BRG-100RF Series

H.F. X-Ray generator

SERVICE & INSTALLATION MANUAL

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SERVICE AND INSTALLATION MANUAL

P.N. #746069

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Communications & Power Industries
communications & medical products division.

PROPRIETARY AND CONFIDENTIAL

CHAPTER 1

PRE-INSTALLATION

1.0 INTRODUCTION

1.1 Purpose

This manual applies to the Indico 100 family of generators and provides instructions for the installation and maintenance of all models of that generator.

This Chapter contains the following sections.

SECTION	TITLE
1A	Introduction
1B	Safety
1C	Preparing for installation
1D	Compatibility listing
1E	Generator layout and Major Components

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CHAPTER 1A

INTRODUCTION

CONTENTS:

1A.1.0 INTRODUCTION

1A.1.1 Purpose

This manual provides instructions for the installation and service of Indico 100 X-ray generators.

1A.2.0 GENERATOR DESCRIPTION

Depending on configuration and options, the generator provides the power and interfacing to operate X-ray tubes, Buckys, Rad tables, GI (gastro-intestinal) tables, remote R&F tables, tomographic devices, and digital imaging systems. The generator consists of power supply and control systems housed in the upper and lower cabinets, a control console, and an optional remote fluoro control along with the necessary interconnecting cable(s).

Major items provided are:

- X-ray generator housed in upper and lower cabinets.
- Control console.
- Optional remote fluoro control.
- Interconnecting cable(s).
- Operator's manual.
- Service and installation manual.

1A.3.0 PHYSICAL SPECIFICATIONS

Figure 1A-1 shows the outline of the Indico 100 X-ray generator main cabinet. Figure 1A-2 shows the outline of the available control consoles, and the remote fluoro control.

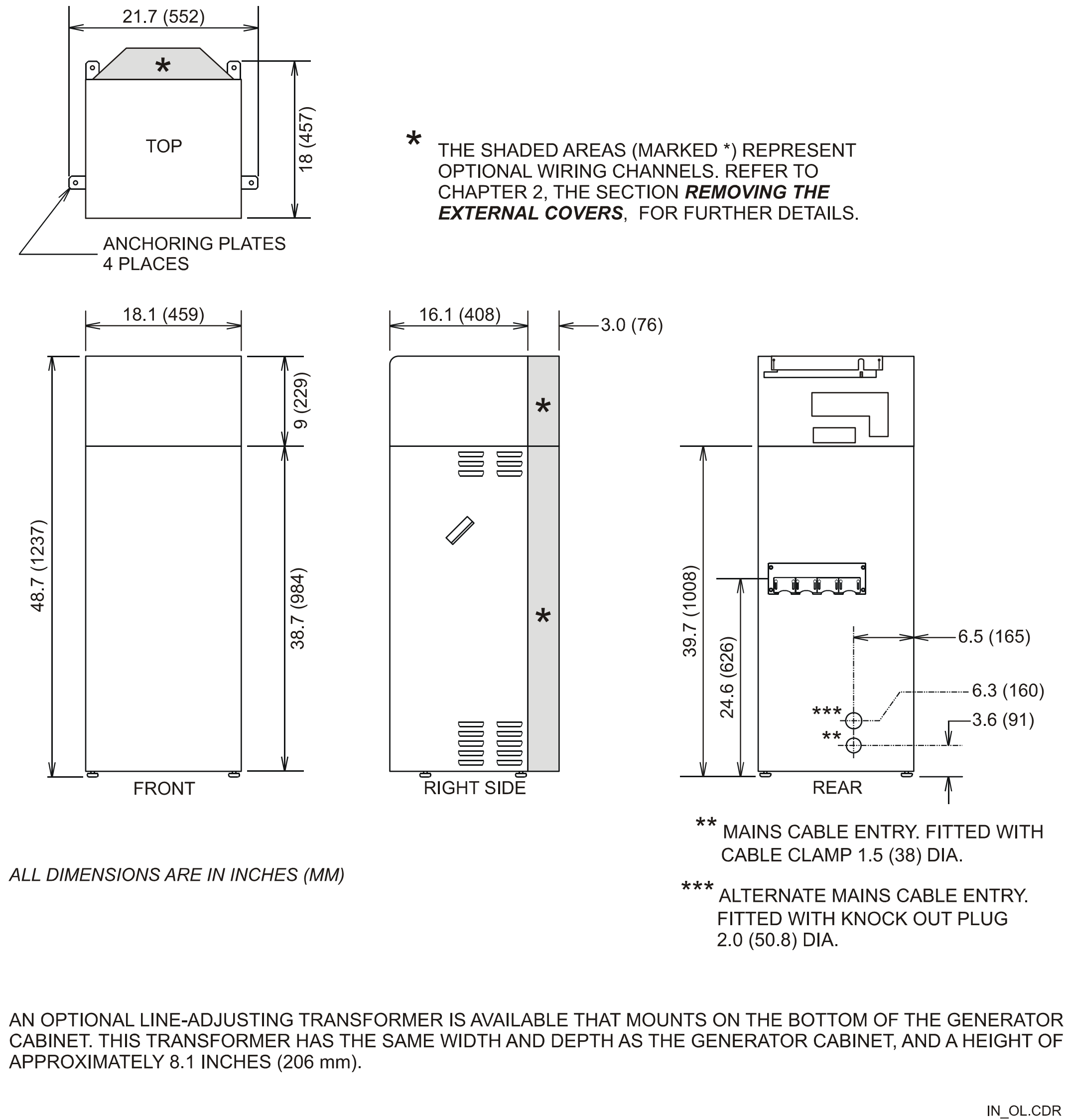

Figure 1A-1: Generator outline drawing

1A.3.0 PHYSICAL SPECIFICATIONS (CONT)

Figure 1A-2 shows the outline of the Indico 100 control consoles, and the remote fluoro control.

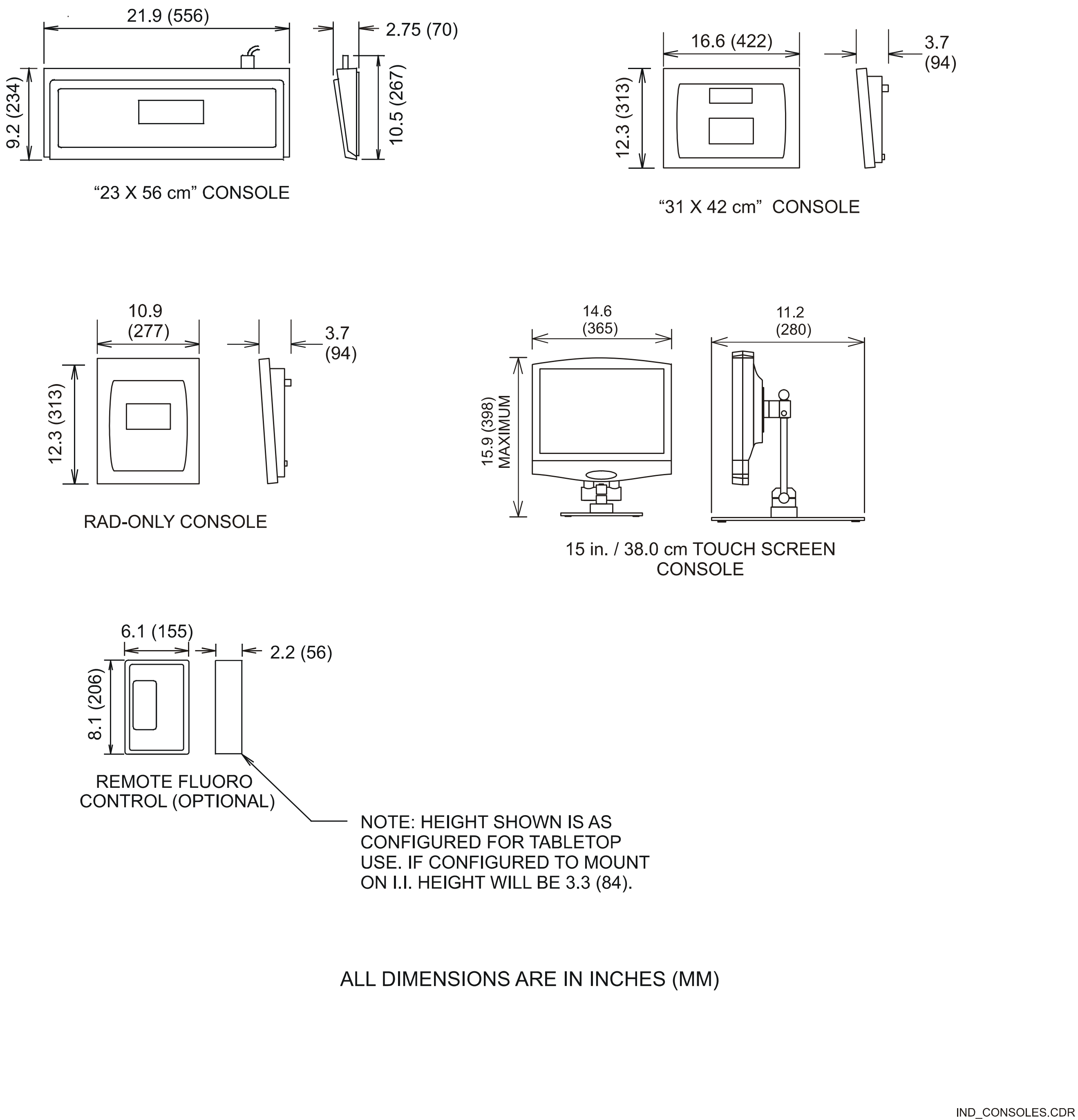

Figure 1A-2: Console / remote fluoro control outline drawing

1A.4.0 APPLICATIONS

RAD SYSTEMS:

- Bucky table, tabletop and off-table radiography.
- Vertical bucky/cassette radiography.
- Conventional tomography.

R&F SYSTEMS:

- Fluoroscopic and spot film applications.
- Tomography with conventional and/or remote R&F tables.
- Optional digital compatible.
- Optional high-level fluoro.

1A.5.0 FEATURES

- High frequency generator.
- One or two tube operation, Rad or Rad / Fluoro.
- Single or dual filament supplies.
- Low speed or dual speed X-ray tube stator supply.
- Optimal matching of X-ray tubes by PROMs.
- Repetitive self checks of generator functions, provides display of system faults and operating errors.
- Optional AEC, up to four inputs.
- Optional ABS with kV or kV/mA fluoro stabilizer.
- Optional remote fluoro control box for tabletop use or SFD mounting.
- Optional Dose-Area Product (DAP) display.
- X-ray Tube protection. The generator allows setting the following limits:
  a) Maximum mA, adjustable for each focal spot.
  b) Maximum kV, adjustable for each X-ray tube.
  c) Maximum kW, adjustable for each focal spot.
  d) Maximum filament current limit, adjustable for large and small focal spots.
  e) Anode heat warning and anode heat alarm levels.
- Calibration features:
  a) Microprocessor design allows all calibration and programming to be performed via the console.
  b) mA calibration is automated.
- Messages and diagnostic information: For users and service personnel, the generator console displays various messages indicating status or equipment problems. The user is prompted in case of errors.
- Error log stores last 200 errors and associated generator settings.
- Service and diagnostic information available via a laptop computer (optional).
- KV range: Radiography 40 to 150 kV.
  Fluoroscopy 40 to 125 kV.
- mA range: Radiography 10 to 400 mA (32 kW), 10 to 500 mA (40 kW),
  10 to 630 mA (50 kW), 10 TO 800 mA (65 kW) and
  10 to 1000 mA (80 and 100 kW).
  Fluoroscopy 0.5 to 10 mA, 0.5 to 20 mA with optional high-level fluoroscopy.
  Normal and high-level pulsed fluoroscopy 5 to 99 mA.

1A.5.0 FEATURES (Cont)

- mAs range: Tube dependent, max 1000 mAs.
- Time range: Radiography 1.0 to 6300 ms.
  Fluoroscopy 0 to 5 or 0 to 10 minutes.

Refer to the compatibility statement (end of section 1D) for compatibility and features of this specific generator.

1A.6.0 ROTOR CONTROL

The generator will be equipped with a low speed starter, or optional dual speed starter.

DUAL SPEED STARTER

Number of tubes permissible:	Maximum of 32 tube types. Tube type is switch selectable
Current monitoring	Both stator circuits
Dual speed starter output frequency	50 or 60 Hz (low speed) 150 or 180 Hz (high speed). (Independent of line frequency)
Braking	Dynamic braking when in high speed rotation
Rotor boost time	Determined by tube selection plus incremental boost time changes from 100 to 700 msec.
Duty cycle	Not to exceed 2 high speed starts per minute.

LOW SPEED STARTER

Current monitoring	Both stator circuits
Duty cycle	Not to exceed 5 consecutive boosts, followed by a minimum 10 second wait period.

1A.7.0 AUXILIARY POWER OUTPUTS

The generator supplies the following power outputs for X-ray room equipment:

- 24 VDC, 4 Amp.
- 120 VAC, 2.5 Amp.
- 240 VAC, 1.5 Amp.

2.5 AMPS IS AVAILABLE AT 120 VAC <u>OR</u> 1.5 AMPS IS AVAILABLE AT 240 VAC, BUT BOTH ARE NOT AVAILABLE SIMULTANEOUSLY.

The above voltage sources are not compatible with:

- Collimator lamps (24 VAC 150 watts). These lamps are not compatible with the 24 VDC supply.
- Fluorescent lamps. These have high starting currents and generate transients when the tube strikes.
- Some inductive loads may cause difficulties (some motors and solenoids).

1A.8.0 SYSTEM DOCUMENTATION

The Indico 100 series of X-ray generators includes the following documentation:

- Operator's manual.
- Service and installation manual.
- Supplements and application notes as required.

1A.9.0 REGULATORIES AND DESIGN STANDARDS

1A.9.1 Environmental Specifications

OPERATING

Ambient temperature range	10 to 40 °C (50 to 104 °F).
Relative humidity	20 to 80%, non-condensing.
Altitude	-700 to 3000 meters (1100 to 700 hPa, 825 to 525 mm Hg).

TRANSPORT AND STORAGE

Ambient temperature range	-25 to 70 °C (-13 to 158 °F)..
Relative humidity	5 to 95%, non-condensing.
Atmospheric pressure range	-700 to 3000 meters (1100 to 700 hPa, 825 to 525 mm Hg).

- Long-term storage over 40 °C will reduce the service life of electrolytic capacitors in the generator.
- The membrane control console is limited to a minimum temperature of -20°C, with a maximum duration of 48 hours at that temperature. Transport and storage is limited to a maximum duration of 120 hours between 50 and 70 °C, with an absolute humidity not to exceed the humidity of 85% RH at 50 °C.
- Touchscreen console temperatures below -20°C and above +50°C are limited to 10 days maximum duration, with a humidity not exceeding 50 % RH.

1A.9.2 Applicable Standards

A) SAFETY

The Indico 100 family of generators complies with the following regulatory requirements and design standards:

- FDA Center for Devices & Radiological Health (CDRH) - 21 CFR subchapter J, section 1010 and 1020 (USA).
- Radiation Emitting Devices Act - C34 (Canada).
- Medical Device Regulations (Canada).
- EC Directive 93/42/EEC (amended by 2007/47/EC) concerning Medical Devices (European Community).
- EN 60601-1/IEC 60601-1, EN 60601-2-7/IEC 60601-2-7, CSA 601.1, UL60601.1
  -Type of protection against electric shock: Class I equipment.
  -Degree of protection against electric shock: Not classified.
  -Degree of protection against harmful ingress of water: Ordinary equipment.
  -Mode of operation: Continuous operation with intermittent loading (standby - exposure).
  -Equipment not suitable for use in presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.
- EN 60601-1-4/IEC 60601-1-4, ISO 14971.
- Warning: To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

NOTE: All referenced standards are considered to be at the latest adopted revision.

1A.9.2 Applicable Standards (con't)

The CE Mark is a declaration by the manufacturer that the product complies with the requirements of the applicable European Union (EU) medical device directive and that the product has been subject to conformity assessment procedures as provided in that directive.

C US

A CSA mark with the indicators "C" and "US" means that product is certified for both the U.S. and Canadian markets, to the applicable U.S. and Canadian standards.

B) EMC (EN 60601-1-2:2001/IEC 60601.1.2:2001)

Guidance and manufacturer's declaration – electromagnetic emissions		
The VZW2930 series of X-ray generators are intended for use in the electromagnetic environment specified below. The customer or the user of the VZW2930 series should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 1	The VZW2930 series of X-ray generators use RF energy only for their internal functions. Therefore, the RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A (The VZW2930 series of X-ray generators in combination with shielded location)	The VZW2930 series of X-ray generators must be used only in a shielded location with a minimum RF shielding effectiveness and, for each cable that exits the shielded location, a minimum RF filter attenuation of 40dB from 30 MHz to 230 MHz and 47dB from 230 MHz to 1 GHz. (The minimum at 30 MHz is 40dB and the minimum at 230 MHz is 47dB). The VZW2930 series is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not Applicable	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Not Applicable	
NOTE It is essential that the actual shielding effectiveness and filter attenuation of the shielded location be verified to assure that they meet the minimum specifications.		

Guidance and manufacturer's declaration – electromagnetic immunity			
The VZW2930 series of X-ray generators are intended for use in the electromagnetic environment specified below. The customer or the user of the VZW2930 series should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment – guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines ± 1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV line to line ± 2 kV line to earth	± 1 kV line to line ± 2 kV line to earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruption, and voltage variations on power supply input lines IEC 61000-4-11	< 5 % U_T (> 95 % dip in U_T) for 0.5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) < 5 % U_T (> 95 % dip in U_T) for 5 s	< 5 % U_T (> 95 % dip in U_T) for 0.5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) < 5 % U_T (> 95 % dip in U_T) for 5 s	Mains power quality should be that of a typical commercial or hospital environment. If the user of the VZW2930 series X-ray generator requires continued operation during power mains interruptions, it is recommended that the X-ray generator be powered from an uninterruptible power supply or battery.
Power frequency (50/60 Hz) IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment
NOTE: U_T is the A.C. mains voltage prior to application of the test level.			

<table>
<tr><th colspan="4">Guidance and manufacturer's declaration – electromagnetic immunity</th></tr>
<tr><td colspan="4">The VZW2930 series of X-ray generators are intended for use in the electromagnetic environment specified below. The customer or the user of the VZW2930 series should assure that it is used in such an environment.</td></tr>
<tr><th>Immunity test</th><th>IEC 60601 test level</th><th>Compliance level</th><th>Electromagnetic environment - guidance</th></tr>
<tr><td>Conducted RF
IEC 61000-4-6</td><td>3 V_{rms}
150 kHz to 80MHz</td><td>3 V_{rms}
150 kHz to 80MHz</td><td>The VZW2930 series of X-ray generators must be used only in a shielded location with a minimum RF shielding effectiveness and, for each cable that enters the shielded location, a minimum RF filter attenuation of 40dB from 30 MHz to 230 MHz and 47dB from 230 MHz to 1 GHz. (The minimum at 30 MHz is 40dB and the minimum at 230 MHz is 47dB.)</td></tr>
<tr><td>Radiated RF
IEC 61000-4-3</td><td>3 V/m
80MHz to 2.5 GHz</td><td>3 V/m
80MHz to 2.5 GHz</td><td>Field strengths outside the shielded location from fixed RF transmitters, as determined by an electromagnetic site survey, should be less than 3 V/m.[a]

Interference may occur in the vicinity of equipment marked with the following symbol:
</td></tr>
<tr><td colspan="4">NOTE 1 These guidelines may not apply all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

NOTE 2 It is essential that the actual shielding effectiveness and filter attenuation of the shielded location be verified to assure that they meet the minimum specification.</td></tr>
<tr><td colspan="4">[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the VZW2930 series of X-ray generators is used exceeds the applicable RF compliance level above, the X-ray generator should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the X-ray generator.</td></tr>
</table>

1A.9.3 Electromagnetic Compatibility (EMC)

In accordance with the intended use, this X-ray generator complies with the European Council Directive concerning Medical Devices. The CE marking affixed to this product signifies this. One of the harmonized standards of this Directive defines the permitted levels of electromagnetic emission from this equipment and its required immunity from the electromagnetic emissions of other devices.

It is not possible, however, to exclude with absolute certainty the possibility that other high frequency electronic equipment, which is fully compliant to the EMC regulations, will not adversely affect the operation of this generator. If the other equipment has a comparatively high level of transmission power and is in close proximity to the generator, these EMC concerns (the risk of interference) may be more pronounced. It is therefore recommended that the operation of equipment of this type such as mobile telephones, cordless microphones and other similar mobile radio equipment be restricted from the vicinity of this X-ray generator.

1A.9.4 RoHS Compliance

Indico 100

产品中有毒有害物质或元素的名称及含量
Table of hazardous substances’ name and concentration.

部件名称 Component Name	有毒有害物质或元素 Hazardous substances’ name					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
Generator	X	O	O	X	O	O
Console	X	O	O	X	O	O

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下
X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006 标准规定的限量要求

- 此表所列数据为发布时所能获得的最佳信息
- 由于缺少经济上或技术上合理可行的替代物质或方案，此医疗设备运用以上一些有毒有害物质来实现设备的预期临床功能，或给人员或环境提供更好的保护效果。

O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.
X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.

- Data listed in the table represents best information available at the time of publication
- Applications of hazardous substances in this medical device are required to achieve its intended clinical uses, and/or to provide better protection to human beings and/or to environment, due to lack of reasonably (economically or technically) available substitutes.

1A.10.0 TECHNIQUE FACTORS DEFINITIONS

- **KV**: KV peak after any initial kV overshoot.
- **TIME**: Time in milliseconds, (ms) that the high voltage (anode to cathode) is greater than or equal to 75% of the desired **kV**.
- **mA**: Average tube current (in mA) during the exposure time.
- **mAs** milliampere-seconds (**mA** x **TIME**).

1A.11.0 RUNTIME LICENSE AGREEMENT (TOUCHSCREEN CONSOLE)

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8. Should you have questions regarding the use of the Software, please contact support@cmp.cpii.com.

Address any questions regarding X-ray generator operation to:

Mail:	Customer Support Department Communications and Power Industries Canada Inc. 45 River Drive Georgetown, Ontario, Canada L7G 2J4
Telephone:	(905) 877-0161
Fax:	(905) 877-8320 Attention: Customer Support Department
E-mail:	marketing@cmp.cpii.com Attention: Customer Support Department

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CPI Communications & Medical Products Division
45 River Drive
Georgetown, Ontario, Canada
L7G 2J4

Telephone:	(905) 877-0161	
Fax:	(905) 877-5327	
E-mail:	marketing@cpii.com	Subject: Open Source Code

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Address any questions regarding X-ray generator operation to:

Mail:	Customer Support Department Communications and Power Industries Canada Inc. 45 River Drive Georgetown, Ontario, Canada L7G 2J4
Telephone:	(905) 877-0161
Fax:	(905) 877-8320 Attention: Customer Support Department
E-mail:	marketing@cpii.com Attention: Customer Support Department

CHAPTER 1B

SAFETY

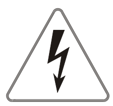
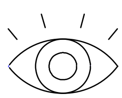
CONTENTS:

1B.1.0 INTRODUCTION

This section contains important safety warnings and safety information required for installing and servicing the generator.

1B.2.0 SAFETY AND WARNING SYMBOLS

The following advisory symbols are used on the safety warning labels, and/or on circuit boards, and/or on the operator console and the optional remote fluoro control.

	High voltage symbol used to indicate the presence of high voltage.
	Warning symbol used to indicate a potential hazard to operators, to service personnel, or to the equipment. It indicates a requirement to refer to the accompanying documentation for details.
	Radiation exposure symbol used on operator console. Lights to indicate that an exposure is in progress. This is accompanied by an audible tone from the console.
	Fluoro radiation exposure symbol used on operator console and on optional remote fluoro control unit. Lights to indicate that a fluoro exposure is in progress. This is accompanied by an audible tone from the console.
WARNING *THIS X-RAY UNIT MAY BE DANGEROUS TO PATIENT AND OPERATOR UNLESS SAFE EXPOSURE FACTORS, OPERATING INSTRUCTIONS AND MAINTENANCE SCHEDULES ARE OBSERVED.*	Radiation warning label on console, used in certain jurisdictions. Never allow unqualified personnel to operate the X-ray generator.

1B.3.0 SAFETY NOTICES AND WARNINGS

<u>WARNING:</u> ***PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO X-RAY GENERATORS ARE THE RESPONSIBILITY OF USERS OF SUCH GENERATORS. CPI CANADA INC. PROVIDES INFORMATION ON ITS PRODUCTS AND ASSOCIATED HAZARDS, BUT ASSUMES NO RESPONSIBILITY FOR AFTER-SALE OPERATING AND SAFETY PRACTICES.***

THE MANUFACTURER ACCEPTS NO RESPONSIBILITY FOR ANY GENERATOR NOT MAINTAINED OR SERVICED ACCORDING TO THIS SERVICE AND INSTALLATION MANUAL, OR FOR ANY GENERATOR THAT HAS BEEN MODIFIED IN ANY WAY.

THE MANUFACTURER ALSO ASSUMES NO RESPONSIBILITY FOR X-RAY RADIATION OVEREXPOSURE OF PATIENTS OR PERSONNEL RESULTING FROM POOR OPERATING TECHNIQUES OR PROCEDURES.

1B.3.0 SAFETY NOTICES AND WARNINGS (Cont)

WARNING: ***THIS X-RAY UNIT MAY BE DANGEROUS TO PATIENT AND OPERATOR UNLESS SAFE EXPOSURE FACTORS, OPERATING INSTRUCTIONS AND MAINTENANCE SCHEDULES ARE OBSERVED.***

X-ray radiation exposure may be damaging to health, with some effects being cumulative and extending over periods of many months or even years**. Operators and service personnel should avoid any exposure to the primary beam** and take protective measures to safeguard against scatter radiation. Scatter radiation is caused by any object in the path of the primary beam and may be of equal or less intensity than the primary beam that exposes the film.

No practical design can incorporate complete protection for operators or service personnel who do not take adequate safety precautions. **Only authorized and properly trained service and operating personnel should be allowed to work with this X-ray generator equipment**. The appropriate personnel must be made aware of the inherent dangers associated with the servicing of high voltage equipment and the danger of excessive exposure to X-ray radiation during system operation.

DO NOT CONNECT UNAPPROVED EQUIPMENT TO THE REAR OF THE CONSOLE.
For the 23 X 56 (cm) console, J5 is used for the interconnect cable to the generator main cabinet, J4 is not used, J2 is a serial port for use by an external computer, and J1 is for connection of an optional printer.

For the 31 X 42 (cm) console, J5 is used for the interconnect cable to the generator main cabinet, J2 is a serial port for use by an external computer, and J13 is for connection of an external hand switch and / or foot switch.

For the Rad-only console, J3 is for connection of an external hand switch, J4 is a serial port for use by an external computer, and J8 is for the interconnect cable to the main cabinet.

For the touchscreen console, GEN on the rear of the touchscreen is for the interconnect cable to the generator main cabinet, HS is for connection of an external hand switch, COM 1 & COM 2 are serial ports for use by external devices, LO (3.5 mm stereo jack) is for customer supplied speakers (minimum 8 ohms, do not use externally amplified speakers), ETH is a standard 10/100 ethernet connection, USBA and USBB are USB ports for connection of external devices, CF is for the compact flash memory card which holds the touchscreen software and SW1 is the console upgrade button.

INCORRECT CONNECTIONS OR USE OF UNAPPROVED EQUIPMENT MAY RESULT IN INJURY OR EQUIPMENT DAMAGE.

CAUTION: ***DO NOT EXCEED THE TUBE MAXIMUM OPERATING LIMITS. INTENDED LIFE AND RELIABILITY WILL NOT BE OBTAINED UNLESS GENERATORS ARE OPERATED WITHIN PUBLISHED SPECIFICATIONS.***

WARNING: ***HAZARDOUS VOLTAGES EXIST INSIDE THE GENERATOR WHENEVER THE MAINS POWER IS SWITCHED ON. THESE AREAS INCLUDE THE MAIN FUSE HOLDER AND PORTIONS OF THE POWER INPUT BOARD, PARTS OF THE GENERATOR INTERFACE BOARD AND ROOM INTERFACE BOARD, THE PRIMARY OF THE ROOM INTERFACE TRANSFORMER, AND THE TERMINALS ON THE LINE ADJUSTING TRANSFORMER, IF FITTED.***

THE CONSOLE ON/OFF SWITCH DOES NOT DISCONNECT THE MAINS POWER FROM THE ABOVE AREAS INSIDE THE GENERATOR.

1B.3.0 SAFETY NOTICES AND WARNINGS (Cont)

NOTE: ***THE DC BUS CAPACITORS MAY PRESENT A SAFETY HAZARD FOR AT LEAST 5 MINUTES AFTER THE POWER HAS BEEN REMOVED FROM THE UNIT. CHECK THAT THESE CAPACITORS ARE FULLY DISCHARGED BEFORE SERVICING THE GENERATOR.***

NOTE: ***WHEN CONNECTING ADDITIONAL EQUIPMENT TO THE GENERATOR, IT IS THE RESPONSIBILITY OF THE INSTALLER TO VERIFY COMPLIANCE TO ALL REGULATORY STANDARDS FOR SAFETY, EMC, AND HAZARD ANALYSIS / RISK ASSESSMENT OF THE FINAL SYSTEM CONFIGURATION.***

The following notes apply to the touchscreen console only.

WARNING: ***THE TOUCHSCREEN CONSOLE HAS NO USER SERVICEABLE PARTS. DO NOT ATTEMPT TO OPEN THE TOUCHSCREEN CONSOLE.***

NOTE: ***WHEN ATTACHING THE BASE TO THE TOUCHSCREEN CONSOLE ENSURE THE TOUCHSCREEN IS RESTING ON A FLAT, CLEAN SURFACE WITH A PIECE OF NON-ABRASIVE MATERIAL BETWEEN THE TOUCHSCREEN AND THE SURFACE.***

NOTE: ***TO AVOID ACCIDENTAL CONTACT WITH ENERGIZED CIRCUITRY INSIDE THE TOUCHSCREEN CONSOLE, THE MAXIMUM BACK PLATE SCREW LENGTH MUST BE LIMITED TO 25 mm (1 inch).***

NOTE: ***FOR WALL MOUNTED TOUCHSCREEN CONSOLES ENSURE THE BASE IS SECURED PROPERLY TO A WALL STUD.***

WARNING: ***PLEASE ENSURE THERE IS SUFFICIENT AREA AROUND THE VENTING SLOTS OF THE TOUCHSCREEN CONSOLE TO ALLOW PROPER COOLING OF THE INTERNAL COMPONENTS.***

NOTE: ***THE SET SCREW COLLAR MUST BE POSITIONED ON THE UPPER HALF OF THE TILT ARM TO PREVENT PERSONAL INJURY SHOULD THE TOUCHSCREEN SLIP WHILE ADJUSTING THE VIEWING HEIGHT.***

USE THE PROVIDED ALLEN KEY TO ENSURE THE SET SCREW COLLAR IS LOCKED INTO POSITION SUCH THAT THERE IS NO LESS THAN 25 mm (1 INCH) OF CLEARANCE BETWEEN BOTTOM EDGE OF THE TOUCHSCREEN CONSOLE AND THE TOUCHSCREEN BASE PLATE WHEN THE TOUCHSCREEN IS ADJUSTED TO ITS MINIMUM HEIGHT. PLEASE BE SURE TO SUPPORT THE TOUCHSCREEN CONSOLE WHEN ADJUSTING ITS VIEWING POSITION.

1B.4.0 SAFETY WARNINGS LABELS

This section describes the safety labels used inside and outside the generator cabinet. Depending on configuration, your X-ray generator may contain some or all of the labels shown.

NOTE: ***THESE LABELS AND WARNINGS ARE INTENDED TO ALERT SERVICE PERSONNEL THAT SERIOUS INJURY WILL RESULT IF THE HAZARD IDENTIFIED IS IGNORED.***

NOTE: ***DUE TO THE DIVERSITY OF GENERATOR MODELS, THE EQUIPMENT MAY NOT BE EXACTLY AS SHOWN.***

WARNING: ***SWITCH OFF THE MAIN POWER DISCONNECT AND ALLOW SUFFICIENT TIME FOR ALL CAPACITORS TO DISCHARGE BEFORE REMOVING ANY COVERS OR PANELS.***

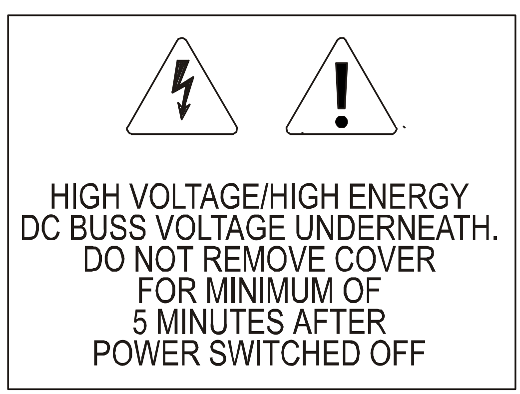
WARNING: ***IF ANY BARRIERS OR COVERS MUST BE REMOVED FOR SERVICE, TAKE ALL REQUIRED PRECAUTIONS WITH RESPECT TO THE HAZARD(S) AND IMMEDIATELY REPLACE THE BARRIERS / COVERS WHEN THE NEED FOR REMOVAL IS COMPLETED.***

WARNING: ***DO NOT MODIFY THIS EQUIPMENT WITHOUT AUTHORIZATION OF THE MANUFACTURER.***

REPLACE ALL FUSES IN THIS GENERATOR WITH THE SAME TYPE AND RATING.

This information is provided to help you establish safe operating conditions for both you and your 100 kHz series X-ray generator. Do not operate this X-ray generator except in accordance with these precautions, and any additional information provided by the X-ray generator manufacturer and/or competent safety authorities.

1B.4.1 High Voltage / High Energy DC Bus

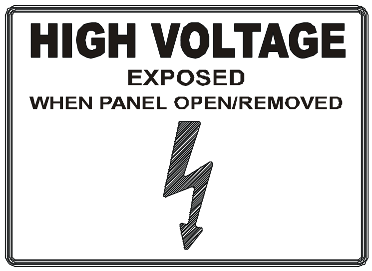


This label is attached to the main access panel on the generator cabinet. The internal capacitors may hold a lethal charge for up to 5 minutes after the console or the main power disconnect is switched off. Do not remove the cover for a minimum of 5 minutes after the power has been switched off.

1B.4.0 SAFETY WARNINGS LABELS (Cont)

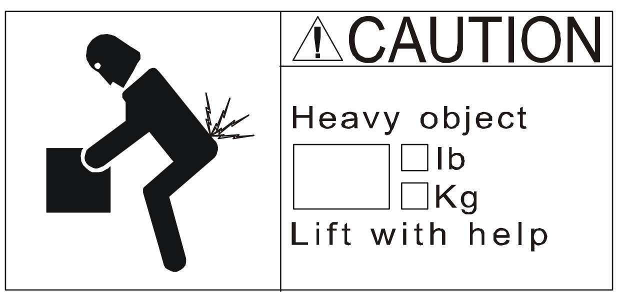
***WARNING*: WAIT A MINIMUM OF 5 MINUTES AFTER THE INPUT MAINS POWER HAS BEEN REMOVED BEFORE REMOVING ANY COVERS OR ACCESS PANELS. ONCE THE COVER(S) / PANEL(S) ARE REMOVED CHECK THAT THE VOLTAGE ACROSS THE DC BUS CAPACITORS IS LESS THAN 48 VDC BEFORE SERVICING. IF THIS VOLTAGE EXCEEDS 48 VDC, THE CAPACITORS MUST BE MANUALLY DISCHARGED BY QUALIFIED SERVICE PERSONNEL.**

1B.4.2 Caution High Voltage Exposed Label



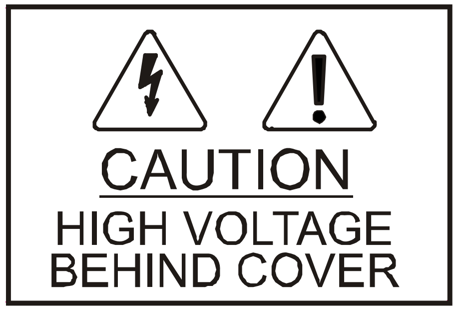
This label is attached to the main access panel on the generator cabinet. High voltage will be exposed if the subject panel is removed and the generator is connected to live AC mains, or if high voltage capacitors are still charged.

1B.4.3 Weight Label



This label is attached to the main access panel on the generator cabinet, and to the HT oil tank. This states the approximate weight of the generator and the HT oil tank, and cautions against attempting to lift those assemblies without proper assistance.

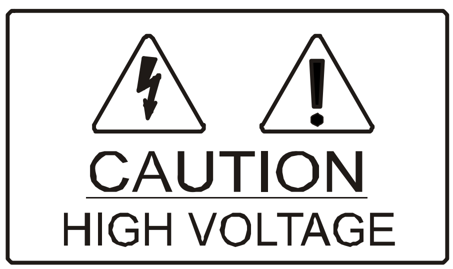
1B.4.4 Caution High Voltage Behind Cover



This label is attached to a cover over the inverter board(s). The inverter assembly is connected to the main DC bus and will have high voltage applied at all times that the generator is switched on. This assembly will remain energized for up to 5 minutes after the generator is switched off or the main disconnect is switched off.

This label is also attached to a cover over the main input fuses on the power input board. This area will have mains voltage applied as long as the main disconnect is switched on.

1B.4.5 Caution High Voltage



This label is attached to the room interface transformer. This transformer has mains voltage on the primary terminals at all times that the generator is connected to live AC mains.

This label is attached to the resonant assembly. The resonant board will have exposed high voltage at all times that the DC bus is charged.

On Indico 100 SP generators, this label is also attached to the power leads for the cooling fan near the power input board. This fan operates from 120 VAC (as do all cooling fans in the generator).

1B.4.6 Danger High Voltage Exposed

This label is attached to the primary terminals on the HT oil tank. These terminals may be energized at all times that the generator is switched on, and for 5 minutes after the console or the main disconnect is switched off.

1B.4.7 Console CPU Board / Console Board

For 23 X 56 (cm) consoles:
HIGH VOLTAGE HAZARD: Approximately 400 VAC is present on this board in the area of U32 and J10. This voltage is used to light the backlight for the LCD display assembly in the console.

For 31 X 42 (cm) Indico 100 R&F consoles:
HIGH VOLTAGE HAZARD: Approximately 400 VAC is present on this board in the area of T1, C61, and J10. This is a high voltage source for the fluorescent backlight on the LCD display.

For Indico 100 Rad-only consoles:
HIGH VOLTAGE HAZARD: Approximately 400 VAC is present on this board in the area of T1, C36, and J5. This is a high voltage source for the fluorescent backlight on the LCD display.

Fuse rating (Indico 100 Rad-only console)
F1: GDC-1 (1A 250V slow blow).

For CPI Touchscreen consoles:
HIGH VOLTAGE HAZARD: Approximately 700 VAC is present on the touchscreen board in the areas of T1, C7, C12, J1, J5 and T2, C106, C94, J26, J19. This is a high voltage source for the fluorescent backlight on the LCD display.

1B.4.8 Generator Interface Board

HIGH VOLTAGE HAZARD: Components within the dashed line on the board have high voltage applied at all times that the main disconnect is switched ON. These components are live EVEN WITH THE CONSOLE SWITCHED OFF.

FUSE RATINGS:

F1	GDC-1.6 (1.6A 250V slow blow).
F2	GDC-2.5 (2.5A 250V slow blow).
F3, F4, F5	GDC-5 (5A 250V slow blow).
F6	GDC-2(2A 250V slow blow).

1B.4.9 Room Interface Board

HIGH VOLTAGE HAZARD: 110 / 220 VAC may be present on this board at all times that the AC mains for the generator is switched on.

1B.4.10 AEC Board

HIGH VOLTAGE HAZARD: AEC board assemblies with an integral high voltage supply for ion chambers or for a PMT may have high voltage present, up to approximately 1000 VDC, at all times that the generator is switched on.

1B.4.11 Power Input Board

HIGH VOLTAGE HAZARD: High voltage is present on this board whenever the generator is connected to live AC mains.

The DC bus capacitors will remain charged for up to 5 minutes after the generator has been switched off.

BURN HAZARD: Power input boards for single phase generators are fitted with several high power resistors that operate at temperatures sufficient to cause skin burn. Ensure that these resistors have cooled sufficiently after the power has been switched off before servicing.

1B.4.12 Low Speed Starter Board

HIGH VOLTAGE HAZARD: High voltage is present on this board whenever the generator is switched on.

BURN HAZARD: This board is fitted with high power resistors that operate at temperatures sufficient to cause skin burn. Ensure that these resistors have cooled sufficiently after the power has been switched off before servicing.

1B.4.13 Dual Speed Starter Board

HIGH VOLTAGE HAZARD: Approximately 600 VDC is present on this board whenever the generator is switched on. This voltage is sourced from the DC bus capacitors in the generator, and therefore the high voltage hazard will remain for up to 5 minutes after the generator has been switched off.

1B.4.14 Inverter Board

HIGH VOLTAGE HAZARD: The inverter boards are connected to the main DC bus and will have high voltage applied at all times that the generator is switched on. This assembly will remain energized for up to 5 minutes after the generator is switched off, or the main disconnect is switched off.

1B.4.15 HT Tank

HIGH VOLTAGE HAZARD: High voltage may be present at the primary terminals on the tank lid board, at the output high voltage connectors, and at the mA/mAs measuring jacks if the shorting link is opened for mA/mAs measurements.

The generator must not be energized if the leads that attach to the primary of the high voltage transformer are disconnected.

TORQUE NOTICE: Do not over-tighten the nuts on the feed through terminals for the primary of the HT transformers. Over tightening may damage the HT tank.

1B.4.16 F1 - Primary of Power Supply Auxiliary Transformer

FUSE RATING: Fuse F1 is located on the generator chassis, to the left of the main input fuses on the power input board.

Single phase generators: FNM-3 (3A 250V).
Three phase generators: FNQ-2 (2A 500V).

1B.4.17 F4 - Primary of Room Interface Transformer

FUSE RATING: Fuse F4 is located on the generator chassis, to the left of the main input fuses on the power input board.

Single phase generators: FNM-3 (3A 250V).
Three phase generators: FNQ-2 (2A 500V).

CHAPTER 1C

PREPARING FOR INSTALLATION

CONTENTS:

1C.1.0 INTRODUCTION

The following items must be considered before installing your generator:

- Power level of your generator.
- Power line requirements.
- Ground requirements.
- Physical placement of the generator.
- Environmental requirements for the generator.
- Cable runs from the generator to all room components: tables, Buckys, X-ray tubes etc.

1C.2.0 GENERATOR POWER REQUIREMENTS

NOTE: ***50 kW AND HIGHER THREE-PHASE INDICO 100 GENERATORS ARE AVAILABLE IN 400 VAC AND 480 VAC MODELS. 400 VAC MODELS MUST BE OPERATED FROM 400 VAC MAINS, OR MAY BE OPERATED FROM 480 VAC MAINS WITH AN OPTIONAL LINE ADJUSTING TRANSFORMER. 480 VAC MODELS MUST BE OPERATED FROM 480 VAC MAINS (THESE ARE THE NOMINAL MAINS VOLTAGES, THE ALLOWED TOLERANCES ARE AS DETAILED IN THE PREVIOUS TABLES).***

1C.2.1 32 kW Single Phase

Line Voltage	230 VAC ± 10%, 1∅.
Line Frequency	50/60 Hz.
Momentary Current	200 Amps.
Nominal Current *	5 Amps.

1C.2.2 40 kW Single Phase

Line Voltage	230 VAC ± 10%, 1∅.
Line Frequency	50/60 Hz.
Momentary Current	250 Amps.
Nominal Current *	5 Amps.

1C.2.3 32 kW Three Phase

Line Voltage	400 VAC ± 10%, 3∅.
	480 VAC ± 10%, 3∅ with optional line adjusting transformer.
Line Frequency	50/60 Hz.
Momentary Current	65 Amps/phase at 400 VAC.
	55 Amps/phase at 480 VAC.
Nominal Current *	5 Amps.

1C.2.4 40 kW Three Phase

Line Voltage	400 VAC ± 10%, 3∅.
	480 VAC ± 10%, 3∅ with optional line adjusting transformer.
Line Frequency	50/60 Hz.
Momentary Current	80 Amps/phase at 400 VAC.
	65 Amps/phase at 480 VAC.
Nominal Current *	5 Amps.

1C.2.5 50 kW Three Phase

Line Voltage	400 VAC ± 10%, 3∅ (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ with optional line adjusting transformer, (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ (for 480 VAC input generators).
	SEE NOTE IN SECTION 1C.2.0.
Line Frequency	50/60 Hz.
Momentary Current	100 Amps/phase at 400 VAC.
	80 Amps/phase at 480 VAC.
Nominal Current *	5 Amps.

1C.2.6 65 kW Three Phase

Line Voltage	400 VAC ± 10%, 3∅ (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ with optional line adjusting transformer, (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ (for 480 VAC input generators).
	SEE NOTE IN SECTION 1C.2.0.
Line Frequency	50/60 Hz.
Momentary Current	125 Amps/phase at 400 VAC.
	105 Amps/phase at 480 VAC.
Nominal Current *	5 Amps.

1C.2.7 80 kW Three Phase

Line Voltage	400 VAC ± 10%, 3∅ (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ with optional line adjusting transformer, (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ (for 480 VAC input generators).
	SEE NOTE IN SECTION 1C.2.0.
Line Frequency	50/60 Hz.
Momentary Current	155 Amps/phase at 400 VAC.
	130 Amps/phase at 480 VAC.
Nominal Current *	5 Amps.

1C.2.8 100 kW Three Phase

Line Voltage	400 VAC ± 10%, 3∅ (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ with optional line adjusting transformer, (for 400 VAC input generators).
	480 VAC ± 10%, 3∅ (for 480 VAC input generators).
	SEE NOTE IN SECTION 1C.2.0.
Line Frequency	50/60 Hz.
Momentary Current	195 Amps/phase at 400 VAC.
	160 Amps/phase at 480 VAC.
Nominal Current *	5 Amps.

***** Nominal Current = Standby current + the current drain in continuous-fluoro or pulsed-fluoro modes (R&F generators) or standby current only (rad-only generators). External or installer-supplied equipment connected to the generator may increase the nominal current beyond the values shown.

1C.2.9 Service Disconnect (All Models)

Refer to the following table for the recommended service disconnect ratings for the Generators (Power Supplies).

1C.3.0 POWER LINE REQUIREMENTS

The following table defines the power line requirements for the generators.

***NOTE:* THE FOLLOWING TABLE CONTAINS RECOMMENDED VALUES FOR THE WIRE SIZES BETWEEN THE MAINS DISCONNECT AND THE GENERATOR. THE ACTUAL VALUES USED AT AN INSTALLATION ARE DEPENDENT ON THE QUALITY OF THE INPUT LINE (VOLTAGE LEVEL), THE CURRENT REQUIREMENTS, THE LENGTH OF THE CABLE RUN, AND MUST BE CONFIRMED BY THE INSTALLER.**

FINAL SELECTION OF GENERATOR INPUT WIRE AND DISCONNECTS AS WELL AS THE CABLING FROM THE DISTRIBUTION TRANSFORMER TO THE MAINS DISCONNECT MUST MEET THE REQUIREMENTS OF THE LOCAL ELECTRICAL CODES AND IS USUALLY DETERMINED BY HOSPITAL/CONTRACTOR ENGINEERING.

ALL THE RATINGS LISTED CONSIDER THE GENERATOR REQUIREMENTS ONLY. THE INSTALLER MUST MAKE THE NECESSARY COMPENSATION FOR ADDITIONAL LOADS.

A POOR QUALITY INPUT LINE MAY RESULT IN THE INSTALLER HAVING TO DERATE THE GENERATOR'S MAXIMUM POWER

Mains Voltage	Minimum Recommended Mains Disconnect to Generator 15 ft/5 m max)	Generator Momentary Line Current	Minimum Recommended Generator Service Rating	Minimum Recommended Distribution Transformer Rating	Minimum Recommended Ground Wire Size	Apparent Mains Resistance
32 kW 1∅ Generator						
230 VAC	#2 (33 mm^2)	200 A	120 A	50 kVA	#2 (33 mm^2)	0.055 Ω
40 kW 1∅ Generator						
230 VAC	#2 (33 mm^2)	250 A	120 A	65 kVA	#2 (33 mm^2)	0.045 Ω
32 kW 3∅ Generator						
400 VAC	#6 (13.3 mm^2)	65 A	100 A	45 kVA	#6 (13.3 mm^2)	0.27 Ω
480 VAC	#6 (13.3 mm^2)	55 A	100 A	45 kVA	#6 (13.3 mm^2)	0.40 Ω
40 kW 3∅ Generator						
400 VAC	#6 (13.3 mm^2)	80 A	100 A	55 kVA	#6 (13.3 mm^2)	0.22 Ω
480 VAC	#6 (13.3 mm^2)	65 A	100 A	55 kVA	#6 (13.3 mm^2)	0.32 Ω

Mains Voltage	Minimum Recommended Mains Disconnect to Generator 15 ft/5 m max)	Generator Momentary Line Current	Minimum Recommended Generator Service Rating	Minimum Recommended Distribution Transformer Rating	Minimum Recommended Ground Wire Size	Apparent Mains Resistance
50 kW 3∅ Generator						
400 VAC	#6 ($13.3\ mm^2$)	100 A	100 A	65 kVA	#6 ($13.3\ mm^2$)	0.17 Ω
480 VAC	#6 ($13.3\ mm^2$)	80 A	100 A	65 kVA	#6 ($13.3\ mm^2$)	0.24 Ω
65 kW 3∅ Generator						
400 VAC	#6 ($13.3\ mm^2$)	125 A	100 A	85 kVA	#6 ($13.3\ mm^2$)	0.13 Ω
480 VAC	#6 ($13.3\ mm^2$)	105 A	100 A	85 kVA	#6 ($13.3\ mm^2$)	0.19 Ω
80 kW 3∅ Generator						
400 VAC	#6 ($13.3\ mm^2$)	155 A	100 A	105 kVA	#6 ($13.3\ mm^2$)	0.10Ω
480 VAC	#6 ($13.3\ mm^2$)	130 A	100 A	105 kVA	#6 ($13.3\ mm^2$)	0.15 Ω
100 kW 3∅ Generator						
400 VAC	#4 ($21\ mm^2$)	195 A	100 A	130 kVA	#4 ($21\ mm^2$)	0.09 Ω
480 VAC	#6 ($13.3\ mm^2$)	160 A	100 A	130 kVA	#6 ($13.3\ mm^2$)	0.12 Ω

- All wiring and grounding must comply with local electrical codes.
- All wiring must be copper.
- The disconnect switch shall be located within reach of the operator.

1C.4.0 GROUND REQUIREMENTS

POWER LINE:

- A suitable ground must be connected from the disconnect switch to the main ground on the generator, located to the left of the main fuse block on the power input board. The ground wire is typically part of the line cord, and the current capacity of the ground conductor must normally be equal to or greater than that of the line conductors.
- If a neutral line is provided with the system, under no circumstances is it to be used for ground purposes. The ground conductor must carry fault currents only.

X-RAY TUBE HOUSING:

- A copper ground cable, #10 AWG (6 mm^2) or greater, is to be connected from each X-ray tube's housing to the H.T. tank ground stud (located at the top of the H.T. tank).

STATOR CABLE:

- For units with a low speed starter, shielded stator cables are recommended. For units with a dual speed starter, shielded stator cables MUST be used.
  The shield for the stator cable(s) must be properly grounded at both the tube and the generator ends of the cable(s).

1C.5.0 OUTLINE DRAWINGS

1C.5.1 Generator Outline

Refer to chapter 1A for the Indico 100 generator outline.

1C.5.2 Generator Weight

The weight of the generator cabinet and of the available consoles is listed below:

Generator cabinet	217 lbs (98.6 kg).
Control console (23 X 56 cm)	7 lbs (3.2 kg).
Control console (31 X 42 cm)	8 lbs (3.7 kg).
Control console (Rad only)	6 lbs (2.7 kg).
Control console (15 in. / 38.5 cm. Touch screen)	18 lbs (8.2 kg) - with base 10 lbs (4.5 kg) - without base.

1C.5.3 Generator Shipping Containers: Dimensions

The overall dimensions of the Indico 100 shipping pack are shown below.

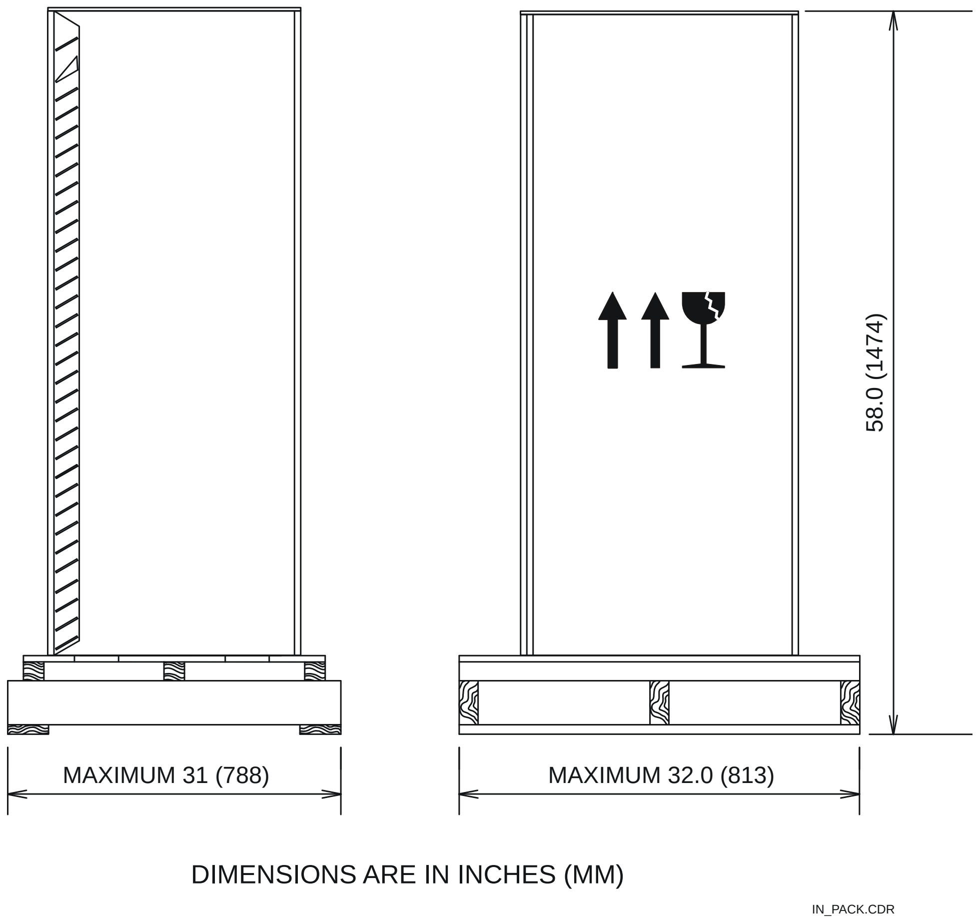


Figure 1C-1: Generator shipping container

1C.6.0 LOCATING THE GENERATOR CABINET AND CONTROLLER

The generator cabinet is self standing and does not need to be supported. However, the installation should meet the following requirements:

- The floor must be flat and level.
- The floor must be capable of supporting a load of approximately 250 lbs (115 Kg).
- The generator installation area must be clean and free of dirt or debris.
- Sufficient room must be provided to allow access to the rear and side panels for installation. Clearance must also be provided at both sides of the cabinet, at the front, and at the rear of the upper cabinet to allow access for service. See Figure 1C-2 for recommended clearances.
- A cable conduit should be provided from the control console to the generator cabinet to allow routing of the control cable if required. Allow for a 2 inch conduit. See Figure 1C-3.
- Refer to 1C.6.2 for the seismic center location and for the mounting-hole locations to secure the generator to the floor, if required.

1C.6.1 Locating The Equipment In The X-Ray Room

Figure 1C-2 shows recommended clearances around the generator. Figure 1C-3 shows recommended clearances for through-the-wall cable routing.

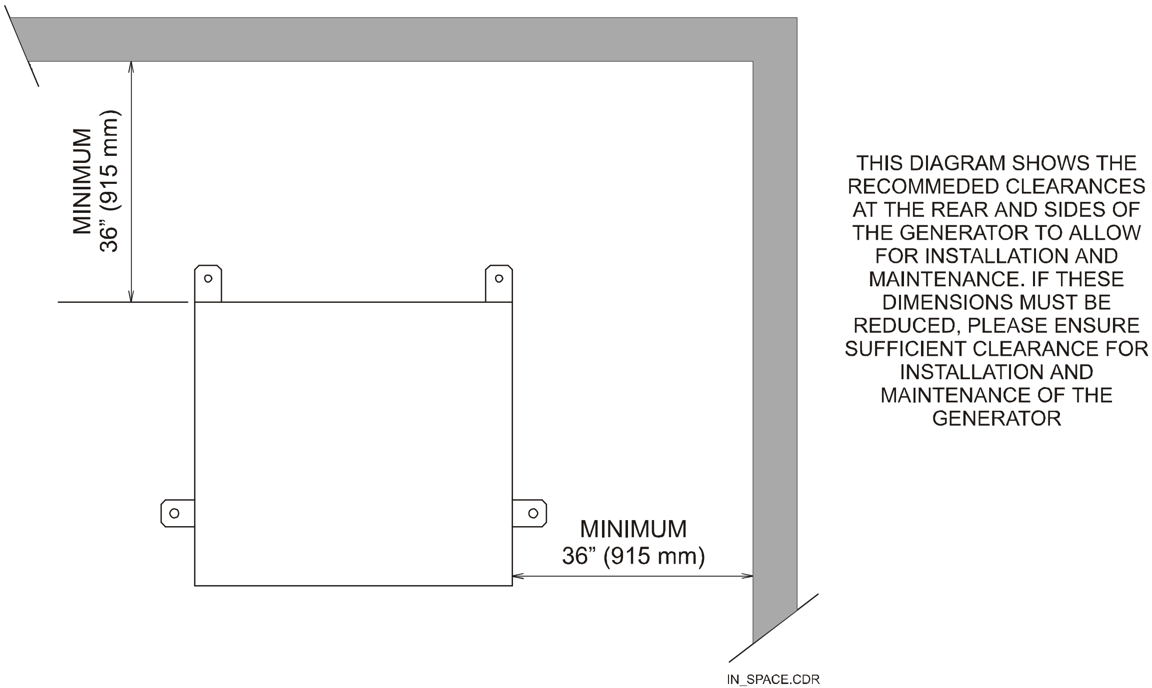


Figure 1C-2: Generator clearances

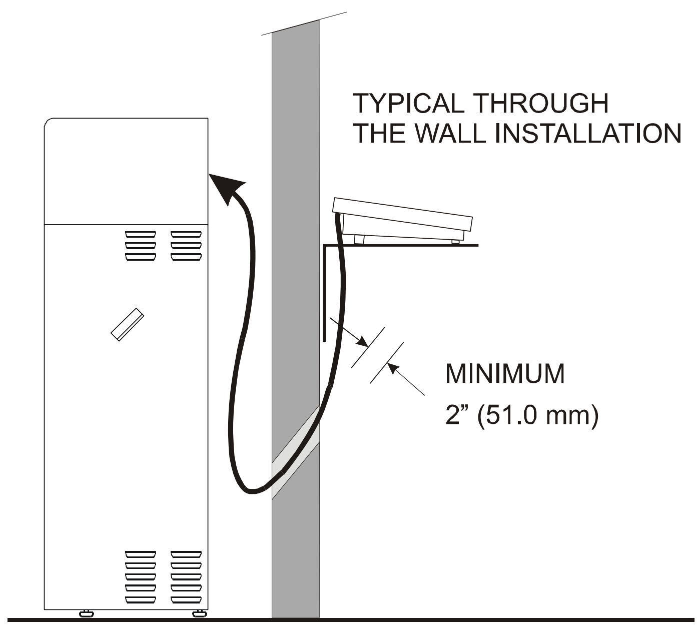
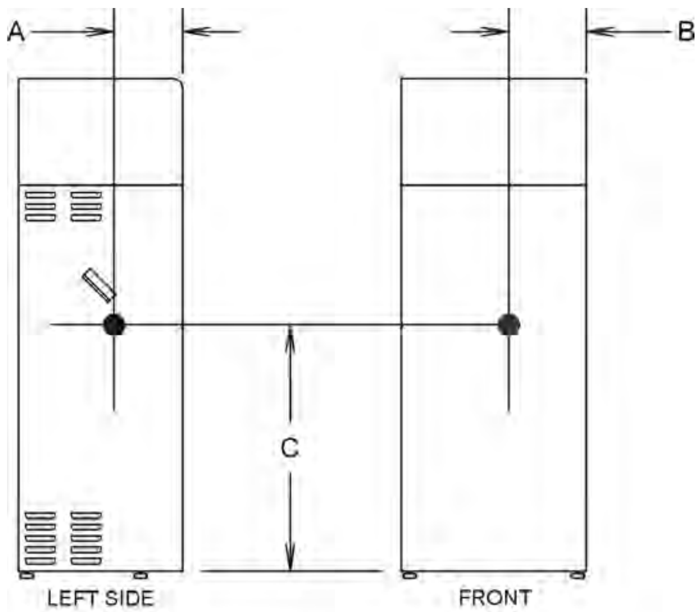


Figure 1C-3: Typical through the wall installation.

1C.6.2 Seismic Centers and mounting hole locations

Figure 1C-4 shows the seismic center location for the Indico 100 X-ray generator. The dimensions are shown as a range of values because the seismic center location will vary slightly, depending on model and configuration of the generator. The installer will need to confirm the exact seismic center location if the published range is insufficiently precise.

The generator should be secured to the floor via the 5/8 inch (16 mm) diameter clearance holes that are located in the base of the cabinet as shown in figure 1C-6, or by means of the anchoring plates shown in figure 1C-5.



DIMENSION	VALUE
A	8.4 - 8.5 (213 - 216)
B	9.4 - 10.0 (238 - 254)
C	19.8 - 20.8 (502 - 527)

DIMENSIONS ARE IN INCHES (MM)

INDICO 100 SEISMIC.CDR

Figure 1C-4: Indico 100 seismic centers

1C.6.2 Seismic Centers and mounting hole locations (Cont)

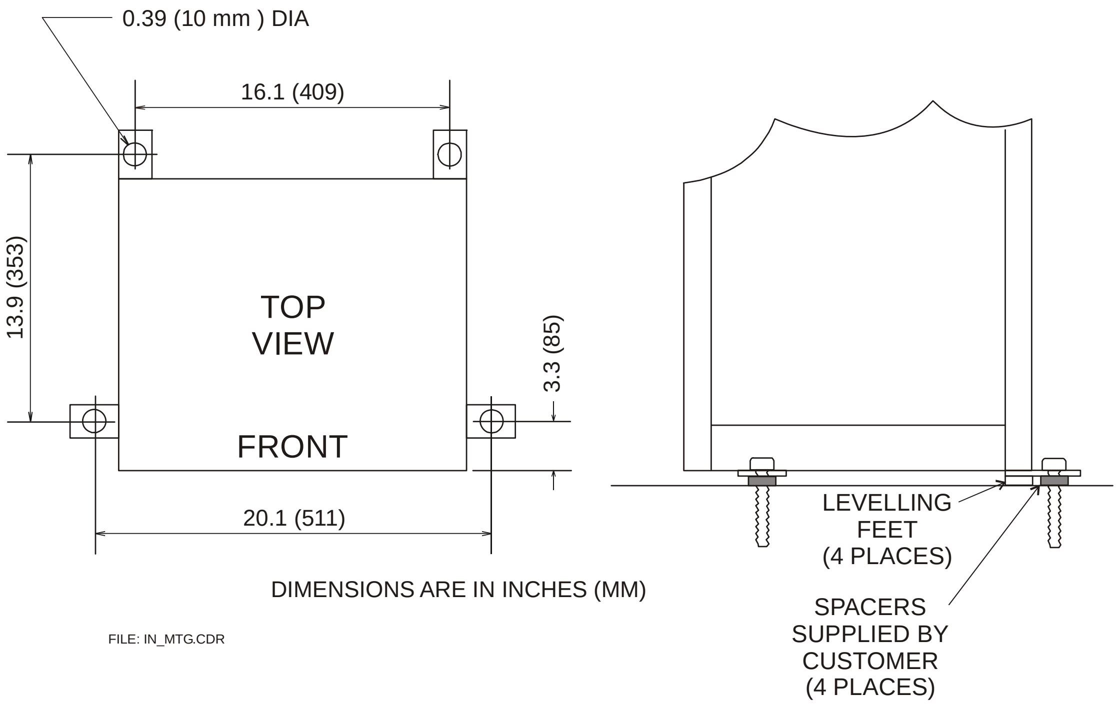


Figure 1C-5: Anchoring plates for securing the generator

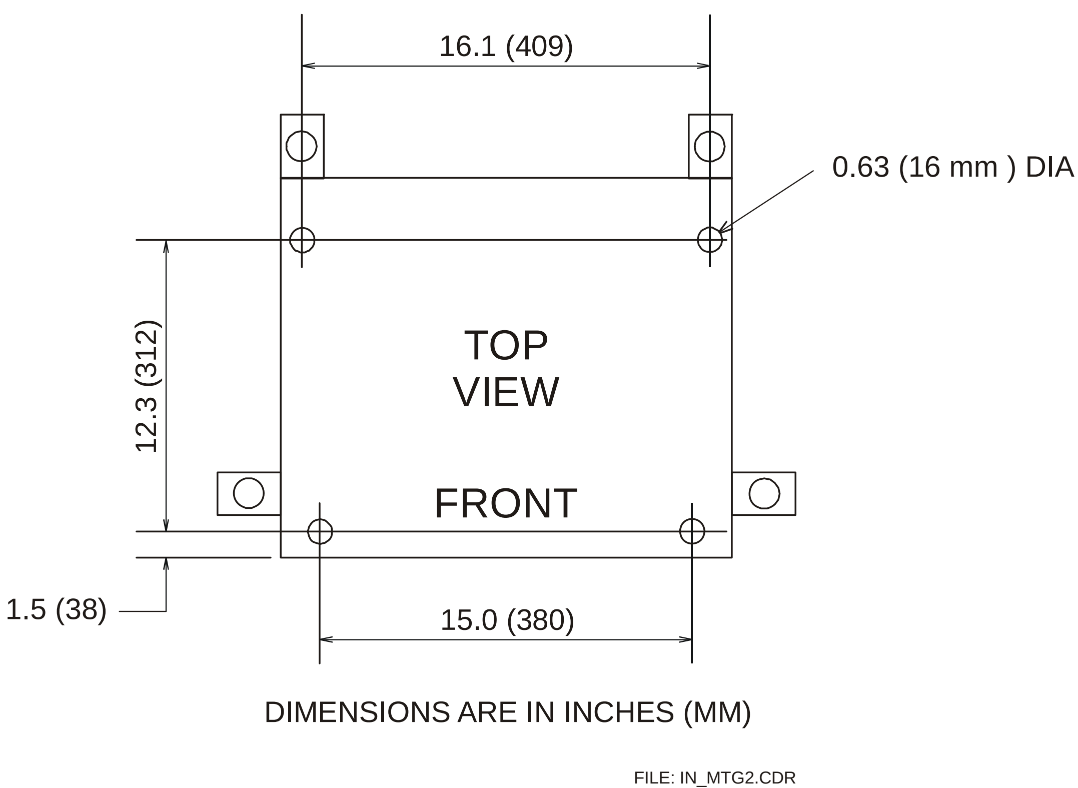


Figure 1C-6: Holes in base of cabinet for securing the generator

1C.7.0 ENVIRONMENTAL REQUIREMENTS

Listed below are the ventilation requirements for the Indico 100 series generator:

- Unrestricted air flow must be provided at the front and sides of the cabinet, as well as underneath the unit.
- Do not allow storage on top of the cabinet.
- Typical heat output of the generator during stand-by is 75 BTU/hr, or 4000 BTU/hr during fluoro operation.
- Control console heat output is negligible (150 BTU/hr).

1C.8.0 CABLES SUPPLIED WITH THE INDICO 100 GENERATOR

Figure 1C-7 shows the cabling supplied with the generator:

- The cable supplied for the console is a 15 conductor cable with a standard length of 50 ft. (15 m).
- The cable supplied for the optional remote fluoro control is a 9 conductor cable with a standard length of 50 ft. (15 m).

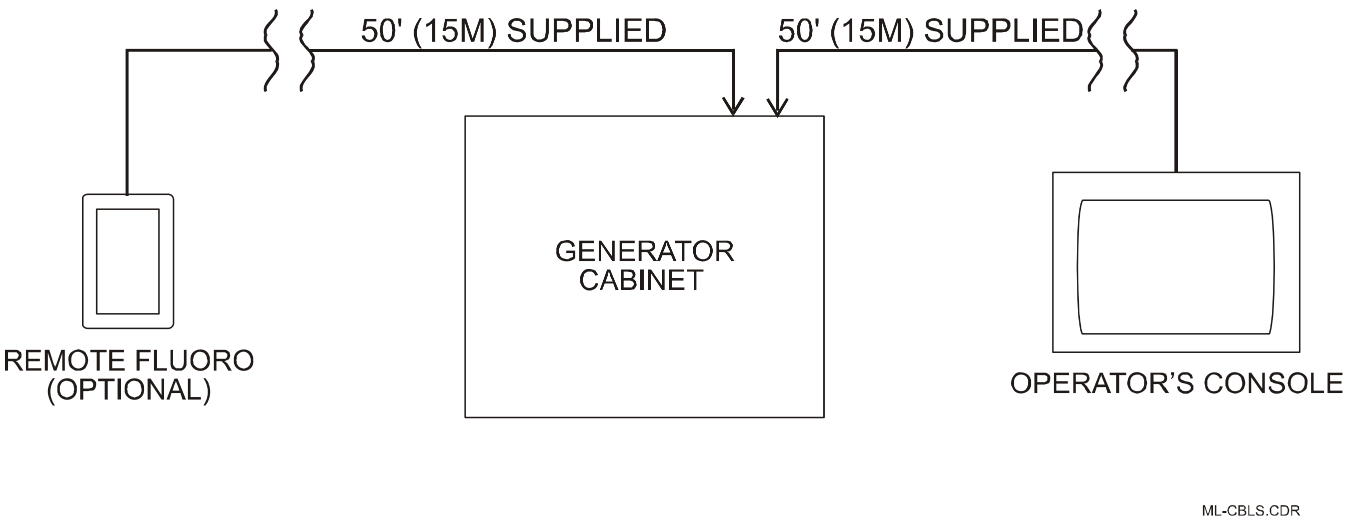


Figure 1C-7: Cabling supplied with generator

1C.9.0 PRE-INSTALLATION CHECK LISTS

The following checklists are provided to help the installer during a pre-installation site visit, prior to installing the generator:

- Site logistics
- Installation equipment

1C.9.1 Site Logistics

Before starting the generator installation, review the following checklist for site logistics.

CHECK √	DESCRIPTION
	Is there an unloading area to transport the generator from the delivery truck to the inside of the building?
	If the installation is not on the same floor as the delivery entrance, is there an elevator available?
	Are all halls and doorways large enough to allow the generator to pass through?
	Is there a transport dolly or similar device to move the Generator? It must have a minimum rating of 350 lb. (160 Kg.)
	Do any regulatory bodies need to be notified prior to installation?
	If movers are required, have arrangements for time and equipment been completed?
	Are lifting straps or some other suitable device available to lift the generator off the shipping pallet?

1C.9.2 Installation Equipment

The following is a checklist of recommended tools and test equipment for installation and calibration of the generator.

NOTE: ***Please note that for membrane consoles GenWare® and a laptop are required for programming and calibration of the generator. Embedded GenWare® may be used when programming and calibrating via the touchscreen console, this can be accessed directly from the System Utilities menu. Refer to chapter 3C for details.***

CHECK √	DESCRIPTION
	GenWare® for setup and calibration using a membrane consoles if required. **Embedded GenWare® may be used when calibrating and programming using a touchscreen console.**
	General hand tools for installation: Wrenches, nut drivers, assortment of screwdrivers, pliers, etc.
	If the generator is to be anchored to the floor, suitable hardware and drills, drill bits etc must be available.
	A supply of connectors for wiring: lugs, caps, line splices etc.
	A calibrated DVM which indicates true RMS voltages.
	Dual trace memory oscilloscope with a minimum 20 MHz bandwidth; appropriate leads, probes, etc.
	Device for measuring true kVp and mA (mAs). This may be a Dynalyzer equivalent or a non-invasive system such as the Keithly TRIAD system.
	A calibrated radiation meter with detectors that will allow for R/min and uR type measurements (or uGy and Gy/min).
	A strobe or reed type tachometer to verify that the anode is rotating up to speed.

1C.9.2 Installation Equipment

CHECK √	DESCRIPTION
	A sufficient selection of absorbers to allow AEC and ABS calibration if applicable. A suggested selection is Lexan in thickness of 5.0, 10.0, and 15.0 cm, or water in plastic containers of homogenous density in thickness of 5.0, 10.0, and 15.0 cm.
	Test phantoms to verify the imaging system with the generator.

CHAPTER 1D

COMPATIBILITY LISTING

CONTENTS:

1D.1.0 INTRODUCTION

This section details external equipment that is compatible with your generator, and lists options that are included in that generator.

1D.2.0 COMPATIBLE DEVICES AND OPTIONS

The Indico 100 family of X-ray generators may be configured to be compatible with various external devices. Certain features must be factory configured, others are user configurable. Please refer to chapter 2 and 3 of this manual and / or consult the factory for further details.

1D.2.1 X-Ray Tubes

Various makes and models of inserts and housings are supported. Refer to the compatibility statement and to chapter 2 of this manual.

CAUTION: ***PLEASE ENSURE THAT THE X-RAY TUBE INSERT IS AS STATED ON THE COMPATIBILITY STATEMENT.***

IF THE HOUSING HAS BEEN RELOADED WITH ANOTHER INSERT TYPE, CALIBRATION MAY BE SERIOUSLY AFFECTED, RESULTING IN TUBE DAMAGE.

1D.2.2 Stators

Various types / impedances of stators are supported. Refer to the compatibility statement and to chapter 2 of this manual.

1D.2.3 AEC Devices

The Indico 100 family of X-ray generators may be configured to be compatible with various AEC devices (ionization, solid state or PMT) via the optional AEC board. Refer to the compatibility statement at the front of this manual for AEC device compatibility of this generator.

1D.2.4 ABS Pickups

Various ABS pickups (light diode, composite video, PMT, etc) may be supported on R&F generators, depending on configuration. Refer to the compatibility statement at the front of this manual, and to chapter 3E.

1D.2.5 Tomographic Tables

Various. Please note that the generator is used as a backup timer ONLY in tomography. AEC is NOT available for tomography.

1D.2.6 Digital Interfaces (R&F Generators)

The generator may be configured to be compatible with various digital imaging systems. Refer to the compatibility statement at the front of this manual.

1D.2.7 DAP (Dose Area Product)

A DAP (Dose-Area Product) meter is available as an option on Indico 100 X-ray generators. Refer to chapter 3F for details.

1D.2.8 Options

Major options include AEC board, digital interface board, DAP, remote fluoro control unit, dual speed starter, line adjusting transformer, and two tube HT transformer.

NOTE: ***REFER TO THE COMPATIBILITY STATEMENT AT THE FRONT OF THIS MANUAL FOR COMPATIBILITY OF THIS GENERATOR.***

1D.3.0 X-RAY TUBE DATA

INSTALLER, PLEASE INSERT THE TUBE RATING CHARTS FOR THE X-RAY TUBES USED WITH THIS GENERATOR.

TUBE #1	
HOUSING (MAKE / MODEL):	
INSERT (MAKE / MODEL):	
SERIAL #:	
STATOR TYPE:	

TUBE #2	
HOUSING (MAKE / MODEL):	
INSERT (MAKE / MODEL):	
SERIAL #:	
STATOR TYPE:	

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CHAPTER 1E

GENERATOR LAYOUT AND MAJOR COMPONENTS

CONTENTS:

1E.1.0 INTRODUCTION

This section contains generator layout drawings and figures that identify the major generator components and circuit board assemblies.

This section also shows the location and correct orientation of the power EPROM (located on the generator CPU board), the console EPROM (located on the console CPU board) if applicable, and the dual speed starter EPROM (located on the dual speed starter board). Refer to the applicable figures to ensure correct EPROM placement and orientation should EPROM replacement be necessary.

1E.2.0 MAJOR COMPONENT LAYOUT

1E.2.1 Generator Cabinet Assembly

The following major assemblies are located within the generator cabinet:

- Auxiliary power supply.
- Generator control circuits.
- Room interface for the X-ray system.
- Low speed starter or optional dual speed starter.
- High frequency inverter.
- H.T. transformer.
- Optional AEC board (automatic exposure control).
- Optional DAP interface board.
- Optional digital I/O board.

Figure 1E-1 shows the major components within the front and right side of the generator cabinet. Figure 1E-2 shows the major components accessible from the left side and the rear of the generator cabinet.

These figures are meant to show major component locations only; minor details may differ from actual units.

1E.2.1 Generator Cabinet Assembly (Cont)

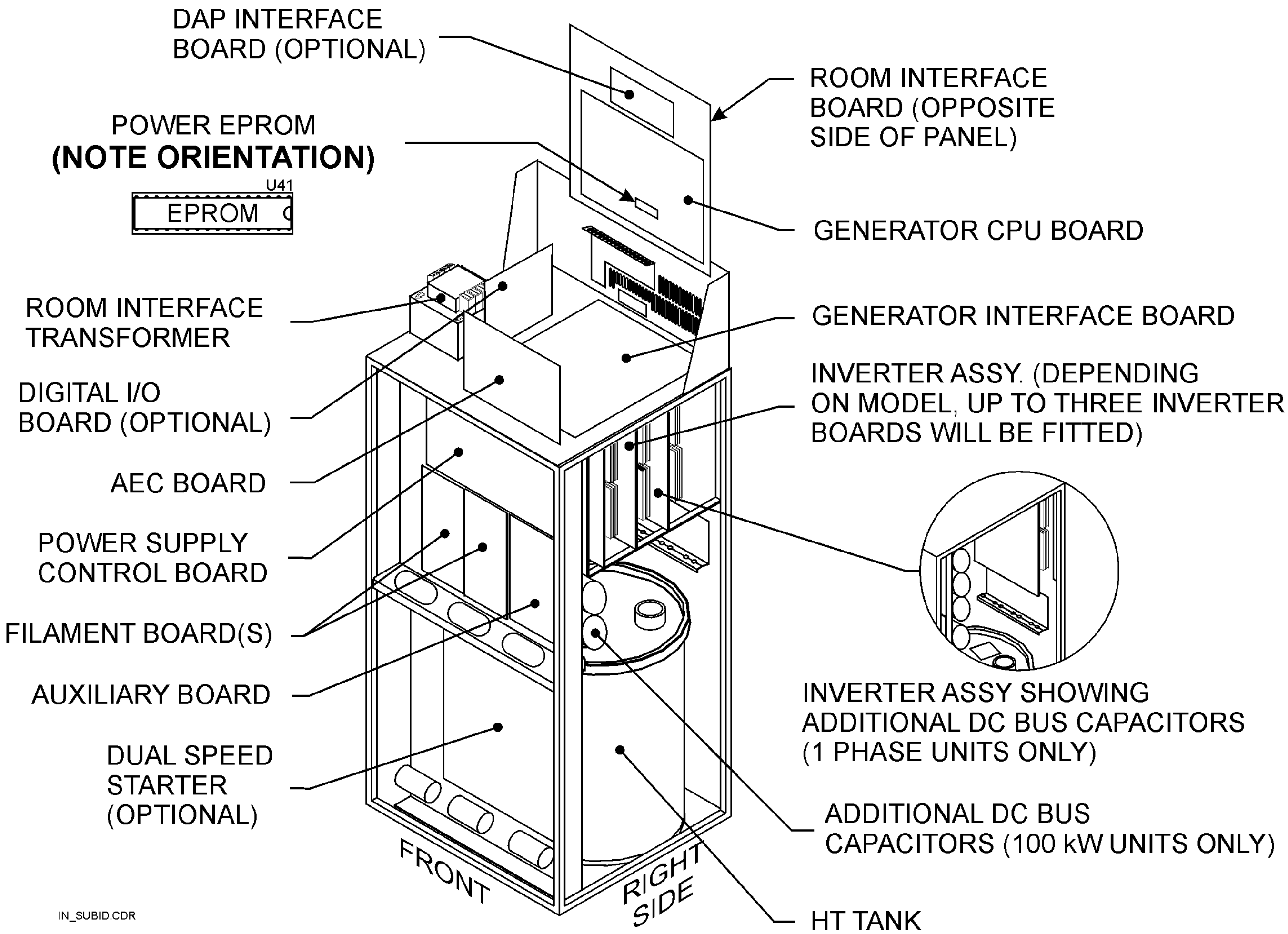

Figure 1E-1: Major generator subassemblies & power EPROM location

Use and disclosure is subject to the restrictions on the title page of this CPI document.

1E.2.1 Generator Cabinet Assembly (Cont)

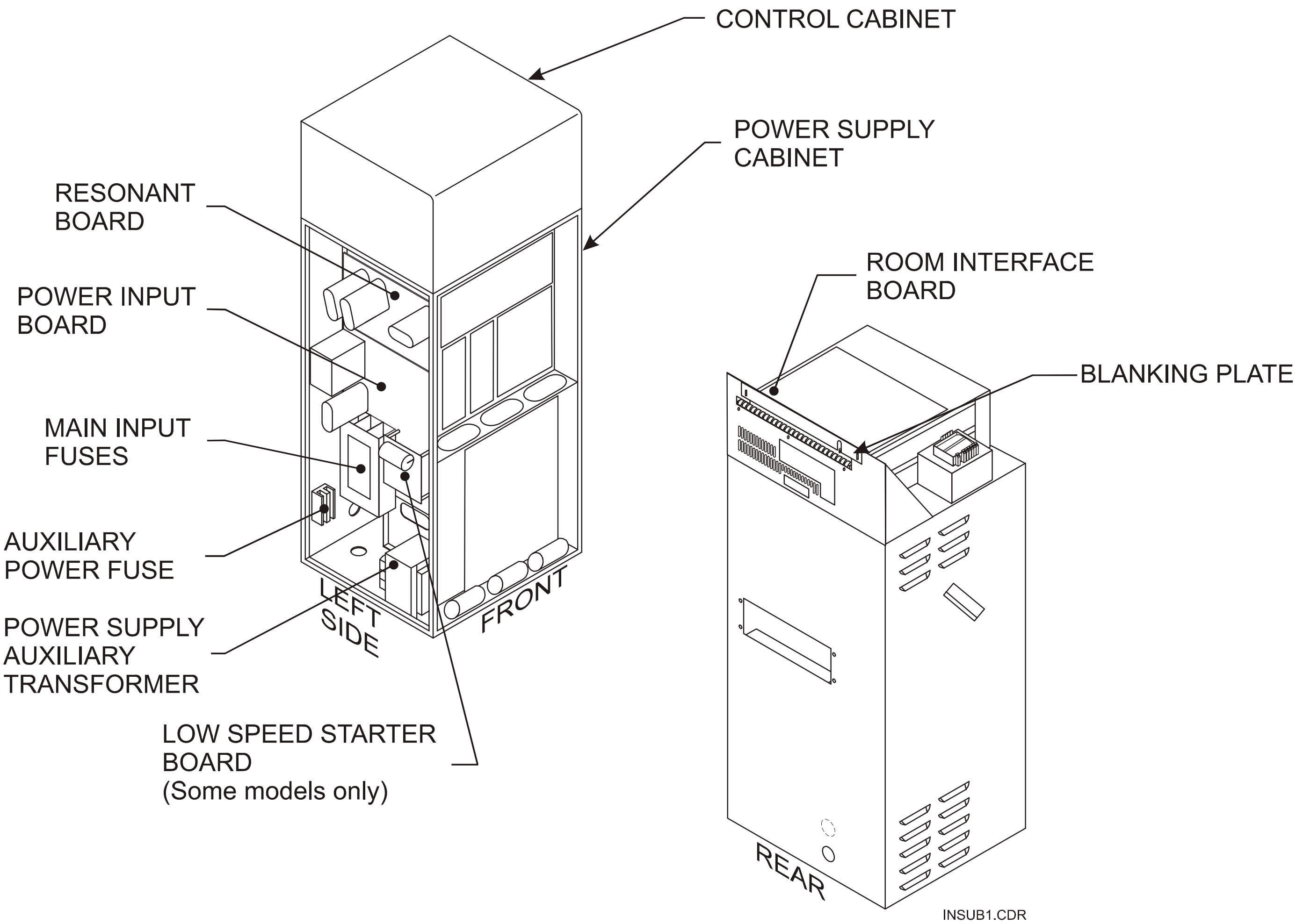

Figure 1E-2: Major generator subassemblies (right side and rear)

1E.2.2 Console Assembly

Figure 1E-3 is an overview of the 23 X 56 cm console, the 31 X 42 cm console, the Rad-only console, and the touch screen console for Indico 100 generators. Figure 1E-4 is an internal view of these console styles (except touch screen), showing the major components and cabling in the console assembly.

The touch screen console contains no user serviceable parts, and must be returned to the factory for service.

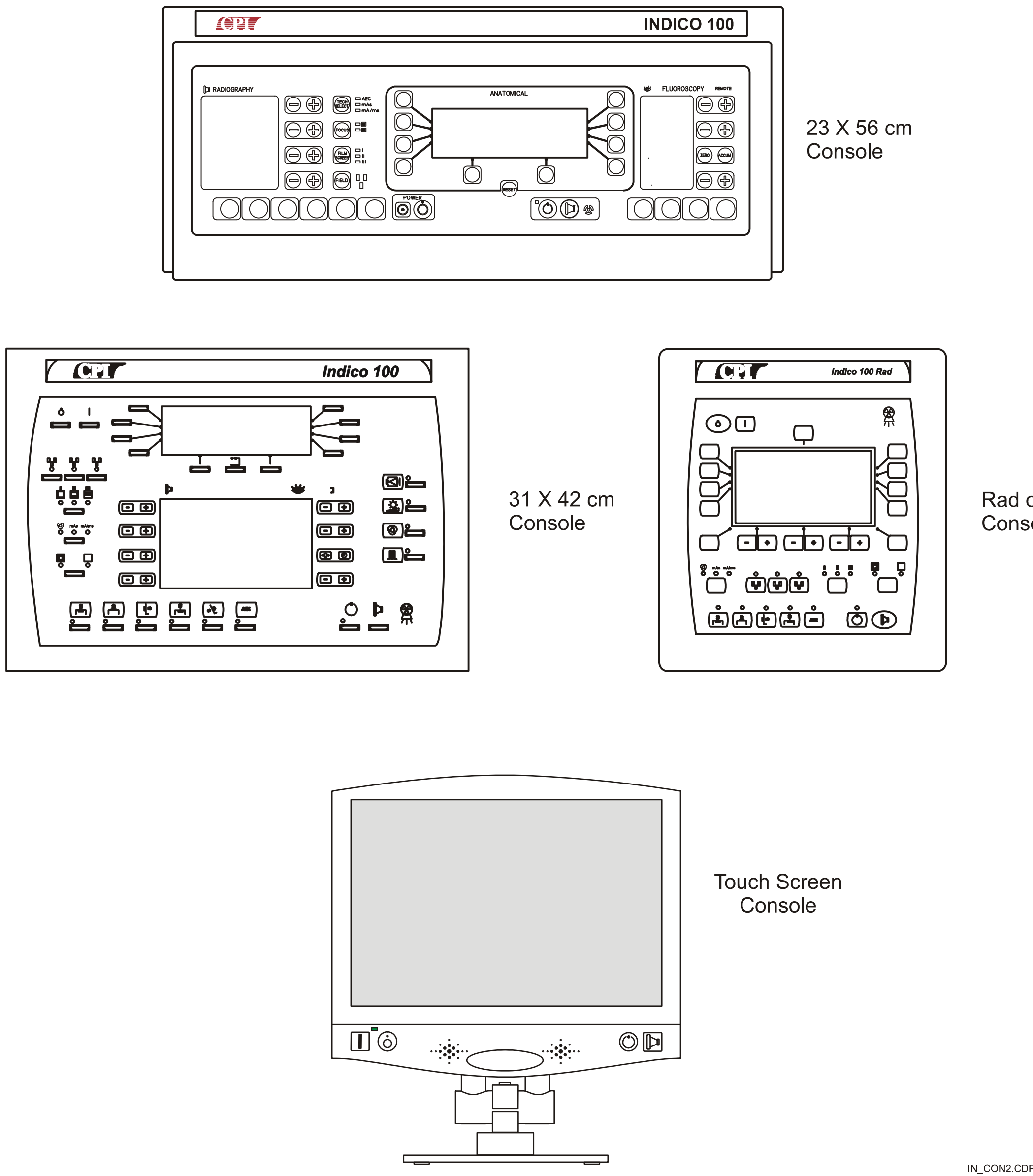

Figure 1E-3: Console top / external view

1E.2.2 Console Assembly (Cont)

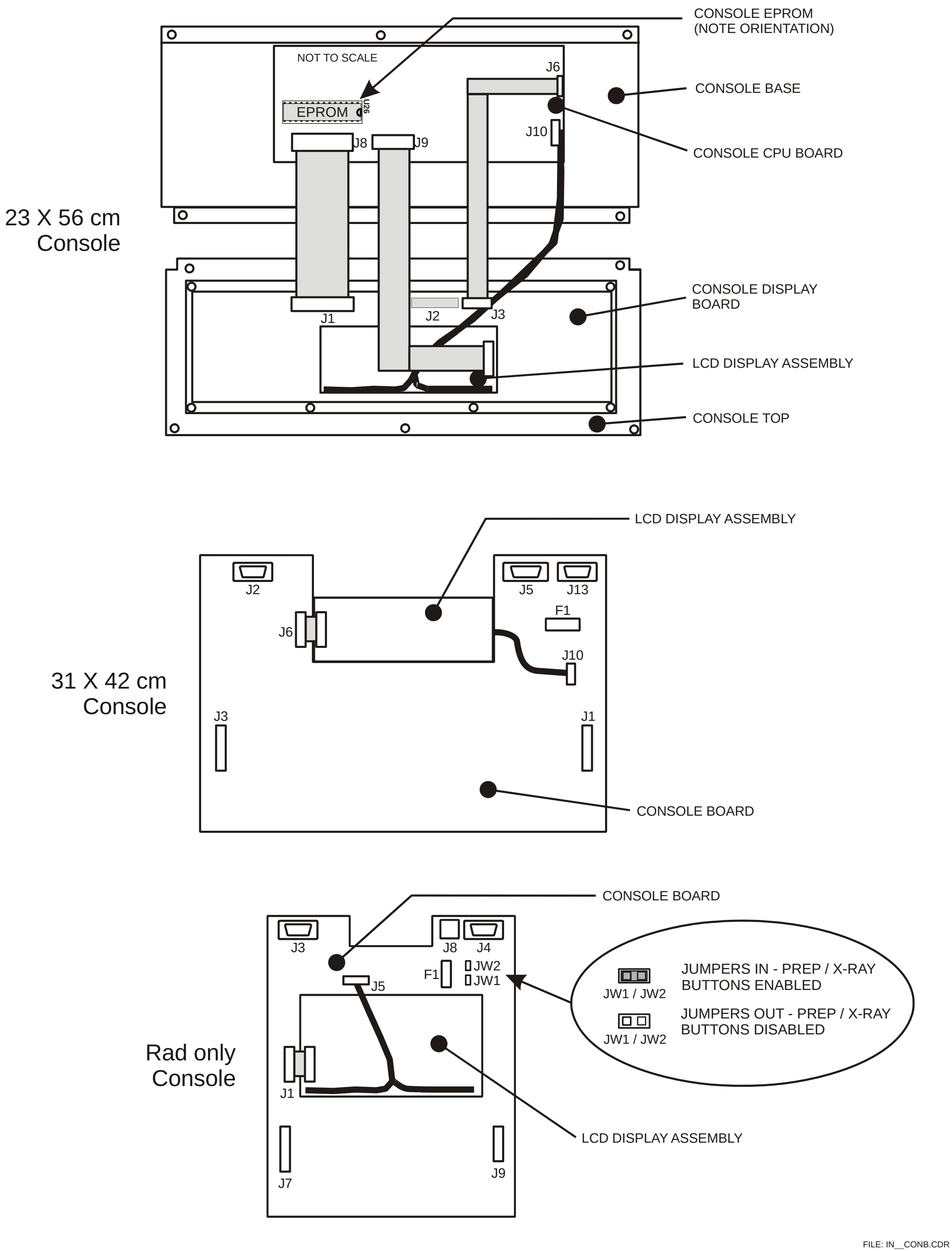

Figure 1E-4: Console internal view including EPROM location (where applicable)

1E.2.3 Remote Fluoro Control

Figure 1E-5 is an overview of the optional remote fluoro control for the Indico 100 generators. This allows operation of fluoro functions from a location other than the main console.

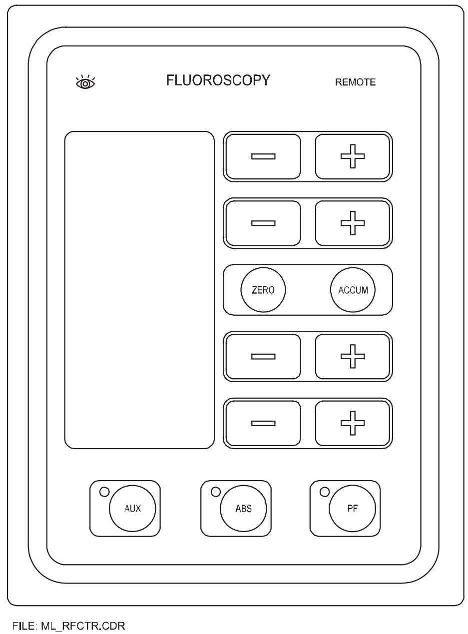

Figure 1E-5: Remote fluoro control unit overview

1E.2.4 Dual Speed Starter EPROM location

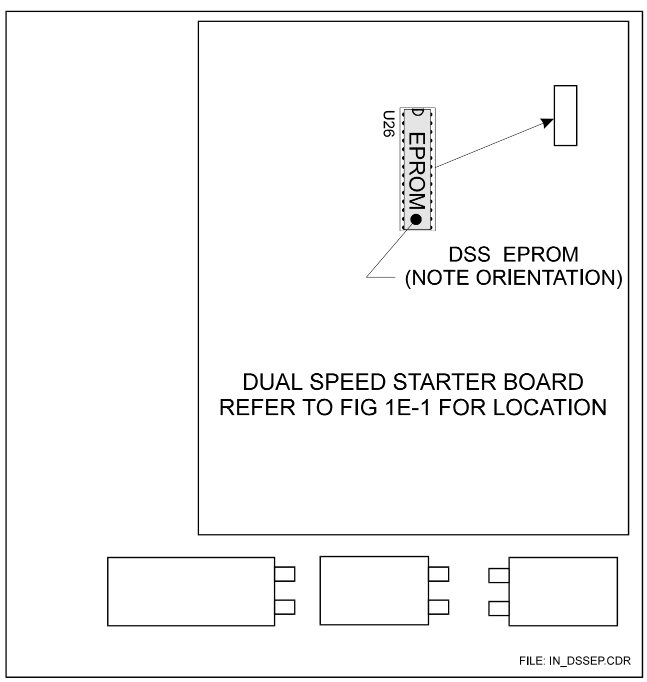

Figure 1E-6: EPROM location inside the dual speed starter

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CHAPTER 2

INSTALLATION

CONTENTS:

2.1.0 INTRODUCTION

This chapter contains instructions for unpacking, positioning, and cabling the Indico 100 series of generators to allow initial operation and calibration. The instructions in this chapter allows the installation engineer to:

- Install the generator and control console.
- Install the optional remote fluoro control.
- Connect power.
- Calibrate one or two X-ray tube(s), depending on the generator model, ***without*** completing the room interface connections. This allows for simpler installation and troubleshooting on the generator itself.

2.2.0 RECEIVING

WARNING: ***THE INDICO 100 GENERATOR CONSISTS OF THE FOLLOWING ITEMS: UPPER AND LOWER CABINETS (FACTORY ASSEMBLED), CONTROL CONSOLE, AND AN OPTIONAL REMOTE FLUORO CONTROL.***

THE COMPLETE GENERATOR WEIGHS APPROXIMATELY 250 POUNDS (115 KG) IN ITS SHIPPING CONTAINER.
THE OPTIONAL LINE ADJUSTING TRANSFORMER IS SUPPLIED IN A SEPARATE ENCLOSURE, THE WEIGHT OF THAT ASSEMBLY IS APPROXIMATELY 100 POUNDS (45 KG).

THE OIL TANK IS LOCATED IN THE LOWER (POWER SUPPLY) CABINET. ONE PERSON SHOULD NOT ATTEMPT TO LIFT OR MOVE THE GENERATOR ASSEMBLY OR OPTIONAL LINE ADJUSTING TRANSFORMER WITHOUT ADEQUATE ASSISTANCE OR PROPER EQUIPMENT.

2.2.1 Major Shipping Assemblies

Refer to figure 1A-1 and 1A-2 (chapter 1A). These figures show the generator cabinet fully assembled, along with the control consoles and optional remote fluoro control unit.

2.3.0 REMOVAL FROM PACK

1. Inspect the shipping pack(s) for evidence of shipping damage. If there is evidence of shipping damage, note this in the event that a damage claim is justified.

2. Locate any documentation attached to the outside of the cardboard sleeve for the generator pack. Be sure to read and understand this documentation before unpacking the generator. Then set this documentation aside temporarily until it can be transferred to a storage location close to the generator for future reference.

3. Remove the cardboard outer pack(s).

CAUTION: ***OPEN THE CARDBOARD PACK(S) AND STRETCH WRAP PACKAGING CAREFULLY. SHARP TOOLS MAY DAMAGE THE CONTENTS.***

4. Set aside the cardboard pack(s).

5. Remove and unpack the control console, any cables packed with the generator, the optional remote fluoro control if used, and the optional hand switch kit if included.
   - Units equipped with a touchscreen console are shipped with the base as a separate component. Remove and unpack the base and check for any damage.

6. Unscrew the bolts that secure the generator to the shipping pallet. Carefully lift the generator from the pallet. Refer to 2.3.1 for the procedure for lifting the generator.

7. If applicable, unpack the optional line-adjusting transformer.

8. Inspect all items for shipping damage. Refer to 2.4.0 for instructions for removing the generator external covers.

9. Unscrew the leveling feet at the bottom of the generator by a minimum of 1 ½ in. (35 mm). This will provide the required airflow underneath the generator cabinet and allow room to make leveling adjustments when the generator is placed in its final location.

NOTE: ***SUPPORT THE CARDBOARD PACKS CONTAINING THE TOUCHSCREEN CONSOLE AND BASE COMPONENTS WHEN REMOVING THE STRETCH WRAP PACKAGING. PRODUCT DAMAGE OR PERSONAL INJURY MAY OCCUR IF THESE ARE NOT SUPPORTED.***

10. Remove and unpack the manuals and any other paperwork that may be packed with the generator.

11. Keep the shipping containers. In case of shipping damage, place the unit(s) back in their shipping pack(s) and notify the carrier and the customer support group at CPI Canada Inc.

2.3.1 Lifting The Generator

One of the following methods is recommended for lifting or maneuvering the generator. Since the generator weighs more that 30 kg (65 lbs), proper lifting equipment should be used or additional help should be obtained to lift the unit. Refer to figure 2-2 for identification of the panels referenced below.

- Lifting straps can be used along with a hoist to raise the generator. The straps should be placed underneath the generator cabinet and along the four sides to properly support the cabinet as it is raised.

- Remove the main access panel and the lower wiring access panel from the generator cabinet. Refer to 2.4.0 for instructions for removing the external covers. The metal cross brace found at the front of the cabinet (below the circuit board mounting panel) may be used, in conjunction with the lip at the upper edge of the opening for the lower wiring access panel, as lifting points. Two people (one on each side) will be required to lift or maneuver the generator cabinet.

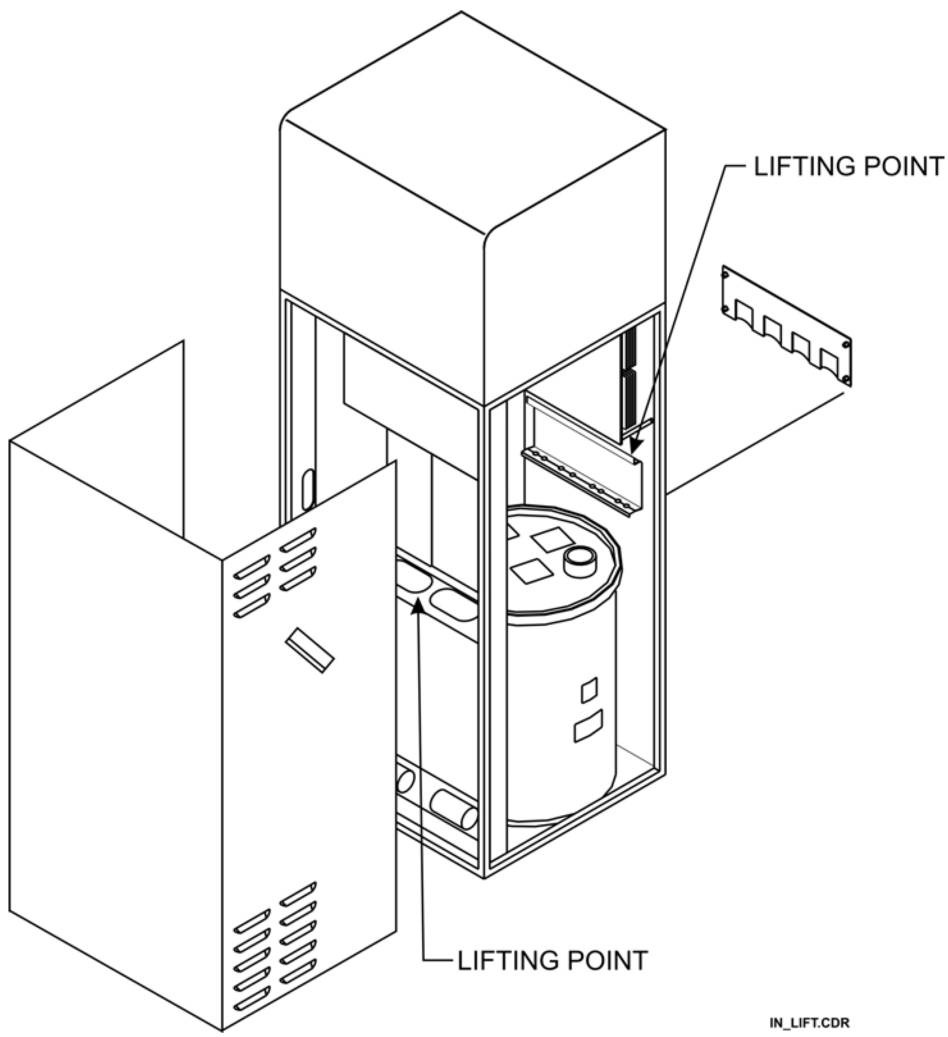

Figure 2-1: Generator lifting points

2.4.0 REMOVING THE EXTERNAL COVERS

***NOTE*: A POTENTIAL HAZARD EXISTS TO OPERATORS, SERVICE PERSONNEL, OR TO THE EQUIPMENT IF THE GENERATOR IS OPERATED WITH ANY OF THE GROUND LEADS TO THE EXTERNAL COVERS DISCONNECTED OR IMPROPERLY CONNECTED.**

BE SURE TO PROPERLY RECONNECT ALL GROUND LEADS AFTER COMPLETING ANY PROCEDURE THAT REQUIRES THEIR REMOVAL.

REFER TO FIGURE 2-2 FOR IDENTIFICATION OF COVERS / PANELS DESCRIBED IN THIS SECTION.

Upper Cabinet Hood

Most generator service and adjustments can be performed by flipping back the hood. It is rarely necessary to completely remove the hood. However, both procedures are detailed below:

Flipping back the hood

Remove the upper wiring channel if fitted. The procedure for doing this is detailed later in 2.4.0. Remove screws **A** (four places, shown in figure 2-2) on both sides of the hood. Loosen screw **B** on both sides of the hood by 1-2 turns.

Lift up on the front of the hood, allowing the hood to pivot on screws **B**. The hood should be supported when flipped open such that the hood does not exert excess pressure on the back of the cabinet.

Removing the hood

With the hood flipped back, disconnect the ground wire at the base of the upper cabinet. Lower the hood back to its normal position and remove the two upper screws (**B** in figure 2-2). Firmly grip the sides of the hood and slide the hood away from the rest of the cabinet.

Be sure to properly re-connect the ground lead when the hood is replaced.

Main Access Panel

Flip back the upper cabinet hood as described above. This must be done before the main access panel can be removed. Then remove the screws that secure the main access panel to the generator cabinet (these screws are located on both sides of the main access panel). The panel may then be pulled away from the frame. Temporarily disconnect the ground lead connecting the panel to the cabinet, if necessary.

Reverse the above steps to reconnect the ground wire(s), and to reinstall the access panel.

Lower Wiring Access Panel

THIS PANEL IS NOT FITTED IF THE OPTIONAL WIRING CHANNELS ARE USED.

Remove the screw from the upper right hand corner of the panel. Pull out the snaps on the three nylon fasteners such as to release the panel. Remove the panel from the generator.

2.4.0 REMOVING THE EXTERNAL COVERS (Cont)

Upper & Lower Wiring Channels

The wiring channels are optional. If the wiring channels are fitted, the lower wiring access panel will not be used.

To remove the lower wiring access panel, remove the screws from the upper left and upper right corner of the panel to be removed. Then slide the wiring channel up such that the shoulder rivets clear the keyhole slot at the bottom of the channel. The wiring channel may then be removed from the generator.

To remove the upper wiring access panel, remove the screws from the upper left and upper right corner of the panel. Then pull out the snaps on the nylon fasteners at the bottom corners of the panel. The wiring channel may then be removed.

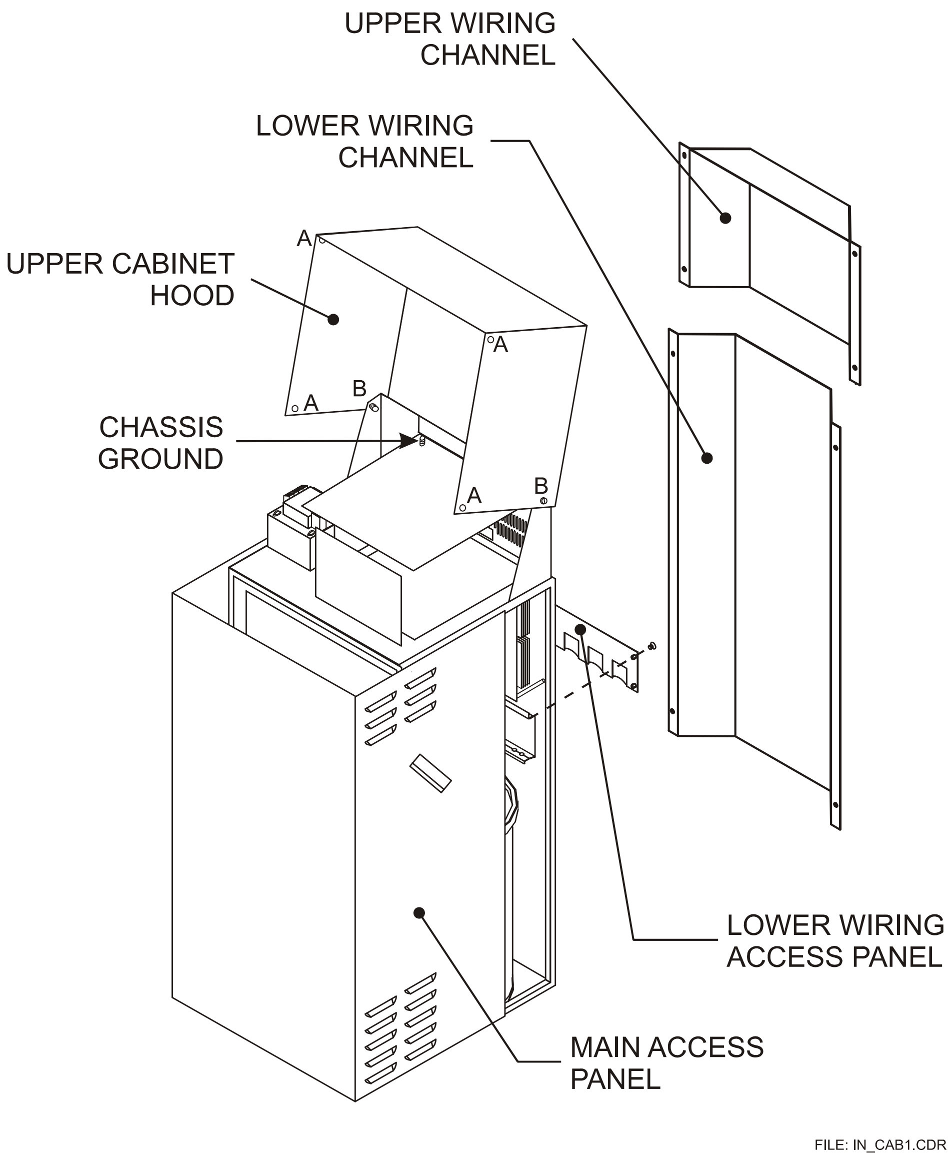

Figure 2-2: Removable external covers on generator cabinet

2.5.0 LINE-ADJUSTING TRANSFORMER

An optional line-adjusting transformer is available if required to allow 480 VAC generators to operate from 400 VAC mains, or to allow 400 VAC generators to be operated from 480 VAC mains. The line-adjusting transformer is supplied in a separate enclosure. Please consult the factory for further details regarding this option.

2.6.0 MAJOR COMPONENT LAYOUT

Refer to chapter 1E for major component identification and layout.

2.7.0 INSPECTING THE HT TANK

Before continuing with the installation of the generator, the HT tank should be inspected as per the following steps:

- Verify that there is no obvious shipping damage to the tank (i.e. dents to the tank surface).
- Carefully check the inside of the generator cabinet and the HT tank for evidence of any oil loss. Refer to chapter 6 if it is suspected that there has been some loss of oil.
- Verify that the clamps supporting the HT oil tank are tight.
- Verify that all the connections to the tank lid are secure.
- Verify that the rubber vent plug on the top of the tank is snug (not fitted on all models).
- Ensure the vent hole is not blocked (not fitted on all models).

2.8.0 EQUIPMENT PLACEMENT

2.8.1 Equipment Cabinet

Place the equipment cabinet in a location that will allow the following:

- Easy front and side access for service and sufficient clearance at the rear for room interface cables. Refer to chapter 1C.
- Air circulation - a minimum height of 1 ½ in. (35 mm) is recommended to allow airflow underneath the generator. Do not cover or block the cooling slots on the cabinet.
- Stable footing - the leveling feet at the bottom of the cabinet will be used to prevent movement during normal operation.
- Close proximity to service disconnect boxes - cables should not be on the floor where they could be stepped on.

2.8.2 Control Console

<u>Membrane Console</u>

Locate the control console in its intended position and ensure that it is stable. Refer to chapter 1C:

- The control console (membrane console, touchscreen console, or mini-console) must be located inside an X-ray shielded control booth within the X-ray room, or outside the X-ray room.
- If the console is located on a shelf, supply index pins or equivalent hardware to the base of the console to prevent slipping.
- Ensure that the console is mounted at a height and angle to allow easy viewing of the displays.
- If the optional CPI pedestal stand is to be used for the console mounting, follow the mounting instructions supplied with the stand.
- Leave sufficient slack in the cabling to the console to allow for future service and maintenance.

2.8.2 Control Console (Cont)

The following steps apply to the Rad-only console.
In some jurisdictions, regulations demand that the console PREP and EXPOSE buttons be disabled if a hand switch assembly is being employed. This is done by removing JW1 and JW2 from the Rad-only console board.

1. Turn the console upside down and place on a clean, non-abrasive surface.
2. Remove and set aside the hardware from the console ground stud and the six screws securing the base to the molded case.
3. Remove the console bottom (the metal bottom panel with the feet attached).
4. Locate and remove JW1 and JW2. Refer to figure 1E-4 for location of JW1 and JW2.
5. Reassemble the console using all the original hardware.

<u>Touchscreen Console</u>

The touchscreen base is shipped as a separate component and must be attached to the touchscreen console before being wired to the generator. A hex key has been included to adjust the tension on the tilt arm mechanism. A Phillips screwdriver is required to attach the base to the touchscreen console.

1. Carefully unpack the touchscreen console and the desk-mount base components and set the packaging aside. Verify that all components are present and undamaged. Note: To avoid damage to the LCD touch sensitive display, place the touchscreen console on a FLAT, CLEAN, NON-ABRASIVE surface.
2. There are two sets of VESA (Video Equipment Standards Association) mounting holes on the back plate and on the touchscreen console. One set is spaced at 100 mm and the other set is spaced at 75 mm. CPI recommends the use of the 100 mm spaced VESA holes. Line up the back plate with the touchscreen (observe orientation). Attach the base using the screws provided. See figure 2-3.

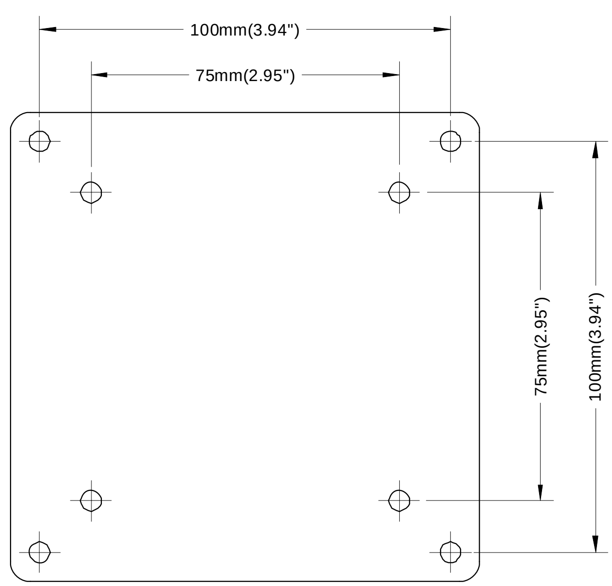

Figure 2-3: Touchscreen base back plate showing VESA mounting holes

2.8.2 Control Console (Cont)

NOTE: ***THE SET SCREW COLLAR MUST BE SECURED ON THE UPPER HALF OF THE TILT ARM TO PREVENT PERSONAL INJURY SHOULD THE TOUCHSCREEN SLIP WHILE ADJUSTING THE VIEWING HEIGHT.***

ADJUST THE SET SCREW COLLAR (FIGURE 2-5) USING THE PROVIDED HEX KEY BEFORE ADJUSTING THE HEIGHT OF THE TOUCHSCREEN CONSOLE. THE SET SCREW COLLAR MUST BE POSITIONED SUCH THAT THERE IS NO LESS THAN 25mm (1 inch) OF CLEARANCE BETWEEN THE BOTTOM EDGE OF THE TOUCHSCREEN CONSOLE AND THE TOUCHSCREEN BASE PLATE WHEN THE TOUCHSCREEN IS ADJUSTED TO ITS MINIMUM HEIGHT.

PLEASE BE SURE TO SUPPORT THE TOUCHSCREEN CONSOLE WHEN ADJUSTING ITS VIEWING POSITION.

NOTE: ***DO NOT LOCATE THE CONTROL CONSOLE WHERE X-RADIATION MAY BE PRESENT DURING INSTALLATION OR OPERATION.***

NOTE: ***IT IS RECOMMENDED THAT THE CONSOLE CABLE NOT BE DISASSEMBLED FOR SYSTEM INSTALLATION. HOWEVER, IF THIS IS ABSOLUTELY NECESSARY TO ROUTE THE CABLE, PLEASE ENSURE CAREFUL AND CORRECT REASSEMBLY OF THE CONNECTOR SHELL TO AVOID ANY POSSIBILITY OF PINCHING OF THE INTERNAL WIRES BY THE SHELL.***

YOU MAY CHOOSE TO TEMPORARILY LOCATE THE CONSOLE NEAR THE GENERATOR FOR INITIAL PROGRAMMING AND CALIBRATION. IF THIS IS SO, PLEASE COMPLETE THE FINAL CONSOLE INSTALLATION PER THIS SECTION WHEN THE GENERATOR INSTALLATION IS COMPLETED.

2.8.3 Anchoring The Generator To The Floor

If it is desired to anchor the generator to the floor, refer to chapter 1C. This should not be done until all cable hookups are completed that require rear access to the generator.

2.8.4 Leveling

Adjust the leveling feet such that the generator is level and stable. This adjustment must be made for both anchored and freestanding generator installations. As noted earlier, the leveling feet must be unscrewed by a minimum of 1 ½ in. (35 mm) to allow for proper airflow underneath the generator.

2.9.0 WIRING TO THE GENERATOR

Ferrules should be used on the ends of all stranded wires that are connected to terminal connections in the generator. These must be supplied by the installer.

2.9.1 Control Console

DO NOT CONNECT UNAPPROVED EQUIPMENT TO THE REAR OF THE CONSOLE.

For the 23 X 56 (cm) console, J5 is used for the interconnect cable to the generator main cabinet, J4 is not used, J2 is a serial port for use by an external computer, and J1 is for connection of an optional printer.

For the 31 X 42 (cm) console, J5 is used for the interconnect cable to the generator main cabinet, J2 is a serial port for use by an external computer, and J13 is for connection of an external hand switch and / or foot switch.

For the Rad-only console, J3 is for connection of an external hand switch, J4 is a serial port for use by an external computer, and J8 is for the interconnect cable to the generator main cabinet.

For the touchscreen console, GEN on the rear of the touchscreen console is for the interconnect cable to the generator main cabinet, HS is for connection of an external hand switch, COM 1 and COM 2 are serial ports for use by external devices, LO (3.5 mm stereo jack) is for customer supplied speakers (minimum 8 ohms, do not use externally amplified speakers), ETH is a standard 10/100 ethernet connection, USBA and USBB are USB ports for connection of external devices, CF is for the compact flash memory card which holds the touchscreen software and SW1 is the console upgrade button.

INCORRECT CONNECTIONS OR USE OF UNAPPROVED EQUIPMENT MAY RESULT IN INJURY OR EQUIPMENT DAMAGE.

Membrane Console

1. For the 23 X 56 (cm) console and the 31 X 42 (cm) console route the generator end of the console cable into the generator cabinet via the access cover in the upper part of the cabinet nearest to J4 on the generator interface board.

   For the Rad-only console, note the protective cover connected to the console cable. This is intended to protect the console cable connectors during shipping and routing of the console cable during installation. Disconnect the generator end of the cable (the end with the ferrite bead) from the protective cover, and then route the free end of the cable (with the protective cover attached) as required. Remove and discard the protective cover when finished. After removing the protective cover, inspect the console cable connectors for any and all damage. Please see figure 2-4 for an example of such damage.

2. For the 23 X 56 (cm) console and the 31 X 42 (cm) console, connect the console cable to J4 on the generator interface board.
   For the Rad-only console, connect the generator end of the console cable to J16 on the generator interface board.

3. Connect the free end of the console cable as follows:

   For the 23 X 56 (cm) console and the 31 X 42 (cm) console, connect the free end of the console cable to J5 at the rear of the console.

   For the Rad-only console, connect the free end of the console cable to J8 at the rear of the console.

   Ensure that the screw locks are fully tightened to secure the connectors.

2.9.1 Control Console (Cont)

Figure 2-4: Console cable connector damage example

Touchscreen Console:

1. Route the generator end of the console cable into the generator cabinet via the access cover in the upper part of the cabinet nearest to J4 on the generator interface board. Connect the generator end of the console cable to J4 on the generator interface board.

2. Connect the free end of the console cable to GEN on the rear of the touchscreen console. Ensure that the screw locks are fully tightened to secure the connectors.

3. Connect one end of the supplied ground wire to the touchscreen console ground screw, shown in figure 2-5. Connect the other end of the ground wire to the ground stud on the inside rear of the generator control chassis (“chassis ground” in figure 2-2). Note that this ground wire is required for EMC compliance only. It has no safety impact.

4. Optional: Connect the customer-supplied speakers (minimum 8 ohms) to LO (3.5 mm stereo jack) on the rear of the touchscreen console (do not use externally amplified speakers). Use cable ties to secure the speaker cable to the console cable for support. Pins 1 and 2 (left and right) of the 3.5 mm male stereo jack must be shorted together at the speaker end. Please note that connecting external speakers will disable one of the on-board touchscreen speakers.

   Figure 2-5 shows the designations and functions of the connectors on the rear panel of the control console.

2.9.1 Control Console (Cont)

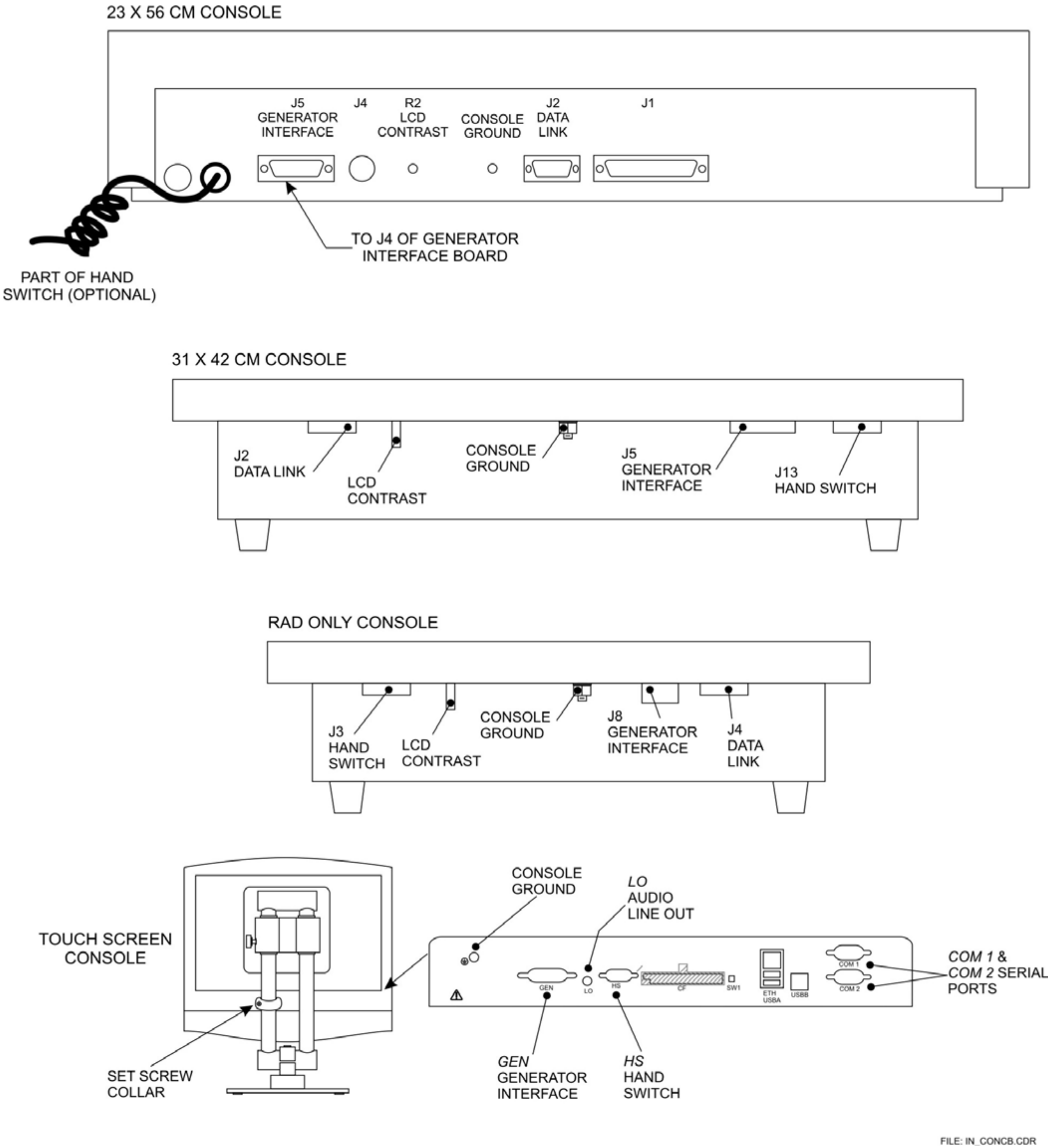

Figure 2-5: Rear of control console

Use and disclosure is subject to the restrictions on the title page of this CPI document.

2.9.2 Remote Fluoro Control (Optional)

1. Connect the free end of the 9-conductor remote fluoro cable (from the optional remote fluoro control box) to J11 of the generator CPU board. Ensure that the screw locks are fully tightened to secure the connector. Refer to figure 2-6 for the location of J11 on the generator CPU board. The cable should be routed into the generator via the access cover in the upper part of the cabinet closest to J11 on the generator CPU board.

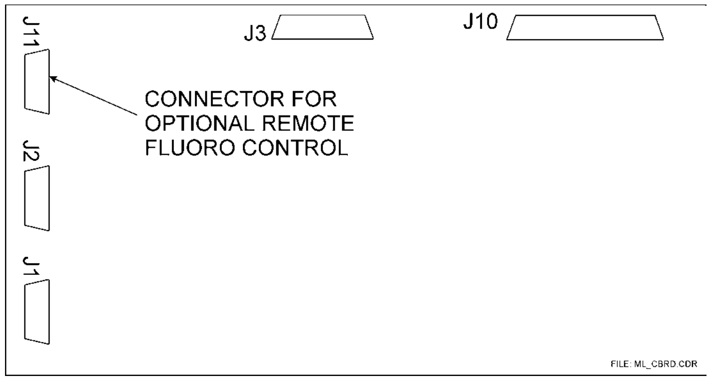

Figure 2-6: Remote fluoro connector on generator CPU board

2.9.3 Hand Switch Installation

FOR 23 X 56 (CM) CONSOLES:

The optional hand switch is supplied as a kit that must be user installed. If this option is used, refer to separate installation instructions packaged along with the hand switch.

For reference, a drawing is supplied in this section showing the hand switch connections to the console CPU board. See figure 2-7.

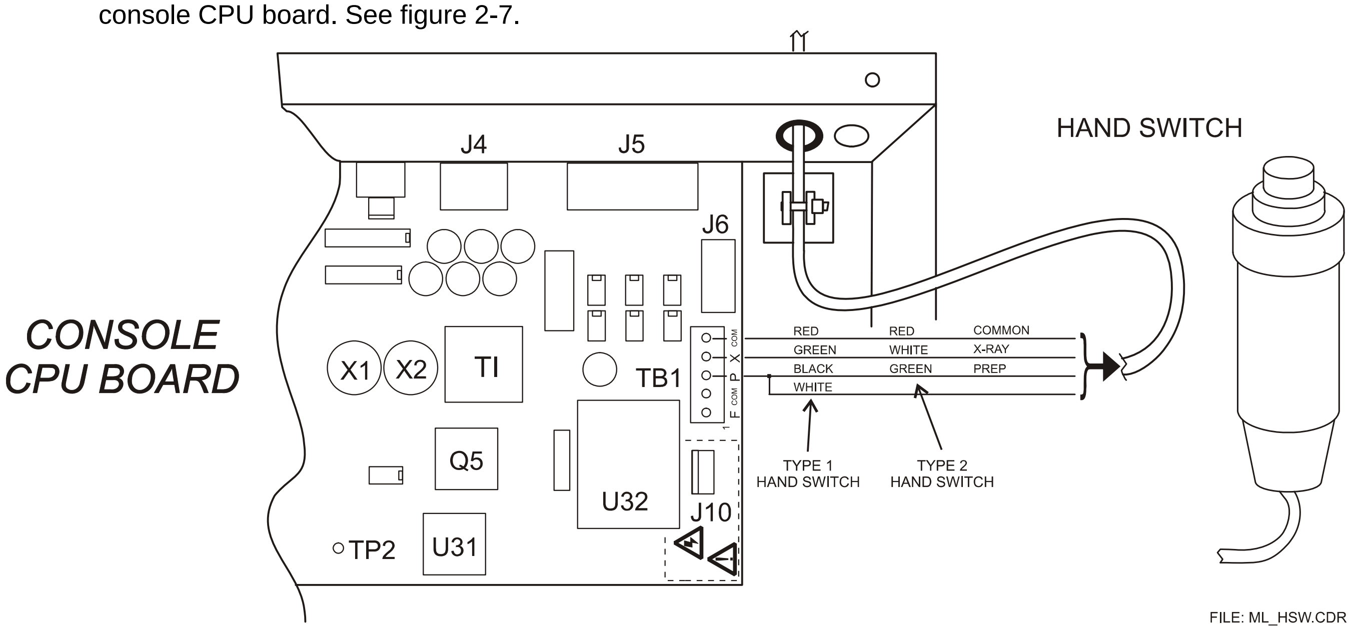

Figure 2-7: Hand switch connections on console CPU board

2.9.3 Hand Switch Installation (Cont)

FOR 31 X 42 (CM) CONSOLES, RAD-ONLY CONSOLES, AND TOUCHSCREEN CONSOLES:

The optional hand switch, if ordered from CPI Canada Inc, is supplied pre-wired to a male 9-pin subminiature ‘D’ connector. This connects to J13 on the rear of the 31 X 42 cm console, to J3 on the rear of the Rad-only console, or to HS on the rear of the touchscreen console.

Fluoro foot switch connections may also be made to this connector (31 X 42 cm console with fluoro option only). For the touchscreen console, the fluoro foot switch connections must be made to the room interface board as per chapter 3B.

The table below shows the pin designations for the hand switch connector on the console. A male 9-pin subminiature ‘D’ connector will need to be provided by the installer if the CPI supplied hand switch is not used.

PIN NUMBER	J13 PIN CONNECTIONS 31 X 42 CM CONSOLE	J3 PIN CONNECTIONS RAD-ONLY CONSOLE AND HS PIN CONNECTIONS TOUCHSCREEN CONSOLE
1	Hand Switch: X-Ray	Hand Switch: X-Ray
2	No Connection	No Connection
3	Hand Switch: Prep	Hand Switch: Prep
4	No Connection	No Connection
5	Hand Switch: Common (ground)	Hand Switch: Common (ground)
6	No Connection	NOT USED
7	Foot Switch: ‘live’ terminal	NOT USED
8	No Connection	NOT USED
9	Foot Switch: ‘ground’ terminal	NOT USED

2.9.4 X-Ray Tube Stator & Thermal Switch Connections

Refer to figure 2-8 for the X-ray tube stator and thermal switch connections.

1. Route the X-ray tube stator cable(s) through the lower wiring access panel on the rear of the generator cabinet, then route the cables towards the stator terminal blocks as shown in the figure below.

   FOR UNITS WITH A LOW SPEED STARTER, SHIELDED STATOR CABLES ARE RECOMMENDED. FOR UNITS WITH A DUAL SPEED STARTER, SHIELDED STATOR CABLES MUST BE USED.
   THE SHIELD FOR THE STATOR CABLE(S) MUST BE PROPERLY GROUNDED AT BOTH THE TUBE END AND THE GENERATOR END OF THE CABLE(S). SEE FIGURE 2-8 FOR GROUNDING AT THE GENERATOR END.

2. Connect the wires to the appropriate terminal as shown. The tube thermal switch will normally be connected to the THERMAL SWITCH connections on the stator terminal block, but may optionally be connected to the room interface board (refer to chapter 3B).

3. Ensure that all terminal connections are tight, then dress and secure the cables.

NOTE: ***ONE TUBE ONLY GENERATORS WILL HAVE 1 STATOR TERMINAL BLOCK FITTED. THE LOWER TERMINAL BLOCK IN FIGURE 2-8 IS ONLY FITTED ON TWO TUBE GENERATORS.***

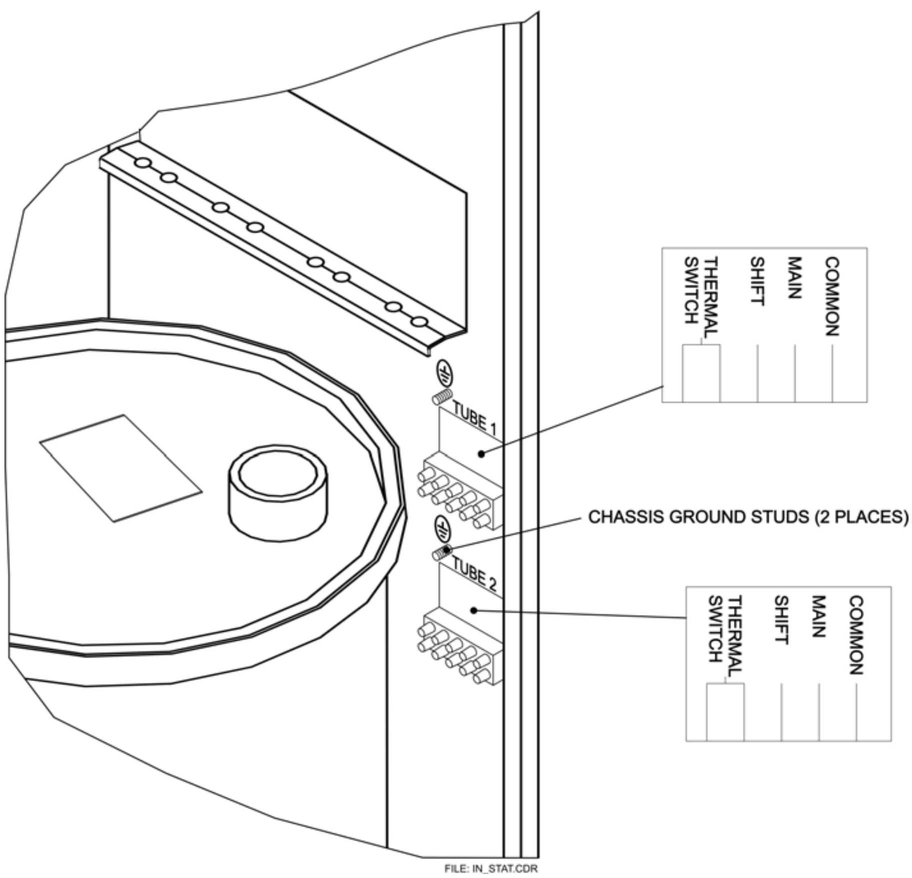

Figure 2-8: Stator connections to generator

2.9.5 Generator Mains Connection

WARNING: ***TO AVOID ELECTRICAL SHOCK, ENSURE THAT THE AC MAINS DISCONNECT IS LOCKED IN THE OFF POSITION, AND THAT ALL MAINS CABLES ARE DE-ENERGIZED BEFORE CONNECTING TO THE GENERATOR.***

Refer to chapter 1C for generator power and generator power line requirements.

1. Pass the AC mains cable through the access hole located at the lower rear of the generator.

2. Use an appropriate cable clamp to secure the mains cable at the cabinet entrance.

3. Temporarily remove the safety cover from the main fuses. Strip sufficient cable jacket to allow the ground wire to reach the main ground connector located at the left side of the main fuse block. Refer to figure 2-9.

4. Connect the ground wire to the main ground connector, and connect the mains wires to the terminals on the bottom of the main fuse holder (3 wires for 3 phase systems, 2 wires for single phase systems). Be sure to replace the main fuse safety cover after all connections are made and properly tightened.
   - Ferrules should be used on the ends of the AC mains wires. These must be supplied by the installer.
   - For China only, the power cable must be CCC approved

5. **DO NOT SWITCH ON MAINS POWER AT THIS TIME.**

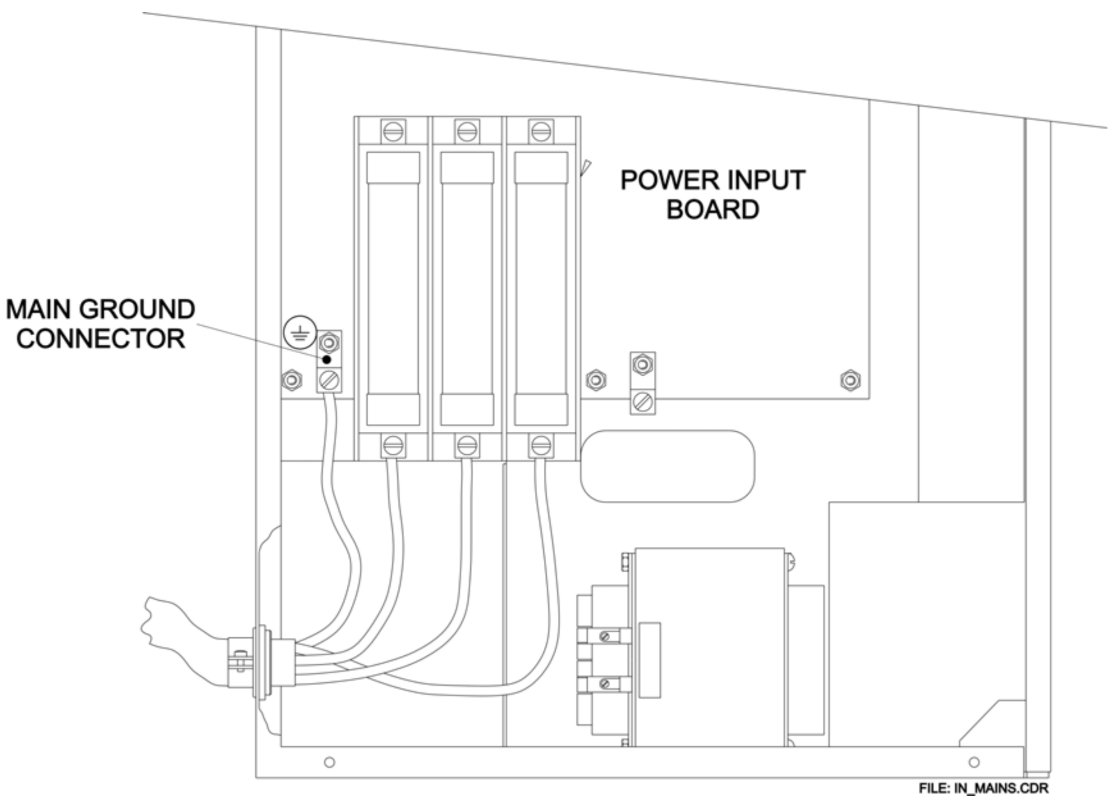

Figure 2-9: Generator mains connections

2.9.6 Room Equipment

Refer to chapter 3B, 3D, 3E, and 3F for connection of the room equipment (Buckys, miscellaneous inputs and outputs, AEC devices, digital imaging systems, DAP, etc.). It is suggested that these items not be connected until after the initial run-up of the generator is complete, and the tube auto calibration has been performed as described near the end of this chapter.

2.9.7 Emergency Power Off / Power Distribution Relay

To connect an external emergency power-off switch, disconnect the jumper from J17-1 to J17-2 on the generator interface board. Then connect the emergency-off switch to J17-1 and J17-2. Refer to MD-0762 in chapter 9.

For installations where installer-supplied auxiliary power distribution circuits are added to the generator, 24 VDC is available on the generator interface board to drive the coil of the power distribution relay. Connect the coil to J17-3 (+) and J17-4 (ground). Refer to MD-0788 in chapter 9. **The maximum current available from this source is 100 mA.**

2.10.0 X-RAY TUBE HOUSING GROUND

A separate ground wire (10 AWG, 6mm^2) must be connected from each X-ray tube housing to one of the ground studs on the HT tank. Refer to figure 2-9 or 2-10. These ground locations may have other ground wires already connected, ensure that these existing ground wires are not disconnected when making the X-ray tube ground connection.

Failure to make this ground connection may result in intermittent operation and/or exposure errors.

2.11.0 HIGH TENSION CABLES

The X-ray tube(s) should be mounted on their normal fixtures i.e. tube stand, G.I. table or other devices.

1. Verify that the HT cable terminations are clean, in good condition i.e. no cracks, and coated with vapor proof compound. The contact pins must be opened sufficiently to make good contact with the mating connector in the HT tank.

2. Remove the plastic caps that cover the high voltage terminals on the HT tank. These should be saved in case of a future requirement to transport the generator or HT tank.

3. Connect the high-tension cables as per the installation requirements. Ensure that the cables for tube 1 (and tube 2 if used) are plugged into the proper connectors on the HT tank. Refer to figure 2-10 and 2-11.

4. Be sure that the HT cable connectors are tight and there is ***no play between*** the connector insulator and the screw down ring.

2.11.0 HIGH TENSION CABLES (cont)

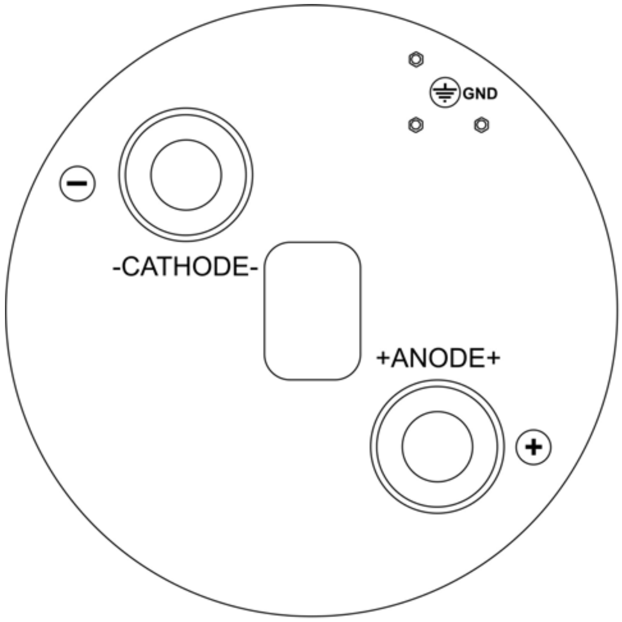

Figure 2-10: HV connectors (1 tube tanks)

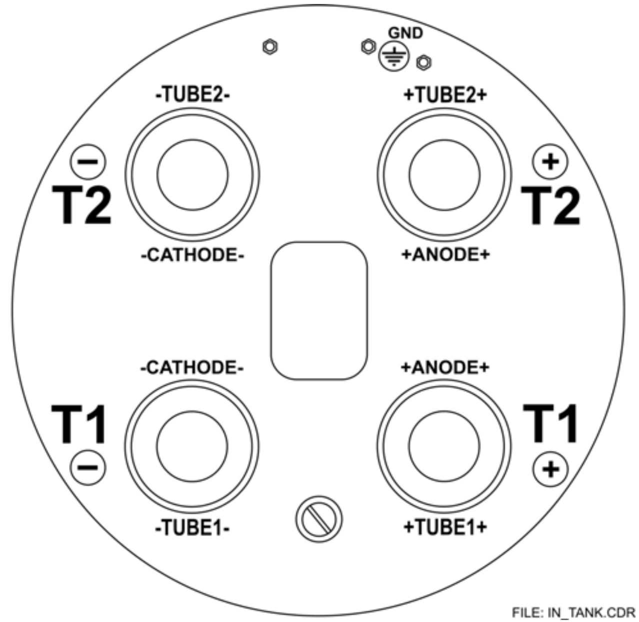

Figure 2-11: HV connectors (2 tube tanks)

NOTE:* *PLEASE OBSERVE THE FOLLOWING IF USING METAL CENTER SECTION X-RAY TUBES

The mA feedback signals, as measured at the mA test points on the control board, represent ***anode*** mA. X-ray emission in the tube is a result of the anode current.

The mA measured at terminals E17 - E18 of the HT tank is ***cathode*** current. In a metal center section tube, the anode current will be less than the cathode current, the difference being body current. In a metal center section tube, the cathode current may exceed the anode current by up to 15%. Although the anode and cathode currents may be unequal, the anode to cathode kV regulation is not affected.

Due to the presence of body current, filament drive and emission may need to be greater than expected for a given mA station. The power "lost" to body current may need to be considered relative to the maximum generator output.

When installing a metal center section tube, it is essential that the center section of the X-ray tube be securely grounded; otherwise, premature tube failure may result.

2.12.0 PROGRAMMING THE LOW SPEED STARTER

This section applies only to units fitted with the low speed starter.

PLEASE BE SURE TO READ AND UNDERSTAND THIS SECTION FULLY BEFORE PROCEEDING.

Before continuing, note the part number of the low speed starter in the generator. Part number 732752-**00** has 30 μF phase-shift capacitance; part number 732752-**01** has 12.5 μF phase-shift capacitance; part number 732752-**02** has 45 μF phase-shift capacitance and part number 732752-**04** has 100 μF phase-shift capacitance. Confirm that the phase shift capacitor(s) are compatible with the desired tube(s) as listed in table 1 in supplement 746026, which follows chapter 2.

The starter boost voltage is set to approximately 240 VAC, (except where specifically noted in table 1 in supplement 746026), and the starter run voltage is selectable to be 52, 73, or 94 VAC. Boost times are selectable to be either 1.5 seconds, or 2.5 seconds. Therefore, the generator may be configured to be compatible with stator types as per table 1 in supplement 746026.

If the desired tube type is not listed, please contact CPI product support for assistance.

WARNING: ***240 VAC IS PRESENT ON THE LOW SPEED STARTER BOARD AT ALL TIMES THAT THE GENERATOR IS SWITCHED ON. TAKE APPROPRIATE PRECAUTIONS WHEN SERVICING THIS BOARD***

2.12.1 Low Speed Starter Tube Select Table

See supplement 746026, which immediately follows this chapter.

2.12.2 Low Speed Starter Boost Voltage Selection

THIS APPLIES TO ONE-TUBE GENERATORS ONLY.

Follow the steps below to verify and configure the correct low speed starter boost voltage.

1. Confirm the required BOOST VOLTAGE for the selected tube type per table 1 in supplement 746026. The requirement for the vast majority of tubes in table 1 is 240 V. For tubes that require 120 V boost, this is noted along with the run voltage, boost time, etc for that tube.
   - Refer to figure 2-11 (power supply auxiliary transformer). Locate this transformer under the power input board; refer to chapter 1E for details.
   - If there is only one connection on the 120V tap on the power supply auxiliary transformer, the boost voltage is set to 240 VAC.
   - If there are two connections on the 120V tap, the boost voltage is set to 120 VAC.
   - Confirm the correct boost voltage at F1 on the low speed starter board with a suitable voltmeter.
   - Go to 2.12.3 if the boost voltage is properly set for the selected tube type and therefore does NOT need to be changed.

2.12.2 Low Speed Starter Boost Voltage Selection (Cont)

THIS APPLIES TO ONE-TUBE GENERATORS ONLY.

2. If the boost voltage tap on the power supply auxiliary transformer needs to be changed from 240V to 120V, proceed as follows:
   - Loosen the clamping screws for the 240V tap and for the 120V tap.
   - Move the boost voltage lead from the 240V tap to the 120V tap. The boost voltage lead is the lead that connects directly to J1 on the low speed starter board. Do not disturb the other leads on the 120V and / or 240V taps.
   - Ensure that the wires are positioned between the two metal clamps on the transformer terminal block.
   - Retighten both of the clamping screws.
   - Confirm the correct boost voltage at F1 on the low speed starter board with a suitable voltmeter.

3. If the boost voltage tap on the power supply auxiliary transformer needs to be changed from 120V to 240V, proceed as follows:
   - Loosen the clamping screws for the 120V tap and for the 240V tap.
   - Move the boost voltage lead from the 120V tap to the 240V tap. The boost voltage lead is the lead that connects directly to J1 on the low speed starter board. Do not disturb the other leads on the 120V and / or 240V taps
   - Ensure that the wires are positioned between the two metal clamps on the transformer terminal block.
   - Retighten both of the clamping screws.
   - Confirm the correct boost voltage at F1 on the low speed starter board with a suitable voltmeter.

2.12.3 Low Speed Starter Run Voltage Selection

Follow the steps below to verify and configure the correct low speed starter run-voltage.

1. Note the required RUN VOLTAGE for the selected tube type per table 1 in supplement 746026, which follows chapter 2. Then confirm the low speed starter run-voltage in the generator. This is determined by the run-voltage setting on the power supply auxiliary transformer. Refer to figure 2-12.
   - Locate this transformer under the power input board; refer to chapter 1E for details.
   - Locate the run-voltage output on the transformer. This will be set to the 52V, 73V, or 94V tap, and must match the required run-voltage for the selected tube in table 1.
   - Go to 2.12.4 if the run-voltage setting is correct for the selected tube type, and therefore does NOT need to be changed.

2. If the run-voltage setting on the power supply auxiliary transformer needs to be changed, proceed as follows:
   - Loosen the clamping screws for the current run-voltage tap, and for the required run-voltage tap.
   - Move the run-voltage output lead from the current tap position to the required tap position (52V, 73V, or 94V). Ensure that the wire is positioned between the two metal clamps on the transformer terminal block.
   - Retighten both of the clamping screws.

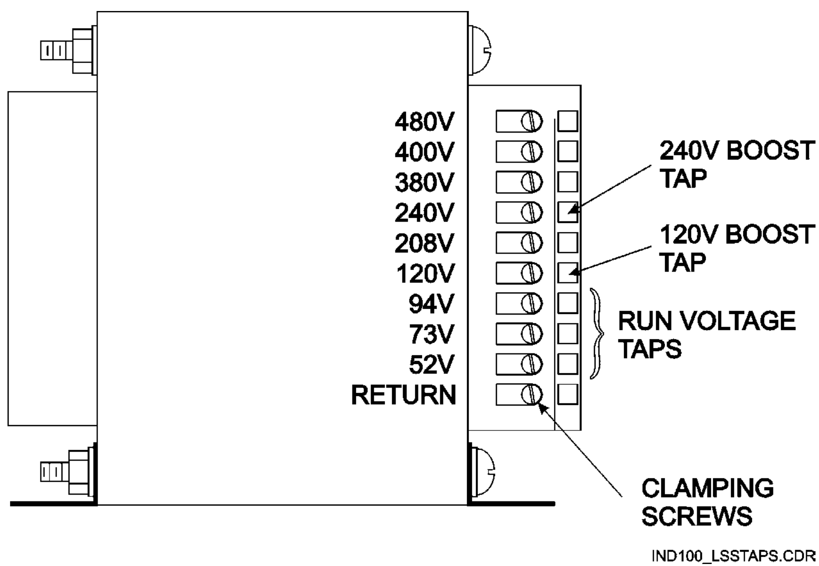

Figure 2-12: Low speed run-voltage tap selection

2.12.4 Low Speed Starter Boost Time Selection

Follow the steps below to verify and configure the low speed starter boost time.

1. Confirm the current low speed starter boost time selection:
   - Locate jumper JW1 on the auxiliary board. Refer to chapter 1E for the board location.
   - Confirm that the current boost time setting matches the tube in use: Jumper position "1.5S" = 1.5 second boost, no jumper at JW1 = 2.5 second boost. Do not use the ".15S" position.

2. If required, adjust the boost time by changing the JW1 jumper position as described above.

NOTE: ***CONFIRM PROPER LOW SPEED STARTER CONFIGURATION USING A SUITABLE TACHOMETER BEFORE MAKING ANY EXPOSURES.***

2.13.0 PROGRAMMING THE DUAL SPEED STARTER

This section applies only to units fitted with the dual speed starter option.

The dual speed starter must be programmed for the X-ray tube type(s) used at this site. This is done via DIP switches SW1 and SW2 on the dual speed starter.

