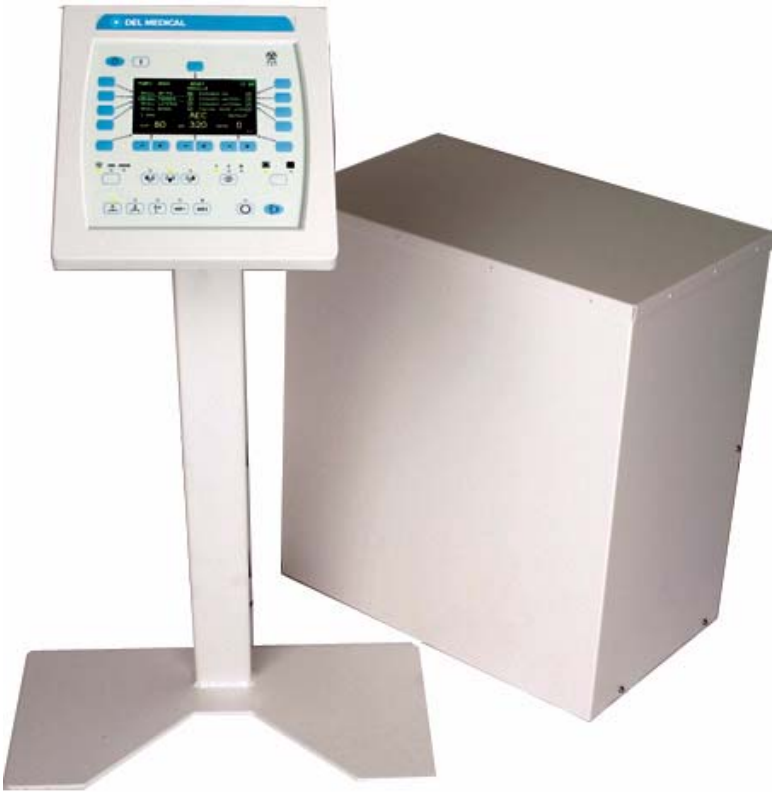
DEL MEDICAL

CM Series
X-Ray Generator
Installation & Service Manual



P/N 8000-CMIS

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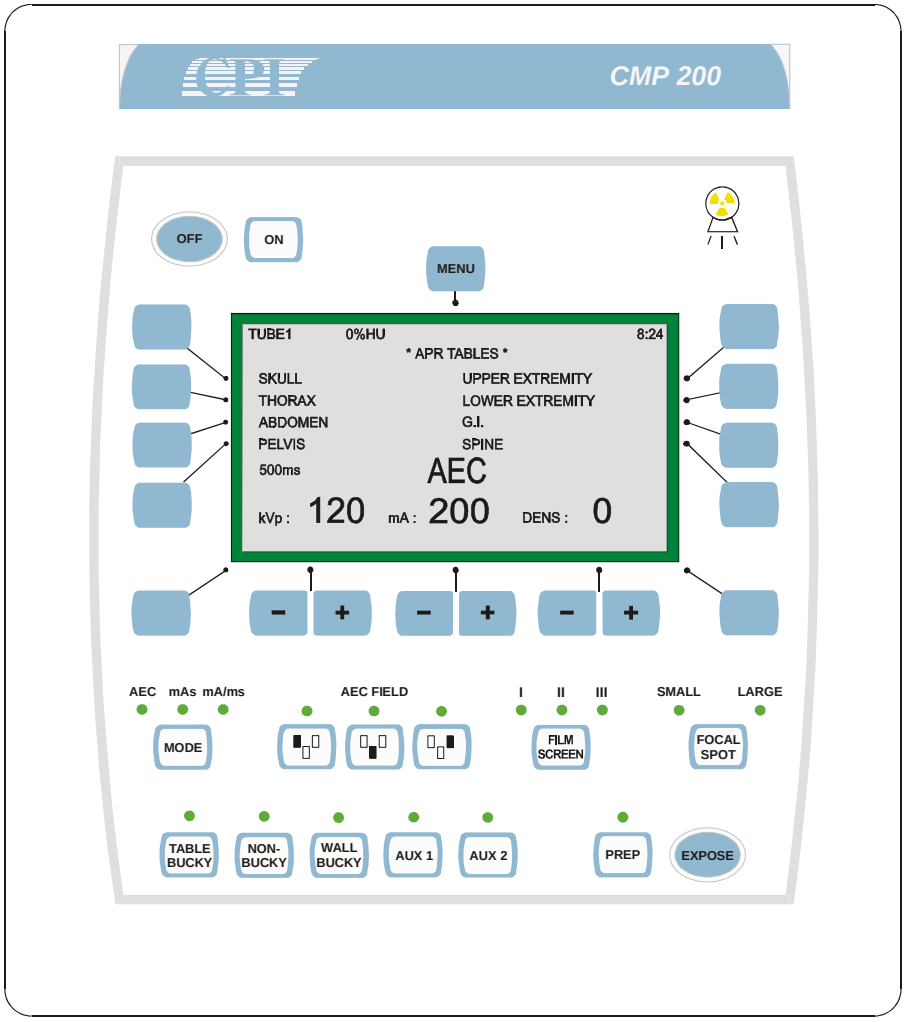
CPI CMP 200 SERIES
X-RAY GENERATOR



CMP200_001A.CDR

SERVICE MANUAL

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CMP 200 SERVICE AND INSTALLATION MANUAL

P/N 740986-00

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Communications & Power Industries
communications & medical products division.

PROPRIETARY AND CONFIDENTIAL

CHAPTER 1

PRE-INSTALLATION

CONTENTS:

1.1.0 INTRODUCTION

This chapter summarizes the main features of the CMP 200 X-ray generator (performance, regulatory and compatibility). Safety information is provided, along with environmental, room, and installation requirements. This chapter concludes with a pre-installation checklist and a diagram showing the major component layout.

The information in this chapter is provided in order for the installer to be able to plan the site layout prior to installation of the generator.

1.1.1 Generator Description

The CMP 200 X-ray generator is intended for use in stationary radiographic X-ray systems, including tomography. The X-ray generator consists of a main power cabinet, and a control console. The main power cabinet contains the HT tank and control circuits, the filament drivers, the low speed starter, and interface connections to the room equipment.

The control console allows the operator to select the technique factors, image receptors, etc., and to initiate an X-ray exposure.

1.1.2 Features

The following are the main features of and the options available for the generator:

- Integral low speed starter, compatible with X-ray tubes with type “R” stator. Optional compatibility with GE 23/23 Ω equal impedance “E” stator.
- 24 VDC, 110, or 220 VAC power source for Buckys.
- 24 VAC 150 watts power source for collimator lamp.
- 24 VDC 45 watts power source for system locks.
- Optional AEC.

1.1.3 Radiographic Performance

kVp range:	40 to 125 kV or 40 to 150 kV, depending on model.
kVp steps:	variable in 1 kV steps.
kVp accuracy:	± 5 %.
Risetime (10-90%):	<1.5 ms.
Time range:	1.0 to 6300 milliseconds.
mAs range	0.1 to 500 mAs (30/32/40 kW), 0.1 to 630 mAs (50 kW).
mAs accuracy:	± (10 % + 0.2) mAs.
mA range	10 to 400 mA (30/32 kW), 10 to 500 mA (40 kW), 10 to 630 mA (50 kW).
Coefficient of linearity:	0.05 (station to station) mAs.
Coefficient of reproducibility:	kV, mAs ≤ 0.05.

1.1.4 Environmental Specifications

OPERATING

Ambient temperature range	10 to 40 °C (50 to 104 °F).
Relative humidity	20 to 80%, non-condensing.
Altitude	Sea-level to 2440 meters (700 to 1100 hPa).

TRANSPORT AND STORAGE

Ambient temperature range	-25 to 70 °C (-13 to 158 °F)..
Relative humidity	5 to 95%, non-condensing.
Atmospheric pressure range	500 to 1060 hPa (375 to 795 mm Hg).

1.1.5 Applicable Standards

The CMP 200 series of X-ray generators comply with the regulatory requirements and design standards in this section as follows:

- VZW2555 series: Only the standards marked with an asterisk ***** under **SAFETY**.
- VZW2556 series: All standards in this section.

A) SAFETY

- ***** FDA Center for Devices & Radiological Health (CDRH) - 21 CFR title 21 subchapter J (USA).
- ***** Radiation Emitting Devices Act - C34 (Canada).
- Medical Device Regulations (Canada).
- EC Directive 93/42/EEC 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, EN ISO 14971.

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

CE 0366

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 SA 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)

<table>
<tr><th colspan="3">Guidance and manufacturer's declaration – electromagnetic emissions</th></tr>
<tr><td colspan="3">The VZW2556 series of X-ray generators is intended for use in the electromagnetic environment specified below. The customer or the user of the VZW2556 series should assure that it is used in such an environment.</td></tr>
<tr><th>Emissions test</th><th>Compliance</th><th>Electromagnetic environment - guidance</th></tr>
<tr><td>RF emissions
CISPR 11</td><td>Group 1</td><td>The VZW2556 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.</td></tr>
<tr><td>RF emissions
CISPR 11</td><td>Class A
(The VZW2556 series of X-ray generators in combination with shielded location)</td><td rowspan="3">The VZW2556 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 VZW2556 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.</td></tr>
<tr><td>Harmonic emissions
IEC 61000-3-2</td><td>Not Applicable</td></tr>
<tr><td>Voltage fluctuations/ flicker emissions
IEC 61000-3-3</td><td>Not Applicable</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

1.1.5 Applicable Standards (Cont)

Guidance and manufacturer's declaration – electromagnetic immunity			
The VZW2556 series of X-ray generators is intended for use in the electromagnetic environment specified below. The customer or the user of the VZW2556 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 differential mode ± 2 kV common mode	± 1 kV differential mode ± 2 kV common mode	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 VZW2556 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.			

1.1.5 Applicable Standards (Cont)

Guidance and manufacturer's declaration – electromagnetic immunity			
The VZW2556 series of X-ray generators is intended for use in the electromagnetic environment specified below. The customer or the user of the VZW2556 series should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Conducted RF IEC 61000-4-6	3 V_{rms} 150 kHz to 80MHz	3 V_{rms} 150 kHz to 80MHz	The VZW2556 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.)
Radiated RF IEC 61000-4-3	3 V/m 80MHz to 2.5 GHz	3 V/m 80MHz to 2.5 GHz	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: 
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.			
[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 VZW2556 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.			

1.1.6 Electromagnetic Compatibility (EMC)

In accordance with the intended use, some models of this series of X-ray generators comply with the European Council Directive concerning Medical Devices. The CE marking affixed to compliant products 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.

1.1.7 RoHS Compliance

CMP 200

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.

1.2.0 SAFETY

1.2.1 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.

	High voltage symbol used to indicate the presence of high voltage.
	Warning symbol used to indicate a potential hazard to operators, 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.
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 operator console. Never allow unqualified personnel to operate the X-ray generator.

1.2.2 Safety Notices and Warnings

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

WARNING: ***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 RESPONSIBILITIES 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.

1.2.2 Safety Notices and Warnings (Cont)

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 membrane 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 touch screen console, J2 on the touch screen interface board is for the interconnect cable to the generator, J3 is for connection of an external hand switch, J5 connects to the membrane switch assembly with the on / off and prep / expose switches, and J4 is a serial port for use by an external computer.

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.***

1.2.2 Safety Notices and Warnings (Cont)

WARNING: ***HAZARDOUS VOLTAGES EXIST INSIDE THE GENERATOR WHENEVER THE MAIN POWER DISCONNECT IS SWITCHED ON. THESE AREAS INCLUDE, BUT ARE NOT LIMITED TO, THE MAIN FUSE HOLDER AND ASSOCIATED CIRCUITS ON THE H.V. AUXILIARY BOARD, THE AUXILIARY AND / OR TOUCHSCREEN TRANSFORMERS, AND THE MAIN POWER CONTACTOR.***
LED DS1 ON THE H.V. AUXILIARY BOARD INDICATES THE PRESENCE OF THE +24 VDC SUPPLY.

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

THE DC BUS CAPACITORS, LOCATED IN THE MAIN CABINET PRESENT A SAFETY HAZARD FOR AT LEAST 5 MINUTES AFTER THE POWER HAS BEEN REMOVED FROM THE UNIT. CHECK THAT THESE CAPACITORS ARE DISCHARGED BEFORE SERVICING THE GENERATOR.

AN LED CONNECTED ACROSS THE DC BUS INDICATES THE PRESENCE OF HIGH VOLTAGE. THIS LED IS MOUNTED ON THE EMC CAPACITOR BOARD (ON SOME MODELS, THE EMC CAPACITOR BOARD DOES NOT CONTAIN ANY COMPONENTS OTHER THAN THE LED AND THE SERIES RESISTORS).

DO NOT RELY SOLELY ON BLEEDER CIRCUITS AND HIGH-VOLTAGE ON INDICATORS IN THE GENERATOR TO PROTECT YOU. DUE TO THE POSSIBILITY OF COMPONENT FAILURE, IT MUST NEVER BE ASSUMED THAT AN UNLIT LED ENSURES THAT NO HIGH VOLTAGE IS PRESENT. USING A VOLTMETER, CONFIRM THAT NO HIGH VOLTAGE IS PRESENT BEFORE ATTEMPTING ANY SERVICE.

1.2.3 Safety Warning Labels

This subsection defines the safety labels used inside and outside the generator cabinet.

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

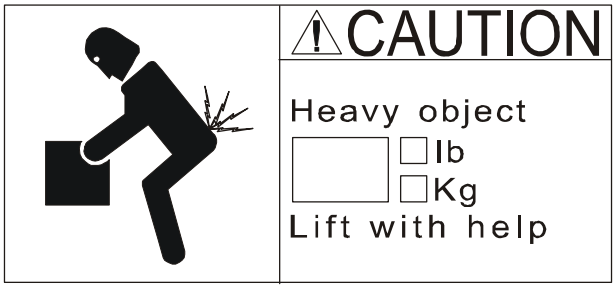
WARNING: ***SWITCH OFF THE MAIN POWER DISCONNECT AND ALLOW SUFFICIENT TIME FOR ALL CAPACITORS TO DISCHARGE BEFORE REMOVING ANY COVERS.***

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

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

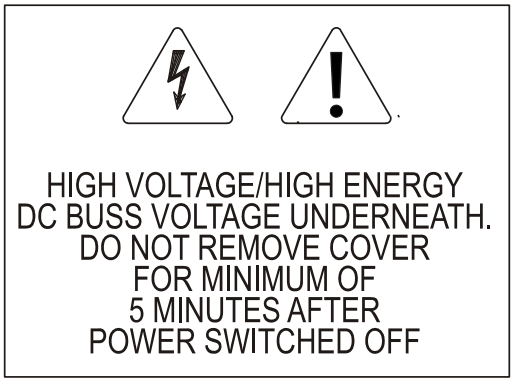
1.2.3 Safety Warning Labels (Cont)

Weight Label



This label is attached to the main generator cabinet and to the HT tank, and states the approximate weight of the main cabinet with the HT tank, and the weight of the HT tank separately. Do not attempt to lift these items without proper assistance.

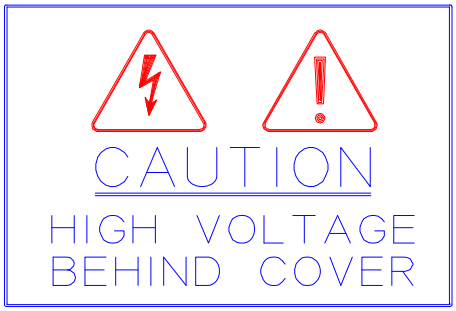
Caution HV/High Energy Warning Label



This label is attached to the generator cabinet and on the inside of the back cover above the HT tank. The DC bus capacitors (approximately 300 to 670 VDC, depending on model) will remain charged for up to 5 minutes after the AC mains is disconnected or the console is switched off.

1.2.3 Safety Warning Labels (Cont)

Caution HV Behind Cover Label



This label is attached to the outside of the generator cabinet, to the cover over the inverter assembly, and to the cover in front of the touchscreen fusing board. Mains voltage is present inside the cabinet whenever the main disconnect is switched on. Additionally, the DC bus capacitors will remain charged for up to 5 minutes after the AC mains is disconnected or the console is switched off.

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

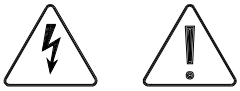
HT Tank - Transformer Terminals Notice

This notice is printed on the HT tank lid and cautions against over-tightening the nuts on the transformer feedthrough terminals (for the primary of the HT transformers).

1.2.3 Safety Warning Labels (Cont)

Danger High Tension Notice

DANGER
HIGH TENSION



This notice is printed on the HT tank lid. 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.

HIGH VOLTAGE HAZARD: Be certain that you are aware of all potential high voltage locations and hazards as detailed in this section before removing any covers, or attempting any service on this X-ray generator.

FUSE RATINGS:

LOCATION	1 PHASE UNITS	3 PHASE UNITS
MAIN LINE FUSES:	F1, F2: FRN-R-50 *	F1, F2, F3: AG40 * (32/40 kW). F1, F2, F3: SC60 * (50 kW).
GENERATOR CONTROL BOARD:	F1: GDC-1A *	F1: GDC-1A *
CONSOLE BOARD:	F1: GDC-1A *	F1: GDC-1A *
	ALL 208/230 V UNITS	**ALL 400/480 V UNITS**
H.V. AUXILIARY BOARD:	F1, F6, F7: S506-8A * F2, F3: GDC-3.15A * F4, F5, F11: GDC-6.3A * F8, F9, F12: GDC-2A * F10: GDC-1A *	F1, F6, F7: S506-8A * F2, F3: GDC-3.15A * F4, F5: FNQ-1 * F8, F9: FNQ 2 * F10: GDC-1A * F11: GDC-6.3A * F12: GDC-2A *

* Refer to chapter 8, spares list, for CPI part number for these fuses.

1.2.3 Safety Warning Labels (Cont)

HIGH VOLTAGE HAZARD: Approximately 400 VAC is present on the console board in the area of T1, C36, and J5. This is a high voltage source for the fluorescent backlight on the LCD display.

HIGH VOLTAGE HAZARD: AC mains voltage and / or DC bus voltage (approximately 325 to 670 VDC, depending on model) is present on the H.V. auxiliary board whenever the AC mains is energized. Ensure that the AC mains is switched off and locked out before servicing this board. See the note below regarding the DC bus voltage.

HIGH VOLTAGE HAZARD: High voltage is present on all components connected to the AC mains (line fuses, main power contactor, H.V. auxiliary board, auxiliary and / or touchscreen transformer, etc) whenever the AC mains is switched on. Additionally, DC bus voltage is present on certain components (mains rectifier assembly, DC bus capacitors, inverter assembly, HT tank, H.V. auxiliary board, etc) whenever the generator is switched on, and will remain on for up to 5 minutes after the console is switched off or the AC mains is switched off or disconnected.

High voltage (approximately 325 to 670 VDC, depending on model) is present on the inverter assembly and associated components whenever the AC mains is energized and the console is switched on, and for up to 5 minutes after the console is switched off or the AC mains is disconnected. **THIS COMBINATION OF HIGH VOLTAGE AND HIGH CURRENT IS POTENTIALLY LETHAL. USE EXTREME CAUTION WHEN SERVICING THIS UNIT.**

1.3.0 PREPARING FOR INSTALLATION

1.3.1 Generator Heat Output

The maximum heat output of the main generator cabinet is less than 1000 BTU / hour in normal clinical use, with a maximum of 70 BTU / hour heat output for the console. The console is primarily conduction cooled, and the main cabinet is fan cooled. The console and main cabinet should never be covered when the generator is switched on, as any covering may interfere with the cooling.

1.3.2 Generator Power Requirements

The tables in this section show mains power requirements for various configurations of CMP 200 X-ray generators. The installer must ensure that the generator is connected to the proper mains voltage as per the nameplate on the generator.

The table below depicts the power requirements for the 30 kW CMP 200 X-ray generators.

Line Voltage	208 VAC - 5% to 230 VAC + 10%, 1 phase.
Line Frequency	50/60 Hz.
Momentary Current	195 Amps at 230 VAC.
Nominal Current *	≤5 Amps.
Momentary Power Consumption	43 kVA.

The table below depicts the power requirements for the 32 kW CMP 200 X-ray generators.

Line Voltage	208 VAC - 5% to 230 VAC + 10%, 3 phase. 400 VAC ± 10%, 3 phase. 480 VAC ± 10%, 3 phase.
Line Frequency	50/60 Hz.
Momentary Current	112 Amps/phase at 230 VAC. 65 Amps/phase at 400 VAC.
Nominal Current *	≤5 Amps.
Momentary Power Consumption	45 kVA.

1.3.2 Generator Power Requirements (Cont)

The table below depicts the power requirements for the 40 kW CMP 200 X-ray generators.

Line Voltage	208 VAC - 5% to 230 VAC + 10%, 1 phase. 208 VAC - 5% to 230 VAC + 10%, 3 phase. 400 VAC ± 10%, 3 phase. 480 VAC ± 10%, 3 phase.
Line Frequency	50/60 Hz.
Momentary Current	250 Amps at 230 VAC (1 phase). 140 Amps/phase at 230 VAC (3 phase). 80 Amps/phase at 400 VAC. 65 Amps/phase at 480 VAC.
Nominal Current *	≤5 Amps.
Momentary Power Consumption	55 kVA.

The table below depicts the power requirements for the 50 kW CMP 200 X-ray generators.

Line Voltage	208 VAC - 5% to 230 VAC + 10%, 3 phase. 400 VAC ± 10%, 3 phase. 480 VAC ± 10%, 3 phase.
Line Frequency	50/60 Hz.
Momentary Current	175 Amps/phase at 230 VAC. 100 Amps/phase at 400 VAC. 80 Amps/phase at 480 VAC.
Nominal Current *	≤5 Amps.
Momentary Power Consumption	69 kVA.

***** Nominal Current = Generator standby current only. External or installer-supplied equipment connected to the generator may increase the nominal current beyond the values shown.

1.3.2 Generator Power Requirements (Cont)

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, AND 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.

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

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

Generator Series and 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
30 kW 208-230 VAC, 1p.	#4 (21 mm^2)	195 A	120 A	45 kVa	#4 (21 mm^2)	0.06 Ω
32 kW 208-230 VAC, 3p.	#4 (21 mm^2)	112 A	100 A	45 kVa	#4 (21 mm^2)	0.09 Ω
32 kW 400 VAC, 3p.	#6 (13.3 mm^2)	65 A	60 A	45 kVa	#6 (13.3 mm^2)	0.27 Ω
40 kW 208-230 VAC, 1p.	#2 (33 mm^2)	250 A	120 A	65 kVa	#2 (33 mm^2)	0.045 Ω
40 kW 208-230 VAC, 3p.	#4 (21 mm^2)	140 A	120 A	55 kVa	#4 (21 mm^2)	0.075 Ω
40 kW 400 VAC, 3p.	#6 (13.3 mm^2)	80 A	100 A	55 kVa	#6 (13.3 mm^2)	0.22 Ω
40 kW 480 VAC, 3p.	#6 (13.3 mm^2)	65 A	100 A	55 kVa	#6 (13.3 mm^2)	0.32 Ω
50 kW 208-230 VAC, 3p.	#4 (21 mm^2)	175 A	200 A	65 kVa	#4 (21 mm^2)	0.055 Ω
50 kW 400 VAC, 3p	#6 (13.3 mm^2)	100 A	100 A	65 kVa	#6 (13.3 mm^2)	0.17 Ω
50 kW 480 VAC, 3p.	#6 (13.3 mm^2)	80 A	100 A	65 kVa	#6 (13.3 mm^2)	0.24 Ω

***** Refer to 1.3.3 for general grounding information.

1.3.2 Generator Power Requirements (Cont)

Recommended Service Disconnect: As per the above table

- All wiring and grounding should comply with the national electrical code or equivalent.
- All wiring must be copper.
- The disconnect switch shall be located within reach of the operator.

1.3.3 Generator Ground Requirements

- A suitable ground must be connected from the disconnect switch to the main ground of the generator, located to the right of the main fuse block. 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.
- A copper ground cable, #10 AWG (6 mm^2) or larger should be connected from the X-ray tube housing to the H.T. tank ground stud (located at the top of the HT tank).
- If a neutral line is provided with the system, under no circumstances is it to be used for ground purposes. The ground must carry fault currents only.

1.3.4 Locating and Mounting the Generator

The main 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 generator installation area must be clean and free of dirt or debris.
- The installer must supply generator hold-down brackets, if required. Alternately, mounting holes may be drilled in the base of the generator. The generator may then be anchored to the floor via these holes.
- Sufficient room must be provided to allow access to the rear and side of the generator for installation and service. See figure 1-1 for recommended clearances.
- A cable trough, conduit, or raceway (1 in; 2.5 mm, diameter) should be provided from the control console to the main cabinet to allow routing of the control cable if required.
- The control console is normally freestanding on a desk or shelf. It may be anchored if necessary.

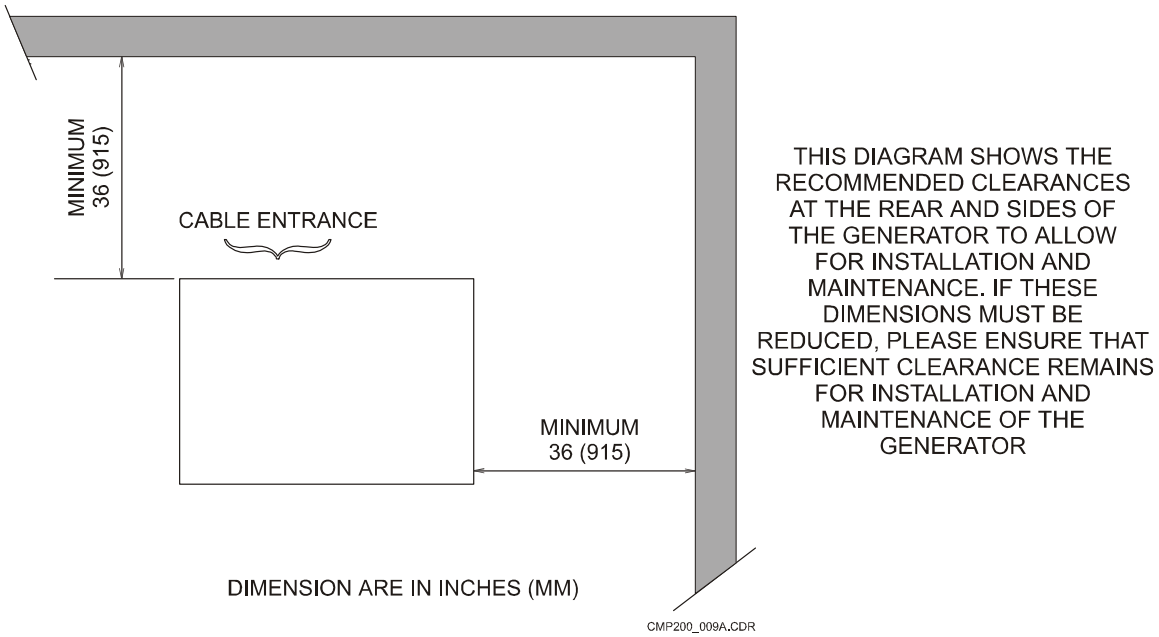


Figure 1-1: Generator clearances

1.3.5 Cable Entrance and Seismic Center Location

Figure 1-2 shows the locations of the cable access slots, the AC mains cable entry, and the seismic center location for the CMP 200 X-ray generator.

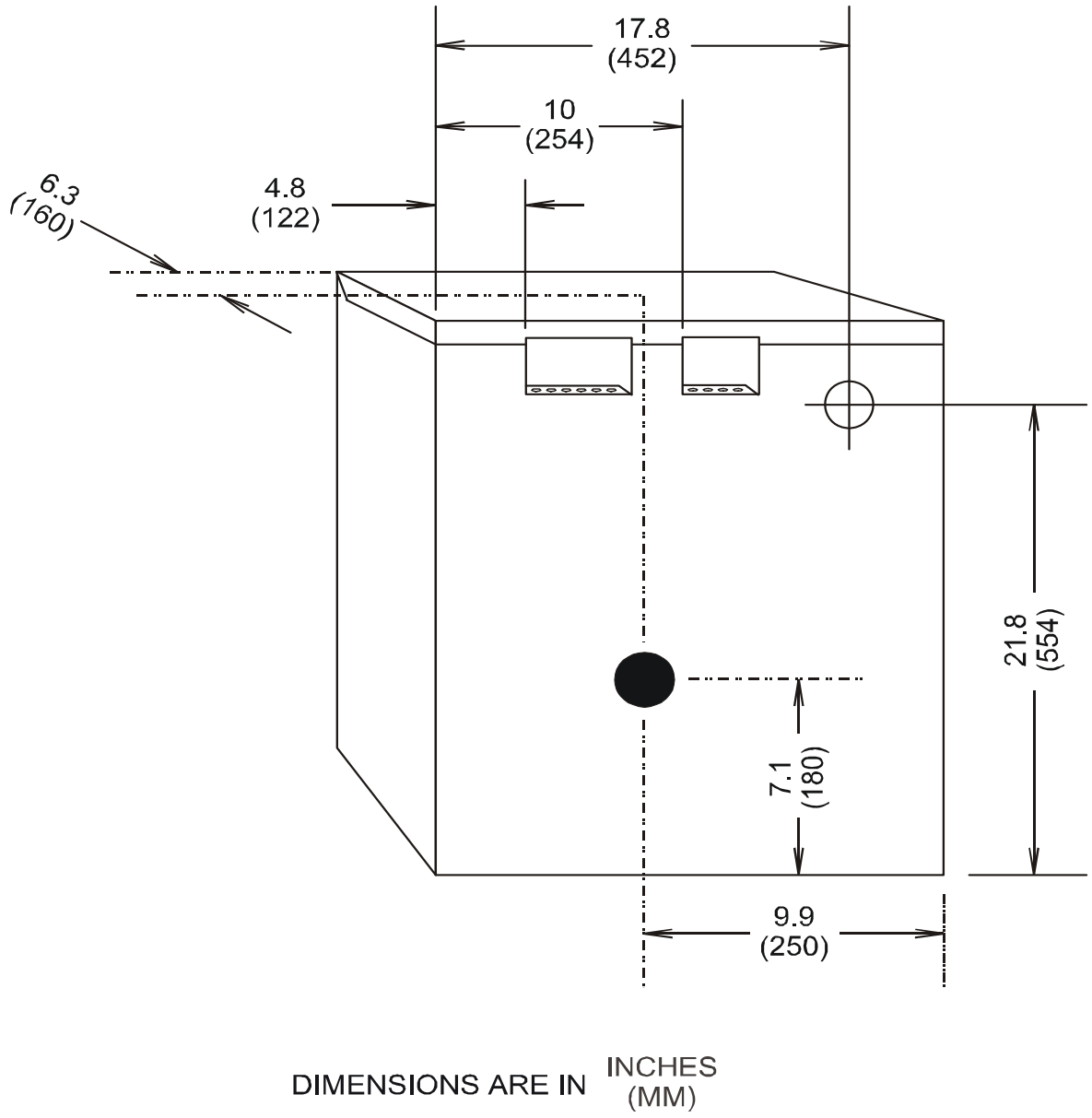


Figure 1-2: CMP 200 cable entry locations and seismic center

1.3.6 Tools and test Equipment Required

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

CHECK √	DESCRIPTION
	General hand tools for installation: Wrenches, nut drivers, assortment of screwdrivers, pliers, etc.
	If the generator is to be anchored to the floor, suitable tools (i.e. drill, drill bits, etc) and mounting hardware must be available.
	A supply of connectors for wiring: terminal lugs, caps, splices etc.
	A calibrated DVM that indicates true RMS voltages.
	Dual trace memory oscilloscope with a minimum 20 MHz bandwidth; appropriate leads, probes, etc.
	Device for measuring true kVp. This may be a Dynalyzer equivalent or a non-invasive meter such as the Keithley TRIAD system.
	A calibrated radiation meter with detectors that will allow for R/min and uR type measurements (or uGy and Gy/min).
	A suitable mA / mAs meter.
	A strobe or reed type tachometer to verify that the anode is rotating up to speed.
	A sufficient selection of absorbers to allow AEC calibration if this option is fitted. 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.
	Vapor proof compound for the HT terminations.

1.3.7 Pre-Installation Checklist

Before starting the generator installation, review the following checklist.

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?
	Is there a transport dolly or similar device to move the generator?
	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?

1.4.0 GENERATOR LAYOUT AND MAJOR COMPONENTS

The dimensions and weight of the generator are shown in the table below.

ITEM	LENGTH	WIDTH	HEIGHT	WEIGHT
Main cabinet in shipping pack	30.5 (775)	21.5 (546)	38 (965)	129 (59)
Main cabinet unpacked	22.8 (580)	13.7 (348)	24.3 (617)	113 (51)
Control console	12.3 (313)	10.9 (277)	3.7 (94)	6 (2.72)

The above dimensions are inches (mm), weights are in pounds (Kg).

Figures 1-3 and 1-4 show the major components located inside the generator cabinet. Figure 1-5 is an internal view of the console, showing the major components and cabling. Figure 1-3 does not show the fan-mounting bracket, nor does it represent all models. This is meant to show major component layout only.

