Biomedical equipment servicing level -IV

Based on May, 2011 Version OS and Feb, 2021 Version 1 Curriculum

Unit of Competence: Install Advanced Biomedical Equipment

Module Title: Installing Advanced Biomedical Equipment

LG Code: EEL BES4 M01 LO (1-3) LG (1-3)

TTLM Code: EEL BES4 TTLM 0121v1

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Table of Contents

Table of figure

List of Tables

LG #01	LO#1: INTERPRET WORK INSTRUCTIONS

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Reading and interpreting work instructions.
- Selecting Tools and testing devices needed to carry out the installation work
- Obtaining materials necessary to complete the work.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Read and interpret work instructions.
- Select Tools and testing devices needed to carry out the installation work
- Obtain materials necessary to complete the work.

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, and Sheet 3.
4. Accomplish the “Self-check 1, Self-check t 2, and Self-check 3” **in page 14, 34, and 37** respectively.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the

Self-checks).

Information Sheet-1	Reading and interpreting work instructions.

Introduction

Installation is the process of assembling or fixing the machine into place. This may require proper site preparation in cases of high technology devices. Installation is basically series of tasks to accomplish fixing the specific device with necessary accessary for safe utilization of the equipment by using variety of tools and man power. Prior to Installation work one should have to read and interpret the instruction to work clearly. For this action each advanced medical device has their own manufacturer guide written in short description or in the installation manual or handbook. The following steps should be followed;

- Reading tags ,any descriptions on the package of the equipment and accessories
- Read main equipment and accessories check list to know proper numbers of item in piece, box or cartoon
- Read and understand the basic safety tags or warning notice written
- Read installation manuals and understanding each and every technical drawing as well as electrical drawing when needed
- Receive the equipment on site and check according to given logistics , specifications , check for damage
- Prior to installation the technical personnel should have to read any aspects of the equipment and interpret it properly regarding Construction / structural changes, utility requirements, etc.

During the Installation work the following condition should be considered;

- Specify installation requirements in terms of civil works, data network, electricity, hot and cold water, special treated water, drainage, medical gases, steam, air conditioning etc.
- The Supplier/Installer shall install the equipment taking into consideration the construction characteristics of the hospital receiving the equipment.
- The Supplier/Installer is responsible to install the equipment “ready to start” for testing and commissioning.
- Any damage to hospital structures or finishing caused by the supplier personnel during the installation will be repaired by the supplier.

The steps to be followed to conduct appropriate Installation procedure;

1. Reception of equipment on site: Major Equipment

Equipment must be delivered to a specially designated area, in which the crates can be kept safely and securely until the equipment is officially accepted and signed for. The equipment should not be delivered directly to a clinical department, where users may assume that it is ready and safe for use. The only exception to this rule would be very large equipment items, which must be delivered to the place where they will be installed. The designated delivery area must be clean and properly secured, e.g. the health facility’s main store, the maintenance workshop…

Reception of equipment on site: Preparation

Documents needed:

- Copy of purchase order
- Shipping documents
- Packing list

- Delivery note
- Acceptance test log-sheet / fault report form

Unpacking and inspecting equipment orders

Unpack, check for damage:

- Systematically open one crate at a time
- Check the boxes/packages inside each crate for possible damage
- Systematically open one package at a time and note what you find on the relevant documents
- Keep all packaging materials, etc. as you may have to re-pack the equipment to return it for repairs
- Ensure that the equipment and supplies do not appear to be damaged
- If anything appears damaged, take a photograph and notify the supplier

Check against documentation

- Check that delivery matches the packing list
- Check that the contents comply with the specification in the purchase order
- Check the type and model of all equipment and supplies
- Check that the quantities are according to the purchasing order

Check technical requirements

- Ensure that the voltage shown on the packing list for power compatibility
- Check that the equipment data-plate matches your order
- Ensure that mains lead and battery charger, if applicable, are included

Package

- Check that all purchased consumables, accessories and spare parts are included
- Keep these supplies in cool, safe place until these can be issued and/or permanently stored
- check that operating manual, service manual and any assembly and installation

instructions are included

- Notify supplier if documentation is missing or mistaken (example wrong language)

Record

- Sign and date all relevant documents to show that the contents of the delivery were correct.
- Record any discrepancies between documents and delivery contents on the documents themselves and on the Fault Report form
- Use the complaints procedure to investigate any discrepancies
- Complete the relevant sections of the Acceptance Test log sheet later after installation get finished.

2. Preparing sites for installations of medical equipment

It is recommended that while planning for the equipment you should have estimated installation costs for in the purchasing budget plan.

Make sure that;

- Site preparation team has installed taps, circuit breakers, pipes junctions, connectors, socket outlets, …
- There is enough space for the equipment
- Power as per specification is available
- Water, if required, is available
- Sufficient light and ventilation is available in the installation room

Prepare tools

- Insulation testing instruments to test insulation and earth connections
- Safety analyzer to test that equipment conforms to IEC 60101 and safety analyzers for the specified machines

Time planning

- Plan and understand how long will the installation and commissioning take from past experience or experts following manufacturer guide.
- Understand and take care the impact on the department, floor or entire facility during the installation.
- You need to ask, understand and inform the department to answer the following questions; will it be necessary to move patients and for how long? What other activities may be interrupted?
- After making sure the above points we need to set; when are the installation teams likely to work? What hours of the day? Over the weekend?

Note!

Many poor installation and commissioning practices are due to poor communication and coordination between the various responsible departments and the different types of staff. Common problems include:

- Equipment arriving on site unannounced
- Contractors arriving to work in the health facility without giving prior warning
- Contractors carrying out work in the health facility without consulting the users and in-house technical staff
- Health service staff left wondering what is happening and unable to plan their work.

3. Assembling components

Assembly is the steps required to put equipment back together again if it was dismantled for shipment. While assembling you need to consider the following key questions;

Do you have the Instruction for Assembling?

- To start and perform the assembly instruction guide is required. Unless you may kill time and do the procedure in wrong manner

How complex is the equipment?

- The more complex an item, the more likely you need the help of the expert biomedical personnel and also support of the manufacturer/representative. This may include CT, MRI, Lithotripter, x-ray machine etc…
- If your team does not have the technical understanding, ask for assistance (from a contractor or supplier).

Are you buying one item or buying in bulk?

If you are only buying one item it may not be worth the expense of getting the manufacturer's help. Your team can manage with written guidance from the manufacturer. However, if you are buying large quantities of the same product it may be worthwhile to contracting the manufacturer to undertake the installation, commissioning, and initial training at as many locations as necessary

Self-Check -1	Multiple choice

1. Which of the following step come first?
   A. Receiving the equipment C. Assembling the component
   B. Preparing site for installation D. Reporting the fault
2. ____is the steps required to put equipment back together again if it was dismantled for shipment.
   A. Assembling B. commissioning C. Compliance check D. A&B
3. Which should be checked in the package of the item received?
   A. Operational manual B. Installation Instruction C. list of consumable and spares D. all
4. Fault Report form apply for
   A. Any discrepancies between documents and delivery contents
   B. Damaged equipment
   C. The type and model compliance of equipment D. all

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-2	**Selecting Tools and testing devices needed to carry out the installation work**

To perform installation of advanced device for this level special tools and testing devices are required based on type of the device. Additionally special room design may need for radiation emitting equipment for safety and standard protocol.

Tools and testing devices for Installation work

A tool is any instrument used in doing work. A hand tool is any tool operated by hand to do work. A power tool is operated by some source of power other than human power. There are good tool habits which will help you perform your work more efficiently as well as safely. A place for everything and everything in its place" is just common sense. You cannot do an efficient, fast repair job if you have to stop and look around for each tool that you need. The following rules, if applied, will make your job easier.

Keep each tool in its proper storage place.

A tool is useless if you cannot find it. If you return each tool to its proper place, you will know where it is when you need it.

Keep your tools in good condition: Keep them free of rust, nicks, burrs, and breaks. You need to develop good tool handling habits.

Keep your tool set complete: If you are issued a tool box, each tool should be placed in it when not in use.

Use each tool only on the job for which it was designed: If you use the wrong tool to make an adjustment, the result will probably be unsatisfactory.

Keep your tools where you easy reach and where they cannot fall on the floor or on machine: Avoid placing tools anywhere above machinery or

electrical apparatus. Serious damage will result if the tool falls into the machinery after the equipment is turned on or running.

Basic tools used to install advanced medical device will be discussed as follows;

1. **Screwdriver:** The screwdriver is a tooling agent that can be manual or power and it is used for screwing and unscrewing screws. Its shaft is made up of tough steel to resist twisting and bending. A simple screwdriver consists of a handle and a shaft that ends with a tip and for the user, it puts into the screw head before turning the handle. A simple form of the screwdriver has been replaced in many workplaces and homes with a Power Drill because they are quicker easier and can drill holes too.

Figure 1 .different type of screw driver

Screwdriver Types:

- Flat Head (or Slotted Head): A flat-head screwdriver has a wedge-shaped flat tip that is used to tighten or loosen screws that have a straight and linear notch on their heads.

Figure 2.Flat head screw driver

- Screwdriver Phillips Screwdriver: It is also the crosshead screwdriver when the X-shape blade fits into the head cavity snugly so it provides better traction when tightening or loosening the screw.

- Torx Screwdriver: sometimes called the star screw. It has a 6-point recessed star tip in sizes that range from 0.031” to 0.81” and are designated by T numbers (from T1 to T100)

Figure 3.Torx screw driver

- Hex Screwdriver or Hexagon Screwdriver: Screwdrivers and bits come in size to fit the hex-head screw recesses from around 0.03” to 3/8”.

- Robertson or Square Screwdriver: This is the least common of the common screwdrivers and has perhaps the highest torque tolerance of all drive types. Square head screws are commonly found in the automotive and furniture industries because of their durability.

Figure 4.Robertson screw driver

- Frearson or Reed and Prince Screwdriver: At first glance, this variation of the screwdriver is the same as Phillips but has some important differences. The tip of a Frearson comes to a sharp point; as compared to the Phillips has a rounded point. The angle of the tip is closer to a 45-degree angle than on a Phillips.

Figure 5.Frearson screw driver

- Hex Socket or hex screw driver: The hex socket screw driver has a hexagonal recess and driven by an Allen key, hex key, or hex screwdriver. A hex screwdriver features a hexagonal tip for driving certain nuts, bolts, and screws.

Figure 6.Hex socket screw driver

- Battery-Operated Screwdriver: It is the perfect tool when you need to lie beneath an object and there is hardly enough space between the floor and the working area.

Figure 7.Battery operated screw driver

- Magnetic Screwdriver: Magnetic-tipped screwdrivers have a large application that is handy and make the screwing application very easier as magnetic bits attract and hold small screws.

Figure 8.Magnetic screw driver

- Ratcheting Screwdriver: Ratcheting screwdrivers reduce the lift as well as save time. It repositions the screwdriver tip after every turn. Ratcheting screwdrivers have an internal ball-bearing mechanism that allows the user to make multiple turns of the screw with an easy back-and-forth wrist action.

Figure 9.Ratchet screw driver

Allen key: Used for screw hexagonal bolt on their head

Figure 10.Allen key

2. Forklift

For heavy package like X-ray machine, Mammography x ray, Dialysis machine, Lithotripter, CT, MRI forklift is essential to place the equipment safely to its appropriate room without causing any damage on the machine, the building as well as man power. Most commonly manually driven lift can be used in hospital facility.

Figure 11.Forklift

3. Cutting ,drilling materials

For any adjustment cutting materials like saw may needed. For parts or accessories fixed on floor or roof drilling of the building may require accordingly. For example for CT and MRI room we need AC system to condition and monitor room temperature with in the specified limit; so using electric driller we fix the cold chain system at specified place.

Figure 12.Electrical driller

Cutting tool also needed during unpacking most of the time wooden material. For this purpose we can use manual saw as well as electrical saw.

Figure 13.Cutting tools

Another tool we may use during the activity is Hammer which used dismantle the package mostly for wooden packed equipment.

Figure 14.Manual hammer

4. **Tape meter**: Used to measure appropriate distance for instance; wall clearance to place the machine, to know exact space occupied by the equipment, etc.

Figure 15.Tape meter

5. **Pliers:** Pliers are used to cut and shape electric conductors and to grip a variety of objects. This has caused many types of pliers to be developed.

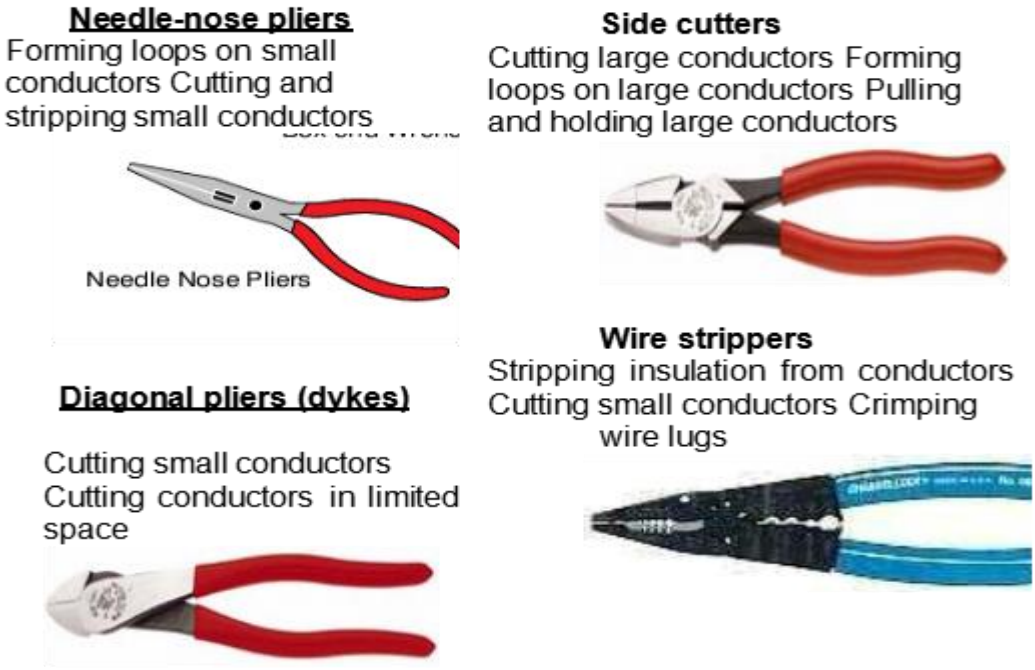

Figure 16.Pliers

6. **Wrench:** A wrench is a tool specially designed to tighten or loosen nuts, bolts, studs, and pipes. Wrenches are made from steel alloy to prevent breakage. There are many different types of wrenches. Each type has its own use. By using the proper wrench for the task to be done, you will not break the wrench, damage the equipment, or cause personal injury.

Figure 17.Different types of wrench

7. Soldering Iron

Soldering is the process of joining two or more electronic parts together by melting solder around the connection. Solder is a metal alloy and when it cools it creates a strong electrical bond between the parts.

Figure 18.Soldering iron

Testing and Calibrator device

Testing and calibration devices are equipment used to adjust instrument accuracy, often associated with a specific application.