The following tube functions are set with these switches:

- High speed start and run voltages
- Low speed start and run voltages
- Brake time and brake voltage (high speed)
- Boost times
- Boost time increments. Boost time may be increased in 100 ms steps in the range of 100 to 700 ms

SW1 and SW2 on the dual speed starter must be set correctly to match the X-ray tube(s) in use. Failure to set these correctly may result in improper anode RPM and therefore may damage the X-ray tube.
PLEASE BE SURE TO READ AND UNDERSTAND THIS SECTION FULLY BEFORE PROCEEDING.

2.13.1 Setting tube type

1. Select the desired tube type from table 2 in supplement 746026, which follows chapter 2. Record the tube type number (housing and insert) and the binary code as per the third column in the table. Please note that the tube compatibility applies only to the housing and inserts listed, i.e. for the specific manufacturer(s) shown.

2. If the desired tube type is not listed, please contact CPI product support for assistance.

3. Several dual speed starters are available, each configured to support one or more types of stators. Only stators of the type(s) supported by the dual speed starter currently installed may be used with this generator.

   REFER TO SECTION 2.13.2 IF IT IS DESIRED TO USE TUBES WITH STATOR TYPES NOT COMPATIBLE WITH THIS GENERATOR, OR IF YOU ARE NOT CERTAIN THAT THIS GENERATOR IS COMPATIBLE WITH THE STATOR IN YOUR TUBE.

2.13.1 Setting tube type (cont)

4. Refer to figure 2-13. Set the DIP switch SW1 (for tube 1) with the binary code for the selected tube. The binary code shown in the table programs the tube type (housing and insert), for example housing type Varian Sapphire with standard “R” stator and inserts per table 2 in Supplement 746026, which follows chapter 2, requires SW1-1 to be set ON, SW1-2 OFF, SW1-3 ON, SW1-4 OFF and SW1-5 OFF. This programs the voltages, brake times, and boost times in table 2.

   Additionally, SW1-6 to SW1-8 may be set to give incremental increases in boost time over the preselected values (i.e. to run an older tube with worn bearings). For example, binary 000 gives zero increase, binary 001 gives 100 ms increase, binary 100 gives 400 ms increase, and binary 111 gives a 700 ms increase in boost time. SW1-6 represents bit 1, SW1-7 bit 2, and SW1-8 represents bit 3.

   EXAMPLE:
   Binary 100 = decimal 4 = 400 ms incremental boost time increase:

1	0	0
Bit 3	Bit 2	Bit 1
SW1-8	SW1-7	SW1-6

5. The example DIP switch setting shown in figure 2-13 is for the example in step 4 with an incremental increase in boost time of 200 ms.

6. If this is a two-tube installation, repeat steps 1 to 4 using DIP switch SW2 for the second tube.

7. **Please confirm all settings using a suitable tachometer to ensure proper anode RPM before making any exposures.**

NOTE: ***FOR TUBES WHERE “LOW SPEED OPERATION ONLY” IS INDICATED, THE DUAL SPEED STARTER MUST BE PROGRAMMED FOR LOW SPEED ONLY, AND WHERE “HIGH SPEED OPERATION ONLY” IS INDICATED, THE DUAL SPEED STARTER MUST BE PROGRAMMED FOR HIGH SPEED OPERATION ONLY. REFER TO THE TUBE SELECTION SECTION IN CHAPTER 3C FOR THE PROCEDURE TO DO THIS.***

THE EXAMPLE DIP SWITCH SHOWN IN FIGURE 2-12 IS REPRESENTATIVE OF ONE STYLE OF SWITCH ONLY. DEPENDING ON MANUFACTURER, YOUR DIP SWITCH STYLE MAY VARY. PLEASE NOTE THE ON/OFF POSITIONS CAREFULLY FOR YOUR UNIT.

2.13.1 Setting tube type (cont)

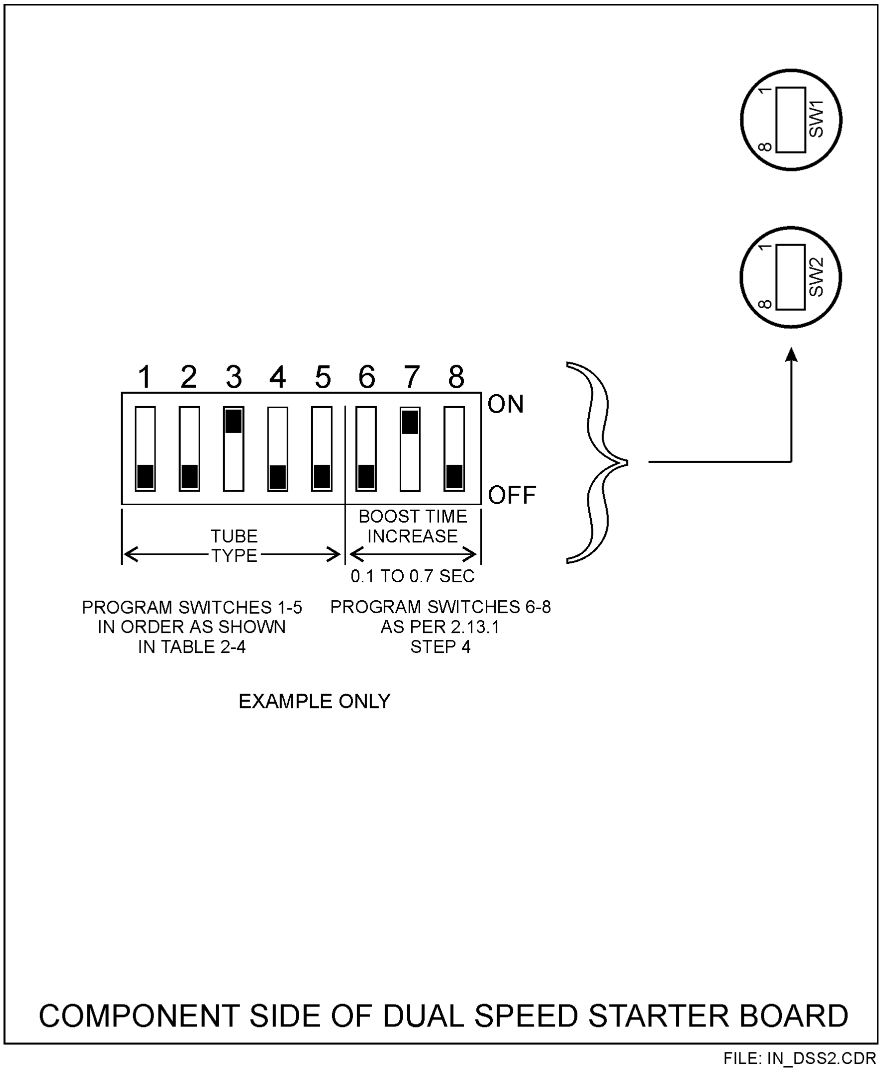

Figure 2-13: DIP switches on dual speed starter

2.13.2 Confirming/Changing DSS Starter Type

Note that some dual speed starters support more than one stator type via relays to switch the phase shift capacitors.

The low speed and high speed phase-shift capacitors for the stator start winding must be matched to the desired stator type, for example the required high speed phase shift capacitor is 6 uF for “R” type stators and 7.5 uF for GE Maxiray type stators. Therefore, for example, a dual speed starter that does not provide 7.5 uF of high speed shift capacitance CANNOT drive a GE Maxiray type stator.

Use the steps in this section to verify that the dual speed starter is compatible with the stator in the desired tube.

1. Record the part number of the dual speed starter assembly in the subject generator. This is printed on a label, near the top left side of the dual speed starter chassis, next to the ground label.

2.13.2 Confirming/Changing DSS Starter Type (Cont)

2. If it is desired to use a different tube from that shown in the compatible X-ray tubes section of the customer product description form, confirm that the desired tube (housing and insert) is listed in table 2 of Supplement 746026 which follows chapter 2, AND that one of the required dual speed starter part numbers for that tube per table 2 is the same as is fitted in your generator.
3. If the preceding steps confirm that the desired tube is fully compatible with the generator, you may proceed with setting the tube type as per section 2.13.1.
4. If in the preceding steps it is determined that the desired stator IS NOT compatible with the generator, the phase shift capacitors in the dual speed starter will need to be changed to match the requirements of the desired tube. Replacement capacitor kits are available to do this as noted in the next step.
5. Note the required H.S. SHIFT CAP. and L.S. SHIFT CAP. values, and the corresponding dual speed starter part number for the desired tube per table 2 in supplement 746026. Using those capacitor values, refer to table 2-1. From this table select the required conversion kit to convert to capacitors as required for the selected tube. The conversion kits are available through the factory/customer support.

IF MAKING THE ABOVE CONVERSION, PLEASE BE SURE TO CHANGE THE PART NUMBER IDENTIFIED IN STEP 1 TO THE NEW CONFIGURATION USING AN INDELIBLE MARKER. THIS WILL ENSURE THAT CONFIGURATION CONTROL OF THE PRODUCT IS MAINTAINED.

TABLE 2-1

DUAL SPD STARTER PART No REQUIRED	HIGH SPEED SHIFT CAP	LOW SPEED SHIFT CAP	CONVERSION KIT P/N
733317-01 / 735925-01	6 uF	31 uF	734424-00
733317-02 / 735925-02	20 uF	60 uF	734424-02
733317-12 / 735925-12	6 uF / 7.5 uF	36 / 37.5 uF	734424-12
733317-13 / 735925-13	5 uF / 6 uF	30 uF	734424-11
733317-15 / 735925-15	3 uF / 6 uF	15.5 / 28 uF	734424-11
733317-16 / 735925-16	6 uF / 12.5 uF	31 / 37.5 uF	734424-11
733317-17 / 735925-17	5 uF / 12.5 uF	30 / 37.5 uF	734424-11

NOTE: ***CAPACITOR VALUES SHOWN IN TABLE 2 IN SUPPLEMENT 746026 ARE EQUIVALENT VALUES OF THE PHASE SHIFT CAPACITORS IN THE DUAL SPEED STARTER. FOR EXAMPLE, THE "-13" VERSION OF THE DUAL SPEED STARTER USES TWO 12.5 uF CAPACITORS AND ONE 25 uF CAPACITOR CONNECTED IN SERIES TO GIVE NOMINAL 5 uF FOR HIGH SPEED USE. THIS 5 uF CAPACITANCE IS CONNECTED IN PARALLEL WITH A 25 uF CAPACITOR TO GIVE 30 uF FOR LOW SPEED USE AS SHOWN IN THE TABLES.***

2.13.3 Dual Speed Starter Tube Select Table

See Supplement 746026, which immediately follows this chapter.

2.13.4 Configuring dual speed starter 733317-15 / 735925-15

Dual speed starter part number 733317-15 / 735925-15 is a special configuration in which the low-speed phase shift capacitors may be set to 15.5 uF or 28 uF. The 15.5 uF setting is intended for use in installations where low-speed operation of CGR (GE) Statorix tubes is required. The high-speed capacitance is automatically selected to either 3 uF or 6 uF according to the DIP switch setting.

Refer to figure 2-14. In configuration “A”, (28 uF) two each of the leads are connected to the lower right capacitor. Thus, the capacitor is in-circuit in this configuration. Configuration “B” (15.5 uF) has one of the leads of this capacitor disconnected from the terminals of the adjacent capacitor, thus the capacitor is out of the circuit.

- To change from configuration “A” to “B”, disconnect the lower lead from the adjacent capacitor as shown in figure 2-14, and connect it to the same terminal of the lower right capacitor. This removes the lower right capacitor from the circuit.

- To change from configuration “B” to “A”, reconnect the lead between the two capacitors, as shown in figure 2-14. This connects the capacitor into the circuit.

After the phase shift capacitors are correctly configured, set the DIP switches as follows:

- Locate the desired tube(s) in table 2 of supplement 746026, which follows chapter 2. With dual speed starter 733317-15 / 735925-15 set to configuration “A”, this starter is compatible with all tubes requiring a 3 uF or 6 uF high-speed shift capacitor (unless indicated otherwise) and a 28, 30 or 31 uF low-speed shift capacitor. When set to configuration “B”, it is only compatible with tubes requiring a 3 uF or 6 uF high-speed shift capacitor (unless indicated otherwise) and a 15.5 uF low-speed shift capacitor. Set the DIP switches as per 2.13.1.

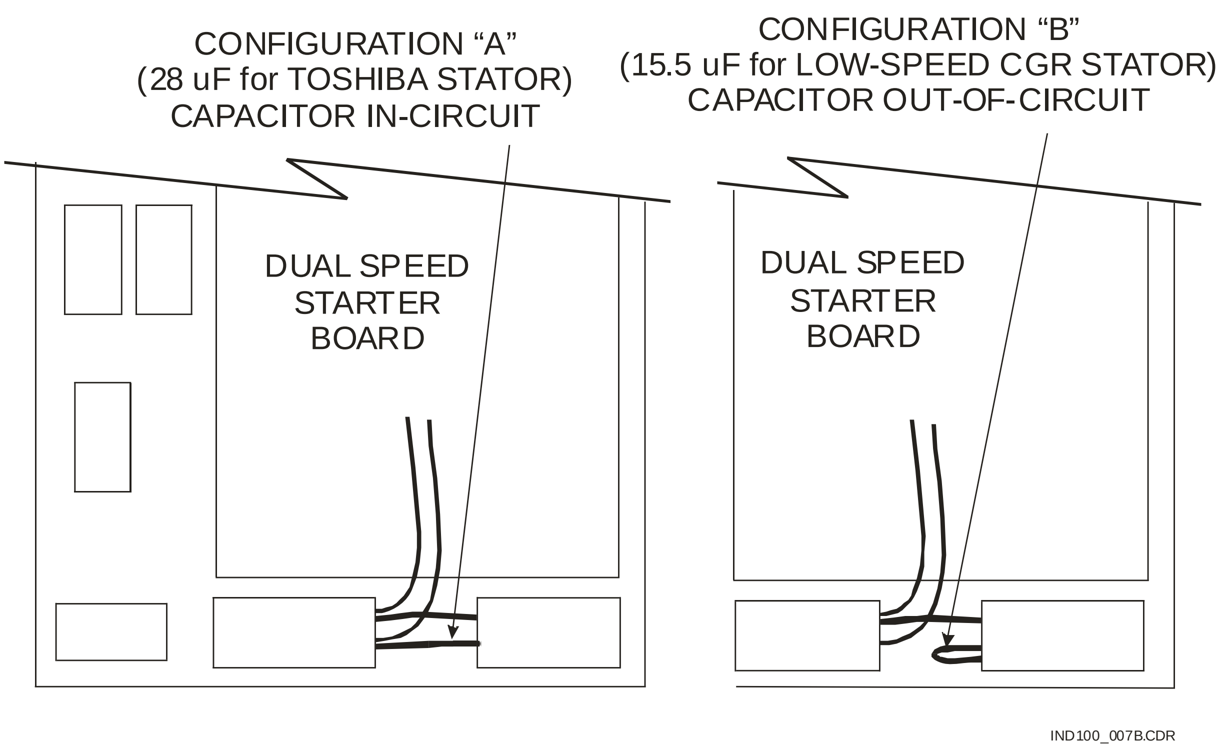

Figure 2-14: Selection of phase shift capacitance

2.14.0 GENERATOR LOCKOUT SWITCH

A safety lockout switch (S3) is provided on the generator interface board. When this switch is in the **LOCKOUT** position, the generator cannot be switched on either from the console or from the adjacent service switch S2 on the generator interface board. This prevents inadvertent switching on of the generator while it is being serviced.

S3, the generator lockout switch, must be in the **NORMAL** position to enable switching the generator on. Refer to figure 2-15 for these switch locations.

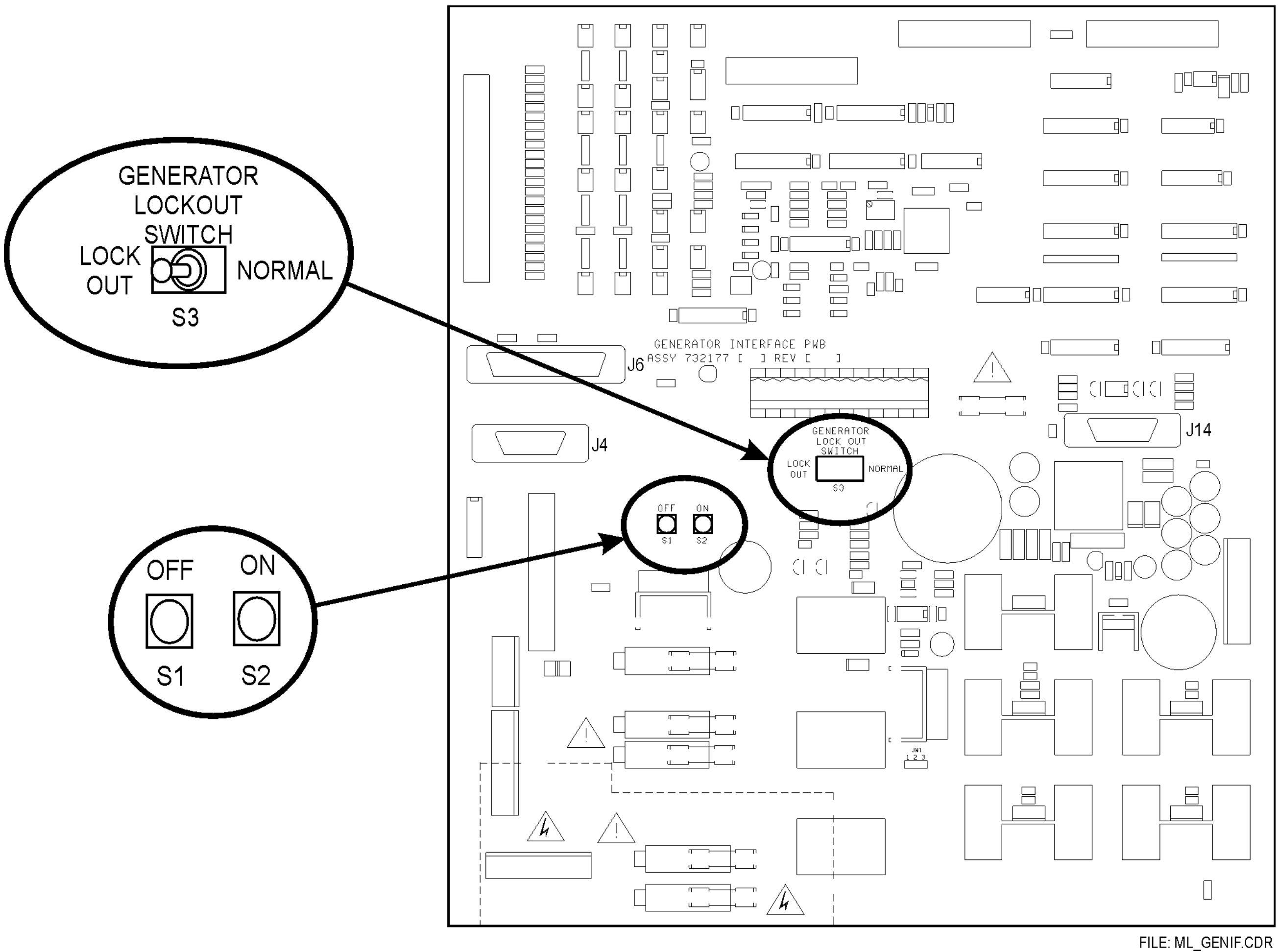

Figure 2-15: Location of lockout switch and local ON/OFF switches

2.15.0 SAFETY INTERLOCKS

It is strongly recommended that the following two interlocks be wired to the generator before preparing to make any exposures:

DOOR INTERLOCK
The room door interlock switch must be wired to the generator before proceeding. Use configuration A or configuration B as described below, depending on the desired mode of operation.

<u>Configuration A</u>

This configuration inhibits new exposures if the room door is open. This does not interrupt exposures in process when the door is opened. The door interlock switch is connected to TB4-4 and TB4-5 on the room interface board.

<u>Configuration B</u>

This configuration inhibits new exposures if the room door is open, and stops fluoro exposures if the room door is opened during a fluoro exposure. One pole on the door interlock switch is connected to TB4-4 and TB4-5 on the room interface board. One side of the second pole on the door interlock switch connects to TB6-5 on the room interface board, and one side of the fluoro footswitch connects to TB6-6. The other side of the room interlock switch and the other side of the fluoro footswitch should be spliced together using a suitable insulated connector. This wires the door interlock switch and the fluoro footswitch in series across the remote fluoro exposure input terminals TB6-5 and TB6-6. Refer to MD-0763 in chapter 9.

X-RAY TUBE THERMAL SWITCH
The X-ray tube(s) thermal switch(s) should be connected to the generator for tube thermal protection. These may be connected either at the stator terminal blocks (section 2.9.4), or at the room interface board. The connections on the room interface board are TB4-8 and TB4-9 for tube 1, and TB4-6 and TB4-7 for tube 2.

2.16.0 CHECKING THE RAM BACKUP BATTERY VOLTAGE

It is recommended that the backup battery voltage be checked before continuing. The normal life expectancy of these batteries is estimated at 5 years.

CONSOLE CPU BOARD (23 X 56 cm console):

1. Turn the operator console upside down carefully to protect the front panel. Remove the six screws securing the base to the molded case.

2. Open the console carefully, such that the interconnecting cables are not strained.

3. Locate the battery on the console CPU board; refer to figure 2-16. Measure the battery voltage with a DVM. The top of the battery is the positive side; ground (TP2 on the board) is the negative side.

4. The nominal battery voltage should be approximately 3.0V; replace the battery if it is under 2.80V.

5. Before closing the console, refer to the section ***DIP SWITCH SETTINGS*** in this chapter.

6. Re-assemble the console. DO NOT OVER TIGHTEN THE SCREWS SECURING THE BASE TO THE MOLDED CONSOLE TOP.

2.16.0 CHECKING THE RAM BACKUP BATTERY VOLTAGE (Cont)

CONSOLE BOARD (31 X 42 cm console and Rad-only console):

The 31 X 42 cm and the Rad-only consoles use flash memory, which does not require a backup battery.

GENERATOR CPU BOARD:

1. Locate the battery on the generator CPU board, refer to figure 2-16. Measure the battery voltage with a DVM. The top of the battery is the positive side; ground (TP21 on the board) is the negative side.

2. The nominal battery voltage should be approximately 3.0V, replace the battery if it is under 2.80V.

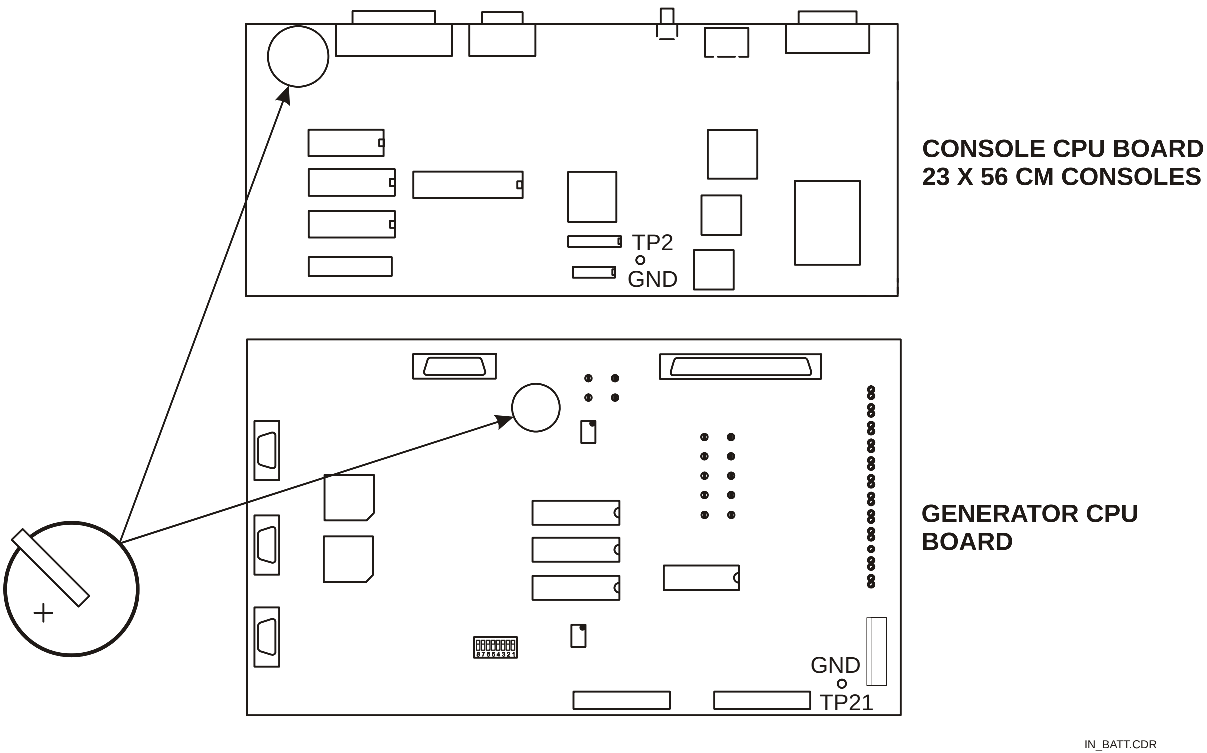

Figure 2-16: Location of battery on generator CPU board and on 23 X 56 cm console CPU board

2.17.0 DIP SWITCH SETTINGS

Before continuing, verify the DIP switch settings on the console CPU board (23 X 56 cm console only) and on the generator CPU board. These switches have been factory set but may have been readjusted, particularly if this generator is a re-install.

CONSOLE CPU BOARD (23 X 56 cm console):

The selections described below are accessed in CONSOLE utilities screen 2 on the 31 X 42 cm console and on the Rad-only console.

- Verify the settings on SW1 (If applicable, as described above). Refer to console utilities screen 2 in chapter 3C for a description of these functions.

LANGUAGE	SW1 -4	SW1-3	SW1-2	SW1-1
English	OFF	OFF	OFF	OFF
German	OFF	OFF	OFF	ON
French	OFF	OFF	ON	OFF
Italian	OFF	OFF	ON	ON
Swedish	OFF	ON	OFF	OFF
Spanish	OFF	ON	OFF	ON

SW1-5	NOT USED	
SW1-6	NOT USED	
SW1-7	OFF > LOGO NOT DISPLAYED	ON > LOGO DISPLAYED
SW1-8	OFF > CONSOLE DEFAULTS OFF *	ON > LOAD CONSOLE DEFAULTS *

GENERATOR CPU BOARD:

- Verify the settings on SW1. Refer to the table below for the proper settings for this switch.

GENERATOR POWER	MAXIMUM mA	SW1 -3	SW1-2	SW1-1
32 kW	400 mA	ON	ON	OFF
40 kW	500 mA	ON	OFF	ON
50 kW	630 mA	OFF	ON	ON
65 kW	800 mA	OFF	ON	OFF
80 kW	1000 mA	OFF	OFF	ON
100 kW	1000 mA	OFF	OFF	OFF

SW1-4	OFF > 2 FILAMENT BOARDS	ON > I FILAMENT BOARD
SW1-5	OFF > 150 kV MAXIMUM	ON > 125 kV MAXIMUM
SW1-6	OFF > DUAL SPEED STARTER	ON > LOW SPEED STARTER
SW1-7	OFF > 2 TUBE GENERATOR	ON > 1 TUBE GENERATOR
SW1-8	OFF > SET FACTORY DEFAULTS *	ON > DEFAULTS DISABLED *

* Refer to ***Resetting Factory Defaults*** in chapter 6 for details regarding this function.

2.18.0 INITIAL RUN-UP

This section describes the procedure for initial power-on of the generator after it has first been installed.

PLEASE OBSERVE THE FOLLOWING POINTS REGARDING THE MAIN DISTRIBUTION TRANSFORMER:

- ***IF USING A DISTRIBUTION TRANSFORMER WITH AN ISOLATED SECONDARY, THE SECONDARY WINDING MUST BE A WYE (STAR) CONFIGURATION WITH THE CENTER POINT GROUND REFERENCED. DO NOT USE A DELTA CONFIGURED SECONDARY AS THERE IS NO GROUND REFERENCE IN THIS CONFIGURATION.***
- ***IF USING AN AUTOTRANSFORMER TYPE DISTRIBUTION TRANSFORMER, THE A.C. INPUT TO THE TRANSFORMER MUST BE GROUND REFERENCED.***

2.18.1 Initial Voltage Measurements

1. Verify that the mains voltage and current capacity is correct for the generator installation. Refer to the product ID label on the generator cabinet and chapter 1C of this manual.

2. Temporarily remove the safety cover over the main input fuses in the generator.

3. If the mains supply is compatible with the generator, switch on the main breaker and/or disconnect switch and check for the following voltages:

<u>NOTE:</u> DO NOT SWITCH ON THE GENERATOR AT THIS TIME. ONLY THE AC MAINS TO THE GENERATOR IS TO BE SWITCHED ON AT THIS TIME.

<u>WARNING:</u>
1. USE EXTREME CARE IN MEASURING THESE VOLTAGES. ACCIDENTAL CONTACT WITH MAINS VOLTAGES MAY CAUSE SERIOUS INJURY OR DEATH.
2. MAINS VOLTAGE WILL BE PRESENT INSIDE THE GENERATOR CABINET, EVEN WITH THE CONSOLE SWITCHED OFF.
3. THE DC BUS CAPACITORS, LOCATED ON THE POWER INPUT BOARD AND ABOVE THE HT TANK ON SOME MODELS, PRESENT A SAFETY HAZARD FOR UP TO 5 MINUTES AFTER THE POWER HAS BEEN REMOVED FROM THE UNIT. CHECK THAT THESE CAPACITORS ARE DISCHARGED BEFORE TOUCHING ANY PARTS.

PLEASE NOTE THAT THE VOLTAGE MEASURED IN STEP 4 WILL NOT NECESSARILY BE THE SAME AS THE VOLTAGE AT THE MAIN DISCONNECT BOX IN THE ROOM. THE REASON FOR THIS IS THAT A LINE ADJUSTING TRANSFORMER MAY BE USED WITH THE GENERATOR WHICH STEPS THE INCOMING LINE VOLTAGE TO THE GENERATOR UP OR DOWN.

GENERATORS WITH NO LINE ADJUSTING TRANSFORMER SHOULD HAVE THE SAME VOLTAGE IN STEP 4 AS IS SUPPLIED AT THE MAIN DISCONNECT BOX IN THE ROOM. UNITS WITH A LINE ADJUSTING TRANSFORMER SHOULD HAVE THE FOLLOWING VOLTAGES AT THE MAIN LINE FUSES IN THE POWER SUPPLY CABINET.

VOLTAGE AT MAIN DISCONNECT BOX (LINE ADJUSTING TRANSFORMER INPUT)	VOLTAGE AT MAIN FUSES IN POWER SUPPLY (LINE ADJUSTING TRANSFORMER OUTPUT)
480 VAC ± 10 %	400 VAC ± 10 %
400 VAC ± 10 %	480 VAC ± 10 %

2.18.1 Initial Voltage Measurements (Cont)

4. Measure and record the voltage across the main line fuses in the generator. Single-phase units will only use one set of voltage measurements.

L1 phase to L2 phase: ______	VAC.	L1 phase to ground: ______	VAC.
L1 phase to L3 phase: ______	VAC.	L2 phase to ground: ______	VAC.
L2 phase to L3 phase: ______	VAC.	L3 phase to ground: ______	VAC.

5. Are these voltages within specification for the unit as per chapter 1C for generators without a line-adjusting transformer, or within specification per the table above for units with a line-adjusting transformer? For 3 phase units, the phase to ground voltage should be 230 V ± 10 % for 400 V units, and 277 V ± 10 % for 480 V units. For single phase 230 V units, the line to ground voltage should be 115 V ± 10 %.

   ___ Check

BEFORE CONTINUING, REFER TO SECTION 2.18.3 OR 2.18.4 FOR THE PROCEDURE FOR ADJUSTING LINE VOLTAGE TAPS ON THE ROOM INTERFACE TRANSFORMER AND THE POWER SUPPLY AUXILIARY TRANSFORMER.

6. Switch OFF the mains power to the generator. Verify that there is no voltage present across any of the mains input phases. Replace the safety cover on the main input fuse block, and then switch ON the mains.

7. Switch on the generator via the console power ON switch.

8. Verify that the red LED (DS1) located near the center of the generator interface board is lit.

   _____ Check

9. Verify that the red LED (DC BUSS OK) located on the power input board is lit.

   _____ Check

2.18.2 Initial Power Up

1. Switch on the generator at the console and observe the startup sequence on the console APR display.
   - MEMORY TEST.... will be displayed.
   - HIGH FREQUENCY GENERATOR XX KW will be displayed (XX will be the kW rating for that model).
   - The next screen will show console software revision and power software revision.

2. In the upper part of the generator cabinet, verify the following:
   - Verify that DS1 on the room interface board is lit.
   - On the generator CPU board verify that the following LEDs are lit (these indicate presence of the DC rails as indicated).

DS33	+5 V
DS36	+15 V
DS37	-15 V
DS38	+12 V
DS39	-12 V

2.18.2 Initial Power Up (Cont)

3. In the lower part of the generator cabinet, verify the following:
   - On the auxiliary board verify that the following LEDs are lit:

CNTCTR CLSD
S.S. OK
+12V
-12V
+/- 35V

2.18.3 Single Phase Primary Tap Selection

THIS SECTION APPLIES TO SINGLE PHASE GENERATORS ONLY. ENSURE THAT THE AC MAINS IS SWITCHED OFF AND LOCKED OUT, AND THAT ALL CAPACITORS ARE DISCHARGED BEFORE PROCEEDING.

1. Note the position of the 208 / 240V tap on the power supply auxiliary transformer; this is factory set to 240 VAC. Refer to figure 2-12, this shows the locations of the transformer taps.

2. Based on the line voltage measured in step 4 of section 2.18.1, set the tap referenced in the previous step as follows. Refer to figure 2-17, this shows the line voltage taps schematically.
   - Use the 208V tap if the line voltage is 215 VAC or less.
   - Use the 240V tap if the line voltage is 216 VAC or higher.

3. Note the primary voltage tap setting on the room interface transformer, this is factory set to 240 VAC. Refer to figure 2-18 and 2-19. The primary windings are connected in parallel for 200 / 240 VAC operation as per figure 2-19.
   - Use the 200V taps if the line voltage is 215 VAC or less.
   - Use the 240V taps if the line voltage is 216 VAC or higher.

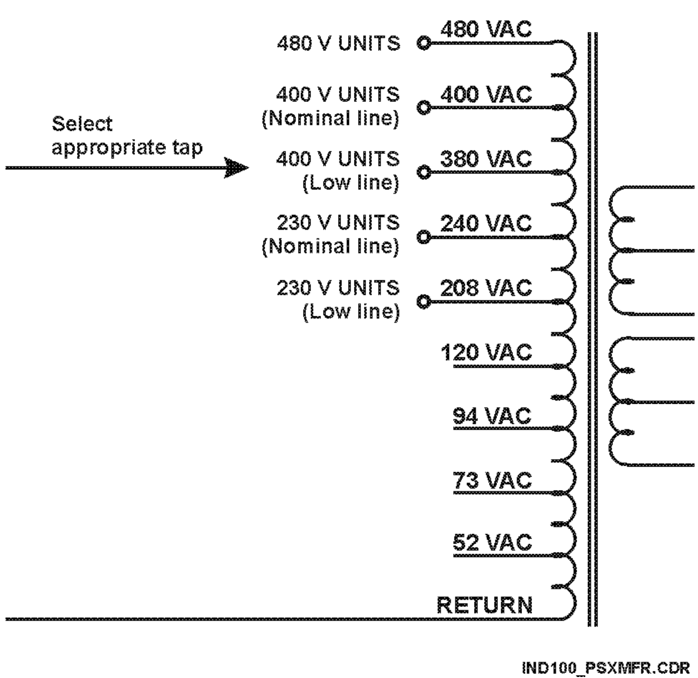

Figure 2-17: Schematic, primary of power supply aux transformer

2.18.3 Single Phase Primary Tap Selection (Cont)

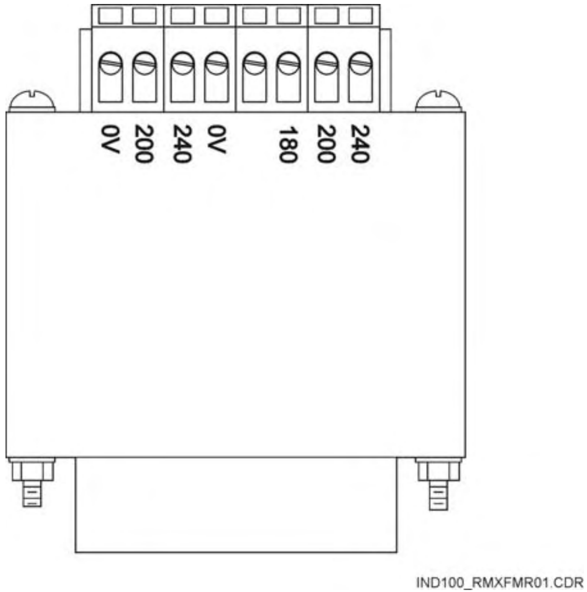

Figure 2-18: Room interface transformer primary taps

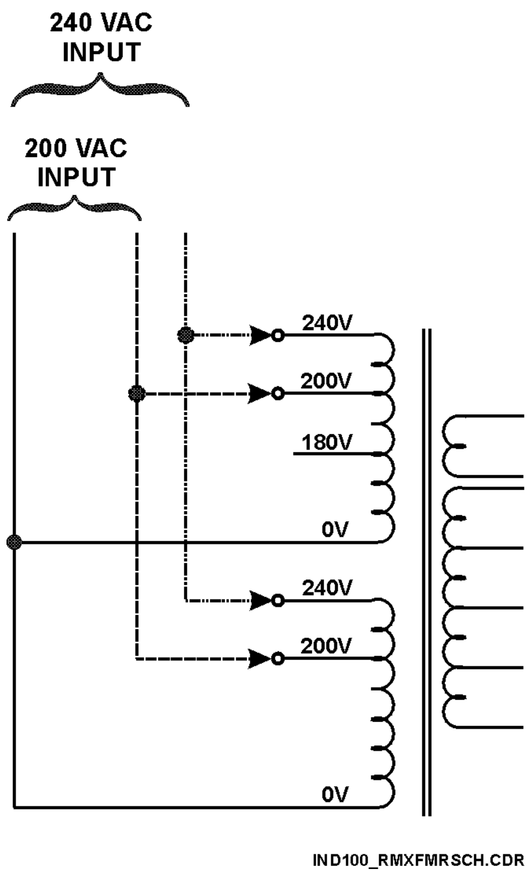

Figure 2-19: Schematic, primary of room I/F transformer (200/240V)

2.18.4 Three Phase Primary Tap Selection

THIS SECTION APPLIES TO 400 VAC THREE PHASE GENERATORS ONLY. NO TAP CHANGE IS NEEDED ON 480 VAC UNITS.
ENSURE THAT THE AC MAINS IS SWITCHED OFF AND LOCKED OUT, AND THAT ALL CAPACITORS ARE DISCHARGED BEFORE PROCEEDING.

1. Note the position of the 380 / 400V tap on the power supply auxiliary transformer (this is factory set to 400 VAC). Refer to figure 2-12, this shows the locations of the transformer taps.

2. Based on the line voltage measured in step 4 of section 2.18.1, set the tap referenced in the previous step as follows. Refer to figure 2-17, this shows the line voltage taps schematically.
   - Use the 380V tap if the line voltage is 389 VAC or less.
   - Use the 400V tap if the line voltage is 390 VAC or higher.

3. Note the primary voltage tap setting on the room interface transformer (this is factory set to 400 VAC). Refer to figure 2-18 and 2-20. The primary windings are connected in series for 380 / 400 VAC operation as per figure 2-20.
   - Use the 380V setting (180V tap on top winding) if the line voltage is 389 VAC or less.
   - Use the 400V setting (200V tap on top winding) if the line voltage is 390 VAC or higher.

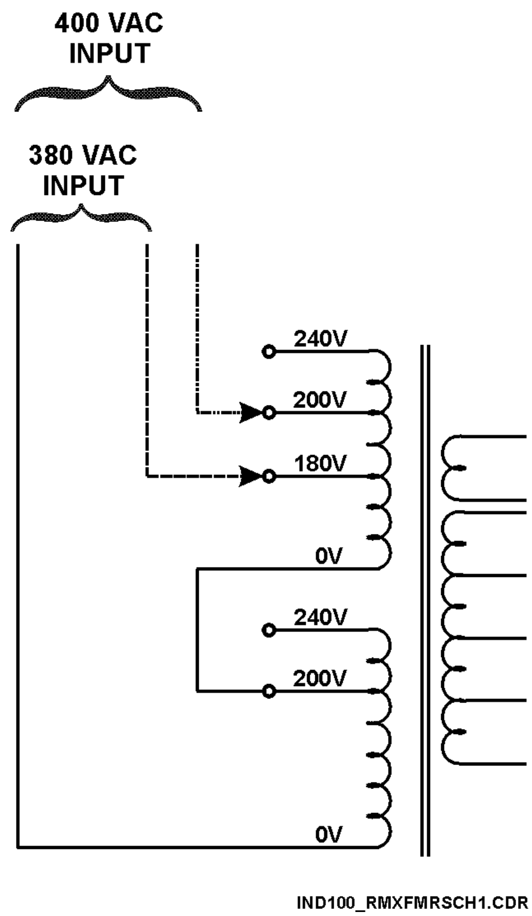

Figure 2-20: Schematic, primary of room I/F transformer (380/400V)

2.19.0 PROGRAMMING AND CALIBRATION

Refer to chapter 3C, 3D, 3E, and 3F (as applicable) for programming and calibration of the generator.

PLEASE NOTE THE FOLLOWING REGARDING GenWare® AND THE *DATA LINK* FUNCTION

For the 23 X 56 cm and 31 X 42 cm membrane consoles and for the touchscreen console, the **DATA LINK** function on the consoles is directly used to communicate with a PC running the CPI GenWare® utility software. This allows transfer of APR data, editing of APR text, performing generator setup and calibration, and has other minor functionality. Further documentation is included with PC GenWare®.
For the 31 X 42 cm console and the Rad-only console, the DATA LINK button provides access to the function **CONNECT TO GENWARE**, which allows for communication with GenWare® on that console. Refer to chapter 3C.

A computer (i.e. a laptop) and a 9-pin null-modem cable with socket connectors (female) on both ends are required to run this software and interface to the generator.

The null-modem cable will normally be connected from a serial port on the computer that is running GenWare® to the *DATA LINK* connector (membrane consoles) or to COM 1 / COM 2 (touchscreen console). Refer to the figure “Rear of control console” earlier in this chapter for the location of this connector.
If the data link connector is not available, i.e. on units without a CPI supplied console, J1 or J2 on the generator CPU board may be used.

CONNECTING AN EXTERNAL COMPUTER TO J11 ON THE GENERATOR CPU BOARD MAY DAMAGE THE COMPUTER. THIS WAS DESIGNED FOR CONNECTION OF THE OPTIONAL REMOTE FLUORO CONTROL ONLY.

NOTE: ***PC GenWare® should be closed before exiting the DATA LINK function on the console. Failure to do so may require that the console be switched off and then on again in order to re-initialize communication with the generator.***

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2.20.0 TUBE AUTO CALIBRATION

It is recommended that the generator be tested at this point with only the X-ray tube and rotor / high-tension cables connected. The generator should be able to complete an X-ray tube calibration and seasoning cycle without other equipment connected to the generator (other than the basic interlocks as noted below). This will allow for easier fault isolation as each section of the system is connected and tested.

Before being able to make X-ray exposures, the room door interlock must be closed and the thermal switch must be closed. The interlocks cannot be deprogrammed during tube auto calibration.

Before beginning tube auto calibration, the tube(s) used in this installation must be properly selected, and the generator limits should be programmed. Refer to chapter 3C.

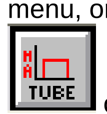
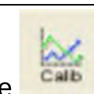
Before beginning tube auto calibration on Tube 2 (if applicable), a receptor programmed for Tube 2 operation must be selected.

It is recommended that the tube(s) be conditioned (seasoned) during tube auto calibration, particularly if the tube has not been used for some time. Refer to chapter 6.

WARNING: ***THE FOLLOWING PROCEDURES PRODUCE X-RAYS. TAKE ALL SAFETY PRECAUTIONS TO PROTECT PERSONNEL FROM X-RADIATION.***

CAUTION: ***ALWAYS VERIFY THE MANUFACTURER OF THE TUBE INSERT. IF THE X-RAY TUBE HAS BEEN REBUILT, THE TUBE INSERT AND TUBE HOUSING MAY BE FROM DIFFERENT MANUFACTURERS.***

Use these steps to perform the tube auto calibration.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **GENERATOR SETUP** menu (chapter 3C) select **GEN CONFIGURATION**.	Select **Auto Tube Calibration** from the **Setup** menu, or use the auto calibration button  on the GenWare® toolbar.	Press the  button on the GenWare toolbar to access the **Tube Calibration** utility.
2.	Select **TUBE CALIBRATION**.		

2.20.0 TUBE AUTO CALIBRATION (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	Select **TUBE SELECTED.** Toggle the button to select the desired tube to calibrate (tube **1** or tube **2)**. Next, select a receptor that is programmed for the desired tube (i.e. for tube 1 you must select a receptor programmed for tube 1, and for tube 2 you must select a receptor programmed for tube 2). Tube 2 is only available on two tube generators.	Under **Tube,** select the desired tube to calibrate (**Tube 1** or **Tube 2)**. Next, select a receptor that is programmed for the desired tube (i.e. for tube 1 you must select a receptor programmed for tube 1, and for tube 2 you must select a receptor programmed for tube 2). Tube 2 is only available on two tube generators.	Under **Tube,** select the desired tube to calibrate (**Tube 1** or **Tube 2)**. Next, select a receptor that is programmed for the desired tube (i.e. for tube 1 you must select a receptor programmed for tube 1, and for tube 2 you must select a receptor programmed for tube 2). Tube 2 is only available on two tube generators.
4.	Select **FOCAL SPOT**. Toggle the button to select the desired focal spot to calibrate (**SMALL** or **LARGE)**. Start with **SMALL**.	Under **Focus,** select the desired focal spot to calibrate (**small** or **large)**. Start with **small**.	Under **Focus,** select the desired focal spot to calibrate (**Small Focus** or **Large Focus)**. Start with **Small Focus**.
5.	Press and hold the X-RAY button (or use the optional hand switch) to begin the calibration procedure.	Press and hold the X-RAY button (or use the optional hand switch) to begin the calibration procedure.	Press and hold the X-RAY button (or use the optional hand switch) to begin the calibration procedure.
6.	Press **RETURN.** Repeat steps 3 to 5 to perform the calibration on the other focal spot or on the other tube.	Repeat steps 3 to 5 to perform the calibration on the other focal spot or on the other tube.	Repeat steps 3 to 5 to perform the calibration on the other focal spot or on the other tube.
7.	When auto-calibration is completed, press **EXIT** to exit the tube auto calibration menu.		
8.	Press **EXIT** to return to the **GENERATOR SETUP** menu.		
9.	Press **EXIT SETUP** to exit out of the setup and calibration mode and return to the normal operating mode.		
	REFER TO THE NOTE BELOW REGARDING A SPECIAL DIAGNOSTIC MODE THAT IS ENTERED WHEN EXITING OUT OF THE AUTO-CALIBRATION MODE, AND INTO THE NORMAL OPERATING MODE.		

2.20.0 TUBE AUTO CALIBRATION (Cont)

NOTE: ***SHOULD AN ERROR OCCUR DURING AUTO CALIBRATION, AN ERROR MESSAGE WILL BE DISPLAYED. THE GENERATOR WILL THEN LIMIT THE TUBES OPERATION TO THE RANGE IN WHICH IT WAS CALIBRATED, THUS ALLOWING FOR PARTIAL OPERATION OF THE GENERATOR.***

NOTE: ***A SPECIAL DIAGNOSTIC MODE IS INVOKED WHEN YOU EXIT THE AUTO-CALIBRATION ROUTINE. THIS MODE REMAINS IN EFFECT UNTIL THE GENERATOR IS SWITCHED OFF. THIS ALLOWS LIMITED FUNCTIONALITY OF THE GENERATOR IN CASE THE AUTO CALIBRATION COULD NOT BE COMPLETED DUE TO A FAULT.***

WHILE IN THIS MODE, THE GENERATOR WILL DEFAULT THE FILAMENT CURRENT TO 2.0 AMPS FOR ALL UNCALIBRATED MA STATIONS. ADDITIONALLY, THE MA TOLERANCE CHECK WILL BE DISABLED.

THIS ALLOWS ONE TO EXIT TO THE NORMAL OPERATING MODE WHERE THE PREP STATE MAY BE ENTERED. THE FILAMENT AND ROTOR CIRCUITS CAN BE OBSERVED, AND AN EXPOSURE MAY BE TAKEN AT THIS TIME. THE EXPOSURE WILL OBVIOUSLY BE INCORRECT, AS THE FILAMENT CURRENT IS SET TO 2 AMPS, BUT THIS ALLOWS KV MEASUREMENTS TO BE PERFORMED ALONG WITH OTHER SYSTEM CHECKS TO AID IN TROUBLESHOOTING.

2.21.0 FINAL CHECKS

The room interface connections may now be completed. These items are described in 2.9.6.

- When finished all wiring, check that all connections are tight and secure.
- Check that all cables are dressed neatly inside the main cabinet, kept away from high voltage areas, and secured as necessary.
- Check the Blanking Plate at the back of the control cabinet. Refer to the ***Major generator subassemblies (right side and rear)*** figure in the ***Generator Cabinet Assembly*** section of Chapter 1E. If necessary, lower the blanking plate such as to reduce the cable access gap to acceptable limits. There must be a minimum of 1 / 16" (1 mm) clearance above the cabling.
- Reconnect any grounds that have been removed from covers. Then reinstall all covers before placing the generator into service.
- For units with the touchscreen console, perform touchscreen calibration. Refer to chapter 3C for the proper calibration procedure.

NOTE: ***THE INSTALLER SHOULD ENSURE THAT ALL CABLE CONNECTIONS TO THE GENERATOR ARE SECURE, AND ALL CABLES EXTERNAL TO THE GENERATOR ARE ADEQUATELY PROTECTED AGAINST ACCIDENTAL DISCONNECTION.***

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SUPPLEMENT

X-RAY TUBE STATOR COMPATIBILITY TABLES

CONTENTS:

PROPRIETARY AND CONFIDENTIAL

1.0 INTRODUCTION

This supplement contains the X-Ray Tube Stator Compatibility Tables for the Low Speed Starter and the Dual Speed Starter.

2.0 LOW SPEED STARTER TUBE SELECT TABLE

The boost voltage may be set to either 240 VAC (factory default) or 120 VAC. This should be set to 240 VAC, except where specifically noted in Table 1 below. The Low Speed Starter output is at the same frequency as the AC line (50 Hz or 60 Hz).

The Low Speed Starter (LSS) is a separate sub-assembly within the Indico 100 Generator. The LSS part number corresponds to the value of phase-shift capacitor incorporated within this sub-assembly. The boost time is selectable to either 1.5 seconds or 2.5 seconds, and the run voltage is selectable to any of 52 VAC, 73 VAC or 94 VAC.

The Low Speed Starter is integrated into the H.V. Auxiliary Board within the CMP 200® and CMP 200® DR generators. The phase-shift capacitor is chassis-mounted and may be changed in the field. The LSS part number corresponds to the value of capacitor installed. Note that these generators do not use a separate run voltage, instead cycling the boost voltage on/off as required. The boost duty cycle is not hardware-configurable.

TABLE 1: TUBE TYPES (LOW SPEED STARTER)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**RUN VOLTAGE (Indico only)**	**BOOST TIME (Indico only)**	**GENER-ATOR**	**SHIFT CAP.**	**LSS PART #**
CGR (GE) Statorix 200A/240/260 (50/110 Ω stator)	MN640 M641 MN641 M643	94 VAC	2.5 sec	Indico 100 only	12.5 μF	732752-01
CGR (GE) Statorix 550 (50/110 Ω stator)	RN620 RN621	94 VAC	2.5 sec	Indico 100 only	12.5 μF	732752-01
Chirana Rotax KA 125 (20/50 Ω stator)	RIK-T 0.8/2.0 12/50 RIK-T 1.2/2.0 30/50	73 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Chirana Rotax KA 125 (20/20/20 Ω stator)		52 VAC	1.5 sec	Indico 100 only	100 μF, 52 mH Inductor	732752-04
Comet DO7 / DX7 (25/50 Ω stator)	DX7 DX71HS **(See note 1)**	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Comet DO9 / DX9 (20/50 Ω stator)	DX9 DX91H / HS DX92H / HS DX93H / HS DX94HS DX96HS DX97HS **(See note 1)**	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Comet D010 / DX10 (20/50 Ω stator)	DX10H / HS DX101H / HS DX104HS DX105HS DX106HS **(See note 1)**	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Comet XSTAR (25/50 Ω stator)	XSTAR8 (XST-8) XSTAR74 (XST-74)	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00

2.0 LOW SPEED STARTER TUBE SELECT TABLE (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	RUN VOLTAGE (Indico only)	BOOST TIME (Indico only)	GENER-ATOR	SHIFT CAP.	LSS PART #
Dunlee (Philips) DA10 series (20/50 Ω stator)	DU404 (0.6/1.25)	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Dunlee (Philips) DA350, DA351	DU 1750 DU 3050 DU 2550 DU 33100	See Philips ROT 350, 351				
Dunlee (Philips) DR1400 series (20/50 Ω stator)	DR1429 DR1436 DR1492	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Dunlee (Picker / Philips) PX1300 series (3" anode) "S" stator (15/30 Ω)	PX1302 PX1312 PX1351	52 VAC	2.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Dunlee (Picker / Philips) PX1400 series (4" anode) "S" stator (15/30 Ω)	PX1402 PX1412 PX1415 PX1425 PX1429 PX1431 PX1436 PX1456 PX1463 PX1482 PX1483 PX1492 PX1494 DU404 (0.6/1.25)	52 VAC	2.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Eureka (see Varian)						
GE Maxiray 75 (3" anode) (23/23 Ω equal impedance "E" stator)	MX-75	73 VAC	1.5 sec	Indico 100	45 µF	732752-02
				CMP 200	40 µF	903836-01
GE Maxiray 100 (4" anode) (23/23 Ω equal impedance "E" stator)	MX-100	73 VAC	1.5 sec	Indico 100	45 µF	732752-02
				CMP 200	40 µF	903836-01
Gilardoni Rotagil S/AS	AR11-30 AR20-50 AR30-00-1 AR30-60 AR30-100 AR40-100 AR9000-1 AR9000-2	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Hangzhou Kailong RADII (see Kailong)						
Hangzhou Wandong WANRAY LQ16-XA4		52 VAC	1.5 sec	Indico 100	45 µF	732752-02
				CMP 200	40 µF	903836-01

2.0 LOW SPEED STARTER TUBE SELECT TABLE (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	RUN VOLTAGE (Indico only)	BOOST TIME (Indico only)	GENER-ATOR	SHIFT CAP.	LSS PART #
IAE C30 (25/62 Ω stator)	RTM 70H X20P X22 X40	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
IAE C52, C52 Super C100 C352 (20/40 Ω stator)	RTC 600HS RTC 700HS RTC 1000HS RTM 78H / HS RTM 90H / HS RTM 92H / HS RTM 101H / HS RTM 102H / HS RTM 780H / HS RTM 782H / HS AP DX104 X40 X50H X50AH	52 VAC	1.5 sec	Indico 100	33 µF (prefer)	732752-00
					45 µF	732752-02
				CMP 200	30 µF (prefer)	903836-00
					40 µF	903836-01
Kailong RADII H1074	KL74	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Kailong RADII H1076 (20/50 Ω stator)	KL76	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02
Kailong RADII H1080	KL80 KL80A	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Kailong RADII H1083	KL83	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02
Kailong RADII H1086	KL86	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Machlett (see Varian)						
Philips ROT350 ROT351 Windings in series (high impedance configuration) *** Dunlee tube** **** Varian tube**	RO 1230 RO 1750 / DU 1750* RO 2050 RO 2550 / DU 2550* RO 3050 / DU 3050* RO 33100 / DU 33100* SRO 2250 RAD-34 ** RAD-50 **	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Picker (see Dunlee)						

2.0 LOW SPEED STARTER TUBE SELECT TABLE (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	RUN VOLTAGE (Indico only)	BOOST TIME (Indico only)	GENER-ATOR	SHIFT CAP.	LSS PART #
Shimadzu CIRCLEX RX80 (7.5/35 Ω stator)	P18DE-85 P38E	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
		Note: The starter boost voltage is 120 VAC. This is only available with one-tube generators.				
Shimadzu CIRCLEX RX150 (8.4/24 Ω stator)	P18DK	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
		Note: The starter boost voltage is 120 VAC. This is only available with one-tube generators.				
Siemens Opti 150 "S" stator (14/18 Ω)	20/40 30/52R	52 VAC	2.5 sec	Indico 100	45 µF	732752-02
				CMP 200	40 µF	903836-01
Siemens RAY-8(S)_1, RAY-12(S)_1, RAY-14(S)_1		73 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Toshiba Rotanode	Toshiba x-ray tubes are identified by their "E" number, which is used to represent both the Tube Insert and the complete assembly. The housing number is usually not shown on the identification label. A specific "E" number may be available with several different stator types, each having different starter requirements. Furthermore, a specific stator type may require different starter requirements depending on the housing used. For ease of use, the Toshiba tubes are sorted by Tube Insert Type ("E" number) within this table. The installer must confirm the stator type for the planned tube(s). If the stator type is not identified within the Toshiba documentation, match the stator winding resistance to the appropriate table entry. Contact the factory if the desired Tube Type and stator type / winding resistance are not listed on the same row within this table.					
Toshiba Rotanode XH-121 XH-126 XH-150 XS-AV stator XS-RA stator (27.5/58 Ω)	E7132 E7239 E7240 E7242 **(See note 2)**	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02
Toshiba Rotanode XH-106V XH-180 XH-181 XS-AL stator (9.4/28.3 Ω)	E7252 **(See note 2)**	52 VAC	1.5 sec	Indico 100 ***50 or 60 Hz***	45 µF (prefer)	732752-02
				Indico 100 ***60 Hz only***	33 µF	732752-00
				CMP 200 ***50 or 60 Hz***	40 µF (prefer)	903836-01
				CMP 200 ***60 Hz only***	30 µF	903836-00
		Note: The starter boost voltage is 120 VAC (XS-AL stator only). This is only available with one-tube generators.				
Toshiba Rotanode XH-106V XH-180 XH-181 XS-RA stator (27.5/58 Ω)	E7252 **(See note 2)**	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	RUN VOLTAGE (Indico only)	BOOST TIME (Indico only)	GENER-ATOR	SHIFT CAP.	LSS PART #
Toshiba Rotanode XH-157 XS-RB stator (20.2/38 Ω)	E7254 E7255 **(See note 2)**	94 VAC	1.5 sec	Indico 100 ***60 Hz only***	33 µF	732752-00
				CMP 200 ***60 Hz only***	30 µF	903836-00
Toshiba Rotanode XH-121 XH-126 XS-AV stator XS-RA stator (27.5/58 Ω)	E7299 **(See note 2)**	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02
Toshiba Rotanode XH-106V XH-180 XS-AL stator (9.4/28.3 Ω)	E7813 **(See note 2)**	52 VAC	1.5 sec	Indico 100 ***50 or 60 Hz***	45 µF (prefer)	732752-02
				Indico 100 ***60 Hz only***	33 µF	732752-00
				CMP 200 ***50 or 60 Hz***	40 µF (prefer)	903836-01
				CMP 200 ***60 Hz only***	30 µF	903836-00
		Note: The starter boost voltage is 120 VAC. This is only available with one-tube generators.				
Toshiba Rotanode XH-121 XS-BA stator (18/47.5 Ω)	E7843 **(See note 2)**	52 VAC	1.5 sec	Indico 100 ***50 or 60 Hz***	45 µF	732752-02
				Indico 100 ***60 Hz only***	33 µF	732752-00
				CMP 200 ***50 or 60 Hz***	40 µF	903836-01
				CMP 200 ***60 Hz only***	30 µF	903836-00
Toshiba Rotanode XH-121 XH-126 XH-150 XS-RA stator (27.5/58 Ω)	E7861 **(See note 2)**	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02
Toshiba Rotanode XH-112V XS-AG stator (9.4/28.3 Ω)	E7864 **(See note 2)**	52 VAC	1.5 sec	Indico 100	45 µF	Contact factory
				CMP 200	40 µF	Contact factory
		Note: The starter boost voltage is 120 VAC. This is only available with one-tube generators.				
Toshiba Rotanode XH-121 XS-AV-stator XS-RA stator (27.5/58 Ω)	E7876 **(See note 2)**	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	20 µF	903836-02

2.0 LOW SPEED STARTER TUBE SELECT TABLE (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	RUN VOLTAGE (Indico only)	BOOST TIME (Indico only)	GENER-ATOR	SHIFT CAP.	LSS PART #
Toshiba Rotanode XH-121 XH-126 XH-150 XS-AL stator (9.4/28.3 Ω)	E7884 **(See note 2)**	52 VAC	1.5 sec	Indico 100 ***50 or 60 Hz***	45 μF (prefer)	732752-02
				Indico 100 ***60 Hz only***	33 μF	732752-00
				CMP 200 ***50 or 60 Hz***	40 μF (prefer)	903836-01
				CMP 200 ***60 Hz only***	30 μF	903836-00
		Note: The starter boost voltage is 120 VAC. This is only available with one-tube generators.				
Toshiba Rotanode XH-121 XH-126 XS-AV stator XS-RA stator (27.5/58 Ω)	E7886 **(See note 2)**	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	20 μF	903836-02
Varian (Machlett) Dynamax (DX) 52 “R” stator (16/50 Ω)	A-102 A-132 A-142	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Varian (Machlett) Dynamax (DX) 62 “R” stator (23/56 Ω) Dynamax (DX) 62U cfg as “STD” or “R” stator (15/36 Ω)	A-192B A-196 A-197 A-256 A-272 A-282 A-286 A-292 A-482 A-486	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Varian B-100 “STD” stator (16/50 Ω)	A-102 A-132 / A-134* A-142 / A-144* A-145 *** (See note 3)**	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00
Varian B-130 B-130H B-135H B-150 Std “R” stator (16/50 Ω)	A-152 A-182 / A-184* A-192 / A-194* A-195 A-196 A-197 A-252 A-272 / A-274* A-277 / A-278* A-282 / A-284 * A-286 A-292 / A-294* A-482 G-242 G-256 G-292 *** (See note 3)**	52 VAC	1.5 sec	Indico 100	33 μF	732752-00
				CMP 200	30 μF	903836-00

2.0 LOW SPEED STARTER TUBE SELECT TABLE (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	RUN VOLTAGE (Indico only)	BOOST TIME (Indico only)	GENER-ATOR	SHIFT CAP.	LSS PART #
Varian (Eureka) Diamond Std “R” stator (20/50 Ω)	RAD-12 RAD-13 RAD-14 RAD-68	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Varian (Eureka) Emerald Std “R” stator (20/50 Ω)	RAD-8 RAD-74	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00
Varian (Eureka) Sapphire Std “R” stator (20/50 Ω)	RAD-21 RAD-40 RAD-44 RAD-56 RAD-60 RAD-92 RAD-94	52 VAC	1.5 sec	Indico 100	33 µF	732752-00
				CMP 200	30 µF	903836-00

NOTE 1: Comet tube inserts with the prefix “DI” and “DX” are interchangeable.

NOTE 2: Complete Toshiba tube assemblies include the suffix “X, “FX”, “GX”, or “JX”, which are interchangeable with respect to rotor and anode characteristics.

NOTE 3: These X-ray tubes incorporate a control grid. Grid control is currently not supported by CPI generators. Connect the grid connection to Ground when using these tubes, and select the insert type within the Generator software corresponding to the equivalent non-grid tube.

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3.0 DUAL SPEED STARTER TUBE SELECT TABLE

The Dual Speed Starter (DSS) synthesizes its output frequencies independently of the line frequency and will operate all tubes at 60/180 Hz, unless a particular tube only has published ratings to operate at 150 Hz. In this case, the starter will output 50/150 Hz when set for these tubes.

Unless indicated otherwise within Table 2, setting the switches to the code indicated for the applicable Tube Type selects all required operating parameters. The Dual Speed Starter part number corresponds to the AC line voltage and the configuration of phase-shift capacitors installed.

Reference notes are provided at the end of Table 2. Tube operating parameters for each switch code are contained in Table 3 for reference.

TABLE 2: TUBE TYPES (HIGH SPEED STARTER)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE** Switches 1........5	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
CGR (GE) Statorix 200A/240/260 (50/110 Ω stator)	MN640 M641 MN641 M643	00111	**LOW SPEED OPERATION ONLY (See note 1)** These Dual Speed Starters must be jumper-configured to provide the required 15.5 μF low speed shift capacitance. ***Please see note 9 before attempting to use this Dual Speed Starter configuration***.	50 Hz	N/A	15.5μF	733317-15 735925-15 **(See note 9)**	901297-15 901298-15 **(See note 9)**
CGR (GE) Statorix 200A/240/260 (50/110 Ω stator)	MS740 MSN740 MSN742 RSN742	00111	**HIGH SPEED OPERATION ONLY (See note 1**) For Dual Speed operation, contact factory.	150 Hz	3 μF	15.5μF	733317-15 735925-15 **(See note 9)**	901297-15 901298-15 **(See note 9)**
CGR (GE) Statorix 550 (50/110 Ω stator)	RN620 RN621	00111	**LOW SPEED OPERATION ONLY (See note 1)** These Dual Speed Starters must be jumper-configured to provide the required 15.5 μF low speed shift capacitance. ***Please see note 9 before attempting to use this Dual Speed Starter configuration***.	50 Hz	N/A	15.5μF	733317-15 735925-15 **(See note 9)**	901297-15 901298-15 **(See note 9)**
CGR (GE) Statorix 550 (50/110 Ω stator)	RSN722	00111	**HIGH SPEED OPERATION ONLY (See note 1**) For Dual Speed operation, contact factory.	150 Hz	3 μF	15.5μF	733317-15 735925-15 **(See note 9)**	901297-15 901298-15 **(See note 9)**

2.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1........5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Chirana Rotax KA 125 (20/50 Ω stator, single phase)	RIK-T	10101	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Comet DO7 / DX7 (25/50 Ω stator)	DX7 DX71HS **(See note 3)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Comet DO9 / DX9 (20/50 Ω stator)	DX9 DX91H / HS DX92H / HS DX93H / HS DX94HS DX96HS DX97HS **(See note 3)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1........5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Comet DO10 / DX10 (20/50 Ω stator)	DX10H **(See note 3)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
	DX10HS DX104HS **(See note 3)**	00011	None	50/150 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
	DX105HS DX106HS **(See note 3)**	10011	None	50/150 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Comet DO700 / DX700 (25/50 Ω stator)	DX700HS **(See note 3)**	10011	None	50/150 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE Switches 1........5**	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Dunlee (Philips) DA10 series (20/50 Ω stator)	DU404 (0.6/1.25)	00100	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)
Dunlee (Philips) DA350, DA351	DU 1750 DU 3050 DU 2550 DU 33100 **(See note 6)**	See Philips ROT 350, 351						
Dunlee (Philips) DR1400 (20/50 Ω stator)	DR1429 DR1436 DR1492 DR1494	00100	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)
Dunlee (Picker / Philips) PX1300 3" anode "S" stator (15/30 Ω)	PX1302 PX1312 PX1351	11100	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1........5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Dunlee (Picker / Philips) PX1400 series 4” anode “S” stator (15/30 Ω)	PX1402 PX1412 PX1415 PX1425 PX1429 PX1431 PX1436 PX1456 PX1463 PX1475 PX1482 PX1483 PX1492 PX1494 DU404 (0.6/1.25)	10000	Some tube inserts may be suitable for Low Speed operation only. The installer must ensure compatibility by using the appropriate Dunlee data sheets. **(See note 1)**	60/180 Hz	6 µF	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Dunlee (Picker / Philips) PX1400 series 4” anode “Q” stator (6/12 Ω)	PX1402 PX1412 PX1415 PX1424 PX1429 PX1431 PX1436 PX1456 PX1463 PX1472 PX1473 PX1482 PX1483 DU404 (0.6/1.25)	10110	Some tube inserts may be suitable for Low Speed operation only. The installer must ensure compatibility by using the appropriate Dunlee data sheets. **(See note 1)**	60/180 Hz	20 µF	60 µF	733317-02 735925-02	901297-02 901298-02
Eureka (see Varian)								
GE Maxiray 75 (3” anode) 23/23Ω equal impedance “E” stator	MX-75	01110	None	60/180 Hz	7.5 µF	36 µF	733317-12 735925-12	901297-12 901298-12
GE Maxiray 100 (4” anode) 23/23 Ω equal impedance “E” stator	MX-100	00101	None	60/180 Hz	7.5 µF	36 µF	733317-12 735925-12	901297-12 901298-12

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE** Switches 1........5	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Gilardoni Rotagil (33/36 Ω stator)	AR11-30 AR30-60	01101	**LOW SPEED OPERATION ONLY (See note 1)**	50 Hz	N/A	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)
Gilardoni Rotagil A/A5 (33/36 Ω stator)	AR20-50 AR30-100 AR40-100	01101	None	50/150 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)
IAE C30 (25/62 Ω stator)	X20P X22 X40	01010	**LOW SPEED OPERATION ONLY (See note 1)**	50 Hz	N/A	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)
	RTM 70H	01010	None	50/150 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 (**See note 2**)	901297-12 901298-12 901297-13 901298-13 (**See note 2**)

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE Switches 1........5**	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
IAE C52 C52 Super C100 C352 (20/40 Ω stator)	RTM 78H RTM 90H RTM 92H RTM 101H RTM 102H RTM 780H RTM 782H AP DX104 X40 X50H X50AH	11011	**LOW SPEED OPERATION ONLY** **(See note 1)**	50 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
IAE C52 C52 Super C100 C352 (20/40 Ω stator)	RTC 600HS RTC 700HS RTC 1000HS RTM 78HS RTM 90HS RTM 92HS RTM 101HS RTM 102HS RTM 780HS RTM 782HS AP DX104	11011	None	50/150 Hz	5 µF	30 µF	733317-13 735925-13 733317-17 735925-17 **(See note 2**)	901297-13 901298-13
Machlett (see Varian)								

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3.0 Dual Speed Starter Tube Select Table (cont)

<table>
<tr><th>TUBE TYPE
(HOUSING)</th><th>TUBE TYPE
(INSERT)</th><th>CODE
Switches
1........5</th><th>OPERATING NOTES
(SEE TABLE 3 FOR OPERATING PARAMETERS)</th><th>OUTPUT
FREQ.</th><th>H.S.
SHIFT
CAP.</th><th>L.S.
SHIFT
CAP.</th><th>INDICO 100
DSS
PART NO.**</th><th>CMP 200
DSS
PART NO.**</th></tr>
<tr><td>Philips
ROT 350
ROT 351
(See note 4)

* Dunlee tube
(See note 6)</td><td>RO 1230
RO 1750
RO 2050
RO 3050
SRO 2250

DU 1750 *
DU 3050 *</td><td>10010</td><td>LOW SPEED OPERATION ONLY
(See note 1)</td><td>60 Hz</td><td>N/A</td><td>30µF</td><td>733317-13
735925-13

(See note 2)</td><td>901297-13
901298-13
(See note 2)</td></tr>
<tr><td rowspan="3">Philips
ROT 350
ROT 351
(See note 5)

* Dunlee tube
(See note 6)

** Varian tube</td><td>RO 1230
RO 1750
RO 3050
DU 1750 *
DU 3050 *</td><td>10010</td><td>LOW SPEED OPERATION ONLY
(See note 1)</td><td>60 Hz</td><td>N/A</td><td>37.5µF</td><td rowspan="3">733317-16
735925-16
733317-17
735925-17
(See note 2)</td><td rowspan="3">901297-16
901298-16</td></tr>
<tr><td>RO 2050
SRO 2250
RAD-34 **
RAD-50 **</td><td>10010</td><td>None</td><td>60/180 Hz</td><td>12.5µF</td><td>37.5µF</td></tr>
<tr><td>RO 2550
RO 33100
SRO 1330
DU 2550 *
DU 33100 *</td><td>10010</td><td>HIGH SPEED OPERATION ONLY
(See note 1)</td><td>180 Hz</td><td>12.5µF</td><td>37.5µF</td></tr>
<tr><td rowspan="2">Philips
ROT 500
ROT 501
(9/11 Ω stator)</td><td>SRM 0310</td><td>01111</td><td>None</td><td>60/180 Hz</td><td>12.5µF</td><td>37.5µF</td><td>733317-16
735925-16
733317-17
735925-17
(See note 2)</td><td>901297-16
901298-16</td></tr>
<tr><td>SRM 1080
SRM 35100</td><td>01111</td><td>HIGH SPEED OPERATION ONLY
(See note 1)</td><td>180 Hz</td><td>12.5µF</td><td>37.5µF</td><td>733317-16
735925-16
733317-17
735925-17
(See note 2)</td><td>901297-16
901298-16</td></tr>
<tr><td colspan="9">Picker (see Dunlee)</td></tr>
</table>

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1........5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Shimadzu (Circlex) RX80 RX81 RX82 (7.5/35 Ω stator)	P18DE-85	00001	**LOW SPEED OPERATION ONLY (See note 1)**	60 Hz	N/A	30 µF	733317-01 735925-01 733317-13 735925-13 **(See note 2)**	901297-13 901298-13
	P33D P38D P38DE-85	00001	**HIGH SPEED OPERATION ONLY (See note 1)**	180 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Shimadzu (Circlex) RX100	P38E	00001	None	60/180 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Shimadzu (Circlex) RX150 (8.4/24 Ω stator)	P18DK	00001	**LOW SPEED OPERATION ONLY (See note 1)**	60 Hz	N/A	30 µF	733317-01 735925-01 733317-13 735925-13 **(See note 2)**	901297-13 901298-13
	38DK P324DK	00001	**HIGH SPEED OPERATION ONLY (See note 1)**	180 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Siemens Biangulix "S" stator (1-phase only) (14/18 Ω)	BI 125/20/40 BI 125/30/50 BI 150/30/50 BI 150/30/52R	11101	**HIGH SPEED OPERATION ONLY (See note 1)**	150 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Siemens Opti-150 "S" stator (1-phase only) (14/18 Ω) *** Varian tube**	150/30/52R 150/40/72C 150/12/50 150/40/80 150/30/50 150/40/102C SG-796B *	11101	**HIGH SPEED OPERATION ONLY (See note 1)**	150 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1........5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Siemens OptiTop "S" stator (1-phase only) (14/18 Ω) *** Varian tube**	150/40/80HC-100L 150/40/80HC-102L SG-1096*	11101	**HIGH SPEED OPERATION ONLY (See note 1)**	150 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Siemens Optilix "S" stator (1-phase only) (14/18 Ω)	150/30/50C-100L 150/40/80C-100L	11101	**HIGH SPEED OPERATION ONLY (See note 1)**	150 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Siemens Megalix Siemens SV 125 "S" stator (1-phase only) (14/18 Ω)	125/30/82CM-120LW 125/40/82CM-120LW	00010	**HIGH SPEED OPERATION ONLY (See note 1)**	150 Hz	6 µF	30 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Siemens SV 150 "S" stator (1-phase only) (14/18 Ω)	SV 150/30/50C-100L SV 150/40/80C-100L	11101	**HIGH SPEED OPERATION ONLY (See note 1)**	150 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13
Siemens RAY-8_1, RAY-8S_1 RAY-12_1, RAY-12S_1 20/50 Ω stator (single phase only)		11111	**LOW SPEED OPERATION ONLY (See note 1)**	60 Hz	N/A	30 µF	733317-01 735925-01 733317-13 735925-13 **(See note 2**)	733317-13 735925-13
Siemens RAY-14_1, RAY-14S_1 20/50 Ω stator (single phase only)		11111	None	60/180 Hz	5 µF	30 µF	733317-13 735925-13	901297-13 901298-13

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1........5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Toshiba Rotanode	Most Toshiba x-ray tubes are identified by their "E" number, which is used to represent both the Tube Insert and the complete assembly. The housing number is usually not shown on the identification label. A specific "E" number may be available with several different stator types, each having different starter requirements. Furthermore, a specific stator type may require different starter requirements depending on the housing used. For ease of use, the Toshiba tubes are sorted by Tube Type ("E" number) within this table. The installer must confirm the stator type for the planned tube(s). If the stator type is not identified within the Toshiba documentation, match the stator winding resistance to the appropriate table entry. Contact the factory if the desired Tube Type and stator type / winding resistance are not listed on the same line within this table.							
Toshiba XH-112V-2 XH-112W XS-AA stator XS-AG stator (9.4/28.3 Ω)	DRX-3624H DRX-3724H DRX-4634H	10001	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
Toshiba XH-121 XH-126 XH-150 XS-AV stator XS-RA stator (27.5/58 Ω)	E7132 E7239 E7240 E7242 **(See note 7)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 μF	733317-01 735925-01 733317-13 735925-13 **(See note 2)**	901297-13 901298-13
Toshiba XH-112V XS-AG stator (9.4/28.3 Ω)	E7250 **(See note 7)**	10001	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE Switches 1........5**	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Toshiba XH-106V XH-180 XH-181 XS-AL stator (9.4/28.3 Ω)	E7252 **(See note 7)**	10111	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13	901297-12 901298-12 901297-13 901298-13
Toshiba XH-106V XH-180 XH-181 XS-RA stator (27.5/58 Ω)	E7252 **(See note 7)**	11001	These Dual Speed Starters must be jumper-configured to provide the required 28 μF low speed shift capacitance. ***Please refer to note 9 before attempting to use this Dual Speed Starter configuration***.	60/180 Hz	3 μF	28 μF	733317-15 735925-15 **(See note 9)**	901297-15 901298-15 **(See note 9)**
			LOW SPEED OPERATION ONLY **(See note 1)**	60 Hz	N/A	30 μF	733317-01 735925-01 733317-13 735925-13 **(See note 2**)	901297-13 901298-13
Toshiba XH-157 XS-RB stator (20.2/38 Ω)	E7254 E7255 **(See note 7)**	10101	None	60/180Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Toshiba XH-121 XH-126 XS-AV stator XS-RA stator (27.5/58 Ω)	E7299 **(See note 7)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 μF	733317-01 735925-01 733317-13 735925-13 **(See note 2**)	901297-13 901298-13
Toshiba XH-106V XH-180 XS-AL stator (9.4/28.3 Ω)	E7813 **(See note 7)**	10111	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13	901297-12 901298-12 901297-13 901298-13

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE Switches 1........5**	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Toshiba XH-121 XS-BA stator (18/47.5 Ω)	E7843 **(See note 7)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
Toshiba XH-121 XH-126 XH-150 XS-RA stator (27.5/58 Ω)	E7861 **(See note 7)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF	733317-01 735925-01 733317-13 735925-13 **(See note 2)**	901297-13 901298-13
Toshiba XH-112V XS-AG stator (9.4/28.3 Ω)	E7864 E7869 **(See note 7)**	10001	None	60/180 Hz	6 µF	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
Toshiba XH-121 XS-AV stator XS-RA stator (27.5/58 Ω)	E7876 **(See note 7)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF	733317-01 735925-01 733317-13 735925-13 **(See note 2)**	901297-13 901298-13
Toshiba XH-121 XH-126 XH-150 XS-AL stator (9.4/28.3 Ω)	E7884 **(See note 7)**	10111	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13	901297-12 901298-12 901297-13 901298-13

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE Switches 1........5**	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Toshiba XH-121 XS-126 XS-AV stator XS-RA stator (27.5/58 Ω)	E7886 **(See note 7)**	00000	**LOW SPEED OPERATION ONLY** **(See note 1)**	60 Hz	N/A	30 μF	733317-01 735925-01 733317-13 735925-13 **(See note 2**)	901297-13 901298-13
Varian/Machlett Dynamax 52 Std “R” stator (16/50 Ω)	A-102 A-132 A-142	01000	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Varian/Machlett Dynamax 62 “STD” stator (23/56 Ω) Dynamax 62U configured as “STD” or “R” (15/36 Ω)	A-192B A-196 A-197 A-256 A-272 A-282 A-286 A-292 A-482 A-486	00000	None	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Varian B-100 “R” stator (16/50 Ω)	A-102 A-132 / A-134* A-142 / A-144* A-145 *** (See note 8)**	01000	**(Insert A145 only):** **LOW SPEED OPERATION ONLY** **(See note 1)**	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Varian B-100 “Q” stator (8/15 Ω)	A-102 A-132 / A-134* A-142 / A-144* A-145 *** (See note 8)**	11010	**(Insert A145 only):** **LOW SPEED OPERATION ONLY** **(See note 1)**	60/180 Hz	20 μF	60 μF	733317-02 735925-02	901297-02 901298-02

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	CODE Switches 1……..5	OPERATING NOTES (SEE TABLE 3 FOR OPERATING PARAMETERS)	OUTPUT FREQ.	H.S. SHIFT CAP.	L.S. SHIFT CAP.	INDICO 100 DSS PART NO.**	CMP 200 DSS PART NO.**
Varian B-130 B-130H B-135H B-150 “R” stator (16/50 Ω)	A-152 A-182 / A-184* A-192 / A-194* A-195 A-196 A-197 A-272 / A-274* A-277 / A-278* A-282 / A-284 * A-286 A-292 / A-294* A-482 *** (See note 8)**	00000	None	60/180 Hz	6 µF	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
	G-242 G-256 G-292	10100	None	60/180 Hz	6 µF	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
Varian B-130 B-130H B-135H B-150 “Q” stator (6/11 Ω)	A-152 A-182 / A-184* A-192 / A-194* A-195 A-196 A-197 A-252 A-272 / A-274* A-277 / A-278* A-282 / A-284 * A-286 A-292 / A-294* A-482 G-242 G-256 G-292 *** (See note 8)**	00110	None	60/180 Hz	20 µF	60 µF	733317-02 735925-02	901297-02 901298-02

3.0 Dual Speed Starter Tube Select Table (cont)

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE** Switches 1........5	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Varian B-160 B-160H B-165H “R” Stator (16/50 Ω)	G-1077 G-1078 G-1080 G-1082 / G-1084* G-1086 / G-1087* G-1092 / G-1094* *** (See note 8)**	11110	May use CODE 11000 for shorter exposure delay during high-speed boost. Consult factory.	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Varian B-180 B-180H B-185 B-185H “R” Stator (16/50 Ω)	G-1582 G-1592 G-1593	11110	May use CODE 11000 for shorter exposure delay during high-speed boost. Consult factory.	60/180 Hz	6 μF	30 μF or 36 μF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2**)	901297-12 901298-12 901297-13 901298-13 **(See note 2**)
Varian B-199 “S” Stator (15/18 Ω)	SG-1096	01001	None	50/150 Hz	5 μF	30 μF	733317-13 735925-13 733317-17 735925-17 **(See note 2**)	901297-13 901298-13
Varian B-240H “R” Stator (14/46 Ω)	G-2090	01100	None	100/180 Hz	6 μF	12.5μF	733317-16 735925-16	901297-16 901298-16

TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**CODE Switches 1........5**	**OPERATING NOTES** (SEE TABLE 3 FOR OPERATING PARAMETERS)	**OUTPUT FREQ.**	**H.S. SHIFT CAP.**	**L.S. SHIFT CAP.**	**INDICO 100 DSS PART NO.****	**CMP 200 DSS PART NO.****
Varian (Eureka) Diamond "R" stator (20/50 Ω)	RAD-12	00000	**LOW SPEED OPERATION ONLY (See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
	RAD-13 RAD-14 RAD-68	00000	None	60/180 Hz	6 µF	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
Varian (Eureka) Emerald "R" stator (20/50 Ω)	RAD-8 RAD-74	00000	**LOW SPEED OPERATION ONLY (See note 1)**	60 Hz	N/A	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**
Varian (Eureka) Sapphire "R" stator (20/50 Ω)	RAD-21 RAD-40 RAD-44 RAD-56 RAD-60 RAD-92 RAD-94	10100	None	60/180 Hz	6 µF	30 µF or 36 µF	733317-01 735925-01 733317-12 735925-12 733317-13 735925-13 **(See note 2)**	901297-12 901298-12 901297-13 901298-13 **(See note 2)**

3.0 Dual Speed Starter Tube Select Table (cont)

THE DUAL SPEED STARTER USES MODULATION STRATEGIES TO OBTAIN THE DESIRED OUTPUTS. MEASURED VOLTAGES MAY NOT AGREE WITH THOSE LISTED IN THE TABLE. HOWEVER, THE CURRENTS FLOWING IN THE STATOR WINDINGS ARE EQUIVALENT TO THOSE THAT WOULD EXIST IF THE STATOR WAS EXCITED WITH THESE VOLTAGES.

** Dual Speed Starter part numbers 733317-XX (Indico 100) and 901297-XX (CMP 200® DR) are used in 400 VAC 3ϕ generators / power supplies and in 480 VAC 3ϕ generators / power supplies with a line adjusting transformer.

Dual Speed Starter part numbers 735925-XX (Indico 100) and 901298-XX (CMP 200® DR) are used in 230 VAC 1ϕ generators / power supplies and in 480 VAC 3ϕ direct input generators / power supplies (using no line adjusting transformer).

Where more than one Dual Speed Starter part number is referenced for a particular tube type, any of these (applicable to the generator and input voltage) is acceptable. For 2-tube systems using different tube types, both tube types must be considered.

NOTE 1: Tube types designated as low speed only or high speed only must be programmed for low speed only or high speed only operation. Refer to the section ***Tube Selection*** within Chapter 3 of the applicable generator service manual for details. For some tubes listed as high speed only, the starter may be capable of low speed operation but the Manufacturer's data sheet for the Insert lists high speed only. In other cases, the limitation is due to operational limitations of the Dual Speed Starter itself.

NOTE 2: Dual Speed Starters 733317-01 / 735925-01 (Indico 100 only) provide 6 μF of high speed and 31 μF of low speed shift capacitance. Dual Speed Starters 733317-13 / 735925-13 may be used in place of Dual Speed Starter "-01" in all cases and are preferred.

Dual Speed Starters 733317-12 / 735925-12 (Indico 100) and 901297-12 / 901298-12 (CMP 200® DR) are universal configurations, providing either 6 μF or 7.5 μF of high speed and either 36 μF or 37.5 μF of low speed shift capacitance. Capacitor selection is made automatically by relays located on the Dual Speed Starter.

Dual Speed Starters 733317-13 / 735925-13 (Indico 100) and 901297-13 / 901298-13 (CMP 200® DR) are universal configurations, providing either 5 μF or 6 μF of high speed and 30 μF of low speed shift capacitance. Capacitor selection is made automatically by relays located on the Dual Speed Starter.

Dual Speed Starters 733317-16 / 735925-16 (Indico 100) and 901297-16 / 901298-16 (CMP 200® DR) are special configurations, providing either 6 μF or 12.5 μF of high speed and either 31.5 μF or 37.5 μF of low speed shift capacitance. Capacitor selection is made automatically by relays located on the Dual Speed Starter. These starters are intended for used in place of Dual Speed Starter "-13" in two-tube systems that include both a standard "R" stator (requiring 6 μF of high speed capacitance) and a tube requiring 12.5μF of high speed shift capacitance (Philips ROT 350//500).

Dual Speed Starters 733317-17 / 735925-17 (Indico 100 only) are special configurations, providing either 5 μF or 12.5 μF of high speed and either 30 μF or 37.5 μF of low speed shift capacitance. Capacitor selection is made automatically by relays located on the Dual Speed Starter. These starters may be used in place of Dual Speed Starter configuration -13 in two-tube systems that include both a tube requiring 5μF of high speed shift capacitance (typically IAE tubes) and a tube requiring 12.5μF of high speed shift capacitance (Philips ROT350/500). **Do not use these starters with Siemens tubes due to high-speed shift capacitor voltage limitations.**

NOTE 3: Comet tube inserts with the prefix “DI” and “DX” are interchangeable.

NOTE 4: Philips ROT housing with the windings connected in series (high impedance configuration).

NOTE 5: Philips ROT housing with the windings connected in parallel (low impedance configuration).

NOTE 6: Dunlee tube inserts with the prefix “DU” and Philips tube inserts with the prefix “RO” are interchangeable. Select the corresponding Philips insert type within the Generator software when using Dunlee tubes.

NOTE 7: Complete Toshiba x-ray tube assemblies include the suffix “X, “FX”, “GX”, or “JX”, which are interchangeable with respect to rotor and anode characteristics.

NOTE 8: These X-ray tubes incorporate a control grid. Grid control is currently not supported by CPI generators. Connect the grid connection to Ground when using these tubes, and select the insert type within the Generator software corresponding to the equivalent non-grid tube.

NOTE 9: Dual Speed Starters 733317-15 / 735925-15 (Indico 100) and 901297-15 / 901298-15 (CMP 200® DR) have jumper selectable phase shift capacitance that allows selection of 15.5 μF or 28 μF low speed shift capacitors for operation with CGR (GE) Statorix or Toshiba E7252 (XS-R/RA stator) tubes, respectively, as per table 2. **By default, this starter is factory set to the 28 μF position. Confirm proper configuration per the section “configuring dual speed starter 733317-15 / 735925-15” in chapter 2 before proceeding.** These starters also support standard “R” stators that require 6 μF of high speed shift capacitance.

(Indico 100 only): If configured for 28 μF of low speed capacitance, these Dual Speed Starters also support tubes listed in Table 2 as requiring Dual Speed Starters 733317-13 / 735925-13 and requiring 6 μF of high speed capacitance. For two-tube operation, this configuration will support: a) these tubes and the Toshiba E7252/XS-RA (high and low speed) simultaneously, or, b) these tubes and a CGR Statorix tube (high-speed only) simultaneously. The Toshiba and CGR tubes can be supported simultaneously if one or both of these tubes are operated in high-speed mode only.

(CMP 200® DR only): If configured for 28 μF low speed capacitance, these Dual Speed Starters also support tubes listed in Table 2 as requiring Dual Speed Starters 901297-13 / 901298-13 and requiring 6 μF of high speed capacitance.

3.1 DUAL SPEED STARTER TUBE CODES

Tube operating parameters for each tube type are selected by setting switches to the applicable Code, as indicated in Table 2. For reference, operating parameters applicable to each Code are contained in Table 3 below.

Reference notes are provided at the end of Table 3.

TABLE 3: TUBE TYPE CODES (HIGH SPEED STARTER)

CODE Switches 1........5	TUBE TYPE (CODE)	H.S. START VOLTS	H.S. RUN VOLTS	H.S. BOOST TIME	H.S. FREQ.	H.S. BRAKE VOLTS	H.S. BRAKE TIME	L.S. START VOLTS	L.S. RUN VOLTS	L.S. BOOST TIME	L.S. FREQ. Hz	H.S. SHIFT CAP.	APPLICABLE DSS TYPES (See note 1)
00000	0	400 V	100 V	1.4 sec	180 Hz	100 V	3.0 sec	240 V	60 V	1.4 sec	60 Hz	6 µF	-01, -12, -13, -15, -16
10000	1	400 V	100 V	1.9 sec	180 Hz	100 V	3.0 sec	240 V	70 V	1.9 sec	60 Hz	6 µF	-01, -12, -13, -15, -16
01000	2	400 V	100 V	1.0 sec	180 Hz	100 V	3.0 sec	240 V	60 V	1.0 sec	60 Hz	6 µF	-01, -12, -13, -15, -16
11000	3	400 V	100 V	5.0 sec*	180 Hz	150 V	3.0 sec	240 V	70 V	5.0 sec	60 Hz	6 µF	-01, -12, -13, -15, -16 * (2.5 sec Ready)
00100	4	420 V	70V	1.6 sec	180 Hz	120 V	3.0 sec	240 V	50 V	1.6 sec	60 Hz	6 µF	-01, -12, -13, -15, -16
10100	5	400 V	100 V	2.3 sec	180 Hz	100 V	3.0 sec	240 V	50 V	2.3 sec	60 Hz	6 µF	-01, -12, -13, -15, -16
01100	6	440 V	140 V	6.0 sec*	180 Hz	250 V	4.0 sec**	400 V	110 V	5.0 sec	100 Hz	6 µF ***	-16 * (5.0 sec Ready) ** (LS braking 2.0 sec) *** (12.5uF L.S. cap.)
11100	7	240 V	120 V	2.3 sec	180 Hz	100 V	3.0 sec	240 V	50 V	2.3 sec	60 Hz	6 µF	-01, -12, -13, -15, -16
00010	8	400 V	90 V	3.0 sec	150 Hz	100 V	3.0 sec	240 V	100 V	1.5 sec	50 Hz	6 µF	-01, -12, -13, -15, -16
10010	9	280 V	60 V	1.5 sec	180 Hz	80 V	3.0 sec	180 V	50 V	1.5 sec	60 Hz	12.5 µF	-12 (LS only), -16, -17 (HS/LS)
01010	10	440 V	100 V	0.8 sec	150 Hz	120 V	1.8 sec	220 V	50 V	0.6 sec	50 Hz	6 µF	-01, -12, -13, -15, -16
11010	11	290 V	70 V	0.8 sec	180 Hz	60 V	3.0 sec	150 V	50 V	0.8 sec	60 Hz	20 µF	-02 (HS/LS), -16,-17 (LS only)
00110	12	290 V	60 V	1.3 sec	180 Hz	60 V	3.0 sec	150 V	50 V	1.3 sec	60 Hz	20 µF	-02
10110	13	340 V	60 V	1.0 sec	180 Hz	100 V	3.0 sec	240 V	70 V	1.0 sec	60 Hz	20 µF	-02
01110	14	400 V	90 V	0.9 sec	180 Hz	80 V	2.0 sec	230 V	70 V	0.9 sec	60 Hz	7.5 µF	-12
11110	15	400 V	100 V	5.0 sec	180 Hz	150 V	3.0 sec	240 V	70 V	5.0 sec	60 Hz	6 µF	-01, -12, -13, -15, -16

CODE Switches 1........5	TUBE TYPE (CODE)	H.S. START VOLTS	H.S. RUN VOLTS	H.S. BOOST TIME	H.S. FREQ.	H.S. BRAKE VOLTS	H.S. BRAKE TIME	L.S. START VOLTS	L.S. RUN VOLTS	L.S. BOOST TIME	L.S. FREQ. Hz	H.S. SHIFT CAP.	APPLICABLE DSS TYPES (See note 1)
00001	16	340 V	80 V	1.6 sec	180 Hz	80 V	3.0 sec	150 V	50 V	1.6 sec	60 Hz	5 μF	-13, -17
10001	17	320 V	80 V	2.3 sec	180 Hz	100 V	3.0 sec	200 V	50 V	1.5 sec	60 Hz	6 μF	-01, -12, -13, -15, -16
01001	18	400 V	100 V	2.8 sec	150 Hz	120 V	3.0 sec	180 V	60 V	1.5 sec	50 Hz	5 μF	-13, -17
11001	19	320 V	130 V	2.0 sec	180 Hz	130 V	3.0 sec	240 V	60 V	1.4 sec	60 Hz	3 μF	-15 (HS / LS) -01, -12, -13 (LS only)
00101	20	400 V	90 V	1.0 sec	180 Hz	80 V	3.0 sec	230 V	70 V	1.0 sec	60 Hz	7.5 μF	-12
10101	21	420 V	100 V	2.2 sec	180 Hz	150 V	3.0 sec	240 V	80 V	1.8 sec	60 Hz	6 μF	-01, -12, -13, -15, -16
01101	22	340 V	60 V	1.4 sec	150 Hz	120 V	4.0 sec	220 V	60 V	1.5 sec	50 Hz	6 μF	-01, -12, -13, -15, -16
11101	23	360 V	90 V	1.6 sec	150 Hz	80 V	3.0 sec	150 V	50 V	1.6 sec	50 Hz	5 μF	-13
00011	24	420 V	80 V	1.8 sec	150 Hz	150 V	3.0 sec	240 V	80 V	1.8 sec	50 Hz	6 μF	-01, -12, -13, -15, -16
10011	25	420 V	80 V	2.2 sec	150 Hz	150 V	3.0 sec	240 V	80 V	1.8 sec	50 Hz	6 μF	-01, -12, -13, -15, -16
01011	26	400 V	80 V	1.0 sec	150 Hz	120 V	3.0 sec	240 V	80 V	1.0 sec	50 Hz	5 μF	Reserved
11011	27	440 V	100 V	1.1 sec	150 Hz	120 V	1.8 sec	220 V	80 V	1.1 sec	50 Hz	5 μF	-13, -17
00111	28	450 V	150 V	3.0 sec	150 Hz	120 V	3.0 sec	240 V	90 V	3.0 sec	50 Hz	3 μF	-15
10111	29	240 V	60 V	2.2 sec	180 Hz	80 V	1.6 sec	130 V	50 V	1.3 sec	60 Hz	6 μF	-01, -12, -13, -15, -16
01111	30	420 V	50 V	1.8 sec	180 Hz	150 V	3.0 sec*	240 V	50 V	1.8 sec	60 Hz	12.5 μF	-16, -17 * (LS braking 1.2 sec)
11111	31	330V	80 V	1.4 sec	180 Hz	70V	3.0 sec	240 V	80 V	1.4 sec	60 Hz	5 μF	-13

NOTE 1: Tube Type codes should only be used with the applicable DSS types specified in this table.
Refer to Table 2 for DSS Part Numbers applicable to each Tube Type (Housing and Insert).

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CHAPTER 3

SYSTEM INTERFACING, PROGRAMMING, AEC / ABS CALIBRATION, AND DAP / AK SETUP & CALIBRATION

3.0.0 INTRODUCTION

3.1.0 Purpose

This chapter details the interfacing of the X-ray room equipment to the generator, and also describes the AEC, ABS, and DAP / AK programming of the generator. This chapter also allows the installer to record the necessary information to complete the installation, as well as to record the programming values.

This chapter contains the following sections.

Section	Title
3A	Setup information.
3B	System interfacing.
3C	Programming the generator.
3D	AEC (Automatic Exposure Control) calibration.
3E	ABS (Automatic Brightness Stabilization) calibration.
3F	DAP (Dose-Area Product) setup and calibration / AK (Air Kerma) setup and calibration.

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CHAPTER 3A

SETUP INFORMATION

CONTENTS:

3A.1.0 INTRODUCTION

Please record the setup information for your installation in this section before programming the generator. Enter the information appropriate for your generator model. The data tables will accommodate installations up to a standard R&F installation with the following: tilting G.I. table with Bucky, spot film device, standard image tube with a medical T.V. system, wall Bucky and an overhead tube stand, spot film camera and a digital acquisition system.

3A.2.0 INSTALLATION RECORD

3A.2.1 X-Ray Tubes

Please enter the appropriate information.

a)	Over table X-ray tube (or TUBE # 1)		
b)	Manufacturer and type:		
c)	Focal spot combination:	large =	small =
d)	kW of each focal spot:	large =	small =
e)	Maximum kV:		
f)	Type of stator:		
g)	Dual or single speed:		
h)	Stator delay:	sec =	
i)	Start and run voltage, low speed:	start volts =	run volts =
j)	Start and run voltage, high speed:	start volts =	run volts =
k)	Brake voltage:	volts =	
l)	Maximum filament current:	amps =	
m)	Minimum filament current, stand-by:	amps =	
n)	Thermal switch included:		
o)	Under table X-ray tube (or TUBE # 2)		
p)	Manufacturer and type:		
q)	Focal spot combination:	large =	small =
r)	kW of each focal spot:	large =	small =
s)	Maximum kV:		
t)	Type of stator:		
u)	Dual or single speed:		
v)	Stator delay:	sec =	
w)	Start and run voltage, low speed:	start volts =	run volts =
x)	Start and run voltage, high speed:	start volts =	run volts =
y)	Brake voltage:	volts =	
z)	Maximum filament current:	amps =	
aa)	Minimum filament current, stand-by:	amps =	
bb)	Thermal switch included:		
cc)	X-ray tube fan included:		

3A.2.2 Mains Supply And Fusing

Please record the following information on the mains voltage and current capacity. Check that the information is appropriate for the generator according to the nameplate on the generator cabinet.

Line voltage: ________ VAC.

Line frequency: _ 50 Hz. _ 60 Hz. Line capacity: _____ kVa.

Disconnect fuses (main): ______ amps.

3A.2.3 Automatic Exposure Control

Chamber Type (optional):

Solid State:	____________	Ion Chamber:	____________	PMT:	____________
Make:	____________	Model:	____________		

Receptors with AEC (optional):

Table Bucky:	___yes	Spot film device:	___yes	Digital system:	___yes
Wall Bucky:	___yes	Auxiliary Bucky:	___yes		

3A.2.4 Collimator

Type:	____________________________	
Compatible with X-ray tube:	___yes	___no
Exposure interlock (dry contacts):	___yes	___no
Tomo / stereo by-pass:	___yes	___no

3A.2.5 Image System

Conventional:	________________________	(make & model)
Digital:	________________________	(make & model)
Image intensifier:	___dual mode	___tri-mode
24 hour supply:	___yes	___no
Image system park / position switch:	___yes	___no
Fluoro foot switch to initiate fluoro and spot exposure:	___yes	___no
Spot film advance delay: greater than 850 msec?	___yes	___no
Remote Fluoro controller:	___yes	___no
AEC compensation for multi-spot SFD use:	___yes	___no

3A.2.6 ABS Pickup Assembly

Optical diode: _____ PMT: _____ Proportional DC: _____ Composite Video: _____

Make: ______________________________ Model: ______________

3A.2.7 Table Type

Table type: ______________________________________ Make / Model: ________________________

Grid: _________ Ratio: _________ L/P Inch: _________ Focus Distance: _________

3A.2.8 Wall Receptor

Type: ____

Grid: _________ Ratio: _________ L/P Inch: _________ Focus Distance: _________

3A.2.9 Receptor Assignment

Receptor 1: ________________________

Receptor 2: ________________________

Receptor 3: ________________________

Receptor 4: ________________________

Receptor 5: ________________________

Receptor 6: ________________________

3A.2.10 Miscellaneous Notes

3A.3.0 X-RAY TUBE AND GENERATOR PARAMETER WORKSHEET

Note: ***The information in this table is to be derived from the GEN CONFIGURATION menu.***

Generator Model: _______________ Serial No: ______________

TUBE SELECTION	TUBE 1		TUBE 2	
	DEFAULT	SELECTED	DEFAULT	SELECTED
TUBE SELECTED				
TUBE SPEED				
MAX SF KW LS				
MAX LF KW LS				
MAX SF KW HS				
MAX LF KW HS				
MAX KV				
MAX SF MA				
ANODE HU WARNING				
ANODE HU LIMIT				
SF STANDBY				
LF STANDBY				
SF MAX				
LF MAX				
FIL BOOST				
FIL PREHEAT				
GENERATOR LIMITS	DEFAULT	SELECTED		
MAX KW				
MAX MA				
MIN MA				
MAX MAS				

3A.4.0 IMAGE RECEPTOR PROGRAMMING WORKSHEET

IMAGE RECEPTOR PROGRAMMING WORKSHEET DATE:_______________ SERIAL #:_______________						
FUNCTION	RECEPTOR 1	RECEPTOR 2	RECEPTOR 3	RECEPTOR 4	RECEPTOR 5	RECEPTOR 6
RECEPTOR NAME						
TUBE						
TOMO						
FLUORO						
SERIAL						
INTERFACE OPTS						
FUNCTIONAL OPTS						
RECEPTOR SYM						
FLUORO HANG						
RAD HANG						
LAST IMAGE HOLD						
MEMORY						
REM TOMO BUT						
SF/LF SWITCH						
AEC BACKUP						
AEC BACKUP MAS						
AEC BACKUP MS						
AEC CHANNEL						

3A.5.0 I/O CONFIGURATION WORKSHEET

NOTE: BOXES WITH DOTTED LINES CANNOT HAVE THEIR STATE CHANGED!

FUNCTIONS	STANDBY	PREP	GEN RDY	RAD EXP	FLUORO EXP
INPUTS					
REMOTE EXP	-----		-----		-----
REMOTE PREP	-----		-----	-----	-----
REMOTE FL. EXP	-----	-----	-----	-----	
CONSOLE EXP	-----		-----		-----
CONSOLE PREP	-----		-----	-----	-----
TOMO EXP	-----	-----	-----		-----
REM. TOMO SEL		-----	-----	-----	-----
I/I SAFETY	-----		-----		
COLL. ITLK	-----		-----		
BUCKY CONTACTS	-----	-----	-----		-----
SPARE			-----		
THERMAL SW 1			-----		
THERMAL SW 2			-----		
DOOR ITLK			-----		
MULTI SPOT EXP		-----	-----	-----	-----
OUTPUTS					
BKY 1 SELECT					
BKY 2 SELECT					
BKY 3 SELECT					
TOMO/BKY 4 SEL					
TOMO/BKY STRT					
ALE					
COLL. BYPASS					
ROOM LIGHT					
SPARE					

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CHAPTER 3B

SYSTEM INTERFACING

CONTENTS:

3B.1.0 INTRODUCTION

The Indico 100 X-ray generator may be interfaced to various tables, imaging systems, tomographic devices, AEC pickups, Buckys, ABS pickups, X-ray tubes and collimators.

Most of the room interface inputs can be programmed to accept a dry contact input or a 24 VDC input. Most room interface outputs are programmable to provide dry contact outputs or live contact outputs (24 VDC, 110 VAC, or 220 VAC). Details are provided in sections 3B.3.1 and 3B.3.2.

All interfacing cables enter the generator at the rear of the generator cabinet. Ferrules should be used on the ends of all stranded wires that are connected to terminal connections in the generator. These must be supplied by the installer.

NOTE: ***The installer must provide the necessary interfacing cables.***

NOTE: ***ALL SAFETY WARNINGS AND NOTICES DETAILED IN CHAPTER 1B MUST BE OBSERVED AT ALL TIMES.***

3B.2.0 LOCATIONS OF INPUTS AND OUTPUTS

3B.2.1 Generator Pictorial Showing Connections

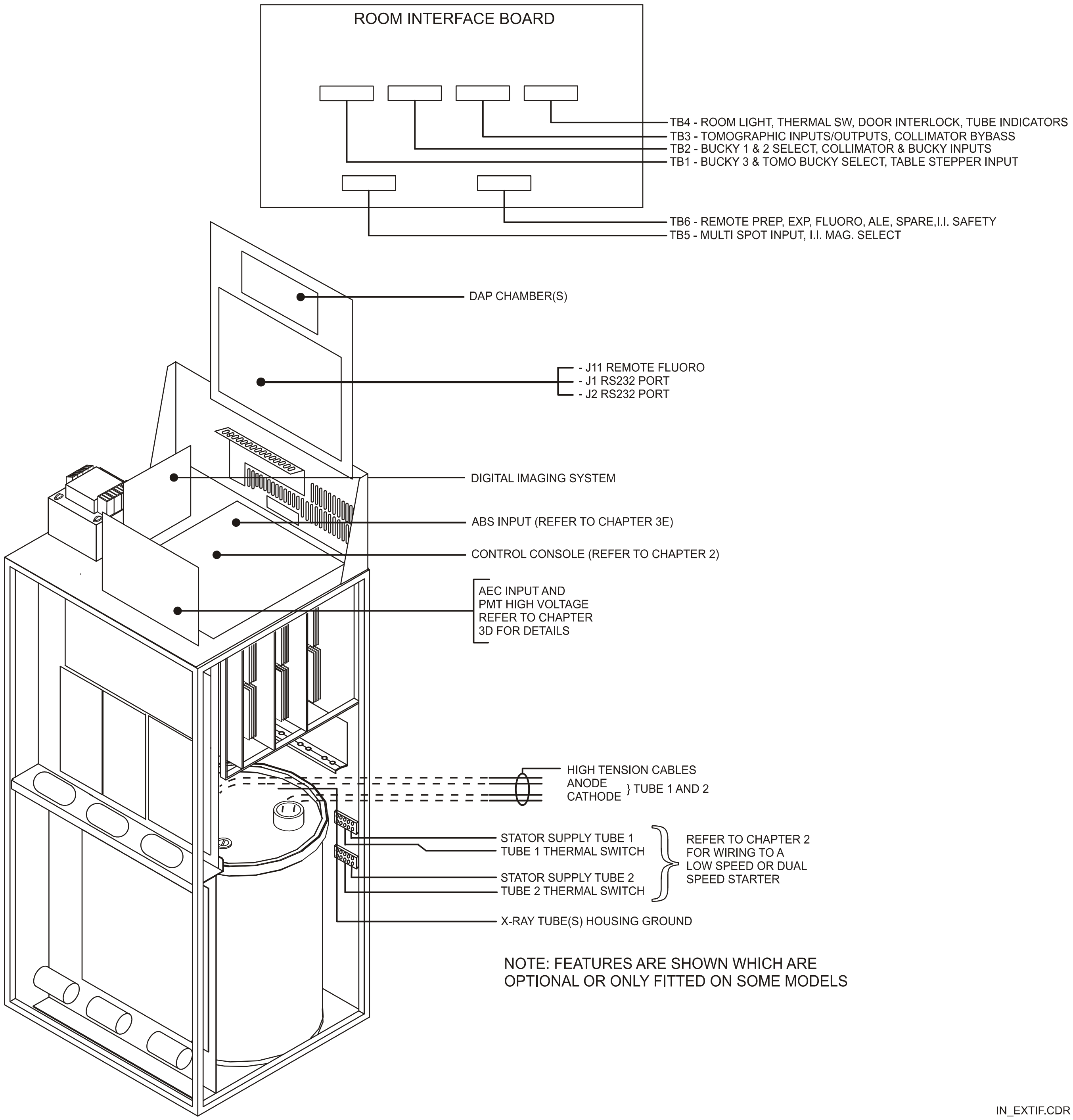

Figure 3B-1: Generator to room interface

CAUTION: ***ENSURE THAT ALL X-RAY TUBE HOUSINGS ARE CONNECTED TO THE GROUND STUD ON THE HT TANK. USE A SEPARATE GROUND WIRE FOR EACH TUBE, #10 AWG (6 mm^2) OR GREATER.***

3B.2.2 Low Speed / Dual Speed Starter

Refer to chapter 2 (installation) for instructions on wiring to the low speed or dual speed starter. The X-ray tube thermal switches may be connected at the stator terminal blocks near the HT tank, or at the room interface board. Both sets of terminals are connected in parallel, and either may be used.

3B.2.3 High Tension Transformer

Accepts the high-tension cables from the X-ray tube(s). Refer to chapter 2.

3B.2.4 Generator Interface Board

The generator interface board provides inputs / outputs for the following:

- ABS; various inputs (R&F generators only). Refer to chapter 3E.
- Control console as per chapter 2.
- Optional Active Dose Reduction system. Supplement 746046 will be included if this option is fitted.
- Emergency power-off switch and power for an installer-supplied power distribution relay. Refer to chapter 2 for details.

3B.2.5 Generator CPU Board

The generator CPU board has the following user-accessible inputs / outputs:

- Optional remote fluoro control. Refer to chapter 2.
- RS 232 Port (J1).
- RS 232 Port (J2). This is used by the DAP interface board if the DAP option is fitted.

3B.2.6 AEC Board

Depending on the generator's configuration, different AEC boards may be fitted. Chapter 3D describes the interfacing and calibration of this board.

3B.2.7 Console CPU Board / Touch Screen

The optional hand switch connects to the console CPU board or to a connector on the rear of the console; refer to chapter 2 for details. If it is desired to connect a remote fluoro footswitch (normally customer supplied), connect to TB6 pins 5 & 6 on the room interface board, or to terminals "F" and "COM" on TB1 on the console CPU board (23 X 56 cm consoles), or to J13 on the 31 X 42 cm console. Refer to chapter 2 for details.

3B.2.8 Digital I/0 Board (optional)

The optional digital I/0 board is used when the Indico 100 generator is interfaced with digital systems, film changers and other dedicated products. The appropriate digital imaging supplement will be included in the front of this manual if applicable.

3B.2.9 DAP Interface Board (optional)

The optional DAP interface board, when interfaced to customer-supplied DAP chambers, is used to measure dose-area- product. This allows the generator to interface with two DAP devices, one for each X-ray tube. Details are provided in chapter 3F.

3B.2.10 Room Interface Board

All the necessary inputs and outputs for the external room equipment are located on this board.

- TB1 - Bucky 3 and tomo / Bucky 4 select, table stepper input,
- TB2 - Bucky 1 and Bucky 2 select, collimator and Bucky inputs.
- TB3 - Tomographic inputs and outputs, collimator bypass.
- TB4 - Room light, thermal switches, door interlock, tube indicators.
- TB5 - Multiple spot input, I.I. mag. select.
- TB6 - Remote prep, exposure and fluoro inputs, I.I. safety input, ALE output, spare output.

3B.3.0 FEATURES OF THE ROOM INTERFACE BOARD

Refer to the following schematics and figures.

- Figure 3B-2, room interface board layout.
- Room interface functional drawing, MD-0763.

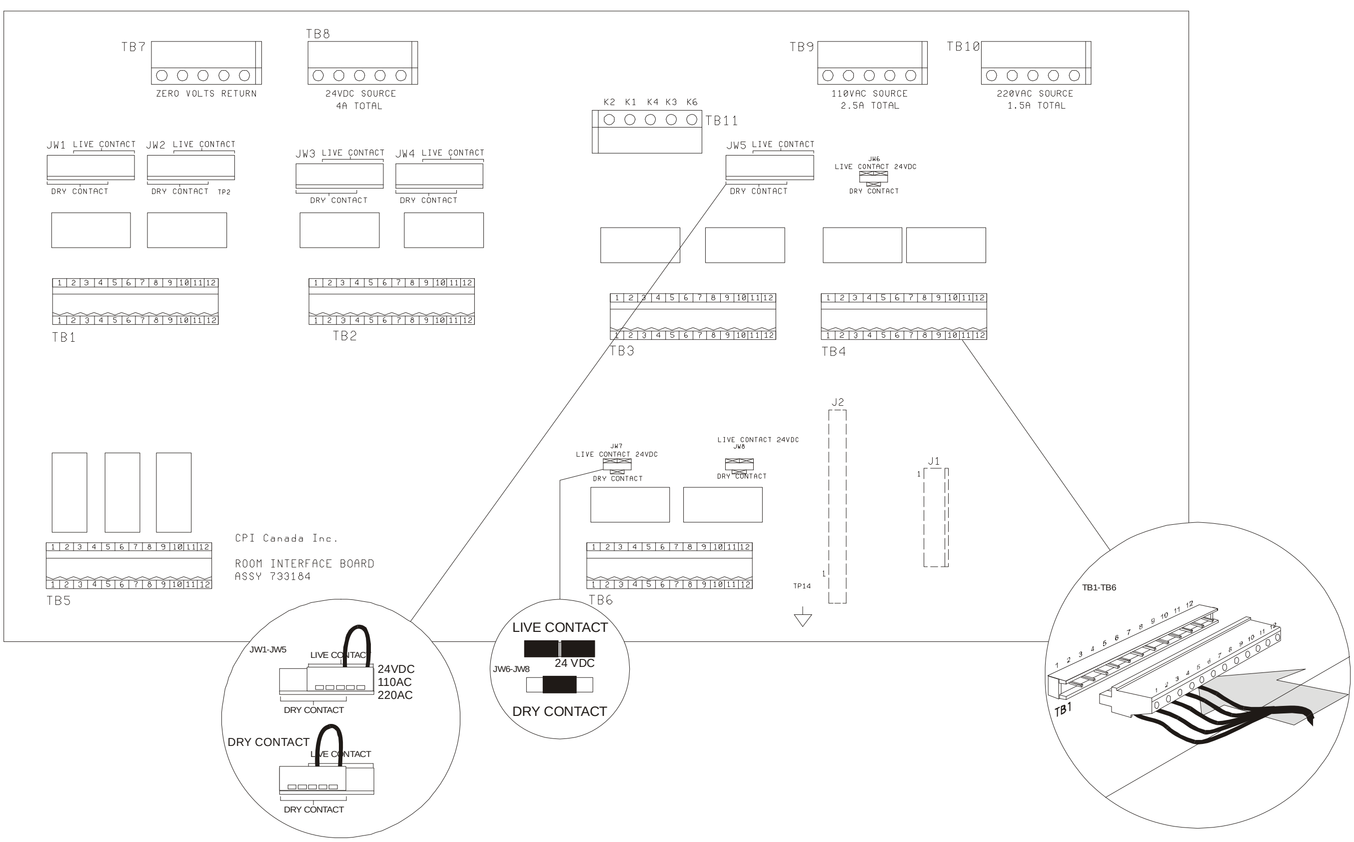

Figure 3B-2: Room interface board

3B.3.1 Inputs

- All inputs are opto coupled. Some inputs may be configured to use an external +/- 24 VDC source or to accept a closed dry contact.
- Note the following inputs and jumper configurations per the table below:

NOTE: ***The Indico 100 generator is shipped from the factory with all inputs configured for dry contact inputs.***

JUMPER CONFIGURATION (INPUTS):

ROOM INTERFACE BOARD	GENERATOR INTERFACE BOARD JUMPER CONFIGURATION
TB1 PINS 4 & 5 (SPARE/TABLE STEPPER *)	JW7 PINS 1-2, 3-4 = DRY CONTACT INPUT JW7 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB2 PINS 6 & 7 (COLLIMATOR INTERLOCK)	JW9 PINS 1-2, 3-4 = DRY CONTACT INPUT JW9 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB2 PINS 4 & 5 (BUCKY CONTACTS)	JW10.PINS 1-2, 3-4 = DRY CONTACT INPUT JW10 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB3 PINS 6 & 7 (TOMO EXPOSURE)	JW3 PINS 1-2, 3-4 = DRY CONTACT INPUT JW3 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB3 PINS 4 & 5 (REMOTE TOMO SELECT)	JW2 PINS 1-2, 3-4 = DRY CONTACT INPUT JW2 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB4 PINS 8 & 9 (THERMAL SWITCH 1)	DRY CONTACT INPUT ONLY
TB4 PINS 6 & 7 (THERMAL SWITCH 2)	DRY CONTACT INPUT ONLY
TB4 PINS 4 & 5 (ROOM DOOR INTLK **)	DRY CONTACT INPUT ONLY
TB5 PINS 11 & 12 (MULT. SPOT EXPOSURE)	JW6 PINS 1-2, 3-4 = DRY CONTACT INPUT JW6 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB6 PINS 9 & 10 (REMOTE EXPOSURE)	JW15 PINS 1-2, 3-4 = DRY CONTACT INPUT JW15 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB6 PINS 7 & 8 (REMOTE PREP)	JW14 PINS 1-2, 3-4 = DRY CONTACT INPUT JW14 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB6 PINS 3 & 4 (I.I. SAFETY/REMOTE HLF SELECT ***)	JW8 PINS 1-2, 3-4 = DRY CONTACT INPUT JW8 PINS 2-3 = 24 VDC EXTERNAL INPUT
TB6 PINS 5 & 6 (REMOTE FLUORO EXP **)	DRY CONTACT INPUT ONLY

* The table stepper function requires a signal from the table that indicates when to step to the next technique. When the table stepper function is enabled, the software will dedicate the spare input as the table stepper input. When the table stepper function is not enabled, this input may be used as a spare input.

The table must provide a signal that causes opto coupler U21 on the generator interface board to turn off, or to turn on (refer to MD-0763) when the generator should step to the next technique. This may be via an open or closed contact, or a 24 VDC source, depending on the input configuration. This input is “edge triggered” in the table stepper mode, where a high-to-low or low-to-high transition indicates that the table has requested the generator to select the next kV-mAs step.

** Refer to chapter 2, the section ***SAFETY INTERLOCKS*** for wiring options for the door interlock switch and the fluoro footswitch.

*** On some models, this input is designated as the remote high-level fluoro select input. If applicable, this will be documented as such in chapter 3E. If the HLF select input is programmed as CONSOLE, this will be the I.I. safety input. If the HLF select input is programmed as REMOTE, this will be the remote HLF selection.

3B.3.2 Outputs

- Outputs are via relay contacts, some of which may be configured to supply a dry contact closure or to supply 24 VDC, 110 VAC, or 220 VAC upon closure.
- Note the following outputs and jumper configurations per the table below:
- To supply power to a ***grounded*** load, use TB1 pin 12 (for example) and jumper on “dry contacts”. This applies also to TB1 pin 1, TB2 pin 12, TB2 pin 1 and TB3 pin 12.

NOTE: ***The Indico 100 generator is shipped from the factory with JW1 to JW5 configured for dry contacts, and JW6 to JW8 configured for 24 VDC output on relay closure.***

JUMPER CONFIGURATION (OUTPUTS):

ROOM INTERFACE BOARD	ROOM INTERFACE BOARD JUMPER CONFIGURATION
TB1 PINS 11 & 12 (BUCKY 3 SELECT)	JW2 DRY CONTACTS OUTPUT JW2 LIVE CONTACTS OUTPUT
TB1 PINS 1 & 2 (TOMO / BUCKY 4 SELECT)	JW1 DRY CONTACTS OUTPUT JW1 LIVE CONTACTS OUTPUT
TB2 PINS 11 & 12 (BUCKY 1 SELECT)	JW4 DRY CONTACTS OUTPUT JW4 LIVE CONTACTS OUTPUT
TB2 PINS 1 & 2 (BUCKY 2 SELECT)	JW3 DRY CONTACTS OUTPUT JW3 LIVE CONTACTS OUTPUT
TB3 PINS 11 & 12 (TOMO/BUCKY START)	JW5 DRY CONTACTS OUTPUT JW5 LIVE CONTACTS OUTPUT
TB3 PINS 1 & 2 (COLLIMATOR BYPASS)	DRY CONTACT OUTPUT ONLY
TB4 PINS 11 & 12 (ROOM LIGHT)	DRY CONTACT OUTPUT ONLY
TB4 PINS 1 & 2 TUBE 2 INDICATOR TB4 PINS 1 & 3 TUBE 1 INDICATOR	JW6 PINS 1-2, 3-4 = 24VDC OUTPUT JW6 PINS 2-3 = DRY CONTACT OUTPUT
TB5 PINS 8 & 9 (I.I. MAG 1)	DRY CONTACT OUTPUT ONLY
TB5 PINS 5 & 6 (I.I. MAG 2)	DRY CONTACT OUTPUT ONLY
TB5 PINS 2 & 3 (I.I. MAG 3)	DRY CONTACT OUTPUT ONLY
TB6 PINS 1 & 2 (ALE OUTPUT)	JW7 PINS 1-2, 3-4 = 24VDC OUTPUT JW7 PINS 2-3 = DRY CONTACT OUTPUT
TB6 PINS 11 & 12 (SPARE OUTPUT)	JW8 PINS 1-2, 3-4 = 24VDC OUTPUT JW8 PINS 2-3 = DRY CONTACT OUTPUT

3B.3.3 Selecting Output Voltages

Five outputs (K1, K2, K3, K4 and K6 for Bucky selects and Bucky start) may be jumper configured for a choice of the following voltages:

- 24 VDC, 4 Amps total.
- 110 VAC, 2.5 Amps total.
- 220 VAC, 1.5 Amps total.

NOTE: ***2.5 AMPS IS AVAILABLE AT 110 VAC OR 1.5 AMPS IS AVAILABLE AT 220 VAC, BUT BOTH ARE NOT AVAILABLE SIMULTANEOUSLY. TOTAL POWER CONSUMPTION MUST NOT EXCEED 350 VA.***

3B.3.3 Selecting Output Voltages (Cont)

The above voltage sources are not compatible with:

- Collimator lamps (24 VAC 150 watts). These lamps are not compatible with the 24 VDC supply. Contact your generator supplier regarding the optional 24VAC / 30VDC room power kit, which may be used for collimator lamps and other room electromechanical devices.
- Fluorescent lamps. These have high starting currents and generate transients when the tube strikes.
- Some inductive loads may cause difficulties (for example some motors, under table tube fans, and solenoids).

IT IS STRONGLY RECOMMENDED THAT CLAMPING / RECOVERY DIODES BE USED ON INDUCTIVE DEVICES SUCH AS RELAYS, ETC WHICH ARE CONNECTED TO THE ROOM INTERFACE BOARD.

Voltage selections are made by adding jumper wires from TB11 to TB8, TB9, or TB10, and placing the jumpers on JW1, JW2, JW3, JW4, or JW5 in the live contact position.
Review figure 3B-3 for typical examples.

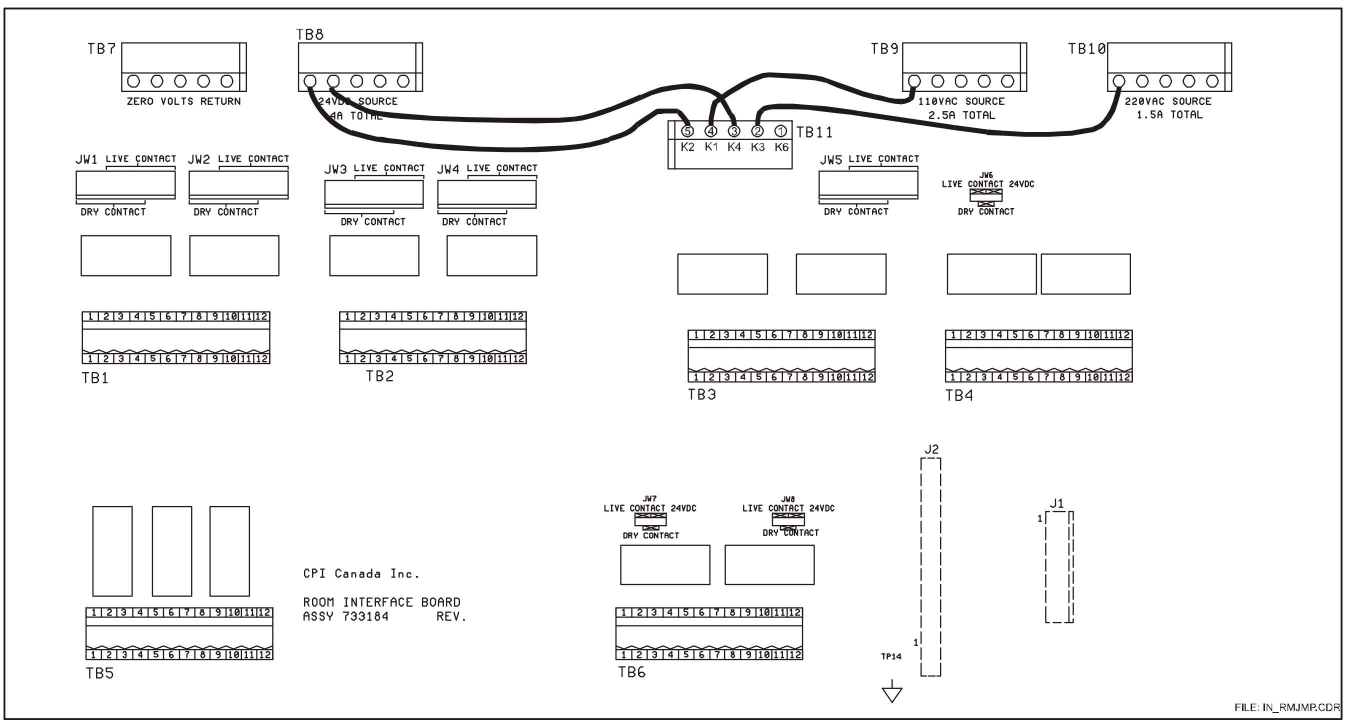

Figure 3B-3: Typical jumper arrangement on the room interface board

The Bucky select and Bucky start relays K1, K2, K3, K4 and K6 on the room interface board have provision for R-C snubber circuits to be connected across these relays. For older Buckys that typically have relay inputs, the R-C snubber circuits usually need to be connected. These snubbers attenuate the dV/dT transients that are generated when the corresponding relay in the Bucky opens.

For newer Buckys with opto-coupler inputs, the R-C snubber circuits across relays K1, K2, K3, K4 and K6 on the room interface board should remain disconnected, as the leakage current through the R-C snubber can be sufficient to energize the opto-couplers in the Bucky(s) when the corresponding relays on the room interface board are open.

3B.3.3 Selecting Output Voltages (Cont)

FOR OLDER BUCKYS WITH RELAY INPUTS:

- **Refer to the table below and to MD-0763 in chapter 9. The required jumpers (JW12, JW9, JW11, JW10 and JW14) must be installed to complete the R-C snubber circuit.**

FOR NEWER BUCKYS WITH OPTO-COUPLER INPUTS:

- **No action required. Junpers JW12, JW9, JW11, JW10 and JW14 are NOT factory installed, therefore the R-C snubber is open-circuit. It is the responsibility of the installer to provide the proper interfacing circuits to the opto coupler(s) in these types of installations.**

The jumper wires that must be installed to complete the R-C snubber circuit across K1, K2, K3, K4 and K6 on the room interface board are shown below.

RELAY	JUMPER WIRE	NOTE
K1	JW12	JW12 is not factory installed.
K2	JW9	JW9 is not factory installed.
K3	JW11	JW11 is not factory installed.
K4	JW10	JW10 is not factory installed.
K6	JW14	JW14 is not factory installed.
K8	JW13	JW13 is factory-installed. This completes the snubber circuit across the room light relay K8.

3B.3.4 Typical Examples

<u>Selected Output Relay</u>	<u>Plug and Jumper</u>	<u>Wire Jumper</u>
K2 (24 VDC)	JW2: Live Contact	(K2) TB11 - 5 to TB8
K1 (110 VAC)	JW1: Live Contact	(K1) TB11 - 4 to TB9
K4 (24 VDC)	JW4: Live Contact	(K4) TB11 - 3 to TB8
K3 (220 VAC)	JW3: Live Contact	(K3) TB11 - 2 to TB10
K6 (dry contacts)	JW5: Dry Contact	(K6) TB11 - no connection
K12 (24 VDC)	JW7: Live Contact 24VDC	N/A
K13 (dry contacts)	JW8: Dry Contact	N/A
K7 (24 VDC)	JW6: Live Contact 24VDC	N/A

The previous examples will configure the outputs as shown below:

- K2 when selected will provide 24 VDC to a load at TB1 pins 11 and 12.
- K1 when selected will supply 110 VAC to a load at TB1 pins 1 and 2.
- K4 when selected will supply 24 VDC to a load at TB2 pins 11 and 12.
- K3 when selected will supply 220 VAC to a load at TB2 pins 1 and 2.
- K6 when selected will supply closed contacts at TB3 pins 11 and 12.
- K12 when selected will supply 24 VDC at TB6 pins 1 and 2.
- K13 when selected will supply closed contacts at TB6 pins 11 and 12.
- K7 will supply 24 VDC at TB4 pin 3 for tube 1, or 24 VDC at TB4 pin 2 for tube 2. Ground reference will be at TB4 pin 1.

3B.3.5 Wiring The Room Interface Terminal Plugs

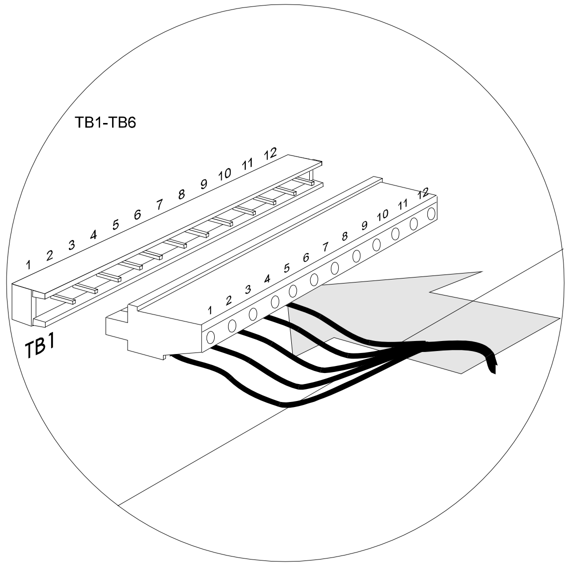

Figure 3B-4: Terminal plug

- Remove the required mating connectors from TB1 to TB6 on the room interface board.
- Back out the wire retaining screws as required.
- Dress the interface cable with a minimum of 5 inch (130 mm) flying leads.
- Strip each wire 0.25 inches (6 mm).
- Insert the wire into the plug and tighten the terminal screw. Several wires may be inserted into a single terminal connection.
- Be sure the plug numbering matches the input/output signals.
- Insert the plug into the room interface plug as shown in Figure 3B-4.
- Leave sufficient cable to allow interface access.
- To eliminate confusion, label each plug.
- Cable access covers are located on the rear panel of the generator to allow for cable entry. The cables should be secured to the lip on the inside of the access covers using tie-wraps or equivalent fasteners.

3B.4.0 GENERATOR INTERFACE BOARD PROGRAMMING FOR 110/220 VAC

The 110/220 VAC supplies available at TB9 and TB10 of the room interface board may be programmed such that:

- 110/220 VAC is present at TB9 and TB10 at all times that the generator main disconnect is switched ON.
- 110/220 VAC is present at TB9 and TB10 only when the generator itself is switched ON.

The desired selection is made using JW1 on the generator interface board. Setting the jumper to JW1 pins 1-2 selects the condition where 110/220 VAC is present at TB9 and TB10 only when the generator is switched ON.

Setting the jumper to JW1 pins 2-3 selects 110/220 VAC to be present at TB9 and TB10 at all times that the generator main disconnect is switched ON.

Refer to figure 3B-5; this shows the jumper position JW1 pins 1-2 which only provides for 110/220 VAC when the generator is switched ON.

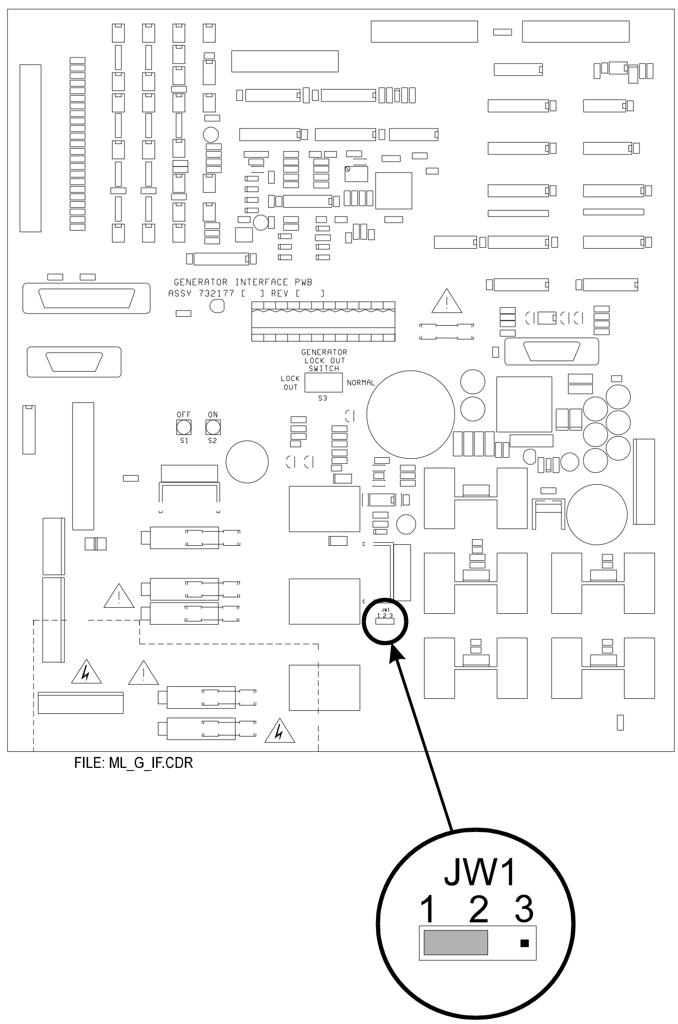

Figure 3B-5: 110/220 VAC programming

3B.5.0 TYPICAL R&F ROOM CONNECTIONS

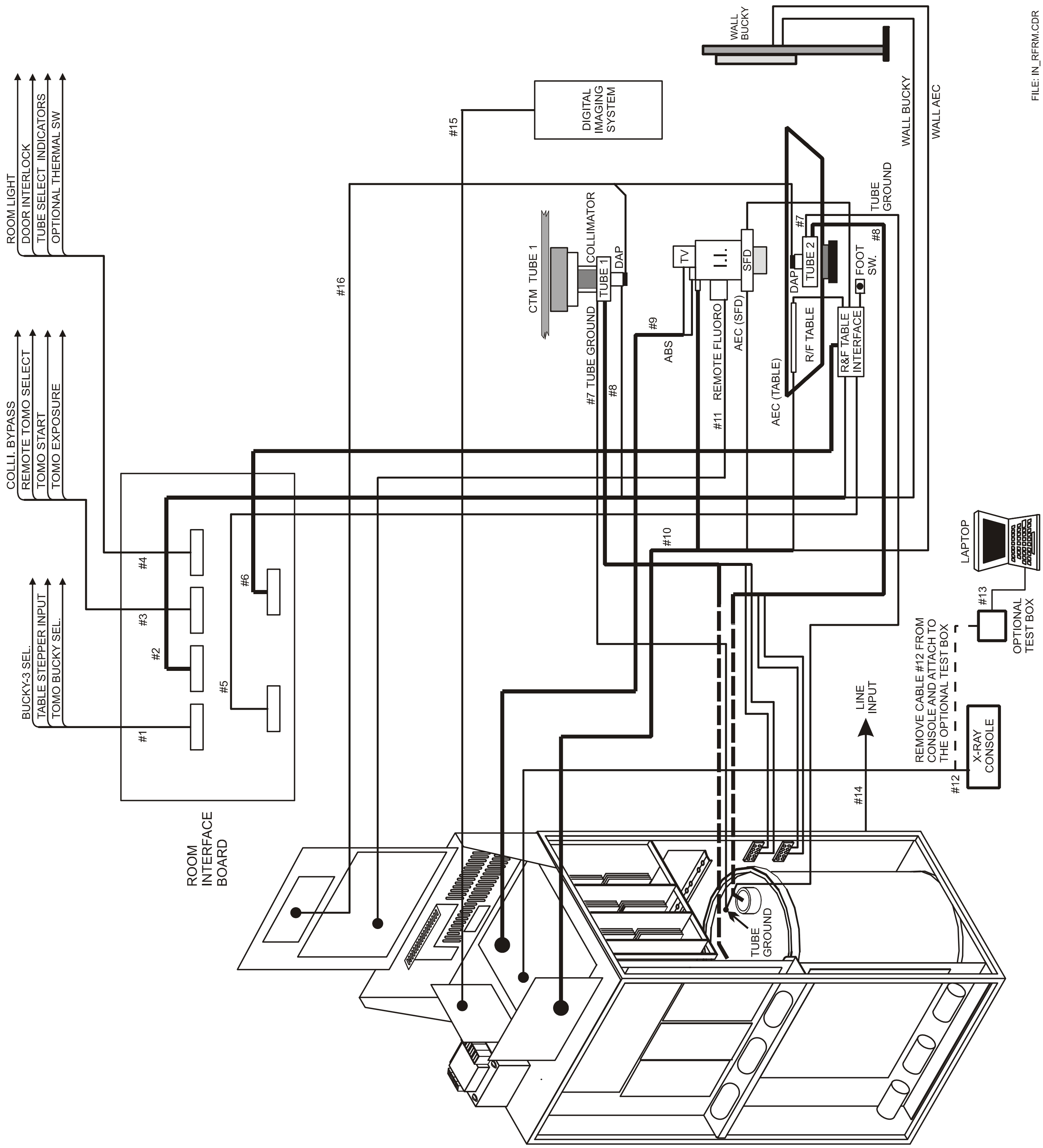

Figure 3B-6: Typical R&F room

3B.6.0 TYPICAL ROOM CABLING AND INTERFACING

The following is for reference only and represents a typical R&F procedure room.

- Cable assembly #1
  1. Bucky 3 select (image receptor).
  2. Table stepper input, indicates to the generator that a stepping table has moved to the next step.
  3. Tomo / Bucky 4 select, usually used to select a tomographic device.

- Cable assembly #2
  1. Bucky 1 select (image receptor), usually used to select the R&F table Bucky.
  2. Collimator interlock, will prevent an exposure if the collimator inputs are not satisfied.
  3. Bucky contacts, all Bucky contacts are paralleled at this connector. Diode isolation may be required.
  4. Bucky 2 select (image receptor), usually used to select vertical wall Bucky.

- Cable assembly #3
  1. Collimator bypass. Usually used with the collimator associated with the tomographic device, to allow non-PBL operation in the tomographic mode.
  2. Remote tomo select, used for selecting tomography operation from a remote R&F table.
  3. Tomo start, will issue a start-to-sweep signal to a tomographic device.
  4. Tomographic exposure; the generator waits for a switch closure during the tomographic sweep.

- Cable assembly #4
  1. Room light. Provides a closed contact to energize the X-ray room warning light. Maximum 250 watts.
  2. Door interlock. Requires a closed dry contact to interlock the generator exposure with the X-ray room's entrance door.
  3. Tube select indicator (source select indicator). Indicates which X-ray tube has been selected.
  4. Optional thermal switch inputs.

- Cable assembly #5
  1. Mag. select. Interfaces with the image intensifier to select the magnification modes.
  2. Multiple-spot exposure. When multi-spot operation is selected at the spot film device, (example: 4 on 1), and this input receives a closed dry contact, the AEC calibration will be offset to compensate for the small fields.

- Cable assembly #6
  1. Interfaces to the table (conventional or remote R&F), the X-ray prep, expose and fluoro footswitch.
  2. The I.I. safety position interlock switch, used if the I.I. may be removed from the spot film device. As described in 3B.3.1, this input is used for remote HLF selection on some models.
  3. ALE, required if an SFC or a serial changer is used.
  4. Spare output.

3B.6.0 TYPICAL ROOM CABLING AND INTERFACING (CONT)

- Cable assembly #7
  1. Must be a #10 AWG (6 mm^2) wire or greater, connected from the housing of both X-ray tubes to ground at the HT tank.

- Cable assemblies #8
  1. Pair of H.T. cables from the over table (tube-1) X-ray tube to the HT tank.
  2. Pair of H.T. cables from the under table (tube-2) X-ray tube to the HT tank.

- Cable assembly #9.
  1. Interfaces the ABS signal from the imaging system.
  2. Interfaces the PMT's high voltage and signal to the generator, if used.

     Refer to chapter 3E for details.

- Cable assembly #10
  1. These cables are usually supplied by the AEC device vendor. Be sure these cables are placed away from any electrical noise sources. When interfacing AEC cables be careful not to cause ground loops. Grounding should **only** be at the AEC board.

     Refer to chapter 3D for details.

- Cable assembly #11
  1. This cable is supplied by CPI for the remote fluoro controller interface.

- Cable assembly #12
  1. This cable is supplied by CPI for the control console interface.

- Cable assembly #13
  1. Supplied with the optional laptop computer interconnect box.

- Cable assembly #14
  1. AC mains cable.

- Cable assembly #15
  1. Cable(s) for digital imaging system. Refer to the digital imaging supplement in the front of this manual (if applicable) for installation and wiring instructions for the digital imaging system.

- Cable assembly #16
  1. Cable(s) for DAP (Dose Area Product).

CHAPTER 3C

PROGRAMMING THE GENERATOR

CONTENTS:

3C.1.0 INTRODUCTION

If you are using a conventional operator control console, the generator may be programmed and calibrated via the control console or via PC GenWare®. When using the console for programming and calibration, all programming / calibration menus are displayed on the LCD display window on the console. The ten “soft key” buttons (1 to 10 in the figure below) are used to navigate through the programming screens and to select and enter values in this section.

When using the touchscreen console, the generator must be programmed and calibrated via GenWare®. This requires the GenWare® utility software, which can be accessed via the Genware® button in the System Utilities menu. PC GenWare® may be used to program the generator if desired.

3C.1.1 Entering Into Programming Mode

To enter into the programming mode if using the membrane console follow the steps below.

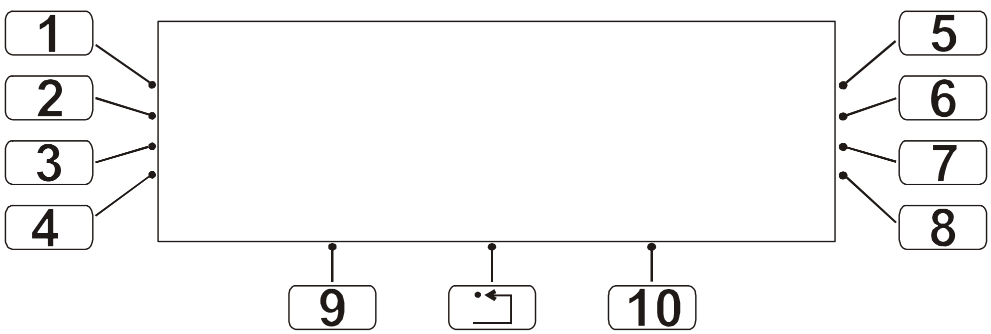

Figure 3C-1: Programming/calibration mode reference

Use these steps to access the **GENERATOR SETUP** menu (membrane console).

Step	Action (membrane console)	Action (GenWare®)
1.	Start with the generator switched OFF.	
2.	While pressing and holding the RESET button, press the generator POWER ON button on the console.	
3.	When the generator has finished the startup sequence, enter the password by pressing the button sequence [**1**] – [**8**] – [**4**] – [**5**].	
4.	The **GENERATOR SETUP** menu will be displayed next.	

3C.2.0 GENERATOR SETUP MENU STRUCTURE

Figure 3C-2 shows the generator setup menu structure.

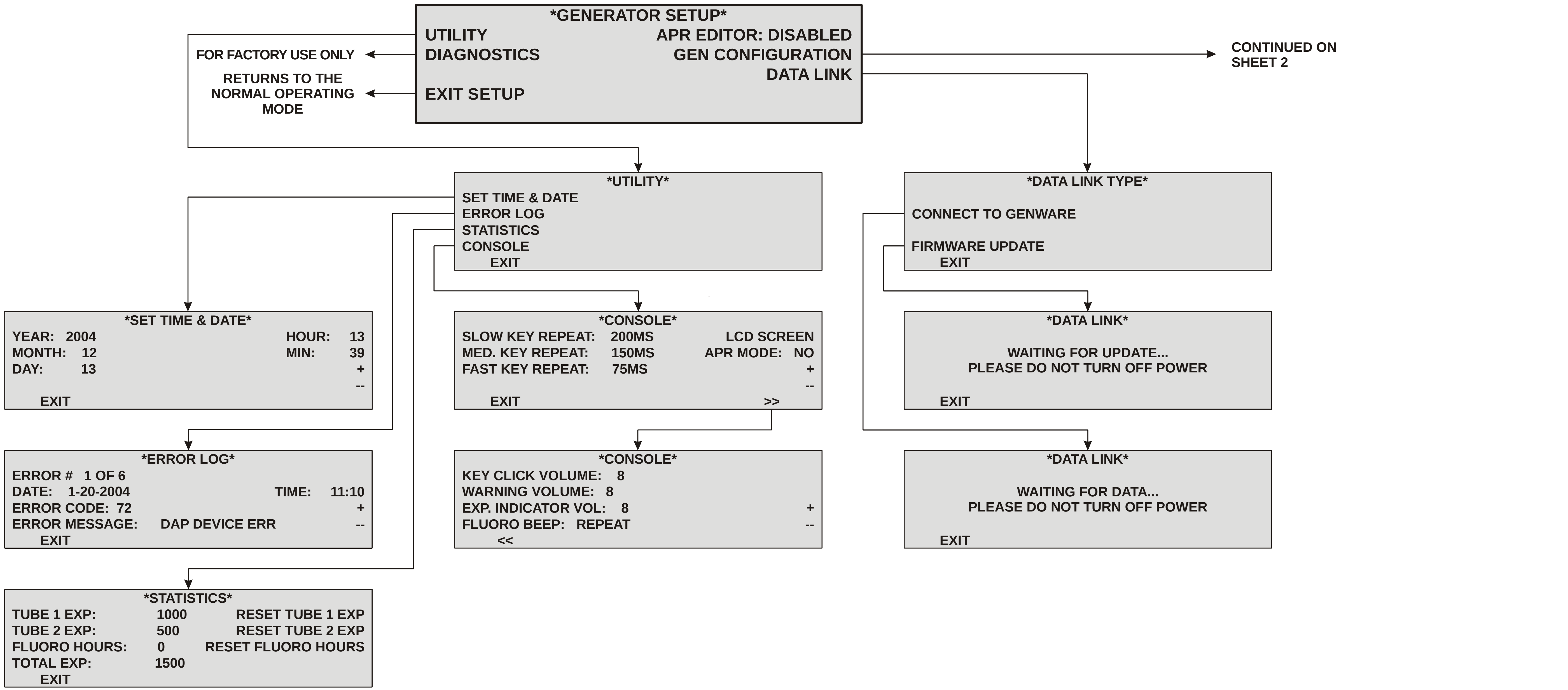

Figure 3C-2, sheet 1: Generator setup menus. This diagram is meant to show the general menu structure only.

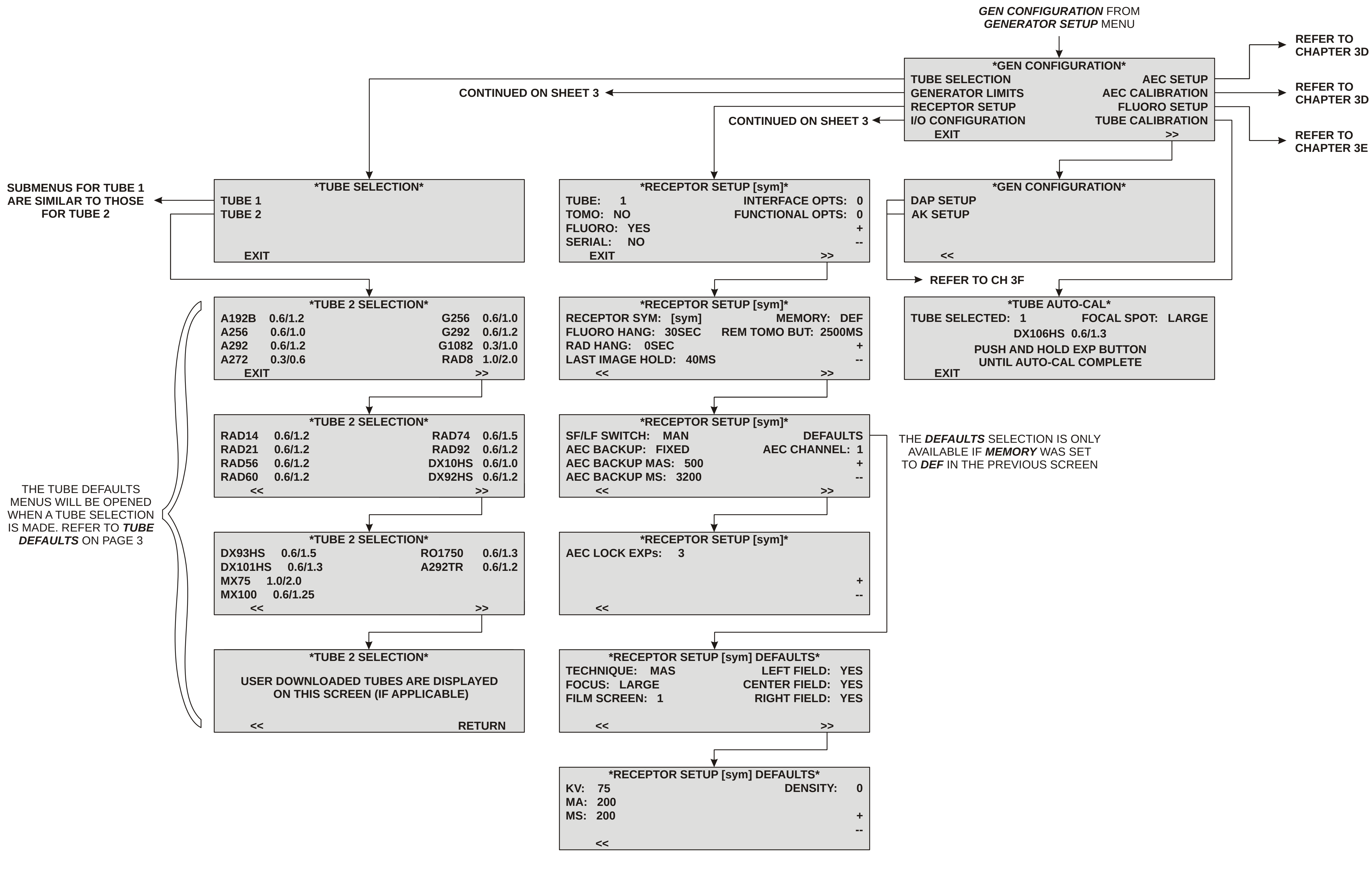

Figure 3C-2, sheet 2: Generator setup menus. This diagram is meant to show the general menu structure only.

