (L1). Disconnect the interconnect cable (L2) from the G-arm assembly. Disconnect any other external connections like footswitch cable (L3), protective earth cable (L4), etc.
- STEP 4 Unlock the wheel brakes on the locking wheels on the G-Arm.
- STEP 5 Guide the G-Arm to the destination using the handles.  
As indicated in *Figure 4-11 (p54)*, use the tube handles (2), arc arm handle (3) and I.I. handle (4) to move the G-Arm. If the G-Arm is out-fitted with a steering unit, you can also use the handles (1) on the steering unit.



WARNING

*Do not pull or push the I.I. handle (4 in Figure 4-11 (p54)) with excessive strength in attempt to move the G-Arm. Use it gently to guide the G-Arm during transport.*

- STEP 6 When you reach the destination, apply the wheel brakes.



CAUTION

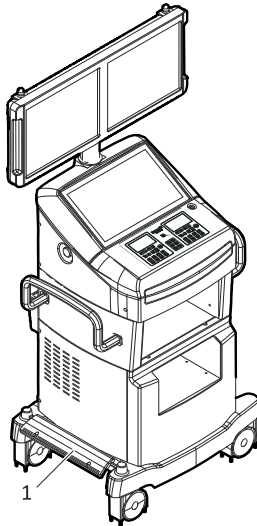
*The G-Arm system uses a separable plug as the isolation means. Do NOT position the G-Arm system in a place where it is difficult to disconnect the equipment from the power supply.*

## 4.11 Locking the Equipment in Position

Both the Control Unit and the G-Arm can be locked in place to prevent unintentional movements. The Control Unit and G-Arm both have a brake pedal to hold the locking wheels in position.

**Lock the Control Unit**

Each of the Control Unit and G-Arm has four swivel locking wheels, which can be together locked via a brake pedal.



**Figure 4-13: The brake pedal on the Control Unit**

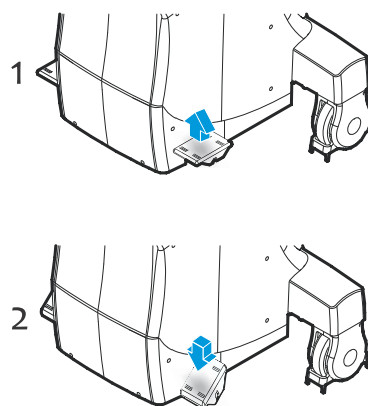
1 Brake pedal

To lock/unlock the Control Unit:

STEP► Press down the brake pedal (1). To unlock it, press it again.

**Lock the G-Arm**

The G-Arm has two brake pedals that, when either one is pressed down, can lock the G-Arm in position.



**Figure 4-14: The brake pedal on the G-Arm**

- 1 Unlocks the wheel brakes on the steering unit to allow the wheels to roll
- 2 Locks the wheel brakes on the steering unit

To lock/unlock the G-Arm:

STEP► Press down either of the brake pedals. To unlock it, press it again.

## 4.12 Positioning the Monitors

From the neutral position, the viewing monitor assembly of the G-Arm system can be rotated 180° to either direction for optimal viewing.

You can manually adjust the contrast and brightness for better display quality. These settings will retain until they are changed again.



WARNING

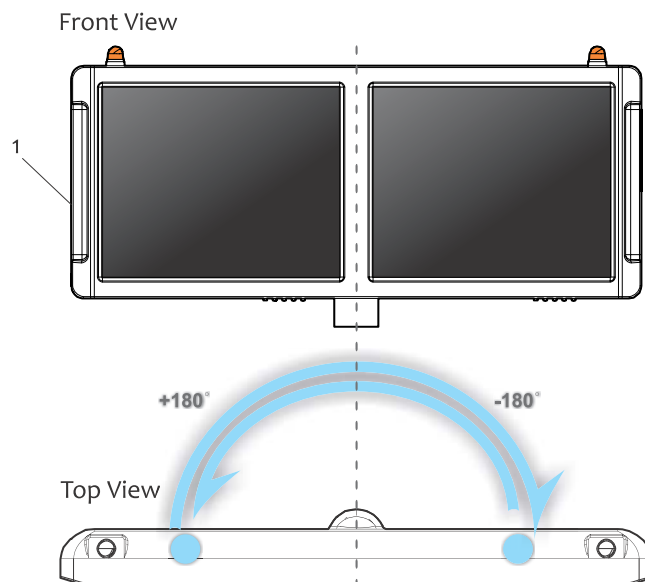
*Touch only the indicated positions to position the monitors. Pulling on other parts of the monitor assemblies during monitor positioning might cause damages to the monitor assembly.*



CAUTION

*Clear all the obstacles within the moving range of the viewing monitors to make sure the monitors do not collide with any objects.*

*Do not drape cables or clothes over the monitors. Pulling a cable or clothes draped over the monitor assemblies could cause the monitors to move unexpectedly.*



**Figure 4-15: Positioning the viewing monitors**

*1 Viewing monitor handle*

To position the viewing monitors:

STEP ► Hold either of two sides (1) of the viewing monitor assembly and pull it to move the monitors to the desired position.

## CHAPTER 5

# OPERATING CONTROLS



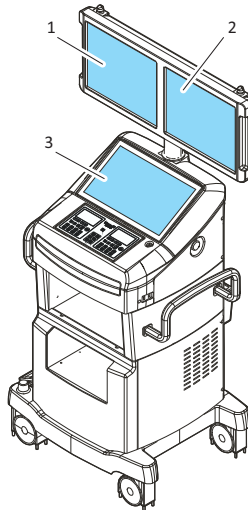
## 5.1 Viewing & Control Monitors

The G-Arm system includes two viewing monitors (1, 2) and one control monitor (3). During the examination, the image will be displayed on Viewing monitors in real-time. The AP & LT fluoroscopic images will be displayed on the left and right viewing monitors.



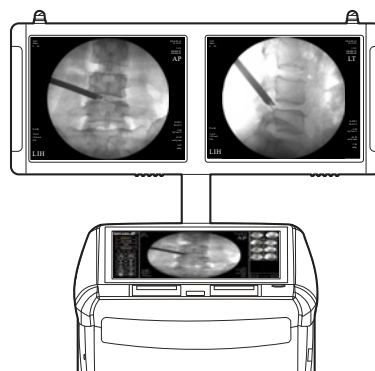
CAUTION

*The terms of AP and LT used on the G-Arm system and in this manual are only to indicate the X-ray plane on which the images are generated. They are not identical to the clinical terms of AP and LT.*



**Figure 5-1: Locations of the monitors (perspective view)**

- 1 Viewing monitor (AP)
- 2 Viewing monitor (LT)
- 3 Control screen

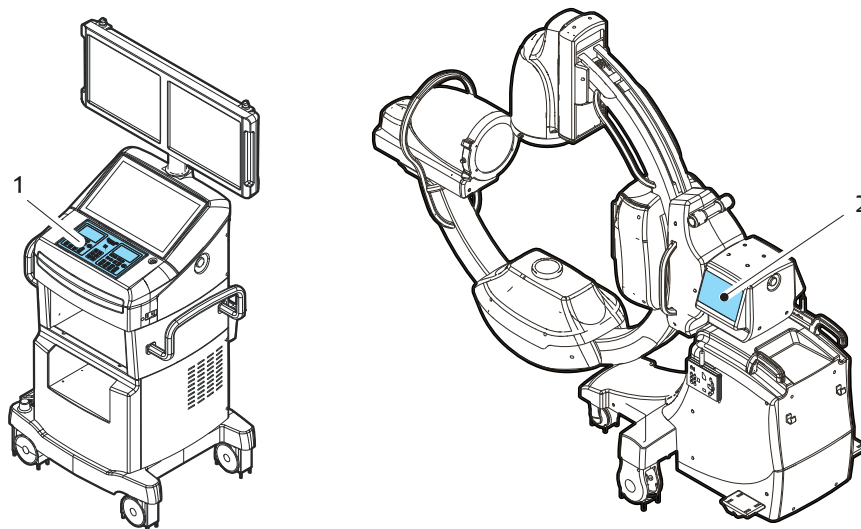


**Figure 5-2: Workstation monitors (front view)**

## 5.2 Control Panel

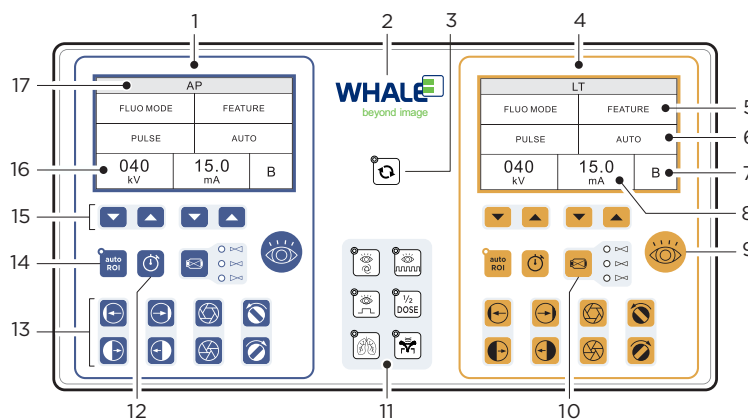
The control panel provides access to all the features and functions that the G-Arm system offers. The control panel is located both on the control unit (1) and the G-Arm base (2).

The control panel on the G-Arm base is identical to that on the Control Unit, except that it does not provide the Exposure key.



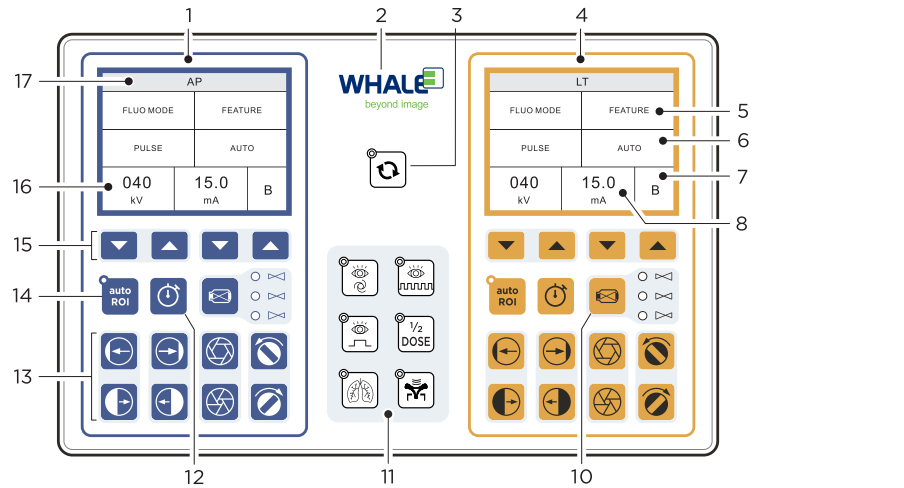
**Figure 5-3: Location of the control panel**

- 1 Control panel on the Control Unit
- 2 Control Panel on the G-Arm Base



**Figure 5-4: Control panel layout (Control Unit)**









**Figure 5-5: Control panel layout (G-Arm base)**

- |                                      |   |
|--------------------------------------|---|
| 1 Control keys on AP plane           | 2 Whale Logo                            |
| 3 Image Parameter Reset key          | 4 Control keys on LT plane              |
| 5 Fluoroscopy mode & feature caption | 6 Fluoroscopy mode or feature display   |
| 7 Soft tissue or limbs display       | 8 Current mA value display              |
| 9 Exposure key                       | 10 FoV (Field of Vision) selection keys |
| 11 Fluoroscopy mode selection keys   | 12 Reset key                            |
| 13 Collimator regulating keys        | 14 Auto ROI (Region of Interest) key    |
| 15 kV/mA adjusting keys              | 16 Current kV value display             |
| 17 Fluoroscopic plane display        |   |

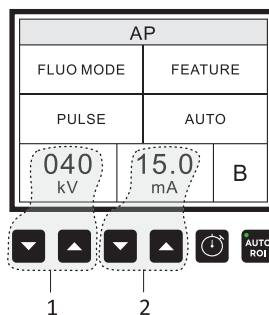
Key	Description	Key	Description
	Automatic Continuous Fluoroscopy		Automatic Pulse Fluoroscopy
	DR Fluoroscopy		Half Dose Fluoroscopy
	Tissue Fluoroscopy		Bone Fluoroscopy
	Left Shutter Open (*)		Right Shutter Open (*)
	Left Shutter Close (*)		Right Shutter Close (*)
	Iris Collimator Close		Iris Collimator Open
	Collimator Shutter Rotation (Clockwise)		Collimator Shutter Rotation (Counter-clockwise)
	kV/mA Increase		kV/mA Decrease
	Automatic Region of Interest (ROI) mode		FoV (Field of Vision) selection key

Key	Description	Key	Description
	Reset accumulated Single Study Fluorocopy Time		Take an exposure
	Reset the image parameters to factory settings. The following image settings will be reset: Sharpening, Noise Reduction, Brightness, Contrast, Rotation, Inversion, and Mirror.		

### 5.2.1 Adjust the voltage/current values

Fluoroscopic imaging is activated by pressing the relevant foot switch or the  key on the control panel.

To manually set the kV or mA values, you can use the triangular shaped arrow keys beneath the LCD screens of the control panel. Use the keys (1) beneath the kV readings to adjust the kV values, and use those (2) beneath mA to adjust the mA values, as below:







**Figure 5-6: kV/mA adjustment keys**

- 1 kV adjusting keys
- 2 mA adjusting keys

### 5.2.2 Adjust the FoV

You can generate an image in three different FoV (Field of Vision) sizes.

To select the FoV size, on the control panel, press the FoV selection key  to switch among the three sizes, which are described in the following table:

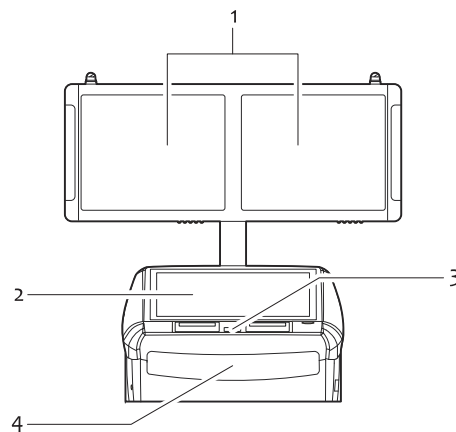
Field Size	FoV Indicator	Level of Magnification
9 inches		1× (this FoV size is by default selected)
6 inches		1.5×
4.5 inches		2×

## 5.3 Touch-screen Controls

The control monitor provides a touch-screen for interacting with the Workstation software. Using the touch-screen (and the keyboard for text-entry) you can:

- Enter and view patient information
- View and process images/videos
- Set imaging parameters
- Annotate, compare, zoom, or rotate images
- Print images
- Generate dose summary reports

For detailed information, please refer to the chapter "*Workstation Software*" (p87).



**Figure 5-7: Control Unit Monitors**

- 1 Viewing monitors
- 2 Control monitor with touch-screen
- 3 Control panel with two LCD screens
- 4 Keyboard drawer

## 5.4 Collimator

The collimator is a fully automatic, microprocessor controlled device designed to provide accurate X-ray collimation. The collimator automatically adjusts itself upon SID (source to image distance) change. The collimator can be manually adjusted through corresponding collimator keys on the control panel.

The collimator will automatically adjust its aperture to control the X-ray field according to the current SID value.

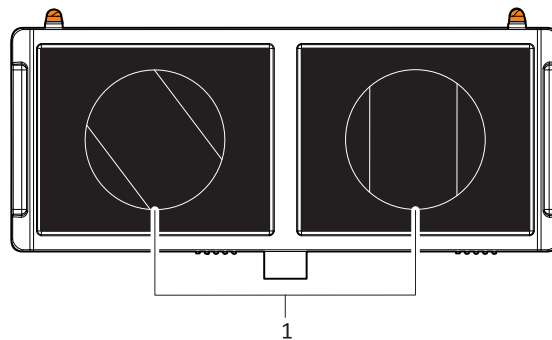
To obtain the best image quality, the SID value shall be adjusted to about 100 cm during fluoroscopic imaging.

At any SID, when both the iris and shutters of a collimator are opened as wide as they can through the adjustment keys on the control panel, the actual X-ray radiation field will remain 25 cm, with a deviation range of  $\pm 2\%$  of the current SID.

### **Collimator preview**

When the collimator control keys are used, on the corresponding viewing monitors, collimator preview will be displayed to simulate the collimator shapes and imitate their movements. This is helpful for the operators to get a hint of the collimator status at any time.

**Note:** The previewing lines appear only after a control command is issued, and will retain on screen for a few seconds.



**Figure 5-8: Collimator preview**

1 Collimator preview: Iris (circle) & shutter (straight lines)

#### **Related Topics**

- For information on collimator control keys, see "Control Panel" (s5.2, p62).

## **5.5 Footswitch**

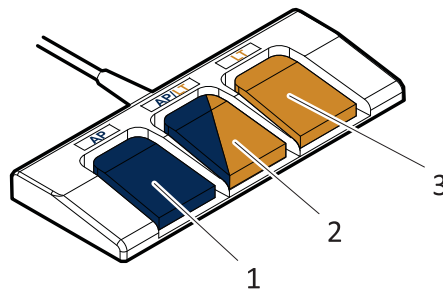
The X-ray footswitch offers maximum flexibility and control over image generation, which allows you to initiate fluoroscopic imaging process on the AP plane, LT plane, or both planes.

Two types of the X-ray footswitch are supported: 3-pedal footswitch (Figure 5-9 (p67)) and 2-pedal footswitch (Figure 5-10 (p67)). The pedals are coated with different colors, representing exposures on AP plane (blue), LT

plane (yellow), and the combination of AP and LT planes (blue and yellow, not available on two-pedal footswitch).

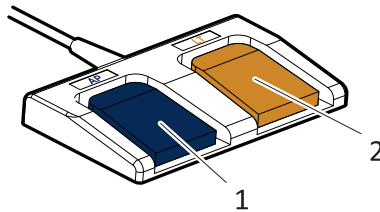


Avoid continuously tapping on the X-ray footswitch pedals over long periods of time.