1. **Digital multi-meter**: Basically used to measure the voltage applied to the machine, Current and Resistance of the power system prior to start the installation work. In our country standard it is known that line voltage is 220-230VAC; but most of the time power system is fluctuating from the mentioned value. For that matter by busing a digital multi-meter you can check the value of wall outlet prior to delivering the power to the machine. Additionally it can measure multiple parameters as required which described in the below table ;

Table 1.Description of modern multi-meter

Symbols	Measurement Functions	Descriptions
$V\sim$ V_{AC}	AC Voltage	Measures amount of AC Electrical Pressure
$V\overline{\overline{\overline{\ }}}$ V_{DC}	DC Voltage	Measures amount of DC Electrical Pressure
mV	Milli Volts	.00V or 1/1000V
A	Amperes	Measures amount of electron flow
mA	Milli Amperes	.001 or 1/1000A
µA	Micro Amperes	.000001A or 1/1,000,000A
Ω	Ohms	Measurement of resistance to the flow of electron
⊣▶⊢	Diode	Device used to control direction of electron flow
▪))	Audible Continuity	Audible indication of continuity for low resistance
⊣(	Capacitance	Device used to store electrical potential
HZ	Hertz	Measurement of Frequency or number of cycles per/sec
°F	Degrees Fahrenheit	Temperature measurement
°C	Degrees Celsius	Temperature measurement

2. Oscilloscope

An oscilloscope, or scope for short, is an electronic test instrument that is used to observe an electronic signal, typically voltage, as a function of time. In other words it is a voltage versus time plotter. Oscilloscopes come in two basic types, analogue or digital, and support various features and functions useful for measuring and testing electronic circuits. An oscilloscope is a key piece of test equipment for any electronics designer.

2.1 Parts of an Oscilloscope

Internally, an oscilloscope is a fairly complex piece of electronic equipment. Fortunately, its operation is simplified through the use of various features and knowing its internal workings is not key to its use. Despite this, as a good designer, it is important to understand the correct operation of test equipment and any affect it may have on the circuit under test

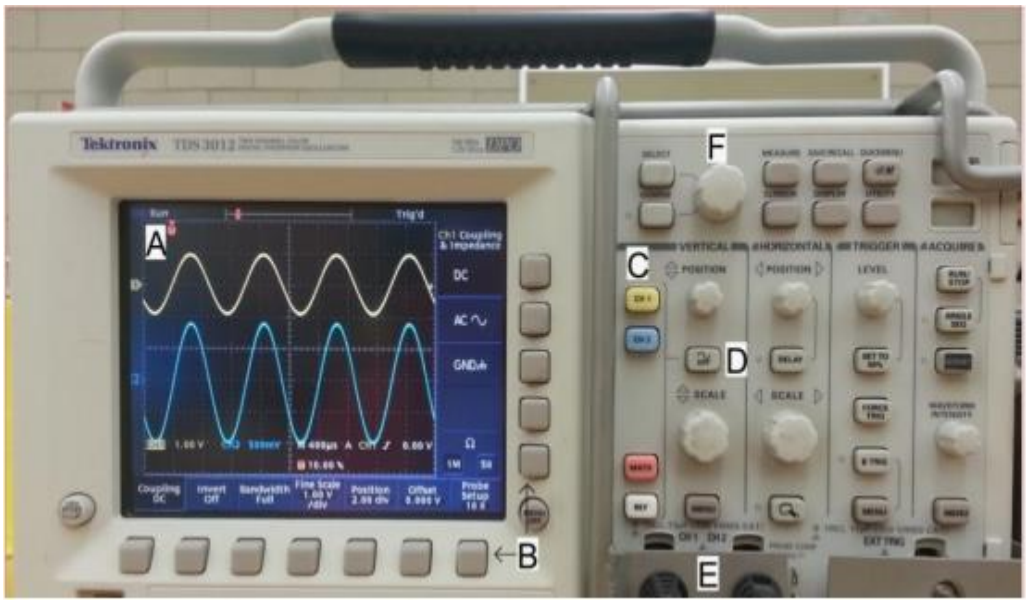

Figure 19.Oscilloscope features

Display: The main feature of an oscilloscope is its display. Analogue versions of oscilloscopes use Cathode Ray Tube (CRT) displays, while digital scopes use LCD (or similar) screens

Probes: The voltage signals that are to be measured must be transferred to the oscilloscope. This is done using oscilloscope probes. Probes are specially designed to minimize noise and interference, while also creating a known load effect on the circuit (so it can be accounted for). Some probes also have

protective features to prevent any damage a signal may cause to the oscilloscope (such as overvoltage).

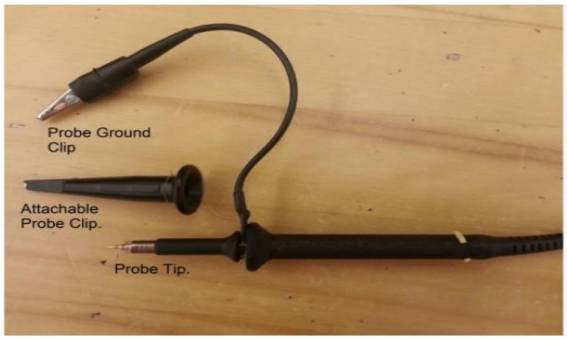

Figure 20.probes

The probing end can consist of either a sharp point as shown on above figure 20, which can be held against a pin, pad, or other conductor, or a small clip, convenient for attaching the probe to a wire or other small circuit feature. In addition, a grounding clip is located at the end of a small wire on the probe. The grounding clip is connected, through the oscilloscope, to chassis ground (in other words, the clip is always at the reference voltage and cannot be used to measure signals), and should be attached to the ground or common signal of the circuit to be measured. Note the probe is relatively heavy and can generally NOT be supported by the circuit features it may be attached to. Take care when attaching clips

Channels: An oscilloscope channel generally refers to the input of a signal (kind of like tuning in a TV channel, except that you can see more than one channel at a time on a scope). It can also refer to the path of the signal through the oscilloscope. An oscilloscope can have 1 or more channels, and it is common to have 2 or 4. Having multiple channels allows for the simultaneous measurement of multiple signals, making comparisons and other functions easier. Each channel typically has its own set of controls or a common set that is toggled.

Controls: The controls of an oscilloscope can be used to adjust almost any aspect of the scope from display parameters to advanced mathematical functions. The controls themselves consist of dials, toggles, buttons, and switches as seen in Figure 20.

2.2 Signal Generator

The signal generator is exactly what its name implies: a generator of signals used as a stimulus for electronic measurements. Most circuits require some type of input signal whose amplitude varies over time. The signal may be a true bipolar AC signal (with peaks oscillating above and below a ground reference point) or it may vary over a range of DC offset voltages, either positive or negative. It may be a sine wave or other analog function, a digital pulse, a binary pattern or a purely arbitrary wave shape.

The signal generator can provide “ideal” waveforms or it may add known, repeatable amounts and types of distortion (or errors) to the signal it delivers. This characteristic is one of the signal generator’s greatest virtues, since it is often impossible to create predictable distortion exactly when and where it’s needed using only the circuit itself.

Waveform Characteristics

Wave forms have many characteristics but their key properties pertain to amplitude, frequency, and phase:

Amplitude: A measure of the voltage “strength” of the waveform. Amplitude is constantly changing in an AC signal. Signal generators allow you to set a voltage range, for example, —3 to +3 volts. This will produce a signal that fluctuates between the two voltage values, with the rate of change dependent upon both the wave shape and the frequency.

Frequency: The rate at which full waveform cycles occur. Frequency is measured in Hertz (Hz), formerly known as cycles per second. Frequency is inversely related to the period (or wavelength) of the waveform, which is a measure of the distance between two similar peaks on adjacent waves. Higher frequencies have shorter periods.

Phase: In theory, the placement of a waveform cycle relative to a 0 degree point. In practice, phase is the time placement of a cycle relative to a reference waveform or point in time

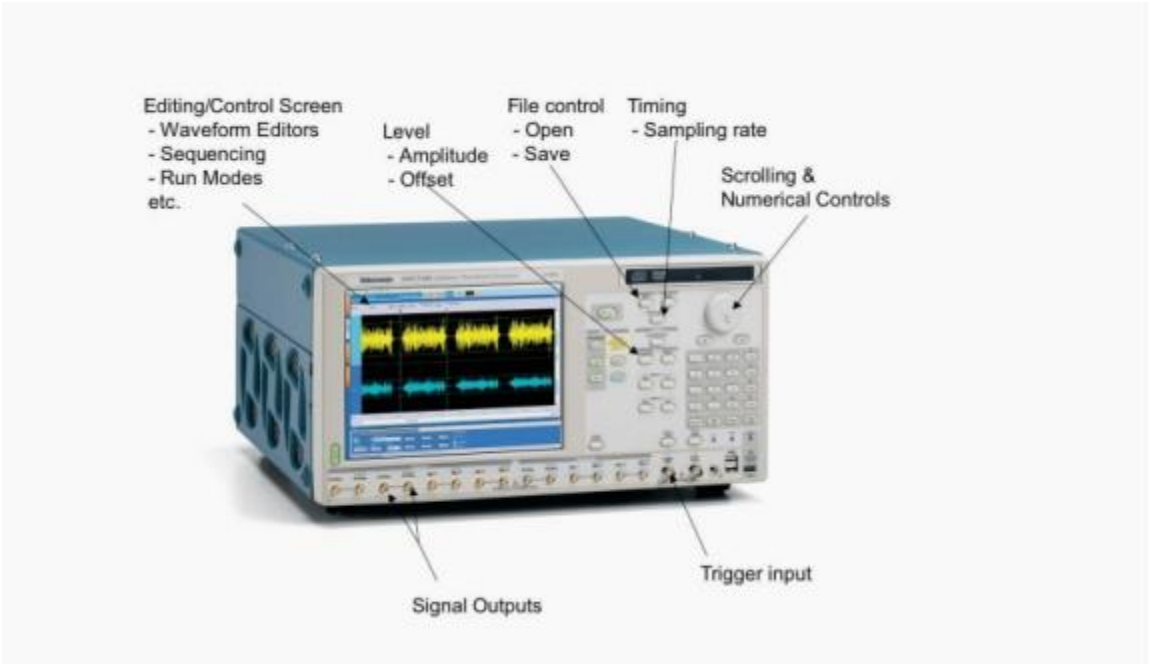

Figure 21.Signal generator

3. Radiation testing device

For radiation emitting medical device like X-ray machine, CT scanner, Lithotripter (if using x-ray source) and others may require radiation testing after Installation using radiation detector/ analyzer. By using the

analyzer you may know x-ray dose, exposure time, and proportional kilo voltage.

Figure 22.Radiation testing equipment

What is Radiation Dosimeter?

Radiation dosimeter is the measurement of absorbed dose resulting from the interaction of ionizing radiations with matter. It also deals with the measurement or calculations of exposure, Kerma, equivalent dose, effective dose and any other radiological quantity.

What is a Dosimeter?

Any device that is capable of measuring absorbed dose “D” deposited in its sensitive volume “V” by ionizing radiation is called a dosimeter.

Generally, there are two types of Luminescence Dosimeters:

1. Thermo luminescent dosimeter-TLD, and
2. Optical Stimulated Luminescence-OSL.

TLD is characteristics of certain material which involves two steps:

- In the first step, it is exposed to the exciting radiation.
- In the second step, the excitation is interrupted by heating the TLD material. During the temperature increase, the sample emits light.

TLD material can absorb energy from ionizing radiation, store a fraction of it, and release it as light when heated above 100^0C to 300 ^{0}C. The light intensity may be measured and related to the radiation dose (The number of photons emitted is proportional to the dose). If the temperature of the material is raised the trapped electrons may acquire sufficient thermal energy and be released. The released electrons may recombine with holes at luminescence center and the excess energy is radiated. The total amount of light is proportional to the number of the trapped electrons, which is proportional to the radiation dose. Like films, TLD's require filters to match their energy response to that of tissue. The most popular TLD materials are Lithium Fluoride (LiF), Calcium Fluoride and Calcium Sulphate. TLD's are mainly used for measurement application such as:

- Personal and Environmental Monitoring;
- Clinical Absorbed Dose Measurement;
- Radiotherapy Absorbed Dose Measurement;
- Diagnostic Radiology Absorbed Dose Measurement, and
- Charged Particle and Neutron Dosimeter.

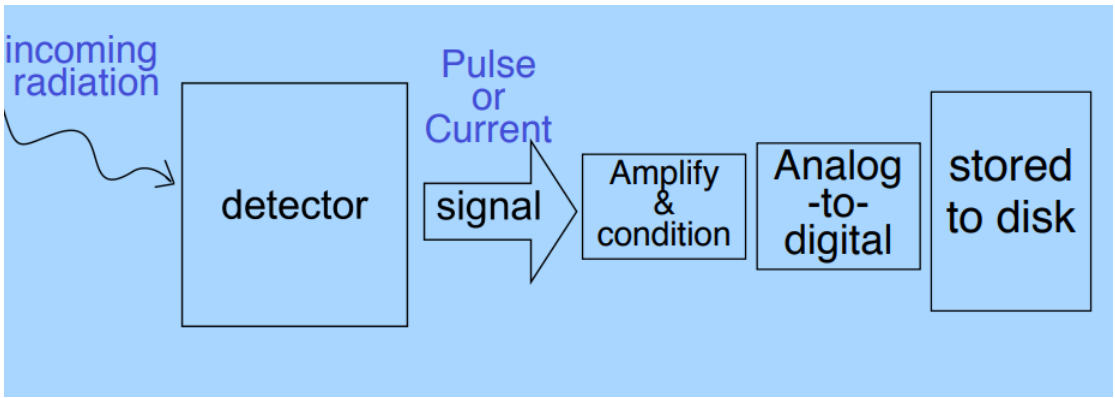

Figure 23.radiation detector working principle

As ionization radiation hits the detector head an electrical pulse is generated from the detector. The generated electrical signal get amplified and converted

to digital output for display system. Finally amount radiation is interpreted as safe or not. Optically Stimulated Luminescence (OSL)

- Aluminum oxide (Al2O3) is the only material being used in OSL dosimeters
- Little is known about the identity of the electron traps is aluminum oxide
- More is known about the recombination centers and the hole traps

Aluminum oxide may be used in either as OSL or as a TL dosimeter; the light output, (the signal provided), is greater when operated in the OSL mode rather than in the TL mode; the intensity of the OSL emissions are greatest when stimulated by light with a wavelength of 500 nm. Advantages of OSL Dosimeters;

- OSL is performed at room temperature, which simplifies the design of the equipment;
- The detector can be reread multiple times – unlike TLDs which may be read only once.

Disadvantages of OSL Dosimeters

- The OSL system is more expensive than TLDs
- Workers might be concerned why doses are being reported using the OSL system when no dose was reported when the TLD system was used.

