Operation

Veterinary Systems

High Frequency Generators

APR-VET Console

Technical Publication
OM-0118R0

CE

¡ IMPORTANTE ! ... Protección ante los rayos-X

LOS EQUIPOS DE RAYOS-X SON PELIGROSOS PARA EL PACIENTE Y EL OPERADOR A MENOS QUE LAS MEDIDAS DE PROTECCION SEAN ESTRICTAMENTE OBSERVADAS

Si el equipo de rayos-X no se usa adecuadamente, puede causar lesiones. Por este motivo, las instrucciones aquí incluidas se deben leer y comprender en su totalidad antes de intentar poner el equipo en funcionamiento. Estaremos gustosos de asistir y cooperar en poner el equipo en marcha.

Aunque el equipo está construido según las normas de seguridad más estrictas y presenta un alto grado de protección contra las radiaciones-X, ningún diseño practico puede ofrecer una protección completa. Tampoco ningún diseño practico puede obligar al operador a tomar las precauciones adecuadas para prevenir la posibilidad de que cualquier persona de manera descuidada, poco sensata o ignorante, se exponga a radiaciones directas o indirectas.

Es importante que cualquier persona relacionada con radiaciones-X esté debidamente entrenada y tome las medidas adecuadas para asegurar la protección contra posibles lesiones.

El fabricante asume que todo operador y personal de servicio autorizado para manejar, instalar, calibrar o mantener este equipo, es consciente del peligro que conlleva la exposición excesiva a las radiaciones-X, está suficientemente entrenado y posee los conocimiento necesarios para ello. Por lo tanto, el equipo aquí descrito se vende entendiendo que el fabricante, sus agentes y representantes no tienen ninguna responsabilidad en caso de lesiones o daños que puedan resultar de la exposición a dichas radiaciones.

Existen diversos materiales y dispositivos protectores, cuyo uso es recomendable.

IMPORTANT ! ... X-ray Protection

X-RAY EQUIPMENT IS DANGEROUS TO BOTH PATIENT AND OPERATOR UNLESS MEASURES OF PROTECTION ARE STRICTLY OBSERVED

X-ray equipment if not properly used may cause injury. Accordingly, the instructions herein should be thoroughly read and understood before attempting to place this equipment in operation. We will be glad to assist and cooperate in placing this equipment in use.

Although this apparatus is built to the highest safety standards and incorporates a high degree of protection against X-radiation other than the useful beam, no practical design of equipment can provide complete protection. Nor can any practical design compel the operator to take adequate precautions to prevent the possibility of any persons carelessly, unwisely, or unknowingly exposing themselves or others to X-radiation.

It is important that everyone working with X-radiation be properly trained and take adequate steps to insure protection against injury.

The manufacturer assumes that all operator and service personnel authorized to use, install, calibrate and maintain this equipment is cognizant of the danger of excessive exposure to X-radiation, is sufficiently trained and has the required knowledges for it. The equipment herein described is sold with the understanding that the manufacturer, its agents, and representatives are not liable for injury or damage which may result from exposure to X-radiation.

Various protective material and devices are available. It is recommended that such materials and devices be used.

IMPORTANT ! ... Protection contre les rayons-X

L'EQUIPEMENT RAYONS-X EST DANGEREUX A LA FOIS POUR LE PATIENT ET POUR L'OPERATEUR A MOINS D'OBSERVER STRICTEMENT LES CONSIGNES DE PROTECTION

L'équipement à rayons-X peut provoquer des blessures s'il n'est pas correctement utilisé. En conséquence, les instructions de ce manuel doivent être lues attentivement et bien assimilées avant de tenter de mettre en route ce matériel. Nous serons heureux de vous assister et de coopérer à l'installation de ce matériel.

Bien que cet équipement soit construit selon les normes de construction les plus sévères et qu'il comporte un haut degré de protection contre le rayonnement-X en dehors du rayon utile, aucune conception n'apporte une protection totale. De même qu'aucune conception ne peut obliger l'opérateur à prendre les précautions adéquates afin d'éviter que toute personne ne s'expose ou n'expose les autres au rayonnement sans précaution, de façon imprudente et inconsciente.

Il est important que toutes les personnes travaillant avec le rayonnement-X soit correctement formées et prennent les mesures adéquates afin de se protéger contre toute blessure.

Le constructeur suppose que tous les utilisateurs et le personnel d'entretien autorisé à utiliser, installer, calibrer et entretenir cet équipement est conscient du danger de l'exposition excessive au rayonnement-X, est suffisamment formé et possède les connaissances nécessaires pour cela. L'équipement décrit dans le présent manuel est vendu sous réserve que le fabricant, ses agents et représentants ne soient pas tenus pour responsables des blessures ou dommages qui pourraient résulter d'une exposition aux rayons-X.

Plusieurs matériels de protection et systèmes sont disponibles. L'utilisation de ces matériels et systèmes de protection est recommandée.

DECLARACION AMBIENTAL
SOBRE LA VIDA UTIL DEL EQUIPO O SISTEMA

Este equipo o sistema contiene componentes y materiales peligrosos para el medioambiente (tales como tarjetas de circuito impreso, componentes electrónicos, aceite dieléctrico usado, plomo, baterías, etc), los cuales se consideran y son residuos peligrosos al finalizar la vida útil del equipo o sistema, según establecen las normas internacionales, nacionales y locales.

El fabricante recomienda que al finalizar la vida útil de equipo o sistema, se contacte con un representante autorizado del fabricante o con un gestor autorizado de residuos para la retirada de este equipo o sistema.

ENVIRONMENTAL STATEMENT
ON THE LIFE CYCLE OF THE EQUIPMENT OR SYSTEM

This equipment or system contains environmentally dangerous components and materials (such as PCB‘s, electronic components, used dielectric oil, lead, batteries etc.) which, once the life-cycle of the equipment or system comes to an end, becomes dangerous and need to be considered as harmful waste according to the international, domestic and local regulations.

The manufacturer recommends to contact an authorized representative of the manufacturer or an authorized waste management company once the life-cycle of the equipment or system comes to an end to remove this equipment or system.

DECLARATION D’ENVIRONNEMENT
SUR LA VIE UTILE DE L’EQUIPEMENT OU SYSTEME

Cet équipement ou système contient des composants et matériaux dangereux pour l’environnement (ex: électroniques cartes, composants électroniques, huile diélectrique usée, plomb, batteries, etc.), lesquels sont considérés comme résidus dangereux en cycle terminal de vie d’un équipement ou système, en accord avec les normes internationales, nationales et locales en vigueur.

Le fabricant recommande une fois le cycle terminal de l’équipement ou système atteint, de contacter un représentant autorisé du fabricant ou les autorités compétentes en la matière afin d’organiser et de gérer le recyclage adéquat de cet équipement ou appareil.

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	DEC 1, 2005	First edition

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.

DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.

Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note ☞

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

SAFETY SYMBOLS

The following safety symbols will be used in the equipment.
Their meaning are described below.

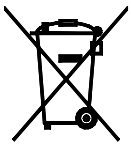
Attention, consult accompanying documents.

Ionizing radiation.

Type B equipment.

Dangerous voltage.

Ground.



This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer or an authorized waste management company for information concerning the decommissioning of your equipment.

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SECTION 1 INTRODUCTION

This manual contains all the necessary information to understand and operate the **Veterinay Systems** with **High Frecuency Generator and Radiographic Console APR-VET**. It provides a general description, safety and regulatory information, operation instructions and specifications concerning the equipment.

Illustration 1-1
Veterinay Systems APR-VET

These Veterinary Systems consist of:

- **High Frequency X-ray Generator** designed for general radiography in Veterinary applications. It provides all the advantages of high frequency waveform generators including lower patient dose, shorter exposure times and greater accuracy and consistency.

  The generator is controlled by multiple microprocessors providing increased exposure consistency, efficient operation and extended tube life. A high level of self-diagnosis greatly increases serviceability and reduces down time.

- **Radiographic Console APR-VET** with controls and displays for radiographic operations and general functions. The operator can select tecniques in one, two or three points or use any anatomical programming (APR).

  The Console is designed to provide an easy operation and it is the interface with the Generator and the rest of the System. Optionally, the Console can be installed alone or assembled on a pedestal.

- **Tube-Collimator Assembly** and **Radiographic Table.** The System configuration is based on both components.

  - **Tube-Collimator Assembly.** Available in three versions: Fixed SID, Variable SID or Sliding Column. This assembly includes the X-ray Tube, Collimator and Control Console.