**Figure 5-9: 3-pedal Footswitch**

- 1 Pedal for taking exposure on the AP plane
- 2 Pedal for taking exposure on both AP and LT planes
- 3 Pedal for taking exposure on the LT plane

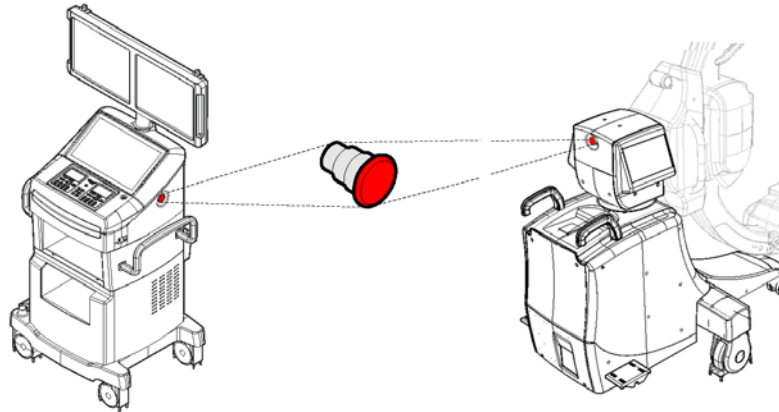


**Figure 5-10: 2-pedal footswitch**

- 1 Pedal for taking exposure on the AP plane
- 2 Pedal for taking exposure on the LT plane

## 5.6 Emergency Stop Switches

Emergency Stop switches are located on each side of the control unit as well as on the back of the main support beam assembly of the G-Arm base. Press either Emergency Stop switch to shut down the equipment.



**Figure 5-11: Emergency Stop Switch on the Control Unit (left) and G-Arm (right)**

To apply the Emergency Stop switch:

STEP ► Press down the switch.

To release the Emergency Stop switch:

STEP ► Turn the knob counter-clockwise to release the switch.

## CHAPTER 6

# **X-RAY IMAGING PROCESS**



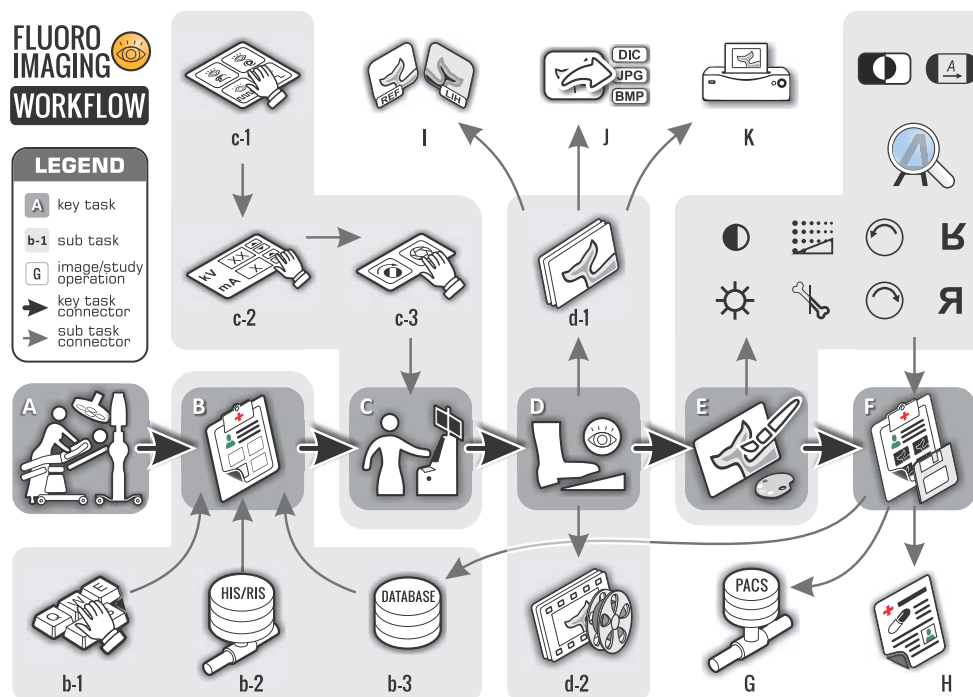


## 6.1 Fluoroscopy Imaging Work-flow

The fluoroscopic imaging process:

- 1 Surgery preparation (patient positioning, starting up the equipment, etc.)
- 2 Create a new study (filling/reusing the information of a patient)
- 3 Make fluoroscopic exposure (generating fluoroscopic images or cine-loops)
- 4 Process the generated images
- 5 Save and close the study

The following flowchart illustrates a more detailed work-flow that may be followed during a fluoroscopic procedure:



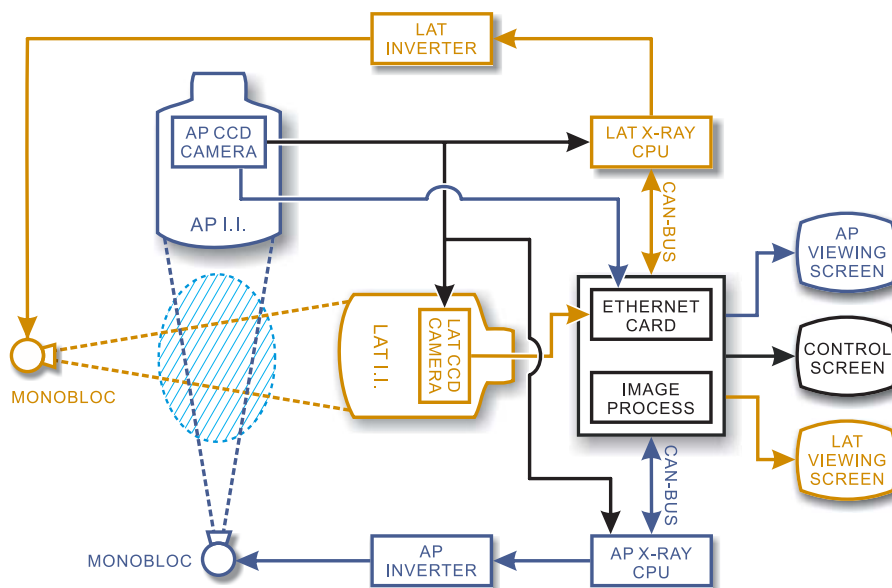
**Figure 6-1: Fluoroscopy Imaging Work-flow**

- |            |   |
|------------|---|
| <b>A</b>   | Position the patient and prepare for fluoroscopic exposure    |
| <b>B</b>   | Create a new patient study by                                 |
| <b>b-1</b> | registering a patient by entering the patient information, or |
| <b>b-2</b> | registering a patient using the information from HIS/RIS, or  |
| <b>b-3</b> | registering patient using the information from local database |
| <b>C</b>   | Set parameters for the fluoroscopy imaging by                 |
| <b>c-1</b> | selecting a fluoroscopy mode                                  |

- c-2** setting the tube voltage and current values (kV and mA)
- c-3** adjusting the collimator
- D** Take an exposure to
  - d-1** generate a static fluoroscopy image
  - d-2** generate a cine loop clip
- E** Process the generated images (sharpen, reduce noise, etc)
- I** Compare a fluoroscopic image with the last image on screen
- J** Export images to a variety of file formats
- K** Print images
- F** Save the study
- G** Transmit the study to a network server via DICOM protocol
- H** Generate dose summary report

\* Steps **G, H, J** and **K** can be performed either before or after the saving action of the study.

## 6.2 Fluoroscopy Imaging Process



**Figure 6-2: TV Chain**

The image intensifier tubes used by the G-Arm system are vacuum tube devices, which are used to increase the intensity of available light in an optical system to facilitate visual imaging of low-light processes, from fluorescence of materials to X-rays to visible sharp contrast images. The images are captured by the CCD cameras, transmitted via the PC to the monitors. The PC has the image information processed before displaying the images on the monitors.

## CHAPTER 7

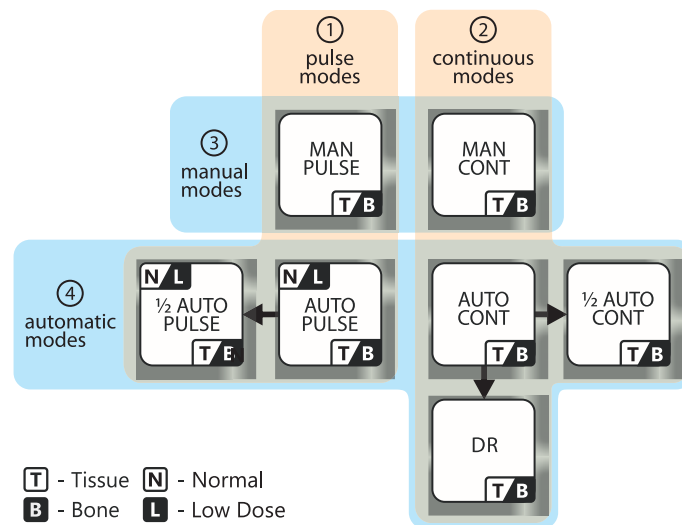
# FLUORO IMAGING MODES



## 7.1 Overview

A fluoroscopy mode allows you to take advantage of the preset fluoroscopy settings and get the G-Arm system ready for fluoroscopic imaging.

The following diagram includes all fluoroscopy modes that the G-Arm system provides, and tries to depict their classifications and the inherent relationships among them.



**Figure 7-1: Fluoroscopy modes**

As shown in the above diagram, the fluoroscopy mode can be categorized by the X-ray emitting pattern or by the control method of the imaging process, which consequently divides a fluoroscopy mode into the following four major types:

- Pulse mode (**by X-ray emitting pattern**)
- Continuous mode (**by X-ray emitting pattern**)
- Manual mode (**by control method**)
- Automatic modes (**by control method**)

These basic modes are briefly introduced in the succeeding topics in this section, together with introduction of some features and mode variants that the G-Arm system offers to facilitate more use cases.

### **Pulse and continuous modes**

According to different patterns through which the X-ray beam is generated, the G-Arm system can be operated in two different types of modes:

- Pulse Fluoroscopy modes (①)

The X-ray is generated and emitted in an on-off pattern at a high frequency, which is often used for fluoroscopic imaging that simultaneously generates X-ray from multiple planes that intersect each other to avoid light interferences.

- Continuous Fluoroscopy modes (②)  
The X-ray is generated and emitted continuously.

### **Manual and automatic modes**

Each of the above two modes can be operated either manually (adjustable loading factors, i.e., kV and mA values) or automatically (loading factors are controlled by the G-Arm system). Combined with the pulse/continuous modes, the fluoroscopy modes can be further divided into four:

- "Automatic Continuous Fluoroscopy" (p78) (②④)
- "Automatic Pulse Fluoroscopy" (p79) (①④)
- "Manual Continuous Fluoroscopy" (p78) (②③)
- "Manual Pulse Fluoroscopy" (p80)(①③)

### **Derivative modes**

Derived from the above two automatic fluoroscopy modes, two additional modes are introduced in order to offer more flexibility to fit various clinical application scenarios, which includes:

- "DR Fluoroscopy" (p80) (modifies only Automatic Pulse Fluoroscopy mode)
- "Half Dose Fluoroscopy" (p81) (modifies only Automatic Pulse Fluoroscopy and Automatic Continuous Fluoroscopy modes)

### **Normal and Low Dose features**

For the automatic pulse fluoroscopy modes, a special derivative named Penetration is offered to produce quality fluoroscopic images for bigger objects by applying higher dosage. To represent regular automatic pulse fluoroscopy without the Penetration feature being turned on, another feature called Resolution is therefore introduced. Now for the automatic pulse modes, you can choose one of the following:

- Normal (applies to automatic pulse fluoroscopy mode)
- Low Dose (applies to automatic pulse fluoroscopy mode)

By default, the Resolution mode is selected.

**Related Topic:** For more information on the Low Dose mode and how it works, see "Normal & Low Dose Features" (p82).

### ***Tissue and bone features***

The G-Arm system comes with two exclusive features for generating the fluoroscopic images of soft tissues and limbs, which offers higher degree of visibility and recognition. These two features are:

- Tissue (applies to all fluoroscopy modes)
- Bone (applies to all fluoroscopy modes)

**Related Topic:** For more information on this topic, see "In Half Dose Fluoroscopy mode, the mA will be reduced by half, namely, 15 mA (1-plane imaging) or 15 mA (2-plane imaging).Tissue & Bone Features" (p83).

## **7.1.1 Bi-plane real-time fluoroscopy**

One of the substantial features that the G-Arm system offers is fluoroscopy in both the AP & LT planes.

Bi-plane fluoroscopy works only in the pulse fluoroscopy modes.

Press the AP/LT footswitch pedal (blue-yellow-colored), the G-Arm system takes exposures and generates fluoroscopic images in both AP and LT planes simultaneously. This feature is available only when the G-Arm system is equipped with 3-pedal footswitch.

If the G-Arm system is in the continuous modes when the AP/LT footswitch pedal is pressed, the G-Arm system will automatically activate the pulse modes to complete the request.

## **7.1.2 Default mode after startup**

Automatic Pulse Fluoroscopy is the default mode when the G-Arm system is started.

## **7.1.3 Recommended mode for different clinical applications**

Lower dosage is always a wise choice if higher image quality is not a primary demand; use the Half-dose Fluoroscopy mode or decrease the loading factor values wherever possible to reduce the dose absorbency of patients as well as physicians.

In most clinical applications, it is recommended to use automatic fluoroscopy modes to allow the G-Arm system to determine the dosage for you.

The following table lists the recommended fluoroscopy modes for some particular body parts:

Body part	Recommended mode
Limbs	Continuous Fluoroscopy
Cervical spine	Continuous Fluoroscopy
Thoracic spine/lumbar/sacral	Pulse Fluoroscopy
Hip	Pulse Fluoroscopy


## 7.2 Automatic Continuous Fluoroscopy

In Automatic Continuous Fluoroscopy mode, the G-Arm system sets the loading factors such as kV and mA values automatically. During fluoroscopic imaging, the X-ray is continuously generated.

In this mode, the mA and the kV values alter to achieve optimal image quality based on the particular conditions of the patient.

### Activating the mode: Automatic Continuous Fluoroscopy

To switch to this mode:

STEP ► In any mode, press the  key.

The LCD screens on the control panel display the current mode - "CONTINUOUS | AUTO FLUO".

### Ranges of loading factors

The ranges of the loading factor values are listed below:



Automatic Continuous Fluoroscopy	
<b>kV</b>	40~120 kV
<b>mA</b>	0.2~ 4.0 mA

## 7.3 Manual Continuous Fluoroscopy

In Manual Continuous Fluoroscopy mode, you manually set the loading factors such as kV and mA values according to the particular conditions of different patients. During fluoroscopic imaging, the X-ray is continuously generated.

### Activating the mode: Manual Continuous Fluoroscopy

To switch to this mode:

STEP ► In the **Automatic Continuous Fluoroscopy** mode, press either of the **kV or mA adjustment keys** ( or ) to switch to the Manual Continuous Fluoroscopy mode.



The LCD screens on the control panel display the current mode - "CONTINUOUS | MANUAL FLUO".

### **Ranges of loading factors**

The ranges of the loading factor values and the step values it will take when you manually adjust the loading factors are listed below:

Manual Continuous Fluoroscopy			
<b>kV</b>	40~120 kV	<b>Step</b>	1 kV
<b>mA</b>	0.2~4.0 mA	<b>Step</b>	0.1 mA

## **7.4 Automatic Pulse Fluoroscopy**


In Automatic Pulse Fluoroscopy mode, the G-Arm system sets the loading factors such as kV and mA values automatically. During fluoroscopic imaging, the X-ray is intermittently generated.

In this mode, the mA and the kV values alter to achieve optimal image quality based on the particular conditions of the patient.

**Note:** Simultaneous bi-plane (AP & LT) fluoroscopy imaging, namely, taking exposures from both AP and LT planes, can only be initiated from the Auto/Manual Pulse Fluoroscopy mode. While in other continuous fluoroscopy modes, if the AP/LT foot pedal (blue & yellow colored) is pressed, the system automatically switches to the pulse modes.

### **Activating the mode: Automatic Pulse Fluoroscopy**

To switch to this mode:

STEP► In any mode, press the  key.

The LCD screens on the control panel display the current mode - "PULSE | AUTO FLUO".

### **Ranges of loading factors**

The ranges of the loading factor values are listed below:

Automatic Pulse Fluoroscopy			
<b>kV</b>	40~120 kV		
<b>mA</b>	0.2~30 mA	(1-plane imaging)	
	0.2~30 mA	(2-plane imaging)	




## 7.5 Manual Pulse Fluoroscopy

In Manual Pulse Fluoroscopy mode, you manually set the loading factors such as kV and mA values according to the particular conditions of different patients. During fluoroscopic imaging, the X-ray is intermittently generated.

**Note:** Simultaneous bi-plane (AP & LT) fluoroscopy imaging, namely, taking exposures from both AP and LT planes, can only be initiated from the Auto/Manual Pulse Fluoroscopy mode. While in other continuous fluoroscopy modes, if the AP/LT foot pedal (blue & yellow colored) is pressed, the system automatically switches to the pulse modes.

### Activating the mode: Manual Pulse Fluoroscopy

To switch to this mode:

- STEP 1 In any mode, press the  key.  
The Automatic Pulse Fluoroscopy mode is activated.
- STEP 2 In the **Automatic Pulse Fluoroscopy** mode, press either of the **kV adjustment keys** ( or ) to switch the Manual Pulse Fluoroscopy mode.  
The LCD screens on the control panel display the current mode - "PULSE | MANUAL FLUO".

### Ranges of loading factors

The ranges of the loading factor values and the step values it will take when you manually adjust the loading factors are listed below:

Manual Pulse Fluoroscopy			
<b>kV</b>	40~120 kV	<b>Step</b>	1 kV
<b>mA</b>	0.2~30 mA (1-plane imaging)	<b>Step</b>	0.1 mA
	0.2~30 mA (2-plane imaging)		


## 7.6 DR Fluoroscopy

The DR (Digital Radiation) Fluoroscopy mode is substantially the same as the Automatic Pulse mode, except with more progressive parameter settings to produce better images.

In this mode, the mA value is fixed, higher than that in the Automatic Pulse mode. Meanwhile, the G-Arm system automatically alters the kV value and the exposure duration to achieve higher image quality.

**Activating the mode: DR Fluoroscopy**

To switch to this mode:

- STEP ► In any mode, press the  key.  
The LCD screens on the control panel display the current mode - "PULSE | DR FLUO".