Self-Check -2	Matching

A	B
1. Forklift___	A. used to move heavy loads
2. OSL __	B. optically stimulated luminescence dosimeter
3. Magnetic Screwdriver___	C. thermo luminescence dosimeter
4. Used to measure frequency___	D. attract and hold screws
5. Oscilloscope _____	E. used to observe electric signal
6. TLD____	F. Digital multi-meter

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-3	Obtaining materials necessary to complete the work.

In this section we discuss necessary materials to accomplish the Installation work effectively. This includes;

Cables

High tension cables are required especially for installation of X-ray machine, Lithotripter, MRI machine and other advanced devices. Cable conductivity and diameter are very crucial parameter to perform effective Installation works.

Figure 24.high tension electrical cable

This type of cable used to connect high voltage system to the machine power control box or circuit breaker. This type of cable differ withstand high temperature and safer hence it has multiple layer of insulation. For some machine that requires network installation you may also need Ethernet cables for data communications.

Wires

There are also different wires used for installation purpose.

Soldering Lead

Used for soldering any defects during installation incase

Wire tie: Used to tighten cables and any other wiring issue

Lead material:

Used for constructing radiation emitting device room especially x ray room and CT scanner room. This material has high density and good enough to

unnecessary radiation emission in the near vicinity. The properties of lead which make it an excellent shielding material are its density, high atomic number, high level of stability, ease of fabrication, high degree of flexibility in application, and its availability.

Lead Shielded Doors and Door Frames: Lead laminated doors are available for both new and existing structures. The standard door is constructed utilizing a single layer of sheet lead in the center equal in thickness to that in the wall in which the door is to be installed. The sheet lead extends to the edges of the door. Lead lined doors can be provided in any face veneer desired. When designing the shield system for the door, it will also be necessary to plan for shielding continuity at the door frame. The method selected to shield the door frame will depend upon the method of wall shielding installed, that is whether the lead was applied to the wall surface or used internally in the wall during construction. It is important to remember that the lead in the door frame must overlap the lead in the wall and be continuous on one side to the door stop surface to achieve effective shielding.

Laboratory reagents

These are used for installation of laboratory device like CBC (Hematology analyzer), Chemistry analyzer machine, CD4 counter machine and etc…

For hematology analyzer the following reagents are required to properly install and test the equipment;

- Diluent solution: Diluent is a buffer solution used to dilute blood cells and prevent cells gathering. With proper osmotic pressure, ion pressure and the electric conductivity, it can maintain the integrality and original volume of the blood cells. Its ingredients are chloride, sulfate, preservative solution, anticoagulant and the buffer solution.
- Lyse solution: A reagent system for substantially lysing red blood cells in a whole blood sample prior to leukocyte analysis.

- Rinse solution: used for cleaning the tubing and other dirty things from the system.
- Probe Cleanser: Probe Cleanser is a hypochlorite cleaning reagent that effectively cleans out cell debris, proteins and triglycerides by oxidative digestion and detergent solubilization.

Gel: for diagnostic ultrasound gel is required to increase the contrast of the image by matching impedance of the tissue or reducing air gaps. It also used in lithotripter again for matching the impedance during the treatment procedure

Self-Check -3	**Multiple choice**

1. ____is used for construction of x-ray room during design

   A. Pb B. Mg C. Al. D. Fe

2. ____is used as buffer solution used to dilute blood cells

   A. Rinse B. Lyse C. Diluent D. Probe cleanser

3. High tension cables are used for 220v AC diagnostic ultrasound machine installation.

   A. True B. False

4. ___is used for destruction of red blood cell during leukocyte measurement

   A. Rinse solution B. Lyse solution C. detergent D. probe cleanser

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

LG #02	LO#2: INSTALL EQUIPMENT AND ACCESSORIES

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Preparing equipment and components for correct sequential installation
- Following OHS policies and procedures
- Using PPE according to company requirements
- Selecting electrical cabling and wiring devices.
- Installing equipment in accordance with manufacturer's instructions.
- Responding unplanned events or conditions.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Prepare equipment and components for correct sequential installation
- Follow OHS policies and procedures
- Use PPE according to company requirements
- Select electrical cabling and wiring devices.
- Install equipment in accordance with manufacturer's instructions.
- Respond unplanned events or conditions.

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2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, sheet 4, sheet 5 and Sheet 6”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4, self-check 5, and Self-check 6” **in page 42, 50, 57, 61, 70 and 74** respectively.
5. Perform operation sheet1 and LAP test 1 on page **76-79**

Information Sheet-1	**Preparing equipment and components for correct sequential installation**

Preparing Ultrasound machine and its accessories

1. Check compliance:

You should have to check the delivered equipment against specification prepared prior to procurement process.

2. Electrical Requirements:

2.1 Regulated power supply

Check the availability of correct rated power system according to specification. To fulfill grounding requirement the power cable of the system is a three-wire cable, the protective grounding terminal of which is connected with the grounding phase of the power supply. Please ensure that the grounding protection of the power supply works normally. Generally check the following;

- A convenient and safe socket outlet should be available.
- Socket outlets should be at least 2 m from a sink or wash basin.
- The socket outlet should be adequate for the electrical capacity for the equipment.
- There should be proper grounding in the sockets.

- Plugs should match the socket outlets.

2.2 EMI Limitation

Ultrasound machines are susceptible to Electromagnetic Interference (EMI) by radio frequencies, magnetic fields, and transient in the air wiring. They also generate a weak electromagnetic radiation. Possible EMI sources should be identified before the unit is installed. Electrical and electronic equipment may produce EMI unintentionally as the result of defect. These sources include: medical lasers, scanners, monitors, cauterizing guns and so on. Besides, other devices that may result in high frequency electromagnetic interference such as mobile phone, radio transceiver and wireless remote control toys are not allowed to be presented or used in the room. Turn off those devices to make sure the ultrasound system can work in a normal way.

3. Installation Conditions:

3.1 Space Requirements

Place the system with necessary peripherals in a position that is convenient for operation:

- Place the system in a room with good ventilation or an air conditioner.
- Leave at least 20cm clearance around the system to ensure effective cooling.
- Adjustable lighting system in the room (dim/bright) is recommended.
- Except the receptacle dedicated for the ultrasound system, at least 3-4 spare receptacles on the wall are available for the other medical devices and peripheral devices.
- Power outlet and place for any external peripheral are within 2 m of each other with peripheral within 1 m of the unit to connect cables.

4. Networking Pre-installation

This is needed for more advanced health facility for better data transfer and communications. It can be wireless and wired LAN depending on ultrasound system. Data transmission is allowed between different departments or areas without network cable other routers related information. DICOM application information may require for further image data storage. To do so DICOM server name, DICOM port, channels, and IP address needed.

5. **Confirmation before Installation**

   Perform the following confirmation before installing the system:

   - The video format used in the region or country where the system is installed.
   - The language used in the region or country where the system is installed.
   - The power voltage used in the region or country where the system is installed.
   - Obstetric formulae and other measurement formulae used in the region or country where the system is installed.
   - Other settings to be used in the region or country where the system is installed but different from the factory settings.
   - The doctor's habits of using the system.

Perform the confirmation above before installing the system. And set up the system to make it according with the usage of the region or country where the system is installed.

6. **Prepare the necessary tools and materials for the installation work Refer *''Information sheet-2''***

Check all main unit and accessory are available like printers, transducers, UPS if the machine supplied in different box/cartoon.

Self-Check -1	**Multiple choice**

1. To avoid EMI in US room which device should be far away?

A. ESU B. Defibrillator C. Chemistry machine D. all

2. Which tool kit we use for installation of US machine?

   A. Hammer B. Cutter C. Screw driver D. forklift E. all

3. It is safe if there no ground system with in the health facility for initial installation of US machine.

   A. True B. False

4. What is safe wall clearance for good cooling of the machine during installation?

   A. 2m B.5m C.20cm D. 1m

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-2	Following OHS policies and procedures

Occupational health and Safety policy

Occupational health and safety (OHS) is the term used to describe the laws and processes that help to protect employees from death, disease and injury while at work. The purpose of the Health and Safety policies and procedures is to guide and direct all employees to work safely and prevent injury, to themselves and others. Ultimate goal is to eliminate or minimize hazards that can cause accidents.

Occupational Health and Safety at workplace

One of your most important responsibilities is to protect your Health and Safety as well as that of your co-workers. What the law requires Workplaces under the jurisdiction are governed by your provincial legislation. The legislation places duties on owners, employers, workers, suppliers, the self-employed and contractors, to establish and maintain safe and healthy working conditions. Your officials are responsible for monitoring compliance.

You are responsible to:

- Protect your own Health and Safety and that of your co-workers;
- Not initiate or participate in the harassment of another worker;
- Co-operate with your supervisor and anyone else with duties under the legislation.

Legislation gives you three rights:

- The right to know the hazards at work and how to control them;

- The right to participate in Occupational Health and Safety;
- The right to refuse work which you believe to be unusually dangerous.

You may not be punished for using these rights. An employer can be required to legally justify any action taken against a worker who is active in Health and Safety.

What is hazard?

The Occupational Health and Safety Regulation 2001 define a hazard as 'anything (including work practices or procedures) that has the potential to harm the health or safety of a person'.

Hazard: is also a situation or thing that has the potential to harm a person.

Hazards at work may include: noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, violence at the workplace etc..

Risk: is the possibility that harm (death, injury or illness) might occur when exposed to a hazard.

Hazards can be grouped into five broad areas:

- Physical hazard:- e.g. noise, radiation, light, vibration
- Chemical hazard:- e.g. poisons, dusts
- Biological:- e.g. viruses, bacterial infection , parasites
- Mechanical/ electrical hazard: - e.g. Trips and falls, tools, electrical equipment (micro or macro shock).
- Psychological hazard: - e.g. fatigue, violence.

Hazards can arise from work environment, use of machinery and substances , poor work design inappropriate systems and procedures

Risk management

Risk management is a proactive process that helps you responds to change and facilitate continuous improvement in your business. It should be planned, systematic and cover all reasonably foreseeable hazards and associated risks. It involves four steps to set out hazards;

Identify hazards – find out what could cause harm.

Assess risks if necessary – understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening.

Control risks – implement the most effective control measure that is reasonably practicable in the circumstances.

Review control measures-to ensure they are working as planned.

Step1 – How to identify hazard

Identifying hazards in the workplace involves finding things and situations that could potentially cause harm to people. We can find hazards by;

- Inspect the work place
- Consult your workers
- Review available information's

Step 2 – How to assess risk

A risk assessment involves considering what could happen if someone is exposed to a hazard and the likelihood of it happening. A risk assessment can help you determine:

- How severe a risk is
- Whether any existing control measures are effective
- What action you should take to control the risk
- Wow urgently the action needs to be taken

STEP 3 – How to control risks

The most important step in managing risks involves eliminating them so far as is reasonably practicable, or if that is not possible, minimizing the risks so far as is reasonably practicable. The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest as shown in Figure below

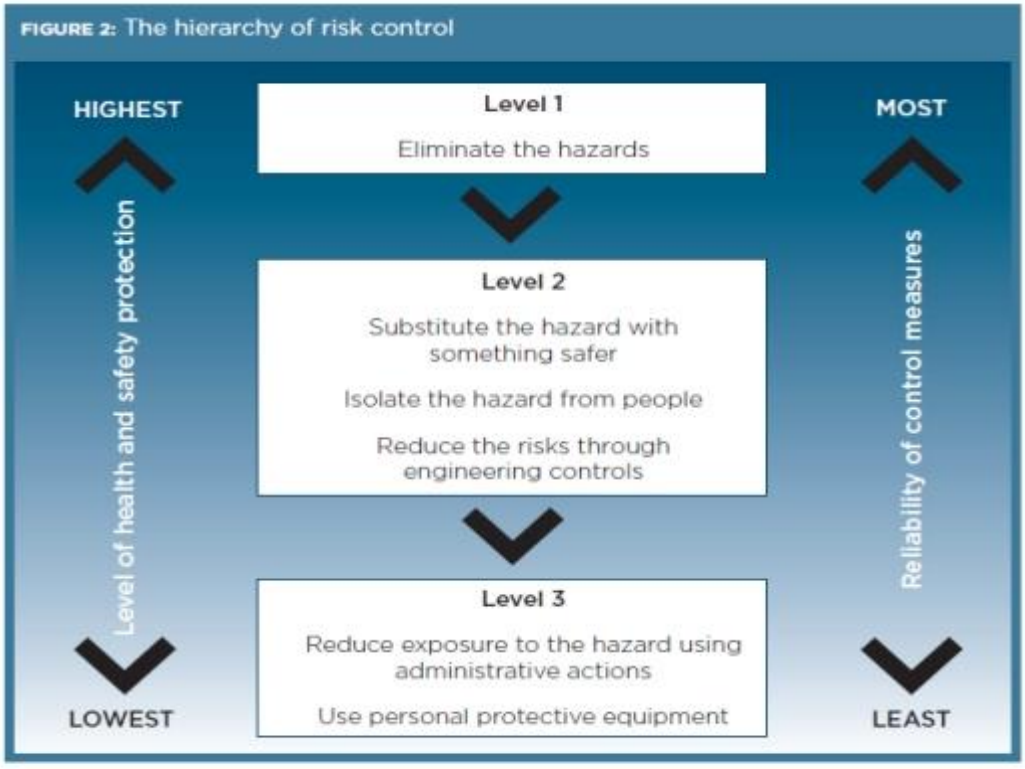


Figure 25.Risk level

LEVEL- 1 Control measures

you must always aim to eliminate a hazard, which is the most effective control. If this is not reasonably practicable, you must minimize the risk by working through the other alternatives in the hierarchy. The best way to do this is by, firstly, not introducing the hazard into the workplace. For example, you can eliminate the risk of a fall from height by doing the work at ground level.

LEVEL- 2 control measures

If it is not reasonably practicable to eliminate the hazards and associated risks, you should minimize the risks using one or more of the following approaches:

Substitute the hazard with something safer

For instance, replace solvent-based paints with water-based ones.

Isolate the hazard from people

This involves physically separating the source of harm from people by distance or using barriers. For instance, use remote control systems to operate machinery; store chemicals in a fume cabinet.

Use engineering controls

An engineering control is a control measure that is physical in nature, including a mechanical device or process. For instance, use mechanical devices such as trolleys to move heavy loads; place guards around moving parts of machinery; install residual current devices (electrical safety switches); set work rates on a production line to reduce fatigue.

LEVEL- 3 control measures

These control measures do not control the hazard at the source. They rely on human behavior and supervision, and used on their own, tend to be least effective in minimizing risks.

Ultrasound machine (Philips HD3) safety and risk management

This equipment has been verified by a recognized third-party testing agency as a Class I device with Type BF and Type CF isolated patient-applied parts and Type B accessories. For maximum safety observe the following:

- Do not connect the ultrasound system to the same circuit used for life-support devices.
- Shock hazards may exist if this system, including all externally mounted recording and monitoring devices is not properly grounded. Protection against electrical shock is provided by grounding the chassis with a three-wire cable and plug.
- The system must be plugged into a grounded outlet. The grounding wire must not be removed or defeated.
- To avoid risks of electrical shock and fire hazards, inspect the system power cord and plug on a regular basis. Ensure that they are not damaged in any way.