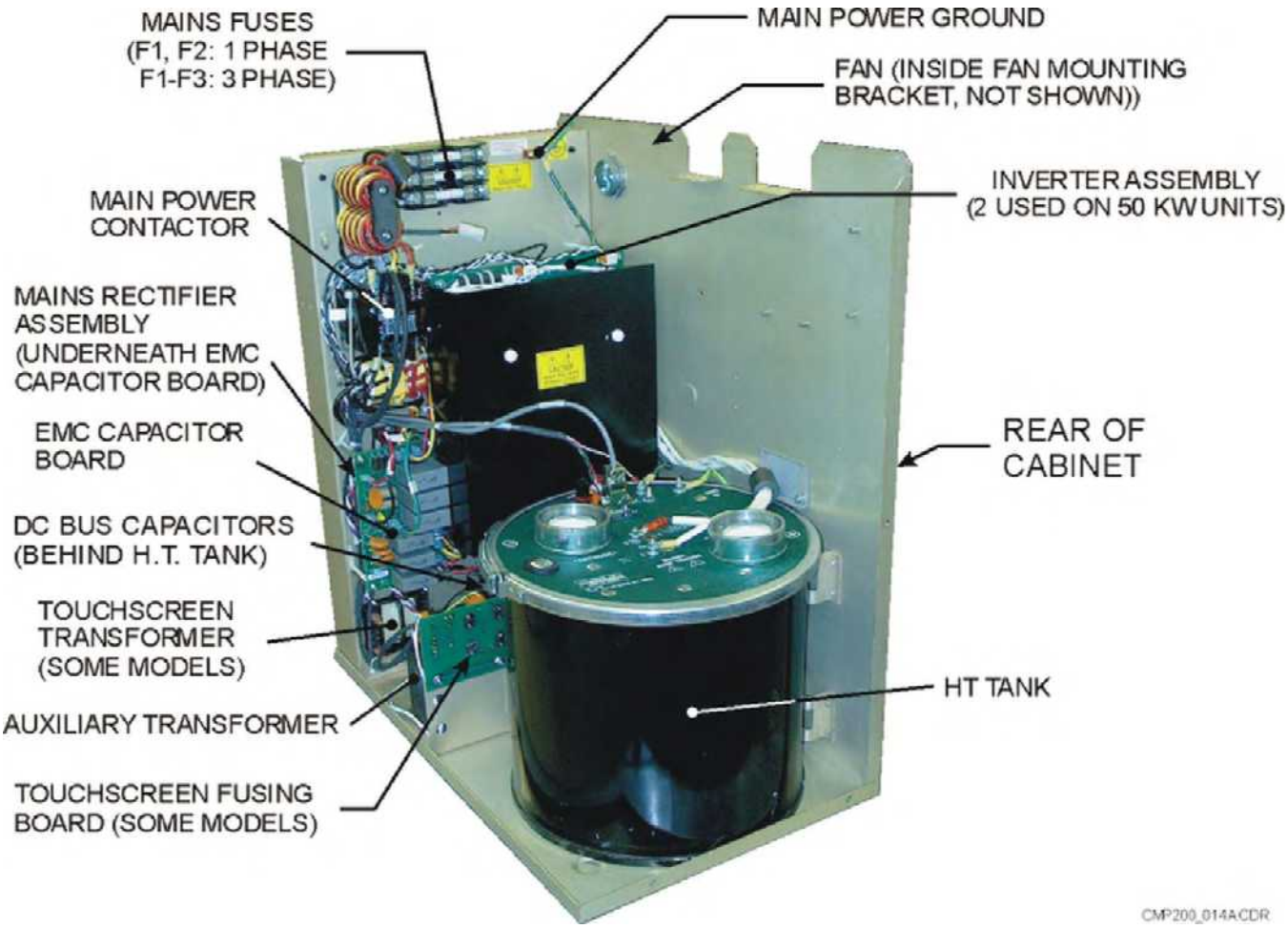


Figure 1-3: Major generator subassemblies view 1

1.4.0 GENERATOR LAYOUT AND MAJOR COMPONENTS (Cont)

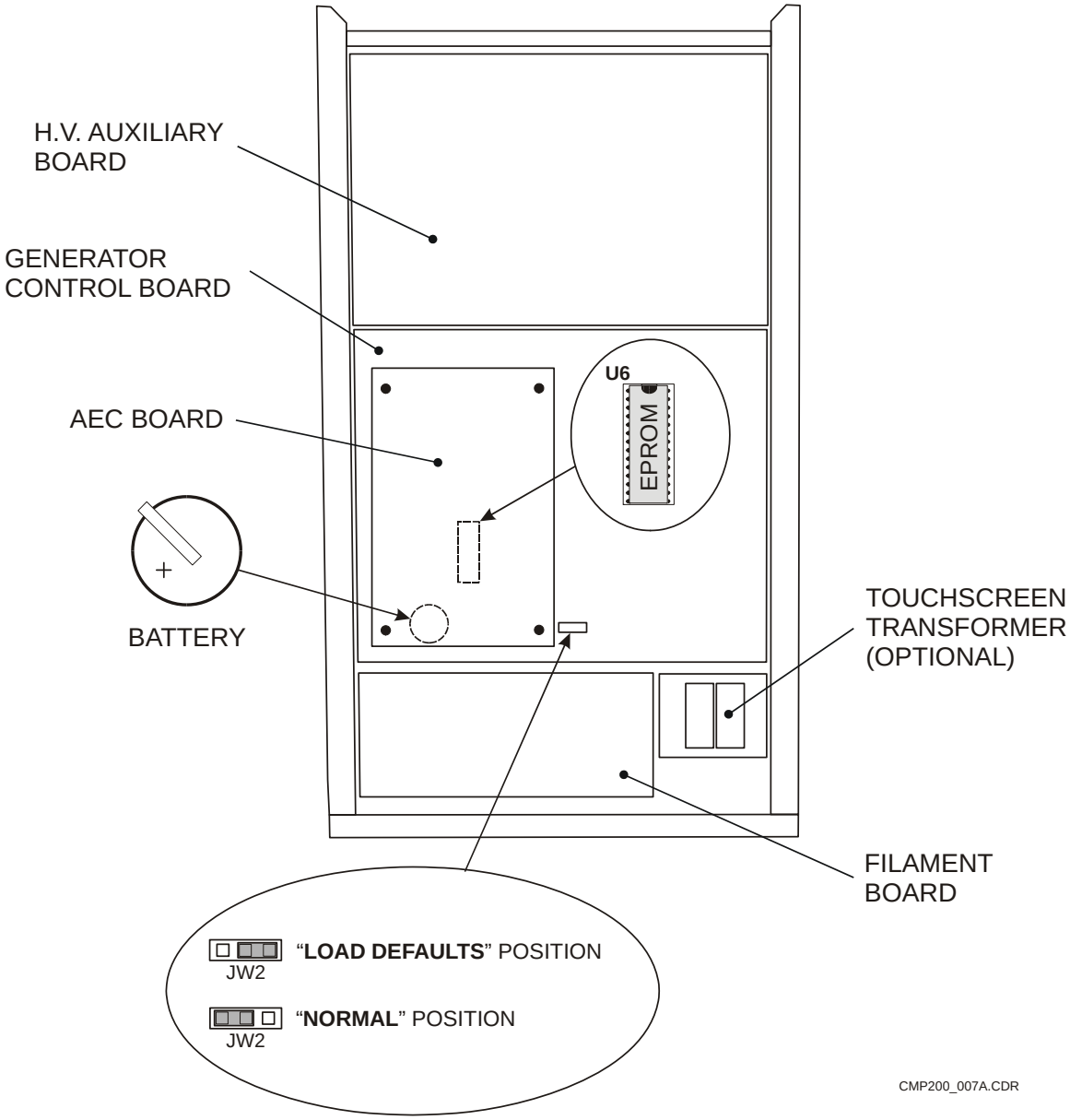


Figure 1-4: Major generator subassemblies view 2

1.4.0 GENERATOR LAYOUT AND MAJOR COMPONENTS (Cont)

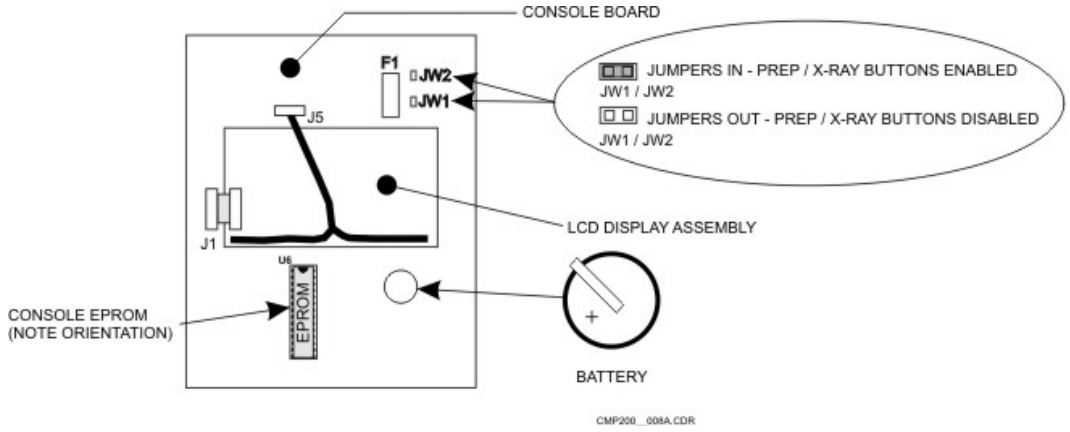


Figure 1-5: Console internal view including EPROM location

1.5.0 COMPATIBILITY LISTING

This X-ray generator is compatible with the following equipment:

X-RAY TUBES:

Refer to the compatibility statement at the end of this chapter.

NOTE: THE LOW SPEED STARTER IS COMPATIBLE WITH "R" TYPE STATORS OR GE 23/23 Ω EQUAL IMPEDANCE STATORS. REFER TO THE COMPATIBILITY STATEMENT OR THE SECTION "LOW SPEED STARTER TUBE COMPATIBILITY" IN CHAPTER 2 TO DETERMINE THE COMPATIBILITY OF YOUR GENERATOR.

AEC DEVICES:

Refer to the compatibility statement at the end of this chapter.

1.6.0 CUSTOMER SUPPORT

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

1.7.0 COMPATIBILITY STATEMENT

The compatibility statement for this generator follows this page.

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REPLACE THIS PAGE WITH

“COMPATIBILITY STATEMENT” form

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Chapter 2

INSTALLATION

CONTENTS:

2.1.0 INTRODUCTION

This chapter contains instructions for unpacking, positioning, and cabling the CMP 200 X-ray generator, allowing for initial power-up and tube auto calibration.

2.2.0 UNPACKING

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

2. Remove the cardboard outer pack. See the cautionary note below before removing the pack.

> ***CAUTION:*** ***OPEN THE CARDBOARD PACK CAREFULLY. SHARP TOOLS MAY DAMAGE THE CONTENTS.***

3. Set aside the cardboard pack(s).

> ***WARNING:*** ***THE GENERATOR MAIN CABINET (WITH HT OIL TANK) WEIGHS APPROXIMATELY 113 POUNDS (51 KG).***
>
> ***ONE PERSON SHOULD NOT ATTEMPT TO LIFT OR MOVE THIS ASSEMBLY WITHOUT PROPER EQUIPMENT OR ASSISTANCE.***

4. Carefully lift the generator from the pallet.

5. Inspect for internal and external shipping damage.

6. Remove and unpack the control console.

7. Unpack the manuals and any other paperwork that may be packed with the generator.

8. Keep the shipping containers. In case of shipping damage, place the unit back in its shipping pack and notify the carrier and the customer support department as per chapter 1 of this manual.

2.3.0 REMOVING THE GENERATOR COVER

1. Remove and set aside the screws and washers securing the cover to the generator chassis.

2. Carefully lift the cover off the chassis.

2.4.0 MAJOR COMPONENT LAYOUT

Refer to *GENERATOR LAYOUT AND MAJOR COMPONENTS* in chapter 1 for major component identification and layout.

2.5.0 EQUIPMENT PLACEMENT

2.5.1 Main Cabinet

Place the generator 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 1.
- Air circulation: The main cabinet is fan cooled. Therefore room-temperature air must be free to circulate around the cabinet, and the cooling slots in the cabinet must be unobstructed at all times.
- Stable footing.
- Close proximity to service disconnect boxes. Cables should not be on the floor where they could be stepped on.

2.5.2 Control Console

Position the control console in its intended location and ensure that it is stable.

- 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.
- Leave sufficient slack in the cabling to the console to allow for future service and maintenance.

Note: 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 Console CPU 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 appropriate figure in chapter 1, in section *GENERATOR LAYOUT AND MAJOR COMPONENTS.*
5. Reassemble the console using all the original hardware.

2.5.2 Control Console (Cont)

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

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.

2.5.3 Anchoring the Generator to the Floor

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

2.6.0 WIRING TO THE GENERATOR

Unless specified otherwise, all cables (except AC mains) should be routed into the generator main cabinet through the cable access slots at the upper rear of the generator. The cables should be secured to the lip on the inside of the cable access slots using tie wraps or equivalent fasteners. For connections that must be made to the H.V. auxiliary board, AEC board, or to the generator control board, route the cables over the top of the fan-mounting bracket and over the chassis divider panel.

The AC mains cable is routed into the generator via the cable clamp on the rear of the generator, adjacent to the main fuses.

All cables should be kept away from high voltage areas in the cabinet, and dressed neatly in place. Cables should be cut to the correct length if possible, as excess cabling may contribute to EMI/RFI problems. For those cables that cannot be cut to the correct length (HT cables and console cables for example), try to minimize the area inside of any loops of excess cable, as these loops can create an antenna.

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.

EXCESS LENGTHS OF CABLING MUST NEVER BE BUNDLED UP AND STORED INSIDE THE GENERATOR.

2.6.1 Control Console

1. Route the generator end of the console cable into the generator cabinet via the cable access slot nearest to the generator control board. The membrane console uses a cable with an RJ45 ethernet-style connector at each end. The touchscreen console uses a cable with an RJ45 ethernet-style connector at the generator end, and a 15-pin “D” connector at the other end.

2. Connect the console cable to J3 on the generator control board. Route the console cable as per figure 2-2. 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 2-1 for an example of such damage.

2.6.1 Control Console (Cont)

Figure 2-1: Console cable connector damage example

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

   For the membrane console, connect the free end of the console cable to J8 at the rear of the console.

   For the touchscreen console, connect the free end of the console cable to J2 on the touchscreen interface board at the rear of the console.

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

4. FOR THE TOUCH SCREEN CONSOLE ONLY:
   a) Connect one end of the supplied ground wire to the touchscreen console ground screw, shown in figure 2-3. On some configurations of touch screen consoles, the viewing-angle adjustment screws may need to be removed, and the console tilted forward in order to be able to access the ground connection.
      Connect the other end of the ground wire to one of the ground studs securing the CMP touchscreen fusing board to the chassis. To do this, remove the hex nut and flat washer, install the ground wire on the mounting stud, and then reinstall the flat washer and hex nut.
   b) Connect the supplied line cord from the rear of the touchscreen to J2 on the CMP touchscreen fusing board.
   c) Dress the ground wire and line cord away from high voltage areas in the generator.

2.6.1 Control Console (Cont)

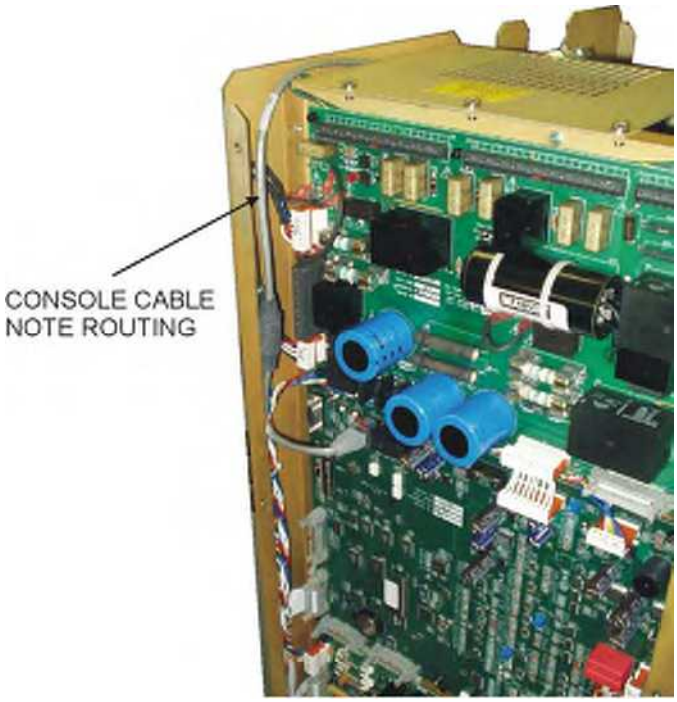

Figure 2-2: Console cable routing

5. Figure 2-3 shows the designations of the connectors on the rear panel of the control console.

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

For the membrane 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 touch screen console, J2 on the touch screen interface board is for the interconnect cable to the generator, J3 is for connection of an external hand switch, J5 connects to the membrane switch assembly with the on / off and prep / expose switches, and J4 is a serial port for use by an external computer.

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

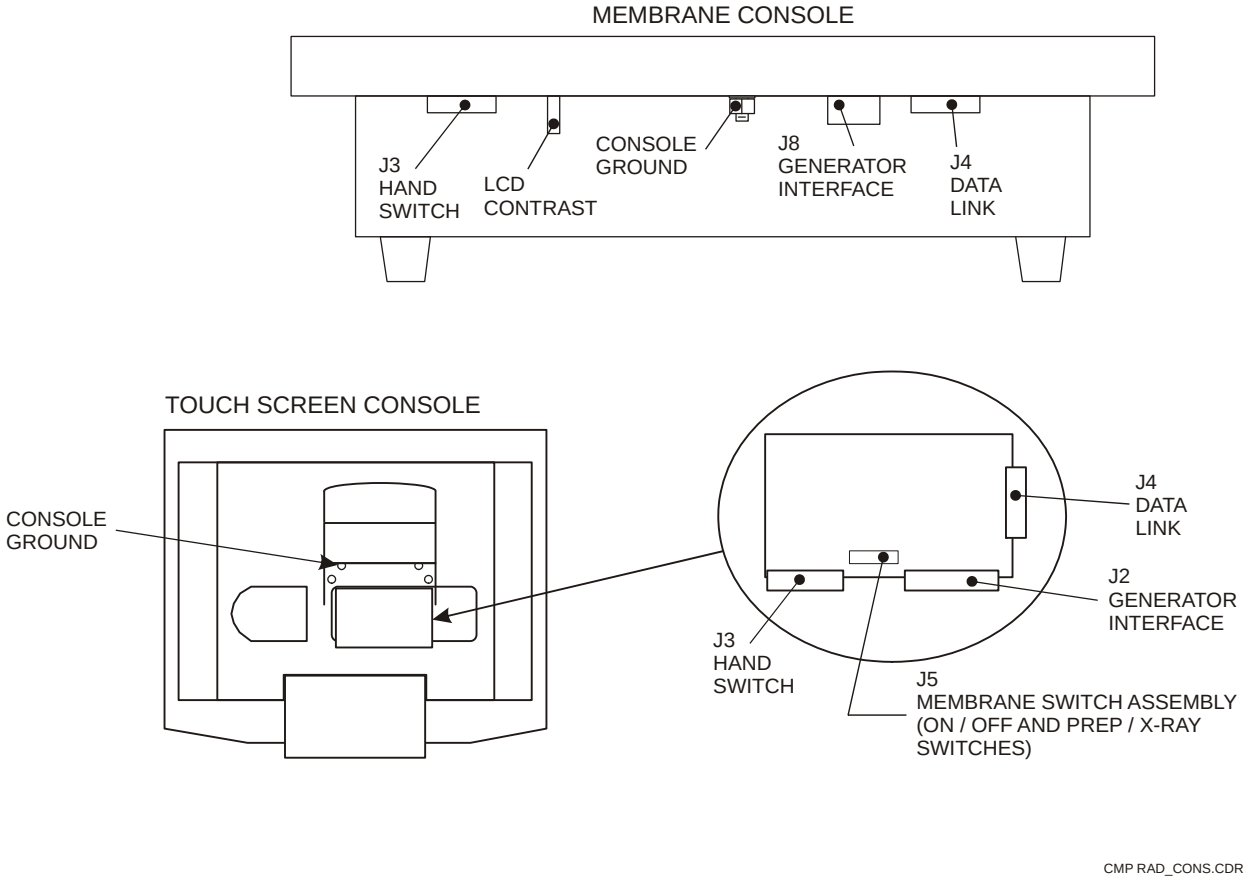

Figure 2-3: Rear of control console

2.6.2 Hand Switch (Optional)

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 J3 on the rear of 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 assignments are as follows:

PIN NUMBER	J3 PIN CONNECTIONS
1	X-ray
2	No Connection
3	Prep
4	No Connection
5	Common (ground)
6	NOT USED
7	NOT USED
8	NOT USED
9	NOT USED

2.6.3 Stator Connections

Refer to figure 2-4 for the X-ray tube stator and thermal switch connections.

1. Route the X-ray tube stator cable to the stator terminal block J7 on the H.V. auxiliary board. This is shown in figure 2-4.

   USE OF A SHIELDED STATOR CABLE IS RECOMMENDED. THE SHIELD FOR THE STATOR CABLE MUST BE PROPERLY GROUNDED AT BOTH THE TUBE END AND THE GENERATOR END OF THE CABLE. CONNECT THE GENERATOR END OF THE SHIELD TO THE GROUND TERMINAL ON J7.

2. Connect the X-ray tube stator connections and the thermal switch connections to J7 on the H.V. auxiliary board terminal block as per the table below.

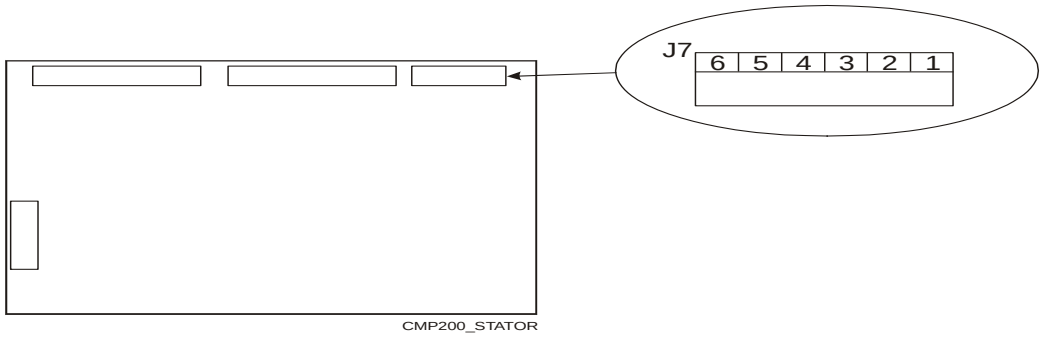

Figure 2-4: Stator connections to H.V. auxiliary board

FUNCTION	CONNECT TO
SHIFT	J7-6
MAIN	J7-5
COMMON	J7-4
GROUND	J7-3
THERMAL SWITCH (Term 1)	J7-2
THERMAL SWITCH (Term 2)	J7-1

2.6.4 Thermal Switch

Refer to 2.6.3 for the X-ray tube thermal switch connections.

2.6.5 Power Line Mains

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 1 for generator power and generator power line requirements.

1. Temporarily remove the fan and fan-mounting bracket by removing the three screws that secure this assembly to the chassis divider panel. Disconnect the fan and set aside the fan and mounting bracket.

2. Pass the AC mains cable through the cable clamp at the upper rear of the generator cabinet, adjacent to the main fuses. Tighten the clamps to secure the cable.

3. Strip sufficient cable jacket to allow the ground and AC mains connections to be made in the next step. Strip the ends of the leads to the required length.

4. Connect the ground wire to the chassis ground connector, and connect the mains power wires to the terminals on the main fuse holder shown in figure 2-5 (for 1 phase generators connect the mains to F1 and F2; for 3 phase units connect the mains to F1, F2, and F3).
   - 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. Reconnect the fan, and reinstall the fan-mounting bracket by reversing step 1.
   Note: Ensure the tabs on the bottom part of the fan mounting bracket are inserted correctly into the slots on the inside wall of the generator beneath the main fuse block prior to reinserting the three screws into the chassis divider panel. Verify the tabs are still inserted correctly after the screws are in place.

6. DO NOT SWITCH ON MAINS POWER UNTIL REQUESTED TO DO SO IN A LATER STEP.

2.6.5 Power Line Mains (Cont)

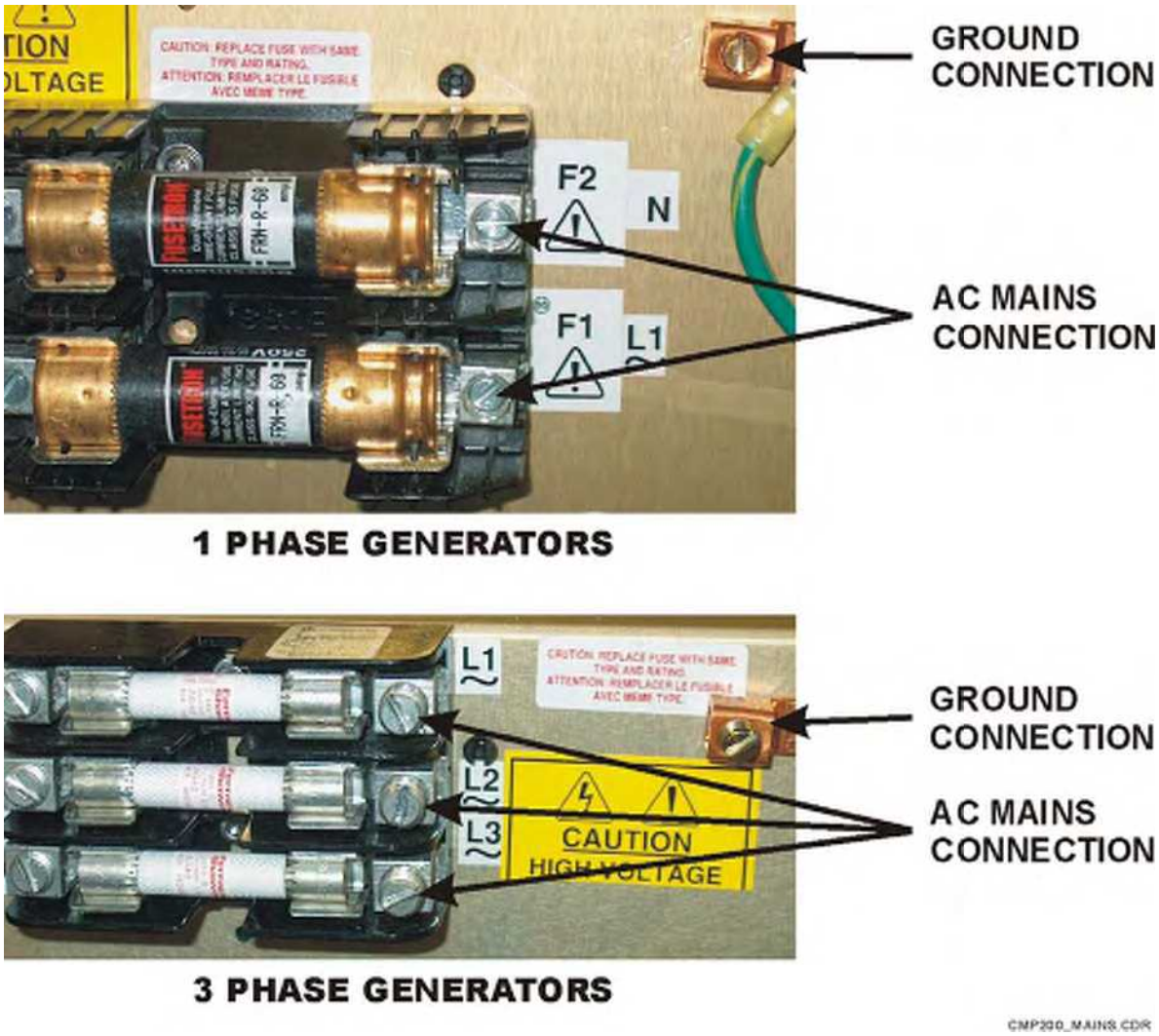

Figure 2-5: Generator mains connection

2.6.6 High Tension Cables

The X-ray tube should be mounted in its normal fixture i.e. tube stand or other device.

1 Verify that the HT cable terminations are clean, in good condition, and coated with vapor proof compound.

2. Remove the dust caps that cover the high voltage terminals on the HT oil tank.

3. Connect the anode and cathode cables to the HT tank. Ensure that the cables are plugged into the proper connectors on the HT tank. Refer to figure 2-6.

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

ab

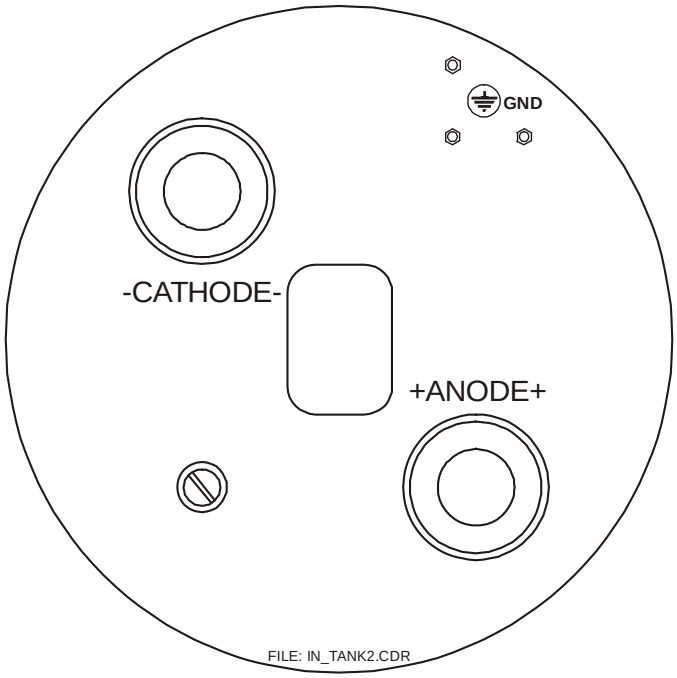

Figure 2-6: HV connector identification

2.6.7 X-Ray Tube Housing Ground

In addition to the X-ray tube manufacturers recommended tube grounding procedure, a separate ground wire (10 AWG, 6mm^2) must be connected from the X-ray tube housing to one of the ground studs on the HT tank. Refer to figure 2-6 for the location of these ground studs. 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.

2.6.8 Room Equipment

Refer to chapter 3C for connection of Buckys, interlocks, room lights, DAP, and collimator lamp and system locks power, and to chapter 3D for installation and calibration of AEC. 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 routine has been performed as described near the end of this chapter.

2.6.9 Safety Interlocks

The room door interlock switch must be wired to the generator as described in *INPUTS* in chapter 3C prior to power up. This switch will provide a closed contact when the door is closed.

2.7.0 LOW SPEED STARTER TUBE COMPATIBILITY

Before continuing, note the part number of the H.V. auxiliary board in the generator. Part numbers 739442-00 / 739445-00 have a 33 μF phase-shift capacitor, and are compatible with the type "R" stator tubes listed in table 2-1. Part numbers 739442-01 / 739445-01 have a 45 μF phase-shift capacitor, and are compatible with the type GE 23/23 Ω stators listed in table 2-1.

Confirm that the boost voltage is set correctly for the selected tube type per table 2-1 before continuing. The procedure for setting the boost voltage is detailed in 2.7.1. The boost voltage may be measured across F6 and F7 on the H.V. auxiliary board.

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

Confirm proper stator operation using a suitable tachometer before making any exposures.

WARNING: ***HIGH VOLTAGE IS PRESENT ON THE H.V. AUXILIARY BOARD AT ALL TIMES THAT THE GENERATOR IS SWITCHED ON. TAKE APPROPRIATE PRECAUTIONS WHEN SERVICING THIS BOARD***

2.7.1 Setting 120 / 240 VAC Boost Voltage

Follow the steps below to verify and configure the low speed starter boost voltage. This is factory configured to 240 VAC.

1 Confirm the required boost voltage for the selected tube as described above. The requirement for the vast majority of tubes in table 2-1 is 240 V. For tubes that require 120 V boost, this is noted in the table.

2. The boost voltage is configured via jumpers on the H.V. auxiliary board:
   - E16 to E15 selects 240 V boost.
   - E14 to E15 selects 120 V boost.

   Swap the connection at E14 and E16 if the boost voltage needs to be changed. The jumper wire (E16 - E15 or E14 - E15) will need to be replaced if making this change. Extra jumper wires are attached to a bag on the lip on the inside of the cable access slot above the HT tank. Select the shortest wire from this bag that will connect between the desired tabs on the board and that has the proper terminations on the jumpers. Do not discard the existing jumper; place it in the jumper kit to be available for future configuration changes.

   Proceed to the next step if the jumper setting is correct.

3. Confirm the proper boost voltage and proper anode rotation as described above.

2.7.2 Low Speed Starter Tube Select Table

TABLE 2-1: SUPPORTED TUBE TYPES				
TUBE TYPE (HOUSING)	**TUBE TYPE (INSERT)**	**BOOST VOLTAGE**	**SHIFT CAPAC**	**H.V. AUXILIARY BOARD PART NO.**
Comet DO7 25/50 Ω stator	DX7	240 VAC	33 μF	739442-00 739445-00
Comet DO9 25/50 Ω stator	DX9 0.6/2.0 DX9 1.2/2.0	240 VAC	33 μF	739442-00 739445-00
Comet DO9 25/50 Ω stator	DX91HS DX92HS DX93HS	240 VAC	33 μF	739442-00 739445-00
Comet DO10 25/50 Ω stator	DX10HS 0.6/1.0 DX10HS 1.0/2.0	240 VAC	33 μF	739442-00 739445-00
Comet DX10 25/50 Ω stator	DX101HS DX104HS DX105HS	240 VAC	33 μF	739442-00 739445-00
Comet XSTAR8 XSTAR74 25/50 Ω stator	XST-8 XST-74	240 VAC	33 μF	739442-00 739445-00
GE Maxiray 75 3" anode 23/23 Ω equal impedance "E" stator	0.6/1.0 11° 0.6/1.5 15° 1.0/2.0 15°	240 VAC	45 μF	739442-01 739445-01
GE Maxiray 100 4" anode 23/23 Ω equal impedance "E" stator	0.3/1.0 11° 0.6/1.0 11° 0.6/1.2 11° 0.6/1.5 11° 0.6/1.5 12° 0.6/1.25 12.5° 1.0/2.0 15°	240 VAC	45 μF	739442-01 739445-01
Gilardoni Rotagil S/AS	AR11-30 AR30-60	240 VAC	33 μF	739442-00 739445-00
Philips ROT350 ROT351	RO 17/50 SRO 22/50 SRO 33/100	240 VAC	33 μF	739442-00 739445-00
Toshiba Rotanode XH-121	E7132X	240 VAC	33 μF	739442-00 739445-00
Varian B100 DX52 Std "R" stator	A102 A132 A142	240 VAC	33 μF	739442-00 739445-00
Varian B100 "STD" stator	A102 A132 A142	240 VAC	33 μF	739442-00 739445-00

2.7.2 Low Speed Starter Tube Select Table (Cont)

TUBE TYPE (HOUSING)	TUBE TYPE (INSERT)	BOOST VOLTAGE	SHIFT CAPAC	H.V. AUXILIARY BOARD PART NO.
Varian B130 B150 Std “R” stator	A192 A272 A282 A286 A292 G256 G292	240 VAC	33 μF	739442-00 739445-00
Varian Diamond Std “R” stator	RAD13 RAD14 0.3/1.2 RAD14 0.6/1.2 RAD14 0.6/1.5	240 VAC	33 μF	739442-00 739445-00
Varian Emerald Std “R” stator	RAD 8 RAD 68 RAD 74	240 VAC	33 μF	739442-00 739445-00
Varian Saphire Std “R” stator	RAD21 RAD56 0.6/1.0 RAD56 0.6/1.2 RAD60 RAD92 RAD94	240 VAC	33 μF	739442-00 739445-00
Varian DX62 300-400 kHu, “STD” stator	A192B A197 A256 A272 A282 A286 A292	240 VAC	33 μF	739442-00 739445-00
Varian DX62U Universal 300-400 kHu, configured as “STD” or “R” stator	A192B A197 A256 A272 A282 A286 A292	240 VAC	33 μF	739442-00 739445-00

2.8.0 INITIAL RUN-UP

This section describes the procedure for auxiliary transformer and touchscreen transformer (if fitted) line voltage tap selection and 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.***

2.8.1 Auxiliary Transformer Line Voltage Tap Selection

For 208 / 230 V generators, the line voltage taps on the auxiliary transformer must be checked before powering up the generator.

For 400 / 480 V generators, the auxiliary transformer line voltage tap is factory set to match the line voltage that was specified at the time of the order. If these units are to be operated from other than the rated line voltage (i.e. if a 400 V generator is to be operated from 480 V mains), the line voltage tap on the auxiliary transformer must be changed as described below.

For 208 / 230 VAC generators:

1. Verify that the mains voltage and current capacity is correct for the generator installation per *GENERATOR POWER REQUIREMENTS* in chapter 1.

2. Locate the auxiliary transformer inside the generator cabinet. Refer to chapter 1. For reference, this transformer is part number 739446.

3. Note the line-voltage tap position on this transformer as determined by the location of the wire on the 208V or the 240V tap on the transformer primary. This is normally set to the 240V tap. Refer to figure 2-7; this shows the front view of the transformer.

4. Based on the nominal line voltage, set the transformer primary voltage tap as follows:
   - Loosen the clamping screws for the current line-voltage tap, and for the required line-voltage tap.
   - Connect to the 208 V tap if the line voltage is 215 VAC or less.
   - Connect to the 240 V tap if the line voltage is 216 VAC or higher.
   - Retighten both of the clamping screws.

2.8.1 Auxiliary Transformer Line Voltage Tap Selection (Cont)

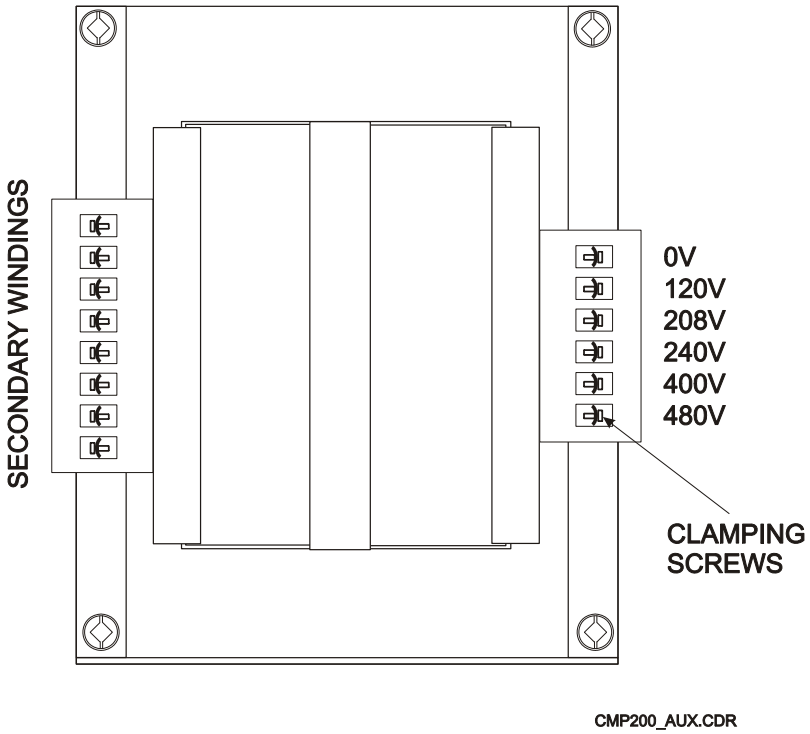

Figure 2-7: Auxiliary transformer, terminal view

For 400 / 480 VAC generators:

The 400 / 480 V tap setting only needs to be changed if a 400 V generator is to be operated from 480 V mains, or if a 480 V generator is to be operated from 400 V.