**Ranges of loading factors**

The ranges of the loading factor values are listed below:

DR Fluoroscopy	
<b>kV</b>	40~120 kV
<b>mA</b>	40.0 mA


## 7.7 Half Dose Fluoroscopy

In Half Dose Fluoroscopy mode, the G-Arm system sets the loading factors such as kV and mA values automatically by simply reducing the mA values of the Automatic Continuous Fluoroscopy or Automatic Pulse Fluoroscopy by half.

During fluoroscopic imaging, the X-ray is continuously/intermittently generated, depending on the fluoroscopy mode that has been previously activated.

**Activating the mode: Half Dose Fluoroscopy**

To switch to this mode:

- STEP ► In any mode, press the  key.  
The LCD screens on the control panel display the current mode - "CONTINUOUS | HALF AUTO FLUO" or "PULSE | HALF AUTO FLUO".

**Ranges of loading factors**

The ranges of the loading factor values are listed below:

½ Dose Auto Cont. Fluoroscopy	
<b>kV</b>	40~120 kV
<b>mA</b>	0.2~2.0 mA

½ Dose Automatic Pulse Fluoroscopy (Normal)	
<b>kV</b>	40~120 kV

<b>½ Dose Automatic Pulse Fluoroscopy (Normal)</b>		
<b>mA</b>	0.2~15 mA	(1-plane imaging)
	0.2~15 mA	(2-plane imaging)

<b>½ Dose Automatic Pulse Fluoroscopy (Low Dose)</b>		
<b>kV</b>	40~120 kV	
<b>mA</b>	0.2~7.5 mA	(1-plane imaging)
	0.2~7.5 mA	(2-plane imaging)

## 7.8 Normal & Low Dose Features

### Low Dose Feature

The Low Dose feature provides lower dosage to penetrate small objects such as the body parts of a patient with a small body size.

### Normal Feature

The Normal feature provides higher dosage to penetrate bigger objects such as the body parts of a patient with a larger body size.

The initial loading factors of Normal Feature for the automatic pulse fluoroscopy are:

---

**kV:** 70 kV

**mA:** 30 mA (1-plane imaging), 30 mA (2-plane imaging)

---

### Access the Penetration mode

STEP 1 Press MODE.

The system prompts you to select a mode, as shown below:

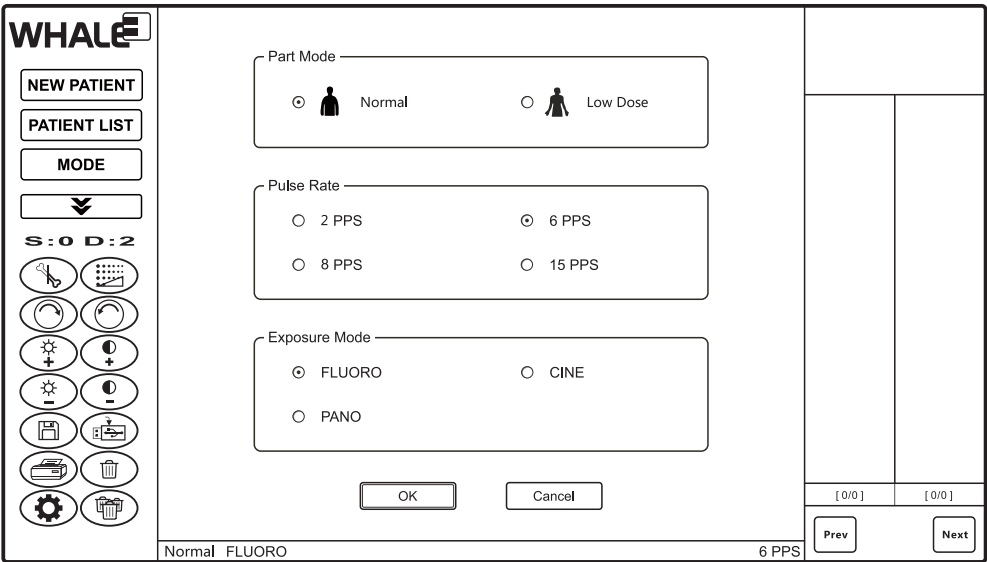


Figure 7-2: Mode Selection

STEP 2 From **Exposure Mode**, select **FLUORO**, from **Part Mode**, select **Penetration**, and then click **OK**.

The system switches to the Penetration mode.

**Note:** Please note that the Penetration mode works only in the Automatic Pulse mode.

### Ranges of loading factors

The ranges of the loading factor values are listed below:

Automatic Pulse Fluoroscopy (Penetration)		
kV	40~120 kV	
mA	30 mA	(1-plane imaging)
	30 mA	(2-plane imaging)



**Note:** In Half Dose Fluoroscopy mode, the mA will be reduced by half, namely, 15 mA (1-plane imaging) or 15 mA (2-plane imaging).

## 7.9 Tissue & Bone Features

The G-Arm system provides the Tissue and Bone features specially for soft tissue and the limb fluoroscopic imaging, which can offer higher degree of object recognition.

### Activating the Tissue or Bone feature

To activate this feature:

STEP ► In any mode, press the **Tissue**  or **Bone**  key.

The LCD screens on the control panel display the currently selected feature - capitalized characters "T" or "B" - in the lower right corners.


**Note:** You can neither activate nor deactivate both of these two features at the same time. The Bone feature is automatically activated upon system start.

### Tissue/Bone Parameters

The parameters used for the Tissue and Bone features are listed below:

	Default Brightness	Default Contrast
<b>Tissue</b>	1	2
<b>Bone</b>	0	1

## 7.10 Automatic Exposure Control

In automatic modes, if you release the footswitch or the  key on the control panel immediately after a press, the G-Arm system will initiate the AEC (Automatic Exposure Control) sequence, in which the loading factors (kV, mA, and exposure duration) are automatically controlled according to the physical characteristics of the patients.


Automatic modes, where the AEC sequence may take over the control, includes the following:

- Automatic Continuous Fluoroscopy mode
- Automatic Pulse Fluoroscopy mode
- Half Dose Automatic Continuous Fluoroscopy mode
- Half Dose Automatic Pulse Fluoroscopy mode
- DR Fluoroscopy mode

### Activate the AEC sequence

Take the following procedure to invoke the AEC sequence:

STEP ► Press and immediately release either of the following:

- any of the footswitch pedals
- either of the  keys on the control panel

**Nominal shortest irradiation time**

The shortest exposure duration that may occur in an AEC sequence is:

**Nominal Shortest Duration Time:** 1.2 sec

**Allowable AEC deviation**

**Deviation Range of Current Time Product:**  $\leq \pm(10\% + 0.2 \text{ mAs})$



*For detailed information of the loading factors of each automatic modes, please read respective sections describing these modes.*



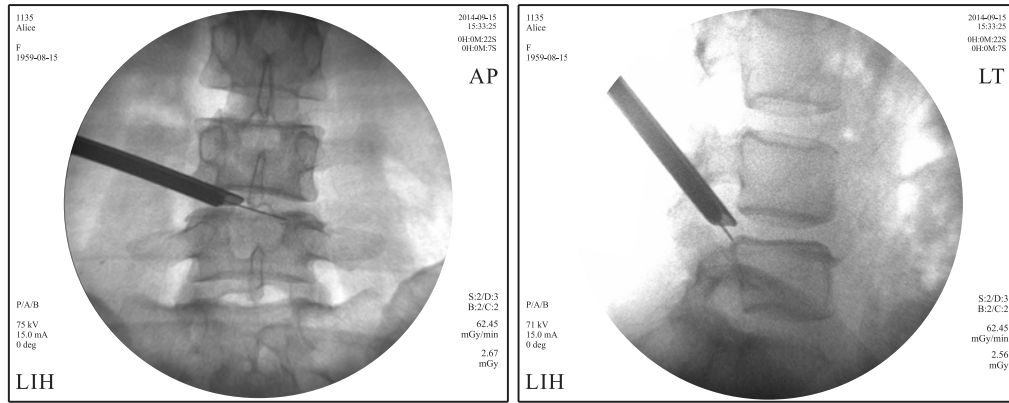


## CHAPTER 8

# WORKSTATION SOFTWARE



## 8.1 Viewing Screens



**Figure 8-1: Viewing screens**

On the viewing screens, the following parameters are displayed:

- |                          |    |   |
|--------------------------|----|---|
| 1135                     | 1  | 1 Patient MRN   |
| Alice                    | 2  | 2 Patient name  |
| F                        | 3  | 3 Patient gender  |
| 1959-08-15               | 4  | 4 Date of birth of the patient                                |
| P/A/B                    | 5  | 5 Fluoroscopy mode ([P C /H]/[A M]/[B T]/[Bi])                |
| 75 kV                    | 6  | 6 Value of voltage (kV)                                       |
| 15.0 mA                  | 7  | 7 Value of current (mA)                                       |
| 0 deg                    | 8  | 8 G-Arm rotation angle (°)                                    |
| LIH                      | 9  | 9 Last-image hold (Possible alternative: REF)                 |
| 2014-09-15               | 10 | 10 Date when the image is generated                           |
| 15:33:25                 | 11 | 11 Time when the image is generated                           |
| 0H:0M:22S                | 12 | 12 Total fluoroscopy time since the system is turned on (sec) |
| 0H:0M:7S                 | 13 | 13 Total fluoroscopy time of the study (sec)                  |
| AP                       | 14 | 14 The plane on which the X-ray imaging is initiated          |
| S:2/D:3                  | 15 | 15 S: Sharpening level, D: Noise reduction level              |
| B:2/C:2                  | 16 | 16 B: Level of brightness, C: Level of contrast               |
| 62.45 mGy/min            | 17 | 17 Dose rate (mGy/min)  |
| 2.67 mGy                 | 18 | 18 Dose (mGy)   |
| 0.05 uGy*cm <sup>2</sup> | 19 | 19 DAP (Dose Area Product) ( Gy*cm <sup>2</sup> )             |



CAUTION

The terms of AP and LT used on the G-Arm system and in this manual are only to indicate the X-ray plane on which the images are generated. They are not identical to the clinical terms of AP and LT.

### 8.1.1 Last-image hold (LIH)

LIH on the viewing screen indicates that the image displayed on the screen is the last image of the generated image sequence before the exposure is terminated.

LIH is a useful feature where a constant image is maintained on the monitor after an X-ray exposure is terminated. LIH is a dose saving feature as it allows physicians to review the last image and plan the next move in a procedure.

If LIH does not appear on the viewing screen, it means that the image currently being displayed is not a frozen last image but a saved image you have selected from the image list. To display the frozen last image on the viewing screen, double-click or double-tap an image in the frozen image refreshing area (5 in Figure 8-2 (p91)).

**Related Topic:** "Control Screen" (p91)

### 8.1.2 Fluoroscopy time summary


Three types of fluoroscopy duration time are displayed on the frozen last images, including:

Total FT <sup>1</sup>	Total fluoroscopy time taken since the system is turned on
Single Study FT	Fluoroscopy time taken during the current study

<sup>1</sup> FT = Fluoroscopy Time

The max allowed Single Image Fluoroscopy Time is 10 seconds.

The Single Study Fluoroscopy Time will be reset to zero when you close the current study and create a new study.

If the accumulated fluoroscopy time for a single study reaches 5 minutes, an alarm is triggered. When the alarm rings, press the **Reset** key  on the control panel to terminate the sound and reset the time counter of the Single Study Fluoroscopy Time to zero.

The total fluoroscopy time counter will keep running until the G-Arm system is shut down.

**Related Topic:** "Exposure Lamps and Audible Signals" (s3.6, p41)

### 8.1.3 First letter combination for fluoroscopy modes

Each of the frozen last images displayed on the viewing screen will show the fluoroscopy mode/feature in which the image is generated.

The modes/features are expressed in acronym combinations. For example, the automatic pulse fluoroscopy mode with the Bone feature turned on is shortened to "P/A/B", and the manual continuous fluoroscopy mode with the Tissue feature on is written as "C/M/T".

#### Possible mode/features

The possible combinations of these modes/features and their meanings are described below:

[P|C]/[H]/[A|M]/[B|T]/[Bi]

P: Pulse	A: Automatic	B: Bone	H: Half-dose
C: Continuous	M: Manual	T: Tissue	Bi: Bi-plane Fluoroscopy

## 8.2 Control Screen

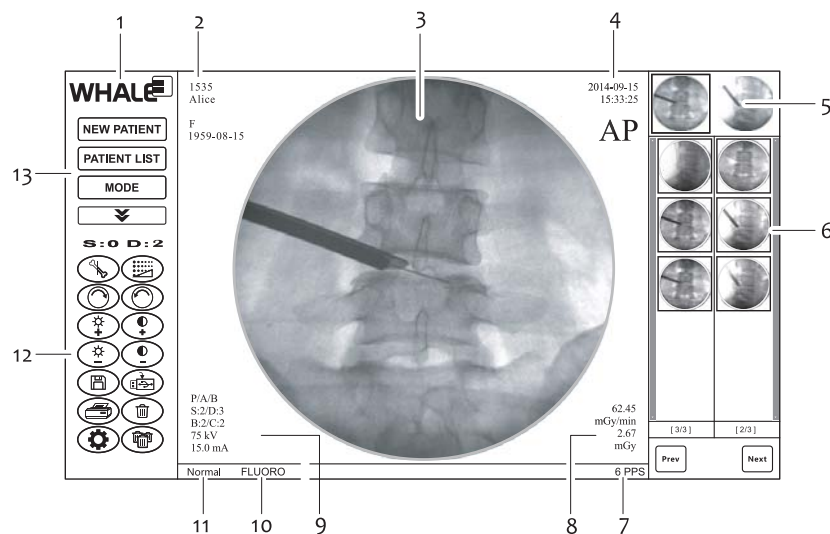




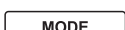

Figure 8-2: Control screen

- |                                |  |
|--------------------------------|--|
| 1 Whale Logo                   | 2 Patient MRN, name, gender, and date of birth |
| 3 Image area                   | 4 Image time and imaging plane                 |
| 5 Frozen image refreshing area | 6 Image list                                   |
| 7 Current pulse rate           | 8 Fluoroscopy dosage information               |

- |                                      |   |
|--------------------------------------|---|
| 9 Loading factors & other parameters | 10 Current mode (fluoroscopy, cine-loop, panoramic) |
| 11 Resolution/Penetration feature    | 12 Tool panel                                       |
| 13 Function switch buttons           |   |

**Function switch buttons (10)**

Use these buttons to switch between the following functions:

-  - Allows you to register a new patient
-  - Allows you to retrieve and manage the saved patient studies
-  - Allows you to choose an Exposure mode, set the pulse rate, or turn on/off the Penetration mode.
-  - Shows more tools for image processing and management

**Tools panel (9)**

Displays various tools for processing and managing images.

**Image area (3)**

Displays the image that is currently being processed.

**Frozen image refreshing area (5)**

Displays thumbnails of the current frozen last images (AP on the left, LT on the right). You can display these images on the viewing screens by double-clicking or double-tapping on them.

**Related Topic:** "Last-image hold (LIH)" (p90)

**Image list (6)**

Displays thumbnails of all the saved images of the currently opened study.

**Loading factors and other parameters (2, 4, 7, 8)**

Displays the kV values, mA values, fluoroscopy mode or feature, brightness level, contrast level, denoise level, and sharpening level.

## 8.3 Selecting Exposure Modes

Besides the default fluoroscopic imaging mode, the G-Arm system offers two other types of exposure modes - CINE and PANO:

- **CINE** - "Cine-loop (Optional)" (p99)
- **PANO** - "Panoramic Imaging" (p101)

You need to choose a proper exposure mode before starting taking exposures.

To select an exposure mode:

STEP 1 Press .

STEP 2 From **Exposure Mode**, select a mode. The FLUORO mode is by default selected.

**Note:** For detailed explanation of the options on the Mode screen, check out the rest topics in this section.

The screenshot shows the WHALE Mode Selection screen. On the left is a sidebar with the WHALE logo, buttons for 'NEW PATIENT', 'PATIENT LIST', and 'MODE', a dropdown arrow, and a status bar 'S:0 D:2' with various icons. The main area contains three configuration sections: 'Part Mode' with 'Normal' (selected) and 'Low Dose' options; 'Pulse Rate' with '2 PPS', '6 PPS' (selected), '8 PPS', and '15 PPS' options; and 'Exposure Mode' with 'FLUORO' (selected), 'CINE', and 'PANO' options. Below these are 'OK' and 'Cancel' buttons. At the bottom, a status bar shows 'Normal FLUORO' and '6 PPS', along with 'Prev' and 'Next' buttons and two '[ 0/0 ]' indicators.

**Figure 8-3: Mode Selection**

### Part Mode

The Part Mode allows you to specify whether to turn on the Normal feature or Low Dose feature.

- **Normal**

The Normal feature provides higher dosage to penetrate bigger objects such as the body parts of a patient with a larger body size.

- **Low Dose**

The Low Dose feature provides lower dosage to penetrate smaller objects such as the body parts of a patient with a smaller body size.

Select one feature to turn on the feature; select otherwise to turn it off.

**Note:** Please note that the Normal feature works only in the pulse fluoroscopy mode. Make sure you have the FLUORO exposure mode selected.

### Pulse Rate

You can specify the pulse rate (2 PPS, 6 PPS, 8 PPS, or 15 PPS). The default pulse per second is 6. Larger PPS means more frames for a given time length, or shorter time length for a given frame count, which in turn, result in smoother animation and larger dosage; and vice versa.

**Note:** The pulse rate setting applies only to the Cine-loop exposure mode.

### Exposure Mode

You can choose an exposure mode from the following three: FLUORO (Fluoroscopic imaging mode), CINE (Cine-loop mode), and PANO (Panoramic mode).

## 8.4 Registering Patients

### 8.4.1 Manually register a new patient

The screenshot shows the WHALE software interface. On the left is a sidebar with buttons: NEW PATIENT, PATIENT LIST, and MODE. Below these are icons for various functions. The main window has three tabs: Patient Information, Worklist, and Database. The Patient Information tab is selected. It contains several input fields: MRN\* (with a dropdown arrow), Last Name\*, First Name\*, M.I. (with a dropdown arrow), Sex (with a dropdown arrow), D.O.B. (YYYY-MM-DD with a dropdown arrow), Body Part, Physician, Accession #, Procedure, Social Security #, and Clinical Diagnosis. Below these fields is a soft keyboard with numbers 0-9, letters QWERTYUIOP, ASDFGHJKL, and function keys like ESC, Z, X, C, V, B, N, M, BACK, TAB, CAP, SPACE, ., /, ←, →, and a EN key. At the bottom of the main window are buttons for Register and Exit. A status bar at the very bottom shows 'Normal FLUORO' and '6 PPS'. On the right side of the interface, there are storage status indicators: 'Available: 269 GB' and 'Used: 13.5 GB', and buttons for Prev and Next.