- Do not remove the protective covers on the system; hazardous voltages are present inside.
- Cabinet panels must be in place while the system is in use. All internal adjustments and replacements must be made by a qualified Philips Ultrasound field service engineer.
- Do not operate this system in the presence of flammable gases or anesthetics. Explosion can result from electrical ignition.
- To avoid risk of electrical shock hazards, always disconnect the system from the wall outlet before cleaning the system
- To avoid risk of electrical shock hazards, always inspect transducers before use: Check the face, housing, and cable before use.
- Do not use if the face is cracked, chipped, or torn; the housing is damaged; or the cable is abraded.
- To avoid risk of electrical shock, do not use any transducer that has been immersed beyond the specified cleaning or disinfection level.
- All patient-contact devices, such as transducers, pencil probes, and ECG leads must be removed from the patient contact prior to application of a high-voltage defibrillation pulse.
- Connection of optional devices not supplied by Philips Ultrasound could result in electrical shock. When such optional devices are connected to your ultrasound system, ensure that the total system earth leakage current does not exceed 300mA
- Avoid placing the system in an environment that may produce electrostatic discharges (ESD) that could affect the ultrasound system performance. (Electrostatic discharges can cause the ECG heart rate display to increase by 10% to 15% for a few seconds after the discharge, even though the ECG heart rate display returns to normal within a few seconds.

- Avoid placing the system in an environment that may produce electromagnetic interference (EMI) that could impact the diagnosis of a patient

Mechanical Safety during Installation

Although the system is designed to be mobile, remember that it is very heavy, and that you must take precautions when moving it. The physical aspects of this system present a hazard that can cause injury, property damage, or equipment damage if the following information is ignored:

- Before moving the system, be sure to power it off, remove any loose equipment from the top of the system, disconnect the system power cord, and disconnect all external devices. Move and secure external devices away from the system.
- Make sure the control top is locked, to prevent its up/down movement and unlock the caster locks before moving the system. Push with the handle at the front of the cart. After the system is in position, engage the caster locks to immobilize the system.
- Be aware of the casters as well as the extremities of the system when moving it. The system is heavy enough in any configuration that it can cause injury to you or others. Exercise additional caution when going up or down inclines.
- When attempting to overcome an obstacle, do not push the system with enough force to cause it to tip over. Do not exceed 10 degrees of incline.
- Never park the system on an incline. For transport, make sure the control top is locked and secure the system so that it cannot roll or tip. Engage the caster locks and use wheel chocks and restraining straps.
- Do not attempt to hold the system in place manually. Never strap or secure the system at any point on the control top or monitor.

Self-Check -2	Multiple choice

1. _____ is the term used to describe the laws and processes that help to protect employees from death, disease and injury while at work.

A. OHS B. hazards C. Risk management D. all

2. Protection against electrical shock is provided by grounding the chassis with a _____ cable and plug.

   A. Two wire B. Three wire C. four wire D. five wire

3. To avoid risk of electrical shock, do not use any transducer that;

   A. Has been immersed beyond the specified cleaning or disinfection level.

   B. Cracked at its head

   C. A&B

   D. None

4. Which one is highest health and safety levels for risk control

   A. Level 1 B. Level 2 C. Level 3 D. Level 4

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**
You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-3	Using PPE according to company requirements

Use personal protective equipment (PPE)

Definition: Devices used to protect employees from injury or illness resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. The need for PPE and the type of PPE used is based on hazard present; each situation must be evaluated independently. Examples of PPE include ear muffs, respirators, face masks, hard hats, gloves, lead aprons, lead eye goggle and protective eyewear etc…

PPE limits exposure to the harmful effects of a hazard but only if workers wear and use the PPE correctly. Information about suitable controls for many common hazards and risks can be obtained from:

- Codes of practice and guidance material
- Manufacturers and suppliers of plant, substances and equipment used in your workplace.

PPE is used as a last resort to avoid risk in work place. The use of PPE signifies that the hazard could not be controlled by other methods, such as: administrative controls, engineering or industrial hygiene controls. The use of PPE signals that the hazard still exists in the workplace. Unprotected individuals in the same area will be exposed. Failure of PPE means that the worker will be exposed. PPE type depends on hazard to be protected

Working Clothes

Figure 26.Working clothes

Head protection

Protective helmets (hard hats) come in a variety of shapes. They may be made of tough polyethylene or polycarbonate, one of the toughest hat materials yet developed. Regular hard hats must be insulated so that personnel may be protected from accidental head contacts with electrical circuits and equipment at comparatively low voltages (less than 2200 volts).

Figure 27.Helmet

Eye and Face protection

Common Uses:

- Impact Protection
- Chemical Hazards
- Radiation Protection
- welder's goggles
- laser goggles
- UV and Infrared light

Safety glasses are used to protect the eyes from flying objects. Chemical splash goggles protect against fluids by sealing tightly against the face. Face shields provide highest level of protection

Figure 28.Eye and face protection safety equipment

Hearing Protection

Noise induced hearing loss can occur with exposures >90 dB. All hearing protection devices should have a Noise Reduction Rating (NRR) of decibels they will reduce noise levels.

Types of ear protection device;

Ear Plugs - less expensive, disposable, good ones have fairly high NRRs - sometimes difficult to tell if employees are wearing them

Ear Muffs - more expensive, more durable, typically higher NRRs than plugs, more obvious.

Figure 29.Hearing safety equipment

Arm and Hand protection

Gloves - Typical Uses

- Chemical protection
- Biohazard protection
- Friction protection
- Protection from extremes of heat and cold.

Types

Surgical gloves

Figure 30.hand glove

Foot and Leg protection

Steel-toed footwear, preferably with metatarsal guards, is used to protect feet from crushing injuries caused by heavy objects. Rubber boots are often used to protect feet from exposure to liquids.

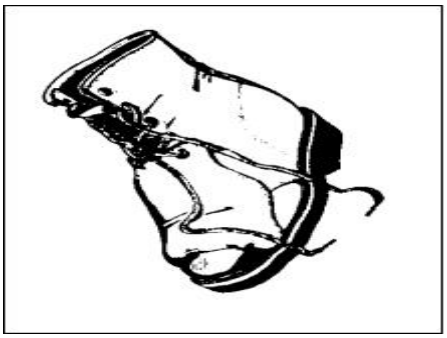


Figure 31.Protective shoe

Respiratory protection

Protects users by removing harmful materials that may enter the body via the lungs. Inhalation is one of the quickest, most efficient ways to introduce lethal levels of hazardous materials into the body.

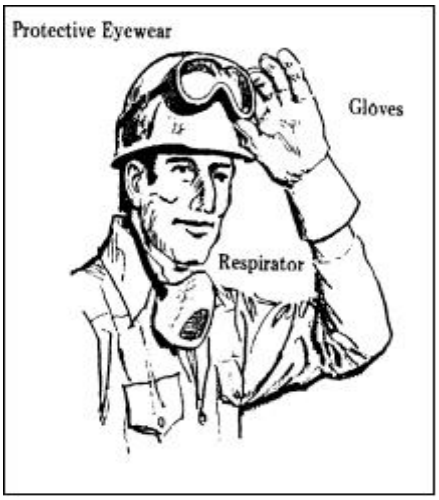


Figure 32.Respiratory protection

Lead Apron

Lead aprons must be used when the primary beam is within 2” (5 cm) of the gonads, for patients who have procreative potential, and when it would not interfere with the diagnostic procedure.

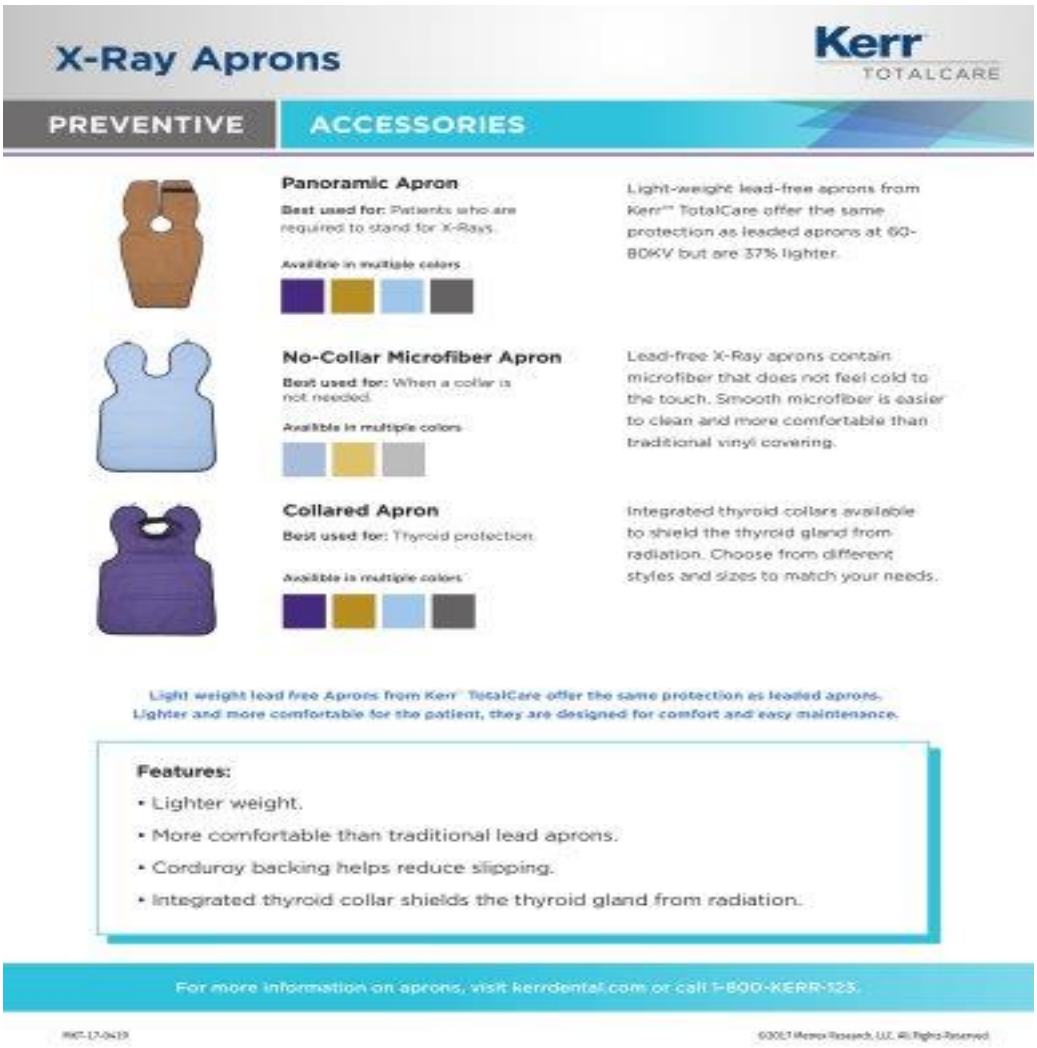


Figure 33.Lead apron

Self-Check -3	Multiple choice

1. Which PPE is must be used is used during X ray installation

   A. Lead apron B. hearing aid C. helmet D. all

2. Which one the following must be used during CBC machine installation?

   A. Eye goggle B. Hand glove C. leaded hand glove D.A&B

3. Which one used for physical protection during installation of heavy equipment unpacking

   A. Shoe cover B. helmet head cover C. heavy hand glove D. all

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**
You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-4	Selecting electrical cabling and wiring devices.

Electrical Cables and wires

Various influences that will affect our choice of electrical wiring involve color, label data with applications. The data printed on the wire shell is totally that you requisite to select the right wire for the home. More often than not, the name (wire or cable) are applied to designate the similar thing, while they are essentially quite altered. Wire acts a single electrical conductor, whereas a cable is a group of wires swathed in sheathing. The term cable eventually denoted to a nautical line of numerous ropes applied to anchor ships, besides to an electrical context, cables (similar to wires) are applied to transmit electrical currents. Cables intended to be very flexible.

Electrical wiring is an electrical system of cabling and linked devices like switches, distribution boards, plugs, and medical equipment those in need. Wiring is subject to protection standards to strategy with installation. Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as;

- Ambient temperature range
- Moisture levels
- Exposure to sunlight and chemicals.

Associated circuit protection, control and distribution devices within a building's wiring system are subject to voltage, current and functional specification. Wiring protection codes vary via locality, state or region. The International Electro technical Commission (IEC) is "struggling to harmonize wiring standards between member countries, while significant differences in design

and installation necessities still exist. An electrical cable is a rally of one or more wires running side by side or bundled, which is applied to transfer electric current.

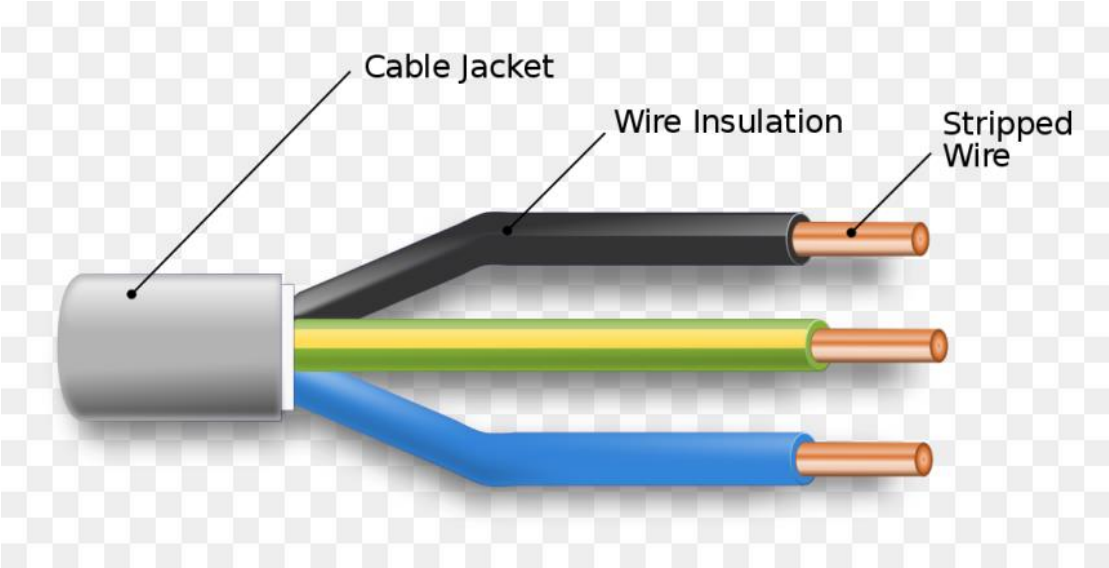


Figure 34.electrical wire

Types of Electrical Wires: There are essentially different types of electrical wires

Triplex Electrical Wires: Triplex electrical wires are commonly applied in single-phase service drop conductors, among the power pole besides weather heads. They are composed of two insulated aluminum wires wrapped with a third bare wire that is applied as a public neutral. The neutral is commonly of a smaller gauge besides grounded at each the electric meter plus the transformer

Non-Metallic Sheathed Electrical Wires: Non-metallic sheath electrical-wire, has conductors, every with plastic insulation, besides a bare crushed wire. The separated wires are protected through another coating of non-metallic sheathing. Since it's moderately cheaper and available in ratings to (10 to 20 amps), this type is favorite in-house wiring.