  - **Radiographic Table***.* Two different models available for a better patient positioning: Fixed Table with Floating Table-Top and Mobile Table with wheels.

    The Fixed Table includes a Bucky and/or a Cassette Tray and the Generator is installed inside the Table.

    In the case of the Mobile Table, the Bucky and/or the Cassette Tray are assembled to the column and the generator is placed at the base.

1.1 GENERAL FEATURES

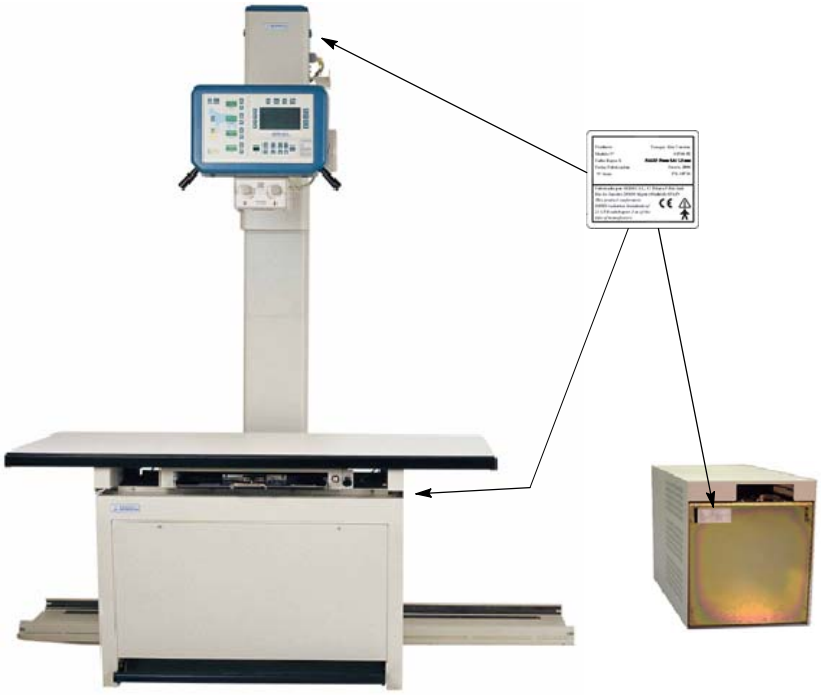
The main features of this System are:

- Constant potential at high frequency single phase or three phase.
- Three point control by selecting kVp, mA and Exposure Time, or two point control by selecting kVp and mAs, or one point control by selecting kVp with AEC operations.
- Anatomical Programming (APR).
- Self-diagnostic warnings that identify malfunctions in the equipment.
- Tube protection circuitry that prolongs tube life and increases system performance.
- Equipped with closed loop control of X-ray tube current, kVp and filaments, which minimize potential errors and the need for readjustments.
- Automatic line voltage compensation due to closed loop operation of X-ray tube current and kVp.
- Heat Unit storage for the X-ray tube. Data available after turning Off / On the equipment.
- Bucky Connection (optional).
- Automatic Exposure Control (AEC) which accomodates the most popular exposure detectors (optional).

1.2 PRODUCT IDENTIFICATION

The major items in the equipment have some identification labels attached to them which provide the following manufacturer and product information.

- Product
- Model.
- Volts (V), Line Phases, Frequency (Hz), and Power (kVA, kW).
- Date of manufacture.
- Serial number.
- Part number.
- Manufacturer.
- Place of manufacture.
- Certification.



1.3 CERTIFICATIONS

The X-ray Unit covered by this Operation Manual is authorized to be marked with **CE MARKING** in accordance with the provisions of the Council Directive 93 / 42 / EEC.

1.4 CLASSIFICATION

The X-ray Generator covered by this Operation Manual is classified as:

- *Protection against Electric Shock*: Class I – Type B applied parts.
- *Protection against Harmful Ingress of Water*: Ordinary.
- *Degree of Safety in the presence of Flammable Anesthetics Mixture with air or with oxygen or with nitrous oxide*: Not suitable for use in the presence of Flammable Anesthetics Mixture with air or with oxygen or with nitrous oxide.
- *Mode of Operation*: Continuous operation with intermittent loading.
- *Permanently Installed Equipment.*

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SECTION 2 SAFETY

2.1 GENERAL

Keep this Operating Manual with the equipment at all times and periodically review the Operating and Safety instructions.

For continue safe use of this equipment follow the instructions in this Operation Manual. Study this manual carefully before using the equipment and keep it at hand for quick reference.

THE EQUIPMENT DESCRIBED IN THIS MANUAL MUST BE ONLY HANDLE BY QUALIFIED PERSONNEL PREVIOUSLY TRAINED IN IT.

X-RAY EQUIPMENT IS DANGEROUS TO BOTH PATIENT AND OPERATOR UNLESS PROTECTION MEASURES ARE STRICTLY OBSERVED.

IT IS VITALLY IMPORTANT THAT EVERYONE ASSOCIATED WITH X-RAY RADIATION IS FAMILIAR WITH THE SAFETY AND REGULATORY INSTRUCTIONS CONTAINED WITHIN THIS MANUAL, IN PARTICULAR, THE STATEMENT AT THE BEGINNING OF THIS MANUAL ENTITLED “IMPORTANT!... X-RAY PROTECTION”.

THESE INSTRUCTIONS SHOULD BE THOROUGHLY READ AND UNDERSTOOD BEFORE ATTEMPTING TO PLACE THIS EQUIPMENT IN OPERATION.

Although X-radiation can be hazardous, X-ray equipment does not pose any danger when it is properly used. Please ensure that all service and operating personnel are properly trained and informed on the hazards of radiation. Those responsible for the system must understand the safety requirements for X-ray operation. Please study this manual and the manuals for each system component to be fully aware of all the safety and operational requirements.

2.2 RESPONSIBILITIES

ENSURE THAT ALL PERSONNEL AUTHORIZED TO USE THE EQUIPMENT ARE AWARE OF THE DANGER OF EXCESSIVE EXPOSURE TO X-RAY RADIATION.

THE EQUIPMENT HEREIN DESCRIBED IS SOLD WITH THE UNDERSTANDING THE MANUFACTURER, ITS AGENTS, AND REPRESENTATIVES ARE NOT LIABLE FOR INJURY OR DAMAGE WHICH MAY RESULT FROM OVEREXPOSURE OF PATIENTS OR PERSONNEL TO X-RAY RADIATION.

THE MANUFACTURER DOES NOT ACCEPT ANY RESPONSIBILITY FOR OVEREXPOSURE OF PATIENTS OR PERSONNEL TO X-RAY RADIATION GENERATED BY THIS EQUIPMENT WHICH IS A RESULT OF POOR OPERATING TECHNIQUES OR PROCEDURES.

NO RESPONSIBILITY WILL BE ASSUMED FOR ANY EQUIPMENT THAT HAS NOT BEEN SERVICED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURER INSTRUCTIONS, OR WHICH HAS BEEN MODIFIED OR TAMPERED WITH IN ANY WAY.

IT IS THE RESPONSIBILITY OF THE OPERATOR TO ENSURE THE SAFETY OF THE PATIENT WHILE THE X-RAY EQUIPMENT IS IN OPERATION BY VISUAL OBSERVATION, PROPER PATIENT POSITIONING, AND USE OF THE DEVICES THAT ARE INTENDED TO PREVENT PATIENT INJURY.

ALWAYS WATCH ALL PARTS OF THE SYSTEM TO VERIFY THAT THERE IS NO INTERFERENCE AND NO POSSIBILITY OF COLLISION WITH THE PATIENT OR WITH OTHER EQUIPMENTS.

SHOULD ANY INTERFERENCE (EMC) BE DETECTED WITH OTHER EQUIPMENT, PLEASE POSITION OTHER EQUIPMENT AWAY FROM THIS ONE.

2.3 MAXIMUM PERMISSIBLE DOSE (MPD)

Before operation, persons qualified and authorized to operate this equipment should be familiar with the Recommendations of the International Commission on Radiological Protection, contained in Annals Number 60 of the ICRP, with applicable National Standards, and should have been trained in use of the equipment.

2.4 RADIATION PROTECTION

Because exposure to X-ray radiation may be damaging to health, use great care to provide protection against exposure to the primary beam. Some of the effects of X-ray radiation are cumulative and may extend over a period of months or years. The best safety rule for X-ray operator is *"Avoid exposure to the primary beam at **all times**"*.