**Figure 8-4: Register a new patient**

To register a new patient:

STEP 1 Press **NEW PATIENT**.

The Patient Information tab is displayed, as shown in *Figure 8-4* (p94).

STEP 2 On the **Patient Information** tab, provide sufficient information in the fields using the on-screen soft keyboard or using the keyboard in the keyboard drawer. Mandatory fields are marked with asterisks (\*). The descriptions of the fields are described in *Table 8-1* (p95).

**Note:** The MRN of the new patient cannot be the same as the existing patients.

STEP 3 Press **Register** to submit the new patient information.

### Fast registration

In emergency, you can bypass the registration process by pressing **Register**.



Later you can complete the patient information at a convenient time. If you forget to do this, you will be prompted to enter the patient information when you try closing the current study.

**Related Topic:** "Edit patient information" (p116)

**Table 8-1: Patient Information Dialog**

Field	Description
MRN	MRN (Medical Record Number). A unique ID for the specific patient.
First Name	The first name of the patient.
Middle Name	The middle name of the patient.
Surname	The family name of the patient.
Sex	The gender of the patient.
D.O.B	The date of birth of the patient.
Body Part	The body part of the patient that is to be inspected.
Physician	The physician name.
Accession #	A unique number given to the new acquisition when the patient is admitted.
Procedure	The operation procedure.
Clinical Diagnosis	The medical diagnosis.
Social Security #	The social security number of the patient.

### 8.4.2 Register a patient from the worklist

If the G-Arm system is integrated and properly configured with other HIS/RIS through the DICOM Worklist, you can directly select a patient from the patient list and register the patient without manually entering the patient information from scratch.

MRN	Name	Sex	D.O.B	Accession #	Scheduled Date and
1010	Alex		2004-04-20	2100765	2015-11-15
1011	Lisa	F	1987-12-26	2100766	2015-11-15
1024	Tom	M	1980-01-29	2100767	2015-11-15
1098	Shelly	F	1994-07-21	2100768	2015-11-16
1253	Eliza	F	1976-03-26	2100769	2015-11-16

Normal FLUORO 6 PPS

**Figure 8-5: Select a patient from the worklist**

To create a study using the patient information from the worklist:

STEP 1 Press **NEW PATIENT**, and then switch to the **Worklist** tab.

The Worklist tab is displayed, as shown in *Figure 8-5* (p96).

STEP 2 On the **Worklist** tab, click or tap to select a patient, and then press **Register**.

The G-Arm system creates a new study for the selected patient, and gets ready for fluoroscopic imaging.



CAUTION

Before you are able to use the worklist to retrieve patient list from other information systems, you need to set up a DICOM service that establishes communications with other systems and have it properly mapped to the worklist feature of the G-Arm system. Refer to "DICOM Setup" (s8.17, p124) for instructions on this topic.

### 8.4.3 Register a patient from local database

All patient information and studies are stored in the G-Arm's database and can be retrieved at any time.

MRN	Name	Sex	D.O.B	Study Time	Image Count	F
1529	Eric		2002-10-10	2015-11-15 13:58:13	10	
1530	John		1983-05-27	2015-11-15 14:57:47	23	
1531	Lily	F	1987-09-30	2015-11-15 15:55:22	19	
1534	June	F	1985-10-24	2015-11-16 08:30:06	8	
1535	Alice	F	1961-04-20	2015-11-16 09:49:04	6	

**Figure 8-6: Select a patient from the database**

To create a study using the patient information from local database:

- STEP 1 Press **NEW PATIENT**, and then switch to the **Database** tab.  
The Database tab is displayed, as shown in *Figure 8-6* (p97).
- STEP 2 On the **Database** tab, click or tap to select a patient, and then press **Register**.  
The G-Arm system creates a new study for the selected patient, and gets ready for fluoroscopic imaging.

## 8.5 Retrieving Patient/Study Info

The patient list is where you retrieve the study information of a patient that has been examined using the G-Arm system. All the patient information, to-

gether with the fluoroscopic images, are stored in the database of the G-Arm system.

**WHALE**

NEW PATIENT  
PATIENT LIST  
B: O C: O

Date:  MRN:

☐ Start: 2015-11-15 Last Name:  First Name:

☐ End: 2015-11-15 Physician:

Search Reset Load Delete Delete All Back

MRN	Name	Sex	D.O.B	Study Time	Image Count	F
1529	Eric		2002-10-10	2015-11-15 13:58:13	10	
1530	John		1983-05-27	2015-11-15 14:57:47	23	
1531	Lily	F	1987-09-30	2015-11-15 15:55:22	19	
1534	June	F	1985-10-24	2015-11-16 08:30:06	8	
1535	Alice	F	1961-04-20	2015-11-16 09:49:04	6	

Total: 5 Filtered: 5 Page: 1/1 Go Page Prev Next

**Figure 8-7: Patient list**

The patient list provide basic tools for you to manage the patient studies:

- "Select and open a study" (p98)
- "Search for a patient study" (p99)
- "Delete a study" (p99)

### 8.5.1 Select and open a study

In a patient list, you can open a study and view the images as well as other information. You can also make changes to the opened study; however, you will not be able to save these changes.

To select and open a study:

STEP 1 Press **PATIENT LIST**.

The Patient List screen is displayed, as shown in *Figure 8-7* (p98).

STEP 2 On the **Patient List** screen, click or tap to select a study, and then press **Load** to open it.

The G-Arm system opens the study and loads the latest taken fluoroscopic image found in the image list.

**Note:** You can also open a study by double-clicking (or double-tapping) on it.

## 8.5.2 Search for a patient study

If the patient list spans a number of pages, you can use the search function provided with the patient list to quickly find a specific study.

To search for a study:

STEP 1 Press **PATIENT LIST**.

The Patient List screen is displayed, as shown in *Figure 8-7 (p98)*.

STEP 2 On the **Search Criteria** area above the **Patient List**, provide the search conditions in the fields, and then click **Search**. The descriptions of the fields are described in *Table 8-2 (p99)*.

**Note:** To clear the entered search criteria for retyping, click **Reset**.

The G-Arm system searches the study in the database and lists the found results in the patient list.

**Table 8-2: Search Criteria Fields**

Field	Description
Date	Date when the study is created
Start Date	Returns the studies created after this date
End Date	Returns the studies created prior to this date
MRN	MRN (Medical Record Number). A unique ID for the specific patient.
Name	The name of the patient
Physician	The physician name

## 8.5.3 Delete a study

To delete a study:

STEP 1 Press **PATIENT LIST**.

The Patient List screen is displayed, as shown in *Figure 8-7 (p98)*.

STEP 2 In the **Patient List** screen, select a study, press **Delete**, and then click **Yes** to confirm the deletion.

The G-Arm system deletes the study from the database.

**Note:** To delete all the studies in the patient list, click **Delete All**.

## 8.6 Cine-loop (Optional)

Besides generating static images, you can also record cine-loop sequences during fluoroscopic imaging.

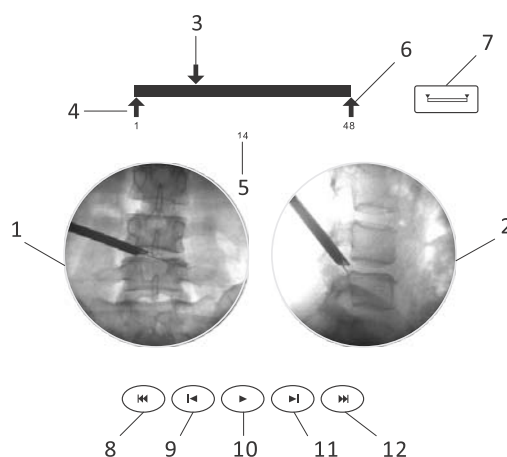
To record a cine-loop sequence:

STEP 1 Press **MODE**.

STEP 2 From **Exposure Mode**, select **CINE**.

STEP 3 Create a new study and initiate fluoroscopic imaging.

The cine-loop sequence will be recorded and automatically played on the control screen. The AP and LT cine-loop sequences (1 & 2) are juxtaposed, as shown in the figure below:



**Figure 8-8: Use the cine mode to record video clips**

STEP 4 Play the cine-loop sequences using the controls underneath, which are shown in Figure 8-8 (p100), as described below:

- 8 Jump backwards by 10 frames
- 9 Jump backwards by 1 frame
- 10 Start or stop the playback
- 11 Jump forwards by 1 frame
- 12 Jump forwards by 10 frames

STEP 5 Drag the slider on the progress bar to browse the video content. Move the two sliders below the progress bar to set the play range. The slider controls are shown in Figure 8-8 (p100) and are described below:

- 3 Slider that sets the current playback position
- 4 Start of the loop
- 5 The current frame
- 6 End of the loop

STEP 6 Press the **Reset** button (7) to reset the loop range settings (the two sliders beneath the progress bar returning to their original position).

Like images, you can choose whether to save a cine-loop sequence to the study, or discard them.

## 8.7 Panoramic Imaging

In addition to ordinary images, the G-Arm system can also generate a panoramic image by combining several fluoroscopic images of the adjacent parts.

It takes at least two persons to complete the panoramic imaging. One person moves the G-Arm while the other conducts the exposure at the same time.



*The G-Arm system support panoramic imaging from both two directions individually or simultaneously.*

To generate a panoramic image:

STEP 1 Press .

STEP 2 From **Exposure Mode**, select **PANO**.

The system activates the Panoramic Imaging mode.

STEP 3 Create a new study and press the footswitch pedal or the Exposure key on the control panel, in the meantime, move the G-Arm (the other person).

The system initiates the exposure process. Meanwhile, a Stop button appears on the control screen, which will remain visible until you click on it or the panoramic imaging process automatically ends.

During the exposure, if you need to adjust the G-Arm position or the exposure parameters, you can always pause the exposure, perform the adjustments, and then resume the exposure.

STEP 4 To generate a panoramic image, you can click the Stop button after you end the exposure. Or, you can continue with the exposure, until it automatically ends.


The maximum duration time for the panoramic imaging allowed by the G-Arm system is as follows:

Mode	PPS	Max. Frame Count	Max. Exposure Duration
Continuous mode	25	150	6 sec.
Pulse mode	15	150	10 sec.

The G-Arm system combines the images, generate a complete panoramic image, and then displays it in the Image area.

## 8.8 Processing Images

You can process an image at any time, either before saving the newly created study, or after loading an existing study. Once a study is saved, you will still be able to open it and make changes to the images in it, but these changes will be discarded once the study is closed.

During routine operations, the image processing tools are visible all the time. You can always show the rest of the tools by pressing .

**Note:** Except the Zoom and Annotation tools, settings of all other image processing tools can be remembered and automatically applied to the subsequent images generated afterwards. For example, if you adjust the image brightness to "4", when you generate another fluoroscopy image, the brightness setting, level 4 in this case, will be automatically applied to the newly generated image.

### 8.8.1 Sharpening

An effective sharpening process makes the edges of an image appear sufficiently pronounced, which corrects the blur brought by the camera sensors and lens and emphasizes the texture, making the image look sharper and clearer.




**Sharpening:** (0, 1, 2, 3, 4) The value 0 stands for no sharpening effect is applied to the image, while 4 means the highest level of sharpening effect. The default level is 0.

*Note:* This feature is only available for the images in the currently unsaved study.

To sharpen an image:

STEP 1 Take a shot to generate a fluoroscopic image.

STEP 2 On the control screen, press **Sharpen**  for one time on the tools panel to the left of the image area.

One click or tap increases the sharpening level by 1.

The sharpening level reading is displayed above the tool button in the form of "S: <value>", for example, "S: 0".

The effect is immediately applied to the selected image.

STEP 3 Go through all the five sharpening levels from 0 ~ 4 to and select the level where the image appears sharp just enough.

### 8.8.2 Noise reduction

Image noise is random (not present in the object imaged) variation of brightness or color information in images, and is usually an aspect of electronic noise. It can be produced by the sensor and circuitry of a digital camera.



Image noise is an undesirable by-product of image capture that adds spurious and extraneous information.




**Noise Reduction:** (0, 1, 2, 3, 4) The value 0 stands for no noise reduction is applied to the image, while 4 means the highest level of noise reduction. The default level is 2.

*Note: This feature is only available for the images in the currently unsaved study.*

To reduce the noise of an image:

STEP 1 Take a shot to generate a fluoroscopic image.

STEP 2 On the control screen, press **Noise Reduction**  for one time on the tools panel to the left of the image area.

One click or tap increases the noise reduction level by 1.

The noise reduction level reading is displayed above the tool button in the form of "D: <VALUE>", for example, "D: 4".

The effect is immediately applied to the selected image.

STEP 3 Go through all the five noise reduction levels from 0 ~ 4 to and select the level where the image appears acceptable.

### 8.8.3 **Brightness and contrast**

You can achieve better detail visibility by adjusting the brightness and contrast of an image.



**Brightness:** Increases the level of brightness.



**Brightness:** Decreases the level of brightness.







**Contrast:** Increases the level of contrast.



**Contrast:** Decreases the level of contrast.

To adjust the brightness or contrast level of an image:

STEP 1 Take a shot to generate a fluoroscopic image, or open an existing study and then select an image from the image list.

STEP 2 On the control screen, press the **Brightness** or **Contrast** adjustment buttons , , , or  on the tools panel to the left of the image area to increase/decrease the brightness/contrast levels. One click or tap increases or decrease the respective level by 1.

The level readings of brightness and contrast are displayed above the tool buttons in the form of "B: <VALUE> C: <VALUE>", for example, "D: 0 C: 0".

STEP 3 Try the levels and select the one where the image appears acceptable.

### Brightness and contrast level readings

The Sharpening and Denoise tools becomes invisible when you press **PATIENT LIST**. This is because they are not applicable to the images that have already been saved. Consequently, the S & D readings are superseded by the B & C readings:

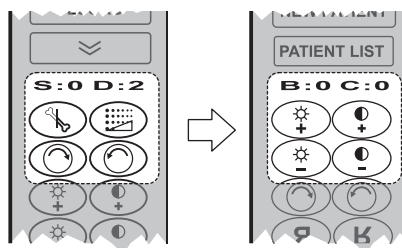


Figure 8-9: Level tags change to brightness and contrast

- S* - Level of sharpening
- D* - Level of noise reduction
- B* - Brightness level
- C* - Contrast level

## 8.8.4 Rotation

You can rotate the fluoroscopic images clockwise or counter-clockwise.





**Rotate:** Rotates the image clockwise.



**Rotate:** Rotates the image counter-clockwise.

To rotate an image:

STEP 1 Take a shot to generate a fluoroscopic image, or open an existing study and then select an image from the image list.

STEP 2 On the control screen, press the **Rotation** buttons  or  on the tools panel to the left of the image area to rotate the image clockwise or counter-clockwise.

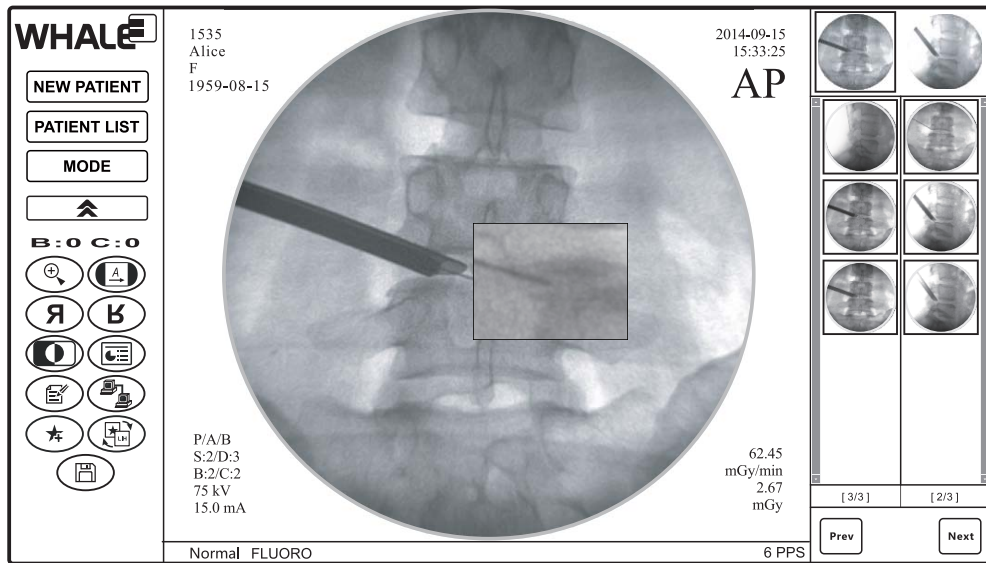
**Note:** You can make the image spin constantly by keeping the rotation buttons pressed down.

## 8.8.5 Magnification

You can enlarge a portion of the fluoroscopic images using the Zoom tool.






**Zoom:** Enlarges the image fourfold.



**Figure 8-10: Enlarge a portion of an image**

To magnify a portion of an image:

- STEP 1 Take a shot to generate a fluoroscopic image, or open an existing study and then select an image from the image list.
- STEP 2 On the control screen, press **Zoom**  on the tools panel to the left of the image area.  
The Zoom button is highlighted.  
**Note:** If on the tools panel you cannot find the Zoom button , press  to show more buttons.
- STEP 3 In the image area, press down and hold the left touch pad button/finger on the spot where you want to enlarge the image.  
A rectangular box appears, which shows an enlarged portion of the image, as shown in Figure 8-10 (p105).
- STEP 4 While keeping the touch pad button/finger pressed down, move the mouse pointer to shift the magnification spot.
- STEP 5 Release the touch pad button/finger when you finish.  
The zooming rectangular box disappears.

## 8.8.6 Annotation

You can use the Annotation tool to add notes to an image. Please note that once the study is saved, these annotations will not be able to be altered or removed.

**Note:** This feature is only available for the images in the currently unsaved study.

You can add multiple annotations to a single image.



**Annotation:** Allows you to annotate the image.


The Annotation tool enables you to perform the following tasks:

- Add annotation text to the image
- Resize the annotation text box
- Remove an annotation

### Add annotation text to the image

To annotate an image:


STEP 1 Take a shot to generate a fluoroscopic image.

STEP 2 On the control screen, press **Annotation**  on the tools panel to the left of the image area.

The Annotation button is highlighted.