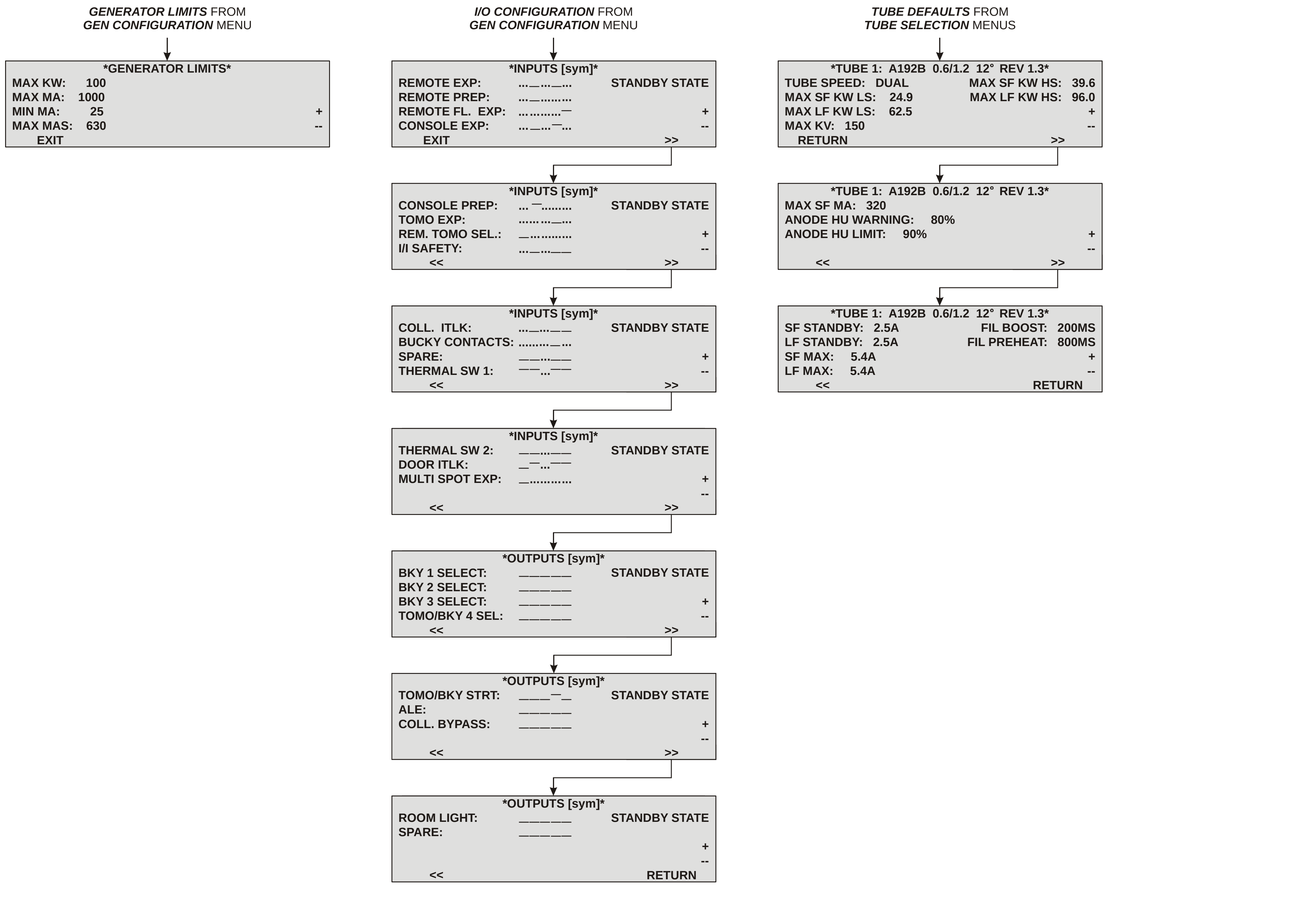

Figure 3C-2, sheet 3: Generator setup menus. This diagram is meant to show the general menu structure only.

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3C.3.0 GENERATOR SETUP MENU

The **GENERATOR SETUP** menu for the membrane console is shown below.

* GENERATOR SETUP *	
UTILITY	APR EDITOR: ENABLED
DIAGNOSTICS	GEN CONFIGURATION
	DATA LINK
EXIT SETUP	

Overview of the functions available within each of the options in the **GENERATOR SETUP** menu.

MENU (MEMBRANE CONSOLE)	SUBMENUS (MEMBRANE CONSOLE)	EQUIVALENT FUNCTION (PC GenWare®)	EQUIVALENT FUNCTION (Touchscreen GenWare®)
UTILITY	• **SET TIME & DATE** • **ERROR LOG** • **STATISTICS** • **CONSOLE**	• **Date and Time** utility. • **Error Log** utility. • **Generator Statistics** utility. • The **CONSOLE** function sets console-specific parameters; therefore, it is not available in GenWare®.	• **Date & Time Control Window.** • **Error Log** utility. • **Generator Statistics** utility. • The **CONSOLE** function sets console-specific parameters; therefore, it is not available in GenWare®.
APR EDITOR	**Enables / disables changes to APR techniques.**	This is a console-specific parameter; therefore, it is not available in GenWare®.	
DIAGNOSTICS	**For factory use only.**	This is a console-specific parameter, therefore it is not available in GenWare.	

3C.3.0 GENERATOR SETUP MENU (Cont)

MENU (MEMBRANE CONSOLE)	SUBMENUS (MEMBRANE CONSOLE)	EQUIVALENT FUNCTION (PC GenWare®)	EQUIVALENT FUNCTION (Touchscreen GenWare®)
GEN CONFIGURATION	• **TUBE SELECTION** • **GENERATOR LIMITS** • **RECEPTOR SETUP** • **I/O CONFIGURATION** • **AEC SETUP** • **AEC CALIBRATION** • **FLUORO SETUP** • **TUBE CALIBRATION** • **DAP SETUP** • **AK SETUP**	• **Tube Selection** utility. • **Generator Limits** utility. • **Receptor Setup** utility. • **Receptor Setup** utility. • **AEC Calibration** utility. • **AEC Calibration** utility. • **Fluoro Setup** utility. • **Auto Tube Calibration** utility. • **DAP Setup** utility. • **Air Kerma Setup** utility.	• **Tube Setup** utility. • **Generator Limits Setup** utility. • **Receptor Setup.** • **Receptor Setup.** • **AEC Setup and Calibration** utility. • **AEC Setup and Calibration** utility. • **Fluoro Setup** utility. • **Tube Calibration** utility. • **DAP Setup** utility. • **Air Kerma Setup** utility.
DATA LINK	• **CONNECT TO GENWARE®** • **FIRMWARE UPDATE**	**N/A**	• **Data Link.** Allows communication with an external computer only.
	The function **CONNECT TO GENWARE®** is described in the section ***DATA LINK (Connect to GenWare®)*** later in this chapter. **FIRMWARE UPDATE** is described under *FIRMWARE UPGRADE* in chapter 6 of this manual.		
EXIT SETUP		• Returns to the normal operating mode (the non setup / programming mode). • Does not apply to GenWare®.	

3C.4.0 UTILITY MENU

The **UTILITY** menu presents the user with the selections shown below. These are described in detail in this section.

* UTILITY *
SET TIME & DATE
ERROR LOG
STATISTICS
CONSOLE
EXIT

3C.4.1 Setting Time and Date

This procedure allows the time and date to be set, or to be changed.

The **SET TIME & DATE** menu for the membrane console is shown below.

* SET TIME & DATE *	
YEAR: 2004	HOUR: 13
MONTH: 12	MIN: 39
DAY: 13	+
	-
EXIT	

3C.4.1 Setting Time and Date (Cont)

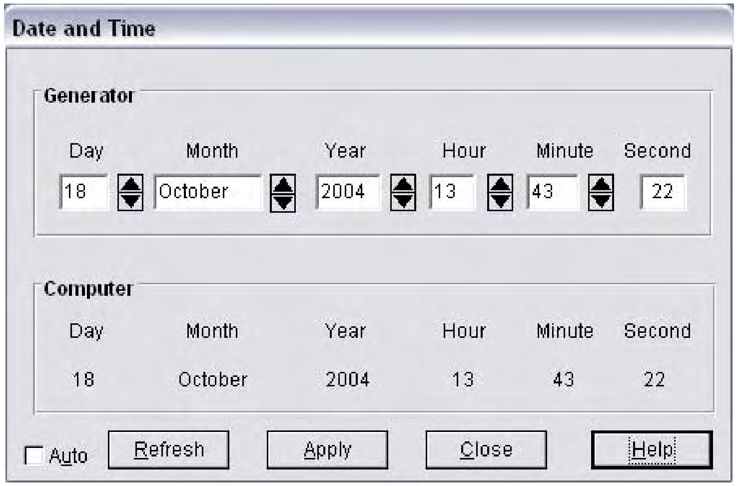


Figure 3C-3a: PC GenWare®

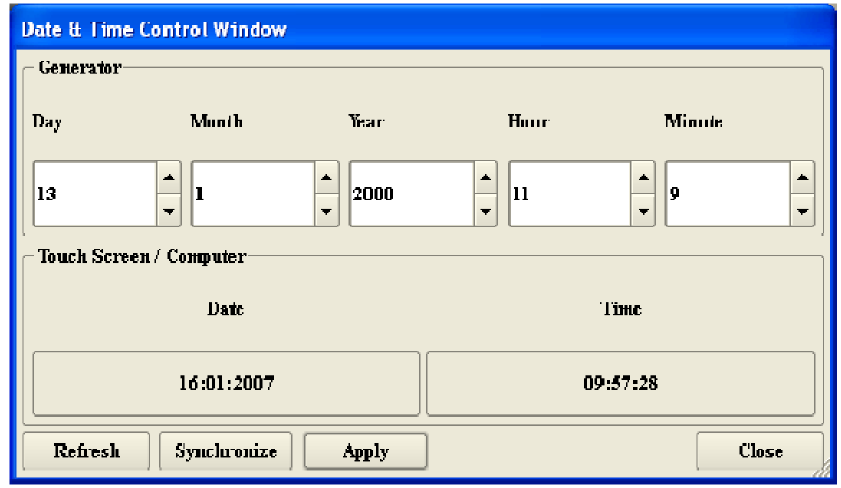
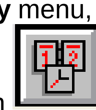


Figure 3C-3b: Touchscreen GenWare®

Date and Time utility / Date & Time Control Window

Use these steps to set the time and date.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **GENERATOR SETUP** menu, select the **UTILITY** menu.	The procedure for starting Genware® and connecting it to the console is described in the Genware® manual, included with Genware®. From the GenWare® GENERATOR UTILITIES application, select **Date and Time** from the **Utility** menu, or use the date and time button  on the GenWare® toolbar.	Touchscreen Genware® must be launched before proceeding. This is done from the Genware® button on the touchscreen **System Utilities** menu. Press the  button on the GenWare® toolbar to access the **Date & Time Control Window**.

3C.4.1 Setting Time and Date (Cont)

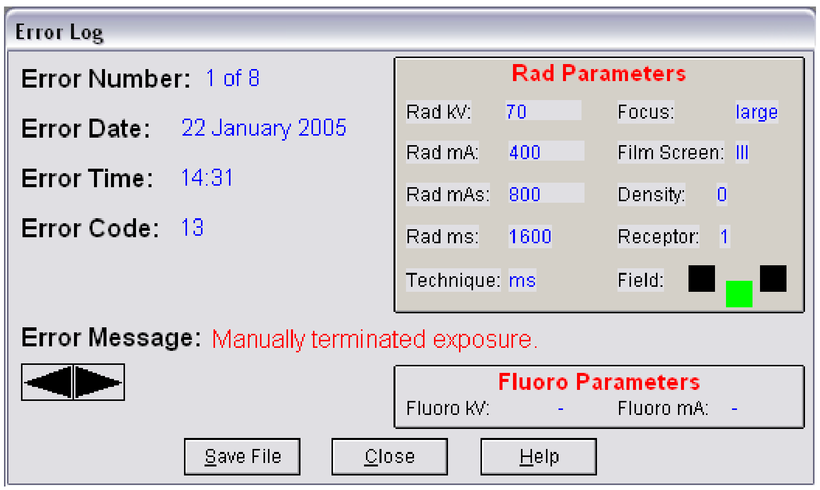
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
2.	From the **UTILITY** menu, select the **SET TIME & DATE** menu.	The date and time may be set manually as described in steps 4 to 8, or the computer clock may be used to set the generator date and time as described in step 8.	The date and time may be set manually as described in steps 4 to 8 or the **Touch Screen / Computer** clock may be used to set the generator date and time as described in step 8.
3.	Select **YEAR**. Use the **+** or **–** buttons to set the year.	Select the year via the **Year** dialog box.	Select the year via the **Year** dialog box.
4.	Select **MONTH**. Use the **+** or **–** buttons to set the month.	Select the month via the **Month** dialog box.	Select the month via the **Month** dialog box.
5.	Select **DAY**. Use the **+** or **–** buttons to set the date.	Select the date via the **Day** dialog box.	Select the date via the **Day** dialog box.
6.	Select **HOUR**. Use the **+** or **–** buttons to set the hour (in 24 hour format).	Select the hour (in 24 hour format) via the **Hour** dialog box.	Select the hour (in 24 hour format) via the **Hour** dialog box.
7.	Select **MIN**. Use the **+** or **–** buttons to set the minutes.	Select the minutes via the **Minute** dialog box.	Select the minutes via the **Minute** dialog box.
8.		To synchronize GenWare® to the clock in your computer, check the **Auto** box in the lower left corner of the **Date and Time** window. Doing so will transfer the computers time and date settings to the time and date dialog boxes in the upper half of the **Date and Time** window. Clicking on **Apply** will apply those settings to the generator's clock.	To synchronize GenWare® to the clock in your touchscreen, press the **Synchronize** button in the lower left corner of the **Date & Time Control Window**. Doing so will transfer the TouchScreen computer's time and date settings to the time and date dialog boxes in the upper half of the **Date and Time Control Window**. Pressing **Apply** will apply those settings to the generator's clock.
9.	Press **EXIT** to return to the **UTILITY** menu.		

3C.4.2 Error Log

This utility allows display of the error messages stored in the generator's error log. Parameters such as kV, mA, time, receptor, focus, technique selection, field, film screen and fluoro parameters will be displayed simultaneously on the console. The error log storage limit is 200 messages at which point the generator will overwrite the messages beginning with the oldest.

The **ERROR LOG** menu for the membrane console is shown below.

	* ERROR LOG *	
ERROR # 1 OF 6		
DATE: 1-20-2004		TIME: 11:10
ERROR CODE: 72		+
ERROR MESSAGE: DAP DEVICE ERR		-
EXIT		



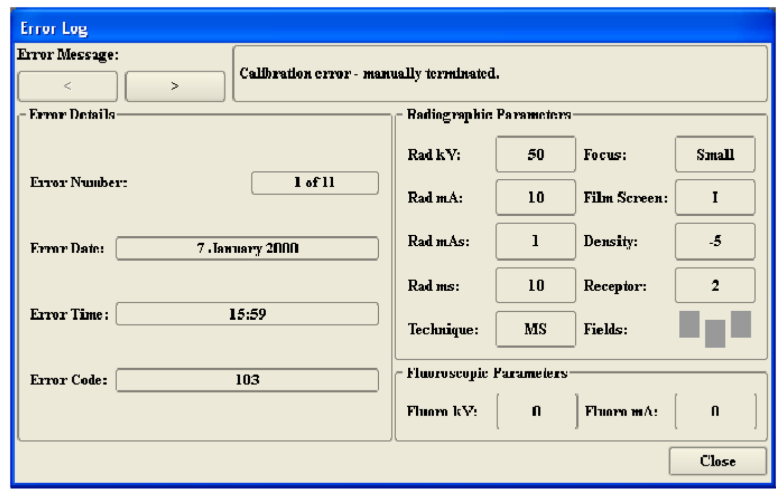
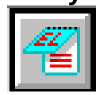
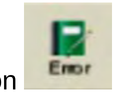


Figure 3C-4a: PC GenWare® ***Figure 3C-4b: Touchscreen GenWare®***

Error Log utility

3C.4.2 Error Log (Cont)

Use these steps to review the error log.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **UTILITY** menu, select **ERROR LOG**.	Select **Error Log** from the **Utility** menu, or use the error log button  on the GenWare® toolbar.	Use the **Error Log** button  on the GenWare® toolbar to access the error log utility
2.	Select **ERROR #** and use the **+** or **-** buttons to scroll through the error log. The error code, error message, date and time of the error will be displayed in the LCD window, and the associated parameters will be displayed on the console displays	Click on the **<** or **>** buttons on the **Error Log** window to scroll through the error log. The error code, error message, date and time of the error will be displayed on the left side of the **Error Log** window, and the associated parameters will be displayed under **Rad Parameters** and / or **Fluoro Parameters**.	Press the **<** or **>** buttons on the **Error Log** window to scroll through the error log. The error message will be displayed to the right of the **< >** buttons on the **Error Log** window. The error code, date and time of the error, etc. will be displayed under **Error Details** on the left side of the **Error Log** window, and the associated parameters will be displayed under **Radiographic Parameters** and / or **Fluoroscopic Parameters**.
3.	Press **EXIT** to return to the **UTILITY** menu.		

3C.4.3 Statistics

This utility shows the tube exposure count, accumulated fluoro hours, and the accumulated generator exposure count. This also allows resetting of the tube 1 / tube 2 exposure counters and the fluoro hours timer.

The **STATISTICS** menu for the membrane console is shown below.

* STATISTICS *		
TUBE 1 EXP:	0	RESET TUBE 1 EXP
TUBE 2 EXP:	0	RESET TUBE 2 EXP
FLUORO HOURS:	0	RESET FLUORO HOURS
TOTAL EXP:	0	
EXIT		

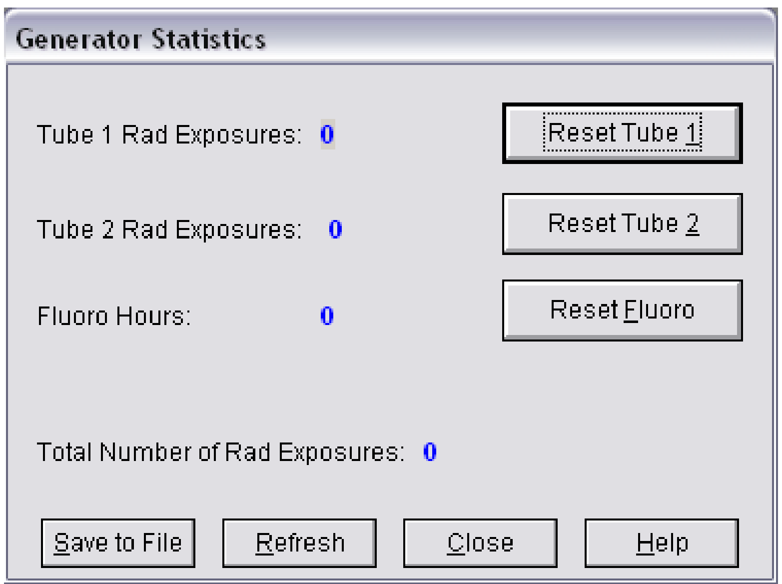


Figure 3C-5a: PC GenWare®

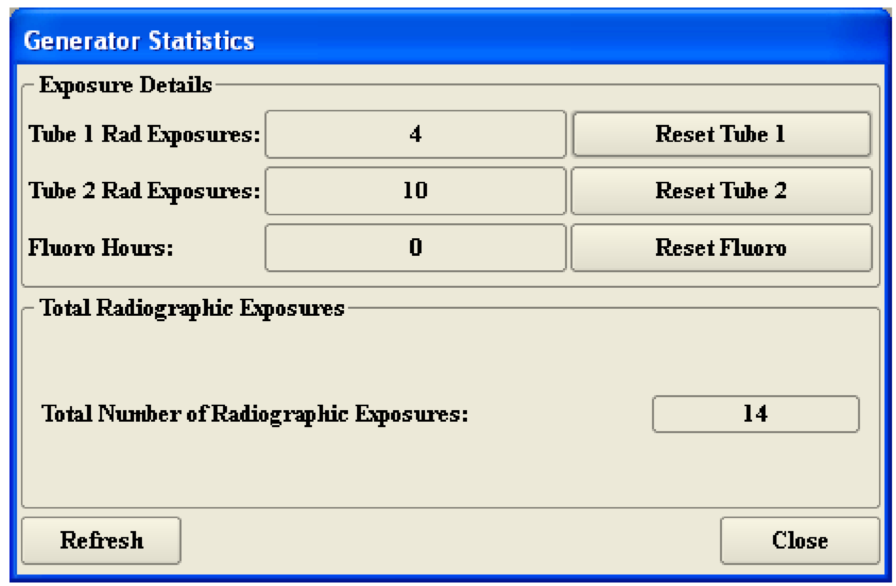


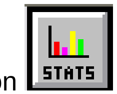
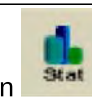
Figure 3C-5b: Touchscreen GenWare®

Generator Statistics utility

3C.4.3 Statistics (Cont)

NOTE: ***REFERENCES TO TUBE 2 AND FLUORO APPLY TO TWO-TUBE UNITS AND FLUOROSCOPIC UNITS ONLY, RESPECTIVELY.***

Use these steps to view the generator statistics.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **UTILITY** menu, select **STATISTICS**.	Select **Generator Statistics** from the **Utility** menu, or use the statistics button  on the GenWare® toolbar.	Use the statistics button  on the GenWare® toolbar to access the **Generator Statistics** window.
2.	The **STATISTICS** menu displays exposure data, and allows the exposure counters and the fluoro timer to be reset as described below: • The **TUBE 1 EXP** and **TUBE 2 EXP** counters display the tube 1 and tube 2 exposure count made since these counters were last reset. • The **FLUORO HOURS** timer displays the fluoro hours accumulated since this timer was last reset. • **TOTAL EXP** displays the total rad exposure count. This is not resettable ***** • Select **RESET TUBE 1 EXP** to reset the tube 1 exposure counter, and select **RESET TUBE 2 EXP** to reset the tube 2 exposure counter. • Select **RESET FLUORO HOURS** to reset the fluoro exposure timer.	The **Generator Statistics** window displays exposure data, and allows the exposure counters and the fluoro timer to be reset as described below: • The **Tube 1 Rad Exposures** and **Tube 2 Rad Exposures** counters display the tube 1 and tube 2 exposure count made since these counters were last reset. • The **Fluoro Hours** timer displays the fluoro hours accumulated since this timer was last reset. • **Total Number of Rad Exposures** displays the total rad exposure count. This is not resettable *****. • Select **Reset Tube 1** to reset the tube 1 exposure counter, and select **Reset Tube 2** to reset the tube 2 exposure counter. • Select **Reset Fluoro** to reset the fluoro exposure timer.	The **Generator Statistics** window displays exposure data, and allows the exposure counters and the fluoro timer to be reset as described below: • The **Tube 1 Rad Exposures** and **Tube 2 Rad Exposures** counters display the tube 1 and tube 2 exposure count made since these counters were last reset. • The **Fluoro Hours** timer displays the fluoro hours accumulated since this timer was last reset. • **Total Number of Radiographic Exposures** displays the total rad exposure count. This is not resettable *****. • Select **Reset Tube 1** to reset the tube 1 exposure counter, and select **Reset Tube 2** to reset the tube 2 exposure counter. • Select **Reset Fluoro** to reset the fluoro exposure timer.

3C.4.3 Statistics (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
	***** The subject exposure counter is reset when the factory defaults are reset. Therefore, the “total exposure” count should be recorded before resetting the factory defaults.		
3.	Press **EXIT** to return to the **UTILITY** menu.		

3C.4.4 Console

The **CONSOLE** menus allow setting of specific operating features to suit operator preferences.

The **CONSOLE** menus for the membrane console are shown below.

	* CONSOLE *	
SLOW KEY REPEAT:	200MS	LCD SCREEN
MED. KEY REPEAT:	150MS	APR MODE: NO
FAST KEY REPEAT:	75MS	+
		-
EXIT		>>

	* CONSOLE *	
KEY CLICK VOLUME:	8	
WARNING VOLUME:	8	
EXP. INDICATOR VOL:	8	+
FLUORO BEEP:	REPEAT	-
EXIT		>>

3C.4.4 Console (Cont)

```
                    * CONSOLE *
LOGO:          YES
LANGUAGE:      ENGLISH
LOAD CONSOLE DEFAULTS:      NO                        +
PASSWORD                                              -
        <<
```

Since the **CONSOLE** setup menus affect the console setup only (setting of specific console operating features to suit operator preferences), no equivalent function is available in GenWare®.

Definitions of **CONSOLE** setup items.

FUNCTION (MEMBRANE CONSOLE)	DESCRIPTION
SLOW KEY REPEAT	Determines the speed at which displays change while the selected key is pressed for the first 5 counts.
MED. KEY REPEAT	Determines the speed at which displays change while the selected key is pressed for the next 5 counts.
FAST KEY REPEAT	Determines the speed at which displays change while the selected key is pressed after 10 counts.
LCD SCREEN	Toggles between normal and reverse video for the LCD display.
APR MODE	Enables / disables the ability of the operator to select the technique (AEC, mAs, mA/ms) in APR mode. **NO:** Allows the operator to select an APR view, and still have the ability to manually select receptors, focus, technique, film screen, AEC fields, etc. **YES:** Allows the operator to select all of the above *EXCEPT* the technique selection (AEC, mAs, mA/ms) i.e. this disables the ability to select AEC, mAs, mA/ms in APR mode. AEC, mAs, mA/ms changes can only be made by selecting an APR technique that has been programmed to the desired technique.

3C.4.4 Console (Cont)

FUNCTION (MEMBRANE CONSOLE)	DESCRIPTION
KEY CLICK VOLUME	Sets the speaker loudness in the range **1** to **10** for the key click function. This applies when an active key (button) on the console is pressed.
WARNING VOLUME	Sets the speaker loudness in the range **1** to **10** for the warning function. This applies when a warning or error message is reported.
EXP. INDICATOR VOLUME	Sets the speaker loudness in the range **1** to **10** for the exposure indicator function. This applies when making a rad or fluoro exposure.
FLUORO BEEP	Sets the audio indicator mode during fluoroscopy. **SINGLE:** The exposure indicator beeps once at the start of a fluoro exposure, and once when the fluoro exposure ends. **REPEAT:** The exposure indicator beeps continuously during a fluoro exposure, at one second intervals.
LOGO	**YES:** The predefined logo is displayed briefly after the generator is switched on. **NO:** The logo is not displayed.
LANGUAGE	Selects the language for status and error messages (the APR text must be changed via the CPI GenWare® utility software).
LOAD CONSOLE DEFAULTS	**YES:** Initializes the console CPU’s NVRAM to the factory-default settings when the generator is switched ON. This restores the factory defaults for the APR and the console settings. **NO:** The NVRAM is not reset when the generator is switched on. ***The normal setting for this function is NO. Do not set to YES unless you intend to restore the console factory defaults.***
PASSWORD	Allows the Programming Mode password to be changed.

3C.4.4 Console (Cont)

This function does not apply to GenWare®.

Use these steps to set the console parameters. Refer to the definitions in the previous table.

Step	Action (membrane console)
1.	From the **UTILITY** menu, select **CONSOLE**.
2.	Select **SLOW KEY REPEAT.** Use the **+** or **–** buttons to set the "slow key repeat" time.
3.	Select **MED. KEY REPEAT.** Use the **+** or **–** buttons to set the "med. key repeat" time.
4.	Select **FAST KEY REPEAT.** Use the **+** or **–** buttons to set the "fast key repeat" time.
5.	Select **LCD SCREEN.** Toggle the button to select normal or reverse video.
6.	Select **APR MODE.** Toggle the button to select **YES** or **NO**.
7.	Press **>>**.
8.	Select **KEY CLICK VOLUME.** Use the **+** or **–** buttons to set the key click loudness.
9.	Select **WARNING VOLUME.** Use the **+** or **–** buttons to set the warning and error indicator loudness.
10.	Select **EXP. INDICATOR VOL.** Use the **+** or **–** buttons to set the rad and fluoro exposure indicator loudness.
11.	Select **FLUORO BEEP.** Toggle the button to select **SINGLE** or **REPEAT**.
12.	Press **>>**.
13.	Select **LOGO**. Toggle the button to select **YES** or **NO**.
14.	Select **LANGUAGE**. Toggle the button to select the desired language.
15.	Select **LOAD CONSOLE DEFAULTS**. Toggle the button to select **YES** or **NO**.
16.	Select **PASSWORD**. Enter and re-enter a new password as prompted. **BE SURE TO RECORD THE NEW PASSWORD BEFORE CHANGING THE DEFAULT PASSWORD. IF THE NEW PASSWORD IS SUBSEQUENTLY LOST, PLEASE CONSULT THE FACTORY.**
17.	Press **<<** and **EXIT** as required to return to the **UTILITY** menu.
18.	Press **EXIT** to return to the **GENERATOR SETUP** menu.

3C.4.5 APR Editor

The **APR EDITOR** enables / disables the ability of the operator to make *and then save* changes to APR techniques.

The **GENERATOR SETUP** menu showing the **APR EDITOR** is shown below.

* GENERATOR SETUP *	
UTILITY	APR EDITOR: ENABLED
	GEN CONFIGURATION
	DATA LINK
EXIT SETUP	

No equivalent function exists in GenWare®, as the **APR EDITOR** affects the console operation only.

Definition of the **APR EDITOR** function.

FUNCTION (MEMBRANE CONSOLE)	DESCRIPTION
APR EDITOR	Enables / disables the ability of the operator to make *and then save* changes to APR techniques.. **ENABLED:** Allows the operator to change the default APR technique(s), and then save the changes to memory. The APR will subsequently default to the changed technique. **DISABLED:** Allows temporary editing of APR technique(s), but does not allow the changes to be saved to memory. The APR will always default to the original technique when the generator is switched OFF and then ON again. ***The generator stores the last APR EDITOR setting before being switched off. If the APR editor was previously ENABLED, APR changes may subsequently be made and then saved in normal operating mode without the need to manually set the APR editor to ENABLED. To disable APR technique changes, the APR editor must be set to DISABLED.***

<u>NOTE:</u> ***APR text may be altered by using a computer running PC GenWare®. Further documentation regarding this function is included with GenWare® in the form of an MS Word document.***
The default location for the Word file is C:\CPI Canada\GenWare32\console\manual\740849*.DOC.

3C.4.5 APR Editor (Cont)

This function does not apply to GenWare®.

Use these steps to set the **APR EDITOR**. Refer to the definition in the previous table.

Step	Action (membrane console)
1.	From the **GENERATOR SETUP** menu, select **APR EDITOR**.
2.	Toggle the button to select **ENABLED** or **DISABLED**.

3C.5.0 GEN CONFIGURATION

The **GEN CONFIGURATION** menus present the user with the selections shown below. These are described in detail in this section.

* GEN CONFIGURATION *	
TUBE SELECTION	AEC SETUP
GENERATOR LIMITS	AEC CALIBRATION
RECEPTOR SETUP	FLUORO SETUP
I/O CONFIGURATION	TUBE CALIBRATION
EXIT	>>

* GEN CONFIGURATION *	
DAP SETUP	
AK SETUP	
<<	

3C.5.1 Tube Selection / Tube Setup

The **TUBE SELECTION** function allows the desired tube type to be selected and assigned to tube 1 and tube 2, and allows setting of tube-related parameters and limits.

The **TUBE SELECTION** menus for the membrane console are shown below.

The menu below is only available on two-tube units. The remaining menus apply to one-tube and two-tube units.

* TUBE SELECTION *		
TUBE 1		
TUBE 2		
EXIT		

* TUBE 1 SELECTION *		
A192B 0.6/1.2	G256 0.6/1.0	
A256 0.6/1.0	G292 0.6/1.2	
A292 0.6/1.2	G1082 0.3/1.0	
A272 0.3/0.6	RAD8 1.0/2.0	
EXIT		>>

* TUBE 1 SELECTION *		
RAD14 0.6/1.2	RAD74 0.6/1.5	
RAD21 0.6/1.2	RAD92 0.6/1.2	
RAD56 0.6/1.2	DX10HS 0.6/1.0	
RAD60 0.6/1.2	DX92HS 0.6/1.2	
<<		>>

3C.5.1 Tube Selection / Tube Setup (Cont)

* TUBE 1 SELECTION *	
DX93HS 0.6/1.5	RO1750 0.6/1.3
DX101HS 0.6/1.3	A292TR 0.6/1.2
MX75 1.0/2.0	
MX100 0.6/1.25	
<<	>>

* TUBE 1 SELECTION *	
IF ADDITIONAL TUBES HAVE BEEN DOWNLOADED FROM GenWare® THEY WILL BE DISPLAYED ON THIS SCREEN	
<<	RETURN

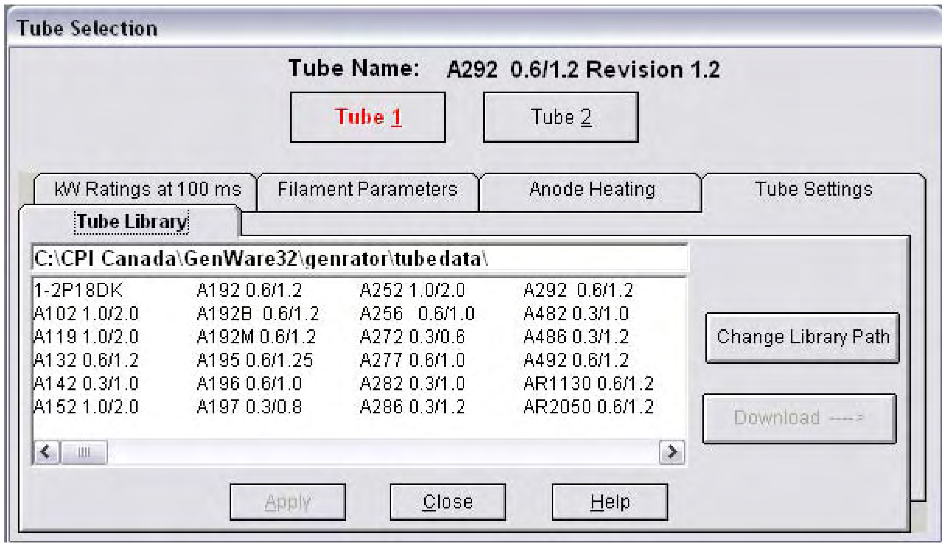
The menus showing the tube limits and associated parameters for the membrane console are shown below.

* TUBE 1: A192B 0.6/1.2 12° REV 1.3*	
TUBE SPEED: DUAL	MAX SF KW HS: 39.6
MAX SF KW LS: 24.9	MAX LF KW HS: 96.0
MAX LF KW LS: 62.5	+
MAX KV: 150	-
RETURN	>>

* TUBE 1: A192B 0.6/1.2 12° REV 1.3*	
MAX SF MA: 320	
ANODE HU WARNING: 80%	
ANODE HU LIMIT: 90%	+
	-
<<	>>

3C.5.1 Tube Selection / Tube Setup (Cont)

* TUBE 1: A192B 0.6/1.2 12° REV 1.3*			
SF STANDBY:	2.5A	FIL BOOST:	200MS
LF STANDBY:	2.5A	FIL PREHEAT:	800MS
SF MAX:	5.4A		+
LF MAX:	5.4A		-
<<		RETURN	



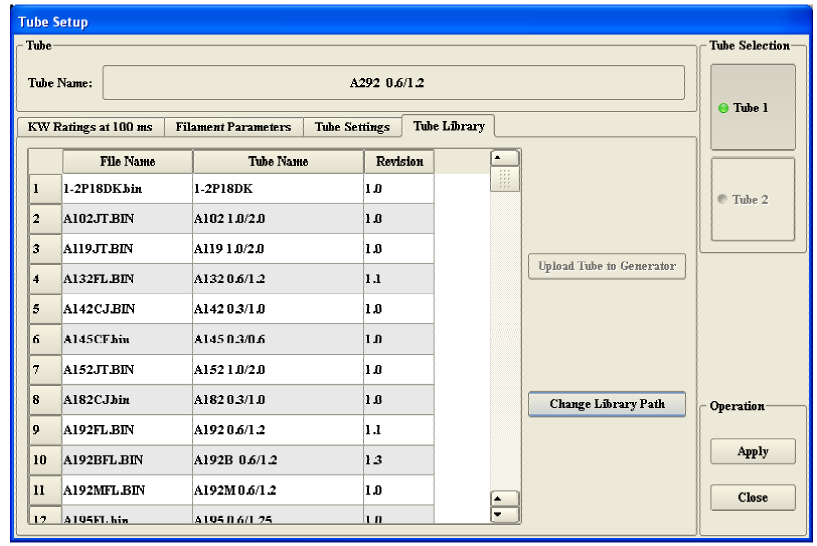
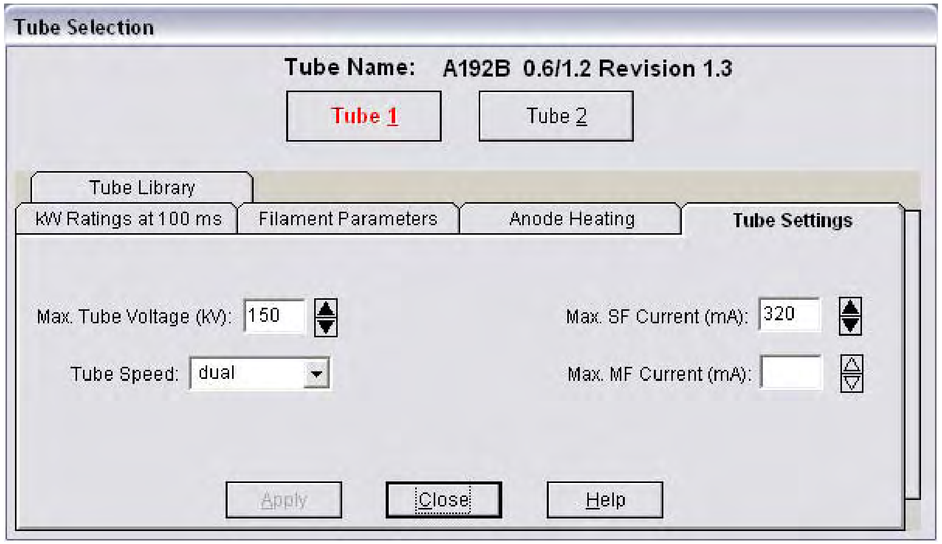


Figure 3C-6a: PC GenWare® *Figure 3C-6b: Touchscreen GenWare®*
Tube Selection / Tube Setup window, Tube Library tab

3C.5.1 Tube Selection / Tube Setup (Cont)



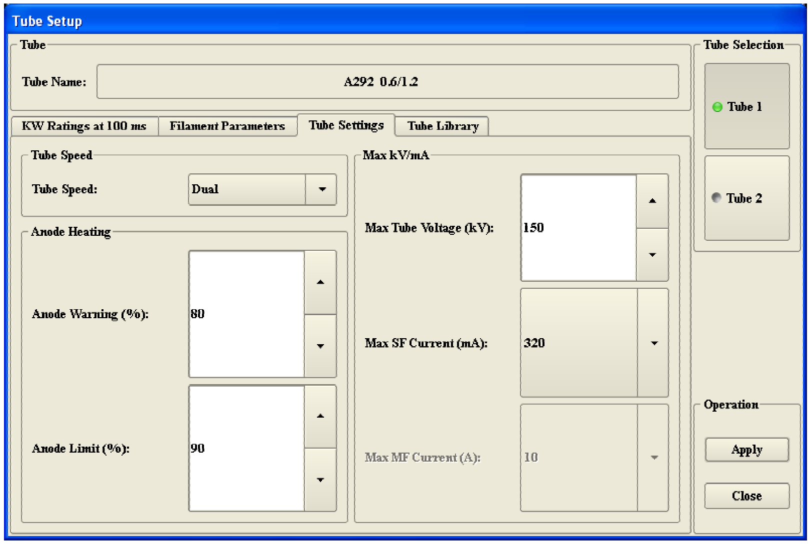
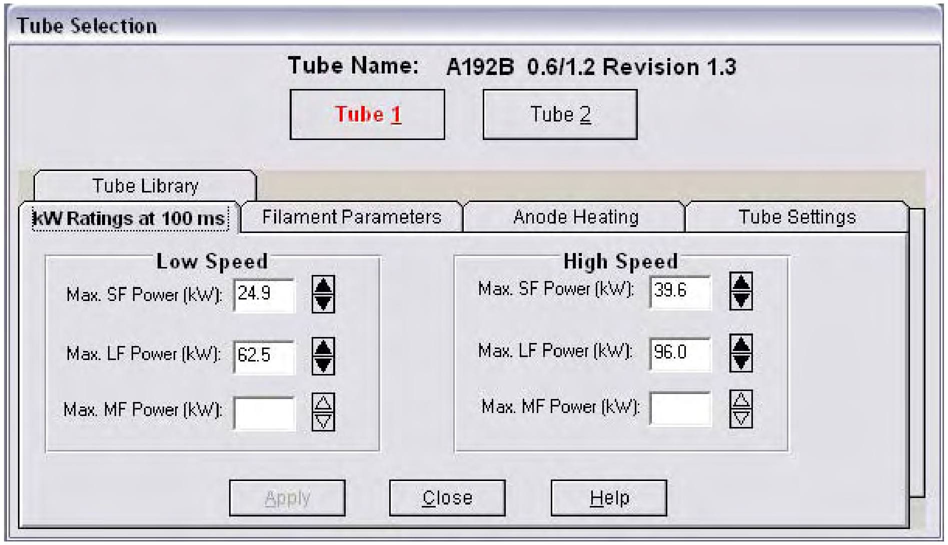


Figure 3C-7a: PC GenWare® *Figure 3C-7b: Touchscreen GenWare®*
Tube Selection / Tube Setup window, Tube Settings tab

3C.5.1 Tube Selection / Tube Setup (Cont)



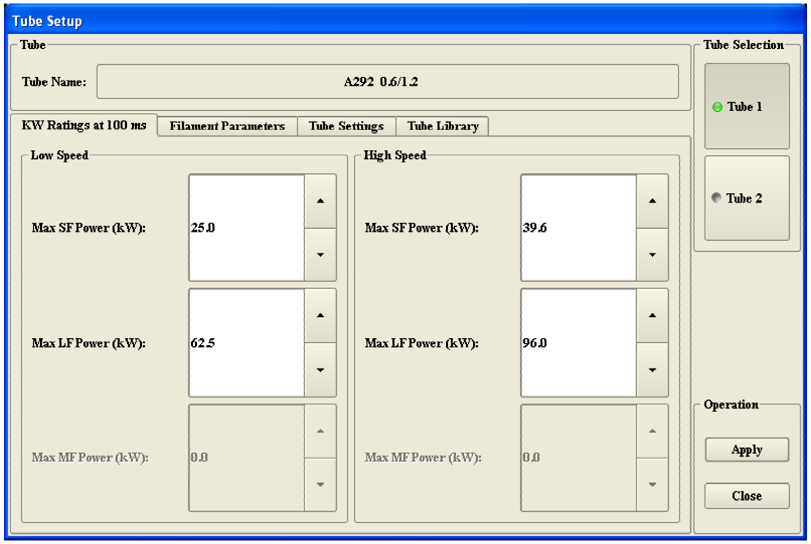
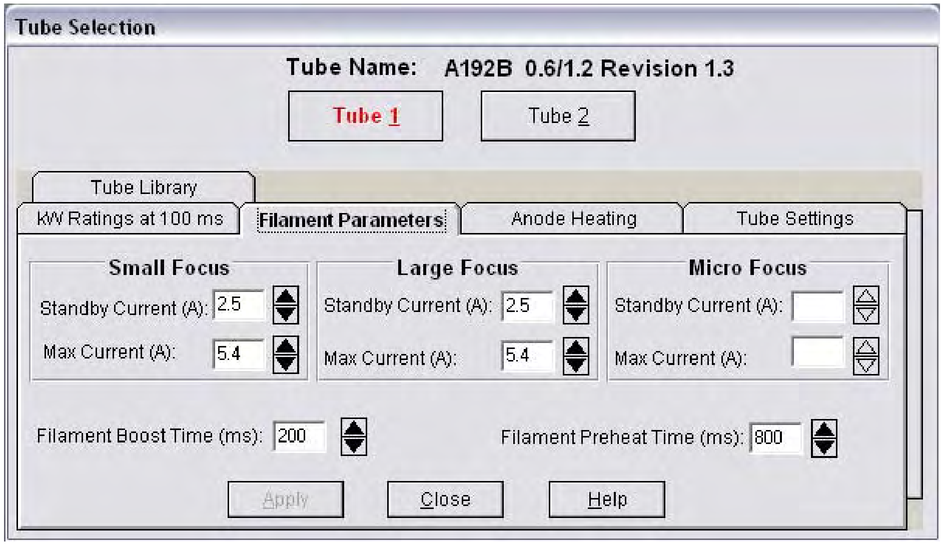


Figure 3C-8a: PC GenWare® *Figure 3C-8b: Touchscreen GenWare®*
Tube Selection / Tube Setup window, kW Ratings at 100ms tab

3C.5.1 Tube Selection / Tube Setup (Cont)



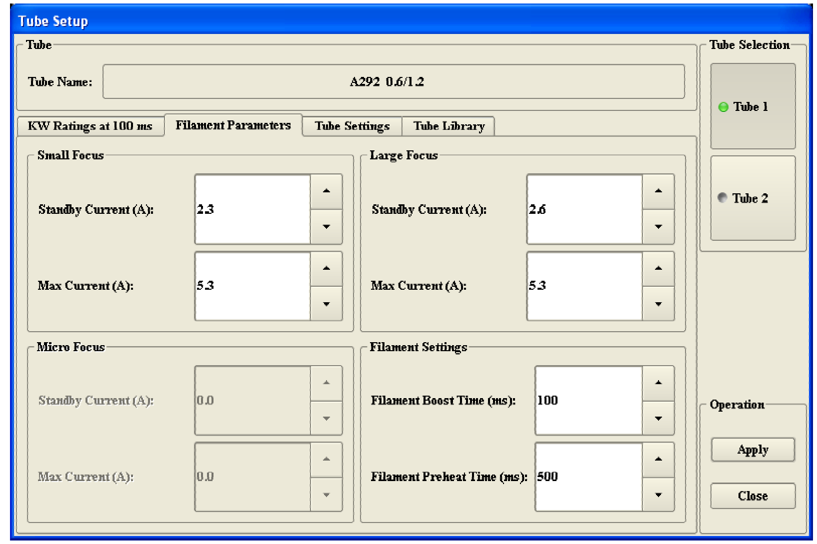


Figure 3C-9a: PC GenWare® ***Figure 3C-9b: Touchscreen GenWare®***
Tube Selection / Tube Setup window, Filament Parameters tab

3C.5.1 Tube Selection / Tube Setup (Cont)

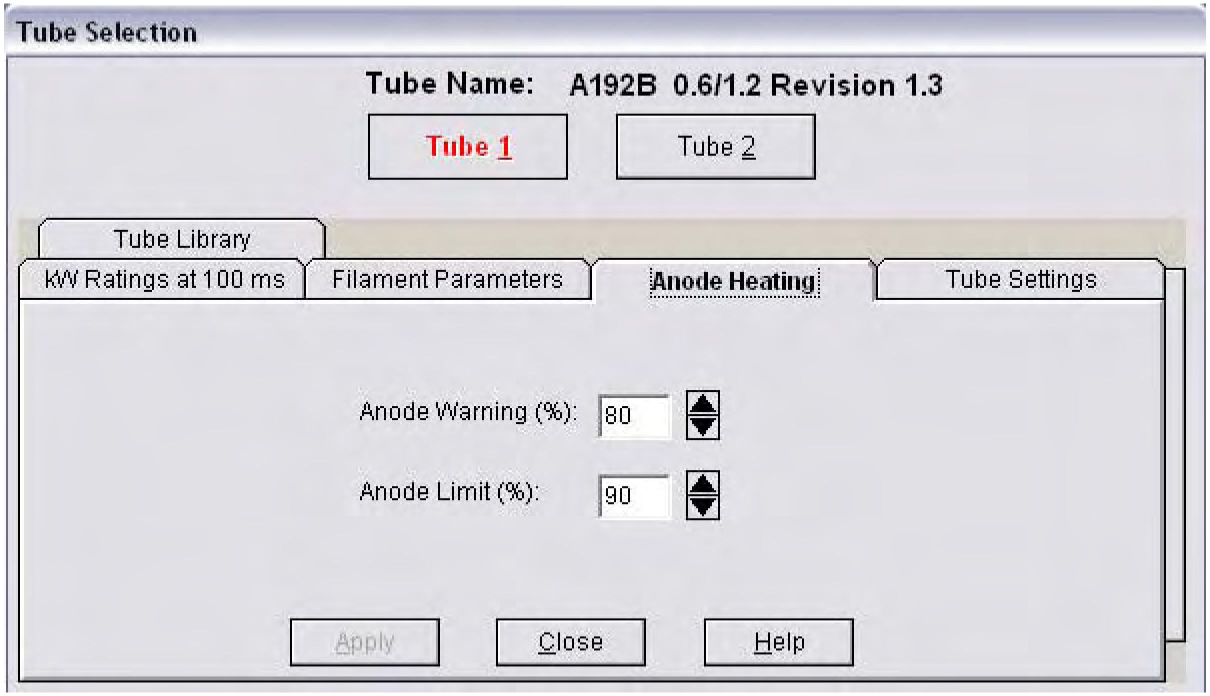


Figure 3C-10: GenWare® Tube Selection window, Anode Heating tab

Note: In touchscreen GenWare®, the **Anode Heating** function is included in the **Tube Settings** tab (see figure 3-7b).

3C.5.1 Tube Selection / Tube Setup (Cont)

Definitions of **TUBE SELECTION** menu items.

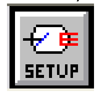
FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
TUBE SPEED	**Tube Speed**	Selects the dual speed starter mode (dual speed starter option only). **LOW:** Low speed mode only is enabled. **HIGH:** High speed mode only is enabled. **DUAL:** Low and high-speed modes are both enabled. The generator will determine when to switch modes, based on exposure parameters and tube rating.
MAX SF KW LS	**Low Speed: Max SF Power (kW)**	Sets the maximum small focus low speed kW limit.
MAX LF KW LS	**Low Speed: Max LF Power (kW)**	Sets the maximum large focus low speed kW limit.
MAX KV:	**Max. Tube Voltage (kV)**	Sets the maximum kV allowed for the selected tube.
MAX SF KW HS	**High Speed: Max SF Power (kW)**	Sets the maximum small focus high speed kW limit.
MAX LF KW HS	**High Speed: Max LF Power (kW)**	Sets the maximum large focus high speed kW limit.
MAX SF MA	**Max. SF Current (mA)**	Sets the maximum mA in small focus. This should be set as low as possible to prevent focal spot track wear and focal spot blooming.
ANODE HU WARNING	**Anode Warning (%)**	Sets the limit at which the anode heat-warning message is displayed.
ANODE HU LIMIT	**Anode Limit (%)**	Sets the limit at which exposures will be inhibited. If the present anode heating is under the threshold, the exposure will be inhibited if the next exposure is calculated to exceed the anode HU limit.

3C.5.1 Tube Selection (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
SF STANDBY	**Small Focus: Standby Current (A)**	Sets the small focus standby filament current. The required value should be obtained from the X-ray tube data sheets.
LF STANDBY	**Large Focus: Standby Current (A)**	As above but for large focus.
SF MAX	**Small Focus: Max Current (A)**	Sets the small focus maximum filament current.
LF MAX	**Large Focus: Max Current (A)**	As above but for large focus.
FIL BOOST	**Filament Boost Time (ms)**	Sets the filament rapid boost duration in order to quickly raise the filament temperature. In installations where a spot film or equivalent device is used, default boost and preheat values may be increased if needed to allow for one second R/F change-over time.
FIL PREHEAT	**Filament Preheat Time (ms)**	The time that the filament is held at the required emission level before an exposure is permitted.

3C.5.1 Tube Selection (Cont)

Use these steps to select the desired tube type.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **GENERATOR SETUP** menu, select **GEN CONFIGURATION**.	Select **Tube Selection** from the **Setup** menu, or use the tube setup button  on the GenWare® toolbar.	Press the  button from the GenWare® toolbar to access the **Tube Setup** utility.
2.	From the **GEN CONFIGURATION** menu, select **TUBE SELECTION**.	Select the **Tube Library** tab.	Select the **Tube Library** tab.
3.	Select **TUBE 1** or **TUBE 2**. (This step applies to two-tube units only).	Select **Tube 1** or **Tube 2**. (This step applies to two-tube units only).	Select **Tube 1** or **Tube 2**. (This step applies to two-tube units only).
4.	Choose the tube type to be assigned to the current tube selection (tube 1 or tube 2) by pressing the button adjacent to the desired selection. Use the **>>** and **<<** buttons to navigate through the tube selection menus if the desired tube is not displayed on the current screen. Additional tube types may be downloaded using the console utility in GenWare®.	Choose the tube type to be assigned to the current tube selection (tube 1 or tube 2). Then select **Download** to download the selected tube to the generator. To select an alternate tube library, press **Change Library Path.** A **Browse For Folder** window will open. Browse to the drive / folder that contains the desired tube library, select the desired item and then select **OK**. The new tube library will replace the default tube library in the Tube Setup window. The desired tube may then be selected.	Choose the tube type to be assigned to the current tube selection (tube 1 or tube 2). Then select **Upload Tube to Generator** to download the selected tube to the generator. To select an alternate tube library, press **Change Library Path.** A pop up window will open that points to the USB flash drive. Select the desired tube library on the USB drive and then select **Open**. The new tube library will replace the default tube library in the Tube Setup window. The desired tube may then be selected. ***The desired tube library must be pre-loaded onto a USB flash drive.***
5.	Once the desired tube has been selected, parameters for that tube are displayed showing the default values. DO NOT adjust the default values at this time.		

3C.5.1 Tube Selection (Cont)

When the desired tube is selected, the default limits are displayed (membrane console). Please consult the X-ray tube data sheet(s) before making any changes.

DO NOT CHANGE ANY DEFAULTS UNLESS THE IMPACT OF THOSE CHANGES IS CLEARLY UNDERSTOOD. INITIAL CALIBRATION SHOULD BE PERFORMED USING THE DEFAULT VALUES.

The dual speed starter operates at 60 or 180 Hz (50 or 150 Hz for some tube types) independent of line frequency.
The low speed starter operates at 50 Hz for 50 Hz mains, or 60 Hz for 60 Hz mains. The generator samples the line frequency via a zero-crossing detector on the generator interface board. Therefore, for units fitted with a low speed starter, the generator automatically derates the 60 Hz tube ratings for 50 Hz operation if required.

NOTE: ***BEFORE CHANGING X-RAY TUBE DEFAULT PARAMETERS, PLEASE FILL IN THE X-RAY TUBE AND GENERATOR PARAMETER WORKSHEET. A BLANK FORM THAT SHOULD BE PHOTOCOPIED IS LOCATED IN SECTION 3A 3.0. THIS ALLOWS RECORDING OF THE DEFAULT VALUES AND THE NEW (CHANGED) VALUES.***

Use these steps to set the tube limits and the associated parameters. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.		Select the **Tube Settings** tab.	Select the **Tube Settings** tab.
2.	Select **TUBE SPEED**. Toggle the button to select **DUAL**, **LOW**, or **HIGH**.	Select **dual**, **low**, or **high** via the **Tube Speed** dialog box.	Select **Dual**, **Low**, or **High** via the **Tube Speed** dialog box.
3.		Select the **kW Ratings at 100 ms** tab.	Select the **kW Ratings at 100 ms** tab.
4.	Select **MAX SF KW LS**. Use the **+** or **–** buttons to set the low speed, small focus kW limit.	Set the low speed, small focus kW limit via the **Max SF Power (kW)** dialog box, under **Low Speed**.	Set the low speed, small focus kW limit via the **Max SF Power (kW)** dialog box, under **Low Speed**.
5.	Select **MAX LF KW LS**. Use the **+** or **–** buttons to set the low speed, large focus kW limit.	Set the low speed, large focus kW limit via the **Max LF Power (kW)** dialog box, under **Low Speed**.	Set the low speed, large focus kW limit via the **Max LF Power (kW)** dialog box, under **Low Speed**.
6.	Select **MAX SF KW HS**. Use the **+** or **–** buttons to set the high speed, small focus kW limit.	Set the high speed, small focus kW limit via the **Max SF Power (kW)** dialog box, under **High Speed**.	Set the high speed, small focus kW limit via the **Max SF Power (kW)** dialog box, under **High Speed**.

3C.5.1 Tube Selection (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
7.	Select **MAX LF KW HS**. Use the **+** or **–** buttons to set the high speed, large focus kW limit.	Set the high speed, large focus kW limit via the **Max LF Power (kW)** dialog box, under **High Speed**.	Set the high speed, large focus kW limit via the **Max LF Power (kW)** dialog box, under **High Speed**.
8.		Select the **Tube Settings** tab.	Select the **Tube Settings** tab.
9.	Select **MAX KV**. Use the **+** or **–** buttons to set the maximum allowable kV.	Set the maximum allowable kV via the **Max. Tube Voltage (kV)** dialog box.	Set the maximum allowable kV via the **Max Tube Voltage (kV)** dialog box.
10.	Press **>>**.		
11.	Select **MAX SF MA**. Use the **+** or **–** buttons to set the maximum small focus mA.	Set the maximum small focus mA via the **Max. SF Current (mA)** dialog box.	Set the maximum small focus mA via the **Max SF Current (mA)** dialog box.
12.		Select the **Anode Heating** tab.	
13.	Select **ANODE HU WARNING**. Use the **+** or **–** buttons to set desired anode HU warning %.	Set the desired anode HU warning % via the **Anode Warning (%)** dialog box.	Set the desired anode HU warning % via the **Anode Warning (%)** dialog box under **Anode Heating**.
14.	Select **ANODE HU LIMIT**. Use the **+** or **–** buttons to set desired anode HU limit %.	Set the desired anode HU limit % via the **Anode Limit (%)** dialog box.	Set the desired anode HU limit % via the **Anode Limit (%)** dialog box under **Anode Heating**.
15.	Press **>>**.	Select the **Filament Parameters** tab.	Select the **Filament Parameters** tab.
16.	Select **SF STANDBY**. Use the **+** or **–** buttons to set the small focus filament standby current.	Set the small focus filament standby current via the **Standby Current (A)** dialog box, under **Small Focus**.	Set the small focus filament standby current via the **Standby Current (A)** dialog box, under **Small Focus**.
17.	Select **LF STANDBY**. Use the **+** or **–** buttons to set the large focus filament standby current.	Set the large focus filament standby current via the **Standby Current (A)** dialog box, under **Large Focus**.	Set the large focus filament standby current via the **Standby Current (A)** dialog box, under **Large Focus**.
18.	Select **SF MAX**. Use the **+** or **–** buttons to set the small focus maximum filament current.	Set the small focus maximum filament current via the **Max Current (A)** dialog box, under **Small Focus**.	Set the small focus maximum filament current via the **Max Current (A)** dialog box, under **Small Focus**.

3C.5.1 Tube Selection (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
19.	Select **LF MAX**. Use the **+** or **–** buttons to set the large focus maximum filament current.	Set the large focus maximum filament current via the **Max Current (A)** dialog box, under **Large Focus**.	Set the large focus maximum filament current via the **Max Current (A)** dialog box, under **Large Focus**.
20.	Select **FIL BOOST**. Use the **+** or **–** buttons to set the filament rapid boost duration.	Set the filament rapid boost duration via the **Filament Boost Time (ms)** dialog box.	Set the filament rapid boost duration via the **Filament Boost Time (ms)** dialog box.
21.	Select **FIL PREHEAT**. Use the **+** or **–** buttons to set the filament preheat time.	Set the filament preheat time via the **Filament Preheat Time (ms)** dialog box.	Set the filament preheat time via the **Filament Preheat Time (ms)** dialog box.
22.	Press **RETURN** and **EXIT** as required to return to the **GEN CONFIGURATION** menu.		
23.	Select and then set up the parameters for the second X-ray tube by repeating the previous steps (two-tube generators only).		
	PLEASE ENSURE THAT THE SELECTED X-RAY TUBE STATOR(S) ARE COMPATIBLE WITH THE LOW SPEED OR DUAL SPEED STARTER IN YOUR GENERATOR. REFER TO THE STARTER PROGRAMMING SECTION IN CHAPTER 2.		
New or replacement X-ray tubes must be auto-calibrated before the generator is placed into service. Refer to TUBE AUTO CALIBRATION in chapter 2 for details.			

Typically, the boost time should be between 200 and 250 msec, and the preheat time should be in the range of 700 - 800 ms.
If in doubt, monitor the filament feedback and be sure that there is no change in the signal level 5 ms. after the start of an exposure, and that the mA starts at the selected level.

Standby current must be below the emission point. If the standby current is too high, the lower fluoro mA values may not calibrate properly resulting in a high mA fault error during fluoro operation.

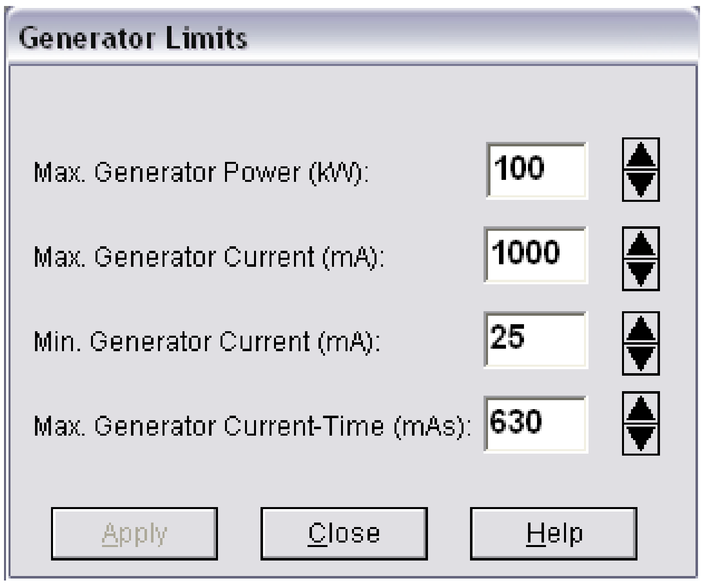
If the maximum filament current is increased, be careful not to exceed the tube manufacturer's specifications.

3C.5.2 Generator Limits

The **GENERATOR LIMITS** function allows setting of the generator output limits defined below.

The **GENERATOR LIMITS** menu for the membrane console is shown below.

* GENERATOR LIMITS *		
MAX KW:	100	
MAX MA:	1000	
MIN MA:	25	+
MAX MAS:	630	-
EXIT		



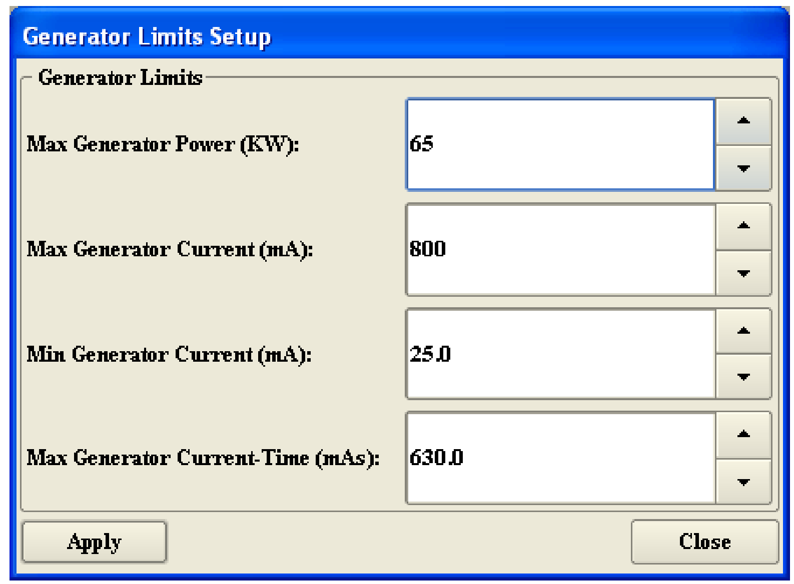


Figure 3C-11a: PC GenWare® Figure 3C-11b: Touchscreen GenWare®
Generator Limits / Generator Limits Setup window

3C.5.2 Generator Limits (Cont)

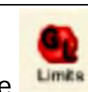
Definitions of **GENERATOR LIMITS** menu items.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
MAX KW	**Max. Generator Power (kW)**	Sets the maximum generator kW limit.
MAX MA	**Max. Generator Current (mA)**	Sets the maximum generator mA limit.
MIN MA	**Min. Generator Current (mA)**	Sets the minimum generator mA limit.
MAX MAS	**Max. Generator Current-Time (mAs)**	Sets the maximum generator mAs limit.

BEFORE MAKING ANY CHANGES IN THIS SECTION, CONSULT THE X-RAY TUBE DATA SHEETS TO ENSURE THAT THE PROPOSED CHANGES DO NOT EXCEED THE MANUFACTURERS RECOMMENDED LIMITS.

NOTE: ***BEFORE CHANGING GENERATOR LIMITS, PLEASE FILL IN THE X-RAY TUBE AND GENERATOR PARAMETER WORKSHEET. A BLANK FORM THAT SHOULD BE PHOTOCOPIED IS LOCATED IN SECTION 3A 3.0. THIS ALLOWS RECORDING OF THE DEFAULT VALUES AND THE NEW (CHANGED) VALUES.***

Use these steps to set the generator limits. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **GEN CONFIGURATION** menu, select **GENERATOR LIMITS**.	Select **Generator Limits** from the **Setup** menu, or use the generator limits button  on the GenWare® toolbar.	Press the  button to access the **Generator Limits** utility.
2.	Select **MAX KW**. Use the **+** or **–** buttons to set the maximum kW.	Set the maximum kW via the **Max. Generator Power (kW)** dialog box.	Set the maximum kW via the **Max Generator Power (kW)** dialog box.
3.	Select **MAX MA**. Use the **+** or **–** buttons to set the maximum mA.	Set the maximum mA via the **Max. Generator Current (mA)** dialog box.	Set the maximum mA via the **Max Generator Current (mA)** dialog box.

3C.5.2 Generator Limits (Cont)

4.	Select **MIN MA**. Use the **+** or **–** buttons to set the minimum mA.	Set the minimum mA via the **Min. Generator Current (mA)** dialog box.	Set the minimum mA via the **Min Generator Current (mA)** dialog box.
5.	Select **MAX MAS**. Use the **+** or **–** buttons to set the maximum mAs.	Set the maximum mAs via the **Max. Generator Current-Time (mAs)** dialog box.	Set the maximum mAs via the **Max Generator Current-Time (mAs)** dialog box.
6.	Press **EXIT** to return to the **GEN CONFIGURATION** menu.		

3C.5.3 Receptor Setup

The **RECEPTOR SETUP** function allows each of the image receptors to be programmed as defined in the table following the example menu screens.

The **RECEPTOR SETUP** menus for the membrane console are shown below.

* RECEPTOR SETUP [sym] *	
TUBE: 1	INTERFACE OPTS: 0
TOMO: NO	FUNCTIONAL OPTS: 0
FLUORO: NO	+
SERIAL: NO	-
EXIT	>>

* RECEPTOR SETUP [sym] *	
RECEPTOR SYM: [sym]	MEMORY: DEF
FLUORO HANG: 30 SEC	REM TOMO BUT: 2500 MS
RAD HANG: 0 SEC	+
LAST IMAGE HOLD: 40 MS	-
<<	>>

3C.5.3 Receptor Setup (Cont)

* RECEPTOR SETUP [sym] *	
SF/LF SWITCH: MAN	DEFAULTS
AEC BACKUP: FIXED	AEC CHANNEL: 1
AEC BACKUP MAS: 500	+
AEC BACKUP MS: 3200	-
<<	>>

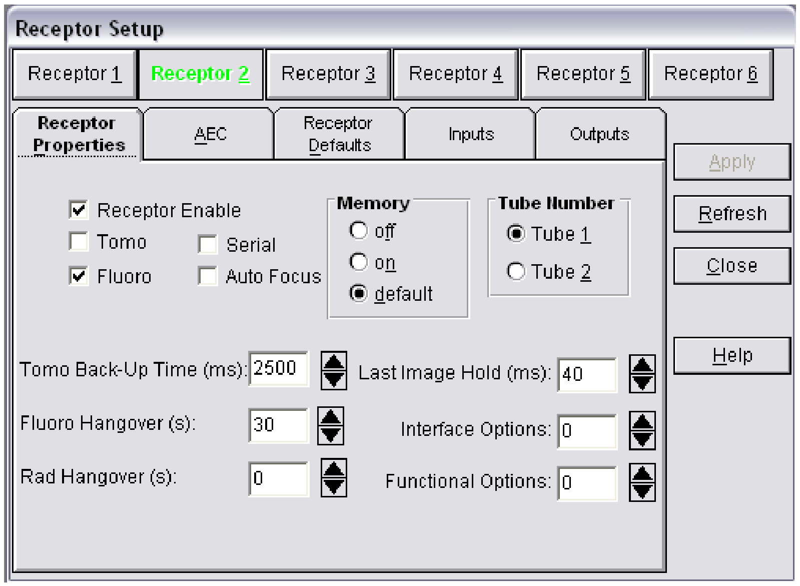
* RECEPTOR SETUP [sym] *	
AEC LOCK EXPs: 3	
	+
	-
<<	

NOTE: ***THE [DEFAULTS] SELECTION IN MENU 3 IS ONLY AVAILABLE IF [MEMORY] IN MENU 2 WAS SET TO [DEF]. RECEPTOR MENUS 5 AND 6, BELOW, ARE ONLY ACCESSIBLE IF [DEFAULTS] IS ENABLED.***

* RECEPTOR SETUP [sym] DEFAULTS*	
TECHNIQUE: AEC	LEFT FIELD: YES
FOCUS: SMALL	CENTER FIELD: YES
FILM SCREEN: 1	RIGHT FIELD: YES
<<	>>

3C.5.3 Receptor Setup (Cont)

* RECEPTOR SETUP [sym] DEFAULTS*			
KV:	75	DENSITY:	0
MA:	320		
MS:	50		+
			-
	<<		



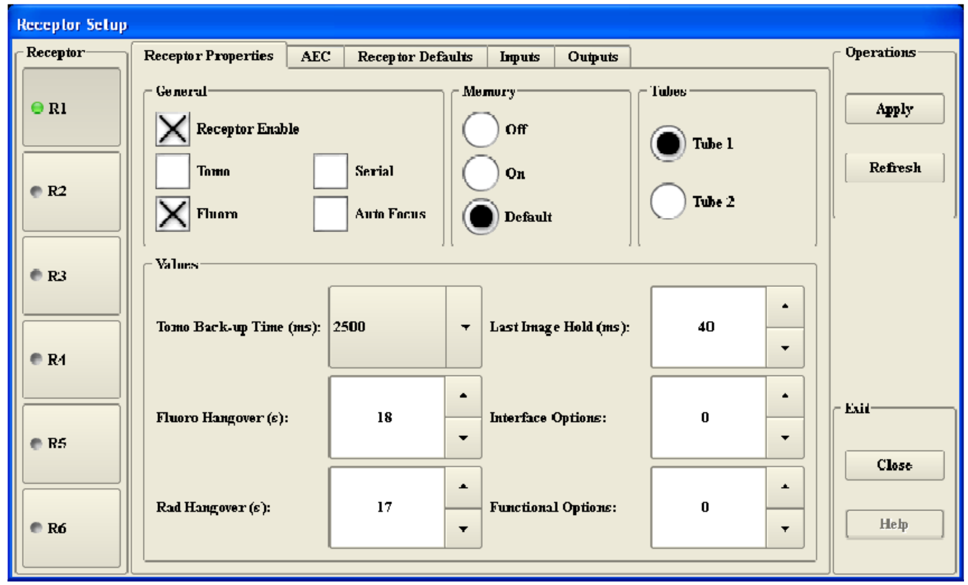
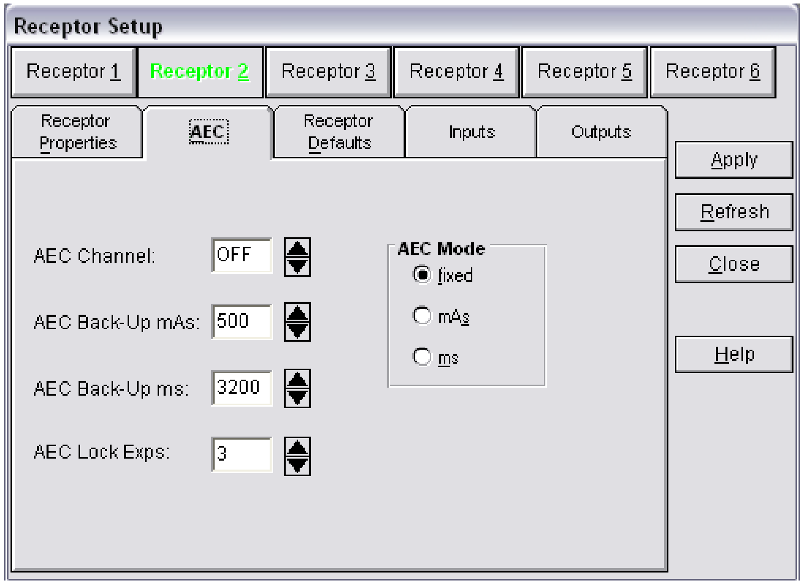


Figure 3C-12a: PC GenWare® *Figure 3C-12b: Touchscreen GenWare®*
Receptor Setup window, Receptor Properties tab

3C.5.3 Receptor Setup (Cont)



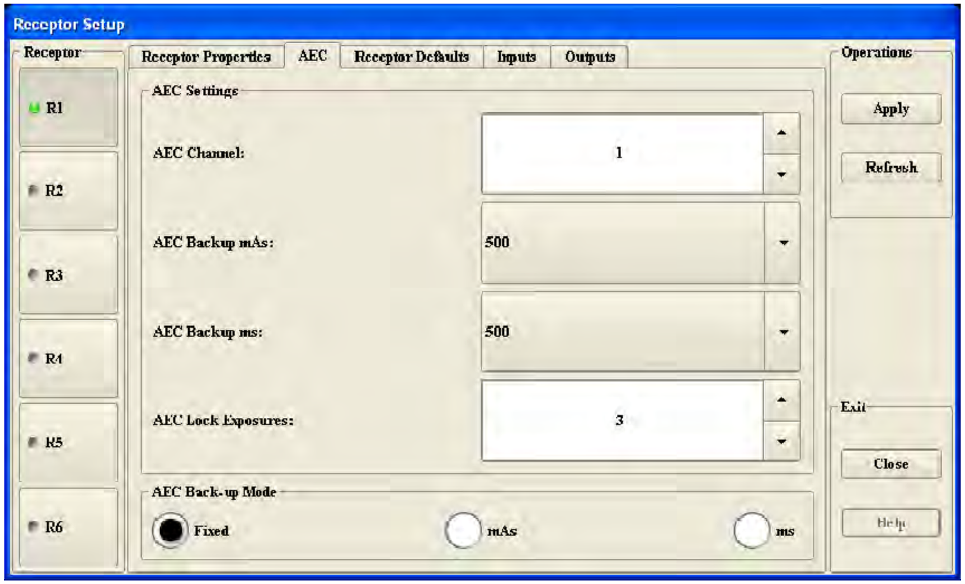
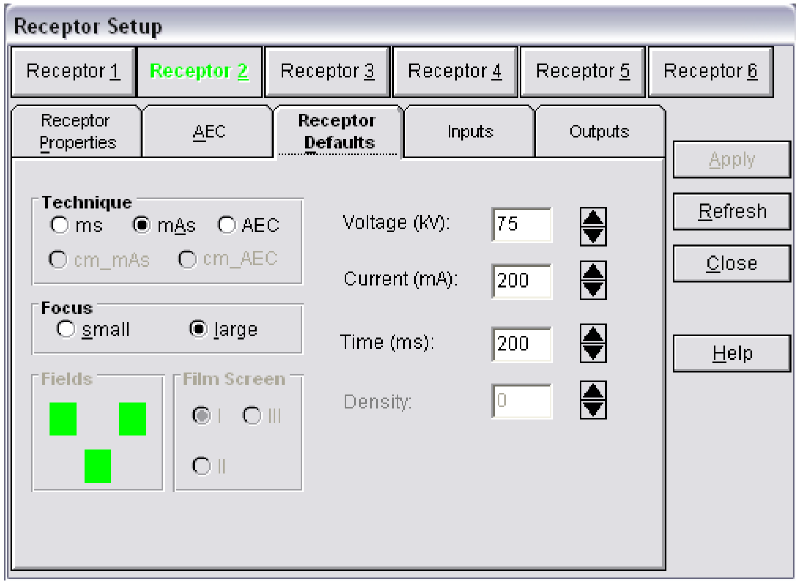


Figure 3C-13a: PC GenWare® *Figure 3C-13b: Touchscreen GenWare®*
Receptor Setup window, AEC tab

3C.5.3 Receptor Setup (Cont)



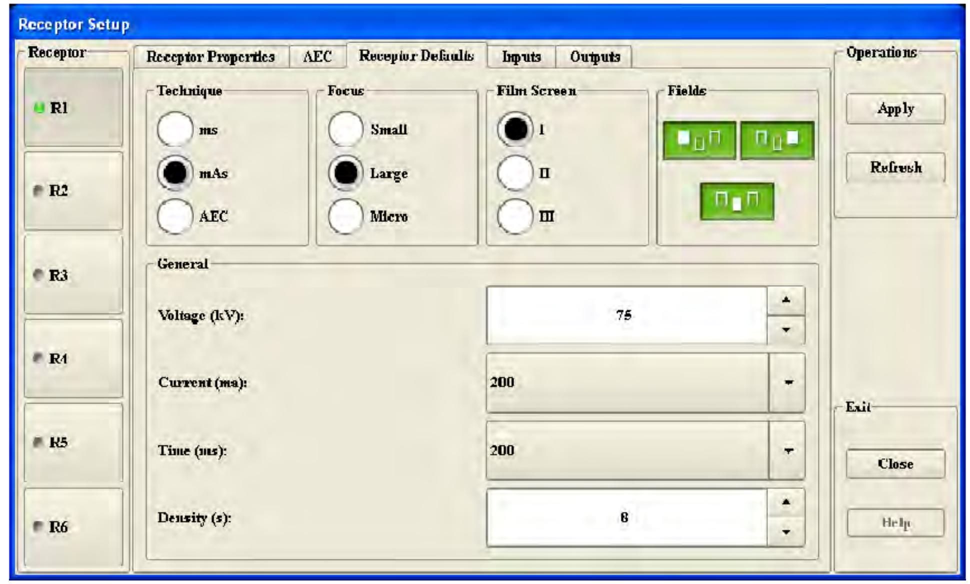


Figure 3C-14a: PC GenWare® *Figure 3C-14b: Touchscreen GenWare®*
Receptor Setup window, Receptor Defaults tab

3C.5.3 Receptor Setup (Cont)

Definitions of **RECEPTOR SETUP** menu items.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
TUBE	**Tube Number (Tubes)** and **Receptor Enable** checkbox	Selects the tube number assigned to the current receptor. ***Tube 2 is only available on two-tube units.*** This function also allows the receptor to be disabled. Membrane console: **NONE:** Disables the currently selected receptor. **1:** Assigns tube 1 to the currently selected receptor. **2:** Assigns tube 2 to the currently selected receptor. GenWare®: **Receptor Enable** Enables / disables the currently selected receptor. **Tube 1:** Assigns tube 1 to the currently selected receptor. **Tube 2:** Assigns tube 2 to the currently selected receptor.
TOMO	**Tomo**	Enables or disables tomographic operation.
FLUORO	**Fluoro**	Enables or disables fluoroscopic operation.
SERIAL	**Serial**	Allows repeated (serial) X-ray exposures without the need to re-prep after each exposure. Normally used with serial film changers or digital imaging systems. Note: The anode kW rating will be reduced by 20% when serial RAD mode is selected.
INTERFACE OPTS	**Interface Options**	Selects pre-defined digital interface options. Refer to the digital imaging supplement in the front of this manual for the appropriate selection for this configuration.

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
FUNCTIONAL OPTS	**Functional Options**	Selects pre-defined special functional options. **0:** None. **1:** Table stepper function (optional). **2:** Cine (optional). **3:** Arcoma grid control (optional). **4:** DSA (optional).
RECEPTOR SYM	**This is a console function only; does not apply to Genware.**	Allows one of the predefined receptor symbols **[sym]** to be assigned to the selected receptor.
FLUORO HANG	**Fluoro Hangover (s)**	Sets the time that the rotor will continue to spin after a fluoro exposure has terminated.
RAD HANG	**Rad Hangover (s)**	Sets the time that the rotor will continue to spin after a rad exposure has terminated.
LAST IMAGE HOLD	**Last Image Hold (ms)**	Sets the time that the fluoro exposure will continue after the footswitch has been released. This enables a frame store device to complete the last image.
MEMORY	**Memory**	Defines the techniques that will be defaulted to when a receptor is selected. **YES / on:** The selected receptor will remember it's last techniques such that those techniques are displayed when that receptor is re-selected. **NO / off:** The selected receptor will not remember the last techniques used on that receptor. The techniques used will be the same as last used on the previous receptor. **DEF / default:** The techniques used for that receptor will be as programmed. See receptor setup menus 5 and 6 (membrane console) or the **Receptor Defaults** tab (GenWare®).
REM TOMO BUT	**Tomo Back-Up Time (ms)**	Sets the default tomo backup time when tomo is selected via the **REMOTE TOMO SELECT** input.

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
SF/LF SWITCH	**Auto Focus**	Enables or disables the ability of the generator to automatically select the large or small focus. **AUTO:** Small or large focus will automatically be selected by the generator. The small to large (and vice-versa) switching will occur at the **MAX SF MA** set point. **MAN:** The operator must manually select small or large focus. In GenWare®, the auto / manual selection is made via the **Auto Focus** checkbox.
AEC BACKUP	**AEC Mode (AEC Back-up Mode)**	Defines the AEC backup mode to be used. **FIXED:** The generator will determine the maximum AEC backup time, not to exceed preset AEC backup mAs/ms values or system limits. The characters **AEC** will be displayed in the time window of the LED display during AEC operation. **MAS:** Allows the operator to adjust the AEC backup mAs, not to exceed preset AEC backup mAs/ms values or system limits. The mAs value will be displayed in the time window of the LED display during AEC operation. **MS:** Allows the operator to adjust the AEC backup ms, not to exceed preset AEC backup mAs/ms values or system limits. The ms value will be displayed in the time window of the LED display during AEC operation.
AEC BACKUP MAS	**AEC Back-Up mAs (AEC Backup mAs)**	Sets the maximum AEC backup mAs, to a limit of 600 mAs.
AEC BACKUP MS	**AEC Back-Up ms (AEC Backup ms)**	Sets the maximum AEC back-up ms.
DEFAULTS	**Receptor Defaults**	This selection is available only if **MEMORY** was set to **DEF** in RECEPTOR SETUP menu 2 (membrane console), or if **Memory** was set to **default** under **Receptor Properties in** GenWare®. The DEFAULTS menus allow the default receptor techniques to be programmed

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
AEC CHANNEL	**AEC Channel**	Defines which AEC channel will be used by the selected receptor. This must be set to a valid AEC input channel number, or to **0** / **OFF** as described below. Select **0** (membrane console) or **OFF** (GenWare®) to disable AEC operation on the selected receptor. If the AEC input is not disabled when required, an error message will be presented. For example, if using an AEC board with only 3 input channels, an error will be displayed when selecting the fourth channel.
AEC LOCK EXPs	**AEC Lock Exps (AEC Lock Exposures)**	Selects the number of AEC "scout" exposures that will be made in order to determine the AEC exposure time during serial exposures. The subsequent exposure time will be locked to that of the last scout exposure.

THE FOLLOWING SELECTIONS ARE ONLY AVAILABLE IF DEFAULTS WAS ENABLED AS PREVIOUSLY DESCRIBED.		
FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
TECHNIQUE	**Technique**	Defines which technique will be defaulted to when a receptor is selected. Membrane console: **MA:** Defaults to mA/ms mode. **MAS:** Defaults to mAs mode. **AEC** Defaults to AEC mode. GenWare®: **ms:** Defaults to mA/ms mode. **mAs:** Defaults to mAs mode. **AEC** Defaults to AEC mode.
FOCUS	**Focus**	Defines which focus will be defaulted to when a receptor is selected. Options are **SMALL** or **LARGE.** **Micro** focus is not available at this time.

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
FILM SCREEN	**Film Screen**	Defines which film screen will be defaulted to when a receptor is selected and AEC enabled. Options are film screen **1**, **2**, or **3** (membrane console) or **I**, **II**, or **III** GenWare®.
LEFT FIELD **CENTER FIELD** **RIGHT FIELD**	**Fields**	Defines which field(s) will be defaulted to when a receptor is selected. Membrane console: **YES:** The selected field will be selected. **NO:** The selected field will not be selected. GenWare®: Refer to the graphic under **Fields:** A black (blue for TouchScreen GenWare®) field select rectangle = field not selected, a green field select rectangle = field selected.
KV	**Voltage (kV)**	Selects the default kV.
MA	**Current (mA)**	Selects the default mA.
MS	**Time (ms)**	Selects the default ms.
DENSITY	**Density**	Selects the default density.

NOTE: ***IT IS RECOMMENDED THAT THE IMAGE RECEPTOR PROGRAMMING WORKSHEET BE FILLED IN FOR EACH RECEPTOR THAT IS PROGRAMMED. A BLANK FORM THAT SHOULD BE PHOTOCOPIED IS LOCATED IN SECTION 3A 4.0. THIS WILL PROVIDE A RECORD OF THE RECEPTOR SETUP FOR FUTURE REFERENCE.***

3C.5.3 Receptor Setup (Cont)

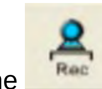
If the image receptor defaults are changed, the original defaults should be recorded in a copy of the following table:

IMAGE RECEPTOR DEFAULT SETTINGS						
FUNCTION	RECEPTOR 1	RECEPTOR 2	RECEPTOR 3	RECEPTOR 4	RECEPTOR 5	RECEPTOR 6
TECHNIQUE						
FOCUS						
FILM SCREEN						
LEFT FIELD						
CENTER FIELD						
RIGHT FIELD						
KV						
MA						
MS						
DENSITY						

NOTE: ***DO NOT SWITCH OFF THE GENERATOR WHILE IN ANY RECEPTOR SETUP MENUS. DOING SO WILL CAUSE THE UPDATED RECEPTOR SETUP PARAMETERS NOT TO BE SAVED. IT IS RECOMMENDED THAT THE FIRST RECEPTOR PROGRAMMING BE COMPLETED, THE RECEPTOR SETUP MENUS BE EXITED TO THE GEN CONFIGURATION MENU, AND THEN THE RECEPTOR SETUP MENU BE RESELECTED TO PROGRAM THE NEXT RECEPTOR. THE ABOVE SHOULD BE REPEATED UNTIL ALL RECEPTORS ARE PROGRAMMED. THIS WILL ENSURE THAT THE UPDATED PARAMETERS ARE SAVED.***

3C.5.3 Receptor Setup (Cont)

Use these steps to set up the receptor parameters. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **GEN CONFIGURATION** menu, select **RECEPTOR SETUP**.	Select **Receptor Setup** from the **Setup** menu, or use the receptor setup button  on the GenWare® toolbar.	Press the  button on the GenWare® toolbar to access the **Receptor Setup** utility.
2.		Select the **Receptor Properties** tab.	Select the **Receptor Properties** tab.
3.	Select the first receptor to be programmed.	Select the first receptor to be programmed.	Select the first receptor to be programmed.
4.	Select **TUBE**. Toggle the button to select **NONE**, **1**, or **2**. Tube 2 is only available on two-tube units.	Check the **Receptor Enable** checkbox to enable the selected receptor. Under **Tube Number**, select **Tube 1** or **Tube 2** to assign the desired tube to the selected receptor. Tube 2 is only available on two-tube units.	Check the **Receptor Enable** checkbox to enable the selected receptor. Under **Tubes**, select **Tube 1** or **Tube 2** to assign the desired tube to the selected receptor. Tube 2 is only available on two-tube units.
5.	Select **TOMO**. Toggle the button to select **YES** or **NO**.	Check the **Tomo** checkbox to enable tomographic operation.	Check the **Tomo** checkbox to enable tomographic operation.
6.	Select **FLUORO**. Toggle the button to select **YES** or **NO**.	Check the **Fluoro** checkbox to enable fluoroscopic operation.	Check the **Fluoro** checkbox to enable fluoroscopic operation.
7.	Select **SERIAL**. Toggle the button to select **YES** or **NO**.	Check the **Serial** checkbox to enable serial operation.	Check the **Serial** checkbox to enable serial operation.
8.	Select **INTERFACE OPTS**. Use the **+** or **–** buttons to select the desired interface option.	Select the desired interface option via the **Interface Options** dialog box.	Select the desired interface option via the **Interface Options** dialog box.
9.	Select **FUNCTIONAL OPTS**. Use the **+** or **–** buttons to select the desired interface option.	Select the desired functional option via the **Functional Options** dialog box.	Select the desired functional option via the **Functional Options** dialog box.
10.	Press **>>**.		

3C.5.3 Receptor Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	Select **RECEPTOR SYM**. Use the **+** or **–** buttons to select the desired receptor symbol.		
12.	Select **FLUORO HANG**. Use the **+** or **–** buttons to select the desired fluoro hangover time.	Select the desired fluoro hangover time via the **Fluoro Hangover (s)** dialog box.	Select the desired fluoro hangover time via the **Fluoro Hangover (s)** dialog box.
13.	Select **RAD HANG**. Use the **+** or **–** buttons to select the desired rad hangover time.	Select the desired rad hangover time via the **Rad Hangover (s)** dialog box.	Select the desired rad hangover time via the **Rad Hangover (s)** dialog box.
14.	Select **LAST IMAGE HOLD**. Use the **+** or **–** buttons to select the desired last image hold time.	Select the desired last image hold time via the **Last Image Hold (ms)** dialog box.	Select the desired last image hold time via the **Last Image Hold (ms)** dialog box.
15.	Select **MEMORY**. Toggle the button to select **NO, YES,** or **DEF**.	Under **Memory**, select **off, on**, or **default**.	Under **Memory**, select **Off, On**, or **Default**.
16.	Select **REM TOMO BUT**. Use the **+** or **–** buttons to select the desired tomo backup time.	Select the desired tomo backup time via the **Tomo Back-Up Time (ms)** dialog box.	Select the desired tomo backup time via the **Tomo Back-up Time (ms)** dialog box.
17.	Press **>>**.		
18.	Select **SF/LF SWITCH**. Toggle the button to select **AUTO** or **MAN.**	Check the **Auto Focus** checkbox to enable auto focal spot selection.	Check the **Auto Focus** checkbox to enable auto focal spot selection.
19.		Select the **AEC** tab.	Select the **AEC** tab.
20.	Select **AEC BACKUP**. Toggle the button to select **FIXED, MAS,** or **MS**.	Under **AEC Mode**, select **fixed, mAs**, or **ms**.	Under **AEC Back-up Mode**, select **Fixed, mAs**, or **ms**.
21.	Select **AEC BACKUP MAS**. Use the **+** or **–** buttons to select the maximum backup mAs.	Select the maximum backup mAs via the **AEC Back-Up mAs** dialog box.	Select the maximum backup mAs via the **AEC Backup mAs** dialog box.
22.	Select **AEC BACKUP MS**. Use the **+** or **–** buttons to select the maximum backup ms.	Select the maximum backup ms via the **AEC Back-Up ms** dialog box.	Select the maximum backup ms via the **AEC Backup ms** dialog box.

3C.5.3 Receptor Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
23.	Select **AEC CHANNEL**. Use the **+** or **–** buttons to assign the desired AEC channel to the selected receptor, or to disable AEC operation on that receptor.	Select the AEC channel to be assigned to the selected receptor, or disable AEC operation on that receptor via the **AEC Channel** dialog box.	Select the AEC channel to be assigned to the selected receptor, or disable AEC operation on that receptor via the **AEC Channel** dialog box.
24.	Press **>>**.		
25.	Select **AEC LOCK EXPs.** Use the **+** or **–** buttons to select the desired number of AEC scout exposures.	Select the desired number of AEC scout exposures via the **AEC Lock Exps** dialog box.	Select the desired number of AEC scout exposures via the **AEC Lock Exposures** dialog box.
	The following steps only apply if **MEMORY** in step 15 was set to **DEF** / **default**.		
26.	Press **<<**.		
27.	Select **DEFAULTS**.	Select the **Receptor Defaults** tab.	Select the **Receptor Defaults** tab.
28.	Select **TECHNIQUE**. Toggle the button to select **MA, MAS,** or **AEC**.	Under **Technique**, select **ms, mAs**, or **AEC**.	Under **Technique**, select **ms, mAs**, or **AEC**.
29.	Select **FOCUS**. Toggle the button to select **SMALL** or **LARGE**.	Under **Focus**, select **small** or **large**.	Under **Focus**, select **Small** or **Large. Micro** focus is not available at this time.
30.	Select **FILM SCREEN**. Toggle the button to select **1, 2,** or **3.**	Under **Film Screen**, select **I, II,** or **III.**	Under **Film Screen**, select **I, II,** or **III**.
31.	Select **LEFT FIELD**. Toggle the button to select **YES** or **NO**.	Click the left field on the graphic under **Fields** to select / deselect that field. Black indicates that the field is not selected; green indicates that the field is selected.	Click the left field on the graphic under **Fields** to select / deselect that field. Black indicates that the field is not selected; green indicates that the field is selected.
32.	Repeat the previous step for the **CENTER** and **RIGHT** fields.	Repeat the previous step for the center and right fields.	Repeat the previous step for the center and right fields.
33.	Press **>>**.		
34.	Select **KV, MA, MS,** and **DENSITY.** Use the **+** or **–** buttons to select the default kV, mA, ms, and density, respectively.	Select the default kV, mA, ms, and density via the **Voltage (kV), Current (mA), Time (ms),** and **Density** dialog boxes, respectively.	Select the default kV, mA, ms, and density via the **Voltage (kV), Current (mA), Time (ms),** and **Density (s)** dialog boxes, respectively.
35.	Press **<<** five times to return to the **GEN CONFIGURATION** menu.		

3C.5.3 Receptor Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
36.	Repeat steps 3 to 35 for the remaining receptors. It is necessary to return to the **GEN CONFIGURATION** menu after programming each receptor to ensure that the updated parameters are saved to memory.		

3C.5.4 I/O Configuration

The **I/O CONFIGURATION** function allows programming the states of the exposure for the inputs and the outputs on the room interface board.

The **I/O CONFIGURATION** menus for the membrane console are shown below.

	* INPUTS [sym] *	
REMOTE EXP:	...---...---...	STANDBY STATE
REMOTE PREP:	...---.........	
REMOTE FL. EXP:	............---	
CONSOLE EXP:	...---...---...	
EXIT		>>

	* INPUTS [sym] *	
CONSOLE PREP:	...---.........	STANDBY STATE
TOMO EXP:	.... ---...	
REM. TOMO SEL.:	---............	
I/I SAFETY:	...---...----- -	
<<		>>

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3C.5.4 I/O Configuration (Cont)

```
                     * INPUTS [sym] *
COLL. ITLK:          ...---...------          STANDBY STATE
BUCKY CONTACTS:      .........---...
SPARE:               ------...------
THERMAL SW 1:        ------...------
     <<                                  >>
```

```
                     * INPUTS [sym] *
THERMAL SW 2:        -----...-----            STANDBY STATE
DOOR ITLK:           ----- ...-----
MULTI SPOT EXP:      ---............

     <<                                  >>
```

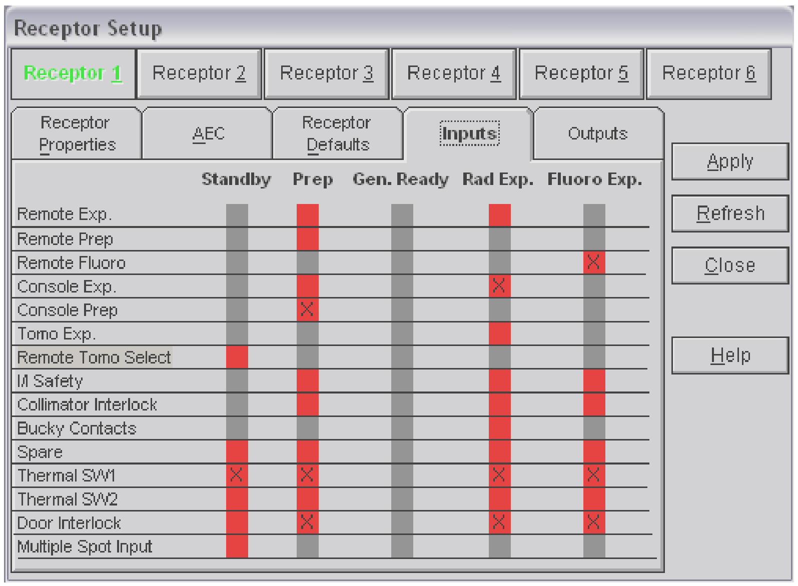
```
                     * OUTPUTS [sym] *
BKY 1 SELECT:        ---------------          STANDBY STATE
BKY 2 SELECT:        ---------------
BKY 3 SELECT:        ---------------
TOMO/BKY 4 SEL:      ---------------
     <<                                  >>
```

```
                     * OUTPUTS [sym] *
TOMO/BKY STRT:       ---------------          STANDBY STATE
ALE:                 ---------------
COLL. BYPASS:        ---------------

     <<                                  >>
```

3C.5.4 I/O Configuration (Cont)

	* OUTPUTS [sym] *	
ROOM LIGHT:	---------------	STANDBY STATE
SPARE:	---------------	
<<		RETURN



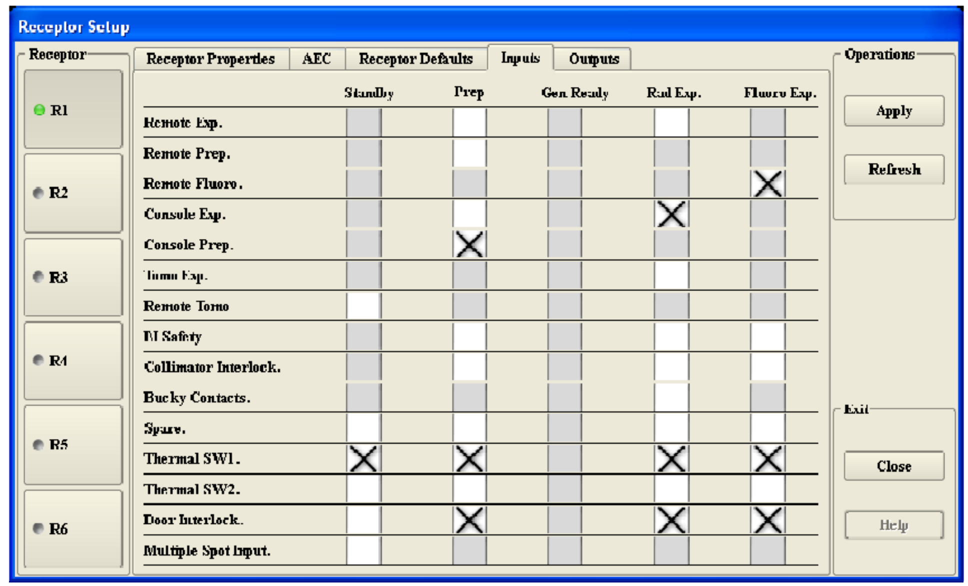


Figure 3C-15a: PC GenWare® *Figure 3C-15b: Touchscreen GenWare®*
Receptor Setup window, Inputs tab

3C.5.4 I/O Configuration (Cont)

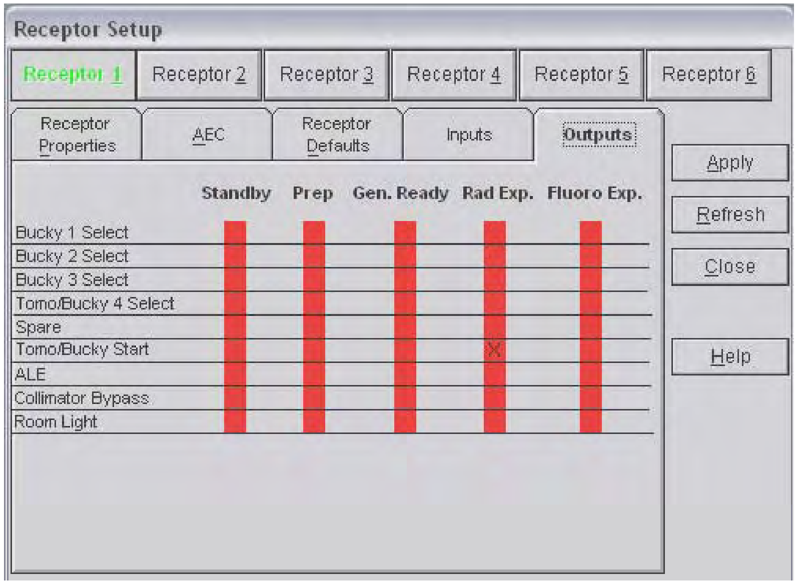


Figure 3C-16a: PC GenWare®

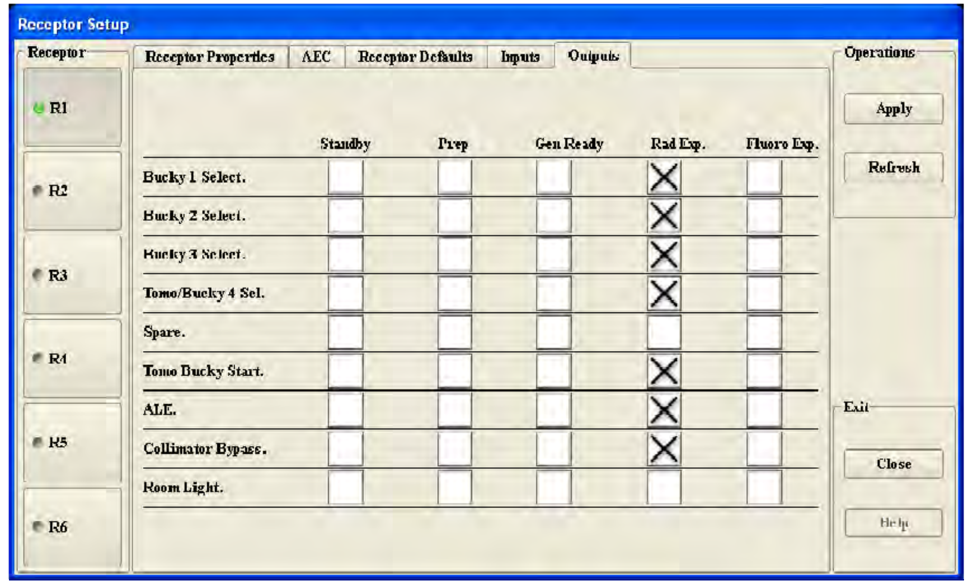


Figure 3C-16b: Touchscreen GenWare®

Receptor Setup window, Outputs tab

Definitions of **I/O CONFIGURATION** menu items.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
REMOTE EXP	**Remote Exp.**	Programs the remote exposure input at TB6-9 and TB6-10 on the room interface board.
REMOTE PREP	**Remote Prep**	Programs the remote prep input at TB6-7 and TB6-8 on the room interface board.
REMOTE FL. EXP	**Remote Fluoro**	Programs the remote fluoro exposure input at TB6-5 and TB6-6 on the room interface board.
CONSOLE EXP	**Console Exp.**	Programs the console expose button.
CONSOLE PREP	**Console Prep**	Programs the console prep button.
TOMO EXP	**Tomo Exp.**	Programs the tomographic exposure input at TB3-6 and TB3-7 on the room interface board.

3C.5.4 I/O Configuration (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
REM. TOMO SEL.	**Remote Tomo Select (Remote Tomo)**	Programs the remote tomo select input at TB3-4 and TB3-5 on the room interface board.
I/I SAFETY	**I/I Safety**	Programs the I.I. safety input at TB6-3 and TB6-4 on the room interface board.
COLL. ITLK	**Collimator Interlock**	Programs the collimator interlock input at TB2-6 and TB2-7 on the room interface board.
BUCKY CONTACTS	**Bucky Contacts**	Programs the Bucky input at TB2-4 and TB2-5 on the room interface board. All Bucky ready signals must be connected to this single input.
SPARE	**Spare**	Programs the spare input at TB1-4 and TB1-5 on the room interface board. This is used for the table stepper input if that function is enabled.
THERMAL SW 1	**Thermal SW1**	Programs the thermal switch 1 input at TB4-8 and TB4-9 on the room interface board.
THERMAL SW 2	**Thermal SW2**	Programs the thermal switch 2 input at TB4-6 and TB4-7 on the room interface board.
DOOR ITLK	**Door Interlock**	Programs the door interlock input at TB4-4 and TB4-5 on the room interface board.
MULTI SPOT EXP	**Multiple Spot Input**	Programs the multiple spot exposure compensation input at TB5-11 and TB5-12 on the room interface board. Refer to chapter 3D for details on this function.
BKY 1 SELECT	**Bucky 1 Select**	Programs the Bucky 1 release output at TB2-11 and TB2-12 on the room interface board.
BKY 2 SELECT	**Bucky 2 Select**	Programs the Bucky 2 release output at TB2-1 and TB2-2 on the room interface board.
BKY 3 SELECT	**Bucky 3 Select**	Programs the Bucky 3 release output at TB1-11 and TB1-12 on the room interface board.
TOMO/BKY 4 SELECT	**Tomo/Bucky 4 Select (Tomo/Bucky 4 Sel.)**	Programs the Tomo / Bucky 4 release output at TB1-1 and TB1-2 on the room interface board.
TOMO/BKY STRT	**Tomo/Bucky Start**	Programs the Tomo / Bucky start output at TB3-11 and TB3-12 on the room interface board. This output is common to all Buckys.
ALE	**ALE**	Programs the ALE (Actual Length of Exposure) output at TB6-1 and TB6-2 on the room interface board.

3C.5.4 I/O Configuration (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
COLL. BYPASS	**Collimator Bypass**	Programs the collimator bypass output at TB3-1 and TB3-2 on the room interface board.
ROOM LIGHT	**Room Light**	Programs the room light output at TB4-11 and TB4-12 on the room interface board.
SPARE	**Spare**	Programs the spare output at TB6-11 and TB6-12 on the room interface board.

The inputs and outputs defined in the previous table are programmable as follows:

- Inputs may be programmed such that the selected input is active or inactive during various states of the generator. Inactive inputs are ignored; unused inputs should normally be programmed to be inactive.
- Outputs may be programmed such that the relay connected to the selected output is energized or de-energized during various states of the generator. Unused outputs should normally be programmed to be de-energized.
- The inputs and outputs must be programmed separately for each receptor. Each receptor may have its own unique programming.

MEMBRANE CONSOLE

The **STATE** button on the upper right hand side of the menu selects the current state. The word **STATE** is preceded by the description of the state: for example, **STANDBY**.

The arrow in the lower middle area points to the current level for the selected state. Moving to the next state is accomplished by pressing the **STATE** button. The states are as follows:

- **STANDBY** — Sets the state of the I/O when the generator is in standby (idle) mode. Standby mode includes fluoroscopic hangover.
- **PREP** — Sets the state of the I/O when the generator enters PREP mode.
- **GEN RDY** — Sets the state of the I/O when the generator has completed PREP mode and is ready to expose.
- **RAD EXP** — Sets the state of the I/O when the generator starts a radiographic exposure.
- **FLUORO EXP** — Sets the state of the I/O when the generator starts a fluoroscopic exposure.

3C.5.4 I/O Configuration (Cont)

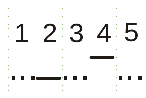
Pressing the button next to the selected input or output on the left of the display selects that function. The level of the selected state is changed by pressing the selection button again (low = off / inactive, high = on / active).

For inputs, setting the level “low” means that the input is ignored during that state. Setting the level “high” requires that the corresponding input is satisfied before the generator will advance to that state. If multiple inputs are programmed “high”, for example if **REMOTE PREP** and **CONSOLE PREP** are both high in the prep state, then both inputs will need to be active before the generator will enter the prep state.

Setting an output level “low” causes the relay associated with that output to be de-energized during the selected state. Setting the level “high” will cause the associated relay to be energized during the selected state.

Certain functions have states indicated by a dotted line. The dotted line indicates invalid states, which cannot be altered. Only states shown by a solid line can be changed. Refer to figure 3C-17 for examples of a TYPICAL input configuration.

REMOTE EXP:



1 = STANDBY STATE (cannot be changed)
2 = PREP STATE (shown low/inactive)
3 = GEN RDY STATE (cannot be changed)
4 = RAD EXP STATE (shown high/active)
5 = FLUORO EXP STATE (cannot be changed)

FILE: ML_IOSTE.CDR

Figure 3C-17: Example of input states

GenWare®

On the **Inputs** and **Outputs** tabs, the generator states are shown above the vertical grey / red bars (grey / white bars for TouchScreen GenWare®). For inputs, grey indicates states where the input cannot be programmed. Only states that are shown in red (white) can be changed. Outputs are programmable for each of the five generator states.

The logic level of the selected state is changed by clicking in the desired state column, to the right of the selected input or output (unchecked = off / inactive, checked = on / active).

For inputs, an unchecked state means that the input is ignored during that state. A checked state (marked with an **X**) requires that the corresponding input be satisfied before the generator will advance to that state. If multiple inputs are enabled, for example if **Remote Prep** and **Console Prep** are both checked in the prep state, then both inputs will need to be active before the generator will enter the prep state.

For outputs, an unchecked state causes the relay associated with that output to be de-energized during the selected state. A checked state (marked with an **X**) will cause the associated relay to be energized during the selected state.

3C.5.4 I/O Configuration (Cont)

NOTE: ***IT IS RECOMMENDED THAT THE I/O CONFIGURATION WORKSHEET BE FILLED IN FOR EACH INPUT OR OUTPUT THAT IS PROGRAMMED. A BLANK FORM THAT SHOULD BE PHOTOCOPIED IS LOCATED IN SECTION 3A.5.0. THIS WILL PROVIDE A RECORD OF THE I/O CONFIGURATION FOR FUTURE REFERENCE.***

Use these steps for programming the I/O functions. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **GEN CONFIGURATION** menu, select **I/O CONFIGURATION**.	From the **Receptor Setup** window, select the **Inputs** tab.	From the **Receptor Setup** window, select the **Inputs tab.**
2.	Select the first receptor to be programmed.	Select the first receptor to be programmed. Use the **Receptor** tabs on the **Receptor Setup** window.	Select the first receptor to be programmed. Use the **Receptor** buttons on the **Receptor** window.
3.	Press the **STATE** button to select the first state that can be programmed for the **REMOTE EXP** input. This is the **PREP** state. Toggle the **REMOTE EXP** button to select the desired logic level (low or high) to disable or enable that input during the prep state.	For the **Remote Exp.** input, identify the first state that can be programmed. This is the **Prep** state. Enable or disable the **Remote Exp.** input during the prep state by checking (with an **X**), or unchecking the **Prep** column to the right of **Remote Exp.**	For the **Remote Exp.** input, identify the first state that can be programmed. This is the **Prep** state. Enable or disable the **Remote Exp.** input during the prep state by checking (with an **X**), or unchecking the **Prep** column to the right of **Remote Exp.**
4.	Repeat the previous step for the remaining states that can be programmed. For the **REMOTE EXP** input, the only other state that can be programmed is the **RAD EXP** state.	Repeat the previous step for the remaining states that can be programmed. For the **Remote Exp.** input, the only other state that can be programmed is the **Rad Exp.** state.	Repeat the previous step for the remaining states that can be programmed. For the **Remote Exp.** input, the only other state that can be programmed is the **Rad Exp.** state.
5.	Repeat steps 3 and 4 for the remaining inputs. Use the >> button to scroll through all four **INPUTS** menus.	Repeat steps 3 and 4 for the remaining inputs.	Repeat steps 3 and 4 for the remaining inputs.

3C.5.4 I/O Configuration (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
6.	Press >> to select the first **OUTPUTS** menu.	Select the **Outputs** tab.	Select the **Outputs** tab.
7.	Repeat the previous steps for the outputs. For outputs, all five states can be programmed. A logic low de-energizes the relay connected to that output during the selected state. A logic high will energize the relay during the selected state.	Repeat the previous steps for the outputs. For outputs, all five states can be programmed. An unchecked state causes the relay connected to that output to be de-energized during the selected state. A checked state (with an **X**) will result in the relay being energized during the selected state.	Repeat the previous steps for the outputs. For outputs, all five states can be programmed. An unchecked state causes the relay connected to that output to be de-energized during the selected state. A checked state (with an **X**) will result in the relay being energized during the selected state.
8.	When finished the I/O programming for the current receptor, exit to the **GEN CONFIGURATION** menu.	Select **Apply** to save the programming for the current receptor.	Select **Apply** to save the programming for the current receptor.
9.	Reselect **I/O CONFIGURATION,** and then select the next receptor to be programmed.	Select the next receptor to be programmed. Use the receptor tabs on the **Receptor Setup** window.	Select the next receptor to be programmed. Use the **Receptor** buttons on the **Receptor Setup** window.
10.	Program all inputs and outputs for the selected receptor.		
11.	When finished programming all receptors, exit to the **GEN CONFIGURATION** menu.		

3C.5.5 AEC Setup

For AEC setup, refer to chapter 3D, AEC SETUP AND CALIBRATION.

3C.5.6 AEC Calibration

For AEC calibration, refer to chapter 3D, AEC SETUP AND CALIBRATION.

3C.5.7 Fluoro Setup and Calibration

For fluoro setup and calibration, refer to chapter 3E, ABS SETUP AND CALIBRATION.

3C.5.8 Tube Calibration

Refer to chapter 2, the section TUBE AUTO CALIBRATION.

3C.5.9 DAP Setup

For setup and calibration of the optional DAP (Dose-Area Product) meter, refer to chapter 3F, DAP / AK SETUP AND CALIBRATION.

3C.5.10 AK Setup

For setup and calibration of the optional AK (Air Kerma) calculator and display, refer to chapter 3F, DAP / AK SETUP AND CALIBRATION.

3C.6.0 DATA LINK (Connect to GenWare®)

This is used with the CPI PC GenWare® utility software. This allows for data communication with a computer in order to download additional tube types, transfer APR data, edit APR text, perform setup and calibration functions, and for other minor functions. Further documentation is included with PC GenWare®.

A computer (i.e. a laptop) and a 9-pin null-modem cable with socket connectors (female) on both ends are required to connect the computer to the generator in order to run GenWare®.

- Connect the null-modem cable from a serial port on the computer with GenWare® to the *DATA LINK* connector on the rear of the control console. Refer to the figure “Rear of control console” in chapter 2 for the location of this connector.
- From the **GENERATOR SETUP** menu select **DATA LINK**, and then select **CONNECT TO GENWARE**. A **DATA LINK** submenu will open, indicating **WAITING FOR DATA…PLEASE DO NOT TURN OFF POWER**.
- Switch on the computer and start GenWare®.
- GenWare® is ready for use when communication is established with the generator.

If the data link connector is not available, i.e. on units without a CPI supplied console, J1 or J2 on the generator CPU board may be used.

CONNECTING AN EXTERNAL COMPUTER TO J11 ON THE GENERATOR CPU BOARD MAY DAMAGE THE COMPUTER. THIS WAS DESIGNED FOR CONNECTION OF THE OPTIONAL REMOTE FLUORO CONTROL ONLY.

NOTE: ***PC GenWare® should be closed before exiting the DATA LINK function on the console. Failure to do so may require that the console be switched off and then on again in order to re-initialize communication with the generator.***

3C.7.0 TOUCHSCREEN SYSTEM UTILITIES

This section applies to generators with the touchscreen option only.

The system utilities menu allows access to the following functions:

FUNCTION	DESCRIPTION
APR Editor	Allows the APR to be edited. Changes may be saved to memory.
APR Backup / Restore	Allows the APR data to be backed up, and backed-up APR data to be restored. The factory-default APR is available in several languages. This also allows APR files to be saved to a USB flash drive, and saved APR files to be downloaded from a USB flash drive.
Date / Time Setup	Allows the touchscreen's date and time to be set or changed.
Receptor Symbols	Allows predefined receptor symbols to be assigned to each image receptor button. Also allows receptor symbols to saved to a USB flash drive and saved receptor symbols to be downloaded from a USB flash drive.
Genware®	Allows access to the TouchScreen GenWare® utility software.
Touch Screen Setup	• Allows for the setting of specific console operating parameters. • Sets up the serial communication ports on the touchscreen console. • Sets the specific customer code for graphical user interfaces (skin). • Sets the screen saver interval. • Allows adjustment of the General Volume. • Allows adjustment of the Exposure Volume. • Allows adjustment of the LCD Brightness. • Enables / disables compatible equipment (i.e. Infimed digital interface). • Allows the operator and service passwords to be changed.
Touch Screen Calibration	Allows for electrical alignment of the touch sensitive membrane with the "buttons" displayed on the touchscreen.
Data Link	Prepares the console for communication with an external computer.
Configuration Backup / Restore	Allows the receptor symbols and auto-positioner data, if applicable, to be backed up, and backed-up receptor symbols and auto-positioner data, if applicable, to be restored.
Main Menu	Press to return to the main console menu.

3C.7.1 Accessing the Utilities Menu

Use these steps to access the systems utilities functions.

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1.</td><td>From the main console menu (figure 3C-18), press System Utilities. A pop-up window will be displayed (figure 3C-19), requesting a password.</td></tr>
<tr><td>2.</td><td>Press 1, 9, 7, 3 in sequence to continue. This is the factory-default service password, and allows access to all of the functions listed above.
Press Clear to cancel an incorrect password.
Press Cancel to return to the main menu.
Press Accept to access the system utilities menu. After a brief delay, the system utilities menu (figure 3C-20) will be displayed. The message Access Denied indicates that an incorrect password was used. The factory-default password may be changed by a service engineer as described later in this supplement. If this was done, the password defined above will not allow access to the system utilities menu.</td></tr>
</table>

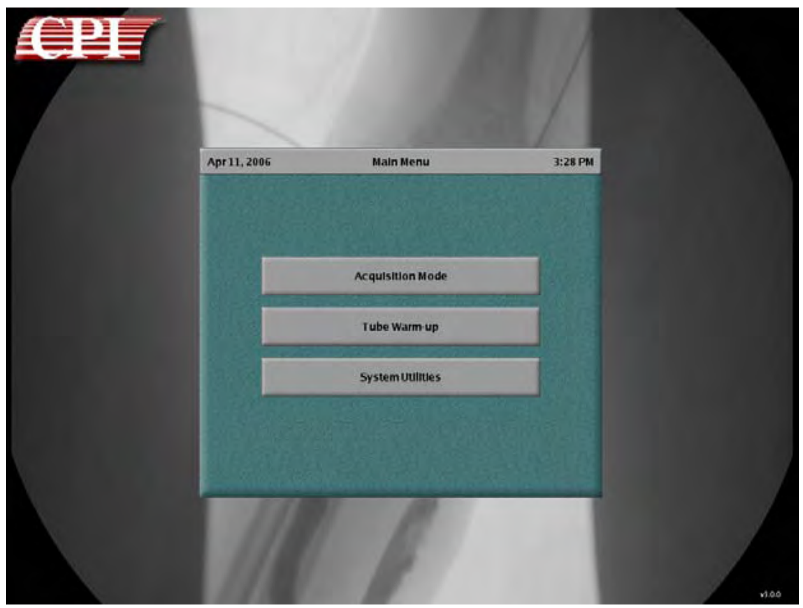


Figure 3C-18: Main menu

3C.7.1 Accessing the Utilities Menu (Cont)

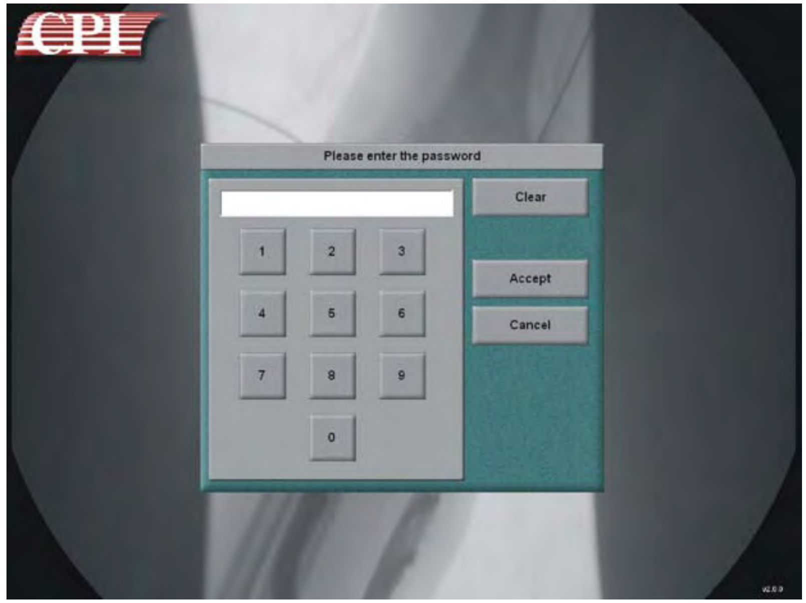


Figure 3C-19: Password window

3C.7.1 Accessing the Utilities Menu (Cont)

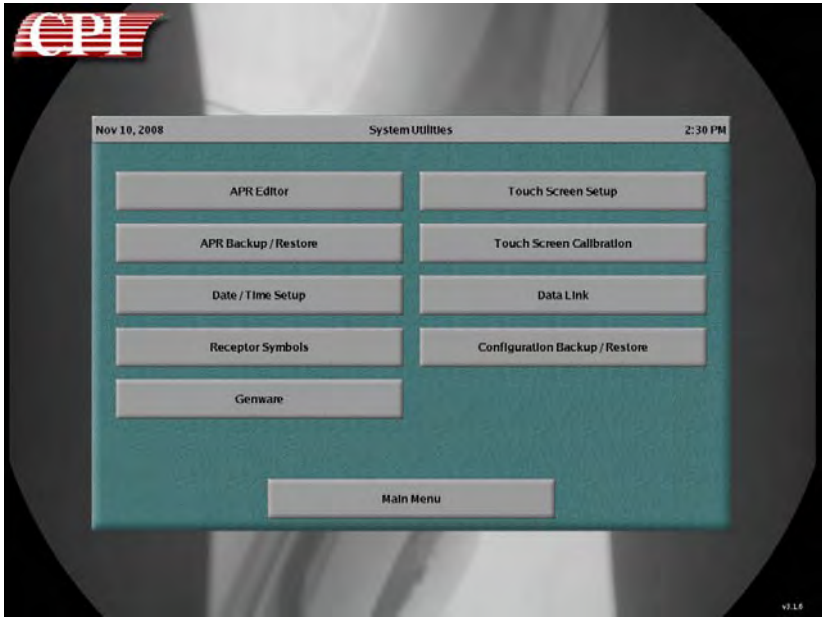


Figure 3C-20: System utilities menu

3C.7.2 APR Editor

It is strongly suggested that you review the subsection ANATOMICAL PROGRAMMING SELECTOR in section 4 of the operator's manual before proceeding. A good understanding of the terminology and APR menu structures is needed to make APR changes.

Use these steps to access the APR editor function.

Step	Action
1.	From the system utilities menu, press **APR Editor.** A screen similar in appearance to the normal operating screen will be displayed (figure 3C-21). However, as a reminder that you are in APR editor mode, the word **APR EDITOR** will be displayed in the APR window.
2.	Refer to the applicable subsections (following) for the procedures to change parameters and technique for existing APR items, and to edit, add, or delete APR, procedural, or menu items.

3C.7.2 APR Editor (Cont)

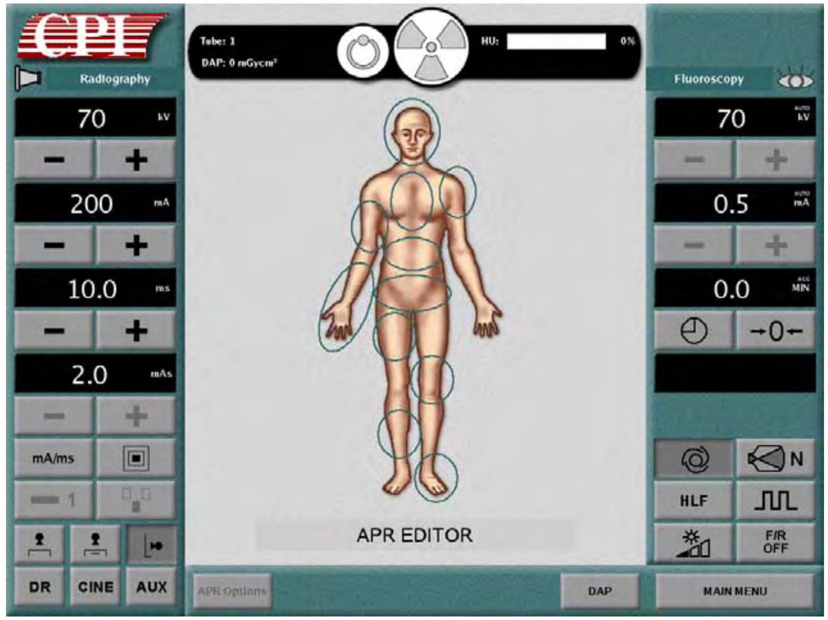


Figure 3C-21: APR editor window

<u>NOTE</u>: THE DISPLAY ON YOUR SYSTEM MAY VARY DEPENDING ON GENERATOR TYPE, AND ON PROGRAMMING AND TECHNIQUE SELECTIONS.
MINOR VARIATIONS MAY EXIST IN COLOR SCHEME AND GRAPHIC STYLES (SKINS) TO SUIT SPECIFIC CUSTOMER REQUIREMENTS.

<u>NOTE</u>: When a region of interest (i.e. SKULL) is selected, a pop-up menu will appear similar to that in normal APR mode. In addition to "new" <Add>, <Edit>, ***and*** <Delete> ***buttons, a*** <Move Up> ***and*** <Move Down> ***button will be displayed.***
The <Move Up> ***and*** <Move Down> ***buttons allow the items in a menu or submenu to be rearranged. To do this, select the item to be moved. This will highlight the item. Press*** <Move Up> ***to move the selected item up in the list, and*** <Move Down> ***to move the selected item down in the list.***

3C.7.2 APR Editor (Cont)

To change parameters or techniques for an existing APR item.

Step	Action
1.	Select the APR item to be changed. If the APR item is in a submenu of a menu or procedural item, select the parent menu item or procedural item, then press **Open Sub-Menu**. It may be necessary to drill down through several submenus to find the desired APR item.
2.	When the selected APR item is highlighted, select the patient size. The desired parameters / technique may be changed for that patient size (rad / fluoro kV and mA, mAs, ms, density, AEC / mA/ms / mAs, focal spot, film screen, AEC fields, image receptor, AEC lock, fluoro mode (continuous / pulsed fluoro / HLF), I.I. mode, dose, ABS). Repeat for all patient sizes for that APR item as required. The highlight will change to red when the programmed APR has been altered.
3.	Repeat steps 1 and 2 for other APR items within that menu or submenu, if applicable.
4.	Press **BACK** when finished changing APR items in that menu / submenu. This may need to be done more than once to return to the top APR menu for the selected region of interest. A pop-up window will display asking if you wish to save the changes. Press **YES** to save the changes; **CANCEL** cancels the changes.

NOTE: ***When editing or adding an APR item, menu item, or procedural item, an English keyboard will pop up at the bottom of the screen. A partial keyboard with international symbols corresponding to the installer-selected language may be displayed at the top of the screen. Characters may then be entered via either keyboard.***

An ID code window may be displayed to the right of the window for the item text. The ID code is used by some imaging systems, and use of the proper code synchronizes the APR's between the touchscreen console and the imaging system. Refer to the appropriate imaging system documentation for valid ID codes.

Touching the ID code window will move the cursor into that window, allowing entry of the ID code. THE I.D. CODE IS NOT AVAILABLE ON ALL SOFTWARE CONFIGURATIONS OF THE TOUCHSCREEN.

3C.7.2 APR Editor (Cont)

To edit (change the name of) an APR item.

Step	Action
1.	Select the APR item as per step 1 under **"To change parameters or technique for an existing APR item".** The selection will be highlighted.
2.	Press **Edit**. Keyboard(s) will display on the screen as described above, with the current name of the APR item highlighted. • Press **CANCEL** on the lower keyboard to exit without changing the name. • Press **DEL** to delete the highlighted name on the keyboard. • Type in the new name for that APR item. Use the **BACKSPACE** key to back space if corrections are needed. • Add / edit the ID code if desired (if displayed). • Press **ENTER** when finished.

To delete an APR item.

Step	Action
1.	Select the APR item to be deleted. The selection will be highlighted.
2.	Press **Delete**. A pop-up window will display asking if you are sure you want to delete this item. Press **YES** to delete the item; **NO** cancels the deletion.

To add an APR item.

Step	Action
1.	Select the appropriate location to add the APR item. An APR item may be added directly to a main APR menu, or may be added to a submenu of another menu or procedural item. If the APR item is to be added to a submenu of a menu or procedural item, select the parent menu item or procedural item, then press **Open Sub-Menu**. It may be necessary to drill down through several submenus to find the desired location for the new APR item.
2.	Press **Add**. A pop-up window will display allowing you to select three item types to be added. Select **APR Item** (this is the default selection, and the only available selection if adding to a procedural menu).
3.	Press **OK** to continue. **Cancel** will cancel this action.

3C.7.2 APR Editor (Cont)

Step	Action
4.	Keyboard(s) will display on the screen as described previously. • Type in the name of the new APR item. • Add the ID code if desired (if displayed). • Press **ENTER** when finished. • The new APR item will appear on the selected menu or submenu. • Change the parameters and technique as per the subsection **"To change parameters or technique for an existing APR item".**

To add, edit, or delete a procedural item.

***NOTE**: A procedural item has only one submenu, which may only contain APR items.*
A procedure item will automatically select the next APR item on its list when the PREP or EXPOSE buttons are released.

***NOTE**: A menu item has one or more submenus, which may include other menu items, procedural items and / or APR items.*
APR items contained within a menu must be selected manually.

Step	Action
1.	To delete a procedural item, follow the steps in **"To delete an APR item".** Doing so will also delete the submenu associated with that procedural item.
2.	To edit a procedural item, follow the steps in **"To edit (change the name of) an APR item".**
3.	To add a procedural item, follow steps 1 to 3 in **"To add an APR item",** except select **APR Procedure** in step 2**.**

3C.7.2 APR Editor (Cont)

Step	Action
4.	Keyboard(s) will display on the screen as described previously. • Type in the name of the new procedural item. • Add / edit the ID code if desired (if displayed). • Press **ENTER** when finished. • The new procedural item will appear on the selected menu or submenu. • Select the newly added procedural item. The selection will be highlighted. • Press **Open Sub-Menu**. A "generic" APR item named **FIRST ITEM** has been automatically inserted in that submenu. • You may now edit the name and change the parameters and technique for that APR item, and add additional APR items for that procedural item as per previous steps.

To add, edit, or delete a menu item.

Step	Action
1.	To delete a menu item, follow the steps in **"To delete an APR item".** Doing so will also delete the submenu associated with that menu item.
2.	To edit a menu item, follow the steps in **"To edit (change the name of) an APR item".**
3.	To add a menu item, follow steps 1 to 3 in **"To add an APR item",** except select **APR Menu** in step 2**.**
4.	Keyboard(s) will display on the screen as described previously. • Type in the name of the new menu item. • Add / edit the ID code if desired (if displayed). • Press **ENTER** when finished. • The new menu item will appear on the selected menu or submenu. • Select the newly added menu item. The selection will be highlighted. • Press **Open Sub-Menu**. A "generic" APR item named **FIRST ITEM** has been automatically inserted in that submenu. • You may now edit the name and change the parameters and technique for that APR item, and add additional APR items for that menu item as per previous steps.

3C.7.3 APR Backup / Restore

Use these steps to access the APR backup / restore function.

Step	Action
1.	From the system utilities menu, press **APR Backup / Restore.** A pop-up window (figure 3C-22) will display showing the available backup files and the factory-default APR files in various languages. Pressing **Close** will exit the backup and restore menu.
2.	Refer to the applicable subsections (following) for the procedures to back-up the current APR data, to restore saved APR data, and to upload and download APR files to and from a USB flash drive. The entire APR (parameters and techniques, APR text, menu structures, etc) is backed up.

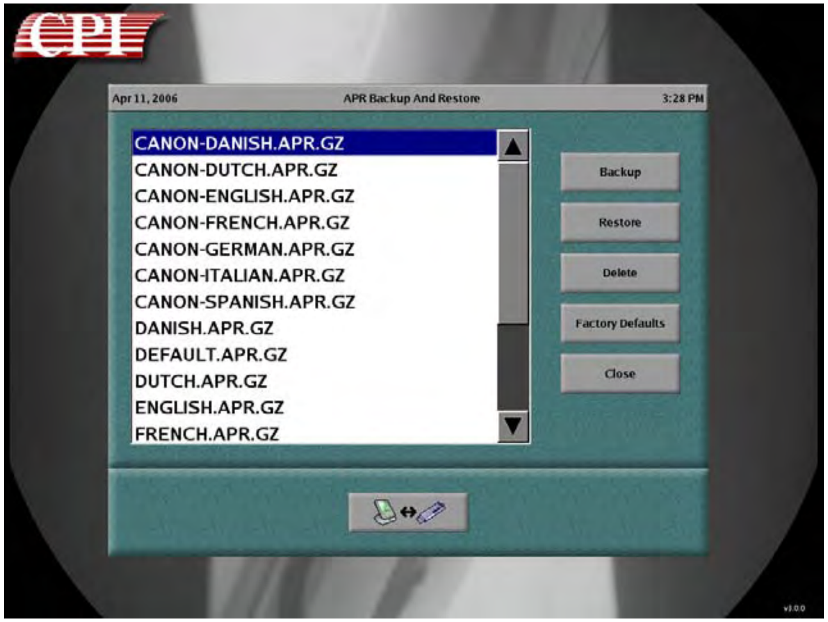


Figure 3C-22: APR back-up and restore window

3C.7.3 APR Backup / Restore (Cont)

To back-up current APR data.

Step	Action
1.	Press **Backup**.
2.	Keyboard(s) will display on the screen as described previously. • Type in the name of the new backup file. • Press **ENTER** when finished. The console will return to the APR backup / restore menu. • A pop-up window will display indicating that the backup was successful. Press **OK** to continue.

To restore backed-up APR data.

Step	Action
1.	Select the APR data file to be restored. The selection will be highlighted.
2.	Press **Restore**.
3.	After a brief delay, a pop-up window will display indicating that restore was successful. Press **OK**.

To delete an APR data file.

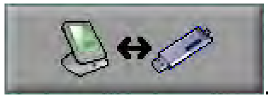
Step	Action
1.	Select the APR data file to be deleted. The selection will be highlighted.
2.	Press **Delete**. A pop-up window will display asking if you are sure you want to delete this file. Press **YES** to delete the file; **NO** cancels the deletion.

To restore the factory default APR data.

Step	Action
1.	Press **Factory Defaults**.
2.	After a brief delay, a pop-up window will display indicating that restore was successful. Press **OK**.

3C.7.3 APR Backup / Restore (Cont)

USB file transfer utility.

Step	Action
1.	The APR USB file transfer utility allows APR files on the touchscreen to be saved to a USB flash drive, or saved APR files on a USB flash drive to be downloaded to the touchscreen.
2.	In order to use this feature a USB flash drive is required. Connect the USB flash drive to **USBA** on the rear of the touchscreen console and press . After a brief auto-detection sequence where the touchscreen looks for the USB flash drive, the **USB File Transfer Utility** window will open.

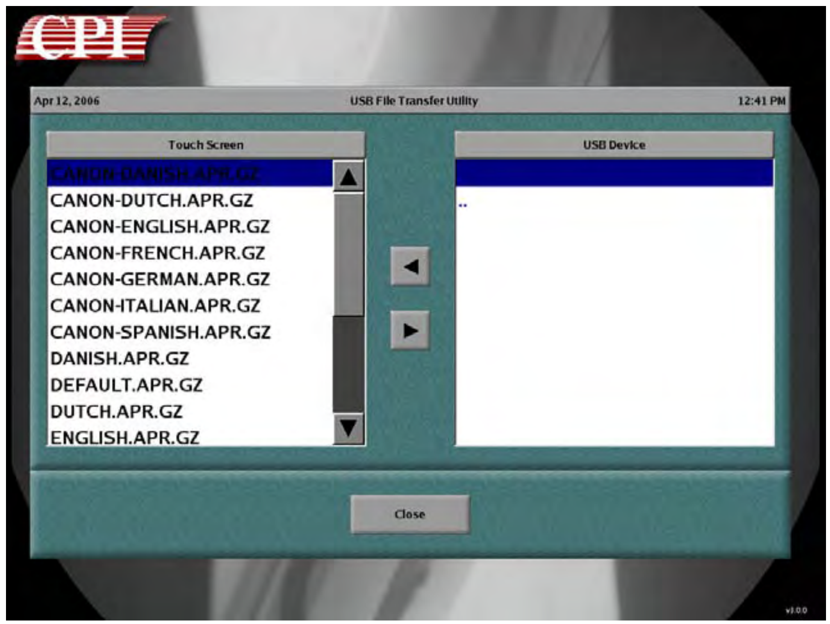
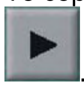
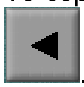


Figure 3C-23: USB File Transfer Utility window

Use and disclosure is subject to the restrictions on the title page of this CPI document.

3C.7.3 APR Backup / Restore (Cont)

Step	Action
3.	To copy an APR file from the touchscreen to the USB flash drive select the desired file from the **Touch Screen** window and press . Once the file is copied successfully it will appear in the **USB Device** window of the **USB File Transfer Utility**.
4.	To copy an APR file from a USB flash drive to the touchscreen select the desired file from the **USB Device** window and press . Once the file is copied successfully it will appear in the **Touch Screen** window of the **USB File Transfer Utility**.
5.	When finished, press **Close** to exit.

3C.7.4 Date / Time Setup

Use these steps to perform the date and time setup.

Step	Action
1.	From the system utilities menu, press **Date / Time Setup.** A pop-up window that allows setting of the date and time will display (figure 3C-24).
2.	**TO SET THE YEAR:** Press the up or down arrows adjacent to ***Year*** to select the desired year. The selected year will display to the left of the up / down selection buttons.
3.	**TO SET THE MONTH:** Press the up or down arrows adjacent to ***Month*** to select the desired month. The selected month will display to the left of the up / down selection buttons.
4.	**TO SET THE DATE:** Press to select the desired date on the calendar that is displayed.
5.	**TO SET THE HOUR** Press the up or down arrows to the right of ***Hour*** to select the desired hour. The selected hour will display to the left of the up / down selection buttons. This must be selected in 24 hour format, i.e. 2 PM would be entered as hour 14.

3C.7.4 Date / Time Setup (Cont)

Step	Action
6.	**TO SET THE MINUTE** Press the up or down arrows to the right of ***Minute*** to select the desired minute. The selected minute will display to the left of the up / down selection buttons. The current time will be displayed under ***Current Time.***
7.	Press **Apply** to apply the current date and time settings without exiting the date and time menu. Pressing **OK** will apply the current settings and return to the system utilities menu. **Cancel** returns to the system utilities menu without applying changes to the time or date.

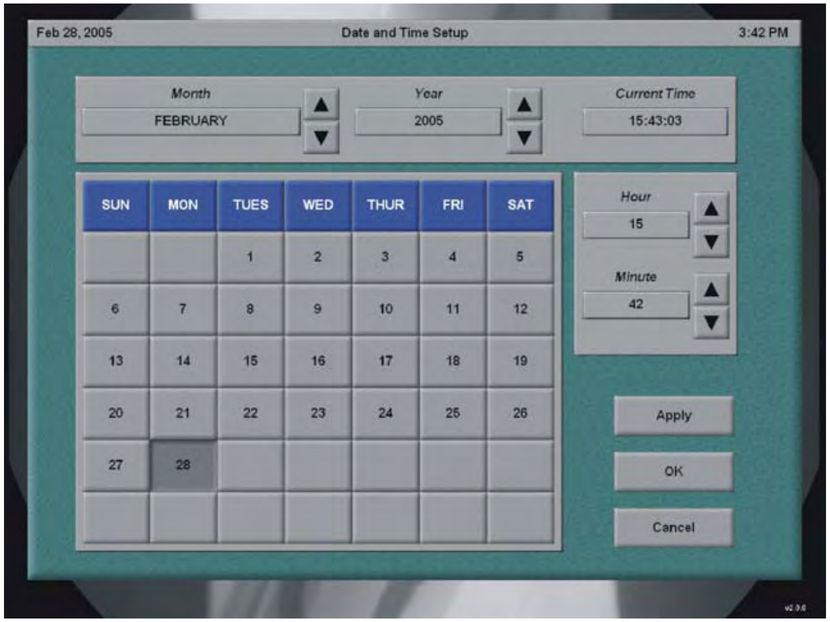


Figure 3C-24: Date and time setup window

3C.7.5 Receptor Symbols

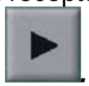
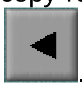
The current image receptor symbols may be replaced with predefined symbols chosen from the receptor symbols library or downloaded from an external device.

Each image receptor button will always select a predefined image receptor (i.e. table Bucky, wall Bucky, DR, etc.). Before changing the image receptor symbols, it must be clearly understood which image receptors are selected by each image receptor button. Each image receptor button should then have a logical and intuitive symbol assigned to that position.

Use these steps to change the receptor symbols.

Step	Action
1.	From the system utilities menu, press **Receptor Symbols**.
2.	A pop-up window will display (figure 3C-25) showing the image receptor buttons with the currently assigned symbols near the right side of the receptor symbols window, and the library of available receptor symbols near the left side of the window.
3.	Select the image receptor button for which the symbol is to be changed. The receptor numbers in figure 3C-25 correspond to the receptor numbers in GenWare®, and are shown for reference only.
4.	Select an appropriate symbol for the selected receptor from the symbols library. The selected symbol will be highlighted.
5.	Press  to assign the selected symbol to the selected image receptor button.
6.	Repeat steps 3 to 5 for each image receptor whose symbol is to be changed.
7.	Press **OK** to continue or **CANCEL** to return to the system utilities menu without making any changes. If **OK** was pressed, a pop-up window will display asking if you wish to save the changes. Press **YES** to save the changes. Press **NO** to return to the system utilities menu; **CANCEL** cancels the changes.
8.	To delete unused symbols from the receptor symbols library, select the symbol to be deleted. The selected symbol will be highlighted. • Press . • A pop-up window will display asking if you wish to delete the selected item. Press **YES** to delete the item; **NO** cancels the deletion. • DO NOT DELETE SYMBOLS YOU MAY WANT TO USE IN THE FUTURE.
9.	To copy receptor symbol files to and from a USB flash drive press  to access the **USB File Transfer Utility**

3C.7.5 Receptor Symbols (Cont)

Step	Action
10.	To copy a receptor symbol file from the touchscreen to a USB flash drive select the desired file from the **Touch Screen** window and press . Once the file has been successfully copied it will appear in the **USB Device** window.
11.	To copy receptor symbol files from a USB flash drive to the touchscreen select the desired file from the **USB Device** and press the . Once the file has been successfully copied it will appear in the **Touch Screen** window.
12.	When finished press **Close** to exit.

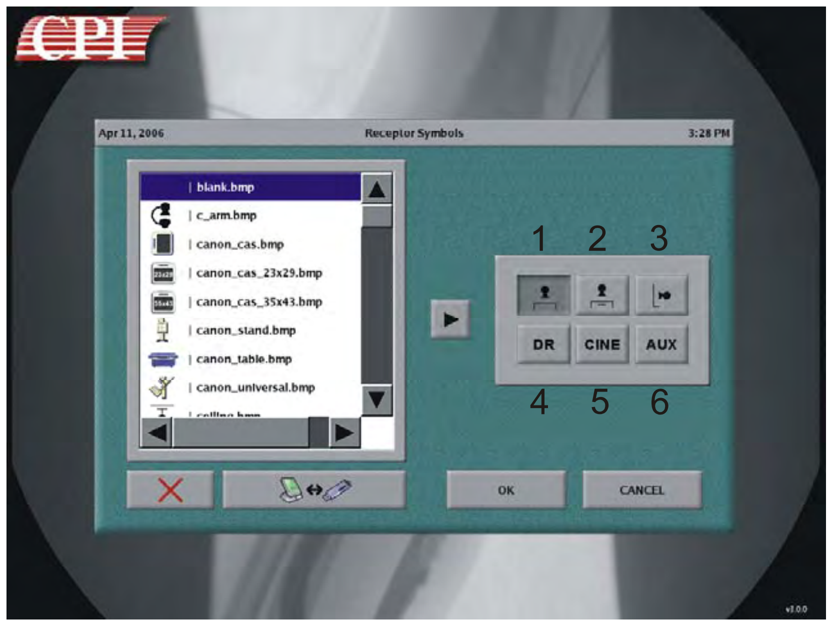


Figure 25: Receptor symbols window

3C.7.6 Touchscreen Setup

The touchscreen setup menu accesses submenus that allow the service engineer to perform the following functions:

- Enable or disable certain console functions (continuous fluoro tone, audible generator ready indication).
- Selection of date format (little or middle endian) for DAP / Air Kerma labels for SLP 440 printer.
- Set up serial communication ports COM 1 and COM 2 on the touchscreen console.
- Select the language for operator and error messages and graphics (i.e. on buttons, etc).
- Select the generator type.
- Select the customer code.
- Select the screen saver interval.
- Select the General Volume.
- Select the Exposure Volume.
- Select the LCD Brightness.
- Select the digital interface type.
- Change the operator and service passwords.

Use these steps to access the touchscreen setup menu.

Step	Action
1.	From the system utilities menu, press **Touch Screen Setup.**
2.	The touchscreen setup window will be displayed (figure 3C-26). This has three tabs, **SETTINGS**, **FEATURES**, and **PASSWORDS** that will be discussed in sequence.

3C.7.6 Touchscreen Setup (Cont)

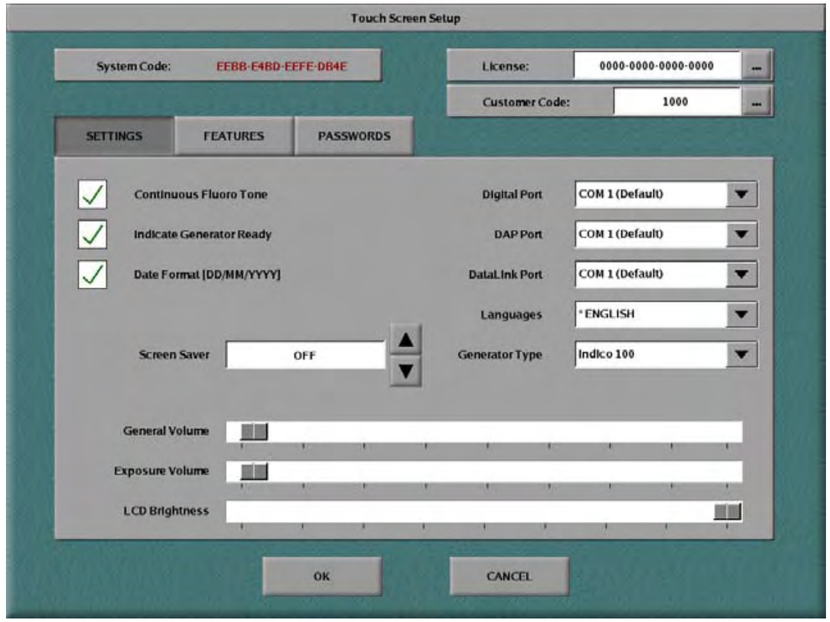


Figure 3C-26: TouchScreen setup window, Settings tab

- The **System Code** is a unique code assigned to each touchscreen on which the software is installed.
- The **License** is a code specifically assigned to each touchscreen. This enables options in the features tab. Please consult the factory to obtain a new license code if it is desired to enable new features, or to reinstall the existing license should the license code be accidentally overwritten.
- The **Customer Code** is a unique code assigned to each customer and selects the color scheme and graphic style (skin) to be displayed on the touchscreen console.

3C.7.6 Touchscreen Setup (Cont)

Settings

The functions near the left side of the settings window are enabled when checked (√).

FUNCTION	DESCRIPTION
Continuous Fluoro Tone	Sets the audio indicator mode during fluoroscopy. On (√): The exposure indicator beeps continuously during a fluoro exposure, at one-second intervals. Off: The exposure indicator beeps once at the start of a fluoro exposure, and once when the fluoro exposure ends.
Indicate Generator Ready	Enables / disables the audible generator ready sounds. On (√): A tone will sound when the generator is ready to make an exposure (while pressing the PREP button, or briefly before making an exposure while the X-RAY button is pressed). Off: A tone will not sound when the generator is ready to make an exposure. A text message only will be presented.
Date Format [DD/MM/YYYY]	This selects the date format for DAP / Air Kerma labels for the SLP 440 printer ***only***. On (√): Selects the date format DD/MM/YYYY (little endian). Off: Selects the date format MM/DD/YYYY (middle endian).

Use these steps to change the parameters on the settings tab.

Step	Action
1.	Program the functions defined in the table above by checking or unchecking the applicable item.
2.	Program the **Digital Port**. This selects the communication port for the optional digital interface i.e. the InfiMed imaging system.
3.	Program the **DAP Port**. This selects the communication port for the optional DAP printer.
4.	Program the **Data Link Port**. This selects the communication port for serial communication to a laptop for the *Data Link* function. **Note: To use the Data Link function the Data Link port must be selected in the touchscreen setup menu to match the serial port in which the null modem cable is connected.**
	Note: There are only two serial COM ports available for use on the touchscreen (COM 1 and COM 2). Therefore only two of the three available functions above may be connected at one time.