Any object in the path of the primary beam produces secondary (scattered) radiation. The intensity of the secondary radiation is dependent upon the energy and intensity of the primary beam and the atomic number for the object material struck by the primary beam. Secondary radiation may be of greater intensity than that of the radiation reaching the film. Take protective measures to safeguard against it.

An effective protective measure is the use of lead shielding. To minimize dangerous exposure, use such items as lead screens, lead impregnated gloves, aprons, thyroid collars, etc. The lead screen should contain a minimum of 2.0 mm of lead or equivalent and personal protective devices (aprons, gloves, etc.) must contain a minimum of 0.25 mm of lead or equivalent. For confirmation of the local requirements at your site, please refer to your "Local Radiation Protection Rules" as provided by your Radiation Protection Advisor.

WHILE OPERATING OR SERVICING X-RAY EQUIPMENT, ALWAYS KEEP A DISTANCE NOT LESS THAN 2 METERS FROM THE FOCAL SPOT AND X-RAY BEAM, PROTECT BODY AND DO NOT EXPOSE HANDS, WRISTS, ARMS OR OTHER PARTS OF THE BODY TO THE PRIMARY BEAM.

2.5 MONITORING OF PERSONNEL

Monitoring of personnel to determine the amount of radiation to which they have been exposed provides a valuable cross check to determine whether or not safety measures are adequate. It may reveal inadequate or improper radiation protection practices and potentially serious radiation exposure situations.

The most effective method of determining whether or not the existing protective measures are adequate is the use of instruments to measure the exposure. These measurements should be taken at all locations where the operator, or any portion of the body may be exposed. Exposure must never exceed the accepted tolerable dose.

A frequently used, but less accurate, method of determining the amount of exposure is the placement of film at strategic locations. After a specified period of time, develop the film to determine the amount of radiation.

A common method of determining whether personnel have been exposed to excessive radiation is the use of personal radiation dosimeters. These consist of X-ray sensitive film or thermoluminescent material enclosed within a holder that may be worn on the body. Even though this device only measures the radiation which reaches the area of the body on which they are worn, they do provide a reasonable indication of the amount of radiation received.

2.6 PROTECTION AGAINST ELECTRIC SHOCK HAZARDS

This X-ray Unit has been classified as equipment of type-B (⍾) in accordance with IEC 60601-1.

This equipment meets the following Safety Standards: IEC 60601-1, IEC 60601-2-7.

ACCORDING TO THE MDD/93/42/EEC, THIS UNIT IS EQUIPPED WITH EMC FILTERS. THE LACK OF THE PROPER GROUNDING MAY PRODUCE ELECTRICAL SHOCK TO THE USER.

2.7 PROTECTION AGAINST HAZARDS FROM UNWANTED OR EXCESSIVE RADIATION

Statement of compliance: This X-ray Unit with radiation protection in accordance with IEC 60601-1-3 for which compliance is to be stated.

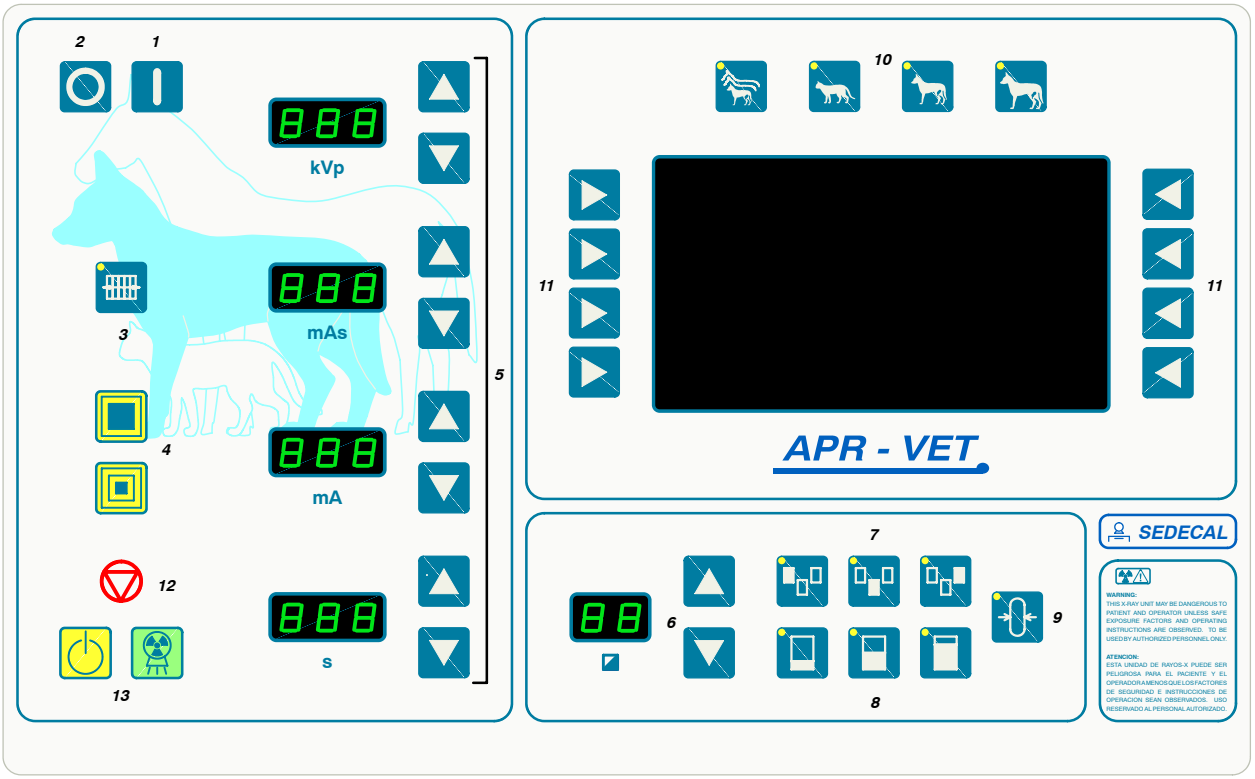
This equipment meets Standard IEC 60601-1-3 requirements.

SECTION 3 OPERATING CONTROLS

Except for the brakes of the mobile components in the system, all the controls, indicators and displays are located on the Console. They are grouped in functional modules.

Note ☞ *Use the operating controls as described in this manual, any other non-indicated combination can cause an incorrect operation of the equipment.*

Illustration 3-1
APR-VET Console



1. On
2. Off
3. Bucky / No Bucky Selection
4. Focal Spot Indicators
5. Radiographic Parameters
6. AEC Density Parameters
7. AEC Area Selection
8. Film / Screen Combination
9. AEC Reset
10. Patient Size Selection (APR)
11. APR Display Selectors
12. Self-Diagnostic Indicator
13. Status Indicators

USE THE EQUIPMENT HAND-GRIPS TO CONTROL AND DRIVE THE UNIT MOVEMENTS, NEVER PUSH DIRECTLY ON THE X-RAY TUBE OR COLLIMATOR.

MONITOR THE SYSTEM MOVEMENTS WITH SPECIAL CARE. AVOID ANY IMPACT OF THE SYSTEM ON FLOOR, CEILING OR OTHER ELEMENTS IN THE ROOM. IT MAY CAUSE SERIOUS DAMAGE TO THE EQUIPMENT.

MONITOR WITH SPECIAL CARE THE PATIENT POSITION TO AVOID INJURY TO PATIENT CAUSED BY TABLE-TOP MOVEMENTS. PATIENT EXTREMITIES BE KEPT AWAY FROM MOBILE COMPONENTS OF THE UNIT.

OPERATOR SHOULD NEVER MOVE TABLE-TOP FROM LATERAL SIDE (PATIENT HEAD OR FEET). IT MAY CAUSE FINGERPINCH UNDER THE TABLE-TOP.

INTRAVENOUS TUBING, CATHETERS AND OTHER PATIENT CONNECTED LINES SHOULD BE ROUTED AWAY FROM MOVING EQUIPMENT.

3.1 RADIOGRAPHY AND GENERAL CONTROLS

The Radiographic module consists of: Power On / Off, Bucky / No Bucky selection, displays and controls of radiographic parameters, Focal Spot, Status and Error indicators.

3.1.1 POWER ON / OFF

ON: The Generator is turned ON by pressing this push-button. This starts a power-up routine and the Console shows the software version (a.e. P05.3 = Vers.5, Rev.3). After the power-up routine the last workstation used will be automatically selected.

OFF: The System is turned OFF by pressing this push-button.