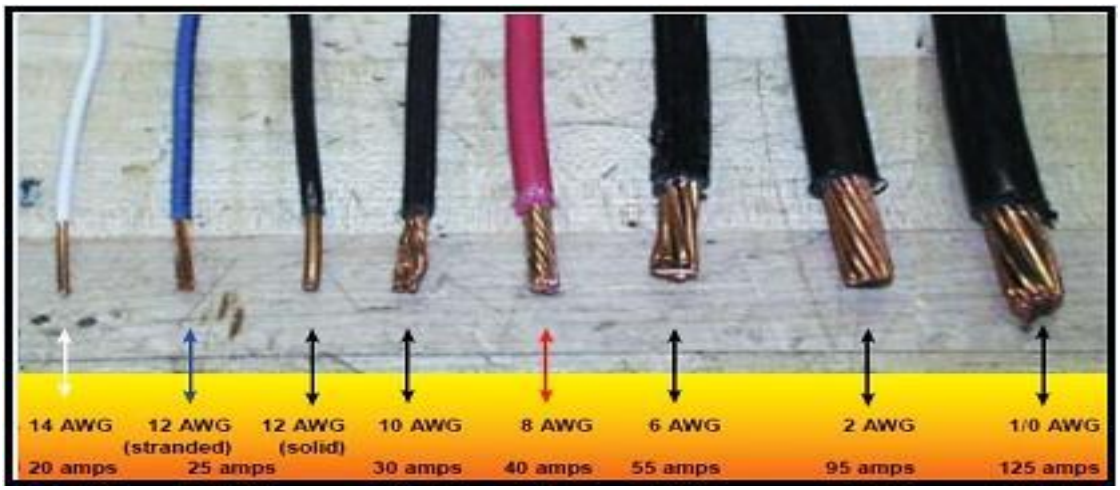


Figure 35.Different types of wire

Cables commonly are protected with special fittings wherever they enter electrical apparatus; this may be a simple screw clamp to jacketed cables in a dry position, or a polymer-gasketed cable connector that automatically engages the amour of an armored cable and supplies a water resistant connection. Special cable fittings may be applied to prevent explosive gases from flowing in the interior of jacketed cables, where the cable passes through areas where flammable gases are current. To avoid loosening of the associates of individual conductors of a cable, cables must be maintained near their entrance to devices and at systematic intervals along their runs. Commonly, merely one cable per fitting is permitted, unless the fitting is rated or summarized for multiple cables. They must also resist corrosion caused by salt water or salt spray, which is accomplished through the use of thicker, specially constructed jackets, and via tinning the individual wire stands.

Self-Check -4	Multiple choice

1. Electrical cable and wire selection can be affected by___.
   A. Amount of current it intended to conduct
   B. Ambient temperature and moisture
   C. Exposure to sunlight
   D. All
2. Grounding cable color is_____.
   A. Yellow B. Green C. Red D. Black

Note: **Satisfactory rating – 4 points** **Unsatisfactory - below 4 points**
You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-5	**Installing equipment in accordance with manufacturer's instructions.**

Introduction

The complete installation process will proceed having all above discussed topics. By compiling necessary man power and tools you accomplish the installation work following OHS policies and procedure. So in this section we continue with diagnostic US machine installation procedures.

To do so we follow the steps below;

1. Check the received equipment in accordance to specification
2. Read and interpret the work instruction ''Refer LO1''
3. Prepare tools and materials required ''Refer LO1''
4. Prepare equipment and Accessories (ultrasound machine)
5. Check the necessary room requirement
6. Start Unpacking:

- Cut the eight bands rounding the box, see the figure below:

Figure 36.unpacking

- Next remove the top cover from the corrugated crate.

Figure 37.opening of the cartoon

- Take away the probe carrying case, accessories case and the protecting foams, then cut the bands rounding the machine, see the figure below:

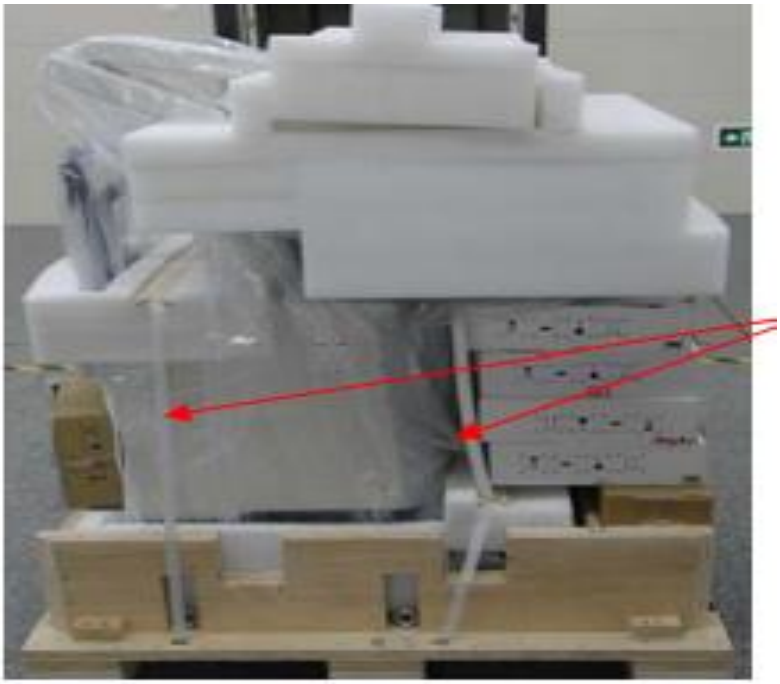


Figure 38.supporting foams to protect accessories

- Take out the complete parts

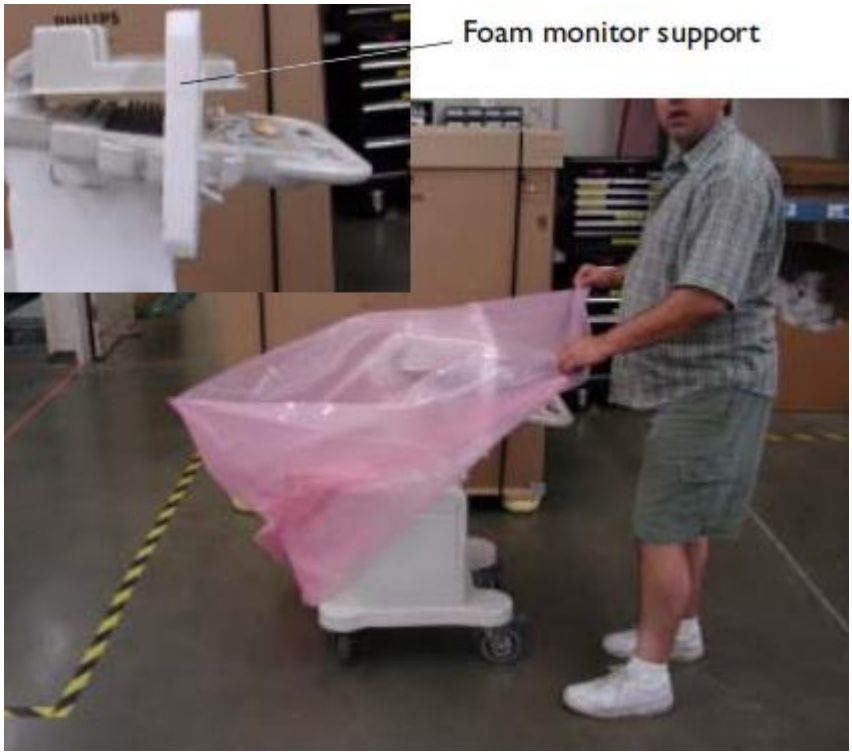


Figure 39.main body

- Assembling parts

Figure 40.Assembling

- Fixing printer holder

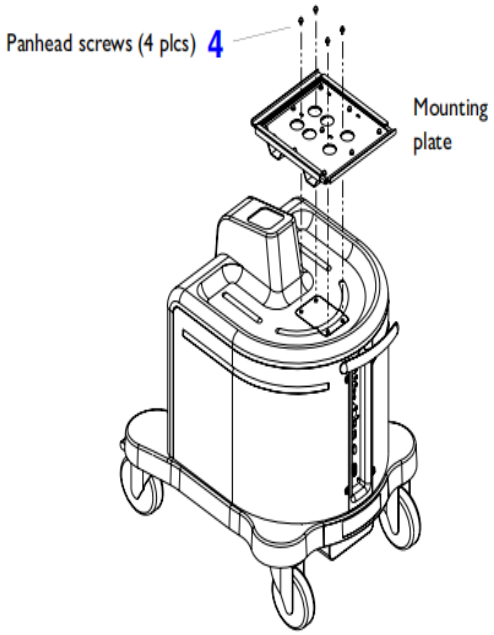
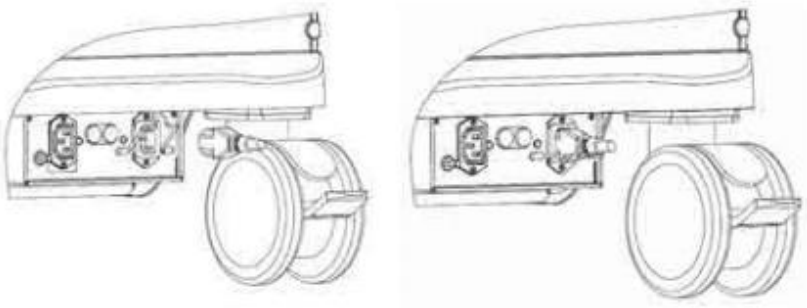


Figure 41.Fixing printer holder

- Connecting power cable: Push the retaining clamp upward, and insert the power plug into the receptacle



Push the retaining clamp downward, and lock the power cord, as shown in the figure (b) above.

Plug the other end power plug into an appropriate outlet. The grounding terminal should be connected with a power grounding cable to ensure that protective grounding works normally.

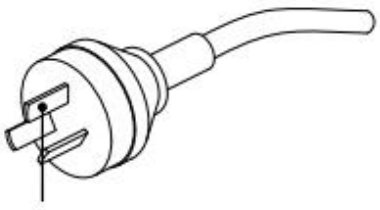
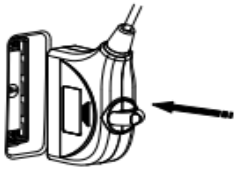
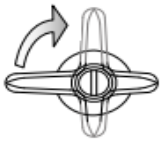


Figure 42.Connecting power plug

- Connecting the Transducer

1. Keep the cable end of the transducer to the right side of the system, and insert the connector into the socket of the system, and then press in fully. (Shown as the left figure)
2. Turn the lock handle 90° clockwise to lock it securely. (Shown as the right figure)





3. Place the probe properly to avoid being treaded or wrapping with other devices. DO NOT allo the probe head to hang free.
4. Turn the lock handle 90°anticlockwise to unlock it, and then pull out the connector.

NOTE: Before inserting the connector into the probe port, inspect the connector pins. If any pin is bent, do not use the probe until it has been inspected / repaired / replaced.

- **System Configuration**

Connect the AC power; make sure the ultrasound system and other optional devices are correctly connected. The circuit breaker should be in the [Up] position for the system to be operational. When the AC power indicator on the control panel is light on (indicator is in green), press the power button on the minor control panel to turn on the system. Press <F10> on the keyboard to open the Setup menu.

Figure 43.Preset options

- Print Preset

  Press and click [Print Preset] to set video printer, graph/laser printer parameters (do the setting according to the printer, and select the printer services correspondingly).

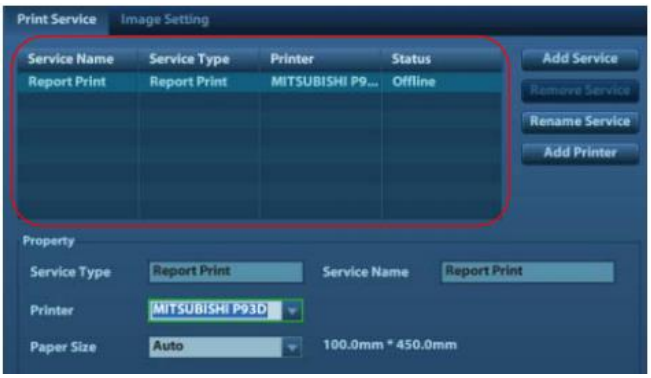


Figure 44.print setup

- Finally installed unit

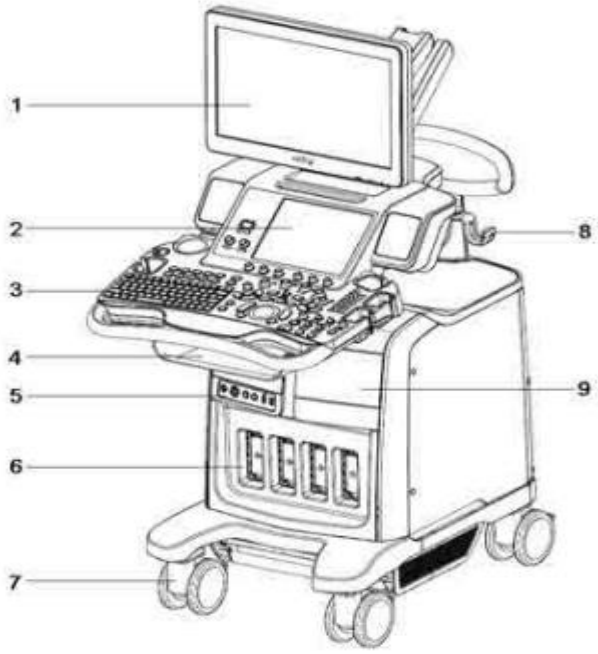


Figure 45.Installed US machine

Self-Check -5	Multiple choice

1. During installation which step sis not proceeds?
   A. Checking specification C. unpacking the equipment
   B. Preparing sites D. using appropriate tools E. none
2. During unpacking of wooden box/crate you may use__.
   A. Hammer B. Cutter C. High duty safety glove D. all
3. During installation if you get faulty (broken) US transducer probe what you could do?
   A. Report to company representative C. try to maintain and install it
   B. Keep silent and proceeds further steps D. all

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-6	**Responding unplanned events or conditions**

During the installation work one may face variety of problems related machine, health facility set up and man power utilization. By those issue fault may occur so considering these things the installer should have to consider all technical aspects regarding to the specific equipment to accomplish the installation work effectively and efficiently before starting the work. This event can be mechanical problem, power problem, fire or explosion etc…

Mechanical hazards equipment has moving parts. The action of moving parts may have sufficient force in motion to cause injury to people. Consider:

- Equipment with moving parts that can be reached by people
- Equipment that can eject objects (parts, components, products or waste items) that may strike a person with sufficient force to cause harm
- Mobile machinery and equipment, such as forklifts, pallet jacks, earthmoving equipment, operated in areas where people may gain access.