3C.7.6 Touchscreen Setup (Cont)

Step	Action
5.	Program the **Languages**. This selects the language for operator and error messages, and for text on the buttons, etc. Languages indicated with the prefix * will have all on-screen text fully translated into that language. Languages that are not indicated with the prefix * will have all on-screen text remain in English. However, the international keyboards will allow entry of the selected language.
6.	Select the **Generator Type**. The touchscreen will not properly communicate with the generator unless this is set correctly.
7.	Set the **Screen Saver Interval**. This sets the time from the last activity on the touchscreen until the screen saver is activated. Once the screen saver has been active for five minutes the **LCD Brightness** will decrease to 10%.
8.	Set the **General Volume** by dragging the slider to the left (lower) or right (louder). This sets the loudness of the button clicks.
9.	Set the **Exposure Volume** by dragging the slider to the left (lower) or right (louder). This sets the loudness of the exposure active tone.
10.	Set the **LCD Brightness** by dragging the slider left (dimmer) or right (brighter). This sets the brightness of the LCD display.
11.	Press **OK** to continue or **CANCEL** to return to the system utilities menu without making any changes. If **OK** was pressed, a pop-up window will display asking if you wish to save the changes. Press **YES** to save the changes. Press **NO** to return to the system utilities menu; **CANCEL** cancels the changes.

3C.7.6 Touchscreen Setup (Cont)

Features

Use these steps to select the digital functions.

Step	Action
1.	From the touchscreen setup window, select **FEATURES**. Available digital interfaces will be shown on this screen.

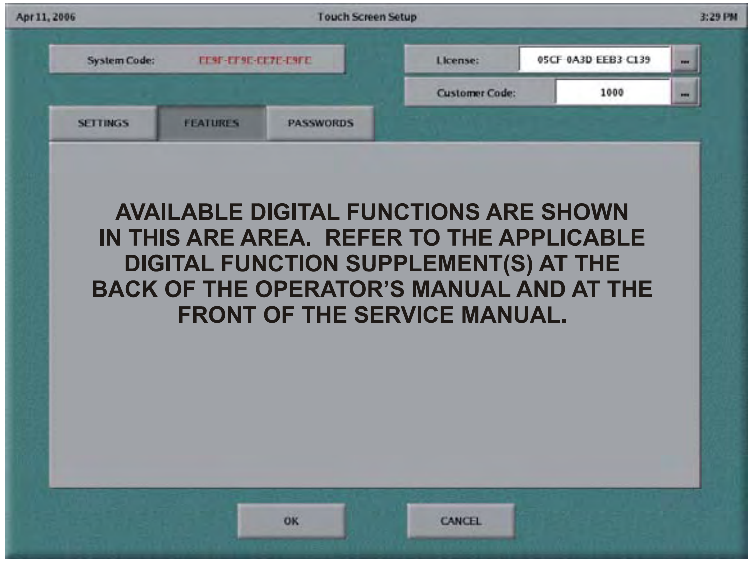


Figure 3C-27: TouchScreen setup window, Features tab

Step	Action
2.	Check the applicable item to enable that function.
3.	Press **OK** to continue or **CANCEL** to return to the system utilities menu without making any changes. If **OK** was pressed, a pop-up window will display asking if you wish to save the changes. Press **YES** to save the changes. Press **NO** to return to the system utilities menu; **CANCEL** cancels the changes.

3C.7.6 Touchscreen Setup (Cont)

Passwords

Use these steps to change the current operator and service passwords.

Step	Action
1.	From the touchscreen setup window, select **PASSWORDS**.
2.	To change the operator password, press the **…** button to the right of the top operator password line. A password window will pop up. Enter the new password. • Press **Clear** to cancel an incorrect entry. • Press **Cancel** to close the password pop-up window. • Press **Accept** to accept the new password.
3.	Repeat the previous step to enter the new password on the second operator password line.

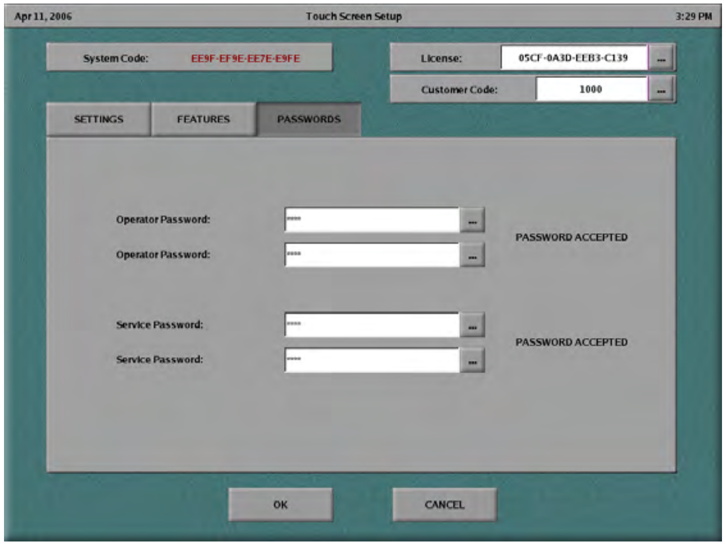


Figure 3C-28: TouchScreen setup window, Passwords tab

3C.7.6 Touchscreen Setup (Cont)

Step	Action
4.	Press **OK** to continue; **CANCEL** cancels the changes.
5.	A pop-up window will display asking if you wish to save the changes. Press **YES** to save the changes. Press **NO** to return to the system utilities menu; **CANCEL** cancels the changes.
	BE SURE TO RECORD THE NEW SERVICE PASSWORD BEFORE CHANGING THE FACTORY-DEFAULT PASSWORD. IF THE NEW PASSWORD IS SUBSEQUENTLY LOST, CONSULT THE FACTORY OR RE-INSTALL THE TOUCHSCREEN SOFTWARE IN ORDER TO RESTORE THE FACTORY-DEFAULT SERVICE PASSWORD.
6.	To change the service password, press the **…** button to the right of the top service password line. A password window will pop up. Enter the new password. • Press **Clear** to cancel an incorrect entry. • Press **Cancel** to close the password pop-up window. • Press **Accept** to accept the new password.
7.	Repeat the previous step to enter the new password on the second service password line.
8.	Press **OK** to continue; **CANCEL** cancels the changes.
9.	A pop-up window will display asking if you wish to save the changes. Press **YES** to save the changes. Press **NO** to return to the system utilities menu; **CANCEL** cancels the changes.

3C.7.7 Touchscreen Calibration

The touchscreen calibration function should be performed if touching the center of a buttons does not activate that function, i.e. if the touch-sensitive area appears displaced from the center of the corresponding icon.

Use these steps to perform the touchscreen calibration.

Step	Action
1.	From the **System Utilities** menu, press **Touch Screen Calibration**. Refer to the note at the end of this section if the touchscreen calibration is so far out that it does not acknowledge the touchscreen calibration request.
2.	A white screen with a cross-hairs target will appear in the top left corner of the display.
3.	Press the center of the target at the top left of the screen. This will set up the touch sensitive area in that quadrant.
4.	Repeat the previous step for the four remaining targets.
5.	Another white screen will appear with an **X** enclosed by a box in the top left corner and a 10 second timer in the center of the display.

3C.7.7 Touchscreen Calibration (Cont)

Step	Action
6.	Press the center of the target at the top left of the screen. This will verify the touch sensitive area in that quadrant.
7.	Repeat the previous step for the four remaining targets.
8.	If the calibration procedure was done properly you will be taken to the **System Utilities** menu. • If the calibration procedure was not done properly the calibration sequence will restart from the beginning allowing you to redo the touchscreen calibration.

NOTE: ***If the touchscreen calibration is out significantly and pressing buttons on the touchscreen does not provide the expected response, there are two shortcuts to entering the touchscreen calibration utility:***

1. Switch the touchscreen off, press SW1 on the back of the touchscreen, and then switch the console on. When the console has finished booting, a *Touch Screen Utilities* ***window will open stating that calibration will automatically start in 10 seconds. Press*** *OK* ***to initiate the calibration procedure.***

2. Connect a PC USB keyboard to one of the USBA ports on the rear of the touchscreen console, power up the touchscreen, and when the Main Menu is displayed press Alt-C to initiate the calibration procedure. No other buttons on the USB keyboard should be pressed as this may inadvertently cause corruption of the touchscreen software.

Follow the steps on the previous page to complete the touchscreen calibration.

3C.7.8 Data Link

This is used with the CPI PC GenWare® utility software. This allows for data communication with a computer in order to download additional tube types, transfer APR data, edit APR text, and for other minor functions. Further documentation is included with GenWare®.

A computer (i.e. laptop) and a 9 pin null modem cable with socket connectors (female) on both ends are required to run this software and interface to the generator.

NOTE: ***PC GenWare® should be closed before exiting the DATA LINK function on the console. Failure to do so may result in improper generator operation.***

3C.7.9 Configuration Backup / Restore

Use these steps to access the Configuration Backup and Restore function. This function backs up and restores the image receptor symbol assignment (Receptor Symbols) and the auto-positioner symbol assignment (Auto Position Symbols) if applicable.

Step	Action
1.	From the system utilities menu, press **Configuration Backup / Restore.** A pop-up window (figure 3C-29) will display showing the available backup files that are stored on the touchscreen console's internal CompactFlash card. Pressing **Close** will exit the backup and restore menu.
2.	Refer to the applicable subsections (following) for the procedures to back-up the current receptor / auto-position symbols, to restore the current receptor / auto-position symbols, and to upload and download receptor / auto-position symbols to and from a USB flash drive.

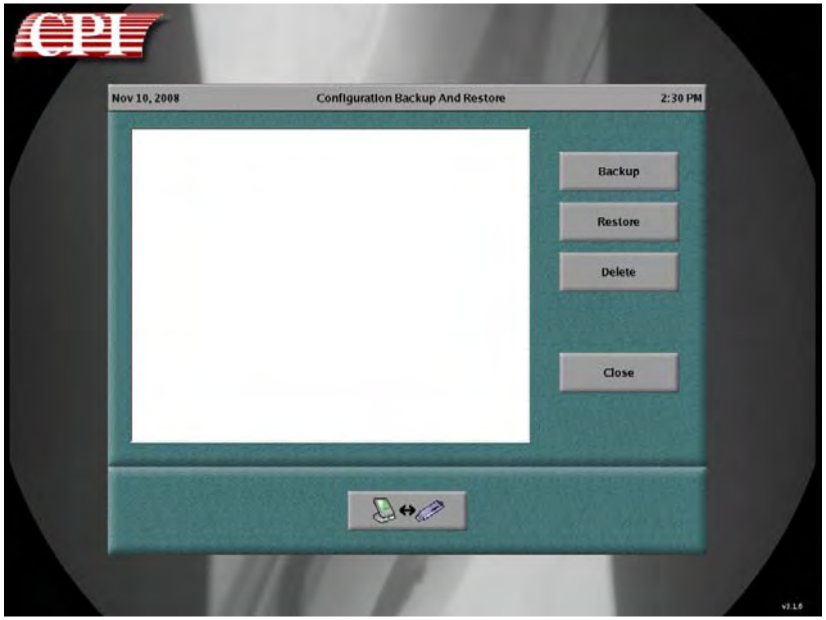


Figure 3C-29: Configuration back-up and restore window

3C.7.9 Configuration Backup / Restore (Cont)

To back-up current receptor / auto-position symbols.

Step	Action
3.	Press **Backup**.
4.	One or two keyboard(s) will display on the screen as described under APR Editor. • Type in the name of the new backup file. • Press **ENTER** when finished. The console will return to the configuration backup / restore menu, and the backed up file will be displayed in the **Configuration Backup And Restore** window.

To restore backed-up receptor / auto-position symbols.

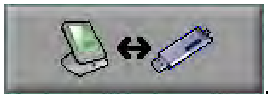
Step	Action
5.	Select the desired backup file from the configuration backup and restore menu. The selection will be highlighted.
6.	Press **Restore**.
7.	A pop-up window will briefly display indicating the file-restoration status. The file restoration is finished when the pop-up window closes.

To delete a receptor / auto-position symbols file.

Step	Action
8.	Select the backup file to be deleted. The selection will be highlighted.
9.	Press **Delete**. A pop-up window will display asking if you are sure you want to delete this file. Press **YES** to delete the file; **NO** cancels the deletion.

3C.7.9 Configuration Backup / Restore (Cont)

USB file transfer utility.

Step	Action
10.	The USB file transfer utility allows the configuration files on the touchscreen to be saved to a USB flash drive, or saved configuration files on a USB flash drive to be downloaded to the touchscreen.
11.	In order to use this feature a USB flash drive is required. Connect the USB flash drive to **USBA** on the rear of the touchscreen console and press . After a brief auto-detection sequence where the touchscreen looks for the USB flash drive, the **USB File Transfer Utility** window will open.

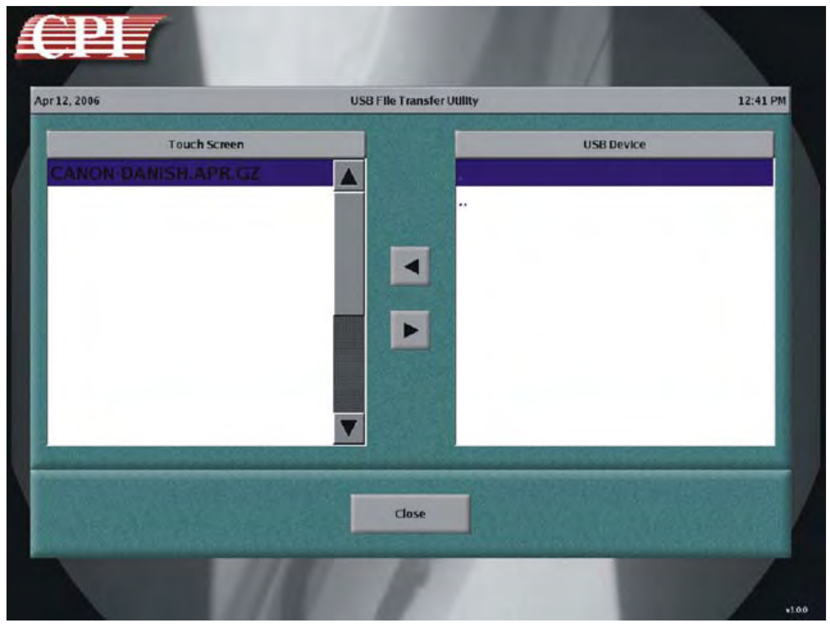
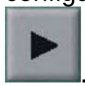
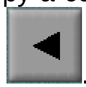


Figure 3C-30: USB File Transfer Utility window

3C.7.9 Configuration Backup / Restore (Cont)

Step	Action
12.	To copy a configuration file from the touchscreen to the USB flash drive, select the desired file from the **Touch Screen** window and press . Once the file is copied successfully it will appear in the **USB Device** window of the **USB File Transfer Utility**.
13.	To copy a configuration file from a USB flash drive to the touchscreen select the desired file from the **USB Device** window and press . Once the file is copied successfully it will appear in the **Touch Screen** window of the **USB File Transfer Utility**.
14.	When finished, press **Close** to exit.

3C.7.10 Touchscreen Console Firmware Upgrade / Restore

This feature allows you to upgrade or restore from backup the firmware in your touchscreen console. A USB flash drive or computer containing the upgrade / original files and a USB cable are required to perform this upgrade.

<u>NOTE</u>: ***PLEASE BACKUP ANY APR DATA TO A USB FLASH DRIVE BEFORE PERFORMING A TOUCHSCREEN FIRMWARE UPDATE. PLEASE SEE "APR BACKUP AND RESTORE - APR USB FILE TRANSFER UTILITY" IN THIS CHAPTER.***

TOUCHSCREEN CONSOLE UPGRADE PROCEDURE USING A USB FLASH DRIVE

Step	Action
1.	Insert a USB flash drive containing the upgrade firmware and press **SW1** on the back of the touchscreen. Switch the touchscreen on. When the touchscreen has finished booting, a **Touch Screen Utilities** window will open stating that calibration will automatically start in 10 seconds. Unless you need to calibrate the touchscreen, select **No**. For further information about touchscreen calibration, refer to ***Touchscreen Calibration*** in this chapter.
2.	A **System Information** screen will display containing details about the firmware on your touchscreen. Press **Next.**
3.	You will be taken to an **Upgrade Media Selection** window that will allow you to choose the method of loading (USB flash drive or computer). Select **Upgrade via a USB Memory Stick.** A pop-up window will display with a list of available firmware files (see figure 3C-31). **Note: The firmware file will always have the .cpm extension.** Select the desired firmware file and press **Open**.

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

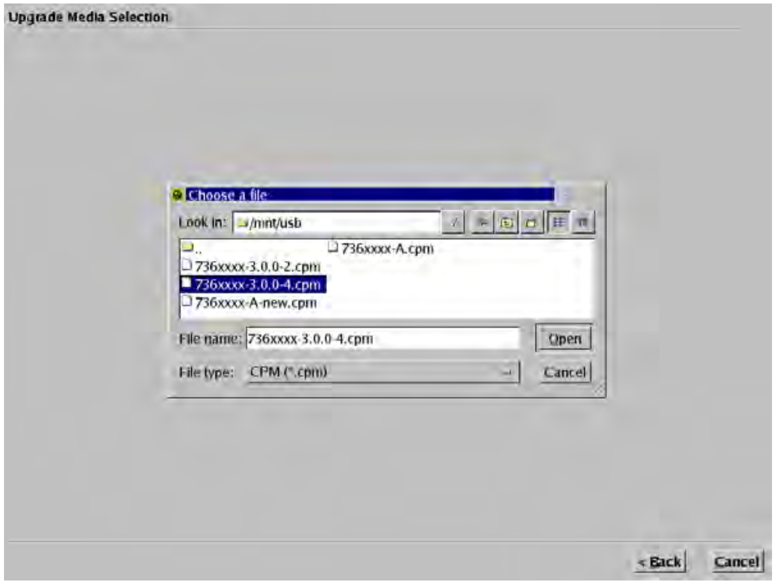


Figure 3C-31: Upgrade Media Selection window-'Choose a file' pop-up

Step	Action
4.	A **Checking for Available Updates** screen will display. It contains two windows: **Current Packets** and **Upgrade Packets** (see figure 3C-32). Select the desired packets from the Upgrade Packets window. Packets that require upgrading will already be selected. Press **Next**. ***Note: If no upgrade is available for the U-boot packet, it will not be available for selection. This is done to prevent software corruption should the touchscreen console inadvertently lose power.*** ***Note: Any Upgrade Packet that is of an earlier version than the one already installed will appear in red.***

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

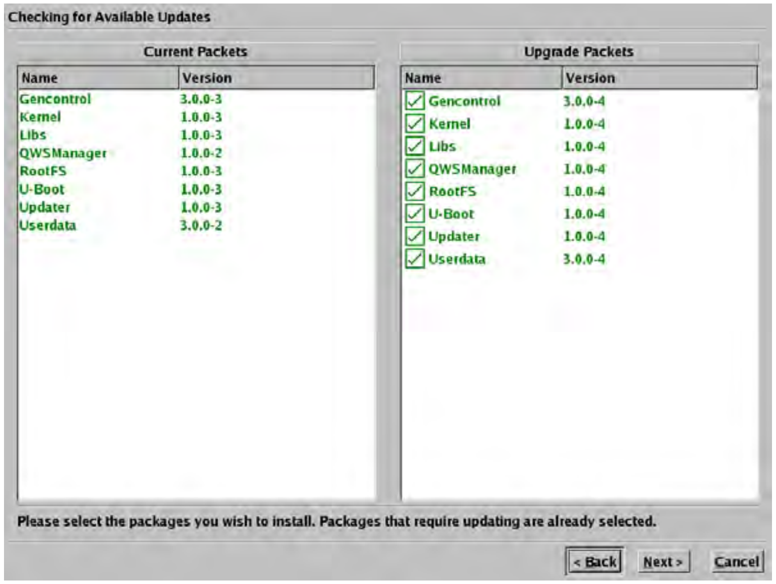


Figure 3C-32: Checking for Available Updates.

Step	Action
5.	The progress of the installation process will be shown on the **Updating Touch Screen** window. ***Note: In the event the upgrade should fail, the details of the error will be displayed in red at the bottom of the screen and a pop-up window will display asking if you would like to retry or abort the upgrade. The cause of the failure should be determined before retrying the upgrade.***
6.	Once the installation process is finished a pop-up window will display stating: **It is very important that you do not disturb this process** (see figure 3C-33)**.** The flash memory is being erased and reloaded with the upgraded firmware.

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

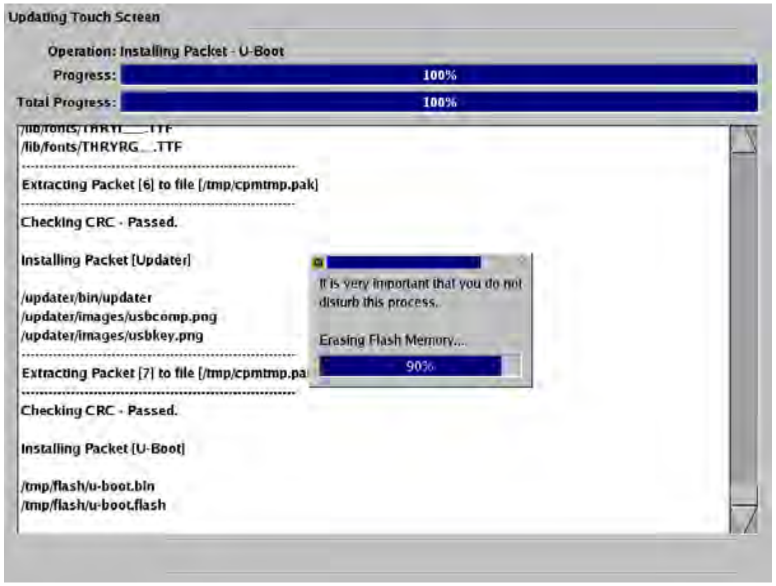


Figure 3C-33: Erasing Flash memory pop-up window

Step	Action
7.	Once the update is complete, a pop-up window will display indicating **Upgrade Complete**. Press **OK**.

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

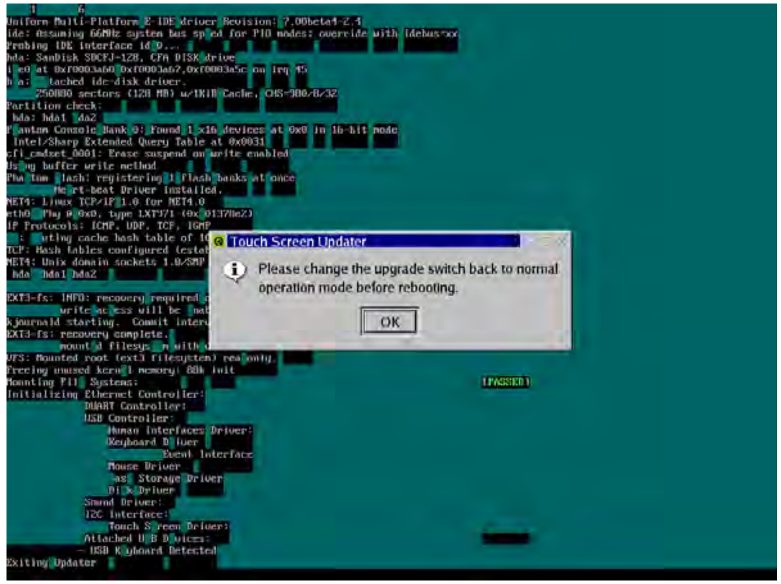


Figure 3C-34: Change the upgrade switch pop-up window

Step	Action
8.	The touchscreen will exit the **Updating Touch Screen** window and you will be prompted to **Please change the upgrade switch back to normal operation mode before rebooting** (see figure 3C-34)**.** Press the upgrade switch (SW1) on the back of the touchscreen console and then select **OK**. The touchscreen will reboot and you will be taken back to the main menu.

TOUCHSCREEN CONSOLE UPGRADE PROCEDURE USING A COMPUTER AND USB CABLE

> ***NOTE*: A COMPUTER, HOST-TO-DEVICE USB CABLE AND CPI TOUCHSCREEN UPDATER PROGRAM ARE REQUIRED FOR THIS PROCEDURE.**

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

NOTE: PLEASE ENSURE ALL RELEVANT UPGRADE FILES ARE SAVED IN AN APPROPRIATE LOCATION ON YOUR COMPUTER.

Step	Action
1.	Connect a host-to-device USB cable to any one of COM 1 to COM 4 on a laptop computer and to USBB on the back of the touchscreen and press **SW1** on the back of the touchscreen. Switch on the touchscreen. When the touchscreen has finished booting, a **Touch Screen Utilities** window will open stating that calibration will automatically start in 10 seconds. Unless you need to calibrate the touchscreen, select **No**. For further information about touchscreen calibration, refer to ***Touchscreen Calibration*** in this chapter.
2.	A **System Information** screen will display containing details of the firmware that is loaded on your touchscreen console. Press **NEXT**. This will take you to the **Upgrade Media Selection** window.
3.	Launch CPI Touch Screen Updater (see figure 3C-35) from your computer and click the **START** button.

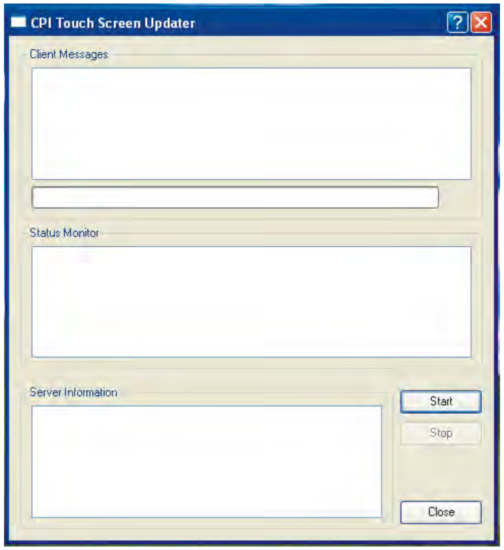


Figure 3C-35: CPI Touch Screen Updater

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

Step	Action
4.	A pop-up window entitled **ServerApp** will open (see figure 3C-36). Locate and select the desired upgrade file and press **OK**. **Note: All upgrade files will have the cpm extension.**

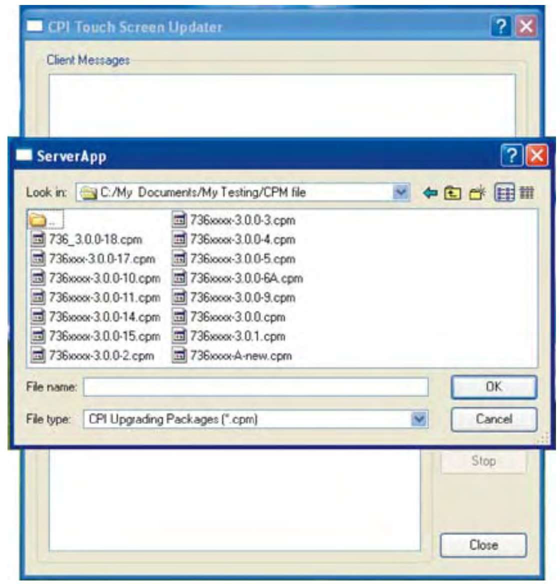


Figure 3C-36: CPI Touch Screen Updater - ServerApp screen

Step	Action
5.	Another pop-up window will open entitled **Select Communication Media**. Select **USB** from the **Media Types** section. Do not alter the **Media Config** section in any way. It is set automatically.

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

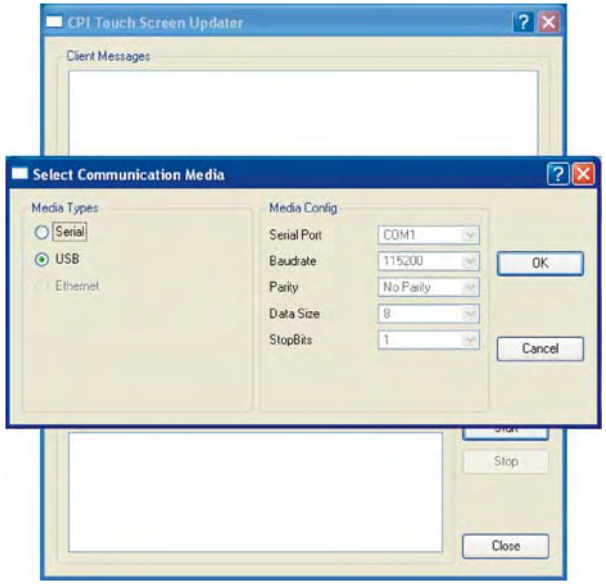


Figure 3C-37: CPI Touch Screen Updater - Select Communication Media screen

Step	Action
6.	Once the communication media is selected, the file path, version and media information will appear in the **Server Information** window of the CPI Touch Screen Updater.
7.	From the **Upgrade Media Selection** window select **Upgrade via a USB to Computer Connection**.
8.	The CPI Touch Screen Updater will read the available firmware packets (see figure 3C-38).

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

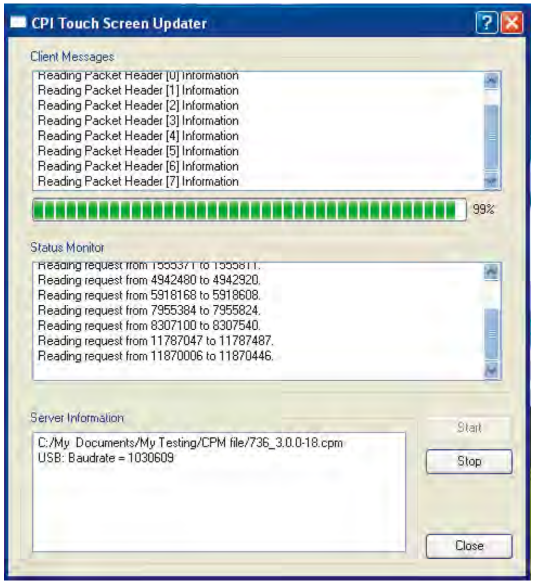


Figure 3C-38: CPI Touch Screen Updater (after Upgrade Media is selected)

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

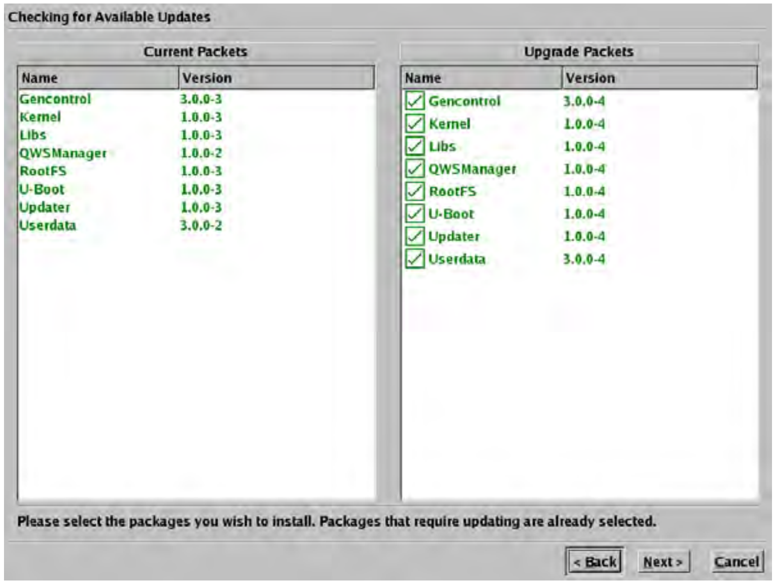


Figure 3C-39: Checking for Available Updates.

Step	Action
9.	A list of current and available upgrade packets will be listed on the touchscreen console in the **Checking for Available Updates** screen. Select the packets you wish to install by touching the box next to the packet such that a check is placed inside the box (as shown in Figure 3C-39). Please note that packets that require updating will already be selected. Press **NEXT**. ***Note: If no upgrade is available for the U-boot packet, it will not be available for selection. This is done to prevent software corruption should the touchscreen console inadvertently lose power.*** ***<u>NOTE</u>: ANY UPGRADE PACKET THAT IS OF AN EARLIER VERSION OF THE ONE ALREADY INSTALLED WILL APPEAR IN RED.***

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

Step	Action
10.	The progress of the installation will be shown on the **Updating Touch Screen** window. ***NOTE: IN THE EVENT THE UPGRADE SHOULD FAIL, THE DETAILS OF THE ERROR WILL BE DISPLAYED IN RED AT THE BOTTOM OF THE SCREEN AND A POP-UP WINDOW WILL DISPLAY ASKING IF YOU WOULD LIKE TO RETRY OR ABORT THE UPGRADE. THE CAUSE OF THE FAILURE SHOULD BE DETERMINED BEFORE RETRYING THE UPGRADE.***
11.	Once the installation process is finished, a pop-up window will display stating: **It is very important that you do not disturb this process** (see figure 3C-40)**.** The flash memory is being erased and reloaded with the upgraded firmware.

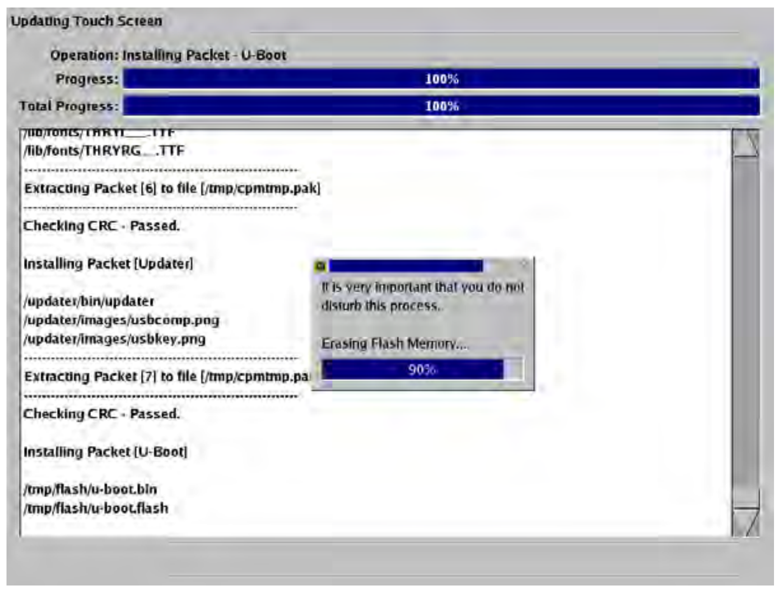


Figure 3C-40: Erasing Flash memory pop-up window

3C.7.10 Touchscreen Console Firmware Upgrade / Restore (Cont)

Step	Action
12.	Once the upgrade is complete, a pop-up window will display indicating **Upgrade Complete**. Press **OK**.

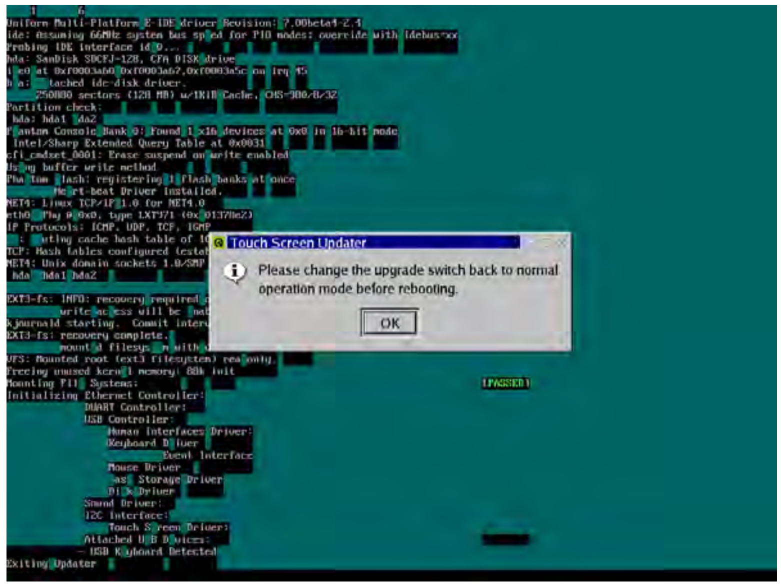


Figure 3C-41: Change the upgrade switch pop-up window

Step	Action
13.	The touchscreen will exit the **Updating Touch Screen** window and you will be prompted to **Please change the upgrade switch back to normal operating mode before rebooting**. Press the upgrade switch (SW1) on the back of the touchscreen console and then select **OK.** The touchscreen will reboot and you will be taken back to the **Main Menu.**

3C.7.11 Generator Configuration Backup and Restore

NOTE: ***A PERMANENT BACKUP FILE OF THE GENERATOR CONFIGURATION (RECEPTOR SETUP, FLUORO SETUP, AEC SETUP AND CALIBRATION, ABS SETUP AND CALIBRATION, ETC,) SHOULD BE KEPT IN THE EVENT THE GENERATOR SOFTWARE IS CORRUPTED OR A "FACTORY DEFAULTS" IS REQUIRED. THE BACKUP FILE SHOULD BE STORED ON AN EXTERNAL STORAGE DEVICE, SUCH AS A LAPTOP OR USB FLASH DRIVE.***

NOTE: ***ENSURE THERE IS AN EXTERNAL USB DEVICE CONNECTED TO THE TOUCHSCREEN CONSOLE USING ONE OF THE TWO AVAILABLE USBA PORTS AT THE REAR OF THE TOUCHSCREEN CONSOLE.***

Figure 3C-42: Generator Configuration Backup and Restore utility

Step	Action
1. 1	Touchscreen Genware® must be launched before proceeding. This is done from the Genware® button on the touchscreen **System Utilities** menu.
2.	Press the  button to launch the **Backup and Restore** utility.

Use and disclosure is subject to the restrictions on the title page of this CPI document.

3C.7.11 Generator Configuration Backup and Restore (Cont)

Step	Action
3.	To exit the **Backup and Restore** utility, press **Close**.

To create a new backup file.

1.	Press the **Backup** button.
2.	Use the keyboard displayed to enter a name for the backup file you wish to create into the **Backup File Name** window. Note that the keyboard will only become active after the **Backup** button is pressed.
3.	The newly created backup file will be saved on the touchscreen compact flash card and will appear in the **Touch Screen** window.

To restore a previously saved backup file to the generator

Note: ***Backup files can only be restored from the Touch Screen window. If the desired backup file resides on the USB flash it must be copied to the touchscreen before restoration. Please see "To copy a backup file from a USB device".***

1.	Select the desire backup file from the **Touch Screen** window.
2.	Press the **Restore** button.

To copy a backup file to a USB device

1.	Select the desire backup file from the **Touch Screen** window.
2.	Press the  button to save the file to the USB device.
3.	The copied file will appear in the **USB Device** window.

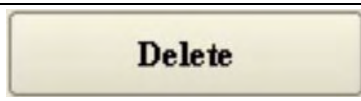
3C.7.11 Generator Configuration Backup and Restore (Cont)

To copy a backup file from a USB device

1.	Select the desired file from the **USB Device** window.
2.	Press the  button to save the file to the touchscreen compact flash card.
3.	The copied file will appear in the **Touch Screen** window.

To delete a backup file

<u>Note</u>: Backup files can only be deleted from the Touch Screen window. If you wish to delete a backup file stored on a USB device, copy it to the touchscreen first. Please see "To copy a backup file from a USB device".

1.	Select the desired file from the **Touch Screen** window.
2.	Press the  button to delete the file from the touchscreen.
3.	The file will be removed from the **Touch Screen** window.

3C.8.0 CONSOLE TEST MODE

A console diagnostics mode is available in the 31 X 42 (cm) console for Indico 100. This tests the CPU and associated components, the LED's and display drivers, and the selector buttons and input buffers.

This mode is only available with 31 X 42 cm consoles when running the console software from flash memory. Refer to the section **Console Software / EPROM** ***in chapter 6 for details.***

If the console software has been updated and is running from EPROM, the console diagnostics mode will be available by temporarily selecting the **FLASH BOOT** ***position as described in chapter 6. If doing so, please ensure that the*** **EPROM BOOT** ***position is selected when finished.***

- To enter this special mode, press and hold button **5** (figure 3C-1) while pressing the generator POWER ON button.
- The part number and revision of the boot loader software will be displayed for approximately 5 seconds after power-up.
- A special utility menu will be entered next, with the following options.
  - **CONSOLE TEST** — This is a basic console diagnostic test, which tests the functions described above.
  - **FLASH LOAD** — This utility is used to load the operating software into flash memory. ***DO NOT SELECT THIS OPTION UNLESS YOU INTEND TO REPROGRAM THE FLASH MEMORY. YOU MUST HAVE THE REQUIRED EQUIPMENT AVAILABLE TO DO SO, ALONG WITH UPGRADED CONSOLE SOFTWARE.***

    CONTINUING WILL ERASE THE FLASH MEMORY, DISABLING THE CONSOLE.
  - **MAIN APPLICATION** — Returns to the normal operating mode (non setup / programming mode).

3C.8.0 CONSOLE TEST MODE (Cont)

Use these steps to perform the **CONSOLE TEST**.

Step	Action
1.	From the special **UTILITY MENU,** select **CONSOLE TEST**.
2.	The logo will be displayed for several seconds in normal video, and then in reverse video. The LCD contrast may be adjusted at this time.
3.	After the logo display is finished, a prompt is displayed asking if you wish to test the RAM. Press **YES** or **NO** to proceed with the RAM test. ***Testing the RAM by pressing YES will erase the contents of the RAM. If the RAM is erased, you will need to restore the console defaults, and use GenWare® to restore the APR data.***
4.	At the prompt **ARE YOU DOING ESS?**, press **NO**.
5.	A serial loop back test is performed next. Pressing **START** to test ch. A will test serial channel A (the port connected to J5, the generator interface).
6.	Testing serial channel B (the port connected to J2, the data link) requires a special loop back connector. This may be made by simply connecting a wire jumper from pin 2 to pin 3 of a 9 pin female "D" connector. Plug this "loop back" connector into J2 on the console for this test. Press **START** if using a loop back connector. Press **SKIP** to omit this test if a loop back connector is not available.
7.	The 7 segment LEDs in the radiographic and fluoroscopic display window are tested next. The individual segments of the first LED will be lit in sequence. Confirm that only one segment lights at one time on the LED being tested. If all segments plus the decimal point light sequentially on the first LED being tested, press **PASSED** to test the next LED.
8.	Repeat step 7 to test all 7 segment LEDs.
9.	The backlight LEDs for the radiographic kV, mAs, mA, etc indicators are lit next. The term "EYE" on the LCD display refers to the X-ray exposure indicator, which should light during this sequence. Press **PASSED** when finished this test.
10.	The backlight LEDs for the fluoroscopic ABS, kV, mA, etc indicators are lit next. The term "REMOTE" on the LCD display refers to the optional remote fluoro control, which is also tested at this time, if fitted. Press **PASSED** when finished this test.
11.	The image receptor LEDs and the prep LED are tested next. Press **PASSED** when finished this test.
12.	The technique selector LEDs, focus, and film screen LEDs are tested next. Press **PASSED** when finished this test.
13.	The fluoro magnification, dose, ABS, pulsed fluoro, fluoro exposure, and AEC field select LEDs are tested next. Press **PASSED** when finished this test.
14.	All LEDs and displays are lit next. Press **YES** or **NO** when finished this test.

3C.8.0 CONSOLE TEST MODE (Cont)

Step	Action
15.	All LEDs and displays are turned off next. Press **YES** or **NO** when finished this test.
16.	The buttons on the console are tested next. Press each button as prompted.
17.	The external prep and external X-ray buttons (hand switch) are tested next. Press the hand switch as requested. If no hand switch is used, the console prep and X-ray button may be pressed at the "external" prep and exposure prompt.
18.	The fluoro foot switch is tested next. Press the foot switch if applicable, press **SKIP** if a foot switch is not used.
19.	The console prep and X-ray buttons are tested next. Press each button as prompted.
20.	Speaker 1 is tested next. The speaker volume will continuously be ramped from 1 (low) to 8 (maximum). Press **PASSED** when finished this test.
21.	Speaker 2 is tested next. The speaker volume will continuously be ramped from 1 (low) to 8 (maximum). Press **PASSED** when finished this test.
22.	This completes the console self test. Note any tests that failed, and discontinue use of the suspected faulty equipment until repairs are made.

CHAPTER 3D

AEC SETUP AND CALIBRATION

CONTENTS:

3D.1.0 INTRODUCTION

This chapter describes interfacing and setup / calibration of the various AEC board assemblies that are used in Indico 100 X-ray generators. Depending on the application and the AEC board that is fitted, the following types of inputs may be used:

MEDIA	AEC CHAMBER / PICKUP TYPE
Film	Ion or solid-state AEC chamber.
Digital imaging system	PMT (universal AEC board only) or photo diode.

THIS X-RAY GENERATOR IS FACTORY CONFIGURED TO BE COMPATIBLE WITH SPECIFIC AEC DEVICE(S). REFER TO THE COMPATIBILITY STATEMENT AT THE FRONT OF THIS MANUAL FOR THE FACTORY CONFIGURED AEC COMPATIBILITY OF THIS GENERATOR.

A SET OF AEC COMPATIBILITY MATRICES IS LOCATED AT THE FRONT OF THIS MANUAL. EACH AEC BOARD HAS A CORRESPONDING AEC COMPATIBILITY MATRIX, I.E. FOR AEC BOARD 734614-XX, USE AEC COMPATIBILITY MATRIX SUP73461400.

THE AEC COMPATIBILITY MATRICES LIST THE AEC CHAMBERS / PREAMPLIFIERS THAT EACH VERSION OF AEC BOARD IS COMPATIBLE WITH, AND THEY ALSO SHOW THE I/O PIN CONNECTIONS AND THEIR FUNCTIONS, AS WELL AS RELATED NOTES.

This chapter contains background information that is relevant to AEC operation. This is located at the back of this chapter, and should be understood before beginning AEC calibration.

3D.2.0 WIRING THE AEC PICKUP DEVICE TO THE GENERATOR

1. Note the part number that is printed on the AEC board in the generator.
2. Connect the AEC device to the AEC board as per 3D.2.1 to 3D.2.5. Supplementary information is in the AEC compatibility matrixes.
3. If you are using a PMT or photo diode for AEC in conjunction with a digital imaging system, refer to the section ***ABS / AEC PICKUP INSTALLATION / WIRING*** in chapter 3E (R&F generators only).

3D.2.1 AEC Board (Solid State Chambers)

The AEC board shown below is compatible with various makes / models of solid-state chambers as per AEC compatibility matrix SUP73799200.

This board will be fitted with 6 pin circular connectors (J1 to J4) or with 7 pin in-line connectors (J11 to J14), depending on the application.

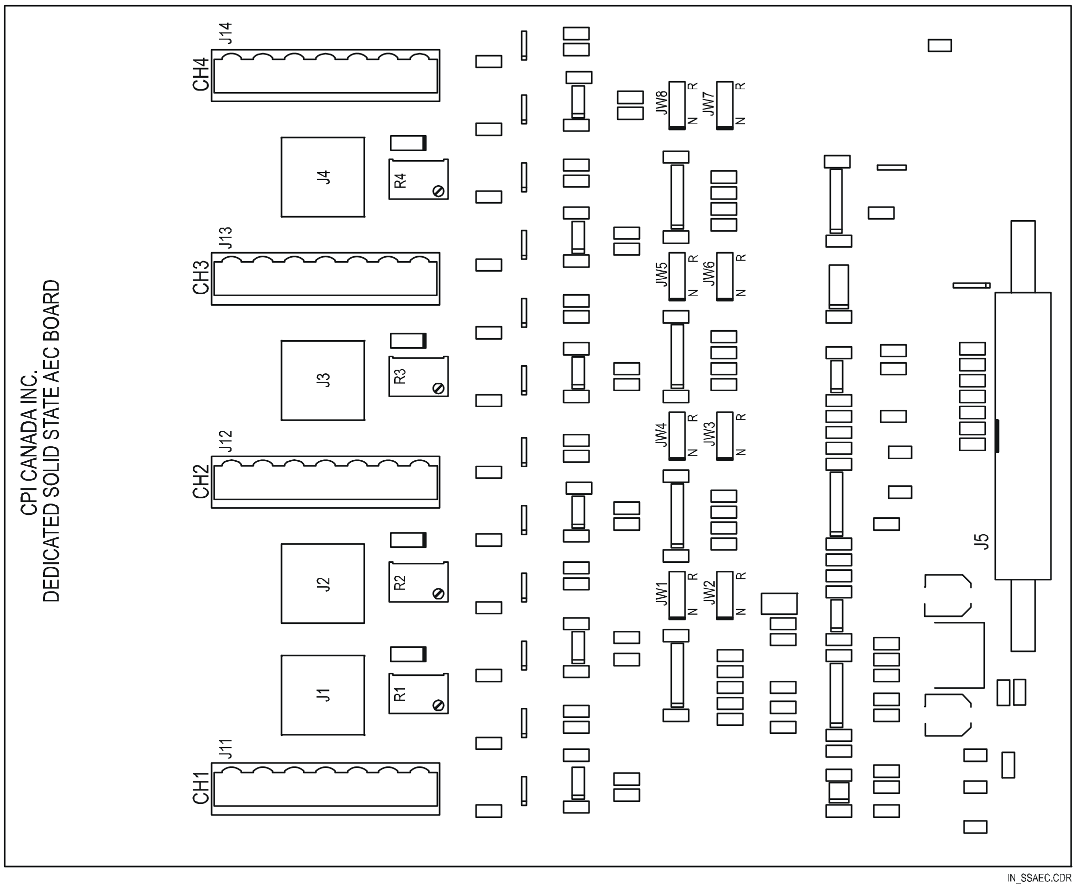


Figure 3D-1: Dedicated solid-state AEC board (assembly 737992)

<u>NOTE:</u> WHEN PERFORMING THE INITIAL AEC SETUP (SECTION 3D.4.0), THE CHAMBER TYPE MUST BE SET TO ION FOR THIS BOARD.

AEC board input assignment (examples only, actual receptor assignments may vary):

- Ch 1 = J1 / J11 - Table Radiographic Bucky.
- Ch 2 = J2 / J12 - Vertical Wall Bucky.
- Ch 3 = J3 / J13 - Spot Film Device.
- Ch 4 = J4 / J14 - Aux. (Extra Bucky, Digital Acquisition, etc).

3D.2.1 AEC Board (Solid State Chambers) Cont

The following potentiometers are used for AEC gain adjustment:

- **R1** is used for channel 1 gain adjustment.
- **R2** is used for channel 2 gain adjustment.
- **R3** is used for channel 3 gain adjustment.
- **R4** is used for channel 4 gain adjustment.

Tables 3D-1 and 3D-2 show the pin outs for both the 6 pin circular connectors and for the 7 pin in-line connectors on the AEC board in figure 3D-1.

FUNCTION	PIN
Anode, right (refer to note below)	3
Cathode, right (refer to note below)	4
Anode, middle	1
Cathode, middle	6
Anode, left (refer to note below)	2
Cathode, left (refer to note below)	5
Ground	Connector shell

Table 3D-1: Pin outs for 6 pin circular connector J1 to J4

FUNCTION	PIN
Anode, right (refer to note below)	1
Cathode, right (refer to note below)	2
Anode, middle	3
Cathode, middle	4
Anode, left (refer to note below)	5
Cathode, left (refer to note below)	6
Ground	7

Table 3D-2: Pin outs for 7 pin in-line connector J11 to J14

NOTE:

Jumpers JW1 to JW8 swap the left and right fields from J1 to J4 and J11 to J14 as per the table below.

CHANNEL	LEFT / RIGHT FIELDS AS PER TABLES 3D-1, 3D-2	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLES 3D-1, 3D-2
1	Jumper JW1, JW2 pins 1-2 (N)	Jumper JW1, JW2 pins 2-3 (R)
2	Jumper JW3, JW4 pins 1-2 (N)	Jumper JW3, JW4 pins 2-3 (R)
3	Jumper JW5, JW6 pins 1-2 (N)	Jumper JW5, JW6 pins 2-3 (R)
4	Jumper JW7, JW8 pins 1-2 (N)	Jumper JW7, JW8 pins 2-3 (R)

3D.2.2 AEC Board (Ion Chambers)

The AEC board shown below is compatible with various makes / models of ion chambers as per AEC compatibility matrix SUP73461400.

This board will be fitted with 9 pin D connectors (J11 to J14), or with 12 pin in-line connectors (J1 to J4), depending on the application.

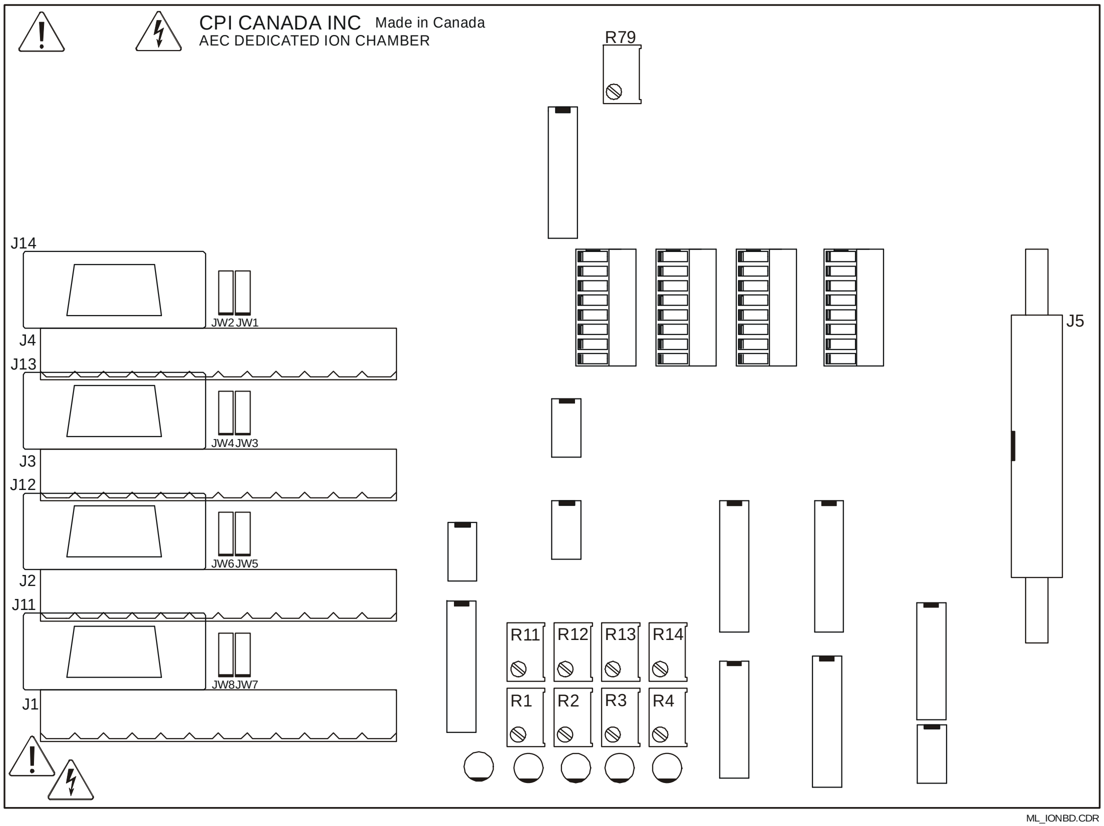


Figure 3D-2: Dedicated ion chamber AEC board (assembly 734614)

AEC board input assignment (examples only, actual receptor assignments may vary):

- Ch 1 = J1 / J11 - Table Radiographic Bucky.
- Ch 2 = J2 / J12 - Vertical Wall Bucky.
- Ch 3 = J3 / J13 - Spot Film Device.
- Ch 4 = J4 / J14 - Aux. (Extra Bucky, Digital Acquisition, etc).

The following potentiometers are used for AEC gain adjustment:

- **R1** is used for channel 1 gain adjustment.
- **R2** is used for channel 2 gain adjustment.
- **R3** is used for channel 3 gain adjustment.
- **R4** is used for channel 4 gain adjustment.

3D.2.2 AEC Board (Ion Chambers) Cont

The following potentiometers are used for short AEC exposure time compensation:

- **R11** is used for channel 1 short exposure time compensation.
- **R12** is used for channel 2 short exposure time compensation.
- **R13** is used for channel 3 short exposure time compensation.
- **R14** is used for channel 4 short exposure time compensation.

R79 adjusts the output of the high voltage bias supply. This is only fitted on versions of this board intended for use with ion chambers that require a separate high voltage bias supply. R79 adjusts the value of the +300 / +500 VDC, and the +45 VDC outputs, and should be set as per the ion chamber manufacturer specifications.

Tables 3D-3 and 3D-4 show the pin outs for both the 9 pin D connectors and for the 12 pin in-line connectors on the AEC board in figure 3D-2. The 9 pin connectors are compatible with most models of AID ionization chambers. However, the installer should verify compatibility of the pin outs with the chamber(s) being used.

FUNCTION	PIN	NOTE
+300 VDC output	1	Only provided on configurations of this board that require the +300 VDC output.
Left field select (refer to note below)	2	
Middle field select	3	
Reset / start	4	
Chamber output	5	
Right field select (refer to note below)	6	
-12 VDC output	7	
+12 VDC output	8	
Ground	9	

Table 3D-3: Pin outs for 9 pin D connector (J11 to J14)

NOTE:

Jumpers JW1 to JW8 swap the left and right fields on J11 to J14 as per the table below.

CHANNEL	LEFT / RIGHT FIELDS AS PER TABLE 3D-3	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLE 3D-3
1	Jumper JW7, JW8 pins 1-2	Jumper JW7, JW8 pins 2-3
2	Jumper JW5, JW6 pins 1-2	Jumper JW5, JW6 pins 2-3
3	Jumper JW3, JW4 pins 1-2	Jumper JW3, JW4 pins 2-3
4	Jumper JW1, JW2 pins 1-2	Jumper JW1, JW2 pins 2-3

3D.2.2 AEC Board (Ion Chambers) Cont

FUNCTION	PIN	NOTE
+500 VDC output	1	The +500, + or -300, and +45 VDC outputs are only provided on configurations of this board designed to interface to ion chambers requiring these voltage outputs. +12, -12, -24 VDC outputs are typically used as the DC supply for a pre-amplifier, often part of the ion chamber.
+ or - 300 VDC output	2	
+45 VDC output	3	
+12 VDC output	4	
-12 VDC output	5	
-24 VDC output	6	
Ground	7	
Reset / start	8	
Right field select	9	
Middle field select	10	
Left field select	11	
Chamber output	12	

Table 3D-4: Pin outs for 12 pin in-line connector (J1 to J4)

3D.2.3 AEC Board (Ion Chambers)

The AEC board shown below is compatible with various models of ion chambers as per AEC compatibility matrix SUP73799800.
This board is fitted with 9 pin D connectors J1 to J4.

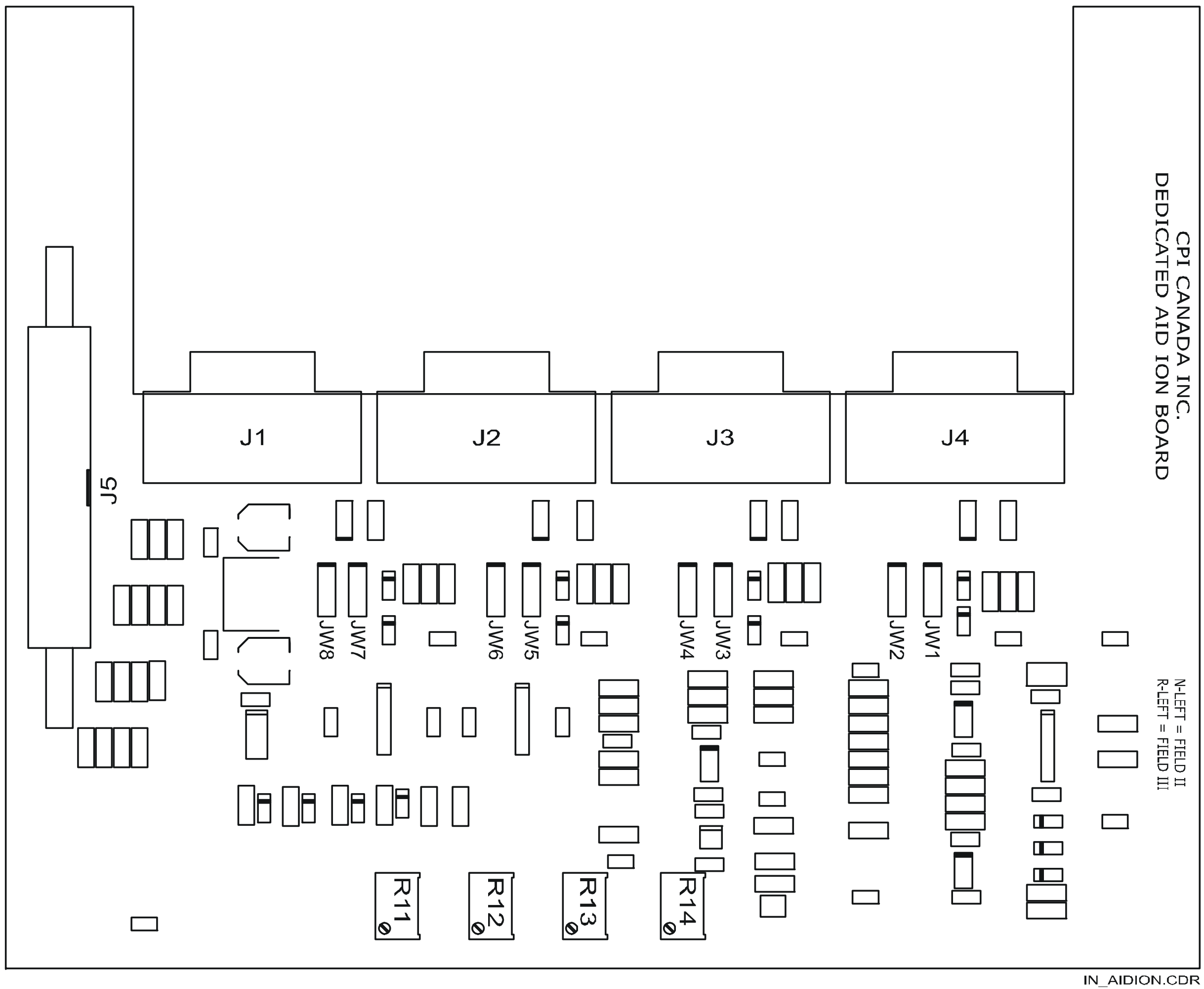


Figure 3D-3: Dedicated ion chamber AEC board (assembly 737998)

AEC board input assignment (examples only, actual receptor assignments may vary):

- Ch 1 = J1 - Table Radiographic Bucky.
- Ch 2 = J2 - Vertical Wall Bucky.
- Ch 3 = J3 - Spot Film Device.
- Ch 4 = J4 - Aux. (Extra Bucky, Digital Acquisition, etc).

The following potentiometers are used for AEC gain adjustment:

- **R11** is used for channel 1 gain adjustment.
- **R12** is used for channel 2 gain adjustment.
- **R13** is used for channel 3 gain adjustment.
- **R14** is used for channel 4 gain adjustment.

3D.2.3 AEC Board (Ion Chambers) Cont

Table 3D-5 shows the pin outs for the 9 pin D connectors on the AEC board in figure 3D-3. The 9 pin connectors are compatible with most models of AID ionization chambers. However, the installer should verify compatibility of the pin outs with the chamber(s) being used.

FUNCTION	PIN	NOTE
Not used	1	
Left field select (refer to note below)	2	See note below.
Middle field select	3	
Reset / start	4	
Chamber output	5	
Right field select (refer to note below)	6	See note below.
-12 VDC output	7	
+12 VDC output	8	
Ground	9	

Table 3D-5: Pin outs for 9 pin D connector (J1 to J4)

NOTE:

Jumpers JW1 to JW8 swap the left and right fields on J1 to J4 as per the table below.

CHANNEL	LEFT / RIGHT FIELDS AS PER TABLE 3D-5	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLE 3D-5
1	Jumper JW7, JW8 pins 1-2 (N)	Jumper JW7, JW8 pins 2-3 (R)
2	Jumper JW5, JW6 pins 1-2 (N)	Jumper JW5, JW6 pins 2-3 (R)
3	Jumper JW3, JW4 pins 1-2 (N)	Jumper JW3, JW4 pins 2-3 (R)
4	Jumper JW1, JW2 pins 1-2 (N)	Jumper JW1, JW2 pins 2-3 (R)

3D.2.4 AEC Board (5-Field Ion Chambers)

The AEC board shown below is designed for use with various three-of-five-field ion chambers as per AEC compatibility matrix SUP73938900.

This board is fitted with 15 pin D connectors J1 and J2.

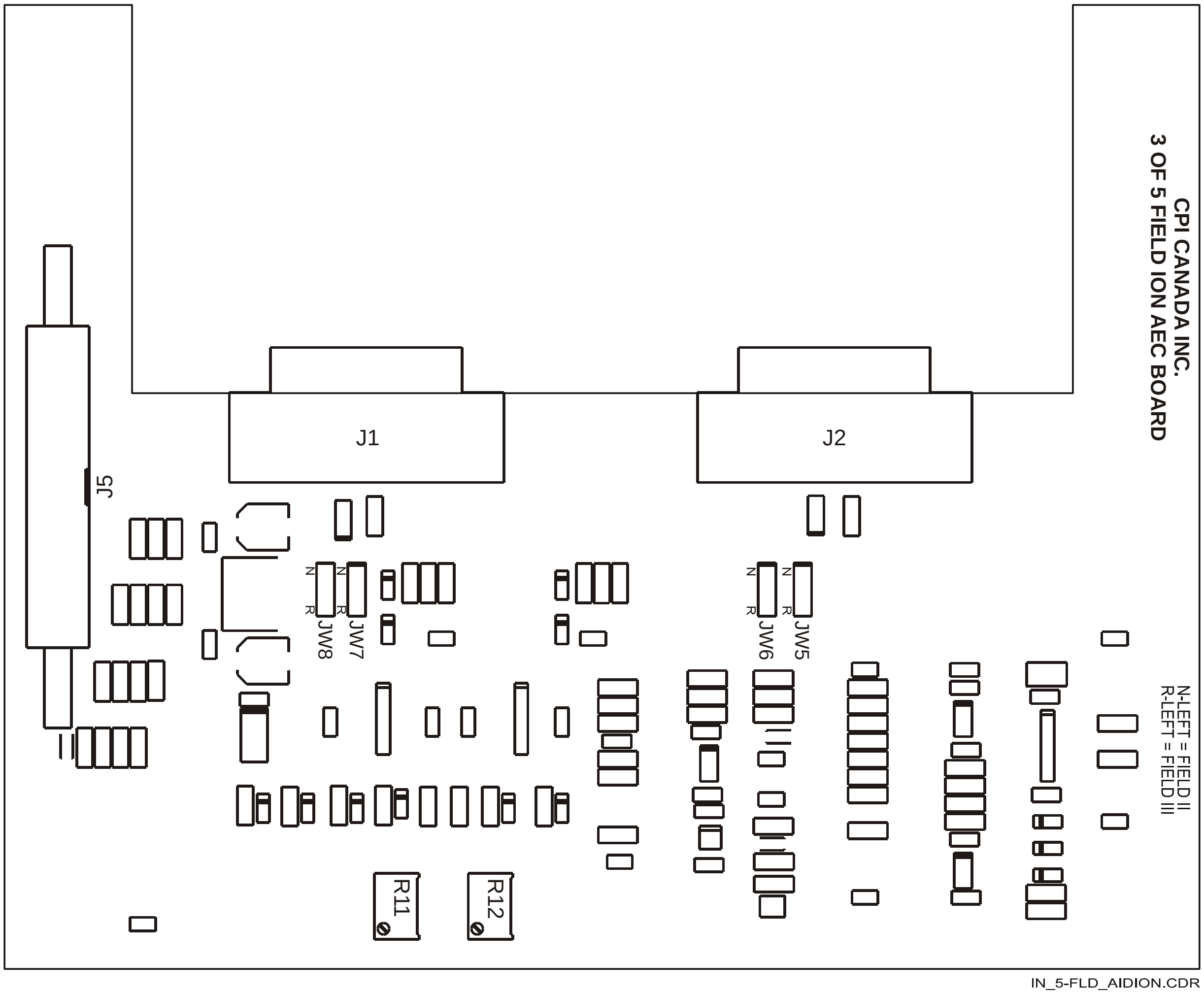


Figure 3D-4: Three-of-five-field ion chamber AEC board (assembly 739389)

AEC board input assignment:

- Ch 1 = J1.
- Ch 2 = J2.

The following potentiometers are used for AEC gain adjustment:

- R11 is used for channel 1 gain adjustment.
- R12 is used for channel 2 gain adjustment.

3D.2.4 AEC Board (5-Field Ion Chambers)

Table 3D-6 shows the pin outs for the 15 pin D connectors on the AEC board in figure 3D-4. The 15 pin connectors are compatible with some models of three-of-five-field AID ion chambers.

FUNCTION	PIN	NOTE
Not used	1	
Left field select (refer to note below)	2	See note below.
Middle field select	3	
Reset / start	4	
Chamber output	5	
Right field select (refer to note below)	6	See note below.
-12 VDC output	7	
+12 VDC output	8	
Ground	9	
Not used	10	
$\overline{\text{Portrait}}$	11	
Not used	12	
$\overline{\text{Inverted}}$	13	
Not used	14	
Not used	15	

Table 3D-6: Pin outs for 15 pin D connector (J1 and J2)

NOTE:

Jumpers JW5 to JW8 swap the left and right fields on J1 and J2 as per the table below.

CHANNEL	LEFT / RIGHT FIELDS AS PER TABLE 3D-6	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLE 3D-6
1	Jumper JW7, JW8 pins 1-2 (N)	Jumper JW7, JW8 pins 2-3 (R)
2	Jumper JW5, JW6 pins 1-2 (N)	Jumper JW5, JW6 pins 2-3 (R)

***NOTE:* THE FIELD COMPENSATION VALUES (*R FIELD COMP, C FIELD COMP, L FIELD COMP*) IN AEC SETUP MENU 2 MUST ALL BE SET TO 0. THE AEC FIELD BALANCE MUST BE DONE AS PER A.I.D.'s RECOMMENDED PROCEDURE.**

3D.2.5 AEC Board (Universal AEC Board With Short AEC Time Compensation)

The AEC board shown below has short AEC time compensation, and is configurable to be compatible with most AEC pickups on the market. This assembly also contains a low current, high voltage supply for a photo multiplier tube (PMT). The PMT supply is located on the upper board, which also contains the connectors to interface to the AEC pickup devices.

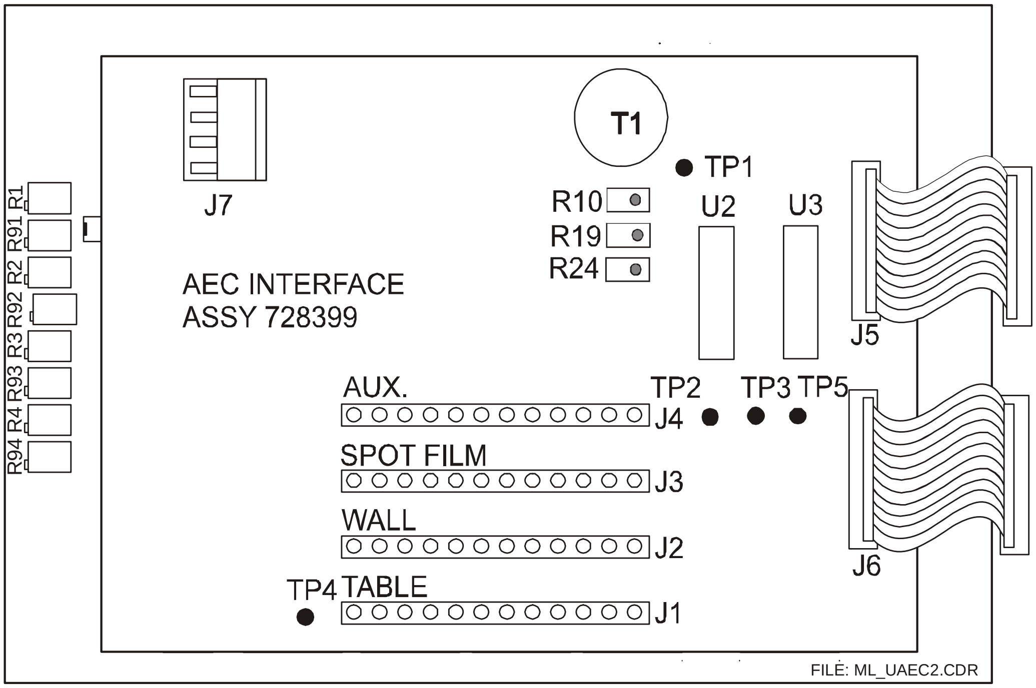


Figure 3D-5: Universal AEC board with short AEC time compensation (assembly 734654 consisting of PWBA 734630 and 728399)

In order to clearly show the adjustment pots on the lower (AEC) board, the upper board which contains the AEC and PMT interface connectors and the high voltage supply is shown shifted from its actual position.

AEC board input / output assignment (examples only, actual receptor assignments may vary):

- Ch 1 = J1 - Table radiographic Bucky.
- Ch 2 = J2 - Vertical wall Bucky or digital applications.
- Ch 3 = J3 - Spot film device or digital applications.
- Ch 4 = J4 - Digital applications.
- J7 = High voltage output for the PMT (if used).

The following potentiometers are used for AEC gain adjustment:

- **R1** is used for channel 1 gain adjustment.
- **R2** is used for channel 2 gain adjustment.
- **R3** is used for channel 3 gain adjustment.
- **R4** is used for channel 4 gain adjustment.

3D.2.5 AEC Board (Universal AEC Board With Short AEC Time Compensation) Cont

The following potentiometers are used for short AEC exposure time compensation:

- **R91** is used for channel 1 short exposure time compensation.
- **R92** is used for channel 2 short exposure time compensation.
- **R93** is used for channel 3 short exposure time compensation.
- **R94** is used for channel 4 short exposure time compensation.

Potentiometers R10, R19, and R24 adjust the output of the +300 / +500 VDC (ion chamber) and -1000 VDC (PMT) high voltage supply. The +300 / +500 VDC outputs are available on J1 to J4 as defined in tables 3D-7 and 3D-8, and –1000 VDC is available on J7.

Logic circuits on the AEC interface board are connected to the AEC channel select lines, and switch the potentiometers that adjust the high voltage into the circuit per the following matrix:

- R10 is active when no AEC channel is selected, i.e. during ABS operation. The adjustment of this potentiometer is described in chapter 3E.
- R19 is active when AEC channel 4 is selected. Channel 4 is typically used for digital applications. The AEC pickup will usually be a PMT or photo diode. The adjustment of this pot is described later in this chapter, under ***AEC USING A PMT***.
- R24 is active when AEC channels 1, 2 or 3 are selected. Channels 1 to 3 may be used for film-based AEC using an ion chamber or solid-state chamber, or may be used for digital applications using a PMT or photo diode, or any combination of the above.
- If AEC channels 1, 2, and 3 are all used with ion chambers, and all three channels require the same ion chamber bias voltage, R24 should be adjusted to set the nominal +300 / +500 VDC outputs to the required bias voltage.
- If AEC channel 1, 2, or 3 is used for digital applications using a PMT, R24 will need to be adjusted to supply the required PMT voltage during AEC operation on those channels. The adjustment of this pot for setting the PMT high voltage is described later in this chapter, under ***AEC USING A PMT***. In this case, the +300 / +500 VDC supply cannot be optimized for ion chamber use. If an ion chamber is connected to any of the remaining channels, it must have a built-in high voltage bias supply.

Tables 3D-7 and 3D-8 show the pin outs for the 12 pin connectors J1 to J4 on the universal AEC board. The pins on J7 are all connected in parallel, thus the PMT high voltage may be taken from any of the pins on that connector.

3D.2.5 AEC Board (Universal AEC Board With Short AEC Time Compensation) Cont

FUNCTION	PIN	NOTE
+500 VDC output	1	+500, +300, +45 VDC outputs are provided for ion chamber use if required. +12, -12, -24 VDC outputs are typically used as the DC supply for a pre-amplifier, often part of the ion chamber. The start command, and left, middle, right field select outputs are jumper configured to be active high or active low as per the AEC chamber requirements. The signal input is jumper configured to accept a positive going or negative going ramp or DC signal as per the AEC chamber output.
+300 VDC output	2	
+45 VDC output	3	
+12 VDC output	4	
-12 VDC output	5	
-24 VDC output	6	
Ground	7	
Reset / start	8	
Right field select	9	
Middle field select	10	
Left field select	11	
Chamber output	12	
For PMT or photo diode AEC pickups, use pin 12 (signal) and pin 7 (ground).		

Table 3D-7: Ion chamber connections

FUNCTION	PIN	NOTE
+500 VDC output	1	Not used for solid state AEC chambers
+300 VDC output	2	Not used for solid state AEC chambers
+45 VDC output	3	Not used for solid state AEC chambers
+12 VDC output	4	Not used for solid state AEC chambers
-12 VDC output	5	Not used for solid state AEC chambers
-24 VDC output	6	Not used for solid state AEC chambers
Ground	7	Connect pin 8 to pin 7 (ground). Connect the common anodes for left, middle, right to pin 8. Connect cathode (left) to *LEFT*, cathode middle to *MIDDLE*, and cathode right to *RIGHT*. Cable shield (if used) connects to pin 8.
Reset / start	8	
Right	9	
Middle	10	
Left	11	
Chamber output	12	Not used for solid state AEC chambers

Table 3D-8: Solid-state chamber connections

3D.2.6 Pre-calibration Notes

This section contains information that must be understood and confirmed before proceeding with AEC calibration.

CAUTION: ***THE PROCEDURES IN THESE SECTIONS REQUIRE X-RAY EXPOSURES. TAKE ALL SAFETY PRECAUTIONS TO PROTECT PERSONNEL FROM X-RADIATION.***

SHOULD AN IMPROPER TECHNIQUE BE SELECTED, OR AN AEC FAULT OCCUR CAUSING NO AEC FEEDBACK SIGNAL TO THE GENERATOR, THE EXPOSURE WILL TERMINATE AND AN "AEC DEVICE ERROR" MESSAGE WILL BE DISPLAYED IF THE RAMP VOLTAGE FAILS TO REACH 4% OF THE EXPECTED RAMP VOLTAGE WHEN THE EXPOSURE TIME REACHES 20% OF THE SELECTED BACK UP TIME.

- When using a PMT or photodiode for AEC, there is normally no need to iterate all the kV break points. It is usually sufficient to use the 75 kV breakpoint calibration value at all kV breakpoints. If doing this, the calibration values should be confirmed at all kV breakpoints using the acquired digital images.
- During AEC calibration, all AEC exposures should be done using mA values such that the exposures are in the 30 to 100 ms range UNLESS STATED OTHERWISE.
- During AEC calibration, always ensure that the central ray is centered relative to the image receptor.
- Prior to placing the absorbers, ensure that the collimator is opened sufficiently to irradiate ALL fields on the AEC pickup device.
- The recommended absorber is Lexan. Water of a similar thickness is also a suitable absorber. This should be in a plastic container of uniform thickness.
- Ensure that the absorber is positioned to fully cover the X-ray field. The absorber must extend a minimum of 3/8 in. (10 mm) beyond the X-ray field.
- All components and assemblies used during AEC calibration must be those that will be used during procedures, and must be positioned as they will be in actual use of the X-ray room.
- The generator must be known to be calibrated before proceeding.
- Care must be exercised when using table Buckys with low kV values because most tabletops and grids absorb considerable radiation in the range of 60 – 65 kV. This will adversely affect AEC operation.
- **During AEC calibration, if exposure times do not change if the mA is varied, it may be that the input signal level to the AEC board is too high. If this is experienced, check the ramp voltage at the output of the first gain stage (the first operational amplifier output) on the AEC board for the subject AEC channel. This voltage must never exceed 10 V. If this voltage does exceed 10 V, reduce the input signal level as required.**

3D.2.7 Required Test Equipment

The following test equipment is required for AEC calibration.

- Lexan or equivalent (or water) absorbers in various thicknesses. Water should be in a plastic container of uniform thickness.
- Radiation dosimeter (for digital applications).
- A supply of film in each film speed that will be calibrated.
- A cassette with intensifying screen in each speed that will be calibrated.

3D.3.0 AEC SETUP MENU STRUCTURE

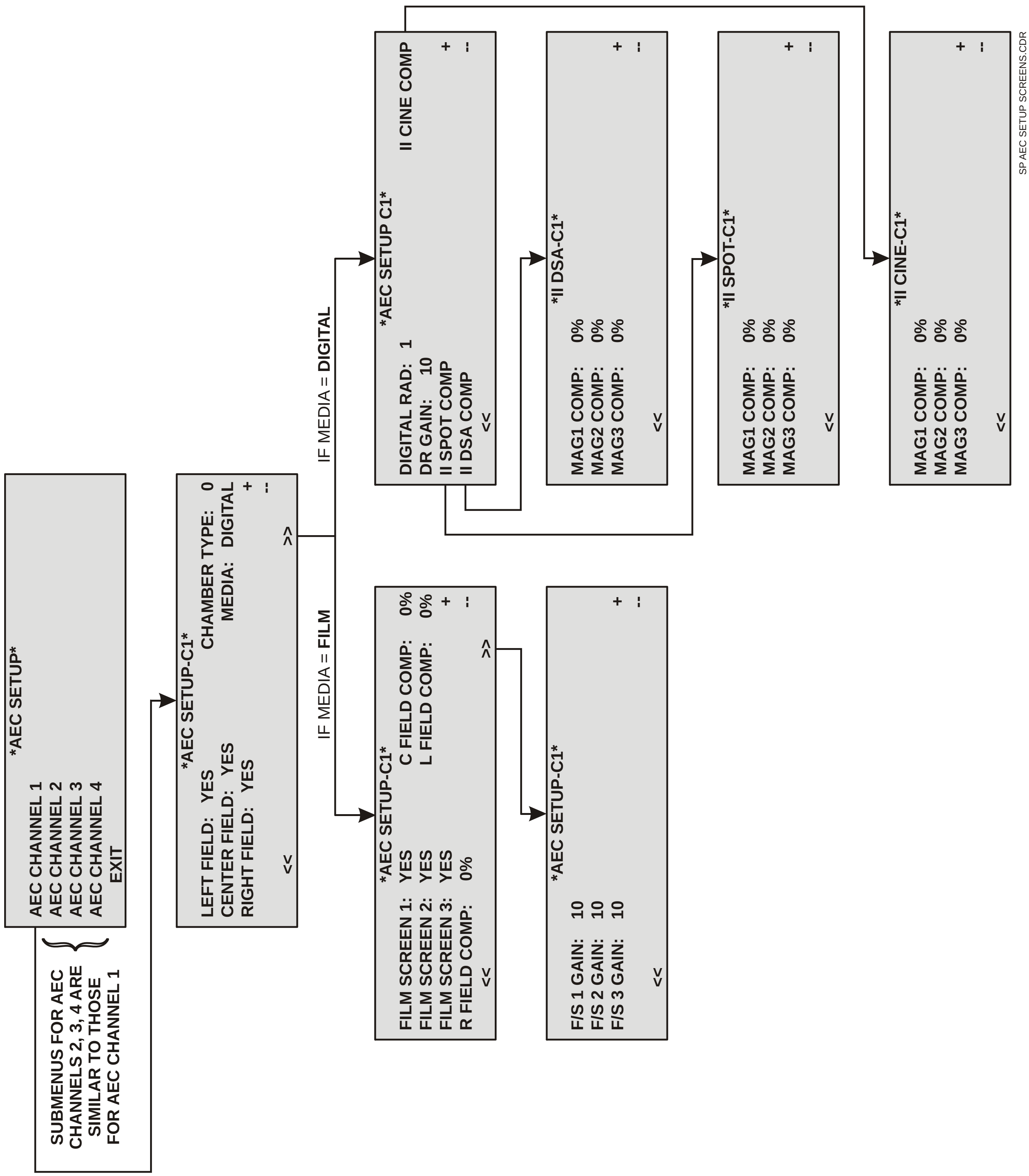


Figure 3D-6: AEC setup menus (membrane console)

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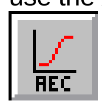
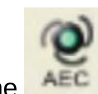
3D.4.0 INITIAL AEC SETUP

NOTE: ***SOME OF THE FEATURES DESCRIBED IN THIS CHAPTER ARE OPTIONAL. DISREGARD THE SECTIONS THAT DO NOT APPLY.***

The basic AEC defaults must be set before proceeding with AEC setup and calibration. This section details the initial AEC setup procedure.

Use these steps to access the **AEC SETUP** menus (membrane console), the AEC Setup & Calibration utility in the PC version of GenWare® or in the version of GenWare® that is resident on the touchscreen console.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	Enter into the programming mode as described in chapter 3C.	The procedure for starting GenWare® and connecting it to the console is described in the GenWare® manual, included with GenWare®. From the GenWare® GENERATOR UTILITIES application, select **AEC Setup and Calibration** from the **Setup** menu, or use the AEC Setup & Calibration button  on the GenWare® toolbar.	Touchscreen GenWare® must be launched before proceeding. This is done from the GenWare® button on the touchscreen **System Utilities** menu. Press the  button on the GenWare® toolbar to access the **AEC Setup and Calibration** window.
2.	When the **GENERATOR SETUP** menu is displayed, select **GEN CONFIGURATION**.		
3.	From the **GEN CONFIGURATION** menu, select **AEC SETUP**.	Select the **AEC Setup** tab.	Select the **AEC Setup** tab.

3D.4.0 INITIAL AEC SETUP (Cont)

The **AEC SETUP** menus that relate to the AEC setup function for the membrane console are shown below.

* AEC SETUP *
AEC CHANNEL 1
AEC CHANNEL 2
AEC CHANNEL 3
AEC CHANNEL 4
EXIT

* AEC SETUP-C1 *	
LEFT FIELD: YES	CHAMBER TYPE: 0
CENTER FIELD: YES	MEDIA: DIGITAL
RIGHT FIELD: YES	+
	-
<<	>>

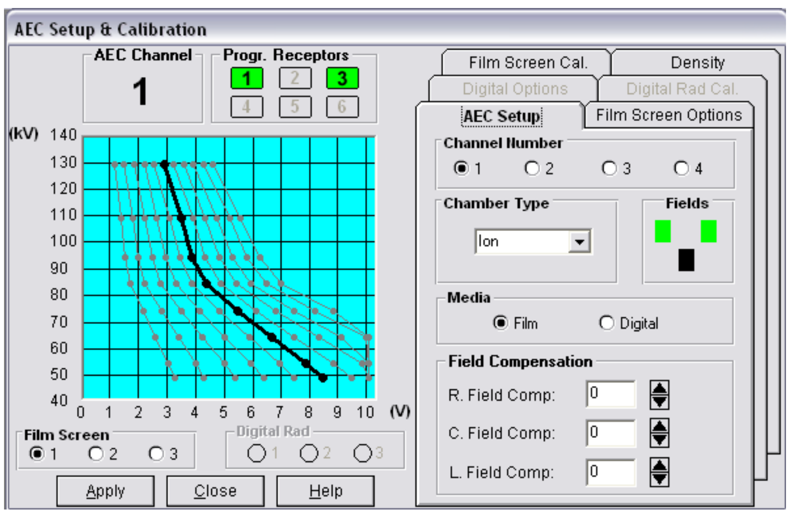


Figure 3D-7a - PC GenWare®

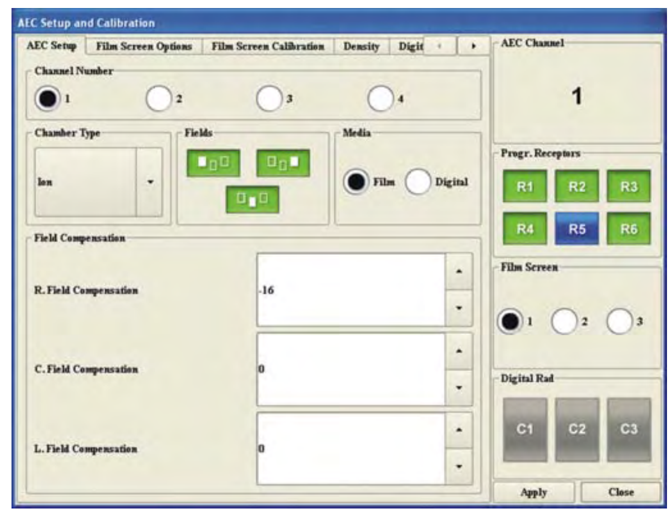


Figure 3D-7b - Touchscreen GenWare®

AEC Setup & Calibration window, AEC Setup tab

3D.4.0 INITIAL AEC SETUP (Cont)

If **MEDIA** = **FILM**

* AEC SETUP-C1 *			
FILM SCREEN 1:	YES	C FIELD COMP:	0%
FILM SCREEN 2:	YES	L FIELD COMP:	0%
FILM SCREEN 3:	YES		+
R FIELD COMP:	0%		-
<<		>>	

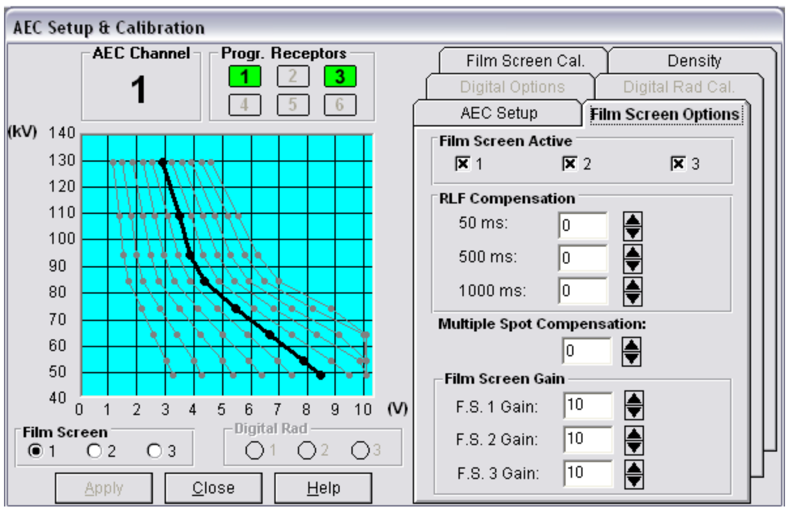


Figure 3D-8a - PC GenWare®

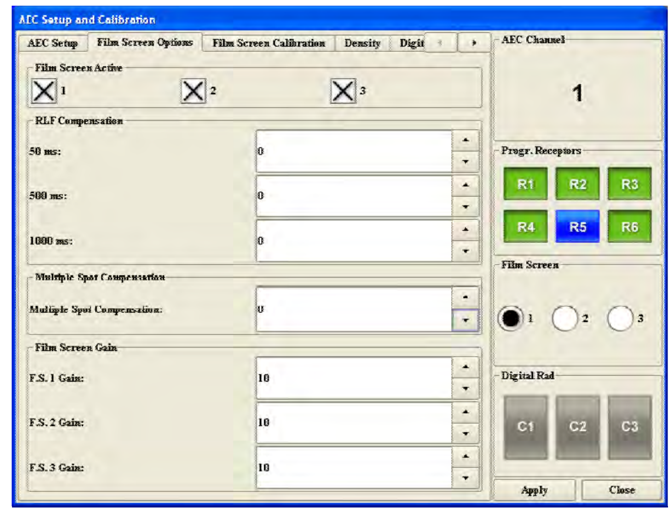


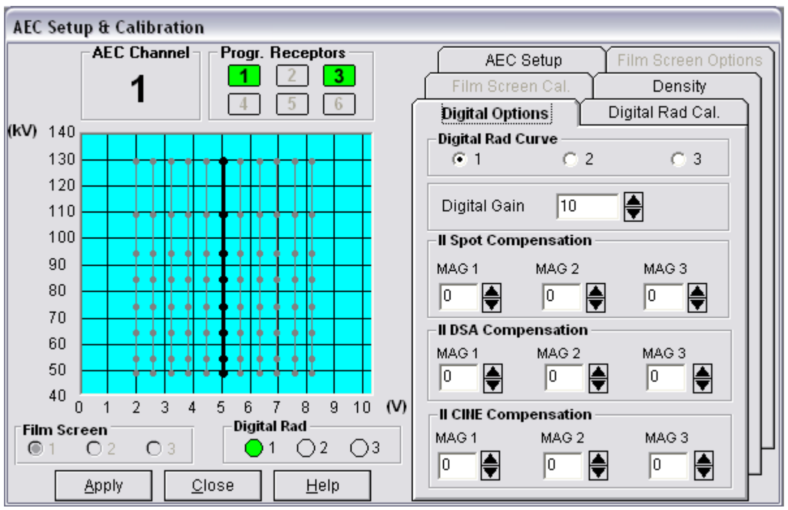
Figure 3D-8b - Touchscreen GenWare®

AEC Setup & Calibration window, Film Screen Options tab

3D.4.0 INITIAL AEC SETUP (Cont)

If **MEDIA** = **DIGITAL**

```
                    * AEC SETUP-C1 *
DIGITAL RAD:    1                          II CINE COMP
DR GAIN:      10
II SPOT COMP                                          +
II DSA COMP                                           -
        <<
```



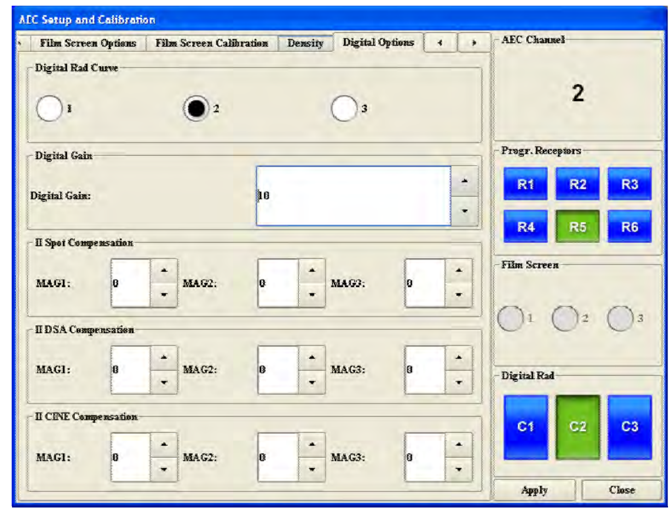


Figure 3D-9a - PC GenWare® *Figure 3D-9b - Touchscreen GenWare®*

AEC Setup & Calibration window, Digital Options tab

Note the following regarding the GenWare® figures in this chapter:

- The **AEC Channel** display on the **AEC Setup & Calibration** window shows the selected AEC channel.
- The **Progr. Receptors** display shows which receptors are programmed for the selected AEC channel.
- The **Digital Rad** display shows which Digital Rad Curve has been selected.

3D.4.0 INITIAL AEC SETUP (Cont)

Definitions of **AEC SETUP** menu items applicable to the initial AEC setup.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
LEFT FIELD **CENTER FIELD** **RIGHT FIELD**	**A graphic depicting the AEC chamber fields.**	Enables or disables the ability to select the left, center, or right AEC fields. Membrane console: **YES:** The selected field is enabled. **NO:** The selected field is disabled. GenWare®: Refer to the graphic under **Fields:** PC GenWare®: Green - the selected field is enabled. Black - the selected field is disabled. Touchscreen GenWare®: Green field display - the highlighted field is enabled. Blue field display - the highlighted field is disabled.
CHAMBER TYPE	**Chamber Type**	Selects the AEC chamber type. Membrane console: **0:** Ion chamber. **1:** Solid-state chamber. **2:** Apelem. GenWare®: **Ion:** Ion chamber. **Solid State:** Solid-state chamber. **Apelem:** Apelem.
MEDIA	**Media**	Selects the media type for the selected AEC channel. **FILM** The image will be recorded on film. **DIGITAL** The imaging medium will be an I.I. or flat panel detector.

3D.4.0 INITIAL AEC SETUP (Cont)

IF MEDIA = FILM		
FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
FILM SCREEN 1 **FILM SCREEN 2** **FILM SCREEN 3**	**Film Screen Active**	Enables or disables the ability to select film screen 1, film screen 2, or film screen 3. Membrane console: **YES:** The selected film screen is enabled. **NO:** The selected film screen is disabled. GenWare®: Checking **1**, **2**, or **3** under **Film Screen Active** enables that film screen.
R FIELD COMP **C FIELD COMP** **L FIELD COMP**	**R. Field Comp (R. Field Compensation)** **C. Field Comp (C. Field Compensation)** **L. Field Comp (L. Field Compensation)**	Allows left, center, and right field balance. This applies to solid-state AEC chambers only. The calibration procedure is described in the section ***AEC CALIBRATION (TABLE BUCKY)***.
F/S 1 GAIN **F/S 2 GAIN** **F/S 3 GAIN**	**F.S. 1 Gain** **F.S. 2 Gain** **F.S. 3 Gain**	These functions are not available at this time.

3D.4.0 INITIAL AEC SETUP (Cont)

IF MEDIA = DIGITAL		
FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
DIGITAL RAD	**Digital Rad Curve**	Selects the AEC calibration curve (kV vs. AEC reference) that is assigned to the selected AEC channel. The available selections are curves **1**, **2**, or **3**.
DR GAIN	**Digital Gain**	This function is not available at this time.

3D.4.0 INITIAL AEC SETUP (Cont)

Use these steps to perform the initial AEC setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the main **AEC SETUP** menu, select the AEC channel that is to be programmed.	Under **Channel Number (AEC Setup** tab**)**, select the AEC channel that is to be programmed.	Under **Channel Number (AEC Setup** tab**)**, select the AEC channel that is to be programmed.
2.	Select **LEFT FIELD**. Toggle the button to select **YES** or **NO**.	Click the left field on the graphic under **Fields** to enable / disable that field. Black indicates that the selected field is disabled; green indicates that the selected field is enabled.	Under **Fields**, select the graphic showing the left AEC field. Green indicates that the selected field is enabled; blue indicates that the selected field is disabled.
3.	Repeat the above for the center and right fields.	Repeat the above for the center and right fields.	Repeat the above for the center and right fields.
	Select the center field only for digital applications.		
4.	Select **CHAMBER TYPE**. Use the **+** or **–** buttons to select the desired AEC chamber type. Select **0** (Ion) for digital applications.	Under **Chamber Type**, select the desired AEC chamber type. Select **Ion** for digital applications.	Under **Chamber Type**, select the desired AEC chamber type. Select **Ion** for digital applications.
	Select ION if using solid state AEC board assembly 737992.		
5.	Select **MEDIA**. Toggle the button to select **FILM** or **DIGITAL**.	Under **Media**, select **Film** or **Digital**.	Under **Media**, select **Film** or **Digital**.
6.	Press **>>**.		
	Steps 7 to 14 apply if **MEDIA** = **FILM**.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
7.		Select the **Film Screen options** tab. This is only available if **Media** = **Film**.	Select the **Film Screen options** tab. This is only active if **Media** = **Film**.
8.	Select **FILM SCREEN 1**. Toggle the button to select **YES** or **NO**.	Under **Film Screen Active,** select film screen **1.** An **X** in the check box indicates that film screen 1 is enabled.	Under **Film Screen Active,** select film screen **1.** An **X** in the check box indicates that film screen 1 is enabled.
9.	Repeat the above for film screen 2 and film screen 3.	Repeat the above for film screen 2 and film screen 3.	Repeat the above for film screen 2 and film screen 3.

3D.4.0 INITIAL AEC SETUP (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
10.		Select the **AEC setup** tab.	Select the **AEC setup** tab.
11.	Select **R FIELD COMP**. Use the **+** or **–** buttons to enter the value **0**%. This may be optimized in a later step if using a solid-state AEC chamber.	Under **Field Compensation**, set the **R. Field Comp** value to **0**. This may be optimized in a later step if using a solid-state AEC chamber.	Under **Field Compensation**, set the **R. Field Compensation** value to **0**. This may be optimized in a later step if using a solid-state AEC chamber.
12.	Repeat the above for **C FIELD COMP** and **L FIELD COMP**	Repeat the above for **C. Field Comp** and **L. Field Comp**.	Repeat the above for **C. Field Compensation** and **L. Field Compensation**.
13.	Repeat the applicable steps in this section for the remaining AEC channels.	Repeat the applicable steps in this section for the remaining AEC channels.	Repeat the applicable steps in this section for the remaining AEC channels.
14.	Press **<<** three times to return to the **GEN CONFIGURATION** menu.		
	Steps 15 to 18 apply if **MEDIA** = **DIGITAL**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
15.		Select the **Digital Options** tab. This is only available if **Media** = **Digital**.	Select the **Digital Options** tab. This is only active if **Media** = **Digital**.
16.	Select **DIGITAL RAD**. Use the **+** or **–** buttons to select the AEC calibration curve that is to be assigned to the current AEC channel. The AEC calibration curves will be established during the AEC calibration procedure.	Under **Digital Rad Curve,** select the AEC calibration curve that is to be assigned to the current AEC channel. The AEC calibration curves will be established during the AEC calibration procedure.	Under **Digital Rad Curve,** select the AEC calibration curve that is to be assigned to the current AEC channel. The AEC calibration curves will be established during the AEC calibration procedure.
17.	Repeat the applicable steps in this section for the remaining AEC channels.	Repeat the applicable steps in this section for the remaining AEC channels.	Repeat the applicable steps in this section for the remaining AEC channels.
18.	Press **<<** three times to return to the **GEN CONFIGURATION** menu.		

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3D.5.0 AEC CALIBRATION MENU STRUCTURE

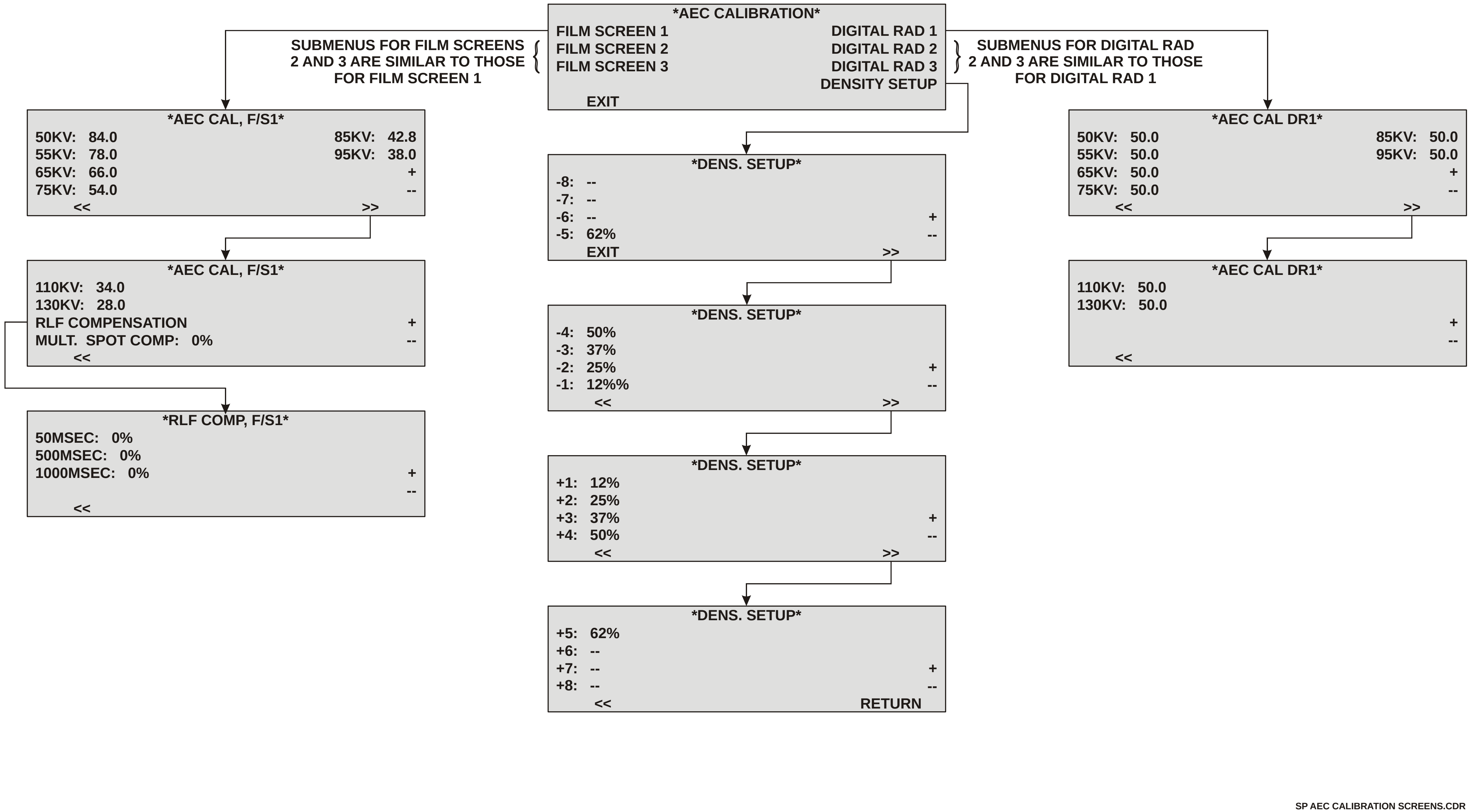

Figure 3D-10: AEC calibration menus (membrane console)

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3D.6.0 AEC CALIBRATION (TABLE BUCKY)

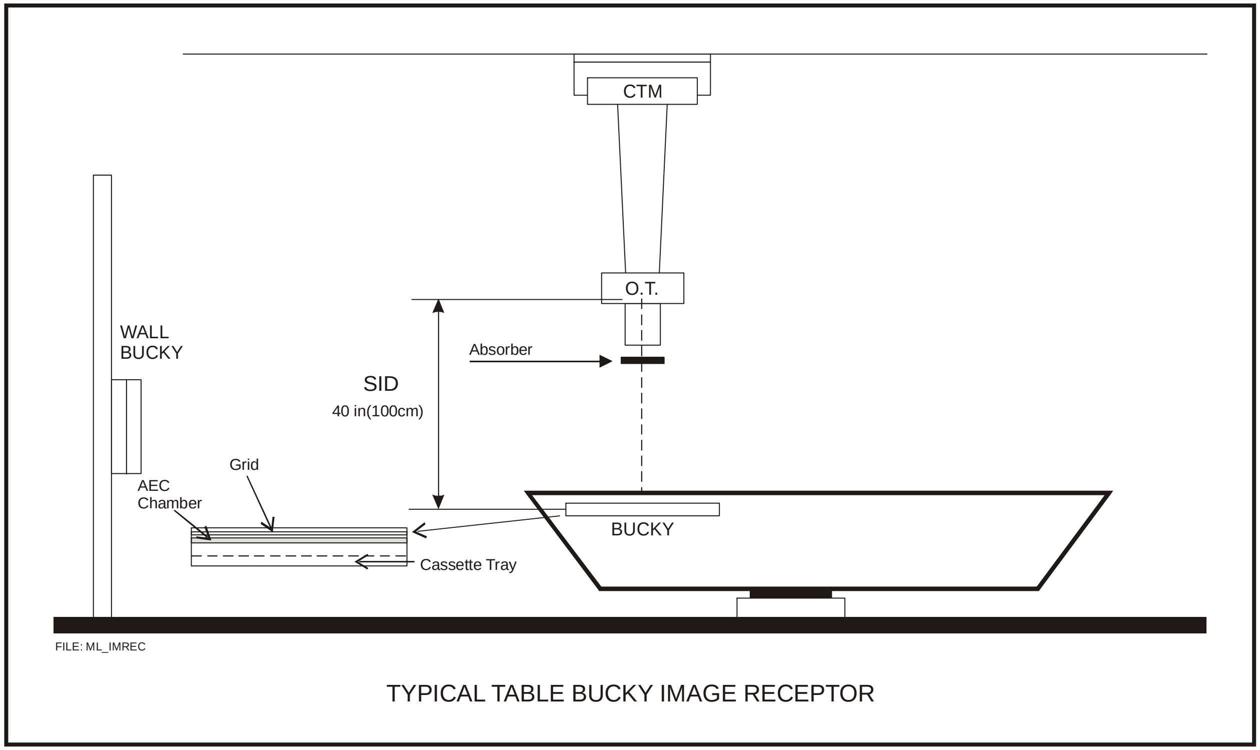


Figure 3D-11: Equipment setup for table Bucky AEC calibration

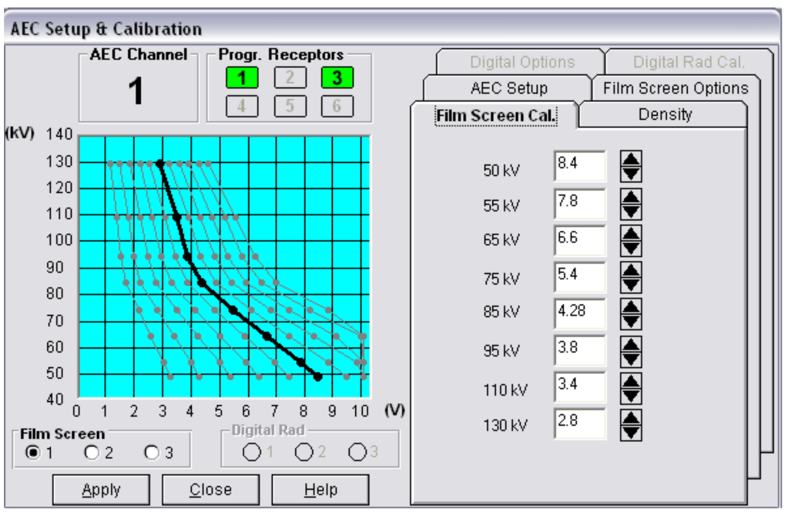
The **AEC CALIBRATION** menus that relate to kV breakpoint calibration for the membrane console are shown below.

* AEC CALIBRATION *	
FILM SCREEN 1	DIGITAL RAD 1
FILM SCREEN 2	DIGITAL RAD 2
FILM SCREEN 3	DIGITAL RAD 3
	DENSITY SETUP
EXIT	

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

* AEC CAL, F/S1 *	
50KV: 84.0	85KV: 42.8
55KV: 78.0	95KV: 38.0
65KV: 66.0	+
75KV: 54.0	-
<<	>>

* AEC CAL, F/S1 *	
110KV: 34.0	
130KV: 28.0	
RLF COMPENSATION	+
MULT. SPOT COMP: 0%	-
<<	



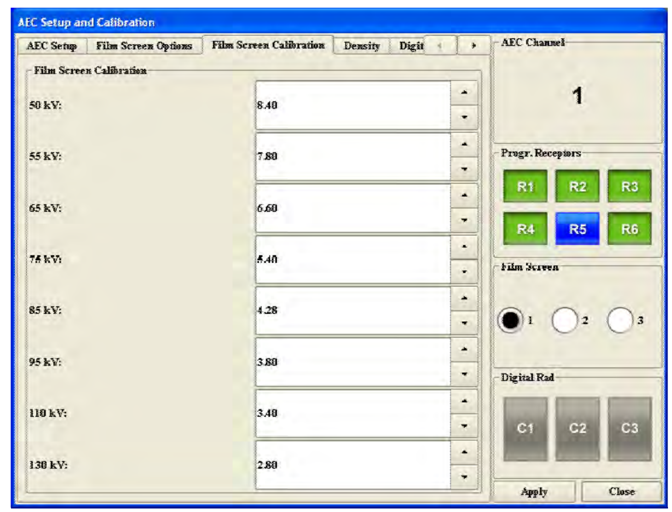


Figure 3D-12a - PC GenWare® *Figure 3D-12b - Touchscreen GenWare®*

AEC Setup & Calibration window, Film Screen Calibration tab

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

Use these steps to perform the table Bucky AEC calibration.

Step	Action		
	IF THE AEC BOARD BEING CALIBRATED HAS SHORT AEC TIME COMPENSATION POTENTIOMETERS, THE SHORT EXPOSURE TIME COMPENSATION MUST FIRST BE DISABLED. **TO DO THIS, ADJUST ALL SHORT AEC EXPOSURE TIME COMPENSATION POTS TO ZERO BY TURNING EACH OF THESE POTENTIOMETERS FULLY CLOCKWISE. THESE ARE MULTI-TURN POTENTIOMETERS, AND MUST BE TURNED BY AS MUCH AS 25 TURNS TO REACH THE ZERO-OHMS LIMIT.** **FAILURE TO PRESET THESE POTS WILL RESULT IN DIFFICULTY IN PERFORMING AEC CALIBRATION.**		
1.	Set up the X-ray tube stand as shown in figure 3D-11.		
2.	Align the tube stand and table Bucky such that the central ray is centered relative to the image receptor.		
3.	Open up the collimator to expose all three fields of the AEC pickup. Ensure that the central ray remains centered relative to the image receptor.		
4.	Place the absorber (with thickness selected for 75 kV per table 3D-10) in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Ensure that in the **RECEPTOR SETUP** menu, each receptor has the desired AEC channel assigned to it. Refer to ***RECEPTOR SETUP*** in chapter 3C.	Ensure that in the **Receptor Setup** window, each receptor has the desired AEC channel assigned to it. Refer to ***RECEPTOR SETUP*** in chapter 3C.	Ensure that in the **Receptor Setup** window, each receptor has the desired AEC channel assigned to it. Refer to ***RECEPTOR SETUP*** in chapter 3C.
6.	In the **RECEPTOR SETUP** menu, set **MEMORY** to **NO** for each image receptor. This will ensure that the next receptor being calibrated will not remember the techniques from the previous receptor. The **MEMORY** function may be reset as desired after AEC calibration is completed.	In the **Receptor Setup** window, under the **Receptor Properties** tab, set **Memory** to **Off** for each image receptor. This will ensure that the next receptor being calibrated will not remember the techniques from the previous receptor. The **Memory** function may be reset as desired after AEC calibration is completed.	In the **Receptor Setup** window, under the **Receptor Properties** tab, set **Memory** to **Off** for each image receptor. This will ensure that the next receptor being calibrated will not remember the techniques from the previous receptor. The **Memory** function may be reset as desired after AEC calibration is completed.
7.	In the **RECEPTOR SETUP** menu, ensure that the **AEC BACKUP MAS** and **AEC BACKUP MS** are set sufficiently high that the generator backup timer will not terminate the exposure.	In the **Receptor Setup** window, under the **AEC** tab, ensure that the **AEC Back-Up mAs** and **AEC Back-Up ms** are set sufficiently high that the generator backup timer will not terminate the exposure	In the **Receptor Setup** window, under the **AEC** tab, ensure that the **AEC Back-Up mAs** and **AEC Back-Up ms** are set sufficiently high that the generator backup timer will not terminate the exposure

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
8.	From the **GEN CONFIGURATION** menu, select **AEC CALIBRATION.**	Reselect the **AEC Setup & Calibration** window.	Reselect the **AEC Setup and Calibration** window.
9.	From the **AEC CALIBRATION** menu, select **FILM SCREEN 1** (the slowest film screen combination).	On the main **AEC Setup & Calibration** window, select **Film Screen 1** (the slowest film screen combination). This will only be available if **Media** was set to **Film** in the **AEC Setup** tab.	On the main **AEC Setup and Calibration** window, select **Film Screen 1** (the slowest film screen combination). This will only be available if **Media** was set to **Film** in the **AEC Setup** tab.

CAUTION: ***DURING THE FOLLOWING CALIBRATION PROCEDURE, BE SURE THAT THE SELECTED TECHNIQUES WILL NOT OVERLOAD THE X-RAY TUBE. USE CAUTION WHEN REPEATING EXPOSURES AS THIS MAY QUICKLY OVERLOAD THE X-RAY TUBE. MOST X-RAY TUBE MANUFACTURERS RECOMMEND NO MORE THAN TWO HIGH SPEED STARTS PER MINUTE.***

NOTE: ***BE SURE TO USE THE SAME CASSETTE FOR EACH EXPOSURE AT THAT FILM SPEED.***

FILM SPEED	mAs @ 75 kV
100	16
200	8
400	4
800	2

Table 3D-9: Film speed vs. mAs @ 75 kV

The mAs values noted in the above table represent the approximate desired mAs at an SID of 40 in. (100 cm), using a grid with a 12:1 ratio. All measurements were done with HVL = 3 mm Al @ 75 kV.

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

Step	Action		
10.	Select the table Bucky image receptor.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.		Select the **Film Screen Cal.** tab.	Select the **Film Screen Calibration** tab.
12.	Select the **75KV** breakpoint. Use the + or – buttons to enter the value **45**.	Enter the value **4.5** into the **75 kV** dialog box, under **Film Screen Cal.**	Enter the value **4.5** into the **75 kV** dialog box, under **Film Screen Calibration.**
13.	Select the appropriate mA for the first film speed being calibrated per table 3D-10, *remembering that the slowest film screen used in that installation must be calibrated first* (example 320 mA for 100 speed film). Select large focus, center field.		
14.	Make an exposure and note the mAs.		
15.	Referring to table 3D-9, select the target mAs required for the film speed being calibrated i.e. approximately 16 mAs at 75 kV for 100 speed film.		
16.	Adjust the required gain potentiometer on the AEC board while taking exposures until the mAs noted in the previous step is obtained.		
17.	Load a test cassette with fresh film and install it in the image receptor. Using the same technique as in the previous step, expose the film and develop it.		
18.	Measure the optical density. The desired value should have been previously recorded in a copy of table 3D-14.		
19.	If the measured O.D. is not the desired value, adjust the gain pot (as per step 17) to increase or decrease the density, and then repeat the previous two steps.		
20.	Once the desired film density is achieved, record the mAs, calibration number and O.D. in a copy of table 3D-11.		
21.	Vary the absorber thickness, and confirm that the mAs changes accordingly.		
	STEPS 22 TO 25 APPLY TO SOLID-STATE AEC CHAMBERS ONLY		
22.	Note the mAs with the center AEC field only selected. Record this value.		
23.	Select the left field, and note the mAs. Compare this value to the value noted for the center field.		
24.	If the field balance is not acceptable, adjust the left field compensation value up or down as described in section 3D.4.0 such that the left field matches the center field. Do not adjust the center field (**C**) compensation value.		

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

For each breakpoint in the remainder of this section, start with the approximate mAs as per table 3D-10. After that mAs is achieved, a film must be exposed and the O.D. verified. If the O.D. is not the desired value, further iterations may be required to achieve the desired optical density.

DO NOT READJUST THE AEC BOARD GAIN POT AFTER THE 75KV BREAKPOINT IS CALIBRATED. FURTHER DENSITY ADJUSTMENTS WILL ONLY BE MADE BY ADJUSTING THE CALIBRATION VALUES FOR THE OTHER KV BREAKPOINTS.

Step	Action		
25.	Repeat steps 23 and 24 for the right field.		
26.	Change the absorber thickness as specified for the 55 kV breakpoint in table 3D-10. As before, ensure that the absorber fully blocks the X-ray field.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
27.	In the following steps, you will need to scroll back and forth between **AEC CAL** menu 1 and **AEC CAL** menu 2 using the **>>** and **<<** buttons in order to access the required breakpoints.		
28.	Select the **55KV** breakpoint. This will set the generator kV demand to 55 kV.	Click in the **55 kV** dialog box, under **Film Screen Cal.** This will set the generator kV demand to 55 kV.	Click in the **55 kV** dialog box, under **Film Screen Calibration.** This will set the generator kV demand to 55 kV.
29.	Make an exposure and note the mAs. Use mA values as specified for the 55 kV breakpoint in table 3D-10.	Make an exposure and note the mAs. Use mA values as specified for the 55 kV breakpoint in table 3D-10.	Make an exposure and note the mAs. Use mA values as specified for the 55 kV breakpoint in table 3D-10.
30.	Adjust the 55 kV calibration number using the **+** or **-** buttons such that the actual mAs is equal to the target mAs at 55 kV as per table 3D-10. **DO NOT READJUST THE AEC BOARD GAIN POT.**	Adjust the 55 kV calibration number such that the actual mAs is equal to the target mAs at 55 kV as per table 3D-10. **DO NOT READJUST THE AEC BOARD GAIN POT.**	Adjust the 55 kV calibration number such that the actual mAs is equal to the target mAs at 55 kV as per table 3D-10. **DO NOT READJUST THE AEC BOARD GAIN POT.**
31.	Load the test cassette with fresh film and install it in the image receptor. Using the same technique, expose the film and develop it.		

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

Step	Action
32.	Measure the optical density. The optical density should be as per step 18.
33.	If the measured O.D. is not the desired value, readjust the 55 kV calibration number, then repeat the previous two steps. **DO NOT READJUST THE AEC BOARD GAIN POT.**
34.	Once the desired film density is achieved, record the required values in a copy of table 3D-11.

100 speed film screen				
Break point	**Absorber**	**mAs**	**Generator mA**	**Generator BUT mAs**
75 kV knee pt.	20 cm H_2O	16 mAs	320 mA	320 mAs (MAX)
55 kV	15 cm H_2O	25 mAs	320 mA	320 mAs (MAX)
50 kV	15 cm H_2O	40 mAs	320 mA	320 mAs (MAX)
65 kV	15 cm H_2O	10 mAs	320 mA	320 mAs (MAX)
110 kV	25 cm H_2O	6.3 mAs	200 mA	320 mAs (MAX)
130 kV	25 cm H_2O	5 mAs	200 mA	320 mAs (MAX)
85 kV	20 cm H_2O	10 mAs	320 mA	320 mAs (MAX)
95 kV	20 cm H_2O	5 mAs	320 mA	320 mAs (MAX)

200 speed film screen				
Break point	**Absorber**	**mAs**	**Generator mA**	**Generator BUT mAs**
75 kVp knee pt.	20 cm H_2O	8 mAs	250 mA	250 mAs (MAX)
55 kVp	15 cm H_2O	12.5 mAs	250 mA	250 mAs (MAX)
50 kVp	15 cm H_2O	20 mAs	250 mA	250 mAs (MAX)
65 kVp	15 cm H_2O	5 mAs	250 mA	250 mAs (MAX)
110 kVp	25 cm H_2O	3.2 mAs	250 mA	250 mAs (MAX)
130 kVp	25 cm H_2O	2.5 mAs	250 mA	250 mAs (MAX)
85 kVp	20 cm H_2O	5 mAs	250 mA	250 mAs (MAX)
95 kVp	20 cm H_2O	2.5 mAs	250 mA	250 mAs (MAX)

Table 3D-10: Target breakpoint calibration factors

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

400 speed film screen				
Break Point	**Absorber**	**mAs**	**Generator mA**	**Generator BUT mAs**
75 kVp knee pt.	20 cm H_2O	4 mAs	200 mA	200 mAs (MAX)
55 kVp	15 cm H_2O	6.3 mAs	200 mA	200 mAs (MAX)
50 kVp	15 cm H_2O	10 mAs	200 mA	200 mAs (MAX)
65 kVp	15 cm H_2O	2.5 mAs	200 mA	200 mAs (MAX)
110 kVp	25 cm H_2O	1.6 mAs	200 mA	200 mAs (MAX)
130 kVp	25 cm H_2O	1.25 mAs	200 mA	200 mAs (MAX)
85 kVp	20 cm H_2O	2.5 mAs	200 mA	200 mAs (MAX)
95 kVp	20 cm H_2O	1.25 mAs	200 mA	200 mAs (MAX)

800 speed film screen				
Break Point	**Absorber**	**mAs**	**Generator mA**	**Generator BUT mAs**
75 kVp knee pt.	20 cm H_2O	2 mAs	100 mA	120 mAs (MAX)
55 kVp	15 cm H_2O	3.2 mAs	100 mA	120 mAs (MAX)
50 kVp	15 cm H_2O	5 mAs	100 mA	120 mAs (MAX)
65 kVp	15 cm H_2O	1.25 mAs	100 mA	120 mAs (MAX)
110 kVp	25 cm H_2O	0.8 mAs	100 mA	120 mAs (MAX)
130 kVp	25 cm H_2O	0.63 mAs	100 mA	120 mAs (MAX)
85 kVp	20 cm H_2O	1.25 mAs	100 mA	120 mAs (MAX)
95 kVp	20 cm H_2O	0.63 mAs	100 mA	120 mAs (MAX)

Table 3D-10: Target breakpoint calibration factors (Cont)

NOTE: ***For SID's other than 40 in. (100 cm) multiply the mAs values in table 3D-10 by the factor [new SID / 40 in. (100 cm)]^2***

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

Record the final measurements in a copy of the table below. The final measurements are those obtained AFTER films have been developed to verify the correct O.D. at each breakpoint.

FILM SCREEN 1	**SPEED =**		
#1 BK. POINT = 75 kV	mAs =	CAL. NO. =	O.D. =
#2 BK. POINT = 55 kV	mAs =	CAL. NO. =	O.D. =
#3 BK. POINT = 50 kV	mAs =	CAL. NO. =	O.D. =
#4 BK. POINT = 65 kV	mAs =	CAL. NO. =	O.D. =
#5 BK. POINT = 110 kV	mAs =	CAL. NO. =	O.D. =
#6 BK. POINT = 130 kV	mAs =	CAL. NO. =	O.D. =
#7 BK. POINT = 85 kV	mAs =	CAL. NO. =	O.D. =
#8 BK. POINT = 95 kV	mAs =	CAL. NO. =	O.D. =

FILM SCREEN 1	**SPEED =**		
#1 BK. POINT = 75 kV	mAs =	CAL. NO. =	O.D. =
#2 BK. POINT = 55 kV	mAs =	CAL. NO. =	O.D. =
#3 BK. POINT = 50 kV	mAs =	CAL. NO. =	O.D. =
#4 BK. POINT = 65 kV	mAs =	CAL. NO. =	O.D. =
#5 BK. POINT = 110 kV	mAs =	CAL. NO. =	O.D. =
#6 BK. POINT = 130 kV	mAs =	CAL. NO. =	O.D. =
#7 BK. POINT = 85 kV	mAs =	CAL. NO. =	O.D. =
#8 BK. POINT = 95 kV	mAs =	CAL. NO. =	O.D. =

Table 3D-11: Breakpoint calibration worksheet

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

FILM SCREEN 1	SPEED =		
#1 BK. POINT = 75 kV	mAs =	CAL. NO. =	O.D. =
#2 BK. POINT = 55 kV	mAs =	CAL. NO. =	O.D. =
#3 BK. POINT = 50 kV	mAs =	CAL. NO. =	O.D. =
#4 BK. POINT = 65 kV	mAs =	CAL. NO. =	O.D. =
#5 BK. POINT = 110 kV	mAs =	CAL. NO. =	O.D. =
#6 BK. POINT = 130 kV	mAs =	CAL. NO. =	O.D. =
#7 BK. POINT = 85 kV	mAs =	CAL. NO. =	O.D. =
#8 BK. POINT = 95 kV	mAs =	CAL. NO. =	O.D. =

Table 3D-11: Breakpoint calibration worksheet (Cont)

Step	Action
35.	Repeat steps 26 to 34 for the remaining breakpoints: 50 kV, 65 kV, 110 kV, 130 kV, 85 kV, and 95 kV. Do the breakpoint calibration in the stated order. **The 50 kV and 130 kV breakpoints only need to be calibrated if these kV ranges are used with AEC. Refer to the comments below.** **50 kV:** At approximately 50 kV and under, the film screen sensitivity becomes too low for practical AEC operation when used with a Bucky. Unless special techniques are used which require the 50 kV range, simply enter the 55 kV calibration number into the 50 kV breakpoint. **130 kV:** Unless special high kV techniques are used which require the 130 kV range, simply enter the 110 kV calibration number into the 130 kV breakpoint.
36.	Repeat steps 9 to 35 for **FILM SCREEN 2**, except: **1. Film screen 2 must be the next highest film speed after film screen 1.** **2. When calibrating the 75 kV breakpoint for film screen 2, DO NOT adjust the AEC board gain pot. mAs adjustments for film screen 2 at 75 kV must only be made by varying the 75 kV breakpoint calibration numbers.**
37.	Repeat steps 10 to 35 for **FILM SCREEN 3**, except: **1. Film screen 3 must be the highest film speed.** **2. When calibrating the 75 kV breakpoint for film screen 3, DO NOT adjust the AEC board gain pot. mAs adjustments for film screen 3 at 75 kV must only be made by varying the 75 kV breakpoint calibration numbers.**

3D.6.0 AEC CALIBRATION (TABLE BUCKY) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
38.	Select **<<** to return to the **AEC CALIBRATION** menu.		

3D.7.0 SHORT AEC TIME COMPENSATION

Use these steps to perform the short AEC exposure time compensation.

Step	Action
	THESE STEPS ONLY APPLY IF AEC EXPOSURES LESS THAN APPROXIMATELY 15 MS ARE REQUIRED, AND THE AEC BOARD HAS SHORT AEC TIME ADJUSTMENT POTS.
1.	Select the image receptor to be short AEC time compensated, i.e. table Bucky.
2.	Select the highest film speed used on the selected receptor, and then select **75** kV.
3.	Set the mA per table 3D-10 for the film speed being used. Reinstall the absorber as per table 3D-10 for the 75 kV breakpoint.
4.	Make an exposure and confirm the mAs readings as previously recorded in table 3D-11.
5.	Increase the mA such as to decrease the AEC exposure time to approximately 10 ms.
6.	Adjust the short AEC time compensation pot for the AEC channel being calibrated such that the mAs is approximately the same as previously recorded (step 4).
7.	Increase the mA again such as to decrease the AEC exposure time to approximately 6 ms (but not less).
8.	Adjust the short AEC time compensation pot for the AEC channel being calibrated such that the mAs is approximately the same as it was in step 6.
9.	The short AEC time compensation adjustments affect the AEC calibration at longer exposure times. Therefore, it may now be necessary to readjust the gain pot (at 75 kV) for the AEC channel being calibrated to restore the mAs values to the values previously recorded in table 3D-11. Ensure that the absorber thickness and mA values are as per table 3D-10 when readjusting the AEC gain pot.
10.	Using 75 kV exposures, films should be exposed and developed, and the O.D. checked at AEC exposure times of approximately 6 ms and approximately 100 ms. If the film density is not acceptable at both short and long AEC exposure times, it will be necessary to iterate the adjustments of both the short AEC time compensation pot and the AEC gain pot by repeating steps 3 to 8.
11.	Repeat steps 1 to 10 for each image receptor (AEC channel) to be short AEC time compensated.

3D.8.0 AEC DENSITY CALIBRATION

The **DENS. SETUP** menus for the membrane console are shown below.

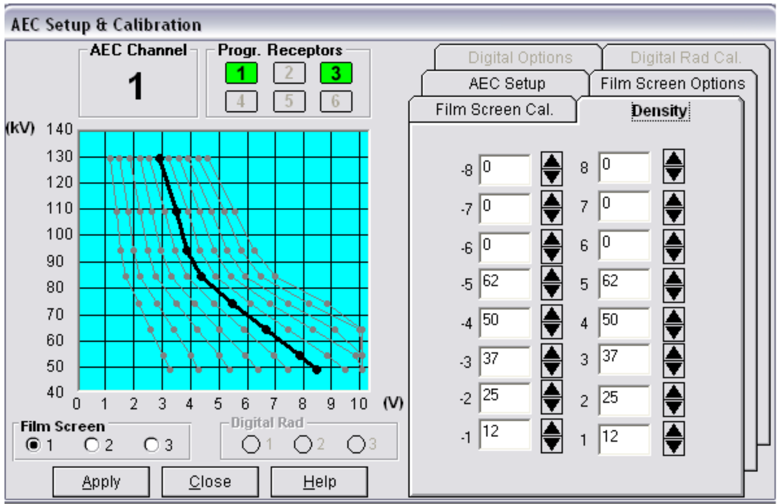
* DENS. SETUP *		
-8:	---	
-7:	---	
-6:	---	+
-5:	62%	-
<<		>>

* DENS. SETUP *		
-4:	50%	
-3:	37%	
-2:	25%	+
-1:	12%	-
<<		>>

* DENS. SETUP *		
+1:	12%	
+2:	25%	
+3:	37%	+
+4:	50%	-
<<		>>

* DENS. SETUP *		
+5:	62%	
+6:	---	
+7:	---	+
+8:	---	-
<<		RETURN

3D.8.0 AEC DENSITY CALIBRATION (Cont)



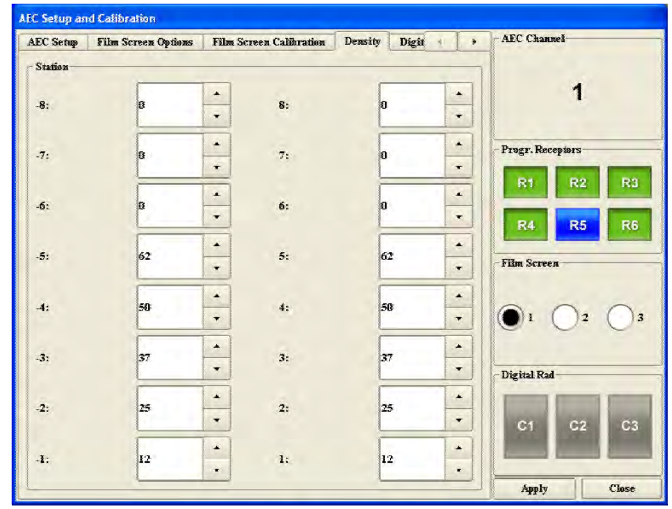


Figure 3D-13a - PC GenWare® ***Figure 3D-13b - Touchscreen GenWare®***

AEC Setup & Calibration window, Density tab

Please note the following points regarding density calibration:

- Up to eight density plus and eight density minus steps are available. If ± 8 density steps are not required, the unwanted density steps may be programmed out per the procedure below. For example, if only ± 5 density steps are desired, then density steps ± 6, 7, 8 may be deprogrammed.
- Once the desired number of ± density steps are known, the relative minimum and maximum mAs values must be determined. Typically the minimum density step will result in half (50%) of the nominal mAs (dose) and the maximum density step will typically give double (100% increase) the nominal mAs (dose). The nominal mAs is the value that was recorded at 0 density in table 3D-11.
- The relative mAs change per density step must be determined next. To do this, note the relative minimum and maximum mAs as determined above (i.e. 50% at min density and 100% increase at max density), then calculate the number of - density steps and the number of + density steps that will be required.

  The relative mAs change between density steps will then be the minimum density (i.e. 50) divided by the number of density minus steps or the maximum density (i.e. 100) divided by the number of density plus steps. This will yield the required mAs increment for each density minus step and for each density plus step respectively.

  For ± 8 density steps, this gives a mAs decrease of 6.25% per density minus step (8 steps x 6.25% per step = 50% mAs at -8 density) or a mAs increase of 12.5% per density plus step (8 steps x 12.5% per step = 100% mAs increase at +8 density).

3D.8.0 AEC DENSITY CALIBRATION (Cont)

Refer to table 3D-12 for two typical examples of density steps vs. calibration numbers. For 8 minus density steps the mAs decrease is 6.25% per step, and for 8 + density steps the mAs increase is 12.5% per step as per the example calculation above.

For 5 minus density steps the mAs decrease is 10% per step, and for 5 + density steps the mAs increase is 20% per step.

DENSITY STEP	CALIBRATION NUMBER (- 8 DENSITY = HALF THE DOSE, +8 DENSITY = DOUBLE THE DOSE)	DENSITY STEP	CALIBRATION NUMBER (- 5 DENSITY = HALF THE DOSE, +5 DENSITY = DOUBLE THE DOSE)
-8	50		
-7	44		
-6	38		
-5	31	-5	50
-4	25	-4	40
-3	19	-3	30
-2	13	-2	20
-1	6	-1	10
0 DENSITY: SHOWN FOR REFERENCE ONLY.			
+1	13	+1	20
+2	25	+2	40
+3	38	+3	60
+4	50	+4	80
+5	63	+5	99
+6	75		
+7	88		
+8	99		

Table 3D-12: Example density values

3D.8.0 AEC DENSITY CALIBRATION (Cont)

Use these steps to perform AEC density calibration.

Step	Action		
1.	Place the absorber (with thickness selected for 75 kV per table 3D-10) in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
2.	Select **DENSITY SETUP**.	Select the **Density** tab.	Select the **Density** tab.
3.	Select **75** kV via the console.	Select **75** kV via GenWare®.	Select **75** kV via GenWare®.
4.	Referring to table 3D-11, note the mAs at 75 kV for film screen 1. This is the mAs required to achieve 0 density.	Referring to table 3D-11, note the mAs at 75 kV for film screen 1. This is the mAs required to achieve 0 density.	Referring to table 3D-11, note the mAs at 75 kV for film screen 1. This is the mAs required to achieve 0 density.
5.	Determine the highest density minus step to be used. If there will be unused density steps, i.e. **–8**, **-7**, **-6**, these density steps must be disabled by setting them to **--**. This is done by using the **–** button to scroll down until the **--** symbol is displayed.	Determine the highest density minus step to be used. If there will be unused density steps, i.e. **–8**, **-7**, **-6**, these density steps must be disabled by setting them to **0**.	Determine the highest density minus step to be used. If there will be unused density steps, i.e. **–8**, **-7**, **-6**, these density steps must be disabled by setting them to **0**.
6.	Select the highest density minus step that will be used, i.e. **–5**. Use the **+** or **–** buttons to set the calibration number for that step to the desired relative density value (example **50,** this will give approximately 1/2 the density.	For the highest density minus step that will be used, i.e. **–5**, enter the desired relative density value (example **50,** this will give approximately 1/2 the density.	For the highest density minus step that will be used, i.e. **–5**, enter the desired relative density value (example **50,** this will give approximately 1/2 the density.
7.	Make an exposure and confirm that the measured mAs is approximately the desired value.	Make an exposure and confirm that the measured mAs is approximately the desired value.	Make an exposure and confirm that the measured mAs is approximately the desired value.
8.	If the measured mAs is not as expected, adjust the calibration number and repeat the previous step.	If the measured mAs is not as expected, adjust the calibration number and repeat the previous step.	If the measured mAs is not as expected, adjust the calibration number and repeat the previous step.
9.	In the following steps, you will need to scroll back and forth between the **DENS. SETUP** menus using the **>>** and **<<** buttons in order to access the required density steps.		

3D.8.0 AEC DENSITY CALIBRATION (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
10.	Select the next density step (i.e. **- 4**) and enter the appropriate calibration number for that step. Then repeat steps 7 and 8.	Select the next density step (i.e. **- 4**) and enter the appropriate calibration number for that step. Then repeat steps 7 and 8.	Select the next density step (i.e. **- 4**) and enter the appropriate calibration number for that step. Then repeat steps 7 and 8.
11.	Repeat the previous step for each remaining density minus step.	Repeat the previous step for each remaining density minus step.	Repeat the previous step for each remaining density minus step.
12.	Determine the highest density plus step to be used. If there will be unused density steps, i.e. **+8**, **+7**, **+6**, these density steps must be disabled by setting them to **--**. This is done by using the **–** button to scroll down until the **--** symbol is displayed.	Determine the highest density plus step to be used. If there will be unused density steps, i.e. **+8**, **+7**, **+6**, these density steps must be disabled by setting them to **0**.	Determine the highest density plus step to be used. If there will be unused density steps, i.e. **+8**, **+7**, **+6**, these density steps must be disabled by setting them to **0**.
13.	Select the highest density plus step that will be used, i.e. **+5**. Use the **+** or **–** buttons to set the calibration number for that step to the desired relative density value (example **99,** this will give approximately double the density).	For the highest density plus step that will be used, i.e. **+5**, enter the desired relative density value (example **99,** this will give approximately double the density).	For the highest density plus step that will be used, i.e. **+5**, enter the desired relative density value (example **99,** this will give approximately double the density).
14.	Make an exposure and confirm that the measured mAs is approximately the desired value.	Make an exposure and confirm that the measured mAs is approximately the desired value.	Make an exposure and confirm that the measured mAs is approximately the desired value.
15.	If the measured mAs is not as expected, adjust the calibration number and repeat the previous step.	If the measured mAs is not as expected, adjust the calibration number and repeat the previous step.	If the measured mAs is not as expected, adjust the calibration number and repeat the previous step.
16.	Select the next lowest density step (i.e. **+4**) and enter the appropriate calibration number for that step. Then repeat steps 14 and 15.	Select the next lowest density step (i.e. **+4**) and enter the appropriate calibration number for that step. Then repeat steps 14 and 15.	Select the next lowest density step (i.e. **+4**) and enter the appropriate calibration number for that step. Then repeat steps 14 and 15.
17.	Repeat the previous step for each remaining density plus step.	Repeat the previous step for each remaining density plus step.	Repeat the previous step for each remaining density plus step.
18.	Press **<<** or **RETURN** as required to return to the **AEC CALIBRATION** menu.		

3D.9.0 RLF COMPENSATION

The following points should be noted regarding RLF compensation. RLF compensation is normally only needed if special techniques are used that result in AEC exposures greater than 100 ms.

- If perfect, film would provide linear density changes with linearly increasing exposure times. In reality, at longer exposures, film effectively becomes slower. This effect is known as reciprocity law failure. To compensate, exposure times must be increased at longer exposures.
  This compensation is achieved by increasing the AEC reference voltage at longer exposure times. RLF compensation is applied to three ranges (50-500 ms, 500-1000 ms, and 1000- 1500 ms) as shown below.
  The examples below are not meant to represent actual RLF compensation percentages in your installation. Actual values will need to be determined per the procedure following.
- Between 0 and 50 ms no RLF compensation is applied. Per figure 3D-14, the AEC reference voltage is constant at 1 unit between 0 and 50 ms.
- At 50 ms, RLF compensation = **10%** is applied. This means that the reference voltage will increase by 10% between 50 ms and 500 ms in a linear fashion. At 500 ms the reference voltage is then 1.0 X 1.10 = 1.10 units.
- At 500 ms, RLF compensation = **20%** is applied. This means that the reference voltage will increase by 20% between 500 ms and 1000 ms in a linear fashion. At 1000 ms the reference voltage is then 1.10 X 1.20 = 1.32 units.
- At 1000 ms, RLF compensation = **30%** is applied. This means that the reference voltage will increase by 30% between 1000 ms and 1500 ms in a linear fashion. At 1500 ms the reference voltage is then 1.32 X 1.30 = 1.72 units
- The rate of increase of the reference voltage beyond 1500 ms will be constant, up to limit of the B.U.T. (backup timer).
- The compensation curve resulting from the RLF values described above is depicted in the graph below.

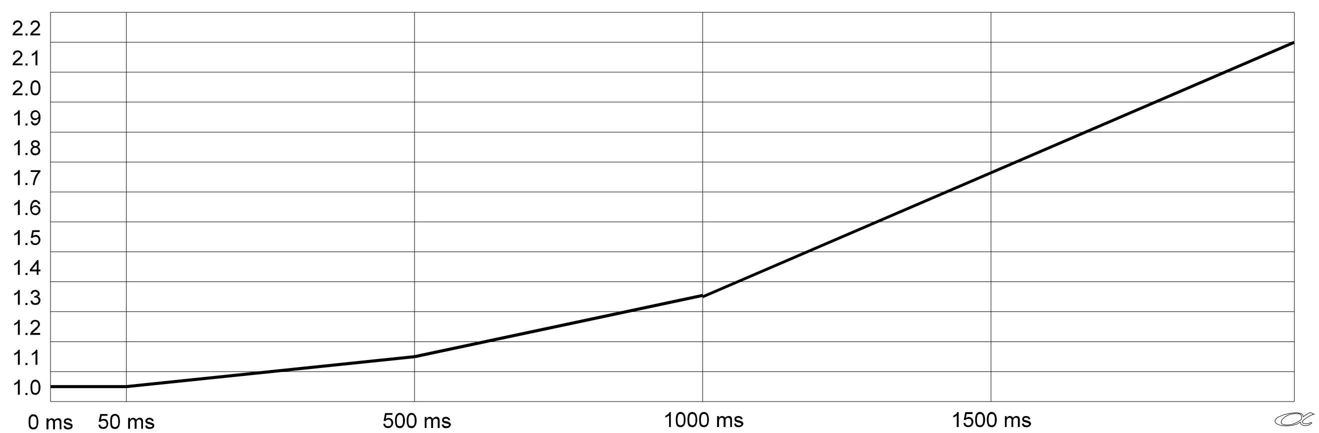
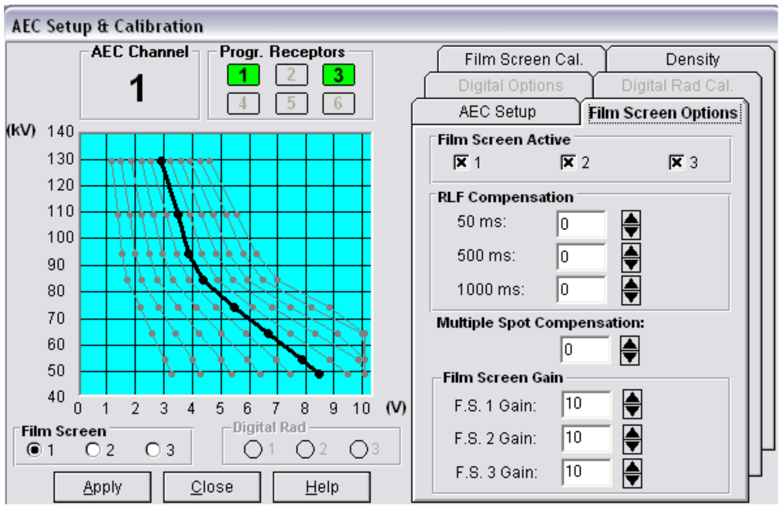


Figure 3D-14: Example RLF compensation curve

3D.9.0 RLF COMPENSATION (Cont)

The **RLF COMP** menu for the membrane console is shown below.

```
                * RLF COMP, F/S1 *
50MSEC:    0%
500MSEC:    0%
1000MSEC:    0%                                 +
                                                -
        <<
```



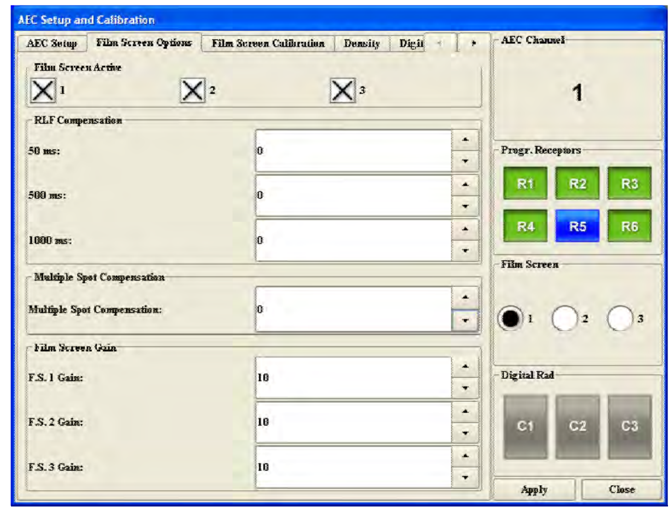


Figure 3D-15a - PC GenWare® *Figure 3D-15b - Touchscreen GenWare®*

AEC Setup & Calibration window, Film Screen Options tab

Use these steps to perform RLF compensation.

Step	Action
1.	Place the absorber (with thickness selected for 75 kV per table 3D-10) in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.
2.	Select the slowest film screen combination to compensate. This will normally be **FILM SCREEN 1.**

3D.9.0 RLF COMPENSATION (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	Press **>>.**	Select the **Film Screen Options** tab.	Select the **Film Screen Options** tab.
4.	Select **RLF COMPENSATION.**		
5.	From the **RLF COMP** menu, select **50MSEC** and set the value to **0** using the **+** or **-** buttons.	Under **RLF Compensation**, set the **50 ms** value to **0.**	Under **RLF Compensation**, set the **50 ms** value to **0.**

Step	Action
6.	Select mA appropriate to the film speed i.e. 100 mA for 100 speed film.
7.	Make an exposure and adjust the mA to give an exposure time of approximately 50 ms.
8.	Load a test cassette with fresh film and install it in the image receptor.
9.	Make an exposure using the techniques per step 7. Record the mAs, then develop the film.
10.	Note the O.D. This should be within 10% of the O.D. that was recorded during AEC calibration.
11.	Make an exposure and reduce the mA to give an exposure time of approximately 500 ms.
12.	Make an exposure using the techniques per the previous step. Record the mAs.
13.	Enter an RLF offset at **50MSEC** (membrane console) / **50 ms** GenWare® to give a mAs increase of approximately **10**%.
14.	Load a test cassette with fresh film and install it in the image receptor. Make an exposure and develop the film.
15.	If the measured O.D. is not within 5% of the value in step 10, adjust the 50 ms RLF compensation value as appropriate.
16.	Repeat steps 14 and 15 until the required O.D. is achieved.
17.	Make an exposure and reduce the mA to give an exposure time of approximately 1000 ms.
18.	Select **500MSEC** (membrane console) / **500 ms** GenWare®, and set the value to **0**.
19.	Make an exposure using the techniques per step 17. Record the mAs.
20.	Enter an RLF offset at **500MSEC** (membrane console) / **500 ms** GenWare® to give a mAs increase of approximately **20**%.
21.	Load the test cassette with fresh film and install it in the image receptor. Make an exposure and develop the film.
22.	If the measured O.D. is not within 5% of the value in step 10, adjust the 500 ms RLF offset value as appropriate.
23.	Repeat steps 21 and 22 until the desired density is achieved.
	THE FOLLOWING STEPS ONLY APPLY IF TECHNIQUES ARE USED RESULTING IN AEC EXPOSURE TIMES GREATER THAN APPROXIMATELY 1500 MS.
24.	Make an exposure and reduce the mA such as to give an exposure time of approximately 1500 ms.
25.	Select **1000MSEC** (membrane console) / **1000 ms** GenWare®, and set the value to **0**.

3D.9.0 RLF COMPENSATION (Cont)

Step	Action		
26.	Make an exposure using the techniques per step 24. Record the mAs.		
27.	Enter an RLF offset at **1000MSEC** (membrane console) / **1000 ms** GenWare® to give a mAs increase of approximately **30**%.		
28.	Load the test cassette with fresh film and install it in the image receptor. Make an exposure and develop the film.		
29.	If the measured O.D. is not within 5% of the value in step 10, adjust the 1000 ms RLF offset value as appropriate.		
30.	Repeat steps 28 and 29 until the desired density is achieved.		
31.	Repeat steps 2 to 30 for **FILM SCREEN 2** and **FILM SCREEN 3** if required.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
32.	Press **<<** three times to return to the **AEC CALIBRATION** menu.		

3D.10.0 MULTIPLE SPOT COMPENSATION

AEC CAL menu 2 for the membrane console with the **MULT. SPOT COMP** function is shown below.

* AEC CAL, F/S1 *		
110KV: 34.0		
130KV: 28.0		
RLF COMPENSATION		+
MULT. SPOT COMP: 0%		-
<<		

In GenWare®, the multiple-spot compensation function is included in the **Film Screen Options** tab (figure 3D-15).

- Multiple-spot compensation may be required when doing multiple exposures on a single film. In this mode of serial recording, the X-ray field is usually coned down to a small area. Due to the lack of scatter and possible AEC field cutoff, an AEC density offset may be added if required. This offset is known as multiple-spot compensation.
- In order to activate the multiple-spot compensation feature, the R & F table must supply a closed dry contact when the SFD is operated in multi-spot mode. The multi-spot input to the generator is at TB5 pins 11 and 12 on the room interface board.

Use these steps to perform the multiple-spot compensation.

Step	Action		
1.	Place the absorber (with thickness selected for 85 kV per table 3D-10) in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.		
2.	Select the slowest film screen combination to compensate. This will normally be **FILM SCREEN 1.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	Press **>>.**		
4.	Select **MULT SPOT COMP.**	Select the **Film Screen Options** tab.	Select the **Film Screen Options** tab.
5.	Set the **MULT SPOT COMP** value to **0%** using the **+** or **-** buttons.	Set the **Multiple Spot Compensation** value to **0.**	Set the **Multiple Spot Compensation** value to **0.**
6.	Select **85** kV via the console.	Select **85** kV via GenWare®.	Select **85** kV via GenWare®.
7.	Select mA appropriate for the film speed per table 3D-10.		
8.	Load the test cassette with fresh film and install it in the SFD.		
9.	Make an exposure and record the mAs, then develop the film.		