IN THE EVENT OF AN EMERGENCY, ISOLATE THE X-RAY SYSTEM FROM THE MAINS POWER BY FORCIBLY DEPRESSING THE X-RAY ROOM "EMERGENCY OFF SWITCH" (USUALLY A RED MUSHROOM-SHAPED SWITCH).

THIS SWITCH SHOULD BE LOCATED ON OR NEAR TO THE X-RAY ROOM ELECTRICAL CABINET, USUALLY PLACED NEAR TO THE GENERATOR CONTROL CONSOLE. MORE THAN ONE OF THESE SWITCHES MAY BE PLACED AROUND THE ROOM FOR GREATER ACCESSIBILITY.

3.1.2 BUCKY / NO BUCKY SELECTION

BUCKY / NO BUCKY: Press this push-button to select the Bucky configured in the system (push-button lighted), or to select "*No Bucky*" (push-button off).

3.1.3 FOCAL SPOT INDICATORS

LARGE FOCAL SPOT: Indicates that the "*Large Focal Spot*" of the X-ray Tube has been selected.

SMALL FOCAL SPOT: Indicates that the "*Small Focal Spot*" of the X-ray Tube has been selected.

Note ☞ *The Focal Spot is automatically selected according to the mA station. The mA station set for the Focal Spot change is configured by the field engineer during the installation. 16 kW Generator model only operates with Small Focal Spot.*

The Focal Spot may also be selected (keeping kV and mAs constant) pressing:

- "*ON*" + "*mA or mAs increase*" push-buttons to select Large Focal Spot.
- "*ON*" + "*mA or mAs decrease*" push-buttons to select Small Focal Spot.

Constant mAs set the maximum mA available and the minimum exposure time.

Note ☞ *The Focal Spot change can be done whenever the present conditions of the X-ray Tube allow it.*

3.1.4 STATUS INDICATORS

READY: Indicates that the technique selected is properly set, there are no interlock failures or system faults, the anode is rotating and the X-ray Tube is ready for exposure.

X-RAY ON: Indicates that the X-ray exposure is in progress. At the same time that radiographic exposures are being made, an audible signal is heard.

3.1.5 SELF DIAGNOSTIC INDICATORS

ERROR INDICATOR: Lights when a malfunction is detected in the system, alerting the operator that one of the following error exists preventing X-ray exposures. This error indicators are shown in the APR Display or as an Error code on the kVp Display. (*See Section 3.7*).

- **DOOR OPEN (DOOR)**: Indicates the X-ray room door is open when the X-ray equipment is in use.
- **GENERATOR OVERLOAD (G.OVL):** Indicates that the exposure has been interrupted because during exposure has been produced arcing or bad function on the HV circuitry (X-ray Tube, HV Transformer and/or HV Cables) or a failure of IGBT module (overheated or defective IGBTs) has been detected.

  It can be also shown making a high power and long exposure with the X-ray Tube cool (X-ray Tube has not been warmed-up).
- **TUBE OVERLOAD (T.OVL)**: Indicates that the technique selected is beyond the X-ray Tube ratings or the present conditions of the X-ray Tube inhibit the exposure (anode overheated). Parameters for next exposure may be temporally limited by the Generator (change the exposure values or wait for the X-ray Tube to cool).

  Check that heat units available are lower than the calculated for the next exposure (heat units close to zero). Reduce exposure factors or wait for the X-ray Tube to cool. *(To display the Heat Units refer to Section 3.5).*
- **ROTOR ERROR (ROTOR):** Indicates that the X-ray Tube anode is not rotating while "*Prep*" is active, then exposures are inhibited.
- **HEAT:** Indicates that the X-ray Tube thermostat / pressurestat is open due to overheating of the Tube housing (housing is too hot, wait for the housing to cool) or to a thermostat / pressurestat mal-function (housing is cool). Heat units may raise to any value.
- **TECHNIQUE ERROR (TECH)**: If displayed during exposure it means that:

The exposure has been interrupted by "Security Timer" because of a failure in the System. Turn Off the Generator and call Field Service.

This error can also be shown after an APR technique selection to advise that exposure parameters displayed on the Console are not the values stored for this APR technique. Exposure parameters are adapted by the Generator to another enable values.

3.1.6 RADIOGRAPHIC PARAMETERS

kV DISPLAY can show:

- The radiographic kV value selected for the technique.
- The actual X-ray Tube heat unit value after pressing the "*On*" push-button (*Refer to Section 3.5*).
- The error messages during a system fault, preceded by the letter "E" (a.e., E02) (*Refer to Section 3.7*).

mAs DISPLAY can show:

- The radiographic mAs value selected for the technique.
- When an exposure is made with AEC, it shows the actual mAs at the end of the exposure whenever the "*Prep*" push-button has not been released.
- If an exposure is aborted by releasing the Exposure Control (Pedal or Handswitch) during the exposure, it shows the actual mAs value until the "*AEC Reset*" push-button is pressed to reset the error condition.

mA DISPLAY: Shows the radiographic mA value selected for the technique.

Time DISPLAY can show:

- The Time value (in seconds) selected for the radiographic technique.
- When an exposure is made with AEC, it shows the back-up time during the exposure and the actual Time at the end of the exposure whenever the "*Prep*" push-button has not been released.
- If an exposure is aborted by releasing the Exposure Control (Pedal or Handswitch) during the exposure, it shows the actual Time until the "*AEC Reset*" push-button is pressed to reset the error condition.

RAD Displays can also show:

- The actual Time, the calculated mAs, and the selected kVp and mA radiographic parameters of the last exposure, with or without AEC, after pressing the "*AEC Reset*" push-button (values flashing).
- The exposure counters (*Refer to Section 3.6)*.

INCREASE / **DECREASE**: Radiographic technique values are increased or decreased by pressing the respective push-buttons. The values increase or decrease step-by-step each time the corresponding push-button is pressed, and changes faster when either of them is pressed continuously.

- **kV:** Selects the X-ray Tube voltage.
- **mAs**: Selects the exposure in mAs.
- **mA**: Selects the X-ray Tube current.
- **s**: Selects the exposure time in seconds.

(Refer to Section 6 for Factor ranges)

Note ☞

If after pressing any of these push-buttons, the technique value is blocked and an acoustic signal is emitted it could mean that:

Radiographic Parameters Blockage. *When any of the maximum or minimum radiographic parameter limit is reached, its related Display blinks.*

Generator Power Limit. *If the power limit (kV x mA) is reached by increasing the mA up to a maximum possible value, the mA value is blocked. Flashing values on kV and mA Displays will alert operator about the situation.*

If required, kV could be increased up to its maximum value while mA value may automatically decrease, as long as mAs value is kept the same.

Space Charge*. If a variation of the kV or mA induces to reach space charge limit in the selected tube, the parameter is blocked, and flashing value on the kV Display will alert operator about the situation.*

Maximum Energy (60 kJ)*. Only in AEC mode, if a variation of the parameters means that the maximum energy (60 kJ) will be exceed, the parameter is blocked. Flashing values on kV and mAs Displays will alert operator about the situation.*

Instantaneous Power. *If a technique reaches the instantaneous power limit of the X-ray Tube (ratings limit or the X-ray Tube is momentarily overheated), some techniques cannot be selected. Flashing values on kV and mAs Displays will alert operator about the situation.*

3.2 AUTOMATIC EXPOSURE CONTROL (AEC)

Automatic Exposure Control (AEC) produces consistent film density with excellent contrast regardless of the radiographic technique selected. The AEC module comprises the controls for the selection of the Exposure Detector Fields (Ion Chamber), the Film/Screen Combination, Film Density Compensation and AEC Reset.

The AEC mode is selected by pressing any of the three AEC Field push-buttons. To exit the AEC mode, press all the illuminated AEC Field push-buttons until none are lit.

In AEC mode the back-up time (or back-up mAs) MUST BE SET MANUALLY pressing the Console controls.

Note ☞

The value of the back-up time (or mAs) must be set at a greater value than the previously considered for the exposure time (or mAs). A value above 50% of the considered value is the recommended. Very extreme values of back-up time (or mAs) should be avoided to prevent patient from excessive exposure when a control error is produced.

FIELD SELECTION: Each push-button indicates its related physical location of the selected field in the AEC Exposure Detector, and it may be selected or deselected by pressing it. Any combination of fields can be selected and the push-buttons illuminate when active.