Common mechanical hazards and associated risks for machinery and equipment are shown below.

Hazard	Risk
Rotating shafts, pullies, sprockets and gears	Entanglement
Hard surfaces moving together	Crushing
Scissor or shear action	Severing
Sharp edge – moving or stationary	Cutting or puncturing
Cable or hose connections	Slips, trips and falls (e.g. oil leaks)

Non-mechanical unplanned hazards associated with machinery and equipment can include harmful emissions, contained fluids or gas under pressure, chemicals and chemical by-products, electricity and noise, all of which can cause serious injury if not adequately controlled. In some cases, people exposed to these hazards may not show signs of injury or illness for years. Where people are at risk of injury due to harmful emissions from machinery and equipment, the emissions should be controlled at their source. Common non-mechanical hazards are shown below:

Non-mechanical hazards	
Dust	Mist (vapours or fumes)
Explosive or flammable atmospheres	Noise
Heat (radiated or conducted)	Ignition sources (flame or spark)
High intensity light (laser, ultraviolet)	Molten materials
Heavy metals (lead, cadmium, mercury)	Chemicals
Steam	Pressurised fluids and gases
Ionising radiation (x-rays, microwaves)	Electrical

Unplanned event during installation

There is mainly two root cause for unplanned event during installation procedure; Equipment failure and Human error. "Equipment failures" include system and component failures manufacturing and installation processes. "Human errors" comprise shutdowns related to or originating from such causes as faulty reaction of personnel to plant transients, use of inadequate procedures, or poor qualification of the individual. The human error category encompasses errors made directly by the plant personnel or caused by deficiencies in information and tools necessary for operation and those errors occurring during plant maintenance.

If "equipment failure" has been identified as the direct cause of an event, subsequent investigation could yield a root cause which may be in the following categories:

- Design deficiency
- Manufacturing/installation deficiency
- Phenomena during plant operation not involving human error

Design deficiency encompasses the whole field of engineering, i.e., components, systems and structures. "Manufacturing/installation deficiency" comprises all errors in the manufacture and/or installation of components. Alternatively, the design, manufacturing and installation of the equipment may all be in order, yet the equipment fails during operation but the failure is not due to human error. In such cases, the root cause can be classified into the third category, i.e., phenomena during plant operation not involving human error. Conversely, equipment failure could occur due to human error (e.g. deficient maintenance). In this case, further root cause analysis is necessary and subsequent classification of the cause will be the same as that for "human error". Root causes related to human error can be classified into the following categories; namely,

- Work control deficiency

- Information deficiency
- Tools deficiency
- Qualification deficiency

People who install equipment could:

- work in isolation
- work on machinery and equipment at height, or over machinery and equipment to connect services, such as electricity, air or water
- work in low light, or with bright directional light
- access machinery and equipment from the top, sides or underneath
- work with or near cranes, forklifts or rigging to lift machinery and equipment
- work in confined spaces
- Use power tools, welders, extension leads, which present electrical hazards if damaged or wet.

By properly following the above procedure we can easily reduce unplanned event occur during the installation work.

Self-Check -6	**Multiple choice**

1. Which is unplanned event occurring during installation?
   A. Equipment failure B. human error C. both D, none
2. To respond the unplanned event one should have to understand the nature of the hazards. A. True B. False
3. Which is categorized as human error?
   A. Design deficiency B. Tools deficiency C. Qualification deficiency D. B&C

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Operation sheet 1

Operation title: Install x-ray machine

Purpose	To make the trainees able to install advanced radiological equipment following basic safety rules and standards
Instruction	
Equipment ,tools and materials	To perform the installation work there are various tools are needed. these are: • Forklift • Radiation protecting safety devices gonad shield, lead apron, gonad shield, lead glove, eye shield • Safety shoe, • Digital multi-meter • Electrical safety tester • Installation tool box • Manufacturer installation guide sheet or manual • Technical specification of the machine • Lead material for the room construction like window, door, toilet area • High tension cable, Circuit breaker • Radiation tester X-ray phantom for checking the image output • Computers and accessories • X-ray digital detector or film detector • UPS for the computer
Conditions or situations for the operations	• All tools, equipment's and materials should be available on time when required. • Make sure the floor plan should met the standards and checked by the ***Ethiopian radiation control authority or any legal body***

	• Make Sure Radiograph Exposure Room Area is 26.2 m^2 And Wall thickness 30 Cm • For analog type prepare the dark room and film development • For digital system software package is needed
Procedures	1. Prepare the equipment and take to the installation site ,radiology room 2. Unpack the equipment following the instruction guide 3. Install the beaker and connect the power from distribution board to the breaker using high tension cable 4. Connect the ground line to the building ground system 5. Fix the x-ray generator the ground 6. Assemble and fix the vertical stand which hold the x-ray tube head 7. Fix the x ray tube to the stand 8. Assemble and fix the patient couch on the floor 9. Prepare the control room in isolated area prepared for it 10. Connect the power from the breaker to the x ray generator 11. Follow the step below for digital system; • Install the software on the computer control • Install the exposure switch near the control panel • Connect the image detector to the computer system 12. Follow the step below for analog system; • Prepare the dark room • Prepare the film developer • Prepare the film dryer 13. Connect high voltage power to the tube head following proper guide and polarity 14. Turn ON the system

	15. Place the radiation tester on the patient table to use it as simulator 16. Set the system from control panel KV: 50KV, mA: 80mA, Exposure time:80ms 17. Press exposure switch and look the radiation output on the tester 18. Place x ray phantom on the patient table and take picture of it to test image contrast. The picture can be visualized on film or CD 19. Test leakage radiation surrounding the room, near the door and other area by placing the tester a bit far away from the x ray source during exposure.
Precautions	• Check the power rating is correct as requirement by the machine • Avoid falling of the x ray tube during assembly • Use high voltage electrical safety protection • Use the radiation protecting device during the test • Avoid direct exposure to the radiation in any way • Make sure door is closed during the test
Quality criteria	• Is there a leakage radiation measured • Did the machine reads expected set value on the radiation tester device • Did installation of all accessories are successful • Did the patient cable is moving and adjusted easily • Did the machine every detail contrast on the testing phantom

Install x-ray machine

LAP Test-1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions:

1. You are required to perform any of the following:
   1.1. **Install x-ray machine and accessories** using necessary material and testing device
   1.2. **Test the radiation output using the radiation tester**
   1.3 test the image quality using x-ray phantom
2. Request your teacher for evaluation and feedback

LG #03	LO#3: TEST INSTALLED EQUIPMENT AND ACCESSORIES

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Testing equipment in accordance with manufacturer's instructions
- Undertaking final inspections.
- Cleaning and clearing work site.
- Preparing and submitting report on installation and testing of equipment.
- Endorsing equipment to appropriate end user.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Test equipment in accordance with manufacturer's instructions
- Undertake final inspections.
- Clean and clearing work site.
- Prepare and submitting report on installation and testing of equipment.
- Endorse equipment to appropriate end user.

Learning Instructions

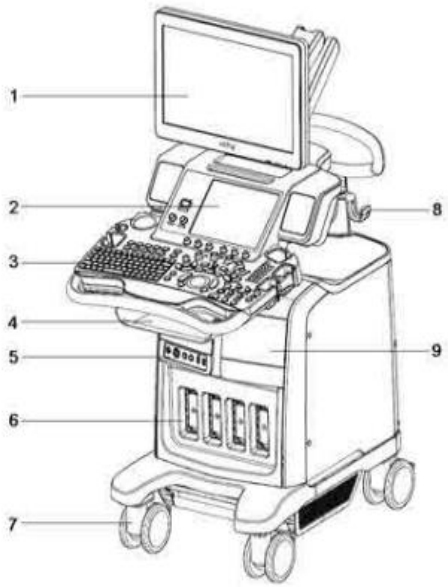
1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3, Sheet 4 and Sheet 5".
4. Accomplish the "Self-check 1, Self-check t 2, Self-check 3, Self-check 4 and self-check 5 **on page 96, 98, 102, 108 and 110** respectively.
5. Accomplish operation sheet and LAP test **on page 111-113**

Information Sheet-1	**Testing equipment in accordance with manufacturer's instructions**

In this section we test the equipment installed. For clarity we continue testing the previous machine selected to install i.e Diagnostic Ultrasound machine. The testing procedure should be in accordance to manufacturer guide line. The test and installation full report can be recorded and filed before endorsed to the user department.

Testing Ultrasound machine

Before start to test the equipment let we discuss all parts of the machine in frontal and rear parts for general understanding of the specific equipment i.e diagnostic ultrasound machine.



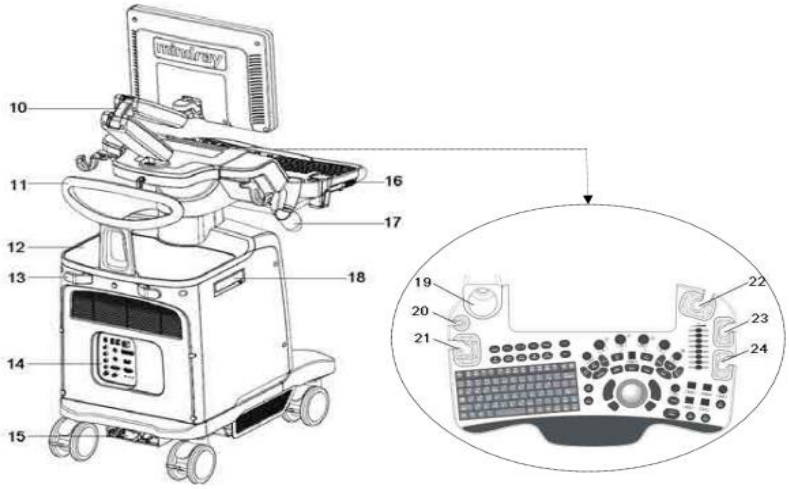


Figure 46.Front and rear parts of US machine

The following table illustrates each keys of the machine in detail.

Table 2.parts of HD3 ultrasound machine with detail

No.	Name	Function
1.	Monitor	Displays the images and parameters during scanning.
2.	Touch screen panel	Operator-system interface or control.
3.	Main control panel	Operator-system interface or control.
4.	Storage compartment	Used for placing small objects.
5.	Physio panel	Used for connecting the ECG leads, PCG transducer, footswitch, external ECG device and PCG signal etc.
6.	Probe port	Sockets connecting transducers and the main unit.
7.	Caster	Used for securing or moving the system
8.	Probe cable hook	Used for fixing the probe cable.
9.	Compartment	Used for placing B/W video printer.
10.	Monitor support arm	Supports the monitor, for adjusting the height and position of the monitor.
11.	Rear handle	Used for pushing and moving the system.
12.	Color video printer placing table	Used for placing the color video printer
13.	Hanger	/
14.	I/O Panel	Interface panel used for inputting and outputting signals.
15.	Power supply panel	Electrical port panel.

16.	USB_MIC port	USB port and MIC port.
17.	Endocavity probe holder	Used for fixing the endocavity probe.
18.	DVD-RW	DVD-RW drive.
19.	Ultrasound gel holder/ gel heater	Used for placing the ultrasound gel or installing the gel heater.
20.	Pencil probe holder	Reserved.
21.	Probe holder	Used for placing general probe, endocavity probe or 4D volume probe.
22.	Probe holder	
23.	Probe holder	Used for placing general probe.
24.	Probe holder	Used for placing general probe.

Machine running initial test

To start the test procedure prepare the necessary testing devices refer ‘’LO1-Information sheet’’. Do the following steps;

- Power on/off normal (duration time is normal), no abnormal sounds or phenomena occur during normal operation.
- After ultrasound system is turned on, the fan starts working and no abnormal sound when the fan is working.
- Check if configuration, software version are normal through the [About] in preset menu.
- Check if contrast and brightness of the monitor are normal.
- Check if time and date are valid and correct.
- Check if all status indicators are normal.
- Check all log records with user, to confirm if there is any abnormality.

Checking control panel

Table 3.checking control panel using standard given

Procedure	Checking standard
Check all buttons, keys and knobs Follow the direction: left to right, and up to down.	All keys and knobs are effective.
Function checking of the trackball:	The trackball can be rotated easily; the cursor

„ • Press the key to enter the Freeze status. „ • Press to enter into measure status, do vertical and horizontal measurement, or do other trackball operations.	responds sensitively, the rotation direction is the same as the direction of the cursor.
• Adjust LCD brightness „ • Adjust LCD contrast	• Press “+”, the brightness increases; and press “-”, the brightness decreases. „ • Press “+”, the contrast increases; and press “-”, the contrast decreases.

Checking peripherals

Table 4.checking peripherals

Procedure	Checking standard
Video printer: Check if the video printer and ultrasound system are correctly connected. Then check the function of each key	Press key, the printer begins to work, no image print deficiency or degradation. Switch video output port; repeat the step
Text/graph printer: Check if the printer and ultrasound system are correctly connected. Then check the function of each key.	Press key, the printer begins to work, no print deficiency or degradation.

Function checking

The following in order

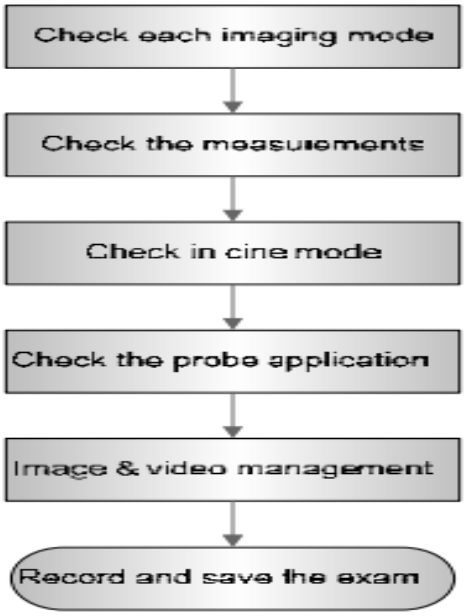


Figure 47.Functional flow

Checking B mode imaging

In B Mode scanning, the image parameter area in the upper left corner of the screen will display the real-time parameter values as follows.

Parameter	F	D	G	FR	DR	iClear	iBeam	iTouch	Zoom
Meaning	Frequency	Depth	Gain	Frame Rate	Dynamic Range	Display when the function is turned on.			

Parameters that can be adjusted to optimize the B Mode image are indicated in the following. To test the image you are expected to check multiple parameters practically and by seeing it on the display. The following tables will guide you to do so.