3D.10.0 MULTIPLE SPOT COMPENSATION (Cont)

Step	Action		
10.	Verify that the film is evenly exposed, and that the O.D. is the desired value.		
11.	Enable the SFD multi-spot function, then make several exposures and record the mAs.		
12.	Develop the film and record the O.D. for each exposure.		
13.	If the measured optical densities are not within 5% of the desired value, enter a multi-spot compensation offset percentage that increases or decreases the mAs as appropriate.		
14.	Repeat steps 8 to 13 until the desired O.D. is achieved on all exposures.		
15.	Repeat steps 2 to 14 for **FILM SCREEN 2** and **FILM SCREEN 3** if required.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
16.	Press **<<** twice to return to the **AEC CALIBRATION** menu.		

3D.11.0 AEC CALIBRATION (WALL BUCKY)

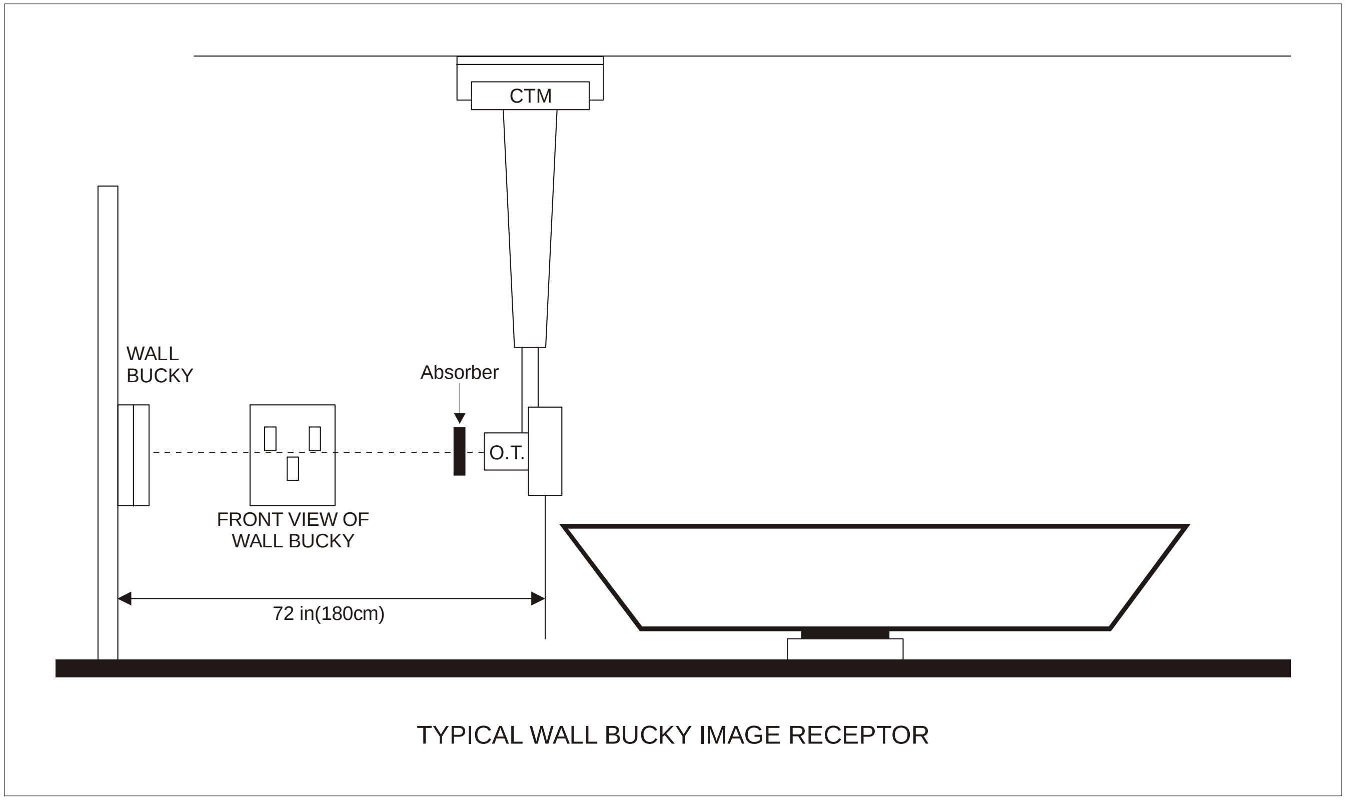


Figure 3D-16: Equipment setup for wall Bucky AEC calibration

Please note the following points regarding wall Bucky calibration:

- If the wall Bucky is dedicated to chest radiography, a focused grid with a 10:1 or 12:1 ratio should be used along with an SID of 72 in. (180 cm).
- If the wall Bucky will be used for conventional as well as chest radiography, then two grids should ideally be used. See the note at the bottom of this page.

A reasonable compromise if a single grid must be used is a 10:1 ratio, 60 in. (150 cm) grid.

3D.11.0 AEC CALIBRATION (WALL BUCKY) Cont

NOTE: ***SINCE MOST WALL BUCKYS ARE USED AT 40 AND 72 IN. (100 AND 180 CM) SID, THE GRID MUST BE CHOSEN WITH CARE WITH RESPECT TO CUT-OFF.***

A TYPICAL GRID WILL HAVE AN 8:1 RATIO, WITH 85 LINE PAIR / INCH OR 10:1 RATIO WITH 150 LINE PAIR / INCH (STATIONARY).

TYPICALLY, 400 SPEED FILM SCREEN WILL BE USED WITH 90 SECOND PROCESSING.

Grid Absorption

The following information may aid in selecting a grid and / or estimating the mAs if required: The percentages listed are approximate.

A 10:1 ratio 60 in. (150 cm) focused grid will exhibit the following absorption when measured 5 in. (13 cm) from center:
At 72 in. (180 cm) absorption = 18%
At 40 in. (100 cm) absorption = 40%

A 12:1 ratio 60 in. (150 cm) focused grid will exhibit the following absorption when measured 5 in. (13 cm) from center:
At 72 in. (180 cm) absorption = 20%
At 40 in. (100 cm) absorption = 50%

A 10:1 ratio 72 in. (180 cm) focused grid will exhibit the following absorption when measured 5 in. (13 cm) from center:
At 40 in. (100 cm) absorption = 65%

A 12:1 ratio 72 in. (180 cm) focused grid will exhibit the following absorption when measured 5 in. (13 cm) from center:
At 40 in. (100 cm) absorption = 75%

A 10:1 ratio 40 in. (100 cm) focused grid will exhibit the following absorption when measured 5 in. (13 cm) from center:
At 72 in. (180 cm) absorption = 65%

A 12:1 ratio 40 in. (100 cm) focused grid will exhibit the following absorption when measured 5 in. (13 cm) from center:
At 72 in. (180 cm) absorption = 75%

3D.11.0 AEC CALIBRATION (WALL BUCKY) Cont

NOTE: ***BREAKPOINT CALIBRATIONS MAY PREVIOUSLY HAVE BEEN DONE FOR ALL THREE FILM SCREEN COMBINATIONS DURING TABLE BUCKY AEC CALIBRATION. IF SO, THE REMAINING IMAGE RECEPTORS MUST USE THE CALIBRATION CURVES PREVIOUSLY ESTABLISHED FOR THOSE FILM SCREENS.***

IF A SPARE FILM SCREEN COMBINATION IS AVAILABLE FOR WALL BUCKY USE, IT IS SUGGESTED THAT TWO RECEPTOR SELECTOR BUTTONS ON THE CONSOLE BE ASSIGNED TO SELECT THE WALL BUCKY. THE FIRST WALL BUCKY SELECTOR SHOULD BE USED FOR 40 IN. (100 CM) SID'S WITH THE APPROPRIATE PREVIOUSLY CALIBRATED FILM SCREEN. THE SECOND WALL BUCKY SELECTOR SHOULD THEN BE USED WITH THE SPARE FILM SCREEN AT 72 IN. (180 CM) SID'S.

THIS METHOD WILL ALLOW THE GRID TO BE OPTIMIZED FOR EACH SID, AS A SEPARATE DEDICATED FILM SCREEN WITH ITS OWN CALIBRATION CURVE CAN BE ASSIGNED TO THE 72 IN. (180CM) SID.

Use these steps to perform the wall Bucky AEC calibration.

Step	Action
	Steps 1 to 15 apply only if using one receptor select button for both SID's, using previously calibrated film screens.
1.	Set up the X-ray tube stand as shown in figure 3D-16.
2.	Align the tube stand and wall Bucky such that the central ray is centered relative to the image receptor.
3.	Open up the collimator to expose all three fields of the AEC pickup. Ensure that the central ray remains centered relative to the image receptor.
4.	Place the absorber (with thickness selected for 75 kV per table 3D-10) in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.
5.	Select the wall Bucky image receptor.
6.	Select the slowest film screen used for the wall Bucky, then select the appropriate mA for that film screen per table 3D-10 (example 320 mA for 100 speed film). Select 75 kV, large focus, center field.
7.	Make an exposure and note the mAs.
8.	Referring to table 3D-11, note the previously established mAs at the 75 kV breakpoint for the film speed being calibrated.
9.	Adjust the gain potentiometer on the AEC board for the channel that is connected to the wall Bucky while taking exposures until the mAs noted in the previous step is obtained. ***DO NOT READJUST THE GAIN POT FOR ANY PREVIOUSLY CALIBRATED CHANNELS.***
10.	Load the test cassette with fresh film and install it in the image receptor. Using the same technique as in the previous step, expose the film and develop it.
11.	Measure the O.D. The desired value should have been previously recorded in a copy of table 3D-14.

3D.11.0 AEC CALIBRATION (WALL BUCKY) Cont

Step	Action
12.	If the measured O.D. is not the desired value, adjust the gain pot to increase or decrease the density, then repeat the previous two steps. Do not readjust the kV breakpoints that were previously calibrated.
13.	Change the SID to 40 in. (100 cm) and repeat steps 10 to 12. Adjust the gain pot if necessary to achieve an acceptable compromise between both SID's.
14.	Verify the O.D. at a range of different kV's.
15.	Press **<<** as required to return to the **GEN CONFIGURATION** menu (membrane console).
	Steps 16 to 21 apply only if using two receptor select buttons (one for each SID), using one previously calibrated film screen and one uncalibrated film screen.
16.	Select the wall Bucky image receptor via the selector configured for the 40 in. (100 cm) SID.
17.	Repeat steps 1 to 12 at the 40 in. (100 cm) SID position using the appropriate previously calibrated film screen.
18.	Verify the O.D. at a range of different kV's.
19.	Select the wall Bucky image receptor via the selector configured for the 72 in. (180 cm) SID.
20.	Calibrate the film screen assigned to this SID as per the table Bucky procedure. The AEC calibration pot must not be readjusted, as it was calibrated at the 40 in. (100 cm) SID. All breakpoints, including the 75 kV breakpoint, are to be calibrated by adjusting the calibration numbers ONLY.
21.	Press **<<** and **EXIT** as required to return to the **GEN CONFIGURATION** menu (membrane console).

3D.12.0 AEC CALIBRATION (AUX, SFD, ETC)

The remaining image receptors are calibrated in a similar manner to the table Bucky receptor. Only the gain pot for that channel is to be adjusted at the slowest film screen used on that receptor. DO NOT READJUST THE GAIN POT FOR PREVIOUSLY CALIBRATED RECEPTORS, AND DO NOT READJUST THE CALIBRATION VALUES IN THE AEC CALIBRATION MENU FOR PREVIOUSLY CALIBRATED FILM SCREENS.

THE **MEMORY** FUNCTION THAT WAS TEMPORARILY CHANGED TO **OFF** EARLIER IN THIS CHAPTER MAY NOW BE RESET TO THE DESIRED VALUE.

3D.13.0 AEC USING A PMT

The PMT wiring for AEC operation is detailed in chapter 3E. The PMT high voltage adjustment using R19 and R24 on the AEC interface board is described in this section.

3D.13.1 Setting the PMT high voltage for AEC

Use these steps to set the PMT high voltage.

Step	Action
	THIS SECTION ONLY APPLIES IF A PMT IS USED FOR AEC.
1.	Set the PMT high voltage (for AEC channel 4) to approximately -650 VDC for AEC operation using R19 on the AEC interface board. AEC channel 4 must be selected in order for R19 to be active. ***USE ONLY TP5 ON THE AEC INTERFACE BOARD (FIGURE 3D-5) FOR THE HV METER GROUND WHEN MEASURING THE PMT HIGH VOLTAGE. CONNECT THE GROUND LEAD FIRST BEFORE MEASURING THE HIGH VOLTAGE.*** **DO NOT ATTEMPT TO MEASURE THIS WITHOUT A SUITABLE METER.**
	THE FOLLOWING STEP ONLY APPLIES IF A PMT IS USED ON AEC CHANNEL 1, 2, OR 3.3
2.	Set the PMT high voltage (for AEC channels 1 to 3) to approximately -650 VDC using R24 on the AEC interface board. AEC channel 1, 2, or 3 must be selected in order for R24 to be active.

3D.14.0 AEC CALIBRATION (DIGITAL APPLICATIONS)

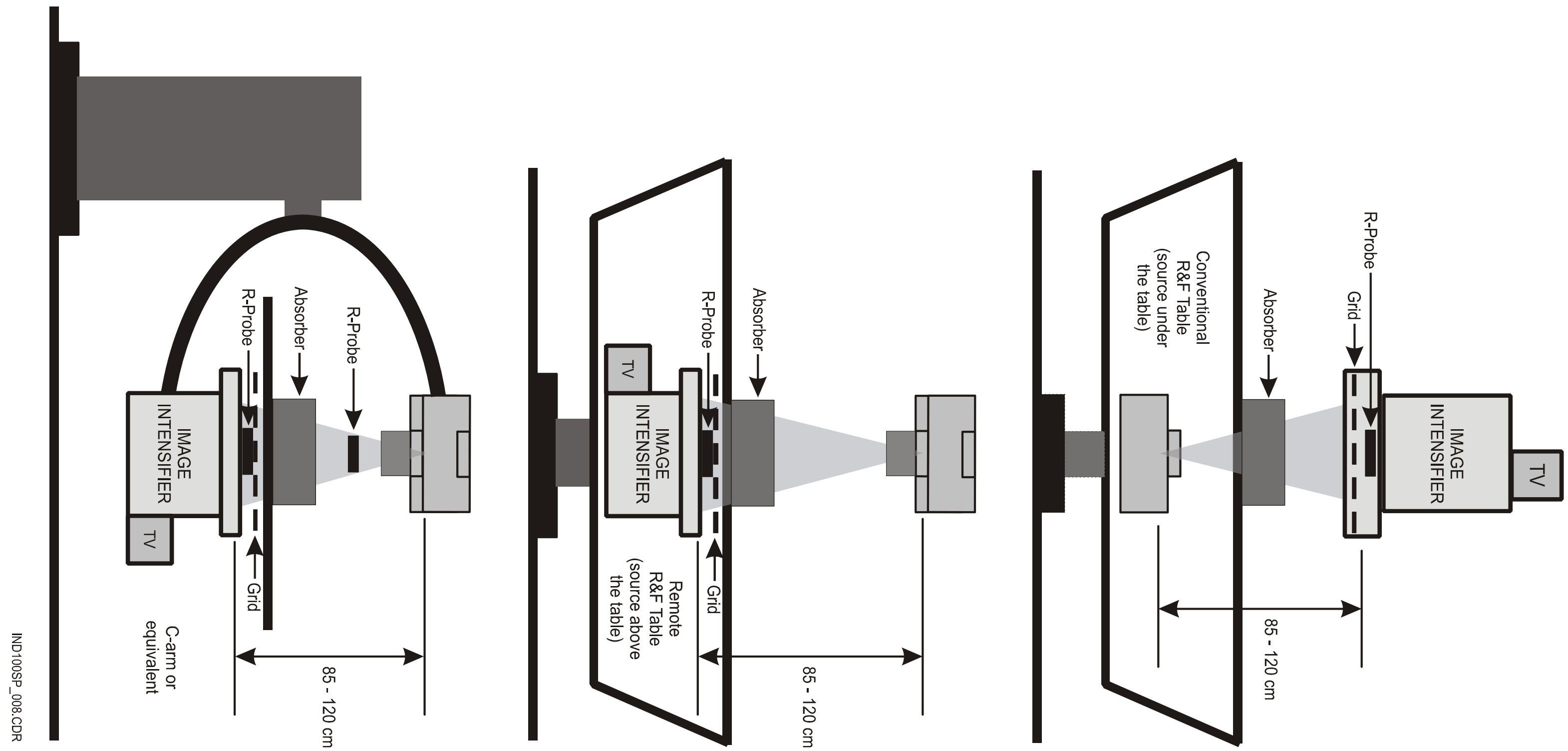


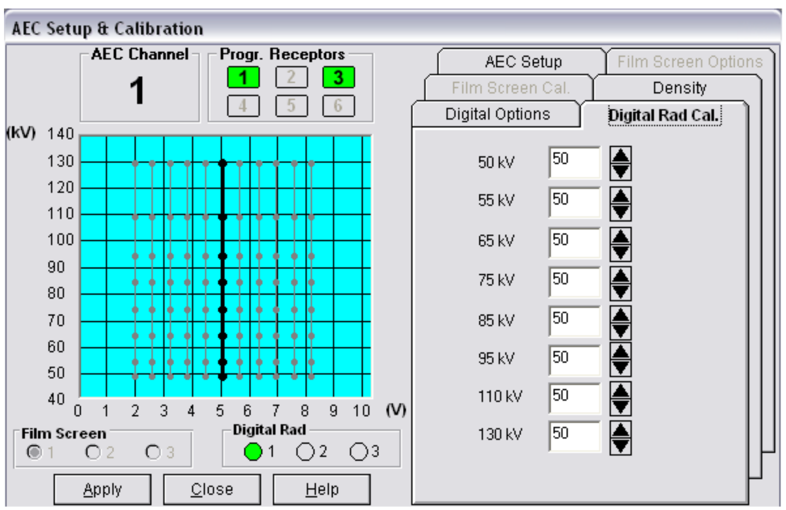
Figure 3D-17: Equipment setup for digital imaging AEC

3D.14.0 AEC CALIBRATION (DIGITAL APPLICATIONS) Cont

The **AEC CAL DR** menus for the membrane console are shown below.

* AEC CAL DR1 *	
50KV: 50.0	85KV: 50.0
55KV: 50.0	95KV: 50.0
65KV: 50.0	+
75KV: 50.0	-
<<	>>

* AEC CAL DR1 *	
110KV: 50.0	
130KV: 50.0	
	+
	-
<<	



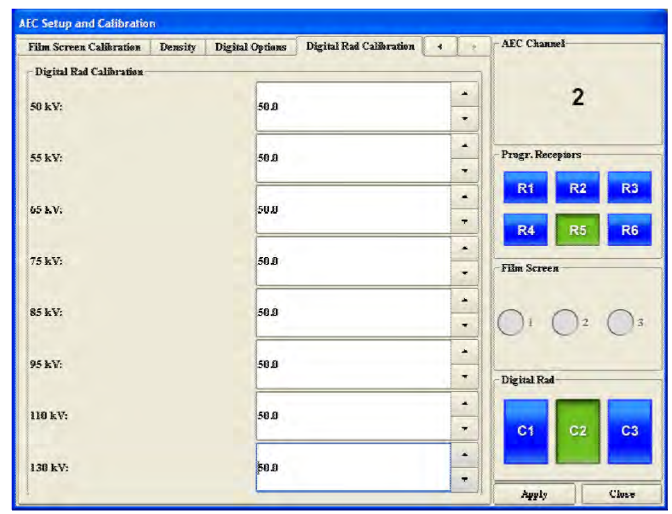


Figure 3D-18a - PC GenWare® *Figure 3D-18b - Touchscreen GenWare®*

AEC Setup & Calibration window, Digital Rad Calibration tab

3D.14.0 AEC CALIBRATION (DIGITAL APPLICATIONS) Cont

The **II SPOT, II DSA** and **II CINE** menus for the membrane console are shown below.

```
                    * II SPOT-C1 *
MAG1 COMP:   0%
MAG2 COMP:   0%
MAG3 COMP:   0%                                  +
                                                 -
      <<
```

```
                    * II DSA-C1 *
MAG1 COMP:   0%
MAG2 COMP:   0%
MAG3 COMP:   0%                                  +
                                                 -
      <<
```

```
                    * II CINE-C1 *
MAG1 COMP:   0%
MAG2 COMP:   0%
MAG3 COMP:   0%                                  +
                                                 -
      <<
```

In GenWare®, the I.I. compensation functions are included in the **Digital Options** tab (figure 3D-9).

3D.14.0 AEC CALIBRATION (DIGITAL APPLICATIONS) Cont

Use these steps to perform the AEC setup for digital applications.

Step	Action		
1.	Set up the radiation probe as per figure 3D-17. Use a dosimeter with sufficient sensitivity to measure the expected dose (typically 150 cc).		
2.	Set up the absorber as shown in figure 3D-17. Start with 20 cm of Lexan. Ensure that the radiation is completely blocked by the absorber. The central ray from the X-ray tube must coincide with the center of the I.I.		
3.	Ensure that an anti-scatter grid, if used, is properly installed. The R-probe must be between the grid and the II input, even if this requires temporary repositioning of the grid.		
4.	Set the SID to the normally used position. This SID must be maintained for the balance of AEC calibration.		
5.	Set the collimator to irradiate an area just beyond the detector circumference.		
6.	Be sure that all compensating filters are out of the active beam.		
7.	Use the largest field of view, i.e. 12 inch in the remaining steps, unless directed otherwise.		
8.	The short exposure time compensation for the AEC channels that will be used with digital applications must be disabled before continuing. To do this, adjust the applicable short AEC time compensation potentiometers to zero by turning the required potentiometers fully <u>clockwise.</u> These are multi-turn potentiometers, and must be turned by as much as 25 turns to reach the zero-ohms limit. **Do not adjust any pots that have previously been calibrated (i.e. for AEC channels using film).**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
9.	Ensure that in the **RECEPTOR SETUP** menu, each receptor has the desired AEC channel assigned to it. Refer to ***RECEPTOR SETUP*** in chapter 3C.	Ensure that in the **Receptor Setup** window, each receptor has the desired AEC channel assigned to it. Refer to ***RECEPTOR SETUP*** in chapter 3C.	Ensure that in the **Receptor Setup** window, each receptor has the desired AEC channel assigned to it. Refer to ***RECEPTOR SETUP*** in chapter 3C.
10.	In the **RECEPTOR SETUP** menu, set **MEMORY** to **NO** for each image receptor. This will ensure that the next receptor being calibrated will not remember the techniques from the previous receptor. The **MEMORY** function may be reset as desired after AEC calibration is completed.	In the **Receptor Setup** window, under the **Receptor Properties** tab, set **Memory** to **Off** for each image receptor. This will ensure that the next receptor being calibrated will not remember the techniques from the previous receptor. The **Memory** function may be reset as desired after AEC calibration is completed.	In the **Receptor Setup** window, under the **Receptor Properties** tab, set **Memory** to **Off** for each image receptor. This will ensure that the next receptor being calibrated will not remember the techniques from the previous receptor. The **Memory** function may be reset as desired after AEC calibration is completed.

3D.14.0 AEC CALIBRATION (DIGITAL APPLICATIONS) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	In the **RECEPTOR SETUP** menu, ensure that the **AEC BACKUP MAS** and **AEC BACKUP MS** are set sufficiently high that the generator backup timer will not terminate the exposure.	In the **Receptor Setup** window, under the **AEC** tab, ensure that the **AEC Back-Up mAs** and **AEC Back-Up ms** are set sufficiently high that the generator backup timer will not terminate the exposure.	In the **Receptor Setup** window, under the **AEC** tab, ensure that the **AEC Back-Up mAs** and **AEC Back-Up ms** are set sufficiently high that the generator backup timer will not terminate the exposure.

NOTE: ***IN THE FOLLOWING SECTIONS, IT IS ASSUMED THAT AEC CHANNELS 2, 3, AND 4 WILL BE USED FOR DIGITAL ACQUISITIONS, DSA ACQUISITIONS, AND CINE ACQUISITIONS RESPECTIVELY.***
THE AEC INPUTS, AEC CURVES, ETC MAY BE REASSIGNED AS REQUIRED, DEPENDING ON THE ACTUAL INSTALLATION.

Digital Rad 1 Curve						
Break point	**Absorber**	**Cal. No.**	**Dose**	**mAs**	**Generator mA**	**Exposure Time**
75 kV	20 cm Lexan	50			250 mA	
65 kV	20 cm Lexan				250 mA	
85 kV	20 cm Lexan				250 mA	
55 kV	15 cm Lexan				160 mA	
65 kV	15 cm Lexan				160 mA	
75 kV	25 cm Lexan	50			250 mA	
85 kV	25 cm Lexan				250 mA	
95 kV	25 cm Lexan				250 mA	
110 kV	25 cm Lexan				250 mA	

Table 3D-13: Breakpoint calibration factors (Digital)

3D.14.0 AEC CALIBRATION (DIGITAL APPLICATIONS) Cont

Digital Rad 2 Curve						
Break point	**Absorber**	**Cal. No.**	**Dose**	**mAs**	**Generator mA**	**Exposure Time**
75 kV	20 cm Lexan	50			320 mA	
65 kV	20 cm Lexan				400 mA	
85 kV	20 cm Lexan				250 mA	
55 kV	15 cm Lexan				160 mA	
65 kV	15 cm Lexan				160 mA	
75 kV	25 cm Lexan	50			400 mA	
85 kV	25 cm Lexan					
95 kV	25 cm Lexan					
110 kV	25 cm Lexan					
Digital Rad 3 Curve						
Break Point	**Absorber**	**Cal. No.**	**Dose**	**mAs**	**Generator mA**	**Exposure Time**
75 kV	20 cm Lexan	50			320 mA	
65 kV	20 cm Lexan					
85 kV	20 cm Lexan					
55 kV	15 cm Lexan					
65 kV	15 cm Lexan					
75 kV	25 cm Lexan	50				
85 kV	25 cm Lexan					
95 kV	25 cm Lexan					
110 kV	25 cm Lexan					

Table 3D-13: Breakpoint calibration factors (Digital) Cont

3D.14.1 AEC Calibration (Digital Acquisitions)

Use these steps to perform the AEC calibration for digital acquisitions.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.		Reselect the **AEC Setup & Calibration** window.	Reselect the **AEC Setup & Calibration** window.
2.	In the **AEC SETUP** menus, ensure that AEC channel 2 is set up to use **DIGITAL RAD** AEC calibration curve **1**. Refer to the section ***INITIAL AEC SETUP*** for details.	Ensure that AEC channel 2 is set up to use **Digital Rad Curve 1**. This selection is under the **Digital Options** tab. Refer to the section ***INITIAL AEC SETUP*** for details.	Ensure that AEC channel 2 is set up to use **Digital Rad Curve 1**. This selection is under the **Digital Options** tab. Refer to the section ***INITIAL AEC SETUP*** for details.
3.	From the **GEN CONFIGURATION** menu, select **AEC CALIBRATION.**		
4.	From the **AEC CALIBRATION** menu, select **DIGITAL RAD 1.**		
5.	Select the image receptor that was configured for digital acquisitions.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
6.	Select the **75KV** breakpoint. Use the **+** or **–** buttons to enter the value **50**.	Select the **Digital Rad Cal.** tab. Enter the value **50** into the **75 kV** dialog box.	Select the **Digital Rad Calibration** tab. Enter the value **50** into the **75 kV** dialog box.
7.	Select 250 mA, large focus, AEC, mag mode **0**.		
8.	Make an exposure and note the dose and mAs.		
9.	Adjust the gain pot on the AEC board to obtain the desired dose, typically 0.88 uGy (100 uR). Record the final dose, mAs, and ms for 75 kV in a copy of table 3D-13.		
10.	Confirm the dose at each kV breakpoint. Adjust the calibration numbers only, not the AEC gain pot. Use absorber and mA values as per table 3D-13, under **Digital Rad 1 Curve.** Record the final calibration number, dose, mAs, and ms for each iteration in a copy of table 3D-13. Some kV values are repeated in order to check AEC tracking with different absorbers.		

3D.14.2 I.I. Mag Compensation (Digital Acquisitions)

Use these steps to perform the II Mag compensation for digital acquisitions.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	Press **<<** as required to return to the **AEC CALIBRATION** menu.		
2.	Press **<<** to return to the **GEN CONFIGURATION** menu.		
3.	Select **AEC SETUP**.	Select the **AEC Setup** tab.	Select the **AEC Setup** tab.
4.	Select **AEC CHANNEL 2.**	Select **Channel Number** = **2**.	Select **Channel Number** = **2**.
5.	Ensure that **MEDIA** = **DIGITAL**. Press **>>**.	Ensure that **Media** = **Digital**.	Ensure that **Media** = **Digital**.
6.	Select **II SPOT COMP.**	Select the **Digital Options** tab.	Select the **Digital Options** tab.
7.	Note the dose at 75 kV per table 3D-13 for the **DIGITAL RAD 1** curve.		
8.	Multiply the dose in step 7 by 1.77 to obtain the required Mag 1 dose. Record this value.		
9.	Multiply the dose in step 7 by 2.25 to obtain the required Mag 2 dose. Record this value.		
10.	Multiply the dose in step 7 by 2.25 to obtain the required Mag 3 dose. Record this value.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	Select **MAG1 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG1 COMP** value such that the mag 1 dose equals the dose noted in step 8.	Under **II Spot Compensation,** set the **MAG 1** value such that the mag 1 dose equals the dose noted in step 8.	Under **II Spot Compensation,** set the **MAG1** value such that the mag 1 dose equals the dose noted in step 8.
12.	Select **MAG2 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG2 COMP** value such that the mag 2 dose equals the dose noted in step 9.	Under **II Spot Compensation,** set the **MAG 2** value such that the mag 2 dose equals the dose noted in step 9.	Under **II Spot Compensation,** set the **MAG2** value such that the mag 2 dose equals the dose noted in step 9.
13.	Select **MAG3 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG3 COMP** value such that the mag 3 dose equals the dose noted in step 10.	Under **II Spot Compensation,** set the **MAG 3** value such that the mag 3 dose equals the dose noted in step 10.	Under **II Spot Compensation,** set the **MAG3** value such that the mag 3 dose equals the dose noted in step 10.
14.	Press **<<** four times to return to the **GEN CONFIGURATION** menu.		

3D.14.3 AEC Calibration (DSA Acquisitions)

Use these steps to perform the AEC calibration for DSA acquisitions.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	In the **AEC SETUP** menus, ensure that AEC channel 3 is set up to use **DIGITAL RAD** AEC calibration curve **2**. Refer to the section ***INITIAL AEC SETUP*** for details.	Ensure that AEC channel 3 is set up to use **Digital Rad Curve 2**. This selection is under the **Digital Options** tab. Refer to the section ***INITIAL AEC SETUP*** for details.	Ensure that AEC channel 3 is set up to use **Digital Rad Curve 2**. This selection is under the **Digital Options** tab. Refer to the section ***INITIAL AEC SETUP*** for details.
2.	From the **GEN CONFIGURATION** menu, select **AEC CALIBRATION.**		
3.	From the **AEC CALIBRATION** menu, select **DIGITAL RAD 2.**		
4.	Select the image receptor that was configured for DSA acquisitions.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Select the **75KV** breakpoint. Use the **+** or **–** buttons to enter the value **50**.	Select the **Digital Rad Cal.** tab. Enter the value **50** into the **75 kV** dialog box, under **Digital RAD**.	Select the **Digital Rad Calibration** tab. Enter the value **50** into the **75 kV** dialog box, under **Digital RAD**.
6.	Select 320 mA, large focus, AEC, mag mode **0**.		
7.	Make an exposure and note the dose and mAs.		
8.	Adjust the gain pot on the AEC board to obtain the desired dose, typically 2.6 uGy (300 uR). Record the final dose, mAs, and ms for 75 kV in a copy of table 3D-13.		
9.	Confirm the dose at each kV breakpoint. Adjust the calibration numbers only, not the AEC gain pot. Use absorber and mA values as per table 3D-13, under **Digital Rad 2 Curve.** Record the final calibration number, dose, mAs, and ms for each iteration in a copy of table 3D-13. Some kV values are repeated in order to check AEC tracking with different absorbers.		

3D.14.4 I.I. Mag Compensation (DSA Acquisitions)

Use these steps to perform the II Mag compensation for DSA acquisitions.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	Press **<<** as required to return to the **AEC CALIBRATION** menu.		
2.	Press **<<** to return to the **GEN CONFIGURATION** menu.		
3.	Select **AEC SETUP**.	Select the **AEC Setup** tab.	Select the **AEC Setup** tab.
4.	Select **AEC CHANNEL 3.**	Select **Channel Number** = **3**.	Select **Channel Number** = **3**.
5.	Ensure that **MEDIA** = **DIGITAL**. Press **>>**.	Ensure that **Media** = **Digital**.	Ensure that **Media** = **Digital**.
6.	Select **II DSA COMP.**	Select the **Digital Options** tab.	Select the **Digital Options** tab.
7.	Note the dose at 75 kV per table 3D-13 for the **DIGITAL RAD 2** curve.		
8.	Multiply the dose in step 7 by 1.77 to obtain the required Mag 1 dose. Record this value.		
9.	Multiply the dose in step 7 by 2.25 to obtain the required Mag 2 dose. Record this value.		
10.	Multiply the dose in step 7 by 2.25 to obtain the required Mag 3 dose. Record this value.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	Select **MAG1 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG1 COMP** value such that the mag 1 dose equals the dose noted in step 8.	Under **II DSA Compensation,** set the **MAG 1** value such that the mag 1 dose equals the dose noted in step 8.	Under **II DSA Compensation,** set the **MAG1** value such that the mag 1 dose equals the dose noted in step 8.
12.	Select **MAG2 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG2 COMP** value such that the mag 2 dose equals the dose noted in step 9.	Under **II DSA Compensation,** set the **MAG 2** value such that the mag 2 dose equals the dose noted in step 9.	Under **II DSA Compensation,** set the **MAG2** value such that the mag 2 dose equals the dose noted in step 9.
13.	Select **MAG3 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG3 COMP** value such that the mag 3 dose equals the dose noted in step 10.	Under **II DSA Compensation,** set the **MAG 3** value such that the mag 3 dose equals the dose noted in step 10.	Under **II DSA Compensation,** set the **MAG3** value such that the mag 3 dose equals the dose noted in step 10.
14.	Press **<<** four times to return to the **GEN CONFIGURATION** menu.		

3D.14.5 AEC Calibration (Cine Acquisitions)

Use these steps to perform the AEC calibration for Cine acquisitions.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	In the **AEC SETUP** menus, ensure that AEC channel 4 is set up to use **DIGITAL RAD** AEC calibration curve **3**. Refer to the section ***INITIAL AEC SETUP*** for details.	Ensure that AEC channel 4 is set up to use **Digital Rad Curve 3**. This selection is under the **Digital Options** tab. Refer to the section ***INITIAL AEC SETUP*** for details.	Ensure that AEC channel 4 is set up to use **Digital Rad Curve 3**. This selection is under the **Digital Options** tab. Refer to the section ***INITIAL AEC SETUP*** for details.
2.	From the **GEN CONFIGURATION** menu, select **AEC CALIBRATION.**		
3.	From the **AEC CALIBRATION** menu, select **DIGITAL RAD 3.**		
4.	Select the image receptor that was configured for cine acquisitions.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Select the **75KV** breakpoint. Use the **+** or **–** buttons to enter the value **50**.	Select the **Digital Rad Cal.** tab. Enter the value **50** into the **75 kV** dialog box, under **Digital RAD**.	Select the **Digital Rad Calibration** tab. Enter the value **50** into the **75 kV** dialog box, under **Digital RAD**.
6.	Select 320 mA, large focus, AEC, mag mode **0**.		
7.	Make an exposure and note the dose and mAs.		
8.	Adjust the gain pot on the AEC board to obtain the desired dose, typically 0.13 uGy (15 uR) / frame. Record the final dose, mAs, and ms for 75 kV in a copy of table 3D-13.		
9.	Confirm the dose at each kV breakpoint. Adjust the calibration numbers only, not the AEC gain pot. Use absorber and mA values as per table 3D-13, under **Digital Rad 3 Curve.** Record the final calibration number, dose, mAs, and ms for each iteration in a copy of table 3D-13. Some kV values are repeated in order to check AEC tracking with different absorbers.		

3D.14.6 I.I. Mag Compensation (Cine Acquisitions)

Use these steps to perform the II Mag compensation for cine acquisitions.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	Press **<<** as required to return to the **AEC CALIBRATION** menu.		
2.	Press **<<** to return to the **GEN CONFIGURATION** menu.		
3.	Select **AEC SETUP**.	Select the **AEC Setup** tab.	Select the **AEC Setup** tab.
4.	Select **AEC CHANNEL 4.**	Select **Channel Number** = **4**.	Select **Channel Number** = **4**.
5.	Ensure that **MEDIA** = **DIGITAL**. Press **>>**.	Ensure that **Media** = **Digital**.	Ensure that **Media** = **Digital**.
6.	Select **II CINE COMP.**	Select the **Digital Options** tab.	Select the **Digital Options** tab.
7.	Note the dose at 75 kV for the **DIGITAL RAD 3** curve.		
8.	Multiply the dose in step 7 by 1.77 to obtain the required Mag 1 dose. Record this value.		
9.	Multiply the dose in step 7 by 2.25 to obtain the required Mag 2 dose. Record this value.		
10.	Multiply the dose in step 7 by 2.25 to obtain the required Mag 3 dose. Record this value.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	Select **MAG1 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG1 COMP** value such that the mag 1 dose equals the dose noted in step 8.	Under **II CINE Compensation,** set the **MAG 1** value such that the mag 1 dose equals the dose noted in step 8.	Under **II CINE Compensation,** set the **MAG1** value such that the mag 1 dose equals the dose noted in step 8.
12.	Select **MAG2 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG2 COMP** value such that the mag 2 dose equals the dose noted in step 9.	Under **II CINE Compensation,** set the **MAG 2** value such that the mag 2 dose equals the dose noted in step 9.	Under **II CINE Compensation,** set the **MAG2** value such that the mag 2 dose equals the dose noted in step 9.
13.	Select **MAG3 COMP**. While making an exposure, use the **+** or **–** buttons to set the **MAG3 COMP** value such that the mag 3 dose equals the dose noted in step 10.	Under **II CINE Compensation,** set the **MAG 3** value such that the mag 3 dose equals the dose noted in step 10.	Under **II CINE Compensation,** set the **MAG3** value such that the mag 3 dose equals the dose noted in step 10.
14.	Press **<<** four times to return to the **GEN CONFIGURATION** menu.		

THE **MEMORY** FUNCTION THAT WAS TEMPORARILY CHANGED TO **OFF** EARLIER IN THIS CHAPTER MAY NOW BE RESET TO THE DESIRED VALUE.

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3D.15.0 AEC OVERVIEW AND BACKGROUND INFORMATION

AEC exposures should normally be kept well under one second. When X-ray techniques are used that result in longer exposures, the film density will not be correct due to failure of reciprocity of the film.

RLF (reciprocity law failure) compensation is provided to compensate for longer AEC exposure times. An offset may be added to each AEC calibration set (each film screen combination) to increase the AEC ON time as exposure time increases. RLF compensation is applied to the following range of times:

- 50 ms to 500 ms.
- 500 ms to 1000 ms.
- 1000 ms and above.

3D.15.1 Film/Screen Response vs. kV

Film screen response to kV is not linear. Therefore, compensation must be provided in order to maintain constant film density as kV is changed for different anatomical studies. By selecting and calibrating various kV breakpoints, the overall system response will be compensated such as to yield a constant film density.

Up to eight breakpoints per film screen combination are available. The eight breakpoints are spread over three kV ranges as shown below:

- Low kV: 50, 55, 65 kV.
- Knee kV: 75 kV.
- High kV: 85, 95, 110, 130 kV.

Refer to figure 3D-19.

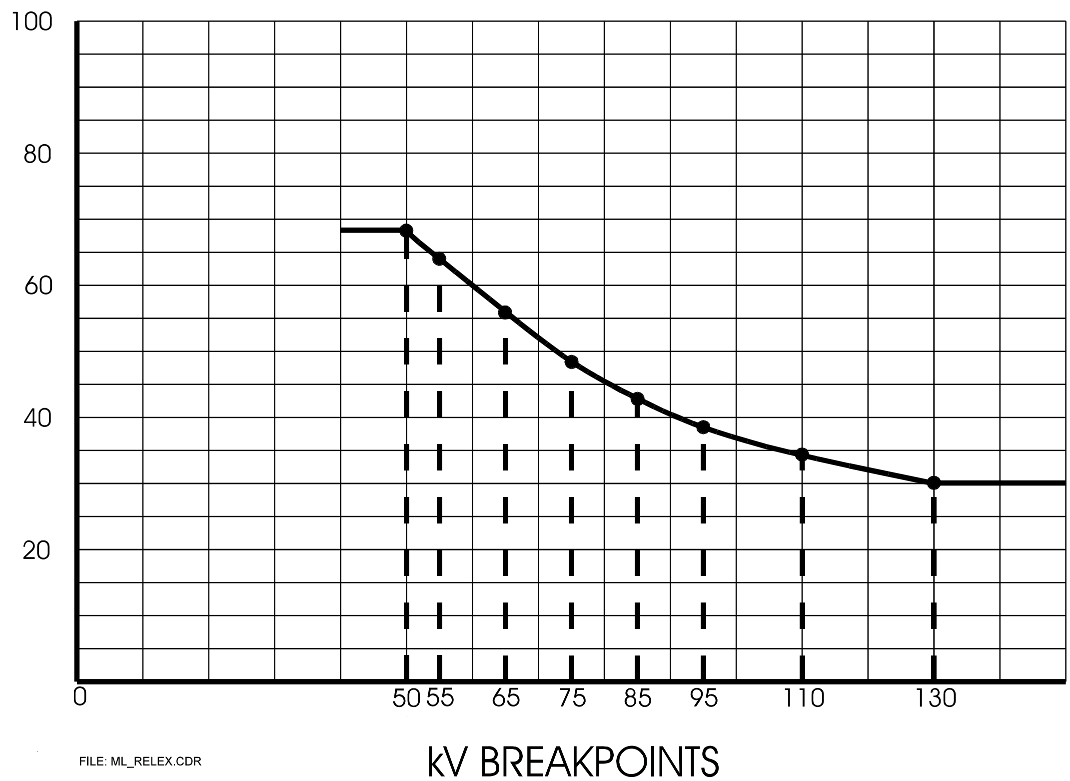

Figure 3D-19: kV vs. relative density

3D.15.2 AEC Calibration Range

Since the Indico 100 family of X-ray generators allows for up to three separate film screen combinations to be calibrated, the following points must be considered:

- The AEC board allows for a zero to a maximum of 10-volt ramp at the comparator input. All AEC signals must fit within this range (for all film / screens, densities, and techniques).
- Most X-ray film-based applications require the use of two or more different film screen combinations, all of which will require different exposure doses.
- Using the slowest film screen combination, the required film input dose will be determined.
- Once this value is determined (during AEC calibration), the density calibration is performed to allow 100% (double the dose) and 50% (half the dose) values. These are typical values, and will determine the maximum required range of the AEC reference voltage (the output from the D/A converter).
- Figure 3D-20 illustrates the different windows required for various film screen combinations.

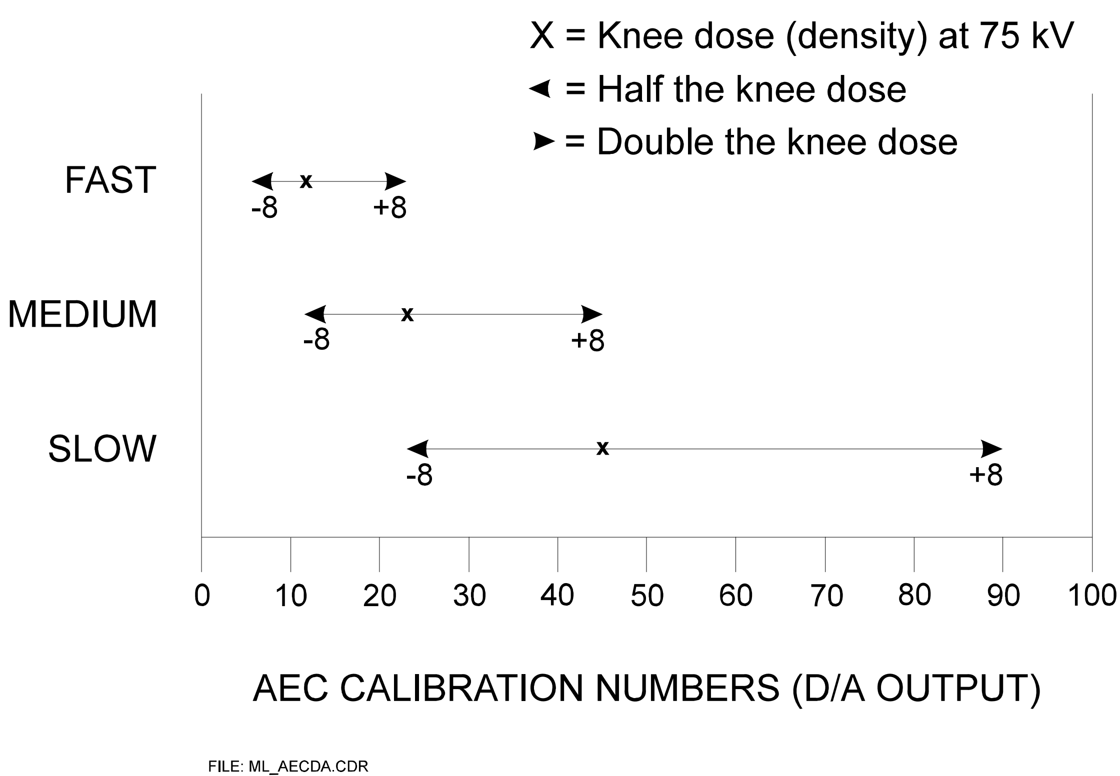

Figure 3D-20: Film/screen speed vs. D/A output

3D.15.3 Multiple Spot Compensation

Separate density compensation is provided when a SFD (Spot Film Device) is used for doing multiple exposures on a single film. In this mode of operation, the X-ray field is usually coned down to a small area. Due to the resulting AEC field cutoff, an AEC offset may be required. This is designated multiple spot compensation.

An external output from the SFD must be provided when multiple spots are requested to enable this function.

3D.15.4 A Typical R&F Room

Figure 3D-21 shows source-image distances and image receptors as used in a typical R&F installation.

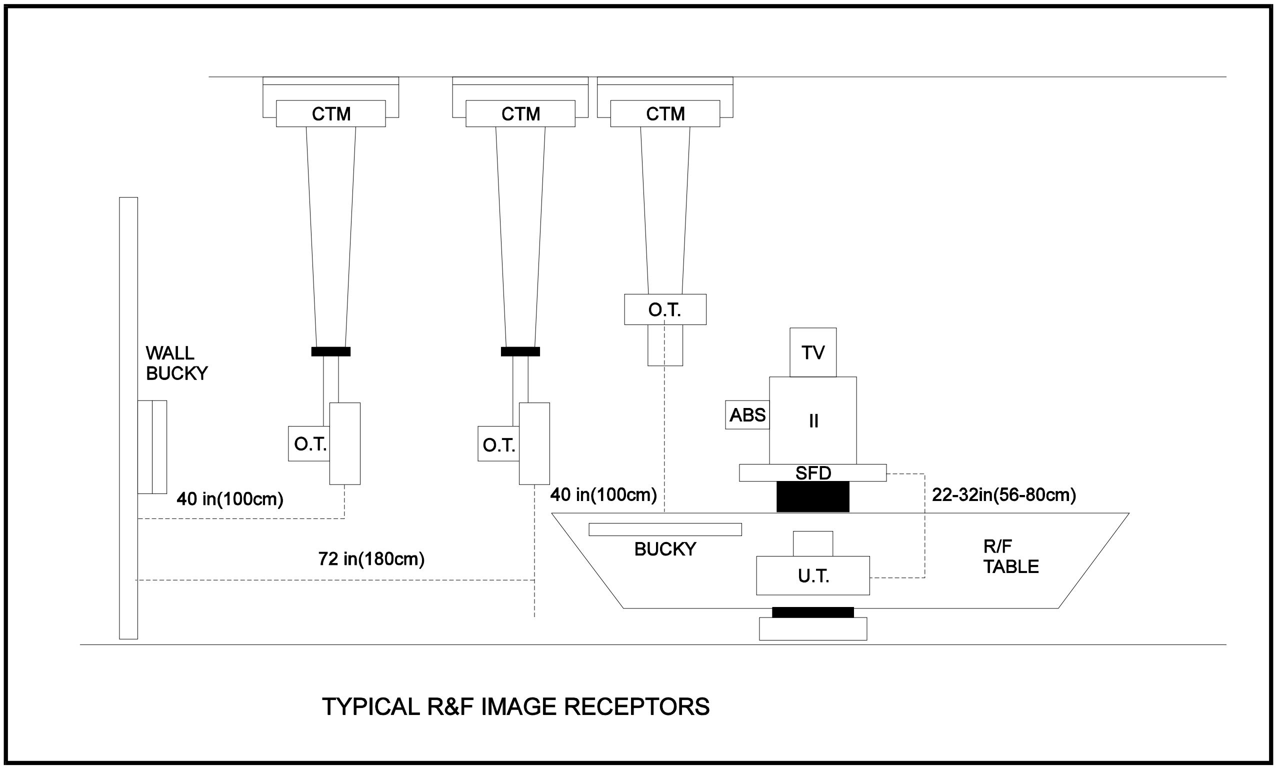

Figure 3D-21: Typical R&F installation

3D.16.0 PRECALIBRATION SETUP

3D.16.1 AEC Setup Worksheet

Before continuing, it is suggested that a copy of the table below be filled in with all required information. Refer to the example AEC setup worksheet on the next page.

FUNCTION		RECEPTOR 1	RECEPTOR 2	RECEPTOR 3	RECEPTOR 4
Film/Screen	1.				
	2.				
	3.				
Nominal optical density:					
Grid ratio/SID:					
Min - max kVp range:					
± Density steps					
Density mAs (dose) change	+%:				
(per step)	-%:				
Chamber type:					
Regulatory AEC dose requirements?					
Is film processing maintained?					
Assigned receptor name:					
Are all cassettes similar?					
Additional notes:					
Additional notes:					

Table 3D-14: AEC setup worksheet

ALL RECEPTORS MUST HAVE THE SAME NUMBER OF DENSITY STEPS AND THE SAME DENSITY DOSE CHANGE PER STEP (DENSITY SETTINGS ARE COMMON TO ALL FILM SCREENS AND RECEPTORS).

3D.16.1 AEC Setup Worksheet (Cont)

Note: ***The example below is supplied for reference only. It does not represent an actual installation.***

FUNCTION		RECEPTOR 1	RECEPTOR 2	RECEPTOR 3	RECEPTOR 4
Film/Screen	1.	Lanex/reg	Lanex/reg	Lanex/reg	PMT/I.I.
	2.	Lanex/med	Lanex/chest		
	3.				
Nominal optical density:		1.2	1.1	1.4	
Grid ratio/SID:		12:1	8:1	10:1	10:1
Min - max kVp range:		60 - 120	65 - 140	80 - 110	70 - 120
± Density steps		± 8	± 8	± 8	± 8
Density mAs (dose) change (per step)	+%:	12.5	12.5	12.5	12.5
	-%:	6.25	6.25	6.25	6.25
Chamber type:		Ion	Solid state	Ion	PMT
Regulatory AEC dose requirements?		Yes	Yes	Yes	Yes
Is film processing maintained?		Yes	Yes	Yes	N/A
Assigned receptor name:		Table	Wall	SFD	Digital
Are all cassettes similar?		Yes	Yes	Yes	N/A
Additional notes:					
Additional notes:					

Table 3D-15: Sample AEC setup worksheet

3D.16.2 AEC Pre-calibration Checks

It is recommended that a copy of the form below be filled in with the required information before attempting AEC calibration.

1.	Verify that the AEC chambers are mounted correctly in the Bucky or spot film device. Note that some chamber types must be physically isolated from equipment ground, refer to figure 3D-22 as an example.	CHECK:
2.	Verify that each AEC chamber / pickup is properly connected to its intended input channel on the AEC board.	CHECK:
3.	Make and type of AEC chamber/pickup:	AEC Ch 1________________ AEC Ch 2________________ AEC Ch 3________________ AEC Ch 4________________
4.	Verify signal grounding for the AEC chamber. The only electrical ground should be at the AEC board in the generator. This applies to the ground braid (shield) for the AEC signal cable and to the ground return conductor(s) in the AEC signal cable.	CHECK:
5.	Before calibrating, verify that the AEC system is functioning. This includes the AEC chambers / devices and the AEC circuits in the generator. Each of the fields on the AEC device must be able to terminate the exposure.	CHECK:
6.	Radiographic techniques to be performed with the equipment (high kV chest, G.I. studies etc)?	
7.	Normal exposure factors used by the customer (typical mAs / kV range)?	

Table 3D-16: Precalibration checklist

3D.16.3 AEC Chamber Installation

Figure 3D-22 illustrates an installed AEC chamber. Note particularly the use of a suitable insulating material to isolate the body of the chamber from the receptor ground. This is required for non-insulated AEC chambers.

3D.16.3 AEC Chamber Installation (Cont)

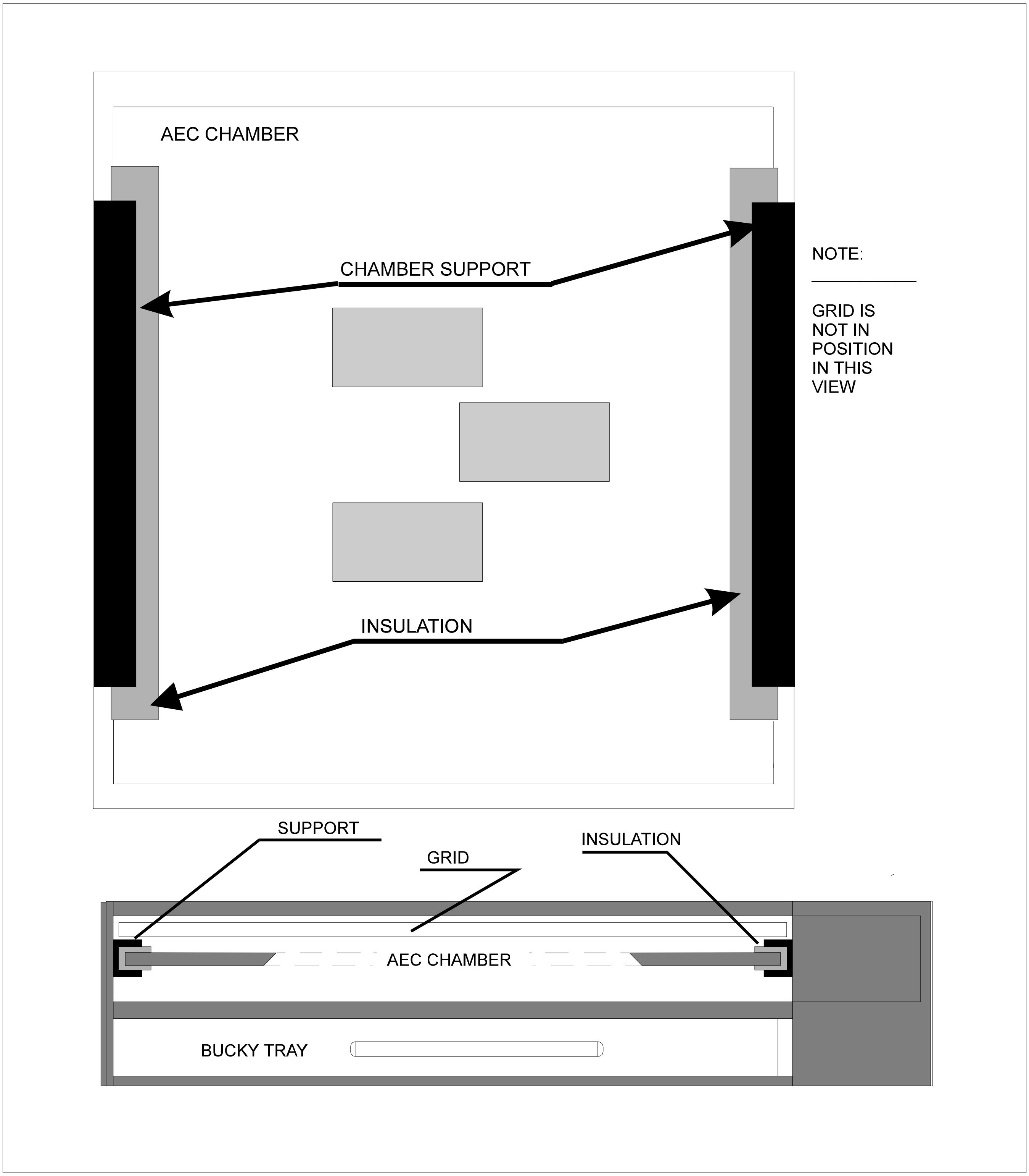

Figure 3D-22: AEC chamber installation

Use and disclosure is subject to the restrictions on the title page of this CPI document.

3D.16.4 AEC Pickup Connections (Overview)

Review the applicable sections of chapter 3C for programming the image receptors to select the correct AEC channel (or no AEC if desired). It should be ensured that each receptor used for AEC has a Bucky or equivalent. A typical R&F room configuration will consist of combinations of the following:

- Table Bucky.
- Wall Bucky.
- Spot film Bucky.
- Digital acquisition.

Refer to Figure 3D-23 for typical AEC connections. This is a simplified view only; refer to figures 3D-1 to 3D-5 for the AEC board layout used in Indico 100 X-ray generators. Only four AEC inputs are available. More than one AEC input may be used for digital applications, but this will reduce the available inputs for ion or solid-state AEC chambers.

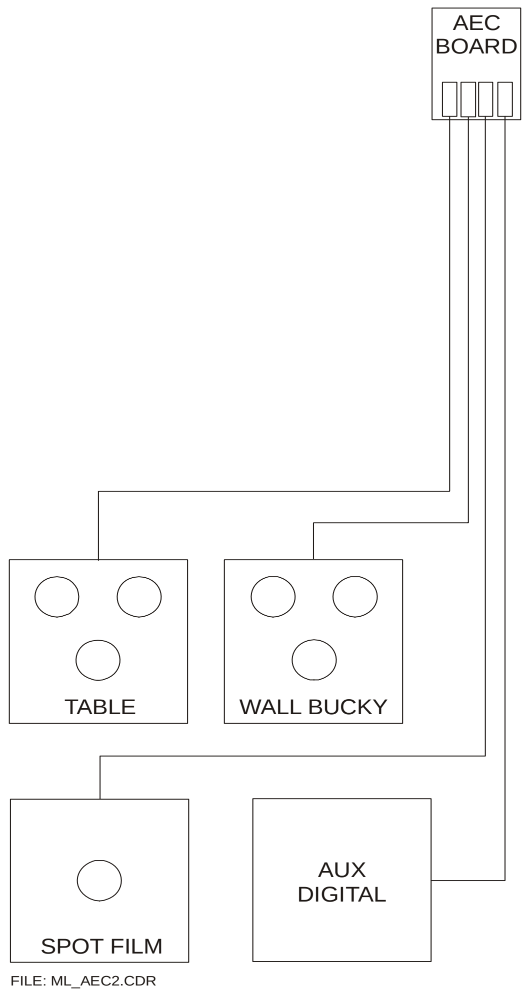

Figure 3D-23: AEC pickup connections

CHAPTER 3E

ABS SETUP AND CALIBRATION

CONTENTS:

3E.1.0 INTRODUCTION

This section provides an overview of various ABS pickup devices, wiring information for connecting these to the generator, and the procedure for ABS setup and calibration.

3E.1.1 Required Test Equipment

The following test equipment is required for ABS calibration.

- Resolution test pattern.
- Central ray alignment fixture.
- Collimator centering test pattern.
- A selection of Al filters for HVL determination.
- Water or lexan (or equivalent) absorbers in various thicknesses. Water should be in a plastic container of uniform thickness.
- Digital storage oscilloscope.
- Radiation dosimeter. Must be capable of measuring mGy / min and uGy / min as well as dose rate per frame.

3E.2.0 ABS / AEC PICKUP INSTALLATION / WIRING

ABS

For digital imaging systems, the ABS control signal is typically supplied by a PMT or by the imaging system in the form of a DC signal that is proportional to brightness.

AEC

A maximum of four inputs are available on the AEC board. These inputs are available for use with ion or solid-state AEC chambers as described in chapter 3D, or with a PMT or photo diode as described in this section, or a combination of both.

Figures 3E-1 to 3E-3 illustrate typical combinations of ABS / AEC pickups used in modern digital imaging systems.

THE GENERATOR IS FACTORY CONFIGURED FOR ONE SPECIFIC TYPE OF ABS / AEC PICKUP ONLY. REFER TO THE COMPATIBILITY STATEMENT / CUSTOMER PRODUCT DESCRIPTION FORM IN CHAPTER 1D FOR THE FACTORY CONFIGURED ABS / AEC COMPATIBILITY OF THIS GENERATOR.

<u>WARNING:</u>	***SWITCH OFF THE GENERATOR AND ENSURE THAT ALL CAPACITORS ARE DISCHARGED BEFORE CONNECTING ANY ABS PICKUP DEVICES.***

3E.2.1 PMT (Photo Multiplier Tube)

A PMT may be used for kV and / or kV/mA control during ABS operation ***and*** for AEC control for digital acquistions, or for AEC control for digital acquistions only. The generator must be fitted with the “Universal AEC Board” assembly if using a PMT. The high voltage supply for the PMT is located on this assembly.

1. Dress the PMT cable such as to allow the dynode high voltage lead to connect to J7 on the AEC interface board. J7 is the high voltage output for the PMT; all pins on this connector are connected in parallel and thus any of the four pins on J7 may be used. Ensure that the high voltage lead is rated at 1500 VDC minimum.
   NOTE: The total resistive load of all dynodes must be greater than 1 megohm to prevent excessive PMT power supply loading.

2. Wire the PMT as per figure 3E-1 or 3E-3.

3. Secure the PMT high voltage and signal cables such as to prevent mechanical stress on the connections.

4. Position the jumpers on the generator interface board as per table 3E-1.

5. The PMT high voltage calibration for ABS will be done in a later step. The PMT high voltage calibration for AEC is described in chapter 3D.

3E.2.2 Photo Diode

A photo diode may be used for AEC control for digital acquisitions.

1. Wire the photo diode as per figure 3E-2.

2. Secure the cables such as to prevent mechanical stress on the connections.

3. Position the jumpers on the generator interface board as per table 3E-1.

3E.2.3 DC Proportional

The DC proportional signal is generated by the digital imaging system, and may be used for kV and / or kV/mA control during ABS operation.

1. Wire the DC proportional signal as per figure 3E-2 or 3E-3. Depending on the particular imaging system being used, the ABS feedback signal may be connected to the generator interface board via the digital I/O board, or the ABS feedback signal may be via a separate cable that will be connected to J7 on the generator interface board.

2. Secure the cables such as to prevent mechanical stress on the connections.

3. Position the jumpers on the generator interface board as per table 3E-1.

3E.2.4 Wiring the PMT for ABS and AEC Operation

Systems that use a PMT for ABS and for AEC will typically be wired as shown in figure 3E-1.

- The high voltage output for the PMT is taken from J7 on the AEC interface board. Appropriate high voltage shielded cable should be used for this application.
- The signal lead from the PMT is connected to the input of the generator interface board as shown. Microphone type shielded cable is recommended.
- The PMT output is available at J7-10 on the generator interface board via a series resistor on this board. This output should be connected to the AEC board as per figure 3E-1. Microphone type shielded cable is recommended.
- This provides ABS control via the generator interface board, and AEC control via the connections to the AEC board:

  ***** Conventional R&F systems will typically use AEC channel 4 for digital acquisitions and possibly AEC channel 3 for DSA acquisitions. For special procedures generators, AEC channel 4 will typically be used for cine acquisitions, channel 3 for DSA acquisitions, and channel 2 for digital acquisitions. The PMT connections to AEC channels 2 and 3 should be omitted if not needed for digital acquisitions, leaving these inputs available for conventional AEC chambers, if required.

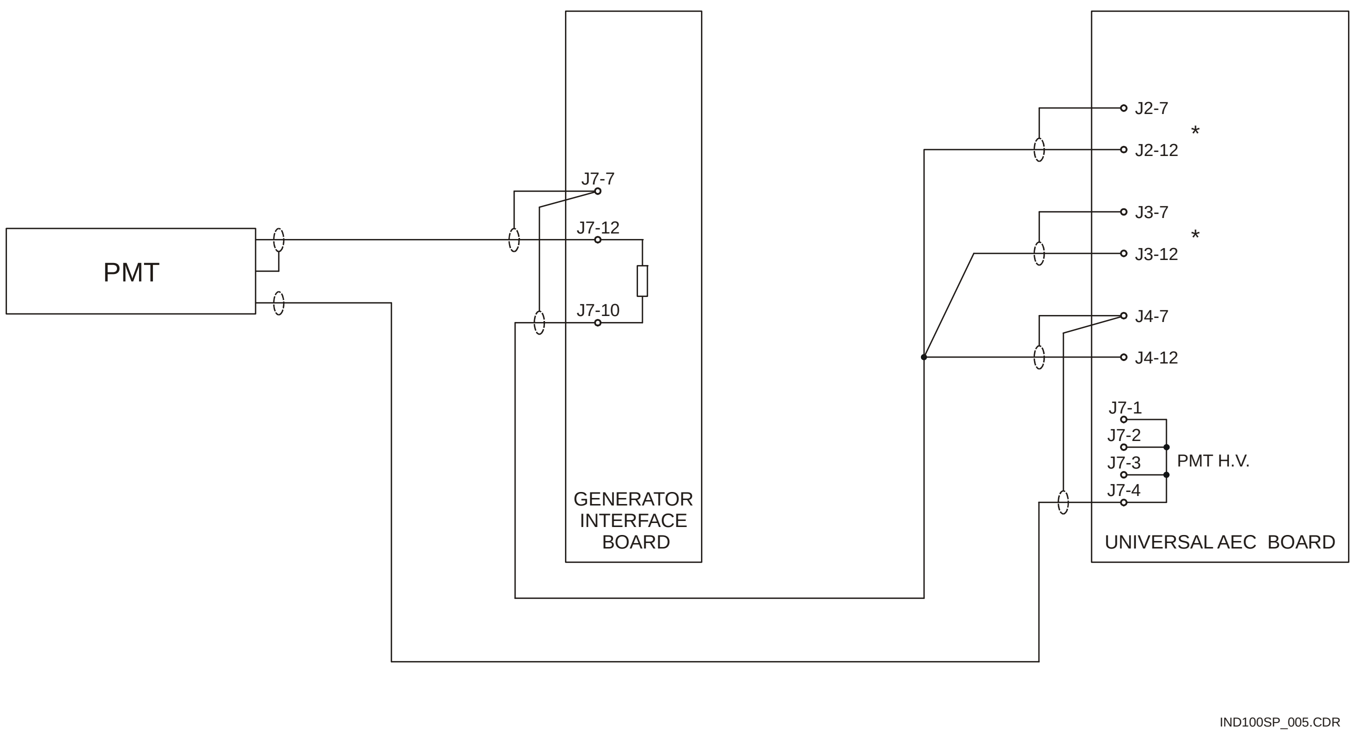

Figure 3E-1: Pictorial: Wiring a PMT for ABS and AEC (typical)

3E.2.5 Wiring Proportional DC for ABS, and a Photo Diode for AEC Operation

Systems that use proportional DC for ABS and a photo diode for AEC will typically be wired as shown in figure 3E-2.

- The proportional DC output from the digital imaging system is typically connected to the digital I/O board along with the other connections to / from the digital imaging system as detailed in the digital imaging supplement in the front of this manual. The ABS signal is passed through the digital I/O board, to J13-20 on the generator interface board, and then to the ABS circuits on the generator interface board.
- In some digital imaging systems, the proportional DC output will be taken directly to the generator interface board as shown in alternate connection "A", below. *For the CPIVision digital imaging system, the proportional DC output is taken directly to BNC connector J8 on the generator interface board as shown in alternate connection "B", below*.
- The photo diode should be connected to the AEC board as per figure 3E-2. The signal needs to be split using 47K resistors connected in series with each input on the AEC board. Microphone type shielded cable is recommended.

  ****** Conventional R&F systems will typically use AEC channel 4 for digital acquisitions and possibly AEC channel 3 for DSA acquisitions. For special procedures generators, AEC channel 4 will typically be used for cine acquisitions, channel 3 for DSA acquisitions, and channel 2 for digital acquisitions. The photo diode connections to AEC channels 2 and 3 should be omitted if not needed for digital acquisitions, leaving these inputs available for conventional AEC chambers, if required.

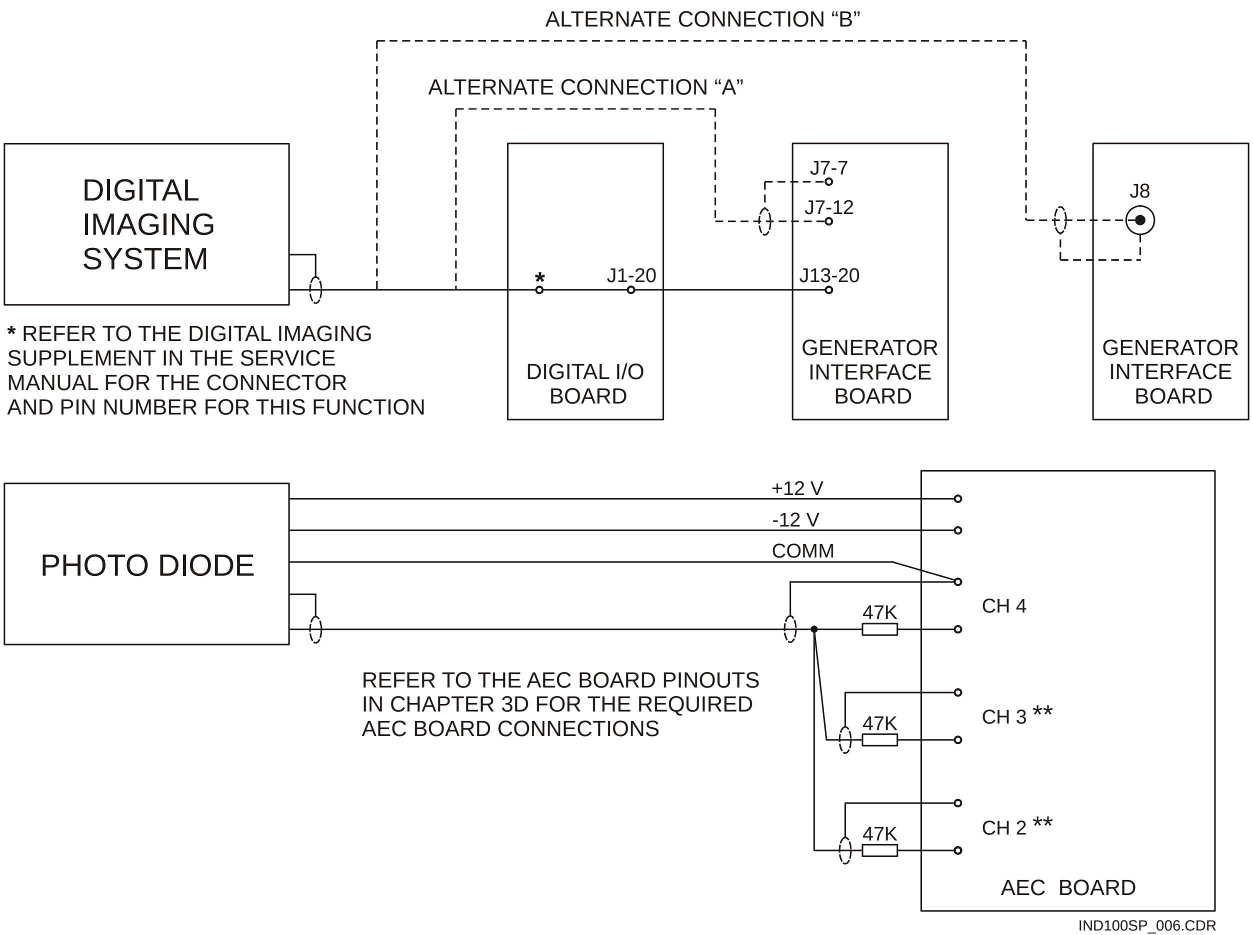

Figure 3E-2: Pictorial: Wiring proportional DC for ABS, and a photo diode for AEC (typical)

3E.2.6 Wiring Proportional DC for ABS, and a PMT for AEC Operation

Systems that use proportional DC for ABS and a PMT for AEC will typically be wired as shown in figure 3E-3.

- The proportional DC output from the digital imaging system is typically connected to the digital I/O board along with the other connections to / from the digital imag125
- ing system as detailed in the digital imaging supplement in the front of this manual. The ABS signal is passed throught the digital I/O board, to J13-20 on the generator interface board, and then to the ABS circuits on the generator interface board.
- In some digital imaging systems, the proportional DC output will be taken directly to the generator interface board as shown in the “alternate connection”, below.
- The PMT output should be connected to the AEC board as per figure 3E-3. The signal needs to be split using 47K resistors connected in series with each input on the AEC board. Microphone type shielded cable is recommended.

  ***** Conventional R&F systems typically use AEC channel 4 for digital acquisitions and possibly AEC channel 3 for DSA acquisitions. For special procedures generators, AEC channel 4 is typically used for cine acquisitions, channel 3 for DSA acquisitions, and channel 2 for digital acquisitions. The PMT connections to AEC channels 2 and 3 should be omitted if not needed for digital acquisitions, leaving these inputs available for conventional AEC chambers, if required.

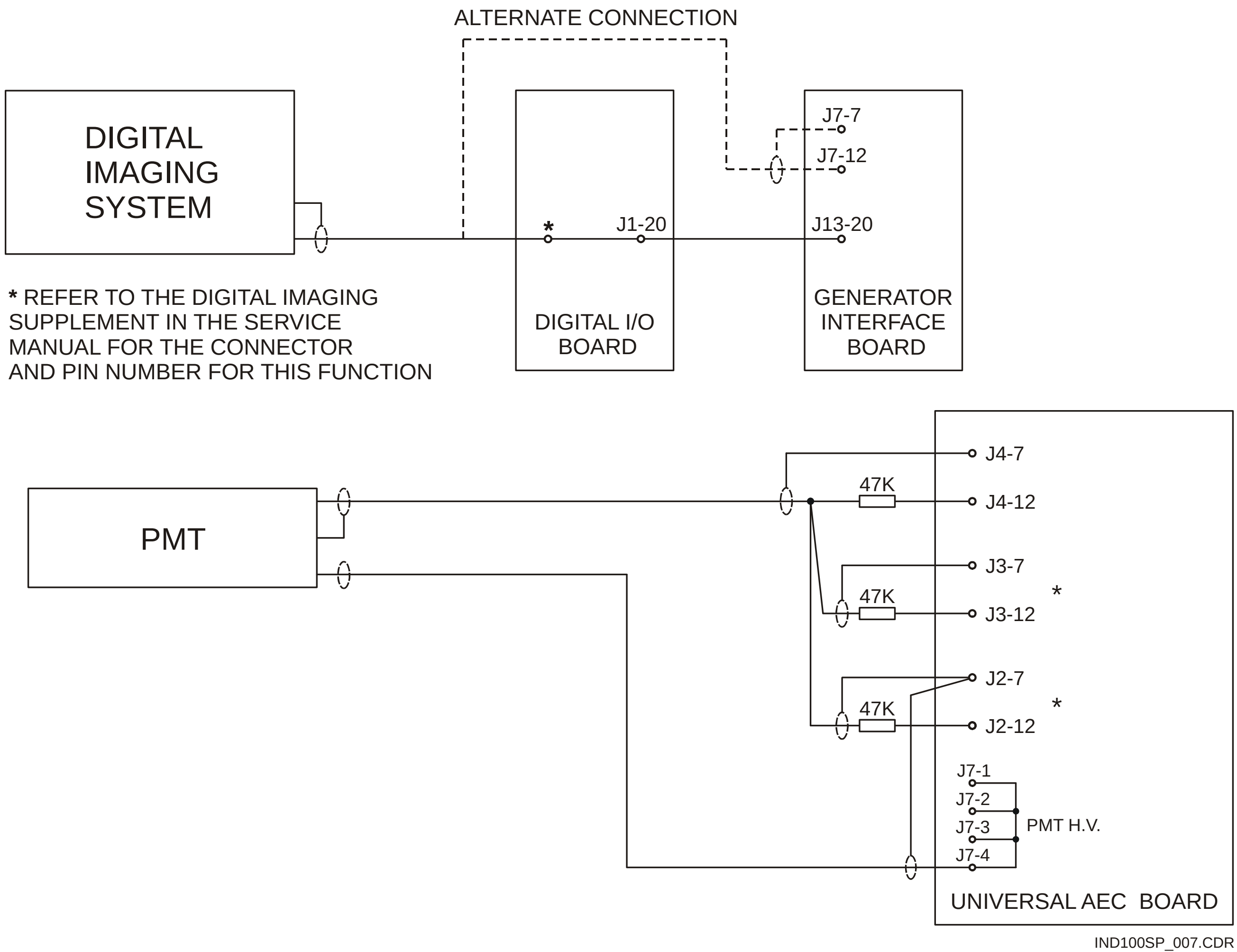

Figure 3E-3: Pictorial: Wiring proportional DC for ABS, and a PMT for AEC (typical)

3E.2.7 ABS Jumper Matrix

The table below details the generator interface board jumper positions as required to be compatible with the various ABS pickups. Refer to the ABS functional drawing MD-0758 in conjunction with this table.

ABS PICKUP TYPE	GENERATOR INTERFACE BOARD INPUTS & JUMPER CONFIGURATIONS								
	INPUT	JW4	JW5	JW11	JW12	JW13	JW19	JW20	JW21
Photo Multiplier Tube	J7	OUT	*	PINS 1-2	OUT	OUT	*	*	PINS 2-3
Photo Multiplier Tube	J8	OUT	*	PINS 1-2	OUT	OUT	PINS 1-2	IN	PINS 2-3
Photo Diode (negative output) **	J7	OUT	*	PINS 1-2	OUT	OUT	*	*	PINS 2-3
Photo Diode (positive output) **	J7	OUT	*	PINS 2-3	OUT	OUT	*	*	PINS 2-3
Error signal 0 to 5 / 12 VDC negative/positive **	J7	OUT	*	PINS 2-3	OUT	OUT	*	*	PINS 2-3
Photo Diode 0 to 5 / 12 VDC negative/positive **	J7	OUT	*	PINS 2-3	OUT	OUT	*	*	PINS 2-3
Proportional DC 0 to +5 / +12 VDC **	J7	OUT	*	PINS 2-3	OUT	OUT	*	*	PINS 2-3
Proportional DC 0 to +5 / +12 VDC **	J8	OUT	*	PINS 2-3	OUT	OUT	PINS 1-2	IN	PINS 2-3
Proportional DC 0 to -5 / -12 VDC **	J7	OUT	*	PINS 1-2	OUT	OUT	*	*	PINS 2-3
Proportional DC 0 to -5 / -12 VDC **	J8	OUT	*	PINS 1-2	OUT	OUT	PINS 1-2	IN	PINS 2-3
Composite video terminated 75 Ω	J8	IN	IN	PINS 3-4	OUT	OUT	PINS 2-3	IN	PINS 2-3
Composite video high impedance	J8	IN	OUT	PINS 3-4	OUT	OUT	PINS 2-3	IN	PINS 2-3
Proprtional DC supplied by the digital imaging system via the digital I/O board. (alternate connection “A” in fig 3E-2, and “alternate connection” in fig 3E-3)	Via J13 on gen I/F board	OUT	*	*	*	*	*	*	PINS 1-2
Proportional DC 0 to +5 / +12 VDC ** (alternate connection “B” in fig 3E-2)	J8	OUT	OUT	PINS 2-3	OUT	OUT	PINS 1-2	IN	PINS 2-3

Table 3E-1: ABS jumper matrix

3E.2.7 ABS Jumper Matrix (Cont)

* Don't care i.e. jumper may be in any position.

** If the magnitude of the proportional DC is greater than ±5VDC, JW26 and JW27 on the generator interface board should be removed. These jumpers should be installed if the magnitude of the proportional DC is less than or equal to ±5VDC.

For the CPIVision imaging system, the proportional DC is 0 to +5VDC, therefore these jumpers should be installed.

JW24 on the generator interface board must be installed at all times, and JW23 and JW25 on this board must be out at all times.

3E.3.0 PRE-CALIBRATION CHECKS AND SETUP

Before the ABS system can be calibrated, the imaging system must be functional and properly set up. Please verify the following:

- The image intensifier and its power supply are functional.
- The TV camera is calibrated for this application.
- All beam attenuating devices are in place.
- The tabletop is in position.
- The fluoro grid is in the path of the X-ray beam.
- The imaging system is in the operational position.
- The imaging collimator is functional.
- The collimator opening varies as S.I.D. is changed. (S.I.D. = source-image distance).
- The collimator opening varies as the image intensifier's MAG mode setting is changed.
- The ABS pickup device must be installed and functional.
- The half-value layer of the beam must be determined before proceeding. Sufficient filters must be added to the X-ray tube to provide the required HVL.
- The fluoro imaging and receptor devices have been programmed. Refer to chapter 3C.
- The kVp and mA must be in calibration. Refer to chapter 4.
- Ensure that JW22 on the generator interface board is set properly for the application: Connect JW22 pins 1-2 to provide line frequency sync pulses (for conventional imaging systems), or connect JW22 pins 2-3 for external sync input (for digital imaging systems).

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3E.4.0 FLUORO SETUP MENU STRUCTURE

Figure 3E-4 shows the fluoro setup menu structure. Information on the top and bottom lines of the LCD display, such as tube number, I.I. magnification, dose setting, etc is omitted on these figures for clarity.

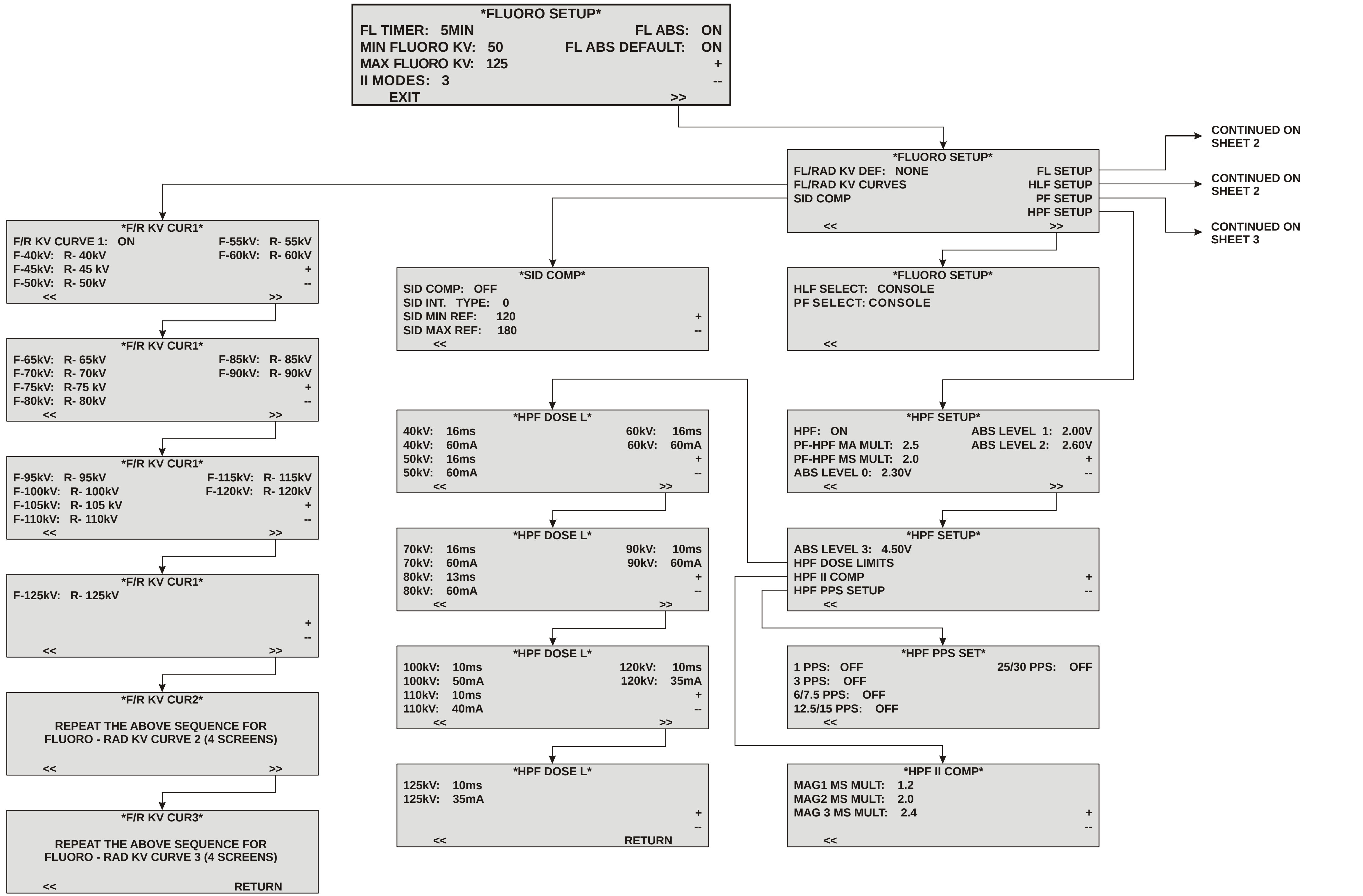

Figure 3E-4, sheet 1: Fluoro setup menus (membrane console). This diagram is meant to show the general menu structure only, in non-S.I.D. configuration mode.

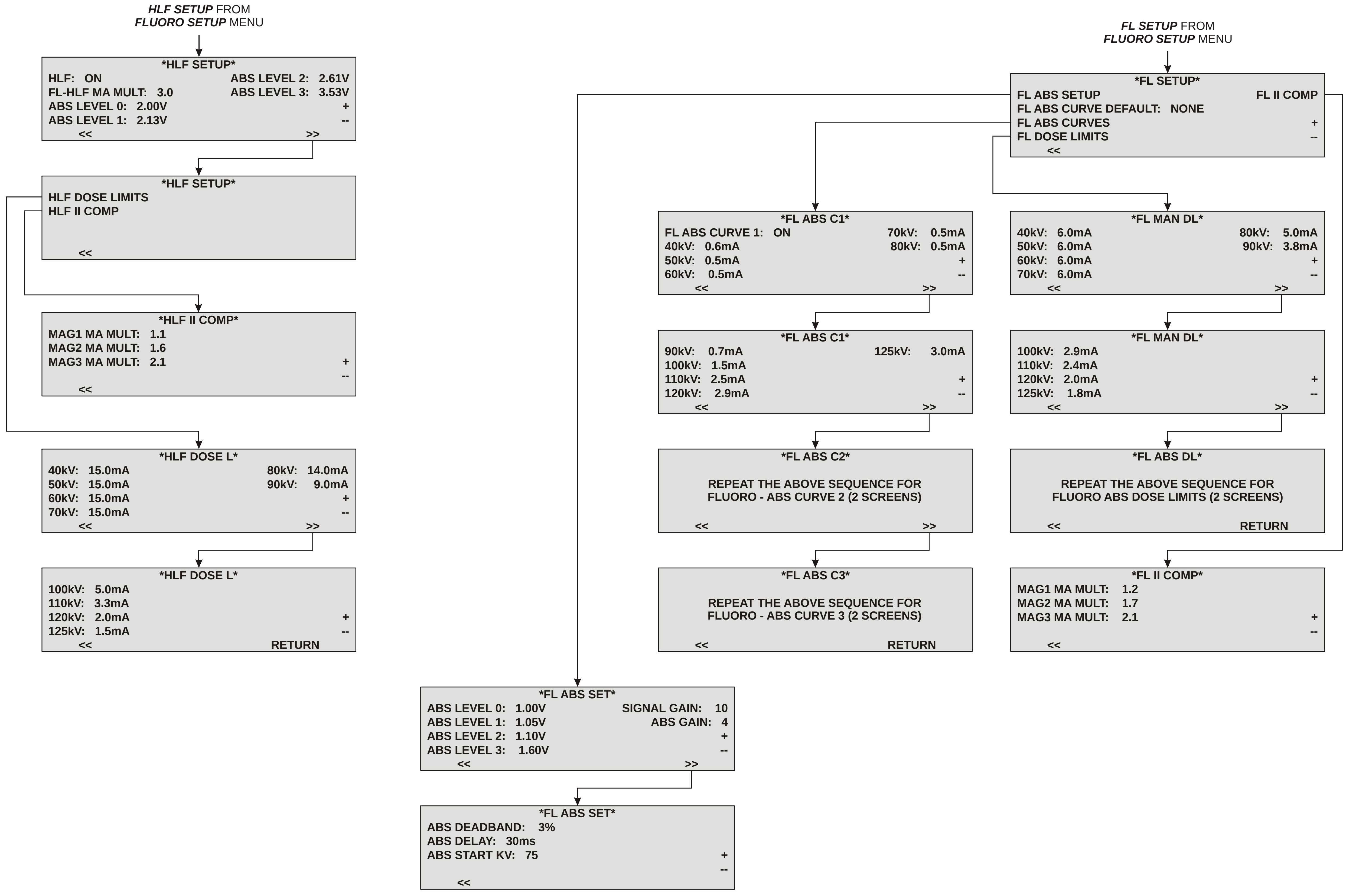

Figure 3E-4, sheet 2: Fluoro setup menus (membrane console). This diagram is meant to show the general menu structure only, in non-S.I.D. configuration mode.

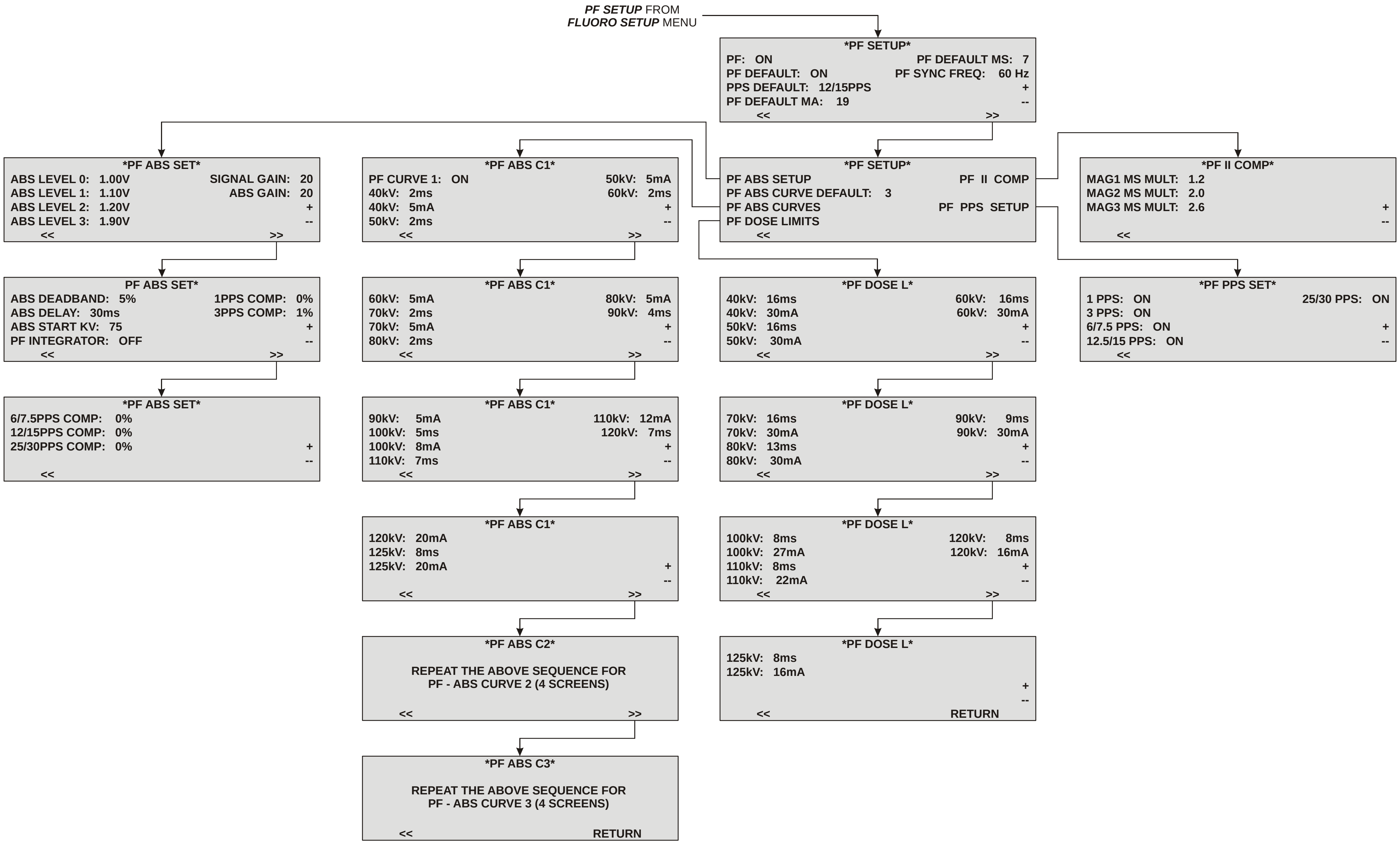

Figure 3E-4, sheet 3: Fluoro setup menus (membrane console). This diagram is meant to show the general menu structure only, in non-S.I.D. configuration mode.

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3E.5.0 INITIAL FLUOROSCOPIC SETUP

NOTE: ***SOME OF THE FEATURES DESCRIBED IN THIS CHAPTER ARE OPTIONAL. DISREGARD THE SECTIONS THAT DO NOT APPLY.***

Note: ***This manual contains simulated images of the membrane console display and "screen captures" of GenWare®. Calibration and setup parameters shown are for illustrative purposes only. The settings and limits shown do not represent CPI recommended settings to be used during setup and calibration of the generator.***

Default settings and limits that are provided in the generator software are not intended as final values in installed generators. All settings and limits must be confirmed and / or adjusted as required during setup and calibration of the generator.

Note: ***The default values in the Dose Limits menus were determined to limit the Air Kerma Rate to less than 44 mGy / min (normal continuous fluoro, manual mode), less than 88 mGy / min (normal continuous fluoro, ABS mode), less than 88 mGy / min (normal pulsed fluoro) and less than 176 mGy / min (high-level continuous and pulsed fluoro) with the following test setup in the factory:***

- Varian A196 (0.6/1.0) X-ray tube.

- 40 in. (100 cm) S.I.D.

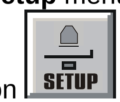
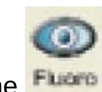
- Total filtration 4.5 mm Al (X-ray tube / housing = 1.8 mm, Collimator = 0.7 mm, added filtration = 2.0 mm).

The Air Kerma Rate limits calibration must be performed as described in this chapter during generator setup and calibration. Do not simply use the default dose limit values.

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)

The basic fluoroscopic defaults must be set before proceeding with fluoro setup and calibration. This section details the initial fluoroscopic setup procedure.

Use these steps to access the **FLUORO SETUP** menus (membrane console), or the **Fluoro Setup** utility in GenWare®.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	Enter into the programming mode as described in chapter 3C.	The procedure for starting GenWare® and connecting it to the console is described in the GenWare® manual, included with GenWare®. From the GenWare® GENERATOR UTILITIES application, select **Fluoro Setup** from the **Setup** menu, or use the fluoro setup button  on the GenWare® toolbar.	Touchscreen GenWare® must be launched before proceeding. This is done from the GenWare® button on the touchscreen System Utilities menu. Press the  button on the GenWare® toolbar to access the **Fluoro Setup** window.
2.	When the **GENERATOR SETUP** menu is displayed, select **GEN CONFIGURATION**.		
3.	From the **GEN CONFIGURATION** menu, select **FLUORO SETUP**.	Select the **Fluoro Setup** tab.	Select the **General Fluoro** tab.

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)

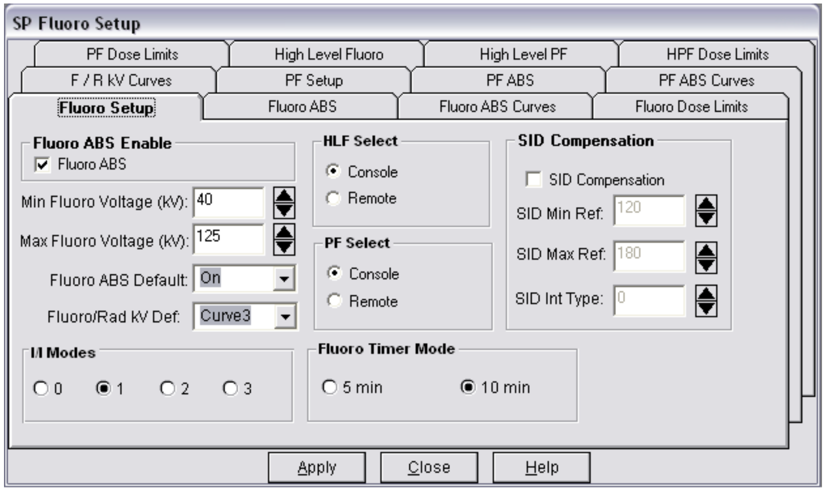
The **FLUORO SETUP** menus for the membrane console are shown below.

* FLUORO SETUP *	
FL TIMER: 5MIN	FL ABS: ON
MIN FLUORO KV: 40	FL ABS DEFAULT: OFF
MAX FLUORO KV: 125	+
II MODES: 3	-
EXIT	>>

* FLUORO SETUP *	
FL/RAD KV DEF: NONE	FL SETUP
FL/RAD KV CURVES	HLF SETUP
SID COMP	PF SETUP
	HPF SETUP
<<	>>

* FLUORO SETUP *	
HLF SELECT: CONSOLE	
PF SELECT: CONSOLE	
<<	

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)



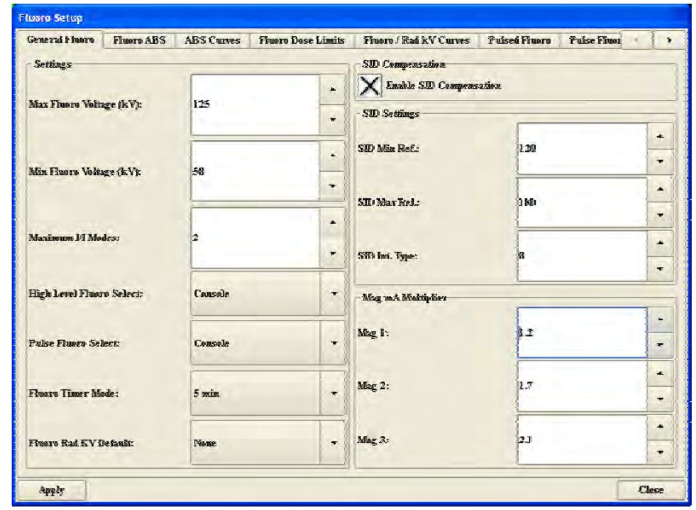


Figure 3E-5a - PC GenWare® *Figure 3E-5b - Touchscreen GenWare®*

Fluoro Setup window, Fluoro Setup / General Fluoro tab

Definitions of **FLUORO SETUP** menu items applicable to the initial fluoroscopic setup.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
FL TIMER	**Fluoro Timer Mode**	Selects the fluoro timer mode. **5 MIN:** Alarms at 5.0 minutes, and stops incrementing the timer. Fluoro exposures may continue. **10 MIN:** Alarms at 5.0 minutes, and stops incrementing the timer at 9.6 minutes. Fluoro exposures will be inhibited at 9.6 minutes.

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
MIN FLUORO KV	**Min Fluoro Voltage (kV)**	Sets the minimum kV to be allowed in all modes of fluoro operation.
MAX FLUORO KV	**Max Fluoro Voltage (kV)**	Sets the maximum kV to be allowed in all modes of fluoro operation.
II MODES	**I/I Modes** **(Maximum I/I Modes)**	Sets the maximum number of magnification modes in the I.I. (2 corresponds to 2 mag modes plus normal mode). If this is set to **0**, the console and remote fluoro control will not display the mag status. This may be desired if an external mag mode control and display is used.
FL ABS	**Fluoro ABS Enable** (PC GenWare®) **Enable Fluoro ABS** (under **Fluoro ABS** tab on Touchscreen GenWare®)	Enables or disables the ability to select fluoro ABS. **OFF:** ABS may not be selected in fluoroscopy. **ON:** ABS may be selected in fluoroscopy.
FL ABS DEFAULT	**Fluoro ABS Default** (PC GenWare®) **Fluoro ABS Default** (under **Fluoro ABS** tab on Touchscreen GenWare®)	Sets the ABS state when a fluoro receptor is selected. **NONE:** The ABS will remain at its last setting. **OFF:** The ABS will default to OFF. **ON:** The ABS will default to ON.

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
FL/RAD KV DEF	**Fluoro/Rad kV Def.** **(Fluoro Rad KV Default)**	Selects the fluoro to rad kV transfer curve when a fluoro receptor is selected. **NONE:** The fluoro - rad kV transfer curve remains at its last setting. **OFF:** The fluoro - rad kV transfer function is disabled. **1 - 3:** Selects the fluoro - rad kV transfer curve where **1** = low, **2** = medium, **3** = high. **One fluoro-rad kV transfer curve is standard; three fluoro-rad kV transfer curves are optional.**
HLF SELECT	**HLF Select** **(High Level Fluoro Select)**	Selects the location from which high level fluoroscopy is selected for all fluoro modes. **CONSOLE:** In this mode, the console HLF button is used to select the high-level fluoro mode. High-level fluoro exposures will result when HLF is enabled via the console HLF button and the fluoro foot switch is activated. The high-level fluoro mode will remain active until the HLF button on the console is deselected. **This mode is applicable to therapy simulators only.** **REMOTE:** In this mode, the II SAFETY input on the room interface board selects high-level fluoro. HLF will only be selected when the II SAFETY input is active. In practice, a two-pole footswitch can be used where the contacts from the first pole are connected to the fluoro exposure input. The second pole on the foot switch is then connected to the II SAFETY input. Pressing the fluoro foot switch to close the first set of contacts will activate normal fluoro mode. Fully depressing the fluoro foot switch will close the second set of contacts, activating the II SAFETY input. This selects the high-level fluoro mode. **In this mode, normal fluoro mode will resume as soon as the fluoro foot switch is released sufficiently to open the second set of contacts.**
PF SELECT	**PF Select** **(Pulse Fluoro Select)**	This function is not available at this time.

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)

Use these steps to perform the initial fluoroscopic setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the **FLUORO SETUP** menu, select **FL TIMER.** Toggle the button to select **5MIN** or **10MIN**.	Under **Fluoro Timer Mode**, select **5 Min** or **10 Min**.	For **Fluoro Timer Mode**, select **5 Min** or **10 Min**.
2.	Select **MIN FLUORO KV**. Use the **+** or **–** buttons to set the desired minimum fluoro kV.	Select the desired minimum fluoro kV via the **Min Fluoro Voltage (kV)** dialog box.	Select the desired minimum fluoro kV via the **Min Fluoro Voltage (kV)** dialog box.
	This should be set to 40 kV until the ABS calibration is complete. Make a note to set this to the desired value after ABS setup and calibration is finished.		
3.	Select **MAX FLUORO KV**. Use the **+** or **–** buttons to set the desired maximum fluoro kV.	Select the desired maximum fluoro kV via the **Max Fluoro Voltage (kV)** dialog box.	Select the desired maximum fluoro kV via the **Max Fluoro Voltage (kV)** dialog box.
	This should be set to 125 kV until the ABS calibration is complete. Make a note to set this to the desired value after ABS setup and calibration is finished.		
4.	Select **II MODES**. Use the **+** or **–** buttons to select the desired number of II modes.	Under **I/I Modes**, select the desired number of II modes.	For **Maximum I/I Modes**, select the desired number of II modes.
5.	Select **FL ABS.** Toggle the button to select **ON** or **OFF**.	Under **Fluoro ABS Enable**, clear the check box for **OFF**, or check the check box for **ON**.	Select the **Fluoro ABS** tab. Clear the **Enable Fluoro ABS** check box for **OFF**, or check the check box for **ON**.
6.	Select **FL ABS DEFAULT**. Toggle the button to select **NONE**, **OFF**, or **ON**.	Select **None**, **Off**, or **On** via the **Fluoro ABS Default** dialog box.	Under **Fluoro ABS Default**, select **None**, **Off**, or **On**.
7.	Press **>>**.		
8.	Select **FL/RAD KV DEF.** Toggle the button to select **NONE**, **OFF**, **1, 2,** or **3**.	Select **None**, **Off**, **Curve1**, **Curve2**, or **Curve3** via the **Fluoro/Rad kV Def** dialog box.	Reselect the **General Fluoro** tab. Select **None**, **Off**, **Curve 1**, **Curve 2**, or **Curve 3** via the **Fluoro Rad KV Default** dialog box.
	NOTE: Fluoro to rad kV transfer curves 2 and 3 are optional.		
9.	Press **>>**.		

3E.5.0 INITIAL FLUOROSCOPIC SETUP (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
10.	Select **HLF SELECT.** Toggle the button to select **CONSOLE** or **REMOTE**.	Under **HLF Select**, select **Console** or **Remote.**	For **High Level Fluoro Select**, select **Console** or **Remote.**
11.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

3E.6.0 FLUORO SETUP & DOSE LIMITS SETUP (NO S.I.D. COMPENSATION)

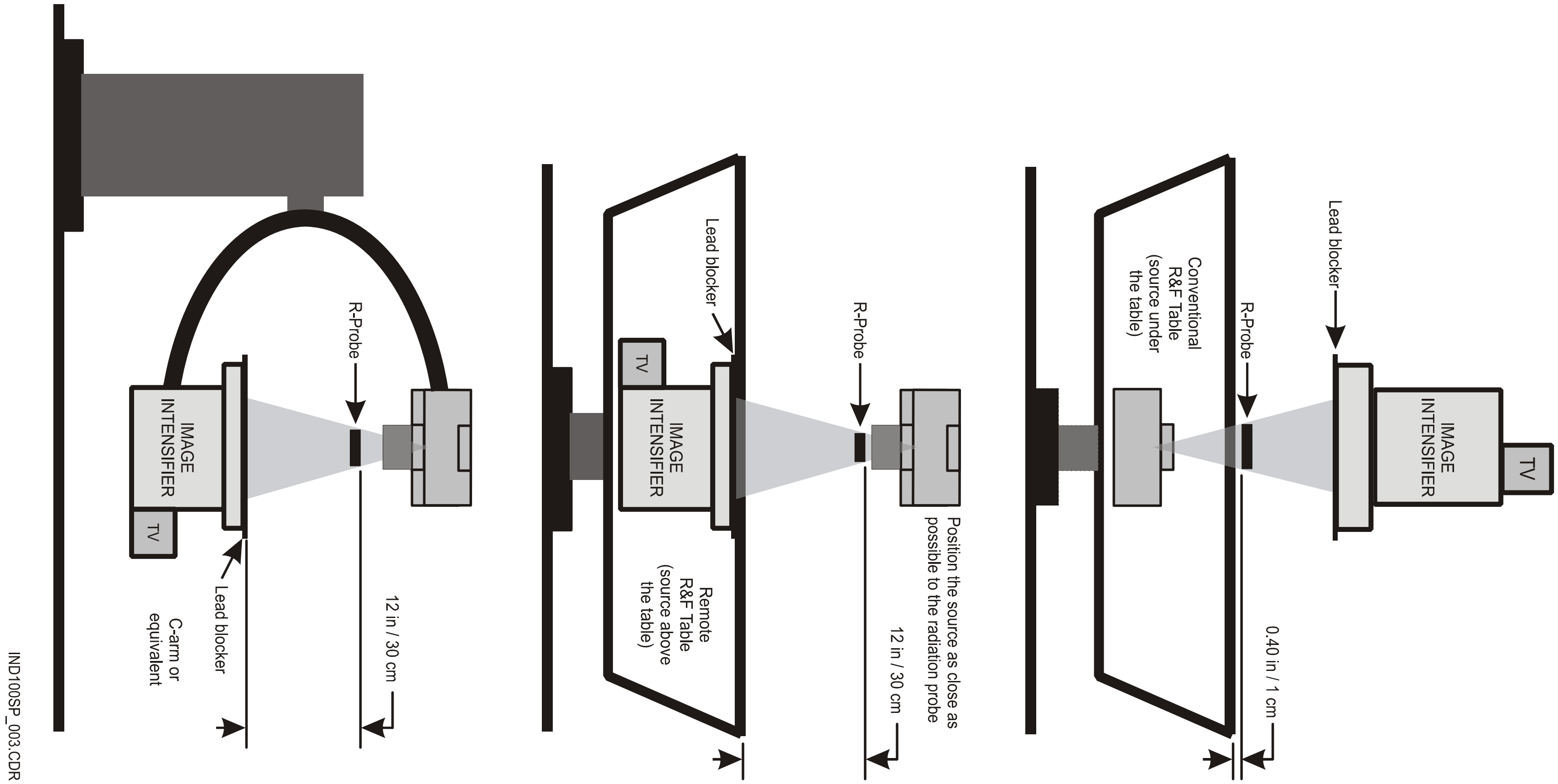


Figure 3E-6: Typical Dose limits test setup

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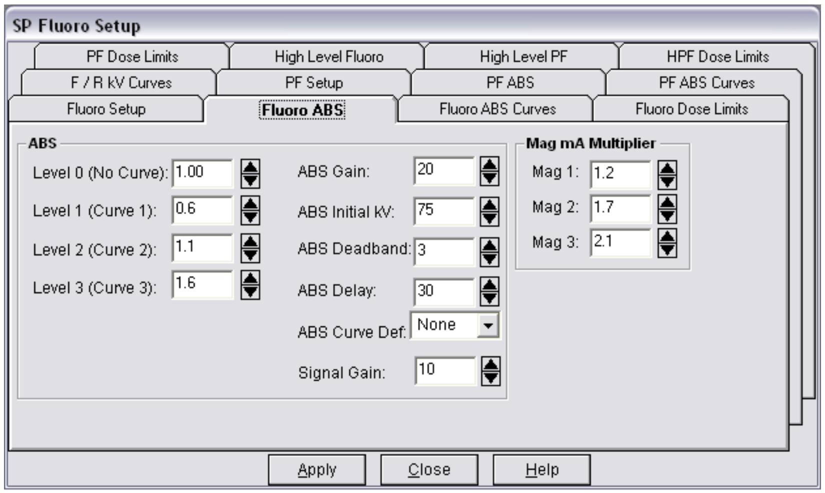
3E.6.1 Continuous Fluoro Setup

The **FL SETUP** menu for the membrane console is shown below.

```
                    * FL SETUP *
FL ABS SETUP                                  FL II COMP
FL ABS CURVE DEFAULT:    NONE
FL ABS CURVES
FL DOSE LIMITS
      <<
```



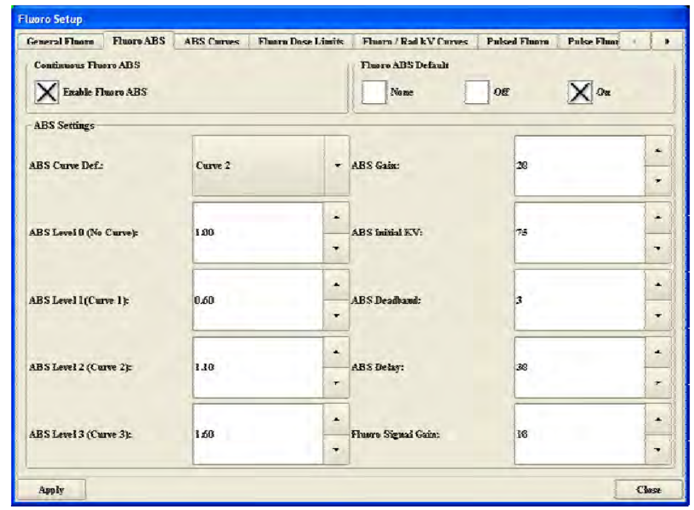


Figure 3E-7a - PC GenWare® *Figure 3E-7b - Touchscreen GenWare®*
Fluoro Setup window, Fluoro ABS tab

3E.6.1 Continuous Fluoro Setup (Cont)

Definitions of **FL SETUP** menu items applicable to the initial fluoroscopic setup.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
FL ABS CURVE DEFAULT	**ABS Curve Def**	Selects the fluoro ABS curve default when a fluoro receptor is selected. This applies to both low and high-level fluoro. **NONE:** The ABS curve remains at its last setting. **OFF:** The ABS curve is disabled. **1, 2, 3** or **Curve 1, Curve 2, Curve 3:** Sets the ABS default curve where **1** = low, **2** = medium, **3** = high. **One ABS curve is standard; three ABS curves are optional.**

Use these steps to perform the initial continuous fluoro setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **FL SETUP.**	Select the **Fluoro ABS** tab.	Select the **Fluoro ABS** tab.
3.	Select **FL ABS CURVE DEFAULT.** Toggle the button to select **NONE**, **OFF**, **1, 2,** or **3**.	Select **None**, **Off**, **Curve1**, **Curve2**, or **Curve3** via the **ABS Curve Def** dialog box.	Select **None**, **Off**, **Curve 1**, **Curve 2**, or **Curve 3** via the **ABS Curve Def** dialog box.
	NOTE: Fluoro ABS curves 2 and 3 are optional.		

3E.6.2 Continuous Fluoro Dose Limits (no SID compensation)

This procedure sets the maximum mA allowed for each kV setting in both manual and ABS mode of continuous fluoro operation for systems without SID compensation.

NOTE: ***THIS SECTION DETAILS DOSE LIMITS SETUP WITHOUT S.I.D. COMPENSATION. REFER TO 3E.9.0 FOR DOSE LIMITS SETUP WITH S.I.D. COMPENSATION.***

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **FL MAN DL** and **FL ABS DL** menus for the membrane console are shown below (no SID comp).

* FL MAN DL *			
40 kV:	10.0mA	80 kV:	5.0mA
50 kV:	6.0mA	90 kV:	3.8mA
60 kV:	6.0mA		+
70 kV:	6.0mA		-
	<<	>>	

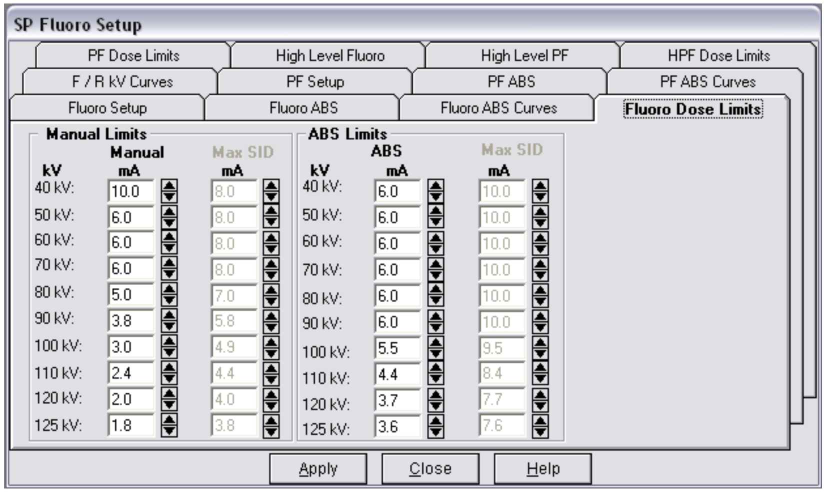
3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont

	* FL MAN DL *		
100 kV:	2.9mA		
110 kV:	2.4mA		
120 kV:	2.0mA		+
125 kV:	1.8mA		-
<<		>>	

	* FL ABS DL *		
40 kV:	6.0mA	80 kV:	6.0mA
50 kV:	6.0mA	90 kV:	6.0mA
60 kV:	6.0mA		+
70 kV:	6.0mA		-
<<		>>	

	* FL ABS DL *		
100 kV:	5.5mA		
110 kV:	4.4mA		
120 kV:	3.7mA		+
125 kV:	3.6mA		-
<<		RETURN	

3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont



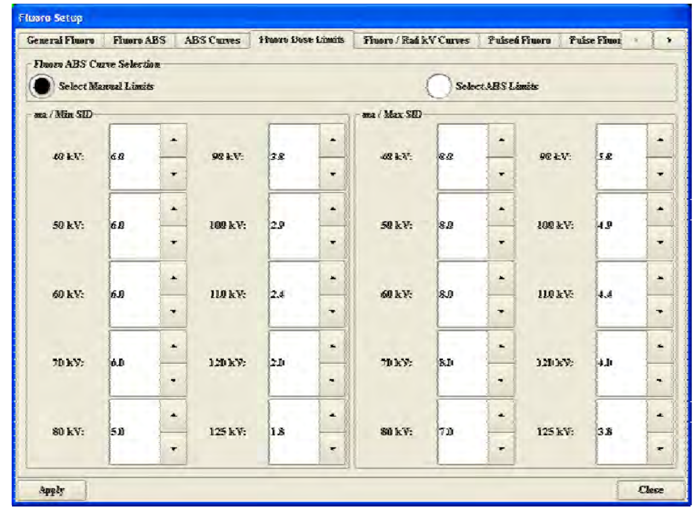


Figure 3E-8a - PC GenWare® *Figure 3E-8b - Touchscreen GenWare®*

Fluoro Setup window, Fluoro Dose Limits tab

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the continuous fluoro dose limits (no SID compensation).

Step	Action
⚠	**When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.**
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.
2.	Temporarily disconnect the ABS pickup to the generator.
3.	Ensure that the SID compensation function is disabled if this option is fitted. Refer to 3E.9.1.
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**

3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont

<table>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>5.</td><td>From the FL SETUP menu, select FL DOSE LIMITS.</td><td>Select the Fluoro Dose Limits tab.</td><td>Select the Fluoro Dose Limits tab.</td></tr>
<tr><td>6.</td><td>Select the 40 kV step in the FL MAN DL menu. Use the + button adjacent to the LCD display to enter the maximum available mA.</td><td>Enter the maximum available mA into the fluoro dose limits dialog box under Manual Limits, Manual, adjacent to 40 kV.</td><td>Under Fluoro ABS Curve Selection, select Select Manual Limits.
Enter the maximum available mA into the fluoro dose limits dialog box under ma / Min SID, adjacent to 40 kV.</td></tr>
<tr><td>7.</td><td>Repeat the above for 50 kV to 90 kV.</td><td>Repeat the above for 50 kV to 125 kV.</td><td>Repeat the above for 50 kV to 125 kV.</td></tr>
<tr><td>8.</td><td>Press >>.</td><td></td><td></td></tr>
<tr><td>9.</td><td>Repeat the above for 100 kV to 125 kV.</td><td></td><td></td></tr>
<tr><td>10.</td><td>Press <<.</td><td></td><td></td></tr>
<tr><td>11.</td><td colspan="3">Select a fluoroscopic image receptor.</td></tr>
<tr><td>12.</td><td colspan="3">Record the maximum permissible Air Kerma Rate for non-ABS (manual) mode of normal continuous fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>44 mGy / min *.</td><td>50 mGy / min *.</td><td>The maximum Air Kerma Rate must comply with local regulations.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for Non-ABS (manual) mode:_____________ mGy / min.

Record the maximum permissible Air Kerma Rate for ABS (automatic) mode of normal continuous fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>88 mGy / min *.</td><td>100 mGy / min *.</td><td>The maximum Air Kerma Rate must comply with local regulations.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for ABS (automatic) mode:_____________ mGy / min.</td></tr>
</table>

3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont

Step	Action		
13.	Ensure that the generator is set for normal continuous fluoro mode, and that ABS is switched off.		
14.	Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
15.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console such that the maximum permitted dose as recorded in step 12 for non-ABS mode is not exceeded.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of GenWare® such that the maximum permitted dose as recorded in step 12 for non-ABS mode is not exceeded.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of GenWare® such that the maximum permitted dose as recorded in step 12 for non-ABS mode is not exceeded.
Step	Action		
16.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______(non-ABS).		
17.	Repeat steps 14 to 16 for **50** kV. Max mA for 50kV = ______(non-ABS).		
18.	Repeat steps 14 to 16 for **60** kV. Max mA for 60kV = ______(non-ABS).		
19.	Repeat steps 14 to 16 for **70** kV. Max mA for 70kV = ______(non-ABS).		
20.	Repeat steps 14 to 16 for **80** kV. Max mA for 80kV = ______(non-ABS).		
21.	Repeat steps 14 to 16 for **90** kV. Max mA for 90kV = ______(non-ABS).		
22.	Repeat steps 14 to 16 for **100** kV. Max mA for 100kV = ______(non-ABS).		
23.	Repeat steps 14 to 16 for **110** kV. Max mA for 110kV = ______(non-ABS).		

3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont

Step	Action		
24.	Repeat steps 14 to 16 for **120** kV. Max mA for 120kV = ______(non-ABS).		
25.	Repeat steps 14 to 16 for **125** kV. Max mA for 125 kV = ______(non-ABS).		
26.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
27.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console such that the maximum permitted dose as recorded in step 12 for ABS mode is not exceeded. ABS must remain off.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of GenWare® such that the maximum permitted dose as recorded in step 12 for ABS mode is not exceeded. ABS must remain off.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of GenWare® such that the maximum permitted dose as recorded in step 12 for ABS mode is not exceeded. ABS must remain off.
28.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______(ABS).		
29.	Repeat steps 26 to 28 for **50** kV. Max mA for 50kV = ______(ABS).		
30.	Repeat steps 26 to 28 for **60** kV. Max mA for 60kV = ______(ABS).		
31.	Repeat steps 26 to 28 for **70** kV. Max mA for 70kV = ______(ABS).		
32.	Repeat steps 26 to 28 for **80** kV. Max mA for 80kV = ______(ABS).		
33.	Repeat steps 26 to 28 for **90** kV. Max mA for 90kV = ______(ABS).		
34.	Repeat steps 26 to 28 for **100** kV. Max mA for 100kV = ______(ABS).		

3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont

Step	Action		
35.	Repeat steps 26 to 28 for **110** kV. Max mA for 110kV = ______(ABS).		
36.	Repeat steps 26 to 28 for **120** kV. Max mA for 120kV = ______(ABS).		
37.	Repeat steps 26 to 28 for **125** kV. Max mA for 125 kV = ______(ABS).		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
38.	Select the **40** kV step in the **FL MAN DL** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the mA as determined in step 16 for 40 kV.	Enter the mA as determined in step 16 into the fluoro dose limits dialog box under **Manual Limits, Manual,** adjacent to 40 kV**.**	Enter the mA as determined in step 16 into the fluoro dose limits dialog box under **ma / Min SID,** adjacent to 40 kV**.**
39.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 17 to 21.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 17 to 25.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 17 to 25.
40.	Press **>>**.		
41.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 22 to 25.		
42.	Press **>>**.		
43.	Select the **40** kV step in the **FL ABS DL** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 28 for 40 kV.	Enter the mA as determined in step 28 into the fluoro dose limits dialog box under **ABS Limits, ABS,** adjacent to 40 kV**.**	Under **Fluoro ABS Curve Selection**, select **Select ABS Limits**. Enter the mA as determined in step 28 into the fluoro dose limits dialog box under **ma / Min SID,** adjacent to 40 kV**.**
44.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 29 to 33.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 29 to 37.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 29 to 37.
45.	Press **>>**.		

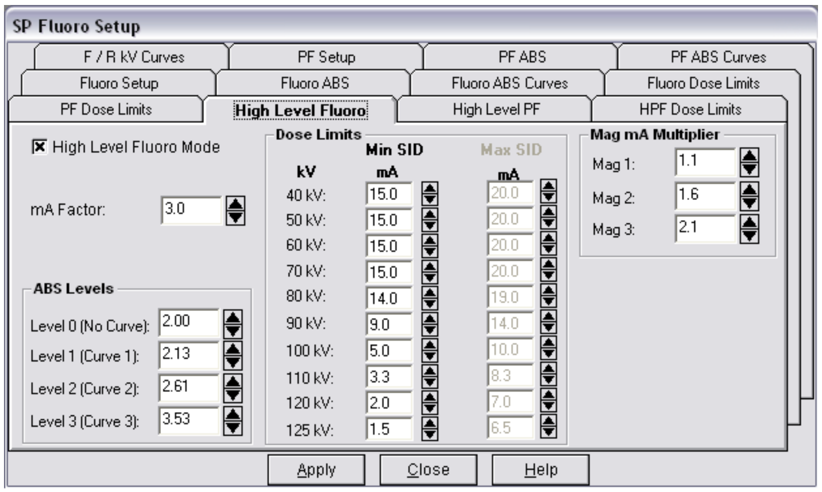
3E.6.2 Continuous Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
46.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 34 to 37.		
47.	Press **RETURN** to return to the **FL SETUP** menu.		
48.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

3E.6.3 High-Level Fluoro Setup

HLF SETUP menu 1 for the membrane console is shown below.

	* HLF SETUP *		
HLF: ON		ABS LEVEL 2:	2.61V
FL-HLF MA MULT: 2.0		ABS LEVEL 3:	3.53V
ABS LEVEL 0: 2.00V			+
ABS LEVEL 1: 2.13V			-
<<		>>	



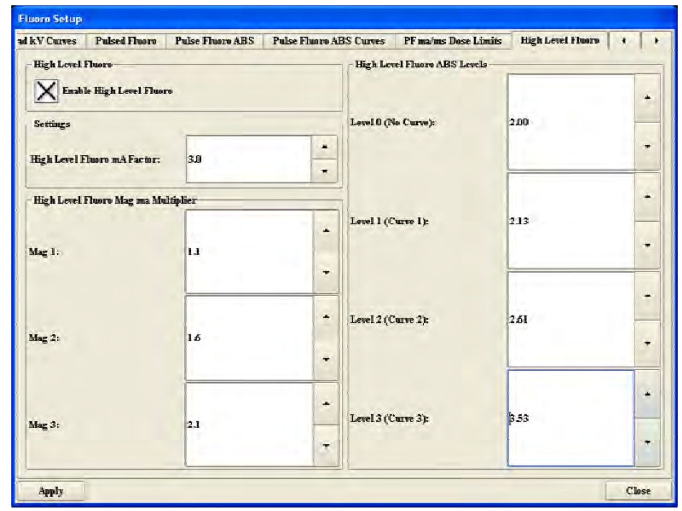


Figure 3E-9a - PC GenWare® *Figure 3E-9b - Touchscreen GenWare®*
Fluoro Setup window, High Level Fluoro tab

3E.6.3 High-Level Fluoro Setup (Cont)

Definitions of **HLF SETUP** menu items applicable to high-level fluoro setup.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
HLF	**High Level Fluoro Mode** **(Enable High Level Fluoro)**	Enables / disables the high-level fluoro option. **ON:** High-level fluoro is enabled. **OFF:** High-level fluoro is disabled.
FL-HLF MA MULT	**mA Factor** **(High Level Fluoro mA Factor)**	Sets the mA multiplication factor applied to low-level fluoro mA settings to achieve high-level fluoroscopy. For example, if the normal fluoro mA range is 0.5 to 6.0 mA and a multiplication factor of 3.0 is used, the HLF range will be 1.5 to 18 mA.

Use these steps to perform the initial high-level fluoro setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **HLF SETUP.**	Select the **High Level Fluoro** tab.	Select the **High Level Fluoro** tab.
3.	From the **HLF SETUP** menu, select **HLF.** Toggle the button to select **ON** or **OFF.**	Clear the **High Level Fluoro Mode** check box for **OFF**, or check the check box for **ON**.	Clear the **Enable High Level Fluoro** check box for **OFF**, or check the check box for **ON**.
4.	Select **FL-HLF MA MULT**. Use the **+** or **–** buttons to select the mA multiplier for HLF.	Select the mA multiplier via the **mA Factor** dialog box.	Select the mA multiplier via the **High Level Fluoro mA Factor** dialog box.
5.	Press **>>** to go to **HLF SETUP** menu 2.		

3E.6.4 High-Level Fluoro Dose Limits (no SID compensation)

This procedure sets the maximum mA allowed for each kV setting in high-level fluoro mode for systems without SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **HLF DOSE L** menus for the membrane console are shown below (no SID comp).

	* HLF DOSE L *		
40 kV: 15.0mA		80 kV: 14.0mA	
50 kV: 15.0mA		90 kV: 9.0mA	
60 kV: 15.0mA			+
70 kV: 15.0mA			-
<<		>>	

	* HLF DOSE L *		
100 kV: 5.0mA			
110 kV: 3.3mA			
120 kV: 2.0mA			+
125 kV: 1.5mA			-
<<		RETURN	

In PC GenWare®, high-level fluoro **Dose Limits** is included in the **High Level Fluoro** tab (figure 3E-9). In touchscreen GenWare®, **HLF Dose Limits** is included in the **HLF Dose Limits** tab (figure 3E-10).

3E.6.4 High-Level Fluoro Dose Limits (no SID compensation) Cont

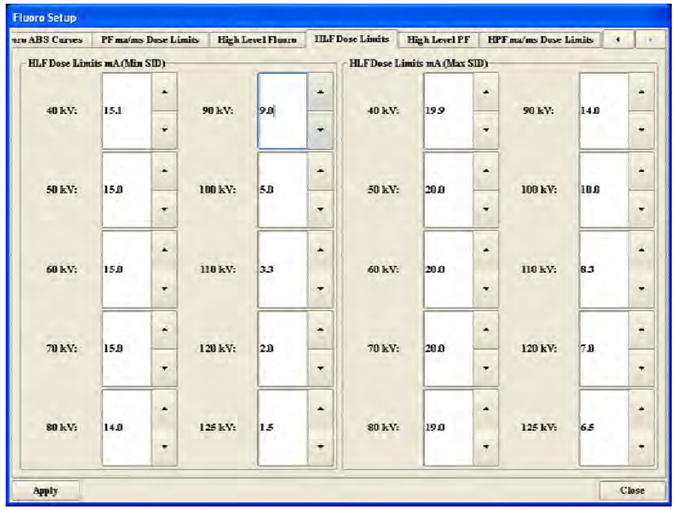


Figure 3E-10: Touchscreen GenWare® HLF Dose Limits tab

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the high-level fluoro dose limits (no SID compensation).

Step	Action
⚠	**When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.**
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.
2.	Temporarily disconnect the ABS pickup to the generator.
3.	Ensure that the SID compensation function is disabled if this option is fitted. Refer to 3E.9.1.
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**

3E.6.4 High-Level Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	From **HLF SETUP** menu 2, select **HLF DOSE LIMITS.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
6.	Select the **40** kV step in the **HLF DOSE L** menu. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **Dose Limits, Min SID** dialog box**,** adjacent to **40** kV**.**	Select the **HLF Dose Limits** tab. Enter the maximum available mA into the **HLF Dose Limits mA (Min SID)** dialog box**,** adjacent to **40** kV**.**
7.	Repeat the above for **50** kV to **90** kV.	Repeat the above for **50** kV to **125** kV.	Repeat the above for **50** kV to **125** kV.
8.	Press **>>**.		
9.	Repeat the above for **100** kV to **125** kV.		
10.	Press **<<**.		
11.	Select a fluoroscopic image receptor.		
12.	Record the maximum permissible Air Kerma Rate for **high-level fluoroscopy**. Note the guidelines below.		
13.	Ensure that the generator is set for high-level fluoro, and that ABS is switched off.		
14.	Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
15.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console such that the maximum permitted dose as recorded in step 12 is not exceeded.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of GenWare® such that the maximum permitted dose as recorded in step 12 is not exceeded.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of GenWare® such that the maximum permitted dose as recorded in step 12 is not exceeded.

Step 12 guidelines:

FDA (USA)	Health Canada	IEC
176 mGy / min *.	150 mGy / min *.	176 mGy / min *.
* The listed Air Kerma Rate values should be confirmed by consulting local regulations.		

Maximum permitted Air Kerma Rate for high-level fluoroscopy:_____________ mGy / min.

3E.6.4 High-Level Fluoro Dose Limits (no SID compensation) Cont

Step	Action
16.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______.
17.	Repeat steps 14 to 16 for **50** kV. Max mA for 50kV = ______.
18.	Repeat steps 14 to 16 for **60** kV. Max mA for 60kV = ______.
19.	Repeat steps 14 to 16 for **70** kV. Max mA for 70kV = ______.
20.	Repeat steps 14 to 16 for **80** kV. Max mA for 80kV = ______.
21.	Repeat steps 14 to 16 for **90** kV. Max mA for 90kV = ______.
22.	Repeat steps 14 to 16 for **100** kV. Max mA for 100kV = ______.
23.	Repeat steps 14 to 16 for **110** kV. Max mA for 110kV = ______.
24.	Repeat steps 14 to 16 for **120** kV. Max mA for 120kV = ______.
25.	Repeat steps 14 to 16 for **125** kV. Max mA for 125 kV = ______.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
26.	Select the **40** kV step in the **HLF DOSE L** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 16 for 40 kV.	Enter the maximum mA as determined in step 16 into the **Dose Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum mA as determined in step 16 into the **HLF Dose Limits mA (Min SID)** dialog box**,** adjacent to **40** kV**.**
27.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 17 to 21.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 17 to 25.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 17 to 25.

3E.6.4 High-Level Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
28.	Press **>>**.		
29.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 22 to 25.		
30.	Press **RETURN**.		
31.	Press **<<** three times to return to the main **FLUORO SETUP** menu.		

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3E.6.5 Pulsed Fluoro Setup

The **PF SETUP** menus for the membrane console are shown below.

* PF SETUP *	
PF: ON	PF DEFAULT MS: 7
PF DEFAULT: ON	PF SYNC FREQ: 60Hz
PPS DEFAULT: 12/15PPS	+
PF DEFAULT MA: 20	-
<<	>>

* PF SETUP *	
PF ABS SETUP	PF II COMP
PF ABS CURVE DEFAULT: 1	
PF ABS CURVES	PF PPS SETUP
PF DOSE LIMITS	
<<	

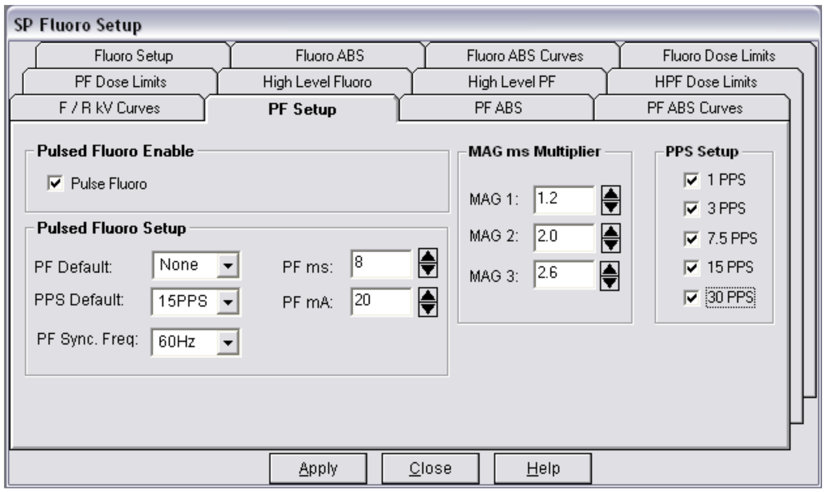
PF ABS SET menu 2 for the membrane console is shown below.

* PF ABS SET *	
ABS DEADBAND: 5%	1PPS COMP: 0%
ABS DELAY: 30ms	3PPS COMP: 0%
ABS START KV: 75	+
PF INTEGRATOR: ON	-
<<	>>

3E.6.5 Pulsed Fluoro Setup (Cont)

The **PF PPS SET** menu for the membrane console is shown below.

* PF PPS SET *	
1 PPS: ON	25/30 PPS: ON
3 PPS: ON	
6/7.5 PPS: ON	+
12.5/15 PPS: ON	-
<<	



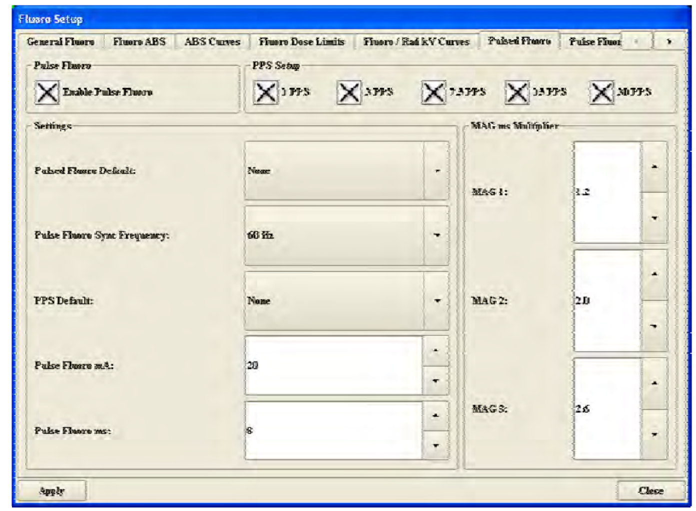
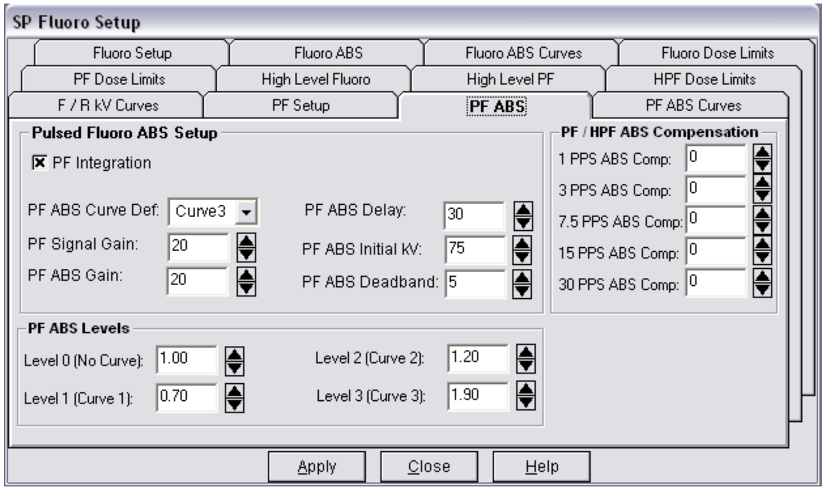


Figure 3E-11a - PC GenWare® *Figure 3E-11b - Touchscreen GenWare®*

Fluoro Setup window, PF Setup / Pulsed Fluoro tab

3E.6.5 Pulsed Fluoro Setup (Cont)



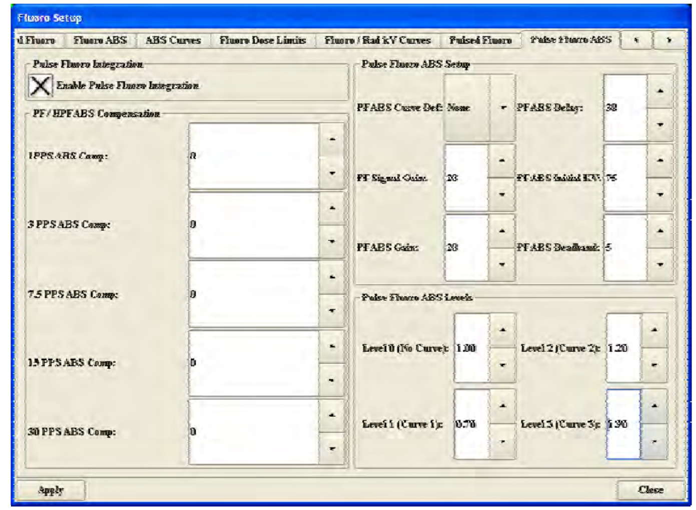


Figure 3E-12a - PC GenWare® *Figure 3E-12b - Touchscreen GenWare®*
Fluoro Setup window, PF ABS / Pulse Fluoro ABS tab

Definitions of **PF SETUP** menu items applicable to pulsed fluoro setup.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
PF	**Pulsed Fluoro Enable** **(Enable Pulse Fluoro)**	Enables / disables the pulsed fluoro option. **ON:** PF is enabled. **OFF:** PF is disabled.

3E.6.5 Pulsed Fluoro Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
PF DEFAULT	**PF Default** **(Pulsed Fluoro Default)**	Selects the pulsed fluoro default state when a pulsed fluoro receptor is selected. **NONE:** The PF will remain at its last setting. **OFF:** The PF will default to OFF. **ON:** The PF will default to ON.
PPS DEFAULT	**PPS Default**	Sets the pulsed fluoro default PPS when pulsed fluoro is selected. **NONE:** The PPS will remain at its last setting. **1PPS:** The PPS will default to 1 PPS. **3PPS:** The PPS will default to 3 PPS. **6/7.5PPS:** The PPS will default to 6 or 7.5 PPS. **12/15PPS:** The PPS will default to 12 or 15 PPS. **25/30PPS:** The PPS will default to 25 or 30 PPS.
PF DEFAULT MA	**PF mA** **(Pulse Fluoro mA)**	Sets the pulsed fluoro default mA when pulsed fluoro is selected in non-ABS mode.
PF DEFAULT MS	**PF ms** **(Pulse Fluoro ms)**	Sets the pulsed fluoro default ms when pulsed fluoro is selected in non-ABS mode.
PF SYNC FREQ	**PF Sync. Freq** **(Pulse Fluoro Sync Frequency)**	Selects the pulsed fluoro sync frequency. The generator uses this to select the appropriate PPS values. **50Hz:** Sets the sync frequency range to 20-27 Hz or 41-55 Hz. **60Hz:** Sets the sync frequency range to 28-40 Hz or 56-65 Hz.

3E.6.5 Pulsed Fluoro Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
PF ABS CURVE DEFAULT	**PF ABS Curve Def**	Selects the pulsed fluoro ABS curve default when a fluoro receptor is selected. This applies to low and high-level pulsed fluoro. **NONE:** The PF ABS curve remains at its last setting. **OFF:** The PF ABS curve is disabled. **1, 2, 3 or Curve 1, Curve 2, Curve 3:** Selects the PF ABS curve where **1** = low, **2** = medium, **3** = high. **One PF ABS curve is standard; three PF ABS curves are optional.**
1 PPS	**PPS Setup: 1 PPS**	When enabled, allows the operator to select 1 PPS in low-level pulsed fluoro mode.
3 PPS	**PPS Setup: 3 PPS**	When enabled, allows the operator to select 3 PPS in low-level pulsed fluoro mode.
6/7.5 PPS	**PPS Setup: 7.5 PPS**	When enabled, allows the operator to select 6 / 7.5 PPS in low-level pulsed fluoro mode.
12.5/15 PPS	**PPS Setup: 15 PPS**	When enabled, allows the operator to select 12 / 15 PPS in low-level pulsed fluoro mode.
25/30 PPS	**PPS Setup: 30 PPS**	When enabled, allows the operator to select 25 / 30 PPS in low-level pulsed fluoro mode.
PF INTEGRATOR	**PF Integration** **(Enable Pulse Fluoro Integration)**	Sets the integration mode for the ABS feedback signal. **ON:** The ABS feedback signal will be integrated. Use this setting if the ABS feedback device is a PMT or other device which provides a pulsed ABS feedback signal in pulsed fluoro mode. **OFF:** The ABS feedback signal will not be integrated. Use this setting if the ABS feedback signal is integrated (smooth DC) in pulsed fluoro mode, i.e. some imaging systems will integrate the ABS signal.

3E.6.5 Pulsed Fluoro Setup (Cont)

Use these steps to perform the initial pulsed fluoro setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **PF SETUP.**	Select the **PF Setup** tab.	Select the **Pulsed Fluoro** tab.
3.	From the **PF SETUP** menu, select **PF.** Toggle the button to select **ON** or **OFF**.	Clear the **Pulse Fluoro** check box for OFF, or check the check box for ON.	Clear the **Enable Pulse Fluoro** check box for OFF, or check the check box for ON.
4.	Select **PF DEFAULT**. Toggle the button to select **NONE**, **ON** or **OFF**.	Select **None**, **Off**, or **On** via the **PF Default** dialog box.	Select **None**, **Off**, or **On** via the **Pulsed Fluoro Default** dialog box.
5.	Select **PPS DEFAULT**. Toggle the button to select **NONE**, **1PPS, 3PPS, 6/7.5PPS, 12/15PPS,** or **25/30PPS.**	Select **None**, **1PPS, 3PPS, 7.5PPS, 15PPS,** or **30PPS** via the **PPS Default** dialog box.	Select **None**, **1 PPS, 3 PPS, 7.5 PPS, 15 PPS,** or **30 PPS** via the **PPS Default** dialog box.
6.	Select **PF DEFAULT MA.** Use the **+** or **–** buttons to set the desired default mA.	Select the desired default mA via the **PF mA** dialog box.	Select the desired default mA via the **Pulse Fluoro mA** dialog box.
7.	Select **PF DEFAULT MS.** Use the **+** or **–** buttons to set the desired default ms (approximately 10 ms is recommended).	Select the desired default ms via the **PF ms** dialog box (approximately 10 ms is recommended).	Select the desired default ms via the **Pulse Fluoro ms** dialog box (approximately 10 ms is recommended).
8.	Select **PF SYNC FREQ**. Toggle the button to select **50Hz** or **60Hz**.	Select **50Hz** or **60Hz** via the **PF Sync. Freq** dialog box.	Select **50Hz** or **60Hz** via the **Pulse Fluoro Sync Frequency** dialog box.
9.	Press **>>**.	Select the **PF ABS** tab.	Select the **Pulse Fluoro ABS** tab.
10.	Select **PF ABS CURVE DEFAULT**. Toggle the button to select **NONE**, **OFF, 1, 2,** or **3.**	Select **None**, **Off**, **Curve1, Curve2,** or **Curve3** via the **PF ABS Curve Def** dialog box.	Select **None**, **Off**, **Curve 1, Curve 2,** or **Curve 3** via the **PF ABS Curve Def** dialog box.
	NOTE: PF ABS curves 2 and 3 are optional.		
11.	Select **PF PPS SETUP**.	Select the **PF Setup** tab.	Select the **Pulsed Fluoro** tab.
12.	Select **1 PPS.** Toggle the button to select **ON** or **OFF**.	Under **PPS Setup,** clear the **1 PPS** check box for OFF, or check the check box for ON.	Under **PPS Setup,** clear the **1 PPS** check box for OFF, or check the check box for ON.

3E.6.5 Pulsed Fluoro Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
13.	Select **3 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **3 PPS**.	Repeat the above for **3 PPS**.
14.	Select **6/7.5 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **7.5 PPS**.	Repeat the above for **7.5 PPS**.
15.	Select **12.5/15 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **15 PPS**.	Repeat the above for **15 PPS**.
16.	Select **25/30 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **30 PPS**.	Repeat the above for **30 PPS**.
17.	Press **<<**, then select **PF ABS SETUP.**		
18.	Press **>>.**	Select the **PF ABS** tab.	Select the **Pulse Fluoro ABS** tab.
19.	Select **PF INTEGRATOR.** Toggle the button to select **ON** or **OFF**.	Clear the **PF Integration** check box for OFF, or check the check box for ON.	Clear the **Enable Pulse Fluoro Integration** check box for OFF, or check the check box for ON.
20.	Press **<<** twice to return to **PF SETUP** menu 2.		

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3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation)

This procedure sets the maximum mA and pulse width allowed for each kV setting in pulsed fluoro mode for systems without SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **PF DOSE L** menus for the membrane console are shown below (no SID comp).

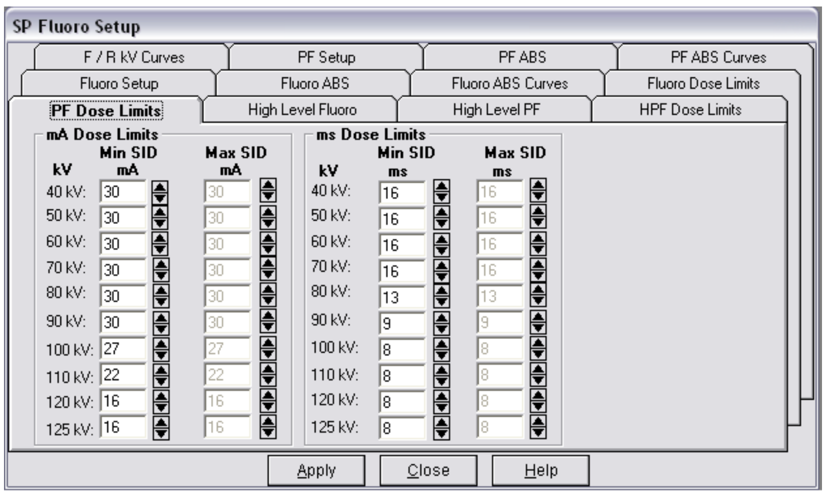
		* PF DOSE L *		
40 kV:	16ms		60 kV:	16ms
40 kV:	30mA		60 kV:	30mA
50 kV:	16ms			+
50 kV:	30mA			-
	<<		>>	

		* PF DOSE L *		
70 kV:	16ms		90 kV:	9ms
70 kV:	30mA		90 kV:	30mA
80 kV:	13ms			+
80 kV:	30mA			-
	<<		>>	

3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation) Cont

	* PF DOSE L *	
100 kV: 8ms		120 kV: 8ms
100 kV: 27mA		120 kV: 16mA
110 kV: 8ms		+
110 kV: 22mA		-
<<		>>

	* PF DOSE L *	
125 kV: 8ms		
125 kV: 16mA		
		+
		-
<<		RETURN



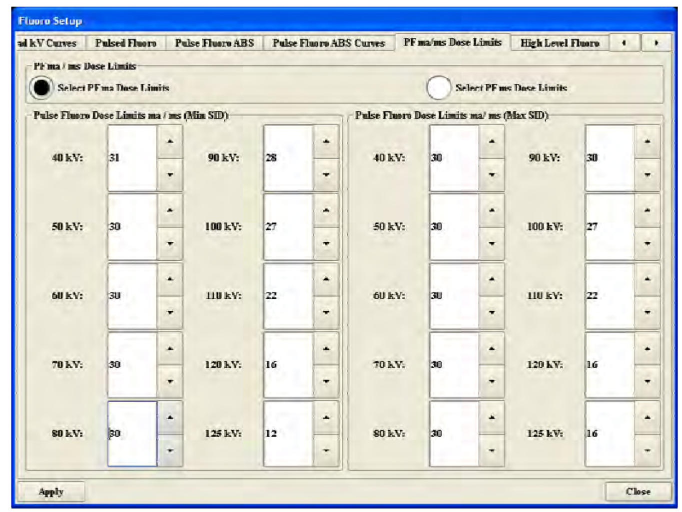


Figure 3E-13a - PC GenWare® *Figure 3E-13b - Touchscreen GenWare®*

Fluoro Setup window, PF Dose Limits / PF ma/ms Dose Limits tab

3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation) Cont

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the pulsed fluoro dose limits (no SID compensation).