FILM / SCREEN COMBINATION: Each of these push-buttons allows adjustment of the mAs in relation to a programmed Film / Screen combination that may be in use slow, medium, or fast respectively (200, 400, 800). Each time a Film / Screen push-button is selected (illuminated), the others are automatically deselected.

DENSITY: These push-buttons are used to adjust the radiographic film density. Normal film density (0) is the automatic default value when AEC is selected.

Film density can be proportionally increased or decreased in different steps. The variation percentage density between steps can be changed during the equipment calibration by the engineer according to customer preferences (the percentage by default is 25%).

AEC RESET: If the exposure is aborted by the AEC back-up timer, the indicator on the "*AEC Reset*" push-button blinks accompanied of an audible alarm. Next exposure is inhibited until the AEC function is reset by pressing the "*AEC Reset*" push-button. When the Generator is in *"Prep"* mode, the AEC function can not be reset.

The "*AEC Reset*" push-button may blink when the kVp value, AEC Density and Film / Screen Combination select a technique that is out of the operative range with AEC, it inhibits the next exposure. Change any parameter (kVp value, AEC Density or Film / Screen Combination) in order to obtain a technique enabled for AEC.

3.3 ANATOMICAL PROGRAMMER (APR)

Anatomical Programmer (APR) selects the values for the radiographic technique in accordance to the selected Body Region and Thickness in centimeters. (*Refer to Illustration 3-2)*.

Besides the radiographic parameters, AEC (Density, AEC Fields and Film/Screen Combination) selections can be assigned to the APR techniques. APR techniques can be modified and stored again in a non-volatile memory by the operator.

The APR techniques are intended as a *guide line only*. Accurate exposure factors depend among other things on the Bucky Grid factors, Table-Top absorption, Film / Screen Combinations and Film processing.

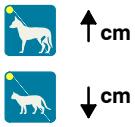
Note ☞ *APR language may be changed just after APR activation by pressing the "Power ON" push-button. Language selection remains stored even after the equipment is turned Off. (Only for Generators equipped with this option).*

Note ☞ *If an APR technique is to be stored with AEC parameters, a suitable back-up time (and/or mAs) MUST be stored in the programme by the operator.*

APR DISPLAY: Shows the different Body Regions (Skull, Abdomen, Pelvis, Thorax, Extremity, Spine, Exotics or Dental) and the Thickness range in centimeters of the area to be exposed.

APR MODE SELECTION: This push-button (C) is used to activate (lighted) or deactivate the APR mode.

This push-button (A) has not assigned function with this APR mode.



THICKNESS INCREASE / DECREASE: These push-buttons are used to decrease (B) or increase (D) the Thickness in centimeters of the area to be exposed, in order to **adjust the kVp value** of the APR technique according to the patient size.

This data is shown on the lower right area of the APR Display after selecting the Body Region and Thickness range. Thickness can be also modified by using the push-buttons 7 (UP) and 8 (DOWN) of the APR (to increase or decrease centimeters). *(Refer to Illustration 3-2).*

DISPLAY SELECTORS: Each push-button is related to the nearest area of the APR Display. They are used to select:

- One of the displayed Body Regions (Skull, Abdomen, Pelvis, Thorax, Extremity, Spine, Exotics or Dental).
- Thickness Range (from 1 to 10 cm, from 11 to 20 cm, from 21 to 30 cm, and from 31 to 40 cm). "*Extremity*" and "*Dental*" only allow a Thickness Range selection from 1 to 10 cm.
- To increase or decrease the final thickness selection of the area to be exposed.

mAs COMPENSATION: With this APR mode, the mAs value of the technique can be modified by using the AEC push-buttons for Film/Screen Combination and AEC Density, even though AEC option is not activated.

The "*Film/Screen Combination*" push-buttons are used to adjust the mAs in relation to Film / Screen speed. The "*Medium Film/Screen*" push-button is selected by default.

Selection of "*Slow Film/Screen*" increases the mAs value to the double of the value for "*Medium Film/Screen*". Speed of "*Slow Film/Screen*" has to be the half speed of "*Medium Film/Screen*".

Selection of "*Fast Film/Screen*" reduces the mAs value to the half of the value for "*Medium Film/Screen*". Speed of "*Fast Film/Screen*" has to be the double speed of "*Medium Film/Screen*".

The "*Density*" push-buttons are used to adjust the radiographic film density changing the mAs value in different steps. Normal film density (0) is selected by default.

The variation percentage density between steps can be changed during the equipment calibration by the engineer according to customer preferences (the percentage by default is 25%).

APR TECHNIQUE SELECTION

(Refer to Illustration 3-2)

1. When the APR mode is activated, the APR Display shows the Body Regions: Skull (1), Abdomen (2), Pelvis (3), Thorax (4), Extremity (5), Spine (6), Exotics (7) or Dental (8).

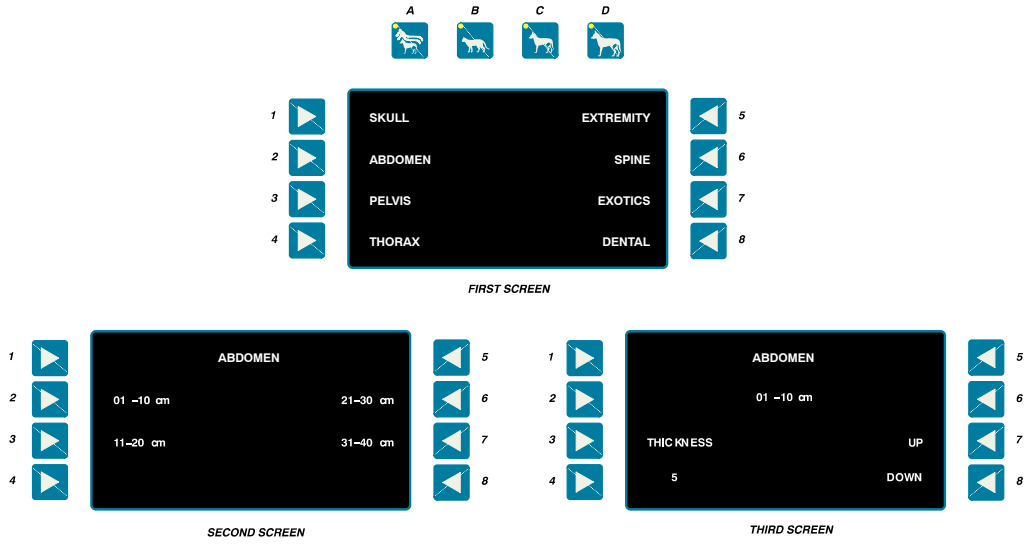
2. After selecting a Body Region, the APR Display shows the selected Body Region and the four Thickness ranges (push-buttons 2, 3, 6 and 7).

3. After selecting a Thickness range, the APR Display shows the selected Body Region, the selected Thickness range and the final thickness selection of the area to be exposed. Also the Console displays the Bucky / No Bucky, AEC or mAs Compensation (Film/Screen and AEC Density push-buttons) and Technique parameters.

4. All the values and selections can be modified with the respective push-buttons.

   - Press the push-buttons "*7*" and "*8*" or "*B*" and "*D*" to increase or decrease the final thickness.
   - Press the push-buttons "*2*" or "*6*" to go back to the Thickness Range level.
   - Press the push-buttons "*1*" or "*5*" to go back to the Body Region level.

Illustration 3-2
APR Module - Thickness in Centimeters



APR TECHNIQUE CHANGES

The APR techniques are factory pre-programmed to standard technique sets. All the parameters and selections of the APR techniques can be modified by the operator and stored in the non-volatile memory for later use.

If the operator determines that some factors in an APR technique should be re-programmed, use the following procedure:

1. Select an APR technique (Body Region and Thickness).

2. Modify the factors, thickness (cm), selections of Bucky / No Bucky, AEC and/or mAs Compensation according to the desired technique.