1. Verify that the mains voltage and current capacity is correct for the generator installation per *GENERATOR POWER REQUIREMENTS* in chapter 1.

2. Locate the auxiliary transformer inside the generator cabinet. Refer to chapter 1. For reference, this transformer is part number 739446.

3. Note the line-voltage tap position on this transformer as determined by the location of the wire on the 400V or the 480V tap on the transformer primary. This is set to the 400 or 480V tap to match the line voltage specified at the time of the order. Refer to figure 2-7; this shows the front view of the transformer.

4. Based on the nominal line voltage, set the transformer primary voltage tap as follows:
   - Loosen the clamping screws for the current line-voltage tap, and for the required line-voltage tap.
   - Connect to the 400 V tap if the line voltage is nominally 400 VAC.
   - Connect to the 480 V tap if the line voltage is nominally 480 VAC.
   - Retighten both of the clamping screws.

2.8.2 Touchscreen Transformer Line Voltage Tap Selection

This applies to 400 / 480 V generators with the optional touchscreen transformer only:

The touchscreen transformer line voltage tap is factory set to match the line voltage that was specified at the time of the order. If these units are to be operated from other than the rated line voltage (i.e. if a 400 V generator is to be operated from 480 V mains), the line voltage tap on the touchscreen transformer must be changed as described below.

1. Verify that the mains voltage and current capacity is correct for the generator installation per *GENERATOR POWER REQUIREMENTS* in chapter 1.

2. Locate the touchscreen transformer inside the generator cabinet. The transformer terminals are accessible via the HT tank side of the chassis, below the EMC capacitor board. Refer to chapter 1.

3. Note the primary tap position on this transformer as determined by the location of the wire on the 400 V or the 480 V tap. This is set to the 400 or 480 V tap to match the line voltage specified at the time of the order. Refer to figure 2-8; this shows the terminal side of the transformer.

4. Based on the nominal line voltage, set the transformer primary voltage tap as follows:
   - Connect to the 400 V tap if the line voltage is nominally 400 VAC.
   - Connect to the 480 V tap if the line voltage is nominally 480 VAC.

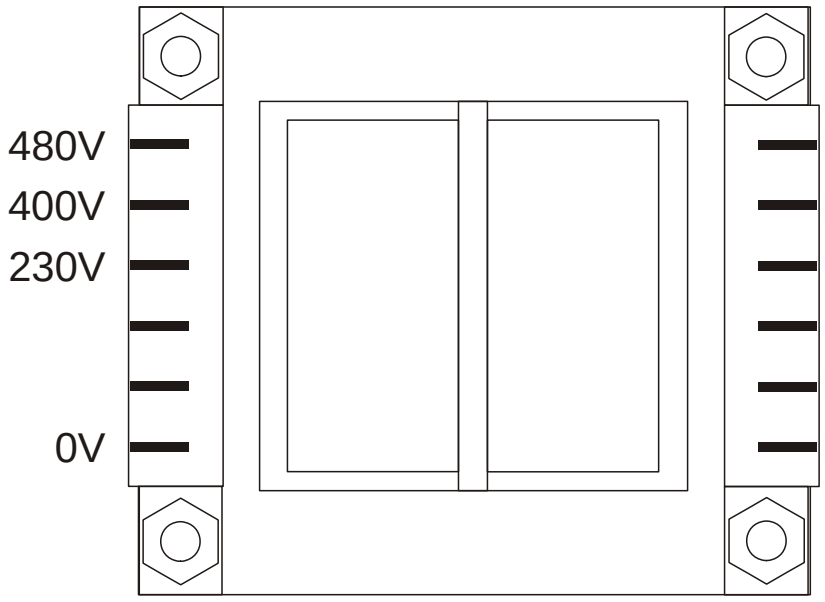

Figure 2-8: Touchscreen transformer, terminal view

2.8.3 Initial Voltage Measurements

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

NOTE:	***DO NOT SWITCH THE GENERATOR ON AT THIS TIME (ONLY THE AC MAINS TO THE GENERATOR IS TO BE SWITCHED ON).***

WARNING:	***USE EXTREME CARE IN MEASURING THESE VOLTAGES. ACCIDENTAL CONTACT WITH MAINS VOLTAGES MAY CAUSE SERIOUS INJURY OR DEATH.*** ***MAINS VOLTAGE WILL BE PRESENT INSIDE THE GENERATOR CABINET, EVEN WITH THE CONSOLE SWITCHED OFF.*** ***THE DC BUS CAPACITORS MAY PRESENT A SAFETY HAZARD FOR A MINIMUM OF 5 MINUTES AFTER THE GENERATOR HAS BEEN SWITCHED OFF. CHECK THAT THESE CAPACITORS ARE DISCHARGED BEFORE TOUCHING ANY PARTS IN THE GENERATOR.***

2. 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.

3. Are the line to line and line to ground voltages within specification for the unit? For single phase 230 V units, the line to ground voltage should be 99 – 127 V. For 3 phase units, the phase to ground voltage should be 114 – 146 V for 208 / 230 V units, 230 V ± 10 % for 400 V units, and 277 V ± 10 % for 480 V units.

   ___ Check

4. Confirm that the auxiliary transformer line and filament voltage taps are set to the appropriate position as per the measured line voltage.

   ___ Check

2.9.0 TUBE MA AUTO CALIBRATION

It is recommended that the generator be tested at this point with only the rotor and 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.

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.

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

2.10.0 FINAL CHECKS

The room interface connections may now be completed. These items are described in 2.6.8.

- When finished all wiring, check that all connections are tight and secure.
- Check that all cables are dressed neatly inside the main cabinet, and secured as necessary.
- Reconnect any grounds that have been removed from covers. Then reinstall all covers before placing the generator into service.

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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CHAPTER 3

INTERFACING, PROGRAMMING, AND CALIBRATION

3.0.0 INTRODUCTION

3.1.0 Purpose

This chapter describes the interfacing of the CMP 200 X-ray generator to Bucky's, interlocks, collimator lamp, etc, and to the AEC chambers (if the AEC option is fitted).
Generator programming and AEC calibration is also covered in this chapter.

This chapter contains the following sections.

Section	Title
3A	Not Used
3B	Not Used
3C	Interfacing and Programming
3D	AEC (Automatic Exposure Control) calibration

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CHAPTER 3C

INTERFACING AND PROGRAMMING

CONTENTS:

3C.1.0 INTRODUCTION

This chapter describes the interfacing of the CMP 200 X-ray generator to Bucky(s), interlocks, room lights, DAP, and collimator lamp and tube stand locks, and also describes the generator programming.

3C.2.0 WIRING TO INPUTS & OUTPUTS

NOTE: ***THE INSTALLER MUST PROVIDE THE NECESSARY INTERFACING CABLES FOR WIRING TO THE GENERATOR INPUTS AND OUTPUTS DESCRIBED IN THIS SECTION.***

WARNING: ***LINE VOLTAGE IS PRESENT INSIDE THE GENERATOR AT ALL TIMES THAT THE MAIN DISCONNECT IS SWITCHED ON. FOR SAFETY, THE MAIN DISCONNECT SHOULD BE SWITCHED OFF AND LOCKED OUT WHILE CONNECTING ROOM EQUIPMENT.***

3C.2.1 Inputs

The Bucky inputs, interlock 1 and interlock 2 / tomo inputs, and room door interlock inputs are opto coupled. This means that a relay contact, transistor, or other low-impedance switching device ($\leq$ 100 Ω, 10 mA current rating) must be connected across each of these inputs. Table 3C-1 defines the pin outs, polarity at the terminals and the logic condition required for that input. If using a directional switching device, such as a transistor, the polarity of the voltage seen by the switching device must be observed. This is shown in the table below.

Refer also to figure 3C-1. This is a pictorial drawing of the J2, J4, and J11 inputs and outputs on the H.V. auxiliary board.

Refer to 3C.2.4 for details on AEC connections.

WARNING: ***DO NOT DEFEAT THE ROOM DOOR INTERLOCK, OR THE INTERLOCK 1 AND 2 INPUTS UNLESS THE CORRESPONDING DEVICE IS NOT PRESENT. CONSULT THE APPLICABLE REGULATIONS BEFORE DISABLING ANY EXPOSURE INTERLOCKS. DO NOT VIOLATE ANY REGULATIONS FOR X-RAY SAFETY.***
NEVER BYPASS THE X-RAY TUBE THERMAL SWITCH INTERLOCK.
OBSERVE IONIZING RADIATION PERSONAL PROTECTION AT ALL TIMES.

NOTE: ***THE BUCKY 1 AND TOMO / BUCKY 2 OUTPUTS MAY BE INSTALLER-PROGRAMMED. BUCKY 1 WILL NORMALLY BE PROGRAMMED TO CORRESPOND TO THE TABLE BUCKY, AND BUCKY 2 WILL NORMALLY BE PROGRAMMED FOR THE WALL BUCKY OR FOR TOMO.***

3C.2.1 Inputs (Cont)

H.V. AUXILIARY BOARD	DEFINITION
J2-5 (-) J2-6 (+)	B2: Bucky 1 ready. A contact closure from pin 5 to 6 indicates B1: BUCKY 1 READY. *
J4-5 (-) J4-6 (+)	B2: Bucky 2 ready. A contact closure from pin 5 to 6 indicates B1: BUCKY 2 READY. *
J4-9 (-) J4-10 (+)	Door interlock. A contact closure from pin 9 to 10 indicates that the room door is closed. *
J2-1 (-) J2-2 (+)	Interlock 2. A contact closure from pin 1 to 2 indicates that interlock 2 is closed. * This is the tomo exposure input for any image receptor that is programmed for tomo operation. The tomo start / stop command is generated by the tomo system. The generator will only terminate the tomo exposure if the tomo backup time is exceeded. *
J2-3 (-) J2-4 (+)	Interlock 1. A contact closure from pin 3 to 4 indicates that interlock 1 is closed. *

Table 3C-1: Generator inputs

* ***These inputs are meant for dry contacts only. Do not apply any voltage source to these inputs.***

3C.2.2 Outputs

Table 3C-2 shows the Bucky and auxiliary power outputs from the generator. Refer also to figure 3C-1.

H.V. AUXILIARY BOARD	DEFINITION
J2-10	B4: Bucky 1 return.
J2-9	B6: Ground (Bucky 1).
J2-8	B8: 24 VDC, 110 / 220 VAC out (Bucky 1). *See note below.*
J2-7	B3: 24 VDC, 110 / 220 VAC out (Bucky 1 start). *See note below.*
J4-4	B4: Tomo / Bucky 2 return.
J4-3	B6: Ground (Tomo / Bucky 2).
J4-2	B8: 24 VDC, 110 / 220 VAC out (Tomo / Bucky 2). *See note below.*
J4-1	B3: 24 VDC, 110 / 220 VAC out (Tomo / Bucky 2 start). *See note below.*
J11-3 J11-4	Room lights. The generator supplies a dry contact closure when the room light is to be activated.
J11-5 J11-6	24 VAC @ 150 watts output for customer use.
J11-1 (-) J11-2 (+)	24 VDC @ 45 watts output for customer use (unswitched).

Table 3C-2: Generator outputs

NOTE: The generator is factory configured to supply 110 VAC to drive the Buckys. The Bucky outputs may be reconfigured to supply 24 VDC or 220 VAC if required, as described in chapter 8. Please confirm compatibility with the Buckys used in this installation before proceeding. For tomo operation, the applicable Bucky outputs must be programmed as necessary.

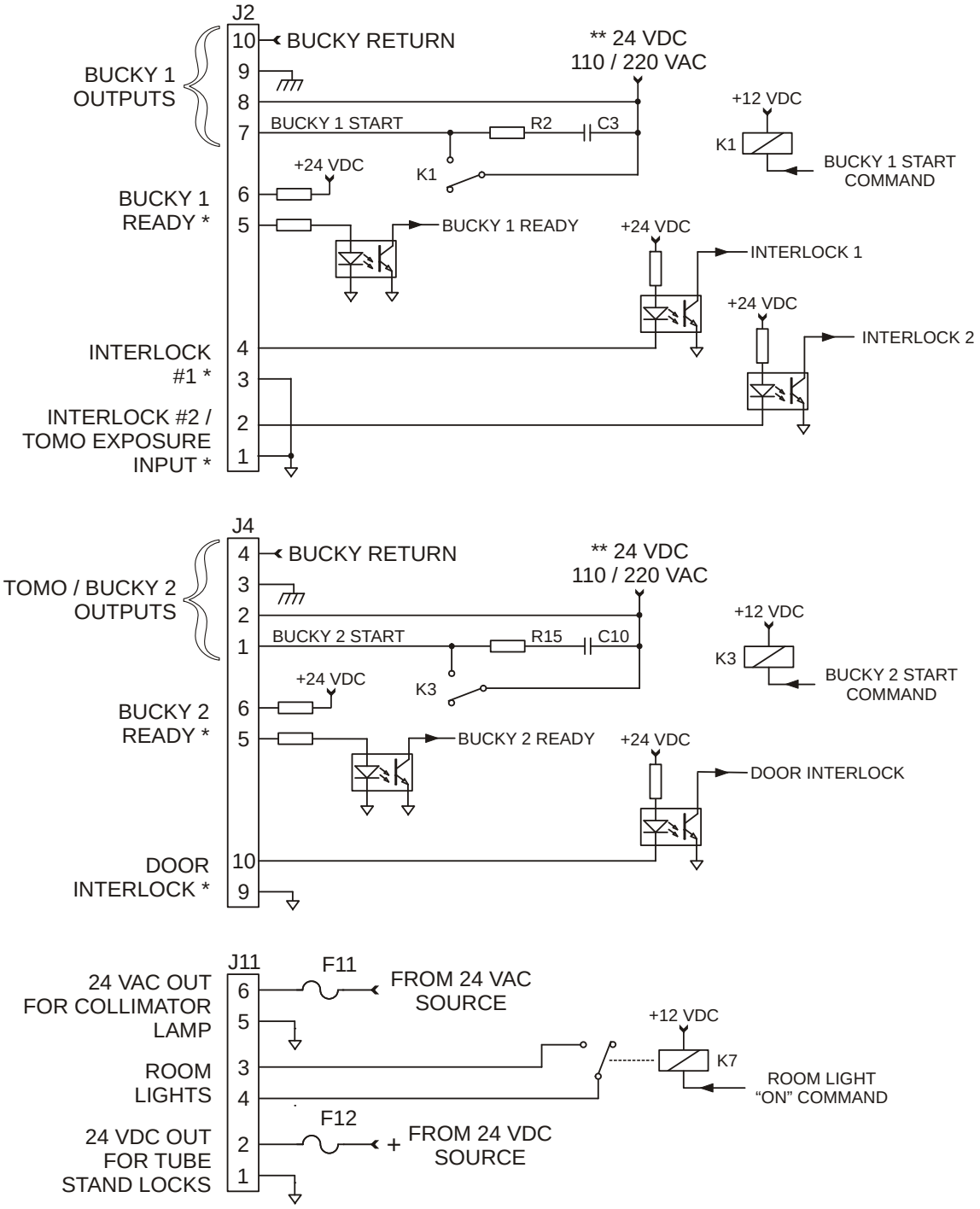
3C.2.2 Outputs (Cont)

IN SOME INSTALLATIONS, BUCKY START RELAYS K1 OR K3 ON THE H.V. AUXILIARY BOARD MAY DRIVE THE INPUTS OF OPTO COUPLERS OR OTHER LOW CURRENT DEVICES ON THE BUCKY. THE LEAKAGE CURRENT THROUGH THE R-C SNUBBER THAT IS CONNECTED ACROSS THE RELAY CONTACTS (C3 AND R2 FOR K1, C10 AND R15 FOR K3) MAY BE SUFFICIENT TO ENERGIZE THE BUCKY INPUTS WHEN THE RELAYS ARE OPEN.

IF THIS IS EXPERIENCED, THE SNUBBER SHOULD BE DEFEATED. REMOVING THE SERIES RESISTOR, PART OF THE R-C SNUBBER, WILL ELIMINATE THIS PROBLEM.

Removing R2 open-circuits the snubber across the K1 contacts, removing R15 defeats the snubber across the contacts of K3.

3C.2.3 Inputs & Outputs (simplified schematic)



* REFER TO TABLE 3C-1 FOR REQUIRED INPUT LOGIC LEVELS

** THE BUCKY OUTPUTS MAY BE CONFIGURED FOR +24 VDC, 110 VAC, OR 220 VAC. REFER TO CHAPTER 8 FOR DETAILS.

FILE: CMP200_012B.CDR

Figure 3C-1: J2, J4, and J11 inputs and outputs (H.V. auxiliary board)

3C.2.4 AEC Interconnect

Refer to chapter 3D for an overview of AEC theory, for AEC chamber connections, and for the AEC calibration procedure.

3C.3.0 GENERATOR PROGRAMMING

If you are using a membrane console, the generator may be programmed and calibrated via the control console or via GenWare®. When using the console for programming and calibration, all programming / calibration menus are displayed on the LCD display window on the console. The “soft key” buttons on the console 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, a laptop computer (or equivalent), and a null modem cable.

3C.3.1 Entering Into Programming Mode

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

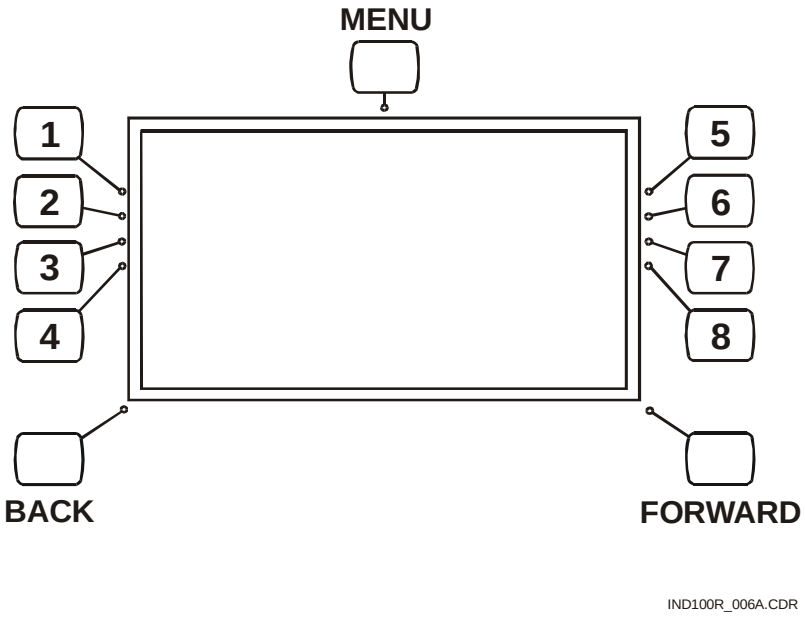


Figure 3C-2: Programming / calibration mode reference

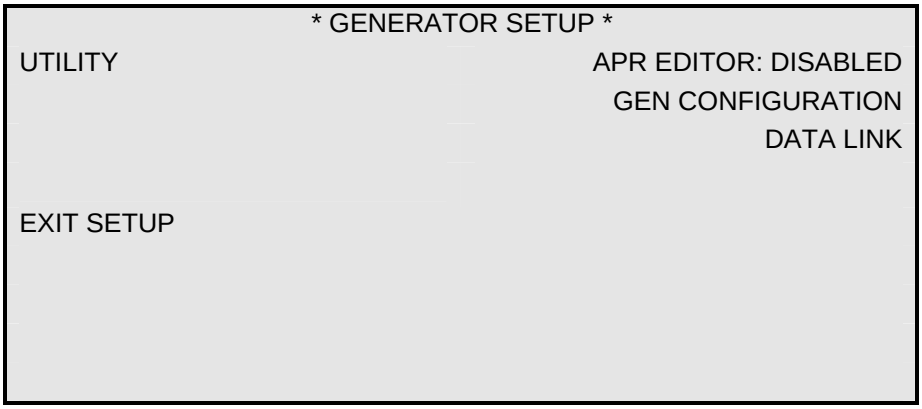
3C.3.1 Entering Into Programming Mode (Cont)

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 **MENU** button, press the power **ON** button on the console.	
3.	Enter the password by pressing the button sequence: [**1**] - [**8**] - [**4**] - [**5**].	
4.	The **GENERATOR SETUP** menu will be displayed next.	

3C.4.0 GENERATOR SETUP MENU

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



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

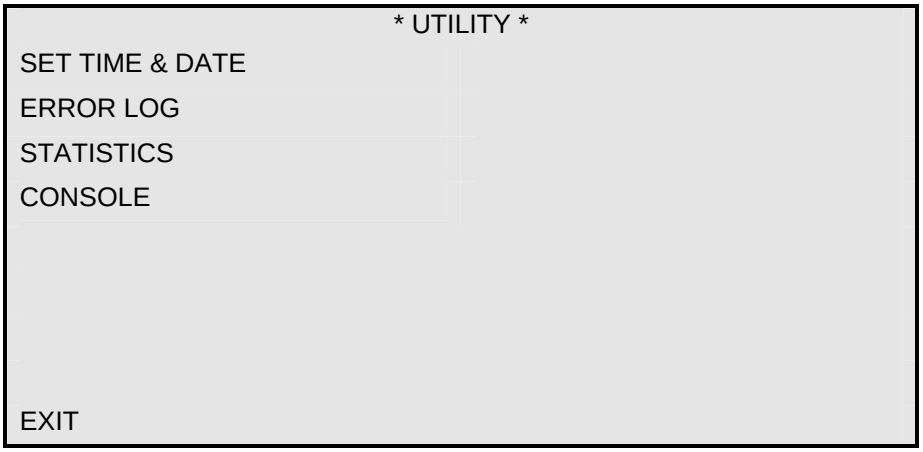
MENU (MEMBRANE CONSOLE)	**SUBMENUS (MEMBRANE CONSOLE)**	**EQUIVALENT FUNCTION (GenWare®)**
UTILITY	• **SET TIME & DATE** • **ERROR LOG** • **STATISTICS** • **CONSOLE**	• **Date and Time** utility. • **Error Log** utility. • **Generator Statistics** utility. • The **CONSOLE** function sets console-specific parameters; therefore, it is not available in GenWare®.
APR EDITOR	• This is a console-specific parameter; therefore, it is not available in GenWare®.	

3C.4.0 GENERATOR SETUP MENU (Cont)

MENU (MEMBRANE CONSOLE)	SUBMENUS (MEMBRANE CONSOLE)	EQUIVALENT FUNCTION (GenWare®)
GEN CONFIGURATION	• **TUBE SELECTION** • **GENERATOR LIMITS** • **RECEPTOR SETUP** • **I/O CONFIGURATION** • **AEC SETUP** • **AEC CALIBRATION** • **TUBE CALIBRATION** • **DAP SETUP**	• **Tube Selection** utility. • **Generator Limits** utility. • **Receptor Setup** utility. • **Receptor Setup** utility. • **AEC Calibration** utility. • **AEC Calibration** utility. • **Auto Tube Calibration** utility. • **DAP Setup** utility.
DATA LINK	The **DATA LINK** function on the membrane console is used to communicate with an external computer running GenWare®.	
EXIT SETUP	• Returns to the normal operating mode (the non setup / programming mode). • Does not apply to GenWare®.	

3C.5.0 UTILITY MENU

The **UTILITY** menu presents the user with the options shown below.



3C.5.1 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:    2002                          HOUR:   18
MONTH:      3                          MIN:    29
DAY:       30                                   +
                                                -




EXIT
```

Figure 3C-3: GenWare® Date and Time utility

3C.5.1 Setting Time And Date (Cont)

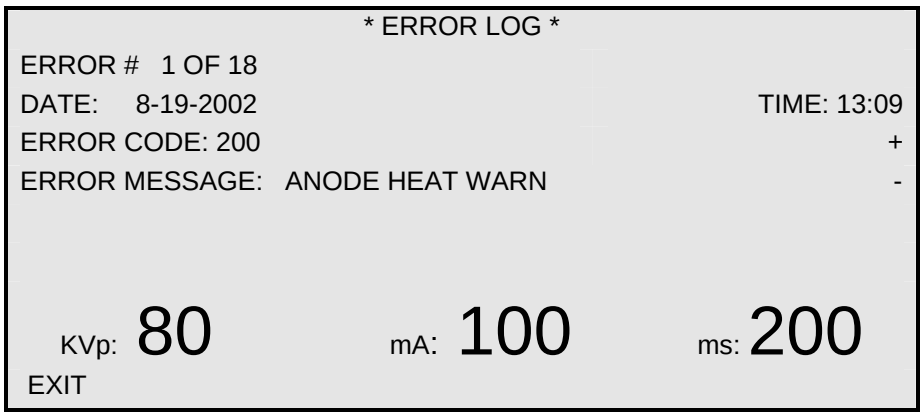
Use these steps to set the time and date.

Step	Action (membrane console)	Action (GenWare®)
1.	From the **GENERATOR SETUP** menu, select the **UTILITY** menu.	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.
2.	From the **UTILITY** menu, select the **SET TIME & DATE** menu.	The date and time may be set manually as described in steps 3 to 7, or the 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.
4.	Select **MONTH**. Use the **+** or **–** buttons to set the month.	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.
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.
7.	Select **MIN**. Use the **+** or **–** buttons to set the minutes.	Select the minutes via the **Minute** dialog box.
8.	NOTE: The time does not increment when in the SET TIME & DATE mode.	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.
9.	Press **EXIT** to return to the **UTILITY** menu.	

3C.5.2 Error Log

This utility allows display of the error messages stored in the generator's error log.

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



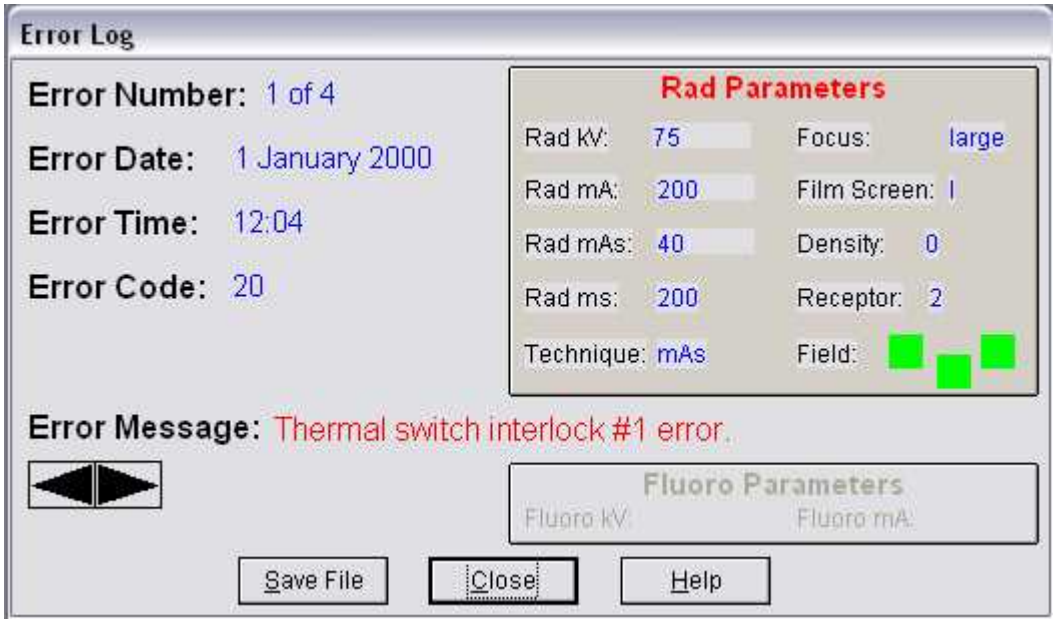


Figure 3C-4: GenWare® Error Log utility

3C.5.2 Error Log (Cont)

Use these steps to review the error log.

Step	Action (membrane console)	Action (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.
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**.
3.	Press **EXIT** to return to the **UTILITY** menu.	

3C.5.3 Statistics

This utility shows the tube exposure count and the accumulated generator exposure count. This also allows resetting of the tube 1 exposure counter.

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

```
                    * STATISTICS *
TUBE 1 EXP:          500                    RESET TUBE 1 EXP


TOTAL EXP:           1100



EXIT
```

3C.5.3 Statistics (Cont)

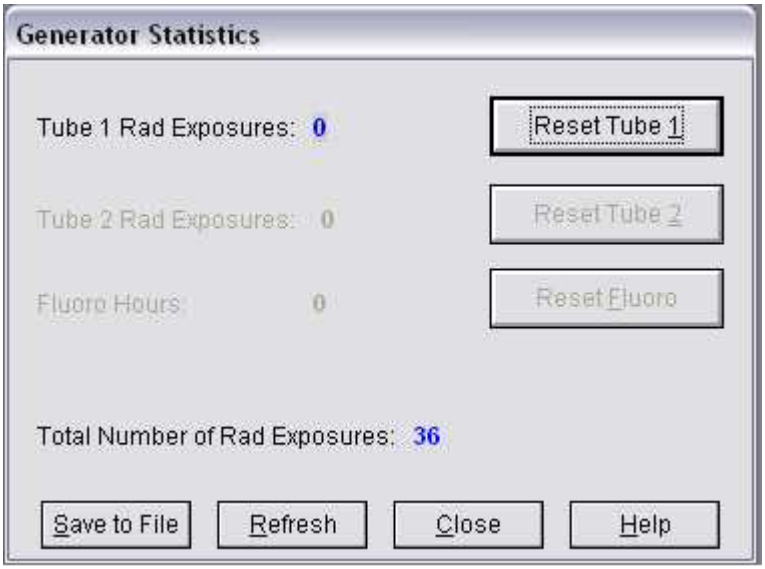


Figure 3C-5: GenWare® Statistics utility

Use these steps to view the generator statistics.

Step	Action (membrane console)	Action (GenWare®)
1.	From the **UTILITY** menu, select **STATISTICS**.	Select **Generator Statistics** from the **Utility** menu, or use the statistics button  on the GenWare® toolbar.
2.	The **STATISTICS** menu displays exposure data, and allows the exposure counter to be reset as described below: • The **TUBE 1 EXP** counter displays the tube 1 exposure count made since this counter 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.	The **Generator Statistics** window displays exposure data, and allows the exposure counter to be reset as described below: • The **Tube 1 Rad Exposures** counter displays the tube 1 exposure count made since this counter 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.
	***** 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.5.4 Console

The **CONSOLE CONFIG** menus allow setting of specific console operating features to suit operator preferences, and also allow resetting of the console parameters to the factory defaults.

CONSOLE CONFIG screen 1

```
                * CONSOLE CONFIG*
SLOW KEY REPEAT:    200MS              LCD SCREEN
MED. KEY REPEAT:    150MS          APR MODE:   NO
FAST KEY REPEAT:     75MS                      +
SPEAKER VOLUME:   15                           -



EXIT                                          >>
```

CONSOLE CONFIG screen 2

```
                * CONSOLE CONFIG*
LOAD CONSOLE DEFAULTS?:  NO
LOGO ON?:     NO
LANGUAGE:     ENGLISH
CM THICKNESS ON?:     NO
PASSWORD