Step	Action		
!	**When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.**		
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.		
2.	Temporarily disconnect the ABS pickup to the generator.		
3.	Ensure that the SID compensation function is disabled if this option is fitted. Refer to 3E.9.1.		
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Temporarily set the **PF DEFAULT MS** to the maximum value as described in the preceding section.	Temporarily set the **PF ms** to the maximum value as described in the preceding section.	Temporarily set the **Pulse Fluoro ms** to the maximum value as described in the preceding section.
6.	From **PF SETUP** menu 2, select **PF DOSE LIMITS.**	Select the **PF Dose Limits** tab.	Select the **PF ma/ms Dose Limits** tab.
7.	Select the **40** kV (ms) step in the **PF DOSE L** menu. Use the **+** button adjacent to the LCD display to enter the maximum available ms.	Enter the maximum available ms into the **ms Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. Enter the maximum available ms into the **Pulse Fluoro Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV.
8.	Select the **40** kV (mA) step in the **PF DOSE L** menu. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **mA Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **PF ma / ms Dose Limits**, select **Select PF ma Dose Limits**. Enter the maximum available mA into the **Pulse Fluoro Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV.
9.	Repeat the two previous steps for **50** and **60** kV.	Repeat the two previous steps for **50** to **125** kV.	Repeat the two previous steps for **50** to **125** kV.
10.	Press **>>**.		

3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation) Cont

<table>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>11.</td><td>Repeat the previous steps for 70 to 90 kV.</td><td></td><td></td></tr>
<tr><td>12.</td><td>Press >>.</td><td></td><td></td></tr>
<tr><td>13.</td><td>Repeat the previous steps for 100 to 120 kV.</td><td></td><td></td></tr>
<tr><td>14.</td><td>Press >>.</td><td></td><td></td></tr>
<tr><td>15.</td><td>Repeat the previous steps for 125 kV.</td><td></td><td></td></tr>
<tr><td>16.</td><td>Press << three times to return to PF DOSE L menu 1.</td><td></td><td></td></tr>
<tr><td>17.</td><td colspan="3">Select a fluoroscopic image receptor.</td></tr>
<tr><td>18.</td><td colspan="3">Record the maximum permissible Air Kerma Rate for normal pulsed fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>88 mGy / min *.</td><td>100 mGy / min *.</td><td>The maximum Air Kerma Rate must comply with local regulations.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for normal pulsed fluoroscopy:______________ mGy / min.</td></tr>
<tr><td>19.</td><td colspan="3">Ensure that the generator is set for pulsed fluoro, and that ABS is switched off.</td></tr>
<tr><td>20.</td><td colspan="3">Select the highest PPS frame rate for determining the maximum dose.</td></tr>
<tr><td>21.</td><td colspan="3">Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.</td></tr>
</table>

3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
22.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **PF DOSE L** menu such that the maximum permitted dose as recorded in step 18 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified ms range.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **ms Dose Limits, Min SID** dialog box, such that the maximum permitted dose as recorded in step 18 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **Pulse Fluoro Dose Limits ma / ms (Min SID)** dialog box, such that the maximum permitted dose as recorded in step 18 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.
23.	Record the ms and the mA as determined in the previous step for the **40** kV setting. Max ms for 40kV = ______. Max mA for 40kV = ______.		
24.	Repeat steps 21 to 23 for **50** kV. Max ms for 50kV = ______. Max mA for 50kV = ______.		
25.	Repeat steps 21 to 23 for **60** kV. Max ms for 60kV = ______. Max mA for 60kV = ______.		
26.	Repeat steps 21 to 23 for **70** kV. Max ms for 70kV = ______. Max mA for 70kV = ______.		
27.	Repeat steps 21 to 23 for **80** kV. Max ms for 80kV = ______. Max mA for 80kV = ______.		
28.	Repeat steps 21 to 23 for **90** kV. Max ms for 90kV = ______. Max mA for 90kV = ______.		
29.	Repeat steps 21 to 23 for **100** kV. Max ms for 100kV = ______. Max mA for 100kV = ______.		
30.	Repeat steps 21 to 23 for **110** kV. Max ms for 110kV = ______. Max mA for 110kV = ______.		

3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation) Cont

Step	Action		
31.	Repeat steps 21 to 23 for **120** kV. Max ms for 120kV = ______. Max mA for 120kV = ______.		
32.	Repeat steps 21 to 23 for **125** kV. Max ms for 125kV = ______. Max mA for 125kV = ______.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
33.	Select the **40** kV (ms) step in the **PF DOSE L** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum ms as determined in step 23 for 40 kV.	Enter the maximum ms as determined in step 23 into the **ms Dose Limits, Min SID** dialog box, adjacent to 40 kV**.**	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. Enter the maximum ms as determined in step 23 into the **Pulse Fluoro Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV**.**
34.	Select the **40** kV (mA) step in the **PF DOSE L** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 23 for 40 kV.	Enter the maximum mA as determined in step 23 into the **mA Dose Limits, Min SID** dialog box, adjacent to 40 kV**.**	Under **PF ma / ms Dose Limits**, select **Select PF ma Dose Limits**. Enter the maximum mA as determined in step 23 into the **Pulse Fluoro Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV**.**
35.	Repeat the two previous steps for **50** kV and **60** kV using the mA and ms determined in steps 24 and 25.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 24 to 32.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 24 to 32.
36.	Press **>>**.		
37.	Repeat the above for **70** kV to **90** kV using the mA and ms determined in steps 26 to 28.		
38.	Press **>>**.		
39.	Repeat the above for **100** kV to **120** kV using the mA and ms determined in steps 29 to 31.		
40.	Press **>>**.		

3E.6.6 Pulsed Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
41.	Repeat the above for **125** kV using the mA and ms determined in step 32.		
42.	Press **RETURN**.		
43.	Press **<<**.		
44.	Set the **PF DEFAULT MS** to the desired value as described in the preceding section.	Set the **PF ms** to the desired value as described in the preceding section.	Set the **PF ms** to the desired value as described in the preceding section.
45.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

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3E.6.7 High Level Pulsed Fluoro Setup

The **HPF SETUP** menus for the membrane console are shown below.

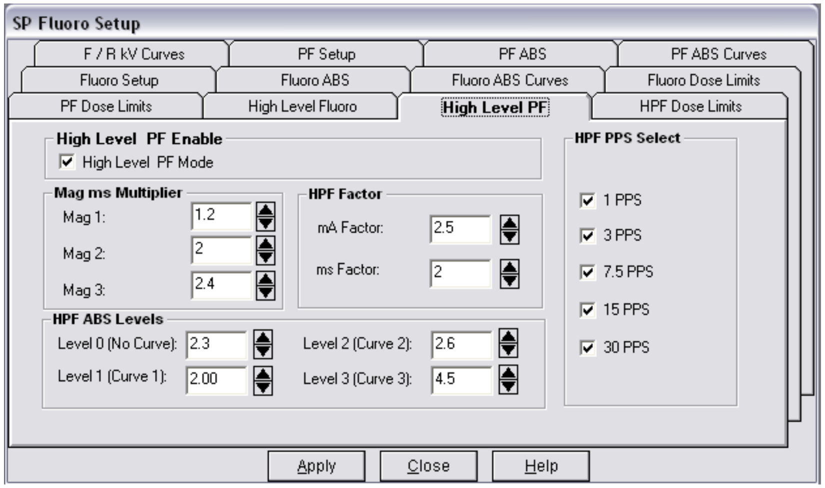
	* HPF SETUP *	
HPF: ON		ABS LEVEL 1: 2.00V
PF-HPF MA MULT: 2.5		ABS LEVEL 2: 2.60V
PF-HPF MS MULT: 2.0		+
ABS LEVEL 0: 2.30V		-
<<		>>

	* HPF SETUP *	
ABS LEVEL 3: 4.50V		
HPF DOSE LIMITS		
HPF II COMP		+
HPF PPS SETUP		-
<<		

The **HPF PPS SETUP** menu for the membrane console is shown below.

	* HPF PPS SET *	
1 PPS: ON		25/30 PPS: ON
3 PPS: ON		
6/7.5 PPS: ON		+
12.5/15 PPS: ON		-
<<		

3E.6.7 High-Level Pulsed Fluoro Setup (Cont)



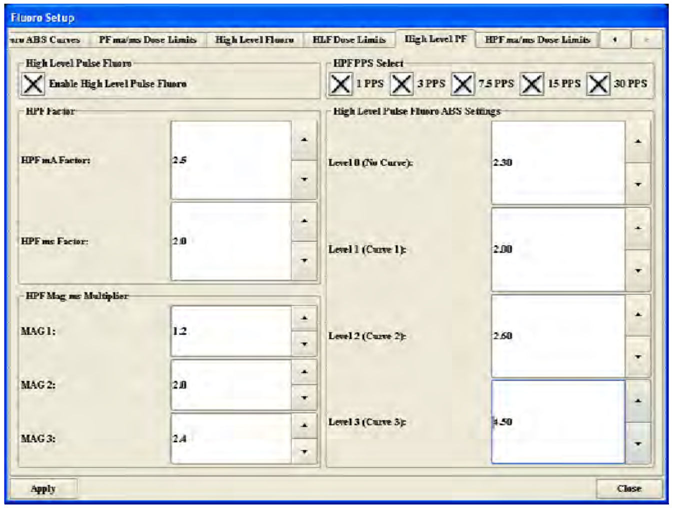


Figure 3E-14a - PC GenWare® *Figure 3E-14b - Touchscreen GenWare®*
Fluoro Setup window, High Level PF tab

Definitions of **HPF SETUP** menu items applicable to high-level pulsed fluoro setup.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
HPF	**High Level PF Mode** **(Enable High Level Pulse fluoro)**	Enables / disables the high-level pulsed fluoro option. **ON:** HPF is enabled. **OFF:** HPF is disabled.
PF-HPF MA MULT	**mA Factor** **(HPF mA Factor)**	Sets the mA multiplication factor applied to low-level pulsed fluoro mA settings to achieve high-level pulsed fluoroscopy. For example, if the normal pulsed fluoro mA is 10 mA and a multiplication factor of 2.5 is used, the HLF pulsed fluoro will be 25 mA.

3E.6.7 High Level Pulsed Fluoro Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
PF-HPF MS MULT	**ms Factor** **(HPF ms Factor)**	Sets the ms multiplication factor applied to low-level pulsed fluoro ms settings to achieve high-level pulsed fluoroscopy.
1 PPS	**HPF PPS Select: 1 PPS**	When enabled, allows the operator to select 1 PPS in high-level pulsed fluoro mode.
3 PPS	**HPF PPS Select: 3 PPS**	When enabled, allows the operator to select 3 PPS in high-level pulsed fluoro mode.
6/7.5 PPS	**HPF PPS Select: 7.5 PPS**	When enabled, allows the operator to select 6 / 7.5 PPS in high-level pulsed fluoro mode.
12.5/15 PPS	**HPF PPS Select: 15 PPS**	When enabled, allows the operator to select 12 / 15 PPS in high-level pulsed fluoro mode.
25/30 PPS	**HPF PPS Select: 30 PPS**	When enabled, allows the operator to select 25 / 30 PPS in high-level pulsed fluoro mode.

Use these steps to perform the initial high-level pulsed fluoro setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **HPF SETUP.**	Select the **High Level PF** tab.	Select the **High Level PF** tab.
3.	From the **HPF SETUP** menu, select **HPF.** Toggle the button to select **ON** or **OFF**.	Clear the **High Level PF Mode** check box for OFF, or check the check box for ON.	Clear the **Enable High Level Pulse Fluoro** check box for OFF, or check the check box for ON.
4.	Select **PF-HPF MA MULT**. Use the **+** or **–** buttons to select the mA multiplier for HPF.	Select the mA multiplier via the **mA Factor** dialog box.	Select the mA multiplier via the **HPF mA Factor** dialog box.

3E.6.7 High Level Pulsed Fluoro Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Select **PF-HPF MS MULT**. Use the **+** or **–** buttons to select the ms multiplier for HPF.	Select the ms multiplier via the **ms Factor** dialog box.	Select the ms multiplier via the **HPF ms Factor** dialog box.
6.	Press **>>**.		
7.	Select **HF PPS SETUP**.		
8.	Select **1 PPS.** Toggle the button to select **ON** or **OFF**.	Under **HPF PPS Select,** clear the **1 PPS** check box for OFF, or check the check box for ON.	Under **HPF PPS Select,** clear the **1 PPS** check box for OFF, or check the check box for ON.
9.	Select **3 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **3 PPS**.	Repeat the above for **3 PPS**.
10.	Select **6/7.5 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **7.5 PPS**.	Repeat the above for **7.5 PPS**.
11.	Select **12.5/15 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **15 PPS**.	Repeat the above for **15 PPS**.
12.	Select **25/30 PPS.** Toggle the button to select **ON** or **OFF**.	Repeat the above for **30 PPS**.	Repeat the above for **30 PPS**.
13.	Press **<<**.		

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation)

This procedure sets the maximum mA and pulse width allowed for each kV setting in high-level pulsed fluoro mode for systems without SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **HPF DOSE L** menus for the membrane console are shown below (no SID comp).

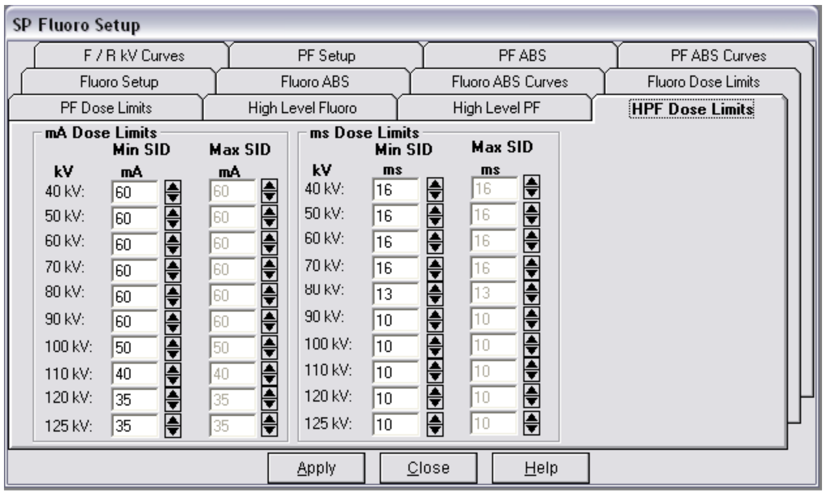
* HPF DOSE L *			
40 kV:	16ms	60 kV:	16ms
40 kV:	60mA	60 kV:	60mA
50 kV:	16ms		+
50 kV:	60mA		-
	<<	>>	

* HPF DOSE L *			
70 kV:	16ms	90 kV:	10ms
70 kV:	60mA	90 kV:	60mA
80 kV:	13ms		+
80 kV:	60mA		-
	<<	>>	

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation) Cont

```
                    * HPF DOSE L *
100 kV:   10ms                           120 kV:   10ms
100 kV:   50mA                           120 kV:   35mA
110 kV:   10ms                                        +
110 kV:   40mA                                        -
      <<                                      >>
```

```
                    * HPF DOSE L *
125 kV:   10ms
125 kV:   35mA
                                                      +
                                                      -
      <<                                    RETURN
```



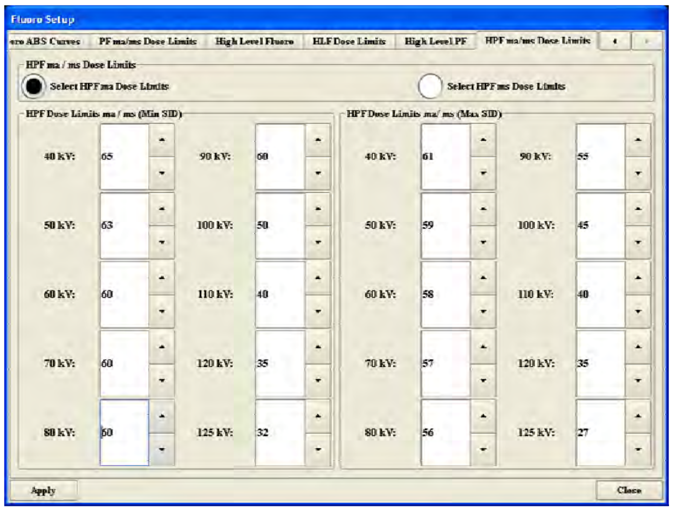


Figure 3E-15a - PC GenWare® *Figure 3E-15b - Touchscreen GenWare®*
Fluoro Setup window, HPF Dose Limits / HPF ma/ms Dose Limits tab

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation) Cont

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the high-level pulsed fluoro dose limits (no SID compensation).

Step	Action		
	When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.		
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.		
2.	Temporarily disconnect the ABS pickup to the generator.		
3.	Ensure that the SID compensation function is disabled if this option is fitted. Refer to 3E.9.1.		
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Temporarily set the **PF DEFAULT MS** to the maximum value as described in the ***Pulsed Fluoro Setup*** section.	Temporarily set the **PF ms** to the maximum value as described in the ***Pulsed Fluoro Setup*** section.	Temporarily set the **Pulse Fluoro ms** to the maximum value as described in the ***Pulsed Fluoro Setup*** section.
6.	From **HPF SETUP** menu 2, select **HPF DOSE LIMITS.**	Select the **HPF Dose Limits** tab.	Select the **HPF ma/ms Dose Limits** tab.
7.	Select the **40** kV (ms) step in the **HPF DOSE L** menu. Use the **+** button adjacent to the LCD display to enter the maximum available ms.	Enter the maximum available ms into the **ms Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. Enter the maximum available ms into the **HPF Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV.
8.	Select the **40** kV (mA) step in the **HPF DOSE L** menu. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **mA Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **HPF ma / ms Dose Limits**, select **Select HPF ma Dose Limits**. Enter the maximum available mA into the **HPF Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV.
9.	Repeat the two previous steps for **50** and **60** kV.	Repeat the two previous steps for **50** to **125** kV.	Repeat the two previous steps for **50** to **125** kV.

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation) Cont

<table>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>10.</td><td>Press >>.</td><td></td><td></td></tr>
<tr><td>11.</td><td>Repeat the previous steps for 70 to 90 kV.</td><td></td><td></td></tr>
<tr><td>12.</td><td>Press >>.</td><td></td><td></td></tr>
<tr><td>13.</td><td>Repeat the previous steps for 100 to 120 kV.</td><td></td><td></td></tr>
<tr><td>14.</td><td>Press >>.</td><td></td><td></td></tr>
<tr><td>15.</td><td>Repeat the previous steps for 125 kV.</td><td></td><td></td></tr>
<tr><td>16.</td><td>Press << three times to return to HPF DOSE L menu 1.</td><td></td><td></td></tr>
<tr><td>17.</td><td colspan="3">Select a fluoroscopic image receptor.</td></tr>
<tr><td>18.</td><td colspan="3">Record the maximum permissible Air Kerma Rate for high-level pulsed fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>176 mGy / min *.</td><td>150 mGy / min *.</td><td>176 mGy / min *.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for high-level pulsed fluoroscopy:______________ mGy / min.</td></tr>
<tr><td>19.</td><td colspan="3">Ensure that the generator is set for high-level pulsed fluoro, and that ABS is switched off.</td></tr>
<tr><td>20.</td><td colspan="3">Select the highest PPS frame rate for determining the maximum dose.</td></tr>
<tr><td>21.</td><td colspan="3">Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.</td></tr>
</table>

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
22.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **HPF DOSE L** menu such that the maximum permitted dose as recorded in step 18 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **ms Dose Limits, Min SID** dialog box, such that the maximum permitted dose as recorded in step 18 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **HPF Dose Limits ma / ms (Min SID)** dialog box, such that the maximum permitted dose as recorded in step 18 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.
23.	Record the ms and the mA as determined in the previous step for the **40** kV setting. Max ms for 40kV = ______. Max mA for 40kV = ______.		
24.	Repeat steps 21 to 23 for **50** kV. Max ms for 50kV = ______. Max mA for 50kV = ______.		
25.	Repeat steps 21 to 23 for **60** kV. Max ms for 60kV = ______. Max mA for 60kV = ______.		
26.	Repeat steps 21 to 23 for **70** kV. Max ms for 70kV = ______. Max mA for 70kV = ______.		
27.	Repeat steps 21 to 23 for **80** kV. Max ms for 80kV = ______. Max mA for 80kV = ______.		
28.	Repeat steps 21 to 23 for **90** kV. Max ms for 90kV = ______. Max mA for 90kV = ______.		
29.	Repeat steps 21 to 23 for **100** kV. Max ms for 100kV = ______. Max mA for 100kV = ______.		
30.	Repeat steps 21 to 23 for **110** kV. Max ms for 110kV = ______. Max mA for 110kV = ______.		

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation) Cont

Step	Action		
31.	Repeat steps 21 to 23 for **120** kV. Max ms for 120kV = ______. Max mA for 120kV = ______.		
32.	Repeat steps 21 to 23 for **125** kV. Max ms for 125kV = ______. Max mA for 125kV = ______.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
33.	Select the **40** kV (ms) step in the **HPF DOSE L** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum ms as determined in step 23 for 40 kV.	Enter the maximum ms as determined in step 23 into the **ms Dose Limits, Min SID** dialog box, adjacent to 40 kV**.**	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. Enter the maximum ms as determined in step 23 into the **HPF Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV.
34.	Select the **40** kV (mA) step in the **HPF DOSE L** menu. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 23 for 40 kV.	Enter the maximum mA as determined in step 23 into the **mA Dose Limits, Min SID** dialog box, adjacent to 40 kV**.**	Under **HPF ma / ms Dose Limits**, select **Select HPF ma Dose Limits**. Enter the maximum mA as determined in step 23 into the **HPF Dose Limits ma / ms (Min SID)** dialog box, adjacent to 40 kV.
35.	Repeat the two previous steps for **50** kV and **60** kV using the mA and ms determined in steps 24 and 25.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 24 to 32.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 24 to 32.
36.	Press **>>**.		
37.	Repeat the above for **70** kV to **90** kV using the mA and ms determined in steps 26 to 28.		
38.	Press **>>**.		
39.	Repeat the above for **100** kV to **120** kV using the mA and ms determined in steps 29 to 31.		
40.	Press **>>**.		

3E.6.8 High Level Pulsed Fluoro Dose Limits (no SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
41.	Repeat the above for **125** kV using the mA and ms determined in step 32.		
42.	Press **RETURN**.		
43.	Press **<<** three times to return to the main **FLUORO SETUP** menu.		
44.	Set the **PF DEFAULT MS** to the desired value as described in the ***Pulsed Fluoro Setup*** section. Go back to the main **FLUORO SETUP** menu when finished.	Set the **PF ms** to the desired value as described in the ***Pulsed Fluoro Setup*** section.	Set the **PF ms** to the desired value as described in the ***Pulsed Fluoro Setup*** section.

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3E.7.0 F/R AND ABS CURVES SETUP

Indico 100 X-ray generators include the following factory-default fluoro to rad kV transfer and fluoro ABS curves:

Curve type	Standard	Optional
Fluoro to rad kV transfer	One curve	Three curves
Fluoro ABS mA / kV	One curve	Three curves
Pulsed fluoro ABS mA / kV / ms	One curve	Three curves

The next three sections detail the procedure to reprogram the factory-default curves, if required.

3E.7.1 Fluoro to Rad kV Curves Setup

This section details the procedure to reprogram the fluoro to rad kV transfer curves. Figures 3E-16 to 3E-18 show the factory-default fluoro to rad kV transfer curves. These should be reviewed before determining the need to reprogram the factory-default curves.

The **F/R KV CUR1, F/R KV CUR2, F/R KV CUR3** menus for the membrane console are shown below.

	* F/R KV CUR1 *	
F/R KV CURVE 1: ON		F-55KV: R- 55KV
F-40KV: R- 40KV		F-60KV: R- 60KV
F-45KV: R- 45KV		+
F-50KV: R- 50KV		-
<<		>>

	* F/R KV CUR1 *	
F-65KV: R- 65KV		F-85KV: R- 85KV
F-70KV: R- 70KV		F-90KV: R- 90KV
F-75KV: R- 75KV		+
F-80KV: R- 80KV		-
<<		>>

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

* F/R KV CUR1 *	
F-95KV: R- 95KV	F-115KV: R- 115KV
F-100KV: R- 100KV	F-120KV: R- 120KV
F-105KV: R- 105KV	+
F-110KV: R- 110KV	-
<<	>>

* F/R KV CUR1 *	
F-125KV: R- 125KV	
	+
	-
<<	>>

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

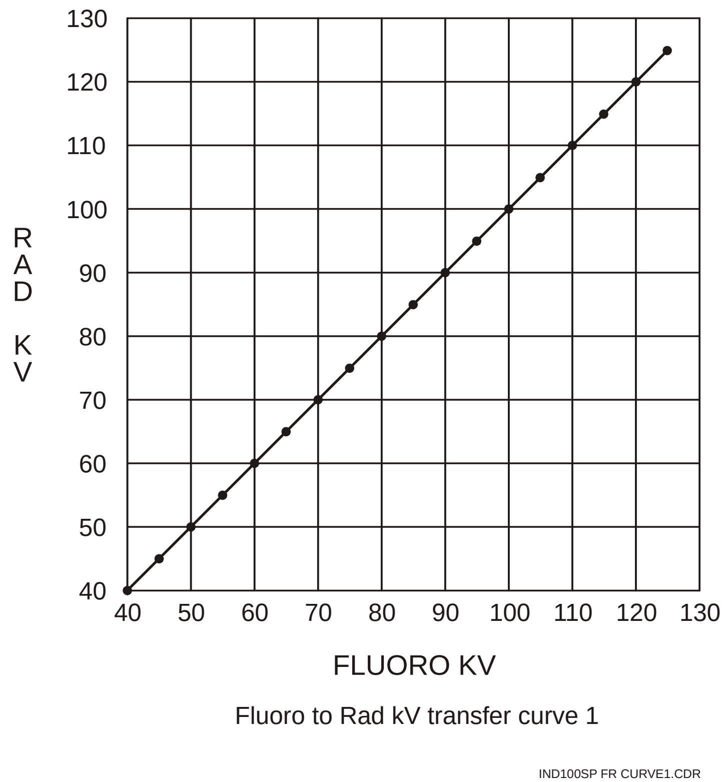


Figure 3E-16: Factory-default fluoro to rad kV transfer curve 1

	* F/R KV CUR2 *	
F/R KV CURVE 2: ON		F-55KV: R- 55KV
F-40KV: R- 50KV		F-60KV: R- 57KV
F-45KV: R- 51KV		+
F-50KV: R- 53KV		-
<<		>>

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

	* F/R KV CUR2 *	
F-65KV: R- 59KV		F-85KV: R- 69KV
F-70KV: R- 61KV		F-90KV: R- 72KV
F-75KV: R- 64KV		+
F-80KV: R- 66KV		-
<<		>>

	* F/R KV CUR2 *	
F-95KV: R- 74KV		F-115KV: R- 82KV
F-100KV: R- 76KV		F-120KV: R- 83KV
F-105KV: R- 79KV		+
F-110KV: R- 81KV		-
<<		>>

	* F/R KV CUR2 *	
F-125KV: R- 84KV		
		+
		-
<<		>>

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

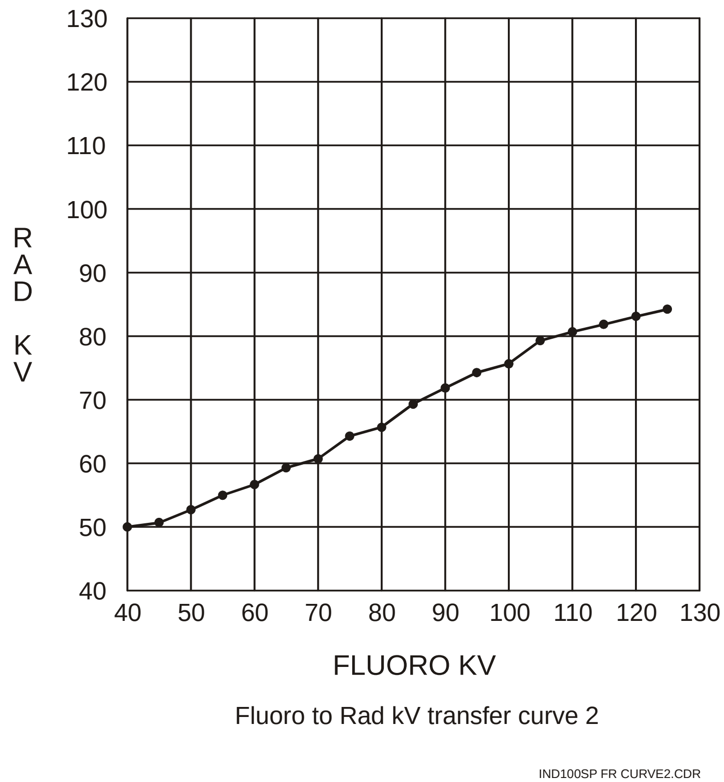


Figure 3E-17: Factory-default fluoro to rad kV transfer curve 2 (optional)

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

```
                         * F/R KV CUR3 *
F/R KV CURVE 3:   ON                           F-55KV:  R- 63KV
F-40KV:  R- 55KV                               F-60KV:  R- 65KV
F-45KV:  R- 58KV                                              +
F-50KV:  R- 60KV                                              -
         <<                                         >>
```

```
                         * F/R KV CUR3 *
F-65KV:  R- 68KV                               F-85KV:  R- 77KV
F-70KV:  R- 70KV                               F-90KV:  R- 80KV
F-75KV:  R- 75KV                                              +
F-80KV:  R- 75KV                                              -
         <<                                         >>
```

```
                         * F/R KV CUR3 *
F-95KV:    R- 83KV                            F-115KV:  R- 93KV
F-100KV:   R- 85KV                            F-120KV:  R- 95KV
F-105KV:   R- 87KV                                            +
F-110KV:   R- 90KV                                            -
         <<                                         >>
```

```
                         * F/R KV CUR3 *
F-125KV:   R- 98KV


                                                              +
                                                              -
         <<                                       RETURN
```

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

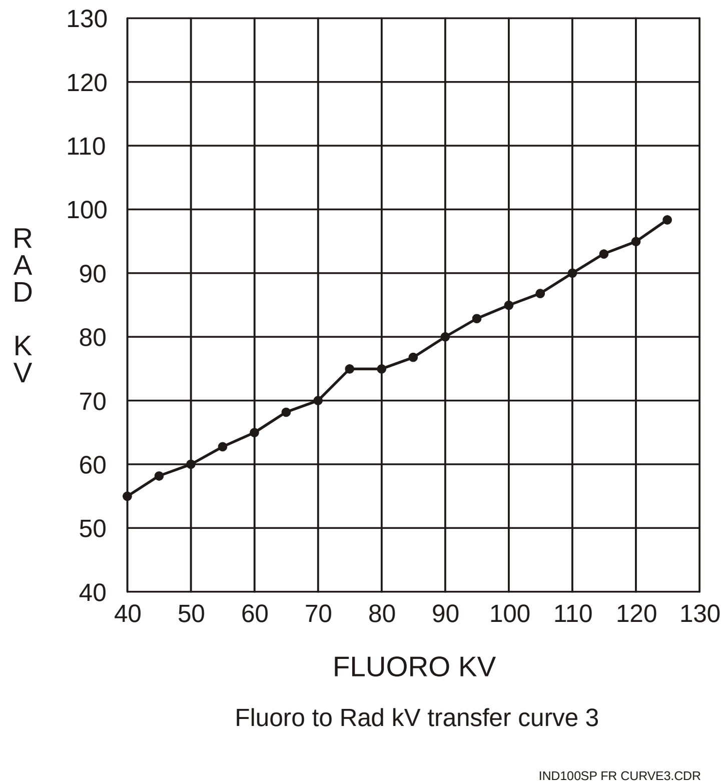
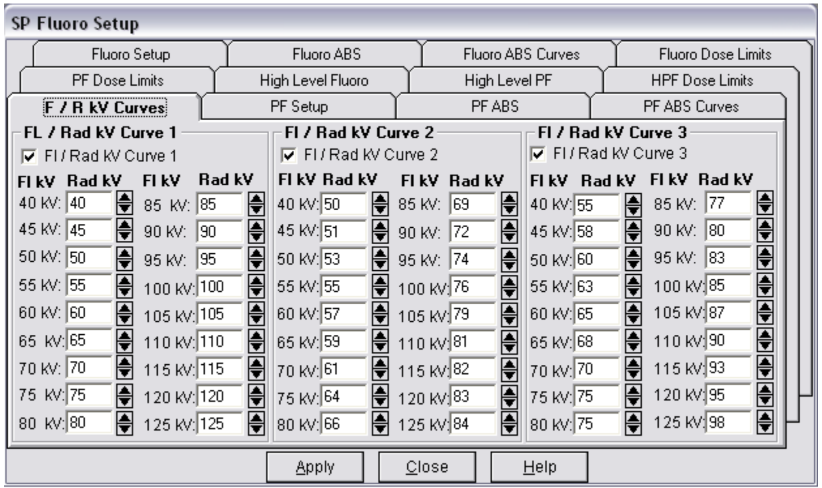


Figure 3E-18: Factory-default fluoro to rad kV transfer curve 3 (optional)

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)



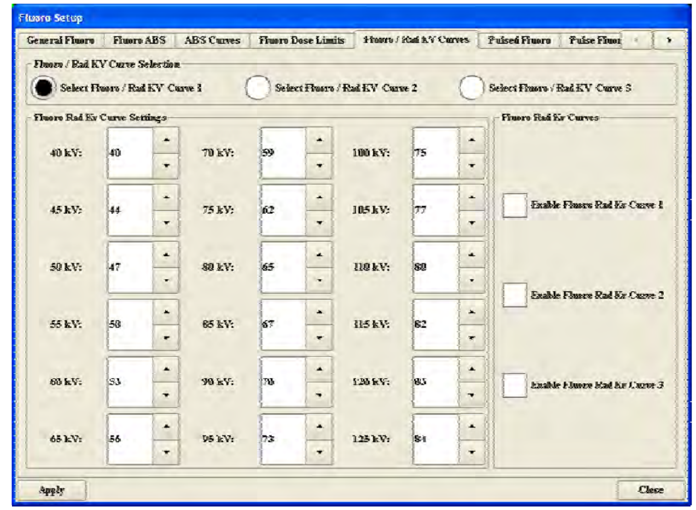


Figure 3E-19a - PC GenWare® *Figure 3E-19b - Touchscreen GenWare®*
Fluoro Setup window, F/R kV Curves / Fluoro / Rad kV Curves tab

Use these steps to set up the fluoro to rad kV curves.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
	Before attempting to program the fluoro to rad kV transfer curves, graphs of the desired curves should be prepared in a format similar to those in figures 3E-16 to 3E-18.		
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **FL/RAD KV CURVES.**	Select the **F/R kV Curves** tab.	Select the **Fluoro / Rad kV Curves** tab.
3.	From **F/R KV CUR1** menu 1, select **F/R KV CURVE 1.** Enable or disable fluoro to rad kV curve 1 by toggling the button to select **ON** or **OFF**.	Enable or disable fluoro to rad kV curve 1 by clearing the **Fl / Rad kV Curve 1** check box for OFF, or checking the check box for ON.	Enable or disable fluoro to rad kV curve 1 by clearing the **Enable Fluoro Rad Kv Curve 1** check box for OFF, or checking the check box for ON.

3E.7.1 Fluoro to Rad kV Curves Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
4.	Select the **40** kV fluoro step. Use the **+** or **–** buttons to enter the desired corresponding rad kV.	For the **40** kV fluoro selection, enter the desired corresponding rad kV under **Fl / Rad kV Curve 1.**	Under **Fluoro / Rad KV Curve Selection**, select **Select Fluoro / Rad KV Curve 1**. For the **40** kV fluoro selection, enter the desired corresponding rad kV under **Fluoro Rad Kv Curve Settings.**
5.	Repeat the previous step for **45** to **60** kV.	Repeat the previous step for **45** to **125** kV.	Repeat the previous step for **45** to **125** kV.
6.	Press **>>.**		
7.	Repeat the previous step for **65** to **90** kV.		
8.	Press **>>.**		
9.	Repeat the previous steps for **95** to **120** kV.		
10.	Press **>>.**		
11.	Repeat the previous steps for **125** kV.		
	Disregard the next three steps if the three-curves option is not fitted.		
12.	Press **>>.**		
13.	Repeat steps 3 to 12 for fluoro to rad kV transfer curve 2.	Repeat steps 3 to 5 for fluoro to rad kV transfer curve 2.	Repeat steps 3 to 5 for fluoro to rad kV transfer curve 2. Be sure to select **Fluoro / Rad KV Curve 2** in step 4.
14.	Repeat steps 3 to 11 for fluoro to rad kV transfer curve 3.	Repeat steps 3 to 5 for fluoro to rad kV transfer curve 3.	Repeat steps 3 to 5 for fluoro to rad kV transfer curve 3. Be sure to select **Fluoro / Rad KV Curve 3** in step 4.
15.	Press **RETURN.**		
16.	Press **<<** to return to the main **FLUORO SETUP** menu.		

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3E.7.2 Fluoro ABS Curves Setup

This section details the procedure to reprogram the fluoro ABS curves. Figures 3E-20 to 3E-22 show the factory-default fluoro ABS curves. This should be reviewed before determining the need to reprogram the factory-default curves. For both low and high-level fluoro, with ABS on, the mA will follow the programmed curves. In high-level fluoro mode, the mA is multiplied by the factor set via the **FL-HLF MA MULT** function.

The **FL ABS C1, FL ABS C2, FL ABS C3** menus for the membrane console are shown below.

	* FL ABS C1 *		
FL ABS CURVE 1: ON		70KV:	0.5mA
40KV:	0.5mA	80KV:	0.5mA
50KV:	0.5mA		+
60KV:	0.5mA		-
	<<	>>	

	* FL ABS C1 *		
90KV:	0.7mA	125KV:	3.0mA
100KV:	1.5mA		
110KV:	2.5mA		+
120KV:	2.9mA		-
	<<	>>	

3E.7.2 Fluoro ABS Curves Setup (Cont)

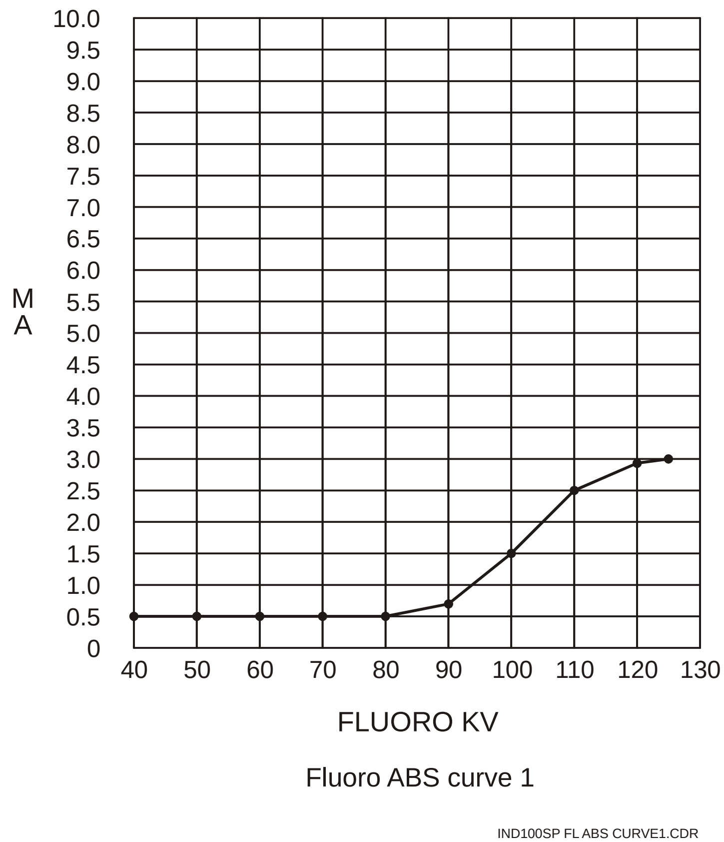


Figure 3E-20: Factory-default fluoro ABS curve 1

3E.7.2 Fluoro ABS Curves Setup (Cont)

	* FL ABS C2 *		
FL ABS CURVE 2:	ON	70KV:	0.5mA
40KV:	0.5mA	80KV:	1.3mA
50KV:	0.5mA		+
60KV:	0.5mA		-
	<<	>>	

	* FL ABS C2 *		
90KV:	3.0mA	125KV:	4.5mA
100KV:	4.0mA		
110KV:	4.2mA		+
120KV:	4.9mA		-
	<<	>>	

3E.7.2 Fluoro ABS Curves Setup (Cont)

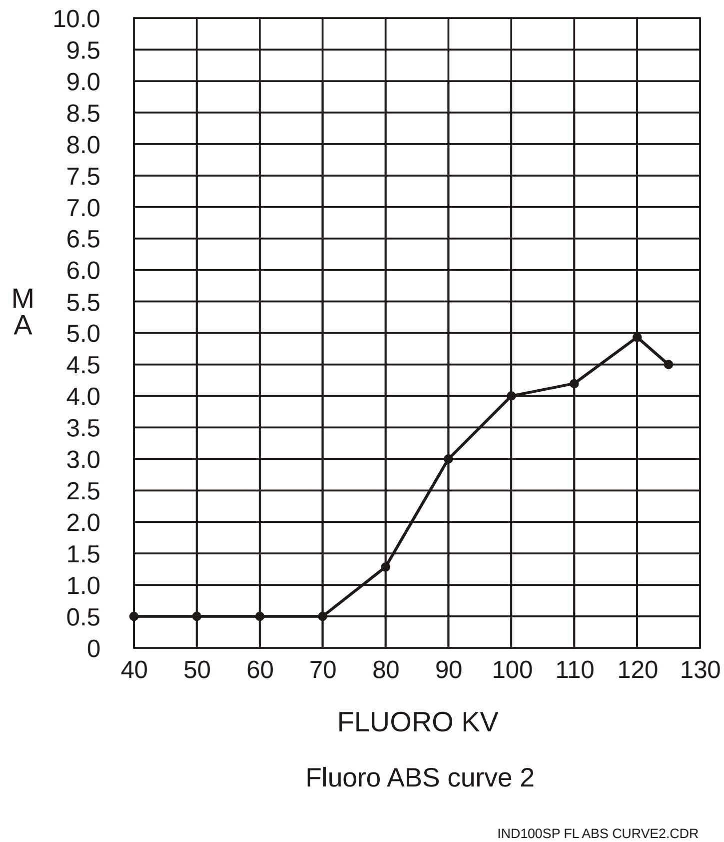


Figure 3E-21: Factory-default fluoro ABS curve 2 (optional)

3E.7.2 Fluoro ABS Curves Setup (Cont)

		* FL ABS C3 *		
FL ABS CURVE 3:	ON		70KV:	3.0mA
40KV:	0.5mA		80KV:	4.0mA
50KV:	0.5mA			+
60KV:	1.3mA			-
	<<		>>	

		* FL ABS C3 *		
90KV:	6.0mA		125KV:	3.5mA
100KV:	5.5mA			
110KV:	4.4mA			+
120KV:	3.7mA			-
	<<		RETURN	

3E.7.2 Fluoro ABS Curves Setup (Cont)

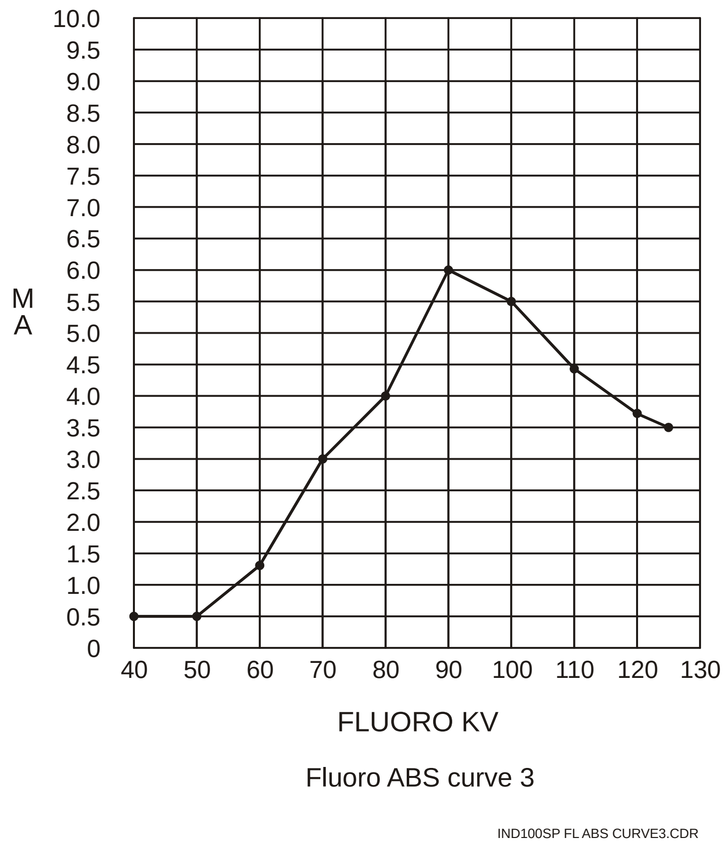
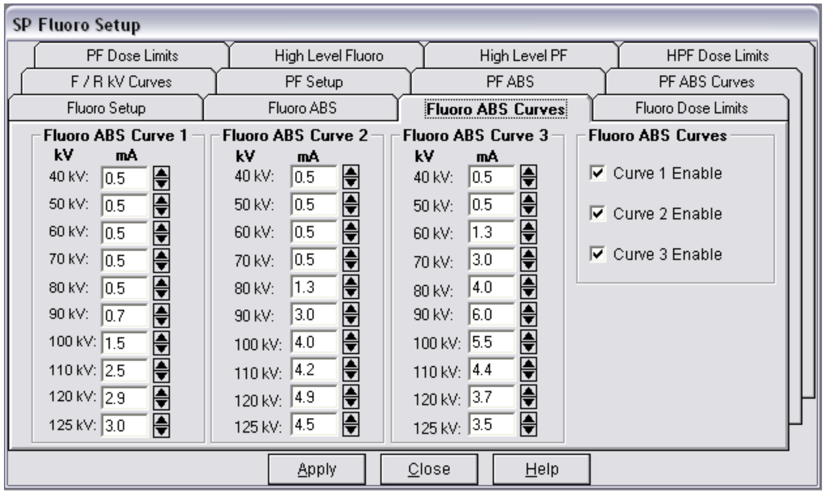


Figure 3E-22: Factory-default fluoro ABS curve 3 (optional)

3E.7.2 Fluoro ABS Curves Setup (Cont)



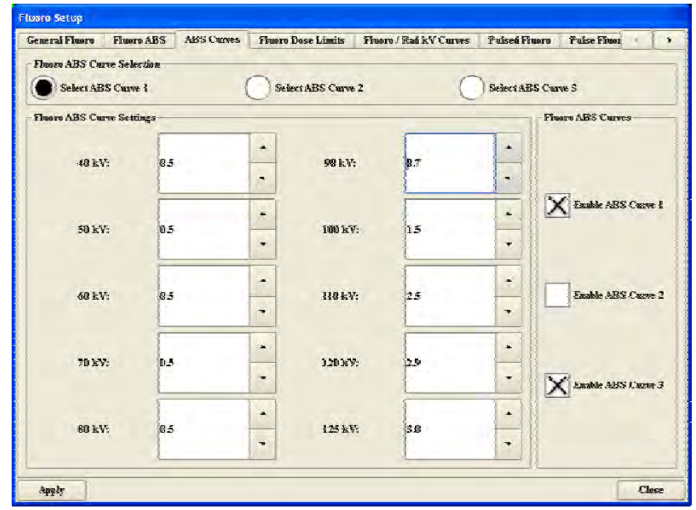


Figure 3E-23a - PC GenWare® *Figure 3E-23b - Touchscreen GenWare®*
Fluoro Setup window, Fluoro ABS Curves / ABS Curves tab

Use these steps to set up the fluoro ABS dose curves.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
	Before attempting to program the fluoro ABS curves, graphs of the desired curves should be prepared in a format similar to those in figures 3E-20 to 3E-22.		
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **FL SETUP.**		
3.	Select **FL ABS CURVES.**	Select the **Fluoro ABS Curves** tab.	Select the **ABS Curves** tab.
4.	From **FL ABS C1** menu 1, select **FL ABS CURVE 1.** Enable or disable fluoro ABS curve 1 by toggling the button to select **ON** or **OFF**.	Enable or disable fluoro ABS curve 1 by clearing the **Curve 1 Enable** check box for OFF, or checking the check box for ON.	Enable or disable fluoro ABS curve 1 by clearing the **Enable ABS Curve 1** check box for OFF, or checking the check box for ON.

3E.7.2 Fluoro ABS Curves Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Select the **40** kV fluoro step. Use the **+** or **–** buttons to enter the desired corresponding mA.	For the **40** kV fluoro selection, enter the desired corresponding mA under **Fluoro ABS curve 1**	Under **Fluoro ABS Curve Selection**, select **Select ABS Curve 1**. For the **40** kV fluoro selection, enter the desired corresponding mA under **Fluoro ABS Curve Settings.**
6.	Repeat the previous step for **50** to **80** kV.	Repeat the previous step for **50** to **125** kV.	Repeat the previous step for **50** to **125** kV.
7.	Press **>>.**		
8.	Repeat the previous steps for **90** to **125** kV.		
	Disregard the next three steps if the three-curves option is not fitted.		
9.	Press **>>.**		
10.	Repeat steps 4 to 9 for fluoro ABS curve 2.	Repeat steps 4 to 6 for fluoro ABS curve 2.	Repeat steps 4 to 6 for fluoro ABS curve 2. Be sure to select **ABS Curve 2** in step 5.
11.	Repeat steps 4 to 9 for fluoro ABS curve 3.	Repeat steps 4 to 6 for fluoro ABS curve 3.	Repeat steps 4 to 6 for fluoro ABS curve 3. Be sure to select **ABS Curve 3** in step 5.
12.	Press **RETURN.**		
13.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

3E.7.3 Pulsed Fluoro ABS Curves Setup

This section details the procedure to reprogram the pulsed fluoro ABS curves. Figures 3E-24 to 3E-26 show the factory-default pulsed fluoro ABS curves. The graphs show the mAs that results from the programmed mA and ms values. The graphs should be reviewed before determining the need to reprogram the factory-default values. For both low and high-level pulsed fluoro, with ABS on, the mA and ms will follow the programmed mA and ms curves. In high-level pulsed fluoro mode, the mA and the ms is multiplied by the factors set via the **PF-HPF MA MULT** and **PF-HPF MS MULT** functions respectively.

The **PF ABS C1, PF ABS C2, PF ABS C3** menus for the membrane console are shown below.

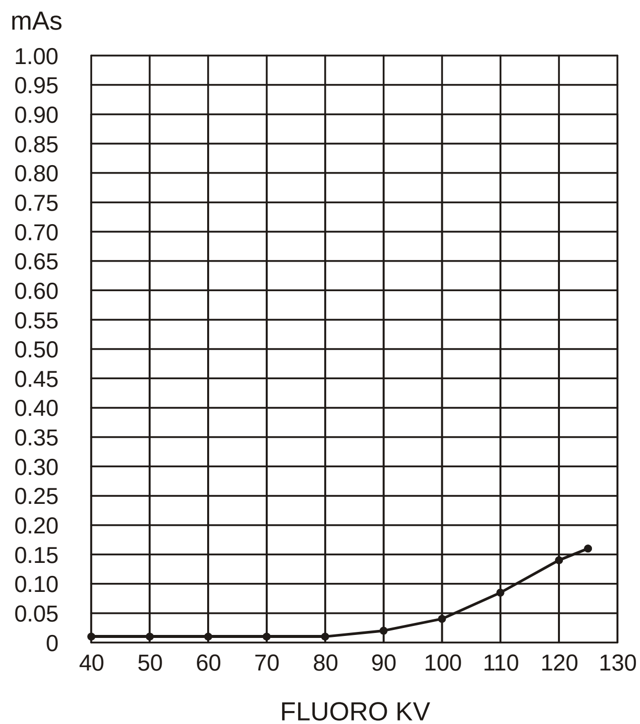
* PF ABS C1 *			
PF CURVE 1:	ON	50KV:	5mA
40KV:	2ms	60KV:	2ms
40KV:	5mA		+
50KV:	2ms		-
	<<	>>	

* PF ABS C1 *			
60KV:	5mA	80KV:	5mA
70KV:	2ms	90KV:	4ms
70KV:	5mA		+
80KV:	2ms		-
	<<	>>	

* PF ABS C1 *			
90KV:	5mA	110KV:	12mA
100KV:	5ms	120KV:	7ms
100KV:	8mA		+
110KV:	7ms		-
	<<	>>	

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

* PF ABS C1 *		
120KV:	20mA	
125KV:	8ms	
125KV:	20mA	+
		-
<<		>>



PF ABS curve 1

IND100SP PF ABS CURVE1.CDR

Figure 3E-24: Factory-default pulsed fluoro ABS curve 1

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

* PF ABS C2 *			
PF CURVE 2:	ON	50KV:	5mA
40KV:	3ms	60KV:	4ms
40KV:	5mA		+
50KV:	4ms		-
	<<	>>	

* PF ABS C2 *			
60KV:	12mA	80KV:	17mA
70KV:	4ms	90KV:	5ms
70KV:	12mA		+
80KV:	5ms		-
	<<	>>	

* PF ABS C2 *			
90KV:	20mA	110KV:	25mA
100KV:	8ms	120KV:	8ms
100KV:	25mA		+
110KV:	8ms		-
	<<	>>	

* PF ABS C2 *			
120KV:	25mA		
125KV:	9ms		
125KV:	25mA		+
			-
	<<	>>	

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

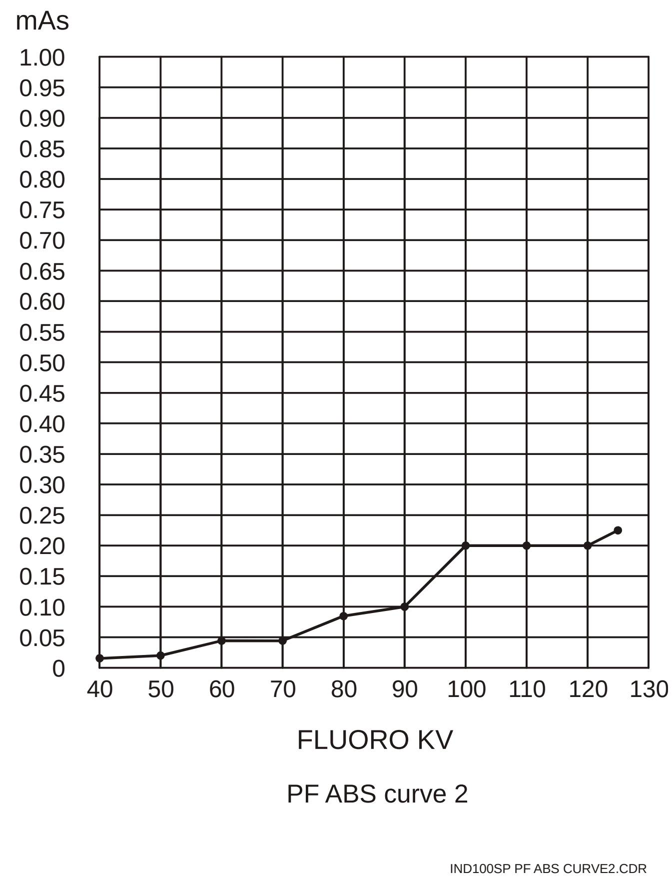


Figure 3E-25: Factory-default pulsed fluoro ABS curve 2 (optional)

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

*** PF ABS C3 ***

PF CURVE 3:	ON	50KV:	10mA
40KV:	3ms	60KV:	6ms
40KV:	10mA		+
50KV:	6ms		-
	<<	>>	

*** PF ABS C3 ***

60KV:	20mA	80KV:	25mA
70KV:	7ms	90KV:	13ms
70KV:	25mA		+
80KV:	11ms		-
	<<	>>	

*** PF ABS C3 ***

90KV:	25mA	110KV:	30mA
100KV:	13ms	120KV:	16ms
100KV:	25mA		+
110KV:	13ms		-
	<<	>>	

*** PF ABS C3 ***

120KV:	35mA		
125KV:	16ms		
125KV:	35mA		+
			-
	<<	RETURN	

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

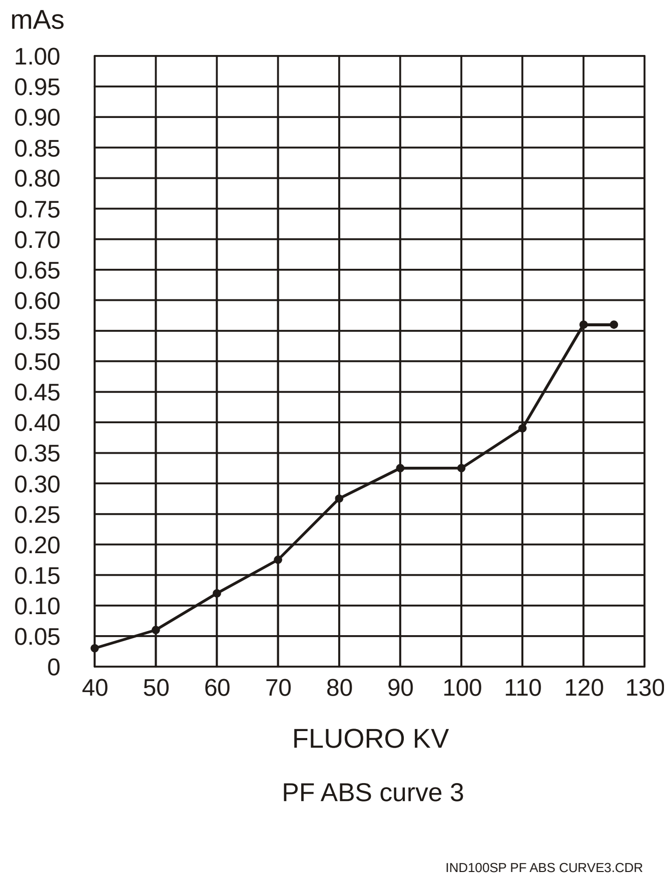
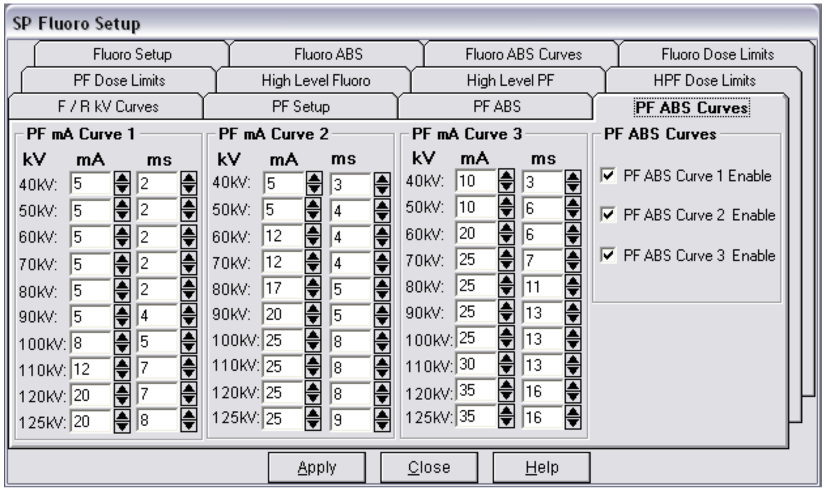


Figure 3E-26: Factory-default pulsed fluoro ABS curve 3 (optional)

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)



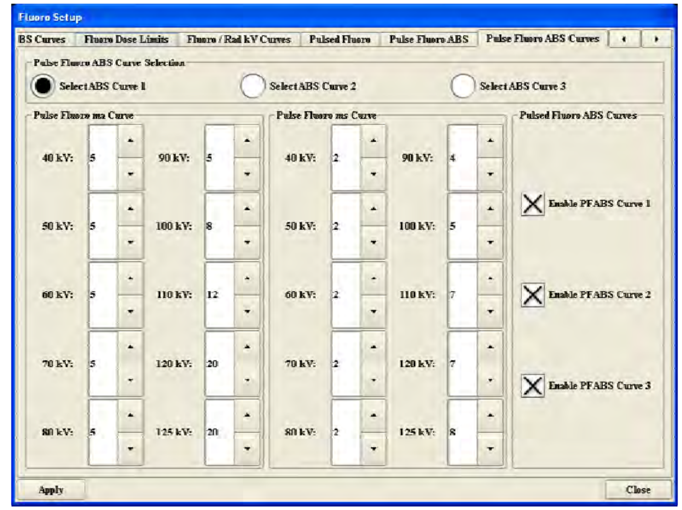


Figure 3E-27a - PC GenWare® ***Figure 3E-27b - Touchscreen GenWare®***
Fluoro Setup window, PF ABS Curves / Pulse Fluoro ABS Curves tab

Use these steps to set up the pulsed fluoro ABS dose curves.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
	Before attempting to program the PF ABS curves, graphs of the desired curves should be prepared in a format similar to those in figures 3E-24 to 3E-26.		
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **PF SETUP.**		
3.	Press **>>.**		
4.	Select **PF ABS CURVES.**	Select the **PF ABS Curves** tab.	Select the **Pulse Fluoro ABS Curves** tab.
5.	From **PF ABS C1** menu 1, select **PF CURVE 1.** Enable or disable pulsed fluoro ABS curve 1 by toggling the button to select **ON** or **OFF.**	Enable or disable pulsed fluoro ABS curve 1 by clearing the **PF ABS Curve 1 Enable** check box for OFF, or checking the check box for ON.	Enable or disable fluoro ABS curve 1 by clearing the **Enable PF ABS Curve 1** check box for OFF, or checking the check box for ON.

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
	In the following steps, it is suggested that the ms be set to 8-10 ms, and the mA be set as required to yield the desired mAs.		
6.	Select the **40** kV (ms) step. Use the **+** or **–** buttons to enter the desired corresponding pulse width (ms).	For the **40** kV fluoro selection, enter the desired corresponding pulse width (ms) under **PF mA Curve 1.**	Under **Pulse Fluoro ABS Curve Selection**, select **Select ABS Curve 1**. For the **40** kV fluoro selection, enter the desired corresponding pulse width (ms) under **Pulse Fluoro ms Curve.**
7.	Select the **40** kV (mA) step. Use the **+** or **–** buttons to enter the desired corresponding mA.	For the **40** kV fluoro selection, enter the desired corresponding mA under **PF mA Curve 1.**	For the **40** kV fluoro selection, enter the desired corresponding mA under **Pulse Fluoro ma Curve.**
8.	Repeat the previous steps for **50** kV and **60** kV (ms).	Repeat the previous steps for **50** to **125** kV.	Repeat the previous steps for **50** to **125** kV.
9.	Press **>>.**		
10.	Repeat the previous steps for **60** kV (mA) to **90** kV (ms).		
11.	Press **>>.**		
12.	Repeat the previous steps for **90** kV (mA) to **120** kV (ms).		
13.	Press **>>.**		
14.	Repeat the previous steps for **120** kV (mA) to **125** kV (mA).		
	Disregard the next three steps if the three-curves option is not fitted.		
15.	Press **>>.**		
16.	Repeat steps 5 to 15 for PF ABS curve 2.	Repeat steps 5 to 8 for PF ABS curve 2.	Repeat steps 5 to 8 for PF ABS curve 2. Be sure to select **ABS Curve 2** in step 6.
17.	Repeat steps 5 to 14 for PF ABS curve 3.	Repeat steps 5 to 8 for PF ABS curve 3.	Repeat steps 5 to 8 for PF ABS curve 3. Be sure to select **ABS Curve 3** in step 6.

3E.7.3 Pulsed Fluoro ABS Curves Setup (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
18.	Press **RETURN.**		
19.	Press **<<** three times to return to the main **FLUORO SETUP** menu.		

3E.8.0 I.I. INPUT DOSE SETUP AND CALIBRATION

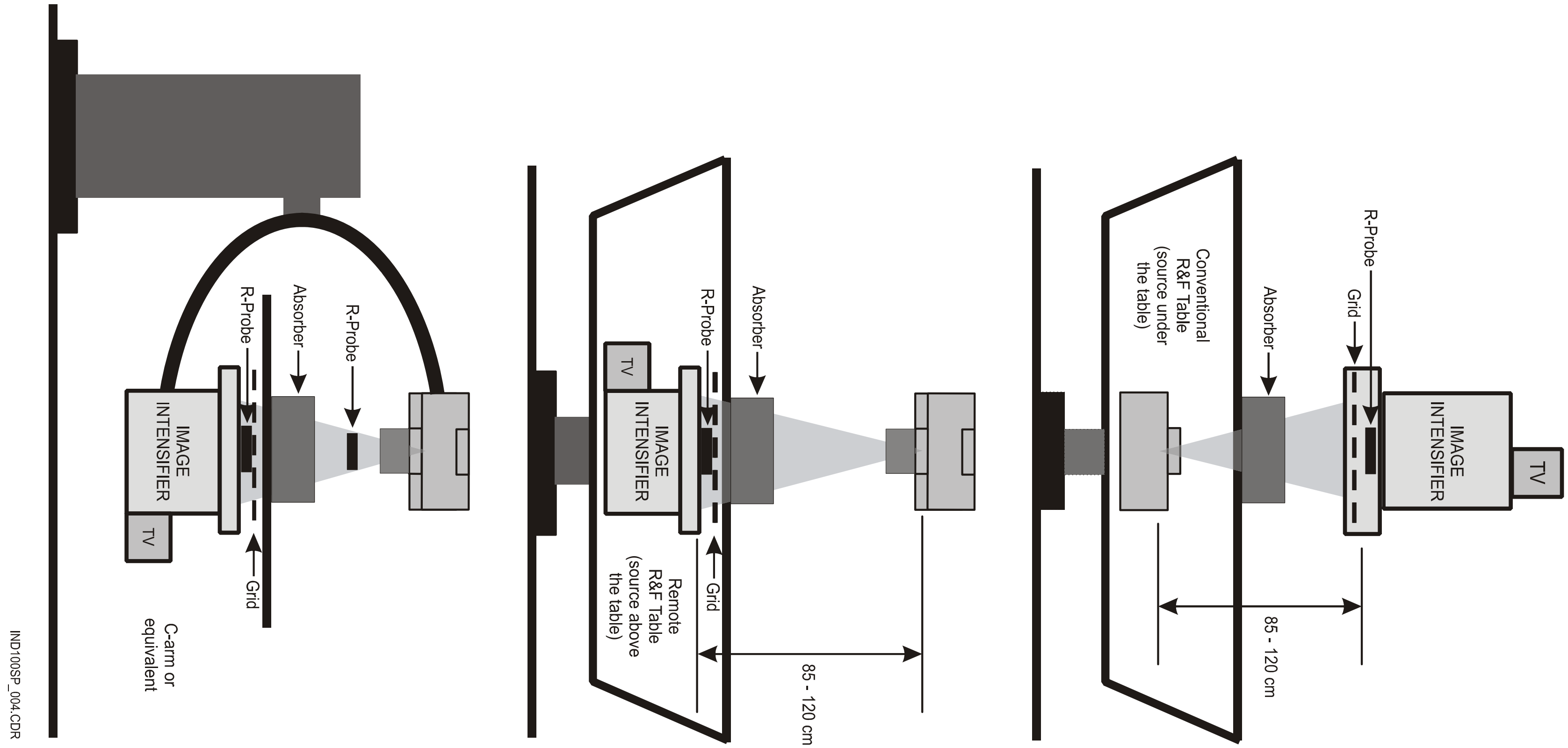


Figure 3E-28 I.I. input dose test setup

3E.8.1 Setting the PMT High Voltage

This procedure sets the PMT operating voltage. Disregard this section if a PMT is not being used for ABS.

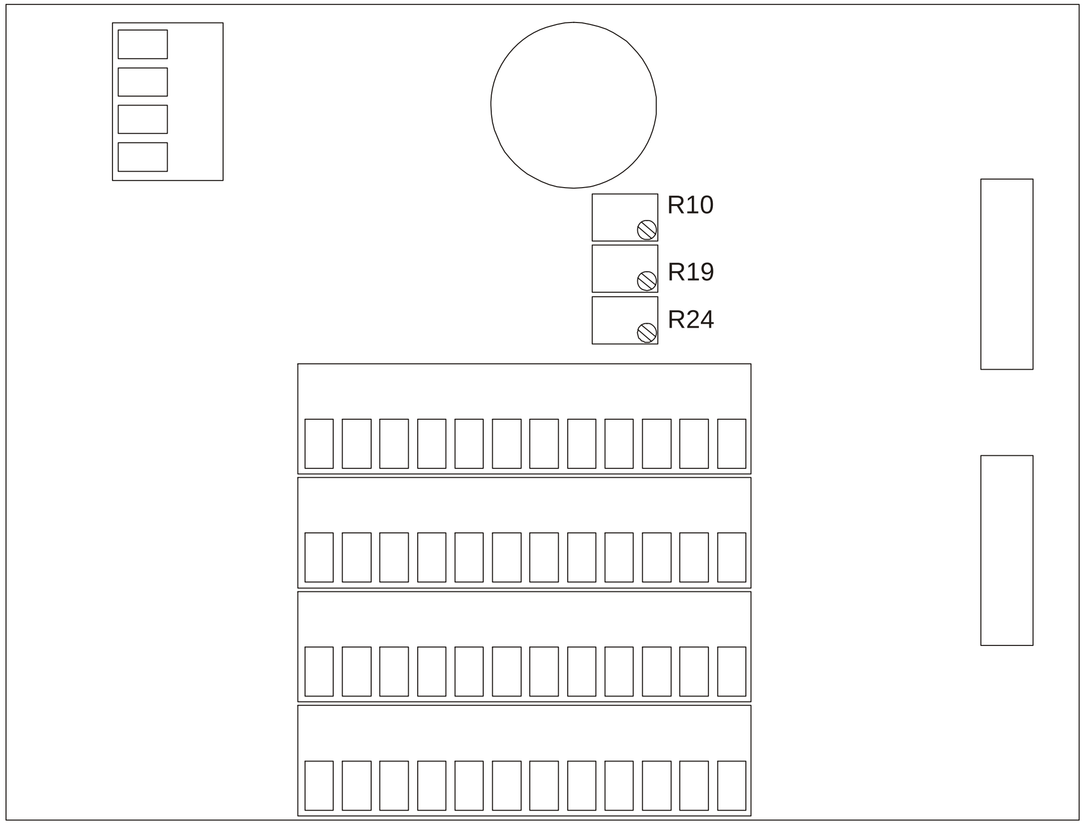


Figure 3E-29: PMT high voltage adjustment (AEC interface board)

- R10 adjusts the PMT high voltage during ABS operation.
- R19 adjusts the PMT high voltage when AEC channel 4 is selected, and R24 adjusts the high voltage when AEC channel 1, 2, or 3 is selected. Refer to chapter 3D for the procedure to adjust these potentiometers for AEC operation.

3E.8.1 Setting the PMT high voltage (Cont)

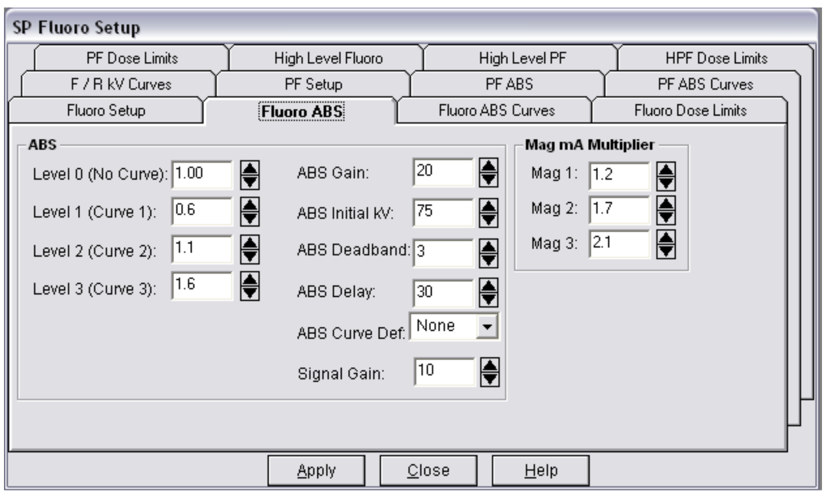
Step	Action
1.	Reconnect the ABS pickup plug that was temporarily disconnected in an earlier step.
	WARNING: SWITCH OFF THE GENERATOR AND ENSURE THAT ALL CAPACITORS ARE DISCHARGED BEFORE MAKING AND REMOVING THE PMT CURRENT MEASURING EQUIPMENT IN THE FOLLOWING STEPS
2.	Connect a micro ammeter in series with the PMT signal output. Alternately, if a micro ammeter is not available, use a series resistor as described below: • Temporarily connect a 10K resistor in series with the PMT output (pin 12 of J7 on the generator interface board). A DVM can then be used to measure the voltage developed by the PMT current across this resistor. However, this is not the preferred method of measurement.
3.	Set up the radiation probe as per figure 3E-28. Use a dosimeter with sufficient sensitivity to measure 10-100 uGy (1-10 mR) / min (typically 150 cc). Set the dosimeter to read uGy / min.
4.	Set up the absorber as shown in figure 3E-28. 20 cm of Lexan is recommended. Ensure that the absorber covers the full input field of the I.I. The central ray from the X-ray tube must coincide with the center of the I.I.
5.	Ensure that an anti-scatter grid, if used, is properly installed. The R-probe must be between the grid and the II input, even if this requires temporary repositioning of the grid.
6.	Set the SID to the normally used position.
7.	Select continuous fluoro. Ensure that the ABS is switched off. Select 75 kV and 1.5 mA.
8.	Ensure that the I.I. is in the NORMAL mode (MAG = 0).
9.	Make a fluoro exposure and measure the I.I. input dose.
10.	Adjust the fluoro mA to obtain a reading of approximately 35 uGy (4 mR) / min.
11.	Adjust the PMT high voltage using R10 on the AEC interface board (refer to figure 3E-29) while pressing the fluoro footswitch such that the PMT current is 20 to 25 uA. This corresponds to a voltage of 0.20 to 0.25 VDC across the resistor if using the series-resistor method.
12.	Measure the PMT high voltage at J7 on the AEC interface board using a suitable meter. ***USE TP5*** **ONLY** ***ON THE AEC INTERFACE BOARD FOR THE HV METER GROUND WHEN MEASURING THE PMT HIGH VOLTAGE. CONNECT THE GROUND FIRST BEFORE MEASURING THE HIGH VOLTAGE.*** The high voltage should be approximately -750 to –800 VDC.
13.	If the desired current cannot be obtained within the stated PMT voltage range, the light entrance to the PMT in the optic cube may need adjustment. Refer to the appropriate manufacturer's documentation for the procedure to adjust this.
14.	Disconnect the meter (and resistor, if applicable) that was connected in step 2. Reconnect the PMT signal lead if required.

3E.8.2 I.I. Input Dose Calibration for Continuous Fluoro

The **FL ABS SET** menus for the membrane console are shown below.

	* FL ABS SET *	
ABS LEVEL 0: 1.00V		SIGNAL GAIN: 10
ABS LEVEL 1: 0.60V		ABS GAIN: 20
ABS LEVEL 2: 1.10V		+
ABS LEVEL 3: 1.60V		-
<<		>>

	* FL ABS SET *	
ABS DEADBAND: 3%		
ABS DELAY: 30ms		
ABS START KV: 75		+
		-
<<		



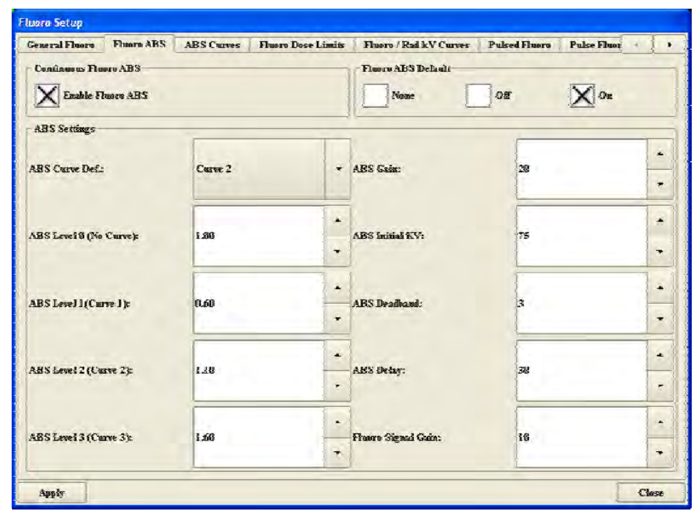


Figure 3E-30a - PC GenWare® *Figure 3E-30b - Touchscreen GenWare®*
Fluoro Setup window, Fluoro ABS tab

3E.8.2 I.I. Input Dose Calibration for Continuous Fluoro (Cont)

Use these steps to perform the I.I. input dose calibration for continuous fluroscopy.

NOTE: *The fluoro ABS dose curve selection (off, low, medium, high) will need to be varied in the following steps. For the membrane console, this is done via the* **FL ABS CURVE** *function, which is accessed by pressing the* **MENU** *button. After selecting the desired fluoro ABS dose curve, press* **<<** *to return to the previous ABS setup screen. For PC GenWare®, the fluoro ABS curves are set via the* **ABS Curve** *dialog box, under* **Curves** *in the lower right corner of GenWare®. For touchscreen GenWare®, this is done via the* **ABS Curve** *selection buttons near the lower right corner of GenWare®.*

Step	Action		
1.	Connect a DVM to TP8 and TP14 (ground) on the generator interface board.		
2.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
3.	If an oscilloscope is available, the kV waveform may be viewed, simplifying the process of stabilizing the kV in the following steps. Connect the oscilloscope to TP8 and TP14 (ground) on the generator CPU board.		
4.	**If the ABS signal is derived from the imaging system, follow the manufacturer's instructions for performing the ABS calibration of the imaging system.** **DO THIS BEFORE PROCEEDING**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	From the main **FLUORO SETUP** menu, press **>>.**		
6.	Select **FL SETUP.**		
7.	Select **FL ABS SETUP.**	Select the **Fluoro ABS** tab.	Select the **Fluoro ABS** tab.
8.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED**.	Select **ABS Curve** = **Med**.
	In the following steps, you will need to scroll back and forth between **FL ABS SET** menu 1 and **FL ABS SET** menu 2 using the **>>** and **<<** buttons in order to access the functions described in this section.		
9.	Set the **ABS START KV** to the midpoint of the normal operating range, typically 75kV.	Set the **ABS Initial kV** to the midpoint of the normal operating range, typically 75kV.	Set the **ABS Initial KV** to the midpoint of the normal operating range, typically 75kV.

3E.8.2 I.I. Input Dose Calibration for Continuous Fluoro (Cont)

<table>
<tr><th>Step</th><th colspan="3">Action</th></tr>
<tr><td>10.</td><td colspan="3">Ensure that ABS is on, and while making a fluoroscopic exposure verify stability of the ABS system with continuous fluoroscopy. The imaging system should be panned over varying absorber thicknesses to force the kV to fluctuate.
The ABS should stabilize without hunting or settling on the wrong kV value.</td></tr>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>11.</td><td>If the ABS is unstable, adjust the ABS GAIN until the hunting is minimized, and the fluoro kV stabilizes quickly.</td><td>If the ABS is unstable, adjust the ABS Gain until the hunting is minimized, and the fluoro kV stabilizes quickly.</td><td>If the ABS is unstable, adjust the ABS Gain until the hunting is minimized, and the fluoro kV stabilizes quickly.</td></tr>
<tr><td>12.</td><td>If the deadband is excessive, adjust the ABS DEADBAND. This should normally be in the range of 3 to 10%.</td><td>If the deadband is excessive, adjust the ABS Deadband. This should normally be in the range of 3 to 10%.</td><td>If the deadband is excessive, adjust the ABS Deadband. This should normally be in the range of 3 to 10%.</td></tr>
<tr><td>13.</td><td>Set the ABS DELAY to 30 ms.</td><td>Set the ABS Delay to 30 ms.</td><td>Set the ABS Delay to 30 ms.</td></tr>
<tr><td>14.</td><td colspan="3">Confirm that the ABS stabilizes without hunting or settling on the wrong kV value while panning the imaging system over varying absorber thicknesses.</td></tr>
<tr><td>15.</td><td colspan="3">Use the test set up as described in steps 3 to 6 of the section Setting the PMT High Voltage.</td></tr>
<tr><td>16.</td><td colspan="3">Select the largest I.I. mode. Ensure that ABS is on.</td></tr>
<tr><td>17.</td><td>Select FL ABS CURVE = MED.</td><td>Select ABS Curve = MED.</td><td>Select ABS Curve = Med.</td></tr>
<tr><td>18.</td><td>Select mag mode 0.</td><td>Select MAG = N.</td><td>Select MAG = Off.</td></tr>
<tr><td>19.</td><td>Select ABS LEVEL 2. Use the + or – buttons to set the ABS LEVEL 2 value to 1.00V.</td><td>Set the Level 2 (Curve 2) value to 1.00V.</td><td>Set the ABS Level 2 (Curve 2) value to 1.00V.</td></tr>
<tr><td rowspan="2">20.</td><td>Select SIGNAL GAIN. While making a fluoroscopic exposure, use the + or – buttons to set the I.I. input dose to 26 uGy (3 mR) / min.</td><td>While making a fluoroscopic exposure, set the Signal Gain to set the I.I. input dose to 26 uGy (3 mR) / min.</td><td>While making a fluoroscopic exposure, set the Fluoro Signal Gain to set the I.I. input dose to 26 uGy (3 mR) / min.</td></tr>
<tr><td colspan="3">This step adjusts the digital gain potentiometer in the ABS loop on the generator interface board. Increasing the SIGNAL GAIN value will reduce the dose, and vice versa.</td></tr>
<tr><td></td><td colspan="3">Do not readjust the following parameters:
Membrane Console: SIGNAL GAIN, ABS GAIN, ABS DEADBAND, or ABS START KV.
GenWare®: Signal Gain (Fluoro Signal Gain), ABS Gain, ABS Deadband, or ABS Initial kV.</td></tr>
</table>

3E.8.2 I.I. Input Dose Calibration for Continuous Fluoro (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
21.	Select **FL ABS CURVE** = **OFF.**	Select **ABS Curve** = **OFF.**	Select **ABS Curve** = **Off.**
22.	Set the fluoro mA to **2.0** mA.	Set the fluoro mA to **2.0** mA.	Set the fluoro mA to **2.0** mA.
23.	Select **ABS LEVEL 0**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 0** value for an I.I. input dose of 26 uGy (3 mR) / min.	While making a fluoroscopic exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 26 uGy (3 mR) / min.	While making a fluoroscopic exposure, set the **ABS Level 0 (No Curve)** value for an I.I. input dose of 26 uGy (3 mR) / min.
24.	Select **FL ABS CURVE** = **LOW.**	Select **ABS Curve** = **LOW.**	Select **ABS Curve** = **Low.**
25.	Select **ABS LEVEL 1**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 1** value for an I.I. input dose of 18 uGy (2 mR) / min.	While making a fluoroscopic exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 18 uGy (2 mR) / min.	While making a fluoroscopic exposure, set the **ABS Level 1 (Curve 1)** value for an I.I. input dose of 18 uGy (2 mR) / min.
26.	Select **FL ABS CURVE** = **HI.**	Select **ABS Curve** = **HI.**	Select **ABS Curve** = **High.**
27.	Select **ABS LEVEL 3**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 3** value for an I.I. input dose of 35 uGy (4 mR) / min.	While making a fluoroscopic exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 35 uGy (4 mR) / min.	While making a fluoroscopic exposure, set the **ABS Level 3 (Curve 3)** value for an I.I. input dose of 35 uGy (4 mR) / min.
28.	Press **<<** to return to the **FL SETUP** menu.		

3E.8.3 I.I. Mag Mode Compensation for Continuous Fluoro

The **FL II COMP** menu for the membrane console is shown below.

```
                        * FL II COMP *
MAG1 MA MULT:   1.2
MAG2 MA MULT:   1.7
MAG3 MA MULT:   2.1                                    +
                                                       -
        <<
```

In PC GenWare®, **Mag mA Multiplier** for continuous fluoro is included in the **Fluoro ABS** tab (figure 3E-30). In Touchscreen GenWare®, **Mag mA Multiplier** for continuous fluoro is included in the **General Fluoro** tab (figure 3E-5).

Use these steps to set up the I.I. mag mode compensation for continuous fluoroscopy.

Step	Action		
1.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
2.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	From the **FL SETUP** menu, select **FL II COMP.**		
4.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
5.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off.**
6.	Make a fluoroscopic exposure and record the stabilized kV.		
7.	Select mag mode **1**.	Select **MAG** = **I**.	Select **MAG** = **I**.
8.	Select **MAG1 MA MULT**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **MAG1 MA MULT** value such that the mag 1 kV equals the kV noted in step 6.	While making a fluoroscopic exposure, set the **Mag 1** value such that the mag 1 kV equals the kV noted in step 6.	Select the **General Fluoro** tab. While making a fluoroscopic exposure, set the **Mag 1** value such that the mag 1 kV equals the kV noted in step 6.

3E.8.3 I.I. Mag Mode Compensation for Continuous Fluoro (Cont)

Step	Action		
9.	Repeat steps 7 and 8 for each magnification mode. In high mag mode, the maximum dose limits may be reached when higher mA multiplication factors are selected.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
10.	Press **<<** three times to return to the main **FLUORO SETUP** menu.		

3E.8.4 I.I. Input Dose Calibration for High-Level Fluoro

HLF SETUP menu 1 for the membrane console is shown below.

* HLF SETUP *			
HLF: ON		ABS LEVEL 2:	2.61V
FL-HLF MA MULT:	2.0	ABS LEVEL 3:	3.53V
ABS LEVEL 0:	2.00V		+
ABS LEVEL 1:	2.13V		-
<<		>>	

In GenWare®, the ABS level 0 to ABS level 3 functions for HLF are included in the **High Level Fluoro** tab (figure 3E-9).

Use these steps to set up the I.I input dose for high-level fluoro.

	Action		
1.	Connect a DVM to TP8 and TP14 (ground) on the generator interface board.		
2.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
3.	Select the largest I.I. mode. Ensure that HLF and ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
4.	From the main **FLUORO SETUP** menu, press **>>.**		
5.	Select **HLF SETUP.**	Select the **High Level Fluoro** tab.	Select the **High Level Fluoro** tab.
6.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
7.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off**.
8.	Select **ABS LEVEL 2**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 2** value for an I.I. input dose of 61 uGy (7 mR) / min.	While making a fluoroscopic exposure, set the **Level 2 (Curve 2)** value for an I.I. input dose of 61 uGy (7 mR) / min.	While making a fluoroscopic exposure, set the **Level 2 (Curve 2)** value for an I.I. input dose of 61 uGy (7 mR) / min.
9.	Select **FL ABS CURVE** = **OFF.**	Select **ABS Curve** = **OFF.**	Select **ABS Curve** = **Off.**
10.	Set the fluoro mA to the value that was automatically set by fluoro ABS dose curve 2 in step 8.	Set the fluoro mA to the value that was automatically set by fluoro ABS dose curve 2 in step 8.	Set the fluoro mA to the value that was automatically set by fluoro ABS dose curve 2 in step 8.

3E.8.4 I.I. Input Dose Calibration for High-Level Fluoro (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	Select **ABS LEVEL 0**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 0** value for an I.I. input dose of 35 uGy (4 mR) / min.	While making a fluoroscopic exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 61 uGy (7 mR) / min.	While making a fluoroscopic exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 61 uGy (7 mR) / min.
12.	Select **FL ABS CURVE** = **LOW.**	Select **ABS Curve** = **LOW.**	Select **ABS Curve** = **Low.**
13.	Select **ABS LEVEL 1**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 1** value for an I.I. input dose of 44 uGy (5 mR) / min.	While making a fluoroscopic exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 44 uGy (5 mR) / min.	While making a fluoroscopic exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 44 uGy (5 mR) / min.
14.	Select **FL ABS CURVE** = **HI.**	Select **ABS Curve** = **HI.**	Select **ABS Curve** = **High.**
15.	Select **ABS LEVEL 3**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 3** value for an I.I. input dose of 88 uGy (10 mR) / min.	While making a fluoroscopic exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 88 uGy (10 mR) / min.	While making a fluoroscopic exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 88 uGy (10 mR) / min.
16.	Press **>>** to go to **HLF SETUP** menu 2.		

3E.8.5 I.I. Mag Mode Compensation for High-Level Fluoro

The **HLF II COMP** menu for the membrane console is shown below.

```
                    * HLF II COMP *
MAG1 MA MULT:   1.1
MAG2 MA MULT:   1.6
MAG3 MA MULT:   2.1                                  +
                                                     -
      <<
```

In GenWare®, **Mag mA Multiplier** for HLF is included in the **High Level Fluoro** tab (figure 3E-9).

Use these steps to set up the I.I. mag mode compensation for high-level fluoroscopy.

Step	Action		
1.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
2.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	From **HLF SETUP** menu 2, select **HLF II COMP.**		
4.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
5.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off.**
6.	Make a fluoroscopic exposure and record the stabilized kV.		
7.	Select mag mode **1**.	Select **MAG** = **I**.	Select **MAG** = **I**.
8.	Select **MAG1 MA MULT**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **MAG1 MA MULT** value such that the mag 1 kV equals the kV noted in step 6.	While making a fluoroscopic exposure, set the **Mag 1** value such that the mag 1 kV equals the kV noted in step 6.	While making a fluoroscopic exposure, set the **Mag 1** value such that the mag 1 kV equals the kV noted in step 6.
9.	Repeat steps 7 and 8 for each magnification mode.		
10.	Press **<<** four times to return to the main **FLUORO SETUP** menu.		

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3E.8.6 I.I. Input Dose Calibration for Pulsed Fluoro

PF ABS SET menus 1 and 2 for the membrane console are shown below.

* PF ABS SET *		
ABS LEVEL 0: 1.00V		SIGNAL GAIN: 20
ABS LEVEL 1: 0.70V		ABS GAIN: 20
ABS LEVEL 2: 1.20V		+
ABS LEVEL 3: 1.90V		-
<<		>>

* PF ABS SET *		
ABS DEADBAND: 5%		1PPS COMP: 0%
ABS DELAY: 30ms		3PPS COMP: 0%
ABS START KV: 75		+
PF INTEGRATOR: ON		-
<<		>>

In GenWare®, the functions shown above are included in the **PF ABS / Pulse Fluoro ABS** tab (figure 3E-12).

Use these steps to set up the I.I input dose for pulsed fluoro.

Step	Action		
1.	Connect an oscilloscope to TP8 and TP14 (ground) on the generator interface board. An oscilloscope is needed since this will be a pulsed signal.		
2.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage.***		
3.	Select pulsed fluoro mode, and **30** PPS.		
4.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	From the main **FLUORO SETUP** menu, press **>>.**		
6.	Select **PF SETUP.**		

3E.8.6 I.I. Input Dose Calibration for Pulsed Fluoro (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
7.	Select **>>**.		
8.	Select **PF ABS SETUP.**	Select the **PF ABS** tab.	Select the **Pulse Fluoro ABS** tab.
9.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
	In the following steps, you will need to scroll back and forth between **PF ABS SET** menu 1 and **PF ABS SET** menu 2 using the **>>** and **<<** buttons in order to access the functions described in this section.		
10.	Set the **ABS START KV** to the midpoint of the normal operating range, typically 75kV.	Set the **PF ABS Initial kV** to the midpoint of the normal operating range, typically 75kV.	Set the **PF ABS Initial KV** to the midpoint of the normal operating range, typically 75kV.
11.	Ensure that ABS is on, and verify stability of the ABS system with pulsed fluoroscopy. The imaging system should be panned over varying absorber thicknesses to force the kV to fluctuate. The ABS should stabilize without hunting or settling on the wrong kV value.		
12.	If the ABS is unstable, adjust the **ABS GAIN** until the hunting is minimized, and the pulsed fluoro kV stabilizes quickly.	If the ABS is unstable, adjust the **PF ABS Gain** until the hunting is minimized, and the pulsed fluoro kV stabilizes quickly.	If the ABS is unstable, adjust the **PF ABS Gain** until the hunting is minimized, and the pulsed fluoro kV stabilizes quickly.
13.	If the hysteresis is excessive, adjust the **ABS DEADBAND.** This should normally be in the range of 3 to 10%.	If the hysteresis is excessive, adjust the **PF ABS Deadband.** This should normally be in the range of 3 to 10%.	If the hysteresis is excessive, adjust the **PF ABS Deadband.** This should normally be in the range of 3 to 10%.
14.	Set the **ABS DELAY** to 30 ms.	Set the **PF ABS DELAY** to 30 ms.	Set the **PF ABS DELAY** to 30 ms.
15.	Confirm that the ABS stabilizes without hunting or settling on the wrong kV value while panning the imaging system over varying absorber thicknesses.		
16.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
17.	Set the radiation meter to measure dose per frame at 30 fps (frames per second). This is the measurement unit in pulsed fluoro mode.		

3E.8.6 I.I. Input Dose Calibration for Pulsed Fluoro (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
18.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
19.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off**.
20.	Select **ABS LEVEL 2**. Use the **+** or **–** buttons to set the **ABS LEVEL 2** value to 1.50V.	Set the **Level 2 (Curve 2)** value to 1.50V.	Set the **Level 2 (Curve 2)** value to 1.50V.
21.	Select **SIGNAL GAIN**. While making a pulsed fluoro exposure, use the **+** or **–** buttons to set the I.I. input dose to 0.018 uGy (2 uR) / frame.	While making a pulsed fluoro exposure, set the **PF Signal Gain** to set the I.I. input dose to 0.018 uGy (2 uR) / frame.	While making a pulsed fluoro exposure, set the **PF Signal Gain** to set the I.I. input dose to 0.018 uGy (2 uR) / frame.
	This step adjusts the digital gain potentiometer in the ABS loop on the generator interface board. Increasing the **SIGNAL GAIN** value will reduce the dose, and vice versa.		
22.	Do not readjust the following parameters: Membrane Console: **SIGNAL GAIN, ABS GAIN**, **ABS DEADBAND**, or **ABS START KV**. GenWare®: **PF Signal Gain**, **PF ABS Gain**, **PF ABS Deadband**, or **PF ABS Initial kV**.		
23.	Select **FL ABS CURVE** = **OFF.**	Select **ABS Curve** = **OFF.**	Select **ABS Curve** = **Off.**
24.	Set the fluoro mA to 20 mA.	Set the fluoro mA to 20 mA.	Set the fluoro mA to 20 mA.
25.	Select **ABS LEVEL 0**. While making a pulsed fluoro exposure, use the **+** or **–** buttons to set the **ABS LEVEL 0** value for an I.I. input dose of 0.018 uGy (2 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 0.018 uGy (2 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 0.018 uGy (2 uR) / frame.
26.	Select **FL ABS CURVE** = **LOW.**	Select **ABS Curve** = **LOW.**	Select **ABS Curve** = **Low.**
27.	Select **ABS LEVEL 1**. While making a pulsed fluoro exposure, use the **+** or **–** buttons to set the **ABS LEVEL 1** value for an I.I. input dose of 0.009 uGy (1 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 0.009 uGy (1 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 0.009 uGy (1 uR) / frame.

3E.8.6 I.I. Input Dose Calibration for Pulsed Fluoro (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
28.	Select **FL ABS CURVE** = **HI.**	Select **ABS Curve** = **HI.**	Select **ABS Curve** = **High.**
29.	Select **ABS LEVEL 3**. While making a pulsed fluoro exposure, use the **+** or **–** buttons to set the **ABS LEVEL 3** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.
30.	Press **<<** to return to the **PF SETUP** menu.		

3E.8.7 I.I. Mag Mode Compensation for Pulsed Fluoro

The **PF II COMP** menu for the membrane console is shown below.

* PF II COMP *		
MAG1 MS MULT:	1.2	
MAG2 MS MULT:	2.0	
MAG3 MS MULT:	2.6	+
		-
<<		

In GenWare®, **MAG ms Multiplier** for pulsed fluoro is included in the **PF Setup** / **Pulsed Fluoro** tab (figure 3E-11).

Use these steps to set up the I.I. mag mode compensation for pulsed fluoroscopy.

Step	Action		
1.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
2.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	From the **PF SETUP** menu, select **PF II COMP.**	Select the **PF Setup** tab.	Select the **Pulsed Fluoro** tab.
4.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
5.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off**.
6.	Make a pulsed fluoro exposure and record the stabilized kV.		
7.	Select mag mode **1**.	Select **MAG** = **I**.	Select **MAG** = **I**.
8.	Select **MAG1 MS MULT**. While making a pulsed fluoro exposure, use the **+** or **–** buttons to set the **MAG1 MS MULT** value such that the mag 1 kV equals the kV noted in step 6.	While making a pulsed fluoro exposure, set the **MAG 1** value such that the mag 1 kV equals the kV noted in step 6.	While making a pulsed fluoro exposure, set the **MAG 1** value such that the mag 1 kV equals the kV noted in step 6.

3E.8.7 I.I. Mag Mode Compensation for Pulsed Fluoro (Cont)

Step	Action		
9.	Repeat steps 7 and 8 for each magnification mode. In high mag mode, the maximum dose limits may be reached when higher mA multiplication factors are selected.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
10.	Press **<<** four times to return to the main **FLUORO SETUP** menu.		

3E.8.8 Pulsed Fluoro Frame Rate Compensation

PF ABS SET menus 2 and 3 for the membrane console are shown below.

* PF ABS SET *	
ABS DEADBAND: 5%	1PPS COMP: 0%
ABS DELAY: 30ms	3PPS COMP: 0%
ABS START KV: 75	+
PF INTEGRATOR: ON	-
<<	>>

* PF ABS SET *	
6/7.5PPS COMP: 0%	
12/15PPS COMP: 0%	
25/30PPS COMP: 0%	+
	-
<<	

In GenWare®, **PF/HPF ABS Compensation** is included in the **PF ABS / Pulse Fluoro ABS** tab (figure 3E-12).

Use these steps to set up the pulsed fluoro frame rate compensation.

Step	Action		
1.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
2.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	From the main **FLUORO SETUP** menu, press **>>.**		
4.	Select **PF SETUP**.		
5.	Press **>>**, then select **PF ABS SETUP**.		
6.	Press **>>** twice to go to **PF ABS SET** menu 3.	Select the **PF ABS** tab.	Select the **Pulse Fluoro ABS** tab.

3E.8.8 Pulsed Fluoro Frame Rate Compensation (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
7.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
8.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off**.
9.	Select PF, and set the PPS rate = **30**. Set the radiation meter to measure dose per frame at 30 fps (frames per second).		
10.	Select **25/30PPS COMP**. Use the **+** or **–** buttons to set the **25/30PPS COMP** value = **0**.	Set the **30 PPS ABS Comp** value = **0**.	Set the **30 PPS ABS Comp** value = **0**.
11.	Make a pulsed fluoro exposure and record the stabilized kV and the dose rate per frame.	Make a pulsed fluoro exposure and record the stabilized kV and the dose rate per frame.	Make a pulsed fluoro exposure and record the stabilized kV and the dose rate per frame.
12.	Select **12/15PPS COMP**. Make a fluoro exposure, and then set the **12/15PPS COMP** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **15PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **15PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.
13.	Select **6/7.5PPS COMP**. Make a fluoro exposure, and then set the **6/7.5PPS COMP** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **7.5PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **7.5PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.
14.	Press **<<.**		
15.	Select **3PPS COMP**. Make a fluoro exposure, and then set the **3PPS COMP** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **3PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **3PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.
16.	Select **1PPS COMP**. Make a fluoro exposure, and then set the **1PPS COMP** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **1PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.	Make a fluoro exposure, and then set the **1PPS ABS Comp** value such that the kV and dose rate per frame rate equals the kV and dose rate as per step 11.
17.	Press **<<** five times to return to the main **FLUORO SETUP** menu.		

3E.8.9 I.I. Input Dose Calibration for High-Level Pulsed Fluoro

The **HPF SETUP** menus for the membrane console are shown below.

```
                    * HPF SETUP *
HPF:    ON                              ABS LEVEL 1:    2.00V
PF-HPF MA MULT:   2.5                   ABS LEVEL 2:    2.60V
PF-HPF MS MULT:   2.0                                       +
ABS LEVEL 0:    2.30V                                       -
        <<                                    >>
```

```
                    * HPF SETUP *
ABS LEVEL 3:    4.50V
HPF DOSE LIMITS
HPF II COMP                                                 +
HPF PPS SETUP                                               -
        <<
```

In GenWare®, the functions shown above are included in the **High Level PF** tab (figure 3E-14).

Use these steps to set up the I.I input dose for high-level pulsed fluoro.

Step	Action		
1.	Connect an oscilloscope to TP8 and TP14 (ground) on the generator interface board. An oscilloscope is needed since this will be a pulsed signal.		
2.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
3.	Select high-level pulsed fluoro mode, and **30** PPS.		
4.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	From the main **FLUORO SETUP** menu, press **>>.**		
6.	Select **HPF SETUP.**	Select the **High Level PF** tab.	Select the **High Level PF** tab.

3E.8.9 I.I. Input Dose Calibration for High-Level Pulsed Fluoro (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
7.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
8.	Set the radiation meter to measure dose per frame at 30 fps (frames per second).		
9.	Select **ABS LEVEL 2**. While making a fluoroscopic exposure, use the **+** or **–** buttons to set the **ABS LEVEL 2** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.	While making a fluoroscopic exposure, set the **Level 2 (Curve 2)** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.	While making a fluoroscopic exposure, set the **Level 2 (Curve 2)** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.
10.	Select **FL ABS CURVE** = **OFF.**	Select **ABS Curve** = **OFF.**	Select **ABS Curve** = **Off.**
11.	Select **ABS LEVEL 0**. While making a pulsed fluoro exposure, set the **ABS LEVEL 0** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 0 (No Curve)** value for an I.I. input dose of 0.035 uGy (4 uR) / frame.
12.	Select **FL ABS CURVE** = **LOW.**	Select **ABS Curve** = **LOW.**	Select **ABS Curve** = **Low.**
13.	Select **ABS LEVEL 1**. While making a pulsed fluoro exposure, set the **ABS LEVEL 1** value for an I.I. input dose of 0.018 uGy (2 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 0.018 uGy (2 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 1 (Curve 1)** value for an I.I. input dose of 0.018 uGy (2 uR) / frame.
14.	Select **FL ABS CURVE** = **HI.**	Select **ABS Curve** = **HI.**	Select **ABS Curve** = **High.**
15.	Press **>>**.		
16.	Select **ABS LEVEL 3**. While making a pulsed fluoro exposure, set the **ABS LEVEL 3** value for an I.I. input dose of 0.070 uGy (8 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 0.070 uGy (8 uR) / frame.	While making a pulsed fluoro exposure, set the **Level 3 (Curve 3)** value for an I.I. input dose of 0.070 uGy (8 uR) / frame.

3E.8.10 I.I. Mag Mode Compensation for High-Level Pulsed Fluoro

The **HPF II COMP** menu for the membrane console is shown below.

* HPF II COMP *		
MAG1 MS MULT:	1.2	
MAG2 MS MULT:	2.0	
MAG3 MS MULT:	2.4	+
		-
<<		

In GenWare®, the functions shown above are included in the **High Level PF** tab (figure 3E-14).

Use these steps to set up the I.I. mag mode compensation for high-level pulsed fluoroscopy.

Step	Action		
1.	Use the test set up as described in steps 3 to 6 of the section ***Setting the PMT High Voltage***.		
2.	Select the largest I.I. mode. Ensure that ABS is on.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
3.	From **HPF SETUP** menu 2, select **HPF II COMP.**	Select the **High level PF** tab.	Select the **High level PF** tab.
4.	Select **FL ABS CURVE** = **MED.**	Select **ABS Curve** = **MED.**	Select **ABS Curve** = **Med.**
5.	Select mag mode **0**.	Select **MAG** = **N**.	Select **MAG** = **Off**.
6.	Make a pulsed fluoro exposure and record the stabilized kV.		
7.	Select mag mode **1**.	Select **MAG** = **I**.	Select **MAG** = **I**.
8.	Select **MAG1 MS MULT**. While making a pulsed fluoro exposure, set the **MAG1 MS MULT** value such that the mag 1 kV equals the kV noted in step 6.	While making a pulsed fluoro exposure, set the **MAG 1** value such that the mag 1 kV equals the kV noted in step 6.	While making a pulsed fluoro exposure, set the **MAG 1** value such that the mag 1 kV equals the kV noted in step 6.
9.	Repeat steps 7 and 8 for each magnification mode. In high mag mode, the maximum dose limits may be reached when higher mA multiplication factors are selected.		
10.	Press **<<** three times to return to the main **FLUORO SETUP** menu.		

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3E.9.0 DOSE LIMITS SETUP (WITH S.I.D. COMPENSATION)

This section details the procedure for setting up the dose limits on systems with optional SID compensation. Use this section for performing dose limits setup on systems with S.I.D compensation.

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation)

This procedure sets the maximum mA allowed for each kV setting in both manual and ABS mode of continuous fluoro operation for systems with SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **SID COMP** menu for the membrane console is shown below.

* SID COMP *		
SID COMP: ON		
SID INT. TYPE: 0		
SID MIN REF: 120		+
SID MAX REF: 180		-
<<		

In GenWare®, **SID COMPENSATION** is included in the **Fluoro Setup / General Fluoro** tab (figure 3E-5).

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Definitions of **SID COMP** menu items.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
SID COMP	**SID Compensation** **(Enable SID Compensation)**	Enables / disables SID compensation. **ON:** SID compensation is enabled. **OFF:** SID compensation is disabled.
SID INT. TYPE	**SID Int Type**	Selects the SID interface type. **0:** NRT Celex table (serial communication).
SID MIN REF	**SID Min Ref**	Sets the minimum SID for the imaging system.
SID MAX REF	**SID Max Ref**	Sets the maximum SID for the imaging system.

Use these steps to perform the initial S.I.D. compensation setup.

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
1.	From the main **FLUORO SETUP** menu, press **>>.**		
2.	Select **SID COMP**.	Select the **Fluoro Setup** tab to access the functions described in this section.	Select the **General Fluoro** tab to access the functions described in this section.
3.	From the **SID COMP** menu, select **SID COMP.** Press the button again to select **ON**. **SID COMP** must be on if setting dose limits with SID compensation.	Check the **SID Compensation** check box for ON. **SID Compensation** must be on if setting dose limits with SID compensation.	Check the **Enable SID Compensation** check box for ON. **SID Compensation** must be on if setting dose limits with SID compensation.
4.	Select **SID INT. TYPE**. Use the **+** or **–** buttons to select the desired SID interface type.	Select the desired SID interface type via the **SID Int Type** dialog box.	Select the desired SID interface type via the **SID Int. Type** dialog box.

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Select **SID MIN REF**. Use the **+** or **–** buttons to select the minimum SID.	Select the minimum SID via the **SID Min Ref** dialog box.	Select the minimum SID via the **SID Min Ref** dialog box.
6.	Select **SID MAX REF**. Use the **+** or **–** buttons to select the maximum SID.	Select the maximum SID via the **SID Max Ref** dialog box.	Select the maximum SID via the **SID Max Ref** dialog box.
7.	Press **<<** to return to **FLUORO SETUP** menu 2.		

The **FL MAN DL** and **FL ABS DL** menus for the membrane console are shown below (with SID comp).

* FL MAN DL *			
40 kV-minSID:	6.0mA	80 kV-minSID:	6.0mA
50 kV-minSID:	6.0mA	90 kV-minSID:	6.0mA
60 kV-minSID:	6.0mA		+
70 kV-minSID:	6.0mA		-
<<		>>	

* FL MAN DL *			
100 kV-minSID:	6.0mA		
110 kV-minSID:	6.0mA		
120 kV-minSID:	6.0mA		+
125 kV-minSID:	6.0mA		-
<<		>>	

* FL MAN DL *			
40 kV-maxSID:	6.0mA	80 kV-maxSID:	6.0mA
50 kV-maxSID:	6.0mA	90 kV-maxSID:	6.0mA
60 kV-maxSID:	6.0mA		+
70 kV-maxSID:	6.0mA		-
<<		>>	

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

		* FL MAN DL *		
100 kV-maxSID:	6.0mA			
110 kV-maxSID:	6.0mA			
120 kV-maxSID:	6.0mA			+
125 kV-maxSID:	6.0mA			-
<<			>>	

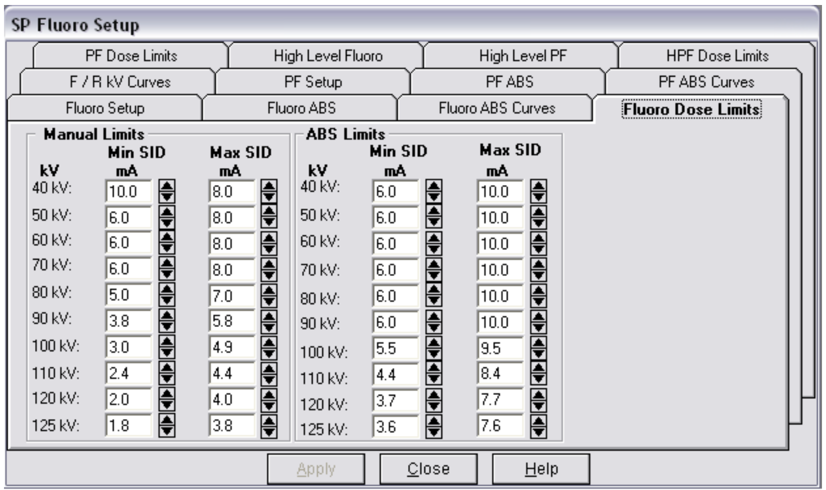
		* FL ABS DL *		
40 kV-minSID:	6.0mA		80 kV-minSID:	6.0mA
50 kV-minSID:	6.0mA		90 kV-minSID:	6.0mA
60 kV-minSID:	6.0mA			+
70 kV-minSID:	6.0mA			-
<<			>>	

		* FL ABS DL *		
100 kV-minSID:	6.0mA			
110 kV-minSID:	6.0mA			
120 kV-minSID:	6.0mA			+
125 kV-minSID:	6.0mA			-
<<			>>	

		* FL ABS DL *		
40 kV-maxSID:	6.0mA		80 kV-maxSID:	6.0mA
50 kV-maxSID:	6.0mA		90 kV-maxSID:	6.0mA
60 kV-maxSID:	6.0mA			+
70 kV-maxSID:	6.0mA			-
<<			>>	

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

* FL ABS DL *		
100 kV-maxSID:	6.0mA	
110 kV-maxSID:	6.0mA	
120 kV-maxSID:	6.0mA	+
125 kV-maxSID:	6.0mA	-
<<		RETURN



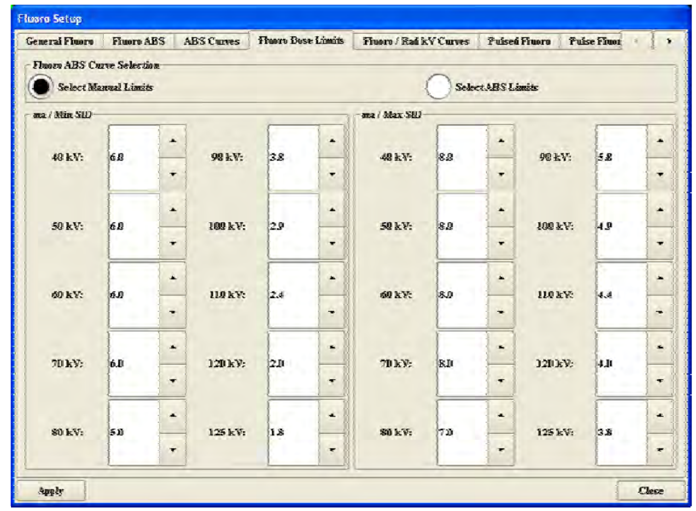


Figure 3E-31a - PC GenWare® *Figure 3E-31b - Touchscreen GenWare®*
Fluoro Setup window, Fluoro Dose Limits tab

***NOTE:** IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.*

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Use these steps to set the continuous fluoro dose limits (with SID compensation).

Step	Action		
	When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.		
8.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.		
9.	Temporarily disconnect the ABS pickup to the generator.		
10.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	From **FLUORO SETUP** menu 2, select **FL SETUP.**		
12.	From the **FL SETUP** menu, select **FL DOSE LIMITS.**	Select the **Fluoro Dose Limits** tab to access the functions described in this section.	Select the **Fluoro Dose Limits** tab to access the functions described in this section.
13.	Select the **40** kV step in the **FL MAN DL** menu for minimum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **Manual Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Under Fluoro ABS Curve Selection, select **Select Manual Limits**. Enter the maximum available mA into the **ma / Min SID** dialog box**,** adjacent to 40 kV**.**
14.	Repeat the above for **50** kV to **90** kV.	Repeat the above for **50** kV to **125** kV.	Repeat the above for **50** kV to **125** kV.
15.	Press **>>**.		
16.	Repeat the above for **100** kV to **125** kV.		
17.	Press **>>**.		
18.	Select the **40** kV step in the **FL MAN DL** menu for maximum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **Manual Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum available mA into the **ma / Max SID** dialog box**,** adjacent to 40 kV**.**
19.	Repeat the above for **50** kV to **90** kV.	Repeat the above for **50** kV to **125** kV.	Repeat the above for **50** kV to **125** kV.
20.	Press **>>**.		
21.	Repeat the above for **100** kV to **125** kV.		
22.	Press **<<** three times.		

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>23.</td><td>Select a fluoroscopic image receptor.</td></tr>
<tr><td>24.</td><td>Record the maximum permissible Air Kerma Rate for non-ABS (manual) mode of normal continuous fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>44 mGy / min *.</td><td>50 mGy / min *.</td><td>The maximum Air Kerma Rate must comply with local regulations.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for Non-ABS (manual) mode:______________ mGy / min.

Record the maximum permissible Air Kerma Rate for ABS (automatic) mode of normal continuous fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>88 mGy / min *.</td><td>100 mGy / min *.</td><td>The maximum Air Kerma Rate must comply with local regulations.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for ABS (automatic) mode:______________ mGy / min.</td></tr>
<tr><td>25.</td><td>Ensure that the generator is set for normal continuous fluoro mode, that ABS is switched off, and that SID compensation is on.</td></tr>
<tr><td>26.</td><td>Set the imaging system to minimum SID.</td></tr>
<tr><td>27.</td><td>Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.</td></tr>
<tr><td>28.</td><td>While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console or GenWare® such that the maximum permitted dose as recorded in step 24 for non-ABS mode is not exceeded.</td></tr>
<tr><td>29.</td><td>Record the mA as determined in the previous step for the 40 kV setting.
Max mA for 40kV = ______(non-ABS).</td></tr>
<tr><td>30.</td><td>Repeat steps 27 to 29 for 50 kV.
Max mA for 50kV = ______(non-ABS).</td></tr>
</table>

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action
31.	Repeat steps 27 to 29 for **60** kV. Max mA for 60kV = ______(non-ABS).
32.	Repeat steps 27 to 29 for **70** kV. Max mA for 70kV = ______(non-ABS).
33.	Repeat steps 27 to 29 for **80** kV. Max mA for 80kV = ______(non-ABS).
34.	Repeat steps 27 to 29 for **90** kV. Max mA for 90kV = ______(non-ABS).
35.	Repeat steps 27 to 29 for **100** kV. Max mA for 100kV = ______(non-ABS).
36.	Repeat steps 27 to 29 for **110** kV. Max mA for 110kV = ______(non-ABS).
37.	Repeat steps 27 to 29 for **120** kV. Max mA for 120kV = ______(non-ABS).
38.	Repeat steps 27 to 29 for **125** kV. Max mA for 125 kV = ______(non-ABS).
39.	Set the imaging system to maximum SID.
40.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.
41.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console or GenWare® such that the maximum permitted dose as recorded in step 24 for non-ABS mode is not exceeded.
42.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______(non-ABS).
43.	Repeat steps 40 to 42 for **50** kV. Max mA for 50kV = ______(non-ABS).
44.	Repeat steps 40 to 42 for **60** kV. Max mA for 60kV = ______(non-ABS).

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action
45.	Repeat steps 40 to 42 for **70** kV. Max mA for 70kV = ______(non-ABS).
46.	Repeat steps 40 to 42 for **80** kV. Max mA for 80kV = ______(non-ABS).
47.	Repeat steps 40 to 42 for **90** kV. Max mA for 90kV = ______(non-ABS).
48.	Repeat steps 40 to 42 for **100** kV. Max mA for 100kV = ______(non-ABS).
49.	Repeat steps 40 to 42 for **110** kV. Max mA for 110kV = ______(non-ABS).
50.	Repeat steps 40 to 42 for **120** kV. Max mA for 120kV = ______(non-ABS).
51.	Repeat steps 40 to 42 for **125** kV. Max mA for 125 kV = ______(non-ABS).
52.	Set the imaging system to minimum SID.
53.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.
54.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console or GenWare® such that the maximum permitted dose as recorded in step 24 for ABS mode is not exceeded.
55.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______(ABS).
56.	Repeat steps 53 to 55 for **50** kV. Max mA for 50kV = ______(ABS).
57.	Repeat steps 53 to 55 for **60** kV. Max mA for 60kV = ______(ABS).
58.	Repeat steps 53 to 55 for **70** kV. Max mA for 70kV = ______(ABS).

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action
59.	Repeat steps 53 to 55 for **80** kV. Max mA for 80kV = ______(ABS).
60.	Repeat steps 53 to 55 for **90** kV. Max mA for 90kV = ______(ABS).
61.	Repeat steps 53 to 55 for **100** kV. Max mA for 100kV = ______(ABS).
62.	Repeat steps 53 to 55 for **110** kV. Max mA for 110kV = ______(ABS).
63.	Repeat steps 53 to 55 for **120** kV. Max mA for 120kV = ______(ABS).
64.	Repeat steps 53 to 55 for **125** kV. Max mA for 125 kV = ______(ABS).
65.	Set the imaging system to maximum SID.
66.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.
67.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console or GenWare® such that the maximum permitted dose as recorded in step 24 for ABS mode is not exceeded.
68.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______(ABS).
69.	Repeat steps 66 to 68 for **50** kV. Max mA for 50kV = ______(ABS).
70.	Repeat steps 66 to 68 for **60** kV. Max mA for 60kV = ______(ABS).
71.	Repeat steps 66 to 68 for **70** kV. Max mA for 70kV = ______(ABS).
72.	Repeat steps 66 to 68 for **80** kV. Max mA for 80kV = ______(ABS).

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action		
73.	Repeat steps 66 to 68 for **90** kV. Max mA for 90kV = ______(ABS).		
74.	Repeat steps 66 to 68 for **100** kV. Max mA for 100kV = ______(ABS).		
75.	Repeat steps 66 to 68 for **110** kV. Max mA for 110kV = ______(ABS).		
76.	Repeat steps 66 to 68 for **120** kV. Max mA for 120kV = ______(ABS).		
77.	Repeat steps 66 to 68 for **125** kV. Max mA for 125 kV = ______(ABS).		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
78.	Select the **40** kV step in the **FL MAN DL** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 29 for 40 kV.	Enter the maximum mA as determined in step 29 into the **Manual Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum mA as determined in step 29 into the **ma / Min SID** dialog box**,** adjacent to 40 kV**.**
79.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 30 to 34.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 30 to 38.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 30 to 38.
80.	Press **>>**.		
81.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 35 to 38.		
82.	Press **>>**.		

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
83.	Select the **40** kV step in the **FL MAN DL** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 42 for 40 kV.	Enter the maximum mA as determined in step 42 into the **Manual Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum mA as determined in step 42 into the **ma / Max SID** dialog box**,** adjacent to 40 kV**.**
84.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 43 to 47.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 43 to 51.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 43 to 51.
85.	Press **>>**.		
86.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 48 to 51.		
87.	Press **>>**.		
88.	Select the **40** kV step in the **FL ABS DL** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 55 for 40 kV.	Enter the maximum mA as determined in step 55 into the **ABS Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Under Fluoro ABS Curve Selection, select **Select ABS Limits**. Enter the maximum mA as determined in step 55 into the **ma / Min SID** dialog box**,** adjacent to 40 kV**.**
89.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 56 to 60.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 56 to 64.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 56 to 64.
90.	Press **>>**.		
91.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 61 to 64.		
92.	Press **>>**.		

3E.9.1 Continuous Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
93.	Select the **40** kV step in the **FL ABS DL** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 68 for 40 kV.	Enter the maximum mA as determined in step 68 into the **ABS Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum mA as determined in step 68 into the **ma / Max SID** dialog box**,** adjacent to 40 kV**.**
94.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 69 to 73.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 69 to 77.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 69 to 77.
95.	Press **>>**.		
96.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 74 to 77.		
97.	Press **RETURN**.		
98.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

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3E.9.2 High-Level Fluoro Dose Limits (with SID compensation)

This procedure sets the maximum mA allowed for each kV setting in high-level fluoro mode for systems with SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **HLF DOSE L** menus for the membrane console are shown below (with SID comp).

* HLF DOSE L *				
40 kV-minSID:	:15.0mA	80 kV-minSID:	:14.0mA	
50 kV-minSID:	:15.0mA	90 kV-minSID:	:9.0mA	
60 kV-minSID:	:15.0mA			+
70 kV-minSID:	:15.0mA			-
<<		>>		

* HLF DOSE L *				
100 kV-minSID:	:5.0mA			
110 kV-minSID:	:3.3mA			
120 kV-minSID:	:2.0mA			+
125 kV-minSID:	:1.5mA			-
<<		>>		

3E.9.2 High-Level Fluoro Dose Limits (with SID compensation) Cont

* HLF DOSE L *			
40 kV-maxSID:	:20.0mA	80 kV-maxSID:	:19.0mA
50 kV-maxSID:	:20.0mA	90 kV-maxSID:	:14.0mA
60 kV-maxSID:	:20.0mA		+
70 kV-maxSID:	:20.0mA		-
<<		>>	

* HLF DOSE L *			
100 kV-maxSID:	:10.0mA		
110 kV-maxSID:	:8.3mA		
120 kV-maxSID:	:7.0mA		+
125 kV-maxSID:	:6.5mA		-
<<		RETURN	

In PC GenWare®, high-level fluoro **Dose Limits** is included in the **High Level Fluoro** tab (figure 3E-9. In Touchscreen GenWare®, **HLF Dose Limits mA** is included in the **HLF Dose Limits** tab (figure 3E-10).

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the high-level fluoro dose limits (with SID compensation).

Step	Action
!	**When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.**
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.
2.	Temporarily disconnect the ABS pickup to the generator.
3.	Ensure that SID compensation is enabled, and that the SID compensation setup is done as per 3E.9.1.
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**

3E.9.2 High-Level Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	From the **FLUORO SETUP** menu, press **>>**.		
6.	Select **HLF SETUP.**		
7.	Press **>>**.		
8.	From **HLF SETUP** menu 2, select **HLF DOSE LIMITS.**	Select the **High Level Fluoro** tab to access the functions described in this section.	Select the **HLF Dose Limits** tab to access the functions described in this section.
9.	Select the **40** kV step in the **HLF DOSE L** menu for minimum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **Dose Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum available mA into the **HLF Dose Limits mA (Min SID)** dialog box**,** adjacent to 40 kV**.**
10.	Repeat the above for **50** kV to **90** kV.	Repeat the above for **50** kV to **125** kV.	Repeat the above for **50** kV to **125** kV.
11.	Press **>>**.		
12.	Repeat the above for **100** kV to **125** kV.		
13.	Press **>>**.		
14.	Select the **40** kV step in the **HLF DOSE L** menu for maximum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **Dose Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum available mA into the **HLF Dose Limits mA (Max SID)** dialog box**,** adjacent to 40 kV**.**
15.	Repeat the above for **50** kV to **90** kV.	Repeat the above for **50** kV to **125** kV.	Repeat the above for **50** kV to **125** kV.
16.	Press **>>**.		
17.	Repeat the above for **100** kV to **125** kV.		
18.	Press **<<** three times.		
19.	Select a fluoroscopic image receptor.		

3E.9.2 High-Level Fluoro Dose Limits (with SID compensation) Cont

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>20.</td><td>Record the maximum permissible Air Kerma Rate for high-level fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>176 mGy / min *.</td><td>150 mGy / min *.</td><td>176 mGy / min *.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for high-level fluoroscopy:______________ mGy / min.</td></tr>
<tr><td>21.</td><td>Ensure that the generator is set for high-level fluoro, and that ABS is switched off.</td></tr>
<tr><td>22.</td><td>Set the imaging system to minimum SID.</td></tr>
<tr><td>23.</td><td>Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.</td></tr>
<tr><td>24.</td><td>While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console or GenWare® such that the maximum permitted dose as recorded in step 20 is not exceeded.</td></tr>
<tr><td>25.</td><td>Record the mA as determined in the previous step for the 40 kV setting.
Max mA for 40kV = ______.</td></tr>
<tr><td>26.</td><td>Repeat steps 23 to 25 for 50 kV.
Max mA for 50kV = ______.</td></tr>
<tr><td>27.</td><td>Repeat steps 23 to 25 for 60 kV.
Max mA for 60kV = ______.</td></tr>
<tr><td>28.</td><td>Repeat steps 23 to 25 for 70 kV.
Max mA for 70kV = ______.</td></tr>
<tr><td>29.</td><td>Repeat steps 23 to 25 for 80 kV.
Max mA for 80kV = ______.</td></tr>
<tr><td>30.</td><td>Repeat steps 23 to 25 for 90 kV.
Max mA for 90kV = ______.</td></tr>
<tr><td>31.</td><td>Repeat steps 23 to 25 for 100 kV.
Max mA for 100kV = ______.</td></tr>
</table>

3E.9.2 High-Level Fluoro Dose Limits (with SID compensation) Cont

Step	Action
32.	Repeat steps 23 to 25 for **110** kV. Max mA for 110kV = ______.
33.	Repeat steps 23 to 25 for **120** kV. Max mA for 120kV = ______.
34.	Repeat steps 23 to 25 for **125** kV. Max mA for 125 kV = ______.
35.	Set the imaging system to maximum SID.
36.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.
37.	While observing the dosimeter, make a fluoroscopy exposure. Adjust the mA via the fluoro section of the console or GenWare® such that the maximum permitted dose as recorded in step 20 is not exceeded.
38.	Record the mA as determined in the previous step for the **40** kV setting. Max mA for 40kV = ______.
39.	Repeat steps 36 to 38 for **50** kV. Max mA for 50kV = ______.
40.	Repeat steps 36 to 38 for **60** kV. Max mA for 60kV = ______.
41.	Repeat steps 36 to 38 for **70** kV. Max mA for 70kV = ______.
42.	Repeat steps 36 to 38 for **80** kV. Max mA for 80kV = ______.
43.	Repeat steps 36 to 38 for **90** kV. Max mA for 90kV = ______.
44.	Repeat steps 36 to 38 for **100** kV. Max mA for 100kV = ______.
45.	Repeat steps 36 to 38 for **110** kV. Max mA for 110kV = ______.

3E.9.2 High-Level Fluoro Dose Limits (with SID compensation) Cont

Step	Action		
46.	Repeat steps 36 to 38 for **120** kV. Max mA for 120kV = ______.		
47.	Repeat steps 36 to 38 for **125** kV. Max mA for 125 kV = ______.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
48.	Select the **40** kV step in the **HLF DOSE L** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 25 for 40 kV.	Enter the maximum mA as determined in step 25 into the **Dose Limits, Min SID** dialog box under**,** 40 kV**.**	Enter the maximum mA as determined in step 25 into the **HLF Dose Limits mA (Min SID)** dialog box under**,** 40 kV**.**
49.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 26 to 30.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 26 to 34.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 26 to 34.
50.	Press **>>**.		
51.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 31 to 34.		
52.	Press **>>**.		
53.	Select the **40** kV step in the **HLF DOSE L** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 38 for 40 kV.	Enter the maximum mA as determined in step 38 into the **Dose Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Enter the maximum mA as determined in step 38 into the **HLF Dose Limits mA (Max SID)** dialog box**,** adjacent to 40 kV**.**
54.	Repeat the above for **50** kV to **90** kV using the mA determined in steps 39 to 43.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 39 to 47.	Repeat the above for **50** kV to **125** kV using the mA determined in steps 39 to 47.
55.	Press **>>**.		
56.	Repeat the above for **100** kV to **125** kV using the mA determined in steps 44 to 47.		

3E.9.2 High-Level Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
57.	Press **<<** four times to return to the **HLF SETUP** menu.		
58.	Press **<<** three times to return to the main **FLUORO SETUP** menu.		

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation)

This procedure sets the maximum mA and pulse width allowed for each kV setting in pulsed fluoro mode for systems with SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **PF DOSE L** menus for the membrane console are shown below (with SID comp).

	* PF DOSE L *		
40 kV-minSID:	40ms	60 kV-minSID:	40ms
40 kV-minSID:	40mA	60 kV-minSID:	40mA
50 kV-minSID:	40ms		+
50 kV-minSID:	40mA		-
<<		>>	

	* PF DOSE L *		
70 kV-minSID:	40ms	90 kV-minSID:	40ms
70 kV-minSID:	40mA	90 kV-minSID:	40mA
80 kV-minSID:	40ms		+
80 kV-minSID:	40mA		-
<<		>>	

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

		* PF DOSE L *		
100 kV-minSID:	40ms		120 kV-minSID:	40ms
100 kV-minSID:	40mA		120 kV-minSID:	40mA
110 kV-minSID:	40ms			+
110 kV-minSID:	40mA			-
<<			>>	

		* PF DOSE L *		
125 kV-minSID:	40ms			
125 kV-minSID:	40mA			
				+
				-
<<			>>	

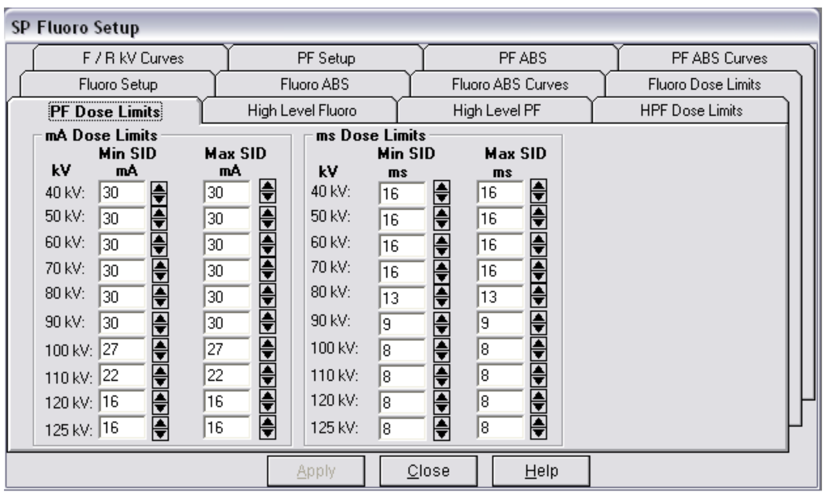
		* PF DOSE L *		
40 kV-maxSID:	40ms		60 kV-maxSID:	16ms
40 kV-maxSID:	40mA		60 kV-maxSID:	30mA
50 kV-maxSID:	40ms			+
50 kV-maxSID:	33mA			-
<<			>>	

		* PF DOSE L *		
70 kV-maxSID:	16ms		90 kV-maxSID:	9ms
70 kV-maxSID:	30mA		90 kV-maxSID:	30mA
80 kV-maxSID:	13ms			+
80 kV-maxSID:	30mA			-
<<			>>	

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

* PF DOSE L *			
100 kV-maxSID: 8ms		120 kV-maxSID: 8ms	
100 kV-maxSID: 27mA		120 kV-maxSID: 16mA	
110 kV-maxSID: 8ms			+
110 kV-maxSID: 22mA			-
<<		>>	

* PF DOSE L *			
125 kV-maxSID: 8ms			
125 kV-maxSID: 16mA			
			+
			-
<<		RETURN	



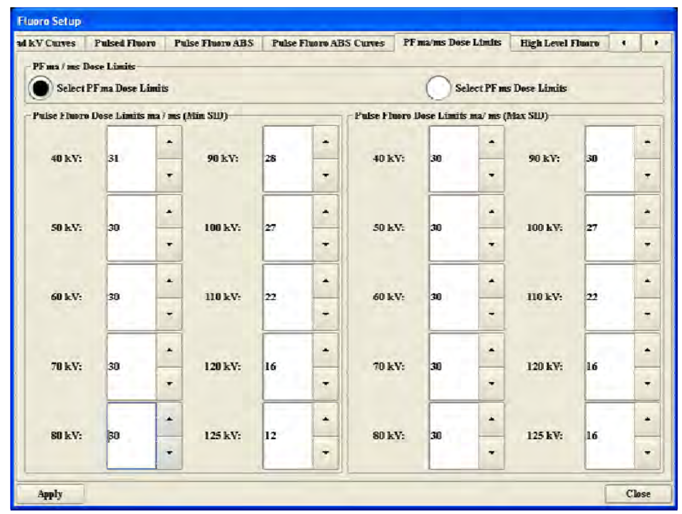


Figure 3E-32a - PC GenWare® *Figure 3E-32b - Touchscreen GenWare®*
Fluoro Setup window, PF Dose Limits / PF ma/ms Dose Limits tab

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the pulsed fluoro dose limits (with SID compensation).

Step	Action		
!	**When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.**		
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.		
2.	Temporarily disconnect the ABS pickup to the generator.		
3.	Ensure that SID compensation is enabled, and that the SID compensation setup is done as per 3E.9.1.		
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Temporarily set the **PF DEFAULT MS** to the maximum value as described in the section ***Pulsed Fluoro Setup***.	Temporarily set the **PF ms** to the maximum value as described in the section ***Pulsed Fluoro Setup***.	Temporarily set the **Pulse Fluoro ms** to the maximum value as described in the section ***Pulsed Fluoro Setup***.
6.	From **PF SETUP** menu 2, select **PF DOSE LIMITS.**	Select the **PF Dose Limits** tab to access the functions described in this section.	Select the **PF ma/ms Dose Limits** tab to access the functions described in this section.
7.	Select the **40** kV (ms) step in the **PF DOSE L** menu for minimum SID. Use the **+** button adjacent to the LCD display to enter the maximum available ms.	Enter the maximum available ms into the **ms Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. Enter the maximum available ms into the **Pulse Fluoro Dose Limits ma/ms (Min SID)** dialog box, adjacent to 40 kV.
8.	Select the **40** kV (mA) step in the **PF DOSE L** menu for minimum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **mA Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **PF ma ms Dose Limits**, select **Select PF ma Dose Limits**. Enter the maximum available mA into the **Pulse Fluoro Dose Limits ma/ms (Min SID)** dialog box, adjacent to 40 kV.
9.	Repeat the two previous steps for **50** and **60** kV.	Repeat the two previous steps for 50 to 125 kV.	Repeat the two previous steps for 50 to 125 kV.

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
10.	Press **>>**.		
11.	Repeat the previous steps for **70** to **90** kV.		
12.	Press **>>**.		
13.	Repeat the previous steps for **100** to **120** kV.		
14.	Press **>>**.		
15.	Repeat the previous steps for **125** kV.		
16.	Press **>>**.		
17.	Select the **40** kV (ms) step in the **PF DOSE L** menu for maximum SID. Use the **+** button adjacent to the LCD display to enter the maximum available ms.	Enter the maximum available ms into the **ms Dose Limits, Max SID** dialog box, adjacent to 40 kV.	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. Enter the maximum available ms into the **Pulse Fluoro Dose Limits ma/ms (Max SID)** dialog box, adjacent to 40 kV.
18.	Select the **40** kV (mA) step in the **PF DOSE L** menu for maximum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **mA Dose Limits, Max SID** dialog box, adjacent to 40 kV.	Under **PF ma / ms Dose Limits**, select **Select PF ma Dose Limits**. Enter the maximum available mA into the **Pulse Fluoro Dose Limits ma/ms (Max SID)** dialog box, adjacent to 40 kV.
19.	Repeat the two previous steps for **50** and **60** kV.	Repeat the two previous steps for **50** to **125** kV.	Repeat the two previous steps for **50** to **125** kV.
20.	Press **>>**.		
21.	Repeat the previous steps for **70** to **90** kV.		
22.	Press **>>**.		
23.	Repeat the previous steps for **100** to **120** kV.		
24.	Press **>>**.		
25.	Repeat the previous steps for **125** kV.		

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

<table>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>26.</td><td>Press << seven times to return to PF DOSE L menu 1.</td><td></td><td></td></tr>
<tr><td>27.</td><td colspan="3">Select a fluoroscopic image receptor.</td></tr>
<tr><td>28.</td><td colspan="3">Record the maximum permissible Air Kerma Rate for normal pulsed fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>88 mGy / min *.</td><td>100 mGy / min *.</td><td>The maximum Air Kerma Rate must comply with local regulations.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>

Maximum permitted Air Kerma Rate for normal pulsed fluoroscopy:______________ mGy / min.</td></tr>
<tr><td>29.</td><td colspan="3">Set the imaging system to minimum SID.</td></tr>
<tr><td>30.</td><td colspan="3">Ensure that the generator is set for pulsed fluoro, and that ABS is switched off.</td></tr>
<tr><td>31.</td><td colspan="3">Select the highest PPS frame rate for determining the maximum dose.</td></tr>
<tr><td>32.</td><td colspan="3">Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.</td></tr>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>33.</td><td>While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms for minimum SID (40kV-minSID) via the PF DOSE L menu such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.</td><td>While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the ms Dose Limits, Min SID dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.</td><td>Under PF ma / ms Dose Limits, select Select PF ms Dose Limits.
While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the Pulse Fluoro Dose Limits ma/ms (Min SID) dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.</td></tr>
</table>

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action
34.	Record the ms and the mA as determined in the previous step for the **40** kV setting. Max ms for 40kV = ______. Max mA for 40kV = ______.
35.	Repeat steps 32 to 34 for **50** kV. Max ms for 50kV = ______. Max mA for 50kV = ______.
36.	Repeat steps 32 to 34 for **60** kV. Max ms for 60kV = ______. Max mA for 60kV = ______.
37.	Repeat steps 32 to 34 for **70** kV. Max ms for 70kV = ______. Max mA for 70kV = ______.
38.	Repeat steps 32 to 34 for **80** kV. Max ms for 80kV = ______. Max mA for 80kV = ______.
39.	Repeat steps 32 to 34 for **90** kV. Max ms for 90kV = ______. Max mA for 90kV = ______.
40.	Repeat steps 32 to 34 for **100** kV. Max ms for 100kV = ______. Max mA for 100kV = ______.
41.	Repeat steps 32 to 34 for **110** kV. Max ms for 110kV = ______. Max mA for 110kV = ______.
42.	Repeat steps 32 to 34 for **120** kV. Max ms for 120kV = ______. Max mA for 120kV = ______.
43.	Repeat steps 32 to 34 for **125** kV. Max ms for 125kV = ______. Max mA for 125kV = ______.
44.	Set the imaging system to maximum SID.
45.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
46.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms for maximum SID (40kV-maxSID) via the **PF DOSE L** menu such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should be in the 5 – 12 ms range. If the ms is too low, reduce the mA via the fluoro control section of the console such that the final maximum ms is in the 5 – 12 ms range.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **ms Dose Limits, Max SID** dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should be in the 5 – 12 ms range. If the ms is too low, reduce the mA via the fluoro control section of GenWare® such that the final maximum ms is in the 5 – 12 ms range.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **Pulse Fluoro Dose Limits ma/ms (Max SID)** dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should be in the 5 – 12 ms range. If the ms is too low, reduce the mA via the fluoro control section of GenWare® such that the final maximum ms is in the 5 – 12 ms range.

Step	Action
47.	Record the ms and the mA as determined in the previous step for the **40** kV setting. Max ms for 40kV = ______. Max mA for 40kV = ______.
48.	Repeat steps 45 to 47 for **50** kV. Max ms for 50kV = ______. Max mA for 50kV = ______.
49.	Repeat steps 45 to 47 for **60** kV. Max ms for 60kV = ______. Max mA for 60kV = ______.
50.	Repeat steps 45 to 47 for **70** kV. Max ms for 70kV = ______. Max mA for 70kV = ______.
51.	Repeat steps 45 to 47 for **80** kV. Max ms for 80kV = ______. Max mA for 80kV = ______.
52.	Repeat steps 45 to 47 for **90** kV. Max ms for 90kV = ______. Max mA for 90kV = ______.
53.	Repeat steps 45 to 47 for **100** kV. Max ms for 100kV = ______. Max mA for 100kV = ______.
54.	Repeat steps 45 to 47 for **110** kV. Max ms for 110kV = ______. Max mA for 110kV = ______.

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action		
55.	Repeat steps 45 to 47 for **120** kV. Max ms for 120kV = ______. Max mA for 120kV = ______.		
56.	Repeat steps 45 to 47 for **125** kV. Max ms for 125kV = ______. Max mA for 125kV = ______.		
57.	Press **<<** seven times to return to **PF DOSE L** menu 1.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
58.	Select the **40** kV (ms) step in the **PF DOSE L** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum ms as determined in step 34 for 40 kV.	Enter the maximum ms as determined in step 34 into the **ms Dose Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. Enter the maximum ms as determined in step 34 into the **Pulse Fluoro Dose Limits ma/ms (Min SID)** dialog box**,** adjacent to 40 kV**.**
59.	Select the **40** kV (mA) step in the **PF DOSE L** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 34 for 40 kV.	Enter the maximum mA as determined in step 34 into the **mA Dose Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Under **PF ma / ms Dose Limits**, select **Select PF ma Dose Limits**. Enter the maximum mA as determined in step 34 into the **Pulse Fluoro Dose Limits ma/ms (Min SID)** dialog box**,** adjacent to 40 kV**.**
60.	Repeat the two previous steps for **50** kV and **60** kV using the mA and ms determined in steps 35 and 36.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 35 to 43.	Repeat the two previous steps for **50** kV to **125** kV using the mA amd ms determined in steps 35 to 43.
61.	Press **>>**.		
62.	Repeat the above for **70** kV to **90** kV using the mA and ms determined in steps 37 to 39.		
63.	Press **>>**.		
64.	Repeat the above for **100** kV to **120** kV using the mA and ms determined in steps 40 to 42.		

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
65.	Press **>>**.		
66.	Repeat the above for **125** kV using the mA and ms determined in step 43.		
67.	Press **>>**.		
68.	Select the **40** kV (ms) step in the **PF DOSE L** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum ms as determined in step 47 for 40 kV.	Enter the maximum ms as determined in step 47 into the **ms Dose Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Under **PF ma / ms Dose Limits**, select **Select PF ms Dose Limits**. Enter the maximum ms as determined in step 47 into the **Pulse Fluoro Dose Limits ma/ms (Max SID)** dialog box**,** adjacent to 40 kV**.**
69.	Select the **40** kV (mA) step in the **PF DOSE L** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 47 for 40 kV.	Enter the maximum mA as determined in step 47 into the **mA Dose Limits, Max SID** dialog box**,** adjacent to 40 kV**.**	Under **PF ma / ms Dose Limits**, select **Select PF ma Dose Limits**. Enter the maximum ms as determined in step 47 into the **Pulse Fluoro Dose Limits ma/ms (Max SID)** dialog box**,** adjacent to 40 kV**.**
70.	Repeat the two previous steps for **50** kV and **60** kV using the mA and ms determined in steps 48 and 49.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 48 to 56.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 48 to 56.
71.	Press **>>**.		
72.	Repeat the above for **70** kV to **90** kV using the mA and ms determined in steps 50 to 52.		
73.	Press **>>**.		
74.	Repeat the above for **100** kV to **120** kV using the mA and ms determined in steps 53 to 55.		
75.	Press **>>**.		
76.	Repeat the above for **125** kV using the mA and ms determined in step 56.		

3E.9.3 Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
77.	Press **RETURN**.		
78.	Press **<<**.		
79.	Set the **PF DEFAULT MS** to the desired value as described in the section ***Pulsed Fluoro Setup***.	Set the **PF ms** to the desired value as described in the section ***Pulsed Fluoro Setup***.	Set the **Pulse Fluoro ms** to the desired value as described in the section ***Pulsed Fluoro Setup***.
80.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation)

This procedure sets the maximum mA and pulse width allowed for each kV setting in high-level pulsed fluoro mode for systems with SID compensation.

CAUTION: ***MAXIMUM INPUT DOSE LIMITS ARE USUALLY ESTABLISHED BY LOCAL, STATE OR COUNTRY REGULATIONS. THESE LIMITS MUST BE DETERMINED IN ADVANCE OF ATTEMPTING DOSE LIMITS SETUP, AND ADHERED TO DURING GENERATOR CALIBRATION.***

NOTE: ***THE DOSE LIMIT MEASUREMENTS MUST BE MADE WITH THE R-PROBE CORRECTLY POSITIONED. THIS IS TYPICALLY AS PER FIGURE 3E-6, HOWEVER, LOCAL REGULATIONS SHOULD BE CONSULTED TO CONFIRM THE PROPER TEST SET-UP.***

CAUTION: ***PROCEDURES IN THE FOLLOWING SECTIONS REQUIRE THE PRODUCTION OF X-RAYS. ESTABLISHED GUIDELINES MUST BE FOLLOWED AT ALL TIMES TO PROTECT PERSONNEL FROM RADIATION EXPOSURE.***

The **HPF DOSE L** menus for the membrane console are shown below (with SID comp).

* HPF DOSE L *			
40 kV-minSID:	16ms	60 kV-minSID:	16ms
40 kV-minSID:	60mA	60 kV-minSID:	60mA
50 kV-minSID:	16ms		+
50 kV-minSID:	60mA		-
<<		>>	

* HPF DOSE L *			
70 kV-minSID:	16ms	90 kV-minSID:	10ms
70 kV-minSID:	60mA	90 kV-minSID:	60mA
80 kV-minSID:	13ms		+
80 kV-minSID:	60mA		-
<<		>>	

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

		* HPF DOSE L *		
100 kV-minSID:	10ms		120 kV-minSID:	10ms
100 kV-minSID:	50mA		120 kV-minSID:	35mA
110 kV-minSID:	10ms			+
110 kV-minSID:	40mA			-
<<			>>	

		* HPF DOSE L *		
125 kV-minSID:	10ms			
125 kV-minSID:	35mA			
				+
				-
<<			>>	

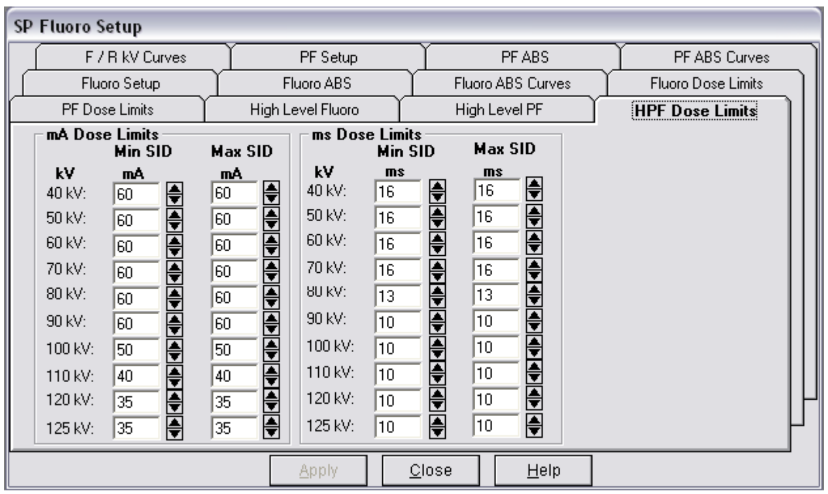
		* HPF DOSE L *		
40 kV-maxSID:	16ms		60 kV-maxSID:	16ms
40 kV-maxSID:	60mA		60 kV-maxSID:	60mA
50 kV-maxSID:	16ms			+
50 kV-maxSID:	60mA			-
<<			>>	

		* HPF DOSE L *		
70 kV-maxSID:	16ms		90 kV-maxSID:	10ms
70 kV-maxSID:	60mA		90 kV-maxSID:	60mA
80 kV-maxSID:	13ms			+
80 kV-maxSID:	60mA			-
<<			>>	

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

* PF DOSE L *			
100 kV-maxSID:	10ms	120 kV-maxSID:	10ms
100 kV-maxSID:	50mA	120 kV-maxSID:	35mA
110 kV-maxSID:	10ms		+
110 kV-maxSID:	40mA		-
<<		>>	

* PF DOSE L *			
125 kV-maxSID:	10ms		
125 kV-maxSID:	35mA		
			+
			-
<<		RETURN	



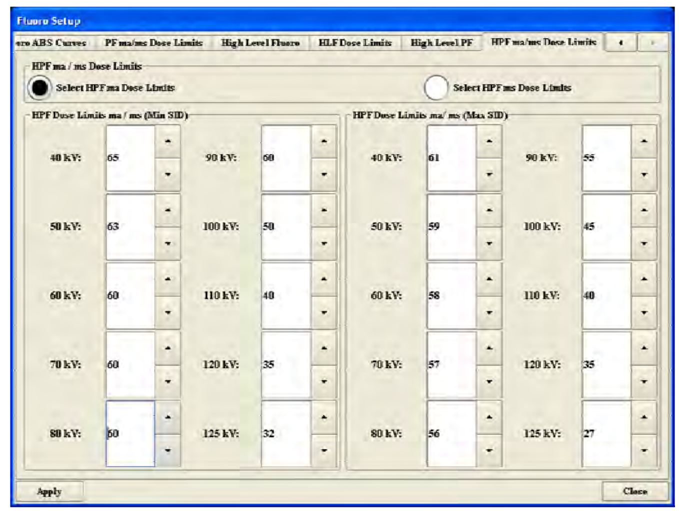


Figure 3E-33a - PC GenWare® *Figure 3E-33b - Touchscreen GenWare®*
Fluoro Setup window, HPF Dose Limits / HPF ma/ms Dose Limits tab

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

NOTE: ***IT IS RECOMMENDED THAT COPIES BE MADE OF ALL PAGES WHERE RESULTS ARE TO BE RECORDED. THE RESULTS SHOULD THEN BE RECORDED ON THE COPIES, LEAVING THE ORIGINALS BLANK.***

Use these steps to set the high-level pulsed fluoro dose limits (with SID compensation).

Step	Action		
	When setting the maximum Air Kerma Rate limits, use the minimum optional filtration that will be used in this X-ray installation.		
1.	Set up the radiation probe as per figure 3E-6, observing the note near the beginning of this section regarding the required R-probe location within the X-ray field.		
2.	Temporarily disconnect the ABS pickup to the generator.		
3.	Ensure that SID compensation is enabled, and that the SID compensation setup is done as per 3E.9.1.		
4.	**Temporarily de-energize the I.I. power supply, or cover the I.I. with a minimum of 2.0 mm lead.**		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
5.	Temporarily set the **PF DEFAULT MS** to the maximum value as described in the section ***Pulsed Fluoro Setup***.	Temporarily set the **PF ms** to the maximum value as described in the section ***Pulsed Fluoro Setup***.	Temporarily set the **Pulse Fluoro ms** to the maximum value as described in the section ***Pulsed Fluoro Setup***.
6.	From **HPF SETUP** menu 2, select **HPF DOSE LIMITS.**	Select the **HPF Dose Limits** tab to access the functions described in this section.	Select the **HPF ma/ms Dose Limits** tab to access the functions described in this section.
7.	Select the **40** kV (ms) step in the **HPF DOSE L** menu for minimum SID. Use the **+** button adjacent to the LCD display to enter the maximum available ms.	Enter the maximum available ms into the **ms Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. Enter the maximum available ms into the **HPF Dose Limits ma/ms (Min SID)** dialog box, adjacent to 40 kV.
8.	Select the **40** kV (mA) step in the **HPF DOSE L** menu for minimum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **mA Dose Limits, Min SID** dialog box, adjacent to 40 kV.	Under **HPF ma / ms Dose Limits**, select **Select HPF ma Dose Limits**. Enter the maximum available mA into the **HPF Dose Limits ma/ms (Min SID)** dialog box, adjacent to 40 kV.
9.	Repeat the two previous steps for **50** and **60** kV.	Repeat the two previous steps for **50** to **125** kV.	Repeat the two previous steps for **50** to **125** kV.
10.	Press **>>**.		