3. Verify that all factors of the technique are at the required values.

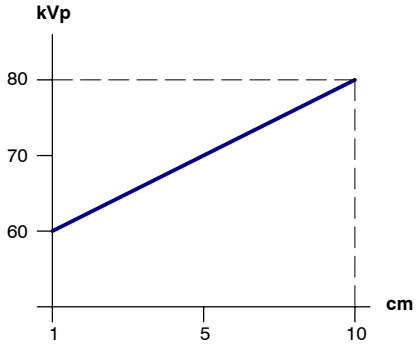
4. Simultaneously press the push-buttons "*2-6*" of the APR Display to store the new technique. *(Refer to Illustration 3-2).*

   The newly selected technique is now stored in memory and can be recalled for future examinations. The changes performed and stored on an APR technique affect to the other thickness selection for that Body Region and Thickness Range in the following manner:

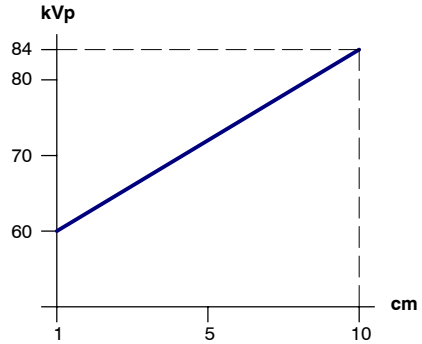
   - If the thickness value (cm) of the stored APR technique is the minimum or maximum value of its Thickness Range, all RAD parameters are stored changing the slope of the kVp line for this Thickness Range.

     For example: After selection of an APR technique for "Abdomen", "Thickness Range from 1 to 10 cm" and "Final Thickness selection at 10 cm (maximum value in its range)", the kVp value is increased from 80 kVp to 84 kVp. The slope of the kVp line for this Thickness Range changes as indicated below:

$$kVp = \frac{(\text{Selected Thickness} - \text{Min Thickness}) \times (\text{Max kVp} - \text{Min kVp})}{(\text{Max Thickness} - \text{Min Thickness})} + \text{Min kVp}$$

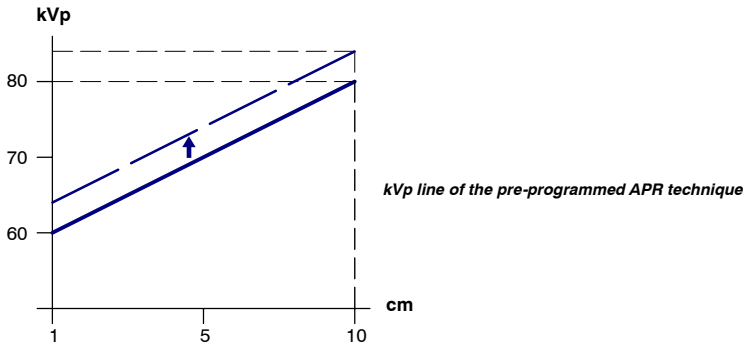


Slope of the pre-programmed APR technique

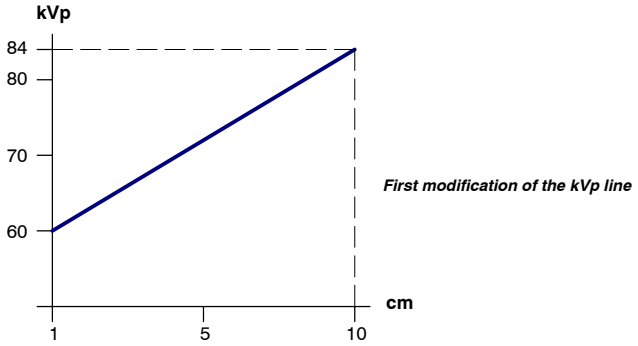


Slope of the new APR technique (modified)

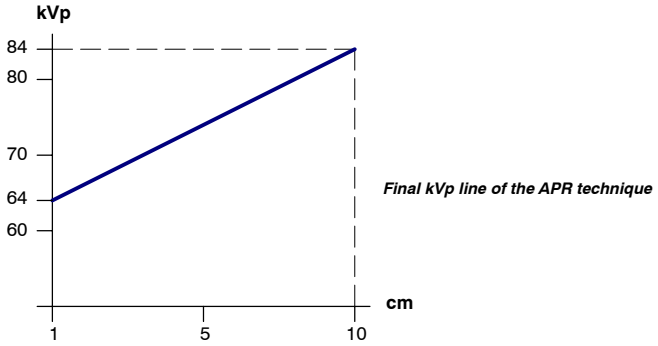
Each Thickness Range of a Body Regions has its own slope of the kVp line. When it is required to move all the line, change and store both APR techniques at maximum and minimum thickness in the selected range.



kVp line of the pre-programmed APR technique



First modification of the kVp line



Final kVp line of the APR technique

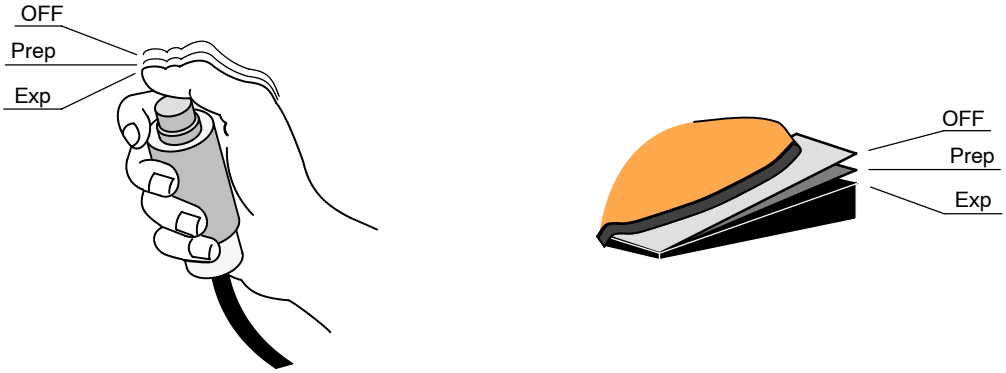
- If the thickness value (cm) of the stored APR technique is not the minimum or maximum value of its Thickness Range, information about the selected kVp is not stored.
- Independently of the thickness value (cm), the new mAs value (or mA and Exposure Time) is stored in all cases for the selected Thickness Range. Also, information about AEC selections is stored in all cases (when AEC is installed) for the selected Thickness Range.

3.4 EXPOSURE CONTROLS

Radiographic exposures are initiated with the Handswitch or with the Footswitch. The status of the exposure is indicated by the "*Ready*" and "*X-ray On*" indicators for the duration of the exposure.

The X-ray Handswitch as well as the Footswitch have three positions: "*OFF*", "*Preparation*" (halfway) and "*X-ray Exposure*" (fully depress).

Illustration 3-3
Handswitch / Footswitch



PREP: Press the Handswitch or Footswitch half-way (*"Prep"* position) to prepare the X-ray Tube for exposure. The *"Ready"* indicator on the Console will light when the X-ray Tube is prepared and there are no interlock failure or system faults.

After pressing it, the following functions are activated:

- Anode rotation.
- Filament current switches from stand-by to the selected mA.

EXP: After the "*Ready*" indicator is illuminated, fully press the Handswitch or Footswitch to start a X-ray exposure. If the switch is released before the Generator completes the selected time or the AEC time, the exposure will be prematurely terminated and the actual mAs and Exposure Time will be displayed.

The "*X-ray On*" indicator remains illuminated during the length of exposure.

3.5 HEAT UNITS

This X-ray Generator is equipped with a Heat Unit Calculator. During exposures, the Heat Units are calculated and totalled.

To view the remaining Heat Units, press the "*On*" push-button. The kVp Display shows the percentage of Heat Units that remain preceded by the letter "H". For example, a display of "H75" would indicate that 75% of Heat Units capacity of the X-ray Tube remains. "H – – " indicates that all the capacity remains. The kVp Display reverts to its normal function after releasing the "*On*" push-button.

3.6 EXPOSURE COUNTERS

The operator can read the number of exposures made by the Generator, as indicated below:

RAD EXPOSURES	Press and hold  and press once 

The number of exposures is shown on the kVp and mAs Displays, up to a maximum of 999,999 exposures.

kV **mAs** **= 123.456 exposures**

3.7 ERROR CODES

Error codes indicate the potential cause of a system failure. Error codes are shown on the kVp Display at the same time an audio signal is emitted. Correct the error cause and keep pressed the "*AEC Reset*" push-button till the Console indication disappears. *(Refer to Table 3-1).*

All these error codes are preceded by the letter "E" (i.e., E01) and they will enable the operator to indirectly convey the possible source of error to service personnel. This may prevent the need for a service call or enable service personnel to anticipate corrective actions prior to arriving on site.