**Note:** If on the tools panel you cannot find the Annotation button



 to show more buttons.

STEP 3 In the image area, drag a square region to contain the annotation text.

**Note:** For instruction on how to draw a square on the control screen, see "Drag and drop operation" (p107).

A rectangular box appears above the image, and the text insertion cursor blinks inside the box, ready for you to enter annotation text.

STEP 4 Type some notes to the image, and then click or tap outside of the box.

The annotation box disappears, leaving the green colored text on the image.

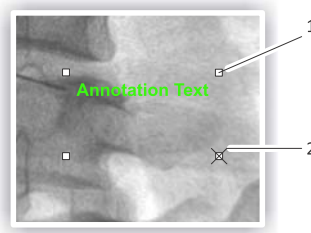
### Resize the annotation text box

If you found the annotation text area previously drawn is not suitable, you can resize the text box of the annotation with a drag-and-drop operation.

**Note:** Touch pad on the keyboard is always recommended whenever you have to tackle with precise on-screen positioning operations.

To resize the text box:

- STEP 1 Click or tap on the annotation text to select it.  
Several small handles (1) appear around the annotation text box with invisible borders.
- STEP 2 Use the touch pad to move the mouse cursor over one of these handles.  
The mouse cursor changes its appearance (2) when it hits any of the handles.
- STEP 3 Press down and hold the left button of the touch pad to seize the handle, move the cursor toward any direction to resize the text box.
- STEP 4 Release the touch pad button when you are done.



**Figure 8-11: Use small handles to resize the text box**

### **Remove an annotation**

You can remove the unwanted annotation text box from the image.

To delete an annotation:

- STEP ► Right-click on the annotation text. On the context menu, click **Delete**.

### **Drag and drop operation**

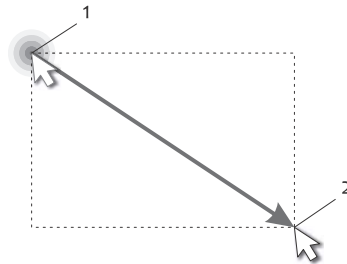
To draw a square box on the control screen using the keyboard touch pad:

- STEP 1 Move the mouse pointer over the spot where you want to use as the top-left corner of the square.
- STEP 2 Press and hold the left touch pad button, and then move the mouse pointer along the diagonal line of the imaginary square region that you want to draw and then release the touch pad button.

To draw a square box on the control screen using your fingers:

- STEP 1 Move your finger over the spot where you want to use as the top-left corner of the square.

- STEP 2 Press and hold your finger on the control screen, and then move your finger along the diagonal line of the imaginary square region that you want to draw and then release your finger.



**Figure 8-12: Draw a square**

1 Press and hold      2 Move and release

### 8.8.7 Mirror

An image can be mirrored horizontally or vertically.





**Mirror Horizontally:** Flips the image from left to right.



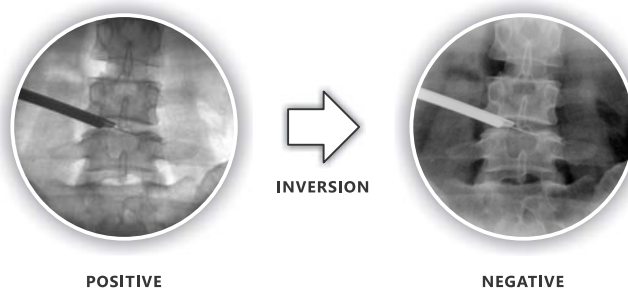
**Mirror Vertically:** Flips the image from top to bottom.

To mirror an image:

- STEP 1 Take a shot to generate a fluoroscopic image, or open an existing study and then select an image from the image list.
- STEP 2 On the control screen, press the **Mirror** buttons  or  on the tools panel to the left of the image area to mirror the image horizontally or vertically.

### 8.8.8 Inversion

You can reverse the image colors to create a photographic negative effect. For example, as in the below figure, the left image is positive, while the one on the right is a negative.




**Figure 8-13: Positive/negative image comparison**



**Invert:** Reverses the colors of an image. Inverting an image creates the appearance of a photographic negative.

To invert an image:

- STEP 1 Take a shot to generate a fluoroscopic image, or open an existing study and then select an image from the image list.
- STEP 2 On the control screen, press **Invert**  on the tools panel to the left of the image area to reverse the colors of the image.

## 8.9 Comparing Images

You can compare a frozen last image (LIH) and another image that has been set as a reference image (REF) by displaying these two images alternately with a single click or tap on a button.



**Set as Reference:** Sets the selected image as a reference image.





**Compare with Reference:** Switches the images displayed on the viewing monitors between a reference image (REF) and the frozen last image (LIH), if such a reference image exists.

To alternately display two images:

- STEP 1 Get ready for fluoroscopic imaging. Create a new study if you haven't done so.
- STEP 2 In the image list or in the frozen image refreshing area (5 in Figure 8-2 (p91)) click on the image that you want to set as a reference image. The specified image will be displayed on the corresponding viewing screen, depending on the X-ray plane where it has been generated.

For example, an AP image will be displayed on the left viewing screen.

STEP 3 Press  to show more buttons, and then press **Set as Reference** .


The image specified in *Step 2* will be set as a reference image. Later it can be used as a reference when comparing with any other specified images.


If the image you specify was generated together with an image from the other X-ray plane, both of them will be set as reference images.

**Note:** When being displayed on the viewing monitor, a reference image is marked with "REF" in the lower-left corner of the screen, in the location where the mark "LIH" used to be.

STEP 4 Continue to generate another fluoroscopic image.

The last generated image will be held on the corresponding viewing screen (for bi-plane imaging, on both screens).

STEP 5 Press **Compare with Reference**  to see the reference image. The images displayed on the viewing screens will be switched to the one previously set as a reference image.

STEP 6 Press **Compare with Reference**  again to switch back to the last generated image. Repeat this to display LIH and REF images alternately on the viewing monitors.

## 8.10 Operation Guidelines (Optional)

An operation guideline is a virtual line that acts as a visual aid to help you improve the accuracy of the surgical operation procedure.

You can add, edit, or remove one or more operation guidelines on the frozen last images on the viewing screens.

### Add a guideline

To add an operation guideline:

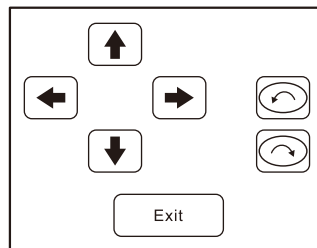
STEP 1 Right-click anywhere on the viewing screen.

STEP 2 On the context menu, click **Add**.

A straight line appears, together with several tool buttons.



STEP 3 Use the on-screen tool buttons to rotate and move the line.



**Figure 8-14: Guideline tool buttons**

### **Edit a guideline**

To edit an operation guideline:

STEP 1 On the viewing screen, right-click on the guideline.

STEP 2 On the context menu, click **Edit** to activate the edit mode.  
The guideline tool buttons appear.

STEP 3 Use the on-screen tool buttons to rotate and move the line, as shown in *Figure 8-14 (p111)*.

STEP 4 Click **OK** to save the changes.

### **Remove a guideline**

To remove an operation guideline:

STEP 1 On the viewing screen, right-click on the guideline.

STEP 2 On the context menu, click **Remove**.

## **8.11 Generating Dose Reports**

You can generate a report for the current study that summaries various types of dosage given to the patient in this clinical procedure.



The items included in a dose summary report are explained as below:

<b>Report Date:</b>	Date when the dose summary report was generated.
<b>MRN:</b>	MRN (Medical Record Number). A unique ID for the specific patient.
<b>Name:</b>	The name of the patient.
<b>Accession #:</b>	A unique number given to the new acquisition when the patient is admitted.
<b>Physician:</b>	The physician name.
<b>Clinical Diagnosis:</b>	The medical diagnosis.

<b>AP (Single):</b>	Exposure(s) conducted on the AP plane alone.
<b>LT (Single):</b>	Exposure(s) conducted on the LT plane alone.
<b>Bi-plane:</b>	Exposure(s) conducted simultaneously on both AP and LT planes.
<b>Total:</b>	The sum of respective values for all exposures taken on AP, LT and Bi-plane.
<b>PCT (%):</b>	Percentage that the continuous/pulse mode accounts in total exposure count, total exposure duration, total DAP, or total dosage.
<b>C/Counter:</b>	Count of the exposures taken in the automatic continuous fluoroscopy mode.
<b>C/Time (s):</b>	Duration of the exposures taken in the automatic continuous fluoroscopy mode.
<b>P/Counter:</b>	Count of the exposures taken in the automatic pulse fluoroscopy mode.
<b>P/Time (s):</b>	Duration of the exposures taken in the automatic pulse fluoroscopy mode.
<b>C/DAP (uGy*m^2):</b>	Total DAP of the exposures taken in the automatic continuous fluoroscopy mode.
<b>C/Dose (mGy):</b>	Total dosage of the exposures taken in the automatic continuous fluoroscopy mode.
<b>P/DAP (uGy*m^2):</b>	Total DAP of the exposures taken in the automatic pulse fluoroscopy mode.
<b>P/Dose (mGy):</b>	Total dosage of the exposures taken in the automatic pulse fluoroscopy mode.

To generate a dose summary report:

STEP 1 Create or open a study, make sure it contains fluoroscopic images.

STEP 2 Press  to show more buttons, and then press **Dose Summary Report** .

A dose summary report about this study is generated.

STEP 3 On the **Dose Summary Report** screen, you can continue to perform the following operations:


- Saving the report as a picture: Press **Generate Image** to save the report as a bitmap (\*.bmp) file.
- Saving the report as a PDF file: Press **PDF** to print the report in the PDF format.
- Printing the report: Press **Print** to print the report on A4-size paper.

## 8.12 Printing Images


You can pick several images and print them out via a printer.

The G-Arm system supports three types of printing, including:

- **DICOM Printing**  
Images will be printed through a DICOM printer. This option is unavailable if the connection to the DICOM printer server is disconnected.
- **Ordinary Printing - Laser Printer**  
Images will be printed through a laser printer.
- **Ordinary Printing - Thermal Printer**  
Images will be printed through a thermal printer.

Which printing type is used when you press **Print**  is determined by the **Print Type** selection in the system settings.

To print one or more images through a thermal/laser printer:

**STEP 1** In the current study, on the tools panel to the left of the image area, press **Print** .

The Printing Setup screen is displayed (*Figure 8-15 (p114)* and *Figure 8-16 (p114)*), allowing you to select the images to print, set the image layout, or enlarge the image.

**STEP 2** On the **Print Setup** screen, select a print layout from the four presets (see "*Print layout*" (p115)).

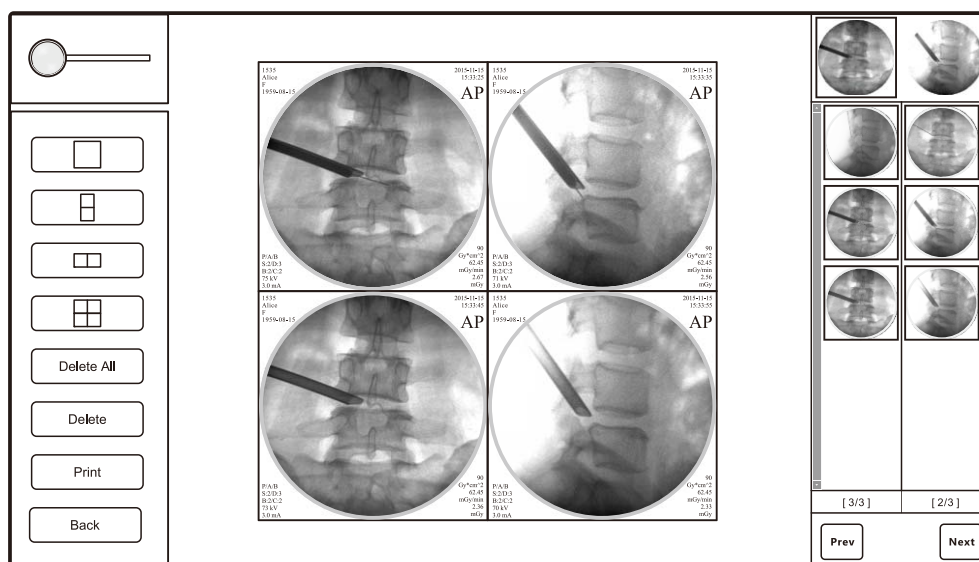
**STEP 3** From the image list, double-click an image to add it to the image layout.

The image is appended to the end of the image layout. Repeat this step until all the images that you want to print are added. You can print at most four images at a time.

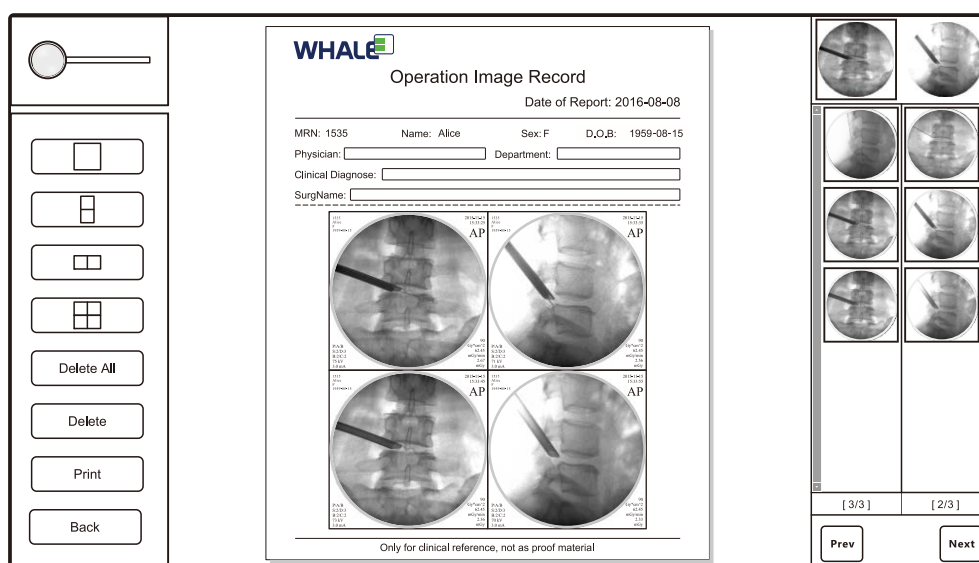
**STEP 4** When you are done with the setup, press **Print** .

## Print Types

Setup screens of different print types are shown in the following figures:



**Figure 8-15: Setup screen for thermal printing**



**Figure 8-16: Setup screen for laser printing**

### **Print layout**

There are four layouts provided for printing (*row × column*):

- 1 × 1
- 1 × 2
- 2 × 1
- 2 × 2

### **Technique for rearranging images**

The G-Arm workstation software does not provide an intuitive method for you to move the images around in the layout. If you are not satisfied with the order in which the images are displayed, you can rearrange the images by removing all the images and then add them back again in the order you want.

If the order is rather different from the current one, you are recommended to clear and add all the images again:

STEP ► Press **Delete All** and re-add images in the order you want.

However, you can use the following technique to rearrange the layout if only one or two images need to be re-arranged:

STEP 1 Select that image, press **Delete**.

Each image after that image will move one frame forward to fill the blank frame left by the deleted image.

STEP 2 Click **Back** and re-add that image to the layout.

That image will be added to the last frame of the layout (the lower-right frame for the 2 × 2 layout).

### **Show ROI in a image**

You can enlarge the images in the layout to show a more detailed portion of the image with smaller field of view (FoV). You can also drag and move the enlarged image to change the region of interest (ROI) in the layout frame, which acts more like a view port now.

To show a more detailed portion of an image:

STEP 1 Select an image.

STEP 2 Drag the slider on the **Enlarge** control  to the right.

**Note:** You can also directly click or tap on the sliding bar to move the slider to that position.

STEP 3 Click or tap inside the selected image and hold down the left button or finger to drag the image around. Repeat this until the ROI is displayed in the frame.

The image will retain its enlargement settings when it is printed out.

### 8.12.1 **Print through a DICOM printer**

To print images through a DICOM printer, you need to configure and setup the connection to the DICOM printer server. For instructions on how to set up a DICOM printer service, see "DICOM Setup" (p124).

## 8.13 **Managing Images and Studies**

### 8.13.1 **Edit patient information**


Sometimes you may want, or be prompted, to modify or complete the patient information, especially when the patient is admitted through a fast registration process, which means that some patient information has been left unfilled when the study is firstly being created.



**Edit Patient Info:** Allows you to modify the patient information.

---

To edit patient information of a study:

STEP 1 While in a study, press **Edit Patient Info**  on the tools panel. The Patient Information dialog is displayed, as shown in *Figure 8-17* (p117).

**Note:** If on the tools panel you cannot find the Edit Patient Info button



, press  to show more buttons.

STEP 2 On the **Patient Information** dialog, provide sufficient information in the fields using the on-screen keyboard or the keyboard in the keyboard drawer. The mandatory fields are marked with asterisks (\*). The descriptions of the fields are described in *Table 8-1* (p95).

STEP 3 Press **Modify** to save the information of the patient.

**Note:** The patient MRN shall be unique, which means that it cannot be the same as that of any existing patients.

Figure 8-17: Edit patient information

### 8.13.2 Save an image

You can save an image to preserve it. You can also have the images saved automatically after they are generated.



**Save Image:** Saves the image to the local database.

**Note:** This feature is only available for the images in the currently unsaved study.

#### Auto-saving feature

By default, images are automatically saved to local database after they are generated.

This strategy is helpful in the event that the physicians forget to save the generated image.

If the auto-saving feature is turned off, the generated images stay unsaved until you manually save the images using the Save Image button on the tools panel.

**Related Topic:** For instructions on how to turn on/off the auto-saving feature, see "System Settings" (p121).

### Manually save an image

To manually save an image:

STEP 1 Take a shot to generate a fluoroscopic image.

The frozen last image is displayed on the corresponding viewing screen, depending on the X-ray plane where it has been generated. For example, an AP image will be displayed on the left viewing screen.

STEP 2 On the control screen, press **Save Image**  on the tools panel to the left of the image.

The image is saved and a thumbnail of it will be appended to the image list.

**Note:** If the image was generated together with an image from the other X-ray plane, both of them will be saved.

### 8.13.3 Save a study

You can save a study for future use.

Please note that a study can only be saved once for some reason. Therefore, no explicit saving button is introduced as such a button may imply a repeatable saving action, which in many cases is misleading.