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
11.	Repeat the previous steps for **70** to **90** kV.		
12.	Press **>>**.		
13.	Repeat the previous steps for **100** to **120** kV.		
14.	Press **>>**.		
15.	Repeat the previous steps for **125** kV.		
16.	Press **>>**.		
17.	Select the **40** kV (ms) step in the **HPF DOSE L** menu for maximum SID. Use the **+** button adjacent to the LCD display to enter the maximum available ms.	Enter the maximum available ms into the **ms Dose Limits, Max SID** dialog box, adjacent to 40 kV.	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. Enter the maximum available ms into the **HPF Dose Limits ma/ms (Max SID)** dialog box, adjacent to 40 kV.
18.	Select the **40** kV (mA) step in the **HPF DOSE L** menu for maximum SID. Use the **+** button adjacent to the LCD display to enter the maximum available mA.	Enter the maximum available mA into the **mA Dose Limits, Max SID** dialog box, adjacent to 40 kV.	Under **HPF ma / ms Dose Limits**, select **Select HPF ma Dose Limits**. Enter the maximum available mA into the **HPF Dose Limits ma/ms (Max SID)** dialog box, adjacent to 40 kV.
19.	Repeat the two previous steps for **50** and **60** kV.	Repeat the two previous steps for **50** to **125** kV.	Repeat the two previous steps for **50** to **125** kV.
20.	Press **>>**.		
21.	Repeat the previous steps for **70** to **90** kV.		
22.	Press **>>**.		
23.	Repeat the previous steps for **100** to **120** kV.		
24.	Press **>>**.		
25.	Repeat the previous steps for **125** kV.		

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

<table>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>26.</td><td>Press << seven times to return to HPF DOSE L menu 1.</td><td></td><td></td></tr>
<tr><td>27.</td><td colspan="3">Select a fluoroscopic image receptor.</td></tr>
<tr><td>28.</td><td colspan="3">Record the maximum permissible Air Kerma Rate for high-level pulsed fluoroscopy. Note the guidelines below.
<table>
<tr><td>FDA (USA)</td><td>Health Canada</td><td>IEC</td></tr>
<tr><td>176 mGy / min *.</td><td>150 mGy / min *.</td><td>176 mGy / min *.</td></tr>
<tr><td colspan="3">* The listed Air Kerma Rate values should be confirmed by consulting local regulations.</td></tr>
</table>
Maximum permitted Air Kerma Rate for high-level pulsed fluoroscopy:_____________ mGy / min.</td></tr>
<tr><td>29.</td><td colspan="3">Set the imaging system to minimum SID.</td></tr>
<tr><td>30.</td><td colspan="3">Ensure that the generator is set for high-level pulsed fluoro, and that ABS is switched off.</td></tr>
<tr><td>31.</td><td colspan="3">Select the highest PPS frame rate for determining the maximum dose.</td></tr>
<tr><td>32.</td><td colspan="3">Select 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.</td></tr>
<tr><th>Step</th><th>Action (membrane console)</th><th>Action (PC GenWare®)</th><th>Action (Touchscreen GenWare®)</th></tr>
<tr><td>33.</td><td>While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms for minimum SID (40kV-minSID) via the HPF DOSE L menu such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.</td><td>While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the ms Dose Limits, Min SID dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.</td><td>Under HPF ma / ms Dose Limits, select Select HPF ms Dose Limits.
While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the HPF Dose Limits ma/ms (Min SID) dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should typically be in the range of 8 to 12 ms. If the 40 kV dose limits need to be reduced further, reduce the mA via the fluoro control section of the console such that the final ms is in the specified range.</td></tr>
</table>

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action
34.	Record the ms and the mA as determined in the previous step for the **40** kV setting. Max ms for 40kV = ______. Max mA for 40kV = ______.
35.	Repeat steps 32 to 34 for **50** kV. Max ms for 50kV = ______. Max mA for 50kV = ______.
36.	Repeat steps 32 to 34 for **60** kV. Max ms for 60kV = ______. Max mA for 60kV = ______.
37.	Repeat steps 32 to 34 for **70** kV. Max ms for 70kV = ______. Max mA for 70kV = ______.
38.	Repeat steps 32 to 34 for **80** kV. Max ms for 80kV = ______. Max mA for 80kV = ______.
39.	Repeat steps 32 to 34 for **90** kV. Max ms for 90kV = ______. Max mA for 90kV = ______.
40.	Repeat steps 32 to 34 for **100** kV. Max ms for 100kV = ______. Max mA for 100kV = ______.
41.	Repeat steps 32 to 34 for **110** kV. Max ms for 110kV = ______. Max mA for 110kV = ______.
42.	Repeat steps 32 to 34 for **120** kV. Max ms for 120kV = ______. Max mA for 120kV = ______.
43.	Repeat steps 32 to 34 for **125** kV. Max ms for 125kV = ______. Max mA for 125kV = ______.
44.	Set the imaging system to maximum SID.
45.	Reselect 40 kV and the maximum available mA via the fluoro control section of the console or via GenWare®.

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
46.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms for maximum SID (40kV-maxSID) via the **HPF DOSE L** menu such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should be in the 5 – 12 ms range. If the ms is too low, reduce the mA via the fluoro control section of the console such that the final maximum ms is in the 5 – 12 ms range.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **ms Dose Limits, Max SID** dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should be in the 5 – 12 ms range. If the ms is too low, reduce the mA via the fluoro control section of GenWare® such that the final maximum ms is in the 5 – 12 ms range.	While observing the dosimeter, make a fluoroscopy exposure. Reduce the 40 kV ms via the **HPF Dose Limits ma/ms (Max SID)** dialog box, such that the maximum permitted dose as recorded in step 28 is not exceeded. The ms should be in the 5 – 12 ms range. If the ms is too low, reduce the mA via the fluoro control section of GenWare® such that the final maximum ms is in the 5 – 12 ms range.
47.	Record the ms and the mA as determined in the previous step for the **40** kV setting. Max ms for 40kV = ______. Max mA for 40kV = ______.		
48.	Repeat steps 45 to 47 for **50** kV. Max ms for 50kV = ______. Max mA for 50kV = ______.		
49.	Repeat steps 45 to 47 for **60** kV. Max ms for 60kV = ______. Max mA for 60kV = ______.		
50.	Repeat steps 45 to 47 for **70** kV. Max ms for 70kV = ______. Max mA for 70kV = ______.		
51.	Repeat steps 45 to 47 for **80** kV. Max ms for 80kV = ______. Max mA for 80kV = ______.		
52.	Repeat steps 45 to 47 for **90** kV. Max ms for 90kV = ______. Max mA for 90kV = ______.		
53.	Repeat steps 45 to 47 for **100** kV. Max ms for 100kV = ______. Max mA for 100kV = ______.		
54.	Repeat steps 45 to 47 for **110** kV. Max ms for 110kV = ______. Max mA for 110kV = ______.		
55.	Repeat steps 45 to 47 for **120** kV. Max ms for 120kV = ______. Max mA for 120kV = ______.		

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action		
56.	Repeat steps 45 to 47 for **125** kV. Max ms for 125kV = ______. Max mA for 125kV = ______.		
Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
57.	Press **<<** seven times to return to **HPF DOSE L** menu 1.		
58.	Select the **40** kV (ms) step in the **HPF DOSE L** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum ms as determined in step 34 for 40 kV.	Enter the maximum ms as determined in step 34 into the **ms Dose Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. Enter the maximum available ms as determined in step 34 into the **HPF Dose Limits ma/ms (Min SID)** dialog box, adjacent to 40 kV.
59.	Select the **40** kV (mA) step in the **HPF DOSE L** menu for minimum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 34 for 40 kV.	Enter the maximum mA as determined in step 34 into the **mA Dose Limits, Min SID** dialog box**,** adjacent to 40 kV**.**	Under **HPF ma / ms Dose Limits**, select **Select HPF ma Dose Limits**. Enter the maximum mA as determined in step 34 into the **HPF Dose Limits ma/ms (Min SID)** dialog box, adjacent to 40 kV.
60.	Repeat the two previous steps for **50** kV and **60** kV using the mA and ms determined in steps 35 and 36.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 35 to 43.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 35 to 43.
61.	Press **>>**.		
62.	Repeat the above for **70** kV to **90** kV using the mA and ms determined in steps 37 to 39.		
63.	Press **>>**.		
64.	Repeat the above for **100** kV to **120** kV using the mA and ms determined in steps 40 to 42.		
65.	Press **>>**.		
66.	Repeat the above for **125** kV using the mA and ms determined in step 43.		

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
67.	Press **>>**.		
68.	Select the **40** kV (ms) step in the **HPF DOSE L** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum ms as determined in step 47 for 40 kV.	Enter the maximum ms as determined in step 47 into the **HPF Dose Limits** dialog box under **ms Dose Limits, Max SID,** adjacent to 40 kV**.**	Under **HPF ma / ms Dose Limits**, select **Select HPF ms Dose Limits**. Enter the maximum ms as determined in step 47 into the **HPF Dose Limits ma/ms (Max SID)** dialog box, adjacent to 40 kV.
69.	Select the **40** kV (mA) step in the **HPF DOSE L** menu for maximum SID. Use the **+** or **-** buttons adjacent to the LCD display to enter the maximum mA as determined in step 47 for 40 kV.	Enter the maximum mA as determined in step 47 into the **HPF Dose Limits** dialog box under **mA Dose Limits, Max SID,** adjacent to 40 kV**.**	Under **HPF ma / ms Dose Limits**, select **Select HPF ma Dose Limits**. Enter the maximum mA as determined in step 47 into the **HPF Dose Limits ma/ms (Max SID)** dialog box, adjacent to 40 kV.
70.	Repeat the two previous steps for **50** kV and **60** kV using the mA and ms determined in steps 48 and 49.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 48 to 56.	Repeat the two previous steps for **50** kV to **125** kV using the mA and ms determined in steps 48 to 56.
71.	Press **>>**.		
72.	Repeat the above for **70** kV to **90** kV using the mA and ms determined in steps 50 to 52.		
73.	Press **>>**.		
74.	Repeat the above for **100** kV to **120** kV using the mA and ms determined in steps 53 to 55.		
75.	Press **>>**.		
76.	Repeat the above for **125** kV using the mA and ms determined in step 56.		
77.	Press **RETURN**.		
78.	Press **<<**.		

3E.9.4 High Level Pulsed Fluoro Dose Limits (with SID compensation) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (Touchscreen GenWare®)
79.	Set the **PF DEFAULT MS** to the desired value as described in the ***Pulsed Fluoro Setup*** section.	Set the **PF ms** to the desired value as described in the ***Pulsed Fluoro Setup*** section.	Set the **Pulse Fluoro ms** to the desired value as described in the section ***Pulsed Fluoro Setup***.
80.	Press **<<** twice to return to the main **FLUORO SETUP** menu.		

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CHAPTER 3F

DAP / AK SETUP AND CALIBRATION

CONTENTS:

3F.1.0 INTRODUCTION

This section details setup and programming of the DAP (Dose-Area Product) meter and the AK (Air Kerma) calculator and display, both being optional on Indico 100 X-ray generators.
Single tube generators will only use 1 DAP chamber, two tube generators may use 1 or 2 DAP chambers. Any references made to tube 2 or the ability to switch tubes in this section apply to two tube generators only.
Implementation of DAP requires hardware – a DAP chamber and DAP circuits in the generator to process the DAP signal from the DAP chamber. The AK calculator requires no additional hardware. Air kerma measurements are made at several kV stations; the resulting measurements, in mGy, are then entered into the generator AK setup menu. The generator uses the measured values to build a look-up table in order to calculate and display accumulated air kerma and air kerma rate.

3F.2.0 DAP INTERFACING

3F.2.1 DAP Compatibility

The Indico 100 X-ray generator, when equipped with the DAP option, is compatible with the DAP devices listed in section 3F.4.1. The correct DAP device(s) must be selected in the DAP Setup menu as described in sections 3F.4.1, 3F.4.2, or 3F.4.3 in order to ensure device compatibility.

The DAP chamber, when fitted with the proper interconnect cable, plugs directly into the DAP interface board in the generator. When ordering the DAP chamber from the DAP manufacturer, specify the CPI compatible interconnect cable, if available. This is a special cable terminated with a 9 pin male “D” connector that is designed to plug directly into the DAP interface board in the generator. If this cable is not available from the DAP device manufacturer, consult CPI product support for the required cable to connect the DAP chamber to the generator. Refer to the table below for the CPI cable assembly part numbers.

DAP DEVICE	INTERCONNECT CABLE
PTW PX-T11020	736145-00
Gammex-RMI 841S	736146-00
VacuTec VacuDAP 2004	Contact VacuTec for this cable assembly.
Scanditronix-Wellhoefer 120-131	736148-00

3F.2.2 DAP Installation

1. Switch OFF the AC line voltage to the generator at the main disconnect switch. Allow sufficient time for all capacitors in the generator to discharge.
2. Install the DAP chamber as per the manufacturers instructions. The interconnect cable to the generator must be as per 3F.2.1.
3. Route the DAP interconnect cable(s) through the access covers in the upper part of the generator cabinet, then route the cables toward the DAP interface board.
4. Plug the cable from DAP device 1 (for tube 1) into J2, and the cable from DAP device 2 (for tube 2) into J3 of the DAP interface board. Tighten the screw locks on the connectors to secure the cables.

3F.2.2 DAP Installation (Cont)

5. Set JW1 and JW2 on the DAP interface board as per the following table:

	JUMPER	Scanditronix-Wellhoefer	All others
DAP Chamber 1 (J2 on DAP board)	JW1	Jumper pins 1-2	Jumper pins 2-3
DAP Chamber 2 (J3 on DAP board)	JW2	Jumper pins 1-2	Jumper pins 2-3

6. Proceed with DAP setup and calibration as per the remainder of this procedure.

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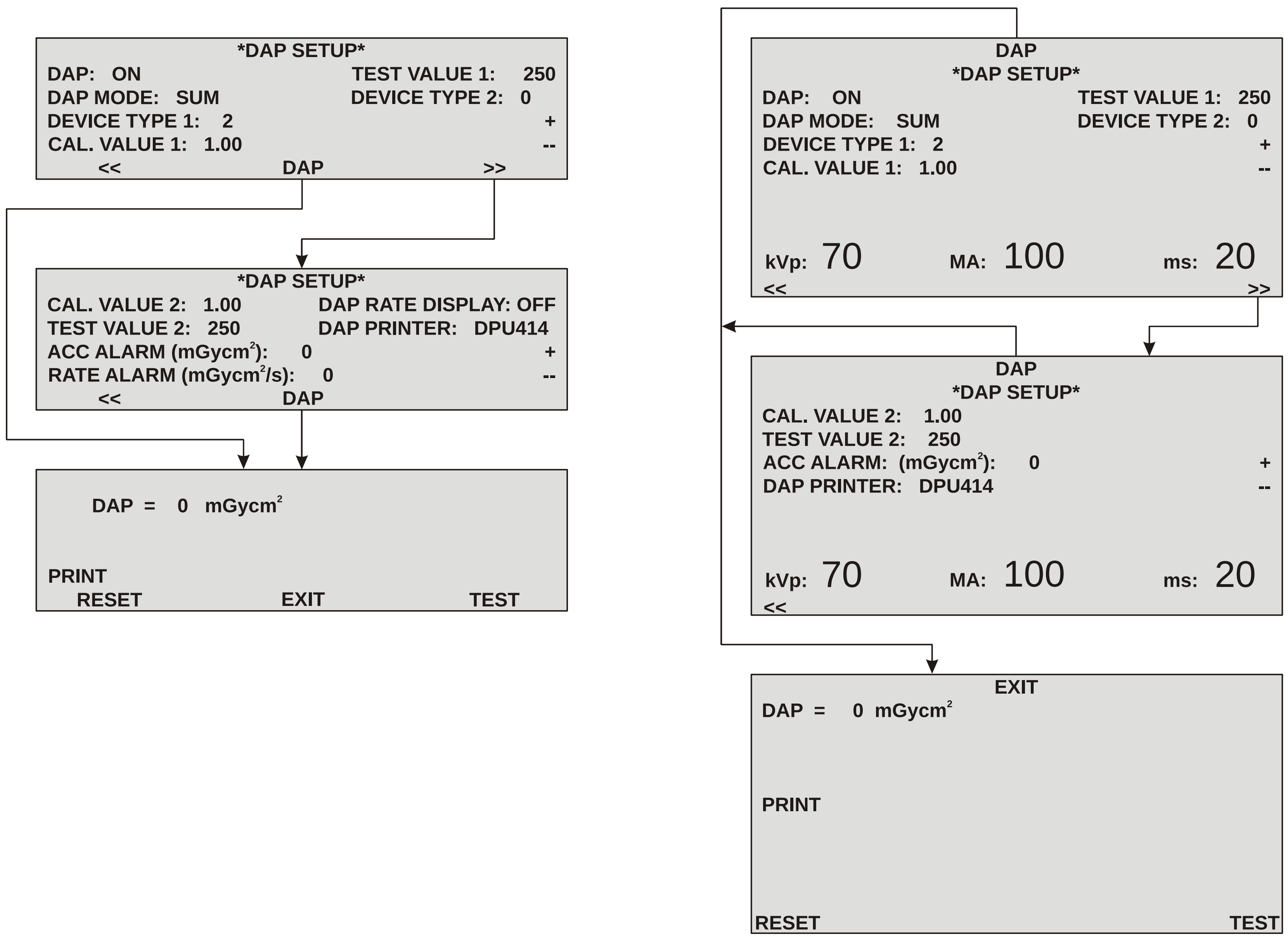
3F.3.0 DAP SETUP MENU STRUCTURE

INDICO 100 R&F **INDICO 100 RAD** **INDICO 100 SP**
SEE NEXT PAGE



SP DAP SETUP SCREENS.CDR

Figure 3F-1, sheet 1: DAP / AK setup menus. This diagram is meant to show the general menu structure only.

INDICO 100 SP

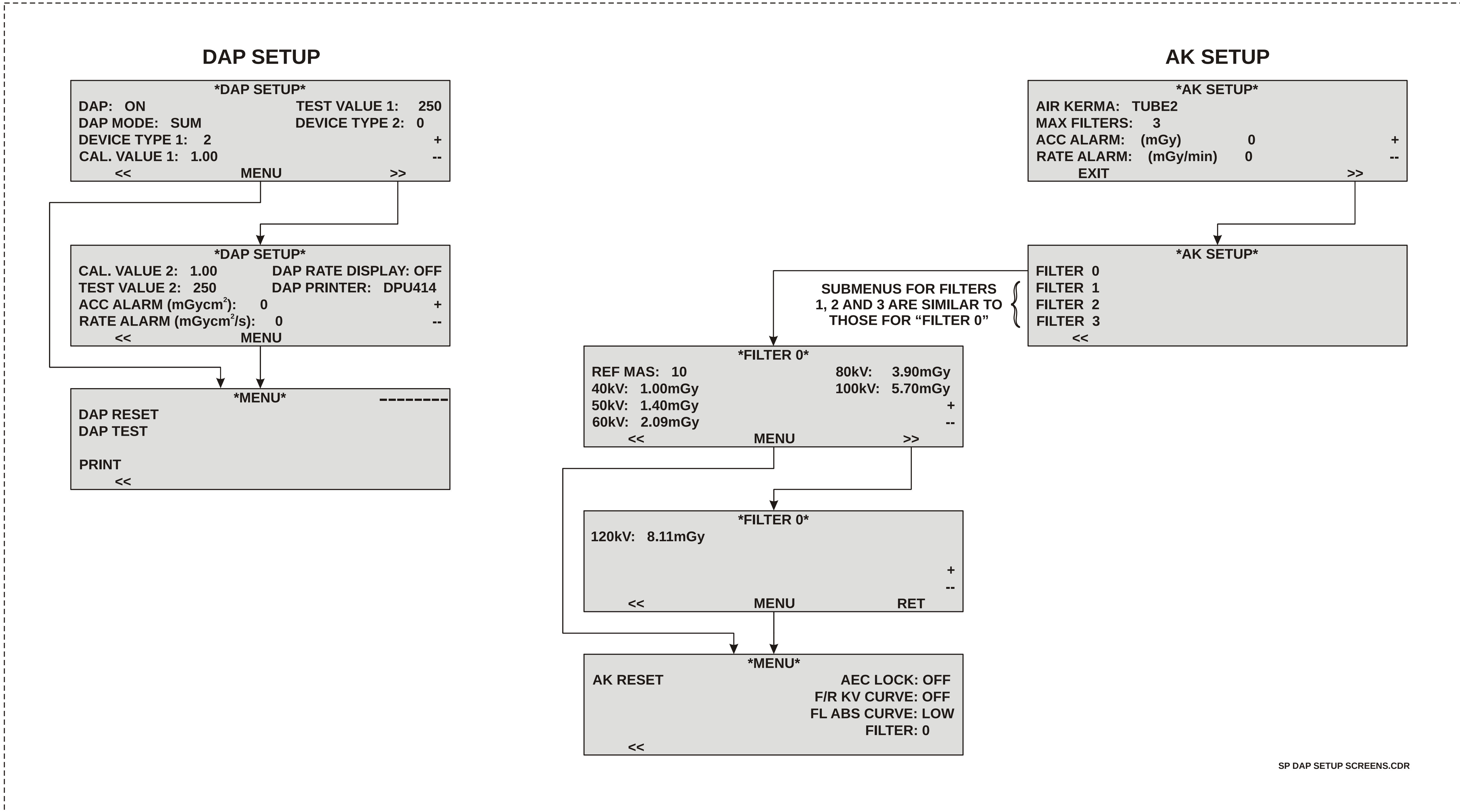


Figure 3F-1, sheet 2: DAP / AK setup menus. This diagram is meant to show the general menu structure only.

3F.4.0 DAP SETUP

The DAP setup functionality is similar for the Indico 100 R&F, Indico 100 rad, and Indico 100 SP generators with the membrane consoles, but the layout of the DAP setup menus varies to some extent between these models. As a result, the Indico 100 R&F, Indico 100 rad, and Indico 100 SP generators each have their own setup procedures within this section. Use the appropriate procedure for your model of generator.

The DAP printer function referenced in this chapter is optional.

Definitions of **DAP SETUP** menu items.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
DAP	**DAP** **(DAP State)** checkbox	Enables or disables the DAP device. This setting applies to both DAP devices if two DAP devices are used. Membrane console: **ON:** The DAP function is enabled. **OFF:** The DAP function is disabled. In GenWare®, the DAP function is enabled or disabled via the **DAP** (**DAP State**) checkbox.
DAP MODE	**DAP Mode**	Selects the DAP mode of operation. **IND:** The generator makes and displays ***individual*** DAP measurements for each tube **SUM:** The generator ***sums*** the DAP measurement from both tubes, and displays the single summed measurement when either tube is selected

3F.4.0 DAP SETUP (Cont)

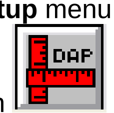
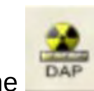
FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
DEVICE TYPE 1 **DEVICE TYPE 2**	**Device Type 1** **Device Type 2** **(DAP Device Type 1)** **(DAP Device Type 2)**	Selects the DAP device. **0** = PTW PX-T11020 *****. **1** = Gammex RMI 841S *****. **2** = VacuTec VacuDAP 2004 *. **3** = Scanditronix-Wellhoefer 120-131 *****. *** JW1 and JW2 must be properly configured, based on the selected DAP chamber(s). Refer to 3F.2.2 for details.**
CAL. VALUE 1 **CAL. VALUE 2**	**DAP Device Type 1: Calibration Value** **DAP Device Type 2: Calibration Value**	Allows the DAP reading to be calibrated by adjusting this parameter.
TEST VALUE 1 **TEST VALUE 2**	**Test Value 1** **Test Value 2**	A numeric value, supplied by the DAP device manufacturer, that represents the number of pulses generated by the DAP device during TEST mode. The generator counts the number of pulses generated by the DAP device during TEST mode, and reports a DAP failure error message if the actual number of test pulses are not the same as the manufacturer-supplied test count, within an allowable margin of error. ***Setting TEST VALUE 1 or TEST VALUE 2 to 0 will disable DAP input 1 or DAP input 2, respectively. For single tube generators, TEST VALUE 2 should be set to 0.***
ACC ALARM ($mGycm^2$)	**DAP Accum Alarm ($mGycm^2$)**	Sets the alarm level for accumulated DAP. The console will present an audible alarm, and a visual warning via the LCD display when the accumulated dose exceeds this limit.
RATE ALARM ($mGycm^2/s$)	**DAP Rate Alarm ($mGycm^2/s$)**	SETS THE ALARM LEVEL FOR THE MAXIMUM DAP RATE. THE CONSOLE WILL PRESENT AN AUDIBLE ALARM AND A VISUAL WARNING VIA THE LCD DISPLAY WHEN THE CURRENT DOSE RATE EXCEEDS THIS LIMIT.

3F.4.0 DAP SETUP (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
DAP RATE DISPLAY	**DAP Rate Display** checkbox	Enables or disables the display of the DAP ***rate*** during fluoro operation. Membrane console: **ON:** DAP rate is displayed during fluoroscopic operation. When the fluoro run is finished, the accumulated DAP will be displayed. **OFF:** Displays the accumulated DAP only during fluoroscopic operation. In GenWare®, the DAP rate display is enabled or disabled via the **DAP Rate Display** checkbox.
DAP PRINTER	**DAP Printer**	Allows selection of the DAP printer type, or disabling of the DAP printer function. This is only available with the DAP printer option. **OFF:** Disables the DAP printer function. **DPU414 :** Selects the Seiko Instruments DPU-414 printer. **SLP200:** Selects the Seiko Instruments SLP-200 printer. Refer to 3F.4.4 for the DAP / Air Kerma printer setup information. The printer settings made via the “Dap Printer” function apply to the membrane console only. The printer selection for the touchscreen console is in the DAP or Air Kerma printer interface window, accessed via the **DAP** or **AK** buttons in the touchscreen’s acquisition mode.
PRINT	**This function is not available in GenWare®**	Prints a DAP label. The printer will print the date and time near the top of the label, and the accumulated Dose-Area Product ($mGycm^2$) near the middle of the label. This information is retrieved from the generator at the time the label is printed. Several headings are also printed on the labels; the corresponding patient information must be manually entered.
RESET **(DAP RESET)**	**Reset**	Resets the DAP display to zero.
TEST **(DAP TEST)**	**Test**	Tests the DAP circuits by counting the number of test pulses (refer to TEST VALUE, above). A pass / fail message will be presented after the DAP test, and the actual number of test pulses counted will be displayed.

3F.4.1 DAP Setup (Indico 100 R&F)

Use these steps to access the **DAP SETUP** menus (membrane console), or the DAP setup utility in GenWare®.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	Enter into the programming mode as described in chapter 3C.	The procedure for starting Genware® and connecting it to the console is described in the Genware® manual, included with Genware®. From the GenWare® GENERATOR UTILITIES application, select **DAP Setup** from the **Setup** menu, or use the DAP setup button  on the GenWare® toolbar.	Touchscreen Genware® must be launched before proceeding. This is done from the Genware® button on the touchscreen **System Utilities** menu. Press the  button on the GenWare® toolbar to access the **DAP Setup** utility
2.	When the **GENERATOR SETUP** menu is displayed, select **GEN CONFIGURATION**.		
3.	Press **>>**, then select **DAP SETUP**		

The **DAP SETUP** menus for the Indico 100 R&F membrane console are shown below.

	* DAP SETUP *	
DAP: ON		TEST VALUE 1: 250
DAP MODE: SUM		DEVICE TYPE 2: 0
DEVICE TYPE 1: 2		+
CAL. VALUE 1: 1.00		-
<<	DAP	>>

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3F.4.1 DAP Setup (Indico 100 R&F) Cont

* DAP SETUP *

CAL. VALUE 2: 1.00 DAP RATE DISPLAY: OFF

TEST VALUE 2: 250 DAP PRINTER: DPU414

ACC ALARM (mGycm^2): 0 +

RATE ALARM (mGycm^2/s): 0 -

<< DAP

DAP = 0 mGycm^2

PRINT

RESET EXIT TEST

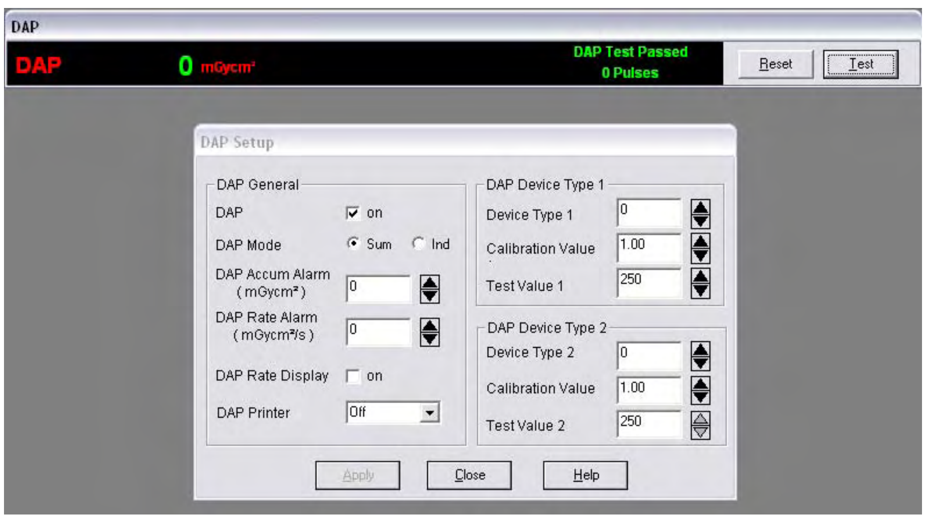


Figure 3F-2a: PC GenWare®

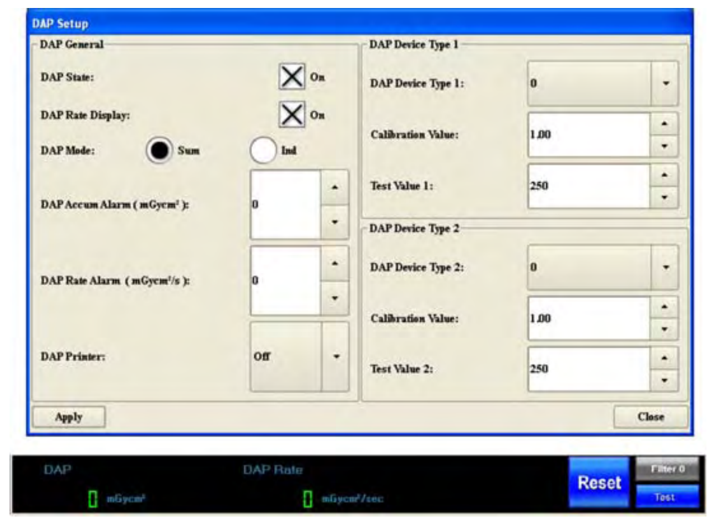


Figure 3F-2b: TouchScreen GenWare®

DAP Setup and display windows

3F.4.1 DAP Setup (Indico 100 R&F) Cont

Use these steps to perform the DAP setup for Indico 100 R&F generators. Refer to the definitions in the previous table.

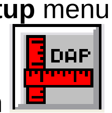
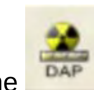
Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	From **DAP SETUP** menu 1, select **DAP**. Toggle the button to select **ON** or **OFF**.	Check the **DAP** checkbox to enable the DAP function.	Check the **DAP State** checkbox to enable the DAP function.
2.	Select **DAP MODE**. Toggle the button to select **SUM** or **IND**.	For **DAP Mode**, select **Sum** or **Ind**.	For **DAP Mode**, select **Sum** or **Ind**.
3.	Select **DEVICE TYPE 1**. Use the **+** or **–** buttons to select the desired DAP 1 device.	Select the desired DAP 1 device via the **Device Type 1** dialog box.	Select the desired DAP 1 device via the **DAP Device Type 1** dialog box.
4.	Select **TEST VALUE 1**. Use the **+** or **–** buttons to select the test value for DAP device 1.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.
5.	Select **DEVICE TYPE 2**. Use the **+** or **–** buttons to select the desired DAP 2 device.	Select the desired DAP 2 device via the **Device Type 2** dialog box.	Select the desired DAP 2 device via the **DAP Device Type 2** dialog box.
6.	Press **>>**.		
7.	Select **TEST VALUE 2**. Use the **+** or **–** buttons to select the test value for DAP device 2.	Select the test value for DAP device 2 via the **Test Value 2** dialog box.	Select the test value for DAP device 2 via the **Test Value 2** dialog box.
8.	Select **ACC ALARM (mGycm^2).** Use the **+** or **–** buttons to set the maximum permissible accumulated DAP.	Set the maximum permissible accumulated DAP via the **DAP Accum Alarm (mGycm^2)** dialog box.	Set the maximum permissible accumulated DAP via the **DAP Accum Alarm (mGycm^2)** dialog box.
9.	Select **RATE ALARM (mGycm^2/s).** Use the **+** or **–** buttons to set the maximum permissible DAP rate for fluoro operation.	Set the maximum permissible DAP rate for fluoro operation via the **DAP Rate Alarm (mGycm^2/s)** dialog box.	Set the maximum permissible DAP rate for fluoro operation via the **DAP Rate Alarm (mGycm^2/s)** dialog box.
10.	Select **DAP RATE DISPLAY**. Toggle the button to select **ON** or **OFF**.	Check the **DAP Rate Display** checkbox to display the DAP rate during fluoroscopic operation.	Check the **DAP Rate Display** checkbox to display the DAP rate during fluoroscopic operation.

3F.4.1 DAP Setup (Indico 100 R&F) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
11.	Select **DAP PRINTER**. Toggle the button to select **OFF, DPU414,** or **SLP200**.	Select **Off**, **SLP200** or **DPU414** via the **DAP Printer** dialog box.	Select **Off**, **SLP200** or **DPU414** via the **DAP Printer** dialog box.
12.	Press **DAP** to access the DAP **RESET**, **TEST**, and **PRINT** functions.	When DAP is enabled, a DAP display window is opened immediately below the GenWare® toolbar, as shown in figure 3F-2a.	When DAP is enabled, a DAP display window is opened immediately to the right of the receptor buttons on the bottom edge of the screen, as shown in figure 3F-2b.
13.	Press **RESET** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.
14.	Press **TEST** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube (tube 1 / DAP 1 or tube 2 / DAP 2).	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube (tube 1 / DAP 1 or tube 2 / DAP 2).	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube (tube 1 / DAP 1 or tube 2 / DAP 2).
15.	Press **PRINT** to print a DAP label.		
16.	Press **EXIT**, then press **<<** three times to return to **GEN CONFIGURATION** menu 1.		

3F.4.2 DAP Setup (Indico 100 Rad)

Use these steps to access the **DAP SETUP** menus (membrane console), or the DAP setup utility in GenWare®.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	Enter into the programming mode as described in chapter 3C.	The procedure for starting Genware® and connecting it to the console is described in the Genware® manual, included with Genware®. From the GenWare® GENERATOR UTILITIES application, select **DAP Setup** from the **Setup** menu, or use the DAP setup button  on the GenWare® toolbar.	Touchscreen Genware® must be launched before proceeding. This is done from the Genware® button on the touchscreen **System Utilities** menu. Press the  button on the GenWare® toolbar to access the **DAP Setup** utility
2.	When the **GENERATOR SETUP** menu is displayed, select **GEN CONFIGURATION**.		
3.	Select **DAP SETUP**		

The **DAP SETUP** menus for the Indico 100 rad membrane console are shown below.

DAP
* DAP SETUP *

DAP: ON	TEST VALUE 1: 250
DAP MODE: SUM	DEVICE TYPE 2: 0
DEVICE TYPE 1: 2	+
CAL. VALUE 1: 1.00	-

kVp: 70 mA: 100 ms: 20

<< >>

3F.4.2 DAP Setup (Indico 100 Rad) Cont

DAP

* DAP SETUP *

CAL. VALUE 2: 1.00

TEST VALUE 2: 250

ACC ALARM ($mGycm^2$): 0 +

DAP PRINTER: DPU414 -

kVp: 70 mA: 100 ms: 20

<<

EXIT

DAP = 0 $mGycm^2$

PRINT

RESET TEST

The GenWare® DAP Setup and display windows are shown in figure 3F-2.

Use these steps to perform the DAP setup for Indico 100 rad generators. Refer to the definitions in 3F.4.1.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	From **DAP SETUP** menu 1, select **DAP**. Toggle the button to select **ON** or **OFF**.	Check the **DAP** checkbox to enable the DAP function.	Check the **DAP State** checkbox to enable the DAP function.
2.	Select **DAP MODE**. Toggle the button to select **SUM** or **IND**.	For **DAP Mode**, select **Sum** or **Ind**.	For **DAP Mode**, select **Sum** or **Ind**.

3F.4.2 DAP Setup (Indico 100 Rad) Cont

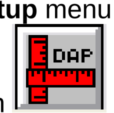
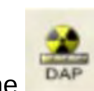
Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
3.	Select **DEVICE TYPE 1**. Use the **+** or **–** buttons to select the desired DAP 1 device.	Select the desired DAP 1 device via the **Device Type 1** dialog box.	Select the desired DAP 1 device via the **DAP Device Type 1** dialog box.
4.	Select **TEST VALUE 1**. Use the **+** or **–** buttons to select the test value for DAP device 1.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.
5.	Select **DEVICE TYPE 2**. Use the **+** or **–** buttons to select the desired DAP 2 device.	Select the desired DAP 2 device via the **Device Type 2** dialog box.	Select the desired DAP 2 device via the **DAP Device Type 2** dialog box.
6.	Press **>>**.		
7.	Select **TEST VALUE 2**. Use the **+** or **–** buttons to select the test value for DAP device 2.	Select the test value for DAP device 2 via the **Test Value 2** dialog box.	Select the test value for DAP device 2 via the **Test Value 2** dialog box.
8.	Select **ACC ALARM (mGycm^2).** Use the **+** or **–** buttons to set the maximum permissible accumulated DAP.	Set the maximum permissible accumulated DAP via the **DAP Accum Alarm (mGycm^2)** dialog box.	Set the maximum permissible accumulated DAP via the **DAP Accum Alarm (mGycm^2)** dialog box.
9.	Select **DAP PRINTER**. Toggle the button to select **OFF, DPU414,** or **SLP200**.	Select **Off**, **SLP200** or **DPU414** via the **DAP Printer** dialog box.	Select **Off**, **SLP200** or **DPU414** via the **DAP Printer** dialog box.
10.	Press **DAP** to access the DAP **RESET**, **TEST**, and **PRINT** functions.	When DAP is enabled, a DAP display window is opened immediately below the GenWare® toolbar, as shown in figure 3F-2a.	When DAP is enabled, a DAP display window is opened immediately to the right of the receptor buttons on the bottom edge of the screen, as shown in figure 3F-2b.
11.	Press **RESET** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.
12.	Press **TEST** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube only (tube 1 / DAP 1 or tube 2 / DAP 2).	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube only (tube 1 / DAP 1 or tube 2 / DAP 2).	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube only (tube 1 / DAP 1 or tube 2 / DAP 2).
13.	Press **PRINT** to print a DAP label.		

3F.4.2 DAP Setup (Indico 100 Rad) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
14.	Press **EXIT**, then press **<<** two times to return to the **GEN CONFIGURATION** menu.		

3F.4.3 DAP Setup (Indico 100 SP)

Use these steps to access the **DAP SETUP** menus (membrane console), or the DAP setup utility in GenWare®.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	Enter into the programming mode as described in chapter 3C.	The procedure for starting Genware® and connecting it to the console is described in the Genware® manual, included with Genware®. From the GenWare® GENERATOR UTILITIES application, select **DAP Setup** from the **Setup** menu, or use the DAP setup button  on the GenWare® toolbar.	Touchscreen Genware® must be launched before proceeding. This is done from the Genware® button on the touchscreen **System Utilities** menu. Press the  button on the GenWare® toolbar to access the **DAP Setup** utility
2.	When the **GENERATOR SETUP** menu is displayed, select **GEN CONFIGURATION**.		
3.	Press **>>**, then select **DAP SETUP**		

3F.4.3 DAP Setup (Indico 100 SP) Cont

The **DAP SETUP** menus for the Indico 100 SP membrane console are shown below.

	* DAP SETUP *	
DAP: ON		TEST VALUE 1: 250
DAP MODE: SUM		DEVICE TYPE 2: 0
DEVICE TYPE 1: 2		+
CAL. VALUE 1: 1.00		-
<<	MENU	>>

	* DAP SETUP *	
CAL. VALUE 2: 1.00		DAP RATE DISPLAY: OFF
TEST VALUE 2: 250		DAP PRINTER: DPU414
ACC ALARM (mGycm^2): 0		+
RATE ALARM (mGycm^2/s): 0		-
<<	MENU	

	MENU	
DAP RESET		
DAP TEST		
PRINT		
<<		

The GenWare® DAP Setup and display windows are shown in figure 3F-2.

Use these steps to perform the DAP setup for Indico 100 SP generators. Refer to the definitions in 3F.4.1.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	From **DAP SETUP** menu 1, select **DAP**. Toggle the button to select **ON** or **OFF**.	Check the **DAP** checkbox to enable the DAP function.	Check the **DAP State** checkbox to enable the DAP function.
2.	Select **DAP MODE**. Toggle the button to select **SUM** or **IND**.	For **DAP Mode**, select **Sum** or **Ind**.	For **DAP Mode**, select **Sum** or **Ind**.

3F.4.3 DAP Setup (Indico 100 SP) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
3.	Select **DEVICE TYPE 1**. Use the **+** or **–** buttons to select the desired DAP 1 device.	Select the desired DAP 1 device via the **Device Type 1** dialog box.	Select the desired DAP 1 device via the **DAP Device Type 1** dialog box.
4.	Select **TEST VALUE 1**. Use the **+** or **–** buttons to select the test value for DAP device 1.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.
5.	Select **DEVICE TYPE 2**. Use the **+** or **–** buttons to select the desired DAP 2 device.	Select the desired DAP 2 device via the **Device Type 2** dialog box.	Select the desired DAP 2 device via the **DAP Device Type 2** dialog box.
6.	Press **>>**.		
7.	Select **TEST VALUE 2**. Use the **+** or **–** buttons to select the test value for DAP device 2.	Select the test value for DAP device 2 via the **Test Value 2** dialog box.	Select the test value for DAP device 2 via the **Test Value 2** dialog box.
8.	Select **ACC ALARM (mGycm^2).** Use the **+** or **–** buttons to set the maximum permissible accumulated DAP.	Set the maximum permissible accumulated DAP via the **DAP Accum Alarm (mGycm^2)** dialog box.	Set the maximum permissible accumulated DAP via the **DAP Accum Alarm (mGycm^2)** dialog box.
9.	Select **RATE ALARM (mGycm^2/s).** Use the **+** or **–** buttons to set the maximum permissible DAP rate for fluoro operation.	Set the maximum permissible DAP rate for fluoro operation via the **DAP Rate Alarm (mGycm^2/s)** dialog box.	Set the maximum permissible DAP rate for fluoro operation via the **DAP Rate Alarm (mGycm^2/s)** dialog box.
10.	Select **DAP RATE DISPLAY**. Toggle the button to select **ON** or **OFF**.	Check the **DAP Rate Display** checkbox to display the DAP rate during fluoroscopic operation.	Check the **DAP Rate Display** checkbox to display the DAP rate during fluoroscopic operation.
11.	Select **DAP PRINTER**. Toggle the button to select **OFF, DPU414,** or **SLP200**.	Select **Off**, **SLP200** or **DPU414** via the **DAP Printer** dialog box.	Select **Off**, **SLP200** or **DPU414** via the **DAP Printer** dialog box.
12.	Press **MENU** to access the **DAP RESET**, **DAP TEST**, and **PRINT** functions.	When DAP is enabled, a DAP display window is opened immediately below the GenWare® toolbar, as shown in figure 3F-2a.	When DAP is enabled, a DAP display window is opened immediately below the GenWare® toolbar, as shown in figure 3F-2b.
13.	Press **DAP RESET** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.

3F.4.3 DAP Setup (Indico 100 SP) Cont

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
14.	Press **DAP TEST** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube (tube 1 / DAP 1 or tube 2 / DAP 2).	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube (tube 1 / DAP 1 or tube 2 / DAP 2).	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits in the generator for the selected tube (tube 1 / DAP 1 or tube 2 / DAP 2).
15.	Press **PRINT** to print a DAP label.		
16.	Press **<<** four times to return to **GEN CONFIGURATION** menu 1.		

3F.4.4 DAP printer setup

Use these steps to set up and configure the DAP printer. This section only applies to units with the DAP printer option.

Step	Action
1.	Connect the DAP printer to the *DATA LINK* connector on the rear of the console. Refer to the figure “*Rear of control console*” in chapter 2 of the service manual for the connector location.
2.	Ensure that the correct DAP printer is selected as per 3F.4.1, 3F.4.2, or 3F.4.3. The printer settings made via the “Dap Printer” function in the membrane console or in GenWare® apply to the membrane console only. The printer selection for the touchscreen console is in the DAP or Air Kerma printer interface window, accessed via the **DAP** or **AK** buttons in the touchscreen’s acquisition mode.
3.	Verify proper printer operation in normal operating mode by printing a test label.

<u>NOTE</u>: THE GENERATOR MUST BE CONFIGURED FOR THE SPECIFIC PRINTER (SEIKO INSTRUMENTS DPU-414 OR SLP-200 PRINTER). THE GENERATOR WILL BE COMPATIBLE ONLY WITH THE SELECTED PRINTER, THEREFORE ONLY THAT PRINTER MODEL MUST BE USED IN THIS INSTALLATION.

<u>NOTE</u>: THE PAPER OR LABELS USED IN THE PRINTER MUST MEET ALL APPLICABLE REGULATIONS. MEDICAL GRADE PAPER OR LABELS, APPROVED FOR MEDICAL RECORDS, MUST NORMALLY BE USED.

3F.5.0 DAP CALIBRATION

The DAP device must be calibrated before use, and the calibration must be periodically checked as per the DAP device manufacturers requirements, or as per local regulations.

3F.5.1 Equipment Required

The following equipment is required for DAP calibration.

- An X-ray cassette and film. The speed of the film / screen is not relevant, as the film is only used to determine the area that is irradiated at the dose measurement plane.

  An X-ray cassette and film is the preferred method to measure the irradiated area, but if this is not readily available, for example if this is a digital only system, a procedure is given to determine the required area using the imaging system.
- A film processor to develop the film, if required.
- A calibrated dosimeter.
- A ruler or tape measure with centimeter markings. This will be needed to measure the exposed area of the film. If measuring in inches, use a calculator and multiply inches by 2.54 to obtain the measurement in centimeters.

3F.5.2 DAP calibration overview

The first step involved in calibrating the DAP meter in the generator is to carefully make a dose measurement at a given distance from the X-ray source. The next step is to expose a test film at the same distance from the X-ray source as the dose measurement that was just made.

The dose-area product is calculated by multiplying the measured dose, in mGy, by the exposed area of the film, in cm^2. This gives the actual dose-area product, in $mGycm^2$.

After the reference dose-area product is determined as described above, it is compared to the DAP reading as measured by the generator. Adjustments are made to the **CAL. VALUE** (membrane console) or **Calibration Value** (GenWare®) parameters in the **DAP SETUP** menu (membrane console) or **DAP Setup** window (GenWare®), such that the DAP display corresponds to the calculated dose-area product. This procedure may need to be repeated several times until the required accuracy is obtained.

The reason the DAP device is able to accurately measure the dose-area product at its location at the bottom of the collimator is that although the radiation level falls off at a rate inversely proportional to the square of the distance from the source, the irradiated area increases as the square of the distance from the source. For example, by doubling the distance, the dose falls to $(½)^2$ = ¼ of the previous dose BUT the area increases to 2^2 = 4 times the area. Therefore, the dose-area product will remain constant at a given distance from the source. This is also the reason that care must be taken to ensure that the area measurement is done at the same distance from the X-ray source as the dose measurement.

3F.5.3 DAP Calibration Procedure

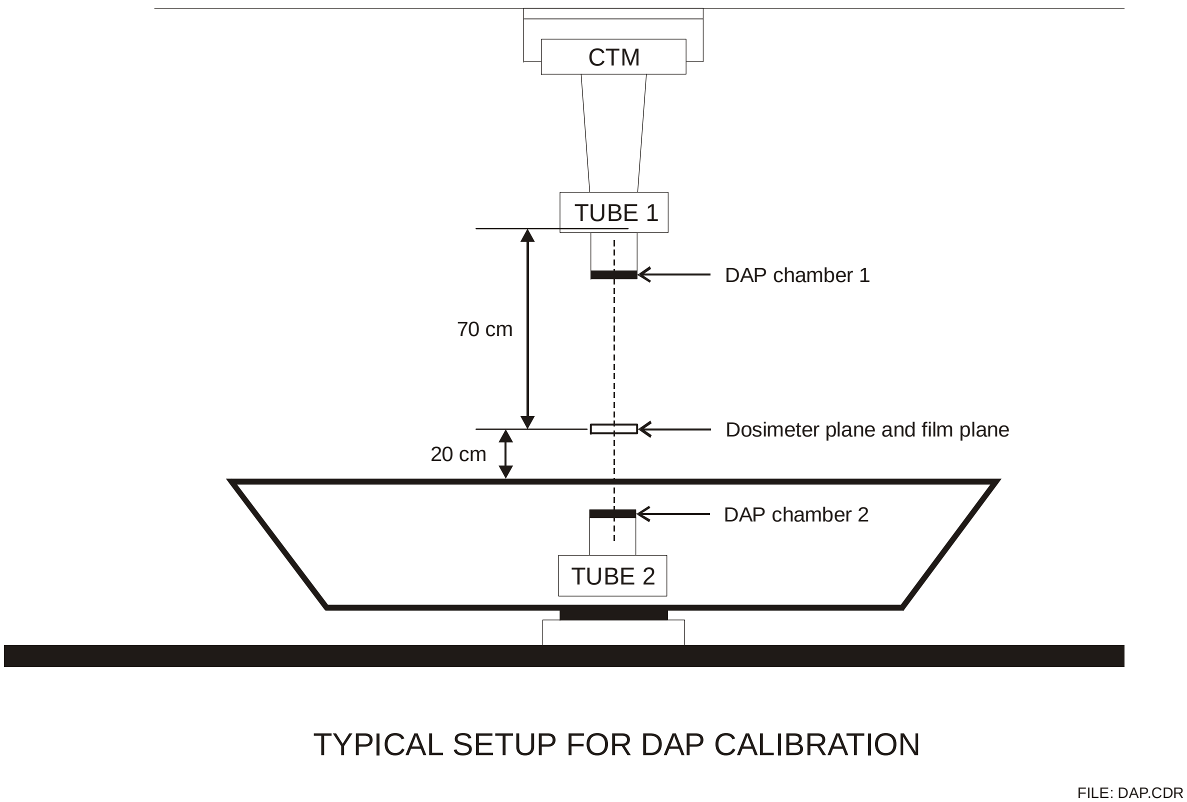


Figure 3F-3: DAP setup

3F.5.3 DAP Calibration Procedure (Cont)

Use these steps to calibrate the DAP meter(s) in the generator.

Step	Action
1.	Set up the dosimeter as per figure 3F-3. The probe should be centered relative to the central ray from the X-ray tube, and sufficiently far off the tabletop to minimize scatter radiation. ***Do not use any absorber during this procedure***.
2.	Open the collimator such that the field size at the location of the probe is approximately 12 cm X 12 cm. Ensure that the probe is fully irradiated.
3.	Temporarily set the **DAP MODE** to **IND**. Refer to sections 3F.4.1, 3F.4.2, or 3F.4.3.
4.	Reset the DAP display to zero as described in sections 3F.4.1, 3F.4.2, or 3F.4.3.
5.	For the membrane console, enter **DAP SETUP** menu 1 or menu 2 as required to display **CAL. VALUE 1** for DAP device 1, or **CAL. VALUE 2** for DAP device 2. For GenWare®, DAP calibration is done via the **Calibration Value** dialog boxes in the **DAP Setup** window as described in a later step.
6.	Select the desired DAP device to calibrate by selecting tube 1 or tube 2 via an appropriate image receptor. Start with the over-table tube.
7.	Set the generator to 70 kV, 100 mA, 20 ms.
8.	Make an X-ray exposure and note the dose per the dosimeter. Record the mR or mGy value in a copy of table 3F-1. Convert the mR value to mGy, if necessary.
9.	Note the DAP value as displayed on the console or GenWare®, and record the value in a copy of table 3F-1.
10.	Replace the dosimeter with an X-ray cassette and film if available. The film plane must be at the same location as the dosimeter was in step 8. If using an image sensor such as an I.I., or flat panel, or other non-film image sensor, the image pickup plane must be at the same location as the dosimeter was in step 8. ***THE IMPORTANCE OF THIS STEP CANNOT BE OVERSTATED: THE IRRADIATED AREA MEASUREMENT MUST BE MADE AT A POINT THAT IS THE SAME DISTANCE FROM THE X-RAY SOURCE AS THE DOSE WAS MEASURED AT.***
11.	Ensure that the collimator field at the measurement plane is smaller than the active area of the image pick-up device (film, I.I., or other). Refer to figure 3F-4. ***Do not readjust the collimator from the setting that was used in step 8.***
12.	Make another exposure using the same settings as in step 6.
13.	Develop the film (if used).

3F.5.3 DAP Calibration Procedure (Cont)

Step	Action
14.	Measure the irradiated image area. For film, measure the length and width of the exposed area, and record the results in table 3F-1. Refer to figure 3F-4. If using a digital imaging system, some systems have a cursor available that allows measurement of the length and width of the area in question. If the digital imaging system does not allow image size measurement, it is suggested that an X-ray opaque item of known dimensions be placed at the image plane. (A collimator test tool would be useful in this application). The length and width of the irradiated area can then be extrapolated by comparison to the size of the reference object. Record the length and width of the irradiated area at the measurement plane in table 3F-1.
15.	Calculate the irradiated image area, in cm^2. Use the length and width recorded in table 3F-1.
16.	Calculate the dose-area product by multiplying the area from table 3F-1 X the dose in mGy from table 3F-1. Record the resulting value at step 3 in table 3F-1.
17.	Calculate the percentage error between the manually calculated DAP measurement (table 3F-1, step 3) and the measured DAP value (table 3F-1, step 4). Record the percentage error in step 5 of the table.
18.	If the displayed DAP reading does not meet the required accuracy, increase or decrease **CAL. VALUE 1** or **CAL. VALUE 2** (membrane console) or **Calibration Value** (**DAP Device 1**) / **Calibration Value** (**DAP Device 2**) for GenWare® by the same percentage as the percentage error.
19.	Repeat steps 7 to 18 until the required accuracy is obtained. Make as many copies of table 3F-1 as required to record the results from all required iterations.
20.	Repeat the above procedure for the second DAP device (tube 2).
21.	Reset the **DAP MODE** as desired. This was temporarily set to **IND** in step 3.

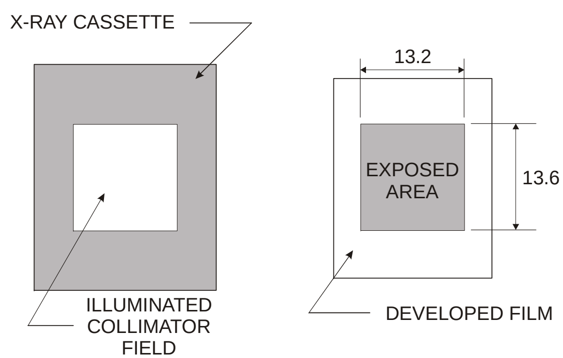


Figure 3F-4: Irradiated area vs. available image area

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3F.5.4 DAP Calculation Worksheet

STEP	ACTION	RESULT
1.	Measured dose: Convert mR to mGy if necessary by multiplying mR X 0.00873. Example 23.3 mR X 0.00873 = 0.203 mGy.	_____________ mR _____________ mGy
2.	Measure and record the exposed area of the film (Length X Width). Calculate the exposed area in cm^2 (length X width).	_____________ Length (cm) _____________ Width (cm) _____________ Area (cm^2)
3.	Multiply the dose in mGy (step 1) X the area in cm^2 (step 2). This will yield the actual dose-area product, in $mGycm^2$.	_____________ DAP ($mGycm^2$)
4.	Record the DAP, in $mGycm^2$, as displayed on the console or GenWare®.	_____________ DAP ($mGycm^2$)
5.	Calculate the percentage error: Refer to the example at the end of this section.	_____________ % error
THIS TABLE IS REPEATED ON THE NEXT PAGE FOR THE SECOND ITERATION OF THE DAP CALIBRATION.		

3F.5.4 DAP Calculation Worksheet (Cont)

STEP	ACTION	RESULT
1.	Measured dose: Convert mR to mGy if necessary by multiplying mR X 0.00873. Example 23.3 mR X 0.00873 = 0.203 mGy.	______________ mR ______________ mGy
2.	Measure and record the exposed area of the film (Length X Width). Calculate the exposed area in cm^2 (length X width).	______________ Length (cm) ______________ Width (cm) ______________ Area (cm^2)
3.	Multiply the dose in mGy (step 1) X the area in cm^2 (step 2). This will yield the actual dose-area product, in $mGycm^2$.	______________ DAP ($mGycm^2$)
4.	Record the DAP, in $mGycm^2$, as displayed on the console or GenWare®.	______________ DAP ($mGycm^2$)
5.	Calculate the percentage error: Refer to the example at the end of this section.	______________ % error

Table 3F-1: DAP worksheets

3F.5.4 DAP Calculation Worksheet (Cont)

Refer to the sample DAP worksheet below:

STEP	ACTION	RESULT
1.	Measured dose: Convert mR to mGy if necessary by multiplying mR X 0.00873. Example 23.3 mR X 0.00873 = 0.203 mGy.	23.3 mR 0.203 mGy
2.	Measure and record the exposed area of the film (Length X Width). Calculate the exposed area in cm^2 (length X width).	13.6 Length (cm) 13.2 Width (cm) 179.52 Area (cm^2)
3.	Multiply the dose in mGy (step 1) X the area in cm^2 (step 2). This will yield the actual dose-area product, in $mGycm^2$.	36.44 DAP ($mGycm^2$)
4.	Record the DAP, in $mGycm^2$, as displayed on the console or GenWare®.	40 DAP ($mGycm^2$)
5.	Calculate the percentage error: Refer to the example at the end of this section.	-8.9 % error

Sample percentage error calculation (step 5):

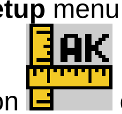
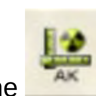
$$\frac{(36.44 - 40)}{40} \text{ X } 100 = \frac{-3.56}{40} \text{ X } 100 = -8.9\ \%$$

3F.6.0 AK SETUP

The AK SETUP function is an option on Indico 100 SP generators.

3F.6.1 AK Setup and calibration

Use these steps to access the **AK SETUP** menus.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	Enter into the programming mode as described in chapter 3C.	The procedure for starting Genware® and connecting it to the console is described in the Genware® manual, included with Genware®. From the GenWare® GENERATOR UTILITIES application, select **AK Setup** from the **Setup** menu, or use the AK setup button  on the GenWare® toolbar.	Touchscreen Genware® must be launched before proceeding. This is done from the Genware® button on the touchscreen **System Utilities** menu. Press the  button on the GenWare® toolbar to access the **Air Kerma Setup** utility.
2.	When the **GENERATOR SETUP** menu is displayed, select **GEN CONFIGURATION**.		
3.	Press **>>**, then select **AK SETUP.**		

AK SETUP menu 1 for the Indico 100 SP membrane console is shown below.

	* AK SETUP *	
AIR KERMA: TUBE2		
MAX FILTERS: 3		
ACC ALARM: (mGy)	0	+
RATE ALARM: (mGy/min)	0	-
EXIT		>>

3F.6.1 AK Setup and calibration (Cont)

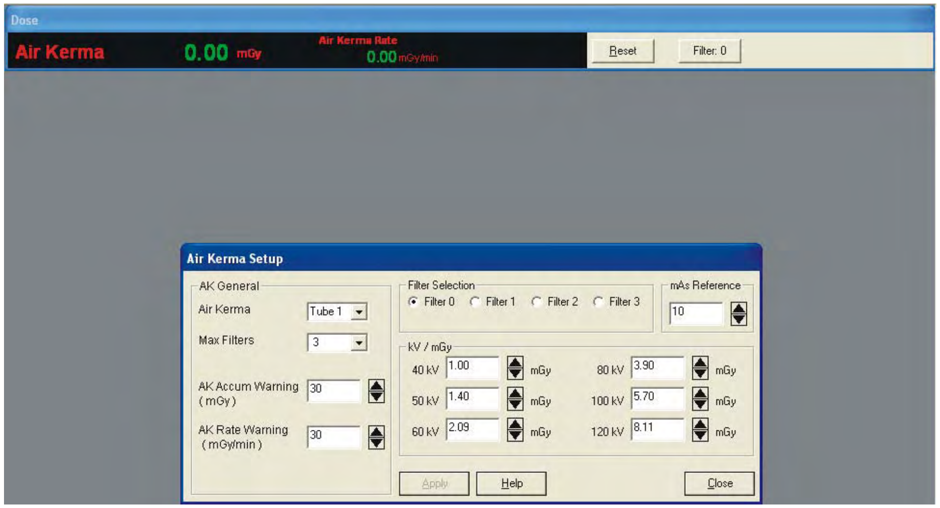


Figure 3F-5a: PC GenWare®

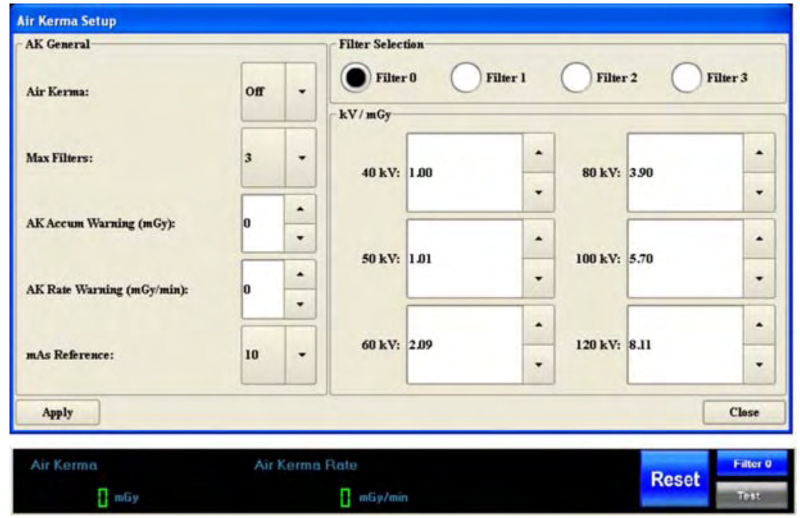


Figure 3F-5b: TouchScreen GenWare®

Air Kerma Setup and display windows

3F.6.1 AK Setup and calibration (Cont)

Definitions of **AK SETUP** menu items.

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
AIR KERMA	**Air Kerma**	Enables or disables the AK (Air Kerma) calculator and display. **OFF:** The AK function is disabled. **TUBE 1** The AK function is enabled for tube 1 only. **TUBE 2** The AK function is enabled for tube 2 only. The air kerma function applies only to R&F systems. Therefore, the R&F tube must be enabled in this setting.
MAX FILTERS	**Max Filters**	A numeric value (**0**, **1**, **2**, or **3**) that defines the number of collimator filters that may be used in the installation. **0** = inherent filtration plus fixed added filtration only; **1, 2,** or **3** means the system may be used with the inherent + fixed filtration only, or 1, 2 or 3 added filters may be used. *DO NOT SET THIS TO A HIGHER VALUE THAN THE ACTUAL NUMBER OF COLLIMATOR FILTERS THAT WILL BE USED. DOING SO WILL ALLOW THE OPERATOR TO MAKE INVALID / UNCALIBRATED FILTER SELECTIONS.*
ACC ALARM (mGy)	**AK Accum Warning (mGy)**	Sets the alarm level for the accumulated air kerma. The console will present an audible alarm, and a visual warning via the LCD display when the accumulated air kerma exceeds this limit.
RATE ALARM (mGy/min)	**AK Rate Warning (mGy/min)**	Sets the alarm level for the maximum air kerma rate. The console will present an audible alarm and a visual warning via the LCD display when the air kerma rate exceeds this limit.

3F.6.1 AK Setup and calibration (Cont)

Use these steps to perform the AK setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	From **AK SETUP** menu 1, select **AIR KERMA**. Toggle the button to select **OFF, TUBE1,** or **TUBE2**. The air kerma function will only be available on the selected tube.	From the **Air Kerma** drop-down menu, select **Off, Tube 1,** or **Tube 2**	From the **Air Kerma** drop-down menu, select **Off, Tube 1,** or **Tube 2**
2.	Select **MAX FILTERS**. Use the **+** or **–** buttons to select the desired number of filters. *As noted previously, do not select a higher value than the number of filters that will actually be used.*	Select the desired number of filters via the **Max Filters** drop-down menu. For Touch Screen console select **0**. *As noted previously, do not select a higher value than the number of filters that will actually be used.*	Select the desired number of filters via the **Max Filters** drop-down menu. For Touch Screen console select **0**. *As noted previously, do not select a higher value than the number of filters that will actually be used.*
3.	Select **ACC ALARM (mGy).** Use the **+** or **–** buttons to set the maximum permissible accumulated air kerma (for radiographic operation).	Set the maximum permissible accumulated AK via the **AK Accum Warning (mGy)** dialog box.	Set the maximum permissible accumulated AK via the **AK Accum Warning (mGy)** dialog box.
4.	Select **RATE ALARM (mGy/min).** Use the **+** or **–** buttons to set the maximum permissible air kerma rate (for serial radiographic or fluoroscopic operation).	Set the maximum permissible AK rate via the **AK Warning (mGy/min)** dialog box.	Set the maximum permissible AK rate via the **AK Warning (mGy/min)** dialog box.
5.	Select **>>** to continue with air kerma calibration. If calibration is not required, select **EXIT** to return to the **GEN CONFIGURATION** menu.		

3F.6.1 AK Setup and calibration (Cont)

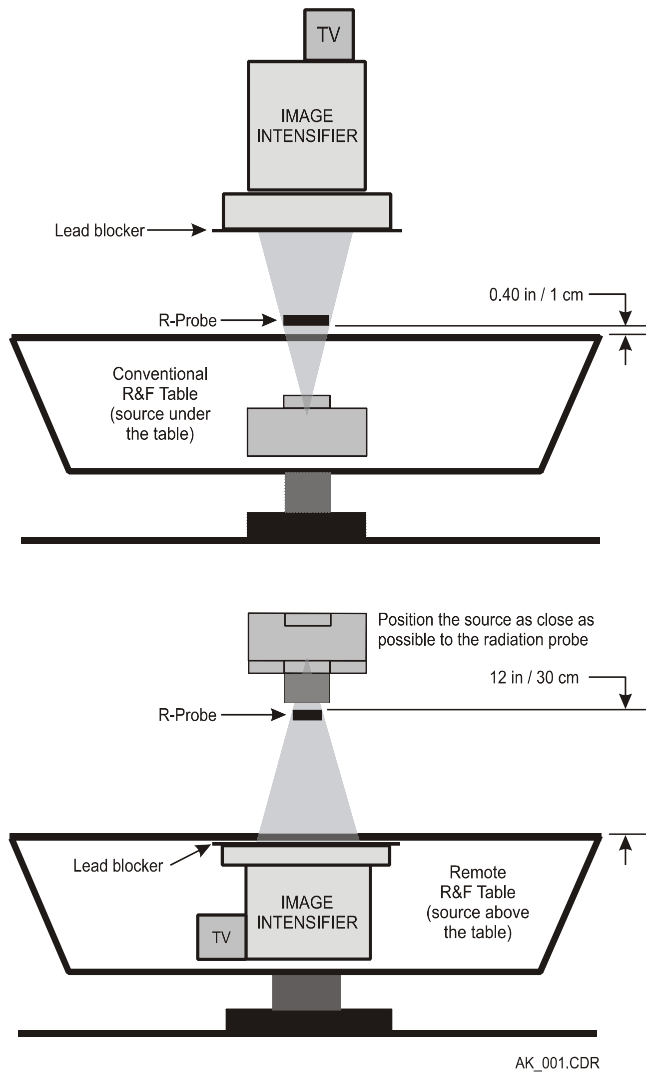


Figure 3F-6:Typical test setup for air kerma measurements

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3F.6.1 AK Setup and calibration (Cont)

AK SETUP menus 2 to 4 for the Indico 100 SP membrane console are shown below.

* AK SETUP *		
FILTER 0		
FILTER 1		
FILTER 2		
FILTER 3		
<<		

* FILTER 0 *		
REF MAS: 10		80kV: 3.90mGy
40kV: 1.00mGy		100kV: 5.70mGy
50kV: 1.40mGy		+
60kV: 2.09mGy		-
<<	MENU	>>

* FILTER 0 *		
120kV: 8.11mGy		
		+
		-
<<	MENU	RET

3F.6.1 AK Setup and calibration (Cont)

Use these steps to perform the AK calibration.

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
1.	Set up the radiation probe as per figure 3F-6. This figure shows the typical probe placement for air kerma measurements; however, local regulations should be consulted to confirm the proper test set-up.	Set up the radiation probe as per figure 3F-6a. This figure shows the typical probe placement for air kerma measurements; however, local regulations should be consulted to confirm the proper test set-up.	Set up the radiation probe as per figure 3F-6b. This figure shows the typical probe placement for air kerma measurements; however, local regulations should be consulted to confirm the proper test set-up.
2.	Temporarily de-energize the I.I. power supply, or cover the I.I with a minimum of 2.0 mm lead.	Temporarily de-energize the I.I. power supply, or cover the I.I with a minimum of 2.0 mm lead.	Temporarily de-energize the I.I. power supply, or cover the I.I with a minimum of 2.0 mm lead.
3.	Temporarily remove all added filters from the collimator. The collimator must contain only inherent + fixed filtration at this point in the procedure.	Temporarily remove all added filters from the collimator. The collimator must contain only inherent + fixed filtration at this point in the procedure.	Temporarily remove all added filters from the collimator. The collimator must contain only inherent + fixed filtration at this point in the procedure.
	AK SETUP menu 2, above, shows the maximum number of filters, i.e. with the **MAX FILTERS** selection set to **3**.		
4.	From **AK SETUP** menu 2, select **FILTER 0.**	Select **Filter 0** from under the **Filter Selection** section of the **Air Kerma Setup** window.	Select **Filter 0** from under the **Filter Selection** section of the **Air Kerma Setup** window.
	Select 40 kV. This may be done one of two ways: • Selecting the 40 kV step from **AK SETUP** menu 3. This will set 40 kV in the radiography section of the console. • Manually, via the radiography kV **+** / **-** buttons. *The generator mAs will automatically be set to **10** mAs. Do not adjust this value.*	Select the following parameters: 40 kV, 10 mAs via the radiography controls on the left side of the GenWare® screen.	Select the following parameters: 40 kV, 10 mAs via the radiography controls on the left side of the GenWare® screen.
5.	While observing the dosimeter, make a radiographic exposure.	While observing the dosimeter, make a radiographic exposure.	While observing the dosimeter, make a radiographic exposure.

3F.6.1 AK Setup and calibration (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
6.	Record the dosimeter reading, in mGy, in a copy of table 3F-2. *To convert from mR to mGy divide the value in mR by 114. This will give the value in mGy (for example 114 mR = 1 mGy).*	Record the dosimeter reading, in mGy, in a copy of table 3F-2. *To convert from mR to mGy divide the value in mR by 114. This will give the value in mGy (for example 114 mR = 1 mGy).*	Record the dosimeter reading, in mGy, in a copy of table 3F-2. *To convert from mR to mGy divide the value in mR by 114. This will give the value in mGy (for example 114 mR = 1 mGy).*
7.	Repeat steps 5 to 7 at 50 kV, 60 kV, 80 kV, 100 kV, and 120 kV.	Repeat steps 5 to 7 at 50 kV, 60 kV, 80 kV, 100 kV, and 120 kV.	Repeat steps 5 to 7 at 50 kV, 60 kV, 80 kV, 100 kV, and 120 kV.
		Steps 9 to 14 apply when using GenWare® to calibrate the collimator filter curves on the membrane console only. Steps 9 to 14 do not apply to the Touch Screen console.	***Steps 9 to 14 apply when using GenWare® to calibrate the collimator filter curves on the membrane console only. Steps 9 to 14 do not apply to the Touch Screen console.***
8.	If the **FILTER 1** selection is used, temporarily insert filter 1 into the collimator. Record the added filter in a copy of table 3F-2.	If the **Filter 1** selection is used, temporarily insert filter 1 into the collimator. Record the added filter in a copy of table 3F-2.	If the **Filter 1** selection is used, temporarily insert filter 1 into the collimator. Record the added filter in a copy of table 3F-2.
9.	Repeat steps 5 to 8 for filter 1, if available.	Repeat steps 5 to 8 for filter 1, if available.	Repeat steps 5 to 8 for filter 1, if available.
10.	If the **FILTER 2** selection is used, temporarily insert filter 2 into the collimator. Record the added filter in a copy of table 3F-2.	If the **Filter 2** selection is used, temporarily insert filter 2 into the collimator. Record the added filter in a copy of table 3F-2.	If the **Filter 2** selection is used, temporarily insert filter 2 into the collimator. Record the added filter in a copy of table 3F-2.
11.	Repeat steps 5 to 8 for filter 2, if available.	Repeat steps 5 to 8 for filter 2, if available.	Repeat steps 5 to 8 for filter 2, if available.
12.	If the **FILTER 3** selection is used, temporarily insert filter 3 into the collimator. Record the added filter in a copy of table 3F-2.	If the **Filter 3** selection is used, temporarily insert filter 3 into the collimator. Record the added filter in a copy of table 3F-2.	If the **Filter 3** selection is used, temporarily insert filter 3 into the collimator. Record the added filter in a copy of table 3F-2.
13.	Repeat steps 5 to 8 for filter 3, if available.	Repeat steps 5 to 8 for filter 3, if available.	Repeat steps 5 to 8 for filter 3, if available.

3F.6.1 AK Setup and calibration (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
14.	Select the 40 kV step from **AK SETUP** menu 3. Confirm that this is for the **FILTER 0** selection (**FILTER 0** will be displayed at the top of the LCD). Use the **+** or **–** buttons adjacent to the LCD display to enter the air kerma as recorded in table 3F-2 (40 kV, filter 0).	Select the **Filter 0** selection. (**Filter 0** must be selected in the **Filter Selection** section of the **Air Kerma Setup** window. Enter the air kerma as recorded in table 3F-2 (40 kV, filter 0) via the dialog box in the **kV / mGy** section of the **Air Kerma Setup** window.	Select the **Filter 0** selection. (**Filter 0** must be selected in the **Filter Selection** section of the **Air Kerma Setup** window. Enter the air kerma as recorded in table 3F-2 (40 kV, filter 0) via the dialog box in the **kV / mGy** section of the **Air Kerma Setup** window.
15.	Repeat the above for **50** kV, **60** kV, **80** kV, **100** kV, and **120** kV, using the air kerma recorded in table 3F-2.	Repeat the above for **50** kV, **60** kV, **80** kV, **100** kV, and **120** kV, using the air kerma recorded in table 3F-2.	Repeat the above for **50** kV, **60** kV, **80** kV, **100** kV, and **120** kV, using the air kerma recorded in table 3F-2.
16.	Press **RET (**RETURN**)** to return to **AK SETUP** menu 2.		
		Steps 18 to 23 apply when using GenWare® to calibrate the collimator filter curves on the membrane console only. Steps 18 to 23 do not apply to the Touch Screen console.	***Steps 18 to 23 apply when using GenWare® to calibrate the collimator filter curves on the membrane console only. Steps 18 to 23 do not apply to the Touch Screen console.***
17.	Select **FILTER 1**, if available.	Select **Filter 1**, if available.	Select **Filter 1**, if available.
18.	Select the 40 kV step (**FILTER 1** will be displayed at the top of the LCD). Use the **+** or **–** buttons adjacent to the LCD display to enter the air kerma as recorded in table 3F-2 (40 kV, filter 1).	Select the **Filter 1** selection. (**Filter 1** must be selected in the **Filter Selection** section of the **Air Kerma Setup** menu. Enter the air kerma as recorded in table 3F-2 (40 kV, filter 0) via the dialog box in the **kV / mGy** section of the **Air Kerma Setup** window.	Select the **Filter 1** selection. (**Filter 1** must be selected in the **Filter Selection** section of the **Air Kerma Setup** menu. Enter the air kerma as recorded in table 3F-2 (40 kV, filter 0) via the dialog box in the **kV / mGy** section of the **Air Kerma Setup** window.
19.	Repeat the above for **50** kV, **60** kV, **80** kV, **100** kV, and **120** kV, using the air kerma recorded in table 3F-2.	Repeat the above for **50** kV, **60** kV, **80** kV, **100** kV, and **120** kV, using the air kerma recorded in table 3F-2.	Repeat the above for **50** kV, **60** kV, **80** kV, **100** kV, and **120** kV, using the air kerma recorded in table 3F-2.
20.	Press **RET (**RETURN**)** to return to **AK SETUP** menu 2.		

3F.6.1 AK Setup and calibration (Cont)

Step	Action (membrane console)	Action (PC GenWare®)	Action (TouchScreen GenWare®)
21.	Repeat steps 18 to 21 for filter 2, if available.	Repeat steps 18 to 20 for filter 2, if available.	Repeat steps 18 to 20 for filter 2, if available.
	Repeat steps 18 to 21 for filter 3, if available.	Repeat steps 18 to 20 for filter 3, if available.	Repeat steps 18 to 20 for filter 3, if available.
22.	This completes the air kerma setup and calibration. Press **<<** as required to return to the **GEN CONFIGURATION** menu.	This completes the air kerma setup and calibration. Press **Apply** at the bottom of the **Air Kerma Setup** menu to save the data to the generator.	This completes the air kerma setup and calibration. Press **Apply** at the bottom of the **Air Kerma Setup** menu to save the data to the generator.

kV	**mGy FILTER 0** **No added filter**	**mGy FILTER 1** **Filter =**	**mGy FILTER 2** **Filter =**	**mGy FILTER 3** **Filter =**
40				
50				
60				
80				
100				
120				

Table 3F-2: Air kerma worksheet

> ***Note**: The collimator filter mapping must be conveyed to the operator, i.e. which physical filter corresponds to FILTER 1, FILTER 2, and FILTER 3. The operator needs this information in order to select the proper look-up table via the FILTER selection in the user menus.*

3F.6.1 AK Setup and calibration (Cont)

Note: ***For Touch Screen Consoles only, no operator selectable collimator filtration curves are available. Curve 0 must be used to perform filter calibration as per the procedure listed above. Curves 1 to 3 do not apply to Touch Screen consoles. If different filtration is required, the filter curve must be recalibrated using Curve 0.***

CHAPTER 4

ACCEPTANCE TESTING

CONTENTS:

4.1.0 INTRODUCTION

This section details acceptance testing, which verifies that the generator is performing within its limits. This must be done at initial installation of the generator, and as required by local regulations. The applicable sections of this chapter should be performed when the generator is reconfigured, or critical component(s) are replaced. Examples of such components are the X-ray tube, HT tank, generator CPU board, generator interface board, AEC board, DAP interface board, power supply control board, filament board(s) and the operator's console or the console board.

WARNING:
1. ***USE EXTREME CARE IN MEASURING HIGH VOLTAGES. ACCIDENTAL CONTACT MAY CAUSE INJURY OR DEATH.***
2. ***EVEN WITH THE GENERATOR SWITCHED OFF AT THE CONSOLE, (OR THE LOCKOUT SWITCH INSIDE THE MAIN CABINET LOCKED OUT), MAINS VOLTAGE IS STILL PRESENT INSIDE THE GENERATOR CABINET. THIS VOLTAGE IS EXTREMELY DANGEROUS. USE EXTREME CAUTION.***
3. ***THE DC BUS CAPACITORS PRESENT A HAZARD UP TO 5 MINUTES AFTER THE POWER HAS BEEN SWITCHED OFF. VERIFY THAT THESE CAPACITORS ARE DISCHARGED BEFORE SERVICING OR TOUCHING ANY PARTS.***

WARNING: THE PROCEDURES IN THIS CHAPTER REQUIRE THE PRODUCTION OF X-RAYS. TAKE ALL SAFETY PRECAUTIONS TO PROTECT PERSONNEL FROM X-RADIATION.

WARNING:
1. ***ALWAYS ENSURE THAT THE EQUIPMENT UNDER TEST AND ALL ASSOCIATED TEST EQUIPMENT IS PROPERLY GROUNDED.***
2. ***ENSURE THAT THE HIGH VOLTAGE CABLES ARE INTACT / UNDAMAGED AND PROPERLY CONNECTED BEFORE ATTEMPTING EXPOSURES.***

ENSURE THAT THE FOLLOWING ITEMS ARE COMPLETED PRIOR TO PERFORMING THE ACCEPTANCE TESTING:

- The generator is interfaced to room equipment noted in the product configuration / compatibility statement.
- The tube auto calibration has been done as per chapter 2 of this manual.
- The receptors have been programmed as per chapter 3C of this manual.
- If the installation has AEC, verify that all receptors have been calibrated as per chapter 3D of this manual.
- If the installation has ABS, verify that the imaging system has been calibrated as per chapter 3E of this manual.
- If the installation has DAP, verify that the DAP chambers have been calibrated as per chapter 3F of this manual.
- Acceptance testing shall only be started after the installation is complete i.e.; generator in final position and installed as per the previous chapters of this manual.

4.2.0 REQUIRED TEST EQUIPMENT FOR GENERATOR VERIFICATION.

- a kV measuring device such as a Dynalyzer or a non-invasive kV meter.
- Storage oscilloscope.
- mA / mAs meter.
- Radiation meter 0-10 mGy (0-1000 mR) and 5–150 mGy/min (1-15 R/min).
- Lead diaphragm or equivalent to collimate the beam.
- General purpose DVM.
- Strobe or reed tachometer.
- Current probe 0 to 20 amps AC.
- A set of HVL filters.
- Calculator.

4.3.0 ACCEPTANCE TESTS (BASIC FUNCTIONS)

4.3.1 Console Rad Tests

For the touch screen console, check the console functionality by pressing the equivalent switch position on the touch screen for the functions described in section 4.3.1 and 4.3.2. Verify the correct response on the touch screen console for each function that is tested.

Step	Action	Result	Check
1.	Press the power ON then power OFF buttons on the console.	Unit switches on and off.	
Note: Steps 2 and 3 apply only if a customer supplied external Emergency Power Off switch is connected. If no Emergency Power Off switch has been connected proceed to step 4.			
2.	Press the Emergency Power Off switch (if installed) and then the power ON button on the console.	Unit will remain unpowered.	
3.	Reset the Emergency Power Off switch	N/A	N/A
4.	Press power ON again to switch the unit on.	Unit switches on.	
5.	Press each of the receptor buttons that are active (those that have been enabled during generator configuration).	Verify that the adjacent LED lights for each receptor. For receptor 6 on the 23 X 56 cm console (adjacent to the power ON button) only the top LED will light.	
Note: The TECHNIQUE / MODE SELECT button used to select AEC / mAs / mA/ms in steps 6, 7, 8 will only be functional if APR mode has been disabled during generator configuration (the TECHNIQUE SELECT function is disabled if APR mode is enabled).			
6.	Select an active radiographic receptor that has AEC programmed. Press the technique select button to select AEC. Verify the following displays:	A: The AEC LED lights. B: kV value is displayed. C: mA value is displayed. D: “AEC”, mAs value or ms value is displayed depending on the AEC backup mode selected. E: Density value is displayed.	
7.	Press the technique select button to select **mAs.** Verify the following displays:	A: The **mAs** LED lights. B: kV value is displayed. C: mAs value is displayed.	
8.	Press the technique select button to select **mA/ms.** Verify the following displays:	A: The **mA/ms** LED lights. B: kV value is displayed. C: mA value is displayed. D: ms value is displayed.	
9.	Press the kV **+/-** buttons.	kV increases if kV **+** is pressed. kV decreases if kV **-** is pressed.	
10.	Ensure that three-point operation is selected (**mA/ms)**. Press the mA **+/-** buttons.	mA increases if mA **+** is pressed. mA decreases if mA **-** is pressed.	
11.	Ensure that three-point operation is selected (**mA/ms)**. Press the ms **+/-** buttons.	ms increases if ms **+** is pressed. ms decreases if ms **-** is pressed.	

4.3.1 Console Rad Tests (Cont)

Step	Action	Result	Check
12.	Ensure that AEC is selected. Press the DENSITY **+/-** buttons.	Density increases if density **+** is pressed. Density decreases if density **-** is pressed.	
13.	Press the focus select button.	The large and small focal spot LED's alternately light as the switch is toggled.	
14.	Ensure that AEC is selected. Press the film-screen select button.	The three film-screen LED's (I, II, III) alternately light as the switch is toggled.	
15.	Select 60 kV, 50 mA, 100 ms. Press the PREP button.	The LED adjacent to the PREP button lights.	
16.	Press the X-ray button.	The X-ray warning indicator lights during an X-ray exposure, and an audible tone is heard from the console.	
17.	Ensure that AEC is selected. Press the **FIELD** select button (23 X 56 cm console) or press the individual AEC field select buttons in sequence (all other consoles).	The three field indicator LED's light to indicate field selection [L+C+R], [R], [C], [R+C], [L], [L+R], [L+C] as the switch is toggled (23 X 56 cm console). For other consoles, the LEFT, CENTER, and RIGHT field selection LED's should light as each field is selected.	
18.	Press the power OFF button on the console.	The unit switches off.	

4.3.2 Console Fluoro Tests

This section applies only to R&F units.

BEFORE CONTINUING, ENSURE THAT THE REMOTE FLUORO CONTROL IS CONNECTED (IF USED WITH THIS INSTALLATION).

Step	Action	Result	Check
1.	Press the power ON button on the console.	Unit switches on.	
2.	Select an active fluoro receptor.	A: The fluoro display area of the console lights. B: The remote fluoro control panel lights (if used).	
3.	Press the DOSE button.	The dose display on the LCD display changes as the switch is toggled.	
	On some consoles, this is the HLF button. If applicable, press the HLF button and verify that the adjacent indicator lights. If the generator is programmed for remote HLF selection, make the remote HLF selection and verify that the HLF LED lights.		

4.3.2 Console Fluoro Tests (Cont)

Step	Action	Result	Check
4.	Press the MAG button on the console. Press the MAG **+/-** buttons on the remote fluoro control if used.	A: The MAG display on the console LCD and remote fluoro display changes (IF **I/I MODES** WAS ENABLED DURING GENERATOR CONFIGURATION) as the MAG button is toggled. B: The Mag display on the console LCD and remote fluoro display increases if MAG **+** button is pressed, decreases if MAG **-** button on the remote fluoro control is pressed (IF **I/I MODES** WAS ENABLED DURING GENERATOR CONFIGURATION.	
5.	Press the ABS button on the console to enter ABS mode.	A: The LED adjacent to the button lights. B: The LED adjacent to the **ABS** button on the remote fluoro control (if used) lights.	
6.	Press the **ABS** button on the remote fluoro control if used, else press the ABS button on the console.	The ABS indicator LED's adjacent to the ABS buttons on the console and the remote fluoro control (if used) switch off.	
7.	Press the fluoro kV **+/-** buttons on the console and remote fluoro control if used.	kV increases if kV **+** is pressed. kV decreases if kV **-** is pressed. Confirm tracking of the kV displays on the console and the remote fluoro control.	
8.	Press the fluoro mA **+/-** buttons on the console and remote fluoro control if used.	mA increases if mA **+** is pressed. mA decreases if mA **-** is pressed. Confirm tracking of the mA displays on the console and the remote fluoro control.	
9.	Press the ACCUMULATED TIME button on the console.	The accumulated time indicator will light, then extinguish on the console as the switch is toggled.	
10.	Press the ACCUMULATED TIME button on the remote fluoro control if used.	The **ACC** indicator will light, then extinguish on the remote fluoro control as the switch is toggled.	
11.	Press the pulse fluoro button on the console (if the pulse fluoro option is fitted).	The pulse fluoro indicator will light, then extinguish as the switch is toggled.	
12.	Press the power OFF button on the console.	Unit switches off.	

4.3.3 Generator Preliminary Tests

***WARNING**: USE EXTREME CAUTION WHEN MEASURING HIGH VOLTAGES.*

***NOTE**: VERIFY THE POSITION OF EACH OF THE SWITCHES OF SW1 ON THE GENERATOR CPU BOARD FOR THE GENERATOR UNDER TEST AS PER THE SECTION "DIP SWITCH SETTINGS" IN CHAPTER 2. THESE SWITCHES MUST BE SET CORRECTLY BEFORE CONTINUING. REFER TO THE PRODUCT CONFIGURATION / COMPATIBILITY STATEMENT IN THE FRONT OF THIS MANUAL FOR THE PRODUCT DEFINITION.*

Step	Action	Result	Check
1.	Ensure unit is switched OFF.	DS1 on generator interface board is lit.	
2.	Press the power ON button on the console.	DS1 on room interface board is lit.	
3.	Switch OFF the console. Switch the NORMAL/LOCKOUT switch on the generator interface board to **LOCKOUT**. Switch the console ON.	The generator will not switch on with the switch in the lockout position.	
4.	Switch the NORMAL/LOCKOUT switch to the **NORMAL** position. Switch the console ON.	The unit switches on.	
5.	Verify that each active receptor (those that have been enabled during generator configuration) displays the desired X-ray tube on the LCD display.	Receptor 1 Tube # _____ Receptor 2 Tube # _____ Receptor 3 Tube # _____ Receptor 4 Tube # _____ Receptor 5 Tube # _____ Receptor 6 Tube # _____	
6.	Switch OFF the console.	N/A	

INDICO 100 X-RAY GENERATORS ARE FITTED WITH A LOW SPEED STARTER, OR OPTIONAL DUAL SPEED STARTER. USE SECTION 4.3.4 OR 4.3.5, AS APPLICABLE, FOR YOUR GENERATOR.

Confirm that the tube(s) being used are compatible with the starter in this generator. The setup as described in chapter 2 and in the supplement at the end of chapter 2 must be done correctly.

Tube 1 selection verified _______
Tube 2 selection verified _______

4.3.4 Low Speed Starter Verification

Step	Action	Result	Check
1.	Connect a current probe to the common lead of tube 1. Switch ON the console. Press and hold the PREP button.	A 60 Hz waveform dropping to less than half amplitude after prep is complete.	
2.	Measure the rotor boost time.	Should be nominally as set in chapter 2.	
3.	Use a strobe or reed tachometer and verify that the tube(s) reach operating speed at the end of boost.	Speed $\geq$ 3300 RPM.	
FOLLOW STEPS 4 TO 6 IF TUBE 2 IS USED (LOW SPEED STARTER)			
4.	Connect a current probe to the common lead of tube 2. Press and hold the PREP button.	A 60 Hz waveform dropping to less than half amplitude after prep complete.	
5.	Measure the rotor boost time.	Should be nominally as set in chapter 2.	
6.	Use a strobe or reed tachometer and verify that the tube(s) reach operating speed at the end of boost.	Speed $\geq$ 3300 RPM.	
7.	Switch OFF the console.	N/A	

4.3.5 Dual Speed Starter Verification

THE GENERATOR MUST BE PROGRAMMED FOR DUAL SPEED STARTER OPERATION IN ORDER TO BE ABLE TO VERIFY BOTH MODES OF OPERATION IN THIS SECTION. DO NOT DO SO IF A TUBE IS USED THAT CANNOT OPERATE AT BOTH LOW AND HIGH SPEEDS.

******* PLEASE OBSERVE A MAXIMUM OF 2 HIGH SPEED BOOSTS PER MINUTE *******

Step	Action	Result	Check
1.	Connect a current probe to the common lead of tube 1. Switch ON the console. Select 70 kV, minimum mA, 50 ms. Press and hold the PREP button.	A 60 Hz waveform dropping to less than half amplitude after prep complete.	
2.	Measure the rotor boost time.	Should agree with the value in the dual speed starter table in the supplement at the end of chapter 2.	
3.	Select 100 kV, maximum mA, 50 ms, small focus. Press and hold the PREP button.	A 180 Hz waveform dropping to less than half amplitude after prep complete.	
4.	Measure the rotor boost time.	Should agree with the value in the dual speed starter table at the end of chapter 2.	
5.	Use a strobe or reed tachometer and verify that the tube(s) reach operating speed at end of boost. Use the techniques in steps 1 and 3 to select low and high-speed modes respectively.	Low Speed ≥ 3300 RPM. High Speed ≥ 9500 RPM.	
6.	After a high-speed prep, verify that the dynamic brake is applied.	Will hear the X-ray tube slow down to 60 Hz.	
FOLLOW STEPS 7 TO 12 IF TUBE 2 IS USED (DUAL SPEED STARTER)			
7.	Connect a current probe to the common lead of tube 2. Select 70 kV, minimum mA, 50 ms. Press and hold the PREP button.	A 60 Hz waveform dropping to less than half amplitude after prep complete.	
8.	Measure the rotor boost time.	Should agree with the value in the dual speed starter table at the end of chapter 2.	
9.	Select 100 kV, maximum mA, 50 ms, small focus. Press and hold the PREP button.	A 180 Hz waveform dropping to less than half amplitude after prep complete.	
10.	Measure the rotor boost time.	Should agree with the value in the dual speed starter table at the end of chapter 2.	
11.	Use a strobe or reed tachometer and verify that the tube(s) reach operating speed at end of boost. Use the techniques in steps 7 and 9 to select low and high-speed modes respectively.	Low Speed ≥ 3300 RPM. High Speed ≥ 9500 RPM.	

4.3.5 Dual Speed Starter Verification (Cont)

	Step	Action	Result
12.	After a high-speed prep, verify that the dynamic brake is applied.	Will hear the X-ray tube slow down to 60 Hz.	
13.	Switch OFF the console.	N/A	

4.4.0 ACCEPTANCE TESTS (kV, mA / mAs and ms)

4.4.1 Generator Rad and FluoroTests

- kV measurements must be made using a non-invasive kV meter or by use of an invasive device such as a Dynalyzer.
- mA / mAs measurements must be made by connecting a mA / mAs meter to the mA measurement jacks on the HT tank.
- ms measurements will typically be made using a non-invasive kV meter with ms measurement capability
- All test equipment must be calibrated and the measurement tolerances of the equipment must be known.

Note: ***The Result column in the following sections shows the acceptable generator limits for kV, mA, mAs and ms. Test and measurement tolerances must be added to the generator limits shown.***

4.4.1 Generator Rad Tests (Cont)

CAUTION: THE FOLLOWING TESTS REQUIRE THE PRODUCTION OF X-RADIATION. USE APPROPRIATE SAFETY PRECAUTIONS TO PROTECT PERSONNEL.

For each step in the tables below, confirm the expected result. The measurement range shown in the ***Result*** column includes the generator tolerances only. ***Test and measurement tolerances must be added to the results shown.***

Step	Action	Result	Check
1.	Switch ON the generator and after initialization select the following radiographic technique: kV = 100, mA = 100, Time = 100 ms. Select an off-table receptor.	N/A	
2.	Make an exposure and verify the following results:	Gen kV = 94-106 kV. Gen mA = 94-106 mA. Gen ms = 97.5-102.5 ms.	
3.	Repeat the previous step but set the values to kV = 65, mA = 200.	Gen kV = 61-69 kV. Gen mA = 189-211 mA. Gen ms = 97.5-102.5 ms.	
4.	Repeat the previous step but set the values to kV = 125.	Gen kV = 118-132 kV. Gen mA = 189-211 mA. Gen ms = 97.5-102.5 ms.	
5.	Select 75 kV, 200 mA. Select the exposure times shown below (3 point operation). Verify the mAs shown. A: 10 ms. B: 20 ms. C: 63 ms. D: 100 ms.	 A: Gen mAs = 1.6-2.4 mAs. B: Gen mAs = 3.4-4.6 mAs. C: Gen mAs = 11-14 mAs. D: Gen mAs = 17.8-22.2 mAs.	
6.	Select 75 kV. Select the mAs shown below (2 point operation). Measure ms at 75% of the peak kV waveform. A: 2 mAs. B: 8 mAs. C: 25 mAs. D: 63 mAs.	NOTE: The time associated with each mAs setting may vary depending on generator configuration. Use the ms displayed on the console as the reference for the measurements below. Gen ms per console. Gen ms per console. Gen ms per console. Gen ms per console.	
	In the above step, note the ms for the pending exposure. Then take the exposure and confirm that the actual ms = the demanded ms within the allowed tolerance: The ms accuracy of the generator is: • ± (2% + 0.5) ms for 5 ms to 6300 ms. • ± (10% +1) ms from 1 to 4 ms (≥0.5 mAs).		

4.4.1 Generator Rad Tests (Cont)

Step	Action	Result	Check
7.	Select 200 mA, 50 ms (3 point operation). Select the kV values shown below. A: 50 kV. B: 60 kV. C: 80 kV. D: 100 kV. E: 125 kV.	A: Gen kV = 46.5-53.5 kV. B: Gen kV = 56-64 kV. C: Gen kV = 78.4-81.6 kV. D: Gen kV = 94-106 kV. E: Gen kV = 118-132 kV.	
8.	Select 100 kV, 50 ms (3 point operation). Select the mA values shown below. Measure mA at 75% of the peak kV waveform. A: 50 mA. B: 100 mA. C: 200 mA. D: 400 mA. E: 500 mA. F: 630 mA G: 800 mA H: 1000 mA. Note: The higher mA values will not be available on all generator models and / or programmed tube types.	A: Gen mA = 46.5-53.5 mA. B: Gen mA = 94-106 mA. C: Gen mA = 189-211 mA. D: Gen mA = 379-421 mA. E: Gen mA = 474-526 mA. F: Gen mA = 598-662 mA. G: Gen mA = 759-841 mA. H: Gen mA = 949-1051 mA.	

4.4.2 Generator Fluoro Tests

This section applies only to R&F units.

Step	Action	Result	Check
1.	Place the generator into the fluoro mode of operation.	N/A	
2.	Place the imaging system into non-ABS mode or cover the fluoro receptor with lead.	N/A	

4.4.2 Generator Fluoro Tests (Cont)

Step	Action	Result	Check
3.	Select 3 mA fluoro. Select the kV values shown below using the remote fluoro control if fitted, or the fluoro section of the console. A: 50 kV B: 65 kV C: 80 kV D: 100 kV E: 110 kV	 A: Gen kV = 46.5-53.5 kV. B: Gen kV = 61-69 kV. C: Gen kV = 75-85 kV. D: Gen kV = 94-106 kV. E: 110 kV = 103.5-116.5 kV.	
4.	Select 70 kV fluoro. Select the fluoro mA values shown below: A: 0.5 mA B: 3.0 mA C: 6.0 mA D: Maximum fluoro mA available.	 A: Gen mA = 0.0-1.5 mA. B: Gen mA = 1.9-4.1 mA. C: Gen mA = 4.8-7.2 mA. D: Gen mA as selected at left. Tolerance = $\pm$ (3% +1) mA.	
5.	Confirm that the fluoro “eye” symbol lights during a fluoroscopic exposure, and that an intermittent tone is heard from the console.		
6.	Select pulsed fluoro if the pulsed fluoro option is fitted. Press the PPS **+** and **-** buttons.	Verify that the pulsed fluoro rate increases and decreases.	
7.	Run a sufficiently long fluoro exposure to accumulate some time on the console fluoro display, and on the remote fluoro control if used Press the ZERO button on the console and on the remote fluoro control if applicable.	Verify that the accumulated time is reset to zero after pressing each of the ZERO buttons.	

4.5.0 ACCEPTANCE TESTS (OPTIONAL INTERFACES)

Refer to separate supplements at the front of this manual for further information IF APPLICABLE.

4.6.0 ACCEPTANCE TESTS (AEC)

For generators with AEC:

1. Review section 3D: AEC Calibration.
2. Recheck the mAs, dose and O.D. as recorded during initial installation. Follow the appropriate steps in chapter 3D to verify the AEC calibration.
3. Indico 100 X-ray generators have a circuit that checks that the AEC ramp is at least 4% of the AEC reference voltage within 20% of the AEC backup time. This step confirms that this circuit is working, and that electrical noise on the AEC input does not exceed the 4% threshold.
   a) Close the collimator and point the X-ray tube away from the image receptor that has AEC channel 1 assigned to it. Alternately, close the collimator and cover the image receptor with a lead apron. Then select this image receptor via the console.
   b) Select the AEC mode of operation and 100 mA.
   c) Select the maximum kV used on that receptor and minimum density. Select the fastest film screen if available.
   d) Make an AEC exposure and verify that an AEC DEVICE ERROR message is displayed.
      - An AEC DEVICE ERROR message indicates that the selected AEC channel has passed this test. Repeat step 3 for the remaining AEC channels by selecting an image receptor that has the desired AEC channel assigned to it.
      - Go to step 3 (e) if an AEC DEVICE ERROR message is not displayed when testing the current AEC channel.
   e) If the generator runs into backup ms or backup mAs, i.e. if an AEC DEVICE ERROR message is not displayed, some troubleshooting is required to determine the reason the “4% / 20%” circuit is not terminating the AEC exposure. Some troubleshooting tips:
      - Repeat steps 3 (a) to 3 (d) but select the minimum kV used on the current receptor, maximum density and the slowest film screen, if available. If an AEC DEVICE ERROR message results with these settings, this almost certainly indicates that there is sufficient noise on the AEC input to exceed 4% of the AEC reference voltage under the test conditions in step 3 (c), where the AEC reference voltage is at its minimum. The cause of excessive noise on the AEC input now needs to be found.
        - ∗ Measure the AEC reference voltage (PT reference). Then check that noise at the output of the AEC board (PT ramp) does not exceed approximately 2% of the AEC reference voltage.
        - ∗ Is the AEC cable routed along with other “noisy” cables i.e. stator cables?
        - ∗ Are the stator cables shielded and properly grounded? Shielded cable is recommended for the low speed starter and required for the dual speed starter. The shield must be grounded at the tube end and at the generator end of the cable(s).
        - ∗ Is the AEC cable shielded? The shield should only be grounded at the AEC board in the generator.
        - ∗ Is the AEC chamber isolated from chassis ground? Some chamber types must be isolated from equipment ground.

4.6.0 ACCEPTANCE TESTS (AEC) Cont

- If the generator runs into backup ms or backup mAs under both sets of test conditions (maximum kV, minimum density, fastest film screen AND minimum kV, maximum density, slowest film screen):
  - ∗ Recheck the troubleshooting steps in 3 (e).
  - ∗ Check the PT ramp at TP11 on the generator interface board.

f) Repeat the previous steps for the remaining AEC channels by selecting an image receptor that has the desired AEC channel assigned to it.

Refer to the section **AEC Calibration Range** in chapter 3D for background information on film screen speed vs. D/A output (reference voltage).

4.7.0 ACCEPTANCE TESTS (ABS)

For R&F generators:

- Review section 3E: ABS calibration.
- Follow the appropriate steps in section 3E to verify the ABS calibration.

4.8.0 ACCEPTANCE TESTS (DAP)

For generators with DAP.

- Review Section 3F: DAP SETUP AND CALIBRATION.
- Follow the appropriate steps in section 3F to verify the DAP calibration.

4.9.0 ACCEPTANCE TESTS (HVL, LINEARITY AND REPRODUCIBILITY)

The procedure for performing reproducibility, linearity and HVL testing is contained in a separate document, part number 740917 that immediately follows this page.

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SUPPLEMENT

REPRODUCIBILITY, LINEARITY, & HVL TESTING

CONTENTS:

PROPRIETARY AND CONFIDENTIAL

1.0 INTRODUCTION

This supplement describes reproducibility, linearity, and half - value layer (HVL) tests which may be used to verify performance of medical X-ray generators.

> ***NOTE:* THIS SUPPLEMENT DETAILS TYPICAL REPRODUCIBILITY, LINEARITY, AND HVL TESTS. LOCAL REGULATIONS SHOULD ALWAYS BE CONSULTED PRIOR TO PERFORMING THESE TESTS, AS DETAILS MAY VARY IN SOME JURISDICTIONS, OR ADDITIONAL TESTS MAY NEED TO BE PERFORMED.**

> ***WARNING:* SOME EXPOSURES IN THIS SECTION MUST BE TAKEN AT THE MAXIMUM GENERATOR KVP. THE X-RAY TUBE MUST BE KNOWN TO BE CAPABLE OF OPERATION AT THAT KVP VALUE, AND THE TUBE SHOULD FIRST BE SEASONED TO ENSURE THAT OPERATION AT HIGH KVP VALUES WILL NOT BE PROBLEMATIC.**

2.0 EQUIPMENT SETUP

1. Place the radiation probe above the table approximately 25 cm (10”). Select an SID of approximately 100 cm (40”).

2. Place a lead diaphragm over the detector and adjust its height so that the X-ray beam covers the detector but does not over radiate the sides of the probe. Refer to figure 1.

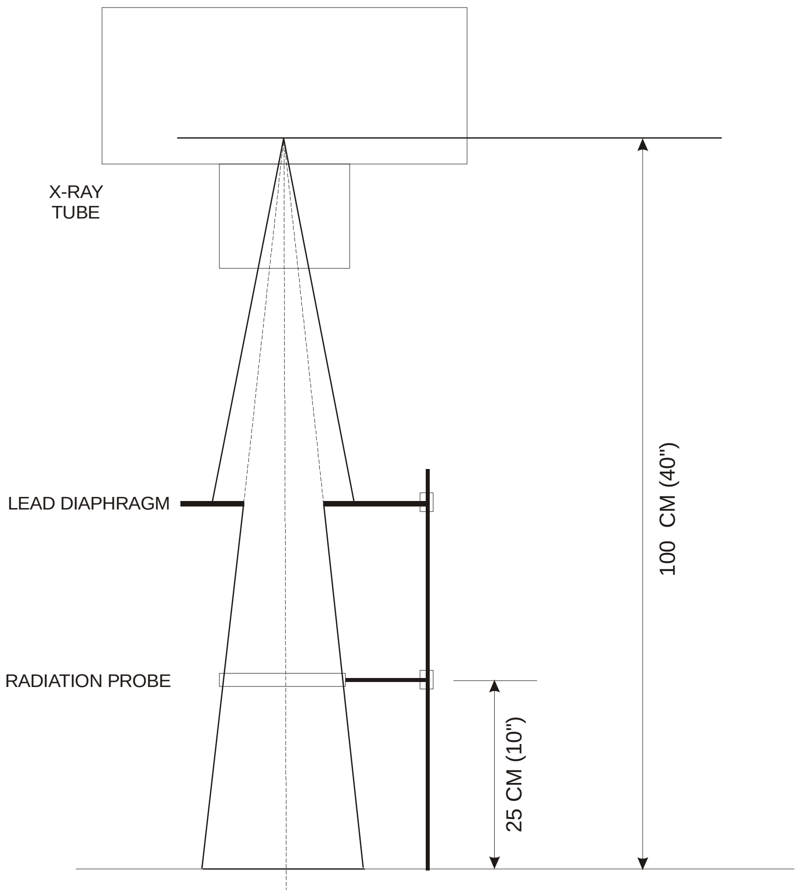

Figure 1: Dose measurement setup

3.0 REPRODUCIBILITY

Calculate reproducibility as follows:

1. Using kV and mA/ms or mAs values per tables 1 to 4, make a series of 5 exposures.

2. Record each of the measured dose values, in mGy, in the appropriate table. Refer to step 3 before starting step 2.
   To convert mR to mGy, divide the value in mR by 114.5. This will give the value in mGy. (for example 114.5 mR = 1 mGy).

3. Record the preselected mAs for each series of exposures in the header of each table. For 3 point generators, this is the calculated mAs value where mAs = mA X time in seconds (example for 160 mA and 125 ms, mAs = 160 X 0.125 = 20 mAs).

3.0 REPRODUCIBILITY (Cont)

4. Calculate and record the average dose $\overline{K}$ (kerma) in mGy.

5. Calculate the difference, $K - \overline{K}$, for each exposure.

6. Square each difference from the previous step.

7. Calculate the sum of the differences squared.

8. Calculate the standard deviation (S) by using the formula.

$$S = \sqrt{\frac{\text{SUM OF DIFFERENCES}^2}{\text{N-1 SAMPLES}}}$$

9. Calculate reproducibility by dividing S by $\overline{K}$.

10. Table 5 shows example reproducibility calculations.

11. If linearity is to be measured, it is suggested that dose measurements be taken at this time for entry into tables 6 and 7. Refer to 4.0 LINEARITY for details.

IN TABLES 1 TO 4, 3 POINT MEANS THAT FOR GENERATORS WHERE KV, MA, AND TIME SELECTION IS AVAILABLE, THE KV, MA AND MS VALUES SHOWN SHOULD BE USED. FOR GENERATORS WHERE 2 POINT OPERATION ONLY IS AVAILABLE, THE KV AND MAS VALUES SHOWN SHOULD BE USED.

3 point = Minimum kV, maximum mA, 100 ms. 2 point = Minimum kV, maximum mAs. mAs = ___________			
EXP No.	**DOSE (K) mGy**	**DIFFERENCE**	**DIFFERENCE^2**
1			
2			
3			
4			
5			
	$\overline{K}$ = ________	Calculate each of the differences ie: $DIFF_1 = K_1 - \overline{K}$. Repeat for each remaining K value.	Square each difference. Then calculate the sum of the difference^2. Sum of difference^2 = _________
Calculate standard deviation (S) using formula at beginning of this section: S = ___________ Calculate reproducibility = $\frac{S}{\overline{K}}$ = _________ (not to exceed 0.045)			

Table 1: Reproducibility

3.0 REPRODUCIBILITY (Cont)

3 point = Maximum kV, minimum mA, 100 ms.
2 point = Maximum kV, minimum mAs. mAs = ___________

EXP No.	DOSE (K) mGy	DIFFERENCE	DIFFERENCE^2
1			
2			
3			
4			
5			
	$\overline{K}$ = _________	Calculate each of the differences ie: $DIFF_1 = K_1 - \overline{K}$. Repeat for each remaining K value.	Square each difference. Then calculate the sum of the difference^2. Sum of difference^2 = __________

Calculate standard deviation (S) using formula at beginning of this section: S = ___________

Calculate reproducibility = $\frac{S}{\overline{K}}$ = __________ (not to exceed 0.045)

Table 2: Reproducibility

3 point = 50% of maximum kV, 250 ms, mA to give 100 - 500 mR (0.9 – 4.4 mGy) dose.
2 point = 50% of maximum kV, mAs to give 100 - 500 mR (0.9 – 4.4 mGy) dose. mAs = ___________

EXP No.	DOSE (K) mGy	DIFFERENCE	DIFFERENCE^2
1			
2			
3			
4			
5			
	$\overline{K}$ = _________	Calculate each of the differences ie: $DIFF_1 = K_1 - \overline{K}$. Repeat for each remaining K value.	Square each difference. Then calculate the sum of the difference^2. Sum of difference^2 = __________

Calculate standard deviation (S) using formula at beginning of this section: S = ___________

Calculate reproducibility = $\frac{S}{\overline{K}}$ = __________ (not to exceed 0.045)

Table 3: Reproducibility

3.0 REPRODUCIBILITY (Cont)

3 point = 80% of maximum kV, 250 ms, mA to give 100 - 500 mR (0.9 – 4.4 mGy) dose. 2 point = 80% of maximum kV, mAs to give 100 - 500 mR (0.9 – 4.4 mGy) dose. mAs = __________			
EXP No.	**DOSE (K) mGy**	**DIFFERENCE**	**DIFFERENCE^2**
1			
2			
3			
4			
5			
	$\overline{K}$ = ________	Calculate each of the differences ie: $DIFF_1 = K_1 - \overline{K}$. Repeat for each remaining K value.	Square each difference. Then calculate the sum of the difference^2. Sum of difference^2 = _________
Calculate standard deviation (S) using formula at beginning of this section: S = __________ Calculate reproducibility = $\frac{S}{\overline{K}}$ = _________ (not to exceed 0.045)			

Table 4: Reproducibility

EXAMPLE mAs = _20_			
EXP No.	**DOSE (K) mGy**	**DIFFERENCE**	**DIFFERENCE^2**
1	2.17	0.036	0.001296
2	2.14	0.006	0.000036
3	2.13	0.004	0.000016
4	2.11	0.024	0.000576
5	2.12	0.014	0.000196
	$\overline{K}$ = _2.134_	Calculate each of the differences ie: $DIFF_1 = K_1 - \overline{K}$. Repeat for each remaining K value.	Square each difference. Then calculate the sum of the difference^2. Sum of difference^2 = _0.00212_
Calculate standard deviation (s) using formula at beginning of this section: S = _0.0230_ Calculate reproducibility = $\frac{S}{\overline{K}}$ = _0.011_ (not to exceed 0.045)			

Table 5: Reproducibility

4.0 LINEARITY

1. Record two additional series of dose measurements for entry into tables 6 and 7:
   - For table 6, use settings per table 3 ***EXCEPT*** use an mA (or mAs) value adjacent to the mA (or mAs) setting used in table 3.
   - For table 7, use settings per table 4 ***EXCEPT*** use an mA (or mAs) value adjacent to the mA (or mAs) setting used in table 4.
   - Record the mAs in the header of tables 6 and 7 as per 3.0 step 3.

1. Calculate and record the average dose $\overline{K}$ (kerma) in mGy for tables 6 and 7.

2. Record the preselected mAs and the average dose values taken from tables 3 and 4, and from tables 6 and 7, at the top of the next page.

3. Using the appropriate mAs and $\overline{K}$ values, calculate X_3, X_4, X_6, and X_7 in tables 8 and 9.

4. Calculate the coefficient of linearity, L, as per tables 8 and 9.

mAs = ___________	
EXP No.	**DOSE (mGy)**
1	
2	
3	
4	
5	
	$\overline{K}$ = _________

Table 6: Linearity

mAs = ___________	
EXP No.	**DOSE (mGy)**
1	
2	
3	
4	
5	
	$\overline{K}$ = _________

Table 7: Linearity

4.0 LINEARITY (Cont)

Record the mAs and $\overline{K}$ values taken from tables 3, 4, 6, and 7 below.

Table 3	mAs_3 = _____	$\overline{K_3}$ = _____
Table 4	mAs_4 = _____	$\overline{K_4}$ = _____
Table 6	mAs_6 = _____	$\overline{K_6}$ = _____
Table 7	mAs_7 = _____	$\overline{K_7}$ = _____

$$X_3 = \frac{\overline{K_3}}{mAs_3} = \_\_\_\_\_\_\_\_$$

$$X_6 = \frac{\overline{K_6}}{mAs_6} = \_\_\_\_\_\_\_\_$$

$$L = \frac{X_3 - X_6}{X_3 + X_6} = \_\_\_\_\_\_\_\_ \quad \text{(not to exceed 0.095)}$$

In the numerator of the above equation, use the absolute value of $X_3 - X_6$ (disregard the minus sign).

Table 8: Linearity

$$X_4 = \frac{\overline{K_4}}{mAs_4} = \_\_\_\_\_\_\_\_$$

$$X_7 = \frac{\overline{K_7}}{mAs_7} = \_\_\_\_\_\_\_\_$$

$$L = \frac{X_4 - X_7}{X_4 + X_7} = \_\_\_\_\_\_\_\_ \quad \text{(not to exceed 0.095)}$$

In the numerator of the above equation, use the absolute value of $X_4 - X_7$ (disregard the minus sign).

Table 9: Linearity

5.0 H.V.L. EVALUATION

1. Be sure the X-ray source assembly (X-ray tube and beam limiting device) is fully assembled and functional.

2. Use the test setup as per figure 1.

3. Set the generator as follows: 3 point generators, 80 kV, 200 mA, 50 ms, large focus. For 2 point generators use 80 kV, 200 mA if this can be set, and 10 mAs.

4. Take a series of three exposures and record the dose K (kerma) values in mGy in table 10. Calculate and record the average of the three exposures.

5. Place 2 mm of Al on top of the lead diaphragm (total of 2 mm added), repeat the exposure and record the K value in table 10.

6. Place an additional 1 mm of Al on top of the lead diaphragm (total of 3 mm added), repeat the exposure; and record the K value in table 10.

7. Place an additional 3 mm of Al on top of the lead diaphragm (total of 6 mm added), repeat the exposure; and record the K value in table 10.

8. The relative transmission for the average of the three K values where no Al was added is assigned a value of 1.00. Using that base, assign relative transmission values to the remaining K values. For example, if the average K value was 2.15 and has a relative transmission factor of 1.00, then 1.41 mGy will have a relative transmission of 1.41 / 2.15 = 0.66.

9. Plot the relative transmission values in figure 1. This should produce a straight line on the graph since the X-axis is logarithmic.

10. Interpolate to determine the HVL. The Al thickness at a relative transmission of 0.5 will be the required HVL value.

11. Repeat steps 4 to 10: 3 point generators, 100 kV, 200 mA, 50 ms, large focus. For 2 point generators use 100 kV, 200 mA if this can be set, and 10 mAs. Use table 11 to record the values and figure 2 to plot the results

12. Table 12 and figure 3 show example HVL determination.

5.0 H.V.L. EVALUATION (Cont)

ADDED ALUMINUM FILTER	DOSE (mGy)	RELATIVE TRANSMISSION
0		
0		
0		
0 (Average of three readings)		1.00
2 (total 2 mm)		
1 (total 3 mm)		
3 (total 6 mm)		

Table 10: HVL dose values 80 kVp

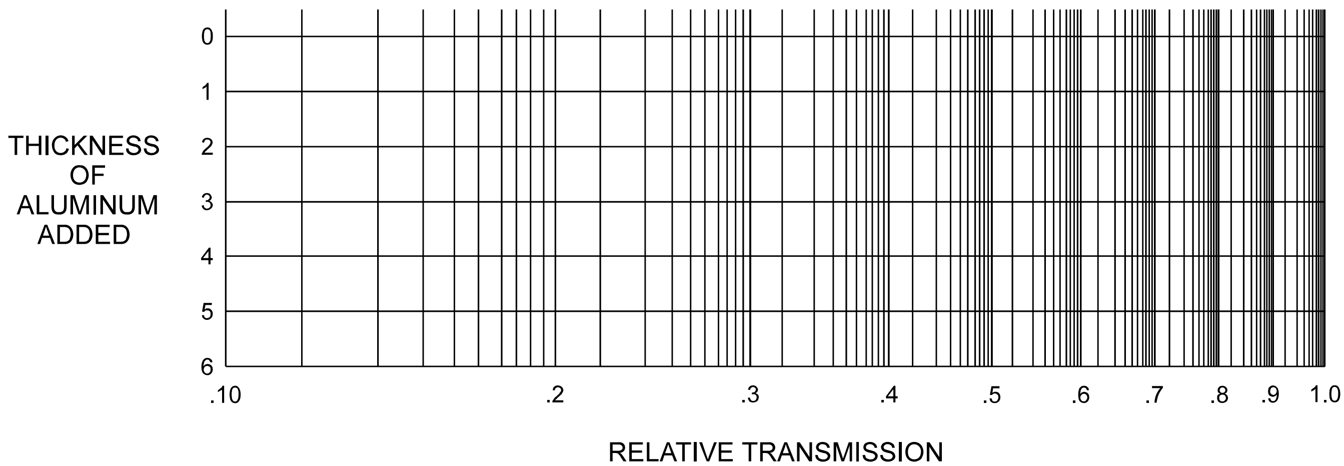

Figure 1: HVL plot 80 kVp

For 80 kVp, the HVL must be ≥ 2.9 mm Al.

5.0 H.V.L. EVALUATION (Cont)

ADDED ALUMINUM FILTER	DOSE (mGy)	RELATIVE TRANSMISSION
0		
0		
0		
0 (Average of three readings)		1.00
2 (total 2 mm)		
1 (total 3 mm)		
3 (total 6 mm)		

Table 11: HVL dose values 100 kVp

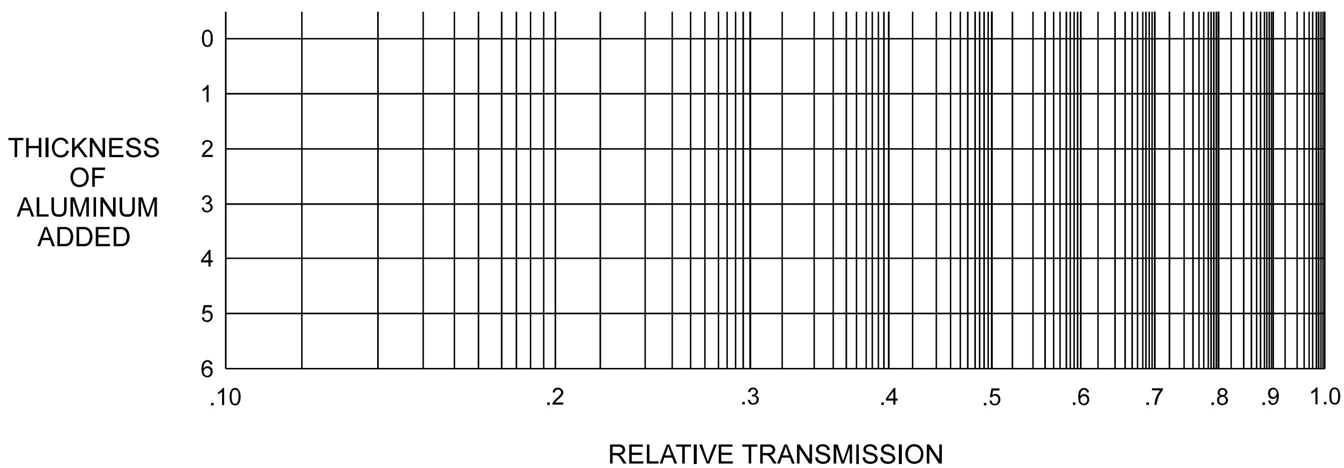

Figure 2: HVL plot 100 kVp

For 100 kVp, the HVL must be ≥ 3.6 mm Al.

5.0 H.V.L. EVALUATION (Cont)

ADDED ALUMINUM FILTER	DOSE (mGy)	RELATIVE TRANSMISSION
0	2.17	
0	2.13	
0	2.16	
0 (Average of above three readings)	2.15	1.00
2 (total 2 mm)	1.41	.66
1 (total 3 mm)	1.14	.53
3 (total 6 mm)	0.61	.28

Table 12: HVL dose values (example)

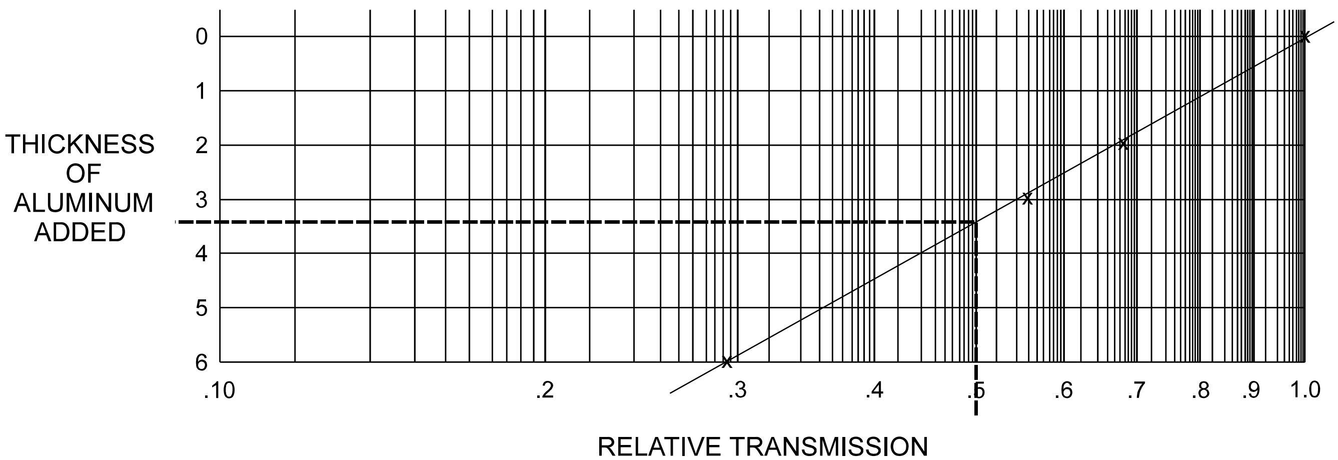

Figure 3: HVL plot (example)

By interpolating the thickness of Al at a relative transmission value of 0.5, it can be seen that the HVL is approximately 3.3.

CHAPTER 5

TROUBLESHOOTING

CONTENTS:

5.1.0 INTRODUCTION

The Indico 100 console will display status and error messages during normal and abnormal operation of the generator. This chapter contains tables of those messages and suggests actions to be taken by service personnel to correct any malfunctions that may occur.

The messages in sections 5.2.1 to 5.2.3 cover all available Indico 100 options and configurations. Some of the messages may not apply to your generator configuration.

This chapter also contains tables that define the functions of the status and diagnostic LEDs on various circuit boards.

5.2.0 STATUS AND ERROR CODES

5.2.1 Operator Messages

These messages indicate the status of the generator.

MESSAGE (membrane console)	MESSAGE (touchscreen console)	DESCRIPTION
DAP NOT READY	DAP not ready	The optional DAP is in its “warm up” state, and not ready to make DAP measurements.
INITIALIZATION		Displayed during power up sequence.
SPINNING ROTOR		Displayed when prep state is active.
X-RAY ON		Displayed during both a rad and fluoro exposure.
X-RAY READY	Generator Ready	Indicates that the generator is ready to make an exposure.
COMM ERROR	Generator off-line	Indicates that the console is unable to communicate with the generator. Ensure that the generator is switched on, and that the console cable is properly connected to the console.

5.2.2 Limit / Misc. Messages

These messages indicate that a parameter, condition, or limit is invalid or out-of-range or cannot be selected.

MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
AEC DENSITY LIM	Generator AEC density limit	Requested density not programmed.	Select another density or program requested density step.
AK ACCUM WARNING	Air Kerma Accumulated Warning	The accumulated air kerma value has reached the programmed limit.	Reset the air kerma display.
AK RATE WARNING	Air Kerma Rate Warning	The current air kerma rate exceeds the programmed air kerma rate limit.	Reduce the exposure.
ANODE HEAT WARN.	Anode warning level exceeded	Anode has exceeded programmed warning level.	Wait for anode to cool.
CAL LIMIT	Calibration limit: selected parameter not calibrated.	Requested parameter not calibrated.	Recalibrate X-ray tube or select a calibrated parameter.

5.2.2 Limit / Misc. Messages (Cont)

MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
CONSOLE BATTERY LOW		Indicates that the console battery is low.	Replace the console battery.
DAP ACC WARNING	DAP accumulated value exceeded.	The accumulated DAP value exceeds the programmed DAP limit.	Reset the DAP.
DAP RATE WARNING	DAP rate value exceeded.	The current DAP rate exceeds the programmed DAP rate limit.	Reduce the dose rate.
DESEL.TOMO TABLE	Please deselect TOMO table.	The selection of the tomo table is invalid.	Deselect the tomo table.
FATAL ERROR: PROGRAM MEMORY ERROR		A fatal error has occurred relative to the console program memory.	Replace the console EPROM.
FATAL ERROR: REVISION INCOMPATIBILITY		The revision of the console software and the generator software is not compatible.	Replace the console and generator EPROM / firmware with a matched set.
FL FOCUS WARNING	Fluoro Focus Warning	The small focus is not working, and the generator is performing fluoroscopy on the large focus.	1. Check the small filament in the X-ray tube. 2. Check the small-focus filament supply board. 3. Check the filament connections in the cathode cable(s).
FL TIMER WARN	Fluoro timer warning level exceeded	Fluoro interval timer ≥ 5.0 mins.	Reset fluoro timer.
GEN DUTY WARNING	Generator duty cycle limit	The X-ray generator has reached its duty cycle warning limit.	Re-evaluate technique factors. Allow generator to cool if possible. If exposures are continued, serious generator damage may result due to overheating.
GEN KV LIMIT	Generator kV limit	Requested kV not allowed as generator kV limit has been reached.	Check technique if this is seen when APR is used.
GEN KW LIMIT	Generator kW limit	Requested parameter not allowed as generator kW limit has been reached.	Check technique if this is seen when APR is used.

5.2.2 Limit / Misc. Messages (Cont)

MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
GEN MA LIMIT	Generator mA limit	Requested mA not allowed as generator mA limit has been reached.	Check technique if this is seen when APR is used.
GEN MAS LIMIT	Generator mAs limit	Requested mAs not allowed as generator mAs limit has been reached.	Check technique if this is seen when APR is used.
GEN MS LIMIT	Generator ms limit	Requested ms not allowed as generator ms limit has been reached.	Check technique if this is seen when APR is used.
GEN PPS LIMIT	Generator PPS limit	Generator PPS limit has been reached.	None.
HOUSE HEAT WARN.	Housing heat warning	X-ray tube housing heat has exceeded housing warning limit.	Wait for the tube housing to cool.
INVALID PARAM	Invalid communication parameter	Generator detected invalid parameter within received message, message ignored.	Select valid parameter.
LABEL JAMMED		The labels are jammed.	Clear the paper jam.
OUT OF LABELS		The printer is out of labels.	Load more labels.
PARAMETER LIMIT	Parameter Limit	The selected parameter has exceeded its limits.	None.
PLATEN OPEN		The paper platen is not positioned properly.	Check the platen position.
PRINTER COMM ERR		The printer has reported a communication error.	Try printing again.
PRINTER ERROR		The printer self-diagnostics have reported a printer problem.	Refer to the printer manual.
PRINTER OFF-LINE		The printer is off-line.	Put the printer on-line.
TOMO ANGLE N/A	The selected TOMO angle is not available.	The selected tomo angle is not available.	Select a valid tomo angle.
TUBE KV LIMIT	Tube kV limit	Requested kV not allowed as tube kV limit has been reached.	Release the KV + button.
TUBE KW LIMIT	Tube kW limit	Requested parameter not allowed as tube kW limit has been reached.	Release the KV + or the mA + buttons.
TUBE MA LIMIT	Tube mA limit	Requested mA not allowed as tube mA limit has been reached.	Release the mA + button.
TUBE MAS LIMIT	Tube mAs limit	Requested mAs not allowed as tube mAs limit has been reached.	Release the mA + or MS + buttons.

5.2.3 Error Messages

These messages indicate that an error has occurred. The errors are logged in the error log; previous errors should be reviewed by service personnel before taking further action.

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
	APR MEMORY ERROR		APR data has been corrupted.	See note 1 near end of this section.
		The license you entered does not appear to be valid. Please re-enter your license key	The Touch Screen software license key has been entered incorrectly.	Verify and re-enter the license key.
E001	GEN EPROM ERR.	Generator CPU EPROM checksum error	Generator CPU EPROM has been corrupted.	Call product support for new generator CPU EPROM.
E003	GEN NVRAM ERR.	Generator CPU NVRAM error	Generator CPU NVRAM data has been corrupted.	Re-initialize generator CPU NVRAM using generator factory defaults.
E004	GEN RTC ERROR	Generator CPU Real Time Clock error.	Generator CPU real time clock is not functioning.	Reset time and date.
E005	PS CONTACT ERR.	Main Contactor Error	Unit did not detect proper charging up of 600V bus caps. Main contactor will not be closed if bus is not charged.	Measure 600V bus and determine reason for not charging. Check fuses and charging resistors on the power input board.
E006	ROTOR FAULT	Rotor Fault	Current relays in main and shift circuits were not energized.	Check D42 on the auxiliary board. If lit, the inverter thermal switch is open. This will prevent the PREP signal from reaching the DSS board. Check the connections of the back of the DSS board, For proper seating. Check DS 1 on the DSS board, if lit there is a breakdown in the starter or stator circuits. Disconnect stator and retry. This will isolate where the fault occurred. Verify the DIP-switch settings on the DSS board. They should be set according to the type of tube being used.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E007	FILAMENT FAULT	Filament Fault	Generator has detected filament current <2 amps.	1. Check for open filament in X-ray tube. 2. Check for poor connections in the cathode cable. 3. Check fuses on filament board(s).
E008	KV/MA FAULT	kV / mA Fault	The generator has detected a fault in the kV or mA output during an exposure and immediately terminated the exposure. This may be caused by arcing in the X-ray tube, arcing of the HV cables, or HT tank.	1. If arcing of the X-ray tube is suspected, check condition of tube. The X-ray tube may be damaged or simply require “seasoning”. Refer to chapter 6 for tube seasoning procedure. 2. If failure of HT tank is suspected, contact product support.
E009	PS NOT READY	Power Supply Not Ready	The generator is not ready to make an exposure.	Retry exposure. If error happens again, wait for inverter to cool. Check +/- 12 V lines in power supply section.
E011	HIGH MA FAULT	mA During Exposure Too High	Generator CPU detected mA greater than allowed tolerance.	Check for actual exposure mA. Do not attempt calibration until satisfied that generator is exposing properly. *
E012	LOW MA FAULT	mA During Exposure Too Low	Generator CPU detected mA less than allowed tolerance.	Check for actual exposure mA. Do not attempt calibration until satisfied that generator is exposing properly. *
E013	MANUAL TERMIN	Manually Terminated Exposure	Operator released exposure switch during exposure.	1. Re-take exposure if necessary. 2. Check for faulty switch contacts or wiring.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E014	AEC BUT ERROR	AEC Back-up Timer - Exposure Terminated	AEC exposure exceeded allowed back up time.	1. Check exposure technique settings. 2. Check that correct AEC chamber is energized.
E015	AEC BU MAS ERR.	AEC mAs Exceeded - Exposure Terminated	AEC exposure exceeded allowed back up mAs.	1. Check exposure technique settings. 2. Check that correct AEC chamber is energized.
E016	TOMO BUT ERROR	Tomo Back-up Timer - Exposure Terminated	Tomo exposure exceeded back up time.	1. Check exposure technique settings. 2. Increase tomo back up time if necessary.
E017	NOT CALIBRATED	Uncalibrated Exposure Parameter	Selected mA not calibrated for selected kV.	Recalibrate X-ray tube.
E018	PREP TIMEOUT	Preparation Timeout	Generator has been in prep state too long.	Reduce length of time in prep state.
E019	ANODE HEAT LIMIT	Anode Heat Limit	Selected parameters will cause X-ray tube to exceed its programmed anode heat limit.	Reduce parameters or wait for tube to cool.
E020	THERMAL INT #1	Thermal Switch Interlock #1 Error	X-ray tube # 1 too hot and its thermal switch has opened.	Wait for X-ray tube # 1 to cool.
E021	THERMAL INT #2	Thermal Switch Interlock #2 Error	X-ray tube # 2 too hot and its thermal switch has opened.	Wait for X-ray tube # 2 to cool.
E022	DOOR INTERLOCK	Door Interlock Error	Door is open.	Close door. Check TB 4, pins 4 and 5 on the room interface board.
E023	COLLIMATOR ERR.	Collimator Interlock Error	Collimator is not ready.	Check collimator. Check TB 2, pins 6 and 7 on the room interface board.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E024	CASSETTE ERROR	Cassette Interlock Error	Generator did not receive a Bucky contact closure in a reasonable time after start of Rad expose state.	Check for grid movement and drive signal to Bucky. Check TB 2 , pins 4 and 5 on the room interface board.
E025	II SAFETY INT.	Image Intensifier Safety Interlock Error	II safety is not ready.	Check II safety. Check TB 6, pins 3 and 4 on the room interface board.
E026	SPARE INT.	Spare Input Interlock Error	Spare input is not ready.	Check spare input. Check TB 1, pins 4 and 5 on the room interface board.
E027	RECEPTOR TIMEOUT	Receptor Timeout Error - Receptor did not respond within the timeout period	The receptor is not responding	Wait for receptor to be ready, then retry exposure.
E028	PREP SW CLOSED	Prep Input Active During Initialization Phase	Prep input active during power on initialization phase.	Check prep switch and input for short circuit.
E029	X-RAY SW CLOSED	X-ray Input Active During Initialization Phase	X-ray input active during power on initialization phase.	Check X-ray switch and input for short circuit.
E030	FLUORO SW CLOSED	Fluoro Input Active During Initialization Phase	Fluoro input active during power on initialization phase.	Check fluoro switch and input for short circuit.
E031	REMOTE COMM ERR.	Remote Fluoro Communication Error	Communication error detected with remote fluoro control unit.	1. Check remote fluoro control cable for damage and proper connection. 2. Turn power off and then on to Reset Generator.
E032	CONSOLE COMM ERR	Console Communication Error	Generator has detected error in communication to console.	1. Check console cable for damage and proper connection. 2. Turn power off and then on to reset generator.
E033	GEN BATTERY LOW	Warning Lithium Battery Voltage Low	Generator detects lithium battery voltage is low.	Replace lithium battery.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E034	+12VDC ERROR	+12 V DC Error	+12VDC rail is out of tolerance.	Check +12VDC supply from generator interface board.
E035	-12VDC ERROR	-12 V DC Error	-12VDC rail is out of tolerance.	Check -12VDC supply from generator interface board.
E036	+15VDC ERROR	+15 V DC Error	+15VDC rail is out of tolerance.	Check +15VDC supply from generator interface board.
E037	-15VDC ERROR	-15 V DC Error	-15VDC rail is out of tolerance.	Check -15VDC supply from generator interface board.
E038	CAL DATA ERROR	Calibration Data Corrupt Error	Generator detects corrupt calibration data.	Re-calibrate X-ray tube(s).
E039	AEC DATA ERROR	AEC data corrupt	Generator detects corrupt AEC data.	Reprogram AEC data or set factory defaults.
E040	FLUORO DATA ERR	Fluoro data corrupt	Generator detects corrupt fluoro data.	Reprogram fluoro data or set factory defaults.
E041	REC DATA ERROR	Receptor data corrupt	Generator detects corrupt receptor data.	Reprogram receptor data or set factory defaults.
E042	TUBE DATA ERR	Tube data corrupt	Generator detects corrupt tube data.	Reprogram tube data or set factory defaults.
E043	KV ERROR	High voltage error - kV detected in non X-ray state	kV detected in non X-ray state. (This can be seen at the end of an exposure if the generator is connected to long, high capacitance HV cables. They may have a charge when the generator expects KV to be 0.)	Switch OFF generator. Prevent further use of generator. Call product support.
E044	COMM ERROR	Invalid communication message	Received communication message not valid and ignored.	Reset error.
E045	NOT SUPPORTED	Communication message not supported	Received message is valid, but not supported by this system.	Reset error.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E046	MODE INHIBITED	Mode Inhibited	Received message is valid, but not allowed during present state.	Reset error. An APR technique may be asking for something that is disabled in the generator setup. Check the APR programming.
E047	FL TIMER LIMIT	Fluoro timer limit	Fluoro timer has exceeded time limit.	Reset Fluoro timer.
E048	FOCUS MISMATCH	Focus mismatch error	Focus selected does not match current focus enabled by power supply.	Check power supply interface cables between power supply and generator CPU board.
E049	NOT ENABLED	Not enabled	Requested function not programmed to be enabled.	Reprogram to enable function or change APR to not select a function.
E050	GEN DATA ERROR	Generator limit data corrupt	Generator detects corrupt generator limit data.	Reprogram generator limit data or set factory defaults.
E051	AEC DEVICE ERR	AEC feedback error (no feedback signal detected)	Generator has detected no, or insufficient, feedback signal from the AEC device.	1. Check that X-ray tube is pointing at correct AEC device. 2. Check AEC cable for damage and proper connection.
E052	HIGH SF CURRENT	High small focus filament current error in standby	Generator detects small focus filament current greater than limits in standby mode.	Check filament reference and feedback signals. Substitute tube cathode with external load before testing. Check small focus filament board (units with 2 filament boards), or check filament board (units with single filament board).

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E053	HIGH LF CURRENT	High large focus filament current error in standby	Generator detects large focus filament current greater than limits in standby mode.	Check filament reference and feedback signals. Substitute tube cathode with external load before testing. Check large focus filament board (units with 2 filament boards), or check filament board (units with single filament board).
E054	AEC OUT OF RANGE	AEC reference out of range	AEC reference has reached a maximum or minimum limit.	Re-adjust AEC calibration including density to operate within AEC range (O to 1O VDC).
E055	NO FIELDS ACTIVE	No fields selected in AEC mode	AEC enabled but no fields are selected.	Select AEC field(s).
E056	NO TUBE SELECTED	Receptor Disabled	All Receptors have no X-ray tube programmed.	Program receptor(s) with tube number.
E057	AEC STOP ERROR	AEC stop signal In wrong state	AEC stop signal (P.T. stop signal) is active low indicating exposure is finished during prep state.	1. Check that the P.T. ramp does not exceed the P.T. reference during prep state. 2. Check AEC device for proper operation.
E058	CONSOLE BUT ERR.	Console back-up timer	Console has detected exposure exceeded backup time and terminated exposure. This error can happen if the console communication is corrupted during an exposure.	Check routing of the console cable, route it away from noise sources. Call product support.
E059	HOUSE HEAT LIMIT	Housing heat limit exceeded	X-ray tube housing has exceeded its heat limit.	Wait for tube to cool.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E060	EXP. KV HIGH	High kV error	kV exceeds high kV tolerance level.	1. Check the output of the kV reference DAC on the generator CPU board. 2. Measure the output of the generator with a dynalyzer or a non-invasive kVp meter.
E061	EXP KV LOW	Low kV error	kV exceeds low kV tolerance level.	1. Check the output of the kV reference DAC on the generator CPU board. 2. Measure the output of the generator with a dynalyzer or a non-invasive kVp meter.
E062	EXP_ SW ERROR	EXP_SW signal active in standby state	The EXP_SW signal on the generator Interface and generator CPU board is enabled when it should be disabled.	Check console overlay for damage. Replace it if necessary. Call product support.
E063	FACTORY DEFAULTS	Factory defaults set	SW1 switch 8 on the generator CPU board is set to restore the factory defaults.	Set SW1 switch 8 to the ON position. The generator will not exit the initialization phase until this switch is set.
E065	TOMO DEVICE ERR	Tomo device error.	The tomo start signal has not been received within 30 seconds of requesting a tomo exposure.	Check tomo table.
E066	NO SYNC SIGNAL	No SYNC signal	Pulsed fluoro has been requested, but no sync pulse is present.	1. Check that the imaging system is active, and cables are connected properly. 2. Check JW22 on the generator interface board.
E067	PS DUTY LIMIT	Power supply duty cycle limit exceeded	Power supply duty cycle limit exceeded.	Re-evaluate technique factors. Allow generator to cool if possible. If exposures are continued, serious generator damage may result due to overheating.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E069	MAS TIMEOUT	MAS Timeout	Applicable to falling-load option only. The requested mAs was not obtained within the desired time period.	Recalibrate the X-ray tube.
E070	SOFTWARE KEY ERR	Generator software key error	Defective or missing GAL U29 on generator CPU board.	Call product support for new GAL U29.
E071	DAP OVERFLOW ERR.	DAP overflow error	The accumulated DAP value exceeds the display limit.	Reset the DAP.
E072	DAP DEVICE ERROR	DAP device error	The DAP device is not functional.	1. Check the DAP wiring. 2. Check the DAP interface board.
E073	DAP DATA ERROR	DAP data error	The DAP configuration data is corrupted.	Reset factory defaults.
E074	TABLE COMM ERR	Table Communication Error	A communication error has occurred with the table.	1. Ensure that the table is powered on. 2. Check the serial communication cable, connectors, etc.
E075	EMERGENCY STOP	Table Emergency Stop	The table emergency stop has been activated.	Reset the table emergency stop.
E076	HIGH μF CURRENT	High Micro Focus Filament Current Error	Generator detects micro focus filament current greater than limits in standby mode.	Check small focus filament board.
E077	ADR INTERLOCK ER	Active Dose Reduction Cable Interlock error	Ground (ADR tank interlock) at J3-9 not detected.	1. ADR tank not connected. 2. Check 9-conductor cable connecting J3 of ADR tank to J15 of generator I/F board. 3. Defective generator interface board.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E078	ADR TANK ERROR	Active Dose Reduction Error	ADR system discharging always, or not discharging at all.	1. Check 9-conductor cable connecting J3 of ADR tank to J15 of generator I/F board. 2. ADR tank failed. Replace ADR tank. 3. Defective generator interface board.
E079	PROCEDURE ABORT	Procedure Aborted	The procedure has been aborted.	Retry the procedure, or troubleshoot the procedure in question.
E080	REC POSITION ERR	Bucky orientation error.	The Bucky tray has failed to properly change orientation.	Check the wiring from the DR system to the generator.
E083	AK OVERFLOW ERR	Air Kerma Overflow Error	The accumulated AK value exceeds the display limit.	Reset the air kerma display.
E084	AK DATA ERROR	Air Kerma data error	The air kerma calibration data is corrupted.	Reset factory defaults.
E085	TABLE ERROR	Table error	The table has sent a table error message to the generator.	Refer to the table manufacturers documentation.
E100	CAL_MAX MA ERR.	Calibration error - maximum mA exceeded	Maximum mA has been exceeded during auto calibration.	Repeat auto calibration and/or decrease standby current.
E101	CAL_DATA LIMIT	Calibration error - calibration data table exceeded	Auto calibration has exceeded data table length due to an excessive number of exposures.	1. Check to see if the filament standby current is too low. 2. Retry auto calibration.
E102	CAL_MAX FIL ERR	Calibration error - maximum filament current exceeded	Maximum filament current for the selected focus has been reached.	Confirm if exposures are accurate. If so raise maximum filament current or lower maximum mA.
E103	CAL_MAN TERM.	Calibration error - manually terminated	Operator released exposure button during auto calibration.	Retry auto Calibration.
E104	CAL_NO MA	Calibration error - no mA	No mA feedback detected during auto calibration.	Check interface cables between lower and upper generator cabinet.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touchscreen console)	PROBLEM	ACTION
E105	CAL_MIN MA ERR.	Calibration error - minimum mA not calibrated	Minimum generator mA was exceeded at start of calibration. This is usually caused by too high a filament standby current on the primary and or secondary filament. (primary is the filament presently being calibrated, secondary is the other filament and applies only to generators with two independent filament supplies).	Reduce filament standby current on primary and / or secondary filament.

* The generator purges the existing X-ray tube auto calibration data before starting the auto calibration routine and saving new calibration data. Therefore, auto calibration should be a last resort during general troubleshooting, and should only be done to recalibrate the tube. For example, if a low mA fault is presented, you should ensure that the generator is fully functional, and actually needs recalibration. If calibration is attempted on a partially functional generator, the auto calibration routine may be aborted before any calibration is done, and the generator will inhibit further exposures until the selected mA is calibrated for the selected kV.

1. For an APR MEMORY ERROR fault, the console factory defaults must be restored or the APR must be restored via GenWare®. The procedure for resetting console factory defaults is described in chapter 6.

5.3.0 LED INDICATORS

The following table describes the normal states and functions of the status and diagnostic LEDs on the circuit boards in the generator.

A change in the state of an LED may be for a brief duration, especially during a fault or an exposure.

5.3.1 Power Input Board

LED	SILK SCREEN	NORMAL STATE	FUNCTION
DS1	DC BUS OK	Lit	Indicates that the DC bus capacitors are charged. The DC bus must be charged before the main line contactor K5 can close.
DS2	+12 VDC OK	Lit	Indicates that +12 VDC is present on the power input board. This LED does NOT indicate that the +12 V rail is within normal limits.
DS3	K3 ON	Lit = tube 2 selected, off = tube 1 selected.	
DS4	K5 ON	Lit	Indicates that the main contactor (K5) is closed.
DS5	K4 ON	Lit = cooling fans on, off = cooling fans off.	
DS6	K2 ON	Lit	Indicates that K2 on the power input board is energized. This relay supplies AC mains power to the primary of the room interface transformer.
DS7	K1 ON	Lit	Indicates that K1 on the power input board is energized. This is the soft-start relay, and is normally energized when the generator is switched on. K1 will open if a DC bus fault is detected.

5.3.2 Auxiliary Board

LED	SILK SCREEN	NORMAL STATE	FUNCTION
D1	± 12V / SS Fault	Off	Except for a brief period during start-up of the generator, indicates that the + or - 12 VDC rails are low, or that a DC bus (soft start) fault is present.
D2	CNTCTR CLSD	Lit	Indicates that the auxiliary board has requested the main line contactor to close.
D3	SS OK	Lit	Indicates that the DC bus capacitors have charged normally, and the logic circuits should allow the main line contactor to close.
D29	+12 V	Lit	Indicates that the +12 VDC supply on the auxiliary board is present. This LED does NOT indicate that the +12 V rail is within normal limits.
D30	-12 V	Lit	Indicates that the -12 VDC supply on the auxiliary board is present. This LED does NOT indicate that the -12 V rail is within normal limits.
D31	±35 V	Lit	Indicates that the + and - 35 VDC supplies on the auxiliary board are present. This LED does NOT indicate that these supplies are within normal limits.
D36	RAD MODE	Lights to indicate that the generator is in the RAD or pulsed fluoro mode. This LED will be off in the continuous fluoro mode of operation.	
D37	FAN ON	Lights to indicate that the cooling fans (if fitted) have been activated. The fans are on during a fluoroscopy exposure, and for 20 minutes after the fluoro exposure has ended. The fans will also be on for the first 20 minutes after the generator has been switched on, and will be activated during radiographic exposures, if required.	

5.3.2 Auxiliary Board (Cont)

LED	SILK SCREEN	NORMAL STATE & FUNCTION
D39	Tube 2 selected	Lights to indicate that tube 2 has been selected (indicates that the tube selection switch in the HT tank is in the tube 2 position). The LED will be off if tube 1 is selected.
D42	Thermal cutoff open	Lights to indicate that the thermal sensor on the inverter assembly has detected an inverter over-temperature condition.

5.3.3 Control Board

LED	SILK SCREEN	NORMAL STATE	FUNCTION
D69	kV	Off	Indicates high kV ≥ 130 kV for 125 kV generators, ≥ 160 kV for 150 kV generators.
D70	Ir	Off	Indicates that the inverter (primary) current has exceeded preset limits.
D71	CI	Off	Indicates that cathode current has exceeded preset limits, usually due to an arc. If this is lit, check the X-ray tube. The X-ray tube may be damaged or simply require seasoning. If this does not solve the problem, check the HT cables and HT connections.
D72	AI	Off	Indicates that anode current has exceeded preset limits, usually due to an arc. Follow the recommendations for D71
D80	Inv. 3	Off	Indicates an inverter fault on inverter module 3 (units with three inverter modules only).
D81	Inv. 2	Off	Indicates an inverter fault on inverter module 2 (units with two or three inverter modules only).
D82	Inv. 1	Off	Indicates an inverter fault on inverter module 1.

5.3.4 Dual Speed Starter Board

LED	NORMAL STATE	FUNCTION
DS1	Off	If lit, indicates that excessive current has been drawn from the DC Bus. This indicates a DSS fault, if lit without a tube stator connected.