EXIT
```

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

Definition of console parameters as used in this section.

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.
SPEAKER VOLUME	Sets the speaker volume for the control console in the range **1** to **15.**
LCD SCREEN	Toggles between normal and reverse video for the LCD display.

3C.5.4 Console (Cont)

FUNCTION (MEMBRANE CONSOLE)	DESCRIPTION
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.
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. Doing so will cause all custom console and APR settings to be lost.***
LOGO ON?	**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).
CM THICKNESS ON?	**YES:** CM THICKNESS mode is enabled. **NO:** CM THICKNESS mode is disabled. If CM THICKNESS is enabled, the AEC BACKUP mode (under RECEPTOR SETUP) must be set to **mAs** for each image receptor. If this is not done, CM thickness will not be available in AEC mode.
PASSWORD	Allows the Programming Mode password to be changed

This function does not apply to GenWare®.

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

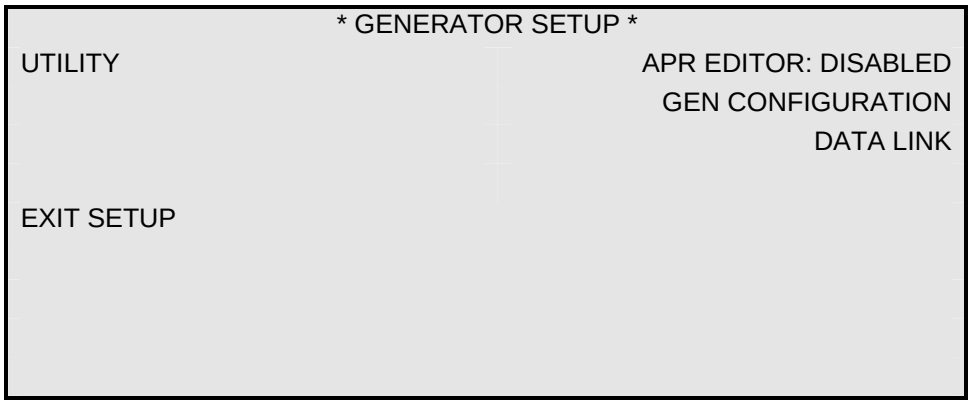
Step	Action (membrane console)
1.	From the **UTILITY** menu select **CONSOLE.** This accesses CONSOLE CONFIG screen 1.
2.	Select **SLOW KEY REPEAT.** Use the **+** or **–** buttons to set the "slow key repeat" time.
3.	Select **MED. KEY REPEAT.** Use the **+** or **–** buttons to set the "med. key repeat" time.
4.	Select **FAST KEY REPEAT.** Use the **+** or **–** buttons to set the "fast key repeat" time.
5.	Select **SPEAKER VOLUME.** Use the **+** or **–** buttons to set the speaker loudness.
6.	Select **LCD SCREEN.** Toggle the button to select normal or reverse video.
7.	Select **APR MODE.** Toggle the button to select **YES** or **NO**.

3C.5.4 Console (Cont)

Step	Action (membrane console)
8.	Press **>>**.
9.	***Do not perform this step unless you intend to restore the console factory defaults.*** To restore the console factory default settings, select **LOAD CONSOLE DEFAULTS?** and then toggle the adjacent selection button to select **YES.** In order for the changes to take effect, the generator must be switched 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. Selecting **NO** will not update the defaults. The **LOAD CONSOLE DEFAULTS** setting automatically resets to **NO** the next time the generator is switched on.
10.	Select **LOGO ON?.** Toggle the button to select **YES** or **NO**.
11.	Select **LANGUAGE.** Toggle the button to select the desired language for status and error messages.
12.	Select **CM THICKNESS ON?**. Toggle the button to select **YES** or **NO**.
13.	Select **PASSWORD**. Enter and re-enter a new password as prompted.
14.	Select **EXIT** to return to CONSOLE CONFIG screen 1.
15.	Select **EXIT** to return to the **UTILITY** menu.
16.	Select **EXIT** again to return to the **GENERATOR SETUP** menu.

3C.6.0 APR EDITOR

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



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

3C.6.0 APR EDITOR (Cont)

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.***

NOTE: ***APR text may be altered by using a computer running GenWare®. Further documentation regarding this function is included with GenWare® in the form of an MS Word document.***

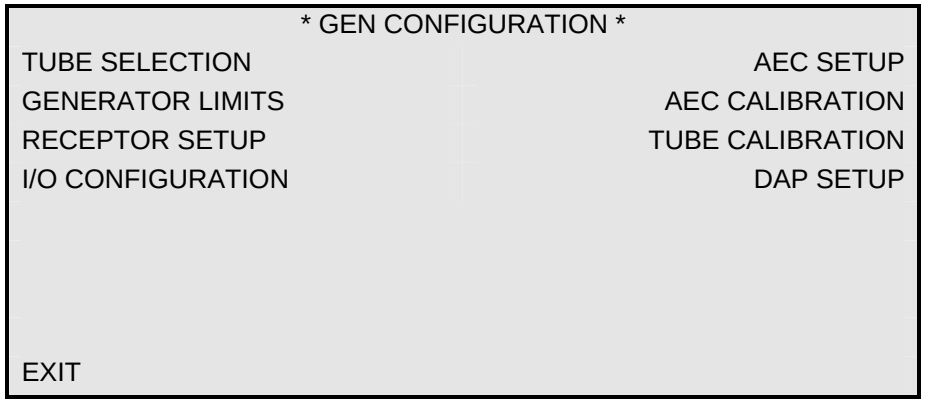
This function does not apply to GenWare®.

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.7.0 GENERATOR CONFIGURATION

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

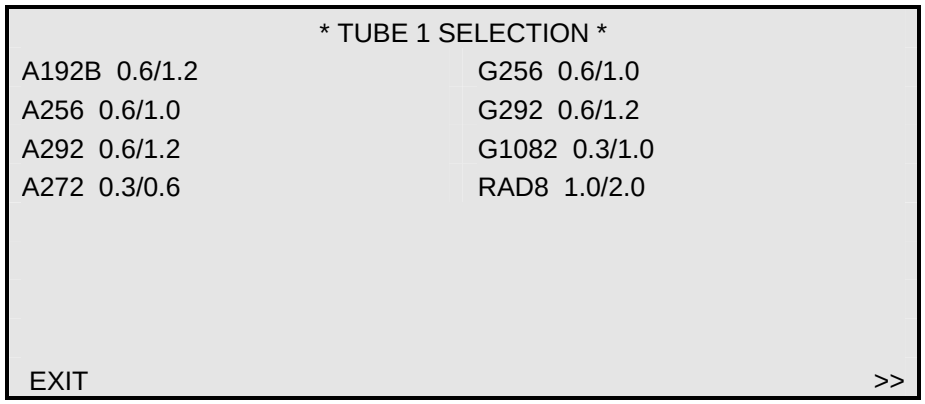


3C.7.1 Tube Selection

The **TUBE SELECTION** function allows the desired tube type to be selected, and allows setting of the default limits for that tube.

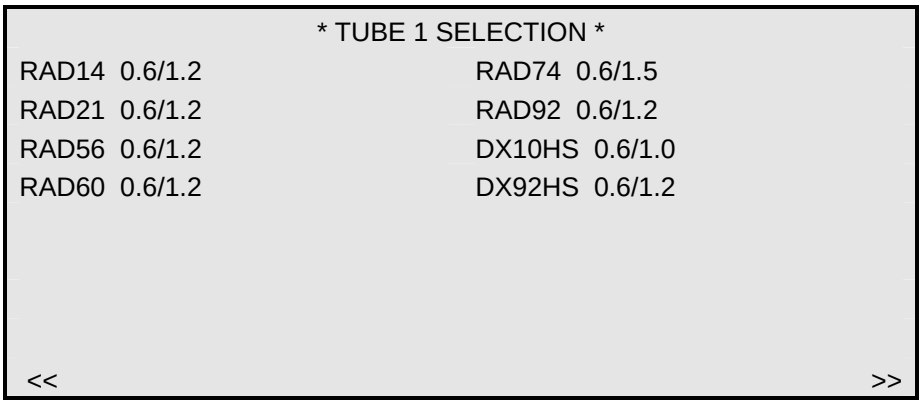
The first screen of the **TUBE SELECTION** menus for the membrane console is shown below. This is followed by additional tube selection menus, with additional tube types. The number of tube selection menus, and the actual tube selections, may not be exactly as shown.

TUBE SELECTION screen 1

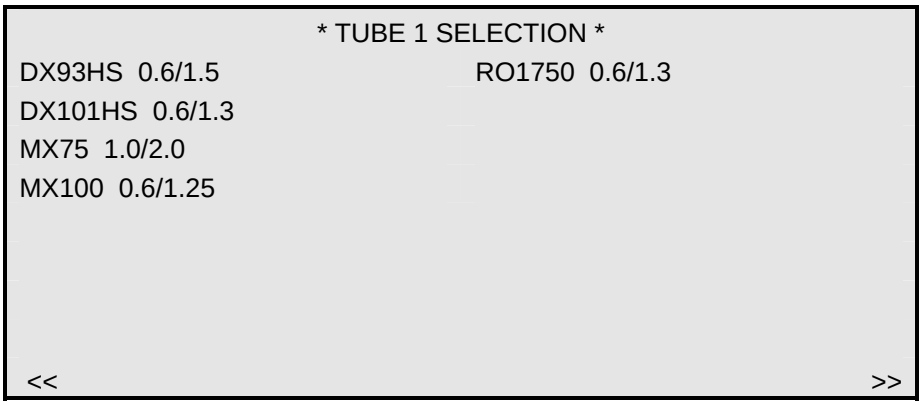


3C.7.1 Tube Selection (cont)

TUBE SELECTION screen 2

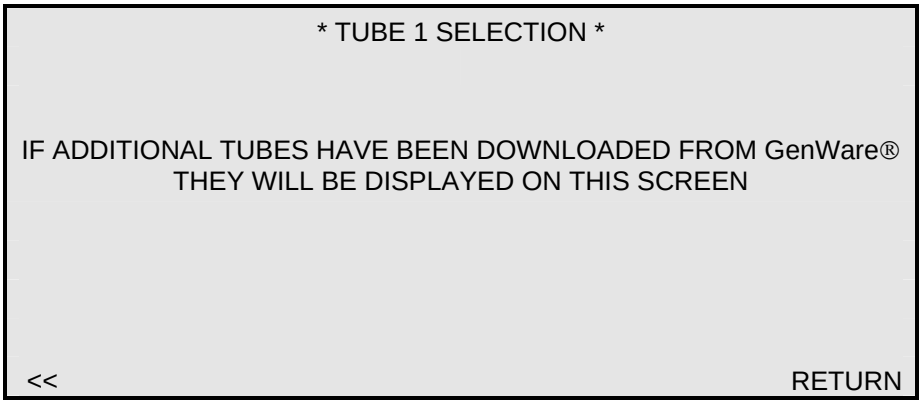


TUBE SELECTION screen 3



The following menu is only available if additional tubes have been downloaded via a computer running GenWare®.

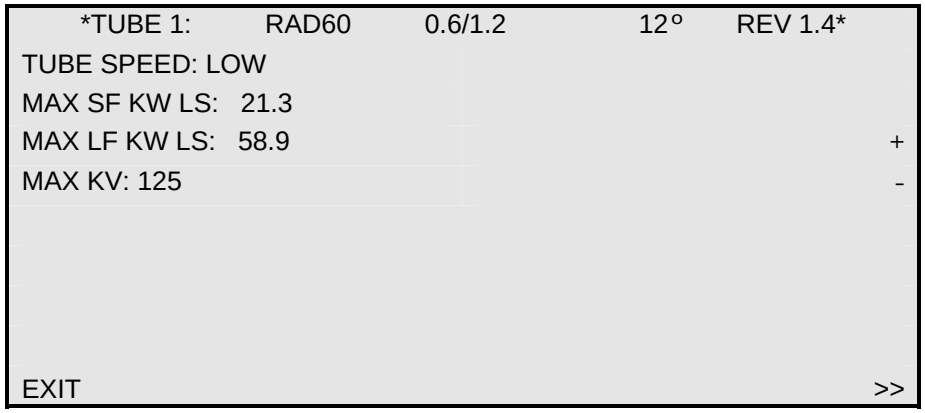
TUBE SELECTION screen 4



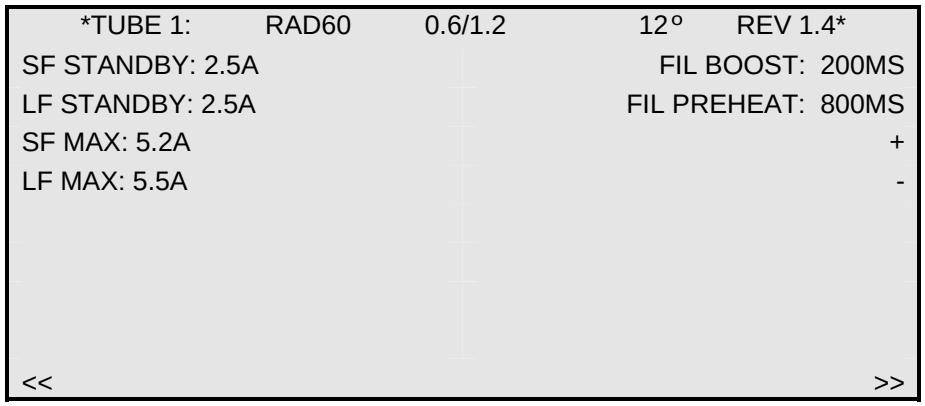
3C.7.1 Tube Selection (cont)

The next three menus show the default tube limits. These menus appear after a tube has been selected in the previous steps.

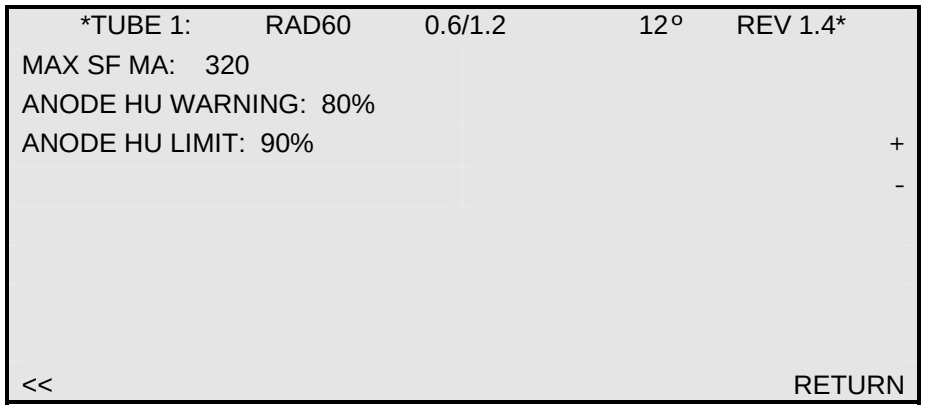
TUBE DEFAULTS screen 1



TUBE DEFAULTS screen 2



TUBE DEFAULTS screen 3



3C.7.1 Tube Selection (cont)

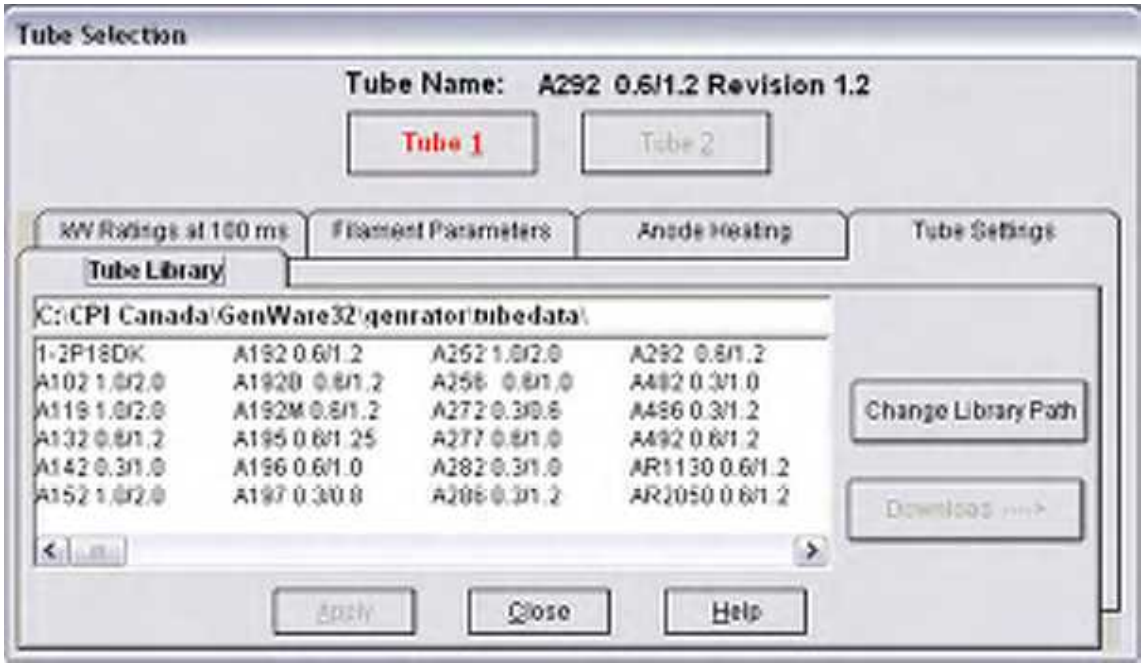


Figure 3C-6: GenWare® Tube Selection window, Tube Library tab

Figure 3C-7: GenWare® Tube Selection window, Tube Settings tab

3C.7.1 Tube Selection (cont)

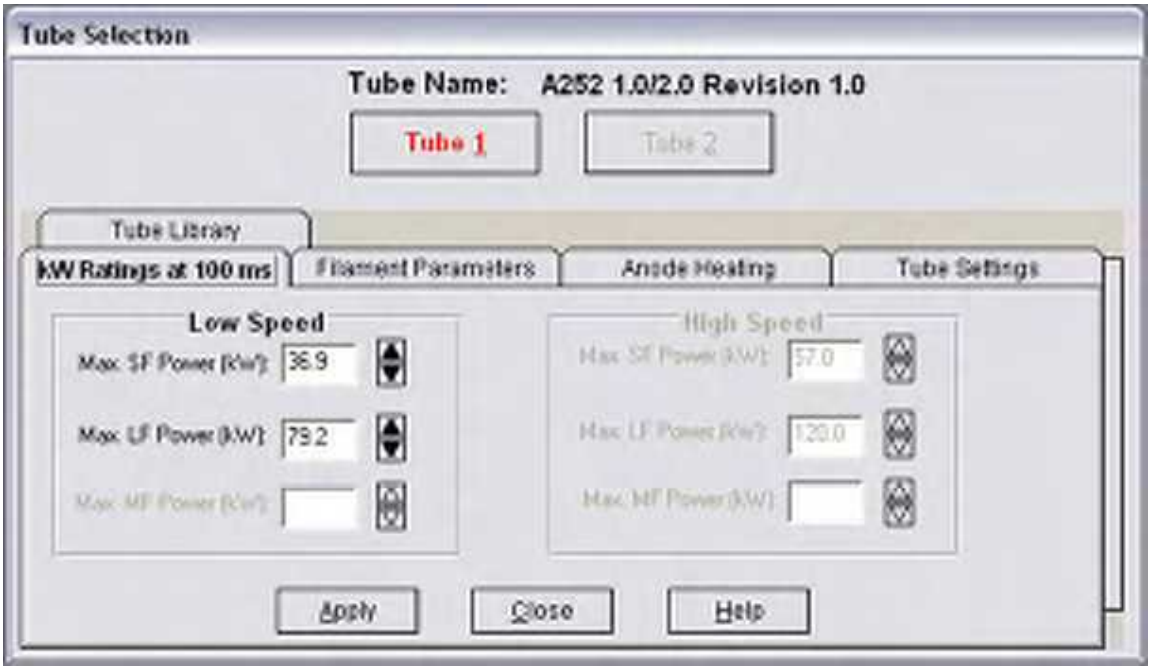


Figure 3C-8: GenWare® Tube Selection window, kW Ratings at 100ms tab

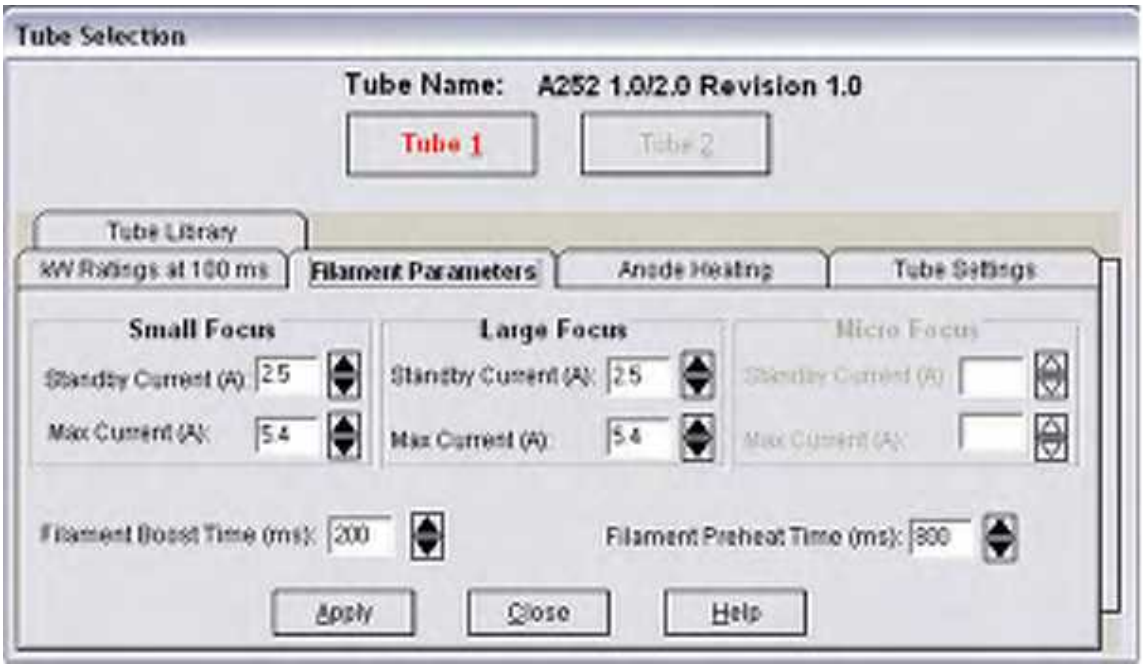


Figure 3C-9: GenWare® Tube Selection window, Filament Parameters tab

3C.7.1 Tube Selection (cont)

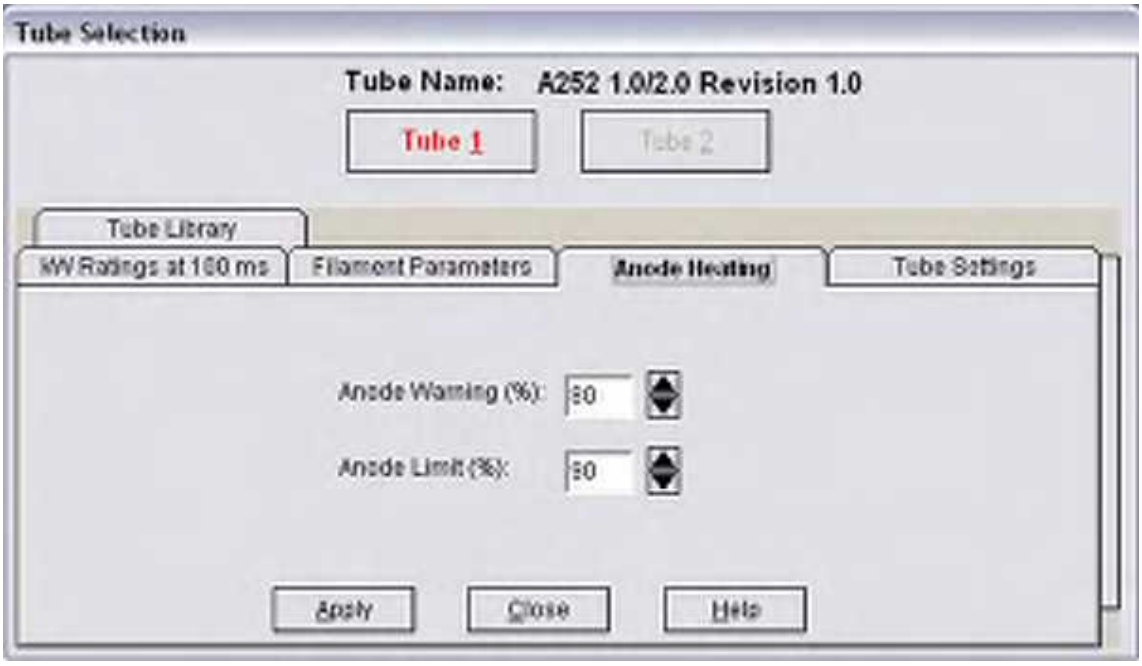


Figure 3C-10: GenWare® Tube Selection window, Anode Heating tab

Definitions of **TUBE SELECTION** menu items.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
TUBE SPEED	**Tube Speed**	This selection is permanently set to low speed.
MAX SF KW LS	**Low Speed: Max SF Power (kW)**	Sets the maximum small focus low speed kW limit (@ 100 ms *****).
MAX LF KW LS	**Low Speed: Max LF Power (kW)**	Sets the maximum large focus low speed kW limit (@ 100 ms *****).
MAX KV	**Max. Tube Voltage (kV)**	Sets the maximum kV allowed.
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.

3C.5.1 Tube Selection (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
FIL BOOST	**Filament Boost Time (ms)**	Sets the filament rapid boost duration in order to quickly raise the filament temperature.
FIL PREHEAT	**Filament Preheat Time (ms)**	The time that the filament is held at the required emission level before an exposure is permitted.
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 anode heating is currently under the limit, the next exposure will be inhibited if the generator calculates that the exposure will exceed the anode HU limit.

***** The stated maximum kW limits apply at the 100 ms point on the X-ray tube load ratings curve. Increasing or decreasing the kW limits will shift the entire curve up or down proportionately to the percentage kW change.

Use these steps to select the desired tube type.

Step	Action (membrane console)	Action (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.
2.	From the **GEN CONFIGURATION** menu, select **TUBE SELECTION**.	Select the **Tube Library** tab.
	Choose the desired tube type 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 desired tube type from the tube library. Press **Download** to download the selected tube to the generator.
3.	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.	
PLEASE ENSURE THAT THE SELECTED X-RAY TUBE STATOR IS COMPATIBLE WITH THE STARTER IN YOUR GENERATOR.		

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.

The low speed starter operates at 50 Hz for 50 Hz mains, or 60 Hz for 60 Hz mains. Therefore, the 60 Hz tube ratings are automatically derated for 50 Hz operation, if required.

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

NOTE: ***BEFORE CHANGING X-RAY TUBE DEFAULT PARAMETERS, PLEASE FILL IN THE X-RAY TUBE AND GENERATOR PARAMETER WORKSHEET, TABLE 3C-3. A BLANK FORM THAT SHOULD BE PHOTOCOPIED IS LOCATED AT THE END OF THIS SECTION. 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 (GenWare®)
1.		Select the **kW Ratings at 100 ms** tab.
2.	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**.
3.	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**.
4.		Select the **Tube Settings** tab.
5.	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.
6.	Press **>>**.	Select the **Filament Parameters** tab.
7.	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**.
8.	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**.
9.	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**.
10.	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**.

3C.5.1 Tube Selection (Cont)

Step	Action (membrane console)	Action (GenWare®)
11.	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.
12.	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.
13.	Press **>>**.	Select the **Tube Settings** tab.
14.	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.
15.		Select the **Anode Heating** tab.
16.	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.
17.	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.
18.	Press **<<** and **EXIT** as required to return to the **GEN CONFIGURATION** menu.	

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

3C.5.1 Tube Selection (Cont)

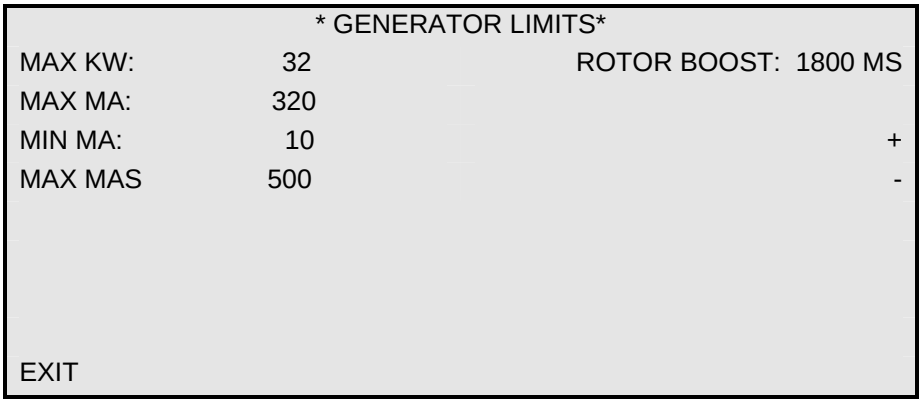
TUBE SELECTION	TUBE 1	
	DEFAULT	SELECTED
TUBE SELECTED		
TUBE SPEED		
MAX SF KW LS		
MAX LF KW LS		
MAX KV		
SF STANDBY		
LF STANDBY		
SF MAX		
LF MAX		
FIL BOOST		
FIL PREHEAT		
MAX SF MA		
ANODE HU WARNING		
ANODE HU LIMIT		
GENERATOR LIMITS	DEFAULT	SELECTED
MAX KW		
MAX MA		
MIN MA		
MAX MAS		
ROTOR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

Table 3C-3: X-ray tube and generator parameter worksheet

3C.7.2 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.



3C.7.2 Generator Limits (Cont)

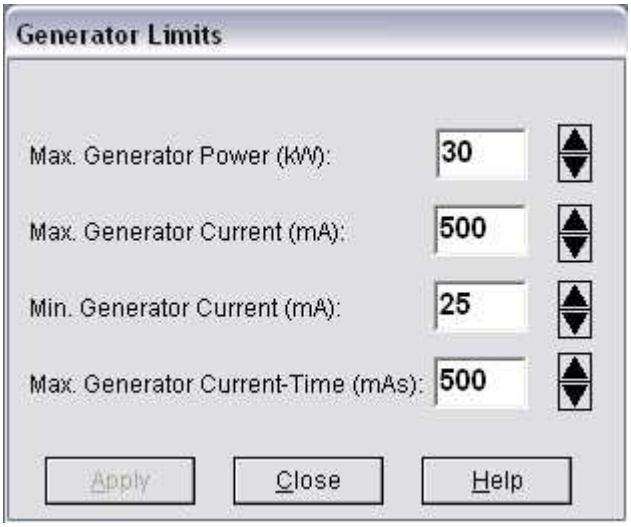


Figure 3E-11: GenWare® Generator Limits window

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.
ROTOR BOOST	**This function is not available in GenWare®**	Sets the low speed starter boost time, in milliseconds. The range is 1000 ms (1 sec) to 4000 ms (4 sec), adjustable in 100 millisecond increments.

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. THE ORIGINAL GENERATOR LIMITS SHOULD BE RECORDED IN A COPY OF TABLE 3C-3 BEFORE CONTINUING.

3C.7.2 Generator Limits (Cont)

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

Step	Action (membrane console)	Action (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.
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.
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.
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.
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.
6.	Select **ROTOR BOOST.** Use the **+** or **–** buttons to set the low speed starter boost time.	This function is not available in GenWare®
7.	Press **EXIT** to return to the **GEN CONFIGURATION** menu.	

3C.7.3 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.

MENU 1

```
                    * RECEPTOR  SETUP [sym] *
TUBE:    1                                  TOMO BUT:  2500 MS
RECEPTOR SYM: [sym]
MEMORY: DEF                                                  +
TOMO:  NO                                                    -




EXIT                                                        >>
```

MENU 2

```
                    * RECEPTOR SETUP [sym]*
SF/LF SWITCH:  MAN                                   DEFAULTS
AEC BACKUP:   FIXED                          AEC CHANNEL:  1
AEC BACKUP MAS:  100                                         +
AEC BACKUP MS:  1000                                         -




<<
```

NOTE: *THE **DEFAULTS** SELECTION IN MENU 2 IS ONLY AVAILABLE IF **MEMORY** IN MENU 1 WAS SET TO **DEF**.*
*RECEPTOR MENUS 3 AND 4 (FOLLOWING) ARE ONLY ACCESSIBLE IF **DEFAULTS** IS ENABLED.*

3C.7.3 Receptor Setup (Cont)

MENU 3

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




<<                                                  >>
```