When you finished the clinical procedure and try to close the study, you will be prompted to save the study.

To save a study:

STEP► In the study, press **PATIENT LIST**, and then on the message box that prompts you to save the study, click **Yes**.

**Note:** Other approaches may also invoke the study saving prompt, so long as the action substantially makes you leave the currently study.

For example, when you press **NEW PATIENT**, you will also be prompted to save the study.

### 8.13.4 Export an image

You can export an image or all the images in the study to other storage media in various formats.




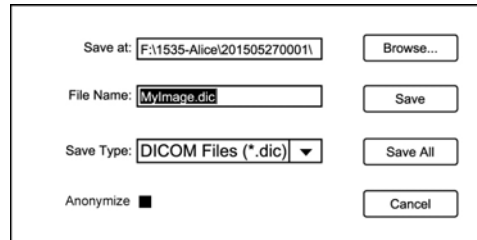
**Export Images:** Saves the current image or all the images in the study to a customized location.

To export an image or all the images within the study:

STEP 1 Take a shot to generate a fluoroscopic image, or open an existing study and then select an image from the image list.



- STEP 2 On the control screen, press  on the tools panel to the left of the image to export the image(s).  
The Save As dialog appears.



The Save As dialog box contains the following fields and buttons:

- Save at:** A text field containing the path `F:\1535-Alice\201505270001\` and a **Browse...** button.
- File Name:** A text field containing `MyImage.dic` and a **Save** button.
- Save Type:** A dropdown menu showing `DICOM Files (*.dic)` and a **Save All** button.
- Anonymize:** A checkbox that is currently unchecked and a **Cancel** button.

**Figure 8-18: Save As dialog**

- STEP 3 On the **Save As** dialog, provide the file information as described in Table 8-3 (p119).

- STEP 4 click **Save** or **Save All** to confirm the operation.

**Table 8-3: Save As Dialog Fields and Commands**

Field	Description
Save at	Specifies the location where the image(s) is (are) saved.
File Name	Specifies a name for the file. <i>Note: If you choose to save all the images within the study, the information provided in this field will be ignored; instead, the images will be automatically named in consecutive three-digit numbers, for example, 001, 002, 003, etc.</i>
Save Type	The following file formats are supported: <ul style="list-style-type: none"> <li>• DICOM Files (*.dic)</li> <li>• DCM Files (*.dcm)</li> <li>• TIFF Files (*.tif)</li> <li>• JPEG Files (*.jpg)</li> <li>• BMP Files (*.bmp)</li> <li>• PNG Files (*.png)</li> <li>• Merge DIC Files (*.dic)</li> </ul>
Browse	Brings a dialog for you to choose a file saving location. You can also manually type the location in the <i>Save at</i> field.
Save	Saves the current image.
Save All	Saves all the images that the current study contains.

### 8.13.5 Transfer an image to the PACS server

You can transfer one or more images in a study to the PACS server.

You need to have the settings properly configured to establish a connection to the server. For instructions on this topic, see "DICOM Setup" (p124).






**DICOM Transfer:** Transfer one or more images in the current study to the PACS server.


To transfer an image to the PACS server:

STEP 1 Stay in the current study, or open an existing study.

STEP 2 On the tools panel, press .

**Note:** If on the tools panel you cannot find the DICOM Transfer tool button , press  to show more buttons.

The icon of the DICOM Transfer tool button changes to , indicating that the image transferring process can be started at any time.

STEP 3 In the image list, select one or more images, and then click . The selected image(s) in the current study will be transferred to the PACS server.

### 8.13.6 Delete an image

A single study can contain up to 300 images. You can discard the unwanted images and remove them from the study.



**Delete Current Image:** Deletes the currently selected image.





**Delete All Images:** Deletes all the images the current study contains.

**Note:** This feature is only available for the images in the currently unsaved study.

To delete an image or all the images within the study:

STEP 1 In the current study, do one of the following:

- select an image, and then press  to delete the currently selected image
- press  to delete all the images within the study.

STEP 2 Press **OK** to confirm the deletion.

## 8.14 Changing Password

The default system password for quitting the workstation or accessing advanced settings is "123456".

To change the system password:

STEP 1 On the keyboard, press **Alt-F3**.

STEP 2 On the **Change Password** dialog, type the old password, type the new password twice, and then click **OK** to confirm the change.

## 8.15 Quitting Workstation Software



CAUTION

*Please follow the instructions described in this section to quit the workstation software. Do not terminate the Workstation software by force. Failure to follow this message could cause unexpected data loss.*

You can quit the workstation software and return to Windows desktop.

To quit the workstation software:

STEP 1 Clear the image area by dismissing all the dialogs, lists, or studies displayed on the center of the control screen.

STEP 2 Press **Alt-F4**, type the password on the dialog that appears, and then click **OK**.

### Notes

- If the key combination does not bring out the password dialog, check whether you have dismissed all the dialogs and had the image area cleared.
- The default password for quitting the Workstation software is "123456".

## 8.16 System Settings


You can set the default values of some functions or turn on/off certain features using the System Settings screen.

You can also access DICOM Setup screens via the System Settings screen.

Item	Content
Hospital Name	
Print Type	Laser Printer
Number of Copies	1
Merged Information on Paper	Yes
Default Denoise Level	4
Default Sharpen Level	1
Magnification	2
Language	English
Show Information on Viewing Screen	Yes
Auto Save Image	Off
Exposure Sound	On

**Figure 8-19: System Settings screen**

To access the System Settings screen:

- STEP 1 On the control screen, press **System Settings** .
- STEP 2 Type the system password, which by default is "123456", and then press **OK**.  
The System Settings screen is displayed, as shown in *Figure 8-19* (p122).
- STEP 3 Change the system settings, and then click **OK** to apply the changes.  
Refer to *Table 8-4* (p122) for descriptions of these settings.

**Table 8-4: System Settings**

Item	Description
Hospital Name	Specifies the name of the hospital. The hospital name will be displayed in the study report.
Print Type	Specifies the printer type, which can be: <ul style="list-style-type: none"> <li>• DICOM Images will be printed through a DICOM printer. This value is hidden if the connection to the DICOM printer server is disconnected.</li> <li>• Laser Printer Images will be printed through a laser printer.</li> <li>• Thermal Printer Images will be printed through a thermal printer.</li> </ul>

**Table 8-4: System Settings (Continued)**

Item	Description
Number of Copies	Specifies the number of copies to print on the printer
Burned Information on Paper	Specifies whether to display the image parameter information on the report. Such information includes patient name, sex, study date time, KV, mA, X-ray plane, etc.
Default Denoise Level	Specifies the default level of noise reduction effect that is automatically applied to a generated image. The value is integer, ranging from 0 to 4.
Default Sharpen Level	Specifies the default level of sharpening effect that is automatically applied to a generated image. The value is integer, ranging from 0 to 4.
Language	Specifies the language of the user interface, including English, Chinese, Norwegian, and Swedish. <i>Note: This setting will take effect after workstation software is restarted.</i>
Show Information on Viewing Screen	Specifies whether to show the image parameters on the viewing screens. Such information includes patient name, sex, study date time, KV, mA, X-ray plane, etc.
Auto Save Image	Specifies whether to automatically save the fluoroscopic images to the local hard drive right after they have been generated. <i>Note: If this setting is set to "No", you will have to manually save every image that you want to preserve.</i>
Exposure Sound	Specifies whether to produce an alarm sound when the fluoroscopic imaging is initiated.
AutoTrackAP	Specifies whether to enable the auto-track feature on the AP plane. The auto-track feature automatically detects the region of interest (ROI) of an image and adjusts the image parameters to offer better image quality and less dosage given to the patients.
AutoTrackLT	Specifies whether to enable the auto-track feature on the LT plane.
DAP Unit	Specifies the DAP unit, such as uGy*m <sup>2</sup> .

### 8.16.1 About

If you want to know about the product or the workstation software, you can always use the About button on the top of the System Settings screen.

The About dialog shows the following information:

**Table 8-5: The About Dialog**

Item	Description
Product Model	The model of the product.

**Table 8-5: The About Dialog (Continued)**

Item	Description
OS Version	The version number of the operating system.
Software Version	The version number of the workstation software.
Released	The build number and the release date of the workstation software.
Tel	The contact telephone number of the manufacturer.
Web	The web address of the manufacturer.
Software Expiration Date	The date on which the software license expires.

## 8.17 DICOM Setup

Reliable connections to DICOM servers are required for certain features to work. Such features include:

- Registering new patients using information provided by HIS/RIS
- Transferring patient images to a PACS server
- Printing images through a DICOM printer server
- Transferring Dose Summary Report to the DICOM server

Namely, you should have the following settings properly configured to allow the above mentioned features to work:

- Connection to a HIS/RIS server
- Connection to a PACS server
- Connection to a DICOM printer server
- Connection to a DICOM report server


### **DICOM setup process**

To enable the DICOM related features, follow this work-flow:

- 1 Add a DICOM service (p 125)
- 2 Combine a feature with a DICOM service (p 126)

### **Access DICOM Setup screen**

To enter the DICOM Setup screen:

STEP 1 On the control screen, press **System Settings** .

STEP 2 Type the system password, which by default is "123456", and then press **OK**.

STEP 3 On the **System Settings** screen, press **DICOM Setup**.

### 8.17.1 Add a DICOM service

You need to set up a connection to the DICOM service before binding a workstation feature to it.

To set up a connection to a PACS server:

STEP 1 On the **DICOM Setup** screen, press **DICOM Server Set**.

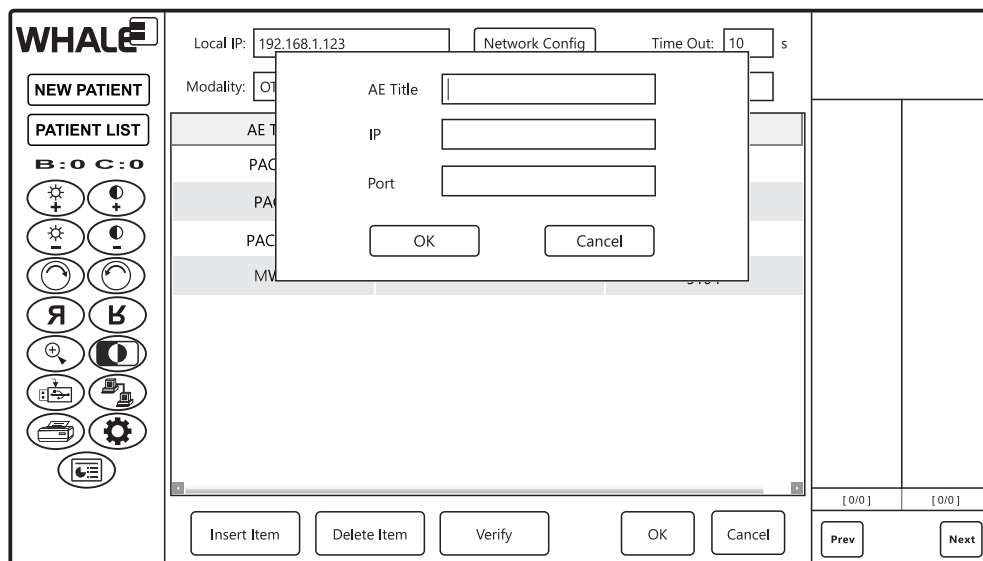
The DICOM Server Setup screen is displayed, which lists all the available DICOM services that have been configured.

**Note:** For instructions on how to access the DICOM Setup screen, see "Access DICOM Setup screen" (p124).

STEP 2 On the **DICOM Server Setup** screen, press **Insert Item**.

STEP 3 On the dialog that pops up, specify the AE title, IP and port of the DICOM service, and then press **OK**.

The new DICOM service is appended to the end of the DICOM Service list.



**Figure 8-20: Add a DICOM service**

The DICOM service list displays the DICOM services that are currently available. To modify a DICOM service, double-click on the service, and then edit the service parameters on the pop-up dialog.

## 8.17.2 Combine with a DICOM service

You need to specify a configured DICOM service to a feature in the G-Arm workstation software before this feature can function.

**Note:** You need to set up a connection to the DICOM service in advance. For instructions on this topic, see "Add a DICOM service" (p125).

To combine a workstation feature with a DICOM service:

STEP 1 Access the **DICOM Setup** screen.

**Note:** For instructions on how to access the DICOM Setup screen, see "Access DICOM Setup screen" (p124).

The DICOM Setup screen lists the G-Arm workstation features and their DICOM binding settings, as shown in Figure 8-21 (p127).

STEP 2 Find the feature you want to bind and click/tap in its **Content** cell. A drop-down list pops up, listing all the available configured DICOM services.

The following table explains the mapping relationship between the Item column and the workstation feature, as well as some image settings.



Item Name	Feature
Storage_AE	Transfers patient studies to a PACS server.
MWL_AE	Registers new patients using information provided by RIS/HIS.
SR_AE	Transfers the dose report to the DICOM server.
Printer_AE	Prints images through a DICOM printer server.
Film Size	Film sizes the DICOM printer supports (inch): 8×10, 10×12, 11×14, 14×17.
Image Bit	Specifies the color depth of the image, including 8-bit and 16-bit. The default value is 16.
Compression Quality Factor	Specifies the level of the image compression quality. The value is integer, ranging from 0 to 2. Larger number means higher compression ratio. The default value is 0 (no compression).

Item	Content
Storage_AE	PACSW
MWL_AE	MWL
SR_AE	
Printer_AE	
Film Size	8IN × 10IN
Image Bit	16
Compression Quality Factor	0

Figure 8-21: Bind to a DICOM service

### 8.17.3 Set up local host

You need to maintain the connectivity of the G-Arm system if it functions as an entity of a network.

The local host network properties include the following:

- Local IP  
Specifies the IP address of the G-Arm system.
- Local Port  
Specifies the opened port of the G-Arm system.

- **Local AE**  
Specifies the AE title of the G-Arm system.
- **Modality**  
Specifies a unique modality name for the G-Arm system.
- **Overtime**  
Specifies the time limit (in seconds) given to the G-Arm system for it trying to establish a connection to another server before the connection attempt is considered as a failure.

To set up network properties for the local host:

STEP 1 On the **DICOM Setup** screen, press **DICOM Server Set**.

The DICOM Server Setup screen is displayed, as shown in *Figure 8-22* (p128).

AE Title	IP	PORT
PACSC	192.168.1.93	5104
PACS	192.168.1.161	5104
PACSW	192.168.1.133	5104
MWL	192.168.1.174	5104

**Figure 8-22: Set up network properties for the local host**

**Note:** For instructions on how to access the DICOM Setup screen, see "Access DICOM Setup screen" (p124).

STEP 2 On the **DICOM Server Setup** screen, specify the connection settings for the G-Arm system, and then click **OK**.

### Verify an application entity

You can verify the connection to the application entity using the Verify button.

To verify the connection:

**STEP ►** On the **DICOM Server Setup** screen, select an application entity from the list, and then click **Verify**.

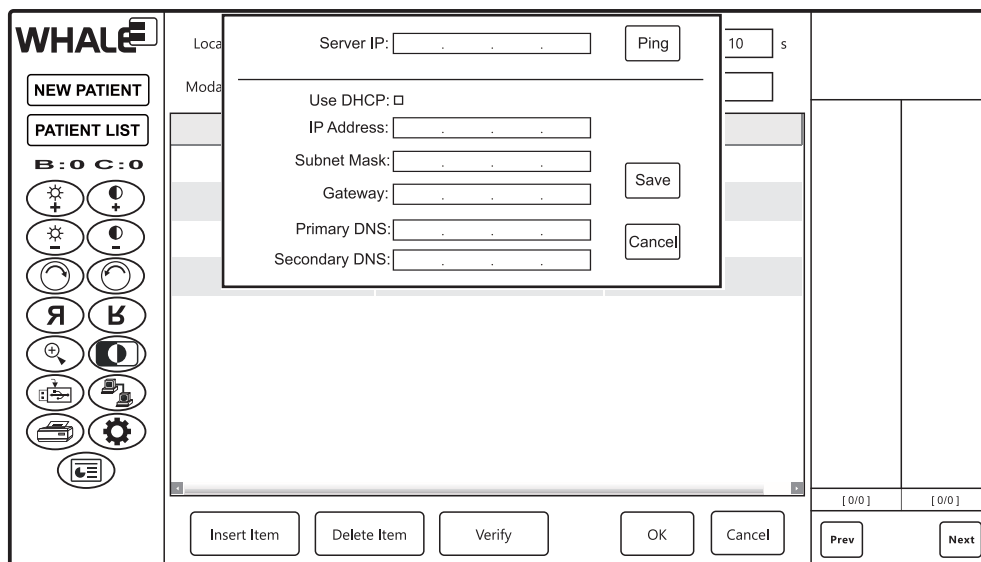
After a while, a message dialog appears, reporting that whether or not the connection to the selected application entity is successfully established.

### Configure a network connection

You can set up a network connection and perform a connection test by specifying an IP address and send a ping command to that address.

To perform a network connection test:

**STEP 1** On the **DICOM Server Setup** screen, click **Network Config**.



**Figure 8-23: Set up network properties for the local host**

**STEP 2** Under **Local Settings**, clear the **Use DHCP** check box if you want to manually provide the network information for the local host; otherwise, please have it checked and skip to STEP 4.

**STEP 3** Provide the IP address, subnet mask, gateway address, and the DNS information. If you want to keep the local network settings, click **Save**.

**STEP 4** Under **Server Test**, type the server IP address, and then click **Ping**. A message dialog will appear after a while, telling you whether or not the network connection to the specified destination is working.



## CHAPTER 9

# MAINTENANCE

*"Inspecting Cables" (s9.2, p127)*

## 9.1 Maintenance Period Overview

In order to maintain the highest possible level of system performance, technical inspection and maintenance of the G-Arm system should be performed periodically by qualified medical physicists, or the authorized service personnel. However, the operator of this unit should take note of any malfunctions and contact the manufacturer or the service personnel authorized by the manufacturer if necessary.