5.3.5 Generator CPU Board

LED	SILK SCREEN	FUNCTION
DS1	TXD	Flashes to indicate that the generator is sending serial data to the console.
DS2	LOW	Lit = pulsed fluoro / low power rad mode. This LED is the complement of DS4.
DS3	RXD	Flashes to indicate that the generator is receiving serial data from the console.
DS4	HIGH	Lit = high power rad mode. This LED is the complement of DS2.
DS5	TUBE 2	Lit = tube 2 selected. If neither DS5 or DS6 is lit, it indicates that a mismatch exists between the tube that was requested, and the tube that is actually selected.
DS6	TUBE 1	Lit = tube 1 selected. If neither DS5 or DS6 is lit, it indicates that a mismatch exists between the tube that was requested, and the tube that is actually selected.
DS7	LS	Lit = low speed selected. This LED is the complement of DS8.
DS8	HS	Lit = high speed selected. This LED is the complement of DS7.
DS9	CONT.	Lit = main contactor K5 closed. This LED is the complement of DS10.
DS10	CONT.	Lit = main contactor K5 not closed. This LED is the complement of DS9.
DS11	HV	Lit = no HV / mA fault. This LED is the complement of DS12.
DS12	HV	Lit = HV / mA fault. This LED is the complement of DS11.
DS13	FIL	Lit = no filament fault. This LED is the complement of DS14.
DS14	FIL	Lit = filament fault. This LED is the complement of DS13.
DS15	TXD	Flashes to indicate that the generator is sending serial data to the remote fluoro control.
DS16		Flashes at a 1 Hz rate if the CPU is operational.
DS17	P/S READY	Lit = ready to make an exposure (no faults detected, and KV ENABLE and PREP commands are present). This LED is the complement of DS18.
DS18	P/S READY	Lit = not ready to make an exposure (a fault has been detected or the KV ENABLE and PREP commands are not present). This LED is the complement of DS17.
DS19		Flashes to indicate that the generator is receiving serial data from the remote fluoro control.
DS20	ROTOR	Lit = normal stator current. This LED is the complement of DS21.
DS21	ROTOR	Lit = stator fault, or starter is in standby mode. This LED is the complement of DS20.
DS22	FLUORO	Lit = fluoro selected. This LED is the complement of DS23.
DS23	$\overline{\text{FLUORO}}$	Lit = rad selected. This LED is the complement of DS22.
DS24	LARGE	Lit = large focus selected. This LED is the complement of DS25.
DS25	SMALL	Lit = small focus selected. This LED is the complement of DS24.
DS26	X-RAY	Lit = X-ray exposure in process.
DS27	PREP	Lit = Prep requested. This LED is the complement of DS28.
DS28	PREP	Lit = Prep not requested. This LED is the complement of DS27.
DS29	TXD	Flashes to indicate that the generator is sending serial data to J2 on the generator CPU board.
DS30	KV EN	Lit = kV Enable requested. This LED is the complement of DS31.
DS31	KV EN	Lit = kV Enable not requested. This LED is the complement of DS30.
DS32	RXD	Flashes to indicate that the generator is receiving serial data from J2 on the generator CPU board.

5.3.5 Generator CPU Board (Cont)

<table>
<tr><th>LED</th><th>SILK SCREEN</th><th colspan="2">FUNCTION</th></tr>
<tr><td>DS33</td><td>+5V</td><td>Normally lit</td><td>Indicates that the +5 VDC supply on the generator CPU board is present. This LED does NOT indicate that the +5 V rail is within normal limits.</td></tr>
<tr><td>DS34</td><td>P/S ON</td><td colspan="2">Lit = generator “on” command issued. This LED is the complement of DS35.</td></tr>
<tr><td>DS35</td><td>P/S ON</td><td colspan="2">Lit = generator “on” command not issued. This LED is the complement of DS34.</td></tr>
<tr><td>DS36</td><td>+15V</td><td>Normally lit</td><td>Indicates that the +15 VDC supply on the generator CPU board is present. This LED does NOT indicate that the +15 V rail is within normal limits.</td></tr>
<tr><td>DS37</td><td>–15V</td><td>Normally lit</td><td>Indicates that the -15 VDC supply on the generator CPU board is present. This LED does NOT indicate that the -15 V rail is within normal limits.</td></tr>
<tr><td>DS38</td><td>+12V</td><td>Normally lit</td><td>Indicates that the +12 VDC supply on the generator CPU board is present. This LED does NOT indicate that the +12 V rail is within normal limits.</td></tr>
<tr><td>DS39</td><td>–12V</td><td>Normally lit</td><td>Indicates that the -12 VDC supply on the generator CPU board is present. This LED does NOT indicate that the -12 V rail is within normal limits.</td></tr>
<tr><td>DS40</td><td colspan="3">Flashes to indicate the presence of sync pulses fed back to the generator CPU. Only applicable if the digital imaging system is supplying sync pulses and JW22 on the generator interface board is set to the external sync position, or if JW22 is set to the internal sync position for line-frequency synchronization.</td></tr>
<tr><td>DS41</td><td colspan="3">Lit = a valid X-ray request has been received by the generator CPU. This LED is the complement of DS42.</td></tr>
<tr><td>DS42</td><td colspan="3">Lit = a valid X-ray request has not been received by the generator CPU. This LED is the complement of DS41.</td></tr>
<tr><td>DS43</td><td colspan="3">Flashes to indicate that the generator is sending serial data to J1 on the generator CPU board.</td></tr>
<tr><td>DS44</td><td colspan="3">Flashes to indicate that the generator is receiving serial data from J1 on the generator CPU board.</td></tr>
<tr><td>DS45</td><td colspan="3">Flashes to indicate that the generator is sending serial data to J15 on the generator CPU board.</td></tr>
<tr><td>DS46</td><td colspan="3">Flashes to indicate that the generator is receiving serial data from J16 on the generator CPU board.</td></tr>
<tr><td>DS47</td><td colspan="3">Flashes to indicate that the generator is receiving serial data from J15 on the generator CPU board.</td></tr>
<tr><td>DS48</td><td colspan="3">Flashes to indicate that the generator is sending serial data to J16 on the generator CPU board.</td></tr>
</table>

5.3.6 Generator Interface Board

LED	NORMAL STATE	FUNCTION
DS1	Lit	Lights when the generator is connected to live AC mains. This LED indicates the presence of 24 VDC as used by the generator ON / OFF circuits.

5.3.7 DAP Interface Board

LED	FUNCTION
DS1	This LED normally flashes at approximately 1 Hz. If the LED flashes at approximately 4 Hz, this indicates that resettable fuse F1 has tripped due to excessive current drain from the DAP device(s). F1 will reset when it has cooled and the over current condition has been removed.
DS2	Lights to indicate that DAP channel 2 is selected.
DS3	Lights to indicate that DAP channel 1 is selected.

5.3.8 AEC Board

Refer to MD-0757 in chapter 9.

5.3.9 Digital I/O Board

Refer to MD-0767 in chapter 9.

5.3.10 Room Interface Board

LED	NORMAL STATE	FUNCTION
DS1	Lit	Lights when the generator is switched ON. This LED indicates the presence of +24 VDC on this board.

5.4.0 MISCELLANEOUS FAULTS

5.4.1 Erratic Console Faults

SYMPTOM: In some environments that are “electrically noisy”, the console may exhibit erratic faults i.e. RAM data error, intermittent loss of communication, or random fault messages may be displayed.

SOLUTION: Connect a separate ground wire, #14 AWG (2.3 mm^2) or larger from the ground stud on the rear of the console (marked CONSOLE GROUND in the figure “*rear of control console*” in chapter 2) to the ground stud located to the left of the main input fuse block. This is marked GROUND in the figure “*generator mains connection*” in chapter 2.

SYMPTOM: In some situations the touchscreen console may appear “frozen”. i.e. cannot activate any of the buttons on the touch sensitive screen. This may be a case of the touchscreen calibration being significantly out of alignment.

SOLUTION: Connect a USB keyboard to the rear of the touchscreen and press **Alt** + **C**. This will activate the touchscreen calibration sequence. Refer to Chapter 3C for the procedure to complete this sequence. If the condition persists, contact Product Support for assistance.

5.4.2 Power Input Board Faults

SYMPTOM: DC bus capacitors do not discharge rapidly when generator is powered off, LS1 buzzer will sound while generator is switched on.

SOLUTION: Check fuse (F7).

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CHAPTER 6

REGULAR MAINTENANCE

CONTENTS:

6.1.0 INTRODUCTION

This chapter provides a recommended schedule for periodic maintenance of the Indico 100 family of X-ray generators.

<u>NOTE:</u> ***REFERENCES IN THIS SECTION TO CONSOLE SERVICING (SETTING CONSOLE CPU FACTORY DEFAULTS, CONSOLE EPROM REPLACEMENT, CONSOLE BATTERY REPLACEMENT, ETC AS APPLICABLE) DO NOT APPLY TO THE TOUCH SCREEN CONSOLE. THE TOUCH SCREEN CONSOLE IS NOT FIELD SERVICEABLE. PLEASE CONTACT THE FACTORY FOR SERVICE.***

6.2.0 X-RAY GENERATOR UPDATE/SERVICE RECORD

The X-ray generator update / service record is included in the front of the service manual for each generator. The installation date and location should be recorded on this form at the time of the original site installation.

Service and repairs must be recorded on the update / service record. The record should be as thorough as possible, detailing the scope and type of work that was performed (all service and a record of all replacement parts that were installed). Additionally, the person performing the work should date and sign the record.

This information will be invaluable in the future for traceability and to ensure continued compatibility of the generator.

6.3.0 MAINTENANCE SCHEDULE

<u>WARNING:</u> ***MAINTENANCE IS TO BE PERFORMED ONLY BY COMPETENT, TRAINED PERSONNEL WHO ARE FAMILIAR WITH THE POTENTIAL HAZARDS ASSOCIATED WITH THIS EQUIPMENT.***

<u>NOTE:</u> ***MAINTENANCE SCHEDULE FREQUENCY MAY BE DETERMINED BY CERTAIN REGULATORY REQUIREMENTS OF THE COUNTRY OR STATE IN WHICH THE INSTALLATION IS LOCATED. ALWAYS CHECK THE LOCAL CODES AND REGULATIONS WHEN DETERMINING A MAINTENANCE SCHEDULE.***

<u>WARNING:</u> ***ALWAYS SWITCH OFF MAINS POWER TO THE GENERATOR AND WAIT A MINIMUM OF 5 MINUTES FOR CAPACITORS TO DISCHARGE BEFORE BEGINNING ANY PREVENTATIVE MAINTENANCE, INCLUDING CLEANING.***

<u>WARNING:</u> ***OBSERVE ESD PRECAUTIONS. KEEP ALL STATIC - SENSITIVE COMPONENTS AND CIRCUIT BOARDS IN THEIR STATIC - SHIELDING PACKAGING UNTIL READY TO INSTALL. ENSURE THAT YOU ARE GROUNDED AT ALL TIMES WHEN HANDLING STATIC - SENSITIVE COMPONENTS AND CIRCUIT BOARDS.***

6.3.0 MAINTENANCE SCHEDULE (Cont)

Maintenance Frequency	Description of Preventative Maintenance
As governed by local regulations:	<u>Mandatory</u> 1. Check and recalibrate the DAP meter in the generator per chapter 3F (units with the DAP option). 2. For units with the AK (Air Kerma) option, verify the air kerma calibration per chapter 3F. 3. Verify the calibration of the generator; refer to chapter 4 of this manual. 4. Perform any additional tests required by laws governing this installation.
Every 6 Months AND whenever a related certifiable X-ray component is replaced:	<u>Mandatory</u> 1. Clean and re-grease the HV connections on the HT tank ***if using vapour-proof compound.*** See note following this table. 2. Perform the X-ray tube auto calibration, refer to chapter 2. ***This is required within 6 months of installing a new X-ray tube, and annually thereafter.*** <u>Recommended (but not mandatory)</u> 1. Clean the control console, remote fluoro control (if used) and main cabinet as needed. **REFER TO 6.5.0 CLEANING** before proceeding. 2. For units with the touch screen console, perform touch screen calibration. Refer to chapter 3C for the calibration procedure. 3. For fan-cooled Indico 100 generators, remove accumulated dust from the external cooling vents, from the fan housing(s) & fan blades and from the inverter heat sinks. Vacuuming is recommended. Remove the fiberglass panel that baffles the inverter airflow in order to vacuum the inverter assemblies. *Be sure to properly replace the fiberglass air baffle before powering up the generator.* 4. Check all visual displays (warning and status lights, technique displays, exposure indicators, etc) for normal operation. 5. Check all audible indicators for normal operation, and check that the loudness settings are adequate for the environment.

6.3.0 MAINTENANCE SCHEDULE (Cont)

Every 12 months:	<u>Mandatory</u> 1. Check the insulating oil in the high voltage output connectors on the HT tank (if applicable). See note following this table. 2. Clean the control console, remote fluoro control (if used) and main cabinet as needed. **REFER TO 6.5.0 CLEANING** before proceeding. 3. For units with the touch screen console, perform touch screen calibration. Refer to chapter 3C for the calibration procedure. 4. For fan-cooled Indico 100 generators, remove accumulated dust from the external cooling vents, from the fan housing(s) & fan blades and from the inverter heat sinks. Vacuuming is recommended. Remove the fiberglass panel that baffles the inverter airflow in order to vacuum the inverter assemblies. *Be sure to properly replace the fiberglass air baffle before powering up the generator.* 5. Test the X-ray tube thermal switch circuits in the generator. Disconnect the tube thermal switch(s), and then verify the correct error message and that X-ray exposures are inhibited. 6. Examine the following for any visible damage and replace any damaged components: • The exterior of the control console and remote fluoro control if used, including the membrane switch assembly. • The cable between the control console and the generator main cabinet and between the remote fluoro control (if used) and generator main cabinet. • The hand switch and fluoro footswitch (if used) and the cables connecting these to the console. 7. Check all visual displays (warning and status lights, technique displays, exposure indicators, etc) for normal operation. 8. Check all audible indicators for normal operation, and check that the loudness settings are adequate for the environment. 9. Open the generator cabinet and examine the unit for any visible damage: Missing or loose ground connections, oil leaks, damaged cables etc. 10. Ensure that there are no obstructions blocking any of the ventilation holes or louvers on the generator cabinet.
Every 5 years:	<u>Mandatory</u> 1. Replace the lithium battery on the generator CPU board in the main cabinet and on the CPU board in the control console (if fitted). Refer to the spares list in chapter 8 for the required part number. Refer to 6.8.0 for the battery replacement procedure. 2. Replace the cooling fans in the generator. The airflow vs. static pressure must be considered when replacing the fans. Replacement fans must have performance characteristics similar to the original fans. Consult the factory if in doubt.

6.3.0 MAINTENANCE SCHEDULE (Cont)

Note: The high voltage receptacles on the HT tank must either be filled with insulating oil (preferred) or the high voltage connectors at the HT tank end must be coated with vapour-proof insulating compound. The method used at the X-ray tube's high voltage connectors is at the discretion of the installer / service engineer, however it must be adequate to prevent arcs / flashover at the X-ray tube end as tube high voltage arcs will impact the generator's usability.

6.4.0 OIL FILL/LEVEL CHECK (HT TANK)

Indico 100 X-ray generators use different styles of HT tanks, depending on model. Refer to figure 6-1. For the HT tank on the right side of figure 6-1, field maintenance is neither necessary nor possible. The oil is factory-filled to the correct level and the HT tank is then sealed. An air-filled "bladder" within the tank will expand and contract as the oil volume changes with pressure and temperature changes.

Note: ***For the HT tank on the right side of figure 6-1, ensure that the vent tube ("VENT" in figure 6-1) is not blocked.***

Note: ***HV connectors are not shown in figure 6-1.***

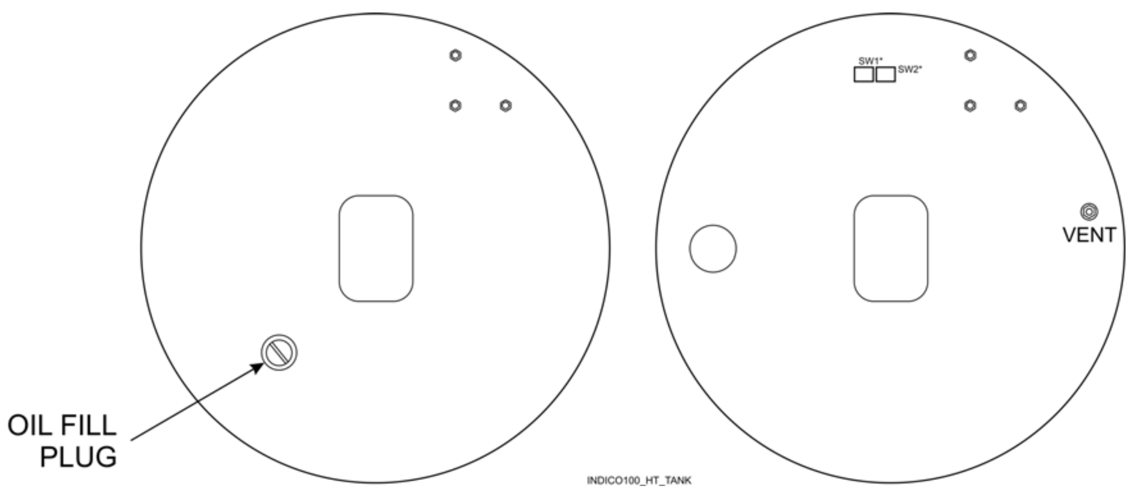


Figure 6-1: HT tank oil fill

**** Do not adjust SW1 / SW2 on the HT tank (not fitted on all models)***

For the HT tank on the left side of figure 6-1, the oil level in the HT tank can be checked in the field and the oil can be topped up if necessary. Refer to the steps below.

The insulating oil level in the HT tank does NOT require periodic checking under normal conditions. However, if there is evidence of possible oil loss, the procedure for checking the correct oil level follows.

1. Loosen the oil fill plug screw on the tank lid.

2. With the screw sufficiently loosened, remove the rubber (neoprene) plug.

6.4.0 OIL FILL/LEVEL CHECK (HT TANK) (Cont)

3. Use a **clean** ruler, strip of cardboard, or other equivalent material to determine the oil level -- **measured always from the TOP surface of the HT tank's lid.**
   - Normally the oil level should be between 0.88 - 1.25 inches (22 - 32 mm) from the top of the tank lid.
   - If the oil level is between 1.25 - 1.6 inches (32 - 41 mm) from the top of the tank lid, then clean oil should be added as needed.
   - If the oil level is greater than 1.6 inches (41 mm) below the top of the tank lid, please consult the factory.

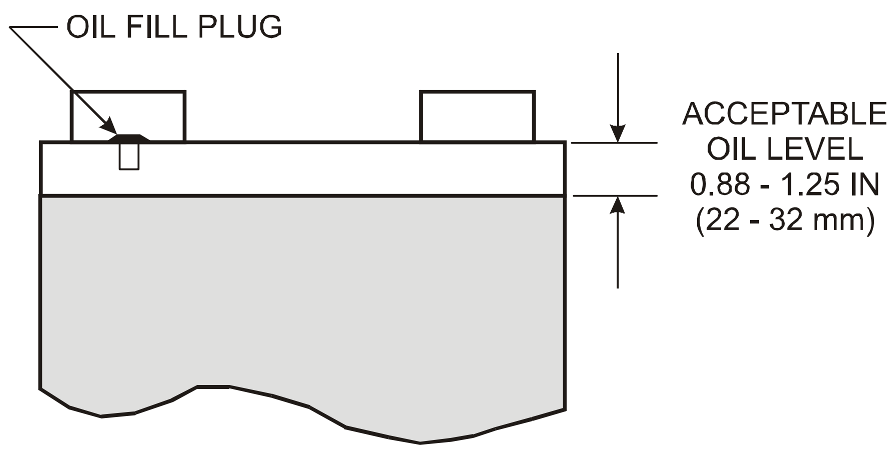


Figure 6-2: HT tank oil level

4. Use only fresh oil, type Shell DIALA AX or equivalent. It is critical that air is not added when topping up the oil. The following procedure is strongly recommended when adding oil.
   - Use a new clean syringe to remove oil from the container. A 60 cc catheter tip syringe is recommended. Approximately 60 cc of oil is required to raise the oil level by one millimeter.
   - Turn the syringe upright and expel any trapped air.
   - Place the tip of the syringe through the oil-fill plug and into the oil, ensuring that it is below the surface of the oil.
   - Gently eject the oil from the syringe into the HT tank, while making sure that the tip of the syringe remains below the surface of the oil until all of the oil is emptied from the syringe.
   - Repeat the previous steps until the required amount of oil has been added.

5. Replace the oil fill plug. Once the plug is installed and the screw is properly seated, continue to tighten the screw until the neoprene plug is firmly secured. Do not over tighten; the screw should mildly compress the neoprene plug when tight. Wipe up any oil spills. Dispose of soiled absorber in compliance with government requirements and ensure conformity to local disposal regulations. THE OIL DOES NOT CONTAIN PCBs.

6.5.0 CLEANING

- If console surfaces need to be disinfected, use Actichlor or equivalent with a Hypochlorite concentration of 3 to 5%.
  - ∗ Dilute the disinfectant 50/50 with water.
  - ∗ Spray or dampen a lint-free cloth with the diluted disinfectant. The cloth must be damp only, not wet.
  - ∗ Gently wipe the console surfaces with the damp cloth.
- **Never use any corrosive, solvent or abrasive detergents or polishes.**
- Ensure that no water or other liquid can enter any equipment. This precaution prevents short circuits and corrosion forming on components.
- Methods of disinfection used must conform to legal regulations and guidelines regarding disinfection and explosion protection.
- If disinfectants are used which form explosive mixtures of gases, these gases must have dissipated before switching on the equipment again.
- Disinfection by spraying is not recommended because the disinfectant may enter the X-ray equipment.
- If room disinfection is done with an atomizer, it is recommended that the equipment be switched OFF, allowed to cool down and covered with a plastic sheet. When the disinfectant mist has subsided, the plastic sheet may be removed and the equipment be disinfected by wiping.

6.6.0 EPROM REPLACEMENT / FIRMWARE UPGRADE

WARNING: ***PLEASE TAKE APPROPRIATE ELECTROSTATIC PRECAUTIONS AT ALL TIMES WHEN HANDLING THE EPROM's.***

6.6.1 Console EPROM / firmware upgrade

NOTE: ***A PERMANENT BACKUP FILE OF THE APR DATA SHOULD BE KEPT IN THE EVENT THE CONSOLE SOFTWARE IS CORRUPTED OR A "CONSOLE DEFAULTS" IS REQUIRED. THE BACKUP FILE SHOULD BE STORED ON AN EXTERNAL STORAGE DEVICE, SUCH AS A LAPTOP OR USB FLASH DRIVE.***

Indico 100 X-ray generators are available with several different control consoles. As a result, there are different procedures for upgrading the console firmware.

- 23 X 56 cm console.
- 31 X 42 cm console part number 735893-12 ***only***.
- 31 X 42 cm console part number 735893 ***all except –12***.
- Rad-only console.

6.6.1 Console EPROM / firmware upgrade (Cont)

23 X 56 cm console.

1. The software for the 23 X 56 cm console resides in an EPROM. When the software for this console needs to be field upgraded, a replacement EPROM will be supplied.
   - Use the GenWare® console utility to back up the APR data. Refer to the manual included with the GenWare® software.
   - With the generator mains power switched OFF, open the console to gain access to the console EPROM. Refer to chapter 2, the section *CHECKING THE RAM BACKUP BATTERY VOLTAGE*, for the procedure to access the console CPU board.
   - Locate and carefully remove the existing EPROM on the console CPU board (refer to figure 1E-4).
   - Carefully insert the replacement EPROM into the socket *observing the orientation per figure 1E-4*.
   - Re-assemble the console as per the procedure in chapter 2.
   - Refer to 6.6.4 before re-energizing the generator.

31 X 42 cm console (part number 735893-12 *only*).

1. Console software for the 31 X 42 cm console (part # 735893-12) initially resides in flash memory on the console board. The console software will be field upgraded by one of the following methods:
   - The flash memory may be reprogrammed in the field if the required hardware is available (a suitable computer, a flash loader, and the proper cables). For details, please consult the factory.
   - Alternatively, an EPROM may be supplied containing the updated software. Continue with the following steps if upgrading the software via an EPROM.
     * Use the GenWare® Console Utility to back up the APR data. Refer to the manual included with the GenWare® software.
     * With the generator mains power switched OFF, remove the EPROM access panel on the bottom of the console to gain the required access to the console CPU board.
     * Locate the EPROM socket U29 on the console CPU board.
     * Carefully insert the EPROM with the upgraded software into the EPROM socket *observing the orientation per the silkscreen on the board*.
     * Ensure that JW1 on the console board is set to the “EPROM boot” position in order to run the updated software on EPROM (JW1 pins 1-2 shorted). This jumper is initially set to the “flash boot” position in order to boot from flash memory (JW1 pins 2-3 shorted). *Note that JW1 on the console board must be reset to the “flash boot” position in order to run existing or upgraded console software from flash memory*.
     * Reinstall the EPROM access panel on the bottom of the console.
     * Refer to 6.6.4 before re-energizing the generator.

6.6.1 Console EPROM / firmware upgrade (Cont)

31 X 42 cm console (all except part number 735893-12) *and* Rad-only console.

For the 31 X 42 cm console (all part numbers except 735893-12) and for the Rad-only console, the firmware resides in flash memory. Follow the procedure below to upgrade the firmware.

1. Ensure that GenWare® MP (version 1.03 or later) is installed on the computer that will be used for the firmware upgrade. The CPI flash program utility is part of GenWare® MP.

2. Start with the console (generator) switched off.

3. Connect a null-modem cable from the serial port on the PC that will be used to do the firmware upgrade to the DATA LINK connector on the console.

4. Copy the updated software file onto the computer's hard drive. The updated software file may be distributed by various means including CD, e-mail, etc. There is only one file to be copied, in the format **123456A.cpm**. Note the folder to which this file has been copied.

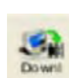
5. Switch the console on.

6. Enter the **GENERATOR SETUP** menu. Select **DATA LINK,** and then select **CONNECT TO GENWARE**. Refer to chapter 3C. The LCD on the console will display **WAITING FOR DATA….PLEASE DO NOT TURN OFF POWER.**

7. **Start** GenWare® MP on your PC. The LCD on the console will display **GENERATOR LINK ENABLED - PLEASE DO NOT TURN OFF POWER.** This indicates that GenWare® MP is communicating with the console.

8. If communication is not established, check the COM port setting in GenWare® MP.

   - Select **Communications Setup**  on the GenWare® MP toolbar. The **Communication Setup** window will open.
   - Under **COM Port Selection**, select the desired COM port, if known.
   - Select **Apply**, and then **Close**.
   - Exit GenWare® MP, then restart GenWare® MP in order for the change to take effect.
   - If the required COM port is not known, you may need to select consecutive COM ports by trial and error. Repeat the previous steps, using a different COM port for each trial.

9. Select **Firmware Updater**  on the GenWare® MP toolbar. The **CPI Generator Flash Program Utility** will open. Refer to figure 6-3.

10. Select **EXIT** on the console to return to the **DATA LINK TYPE** menu.

11. Select **FIRMWARE UPDATE**. The LCD on the console will display **WAITING FOR UPDATE…PLEASE DO NOT TURN OFF POWER**.

12. On the **CPI Generator Flash Program Utility**, under **CPM Format**, ensure that **File** is selected. This is the default setting.

13. Select **Browse**. A dialog box will open asking you to **Choose a file to open**. Select the cpm file that was in step 4.

6.6.1 Console EPROM / firmware upgrade (Cont)

14. The file path and name will be copied into the text field under **CPM Format.**

15. **DO NOT SWITCH OFF THE GENERATOR DURING THE NEXT THREE STEPS. IF POWER IS LOST DURING THE UPGRADE PROCESS, THE CONSOLE WILL NEED TO BE RETURNED TO THE FACTORY TO BE REPROGRAMMED.**

16. Select **Start Download.**

17. If the updated software file is able to successfully download to the console, the **Progress** bar on the downloader utility window will indicate the progress, and the **%** indicator will show the percent completion. The console LCD will display **DOWNLOADING UPDATE… PLEASE DO NOT TURN OFF POWER** and it will also indicate the progress via a progress bar.

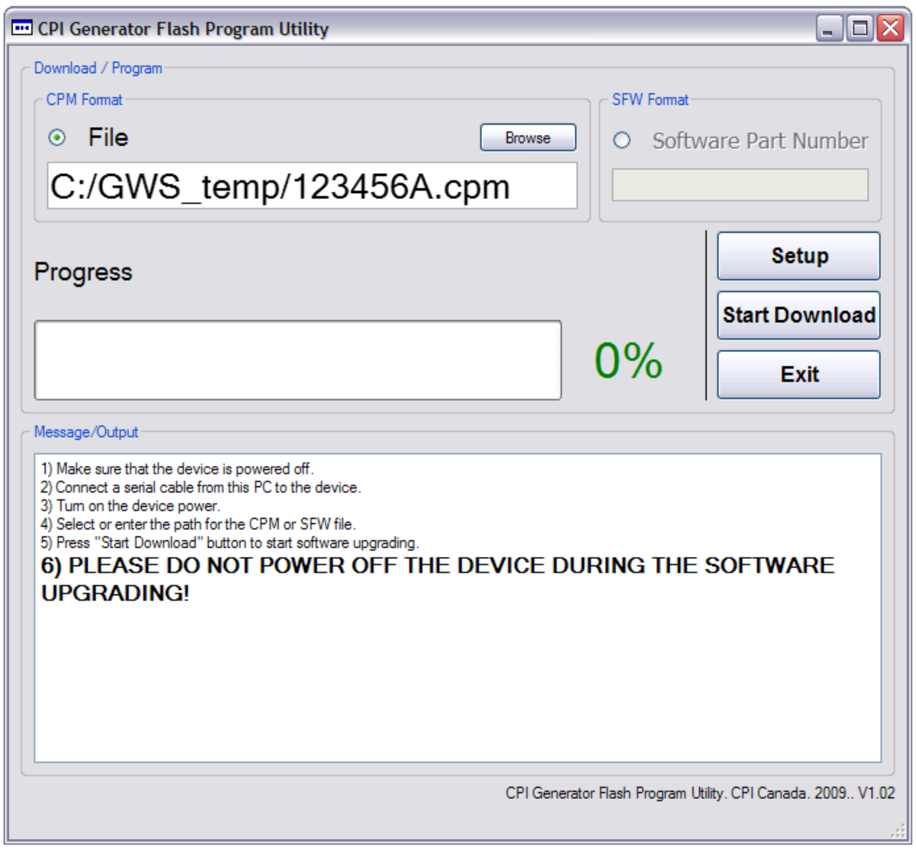


Figure 6-3: Console downloader utility

18. If the message **Console type is not matched!** is displayed, this indicates that the software file is not compatible with that console.

19 When the download is finished and the console's flash memory has been updated, the console will display **UPDATE SUCCESSFUL**. The console and computer may then be switched off, and the null-modem cable may be disconnected.

20. Refer to 6.6.4 before re-energizing the generator.

6.6.2 Power EPROM

NOTE: ***A PERMANENT BACKUP FILE OF THE GENERATOR CONFIGURATION (RECEPTOR SETUP, FLUORO SETUP, AEC SETUP AND CALIBRATION, ABS SETUP AND CALIBRATION, ETC,) SHOULD BE KEPT IN THE EVENT THE GENERATOR SOFTWARE IS CORRUPTED OR A "FACTORY DEFAULTS" IS REQUIRED. THE BACKUP FILE SHOULD BE STORED ON AN EXTERNAL STORAGE DEVICE, SUCH AS A LAPTOP OR USB FLASH DRIVE.***

1. Use the GenWare® software to back up the generator data. For Touchscreen GenWare® software refer to chapter 3C ***Generator Configuration Backup and Restore*** and for PC GenWare® software, refer to the manual included with the GenWare® software.
2. With the generator mains power switched OFF, locate and carefully remove the existing power EPROM on the generator CPU board (U41, refer to figure 1E-1).
3. Carefully insert the replacement EPROM into the socket *observing the orientation per figure 1E-1*.
4. Refer to 6.6.4 before re-energizing the generator.

6.6.3 Dual Speed Starter EPROM (If fitted)

1. Switch the generator mains power OFF, **AND WAIT 5 MINUTES FOR THE DC BUS CAPACITORS TO FULLY DISCHARGE.**
2. Locate and carefully remove the existing EPROM on the dual speed starter board (U26, refer to figure 1E-6).
3. Carefully insert the replacement EPROM into the socket *observing the orientation per figure 1E-6*.

6.6.4 Resetting Factory Defaults

Resetting the factory defaults will restore the CPU's NVRAM / flash memory contents to their factory default state. This will be required if a major firmware upgrade is done. Minor firmware upgrades, such as revision upgrades, do not require resetting of the factory defaults.

The factory defaults should not be reset casually as this will erase all custom programming made to the console or generator.

Determining the part # and revision of the current firmware:

- 23 X 56 cm console: Label on EPROM.
- 31 X 42 cm console*:*
  - ∗ The part number and revision of the software in flash memory is displayed at the password screen, below the message **ENTER PASSWORD: _____,** when initially entering into programming mode.
  - ∗ For units where the software has been updated via an EPROM (735893-12 only), the current software part # and revision will be on the EPROM***.***
- Rad-only console: Label on FPGA U21. Remove the console bottom cover to reveal U21 with the attached label.
- Power EPROM U41 (on generator CPU board): Label on EPROM.
- Dual speed starter: Not applicable.

6.6.4 Resetting Factory Defaults (Cont)

Procedure for resetting factory defaults:

- 23 X 56 cm console and 31 X 42 cm console part number 735893-12 using an EPROM**:**
  - With the power OFF, set switch 8 of SW1 on the console CPU board to its **ON** position.
  - Power ON the generator. The console will prompt for a **YES** or **NO** to loading defaults for two conditions (console settings and APR memory). Select **YES** to both.
  - Power OFF the console. Reset switch 8 of SW1 on the console CPU board to its **OFF** position.
  - This will initialize both the CONSOLE settings (refer to CONSOLE settings in chapter 3C) and the APR to the factory default settings.
- 31 X 42 cm console using flash memory (all versions except 735893-12 with an EPROM) ***and*** Rad-only console:
  - In chapter 3C, refer to **LOAD CONSOLE DEFAULTS.** This is in the **UTILITY** menu, under the **Console** submenu. Set **LOAD CONSOLE DEFAULTS** to **YES**.
  - Select **<<** and **EXIT** to return to the **UTILITY** menu.
  - Select **EXIT** again to return to the **GENERATOR SETUP** menu.
  - Briefly switch the generator OFF, and then ON again. The console will prompt for a **YES** or **NO** to loading defaults when it is powered on again. Select **YES** to both prompts to reset the console and APR defaults.
  - This will initialize both the CONSOLE settings (refer to CONSOLE settings in chapter 3C) and the APR to the factory default settings.
  - The **LOAD CONSOLE DEFAULTS** setting automatically resets to **NO** the next time the generator is switched on.
- Generator CPU factory defaults:
  - With the power OFF, set switch 8 of SW1 on the generator CPU board to its **OFF** position.
  - Power ON the generator. After the initialization is complete, the console will display the message **FACTORY DEFAULTS.**
  - Reset switch 8 of SW1 on the generator CPU board to its **ON** position. Then press RESET (console MENU button) to clear the **FACTORY DEFAULTS** message.
  - This will initialize the following generator data to the factory default settings: Tube selection, generator limits, receptor setup, I/O configuration, AEC setup and calibration, fluoro setup and calibration, Air Kerma and DAP setup and calibration, time & date, error log and statistics.
  - All applicable setup and calibration will need to be performed and / or backed up data will need to be restored via GenWare® before the generator can be placed back into service. *Note that the X-ray tube calibration curves are NOT reset after the factory defaults are reset*.

6.7.0 SOFTWARE KEY INSTALLATION / REPLACEMENT

WARNING: ***PLEASE TAKE APPROPRIATE ELECTROSTATIC PRECAUTIONS AT ALL TIMES WHEN HANDLING THE "SOFTWARE KEY" I.C.***

The "software key" activates specific options in the generator, and may need to be installed to add certain options, or may need to be replaced if it is desired to alter the current configuration of the generator. To install or replace the software key follow the procedure below.

1. With the generator mains power switched OFF, locate the socket for the "software key", U29, on the generator CPU board. Refer to figure 6-4.

2. Remove the existing I.C. U29, if fitted. The original I.C. should be placed in anti-static packaging, and may be set aside for future use in a generator that requires the options that are activated by that I.C.

3. Carefully insert the replacement "software key" into the U29 socket *observing the orientation per figure 6-4*.

4. Perform setup and calibration, if required, of the new features that have been activated by the new software key. Refer to the applicable sections of the service manual.

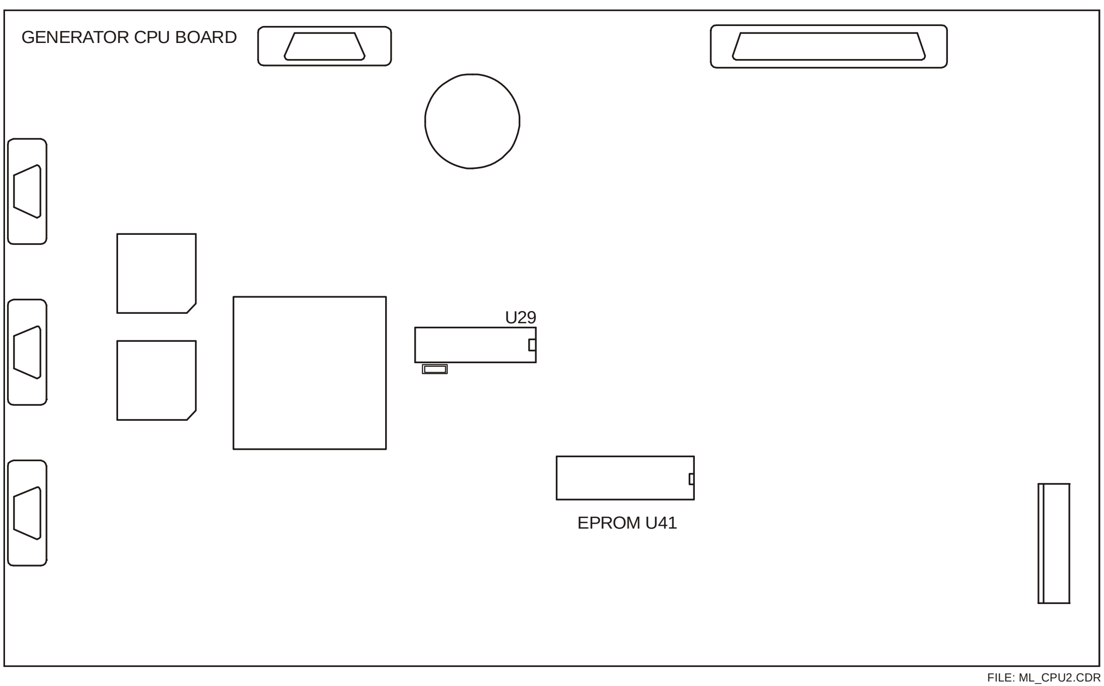


Figure 6-4: Software key location and orientation

6.8.0 BATTERY REPLACEMENT

To replace the battery on the console CPU board (if applicable) or on the generator CPU board, follow the procedure below. Refer to the figure showing the location of these batteries in chapter 2, in the section "CHECKING THE RAM BACKUP BATTERY VOLTAGE". Refer to that section in chapter 2 for console disassembly instructions to gain access to the console CPU board if required.

NOTE: ***THE CONSOLE BATTERY SHOULD BE REPLACED WITH THE GENERATOR POWERED UP. THIS WILL PREVENT THE CONSOLE DATA FROM BEING LOST WHEN THE BATTERIES ARE REMOVED.***

THIS IS THE ONLY EXCEPTION TO THE RULE OF NOT SERVICING THE GENERATOR WHILE THE POWER IS ON. FAMILIARIZE YOURSELF WITH THE HIGH VOLTAGE LOCATIONS AND HAZARDS BEFORE REPLACING THIS BATTERY.

1. Remove the battery from the holder by gently prying under the battery at the access slot in the battery holder using a small screwdriver. Slide the battery over the edge of the holder and remove it when it is free.

2. Check the voltage of the new battery prior to inserting it. This should be nominally 3.0V, do not use if it is under 2.80 V.

3. Wipe the replacement battery with a clean cloth, and ensure that the holder is clean and free of debris before inserting the battery.

4. Gently lift the spring contact on the holder and insert the replacement battery positive (+) side up

6.9.0 TUBE CONDITIONING / SEASONING

Tube conditioning or "seasoning" is particularly important for new tubes or tubes that have not been used for several days. This should also be performed on each X-ray tube before attempting auto calibration, as an unseasoned tube may not operate properly at higher kV values without arcing. Refer to the X-ray tube manufacturer's instructions, if available, for the tube conditioning or "seasoning" procedure. If the X-ray tube manufacturers instructions are not available, the following procedure may be used:

6.9.1 Tube Conditioning (Overview)

The generator does X-ray tube auto calibration at 50 kV, 60 kV, 70 kV, 80 kV, 100 kV and 120 kV. The tube normally needs to be seasoned before it can be operated at the higher voltages encountered during auto calibration.

Tube seasoning is started by auto calibrating the kV stations up to and including part of the 70 kV station. The tube is then seasoned at 70 kV. Progressively higher kV stations are then auto calibrated and seasoned. Finally the entire kV and mA range is auto calibrated, then the tube is seasoned at the remaining high kV values.

Manually releasing the exposure button during auto calibration of a particular kV station in the following procedure prevents the generator from attempting operation beyond that kV/mA value.

NOTE: ***THE TUBE MANUFACTURER'S RECOMMENDED SEASONING PROCEDURE, IF AVAILABLE, MUST ALWAYS BE USED IN PLACE OF THE FOLLOWING PROCEDURE.***

6.9.1 Tube Conditioning (Overview) (Cont)

NOTE: ***LOW SPEED ONLY EXPOSURES ARE RECOMMENDED FOR THE SEASONING EXPOSURES, TO PREVENT EXCESSIVE HEAT BUILD-UP IN THE HOUSING FROM THE STATOR WINDINGS OR THE ROTOR BEARINGS.***

X-ray tubes that have not been used for more than 8 hours may suffer thermal shock if operated at high mA and kV without a warm-up procedure. A cold anode (Molybdenum) is very brittle and when suddenly heated over a small area may experience thermal cracking of the anode surface, eventually leading to permanent tube damage.

6.9.2 Tube Conditioning (Procedure)

X-ray tube seasoning should be done on LARGE focus in order to minimize tube wear.

The procedure below is intended for seasoning an X-ray tube prior to attempting tube auto calibration. To season a tube that does not need to be calibrated, simply follow steps 2, 4, 6, 8, and 9.

1. Start the tube auto calibration sequence, and manually terminate the exposure at 70 kV and 250 mA.

2. Season the tube at 70 kV by taking approximately 10 exposures of 200 mA and 100 ms. These exposures should be taken at the rate of approximately one every 15 seconds.

3. Restart the auto calibration sequence and manually terminate the exposure at 100 kV and 250 mA.

4. Season the tube at 100 kV by taking approximately 5 exposures of 200 mA and 100 ms. These exposures should be taken at the rate of approximately one every 15 seconds.

5. Restart the auto calibration sequence and manually terminate the exposure at 120 kV and 160 mA.

6. Season the tube at 120 kV by taking approximately 5 exposures of 160 mA and 100 ms. These exposures should be taken at the rate of approximately one every 15 seconds.

7. Restart the auto calibration sequence and allow the auto calibration sequence to complete.

8. Season the tube at 130 kV by taking approximately 5 exposures of 100 mA and 50 ms. These exposures should be taken at the rate of approximately one every 15 seconds.

9. Repeat step 8 at 140 kV, and then at 145 kV.

6.10.0 END OF PRODUCT LIFE

The generator's useful life is estimated to be 10 years from point of sale. This will vary depending on use and environmental conditions. If the generator has completed its useful service life, local environmental regulations must be complied with in regard to disposal of possible hazardous materials used in the construction of the generator.

In order to assist with this determination, the noteworthy materials used in the construction of this generator are itemized below:

ITEM

- Electrical insulating oil in HT tank. This is a mineral oil with trace additives (25 Liter, 6.5 U.S. gal).
- Solder (lead/tin).
- Epoxy fiberglass circuit board materials, tracks are solder on copper.
- Wire, tinned copper. Insulated with PVC, tefzel, or silicone.
- Steel and / or aluminum (generator cabinet and console chassis).
- Plastic (console enclosure and console membrane).
- Electrical and electronic components: IC's, transistors, diodes, resistors, capacitors, etc.

WARNING: ***DO NOT DISASSEMBLE, INCINERATE, OR SHORT-CIRCUIT THE BATTERY(S) IN THIS PRODUCT. DO NOT PUT IT IN TRASH THAT IS DISPOSED OF IN LANDFILLS; DISPOSE OF IT AS REQUIRED BY LOCAL ORDINANCES.***

THE FLUORESCENT LAMP IN THE LCD DISPLAY CONTAINS MERCURY. DO NOT PUT IT IN TRASH THAT IS DISPOSED OF IN LANDFILLS; DISPOSE OF IT AS REQUIRED BY LOCAL ORDINANCES.

THE LCD IS MADE OF GLASS. IF THE LCD BREAKS DUE TO ROUGH HANDLING OR DROPPING, AND THE INTERNAL FLUID GETS IN YOUR EYES OR ON YOUR HANDS, IMMEDIATELY WASH THE AFFECTED AREAS WITH WATER FOR AT LEAST 15 MINUTES. SEEK MEDICAL ATTENTION IF ANY SYMPTOMS ARE PRESENT AFTER WASHING.

CHAPTER 7

THEORY OF OPERATION

CONTENTS:

7.1.0 INTRODUCTION

This chapter contains the theory of operation for the Indico 100 series of X-ray generators. The theory of operation is organized by functional blocks as depicted in the functional drawings in chapter 9.

7.2.0 FUNCTIONAL THEORY OF OPERATION

Refer to the appropriate functional block diagram in chapter 9 in conjunction with the theory of operation in this chapter. Waveforms and voltages at the pertinent test points are shown on the last page of each functional drawing.

7.2.1 Interconnect Diagram (MD-0843)

This drawing shows the cabling between the major subassemblies in the Indico 100 X-ray generator. Where applicable, this document references the appropriate functional schematics and sections of the service manual for details on the area of interest.

7.2.2 System ON (MD-0762)

The left side of this drawing shows the wiring from the ON and OFF switches on the console “keyboard assemblies” to J4-10, J4-11 and J4-12 on the generator interface board for the various Indico 100 consoles (J16-3, J16-6, J16-7 for the Rad-only console).

The generator interface board on the Indico 100 X-ray generator includes power ON and OFF switches S2 and S1 that may be used to switch the generator on and off locally while working on the equipment. These switches are connected in parallel with the main generator power ON and OFF switches that are located on the console.

Pressing either of the power ON switches described above turns on Q2 on the generator interface board. This turns on Q3, holding the collector of Q3 low. This latches Q2 on by holding the base of Q2 low when the ON button is released.

The collector of Q3 is connected to K2 and K3 via D16. These relays will energize if S3 is in the NORMAL position when the generator is switched on. If S3 is in the LOCKOUT position, the generator cannot be inadvertently switched on.

When K2 and K3 are energized, the DC rails (+5 V, +12 V, +15 V, +24 V, -12 V, -15 V, and -24 V) on the generator interface board are established, and +24 V is supplied to the console via K3 (see MD-0788, sheet 4).

The generator CPU will issue a P/S ON (power supply ON) command after the +5 V rail is detected as described in 7.2.3.

JW1 on the generator interface board may be jumpered such that K1 is energized only when the generator is switched on, or such that K1 is energized at all times that the AC mains to the generator is on. K1 switches the 110 and 220 VAC supplies for the room interface board, as shown on sheet 4 of MD-0788.

Pressing either of the OFF switches turns on Q1 on the generator interface board. This turns off Q2, turning off Q3. This will de-energize K2, K3, and / or K1 on the generator interface board, removing the DC rails from the generator interface board and removing the +24 V supply from the console. De-energizing K1 (if applicable) will disconnect the 110 / 220 VAC supplies to the room interface board.

In normal operation, J17-1 and J17-2 are joined via a wire jumper. An emergency-off switch may be connected to the generator by removing the jumper between J17-1 and J17-2, and then wiring the emergency-off switch to J17-1 and J17-2.

7.2.3 DC bus & power distribution (MD-0788)

Refer to MD-0788, sheet 1:

Sheet 1 of MD-0788 applies to three phase units. Portions of sheet 1 are common to single phase and three phase units. Sheet 2 details the circuits that are different between single and three phase generators.

Assuming that the AC mains is connected and switched on, line voltage is applied to the primary of room interface transformer T2 via F1 and F2. This will establish the 24 VDC supply via F5 and D3 on the generator interface board, as shown on sheet 4.

Several seconds after the generator has been switched on as per 7.2.2, the generator CPU will issue a P/S ON (power supply ON) command, resulting in 24 VDC being applied to J5-3 and J5-4 on the auxiliary board as described under MD-0788, sheet 3. This will energize K2 and U3 on the power input board via relay K1 on the auxiliary board (K1 is shown in the normal, i.e. no soft-start fault position). With U3 energized, Q2 will be turned on and relay K1 will be energized. DS6 on the power input board indicates that K2 is energized, and DS7 indicates that K1 is energized.

With K2 on the power input board energized, line voltage is applied to power supply auxiliary transformer T1. The primary of T1, an autotransformer, supplies 120 VAC for the fans and for the tube 1 / tube 2 solenoid in the HT tank, 120 or 240 VAC for rotor boost, and 52 / 73 / 94 VAC for rotor-run as described later in this section. The secondary of T1 supplies low voltage AC to the auxiliary board as per sheet 3.

When K1 on the power input board is energized, line voltage is applied to the input of D1 via the soft-start current limit resistors, thus pre-charging the DC bus capacitors. Normal charging of the DC bus is sensed by U1 via R5 to R8, D3, R18 / R19 and R16 / R17.

The emitter of U1 will rise toward +6 V as the DC bus charges. The emitter is connected to the soft-start protection circuit on the auxiliary board. If the DC bus capacitors charge normally, K1 on the auxiliary board will remain de-energized, D3 will be lit, and the soft start driver circuit (U3B, Q6, etc) will issue a contactor-closed signal after approximately 20 seconds. This will light D2 on the auxiliary board, output a logic low signal to the CPU via J5-7 of the auxiliary board to indicate that the main contactor is closed, and light DS4 and close the main power contactor K5 on the power input board. The line voltage will then be directly rectified by D1 to produce approximately 560 VDC for 400 V units, or approximately 670 VDC for 480 V units. This DC bus voltage is switched by the inverter board(s) to produce the drive for the primary of the HT transformers as described in 7.2.6.

If U1 on the power input board does not indicate normal bus charging, the soft start protection circuit will energize K1 on the auxiliary board. This will de-energize K1 on the power input board, but leave K2 energized via R1 / R2. De-energizing K1 on the power input board opens the soft-start charging path. With K1 on the auxiliary board energized, Q6 on the auxiliary board cannot turn on. This keeps K5 on the power input board de-energized, and holds J5-7 of the auxiliary board high to indicate to the generator CPU that the main contactor is open.

For R&F generators, a logic circuit (U11, Q9, etc) on the auxiliary board controls the cooling fans in the generator. During fluoroscopic operation, and for approximately 20 minutes after switching from fluoro to Rad operation, the output of the fluoro fan timer / driver circuit will be low, lighting D37 on the auxiliary board, and lighting DS5 and energizing K4 on the power input board. This will supply 120 VAC to the cooling fans from T1 via F4 and K4 on the power input board. The cooling fans are also energized during radiographic exposures, if required (fans are not fitted on all radiographic models).

When tube 2 is selected (two tube units only), J1-6 on the auxiliary board is pulled low via the control board. This will close K3 on the power input board, supplying 120 VAC to energize the tube 1 / tube 2 solenoid in the HT tank. The tube 1 / tube 2 select signal is also taken to J2-9 on the low speed starter board as described in 7.2.8.

7.2.3 DC bus & power distribution (Cont)

When the generator is switched off, the loss of the DC rails on the generator interface board (which supplies the generator CPU board) will remove the drive for K1 and K2 on the power input board, causing these relays to open. Line voltage will then be removed from the power supply auxiliary transformer T1, causing loss of the DC rails on the auxiliary board. When the 12 V rail has collapsed, U2 on the power input board will turn off. This allows the DC bus discharge circuit to be biased on by R20, rapidly discharging the DC bus capacitors through R16 / R17 and R18 / R19. If a fault occurs where the discharge circuit is active during start-up or normal operation of the generator, F7 will open, isolating the discharge circuit from the DC bus capacitors. With F7 open, voltage is applied to the LS1 buzzer through the buzzer annunciator circuit as an audible warning of a fault. **Note that the DC bus capacitors will <u>not</u> rapid-discharge if F7 is open.**

Depending on the tap settings on T1, the low speed starter boost voltage will be 120 or 240 VAC, and the run-voltage will be 52, 73, or 94 VAC. Refer to chapter 2 of the service manual for the procedure for setting these taps.

<u>Refer to MD-0788, sheet 2:</u>

Sheet 2 of MD-0788 applies to single-phase units. The circuits that are common to single phase and three phase units are described on sheet 1.

Assuming that the AC mains is connected and switched on, line voltage is applied to the primary of room interface transformer T2 via F1 and F2. This will establish the 24 VDC supply via F5 and D3 on the generator interface board, as shown on sheet 4.

Several seconds after the generator has been switched on as per 7.2.2, the generator CPU will issue a P/S ON (power supply ON) command, resulting in 24 VDC being applied to J5-3 and J5-4 on the auxiliary board as described under MD-0788, sheet 3. This will energize K2 and U2 on the power input board via relay K1 on the auxiliary board (K1 is shown in the normal, i.e. no soft-start fault position). With U2 energized, Q1 will be turned on and relay K1 will be energized. DS6 on the power input board indicates that K2 is energized, and DS7 indicates that K1 is energized.

With K2 on the power input board energized, line voltage is applied to power supply auxiliary transformer T1. The primary of T1, an autotransformer, supplies 120 VAC for the fans and for the tube 1 / tube 2 solenoid in the HT tank, 120 or 240 VAC for rotor boost, and 52 / 73 / 94 VAC for rotor-run as described later in this section. The secondary of T1 supplies low voltage AC to the auxiliary board as per sheet 3.

When K1 on the power input board is energized, line voltage is applied to the voltage doubler circuit via the soft-start current limit resistors, thus pre-charging the DC bus capacitors. Normal charging of the DC bus is sensed by U1 via R5 to R8, R16 to R21, D3, etc. DS1 will light to indicate that U1 is energized (indicating that the DC bus is charged).

The emitter of U1 will rise toward +6 V as the DC bus charges. The emitter is connected to the soft-start protection circuit on the auxiliary board, and is described on sheet 1. If the DC bus capacitors charge normally, DS4 on the power input board will light and the main contactor K5 on the power input board will close, applying the line voltage directly to the voltage doubler circuit where it is rectified and doubled to produce approximately 650 VDC. This DC bus voltage is switched by the inverter board(s) to produce the drive for the primary of the HT transformers as described in 7.2.6.

If U1 on the power input board does not indicate normal bus charging, the soft start protection circuit will energize K1 on the auxiliary board, and K5 will remain de-energized as described under sheet 1.

The operation of the cooling fans via K4 on the power input board and the operation of the tube 1 / tube 2 solenoid via K3 is described on the previous page.

The power down sequence is similar to that described on the previous page, except that single phase units do not have a rapid discharge circuit. The DC bus capacitors will discharge through bleeder resistors connected across the bus capacitors, with a time constant ≤ 5 minutes.

7.2.3 DC bus & power distribution (Cont)

Depending on the tap settings on T1, the low speed starter boost voltage will be 120 or 240 VAC, and the run-voltage will be 52, 73, or 94 VAC. Refer to chapter 2 of the service manual for the procedure for setting these taps.

Refer to MD-0788, sheet 3:

Line voltage is connected to the primary of power supply auxiliary transformer T1 when the generator is switched ON, i.e. when K2 on the power input board is energized. The DC rails on the auxiliary board will then be established (+/- 35 V via F3, F4 and D32, and +/- 12 V via F1, F2, D33, U5 and U6 which are connected in parallel, and U4).

The required DC rails are then distributed to the filament supply board(s) and to the control and dual speed starter boards as shown on sheet 3. Regulators on the control board and dual speed starter board supply +5 V for those boards as shown.

When the main contactor K5 on the power input board closes, J5-7 of the auxiliary board is taken low. This logic low signal is taken to the control board, where it enables the prep signal to the dual speed starter board as described in 7.2.9, and also turns on Q16 on the control board, turning on opto-coupler U9 on the generator CPU board. The output of U9, which indicates the contactor-closed status, is monitored by the CPU via U24. U9 also drives contactor-closed status LEDs DS9 / DS10, where DS9 lights to indicate that the contactor is closed.

When the +5 V rail on the generator interface board is established, the generator CPU will start to function. The CPU will perform its start-up diagnostics, and then output data (bit 0) via U27, U19, and U16 to energize opto coupler U17 on the generator CPU board. This will turn on Q4, applying ±15 V to J5-3 and J5-4 on the auxiliary board via current limit resistors R27 / R32 and the control board, resulting in approximately 24 VDC to close K1 and K2 on the power input board, as described earlier. DS34 / DS35 indicate the P/S ON status, where DS34 lights to indicate that the power supply is on.

The tube 1 / tube 2 select signal (bit 2) is generated by the CPU, then latched and buffered by U27 and U19 on the generator CPU board. The tube 1 / tube 2 select signal is then applied to U16 and to the tube 1 / tube 2 tellback logic circuit as per 7.2.11. The output of U16 drives U7 on the control board, which in-turn drives Q1. Q1 turns on when tube 2 is selected, pulling J1-6 on the auxiliary board low. This energizes K3 on the power input board as described earlier. The tube 1 / tube 2 select signal is also fed to the dual speed starter as described in 7.2.9.

For continuous fluoro mode, the CPU sends data (bit 7) to data latch U27 on the generator CPU board. This is then applied to driver U16, and to DS22 / DS23 which indicate continuous fluoro (FLUORO) or Rad / pulsed fluoro (FLUORO bar) operation. The output of U16 drives opto coupler U40 on the control board, which pulls J1-5 on the auxiliary board high for Rad / pulsed fluoro operation and low for continuous fluoro operation. This high / low signal is applied to the fluoro fan timer / driver circuit (sheet 1), and to the Rad / fluoro and power mode select circuits as described in 7.2.10.

When pulsed fluoro or low power Rad operation is selected, the CPU sends data (bit 3) to data latch U49. The data latch drives Q1 and DS2 / DS4 on the generator CPU board. DS2 lights to indicate low power / pulsed fluoro operation, while DS4 indicates high power Rad operation. Q1 on the generator CPU board drives opto coupler U41 on the control board, which pulls J1-3 on the auxiliary board high for PF / low power operation, and low for high power Rad mode. This signal is then applied to the fluoro fan timer / driver circuit (sheet 1), and to the Rad / fluoro and power mode select circuits as described in 7.2.10.

U3C and U3D on the auxiliary board monitor the + and -12 V supplies on that board. The outputs of U3C and U3D will switch low if either of these supplies drops below predefined limits, lighting D1 and sending a fault signal to the control board and to the driver for K1 on the low speed starter board.

A soft-start fault signal is generated if the DC bus capacitors do not charge normally (***SOFT START FAULT SIGNAL*** from the soft start driver circuit on page 1). This signal is fed to U3A on the auxiliary board, whose output will switch low if a soft-start fault exists. This is OR'ed together with the outputs of U3C and U3D, and has the same effect as described above for a +/-12 V fault.

7.2.3 DC bus & power distribution (Cont)

Refer to MD-0788, sheet 4:

Line voltage is connected to the primary of room interface transformer T2 whenever the AC mains is connected and switched on. With the generator switched on, K2 on the generator interface board will close, establishing the DC rails on the generator interface board via F3 / F4 and D1 (+/- 24 V, + 15 V via U5, +5 V via F6 and the +5 V / +16 V power supply circuit, + 12 V via U3, -12 V via U2, and -15 V via U4).

The required DC rails are then distributed to the digital I/O board, to the AEC board, to the room interface board, and to the generator CPU board, where DS33 and DS36-DS39 indicate the presence of the associated DC rails.

The 24 VDC supply that is derived from D3 / C10 is used by the on / off circuit on the generator interface board (MD-0762), and is also fed to the console when the on / off circuit closes K3. Power supplies and / or voltage regulators on the console produce the required DC rails for the console circuits. Additionally, the console includes a 300 VAC power supply that drives the cold-cathode fluorescent lamp that backlights the LCD display.

110 and 220 VAC is supplied to the room interface board. The 110 / 220 VAC supplies are only present when K1 on the generator interface board is closed. K1 may be configured to be closed at all times that AC mains is supplied to the generator, or K1 may be configured to close only when the generator is switched on. Refer to 7.2.2, *SYSTEM ON*, for details.

24 VDC is available at J17-3 and J17-4 to drive the coil of a power distribution relay in installations with installer supplied power distribution circuits. **The maximum current available from this source is 100 mA**.

Refer to MD-0788, sheet 5:

Sheet 5 shows the power distribution (DC rails) to the remote fluoro control, and to the Indico 100 consoles other than those shown on page 4.

7.2.4 Room interface (MD-0763)

Refer to MD-0763, sheet 1:

Sheet 1 shows the room interface inputs. These are shown on the left side of the drawing. Nine of the inputs energize opto couplers via 4-pin jumpers; the remaining inputs energize the associated opto coupler directly. The inputs that have a connector (JW7, JW10, JW15, etc) in series with the opto coupler(s) may be configured such that shorting the input turns on the opto coupler, or may be configured such that applying 24 VDC across the input energizes the opto coupler. The remaining inputs are only active when the inputs are shorted.

For inputs with a 4-pin jumper in series with the opto coupler, the jumper must be across pins 2 and 3 of the connector if the input is a 24 VDC source. If using this configuration, observe the polarity of the 24 VDC source to ensure that the opto coupler is correctly driven. Jumper across pins 1 and 2 and pins 3 and 4 of the connector if it is desired to activate the opto coupler by shorting across that input.

For the ***REMOTE FLUORO EXPOSURE*** input and the ***REMOTE EXPOSURE*** input, two or three opto couplers are connected in series. MD-0763 shows the opto coupler relevant to the room interface function. The second and / or third opto coupler is shown on MD-0761 and described in 7.2.5.

One set of thermal switch inputs is available on the room interface board as shown. A second set of thermal switch inputs is available on the stator terminal block. The thermal switch inputs on the stator terminal block are routed to T1 and T2 (at R33 and R34 respectively) on the generator interface board.

The generator CPU monitors the output of each opto coupler via logic circuits on the generator interface board.

7.2.4 Room interface (Cont)

Refer to MD-0763, sheet 2:

Sheet 2 shows the room interface outputs. These are shown on the right side of the drawing. Five of the outputs may be configured to supply +24 VDC, 110 VAC, or 220 VAC or to provide a dry contact closure when the output is active. Three of the outputs may be configured to supply +24 VDC or to provide a dry contact closure when the output is active, and the remaining three outputs are permanently configured to provide a dry contact closure when the output is active.

When any of the outputs on the room interface board are to be made active, the generator CPU will send data to address decoders, latches, and driver circuits on the generator interface board. These circuits decode the data, and drive relays K1 to K13 on the room interface board. The contacts of each of these relays drive the room interface outputs.

JW1 to JW5 may be configured such that the corresponding output is a dry relay contact by placing the jumper in the DRY position. Placing the jumper in the LIVE position will cause +24 VDC, 110 VAC, or 220 VAC to be output, depending on the voltage source selected at TB11. To select the desired voltage source, a wire jumper must be connected from TB11 pins 1-5 to TB10 to select 220 VAC, to TB9 to select 110 VAC, or to TB8 to select 24 VDC. For example, if it is intended that the TOMO / BUCKY 4 SELECT output should provide 110 VAC when that output is active, JW1 must be jumpered in the LIVE position and a wire jumper must be connected from TB11-4 to one of the available positions on TB9.

With JW1 to JW5 in the LIVE position, relays K1 - K4 and K6 switch the return side of the circuit. If multiple switched voltage outputs are required, jumper the desired voltage to TB11, select the DRY position on JW1 to JW5, connect the switched output to the relay output (example TB1-1 for JW1), and connect the common return directly to TB7.

Relays K1 to K4 and K6 have R-C snubbers connected across the contacts to quench contact arcing when the relay opens while driving inductive loads. If the output is configured to supply 110 or 220 VAC, and the load is an opto coupler or other low-current device, sufficient AC current may flow through the snubber to energize the load when the relay is open. If this is the case, the jumper that is in series with the snubber may need to be removed. Further details on this may be found in chapter 3B.

JW6 to JW8 may be configured such that the corresponding output is a dry relay contact by placing the jumper in the DRY position. Placing the jumper in the LIVE 24 VDC position will cause +24 VDC to be output.

The remaining outputs (collimator bypass, room light, and mag 1 to mag 3) are permanently configured to provide dry contact closures when the output is active.

7.2.5 X-ray exposure Rad / fluoro (MD-0761)

Refer to MD-0761, sheet 1:

The keyboard assembly and console board shown on sheet 1 is used on the 31 X 42 cm console. The console portion of these circuits for the other Indico 100 console types is shown on sheet 3 and 4.

Pressing PREP pulls J4-7 on the generator interface board low via U2 on the console board. This turns on U15 on the generator interface board. The generator CPU monitors the output of U15 via U18 and U25, with a valid prep command being recognized when the output of U15 is low.

Pressing X-ray will pull J4-8 on the generator interface board low via U4 on the console board. This will turn on U37 and U38 on the generator interface board. The generator CPU monitors the output of U37 via U18 and U25. The software will recognize a logic low at the output of U37 as a hardware X-ray request (X-ray switch pressed), and consequently will pull the emitter of U38 low via U25, U12, and U7. With the emitter of U38 held low and U38 energized, the collector of U38 will be held low. This energizes U22 on the generator interface board, turning on U46 on the generator CPU board. The generator CPU monitors the output of U46, recognizing a valid X-ray request when the output of U46 is low. DS42 on the generator CPU board will light to indicate that an X-ray request is being made.

An input via the REMOTE TOMO SELECT input will energize U8 and U10 on the generator interface board (refer also to 7.2.4). The generator CPU monitors the output of U10 via U18 and U25, and recognizes a logic low at the output of U10 as a remote tomo X-ray request. When a remote tomo exposure request is received, the CPU will pull the emitter of U8 low via U25, U12, and U7. With the emitter of U8 held low and U8 energized, the collector of U8 will be held low. This turns on U22 and U46 as described above, indicating to the CPU that a valid remote tomo request is being made.

A remote X-ray exposure request via the REMOTE EXPOSURE input will energize U41and U43 on the generator interface board (refer also to 7.2.4). The generator CPU monitors the output of U41 via U18 and U25, and recognizes a logic low at the output of U41 as a remote exposure request. When a remote exposure request is received, the CPU will pull the emitter of U43 low via U25, U12, and U7. With the emitter of U43 held low and U43 energized, the collector of U43 will be held low. This turns on U22 and U46 as described above, indicating to the CPU that a valid X-ray request is being made.

Pressing the fluoro foot switch (if connected to the console) will pull J4-6 on the generator interface board low via U3 on the console board. This will turn on U30, U42, and U44 on the generator interface board. These same opto couplers will be energized if the fluoro foot switch is connected to the room interface board (refer to 7.2.4), and the fluoro foot switch is pressed. The generator CPU monitors the output of U30 via U18 and U25. The software will recognize a logic low at the output of U30 as a fluoroscopic X-ray request, and consequently will pull the emitter of U42 low via U25, U12, and U7. With the emitter of U42 held low and U42 energized, the collector of U42 will be held low. This turns on U22 and U46 as described above, indicating to the CPU that a valid X-ray request is being made.

The generator interface board contains a last image hold circuit consisting of U44, U32, U39, C30, etc. The last image hold circuit will keep U32 energized for approximately 100 milliseconds after the fluoro foot switch has been released. The emitter of U32 will be held low by the generator CPU for the time of the “last image hold” setting (up to 99 ms) in the receptor setup menu (chapter 3C). This will hold the collector of U32 low, keeping U22 and U46 energized as previously described, and allowing the frame store device to complete the last image.

The console CPU (U18) monitors the output of U3, U2, and U4 on the console board, recognizing a console fluoroscopic X-ray request when the output of U3 is low, a prep request when the output of U2 is low, and a console X-ray request when the output of U4 is low.

7.2.5 X-ray exposure Rad / fluoro (Cont)

Refer to MD-0761, sheet 2:

When a prep request has been made as described on page 1, the CPU will write data to the kV enable and prep latches within U27 on the generator CPU board. The kV enable and prep commands light DS30 and DS27 on the generator CPU board when active, and drive U4 and U2 respectively on the control board via U19 and U16 on the generator CPU board.

The emitter of U4 on the control board is held low when the HT tank is properly connected. If the output of U4 is high (HT tank not connected, or kV enable command not present), the ENABLE line (TP10) will be held low by the comparator circuit consisting of U11A, RN8, etc. This will hold the output of the “PREP ENABLED” and “X-RAY REQUEST” comparator circuits low via D21 and D24, inhibiting the prep and X-ray functions. If the kV ENABLE command is present, the output of U4 will be low, and the kV enable line (TP10) will be high. This will reverse bias D21 and D24, allowing the PREP and X-RAY lines to be pulled high when requested. The RESET command resets kV and mA faults that are latched by circuits on the control board. Pressing the MENU / RESET button on the console toggles the kV enabled circuit, resetting the fault latches.

The output of U2 on the control board will be low when PREP is active, causing the prep line (TP18) to be pulled high by the comparator circuit consisting of U11B, U10C, etc. The prep command is taken to the “GENERATOR READY” detector circuit and the logic “OR / NOR” circuits via D25. If the prep command is present, and no faults exist, the base of Q12 will be pulled low, turning on Q12, thus indicating a generator-ready condition. The prep command also initiates the boost cycle on the low speed or dual speed starter (refer to 7.2.8 and 7.2.9).

When the generator CPU has received a valid X-ray request, the CPU will send an X-ray command to data latch U27 on the generator CPU board. This will light DS26 on the generator CPU board, and will pull the anodes of U5 and U3 on the control board high. The cathodes of U5 and U3 are held low by the ***EXPOSURE ENABLE*** command from U22 (the line connected to the cathode of U46 on the generator CPU board, page 1) during an X-ray request. Therefore, opto couplers U5 and U3 will only be energized if both the hardware and software X-ray commands are present. Because these opto couplers and the comparator circuits (U11D, RN7, U10D, etc) are connected in parallel, both opto couplers must be turned on for TP12 to be pulled high. The X-ray request line is taken to the “OR / NOR” circuits consisting of Q4, Q13, D91, etc. If the prep request is present, and no faults exist at the time of the X-ray request, the line at TP14 will be pulled high. This enables the output of the VCO as described in 7.2.6.

The “GENERATOR READY” detector and the logic “OR / NOR” circuits are shown as a functional block with six inputs as shown (*PREP* input, *X-RAY* input, and four fault inputs), and three outputs (*GENERATOR READY*, *DRIVE ENABLE*, and *HV / MA FAULT*). The generator-ready and drive enable signals are inhibited if any of the fault inputs are active ***(+/- 12V/SS FAULT*, *FILAMENT FAULT*, *STATOR FAULT*, *HIGH KV / INVERTER FAULT*,** or ***HIGH MA FAULT***). This will disable the inverter drive, preventing any kV output.

Refer to MD-0761, sheet 3:

Opto coupler U6 on the generator CPU board will be turned on when the power supply ready signal that originates on page 2 is present. The generator CPU monitors the output of U6 via U24, and DS17 on the generator CPU board will light to indicate the generator-ready status.

For the Rad-only console, pressing PREP and X-RAY energizes U16 and U17 respectively. The inputs to the generator interface board at J16-4 and J16-5 are pulled low via the LED portion of U16 / U17 and the closed prep or X-ray exposure switch. Remove JW1 and JW2 on the console CPU board to disable the keyboard assembly. This will prevent exposures from being created via the control console. In this instance an external hand switch is required to create exposures.

For the 23 X 56 cm console, the operation is similar to that for the 31 X 42 cm console as described on sheet 1, except that the component reference designations are different.

7.2.5 X-ray exposure Rad / fluoro (Cont)

Refer to MD-0761, sheet 4:

Sheet 4 shows the console prep and X-ray exposure circuits for the touch screen console. Pressing prep or X-ray on the console directly pulls J4-7 and J4-8 on the generator interface board low, initiating the appropriate action in the generator as described earlier.

7.2.6 kV control and feedback (MD-0759)

Refer to MD-0759, sheet 1:

When the CPU is satisfied that all requirements have been met to allow an X-ray exposure as described in 7.2.5, the kV reference voltage will be produced by D/A converter U22 on the generator CPU board. This is buffered by U14A, inverted by U13A on the control board, and then summed with the positive going kV feedback signal from U16B at the input of error amplifier U13B. Error amplifier U13B will regulate the kV by producing a DC output that is proportional to the difference between the kV reference voltage and the kV feedback voltage.

The HT primary current is sampled by T1, and rectified by D27 to D30 to produce a current limit signal (a negative voltage proportional to the primary current). This is applied to the input of U21A, where it will limit the kV demand if the primary current exceeds normal limits. This current limit signal is also fed to comparator U15, which generates a fault pulse if excessive primary current is sensed. The fault pulse is detected by latch U32D and inverted by U33D. A primary (resonant) over current fault will light D70 and pull the input of U33E low via D66. This will force the output of U33E high. The output of U33E is one of the inputs to the “GENERATOR READY” detector and logic “OR / NOR” circuits described in 7.2.5. The presence of a fault will immediately remove the generator-ready and drive enable signals, inhibiting the inverter gate drive, thus preventing inverter damage due to the over-current condition.

The output of U21A will swing increasingly negative for increased kV demand. This kV demand voltage is buffered and inverted by U21B, and then applied to the VCO (voltage controlled oscillator).

The VCO generates complementary output pulses that vary in frequency. The frequency of these pulses is inversely proportional to demanded generator output power. The current sense feedback from T2 synchronizes the start of the pulses.

The output pulses from the VCO are applied to AND gates U24A and U24B. The drive enable signal from MD-0761 is applied to the control inputs of U24, holding these inputs high if all logic conditions to allow an X-ray exposure are satisfied. The pulses are inverted and level shifted by U26A and U26B, and then applied to the gate-drive circuit as described on page 2.

The differential kV feedback voltage from the HT tank is brought to J9 on the generator control board. This is applied to the inputs of U12A and U12B, where the kV feedback scaling is precisely set by R215. The differential feedback signals are then summed by U16B. The output of U16B supplies a kV feedback signal to error amplifier U13B as described earlier. The kV feedback signal is also fed to the CPU via U16A on the control board, and U15A, U15B, and A/D converter U37 on the generator CPU board where it is used to monitor the output voltage during an exposure. The kV feedback signal is also routed to the high kV detector and latch, which drives D69 and U33E. The output of U33E, when high, will inhibit the inverter gate drive as described previously.

The outputs of U14A and U15A on the generator CPU board are summed and compared by the HV ON DETECTOR CIRCUIT, consisting of U30D, Q6, etc. This produces a ***HV ON*** signal when the actual kV is greater than approximately 75% of the demanded kV. The ***HV ON*** signal is brought to the digital interface board, where it is made available to those digital imaging systems that require this signal to synchronize the exposure.

7.2.6 kV control and feedback (Cont)

The generator control board contains circuits that protect against an inverter “shoot-through” fault. If a shoot through fault is sensed, current sense transformers on the inverter board(s) will supply a current pulse that is fed to the control board at J14-1 & J14-3, J15-1 & J15-3, and / or J16-1 & J16-3. An inverter fault is then detected by comparator circuits on the control board, latched, and inverted (a logic low at the outputs of the INVERTER 1, INVERTER 2, or INVERTER 3 FAULT LATCH & LOGIC INVERTER circuits indicates a fault). An inverter fault will light D80, D81, or D82, and will pull the output of the logic OR circuit (D87-D89, U35C) low. This will take the input of U33E low, forcing the output of U33E high, thus inhibiting the inverter gate drive as per high primary current and high kV faults described earlier.

The fault latches that drive the input of U33E are reset by the ***RESET*** command, which originates on MD-0761.

<u>*Refer to MD-0759, sheet 2:*</u>

The drive pulses from page 1 are applied to the input of the gate-drive circuit on the control board. The gate-drive circuit utilizes MOSFETs that form a full bridge inverter circuit. This circuit provides current gain for the gate pulses. The high frequency gate pulses are then applied to the power MOSFETS on the inverter board(s) via J10 and / or J11 and / or J12 on the control board.

The inverter board(s) produce the high power drive for the HT transformers (Indico 100 X-ray generators use one, two, or three inverter boards, depending on output power). The output of the inverter board(s) drive the primaries of the HT transformers via the resonant capacitor and the fluoro / EMC / sharing inductors.

During radiographic operation, contactor K1 shorts out the fluoro inductor. This inductor is in-circuit during fluoroscopy, and optimizes the output tuning during fluoroscopic operation. The drive circuit for K1 is detailed in 7.2.10.

For 80 and 100 kW units, the drive to inverter board #3 is disabled by relay K2 during low power operation. Refer to 7.2.10 for details.

<u>*Refer to MD-0759, sheet 3:*</u>

The HT tank has similar anode and cathode sections. The cathode and anode sections each have their own high voltage transformer and high voltage multiplier board. The anode section generates the anode voltage, 0 to 75 kV, and the cathode section generates the cathode voltage, 0 to -75 kV. The anode and cathode sections contain voltage dividers that supply kV anode and cathode feedback voltages. The kV feedback from the HT tank is brought to J9 on the control board as described earlier in this section.

The HT tank is not field-repairable. Defective HT tanks must be exchanged with equivalent units.

7.2.7 Filament drive and mA control (MD-0760)

<u>*Refer to MD-0760, sheet 1:*</u>

When the CPU receives a prep request, D/A converter U18 or U22 on the generator CPU board will output the filament reference voltage (1 volt = 1 amp of filament current). For units with two filament supplies, U18 outputs the small filament drive and U22 outputs the large filament drive. For units with a single filament board, U22 supplies the filament drive. The filament drives are buffered by U14D and U14B, and then routed to the filament supply board via J3 and J10 of the generator CPU board.

The filament reference voltage is applied to U1B on the filament supply board. The output of U1B is summed with the output of current limit clamp U1A. The filament current limit is set at 5.5 or 6.5 amps via JW1.

7.2.7 Filament drive and mA control (Cont)

The filament reference voltage may be measured at the cathode of D6 on the filament board (at the output of U1B). Attempting to measure the filament reference at the input to U1B will provide erroneous results.

The filament reference voltage is then summed with the filament feedback voltage at the input of error amplifier U4B. When the filament reference is greater than the feedback, the output of U4B rises, causing the pulse width at the output of U3 to increase.

The filament supply blocks are shown in very limited detail on sheet 1 of MD-0760. Refer to sheet 3 for a more detailed functional diagram of the filament supply board.

PWM (pulse width modulator) U3 drives MOSFETS Q6, Q7, Q12, and Q13, which form a full bridge inverter. The MOSFETS convert the + and - 35 V supplies to high frequency AC to drive the primary of the filament transformers at the filament switching frequency, approximately 40 kHz, via C22, the primary of T1, J4 / J8 / K1, J5 on the filament supply board, and J4 on the tank lid board.

The output of filament current sense transformer T1 on the filament supply board is rectified by D12, D13, D27, and D28, and fed to the RMS converter circuit consisting of U7 and associated components. The output of the RMS converter drives U4A, which is a variable gain amplifier. The filament current feedback is calibrated such that 1 volt = 1 amp of filament current. The calibrated filament feedback voltage (representing actual filament current) appears at the input of buffer U2B and at the summing input of error amplifier U4B as previously described.

The output of U2B is brought to J2-2 or J2-4 on the filament supply board, depending on configuration. This filament current feedback signal is then fed to the CPU as shown on sheet 2 and 3.

The filament feedback signal from the output of U2B is compared with a 1.7 volt reference by U2A. The output of U2A will swing low if the filament current drops below approximately 1.7 amps, indicating a filament fault. This will turn off Q1 on the filament supply board, taking J2-10 on the filament board and J3-10 on the control board high. The ***FILAMENT FAULT*** signal is taken to one of the inputs on the “GENERATOR READY” detector and logic “OR / NOR” circuits described in 7.2.5, where a fault will inhibit inverter drive by removing the generator-ready and drive enable signals. A filament fault condition will also turn off Q15 on the control board, turning off opto coupler U7 on the generator CPU board. The output of U7 drives filament fault status LEDs DS13 /DS14 and the input of U24, which is monitored by the generator CPU.

The ***HIGH KV / INVERTER FAULT*** and the ***HIGH MA FAULT*** signals from MD-0759 and MD-0760 respectively are OR’ed together, and designated as the ***HV / MA FAULT*** signal. This is fed to the base of Q14 on the control board, and will be high for a fault. During a HV / mA fault, Q14 will be turned off, turning off opto coupler U8 on the generator CPU board. The output of U8 is monitored by the CPU via U24. U8 also drives DS11 / DS12, with DS12 being lit for a HV / mA fault condition.

For generators with a single filament board, U27 on the generator CPU board outputs the large / small filament select command. The output of U27 will be low for large focus, lighting DS24. U19 and U16 invert the large / small focus signal and drive U1 on the control board. The output of U1 will be low for large focus, causing the large / small select line, J3-11 on the control board, to be pulled high by the comparator circuit consisting of U11C, Q2 etc. This de-energizes K1 on the filament board, selecting large focus.

The logic high signal at J3-11 drives the base of Q3 on the control board, holding Q3 off when large focus is selected. Q3 drives opto coupler U10 on the generator CPU board, turning off U10 for large focus. The output of U10 is monitored by the CPU via U24.

7.2.7 Filament drive and mA control (Cont)

<u>*Refer to MD-0760, sheet 2:*</u>

The filament drive from page 1 is applied to the secondaries of the filament transformers, which provide high voltage isolation and drive the X-ray tube filaments via the HV cathode board and the cathode high voltage connector as shown.

When an exposure is being made, X-ray tube current flows through series resistors on the HV anode and cathode boards. The voltage developed across these resistors, which is proportional to the X-ray tube current, is taken to J9 of the control board. Transient protectors on the high voltage boards clamp the voltage across the series resistors during high voltage arcs.

The “ground” side of the high voltage boards in the HT tank is connected to the mA test jacks E17 / E18 on the tank lid board. Transient protectors on the tank lid board clamp the voltage across the mA measuring device during high voltage arcs, and prevent the voltage at E17 and E18 from rising above approximately 15 volts if the mA test jack shorting strap is removed.

The anode mA feedback that appears at J9-1 and J9-2 of the generator control board is scaled approximately 0.4 volts = 100 mA of anode current, and is applied to the input of differential amplifier U6B. The output of U6B is taken to the anode over current detector, whose output is applied to the high anode current latch and inverter circuit. The output of U33C will be low for a high anode current condition. This will light D72 and pull the input of U33E low via D65, forcing the output of U33E high. The output of U33E is one of the inputs to the “GENERATOR READY” detector and logic “OR / NOR” circuits described in 7.2.5. An over current condition will immediately remove the generator-ready and drive enable signals, preventing possible damage due to the over-current condition.

The ***ANODE OVERVOLTAGE*** signal from MD-0759 is also fed into the anode over current detector circuit. Therefore, an anode over voltage condition will disable the inverter gate drive as described above.

The output of U6B is also applied to the input of U9 and U30B. U30B provides a scaled mA feedback voltage, calibrated by R216, such that 1 volt = 100 mA at the output of U30B. The output of U30B is fed to the generator CPU board as shown on sheet 3.

U9 is a high gain amplifier, and provides a scaled mA feedback voltage 1 volt = 2.5 mA. R212 calibrates the mA feedback, and R213 provides offset voltage adjustment. The output of U9 is fed to the generator CPU board as shown on sheet 3.

The cathode mA feedback at J9-4 and J9-3 of the generator control board is used for cathode over-current detection only. The cathode mA feedback is applied to the input of differential amplifier U6A. The output of U6A is taken to the cathode over current detector, whose output is applied to the high cathode current latch and inverter circuit. The output of U33B will be low for a high cathode current condition. This will light D71 and pull the input of U33E low via D64, inhibiting the inverter drive as described above for an anode over voltage fault.

The ***CATHODE OVERVOLTAGE*** signal from MD-0759 is also fed into the cathode over current detector circuit. Therefore, a cathode over voltage condition will disable the inverter gate drive as described above.

The high anode and high cathode current fault latches are reset by the ***RESET*** command, which originates on MD-0761.

The large and small filament current feedback signals from page 1 are brought to J3 on the control board, and then routed to J2 and J1 on the control board. From there, these signals are taken to the generator CPU board as shown on sheet 3.

7.2.7 Filament drive and mA control (Cont)

<u>*Refer to MD-0760, sheet 3:*</u>

The large and small filament current feedback signals from page 2 are fed to differential amplifiers U30A and U30B respectively on the generator CPU board. The CPU monitors the outputs of U30A and U30B via A/D converter U37.

The Rad mA feedback voltage (1 volt = 100 mA) is applied to U15C on the generator CPU board, and the fluoro mA feedback signal (1 volt = 2.5 mA) is applied to U23A. The outputs of U15C and U23A are fed to A/D converter U37, which supplies the mA feedback values to the CPU. The CPU uses the Rad and fluoro mA feedback information to regulate the X-ray tube mA and to perform mA monitoring functions during exposures.

The figure on the right of sheet 3 is an expanded functional schematic of the Indico 100 filament supplies, showing more detail than the figures on page 1.

7.2.8 Low speed starter (MD-0764)

<u>*Refer to MD-0764, sheet 1:*</u>

The 120 / 240 VAC and the 52 / 73 / 94 VAC supplies originate on MD-0788. The boost voltage (120 or 240 VAC) and the run-voltage (52, 73, or 94 VAC) is supplied by the power supply auxiliary transformer T1. These voltages must be properly selected via taps on T1 as described in chapter 2 of the service manual.

When the CPU receives a prep request, the ***ENABLE*** command is generated as described in 7.2.5. This command originates on the control board, and is brought to the cathode of D17 on the auxiliary board. This is OR'ed with the ***TUBE 1 / TUBE 2 MISMATCH & THERMOSTAT OPEN*** and ***12 VDC / SOFT START FAULT*** signal in the base circuit of Q15. If all three of these lines are high, i.e. if the ENABLE command is present and no tube 1 / tube 2 mismatch & thermostat open or 12 VDC / soft start faults exist, the base of Q15 will be pulled high, turning on Q15. This will energize K1 on the low speed starter board. K1 is a protection relay that is closed during normal operation, and open-circuits the stator drive if any of the above faults are present.

Also when a prep request is made, the ***PREP*** command will be applied to the boost and run logic circuit on the auxiliary board. This will pull J4-11 on the control board low, energizing U2 on the low speed starter board, initiating the boost cycle. The boost duration is 1.5 seconds or 2.5 seconds, and is determined by the setting of JW1 on the auxiliary board.

At the completion of the boost cycle, the boost and run logic circuit will pull J4-11 high, turning U2 on the low speed starter off. Approximately 100 milliseconds after U2 turns off, J4-12 will be pulled low, turning on U1 on the low speed starter board, initiating the rotor-run cycle.

Q2 and Q1 are triacs that are triggered on the zero crossing points of the AC waveform when U2 or U1 is energized. These act as low resistance switches when triggered, with Q2 switching the stator boost voltage, and Q1 switching the stator run-voltage. The output of the triacs is OR'ed together; therefore their common output will carry the boost voltage or run-voltage, depending on which triac is energized.

The COMMON line (AC return), connects to the "common" terminal on the stator terminal blocks via K1. The boost / run voltages that are controlled by Q2 and Q1 are brought to protection relay K1, and then applied to the main winding via K3 and K4, and to the shift winding via K2, shift capacitor(s) and K4.

K4 switches the main and shift currents to tube 1 or tube 2. The ***TUBE SELECT*** signal that drives K4 is described in 7.2.3. K3 and K2 are current sense relays that are energized when the stator current is above preset limits. With K3 and K2 closed, Q3 on the auxiliary board is supplied with base current. This will turn on Q3, turning on Q18 on the control board.

7.2.8 Low speed starter (Cont)

The ***STATOR FAULT*** line (J6-10) on the control board will be low if there is no stator fault, and high for a fault. This is one of the inputs to the “GENERATOR READY” detector and logic “OR / NOR” circuits described in 7.2.5. A stator fault condition will immediately remove the generator-ready and drive enable signals, inhibiting kV output. When the CPU detects a stator fault condition (via the circuits depicted on sheet 2), the kV enable and prep signals are immediately removed, opening relay K1 on the low speed starter board.

Refer to MD-0764, sheet 2:

When Q18 on the control board is turned on as described on sheet 1, indicating no stator fault, U5 on the generator CPU board will be turned on. The CPU monitors the output of U5 via U24, and DS20 / DS21 indicate the stator fault status (DS20 indicates no stator fault, and DS21 indicates a stator fault).

7.2.9 Dual speed starter (MD-0765)

Refer to MD-0765, sheet 1:

The CPU will determine whether the pending exposure should be made at low speed or high-speed operation. Based on this determination, the CPU will output the high speed / low speed command via U27 on the generator CPU board. The output of U27 drives DS8 and DS7 on the generator CPU board, and energizes U12 on the dual speed starter board via U19 and U16. The dual speed starter CPU monitors the output of U12, and sets low or high-speed operation based on the state of U12.

The ***CONTACTOR CLOSED*** signal that originates on the auxiliary board and closes the main contactor K5, is also brought to the emitter of Q7 on the control board via R94. This signal is low when the contactor is closed, turning on U13 on the dual speed starter board **if** the prep command is present.

The ***PREP COMMAND*** is brought to the cathode of D47 on the control board. This is low when prep is not requested, turning on Q7. With Q7 on, the cathode of U13 on the dual speed starter will be held high, keeping U13 off. During prep, the prep command will be high. This turns off Q7, allowing U13 to turn on. The dual speed starter CPU monitors the output of U13, and starts the boost cycle when the output of this opto coupler is low.

The ***TUBE 1 / TUBE 2*** select signal from MD-0788 is applied to J4-16 of the control board. This will be low when tube 2 has been selected, energizing U14 on the dual speed starter board. The dual speed starter CPU monitors the output of U14, and selects tube 1 or tube 2 based on the state of U14. K1 on the dual speed starter board will close to select tube 1, and K2 will close to select tube 2, all at the start of prep. K4 is energized only when K1 or K2 is energized, thus isolating the high voltage from the stator terminals at all times except during normal operation of the dual speed starter.

The dual speed starter contains an inverter (Q1 to Q4) that produces the required stator current at 50, 60, 150, or 180 Hz by precisely switching the 560 / 650 volt DC bus. The dual speed starter CPU controls the switching of the inverter via the driver circuit consisting of U1-U10 and T1-T4, etc. The setting of DIP switches SW1 and SW2 determines all stator drive parameters (boost voltage and boost time, run voltage, brake voltage and brake time, etc).

The modulated output from the inverter is applied to the common stator terminal via one leg of the inverter. The shift and main currents are taken from the other leg of the inverter via K5 and K6. K1-A and K2-A switch the main current, and K1-A and K1-B switch the shift current.

The following description applies to dual-speed starters 733317-12, 13, 16, 17 and 735925-12, 13, 16, 17 only. Relay K3 is held open for high-speed operation and closed for low-speed operation. The dual-speed starter will automatically set K7 open or closed based on the setting of DIP switch SW1, selecting one-of-two possible capacitor values. The available capacitor values are shown in the tables on MD-0765.

7.2.9 Dual speed starter (Cont)

The operation of dual-speed starter 733317-15 and 735925-15 is similar, except that relay K7 is always held open during low-speed operation, providing 28μF of low-speed capacitance. It is also possible to configure this starter to provide 15.5μF of low-speed capacitance by removal of one of the low speed capacitors. One-of-two possible value of high-speed capacitance is automatically selected using K7.

The operation of dual-speed starters 733317-01, 02 and 735925-01, 02 is similar, except that K7 is not used, resulting in only one value each of low-speed and high speed capacitance: (31μF / 6μF) for -01 and (60μF / 20μF) for -02, respectively.

The contacts of current sense relays K5 and K6 will be closed when the stator current is above preset limits. With K5 and K6 closed, Q5 on the dual speed starter board is supplied with base current. This will turn on Q5, whose output is monitored by the dual speed starter CPU. If a stator fault is detected, the CPU will output a high at J1-10 on the dual speed starter board. This signal is fed to the "GENERATOR READY" detector and logic "OR / NOR" circuits described in 7.2.5. A fault condition will immediately remove the generator-ready and drive enable signals, inhibiting kV output. Also, the dual speed starter CPU will open K1 or K2 and K4 on the dual speed starter board, removing the stator drive.

The stator fault signal is also applied to the base of Q18 on the control board. The base of Q18 will be low if there is no stator fault, turning on Q18. This will turn on U5 on the generator CPU board. The generator CPU monitors the output of U5 via U24, and DS20 / DS21 indicate the stator fault status.

7.2.10 Rad / fluoro and power mode select (MD-0786)

The circuits shown on MD-0786 control the Rad / fluoro contactor on the resonant board and relay K2 on the control board, both described in 7.2.6.

The Rad / fluoro select signal from J1-5 of MD-0788 is applied to the base of Q5 on the auxiliary board via R79. This is high for the Rad / pulsed fluoro mode, and low for the continuous fluoro mode. When in Rad / pulsed fluoro mode, Q5 will be turned on, lighting D36 and energizing K1 on the resonant board. K1 shorts out the fluoro inductor as described in 7.2.6. In continuous fluoro mode, Q5 is off, de-energizing K1.

For Rad-only units, the resonant board is not fitted and a jumper is connected from J2-2 to J2-3.

Inverter # 3 on 80 and 100 kW generators is disabled during low power operation (pulsed fluoro, continuous fluoro, or low power Rad exposures). This is accomplished as described below.

The Rad / fluoro select signal is also applied to the base of Q27 on the control board via R237. This signal is low in continuous fluoro mode, turning Q27 off. The collector of Q27 will then be high, pulling the base of Q17 high via D104. This will turn on Q17, energizing K2 on the control board. This removes gate drive from inverter #3. In Rad / pulsed fluoro mode, the base of Q27 is pulled high, turning on Q27. The collector of Q27 will then be low. Diode D104 isolates Q27 from Q17 when the collector of Q27 is low.

The low / high power select signal from J8-3 of MD-0788 is applied to the base of Q17 via D105 and R240. This is low for high power Rad exposures, and high for pulsed fluoro / low power Rad operation. Q17 will be turned on during pulsed fluoro / low power operation, energizing K2 on the control board, removing gate drive from inverter #3.

7.2.11 Interlocks & tube 1 / tube 2 tellback (MD-0787)

For R&F generators, a thermal switch is mounted on the inverter heat sink and JW4 on the auxiliary board is not fitted. The thermal switch will open if an inverter over temperature condition is detected. This pulls J2-4 on the auxiliary board high, turning on Q10 and lighting D42. With J2-10 pulled high, Q8 is turned on via D26 and R7. The output of Q8, low for a fault, holds the base of Q15 on the auxiliary board low as described in 7.2.8. The output of Q8 is also OR'ed with the kV ENABLE signal on MD-0761, inhibiting the prep and X-ray functions when the output of Q8 is low. For Rad-only units with no thermal switch, JW4 is jumpered in the **OFF** position (pins 2-3).

The tube 1 / tube 2 tellback portion of MD-0787 ensures that the actual tube selection matches the requested tube selection. Logic circuits compare the tube 1 / tube 2 request signal to the feedback from a contact closure in the HT tank.

The ***TUBE 1 / TUBE 2 SELECT*** command from MD-0788 is low when tube 2 is selected, and high for tube 1. This is applied to one input of the tube 1 / tube 2 tellback logic circuit. The output of U7 is connected to the other input of this logic circuit.

When the tank is in the tube 1 position, U7 and U8 on the auxiliary board are off, and the collector of U7 will be high. In the tube 2 position, U7 and U8 are turned on, and the collector of U7 will be low. If a mismatch is detected, the base of Q8 is pulled high, turning Q8 on. With Q8 turned on, Q15 on the auxiliary board will be turned off, and the prep command will be inhibited as described above.

When U8 on the auxiliary board is on (tube 2 position), U3 on the generator CPU board will be turned on. The output of U3 and the ***TUBE 1 / TUBE 2 SELECT*** signal are connected to U35 on the generator CPU board. U35 decodes the binary inputs, and lights DS5 or DS6 as appropriate.

7.2.12 AEC (MD-0757)

<u>*Refer to MD-0757, sheet 1:*</u>

This shows the circuits on the generator interface board that connect to the AEC board. Eight lines supply the AEC chamber select signals, the field select signals, and the start signal to the AEC board via U25 / U23 and driver U33 on the generator interface board. The AEC start signal is also connected to the base of Q7 on the generator interface board, where it turns Q7 on when the start signal is present, taking J14-3 high.

The AEC ramp (*PT RAMP*) from the AEC board is buffered by U23C on the generator CPU board, and fed to A/D converter U37 such that it can be monitored by the CPU.

D/A converter U18 on the generator CPU board generates the AEC reference voltage. This is buffered by U14C, and fed to the AEC board via J10-10 on the generator interface board. The magnitude of the AEC reference voltage is determined by the CPU, and will be a value between 0 and 10 volts.

The AEC board generates the PT stop signal when the magnitude of the AEC ramp is equal to the AEC reference voltage. This signal will switch low when the exposure is to be terminated. An active PT stop signal will pull the base of Q5 low, turning Q5 off, thus turning Q6 on. The output of Q6 is connected to one of the interrupt inputs on the CPU via U45C on the generator CPU board, where it will terminate the AEC exposure immediately when the interrupt is received.

The circuits connected to J14 are part of the A^2EC^2.circuits. This option is no longer available.

<u>*Refer to MD-0757, sheet 2:*</u>

This is the functional schematic of AEC assembly 734614, used with ionization type AEC chambers. The AEC chambers are connected to J1/J11, J2/J12, J3/J13, and / or J4/J14. The AEC board will either be fitted with 12 pin in-line connectors, or 9 pin ‘D’ connectors, depending on the application. The AEC signal from the AEC chamber(s) is routed to the input of analog switches S1A to S1D on the AEC board. These analog switches are controlled by the chamber-select signals.

The chamber-select signals exit on the generator interface board as per sheet 1. Only one chamber may be active at one time, and the active channel is indicated by DS1 to DS4 on the AEC board. The chamber-select signals are inverted by U3B, U3C, U3D, and U3F; and connected to the control inputs of the analog switches described in the previous paragraph. The analog switch corresponding to the selected AEC input channel will be closed when that channel is selected, thus connecting the AEC signal to preamplifier U1A, which provides voltage gain. The input of U1A will be configured such that U1A is a non-inverting amplifier for use with AEC chambers that have a positive going output, and as an inverting amplifier for use with chambers with a negative voltage output.

7.2.12 AEC (Cont)

The start signal also exits from the generator interface board. This signal, when active, will cause DS5 on the AEC board to be lit. The start signal is buffered and inverted by U3E and U3A, and will be logic low at the output of U3A when the start signal is active. This opens the analog switch that is part of the sample and hold circuit at the input of U2A during an AEC exposure. This analog switch is closed at all other times. The sample and hold circuit will sample any electrical noise at the output of U1A during standby operation, and subtract this noise from the AEC signal during an AEC exposure. This ensures that the output of U2A is proportional to the AEC chamber output voltage only, and is not influenced by noise.

The output of U2A connects to the common inputs of analog switches S2A to S2D. These analog switches are controlled by the chamber-select signal, and the switch corresponding to the active channel will be closed. This connects the output of U2A to the AEC gain adjustment potentiometer R1 to R4 corresponding to the active channel. The AEC signal, which will be either a ramp or a DC voltage depending on AEC chamber type, is now fed to the input of U2B. This will be factory configured as an integrating amplifier by connecting C4 into the circuit for use with AEC chambers that output a DC output voltage, or U2B will be configured as a linear amplifier by connecting R32 into the circuit for use with AEC chambers that provide a ramp voltage. The start signal also connects to analog switch S4. This switch opens when an AEC exposure starts, allowing U2B to start integrating or amplifying the AEC signal.

The output of U2B will be a positive going ramp regardless of the AEC chamber type in use. This ramp voltage is processed by U4A and U4B, and also fed to the short AEC exposure time compensation circuit consisting of R11 to R14, S3A to S3D, R53 and C11. Analog switches S3A to S3D are controlled by the chamber-select signal. The switch corresponding to the active channel will be closed, connecting the phase-lead network C11 / R53 to the wiper of the AEC short-time adjustment potentiometer. This circuit is disabled when the wipers of R11 to R14 are at the ground end of the potentiometers, and maximum short-time compensation is provided when the wipers are set to the end of the potentiometers connected to U2B.

The AEC ramp from U4B is taken to the generator interface board where it is processed as described earlier in this section, and also fed to comparator U6 on the AEC board where it is compared to the AEC reference voltage. The output of U6 is normally high, switching low when the magnitude of the AEC ramp equals the reference voltage. This PT stop signal is further processed on the generator interface board.

The START, and LEFT, MIDDLE, and RIGHT field select signals are brought to the AEC chambers via J1/J11, J2/J12, J3/J13, and J4/J14. The AEC board will be factory configured to directly output the active low signal from the generator interface board to the AEC chamber if required, or to output +12 V or +24 V if the chamber requires active high signals. For AEC chambers that require active high outputs, the start, right, middle, or left field select signal is taken from the collector of Q1 to Q4, respectively. The active low signals from the generator control board turn on Q1 to Q4, outputting either +12 V or +24V (depending on factory configuration) at the collector when active.

Jumpers JW1 to JW8 swap the left and right fields on J11 to J14. Jumpering pins 2-3 of the field selector jumpers (JW7 / JW8 for channel 1, JW5 / JW6 for channel 2, JW3 / JW4 for channel 3, JW1 / JW2 for channel 4) connects the left field select signal to pin 6 and the right field select signal to pin 2. Jumpering pins 1-2 of the field selector jumpers connects the left field select signal to pin 2 and the right field select signal to pin 6.

The AEC board also contains a DC to DC converter that produces +45 V, + or - 300 V, and +500 VDC. The converter circuit consists of U7, T1, output voltage adjustment potentiometer R79, and associated components. The +45 V output is hard wired to all of the AEC chamber connectors, and + or - 300 V is permanently connected to J1 to J4. Additionally, the AEC board will be factory configured to supply either + or - 300 V or +500 V to J11 to J13, and to pin 1 on J1 to J4 (in addition to the + or - 300 V fixed output at pin 2).

7.2.12 AEC (Cont)

Refer to MD-0757, sheet 3:

This page shows the input circuits for AEC board assembly 737992. This board is used with solid-state AEC chambers. The AEC chamber outputs are connected to the anode and cathode inputs of J1/J11, J2/J12, J3/J13, and / or J4/J14. The AEC board will be fitted either with 7 pin in-line connectors, or with circular style connectors, depending on the application. U2A, U2B, U8A, U8B, U16A, U16B, U3A, U3B, U9A, U9B, U17A, and U17B are extremely high gain preamplifiers that convert the current output from the AEC diodes (several hundred pico amps, typically) to a useable voltage.

The output of each preamplifier is connected to an analog switch used for field selection. Selecting the desired field closes the corresponding analog switch, connecting the output of that preamplifier to the summing node at the junction of R69, R9, R22 for channel 1, R40, R47, R55 for channel 2, R70, R11, R23 for channel 3, and R41, R49, R56 for channel 4.

JW1 to JW8 swap the left and right fields. Jumpering pins 1-2 of the field selector jumpers (JW1, JW2 for channel 1, JW3, JW4 for channel 2, JW5, JW6 for channel 3, JW7, JW8 for channel 4) selects the normal left-right orientation, and jumpering pins 2-3 of the field selector jumpers reverses the left-right field selection.

Selecting an active AEC channel closes U4D for channel 1, U14D for channel 2, U5D for channel 3, and U15D for channel 4. The output from the selected AEC channel will then be passed on to the signal processing circuits as shown on the next sheet of MD-0757.

Refer to MD-0757, sheet 4:

This shows the signal processing circuits for AEC board assembly 737992. The AEC channel 1 to channel 4 outputs are connected to the inverting input on U12A, which is a variable gain amplifier where the gain of this stage depends on the number of AEC fields that are selected. With one field selected, the gain of this stage will be at its maximum, and with three fields selected the gain of this stage will be divided by three. The variable gain of U12A compensates for the variable voltage output of the input preamplifiers, thus keeping the signal output from U12A constant relative to the number of fields that are selected.

The output of U12A feeds the inverting input of U11B. A sample and hold circuit is connected to the non-inverting input on U11B. This circuit samples any electrical noise at the output of U12A during standby operation, and subtracts this noise from the AEC signal during an AEC exposure. This ensures that the output of U11B is proportional to the AEC chamber output only, and is not influenced by noise.

The output of U11B is connected to the input of U11A via the gain adjustment pots R1 to R4 and the analog switches for channels 1 to 4.

U11A is an integrating amplifier where C31 starts to integrate the AEC voltage when the AEC exposure starts. This is accomplished by opening the analog switches that are in series with R35, R38, R42, and R59 at the start of the exposure. This produces a ramp whose slope is proportional to the input voltage at U11A.

The AEC ramp is taken to the generator interface board where it is processed as described earlier in this section, and fed to comparator U10 on the AEC board where it is compared to the AEC reference voltage. The output of U10 is normally high, switching low when the magnitude of the AEC ramp equals the reference voltage. This PT stop signal is further processed on the generator interface board.

The chamber-select signals exit on the generator interface board as per sheet 1. Only one chamber may be active at one time, and the active channel is indicated by DS1 to DS4 on the AEC board. The chamber-select signals are inverted by U6, and then connected to the control inputs on analog switches U4D, U14D, U5D, and U15D (sheet 3) for AEC channel selection and to the analog switches in series with R1 to R4 to select the required gain pot.

7.2.12 AEC (Cont)

The field select signals from the generator interface board are also active low. These signals are inverted by U6, and then connected to the analog switches in the feedback loop of U12A, and to the analog switches that select the fields on the previous sheet.

The start signal from the generator interface board is inverted by U6 on the AEC board, and then inverted again by Q2. The output of Q2 is connected to the analog switches in the feedback loop of U11A. The extra inversion provided by Q2 is required to open those analog switches during an exposure.

Refer to MD-0757, sheet 5:

This is the functional schematic of AEC assembly 737998, used with ionization AEC chambers. The AEC chambers are connected to J1 to J4. The AEC signal from the AEC chamber(s) is routed to the input of analog switches U1A to U1D on the AEC board. These analog switches are controlled by the chamber-select signals.

The chamber-select signals exit on the generator interface board as per sheet 1. Only one chamber may be active at one time, and the active channel is indicated by DS1 to DS4 on the AEC board. The chamber-select signals are inverted by U6, and connected to the control inputs of the analog switches described in the previous paragraph. The analog switch corresponding to the selected AEC channel will be closed when that channel is selected, thus connecting the AEC signal to the input of U7A.

The start signal also exits from the generator interface board. This is inverted by U6, and then inverted again by Q4 and Q5. The output of Q5, when active, opens the analog switch that is part of the sample and hold circuit at the input of U8A during an AEC exposure. This analog switch is closed at all other times. The sample and hold circuit will sample any electrical noise at the output of U7A during standby operation, and subtract this noise from the AEC signal during an AEC exposure. This ensures that the output of U8A is proportional to the AEC chamber output voltage only, and is not influenced by noise.

The output of U8A connects to the common inputs of the analog switches that are in series with gain pots R11 to R14. These analog switches are controlled by the chamber-select signal, and the switch corresponding to the active channel will be closed. This connects the output of U8A to the AEC gain adjustment potentiometer R11 to R14 corresponding to the active channel. The AEC signal, which will be a ramp, is now fed to the input of U8B. The analog switch in the feedback loop of U8B is opened during an exposure, allowing the AEC ramp to appear at the outputs of U4A and U4B.

The AEC ramp from U4B is taken to the generator interface board where it is processed as described earlier in this section, and fed to comparator U9 on the AEC board where it is compared to the AEC reference voltage. The output of U9 is normally high, switching low when the magnitude of the AEC ramp equals the reference voltage. This PT stop signal is further processed on the generator interface board.

The START signal from Q4, and the LEFT, MIDDLE, and RIGHT field select signals from Q1, Q2, Q3 respectively are brought to the AEC chambers via J1 to J4.

Jumpers JW1 to JW8 swap the left and right fields on J1 to J4. Jumpering pins 2-3 of the field selector jumpers (JW7 / JW8 for channel 1, JW5 / JW6 for channel 2, JW3 / JW4 for channel 3, JW1 / JW2 for channel 4) connects the left field select signal to pin 6 and the right field select signal to pin 2. Jumpering pins 1-2 of the field selector jumpers connects the left field select signal to pin 2 and the right field select signal to pin 6.

7.2.12 AEC (Cont)

Refer to MD-0757, sheet 6:

This page shows the AEC input connectors J1 to J4, the PMT high voltage connector J7, and the DC to DC converter circuits on the AEC interface board. Also shown are the switching circuits for the start signal, and the chamber-select logic circuits on the AEC board that provide switching signals for the high voltage adjustment potentiometers R10, R19, and R24.

The DC to DC converter circuit produces +45, +300 and +500 VDC for use with ion chambers, and up to -1000 VDC for photo multiplier tubes. The output of the converter circuit is set by potentiometers R10, R19, and R24. These pots are switched into the circuit when required, as described next.

The chamber-select signals from the generator interface board are active when low. If AEC is deselected, as will be the case during fluoroscopic operation, all four chamber-select lines will be high. The input of U1E will then be pulled high via R23, taking the output of U1E low and the output of U1F high. This will close analog switch U2A on the AEC interface board, switching R10 into the circuit during non-AEC operation. This potentiometer is adjusted to set the PMT high voltage during fluoro ABS operation.

When AEC channel 4 is selected, the chamber 4 select line will be low and the output of U1D will be high. This will close analog switch U2D on the AEC interface board, switching R19 into the circuit. AEC channel 4 is typically used for digital applications, and R19 allows the PMT high voltage to be optimized for AEC with digital operation.

If AEC channels 1, 2, or 3 are selected, the output of U1A, U1B, or U1C will be high. This will close analog switch U2C on the AEC interface board, switching R24 into the circuit. R24 may be used to set the PMT high voltage if a PMT is used on AEC channel 1, 2, or 3, or R24 may be used to set the output of the +45 / +300 / +500 VDC supplies for AEC channel 1, 2, or 3 if using an ion chamber that does not have a built-in high voltage bias supply.

The start signal from the generator interface board is active when low. This signal is inverted by Q4, and made available without inversion via D24, D28, D32, and D33. R29 is installed on boards that require +24 V for the start and left, middle, and right field-select signals, and R90 is fitted on boards that require +12 V for the start and left, middle, and right field-select signals. Jumpers JW29, JW31, JW33, and JW35 select +12 or +24 V start signals for AEC channels 1 to 4 respectively, and JW30, JW32, JW34, and JW36 select active low (0 V) start signals for AEC channels 1 to 4 respectively.

Refer to MD-0757, sheet 7:

This page shows the high-gain preamplifiers U6A, U6B, U14A, and U14B for solid-state AEC chambers, the switching circuits for the left, middle, and right field-select signals, and switching circuits that connect the output of solid-state chambers to the high-gain preamplifiers.

For Ion Chambers:

The field-select signals from the generator interface board are active when low. These signals are inverted by Q2, Q1, and Q3 and made available without inversion by D19, D21, D25, and D29 for the left field, D1, D3, D5, and D7 for the middle field, and D8, D12, D14, and D16 for the right field. Jumpers JW5, JW13, and JW21 select +12 V (if R90 is fitted) or +24 V (if R29 is fitted) for the left, middle, and right fields for AEC channel 1. Likewise, jumpers JW7, JW15, and JW23 apply to channel 2, JW9, JW17, and JW25 apply to channel 3, and JW11, JW19, and JW27 to channel 4. Jumpers JW6, JW14, and JW22 select active low (0 V) signals for AEC channel 1. Similarly, jumpers JW8, JW16, and JW24 apply to channel 2, JW10, JW18, and JW26 apply to channel 3, and JW12, JW20, and JW28 to channel 4.

7.2.12 AEC (Cont)

For Solid-State Chambers:

For solid-state AEC chambers, the start signal (pin 8) must be connected to ground (pin 7) at the AEC input connectors J1 to J4. Then JW47, JW52, JW57, or JW62, as applicable, must be installed. This grounds the non-inverting inputs of U6A, U6B, U14A, or U14B. The common anodes on the solid-state AEC chamber are then connected to ground, and the cathodes are wired to the right, middle, and left field-select lines.

The left field-select signal from Q2 (high = active) closes U19C, U17B, U16D, and U16A. Likewise, the middle field-select signal from Q1 closes U19B, U17A, U16C, and U17D, and the right field-select signal from Q3 closes U19A, U19D, U16B, and U17C. These analog switches route the AEC chamber outputs to the preamplifiers as described next.

Jumpers JW73, JW72, and JW71 route the signal from the left, middle, and right cathodes of solid-state AEC chamber 1 to the inverting input of U6A via the analog switches described in the previous paragraph. In the same way, JW68, JW67, and JW74 route the signal from the cathodes of AEC chamber 2 to U6B, JW63, JW70, and JW69 route the signal from the cathodes of AEC chamber 3 to U14A, and JW66, JW65, and JW64 route the signal from the cathodes of AEC chamber 4 to U14B.

Refer to MD-0757, sheet 8:

This page shows the input buffers, sample and hold circuits, integrator circuits, and output comparator circuits. The output signal from ion chambers is fed to R86 for channel 1, R85 for channel 2, R84 for channel 3, and R83 for channel 4. The amplified AEC signal from solid-state chambers is applied to the connections labeled ***S/S OUT 1***, ***S/S OUT 2***, ***S/S OUT 3,*** and ***S/S OUT 4***.

For Ion Chambers, Photo Diodes, and PMT:

For AEC channel 1, JW44 must be inserted for devices with a negative (-) output, and JW45 must be inserted for devices with a positive (+) output. JW43 has no effect for inverting (-) configurations, but is required on most non-inverting (+) configurations of this board. Regardless of the polarity of the input, the output of U7B will be a positive DC signal or positive ramp, depending on the AEC device type.

The output of U7B is fed to the input of U5B and to the input of the sample and hold circuit consisting of U4A, C9, and U7A. When using solid-state or ionization type AEC chambers, this circuit samples any electrical noise at the input of U5B during standby operation, and subtracts this noise from the AEC signal during an AEC exposure. This ensures that the output of U5B is proportional to the AEC chamber output only, and is not influenced by noise. C9 must be shorted if a photo diode or PMT is used for AEC on channel 1.

The output of U5B is connected to gain pot R1 and the input of U5A. The gain of U5A depends on the setting of R1. JW2 must be installed to configure U5A as an integrating amplifier for AEC devices with a DC output, and JW3 must be installed for AEC chambers that output an integrated signal (a DC ramp). Analog switch U4C is connected to the start signal. This switch opens when an AEC exposure starts, allowing U5A to start integrating or amplifying the AEC signal.

The output of U5A is applied to U3B, which only closes if channel 1 is selected. With channel 1 selected, the output of U5A is connected to the AEC short-time adjustment circuit consisting of R91, R120, R121, and C39. This circuit is disabled when the wiper of R91 is at the ground end of the potentiometer, and maximum short-time compensation is provided when the wiper is set to the end of the potentiometer connected to U3B.

The AEC ramp is buffered by U18A and U18B, resulting in a positive ramp at the output of U18B. This ramp is taken to the generator interface board via R53, where it is processed as described earlier in this section. The ramp is also fed to comparator U2 on the AEC board where it is compared to the AEC reference voltage. The output of U2 is normally high, switching low when the magnitude of the AEC ramp equals the reference voltage. This PT stop signal is further processed on the generator interface board.

7.2.12 AEC (Cont)

The circuit description for AEC channels 2 to 4 is similar to that for channel 1. When configuring AEC channels 2 to 4, the corresponding jumpers must be used.

For Solid-State Chambers:

For solid-state AEC chambers, the amplified AEC signal from sheet 9 is fed to the connection labeled ***S/S OUT 1***. Jumper JW46 must be inserted in order to connect the AEC signal to the non-inverting input of U7B. The remainder of the signal flow is as described above.

Refer to MD-0757, sheet 9:

This is the functional schematic of AEC assembly 739389, used with various 3-of-5-field ion chambers. The AEC chambers are connected to J1 or J2. The AEC signal from the AEC chamber(s) is routed to the input of analog switches U1C or U1D on the AEC board. These analog switches are controlled by the chamber-select signals.

The chamber-select signals exit on the generator interface board as per sheet 1. Only one chamber may be active at one time, and the active channel is indicated by DS1 and DS2 on the AEC board. The chamber-select signals are inverted by U6. The signals CH 1 and CH 2 are connected to the control inputs of the analog switches described in the previous paragraph. The analog switch corresponding to the selected AEC channel will be closed when that channel is selected, thus connecting the AEC signal to the input of U7A.

The channel 3 and channel 4 select lines from U6 are inverted by Q6 and Q7. The outputs of Q6 and Q7 are redesignated as the $\overline{\text{PORTRAIT}}$ and $\overline{\text{INVERTED}}$ signals, respectively. These signals select four different combinations of the L-M-R fields from the five available fields on the AEC chamber.

The start signal also exits from the generator interface board. This is inverted by U6, and then inverted again by Q4 and Q5. The output of Q5, when active, opens the analog switch that is part of the sample and hold circuit at the input of U8A during an AEC exposure. This analog switch is closed at all other times. The sample and hold circuit will sample any electrical noise at the output of U7A during standby operation, and subtract this noise from the AEC signal during an AEC exposure. This ensures that the output of U8A is proportional to the AEC chamber output voltage only, and is not influenced by noise.

The output of U8A connects to the common inputs of the analog switches that are in series with gain pots R11 and R12. These analog switches are controlled by the chamber-select signal, and the switch corresponding to the active channel will be closed. This connects the output of U8A to the AEC gain adjustment potentiometer R11 or R12 corresponding to the active channel. The AEC signal, which will be a ramp, is now fed to the input of U8B. The analog switch in the feedback loop of U8B is opened during an exposure, allowing the AEC ramp to appear at the input of U4A via a phase-lead network that provides short time compensation.

The AEC ramp from U4A is again inverted by U4B and taken to the generator interface board where it is processed as described earlier in this section, and fed to comparator U9 on the AEC board where it is compared to the AEC reference voltage. The output of U9 is normally high, switching low when the magnitude of the AEC ramp equals the reference voltage. This PT stop signal is further processed on the generator interface board.

7.2.13 ABS (MD-0758)

The composite video signal is fed into J8 on the generator interface board, and is amplified by U17D. The proportional DC is applied to J7 on the generator interface board. The jumpers (designated JW__) select the input source, input polarity, gain, etc. Refer to chapter 3E for the required positions for these jumpers.

The signal from J7 or from the output of U17D is applied to gain stages U17A and U17B for further processing. A digital gain pot U49 sets the ABS signal level at the output of U17C. The processed ABS signal exits the generator interface board at J11-3, and is buffered by U23D on the generator CPU board. The ABS signal is then fed to the sample and hold circuit, which smoothes out the ABS feedback signal during pulsed fluoro operation. The CPU monitors the output of the sample and hold circuit via A/D converter U37, and uses this information to maintain constant image brightness by regulating the fluoro kV and / or mA.

The output of the PMT at J7-12 of the generator interface board is split by R118 and fed to J7-10 such that the PMT output is also available for AEC control. This is applicable if a PMT is to be used for AEC control on AEC channel 4. Refer to chapter 3D, the section *AEC USING A PMT* for further details.

7.2.14 Remote fluoro control (MD-0766)

The remote fluoro control communicates with the generator via an RS-232 protocol. Serial communication is handled by U20 and U11 on the generator CPU board, and U7 on the remote fluoro control board. DS15 on the generator CPU board will flash to indicate that the generator is sending data to the remote fluoro control, and DS19 will flash to indicate that the remote fluoro control is sending data back to the generator.

The micro controller on the remote fluoro control board handles all remote fluoro functions. It decodes serial data from the generator and decodes inputs from the remote fluoro keyboard assembly. The micro controller drives the speaker on the remote fluoro control board, transmits data to the data latches on the remote fluoro display board in order to drive the desired LEDs, and sends data to the generator in order to set up the requested fluoro parameters.

7.2.15 Digital interface (MD-0767)

Refer to MD-0767, sheet 1:

This page shows the interface circuits between the generator CPU and the digital I/O board. Included are eight data and address lines, and four control lines for the data and address bus.

The ***HV ON*** signal that originates on the generator CPU board is described in 7.2.6, and is routed to the digital I/O board as shown.

The ***EXPOSURE ENABLE*** command is generated by some imaging systems, and is OR'ed with the output of U22 on the generator interface board as shown in MD-0761. When this line is pulled low, U46 on the generator CPU board is energized, enabling an X-ray exposure as described in 7.2.5.

Some imaging systems generate a ***"DIGITAL IMAGING" ABS*** signal. This is fed into the input of U17B on the generator interface board when JW21 is in the appropriate position to select that ABS signal source. Refer to 7.2.13 for details.

A sync signal that synchronizes the start of exposures is fed to the CPU via U51, U45A / U45B, and U28 on the generator CPU board. Depending on the position of JW22 on the generator interface board, the sync signal will be either 50 / 60 Hz line frequency pulses from the zero crossing circuit U40 on MD-0788, or these may be sync pulses supplied by the digital imaging system. DS40 on the generator CPU board will light when sync pulses are present.

This document does not detail the imaging system pin-outs. Refer to the imaging system documentation and the appropriate CPI digital imaging supplement for this information.

7.2.15 Digital interface (Cont)

Refer to MD-0767, sheet 2:

This is the functional schematic of digital I/O board assembly 733752. The address decoder circuits decode the address and data bus. U4 latches the output data, and driver U6 provides the required current gain to drive the output devices. The emitter of U10 is taken low when the generator is ready to make an exposure, and the imaging system will request an exposure by taking the cathode of U10 low. This results in the collector of U10 being pulled low when the generator is ready and the imaging system requests an exposure. The output of U10 is the ***EXPOSURE ENABLE*** command, described on sheet 1.

DS4 and DS6 to DS10 indicate the status of the outputs.

Multiplexer U7 selects one of two ABS feedback signals, these are designated as the ***"DIGITAL IMAGING" ABS*** signal, and fed back to the generator interface board as shown on sheet 1.

The digital outputs from the imaging system (inputs to the digital I/O board) are connected to U11 to U13. When active, these opto couplers will light DS3 to DS1 respectively, and pull the inputs of U8 low. The output of U8 is read by the generator CPU via the address decoder circuits on the digital I/O board.

The ***HV ON*** signal is applied directly to U6, which drives DS4 (***EXON***) and the corresponding input on the imaging system.

U14 and U16 provide isolation for the corresponding outputs on the digital I/O board.

SW1 must be set as defined in the digital imaging supplement. This configures the software specifically to be compatible with the imaging system in use.

Refer to MD-0767, sheet 3:

This is the functional schematic of digital I/O board assembly 733947. The address decoder circuits decode the address and data bus. U13 and U14 latch the output data, and drivers U15 and U16 provide the required current gain to drive the output devices. Q2 and Q3 provide level translation for these two outputs (Q2 and Q3 source +24 VDC when active).

The ***HV ON*** signal is applied to Q1 via D3. This takes the collector of Q1 low when the high voltage is on. Monostable timer U17 is triggered at the start of the ***HV ON*** signal, generating a 13 millisecond pulse. This ensures that the high voltage remains on for a minimum of 13 milliseconds, while having no effect on high voltage pulses longer than 13 milliseconds.

The digital outputs from the imaging system (inputs to the digital I/O board) are connected to U3 to U8. When active, these opto couplers will pull the inputs of U12 low. The output of U12 is read by the generator CPU via the address decoder circuits on the digital I/O board.

SW1 must be set as defined in the digital imaging supplement. This configures the software specifically to be compatible with the imaging system in use.

Refer to MD-0767, sheet 4:

This is the functional schematic of digital I/O board assembly 735921. The circuits that interface with the digital imaging system are the same as those on assembly 733947. These circuits are shown reduced in size on sheet 4 (within the dashed outline), and full size on sheet 3.

Digital I/O board assembly 735921 is used with some imaging systems that have integrated generator control functions. Such installations do not need a separate console to control and monitor the X-ray exposure parameters, but require "X-ray mini consoles" with on / off and prep / X-ray controls, and prep and X-ray exposure indicators.

Assembly 735921 includes the circuits described on sheet 3, plus data latch U18, driver U19, and connectors J4 to J7. J4 on this board connects to the control console connector, J4, on the generator interface board. The X-ray mini consoles connect to J6 and J7.

7.2.15 Digital interface (Cont)

The on / off and prep and X-ray commands originate on the X-ray mini console as described on page 5. These signals are then taken from J6 on the digital I/O board to J4 on the generator interface board. These functions are as described in MD-0762 and MD-0761 when using the X-ray mini console.

U18 latches the data to drive the speakers and the prep / exposure indicators on the mini consoles, and U19 provides the required current gain to drive these devices.

A version of this board exists without the digital imaging interface circuits that are shown within the dashed outline. This board is used with some imaging systems that have integrated generator control functions, and connect to the generator via a serial port instead of the digital I/O board.

Refer to MD-0767, sheet 5:

This sheet shows the optional CPI “mini consoles”. These are typically used in installations where the digital imaging system has integrated generator control functions. Such systems allow control and monitoring of generator exposure parameters, but typically do not contain on / off and prep / X-ray controls and indicators. The CPI mini consoles provide these control and monitoring functions in installations requiring them.

The X-ray mini console connects to J6 on the digital I/O board. This includes on / off and prep / X-ray controls as shown. These functions are routed to J4 on the generator interface board, and perform the on / off and prep / X-ray functions as described in MD-0762 and MD-0761. An optional hand switch connects to J2-1, J2-2, J2-3, and J2-4 on the X-ray mini console board. Power ON indicator DS4 is connected to J6-5 (ground), and lights whenever the generator is switched on. The appropriate bit in U18 is latched high or low in order to turn on / turn off LS1, LS2 and DS1 to DS3. Driver U19 provides current gain to drive these devices via J6-3, J6-4, and J6-6 to J6-8.

The optional mini console X-ray exposure indicator connects to J7 on the digital I/O board, and contains prep and exposure indicators and two speakers. U19 drives DS1, DS2, and LS1, LS2 via J7-1, J7-4, J7-5, and J7-7 as described above.

Refer to MD-0767, sheet 6:

This is the functional schematic of digital I/O board assembly 735406. The address decoder circuits decode the address and data bus. U4 latches the output data, and driver U6 provides the required current gain to drive U7, U10, and U16. U7 and U10 pull the associated inputs on the imaging system low when active.

The emitter of U14 is taken low when the generator is ready to make an exposure, and the imaging system will request an exposure by taking the anode of U14 high. This results in the collector of U14 being pulled low when the generator is ready and the imaging system requests an exposure, turning on U16. The output of U16 is the ***EXPOSURE ENABLE*** command, described on sheet 1. The output of U15, which will also be low when an exposure is requested, is monitored by generator CPU via U8 and the address decoder circuits on the digital I/O board.

The digital outputs from the imaging system (inputs to the digital I/O board) are connected to U11 and U13. When active, these opto couplers will pull the corresponding inputs of U8 low. The output of U8 is read by the generator CPU via the address decoder circuits on the digital I/O board.

This I/O board assembly includes an on-board +5 VDC regulator, U12, that connects to J2-21 and to the anode of U11.

SW1 must be set as defined in the digital imaging supplement. This configures the software specifically to be compatible with the imaging system in use.

7.2.15 Digital interface (Cont)

Refer to MD-0767, sheet 7:

This is the functional schematic of digital I/O board assembly 736153. The address decoder circuits decode the address and data bus. U4 latches the output data, and driver U6 provides the required current gain to drive U7, U10, and U13 to U15. These opto couplers pull the associated inputs on the imaging system low when active. DS3, DS4, and / or DS7 to DS9 light to indicate the active outputs.

The ***HV ON*** signal is NAND'ed with an output from U4 at the input of U3C. With both inputs to U3C high, the output of U3D will be high. This energizes U15 via driver U6 and DS9 / R9.

The digital outputs from the imaging system (inputs to the digital I/O board) are connected to U11 and U12. When these inputs are active, DS5 and / or DS6 will light, and the corresponding inputs of U8 will be low. The output of U8 is read by the generator CPU via the address decoder circuits on the digital I/O board.

SW1 must be set as defined in the digital imaging supplement. This configures the software specifically to be compatible with the imaging system in use.

Refer to MD-0767, sheet 8:

This is the functional schematic of digital I/O board assembly 736894. CPLD U1 decodes the address and data bus, and latches the output data. The output data is applied to drivers U3, U11, and U17. U3 and U11 provide the required current gain to drive the corresponding inputs on the imaging system. The associated LEDs will light to indicate which outputs are active. U17 drives the base of Q1, which provides level translation for that output (sources +24 VDC when active). U17 also energizes K1, and pulls the emitters of U5, U7, U14, and U16 low when the generator is ready to make an exposure.

Signals from the table or imaging system will request an exposure by taking the anode of U4, U6, U13, or U15 high. This will energize opto couplers U4 / U5, U6 / U7, U13 / U14, or U15 / U16 respectively. The outputs of U5, U7, U14, and U16 are OR'ed together, and provide the ***EXPOSURE ENABLE*** command, described on sheet 1.

The outputs of U4, U6, U13, U15, and U8 are monitored by the generator CPU via U1.

The digital outputs from the imaging system (inputs to the digital I/O board) are connected to U2, U9, U10, and U12. The outputs of these drivers are monitored by the generator CPU via U1. The LED in series with each input will light to indicate the status of that input.

The ***"DIGITAL IMAGING" ABS*** signal is taken directly from the imaging system to J1-20.

Refer to MD-0767, sheet 9:

This is the functional schematic of digital I/O board assembly 737950. The address decoder circuits decode the address and data bus. U4, U6, and U17 latch the output data, and driver U18 provides the required current gain to drive outputs via J6 and J7. U11 – U13 provide level translation for the X-ray, prep, and generator outputs, resulting in TTL level (5V) differential outputs. The output associated with U14 is not used at this time.

The ***HV ON*** signal is applied to U10 via U3D and U3C. This takes the output of U3C high when the high voltage is on. Monostable timer U7 is triggered at the start of the ***HV ON*** signal, generating a 13 millisecond pulse. This ensures that the high voltage remains on for a minimum of 13 milliseconds, while having no effect on high voltage pulses longer than 13 milliseconds. U10 provides level translation for the ***HV ON*** signal, providing a TTL level differential output.

With the input to U16 low, the base of Q1 will be pulled high, taking the collector of Q1 low. The collector of Q1 is monitored by the generator CPU via U8. U15 is not used at this time.

SW1 must be set as defined in the digital imaging supplement. This configures the software specifically to be compatible with the imaging system in use. JW101, JW102 and JW103 will be installed for systems using the circuits described on sheet 10.

7.2.15 Digital interface (Cont)

Refer to MD-0767, sheet 10:

This page shows circuits connected to J101.

With the input of U103 pulled low the output of U103 will be low. An exposure request (EXP_REQ) signal is then sent to the digital system via J101-8. The digital system will send an exposure acquire (EXP_ACQ) signal to U106 via J101-2. This active low signal will turn on U106. The U105 driver provides the required current gain to drive U16 (on sheet 9).

The logic high signal on the output of U101 will turn off the preset input of U102. On the next positive going edge of the X-RAY ON signal the output of U102 is pulled low, triggering the monostable timer, U104, generating a short pulse. The output of U104 will pull the base of Q101 high, turning on Q101. The output of Q101 (EXP_END) is read by the digital system and disables the EXP_ACQ signal.

+24V_EXT is supplied to the digital I/O board by the digital system via J102.

Refer to MD-0767, sheet 11:

This page shows the circuits connected to J6 and J9 on digital I/O board assembly 738947. CPLD U9 decodes the address and data bus, and latches the output data. The output data is applied to drivers U7, U8, U10, and U11. Drivers U7, U8, and U10 provide the required current gain to drive the corresponding inputs on the table.

Signals from the table request an exposure by taking the anode of U12 or U14 high. This will energize opto couplers U12 / U13 and U14 / U15. U11 energizes K1, and pulls the emitters of U13 and U15 low when the generator is ready to make a table-requested X-ray exposure or a table-requested fluoroscopic exposure, respectively. The outputs of U13 and U15 are OR'ed together, and provide the ***EXPOSURE ENABLE*** command, described on sheet 1. DS1 indicates that the table is requesting a fluoroscopic exposure, and DS2 indicates that the table is requesting an X-ray exposure.

A prep signal from the table lights DS3 and energizes U19. The output of U19 is monitored by the generator CPU via U9.

The S.I.D. (Source to Image Distance) signal from the table is an analog signal that is buffered by U23A and applied to the input of U20, an analog to digital converter that outputs a digital signal representing the source to image distance.

The sync signal is fed from the imaging system via J7 (sheet 12) to J8-22, or from the table via J6 to J8-22.

Refer to MD-0767, sheet 12:

This page shows the circuits connected to J1 to J4, J7, J10, J11, and the voltage regulator circuits. CPLD U9 decodes the address and data bus, and latches the output data. The output data is applied to drivers U3, U4, U5, U6, and U11. Drivers U3 to U6 provide the required current gain to drive the corresponding inputs on the table. U11 drives the base of Q1, Q2, Q4, and Q5, turning on these transistors when the corresponding input / output is to be energized.

The digital outputs from the imaging system (inputs to the digital I/O board) are connected to U1 and U2. The outputs are monitored by the generator CPU via U9.

The ***HV ON*** signal is applied to U5 via U18B and U17 in parallel with D2. Therefore, the input of U5 will be high when the high voltage is on. Monostable timer U17 is triggered at the start of the ***HV ON*** signal, generating a 13 millisecond pulse. This ensures that the high voltage remains on for a minimum of 13 milliseconds, while having no effect on high voltage pulses longer than 13 milliseconds.

Regulator circuits U16, U21, and U22 produce regulated outputs of +3.3 VDC, +10 VDC, and +2.5 VDC respectively.

The ABS signal is brought from the digital imaging system to the generator interface board via J7-1 and R41 to J8-20, and the sync signal from J7-3 or J7-5 is brought to J8-22 as described under sheet 11.

7.2.15 Digital interface (Cont)

Refer to MD-0767, sheet 13:

This page shows the circuits connected to drivers U14 and U27, MUX U24, and all of the connections to J1, J4, and J9. The connections to J3 are split between this page and page 14, and the connections to J6 and J7 are split between this page and pages 14 and 15.

The output data from U10 is applied to driver U14, which provides the required current gain to directly drive the output J6-17. U14 also drives opto-couplers U26 and U16 / U18, and pulls the emitters of U22 / U32 and U23 / U30 low when active. The collectors of U26 and U16 / U18 drive the outputs shown on J6.

Opto-couplers U21 / U23 are energized when J7-24 is pulled low, U20 / U22 are energized when J7-23 is pulled low, U29 / U30 are energized when J7-16 is pulled high, and U31 / U32 are energized when J6-16 is pulled high. The outputs of U20, U21, U29, and U31 are monitored by U10, and the outputs of U22, U23, U30, and U32 pull the EXPOSURE ENABLE line J8-14 low.

The sync signal is routed from J7-16 to J8-22, and MUX U24 selects the desired ABS signal to be brought to the generator interface board via J8-20.

The X-ray control and communication commands are routed directly between J4 and J1 / J3.

Refer to MD-0767, sheet 14

This page shows the circuits connected to driver U2, all of the connections to J2, the balance of connections to J3, and additional connections to J6 and J7 (in addition to those on pages 13 and 15).

Driver U2 provides the required current gain to drive the outputs J3-3, J3-4 / J2-1, J3-6 / J2-5, J3-7 / J2-7, and J3-8 / J2-4.

Opto-couplers U1, U3 – U8, U9, U11, U12, U17, and U25 are energized when their inputs are pulled low via the associated pin on J6 or J7. The output of each opto-coupler is monitored by the generator CPU via U10.

Refer to MD-0767, sheet 15:

This page shows the balance of the connections to J6 and J7.

Driver U19 provides the required current gain to drive the outputs J6-9, J6-10, J6-11, J6-12, J7-9, J7-10, J7-11, and J7-12. LED’s DS11 to DS14 and DS22 to DS25 indicate which of the eight outputs of U19 are pulled low.

Refer to MD-0767, sheet 16:

This page shows the circuits connected to drivers U14 and U27, MUX U24, and all of the connections to J1, J4, and J9. The connections to J3 are split between this page and page 14, and the connections to J10, J11 and J12 are split between this page and pages 17 and 18.

The output data from U10 is applied to driver U14, which provides the required current gain to directly drive the output J12-10. U14 also drives opto-couplers U26 and U16 / U18, and pulls the emitters of U22 / U32 and U23 / U30 low when active. The outputs of U26 and U16 drive the outputs shown on J10 and J11.

Opto-couplers U21 / U23 are energized when J12-11 is pulled low, U20 / U22 are energized when J12-12 is pulled low, U29 / U30 are energized when J12-8 is pulled high, and U31 / U32 are energized when J12-5 is pulled high. The outputs of U20, U21, U29, and U31 are monitored by U10, and the outputs of U22, U23, U30, and U32 pull the EXPOSURE ENABLE line J8-14 low.

The sync signal is routed from J12-8 to J8-22, and MUX U24 selects the desired ABS signal to be brought to the generator interface board via J8-20.

The X-ray control and communication commands are routed directly between J4 and J1 / J3.

7.2.15 Digital interface (Cont)

Refer to MD-0767, sheet 17

This page shows the circuits connected to driver U2, all of the connections to J2, the balance of connections to J3, and additional connections to J10, J11 and J12 (in addition to those on pages 16 and 18).

Driver U2 provides the required current gain to drive the outputs J3-3, J3-4 / J2-1, J3-6 / J2-5, J3-7 / J2-7, and J3-8 / J2-4.

Opto-couplers U1, U3 – U8, U9, U11, U12, U17, and U25 are energized when their inputs are pulled low via the associated pin on J10, J11 or J12. The output of each opto-coupler is monitored by the generator CPU via U10. U12 has jumper JW1 on the input that will disable the EXPOSURE INHIBIT signal should the jumper be placed at pins 1 and 2.

Refer to MD-0767, sheet 18:

This page shows the balance of the connections to J10, J11 and J12 as well as connections to J13 and J14.

Driver U19 provides the required current gain to drive the outputs J12-4, J11-7, J11-3, J11-5, J10-1, J12-6, J11-2, and J11-1. LED's DS11 to DS14 and DS22 to DS25 indicate which of the eight outputs of U19 are pulled high.

Refer to MD-0767, sheet 19:

This is the functional schematic of digital I/O board assembly 903121. Driver U6 directly drives six of the outputs:

- Five of these outputs are derived from the CPU and latched by U4.
- The sixth directly driven output is the X-ray on signal, which is derived from the ***HV ON*** signal in the generator.

The last output from U6 is inverted by Q1, and this drives the output at J2-14. DS1 to DS 6 indicate that the related outputs are low when these are lit, and DS7 indicates that its output is high when it is lit.

This board also has three inputs:

- The ABS feedback signal at J2-16 is routed to the ABS circuits in the generator via J1-20.
- When the READY input at J2-4 is low, it will turn on Q2, which turns on Q3. The logic state at the output of Q3 is read by the CPU via data buffer U8. The READY input also supplies the sync input via the collector of Q4.
- When the TRIGGER ACKNOWLEDGE input at J2-4 is low, it will turn on Q5, which turns on Q6. The logic state at the output of Q6 is also read by the CPU via data buffer U8.

7.2.16 DAP (MD-0828)

The DAP circuit consists of micro-controller U1, RS-232 driver U2, and associated components on the DAP interconnect board. Micro-controller U1 operates under control of the CPU on the generator CPU board via U31 and U38, and controls all DAP functions (switches the +5/15 V supplies via Q1, Q2, Q3 / Q4, Q5 / Q6, Q7 / Q8, and Q9 / Q10 as required to control and test the DAP devices. The micro-controller also counts the DAP pulses via U5 for DAP chamber #1, and U6 for DAP chamber #2).

For DAP chambers with differential outputs, JW1 and JW2 must be jumpered pins 2-3. This connects the differential output from the DAP chambers directly to the input of U5, U6. For DAP chambers with a single ended output, JW1 and JW2 must be jumpered pins 1-2. This connects the output of the DAP chamber to the input of opto-couplers U8, U9. These opto-couplers provide increased noise immunity when single ended DAP chambers are used, as the signal must be greater than approximately 2V in order to turn on the LED inside U8, U9. The single-ended output of the opto-couplers is then connected to the input of U5, U6.

DS2 and DS3 on the DAP interconnect board indicate that the DAP chambers are sending pulses back to the micro-controller, and DS29 and DS32 on the generator CPU board indicate that the CPU is transmitting and receiving data respectively.

+24 VDC is supplied to the DAP interconnect board from the room interface board. Regulators on the DAP interconnect board regulate this to +15 V and +5 V.

7.2.17 Serial communications (MD-0829)

Refer to MD-0829, sheet 1:

The console board shown on sheet 1 is used on the 31 X 42 cm console. The console for the other Indico 100 console types is shown on sheet 2.

When the generator is switched on and the start-up diagnostics are completed, the console CPU will attempt to communicate with the generator CPU. The console will send data to the generator, and then wait for a response from the generator. If the console receives a response, communication may continue. If the console CPU does not receive a response from the generator CPU, a communication error message will be presented.

When the console is sending data to the generator, DS41 on the console board and DS3 on the generator CPU board will flash. DS1 on the generator CPU board and DS42 on the console board will flash to indicate that the generator CPU board is sending data to the console.

The console communicates with the generator via RS-232 drivers U1 (console board) and U12 (generator CPU board).

U5 on the console board is an RS-232 driver for the serial port, J2. DS44 and DS43 will flash to indicate that data is being sent to, and received from the serial port.

The generator CPU board may include optional communications ports J1 and J2. These are driven via U31 and U42 / U38. Communication to and from these ports is indicated by DS29, DS32, DS43, and DS44.

DS45 on the console board will flash at a consistent 1 Hz rate if the CPU is operational.

Refer to MD-0829, sheet 2:

Sheet 2 shows the console board for the 23 X 56 cm console, and for the Rad only console. Also shown are optional communications ports on the generator CPU board.

The generator CPU board may include optional communications ports J15 and J16. These are driven via U50. Communication to and from these ports is indicated by DS45 to DS48.

DS16 on the generator CPU board will flash at a consistent 1 Hz rate if the CPU is operational.

For the 23 X 56 cm console:

When the console is sending data to the generator, D4 on the console board will flash. D3 on the console board will flash to indicate that the generator CPU board is sending data to the console.

The console communicates with the generator via RS-232 driver U6, or RS-422 drivers U5 / U9 for special applications.

U20 on the console board is an RS-232 driver for the serial port, J2. D2 and D1 will flash to indicate that data is being sent to, and received from the serial port.

D6 on the console board will flash at a consistent 1 Hz rate if the CPU is operational.

For the Rad-only console:

When the console is sending data to the generator, DS2 on the console board will flash. DS3 on the console board will flash to indicate that the generator CPU board is sending data to the console.

The console communicates with the generator via RS-232 driver U8.

U11 on the console board is an RS-232 driver for the serial port, J4. DS4 and DS5 will flash to indicate that data is being sent to, and received from the serial port.

DS1 on the console board will flash at a consistent 1 Hz rate if the CPU is operational.

CHAPTER 8

SPARES

CONTENTS:

8.1.0 INTRODUCTION

This chapter contains the list of recommended spare parts for the various models of Indico 100 generators.

8.2.0 SPARE PARTS LIST INDICO 100 GENERATOR

TABLE 1

DESCRIPTION	PART NUMBER	NOTE	SUGGESTED QTY
Generator CPU board	Consult factory	N/A	N/A
Generator interface board	732177-08	2	1
Room interface board	733184-00	2	1
Control board	Consult factory	N/A	N/A
Filament board	See note ⇒	3	⇐ See note
Auxiliary board	732221-02	4	1
Inverter board	Consult factory	N/A	N/A
Power input board	Consult factory	N/A	N/A
Resonant Board	Consult factory	N/A	N/A
AEC board	See note ⇒	5	⇐ See note
Console CPU board	See note ⇒	1	⇐ See note
Remote fluoro display board	729053-00	6	⇐ See note
Remote fluoro control board	729038-00	6	⇐ See note
Low speed starter board	See note ⇒	7	⇐ See note
Digital I/O board	See note ⇒	8	⇐ See note
DAP interface board	735992-00	9	⇐ See note
Dual speed starter board	728877-03	10	⇐ See note
Dual speed starter subassembly	See note ⇒	10	⇐ See note
Hand switch assembly	See note ⇒	11	⇐ See note
Battery, lithium 3.0V	7412290100	2	2
Fan, axial	2083991400	12	1
Transformer, aux power supply	732417-00	2	1
Transformer, room I/F	735496-01	2	1
HT tank assembly (complete)	See note ⇒	13	⇐ See note
REFER TO TABLE 2 FOR FUSES			

8.2.0 SPARE PARTS LIST INDICO 100 GENERATOR (Cont)

TABLE 2		
FUSE LOCATION	**FUSE TYPE & PART NO.**	**SUGGESTED QTY**
Auxiliary board: F1, F2 (12A 250V Slo-Blo)	MDA-12, 6713746500	5
Auxiliary board: F3, F4 (8A 250V Slo-Blo) Low speed starter board: F1, F3	S506-8A, 5550037500	5
Filament board: F1, F2 (4A 250V Slo-Blo)	GDC-4, 5550033100	5
Dual speed starter: F1, F2 (10A 700V)	A70QS10-14F, 6739951800	5
Power input board. 1 phase: F1, F2 (10A 250V Slo-Blo)	MDA-10, 6713000200	5
Power input board. 1 phase: F5 (A, B) 100A 250VAC	NLN-100, 6711906500	5
Power input board. 3 phase: F1, F2 (10A 500V Slo-Blo)	FNQ-10, 6711905500	5
Power input board. 1 phase: F4 (2A 250V Slo-Blo) Generator interface board: F6 Console CPU board (23 X 56 cm console): F1 Console board (31 X 42 cm console): F1	GDC-2, 5550032600	5
Power input board: 3 phase: F5 (A, B, C) 60A 600VAC	OTS-60, SC3434	5
Generator interface board: F1 (1.6A 250V Slo-Blo)	GDC-1.6, 5550033300	5
Generator interface board: F2 (2.5A 250V Slo-Blo)	GDC-2.5, 5550034400	5
Generator interface board: F3, F4, F5 (5A 250V Slo-Blo) Low speed starter board: F2	GDC-5, 5550035600	5
Console board (Rad-only console): F1 (1A 250V Slo-Blo) Power input board: F6 (three phase units)	GDC-1, 5550032900	5
Digital I/O board 733947, 735921: F1 (500 mA 250V Slo-Blo)	GDC-500 mA, 5550033600	5
Primary of power supply auxiliary transformer: F1 (single phase units) 3A 250V Primary of room interface transformer: F4 (single phase units)	FNM-3, 6711907400	5
Primary of power supply auxiliary transformer: F1 (three phase units) 2A 500V Primary of room interface transformer: F4 (three phase units)	FNQ-2, 5550005300	5
Power input board: F8 (250mA 250V Slo-blo) (three phase units)	GDC 1/4A, 5550034300	5
Power input board: F7 (all three phase units ***except*** 480V 100 kW: 3/10A 250V Slo-blo)	MDL 3/10A / GDL 3/10, 6713533000	5
Power input board: F7 (three phase 480V 100 kW units ***only:*** 3/8A 250V Slo-blo)	MDL 3/8-R 6800001700	5

8.2.0 SPARE PARTS LIST INDICO 100 GENERATOR (Cont)

NOTE:

1. Console board part numbers:

DESCRIPTION	PART NUMBER
Console CPU board, 23 X 56 cm console	733903-00
Console CPU board, 31 X 42 cm console	901618-00
Console board, rad-only console	900923-00

2. This part is common to all models of Indico 100 generators.

3. Three different filament boards are used in Indico 100 generators. RAD only generators use ONE filament board, part number 731407-00. R&F generators use TWO filament boards, part number 731407-01 (large focus) and part number 731407-02 (small focus). Spares should be stocked accordingly.

4. The part number shown is the suggested replacement for the original auxiliary board. The spares board is “jumper configurable” in the field and as such will replace the original auxiliary board. This is intended to eliminate the need to stock multiple configurations of this board.

5. The AEC board for your generator was selected to be compatible with specific AEC device(s). To maintain full compatibility, the original part number must be ordered as a replacement. Refer to chapter 9, section 9.2.0 for the part number of the original AEC board shipped in the generator for which this manual was prepared. Spares should be stocked accordingly.

6. Remote fluoro control is an option; spares should be stocked accordingly.

7. These items only used on generators fitted with low speed starter, spares should be stocked accordingly. The low speed starter part number with 30μF phase-shift capacitance for standard “R” type stators is 732752-**00**. The part number with 12.5μF phase-shift capacitance is 732752-**01**, and the part number with 45μF phase-shift capacitance is 732752-**02** and the part number with 100μF phase-shift capacitance is 732752-**04**.

8. The digital I/O board is optional, and used on generators intended to interface with digital imaging systems. To ensure full compatibility, please order the same part number that is in your generator(s).

9. DAP is an option, spares should be stocked accordingly.

10. This applies to the dual speed starter option only, spares should be stocked accordingly. The part number shown for the dual speed starter board is for the board only, without the phase-shift capacitors. For the complete dual speed starter subassembly, several part numbers (which are tube-stator dependent) are used in Indico 100 generators. To determine which dual speed starter subassembly is in your generator, note the DUAL SPEED STARTER ASSY part number on a label on the rear of the dual speed starter chassis. This will be the part number that must be ordered for spares usage. For reference, this will be part number 733317-XX or 735925-XX where XX is a two digit number designating the exact configuration.

11. For 23 X 56 cm consoles, use hand switch assembly part number 733176-00. For 31 X 42 cm consoles, touchscreen consoles, and rad-only consoles use hand switch assembly part number 735203-00.

12. Cooling fan(s) are used on all R&F and some models of radiographic generators. Spares should be stocked accordingly.

13. For replacement HT oil tank part numbers, consult factory.

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CHAPTER 9

SCHEMATICS

CONTENTS:

9.1.0 INTRODUCTION

This chapter contains the functional schematics for the Indico 100 X-ray generator. Each functional schematic represents a major function in the generator. The functional schematics in this chapter represent all of the major functional blocks in Indico 100 X-ray generators.

9.2.0 FUNCTIONAL SCHEMATIC INDEX

The following functional schematics are included in this manual.

INDICO 100 FUNCTIONAL DRAWINGS	
DESCRIPTION	**DRAWING NUMBER**
Interconnect Diagram	MD-0843
DC Bus and Power Distribution	MD-0788
System ON	MD-0762
Room Interface	MD-0763
X-Ray Exposure - Rad / Fluoro	MD-0761
kV Control and Feedback	MD-0759
Filament Drive and mA Control	MD-0760
Low Speed Starter	MD-0764
Dual Speed Starter	MD-0765
Rad / Fluoro and Power Mode Select	MD-0786
Interlocks and Tube 1 / Tube 2 Tellback	MD-0787
Automatic Exposure Control (AEC)	MD-0757
Automatic Brightness Stabilization (ABS)	MD-0758
Remote Fluoro Control	MD-0766
Digital Interface	MD-0767
DAP (Dose Area Product)	MD-0828
Serial Communications	MD-0829

9.3.0 FUNCTIONAL DRAWINGS

The functional schematics immediately follow this page.