Table 5.Image testing steps and procedures

Adjustment method	Procedure	Standard
Control Panel	Depth	Changes image display depth----<Depth> deflector rod.
	TGC	Manually adjust time gain compensation---- TGC slider.
	Gain	Changes the B mode gain---- <B> knob.
	iTouch	Image auto-optimization----press <iTouch>.
	Focus Position	Changes the focus position----<Focus> deflector rod.
	Steer	Changes B steer angle of linear probe----<Steer> deflector rod.
Touch Screen	Image Quality	Changes the current probe frequency.
	Tint Map	Turns on/off the colorize function; Selects among available colorize maps.
	Invert	Inverts the image vertically or horizontally.
	Rotation	Rotates an image at an angle of 90° each time.
	FOV	Adjusts the scan area.
	ExFOV	Turns on/ off ExFOV function of probe to extend image range.
	Image Merge	Merges images of two windows in Dual mode.
	Dynamic Range	Adjusts contrast resolution of an image, compresses or expands gray display range.
	Gray Map	Selects among post processing map curves to optimize grayscale images.
	Line Density	The function determines the quality and information of the image.
	Focus Number	Changes the number of focuses.
	iClear	Increases image profile, so as to distinguish the image boundary.
	TSI	Optimizes the image by selecting acoustic speed according to tissue characteristics.
	Persistence	Removes image noise to make details to be clearer.
	iBeam	Superimposes and averages images of different steer angles to obtain image optimization.
	HScale	Display or hide the width scale (horizontal scale).
	Dual live	Display different image effects of one probe.
	LGC	Adjust gain of scan lines to increase the image lateral resolution.
Touch Panel	A. power	Selects the acoustic power value.

Checking M mode imaging

In M mode scanning, the image parameter area in the upper left corner of the screen displays the real-time parameter values as follows

Parameter	F	D	G	V	DR
Meaning	Frequency	Depth	M Gain	M speed	M Dynamic Range

Parameters that can be adjusted to optimize the M Mode image are indicated in the following.

Control Panel	Gain, Depth,TGC,Focus Location
Touch Screen	Speed, Display Format, Gray Map, Dynamic Range, Tint Map, M Soften, Edge Enhance

Checking color mode imaging

In Color mode scanning, the image parameter area in the upper left corner of the screen displays the real-time parameter values as follows:

Parameter	F	G	PRF	WF
Meaning	Frequency	Color Gain	Pulse Repetition Frequency (PRF)	Color Wall Filter

Checking Basic Measurements

Table 6.checking the measurements

Procedure	Standard
In B image mode: Press <Measure>: Press <Caliper> key	The system enters application measurements The system enters general measurement mode. Perform any 1-2 measurements (e.g., length, area), the results will display at the lower part of the image.
Press the same key again or press <Esc>.	Exits measurement.

Probe Switching

Procedure	Standard
Press <Freeze> key→ connect the probe to the system→ press <Freeze> key→ press <Probe> key to select the probe.	Connect a convex probe to probe socket A, and then connect a linear probe to probe socket B, the operator can select probe A or probe B as the active probe.
Press <Freeze> key→ disconnect the probe→ connect another probe to the port	The system can recognize the newly connected probe in no time.

Performance Test

The performance test of ultrasound machine specifically done by Ultrasound phantom. Ultrasound Phantom is a test object containing Tissue Mimicking Material (TMM) that simulates certain acoustic and physical properties of tissue it may also contain various types of embedded objects which used to assess diagnostic ultrasound system performance initially during installation process and over a time. Common ultrasound phantom materials are;

- Agar
- Zerdine
- Urethane
- Other : Epoxies, Liquids , Natural materials

Important properties of simulated phantom material

- Speed of Sound
- Attenuation Coefficient
- Backscatter Coefficient or Relative Contrast
- Elasticity
- Thermal Properties
- Mechanical Properties

Types of Phantoms

General Purpose QA Phantoms

- Typically used for general B-Mode imaging

System Specific QA Phantoms

- Prostate Brachytherapy
- Breast Ultrasound
- 3D Systems
- Radiotherapy Systems
- Doppler Systems
- Elasticity Systems

Training & Demonstration Phantoms

1. Developing eye-hand coordination

2. Learning general scan techniques
3. System Demonstrations

Figure 48.Ultrasound phantom

Resolution test by phantom

Transverse resolution

Test Step 1: Cover the scan surface of the phantom with water or couple gel; gently contact the probe with the scan surface, making the transverse resolution testing targets to be displayed around the midline of the image

Test Step 2: Adjust the focus point focuses at the position where the transverse resolution testing targets are displayed.

Test Step 3: Adjust parameters like gain, dynamic range, TGC, making the background tissue unseen, just displaying the target image clearly.

Test Step 4: In condition that the transverse resolution testing targets are horizontally displayed, record the minimal distance of two targets that can be clearly recognized.

Test Step 5: Repeat the operation above for the transverse resolution testing targets at other depths.

Figure 49.Transverse resolution test by phantom

Axial resolution test

Test Step1: Cover the scan surface of the phantom with water or couple gel; gently contact the probe with the scan surface, making the longitudinal resolution testing targets to be displayed around the midline of the image.

Test Step 2: Adjust the focus point focuses at the position where the longitudinal resolution testing targets are displayed.

Test Step 3: Adjust parameters like gain, dynamic range, TGC, making the background tissue unseen, just displaying the target image clearly.

Test Step 4: Record the minimal distance of two longitudinal resolution testing targets that can be clearly recognized.

Test Step 5: Repeat the operation above for the longitudinal resolution testing targets at other depths.

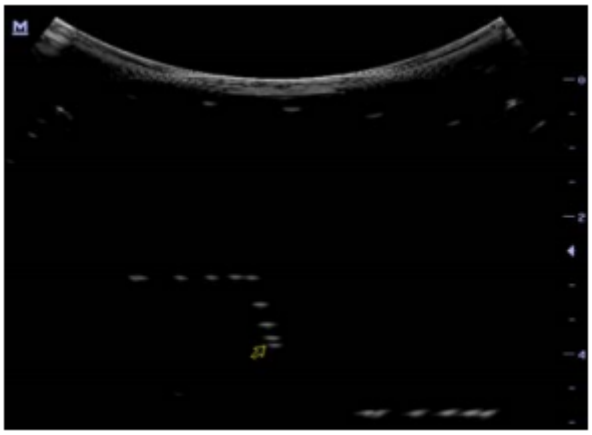


Figure 50.Axial resolution tests

Electrical safety test

Perform these tests after any service or maintenance to detect abnormalities that could prove dangerous to a patient or operator and to assure that system safety and functions have not been compromised:

1. **Chassis to Ground Resistance Test**

   This test checks the entire system for electrical resistance between the chassis and ground. Use electrical safety analyzer to do the task.

To test the system for resistance between chassis and ground

1. Inspect the power cord for cracks and wear.
2. Set the mode on the analyzer to measure resistance in the power cord.
3. Plug the analyzer into an available AC wall outlet. Plug the ultrasound system power plug into the test receptacle on the analyzer.
4. Make the appropriate connections between the analyzer and the ground lug on the ultrasound system's I/O panel.
5. Read chassis ground resistance in milliohms. Flex the ultrasound power cord during the test to detect intermittent changes in resistance value.
6. Record the highest resistance value measured in step 5. Check that the highest resistance value is within the limit specified. If the reading exceeds the specified limit, check the power cord and the associated primary wiring.

A comprehensive ground impedance measurement can be performed using the safety analyzer. The impedance test drives a load current through the ground wire while measuring the AC voltage drop across the entire length of the power cord and to the system chassis. The reading will be in milliohms. The measured R value should not be exceeding 200 milliohms for this specific brand ultrasound.

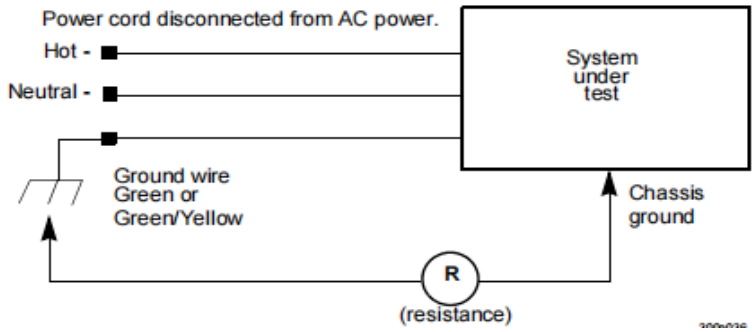


Figure 51.ground to chassis resistance tests

Ground Wire Leakage Current Test

This test checks the entire system for leakage on chassis ground wires.

Note: This test can be hazardous. Avoid any contact with line voltage. Any time during the test that the ground connection is open, do not touch the chassis or the patient cable. To test the system ground wiring for leakage;

1. Set the mode on the analyzer to detect leakage.
2. Plug the analyzer into an available wall outlet. Plug the ultrasound system power plug into the test receptacle on the analyzer. Turn on the ultrasound system's power by starting the internal PC.
3. Take ground wire leakage current measurements in an open ground condition, with both normal and reverse polarity. Record the highest value, and compare it to the limit specified for Normal condition.

4. Take ground wire leakage current measurements in an open ground and open neutral condition, with both normal and reverse polarity. Record the highest value, and compare it to the limit specified for Single Fault condition.

A reading higher than acceptable limits can indicate a problem with the power cord, with its associated connections, or with the power transformer.

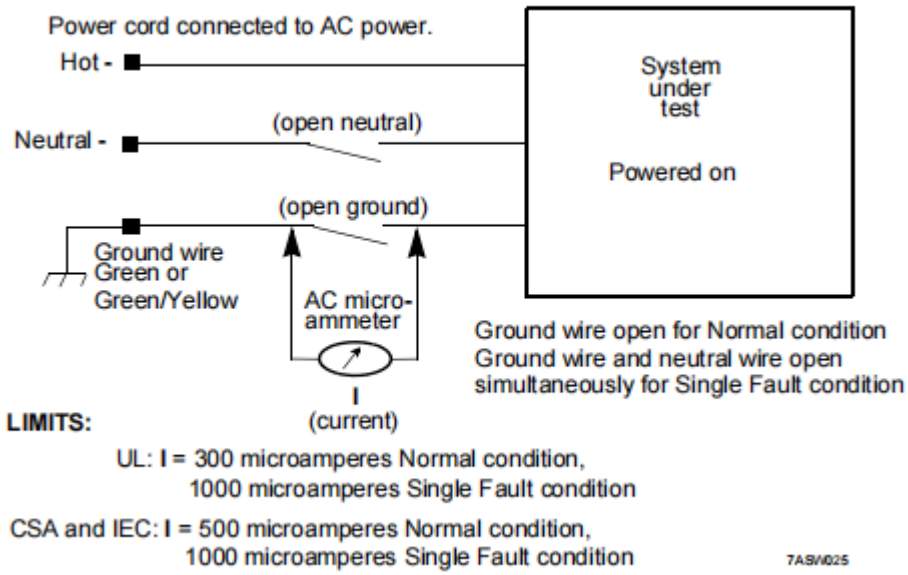


Figure 52.ground wire leakage current tests

Transducer Tests

This section describes two electrical leakage current tests for transducers. To ensure patient safety, it is very important to verify the integrity of the insulating layers of all transducers. When you perform the safety tests, use saline solution in a container as a conductive medium. The solution penetrates any cracks or holes in the transducer insulation and provides an electrical path between the submerged lead wire and the inner transducer shield. The following tools are required for these transducer safety tests:

- Safety analyzer
- Saline holder

- ECG lead wire
- Saline solution, If saline is not available, mix 27 grams of table salt in 3 liters of tap water

Transducer Leakage Current Test (Source)

This test checks a transducer for electrical leakage while it is connected to the ultrasound system. The system sends normal operating voltages to the transducer, and leakage is measured using a safety analyzer. **To test transducer leakage current**

1. Set the analyzer mode to test ECG leads.
2. Plug the analyzer into an available AC wall outlet. Plug the ultrasound system power plug into the test receptacle on the analyzer.
3. Turn on the ultrasound system.
4. Plug the transducer to be tested into the ultrasound system. Connect an ECG lead wire to the appropriate jack on the analyzer.
5. Fill a test container with enough saline to completely cover the appropriate parts of the transducer. Insert the exposed end of the ECG lead into the saline, and carefully insert the transducer. For transthoracic and endocavity transducers, submerge the head and 5 cm (2 in) of the cable. Be careful not to submerge the connector.
6. Set the analyzer to read leakage current in microamperes.
7. Read the current in both normal and reverse polarity, and record the highest value. Check that the highest value is within the limit specified for Normal condition.
8. Read the current with an open ground condition imposed, in both normal and reverse polarity. Write down the highest value; this is the value for the first Single Fault condition.
9. Read the current with an open neutral condition imposed, in both normal and reverse polarity. Write down the highest value; this is the value for the second Single Fault condition.

10. Check that the highest current value measured in step 8 and step 9 is within the limit specified for Single Fault condition. Values exceeding the limits may indicate a fault in the transducer housing or the cable sheath. To locate a fault precisely, repeat the measurement while slowly inserting the transducer into the saline. The aberrant reading appears when the fault in the cable enters the saline.
11. In normal polarity with an open ground condition imposed, measure ground wire leakage. Compare this to the highest value for transducer leakage current, Single Fault condition obtained in step 10. If the transducer leakage is greater than 80% of the chassis leakage, there is a fault in the transducer. To locate the fault, slowly insert the transducer in the saline, as in step 10.

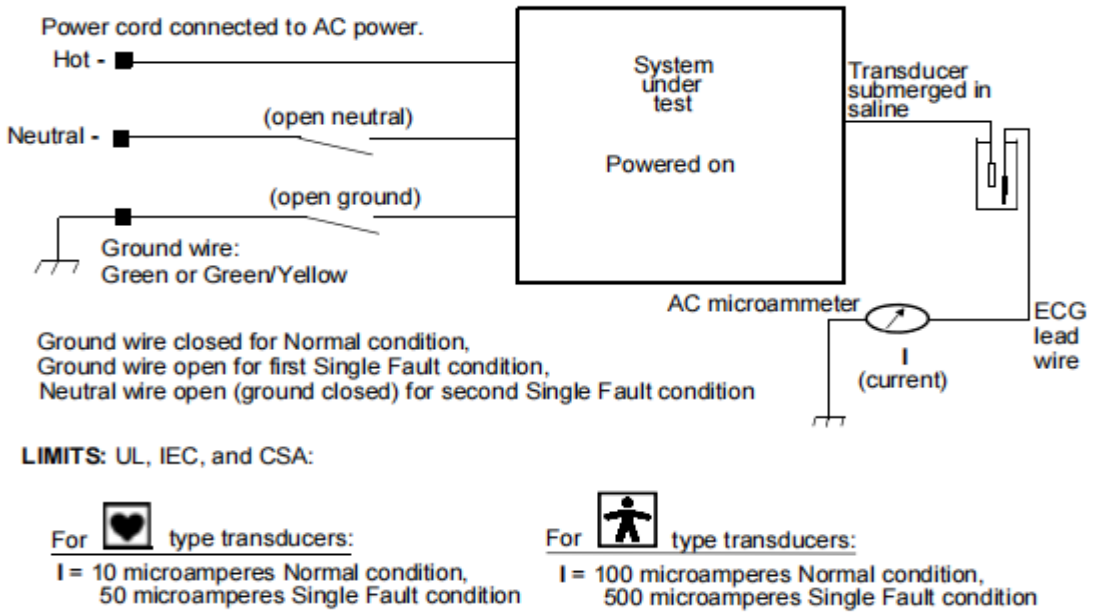


Figure 53.Transducer leakage current tests

Transducer Isolation Leakage Current Test

1. Set the analyzer to test ECG.
2. Plug the analyzer into an available AC wall outlet. Plug the ultrasound system power plug into the test receptacle on the analyzer.