Each time before use, parts or functions below shall be checked by the end users before each use:

- Cables and cable clamps (p127)
- Movement of the Image Intensifier units (p128)
- Wheel functionality for the Control Unit and the G-Arm (p129)
- Laser light indicator (p129)
- Monitor rotation (p130)
- Function of the X-ray indicator lamp (p130)

Each time after use, the hospital should carefully clean the G-Arm system according to the instructions described in "Cleaning and Disinfection" (p132)

The function below shall be checked by the end user twice a year:

- Automatic Exposure Control (p78)

Once a year, qualified medical physicists or authorized service personnel shall measure the following items:

- Automatic Exposure Control (p130)
- Accuracy of X-ray tube voltage (kV) (p131)

### Notes

- *All the testing items should be conducted periodically and recorded properly, the recommended QC testing log is attached as in Appendix IV: QC TEST LOG FORM (p175).*
- *Should any testing item fail, please contact the manufacturer. For contact information consult the last page of the user's manual.*

## 9.2 Inspecting Cables

The following cables shall be inspected by the end users each time before use:

- Power Cable (L1)
- Protective Earth Cable (L4)

- STEP 1 Inspect the power cable and protective earth cables. Make sure they look intact and undamaged.
- STEP 2 Check the connections. Make sure they are both securely connected.

## 9.3 Checking the I.I. Movements



*Before starting to inspect the I.I. movements, clear all the obstacles within the movement range to make sure the image intensifiers do not collide with any objects.*

The movements of the Image Intensifier should be inspected by the end users each time before use for any potential movement abnormalities.

- STEP 1 Start up the equipment.
- STEP 2 On the Control Panel, press any movement key to move the Image Intensifier on either plane towards either direction.  
Check whether the image intensifier can move smoothly without any abnormal noise and can reach the maximum or minimum SID.
- STEP 3 Perform the same operations on the other Image Intensifier and check whether it works as expected.

Contact the service personnel immediately with any abnormalities.



*If the equipment has not been used for an extended amount of time (over 30 days), turn it on and leave it idle without taking any exposures for 2~3 hours in order to maintain the required vacuum in the image intensifier.*



*Before service engineers can begin any maintenance, cut off the power supply so that the high-voltage capacitor can be fully discharged. This is to avoid potential hazards of electric shocks.*



*The image intensifier is unable to bear the shock or vibration acceleration of more than 1 g for 6 milliseconds ( $1\text{ g} = 9.8\text{ m/s}^2$ ).*



*Wear protective gloves or visors to avoid any possible injuries during maintenance.*



## 9.4 Checking Locking Wheel Movements

The locking wheel movement of the Control Unit and the G-Arm shall be inspected by the end users every time before use for any potential movement abnormalities.



*Before starting the test procedure, turn off the equipment. Observe the working field to make sure the ground is flat and level and there are no obstacles or small objects that can obstruct the locking wheel movement.*

- STEP 1 Check the exterior conditions of all the locking wheels of the Control Unit or G-Arm. Make sure they are all intact and undamaged.
- STEP 2 Raise the brake pedal on the Control Unit or G-Arm. Move the unit by pushing or pulling the handles to see whether it can be moved smoothly.
- STEP 3 Press down the brake pedal to lock all the wheels on the Control Unit or G-Arm. Try to move the unit by pushing or pulling the handles to see whether it can stay still.

Should any abnormalities be observed during the above procedure, contact the service personnel immediately.

## 9.5 Checking Laser Indicator

In order to make sure the laser indicator can accurately point to the expected irradiating zone of the X-ray beam center, it shall be inspected by the end users each time before use.

The dot illuminated on the carbon fiber plate of the tube assembly by the laser indicator shall coincide with the X-ray beam center of the corresponding plane, with an error range  $\leq \pm 6$  mm.

To check whether the laser indicator is accurate:

- STEP 1 Keep the laser indicator off, and move the image intensifier to the mid-point of travel distance.
- STEP 2 On the carbon fiber plate of the tube assembly, attach a  $\varnothing 12$  mm pad to the center of the X-ray beam.
- STEP 3 Initiate fluoroscopic imaging and adjust the pad position so that the pad center coincide with the image center.
- STEP 4 Switch on the laser indicator. See if the generated light dot lies inside the  $\varnothing 12$  mm pad.

If the light dot does not hit the target, namely the generated light dot lies outside the pad, you need to have the laser light re-calibrated.

## 9.6 **Checking Monitor Rotation Movements**

The movements of the viewing monitors should be inspected by the end users each time before use for any potential movement abnormalities.



WARNING

*Before starting to inspect monitor rotation movements, clear all the obstacles within the movement range to make sure the viewing monitors do not collide with any objects.*

- STEP 1 Rotate the viewing monitor assembly clockwise by pulling either side of the viewing monitors. See if it can be moved smoothly and reach its maximum rotation angle (180°).
- STEP 2 Spin the monitor assembly backwards and stop the rotation movement at a random position. Release the monitor. See if it can hold its position and stay still.
- STEP 3 Spin the monitor assembly counter-clockwise, passing its neutral position, all the way to the other end position. See if the movement is smooth and it can reach its maximum rotation angle (180°).

Should any abnormalities be observed during the above procedure, contact the service personnel immediately.

## 9.7 **Checking Exposure Indication**

Exposure indication functions (exposure lamp and exposure sound) shall be inspected at any time during use.

- STEP► Take an exposure. Check whether the exposure lamp is illuminated and the exposure sound beeps.

## 9.8 **Measuring Automatic Exposure Control**

Automatic Exposure Control (AEC) is a sequence that is automatically initiated when the footswitch pedal is released immediately after being pressed down, in which the G-Arm system automatically calculates suitable loading factors (kV, mA, and fluoroscopic duration) according to the physical characteristics of the patient.

AEC applies to the following fluoroscopy mode:

- Automatic Pulse Fluoroscopy
- Automatic Continuous Fluoroscopy
- Half Automatic Continuous Fluoroscopy
- Half Automatic Pulse Fluoroscopy

- DR Fluoroscopy

To measure the accuracy of the AEC sequence:

STEP 1 Turn on the G-Arm system.

STEP 2 Set the SID to 910 mm. Place a 20 cm thick PMMA rectangular block with sides  $\geq 25$  cm as close as possible to the image intensifier.

STEP 3 Perform AEC sequence in each mode as described in the following table, and record the values of current time product and kV value displayed on the G-Arm system.

The deviation between the derived mAs and the reference mAs shall not exceed  $\pm(10\% + 0.2 \text{ mAs})$ , the deviation between the derived kV and the reference kV shall not exceed  $\pm 10\%$ .

STEP 4 The measured values of the current time product and tube voltage shall be within the value ranges as indicated in the **PCT (mAs)** column of the following table:

Mode	Current (mA)	Time (s)	PCT (mAs)*	kV
Auto. Cont. Fluoroscopy	1.9	1.8	2.878-3.962	52.2-63.8
Auto. Pulse Fluoroscopy	7.0	1.9	11.14-14.06	50.4-61.6
Half Auto. Cont. fluoroscopy	0.9	2	1.42-2.18	53.1-64.9
Half Auto. Pulse fluoroscopy	3.8	2.2	7.324-9.396	51.3-62.7
DR Fluoroscopy	3.6	2.4	7.576-9.704	49.5-60.5

\* PCT = Product of Current and Time

The equation of the PCT range is as follows:

$C = \text{CURRENT (mA)}, T = \text{TIME (s)}, P = \text{PRODUCT}$

$P = C \times T$

$\text{RANGE OF PCT} = (P - (P \times 0.1 + 0.2)) \sim (P + (P \times 0.1 + 0.2))$

## 9.9 Measuring Accuracy of Tube Voltage

The accuracy of the X-ray tube voltage shall be inspected once a year, which requires the following instrument:

No.	Instrument	Recommended Model/Specification
1	Dose meter	RTI/Piranha555

Take the following procedure:

STEP 1 Place the dose meter detector on the center of the surface of image intensifier acceptor, and then turn on the G-Arm system.

STEP 2 Activate **Manual Continuous Fluoroscopy** mode.

STEP 3 Initiate fluoroscopic imaging according to *Table 9-1 (p138)* and record the measured kV values displayed on dose meter.

STEP 4 Switch to **Manual Pulse Fluoroscopy** mode, repeat *step 3*.

For the test to pass, the measured kV values shall be within the range of kV values ( $\pm 10\%$ ), as indicated in the following table:

**Table 9-1: Range of Measured kV Values (Manual Continuous Fluoroscopy)**

kV	mA	kV Range
40	2	36 ~ 44
72	2	64.8 ~ 79.2
108	2	97.2 ~ 118.8
120	2	108 ~ 132

**Table 9-2: Range of Measured kV Values (Manual Pulse Fluoroscopy)**

kV	mA	kV Range
40	15	36 ~ 44
72	15	64.8 ~ 79.2
108	15	97.2 ~ 118.8
120	15	108 ~ 132
40	30	36 ~ 44
72	30	64.8 ~ 79.2
108	30	97.2 ~ 118.8
120	30	108 ~ 132

## 9.10 Cleaning and Disinfection



WARNING

Before cleaning the G-Arm system, always disconnect the AC power cable from the AC power receptacle. Do NOT allow any liquids to drip or splash on the equipment, especially the electric components, to avoid hazards of short circuit, electric shock and fire.

- Clean the equipment by using cotton cloth and do not use abrasive detergent, organic solvent or any kind of detergent containing any kind of organic solvent, or aggressive detergent containing alcohol.
- Do not use spray or spray disinfectant as it can penetrate the surface of the equipment and damage the internal electric elements.
- Use sterile drapes to cover the G-Arm and footswitch to protect the equipment from blood spills and to create a sterilized environment for surgery.

The following table lists the recommended cleaning agents and disinfectants:

**Table 9-3: Recommended Cleaning Agents and Disinfectants**

Solution	Mfr.	Form	Wash Time	Usage
Tap water	All	Liquid	1	Clean
Deionized water				Clean
Soft liquid soap				Clean/disinfect
Ethanol 75%				Clean/disinfect
Hydrogen peroxide solution				Clean

**Note:** The hospital should carefully clean the G-Arm system after each surgery. The person responsible for the cleaning of the equipment should be trained by the manufacturer.



## CHAPTER 10

# TECHNICAL SPECIFICATIONS





## 10.1 System

<b>Resolution:</b>	≥1.6 Lp/mm
<b>Low contrast resolution:</b>	≤ 2%
<b>Brightness ladder level:</b>	≥ 10 degrees
<b>Total equivalent filtration:</b>	4.0 mmAl (at 80 kV)
permanent filtration	2.0 mmAl (at 80 kV)
additional filtration (irremovable)	2.0 mmAl (at 80 kV)
<b>Distortion rate:</b>	≤ 5%

## 10.2 Output Electric Power

When performing real-time manual pulse fluoroscopy from both AP and LT planes, the G-Arm system achieves the highest power, as indicated below:

<b>Nominal electric power:</b>	2.3 kW (100 kV, 15 mA, 1 s)
<b>Highest electric power:</b>	1.8 kW (120 kV, 15 mA)(bi-plane imaging, peak), 1.2 kW (120 kV, 15 mA) (bi-plane imaging, maximum average)

## 10.3 X-ray Tube Assembly

Major parameters of the X-ray tube assembly configuration are listed as below.

<b>Tube Assembly Model:</b>	E-40R HF IMD/XR05
<b>Tube Model:</b>	IMD/XR05
<b>Maximum Voltage to X-ray Tube:</b>	120 kV
<b>Focal spots:</b>	0.3/0.6 mm
<b>Target angle:</b>	10°
<b>Anode:</b>	Rotating Anode
<b>Anode material:</b>	Tungsten
<b>Minimum inherent filtration:</b>	2.0 mmAl
<b>Thermal capacity:</b>	600 kJ
<b>Weight:</b>	19.6 kg
<b>Leakage Radiation:</b>	< 1 mGy/h at 120 kV and 4 mA
<b>Additional Filtration:</b>	2.0 mmAl

For detailed specifications on X-ray tube and tube assembly, consult the following accompanying documents:

### **B6**

Specifications of X-ray Tube (Doc#: XGB6-12-00573 Ver: 1.0)

## 10.4 Generator

Type:	E-9040-5
Operating frequency:	40 kHz $\pm$ 2 kHz
Maximum power:	5 kW

## 10.5 Image Intensifier

Type:	TH9428HP2H653 VR13
Useful entrance field size (mm):	215+/-5 mm
Triple Field	
↳ Normal:	230 mm (9 inches)
↳ Magn.1:	160 mm (6 inches)
↳ Magn.2:	120 mm (4.5 inches)
Output image diameter (mm):	20+/-5 mm
Resolution:	$\geq$ 40 Lp/cm
Contrast ratio:	$\geq$ 18
Conversion factor:	$\geq$ 17 cd/m <sup>2</sup> /μGy/s

## 10.6 Deviations

The readings of the loading factors displayed on the LCD screens of the control panel can be different from the real tube potential and current. The maximal allowable deviations are depicted as below:

Maximum kV deviation:	$\pm$ 10%
Maximum mA deviation:	$\pm$ 10%

## 10.7 TV-Chain

Camera:	CCD, 1024×1024 pixels
Video out:	12 bit
Main monitors:	19" LCD×2, 4:3, Maximum Resolution: 1280×1024@60Hz, flicker-free, high contrast and high brightness, mono 255 Gray-scale
Control monitor:	18.5" LCD×1, 16:9, Native Resolution: 1360×768@60Hz, 255 Gray-scale

## 10.8 Printer

Printer (optional):	SONY UP-971AD
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## 10.9 Grid

Size:	Circular 242 mm
Lines:	103 per inch (40.5 per cm)

<b>Ratio:</b>	8:1
<b>F.D.:</b>	100 cm
<b>Absorber:</b>	PB

## 10.10 G-Arm

<b>SID variable:</b>	910~1210±10 mm
<b>I.I. unit travel distance:</b>	300 mm±10 mm
<b>G-Arm, lift distance:</b>	300 mm±10 mm
<b>G-Arm, rotation angle (orbital):</b>	±35°±2°
<b>G-Arm, rotation angle (lateral):</b>	±45°±2°

## 10.11 Weights

<b>Whole Product Gross Weight:</b>	≈ 670 kg
<b>Weight of G-Arm:</b>	≈ 520 kg
<b>Weight of Control Unit:</b>	≈ 150 kg

## 10.12 Computer

<b>Operating System:</b>	Windows Embedded Standard 7
<b>CPU:</b>	≥ 4-core, 8-thread, 3.4 GHz
<b>Memory:</b>	≥ 4 G
<b>Hard disk:</b>	≥ 500 GByte
<b>Ethernet:</b>	≥ 1000 Mbit/s

## 10.13 Operation Table Dimensions

The recommended dimensions of the operation table is quoted as below:

<b>Height:</b>	≥ 605 mm
<b>Width:</b>	≤ 850 mm

## 10.14 Operation Environment

<b>Temperature:</b>	10°C ~ 40°C
<b>Relative humidity:</b>	15% ~ 70%
<b>Barometric:</b>	700 hPa~1060 hPa

## 10.15 Transport and Storage Environment

<b>Temperature:</b>	-20°C ~ 55°C
<b>Relative Humidity:</b>	10% ~ 90% (Non-condensing)
<b>Barometric:</b>	700 hPa ~ 1060 hPa

## 10.16 Diagnostics Table

Attenuation equivalent of materials located in the X-ray beam should meet the requirements as depicted in the following table; otherwise it will reduce the image quality, which requires higher loading factors to achieve the same image quality:

**Table 10-1: Attenuation equivalent of items in the X-ray beam**

Item	Max. Attenuation Equivalent (mmAl)
Front panel of Cassette Holder (All layers)	1.2
Front panel of Film Changer (All layers)	1.2
Front panel of Digital X-ray Imaging Device (All layers, w/o detector)	1.2
Cradle	2.3
Patient support, stationary, without articulated joints	1.2
Patient support, mobile, without articulated joints (including stationary layers)	1.7
Patient support with radio-lucent panel having one articulated joint	1.7
Patient support with radio-lucent panel having two or more articulated joints	2.3
Patient support, cantilevered	2.3

## 10.17 Quality Standards

- IEC
- **EN 60601-1** Medical Electrical Equipment - Part 1: General Requirements for Basic Safety and Essential Performance
- **EN 60601-1-3** Medical Electrical Equipment - Part 1-3: General Requirements for Safety - Collateral Standard: Radiation Protection in Diagnosis X-Ray Equipment
- **EN 60601-2-54** Medical Electrical Equipment - Part 2-54: Particular Requirements for the Basic Safety and Essential Performance of X-Ray Equipment for Radiography and Radioscopy
- **EN 60601-1-2** Medical Electrical Equipment - Part 1-2: General Requirements for Basic Safety and Essential Performance - Collateral Standard: Electromagnetic Compatibility - Requirements and Test

## CHAPTER 11

# TROUBLE-SHOOTING



## 11.1 Trouble-shooting

The G-Arm system performs a self-check during power-up and displays a message on the LCD screens if any fault is detected, as described in the following table:

**Table 11-1: Error Codes and Solutions**

Error Code	Description	Solution
E01	Power Malfunction	First check the output of AC power supply, then check the output of DC power supply, or call the service
E02	X-ray Tube Overheat	Shut down, do not turn the system on until the X-ray tube cools down
E05	Filament Power Supply Malfunction	Call the service
E06	Inverter Malfunction	
E07	Focus Selection Error	
E09	CPU Malfunction	
E11	Rotation Anode Error	





CHAPTER 12

**TRANSPORT AND  
STORAGE**



## 12.1 Transport and Storage Environment

Use special equipment package for the outdoor transportation of this unit.



*Take extra care when moving the G-Arm system across uneven ground. For example, when getting in/out of elevators, move the equipment as gently as possible to protect the precision components, like the image intensifiers and the CCD cameras, from being damaged by the violent vibration.*

Do not put this unit to a place where the temperature tends to change rapidly and drastically.

The G-Arm system is not allowed to be stored or transported in the environments that do not match the following conditions:

Temperature:	-20°C ~ 55°C
Relative Humidity:	10% ~ 90% (Non-condensing)
Barometric:	700 hPa ~ 1060 hPa



*At initial setup or when removing from storage, stabilize the equipment at ambient temperature and humidity for 4 hours before applying power. Failure to observe this warning might damage the equipment.*















*If the equipment has not been used for an extended amount of time (over 30 days), turn it on and leave it idle without taking any exposures for 2~3 hours in order to maintain the required vacuum in the image intensifier.*

## 12.2 Related Symbols

The following table lists the symbols used on the transport package:

Table 12-1: Symbols Used on the Transport Package

Symbol	Name	Description
	This way up	Indicates the correct upright position of the transport package.
	Do not stack	Indicates that stacking of the transport package is not allowed and no load should be placed on the transport package.
	Fragile, handle with care	Indicates that the contents of the package can be broken or damaged if not handled carefully.
	Temperature limit	Indicates the temperature limits to which the medical device can be safely exposed.
	Humidity limitation	Indicates the range of humidity to which the medical device can be safely exposed.
	Keep dry	Indicates that the contents of the package need to be protected from moisture or rain.
	Atmosphere pressure limitation	Indicates the range of atmospheric pressure to which the medical device can be safely exposed.
	Do not roll	Indicates that the transport package shall not be rolled.
	Protect from heat and radioactive sources	Indicates that the contents of the package contains need protection from heat and radioactive sources.
	Stacking limit by mass	Indicates the maximum stacking load permitted on the transport package.
	Use no hand hooks	Indicates that the transport package shall not be handled by hooks.
	Do not clamp as indicated	Indicates that the transport package should not be handled by the clamps on the sides indicated.