Table 3-1
Error Codes

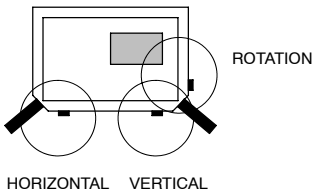
ERROR	DESCRIPTION	WHAT TO DO
- - - - - - on Display	System failure. This indication may appear together with an error on the Console, and indicates that the error is not correctable unless the equipment is turned OFF.	Turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E01, E02	Communication error.	Turn the Generator OFF, check the proper external cable connections and then turn the Generator ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E03	System failure.	Turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E04	The Power Cabinet has activated "*Preparation*" without a Console command intervention.	
E05	External exposure activated during power-up.	Release any external exposure device or push-buttons. Turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E06	"*Exposure*" or/and "*Preparation*" orders are activated during power-up.	Release all the controls. Turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E07, E08	X-ray Tube configuration error.	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E09	Generator Overload error. The exposure has been interrupted because during exposure has been produced arcing or bad function on the HV circuitry (X-ray Tube, HV Transformer and/or HV Cables) or a failure of IGBT module (overheated or defective IGBTs) has been detected. It can be also shown making a high power and long exposure with the X-ray tube cool (X-ray Tube has not been warmed-up).	This error does not require to press the "*AEC Reset*" push-button, its indication disappears automatically. If the error code persists, turn the Generator OFF and wait 30 minutes before turning it ON again. If the equipment remains inoperative, turn it OFF and call Field Service.
E10, E11	System failure.	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E12	No mA during exposure or mA value is out of range.	Press the "*AEC Reset*" push-button. Repeat with same technique values, If the error code persists try with another combinations of kV and mA values. If the equipment remains inoperative, turn it OFF and call Field Service.
E13	No kV during exposure or kV value is out of range.	
E14, E15	System failure.	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON again. If the equipment remains inoperative, turn it OFF and call Field Service.
E16	Invalid value of: kV, mA or kW.	Decrease kV, mA or both. Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E17	Communication error or system failure.	Turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E18	Rotor error. The X-ray tube anode is not rotating while "*Prep*" is active, then exposures are inhibited, or the X-ray tube anode is rotating without console command.	This error does not require to press the "*AEC Reset*" push-button, its indication disappears automatically. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E19, E20	System failure.	Turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E21, E22	Incorrect selection of the X-ray Tube.	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E23	System failure.	
E24	Bucky not ready for an exposure.	

Table 3-1 (cont.)
Error Codes

ERROR	DESCRIPTION	WHAT TO DO
E25	Battery Fault. The batteries charge level is momentarily low, or some batteries are discharged or damaged. *(Only in Generators working with batteries).*	Press the "*AEC Reset*" push-button. Wait 5 minutes before making a new exposure. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E26, E27	System failure.	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E33	Serial Communication error.	Press the "*AEC Reset*" push-button. Check that communication cable between Generator and console is properly connected. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E34	Technique error. If it activates during exposure it means that the exposure has been interrupted by the "*Security Timer*" because of a system failure. Call Field Service. This error can also be shown: - after an APR technique selection to advise that exposure parameters displayed on the console are not the values stored for this APR technique. Exposure parameters are adapted by the Generator to another enable values. - after the "ABC" push-button selection, when ABC is not enable.	These errors do not require to press the "*AEC Reset*" push-button, theirs indications disappear automatically. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E35	Door Open error. The X-ray room door is open when the X-ray equipment is in use.	
E36	Heat Units error. The X-ray Tube thermostat / pressurestat is open due to the tube housing is overheated (housing is too hot, wait for the housing to cool) or a thermostat / pressurestat mal-function (housing is cool). Heat units may raise to any value.	
E37	Tube Overload error. The technique selected is beyond the X-ray tube ratings or present conditions of the X-ray tube inhibit the exposure (anode overheated). Parameters for next exposure may be temporally limited by the Generator (change the exposure values or wait for the X-ray tube to cool). Check that heat units available are lower than the calculated for the next exposure (heat units close to zero). Reduce exposure factors or wait for the X-ray tube to cool.	
E41 to E46	System failure related to Dosimeter.	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E47	Capacitors are not charged when "*Prep*" control is activated. The exposure is inhibited until the Capacitors are charged.	Press the "*AEC Reset*" push-button. Wait one minute for Capacitor charging before activating "*Prep*" control. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E48	Collimator Error. A failure on the Automatic Collimator has been detected (blades are full open or in movement during exposure, etc.)	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E50	Exposure has been aborted by the Operator.	
E51 to E93	System failure related to High Speed Rotor Controller.	
E95	Exposure aborted by the AEC Rapid Termination.	Press the "*AEC Reset*" push-button. Select the correct Ion Chamber or modify parameters. Repeat the exposure. If the equipment remains inoperative, turn it OFF and call Field Service.
E96, E97	System failure related to Capacitor charge (only for Capacitor Powered Generator).	Press the "*AEC Reset*" push-button. If the error code persists, turn the Generator OFF and ON. If the equipment remains inoperative, turn it OFF and call Field Service.
E98	Service Mode Active.	Press the "*AEC Reset*" push-button and call Field Service. This error does not inhibit normal operation.

3.8 BRAKES

3.8.1 BRAKES OF THE TUBE-COLLIMATOR SUPPORT FOR SLIDING COLUMN



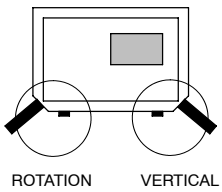
Three push-buttons located at the Control Console are used to release the brakes of the Tube-Collimator Support Assembly for Sliding Column.

HORIZONTAL: Hold down the Console push-button at the left side below the handle to release the brake of the Column Base and allow horizontal motion of the Tube-Collimator Assembly.

VERTICAL: Hold down the Console push-button at the right side below the handle to release the brake of the Vertical Carriage and allow setting the focal distance (SID) with reference to the Radiographic Table.

ROTATION: Hold down the push-button at the right side above the handle to release the brake of the Arm and allow rotation the Tube-Collimator Assembly ±90°.

3.8.2 BRAKES OF THE TUBE-COLLIMATOR SUPPORT FOR VARIABLE SID COLUMN



Two push-buttons located below the Control Console are used to release the brakes of the Tube-Collimator Support Assembly.

VERTICAL: Hold down Console push-button at the right side below the handle to release the brake of the Vertical Carriage and allow setting the focal distance (SID) with reference to the Radiographic Table.

ROTATION: Hold down the left push-button at the left side below the handle to release the brake of the Arm and allow rotation the Tube-Collimator Assembly ±90°.

3.8.3 BRAKES OF THE FIXED RADIOGRAPHIC TABLE WITH FLOATING TABLE-TOP

Applicable to systems with Fixed Radiographic Table with Floating Table-Top.

When the system is working, the Bucky or Cassette Tray and Table-Top are locked at any position by means of the electromagnetic brakes.

TABLE-TOP MOVEMENTS: Hold down the Table-Top Pedal to release the longitudinal and transversal brakes of the Table-Top and allow patient positioning with reference to the Tube-Collimator Assembly.

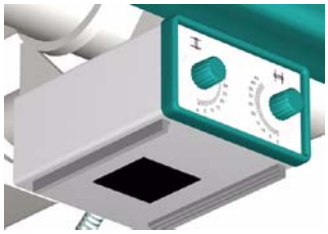
For a better positioning of the patient, the Collimator Lamp turns On when the Table Pedal is pushed down.

BUCKY / CASSETTE TRAY MOVEMENTS: Hold down the push-button on the Bucky / Cassette Tray to release its longitudinal brake and position the Bucky / Cassette Tray under patient.

3.9 BUCKY CASSETTE TRAY

Pull out Cassette Tray to load Cassette Film. According to cassette size and orientation, place manual clamps at corresponding number notch, open the automatic clamp and insert Cassette Film. This Cassette Tray accepts all standard Cassette Film sizes.

3.10 COLLIMATOR CONTROLS



Collimator controls consist of push-button to switch on the Collimator Lamp and two knobs to open or close the internal blades of the Collimator. *(Also, refer to Collimator manual.)*

Exposure field is adjusted by setting the two knobs. The table on the Front Panel shows the opening blades to be set according to the cassette size to be used for a SID of 100 cm.

After pressing the push-button of the lamp, Collimator lamp remains illuminated for a few seconds before switching off the lamp automatically.

PROLONGED LIGHTING WITHOUT ALLOWING THE LAMP TO COOL CAUSES THE COLLIMATOR TO OVERHEAT IN THE INTERNAL AREA NEAR THE LAMP.

The Collimator Lamp is On whenever the Table Pedal is pressed.