MENU 4

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




<<
```

3C.7.3 Receptor Setup (Cont)

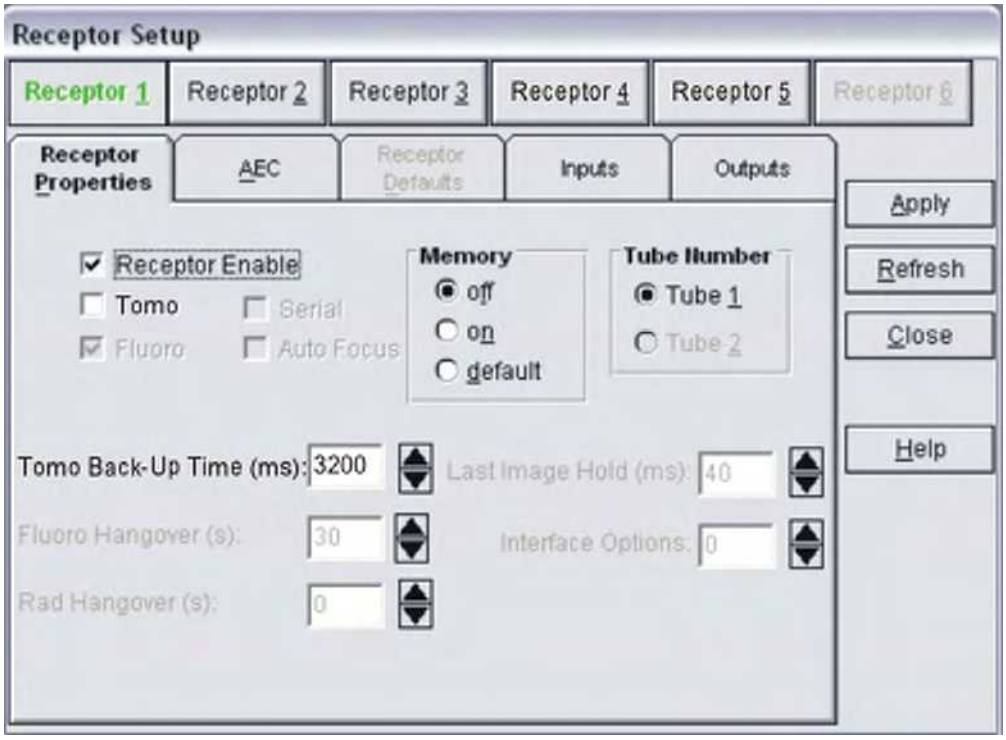


Figure 3C-12: GenWare® Receptor Setup window, Receptor Properties tab

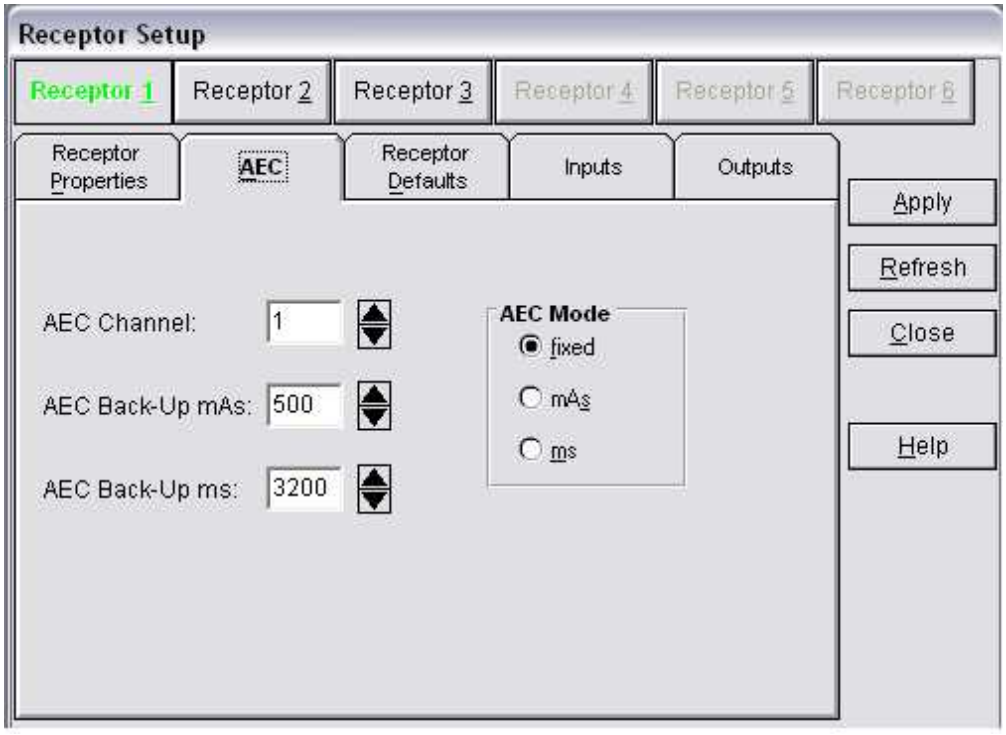


Figure 3C-13: GenWare® Receptor Setup window, AEC tab

3C.7.3 Receptor Setup (Cont)

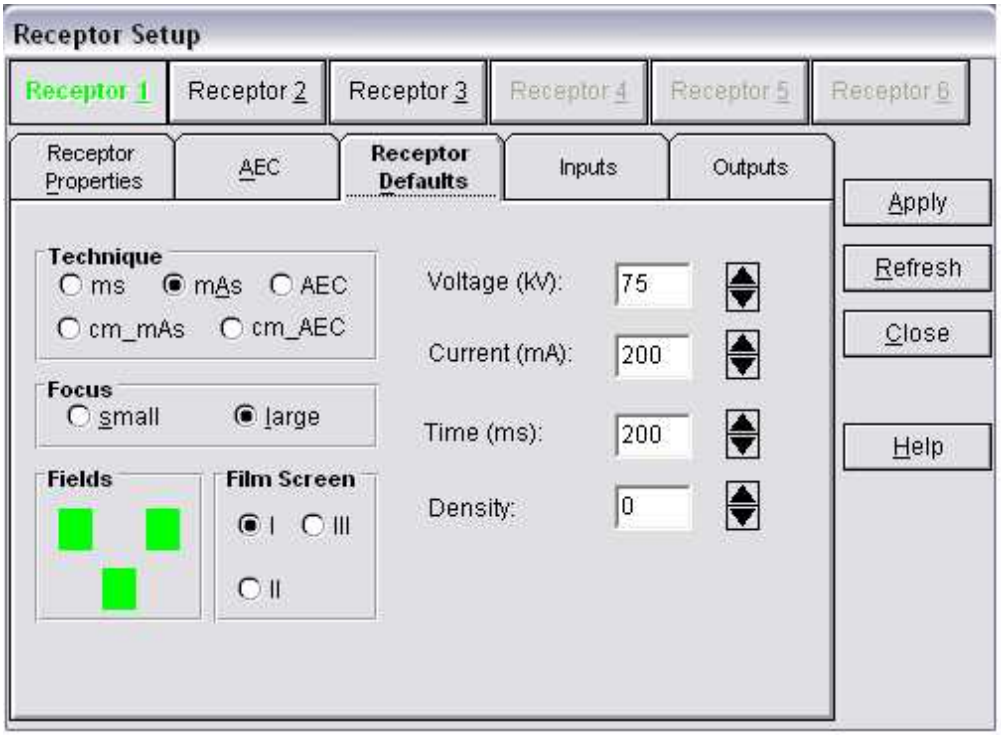


Figure 3C-14: GenWare® Receptor Setup window, Receptor Defaults tab

Definitions of **RECEPTOR SETUP** menu items.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
TUBE	**Receptor Enable** checkbox	This function allows the receptor to be disabled. Membrane console: **NONE:** Disables the currently selected receptor. **1:** Enables the currently selected receptor. GenWare®: **Receptor Enable** Enables / disables the currently selected receptor.
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.

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
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 3 and 4 (membrane console) or the **Receptor Defaults** tab (GenWare®).
TOMO	**Tomo**	Enables or disables tomographic operation.
TOMO BUT	**Tomo Back-Up Time (ms)**	Sets the tomo backup time.
SF/LF SWITCH	**This function is not available in GenWare®**	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.

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
AEC BACKUP	**AEC 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. Density (**DENS**) only will be displayed at the lower right side of the LCD 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. **DENS** and the backup mAs will be displayed at the lower right side of the LCD display during AEC operation. ***mAs mode operation must be set in order to use CM thickness mode in AEC.*** **MS:** Allows the operator to adjust the AEC backup ms, not to exceed preset AEC backup mAs/ms values or system limits. **DENS** and the backup ms will be displayed at the lower right side of the LCD display during AEC operation.
AEC BACKUP MAS	**AEC Back-Up mAs**	Sets the maximum AEC backup mAs.
AEC BACKUP MS	**AEC Back-Up 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 1 (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.
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.

3C.5.3 Receptor Setup (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
THE FOLLOWING SELECTIONS ARE ONLY AVAILABLE IF DEFAULTS WAS ENABLED AS PREVIOUSLY DESCRIBED.		
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**.
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 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.

3C.5.3 Receptor Setup (Cont)

If the image receptor defaults are changed, please record the original defaults 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						

3C.5.3 Receptor Setup (Cont)

NOTE: ***DO NOT SWITCH OFF THE GENERATOR WHILE IN *RECEPTOR SETUP DEFAULTS* MENUS 3 AND 4. 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, 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.***

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

Step	Action (membrane console)	Action (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.
2.		Select the **Receptor Properties** tab.
3.	Select the first receptor to be programmed.	Select the first receptor to be programmed.
4.	Select **TUBE**. Toggle the button to select **NONE** or **1**.	Check the **Receptor Enable** checkbox to enable the selected receptor.
5.	Select **RECEPTOR SYM**. Use the **+** or **–** buttons to select the desired receptor symbol.	
6.	Select **MEMORY**. Toggle the button to select **NO, YES,** or **DEF**.	Under **Memory**, select **off, on**, or **default**.
7.	Select **TOMO**. Toggle the button to select **YES** or **NO**.	Check the **Tomo** checkbox to enable tomographic operation.
8.	Select **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.
9.	Press **>>**.	
10.	Select **SF/LF SWITCH**. Toggle the button to select **AUTO** or **MAN**.	This function is not available in GenWare®
11.		Select the **AEC** tab.
12.	Select **AEC BACKUP**. Toggle the button to select **FIXED, MAS,** or **MS**.	Under **AEC Mode**, select **fixed, mAs**, or **ms**.
13.	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.
14.	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.
15.	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.
	The following steps only apply if **MEMORY** in step 6 was set to **DEF** / **default**.	

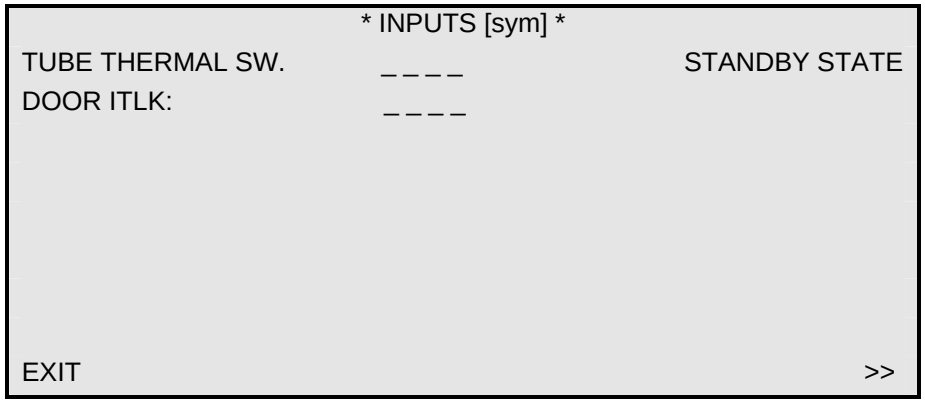
3C.5.3 Receptor Setup (Cont)

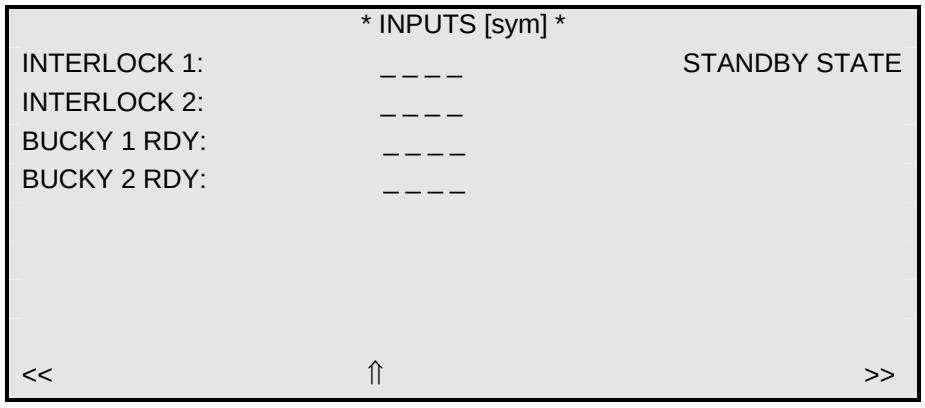
Step	Action (membrane console)	Action (GenWare®)
16.	Select **DEFAULTS**.	Select the **Receptor Defaults** tab.
17.	Select **TECHNIQUE**. Toggle the button to select **MA, MAS,** or **AEC**.	Under **Technique**, select **ms, mAs**, or **AEC**.
18.	Select **FOCUS**. Toggle the button to select **SMALL** or **LARGE**.	Under **Focus**, select **small** or **large**.
19.	Select **FILM SCREEN**. Toggle the button to select **1, 2,** or **3.**	Under **Film Screen**, select **I, II,** or **III**.
20.	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.
21.	Repeat the previous step for the **CENTER** and **RIGHT** fields.	Repeat the previous step for the center and right fields.
22.	Press **>>**.	
23.	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.
24.	Press **<<** and **EXIT** as required to the **GEN CONFIGURATION** menu.	
25.	Repeat steps 3 to 22 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.	

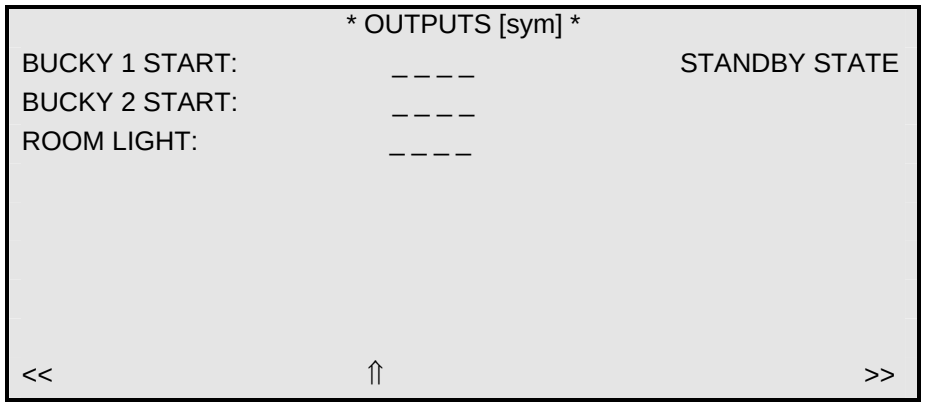
3C.7.4 I/O Configuration

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.







3C.7.4 I/O Configuration (cont)

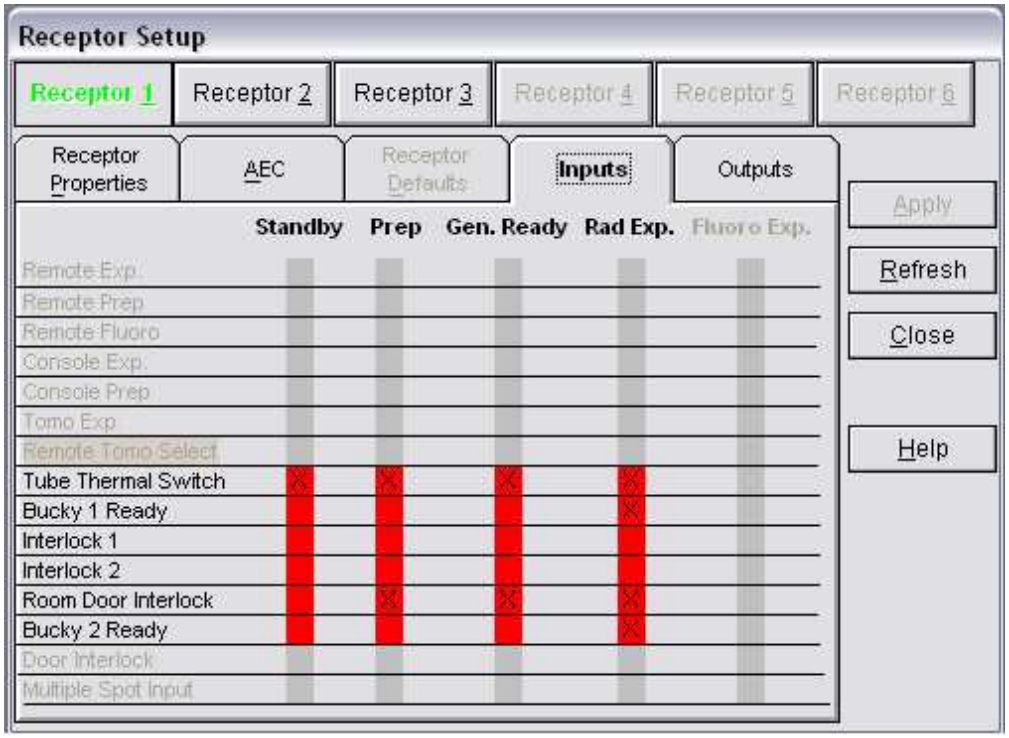


Figure 3C-15: GenWare® Receptor Setup window, Inputs tab

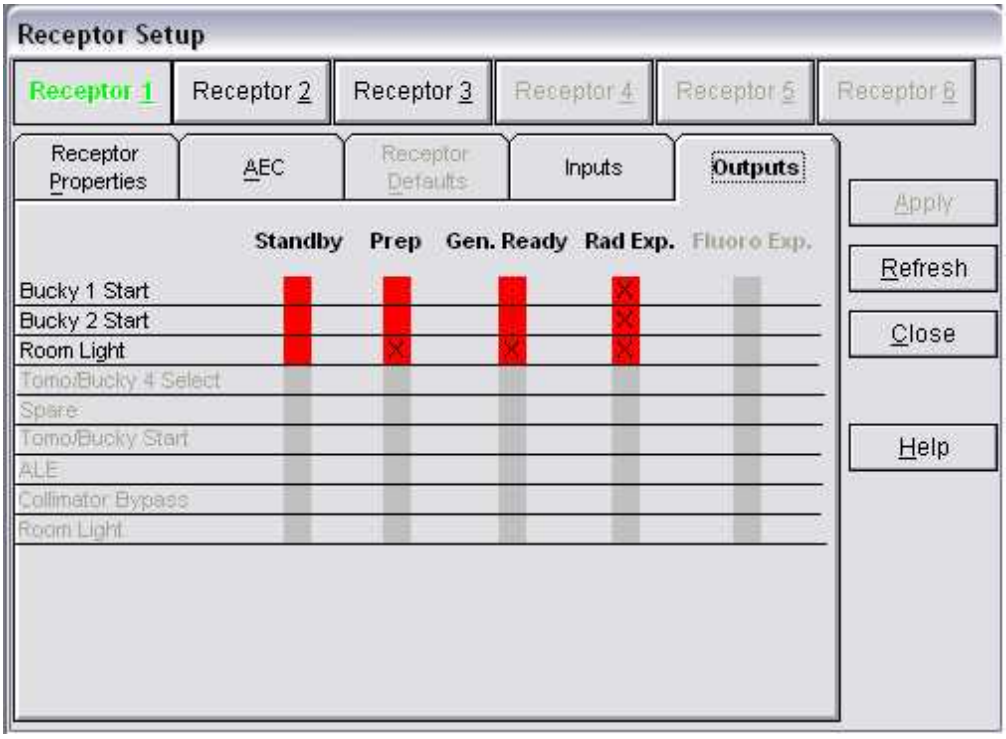


Figure 3C-16: GenWare® Receptor Setup window, Outputs tab

3C.7.4 I/O Configuration (cont)

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

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
TUBE THERMAL SW	**Tube Thermal Switch**	Programs the thermal switch input at J7-1 and J7-2 on the H.V. auxiliary board.
DOOR ITLK	**Room Door Interlock**	Programs the door interlock input at J4-9 and J4-10 on the H.V. auxiliary board.
INTERLOCK 1	**Interlock 1**	Programs the interlock #1 input at J2-3 and J2-4 on the H.V. auxiliary board.
INTERLOCK 2	**Interlock 2**	Programs the interlock #2 input at J2-1 and J2-2 on the H.V. auxiliary board. This is the tomo exposure input for any receptor that is assigned to tomo operation.
BUCKY 1 RDY	**Bucky 1 Ready**	Programs the Bucky 1 input at J2-5 and J2-6 on the H.V. auxiliary board.
BUCKY 2 RDY	**Bucky 2 Ready**	Programs the Bucky 2 input at J4-5 and J4-6 on the H.V. auxiliary board.
BKY 1 START	**Bucky 1 Start**	Programs the Bucky 1 “start” output at J2-7 on the H.V. auxiliary board.
BKY 2 START	**Bucky 2 Start**	Programs the Bucky 2 “start” output at J4-1 on the H.V. auxiliary board. This is normally programmed as the tomo output.
ROOM LIGHT	**Room Light**	Programs the room light output at J11-3 and J11-4 on the H.V. auxiliary 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.

3C.5.4 I/O Configuration (Cont)

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 or idle mode.
- **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.

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. For example, if the door interlock (DOOR ITLK) is set to logic “low” for all states, then an X-ray exposure may be made without a door interlock closure.

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. For example, the Bucky 1 “start” output will be disabled if BKY 1 START is set to “low” for all states.

The example below shows a TYPICAL input configuration.

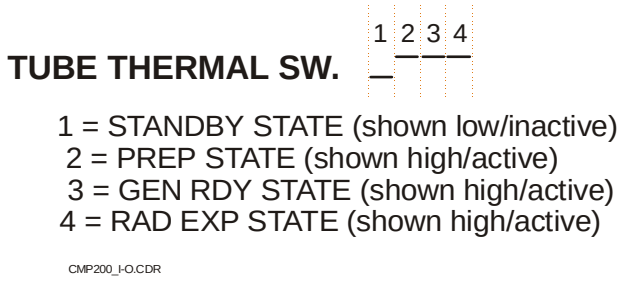


Figure 3C-17: Example of input states

3C.5.4 I/O Configuration (Cont)

GenWare®

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

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.

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

Step	Action (membrane console)	Action (GenWare®)
1.	From the **GEN CONFIGURATION** menu, select **I/O CONFIGURATION**.	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.
3.	Press the **STATE** button to select the first state that can be programmed for the **TUBE THERMAL SW.** input. This is the **STANDBY** state. Toggle the **TUBE THERMAL SW.** button to select the desired logic level (low or high) to disable or enable that input during the standby state.	For the **Tube Thermal Switch** input, identify the first state that can be programmed. This is the **Standby** state. Enable or disable the **Tube Thermal Switch** input during the standby state by checking (with an **X**), or unchecking the **Standby** column to the right of **Tube Thermal Switch.**
4.	Repeat the previous step for each state.	Repeat the previous step for each state.
5.	Repeat steps 3 and 4 for each input. Use the **>>** button to advance to **INPUTS** menu 2.	Repeat steps 3 and 4 for each input.
6.	Press **>>** to select the **OUTPUTS** menu.	Select the **Outputs** tab.
7.	Repeat steps 3 and 4 to program each output.	Repeat steps 3 and 4 to program each output. 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.

3C.5.4 I/O Configuration (Cont)

Step	Action (membrane console)	Action (GenWare®)
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.
10.	Program all inputs and outputs for the selected receptor.	
11.	When finished programming all receptors, exit to the **GEN CONFIGURATION** menu.	

The input and output programming should be recorded in a copy of the table below. This will provide a record of the I/O configuration for future reference.

FUNCTIONS	STANDBY	PREP	GEN RDY	RAD EXP
INPUTS				
TUBE THERMAL SW.				
DOOR ITLK.				
INTERLOCK 1				
INTERLOCK 2				
BUCKY 1 RDY				
BUCKY 2 RDY				
OUTPUTS				
BKY 1 START				
BKY 2 START				
ROOM LIGHT				

3C.7.5 AEC Setup

The **AEC SETUP** menus allow programming of AEC parameters for each AEC channel.

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

MENU 1

```
                        * AEC SETUP*
CHANNEL:    1                          CHAMBER TYPE:  ION
LEFT FIELD:       YES                  FILM SCREEN  1 : YES
CENTER FIELD:     YES                  FILM SCREEN  2 : YES
RIGHT FIELD:      YES                  FILM SCREEN  3 : YES




EXIT                                                  >>
```

MENU 2. Do not adjust these values at this time.

```
                        * AEC SETUP*
R FIELD COMP:       0
C FIELD COMP:       0
L FIELD COMP:       0                                    +
                                                         -