*Do NOT dispose the waste of electrical and electronic equipment as unsorted municipal waste. Separately recycle it according to the rules of the local government.*

*Please contact authorized representatives of the manufacturer or authorized waste management companies for information concerning the decommissioning of the equipment.*



## CHAPTER 13

# **ELECTROMAGNETIC COMPATIBILITY STATEMENT**





## 13.1 Information on Electromagnetic Compatibility

Portable and mobile RF communications equipment can affect the G-Arm System.

The use of accessories, transducers and cables other than those specified, with the exception of transducers and cables sold by the manufacturer of the G-Arm System as replacement parts for internal components, may result in increased emissions or decreased immunity of the G-Arm System.

The G-Arm System should not be used adjacent to or stacked with other equipment and that if adjacent or stacked use is necessary, the G-Arm System should be observed to verify normal operation in the configuration in which it will be used.

**Note:** Beijing East Whale Imaging Technology Co., Ltd. cannot guarantee that accessories, lines and transformers not delivered by Beijing East Whale Imaging Technology Co., Ltd. will correspond with EMC requirements of EN 60601-1-2.

No.	Accessory Part/Name	Article Number	Length/Dimensions (m)
1	Power cord	1	7m
2	Interconnect cable	1	7m
3	Footswitch cable	1	7m
4	Protective earth cable	1	5m

To prevent interference, surrounding equipment should comply with the standard IEC60601-1-2.

**Note:** The G-Arm System is exclusively intended for use by medical professionals. In residential areas, the G-Arm System may cause radio interference in certain circumstances so that it may be necessary to undertake suitable measures such as realigning, rearranging or screening the G-Arm System, or filtering the connection with the public power supply.

## 13.2 Emitted Electromagnetic Interference

The G-Arm imaging system is intended for use in the electromagnetic environment specified below. The customer or the user of the G-Arm imaging system should assure that it is used in such an environment.

#	Emission Test	Compliance
1	RF emissions CISPR 11	Group 1, Class A

#	Emission Test	Compliance
2	Harmonic emissions IEC 61000-3-2	N/A
3	Voltage fluctuations/flicker emissions IEC 61000-3-3	N/A

#### **Electromagnetic Environment – Guidance (#1 in the above table)**

The G-Arm System uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.

## 13.3 Electromagnetic Immunity

#	IMMUNITY Test	Compliance Level
1	Electrostatic discharge (ESD) IEC 61000-4-2 6 kV contact 8 kV air	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV contact $\pm 2$ kV, $\pm 4$ kV, $\pm 8$ kV air discharge
2	Electrical fast transient/burst IEC 61000-4-4 $\pm 2$ kV for power supply lines	$\pm 2$ kV for power supply lines
3	Surge IEC 61000-4-5 $\pm 1$ kV Line to line $\pm 2$ kV Line to earth	$\pm 1$ kV Line to line $\pm 2$ kV Line to earth
4	Conducted RF IEC 61000-4-6 3 Vrms 150 kHz to 80 MHz	3 Vrms 150 kHz to 80 MHz
5	Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz

#### **Electromagnetic Environment - Guidance**

##### **Electrostatic discharge (ESD) (#1 in the above table)**

Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.

##### **Electrical fast transient/burst (#2 in the above table)**

Mains power quality should be that of a typical commercial or hospital environment.

##### **Surge (#3 in the above table)**

Mains power quality should be that of a typical commercial or hospital environment.

**Conducted RF & Radiated RF (#4 & #5 in the above table)**

Portable and mobile RF communications equipment should be used no closer to any part of the G-Arm System, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.

Recommended separation distance:

$$d = \left[ \frac{3.5}{V_i} \right] \sqrt{P}$$

$$d = \left[ \frac{3.5}{E_i} \right] \sqrt{P} \quad (80 \text{ MHz to } 800 \text{ MHz})$$

$$d = \left[ \frac{7}{E_i} \right] \sqrt{P} \quad (800 \text{ MHz to } 2.5 \text{ GHz})$$

where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey<sup>a)</sup>, should be less than the compliance level in each frequency range<sup>b)</sup>.

- a) Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the G-Arm System is used exceeds the applicable RF compliance level above, the G-Arm System should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the G-Arm System.
- b) Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [3] V/m.

Interference may occur in the vicinity of equipment marked with the following symbol:



## 13.4 Recommended Safe Distance

The G-Arm System is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of The G-Arm System can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and The G-Arm System as recommended

below, according to the maximum output power of the communications equipment.

The following table lists the recommended separation distances between portable and mobile RF communications equipment and the G-Arm imaging system:

Rated Maximum Output Power of Transmitter (W)	Separation Distance According to Frequency of Transmitter (m)		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = \left[ \frac{3.5}{V_i} \right] \sqrt{P}$	$d = \left[ \frac{3.5}{E_i} \right] \sqrt{P}$	$d = \left[ \frac{7}{E_i} \right] \sqrt{P}$
0.01	0.12	0.04	0.23
0.1	0.36	0.11	0.74
1	1.17	1.35	2.33
10	3.70	1.11	7.37
100	11.70	3.50	23.30

For transmitters rated at a maximum output power not listed above, the recommended separation distance  $d$  in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where  $P$  is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

#### Notes

- At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
- These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

## APPENDIX I

# SYMBOLS & NAMEPLATES



## A(I)-1 Symbols

Table I-1: Symbols used on this unit (Sheet 1 of 3)

Symbol	Description	Location
	Warning: Dangerous voltage	Near the power inlet terminal
	Warning: Crushing hazard - foot	On the surface of the bottom main girder and on the surface of the wheel buffers
	Warning: Crushing hazard - hand	Near the back cover of the image intensifier
	Warning: Crushing hazard - body	On the surface of the lateral image intensifier's side
	Warning: Ionizing radiation	On the cover of the tube assembly
	Protective earth (ground)	Near the protective earth (ground) terminal and protective earth (ground) copper bar
<b>L</b>	AC power input	Beside Circuit breaker input
<b>N</b>	AC power input	Beside Circuit breaker input
	Focal spot	On the side cover of the tube assembly, corresponding to the focus position of the tube assembly
	Emergency stop	On the surface of the outer cover of the control unit and the back of the G-Arm base, on top of the emergency stop
	Stepping prohibited	On the surface of AP tube assembly

Table I-1: Symbols used on this unit (Sheet 2 of 3)




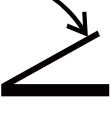









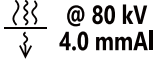
Symbol	Description	Location
	Sitting prohibited	On the surface of the AP tube assembly
	Use no forklift	On the surface of the bottom main girder
	ON/OFF	Near the circuit breaker
	Footswitch	On the surface of the foot switch & the foot switch socket in the control unit
	Protected against water submer- sion	On the surface of the foot switch
	Network Port	On the back cover of the control unit
	USB Port	On the left cover the control unit
	Connection indication	At the back side of the connector case
	G-Arm Connection Indicator	On one end of the heavy duty connector; On G-Arm.
	Control Unit Connection Indica- tor	On one end of the heavy duty connector; On Control Unit.
	5 R/min Indicator	On the base of the image intensifier
	Warning: Laser beam	On the surface of the image intensifier, next to the laser light



Table I-1: Symbols used on this unit (Sheet 3 of 3)

Symbol	Description	Location
	Warning: Laser beam	On the surface of the image intensifier
	Total Equivalent Filtration	On the surface of the x-ray tube assembly

## A(I)-2 Rulers

### A(I)-2-1 SID Ruler

The SID ruler is used to measure the distance from X-ray generating source to the current position of the Image Intensifier.

The SID rulers are labelled on both sides of the bottom covers of the image intensifiers.



Figure I-1: SID Ruler

### A(I)-2-2 G-Arm Orbital Rotation Ruler

The G-Arm orbital rotation ruler is used to measure the orbital rotational angle of the G-Arm.

The G-Arm orbital rotation rulers are labelled on both sides of the back of the curved G-shaped arm.

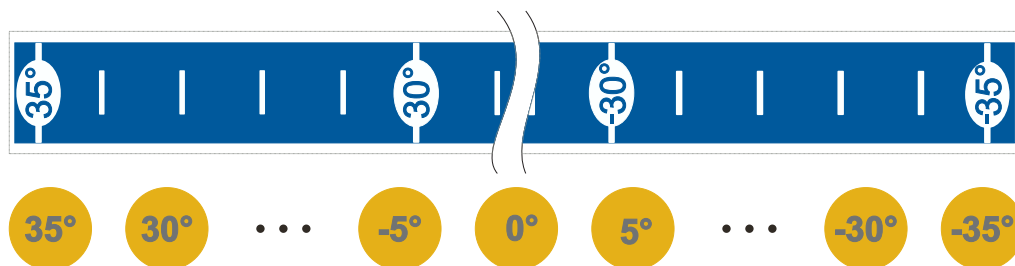
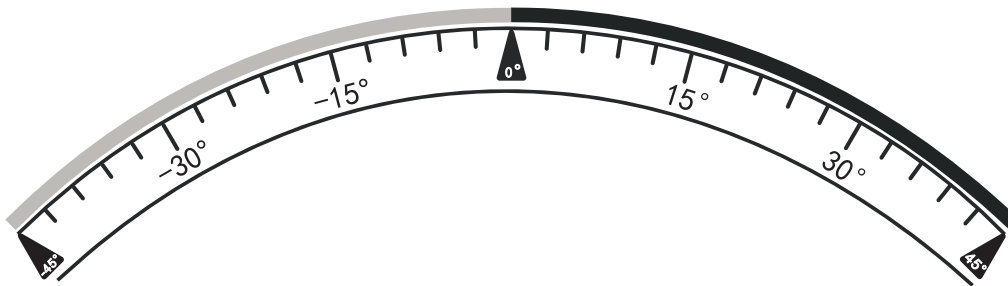


Figure I-2: G-Arm Orbital Rotation Ruler

### A(I)-2-3 G-Arm Radial Rotation Ruler

The G-Arm radial rotation ruler is used to measure the radial rotational angle of the G-Arm.

The G-Arm radial rotation rulers are labelled on back of the main support beam of the curved G-shaped arm.

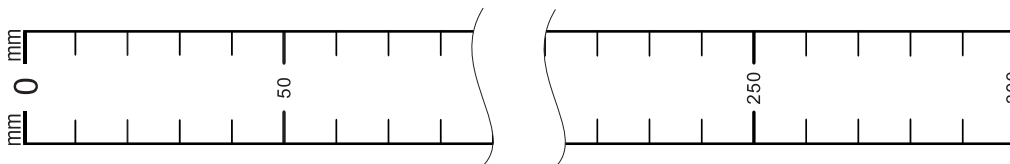


**Figure I-3: G-Arm Radial Rotation Ruler**

### **A(I)-2-4 G-Arm Vertical Movement Ruler**

The G-Arm vertical movement ruler is used to measure the vertical travel distance of the G-Arm.

The G-Arm vertical movement rulers are labelled on pillar of main support beam.







**Figure I-4: G-Arm Vertical Movement Ruler**

### **A(I)-3 Labels**

The following labels are attached to relevant surface area of the equipment to provide important information or warning messages.

Table I-2: Labels used on this unit









Label	Location
 <b>WARNING</b> BEFORE SWITCHING ON CIRCUIT BREAKER, MAKE SURE G-ARM AND CONTROL UNIT ARE CONNECTED PROPERLY THROUGH HEAVY DUTY CONNECTOR.	Near the circuit breaker
 <b>WARNING</b> DO NOT PLACE ANYTHING ON TOP OF THE CONTROL UNIT, ESPECIALLY HEAVY THINGS OR CONTAINERS HOLDING LIQUIDS.	On the surface of the control panel
 <b>WARNING</b> THIS X-RAY UNIT MAY BE DANGEROUS TO PATIENT AND OPERATOR UNLESS SAFE EXPOSURE FACTORS, OPERATING INSTRUCTIONS AND MAINTENANCE SCHEDULES ARE OBSERVED.	
 <b>CAUTION</b> DO NOT ATTEMPT TO MOVE THE EQUIPMENT BY PUSHING THE CASING OF THE IMAGE INTENSIFIER; USE GRAY HANDLES ONLY.	On the surface of the image intensifier on the LT plane.
 <b>WARNING</b> BEFORE CONNECTING TO THE MAINS, MAKE SURE IT CONFORMS TO THE EQUIPMENT POWER SUPPLY REQUIREMENTS. CONSULT USER MANUAL FOR SPECIFIC INFORMATION.	On the surface of the back cover of the control unit, near the power inlet.

## A(I)-4 Nameplates

### A(I)-4-1 Symbols on nameplates

The following table describes the symbols that are used on the nameplates.

Table I-3: Symbols used on nameplates

Symbol	Description
	Caution
	Manufacturer
	Serial Number
	Date of manufacture
	The waste of electrical and electronic facility must not be disposed as unsorted municipal waste and must be collected separately. Use the return and collection systems according to local law.
	European Authorized Representative
	CE mark
	Refer to instruction manual/booklet

## A(I)-4-2 Product Nameplate

The product nameplate indicates manufacturer information and input power requirements.

It is located near the power inlet, on the surface of the back cover of the control unit.

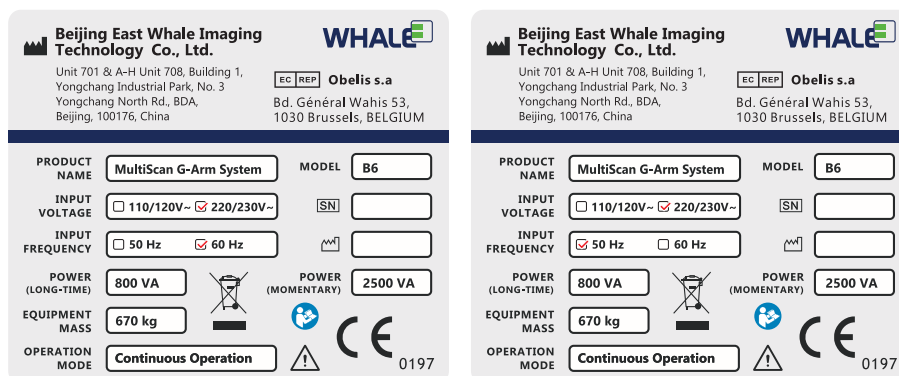


Figure I-5: Product Nameplate of B6

**A(I)-4-3    G-Arm Nameplate**

The G-Arm nameplate is located on the lifter casing of G-Arm.



Figure I-6: G-Arm Nameplate of B6

**A(I)-4-4    Control Unit Nameplate**

The nameplate of Control Unit is located on the back cover of Control Unit, near the power connector.



Figure I-7: Control Unit Nameplate of B6



APPENDIX II

**COMPONENTS AND  
ACCESSORIES**





## **A(II)-1    Components and Accessories**

<b>Standard Components</b>
Power cable (Mains cable)(L1)
Footswitch (2- or 3-pedal)(with cable L3)
Interconnect cable (L2)
Protective earth cable (L4)

<b>Optional Components</b>
Printer

<b>Accessories</b>
DAP Meter
Skin Spacer (Optional)



## APPENDIX III

# RELATED DOCUMENTS



## **A(III)-1    Related Documents**

Besides this user's manual, several other related documents are shipped together with the product, as below:

<b>Specifications of X-ray Tube Assembly</b>	
Doc Number:	XGB6-12-0073
Version:	1.0
Specifications of X-ray tube assembly and X-ray tube for B6.	

The technical description shall contain a statement that the manufacturer will make available on request circuit diagram, component part lists, descriptions, calibration instructions, or other information that will assist service personnel to repair those parts of the G-Arm system that are designated by the manufacturer as repairable by service personnel.



APPENDIX IV

**QC TEST LOG FORM**





**A(IV)-1 Dosimetric Indication Value Test**

Test Group	Test Checkpoint	Man. Cont.	Auto. Cont.	Man. Pulse	Auto. Pulse	DR	½ Auto. Cont.	½ Auto. Pulse
Loading Factors	kV							
	mA							
AKR (mGy/min)	Measured Value							
	Displayed Value							
	Deviation							
	Pass/Fail							
Cumulative AKR (mGy)	Calculated Value							
	Displayed Value							
	Deviation							
	Pass/Fail							
DAP ( $\mu\text{Gy}\cdot\text{m}^2$ )	Calculated Value							
	Displayed Value							
	Deviation							
	Pass/Fail							

**A(IV)-2 Automatic Exposure Control Test**

Exposure Mode	Criteria (mAs, kV)		Value	Pass?	Time	Sig.
Auto Cont. Fluo.	2.878-3.962	52.2-63.8				
Auto Pulse Fluo.	11.14-14.06	50.4-61.6				
½ Dose Auto Cont. Fluo.	1.42-2.18	53.1-64.9				
½ Dose Auto Pulse Fluo.	7.324-9.396	51.3-62.7				
DR Fluo.	7.576-9.704	49.5-60.5				

## A(IV)-3 Accuracy Test of kV Values

**Table IV-1: kV Accuracy Test in Manual Cont. Fluo. Mode**

kV	Criteria	Value	Pass?	Time	Signature
40	36~44				
60	54~66				
80	72~88				
100	90~110				
110	99~121				
120	108~132				

**Table IV-2: kV Accuracy Test in Manual Pulse Fluo. Mode**

kV	Criteria	Value	Pass?	Time	Signature
40	36~44				
60	54~66				
80	72~88				
100	90~110				
110	99~121				
120	108~132				

## Image Intensifier, Collimator, Tube Assembly

Image Intensifier (AP)			
Image Intensifier (LT)			

Collimator (AP)			
Collimator (LT)			

Tube Assembly (AP)			
Tube Assembly (LT)			





## For support please contact

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