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SECTION 4 OPERATING SEQUENCES

4.1 START-UP ROUTINE

System power is applied by pressing the "*Power On*" push-button on the Control Console. The Generator will go through a start-up routine conducting an automatic self-test that will show on the RAD kVp Display information usable only by service personnel.

After the power-up has been completed the Console should display normal radiographic factors. If a malfunction if found, error messages will be displayed on the RAD kVp Display specifying the fault.

Note ☞ *Some indicators on the Console are used to provide service information during the start-up process. These indicators should be ignored by the operator until the unit has completed its power-up sequence.*

4.2 X-RAY TUBE WARM-UP PROCEDURE

Before effecting X-ray exposures ensure that the Tube is properly warmed-up. Make sure that no persons will be inadvertently exposed to unnecessary X-rays during this procedure.

Routine exposures should not be effected unless the Tube is previously warmed-up, this prolongs X-ray Tube life.

It is recommended that the following procedure will be performed for X-ray Tube warm-up, at the start of each day and when the Tube selected has not been in use for approximately one hour.

This warm-up procedure is used for a typical X-ray Tube. Consult the X-ray Tube manufacturer instructions for the actual Tube in use, comparing its recommendations with this procedure. If there is conflict with this procedure, comply with the Tube manufacturer's instructions.

Perform X-ray Tube warm-up as follows:

- Close the collimator blades fully.
- Select 70 kVp, 100 mAs, 200 mA and 500 ms exposure.
- Insure that no one will be exposed.
- Make a total of three exposures, 15 seconds apart.

Excessive filament evaporation shortens X-ray Tube life. Minimize evaporation by keeping Exposure "Preparation" time to an absolute minimum.

4.3 RADIOGRAPHIC OPERATION

A typical RAD examination sequence is as indicated below:

1. Make sure that the X-ray Tube to be used is properly warmed-up.
2. Position the patient for the examination.
3. Select "*Bucky*" or "*No Bucky*", and technique parameters using the RAD controls on the Console.
4. Maintain the patient in the required position. Prepare the X-ray Tube by pressing the Footswitch or the Handswitch until "*Prep*" and maintain it until the "*Ready*" indicator is illuminated.
5. Make the X-ray exposure ("*Exp*") by pressing the Footswitch or the Handswitch to the end of the switch travel. The "*X-ray On*" indicator will light and an audible signal will be heard during the exposure.
6. When the exposure is finished, release the exposure controls.
7. Repeat the procedure if additional exposures are desired.

4.4 AEC OPERATION

The proper use of AEC requires accurate patient positioning. For examination using AEC, the operator will need to select the desired AEC parameters as follows:

1. Make sure that the X-ray Tube to be used is properly warmed-up.
2. Position the patient for the examination.
3. Select "*Bucky*" or "*No Bucky*", and technique parameters using the RAD controls on the Console.
4. Enter AEC mode by selecting at least one Area Detector "*Field*" on the Console.
5. Select a "*Film Screen Combination*" by pressing the corresponding push-button.
6. Set the Film Density if required by using one of the five "*AEC Density*" controls. "*0*" is the normal setting.
7. Select the technique parameters (back-up time / mAs) using the RAD controls on the Console.
8. Continue with the radiographic operation. (*Refer to Section 4.3 - step 4.*)

4.5 APR OPERATION

An examination using an APR technique with reference to the Thickness of the Body Region could consist of the following:

1. Make sure that the X-ray Tube to be used is properly warmed-up.
2. Position the patient for the examination.
3. Activate the APR mode.
4. Select a general "*Body Region*" and the "*Thickness Range*" of the indicated on the APR Display.
5. Select the "*Thickness (cm*)" of the area to be exposed.
6. Technique parameters, "*Bucky*" or "*No Bucky*" selection, Focal Spot, AEC, etc ... corresponding to the APR selection are displayed and indicated on the Control Console. If needed, the parameters and selections can be directly modified by the operator.
7. Continue with the normal procedure for a typical RAD examination. (*Refer to Section 4.3 - step 4.*)

SECTION 5 PERIODIC MAINTENANCE

In order to assure continued safe performance of the X-ray Unit, a periodic maintenance program must be established. It is the **owner's responsibility** to supply or arrange for this service.

There are two levels of maintenance, the first consists of tasks which are performed by the user/operator, and the second are those tasks to be performed by qualified X-ray service personnel.

The first periodic maintenance service should be performed six (6) months after installation, and the subsequent services at twelve (12) month intervals.

The manufacturer undertakes to have available spare parts for this equipment at least for five (5) years after the unit manufacturing.

5.1 OPERATOR TASKS

The tasks of this periodic maintenance shall include the following items:

DO NOT REMOVE ANY COVER, DISASSEMBLE OR MANIPULATE INTERNAL COMPONENTS IN THE UNIT. THESE ACTIONS COULD CAUSE SERIOUS PERSONAL INJURIES AND / OR EQUIPMENT DAMAGE.

NEVER ATTEMPT TO CLEAN ANY PART OF THE UNIT WHEN IT IS SWITCHED ON. ALWAYS SWITCH OFF THE EQUIPMENT AND ISOLATE THE MAINS ELECTRICAL SUPPLY BEFORE CLEANING.

1. Switch the Generator OFF.
2. Externally, check the proper cable connections between each major component in the X-ray system (Power Cabinet, Consoles, etc ...).
3. Clean the equipment frequently, particularly if corroding chemicals are present. Clean external covers and surfaces, specially parts in contact with the patient, with a cloth moistened in warm water with mild soap. Wipe with a cloth moistened in clean water. Do not use cleaners or solvents of any kind.

5.2 SERVICE TASKS

Only service personnel specifically trained on this medical X-ray equipment should work on service tasks or maintenance of the equipment. (*Refer to "Maintenance" document.)*

SECTION 6 TECHNICAL SPECIFICATIONS

6.1 FACTORS

FACTORS	GENERATOR MODEL		
	16 kW	**20 kW**	**32 kW**
Maximum mA	200 mA	320 mA	400 mA
Maximum kVp	125 kVp	125 kVp	125 kVp
Maximum Power kW	16 kW	20 kW	32 kW
Maximum selectable mA at maximum kVp	125 mA	160 mA	250 mA
Maximum selectable kVp at maximum mA	80 kVp	62 kVp	80 kVp

6.2 RANGE OF RADIOGRAPHIC PARAMETERS

PARAMETER	RANGE
kV	From 40 kV to 125 kV in 1 kV steps.
mA	From 10 mA to 400 mA through the following mA stations: 10, 12.5, 16, 20, 25, 32, 40, 50, 64, 80, 100, 125, 160, 200, 250, 320, 400. *(Depending on the Generator model)*
mAs	Product of mA x Time values from 0.1 mAs to 500 mAs
Exposure Time	From 1 millisecond to 10 seconds through the following Time stations: Milliseconds: 1, 2, 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 32, 40, 50, 64, 80, 100, 125, 160, 200, 250, 320, 400, 500, 640, 800. Seconds: 1, 1.25, 1.6, 2, 2.5, 3.2, 4, 5, 6.4, 8, 10.
AEC	mAs: 0.1 mAs to 500 mAs
	Exposure Time: Nominal shortest irradiation Time = 1ms

6.3 DUTY CYCLE

The Generator duty cycle is continuous, but limits should be set during installation depending on the capacity of the X-ray Tube.

6.4 PHYSICAL CHARACTERISTICS

COMPONENT	DIMENSIONS			WEIGHT
	Length	Width	Height	
Compact Generator Cabinet with Power Module and HV Transformer	445 mm	360 mm	568 mm	72 kg
Compact-ESM Generator Cabinet Power Module, HV Transformer, and ESM (30 x 9 A/h Batteries)	813 mm	436 mm	948 mm	350 kg
Sliding Column Assembly with X-ray Tube, Collimator and Control Console	2000 mm	987 mm	2295 mm	224 kg
Tube Support Assembly for Variable SID with X-ray Tube, Collimator and Control Console	500 mm	max. 828 mm	2235 mm	174 kg
Tube Support Assembly for Fixed SID with X-ray Tube, Collimator, Control Console and Bucky / Cassette Tray Support	500 mm	max. 980 mm	2000 mm	77 kg
Fixed Radiographic Table (Floating Table-Top)	1500 mm	719 mm	756 mm	112 kg
Mobile Radiographic Table	1500 mm	719 mm	756 mm	44 kg
Control Console (freestand) (optional)	383 mm	270 mm	90 mm	6.5 kg
Control Console with Pedestal (optional)	383 mm	270 mm	1023 mm	20.5 kg

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