<<
```

3C.7.5 AEC Setup (Cont)

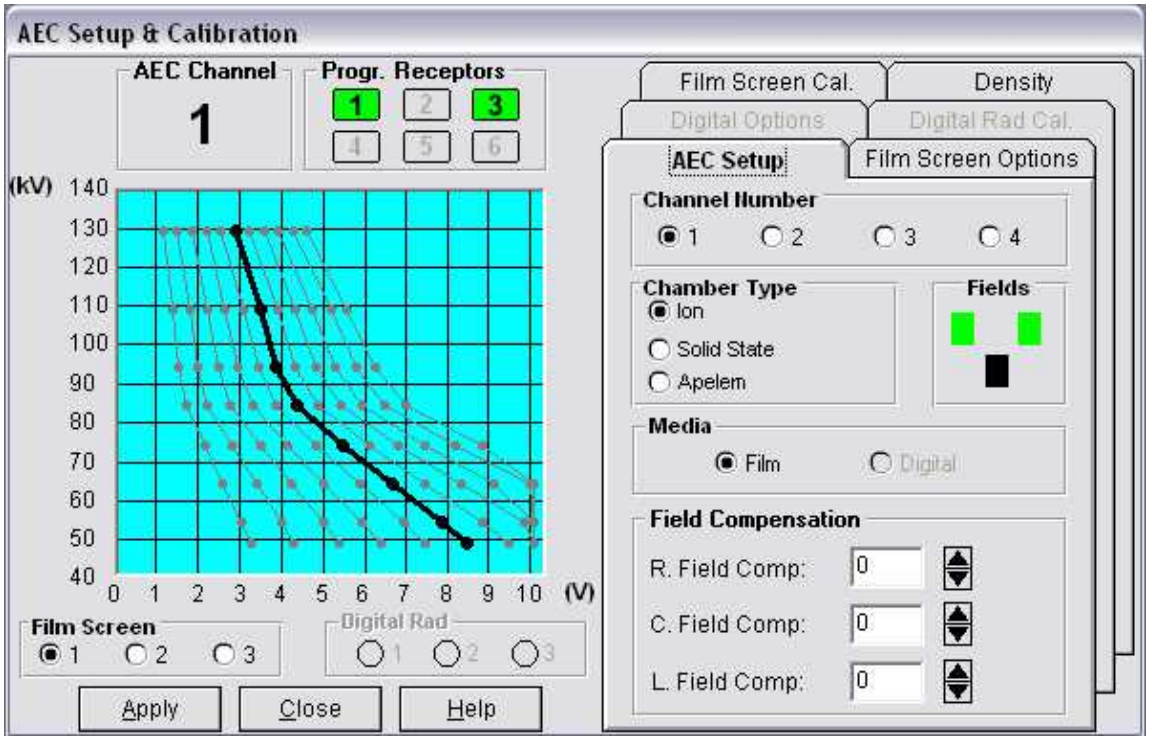


Figure 3C-18: GenWare® AEC Setup & Calibration window, AEC Setup tab

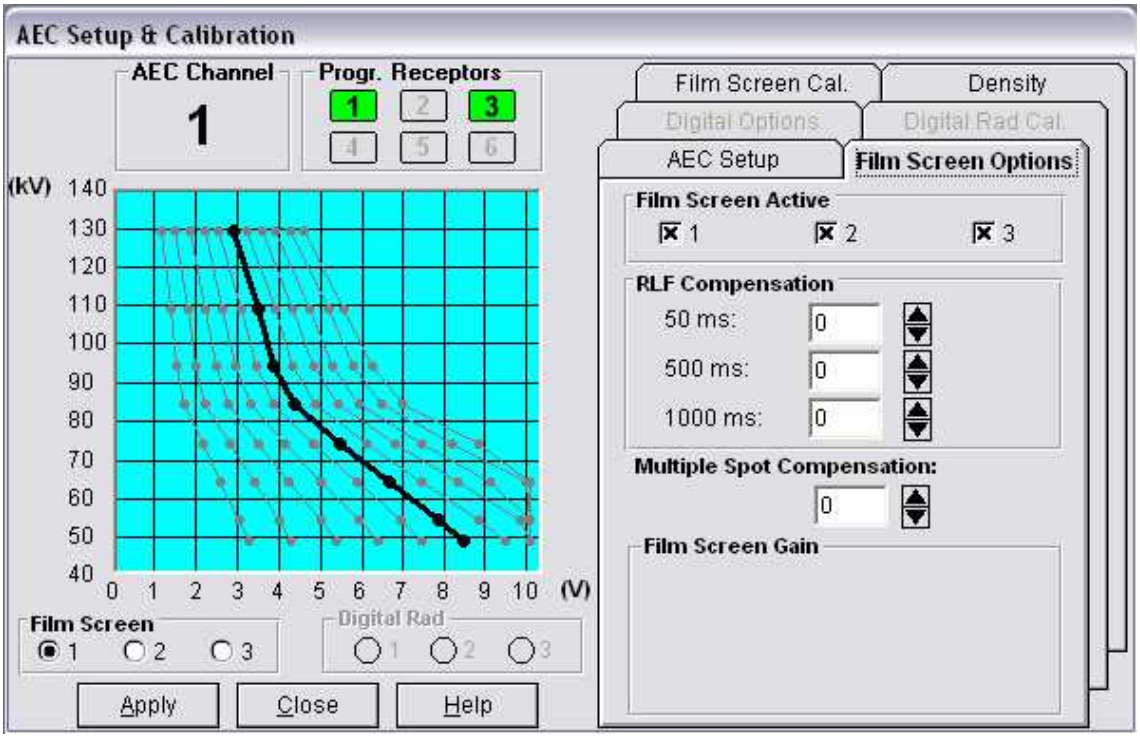


Figure 3C-19: GenWare® AEC Setup & Calibration window, Film Screen Options tab

3C.7.5 AEC Setup (Cont)

Note the following regarding GenWare® figures 3C-16 and 3C-17:

- The **AEC Channel** display near the top left side of the **AEC Setup & Calibration** window shows the selected AEC channel.
- The **Progr. Receptors** display to the right of the AEC channel display shows which receptors are programmed for the selected AEC channel.

Definitions of **AEC SETUP** menu items applicable to the initial AEC setup.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
CHANNEL	**Channel Number**	Selects the AEC channel to be programmed.
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:** A black field select rectangle = disabled, a green field select rectangle = enabled.
CHAMBER TYPE	**Chamber Type**	Selects the AEC chamber type. Membrane console: **ION:** Ion chamber. **S/S:** Solid-state chamber. **APL:** Apelem. GenWare®: **Ion:** Ion chamber. **Solid State:** Solid-state chamber. **Apelem:** Apelem.
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.

3D.4.0 INITIAL AEC SETUP (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
R FIELD COMP	**R. Field Comp**	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*** in chapter 3C.
C FIELD COMP	**C. Field Comp**	
L FIELD COMP	**L. Field Comp**	

Use these steps to perform the initial AEC setup. Refer to the definitions in the previous table.

Step	Action (membrane console)	Action (GenWare®)
1.	From the **GEN CONFIGURATION** menu, select **AEC SETUP**.	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.
2.		Select the **AEC Setup** tab.
3.	From **AEC SETUP** menu 1, select the AEC channel to be programmed. Pressing the **CHANNEL** button will scroll through the available AEC channels.	Under **Channel Number (AEC Setup** tab**)**, select the AEC channel that is to be programmed.
4.	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.
5.	Repeat the above for the center and right fields.	Repeat the above for the center and right fields.
6.	Select **CHAMBER TYPE**. Use the **+** or **–** buttons to select the desired AEC chamber type.	Under **Chamber Type**, select the desired AEC chamber type.
	Select ION if using solid state AEC board assembly 737992.	
7.		Select the **Film Screen options** tab.
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.
9.	Repeat the above for film screen 2 and film screen 3.	Repeat the above for film screen 2 and film screen 3.
10.	Press **>>**.	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.

3D.4.0 INITIAL AEC SETUP (Cont)

Step	Action (membrane console)	Action (GenWare®)
12.	Repeat the above for **C FIELD COMP** and **L FIELD COMP**	Repeat the above for **C. Field Comp** and **L. Field Comp**.
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.
14.	Press **<<** and **EXIT** as required to return to the **GEN CONFIGURATION** menu.	

3C.7.6 AEC Calibration

Refer to chapter 3D.

3C.7.7 Tube Calibration

Before beginning tube auto calibration, the tube used in this installation must be properly selected, and the generator limits should be programmed, as described earlier in this chapter.

It is recommended that the tube 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 (GenWare®)
1.	From the **GENERATOR SETUP** menu select **GEN CONFIGURATION**.	Select **Auto Tube Calibration** from the **Setup** menu, or use the auto calibration button  on the GenWare® toolbar.
2.	Select **TUBE CALIBRATION**.	
3.	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**.
4.	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.

3C.7.7 Tube Calibration (Cont)

Step	Action (membrane console)	Action (GenWare®)
5.	When finished calibrating the small focus, press **RETURN** and then repeat calibration on the large focal spot.	Repeat the calibration on the large focal spot.
6.	When auto-calibration is completed, press **EXIT** to return to the **GENERATOR SETUP** menu.	
7.	Press **EXIT SETUP** to exit out of the setup and calibration mode and return to the normal operation mode.	

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.***

3C.8.0 DAP PRINTER SETUP

1. Connect the DAP printer to the *DATA LINK* connector J4 on the rear of the console. Refer to the figure "*Rear of control console*" in chapter 2 of the CMP 200 service manual for the connector location.

2. Follow the procedure in 3C.10.2 to set up and test the DAP printer.

NOTE: ***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.***

NOTE: ***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.***

3C.9.0 DAP INTERFACING

3C.9.1 DAP Compatibility

The CMP 200 generator, when equipped with the DAP option, is compatible with the DAP devices listed in section 3C.10.2. The correct DAP device must be selected in the DAP SETUP menu as described in 3C.10.2 in order to ensure device compatibility.

The DAP chamber, when fitted with the proper interconnect cable, plugs directly into the generator control 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 generator control board. 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 120-131	736148-00

3C.9.2 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 3C.9.1.

3. Route the DAP interconnect cable through one of the access slots at the upper rear of the generator, and then route the cables toward the generator control board. Secure the cable to the lip on the inside of the cable access slot using tie wraps or equivalent fasteners.

4. Plug the DAP cable into J4 on the generator control board. Tighten the screw locks on the connectors to secure the cables.

5. Proceed with DAP setup and calibration as per the remainder of this procedure.

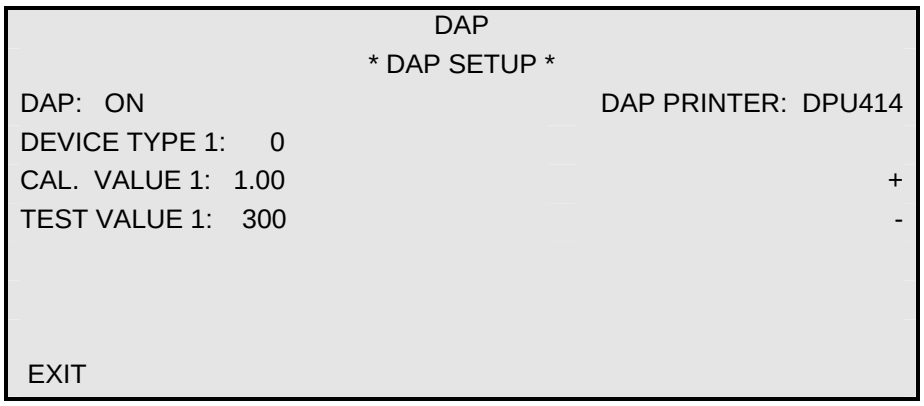
3C.10.0 DAP SETUP

3C.10.1 DAP SETUP Menu

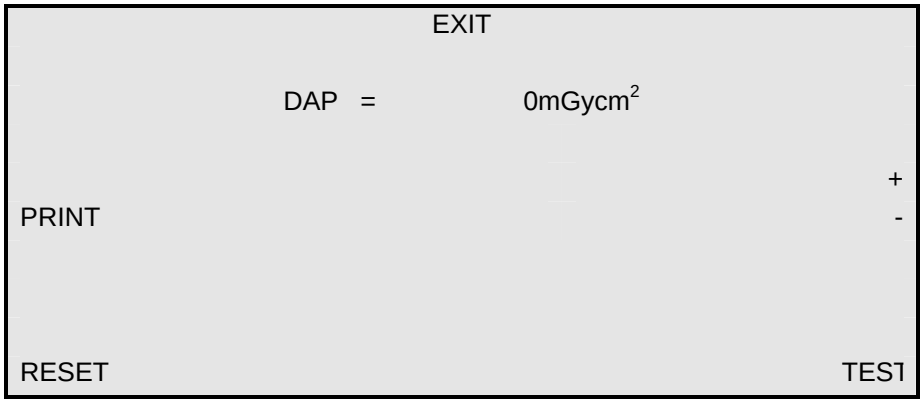
The **DAP SETUP** menus allow setup and calibration of the DAP device.

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

MENU 1: DAP SETUP



MENU 2: DAP RESET / TEST / PRINT



3C.10.1 DAP SETUP Menu (Cont)

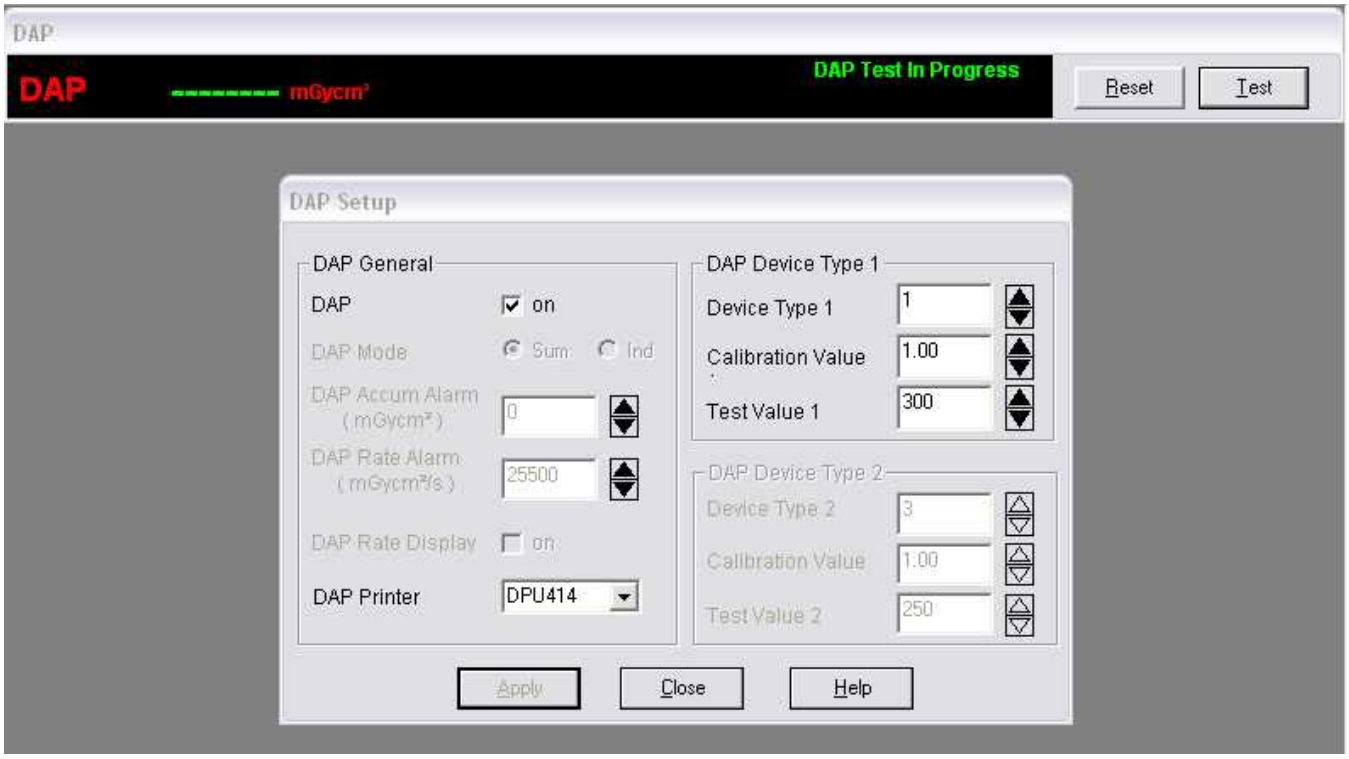


Figure 3C-20: GenWare® DAP Setup and display windows

3C.10.2 DAP SETUP Menu Items

Definitions of **DAP SETUP** menu items.

FUNCTION (MEMBRANE CONSOLE)	**FUNCTION (GenWare®)**	**DESCRIPTION**
DAP	**DAP** checkbox	Enables or disables the DAP device. 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** checkbox.
DEVICE TYPE 1	**Device Type 1**	Selects the DAP device. **0** = PTW PX-T11020. **1** = Gammex RMI 841S. **2** = VacuTec VacuDAP 2004. **3** = Scanditronix-Wellhoefer 120-131.
CAL. VALUE 1	**Calibration Value**	Allows the DAP reading to be calibrated by adjusting this parameter.

3C.10.2 DAP SETUP Menu Items (Cont)

FUNCTION (MEMBRANE CONSOLE)	FUNCTION (GenWare®)	DESCRIPTION
TEST VALUE 1	**Test Value 1**	A numeric value, supplied by the DAP device manufacturer, that represents the number of pulses generated by the DAP device during TEST mode. Typical terms used by DAP device manufacturers for this function are “Test Pulses”, “Test Value”, or “Test Count”, but other names may be used. 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.
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.
DAP	***MEMBRANE CONSOLE ONLY:*** Allows access to a submenu used to reset the DAP display, test the DAP device, and print a test label. This selection is available in the **DAP SETUP** menu when the DAP function is **ON**.	
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	**Reset**	Resets the DAP display to zero.
TEST	**Test**	Tests the DAP circuits by counting the number of test pulses (refer to TEST VALUE 1, above). A pass / fail message will be presented after the DAP test, and the actual number of test pulses counted will be displayed.

3C.10.2 DAP SETUP Menu Items (Cont)

Use these steps to set up the DAP device. DAP calibration is done after DAP setup

Step	Action (membrane console)	Action (GenWare®)
1.	From the **GEN CONFIGURATION** menu, select **DAP SETUP**.	From the GenWare® GENERATOR UTILITIES application, select **DAP Setup** from the **Setup** menu, or use the DAP setup button  on the GenWare® toolbar.
2.	From **DAP SETUP** menu 1, select **DAP**. Toggle the button to select **ON** or **OFF**. The DAP device must be enabled if you wish to continue.	Check the **DAP** checkbox to enable the DAP function. The DAP device must be enabled if you wish to continue.
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.
4.	Select **TEST VALUE 1**. Use the **+** or **–** buttons to enter the test value for DAP device 1.	Select the test value for DAP device 1 via the **Test Value 1** dialog box.
5.	Select **DAP PRINTER**. Toggle the button to select **OFF, DPU414,** or **SLP200**.	Select the desired printer via the **DAP Printer** dialog box.
6.	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 3C-20.
7.	Press **RESET** to reset the DAP display to zero.	Press **Reset** to reset the DAP display to zero.
8.	Press **TEST** to test the DAP system. This will test the DAP chamber and DAP circuits.	Press **Test** to test the DAP system. This will test the DAP chamber and DAP circuits.
9.	Press **PRINT** to print a DAP label.	
10.	Press **EXIT** to return to the **DAP SETUP** menu.	

3C.11.0 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.

3C11.1 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.

3C.11.2 DAP Calibration Overview

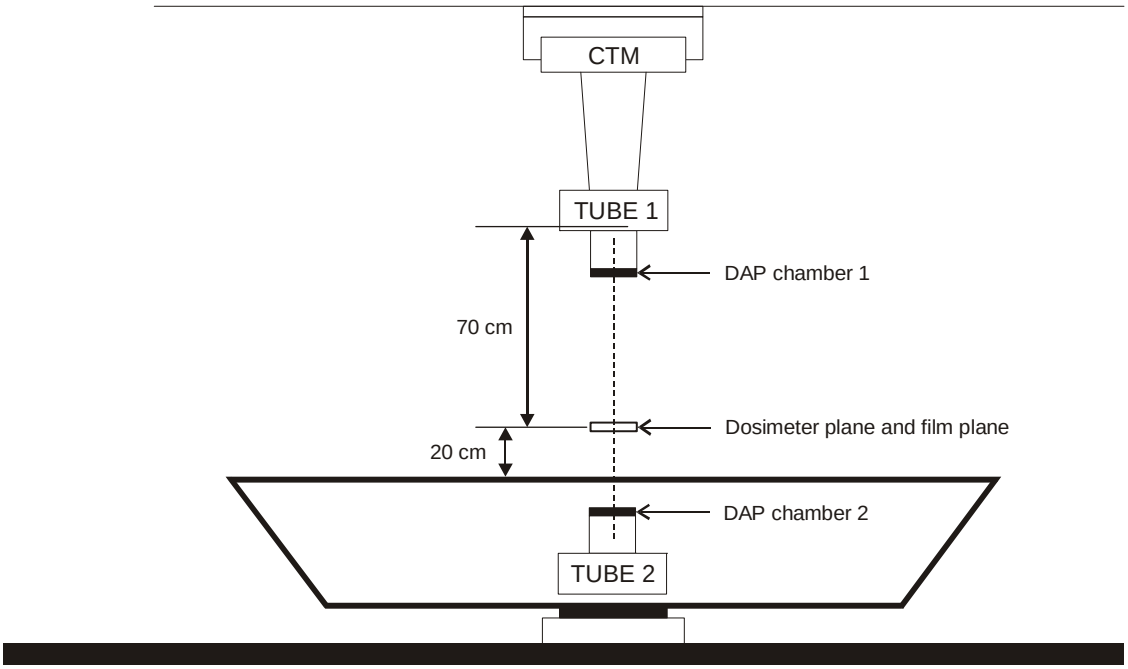
The first step involved in calibrating the DAP meter in the generator is to carefully make a dose measurement at a given distance from the X-ray source. The next step is to expose a test film at the same distance from the X-ray source as the dose measurement that was just made.

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 1** parameter in the **DAP SETUP** menu such that the consoles 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 (a specialized ion chamber) 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.

3C.11.3 DAP Calibration Procedure



TYPICAL SETUP FOR DAP CALIBRATION

FILE: DAP.CDR

Figure 3C-21: DAP setup

Use these steps to calibrate the DAP meter(s) in the generator.

Step	Action
1.	Set up the dosimeter as per figure 3C-21. 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.
4.	Enter the **DAP SETUP** menu.
6.	Set the generator to 70 kV, 100 mA, 20 ms.
7.	Press **DAP** to access the RESET / TEST /PRINT menu, then press **RESET** to reset the DAP display to zero. The DAP will reset to zero, then the generator will return to the **DAP SETUP** menu.
8.	Make an X-ray exposure and note the dose per the dosimeter. Record the mR or mGy value in a copy of table 3C-4. Convert the mR value to mGy, if necessary.
9.	Note the DAP value as displayed on the console, and record the value in a copy of table 3C-4.

3C.11.3 DAP Calibration Procedure (Cont)

Step	Action
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 3C-22. ***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).
14.	Measure the irradiated image area. For film, measure the length and width of the exposed area, and record the results in table 3C-4. Refer to figure 3C-22. 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 3C-4.
15.	Calculate the irradiated image area, in cm^2. Use the length and width recorded in table 3C-4.
16.	Calculate the dose-area product by multiplying the area from table 3C-4 X the dose in mGy from table 3C-4. Record the resulting value at step 3 in table 3C-4.
17.	Calculate the percentage error between the manually calculated DAP measurement (table 3C-4, step 3) and the measured DAP value (table 3C-4, 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** (membrane console) or **Calibration Value (DAP Device Type 1)** 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 3C-4 as required to record the results from all required iterations.

3C.11.3 DAP Calibration Procedure (Cont)

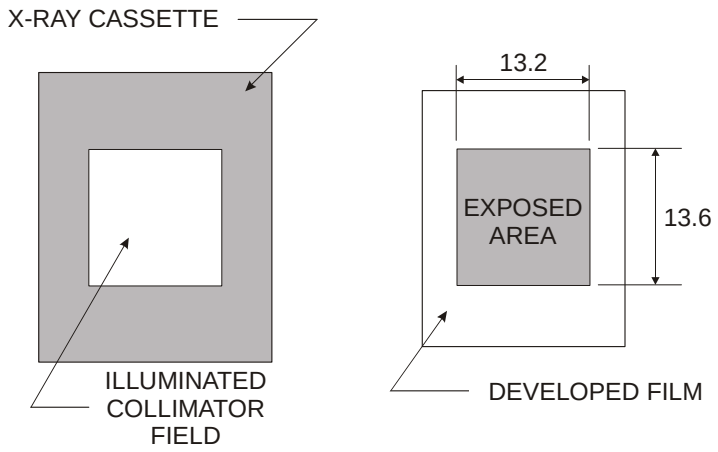


Figure 3C-22: Irradiated area vs. available image area

3C.11.4 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.	_____ DAP ($mGycm^2$)
5.	Calculate the percentage error: Refer to the example at the end of this section.	_____ % error
THIS TABLE IS REPEATED BELOW FOR THE SECOND ITERATION OF THE DAP CALIBRATION.		
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

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3C.11.4 DAP Calculation Worksheet (Cont)

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.	_____ DAP ($mGycm^2$)
5.	Calculate the percentage error: Refer to the example at the end of this section.	_____ % error

Table 3C-4: DAP worksheets

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.	40 DAP ($mGycm^2$)
5.	Calculate the percentage error: Refer to the example at the end of this section.	-8.9 % error

3C.11.4 DAP Calculation Worksheet (Cont)

Sample percentage error calculation (step 5):

$$\frac{(36.44 - 40)}{40} \text{ X } 100 = \frac{-3.56}{40} \text{ X } 100 = -8.9\ \%$$

3C.12.0 DATA LINK

Used with the CPI GenWare® utility software. This allows for data communication with a computer in order to download additional tube types, transfer APR data, edit APR text, run the A^2EC^2 ™ utility, perform setup and calibration functions, 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.

The computer running GenWare® is normally connected 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.

If the data link connector is not available, i.e. on units without a CPI supplied console, the computer running GenWare® must be connected to J3 on the generator control board as described below. A special serial cable with a 9 pin female “D” connector on one end and an RJ45 ethernet style connector on the other end is needed for this step. This cable is available from CPI.

- Connect the custom serial cable, as described above, from the serial port on your laptop to J3 on the generator control board.
- Switch the generator on. This must be done via the ON switch S2 on the generator control board.
- Start the GenWare® generator utilities application on the laptop.

3C.13.0 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 laptop, and saved APR files to be downloaded from a laptop.
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.
Touch Screen Setup	• Allows for the setting of specific console operating parameters. • Sets up the serial communication ports on the touchscreen console. • Sets the screen saver interval. • Allows adjustment of the sound volume. • 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.
Main Menu	Press to return to the main console menu.

3C.13.1 Accessing the Utilities Menu

Use these steps to access the systems utilities functions.

Step	Action
1.	From the main console menu (figure 3C-23), press **System Utilities**. A pop-up window will be displayed (figure 3C-24), requesting a password.
2.	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-25) 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.***

3C.13.1 Accessing the Utilities Menu (Cont)

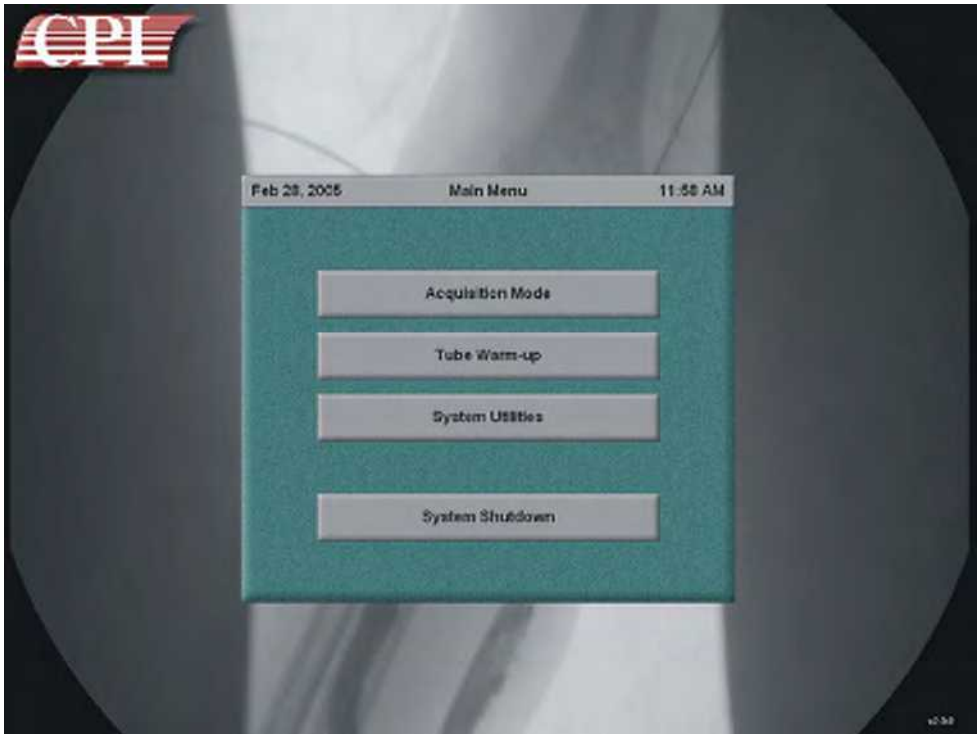


Figure 3C-23: Main menu

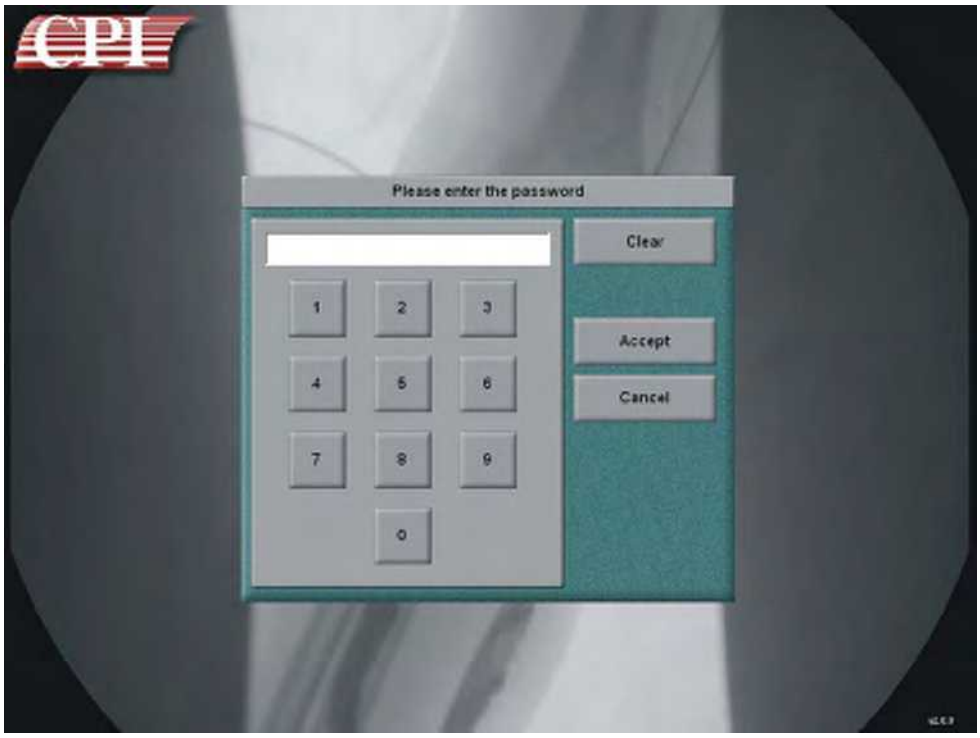


Figure 3C-24: Password window

3C.13.1 Accessing the Utilities Menu (Cont)

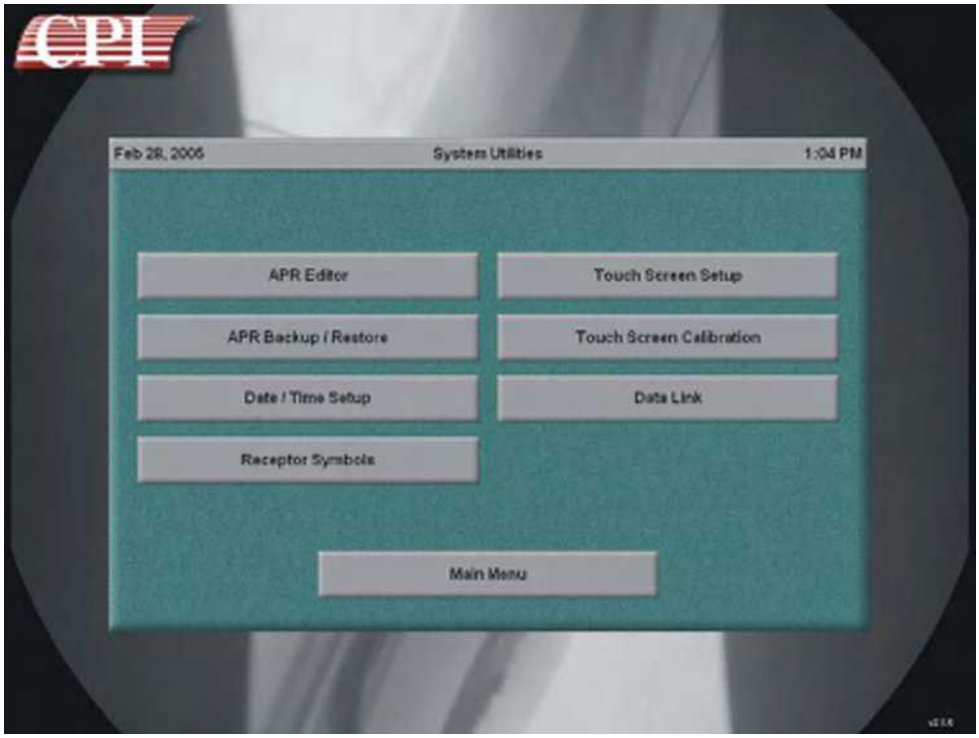


Figure 3C-25: System utilities menu

3C.13.2 APR Editor

It is strongly suggested that you review the section ANATOMICAL PROGRAMMING SELECTOR in 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-26). 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.13.2 APR Editor (Cont)

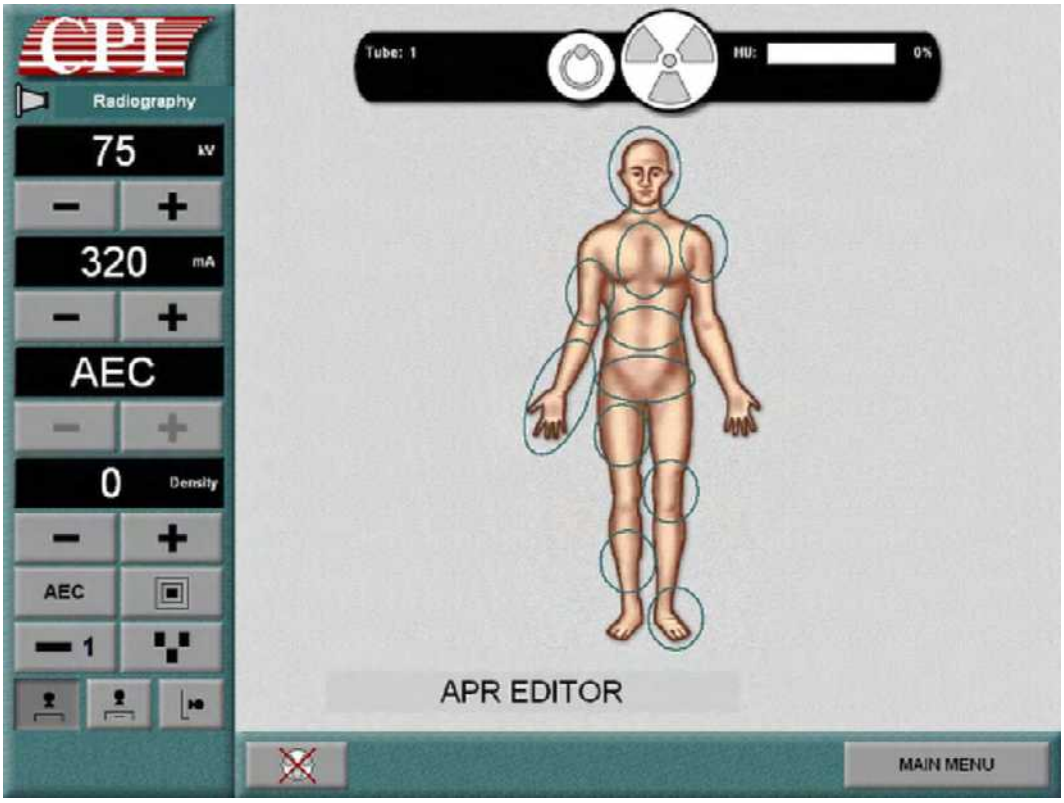


Figure 3C-26: APR editor window

NOTE: ***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.

NOTE: ***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.13.2 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 (kV and mA, mAs, ms, density, AEC / mA/ms / mAs, focal spot, film screen, AEC fields, image receptor). 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 may be displayed at the top of the screen. To display the desired international characters, select the language of your choice from the list near the top right side of the screen. Characters may then be entered via either keyboard.***

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. • Press **ENTER** when finished.

3C.13.2 APR Editor (Cont)

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.
4.	Keyboard(s) will display on the screen as described previously. • Type in the name of the new APR item. • 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.

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**.**
4.	Keyboard(s) will display on the screen as described previously. • Type in the name of the new procedural item. • 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.

3C.13.2 APR Editor (Cont)

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. • 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.13.3 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-27) 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 laptop. The entire APR (parameters and techniques, APR text, menu structures, etc) is backed up.

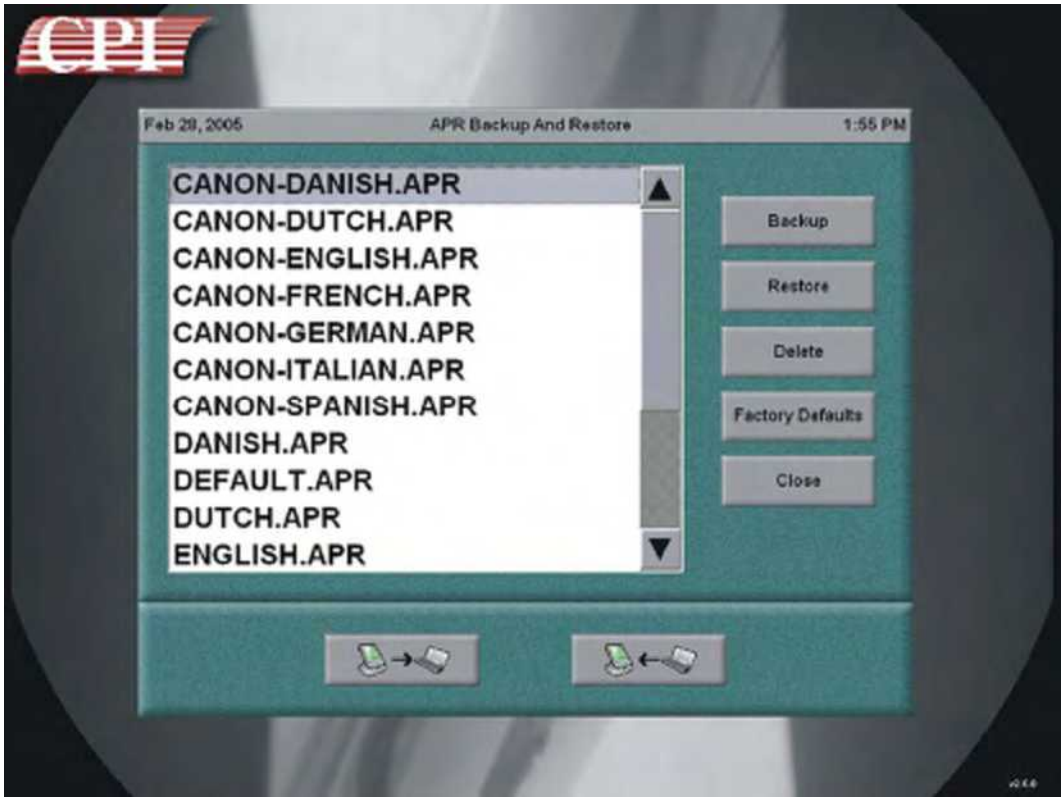


Figure 3C-27: APR back-up and restore window

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.

3C.13.3 APR Backup / Restore (Cont)

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**.

APR upload / download.

Step	Action
1.	The APR upload and download utilities allow APR files on the touchscreen to be saved to a laptop, or saved APR files on a laptop to be downloaded to the touchscreen.
2.	In order to use this feature, a serial communications program that supports the Z-modem serial protocol must be installed on the laptop. Two examples of such programs include Hyper Terminal and Telix for Windows, but there are others.