3. Turn on the ultrasound system.
4. Plug the transducer to be tested into the ultrasound system.
5. Fill a test container with enough saline to completely cover the appropriate parts of the transducer.
6. Insert the exposed end of the ECG lead wire into the saline, and then carefully insert the transducer. For transthoracic and endocavity transducers, submerge the head and 5 cm (1.96 in) of the cable. Be careful not to submerge the connector.
7. Measure the isolation leakage current of the transducer. Record the value, and check that it is within the limit specified.

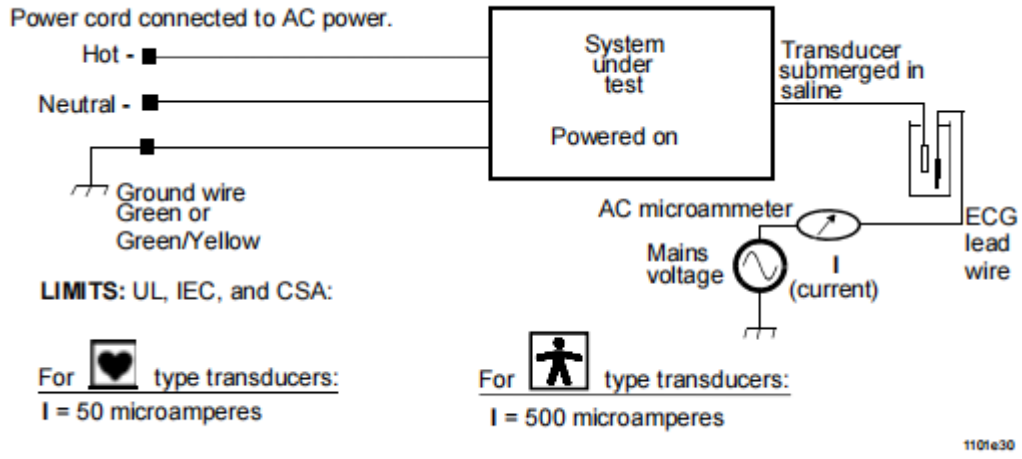


Figure 54.Transducer isolation leakage current tests

Self-Check -1	Multiple choice

1. ____is device used to test ultrasound machine after installation

   A. Electrical safety analyze B. Ultrasound phantom C. Radiation detector D. A&B

2. What are basic properties of ultrasound phantom makes it able to test the machine?

   A. Its speed of sound C. attenuation coefficients'

   B. Elastic properties D. all

3. Which is used for testing ultrasound leakage currents?

   A. Ultrasound probe B. ECG cables C. NIBP cuff D. Ultrasound printer E.A&B F. all

4. If ground to chassis resistance is out of acceptable range

   A. Check power cord B. Ultrasound gel C. building ground system D. All

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-2	**Undertaking final inspections.**

After testing all above discussed things you can visually and using audio inspect the machine. This can be applied by authorized body or certified personnel in case highly sophisticated medical devices like X-ray machine CT scanner MRI machine and radiotherapy equipment. The inspection required for safety of the machine and individuals at work place.

In case of Diagnostic Ultrasound inspect the following

- Moving part is ok
- Wheel castor are working
- Power receptacle is fitted on the wall
- On/Off switch is fine
- All indicator LED is working
- User interface , key board are functioning
- Printer is working
- Print out quality is acceptable
- All necessary peripherals are working
- Basic buttons like FREEZE, CINE, MEASURE, SET are working well
- Brightness adjustment of the screen is working
- Transducer is fitted perfectly and working
- Power rating is enough for the machine and printer as well
- Track ball is moving easily and gently
- Flexible parts are adjusted easily
- Enough space is available considering patient couch , examine/ physician chair and other accessories and consumable placement

Self-Check -2	Multiple choice

1. Inspection can be done by authorized technical personnel
   A. true B. false
2. Inspection can be performed via
   A. Visual check up
   B. Sound check up
   C. By touching the necessary parts
   D. All
3. During the inspection if the power consumed by the machine is not enough
   A. The machine get difficulty to start up
   B. The breaker may trip
   C. The machine my work but the printer may not start up
   D. All

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 3 points**

You can ask your teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-3	**Cleaning and clearing work site.**

Introduction

Workplace cleaning is the removal of gross contamination, organic material, and debris from the premises or respective structures, via mechanical means like sweeping (dry cleaning) and/or the use of water and soap or detergent (wet cleaning). The goal is to minimize organic material to make the installation area attractive and risk free. As we have seen the installation process it is series of tasks and a lot of material can be utilized to accomplish the work. Things that make the installation area unclean are;

- Wooden pallets for large device packing like X-ray, Ultrasound.
- Large cartoon for package of CBC machine, Chemistry machine, and portable ultrasound.
- Different cable tie, accessory holder

Installation workplace cleaning and disinfection should follow the same general principles used in healthcare settings: removal of dirt, frequent disinfection and use of a certain set of disinfecting products. Surfaces that are frequently touched with hands should be cleaned often. This would include (but would not be limited to): Doors in entrance/exiting areas, counters and shelves, desk surfaces, chairs (e.g. arm rests), tables, phones, computer keyboards (especially if shared), counters, light switches, lavatory surfaces, kitchen surfaces and appliances, doorknobs, elevators buttons, handrails, floors and other horizontal surfaces, shared tools and equipment, machinery and truck cabin (clean and disinfect the steering wheel, door handles, frequently used levers and buttons, seats and in general anything you usually touch with your hands.

It is likely that an enhanced cleaning regime will overwhelm a cleaning staff that may be fewer in number than usual. In this case, employee should be responsible for cleaning their own areas and possibly common areas nearby.
It is important to avoid sharing cups, dishes, and cutlery and to ensure that they are thoroughly washed with soap and hot water. If possible, use disposables cutlery, cups and dishes. Garbage collection, and if necessary, storage points, should be increased and emptied regularly throughout each day. If a person is suspected of having pandemic-related disease, it is important to thoroughly clean and disinfect their work area along with any other places may they have been. It is important the early identification of suppliers, prices, stock available, delivery lead time of disposable gloves, detergent, disinfectant and other cleaning products.

Cleaning and disinfecting instructions

1. Disinfecting with bleach and water (5- 10% solution), is the most cost-effective way to disinfect surfaces. This is the approach typically utilized in hospitals and health settings.
    - Bleach must be mixed fresh each day used. Put piece of tape on the bottle and label with the date when made. It should be discarded the next day.
    - Let sit for a short amount of time, the rinse disinfectant-treated surfaces, especially those treated with phenolic, with water. In order to avoid respiratory irritation.
    - Be careful about using bleach on surfaces that may manage (e.g. some wood surfaces). Use other cleaners, if bleach may damage the surface
2. Use disinfectants in accordance with the manufacturer`s instructions, including recommendations for dilution, contact time, shelf-life of batch, and care in handling.

3. Clean equipment surfaces with a detergent/disinfectant. This may be followed with an application of a hospital disinfectant with or without a tuberculocidal claim (depending on the nature of the surface and the degree of contamination), in accordance with disinfectant label instructions. a. Do not use alcohol to disinfect large environmental surfaces.
4. Keep housekeeping surfaces (e.g. floors, walls, and tabletops) visibly clean on a regular basis.
    - Detergent and water are adequate for cleaning surfaces in areas where contamination is not as common. Detergent and water can also inactive most viruses over time
5. Follow proper procedures for effective use of mops, cloths, and solutions including cleaning after use and allowing drying before re-use.
6. For any horizontal surfaces that are not being cleaned and disinfected, wet-dust daily by moistening a cloth with a small amount of an hospital detergent/disinfectant.
7. Do not spray (i.e. fog) occupied or unoccupied rooms with disinfectant. This is a potentially dangerous practice that has no proven disease control benefit.
8. When cleaning, wear glove in accordance with facility policies for environmental cleaning and wear a surgical or procedure mask in accordance with droplet precautions when cleaning a room that has potentially been contaminated. Gowns are not necessary for routine cleaning.
9. Follow standard precautions for handling dishes and eating utensils:
    - When possible, wash reusable items in a dishwasher with detergent at the recommended water temperature
    - If a dishwasher is not available, detergent and water should be used to wash items.

- Rubber gloves should be worn if washing items by hand.
- Disposable dishes and utensils should be discarded with other general waste.
- Wear gloves when handling trays, dishes, and utensils.

Self-Check -3	**Multiple choice**

1. _____Should follows the same general principles used in healthcare settings.

A. Work place cleaning B. workplace disinfection C. A and B D. all

2. Surfaces that are frequently touched include

A. Doors in entrance/exiting areas Counters and shelves C. desk surfaces, chairs) D .tables, phones and computer keyboards E. all

3. At which steps the spaces become dirtier?

A. during unpacking B. during testing C. during inspection D. all

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 3 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-4	Preparing and submitting report on installation and testing of equipment.

Preparing Acceptance and testing log sheet

Hospital name: _____

Bio medical equipment department

New medical Equipment acceptance testing form

Delivery checklist

Undertaken by:

Name: _____

Department:_____

Position: _____

Date:_____

Sign: _____

Approved by:

Name: _____

Department:_____

Position: _____

Date:_____

Sign: _____

Activities	Yes/done
Representative of supplier present?	

Correct number of boxes received?	
After unloading, visible damage to the boxes?	
If damaged, has this been stated on the delivery note and senior management informed?	

Comments:

_____

_____

_____

_____

Activities	**Yes/done**	**Not done**	**Corrected if applicable**
Visible damage to the equipment?			
Equipment complete as ordered?			
User/Operator manual as ordered?			
Service/technical manual as ordered?			
Accessories as ordered?			
Consumables as ordered?			
Spare parts as ordered			

Comments:

Accessories Received

No	Item	Unit	Quantity	Price

Consumables Received

No	Item	Unit	Quantity	Price

Spare Parts Received

No	Item	Unit	Quantity	Price

Manuals Received

No.	**Qty**	**Language**	**Remarks**

User / operational manual			
Service manual			
Installation manual			

Assembly checklist

	Activities	**Yes/done**	**Not done**	**Corrected if applicable**
	Are all parts available?			
	Do they fit together?			
	Mains lead with plug included?			
	Do all the accessories fit?			
	Are markings and labels OK?			
	Any damage?			

Comments:

_____

_____

_____

_____

_____

Performance test log sheet

Electrical integrity test				
No.	Description	Pass	Fail	Remarks
1	Ground to chassis resistance			
2	Leakage current test			
3	Transducer leakage current test			
4	Transduce isolation leakage current test			
Functional test				
1	Contrast resolution test			
2	Axial resolution test			
3	Transverse resolution test			
4	Display test			
5	Keyboard test			
6	Printer test			
7	Peripherals test			
	Mechanical integrity test			
	Wheel castor is ok			
	Flexible part is moving easily			
	Rotating part is ok			
Radiation integrity test				
	Background radiation			

	test (for X-ray source equipment)			
	Leakage radiation test			

Testing device information

Name of device: _____Most recent calibrated date _____

Serial no._____ Next calibration date_____

Model/brand_____

Self-Check -4	**Multiple choice**

1. During acceptance we can check___.
   A. Physical test B. electrical safety test C. mechanical integrity test D. all
2. For medical device who will conduct the acceptance test?
   A. Biomedical Engineer /Biomedical technician
   B. Laboratory technician
   C. User department
   D. All
3. The equipment which fails to pass acceptance sheet criteria should not be used by the user.
   A. True B. false

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 3 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-5	**Endorsing equipment to appropriate end user**

In this section after all installation activity is over training the user department is followed. User training mainly focuses on:

- How to operate the machine- this include basic parts definition and their specific use.
- Steps to turn on/off the machine sequentially: first plug power cable on appropriate wall outlet or turn on the breaker/ any other power distribution system. Then turn on the machine switch for startup. For shutting down after end of use do the reverse.
- Basic parameters to interface with the machine: like patient data enter, selection of part to be diagnosed, type of test performed, pipetting system, KV selection, mA selection, time selection etc…
- SOP preparation on the specific equipment: preparing standard operation procedure for each department
- Daily follow up and care required: visual checkup, cleaning if needed, turning off the device after specified working hour
- Understanding basic warning notice: follow the warning symbol and indicator
- Basic caution to be followed for safe use

Self-Check -5	Multiple choice

1. For effective user training
   A. Use easy words and straightforward explanation
   B. Use detail technical aspects of the machine
   C. Try to deliver basic things
   D. A&C
2. _____is summarized and brief explanation regarding how to use the equipment.
   A. Operational manual B. SOP C. Installation manual D. service manual
3. User is expected to ____
   A. Visually check the machine every day before start using
   B. Clean the device following the standard
   C. Report when fault is happen D. all

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 3 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Operation sheet 2

Operation title: Test proper functioning of Ultrasound machine after installation

Purpose	To acquire the trainees with testing the machine after installation procedure so that the installation works is effective.
Instruction	
Equipment ,tools and materials	Materials, and testing equipment needed or useful performing the test procedure. Include these: • Ultrasound machine with accessories and printer • Ultrasound gel • Ultrasound phantom
Conditions or situations for the operations	• All tools, equipment's and materials should be available on time when required. • The room should be free of any EMI source or equipment generating high frequency •
Procedures	20. Place the machine printer safer place 21. Plug power cable to appropriate setting 220v/50hz and turn on the machine 22. Do the same for peripheral printers 23. Connect the printer to machine by coaxial or USB cable 24. Connect transducer probe to the machine carefully and lock it 25. Select scan mode by pressing ''B'' on control panel 26. Make drop of gel on phantom and hold the transducer on it 27. Press ''patient key'' enter necessary information for this case; Name:'' test image''; sex: ''M/F'';Age:''18" 28. Press ''FREEZE''

	29. Look the image on screen and check it is as expected 30. Press “print” check the print out is clear and acceptable 31. Press ‘’measure’’ 32. Using trackball press ‘’set ‘’ at preferred initial position 33. After taking reference press ‘’set’’ again at another end and look for distance measured 34. Press ‘’Gain’’ and rotate counter clock wise; then check the displayed image is darker 35. Do the reverse check the displayed image is brighter 36. Press ‘’depth’’ and rotate it counter clock wise ; then check the image zoomed in 37. Do the reverse and check the image is zoomed out 38. Perform electrical safety test ; refer ‘’LO3, Information sheet-1 ; page 56-60
Precautions	• Check the power rating is correct for both the machine and printer • Avoid falling of the probe tip • Use gel that is not expired
Quality criteria	• Did the machine works or displayed both axial and transverse resolution of the phantom as expected • Did the electrical safety test result is within the tolerance • Does all the key and buttons are functional • Does the print output is clear

Testing proper functioning of ultrasound machine after installation

LAP Test-2	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions:

1. You are required to perform any of the following:
   1.1. **Ultrasound image resolution test using** necessary material and testing device
   1.2. **Test transducer leakage current** by preparing the unit and necessary testing device
   1.3 test the printer functionality and also quality
2. Request your teacher for evaluation and feedback

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