3.	To prepare the laptop to communicate with the touchscreen refer to the documentation for the serial communications program. You will normally need to select a serial port on the laptop, typically COM1. If you are unable to open COM1, or the serial port of your choice, make sure you are not running any other program that uses the serial port such as GenWare®.
4.	Use the following parameters to configure the serial communications program: Baud / bits per second: 57600 Parity: None Data bits: 8 Stop bits: 1 Flow control: Hardware
5.	A 9-pin null modem cable with socket connectors (female) on both ends is needed. Connect one end to the communications port that was selected in step 3. The other end will typically connect to the *Data Link* connector on the back of the touchscreen. The DAP printer, if used, may temporarily need to be disconnected.

3C.13.3 APR Backup / Restore (Cont)

Step	Action
6.	Set up the communications port on the touchscreen as described in the section ***TOUCH SCREEN SETUP,*** under ***Settings.***
7.	To copy an APR file from the touchscreen to the laptop, select the desired file. Then press  . A file-transfer status window will pop up. This shows the file being sent, and the status of the transmission.
8.	To copy an APR file from the laptop to the touchscreen, you will need to select the file via your communications program. Then press "send" on the laptop or use the equivalent command. After pressing "send" on the laptop, press  on the touchscreen. This will initiate the file transfer to the touchscreen. A file-transfer status window will pop up. This shows the file being sent, and the status of the transmission.

3C.13.4 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-28).
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.
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.

3C.13.4 Date / Time Setup (Cont)

Figure 3C-28: Date and time setup window

3C.13.5 Receptor Symbols

The current image receptor symbols may be replaced with predefined symbols chosen from the receptor symbols library.

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-29) 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-29 correspond to the receptor numbers in GenWare®, and are shown for reference only. For CMP 200, only receptors 1 to 3 are available.
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.

3C.13.5 Receptor Symbols (Cont)

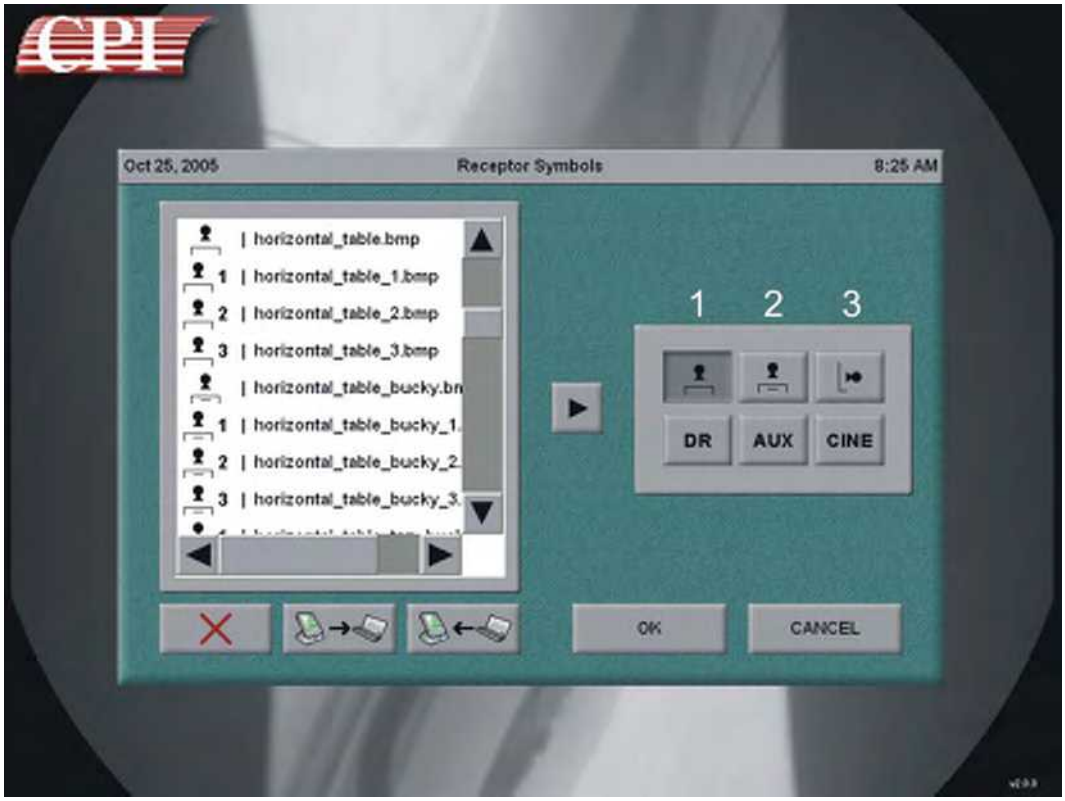


Figure 3C-29: Receptor symbols window

3C.13.6 TouchScreen Setup

The touchscreen setup menu accesses submenus that allow the service engineer to perform the following functions:

- Enable or disable certain console functions (voice messaging, audible generator ready indication, auto power off).
- Set up serial communication ports COM 3 and COM 4 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 screen saver interval.
- Select the sound volume.
- Change the operator and service password.
- Review the console error log.

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-30). This has four tabs, **SETTINGS**, **FEATURES**, **PASSWORDS**, and **ERROR LOGS** that will be discussed in sequence.

3C.13.6 TouchScreen Setup (Cont)

Figure 3C-30: 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.

3C.13.6 TouchScreen Setup (Cont)

Settings

The functions near the left side of the settings window are enabled when checked (√).

FUNCTION	DESCRIPTION
Voice Messaging	Enables / disables verbal status and error messages. On (√): Error and status messages will be annunciated. Languages other than English may not be available. Off: Verbal status and error messages are disabled.
Continuous Fluoro Tone	Not applicable.
Indicate Generator Ready	Enables / disables the audible generator ready sounds (voice and / or tone). 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.
Auto Power Off	Sets the console power-off mode. On (√): The console will automatically switch off when it has detected that the generator has been switched off. Off: The console must be switched off manually.

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.	This selects the communication port for the optional digital interface on the touchscreen. This does not apply at this time.
3.	Program the **DAP Port**. This selects the communication port for the optional DAP printer. The DAP printer will typically be connected to the *Data Link* connector on the touchscreen interface board on the back of the touchscreen. The *Data Link* connector is directly connected to COM 3 on the touchscreen. If using these connections, the DAP port will need to be set to **COM 3**.
4.	Program the **Transfer Port**. This selects the communication port for serial communication to a laptop for the *Data Link* function and for the file transfer function. The laptop may be connected to the *Data Link* connector on the touchscreen interface board on the back of the touchscreen, or to COM 4 on the back of the touchscreen. The transfer port will need to be set to **COM 3** or **COM 4** accordingly.
5.	Program the **Languages**. This selects the language for operator and error messages, and for text on the buttons, etc. Voice messages may only be available in English.

3C.13.6 TouchScreen Setup (Cont)

Step	Action
6.	Select the **Generator Type**. Use **CMP 200**. 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.
8.	Set the **Sound Volume** by dragging the slider to the left (lower) or right (louder). This sets the loudness of the voice messages and button clicks.
9.	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.

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.

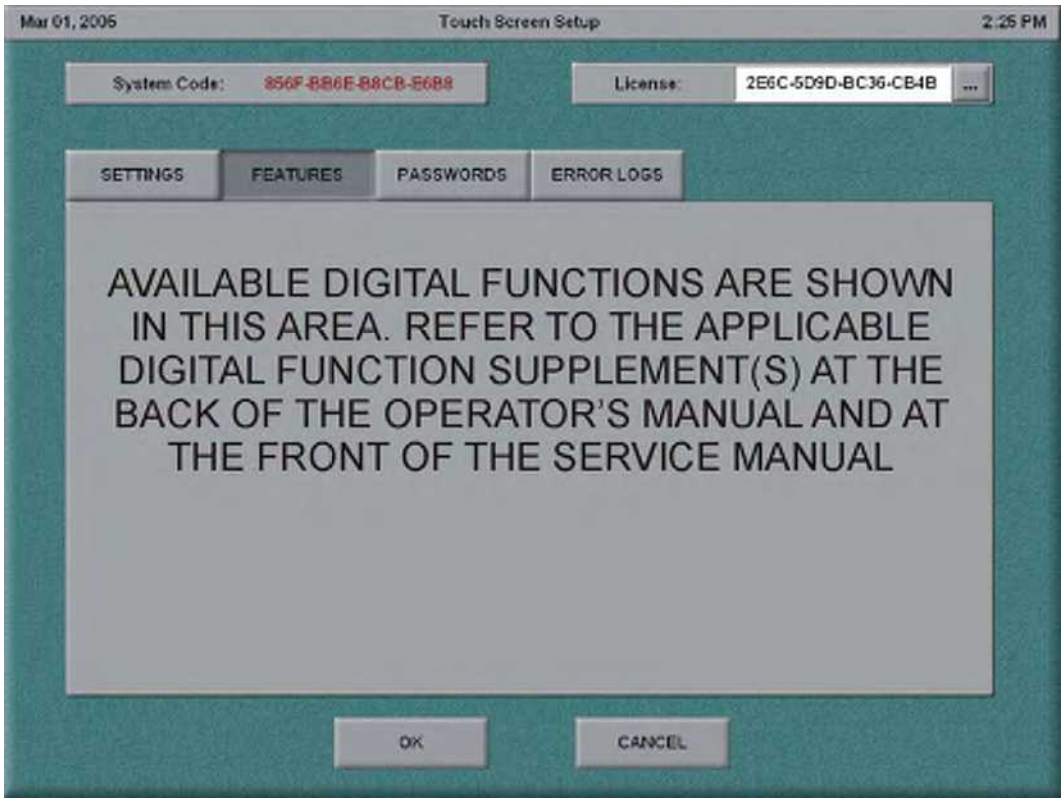


Figure 3C-31: TouchScreen setup window, Features tab

3C.13.6 TouchScreen Setup (Cont)

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.

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-32: TouchScreen setup window, Passwords tab

3C.13.6 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.

Error Logs

The error logs function records console errors only. This screen exists for CPI debugging purposes. The information recorded will generally be of no value to field-service personnel.

3C.13.7 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**.
2.	A pop-up window will display indicating that in order to complete the calibration, the center of each target must be pressed. Press **OK**.
3.	Press **CANCEL** to exit without performing the calibration.
4.	Press the center of the target at the top left of the screen. This will set up the touch sensitive area in that quadrant.
5.	Repeat the previous step for the three remaining targets.
6.	A pop-up window will display asking if you wish to accept this calibration. Press **YES** to accept the calibration; **NO** returns to the system utilities menu.
7.	If you pressed **YES** in the previous step, the touchscreen will restart with the new calibration values.

3C.13.7 TouchScreen Calibration (Cont)

Step	Action
8.	When the touchscreen console restarts, the touchscreen calibration needs to be verified. A screen indicating **Please press the target buttons…** will appear. You must press the center of the target at the top left of the screen, plus the center of the next three targets within 30 seconds. • If the calibration was done properly, you will be taken to the main menu. • If the calibration in steps 4 and 5 was not done properly, it will not be possible to press the center of the targets in this step. The calibration program will run again, allowing you to redo the touchscreen calibration.

3C.13.8 Data Link

This is used with the CPI GenWare® utility software. This allows for data communication with a computer in order to download additional tube types, transfer APR data, edit APR text, run the A^2EC^2 ™ utility, perform setup and calibration functions, 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.

CHAPTER 3D

AEC CALIBRATION

CONTENTS:

3D.1.0 INTRODUCTION

This section describes the interfacing and calibration of the various AEC board assemblies that are used in CMP 200 X-ray generators.

THE GENERATOR IS FACTORY CONFIGURED FOR SPECIFIC AEC CHAMBERS. REFER TO THE COMPATIBILITY STATEMENT IN CHAPTER 1 FOR THE FACTORY CONFIGURED AEC COMPATIBILITY OF THIS GENERATOR.

The introduction in this section contains background information relevant to AEC operation. It is strongly suggested that this be read and understood before beginning AEC calibration.

3D.1.1 AEC Limitations: Minimum and Maximum Exposure Times

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.

Care must be exercised when using low kV values with table Buckys because most table tops and grids absorb considerable radiation in the range of 60 – 65 kV. This will adversely affect AEC operation.

3D.1.2 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-1.

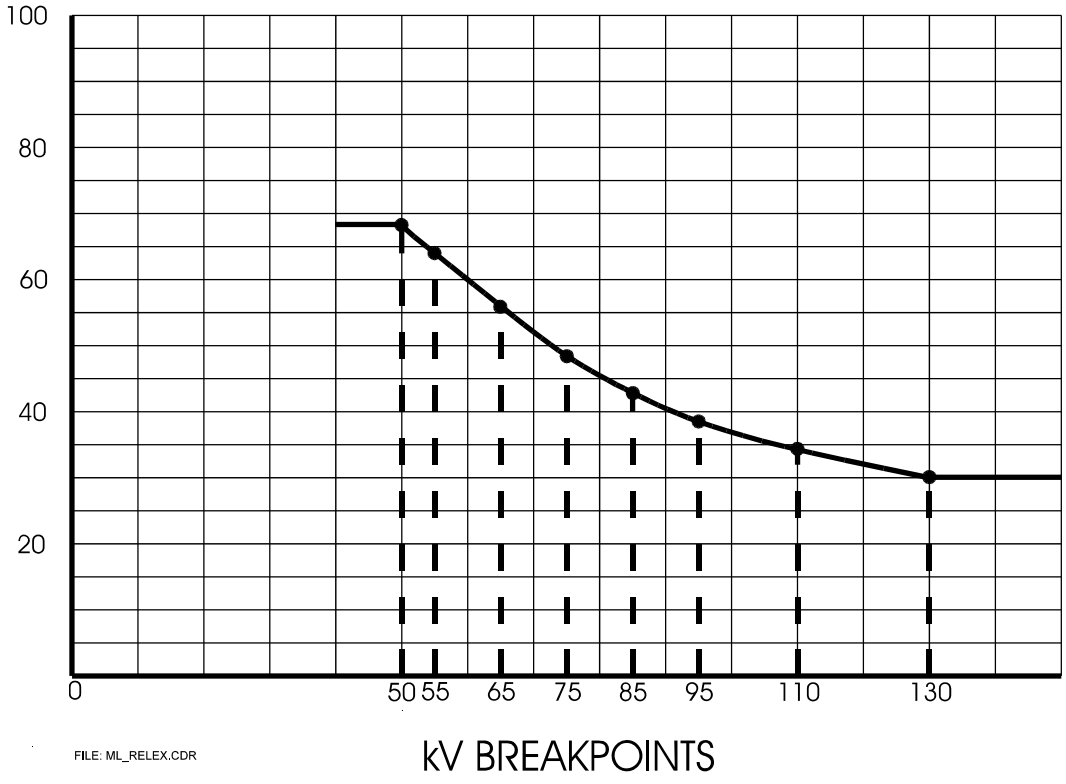
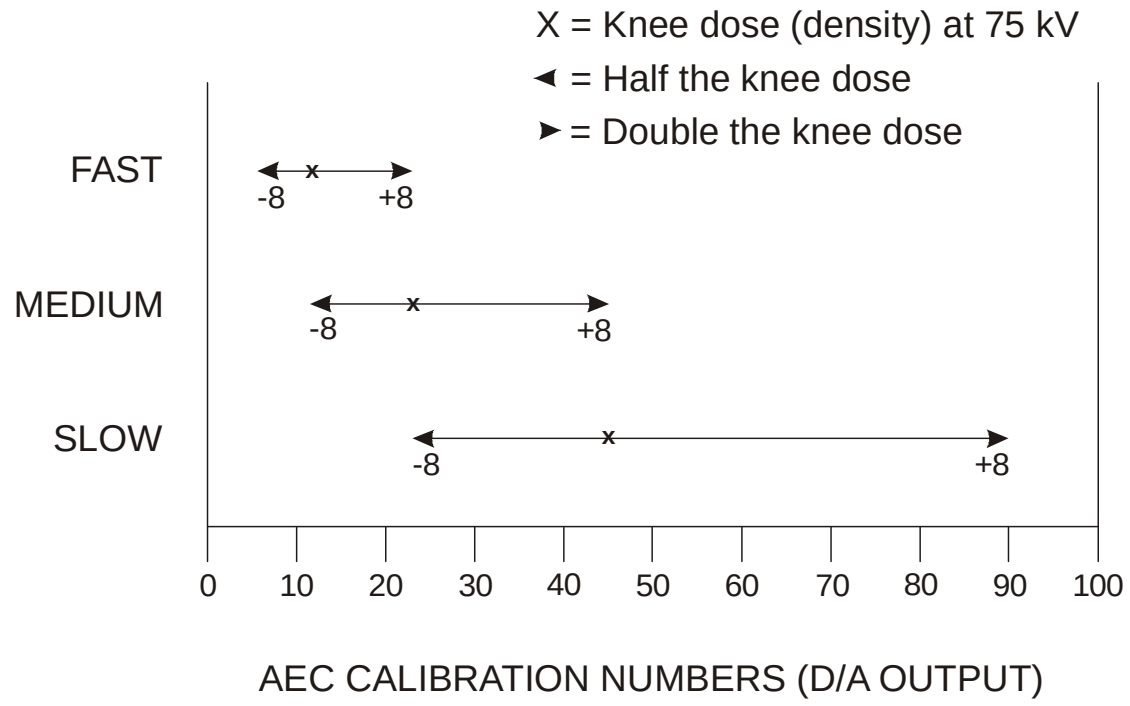


Figure 3D-1: kV vs relative density

3D.1.3 AEC Calibration Range

Since the CMP 200 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-2 illustrates the different windows required for various film screen combinations.



FILE: ML_AECDA.CDR

Figure 3D-2: Film/screen speed vs. D/A output

3D.2.0 PRECALIBRATION SETUP

3D.2.1 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
Film/Screen 1.			
2.			
3.			
Nominal optical density:			
Grid ratio/SID:			
Min - max kV 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-1: 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.2.1 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
Film/Screen	1.	Lanex/reg	Lanex/reg	Lanex/reg
	2.	Lanex/med	Lanex/chest	
	3.			
Nominal optical density:		1.2	1.1	1.4
Grid ratio/SID:		12:1	8:1	10:1
Min - max kVp range:		60 - 120	65 - 140	80 - 110
± Density steps		± 8	± 8	± 8
Density mAs (dose) change (per step)	+%:	12.5	12.5	12.5
	-%:	6.25	6.25	6.25
Chamber type:		Ion	Solid state	Ion
Regulatory AEC dose requirements?		Yes	Yes	Yes
Is film processing maintained?		Yes	Yes	Yes
Assigned receptor name:		Table	Wall	Aux
Are all cassettes similar?		Yes	Yes	Yes
Additional notes:				
Additional notes:				

Table 3D-2: Sample AEC setup worksheet

3D.2.2 AEC Precalibration 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. Note that some chamber types must be physically isolated from equipment ground, refer to figure 3D-3 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_____
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:
6.	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:
7.	Radiographic techniques to be performed with the equipment (high kV chest, G.I. studies etc)?	
8.	Normal exposure factors used by the customer (typical mAs / kV range)?	

Table 3D-3: Precalibration checklist

3D.2.3 AEC Chamber Installation

Figure 3D-3 shows 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.2.3 AEC Chamber Installation (Cont)

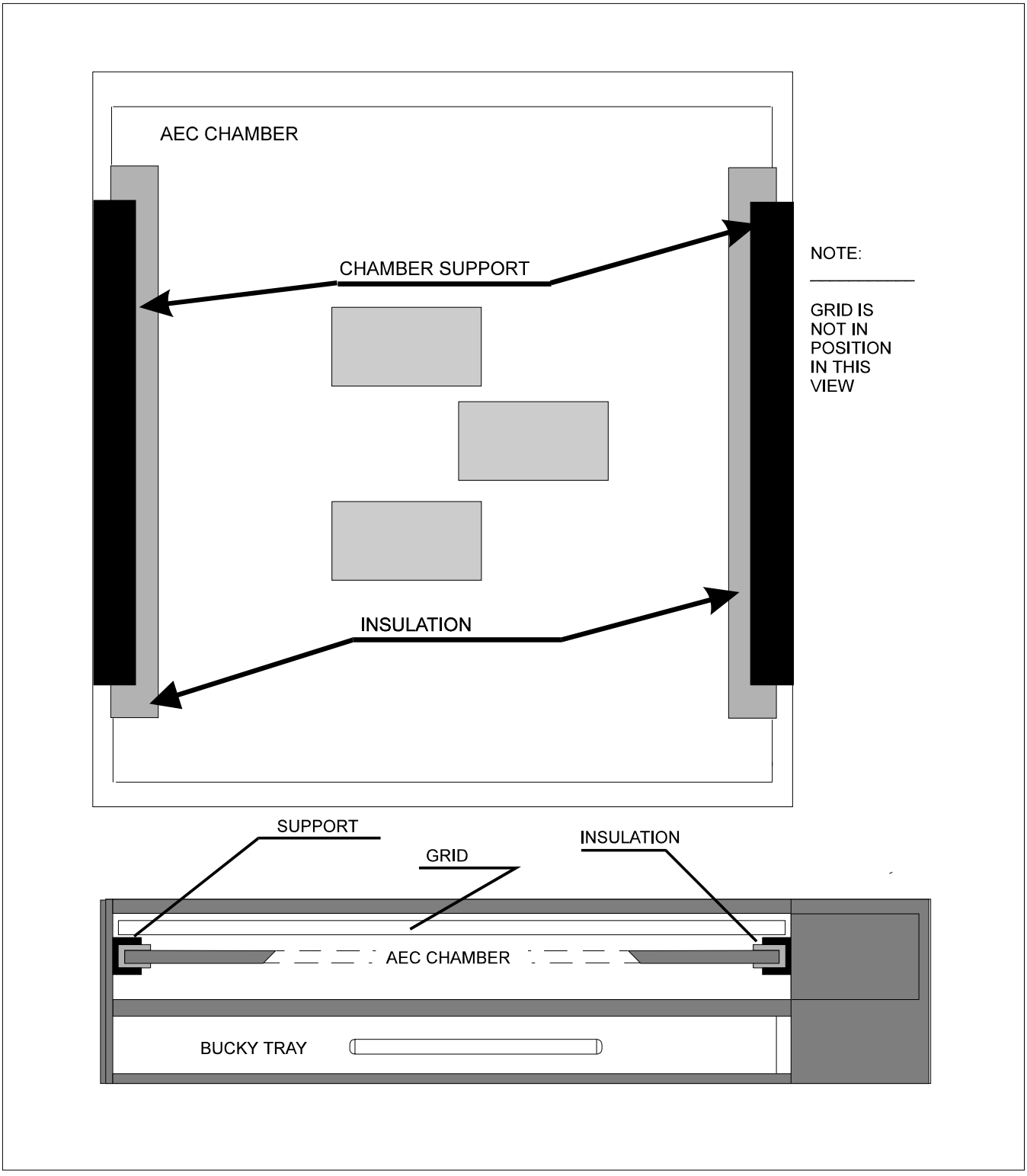


Figure 3D-3: AEC chamber installation

3D.2.4 AEC Board (Solid State Chambers)

The AEC board shown below is compatible with various makes / models of solid-state chambers (i.e. Comet, Ziehm, Gilardoni). This AEC board is used in various models of generators requiring those AEC chamber types.

This board will be fitted with 6 pin circular connectors (J1 to J4) or with 5 pin in-line connectors (J11 to J14), depending on the application.

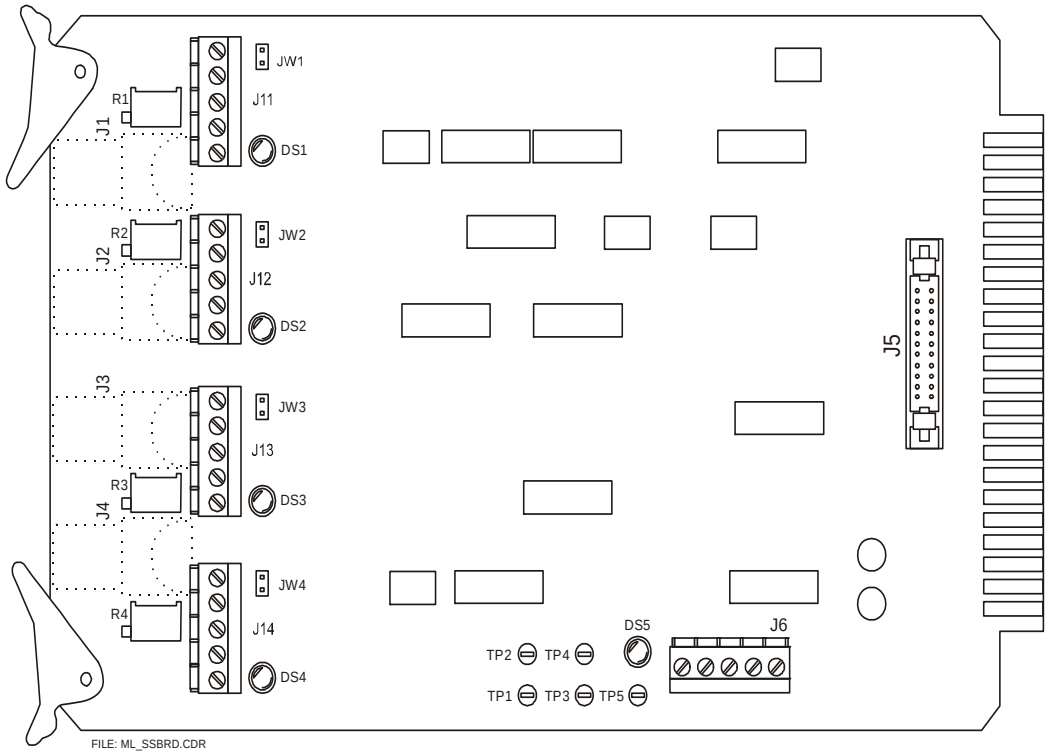


Figure 3D-4: Dedicated solid state AEC board (assembly 733347)

AEC board input assignment:

- 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.2.4 AEC Board (Solid State Chambers) Cont

Tables 3D-4 and 3D-5 show the pin outs for both the 6 pin circular connectors and for the 5 pin in-line connectors on the AEC board in figure 3D-4.

FUNCTION	PIN	
Anode	1	NOTE: PINS 1, 2, AND 3 ON THE
Anode	2	CIRCULAR CONNECTOR ARE
Anode	3	ALL CONNECTED IN PARALLEL.
Cathode, left	4	
Cathode, right	5	
Cathode, middle	6	
Ground	Connector shell	

Table 3D-4: Pin outs for 6 pin circular connector J1 to J4

FUNCTION	PIN
Anode	2
Cathode, left	3
Cathode, right	5
Cathode, middle	4
Ground	1

Table 3D-5: Pin outs for 5 pin in-line connector J11 to J14

If the AEC input signal has excessive electrical noise superimposed on the signal, it is suggested that jumpers JW1 to JW4 as appropriate be temporarily installed. If this improves the signal to noise ratio, the jumper(s) should be left in. Excessive signal to noise ratio generally shows up as inconsistent AEC exposure times at low mAs values.

It is the responsibility of the installer to determine the need for these jumper(s).

3D.2.5 AEC Board (Solid State Chambers)

The AEC board shown below is compatible with various makes / models of solid-state chambers (i.e. Comet, Ziehm, Gilardoni). This AEC board is used in various models of generators requiring those AEC chamber types.

This board will be fitted with 10 pin circular connectors (J1 to J4) or with 7 pin in-line connectors (J11 to J14), depending on the application.

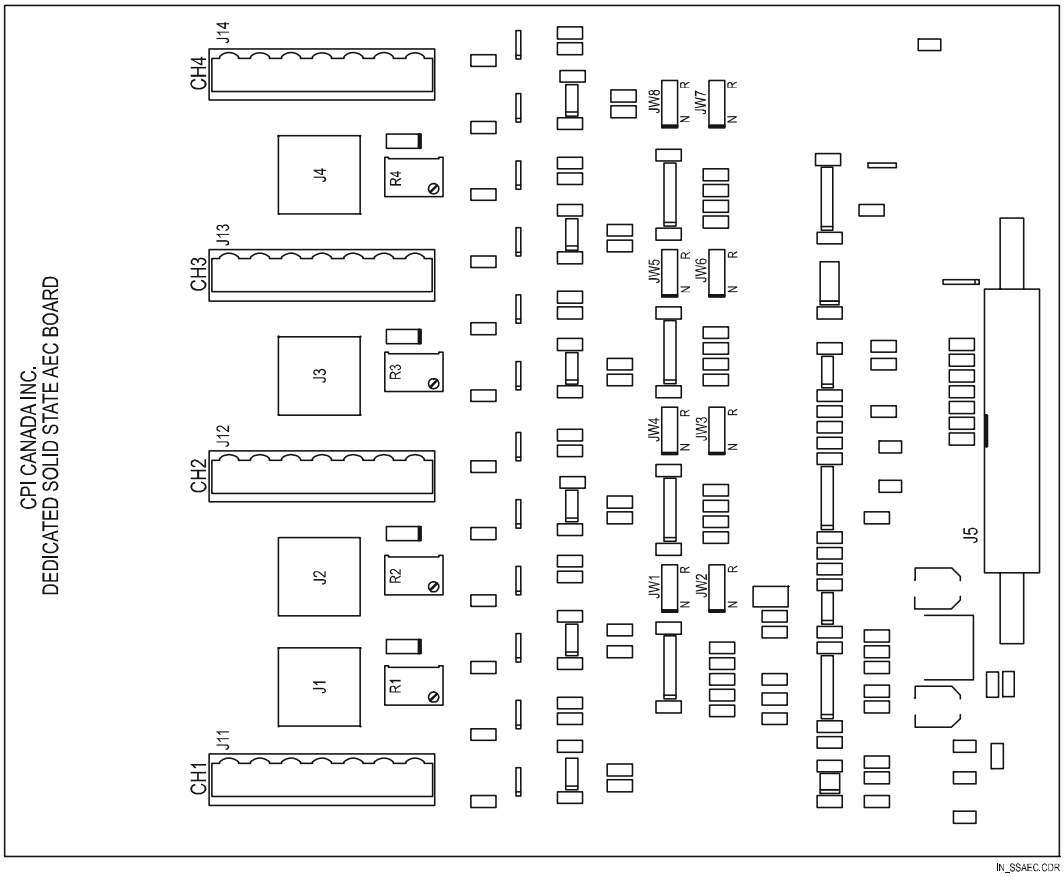


Figure 3D-5: Dedicated solid-state AEC board (assembly 737992)

<u>NOTE:</u> WHEN PERFORMING THE INITIAL AEC SETUP (CHAPTER 3C), THE CHAMBER TYPE MUST BE SET TO ION FOR THIS BOARD.

AEC board input assignment:

- 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.2.5 AEC Board (Solid State Chambers) Cont

Tables 3D-6 and 3D-7 show the pin outs for both the 10 pin circular connectors and for the 7 pin in-line connectors on the AEC board in figure 3D-5.

FUNCTION	PIN
Anode, left (refer to note below)	3
Cathode, left (refer to note below)	4
Anode, middle	1
Cathode, middle	6
Anode, right (refer to note below)	2
Cathode, right (refer to note below)	5
Ground	Connector shell

Table 3D-6: Pin outs for 10 pin circular connector J1 to J4

FUNCTION	PIN
Anode, left (refer to note below)	1
Cathode, left (refer to note below)	2
Anode, middle	3
Cathode, middle	4
Anode, right (refer to note below)	5
Cathode, right (refer to note below)	6
Ground	7

Table 3D-7: 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-6, 3D-7	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLES 3D-6, 3D-7
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.2.6 AEC Board (Ion Chambers)

The AEC board shown below is compatible with various makes / models of ion chambers (i.e. AID, GE, Vacutec, etc). This AEC board is used in various models of generators requiring those AEC chamber types.

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.

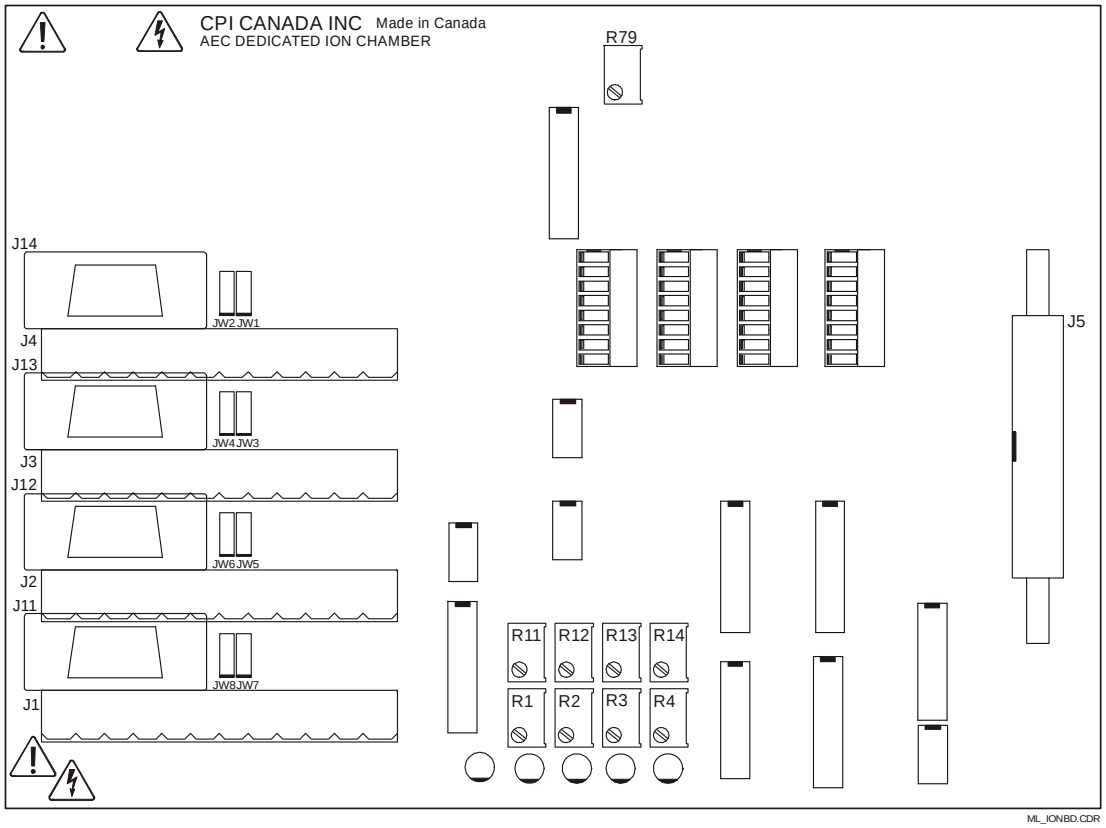


Figure 3D-6: Dedicated ion chamber AEC board (assembly 734614)

AEC board input assignment:

- 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.

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.

3D.2.6 AEC Board (Ion Chambers) Cont

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-8 and 3D-9 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-6. 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.
Right field select (refer to note below)	2	
Middle field select	3	
Start command output	4	
Signal input	5	
Left field select (refer to note below)	6	
-12 VDC output	7	
+12 VDC output	8	
Ground	9	

Table 3D-8: 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-8	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLE 3D-8
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

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. -24 VDC is not available on CMP 200.
+ or - 300 VDC output	2	
+45 VDC output	3	
+12 VDC output	4	
-12 VDC output	5	
-24 VDC output	6	
Ground	7	
Start command output	8	
Left field select	9	
Middle field select	10	
Right field select	11	
Signal input	12	

Table 3D-9: Pin outs for 12 pin in-line connector (J1 to J4)

3D.2.7 AEC Board (Ion Chambers)

The AEC board shown below is compatible with most models of AID ion chambers. This board is fitted with 9 pin D connectors J1 to J4.

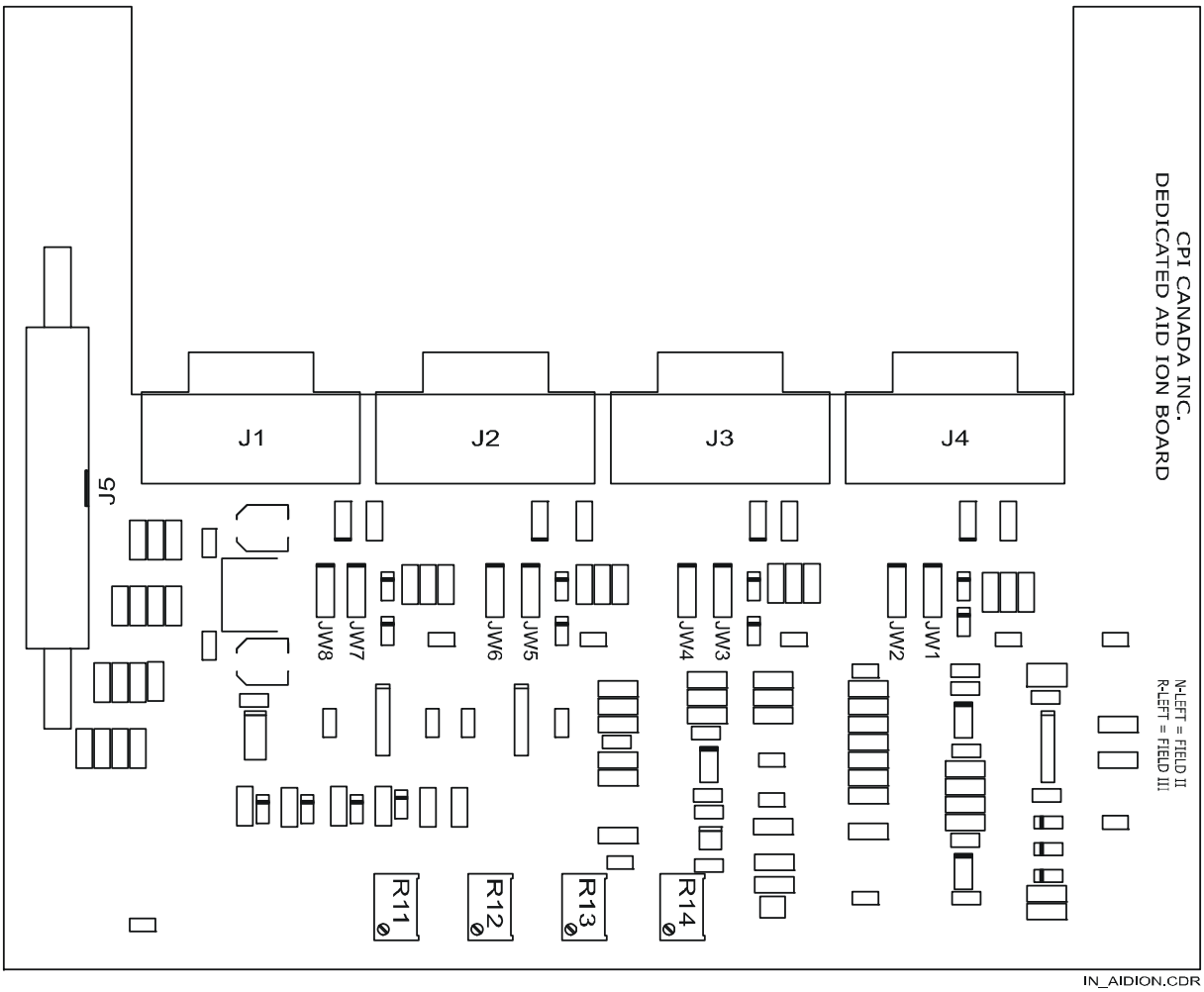


Figure 3D-7: Dedicated ion chamber AEC board (assembly 737998)

AEC board input assignment:

- 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.2.7 AEC Board (Ion Chambers) Cont

Table 3D-10 shows the pin outs for the 9 pin D connectors on the AEC board in figure 3D-7. 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	
Right field select (refer to note below)	2	See note below.
Middle field select	3	
Start command output	4	
Signal input	5	
Left field select (refer to note below)	6	See note below.
-12 VDC output	7	
+12 VDC output	8	
Ground	9	

Table 3D-10: 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-10	LEFT / RIGHT FIELDS SWAPPED RELATIVE TO TABLE 3D-10
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.2.8 Precalibration Notes

Please note the following points before beginning 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.

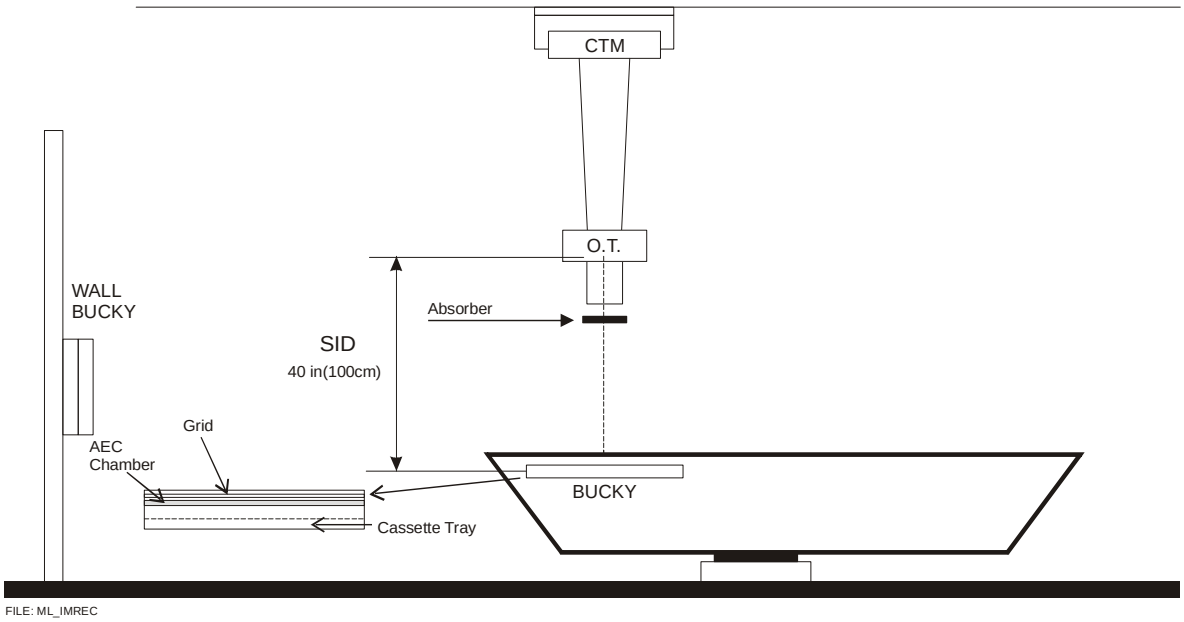
- All setup functions per the preceding sections must be completed before beginning AEC calibration.
- The generator must be known to be calibrated before beginning AEC calibration.
- All components (X-ray tubes, collimators, AEC chambers, etc) used during AEC calibration must be those that will be used during procedures, and must be positioned as they will be in actual use of the X-ray room.
- During AEC calibration, always ensure that the central ray is centered relative to the image receptor.
- Before placing the absorbers, ensure that the collimator is opened sufficiently to irradiate ALL fields on the AEC pickup device.
- 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.
- 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.
- The recommended absorber is water. This should be in a plastic container of uniform thickness. Lexan of a similar thickness is also a suitable absorber.
- **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.2.9 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.
- 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 CALIBRATION (TABLE BUCKY)



TYPICAL TABLE BUCKY IMAGE RECEPTOR

Figure 3D-8: 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                          DENSITY SETUP
FILM SCREEN 2
FILM SCREEN 3




EXIT
```

3D.3.0 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
                                                      +
                                                      -




<<
```

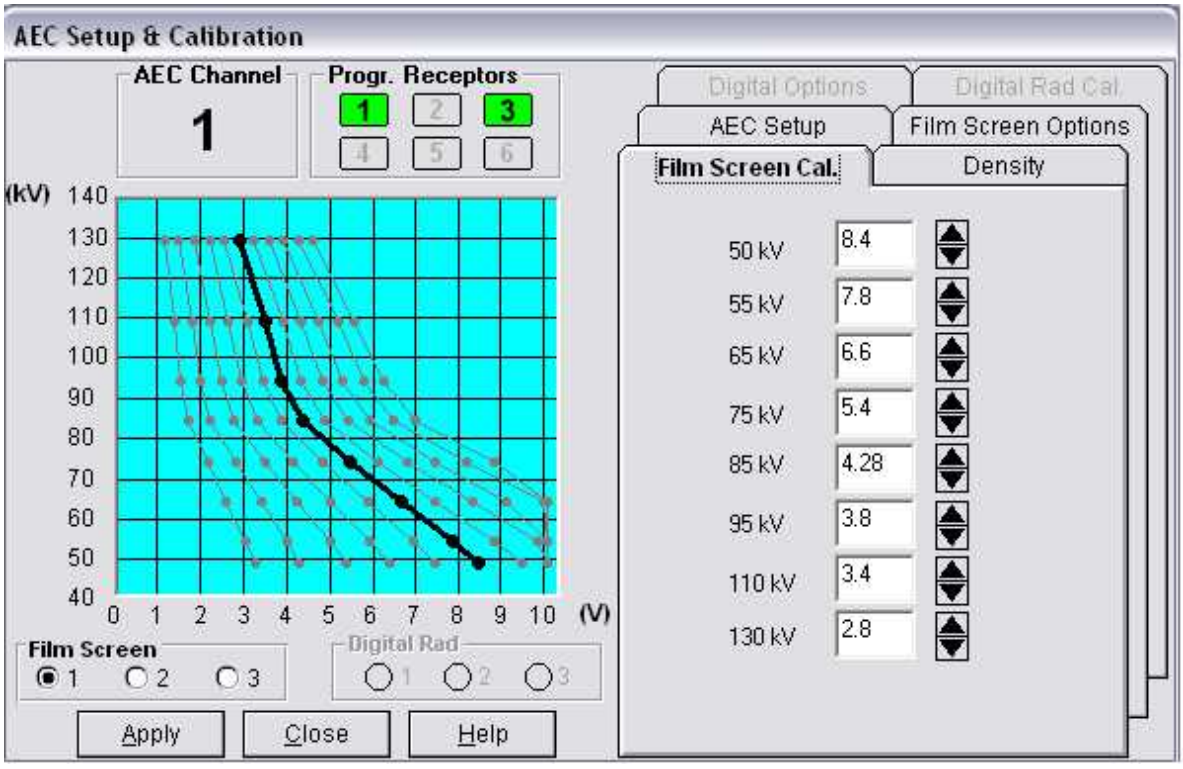


Figure 3D-9: GenWare® AEC Setup & Calibration window, Film Screen Cal. tab

3D.3.0 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-8.	
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-12) in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.	
Step	Action (membrane console)	Action (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.
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.
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
8.	From the **GEN CONFIGURATION** menu, select **AEC CALIBRATION.**	Reselect the **AEC Setup & Calibration** window.
9.	From the **AEC CALIBRATION** menu, select **FILM SCREEN 1** (the slowest film screen combination).	On the main **AEC 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.

3D.3.0 AEC CALIBRATION (TABLE BUCKY) Cont

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-11: 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.

Step	Action	
10.	Select the table Bucky image receptor.	
Step	Action (membrane console)	Action (GenWare®)
11.		Select the **Film Screen Cal.** tab.
12.	Select the **75KV** breakpoint. Use the + or – buttons to enter the value **45**.	Enter the value **45** into the **75 kV** dialog box, under **Film Screen Cal.**
13.	Select the appropriate mA for the first film speed being calibrated per table 3D-12, *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-11, select the target mAs required for the film speed being calibrated i.e. approximately 16 mAs at the 75 kV knee breakpoint 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-1.	
19.	If the measured O.D. is not within the desired value, adjust the gain pot (as per step 16) to increase or decrease the density, and then repeat the previous two steps.	

3D.3.0 AEC CALIBRATION (TABLE BUCKY) Cont

Step	Action
20.	Once the desired film density is achieved, record the mAs, calibration number, and O.D. in a copy of table 3D-13.
21.	Vary the absorber thickness, and confirm that the mAs changes accordingly.
	STEPS 22 TO 25 APPLY TO SOLID-STATE AEC CHAMBERS ONLY
22.	Measure the mAs with the center AEC field only selected. Record this value.
23.	Select the left field, and measure 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 the section ***AEC Setup*** in chapter 3C such that the left field matches the center field. Do not adjust the center field (**C**) compensation value.
25.	Repeat steps 23 and 24 for the right field.

For each breakpoint in the remainder of this section, start with the approximate mAs as per table 3D-12. 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	
26.	Change the absorber thickness as specified for the 55 kV breakpoint in table 3D-12. As before, ensure that the absorber fully blocks the X-ray field.	
Step	Action (membrane console)	Action (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.	Click in the **55 kV** dialog box, under **Film Screen Cal.** 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-12.	Make an exposure and note the mAs. Use mA values as specified for the 55 kV breakpoint in table 3D-12.

3D.3.0 AEC CALIBRATION (TABLE BUCKY) Cont

Step	Action (membrane console)	Action (GenWare®)
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-12. **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-12. **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.	
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-13.	

3D.3.0 AEC CALIBRATION (TABLE BUCKY) Cont

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)

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-12: Target breakpoint calibration factors

3D.3.0 AEC CALIBRATION (TABLE BUCKY) Cont

NOTE: ***For SID's other than 40 in. (100 cm) multiply the mAs by the factor [new SID / 40 in. (100 cm)]^2.***

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. =

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-13: Breakpoint calibration worksheet

3D.3.0 AEC CALIBRATION (TABLE BUCKY) 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. Dose adjustments for film screen 2 at 75 kV must only be made by varying the 75 kV breakpoint calibration numbers.**
37.	Repeat steps 9 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. Dose adjustments for film screen 3 at 75 kV must only be made by varying the 75 kV breakpoint calibration numbers.**

Step	Action (membrane console)	Action (GenWare®)
38.	Select **<<** to return to the **AEC CALIBRATION** menu.	

3D.4.0 SHORT AEC TIME COMPENSATION

Use these steps to perform the short AEC exposure time compensation.

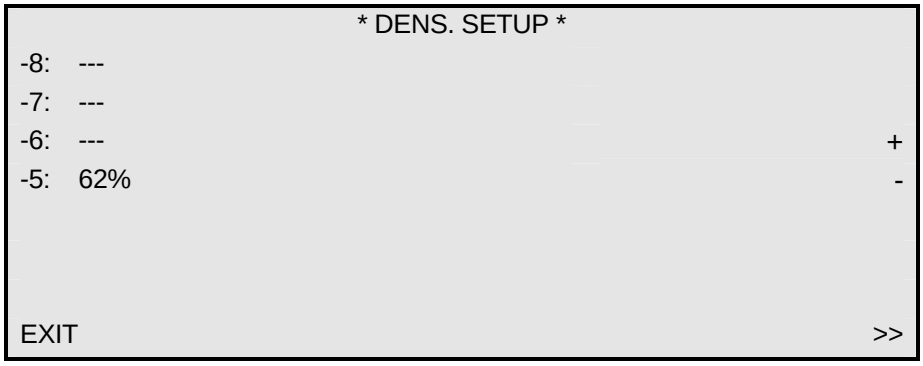
Step	Action
	THESE STEPS ONLY APPLY IF AEC EXPOSURES LESS THAN APPROXIMATELY 15 MS ARE REQUIRED AND THE AEC BOARD HAS SHORT AEC TIME ADJUSTMENT POTENTIOMETERS.
1.	Select the image receptor to be short AEC time compensated, i.e. table Bucky.
2.	Select the highest film speed used on the selected receptor, and then select **75** kV.
3.	Set the mA per table 3D-12 for the film speed being used. Reinstall the absorber as per table 3D-12 for the 75 kV breakpoint.
4.	Make an exposure and confirm the mAs readings as previously recorded in table 3D-13.
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).

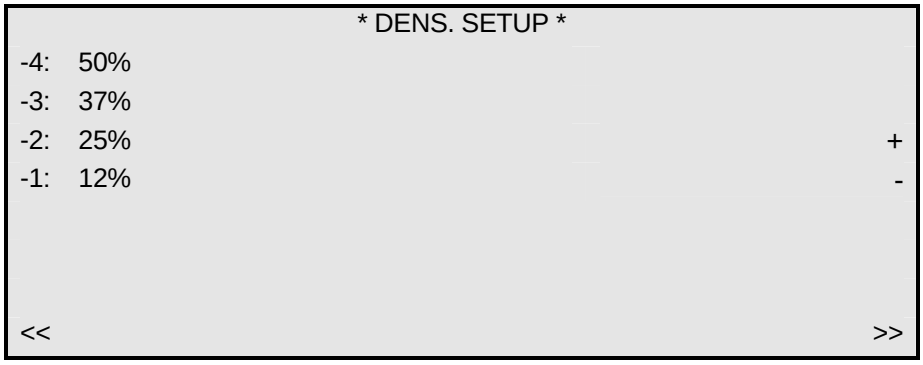
3D.4.0 SHORT AEC TIME COMPENSATION (Cont)

Step	Action
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-13. Ensure that the absorber thickness and mA values are as per table 3D-12 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.

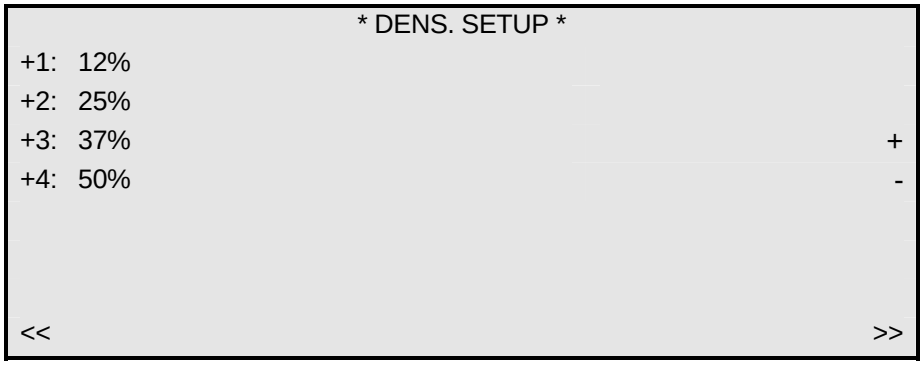
3D.5.0 AEC DENSITY CALIBRATION

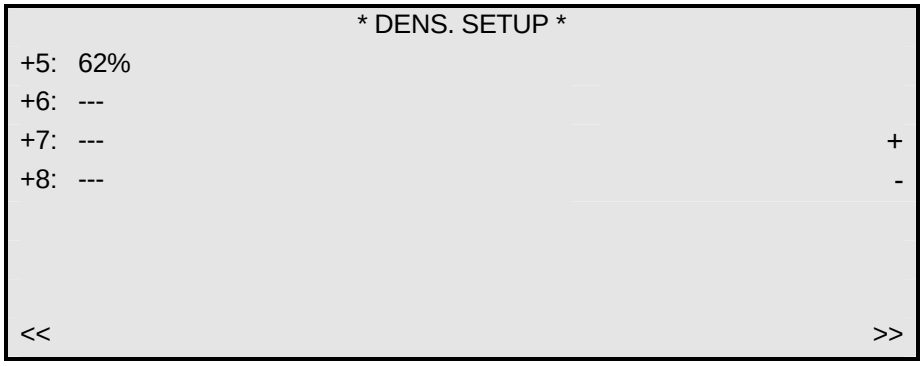
The **DENS. SETUP** menus for the membrane console are shown below.





3D.5.0 AEC DENSITY CALIBRATION (Cont)





3D.5.0 AEC DENSITY CALIBRATION (Cont)

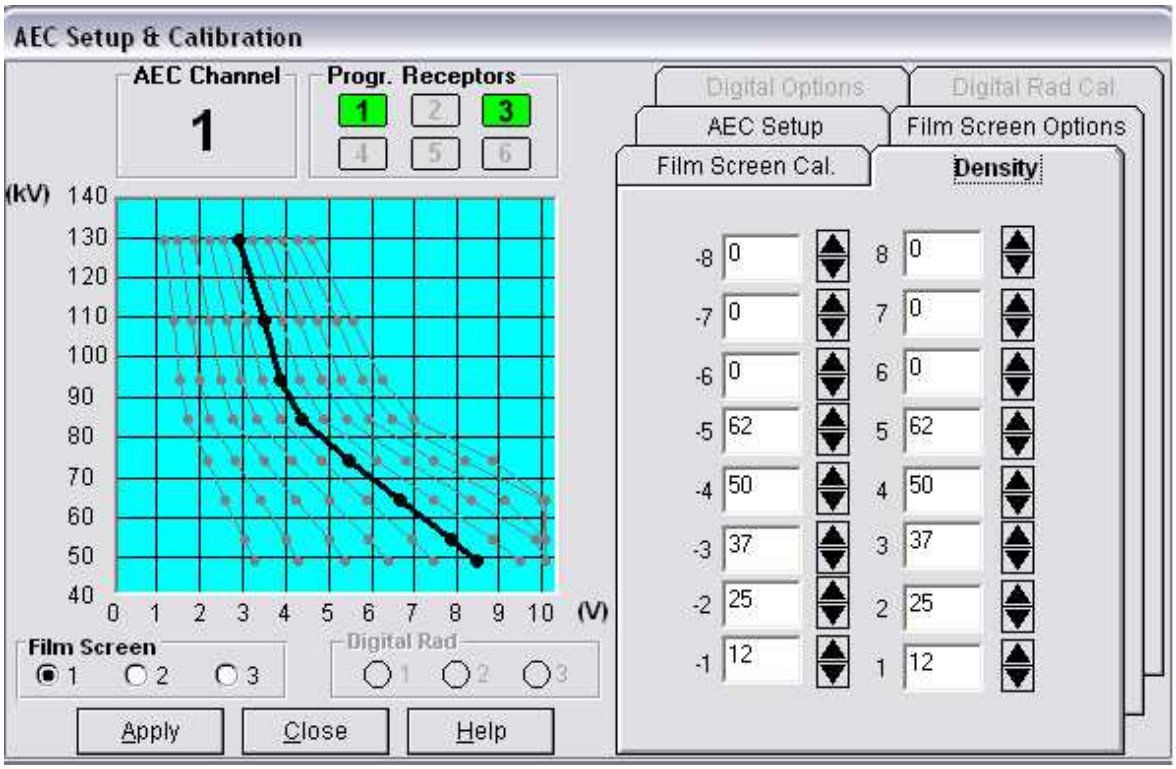


Figure 3D-10: GenWare® AEC Setup & Calibration window, Density tab

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-13.
- 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.5.0 AEC DENSITY CALIBRATION (Cont)

Refer to table 3D-14 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-14: Example density values

3D.5.0 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-12 in the X-ray field, ensuring that the radiation is COMPLETELY blocked by the absorber.	
Step	Action (membrane console)	Action (GenWare®)
2.	Select **DENSITY SETUP**.	Select the **Density** tab.
3.	Select **75** kV via the console.	Select **75** kV via GenWare®.
4.	Referring to table 3D-13, note the mAs at 75 kV for film screen 1. This is the mAs required to achieve 0 density.	Referring to table 3D-13, 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**.
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).
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.
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.
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.	
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.
11.	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**.

3D.5.0 AEC DENSITY CALIBRATION (Cont)

Step	Action (membrane console)	Action (GenWare®)
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).
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.
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.
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.
17.	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.6.0 AEC CALIBRATION (WALL BUCKY)

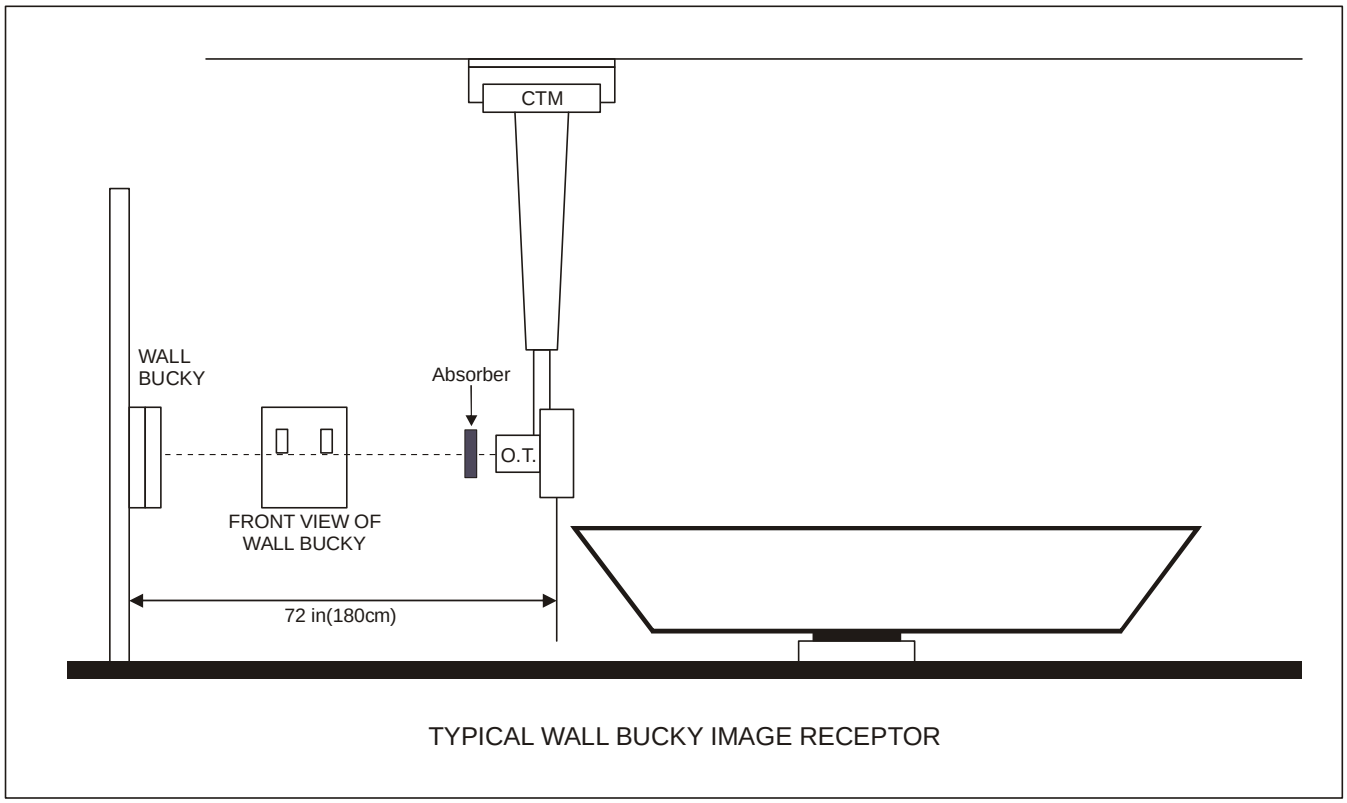


Figure 3D-11: Equipment setup for wall Bucky AEC calibration

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.

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.

3D.6.0 AEC CALIBRATION (WALL BUCKY) Cont

Grid Absorption

The following information may aid in selecting a grid and / or estimating 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%

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.

3D.6.0 AEC CALIBRATION (WALL BUCKY) Cont

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-11.
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-12) 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-12 (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-13, 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-1.
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.

3D.6.0 AEC CALIBRATION (WALL BUCKY) Cont

Step	Action
	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.

3D.7.0 AEC CALIBRATION (MISC)

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.

CHAPTER 4

ACCEPTANCE TESTING

CONTENTS:

4.1.0 INTRODUCTION

This section details acceptance testing, which verifies that the generator is performing within limits. It is recommended that this be done whenever the generator is reconfigured, or component(s) are replaced which may affect the X-ray output. Examples of such components are the X-ray tube, HT tank, console board, generator control board, filament supply board, and the AEC 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, MAINS VOLTAGE IS STILL PRESENT INSIDE THE GENERATOR CABINET. THIS VOLTAGE IS EXTREMELY DANGEROUS; USE EXTREME CAUTION.***
3. ***THE ELECTROLYTIC CAPACITORS, LOCATED BESIDE THE HT TANK, PRESENT A HAZARD FOR A MINIMUM OF 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 compatible room equipment, as noted on the product description \ compatibility statement in chapter 1.
- The tube auto calibration has been done as per chapter 3C.
- The receptors have been programmed as per chapter 3C.
- If the installation has AEC, verify that all receptors have been calibrated as per chapter 3D.
- Acceptance testing shall only be started after the installation is complete i.e. with the generator in the final position and installed as per the previous chapters of this manual.

4.2.0 REQUIRED TEST EQUIPMENT FOR GENERATOR VERIFICATION.

- kV measuring device such as a Dynalyzer (or equivalent).
- Storage oscilloscope.
- mA / mAs meter.
- Radiation meter 0-10 mGy (0-1000 mR).
- 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 Tests

Step	Action	Result	Check
1.	Press the power ON then power OFF buttons on the console.	Unit switches on and off.	
2.	Press power ON again to switch the unit on.	Unit switches on.	
3.	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.	
Note: The technique select button used to select AEC / mAs / mA/ms in steps 4, 5, 6 will only be functional if APR MODE has been disabled during generator configuration (the technique select function is disabled if APR MODE is enabled). This function is described in chapter 3C, in the section *UTILITY MENU*, under *CONSOLE*.			
4.	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: Density value is displayed.	
5.	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.	
6.	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.	
7.	Press the kV **+/-** buttons.	kV increases if kV **+** is pressed. kV decreases if kV **-** is pressed.	
8.	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.	
9.	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.	
10.	Press the focus select button.	The large and small focal spot LED's alternately light as the switch is pressed.	
11.	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 pressed.	
12.	Select 60 kV, 50 mA, 100 ms. Press the PREP button.	The LED adjacent to the prep button lights.	
13.	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.	

4.3.1 Console Tests (Cont)

Step	Action	Result	Check
14.	Ensure that **AEC** is selected. Press the individual AEC field select buttons in sequence.	The LEFT, CENTER, and RIGHT field selection LED's should light as each field is selected.	
15.	Press the power OFF button on the console.	The unit switches off.	

4.3.2 Low Speed Starter Verification

Step	Action	Result	Check
1.	Connect a current probe to the common lead of the X-ray tube stator. 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 approximately 1.5 sec.	
3.	Use a strobe or reed tachometer and verify that the tube reaches operating speed at the end of boost.	Speed $\geq$ 3300 RPM.	
4.	Switch OFF the console.		

4.4.0 ACCEPTANCE TESTS (kV, TIME, mA AND mAs)

Note: ***A Dynalyzer is not recommended for mA measurements with this X-ray generator. Bandwidth limitations of the Dynalyzer will result in inaccurate mA measurements at mA values less than approximately 100 mA. mA measurements should be made with an mA / mAs meter connected to the mA test jacks on the HT tank. Exposure times must be greater than 100 ms to ensure accurate measurements.***

Warning: ***Take all appropriate precautions when connecting the mA / mAs meter to the HT tank. Ensure mains power is switched off and all capacitors are discharged before connecting the meter. Use the same precautions when disconnecting the meter. The mA shorting link must be in place on the HT tank at all times except when an approved mA / mAs meter is connected.***

Note: ***Test equipment tolerances must be allowed for in the measurements in the following sections. Limits stated are the maximum allowed limits, including equipment tolerances and measurement error.***
Disregard "cable charge" spikes at the beginning of the ma waveform.

4.4.0 ACCEPTANCE TESTS (kV, TIME, mA AND mAs) Cont

Step	Action	Result	Check
1.	Set up the kV measuring device to measure kV as per the manufacturers instructions. Connect the output of the kV measuring device to channel 1 of the oscilloscope.	N/A	
2.	Set up an mA / mAs meter to measure X-ray tube current by temporarily open-circuiting the mA measuring link E17-E18 on the HT tank. Connect the mA / mAs meter to these terminals, following the device manufacturers instructions. Connect the output of the mA / mAs meter to channel 2 of the oscilloscope.	N/A	

IF HIGH kV EXPOSURES ARE NOT ALLOWED IN THE FOLLOWING STEPS, CHECK THE MAXIMUM kV SETTING THAT HAS BEEN PROGRAMMED. REFER TO "*TUBE SELECTION*" IN CHAPTER 3.

Step	Action	Result	Check
3.	Switch ON the generator and after initialization select the following parameters: kV = 100, mA = 100, time = 50 ms.	N/A	
4.	Make an exposure and verify the following results.	kV = 100 kV ± 3%. mA = 100 mA ± 5%. Time = 50 ms ± 2 ms.	
5.	Repeat step 4 but set the values to kV = 65, mA = 200.	kV = 65 kV ± 3%. mA = 200 mA ± 5%. Time = 50 ms ± 2 ms.	
6.	Repeat step 4 but set the values to kV = 125, mA = 200.	kV = 125 kV ± 3%. mA = 200 mA ± 4%). Time = 50 ms ± 2 ms.	
7.	Select 75 kV, 200 mA. Select the exposure times shown below (3 point operation). Measure time and mA on the 'scope and check that their product is as per the RESULT column. Measure time at 75% of the peak kV waveform. A: 10 ms (2 mAs) B: 20 ms (4 mAs) C: 63 ms (12 mAs) D: 100 ms (20 mAs)	 A: 2 mAs ± 5%. B: 4 mAs ± 5%. C: 12 mAs ± 5%. D: 20 mAs ± 5%.	

4.4.0 ACCEPTANCE TESTS (kV, TIME, mA AND mAs) Cont

Step	Action	Result	Check
8.	Select 75 kV. Select the mAs shown below (2 point operation). Measure time at 75% of the peak kV waveform. A: 2 mAs (time per LCD display) B: 8 mAs (time per LCD display) C: 25 mAs (time per LCD display) D: 63 mAs (time per LCD display)	Use the time displayed in the LCD window as the reference for the measurements below. ms per LCD disp ± (2% + 1ms). ms per LCD disp ± (2% + 1ms). ms per LCD disp ± (2% + 1ms). ms per LCD disp ± (2% + 1ms).	
9.	Select 200 mA, 50 ms (3 point operation). Select the kV values shown below. Verify the actual kV per the RESULT column. A: 50 kV B: 60 kV C: 80 kV D: 100 kV E: 125 kV	 A: 50 kV ± (3% + 1 kV). B: 60 kV ± (3% + 1 kV). C: 80 kV ± (3% + 1 kV). D: 100 kV ± (3% + 1 kV). E: 125 kV ± (3% + 1 kV).	
10.	Select 75 kV, 50 ms (3 point operation). Select the mA values shown below. Measure mA at 75% of the peak kV waveform. Verify the actual mA per the RESULT column. A: 50 mA B: 100 mA C: 200 mA D: 400 mA	 A: 50 mA ± (5% + 1 mA). B: 100 mA ± (5% + 1 mA). C: 200 mA ± (5% + 1 mA). D: 400 mA ± (5% + 1 mA).	

4.5.0 ACCEPTANCE TESTS (AEC)

This section applies only to generators with AEC.

- Review Section 3D: AEC Calibration.
- Recheck the mAs, dose, and O.D. as recorded during initial installation. Follow the appropriate steps in section 3D to verify the AEC calibration.

4.6.0 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.

SUPPLEMENT

REPRODUCIBILTY, LINEARITY, & HVL TESTING

CONTENTS:

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.

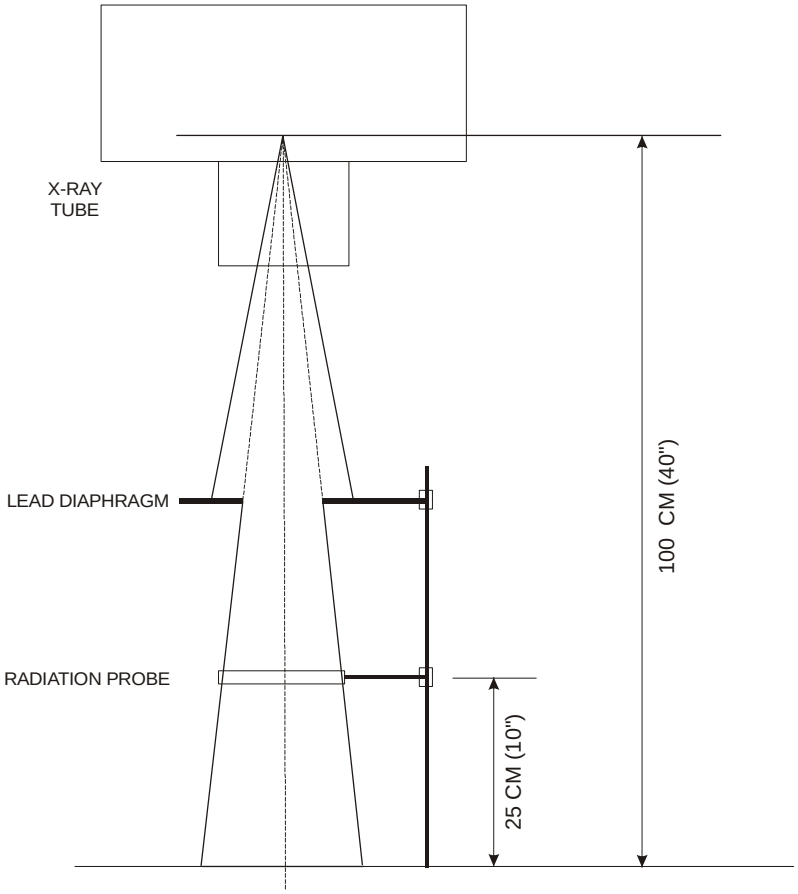


Figure 1: Dose measurement setup

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 = _____ $\overline{K_7}$ = _____

$$X_3 = \frac{\overline{K_3}}{mAs_3} = \_\_\_\_\_$$

$$X_6 = \frac{\overline{K_6}}{mAs_6} = \_\_\_\_\_$$

$$L = \frac{X_3 - X_6}{X_3 + X_6} = \_\_\_\_\_ \text{ (not to exceed 0.095)}$$

In the numerator of the above equation, use the absolute value of $X_3 - X_6$ (disregard the minus sign).

Table 8: Linearity

$$X_4 = \frac{\overline{K_4}}{mAs_4} = \_\_\_\_\_$$

$$X_7 = \frac{\overline{K_7}}{mAs_7} = \_\_\_\_\_$$

$$L = \frac{X_4 - X_7}{X_4 + X_7} = \_\_\_\_\_ \text{ (not to exceed 0.095)}$$

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

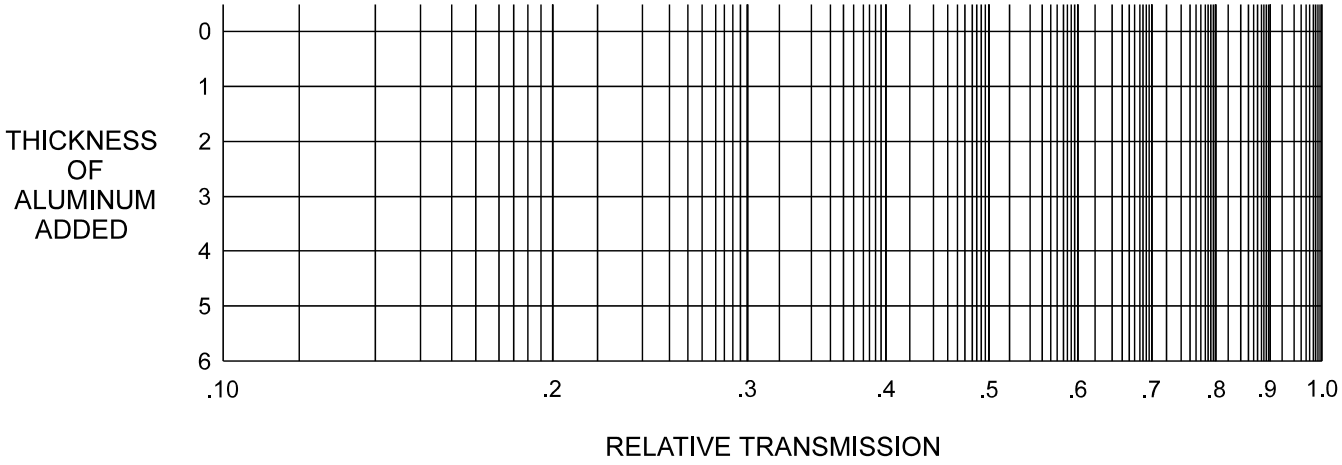


Figure 1: HVL plot 80 kVp

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

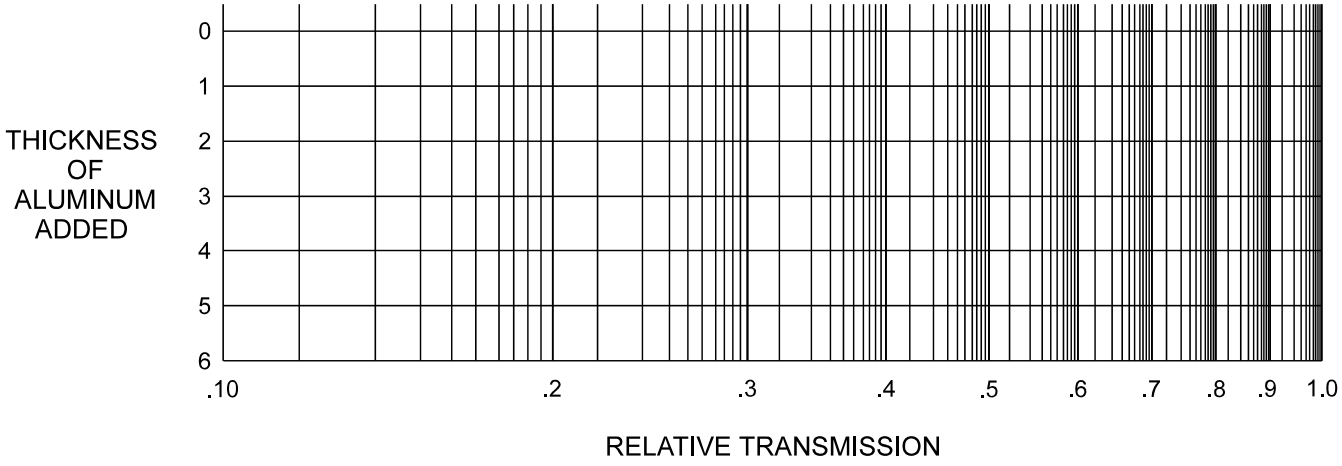


Figure 2: HVL plot 100 kVp

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)

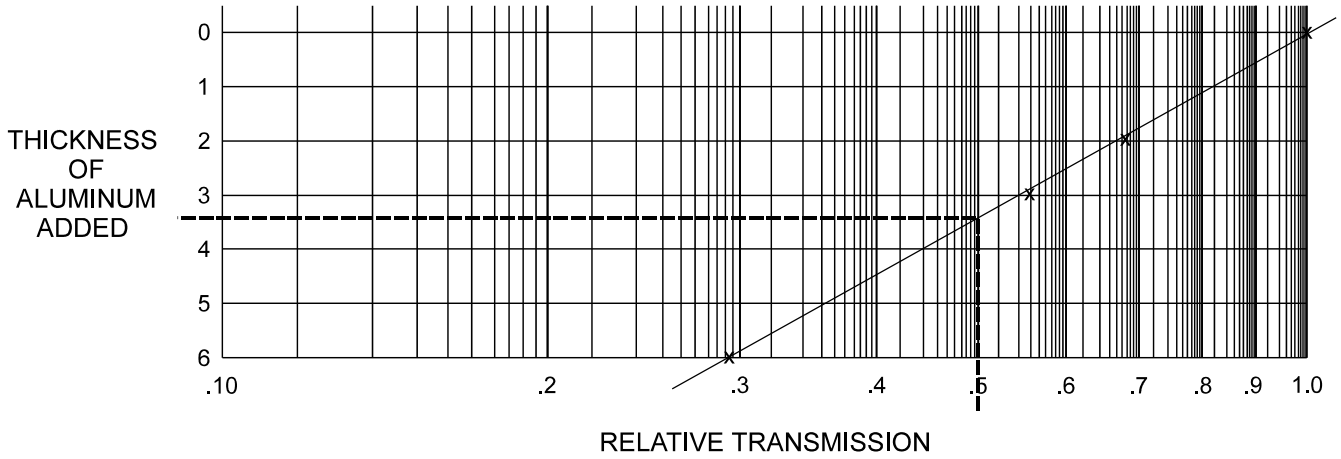


Figure 3: HVL plot (example)

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 CMP 200 operator's console will display status messages on the LCD display 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.

5.2.0 STATUS AND ERROR CODES

5.2.1 Operator Messages

These messages indicate the status of the generator.

MESSAGE (membrane console)	MESSAGE (touch screen 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 an X-ray exposure.
X-RAY READY	Generator Ready	Indicates that the generator is ready to make an exposure.
	Generator offline…	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. Consult your service representative if this does not solve the problem.

5.2.2 Limit Messages

These messages indicate that an exposure has been requested that exceeds one or more limits.

MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
AEC DENSITY LIM.	Generator AEC density limit	Requested density not programmed.	Select another density or program requested density step.
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.
DAP ACCUM. WARN	DAP accumulation Warning.	The accumulated DAP value exceeds the programmed DAP limit.	Reset the DAP.

5.2.2 Limit Messages (Cont)

MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
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. JOULE LIMIT	Generator Joule Limit	The requested exposure will exceed the generators kilo joule heat limit.	Allow the generator to cool sufficiently to allow the requested exposure.
GEN. KV LIMIT	Generator kV limit	Requested kV not allowed as generator kV limit has been reached.	None.
GEN. KW LIMIT	Generator kW limit	Requested parameter not allowed as generator kW limit has been reached.	None.
GEN. MA LIMIT	Generator mA limit	Requested mA not allowed as generator mA limit has been reached.	None.
GEN. MAS LIMIT	Generator mAs limit	Requested mAs not allowed as generator mAs limit has been reached.	None.
GEN. MS LIMIT	Generator ms limit	Requested ms not allowed as generator ms limit has been reached.	None.
INVALID PARAM.	Invalid communication parameter.	Generator detected invalid parameter within received message, message ignored.	Select valid parameter.
TUBE KV LIMIT	Tube kV limit	Requested kV not allowed as tube kV limit has been reached.	None.
TUBE KW LIMIT	Tube kW limit	Requested parameter not allowed as tube kW limit has been reached.	None.
TUBE MA LIMIT	Tube mA limit	Requested mA not allowed as tube mA limit has been reached.	None.
TUBE MAS LIMIT	Tube mAs limit	Requested mAs not allowed as tube mAs limit has been reached.	None.

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 (touch screen console)	PROBLEM	ACTION
	APR MEMORY ERROR		APR data has been corrupted.	See note 1 near end of this section.
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	Main contactor in generator did not energize.	Call product support.
E006	ROTOR FAULT	Rotor Fault	1. Rotor starter may have detected a current fault in the stator. 2. Generator was not ready to start rotor.	Power unit off and retry rotor start.
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.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
E009	PS NOT READY	Power Supply Not Ready	The generator is not ready to make an exposure.	Retry exposure.
E011	HIGH MA FAULT	mA During Exposure Too High	Generator CPU detected mA greater than allowed tolerance.	Recalibrate X-ray tube**. ***
E012	LOW MA FAULT	mA During Exposure Too Low	Generator CPU detected mA less than allowed tolerance.	Recalibrate X-ray tube**. ***
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.
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 backup time.	1. Check exposure technique settings. 2. Increase tomo backup 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.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
E022	DOOR INTERLOCK	Door Interlock Error	Door is open.	Close door.
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.
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.
E034	+12VDC ERROR	+12 V DC Error	+12VDC rail is out of tolerance.	Check +12VDC rail.
E035	-12VDC ERROR	-12 V DC Error	-12VDC rail is out of tolerance.	Check -12VDC rail.
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.
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.	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 (touch screen console)	PROBLEM	ACTION
E046	MODE INHIBITED	Mode Inhibited	Received message is valid, but not allowed during present state.	Reset error.
E049	NOT ENABLED	Not enabled	Requested function not programmed to be enabled.	Reprogram to enable 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 small focus filament board (units with 2 filament boards), or check filament board (units with single filament board).
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 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.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
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.	Call product support.
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.
E063	FACTORY DEFAULTS	Factory defaults set	JW2 on the generator control board is set to the LOAD DEFAULTS position.	Set JW2 to the NORMAL position. The generator will not exit the initialization phase until this is done.
E065	TOMO DEVICE ERR.	Tomo device error.	The tomo start signal was not received within 30 seconds of pressing the X-ray switch on the generator.	1. Check the tomo connections to the generator. 2. Check the tomo system.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
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.
E071	DAP DOSE OVERFLW	DAP overflow error	The accumulated DAP value exceeds the display limit.	Reset the DAP.
E072	DAP DEVICE ERR.	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	INVERTER 1 ERROR	Inverter 1 Error	Power circuit failure.	Contact product support.
E075	INVERTER 2 ERROR	Inverter 2 Error	Power circuit failure.	Contact product support.
E077	RES. CIRCUIT ERR	Resonant Circuit Error	HT primary overcurrent detected.	1. Check for arcing of the X-ray tube. 2. Check for arcing in the HT tank; if failure of HT tank is suspected, contact product support.
E078	BUCKY1 INTERLOCK	Bucky 1 Interlock error	Indicates that Bucky 1 is not ready.	Check Bucky 1.
E079	BUCKY2 INTERLOCK	Bucky 2 Interlock error	Indicates that Bucky 2 is not ready.	Check Bucky 2.
E080	INTERLOCK 1 OPEN	Interlock 1 Open	Indicates that the interlock 1 is open.	Check the circuits connected to interlock 1. Refer to *INPUTS* in chapter 3C.
E081	INTERLOCK 2 OPEN	Interlock 2 Open	Indicates that the interlock 2 is open.	Check the circuits connected to interlock 2. Refer to *INPUTS* in chapter 3C.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
E082	KV OVER VOLTAGE	kV Over Voltage	The output kV exceeded the maximum allowed kV limit.	1. Auto calibrate tube (per *TUBE CALIBRATION* in chapter 3C) *****. 2. Consult product support.
E083	ANODE MA FAULT	Anode mA Fault	The anode current exceeded the maximum allowed limit.	1. Check for arcing of the X-ray tube. 2. Check for arcing in the HT tank; if failure of HT tank is suspected, contact product support.
E084	CATHODE MA FAULT	Cathode mA Fault	The cathode current exceeded the maximum allowed limit.	1. Check for arcing of the X-ray tube. 2. Check for arcing in the HT tank; if failure of HT tank is suspected, contact product support.
E085	ROTOR MAIN FAULT	Rotor Main Fault	Indicates that insufficient current was sensed in the stator main winding.	1. Check the X-ray tube stator wiring. 2. Check the rotor board.
E086	ROTOR SHFT FAULT	Rotor Shift Fault	Indicates that insufficient current was sensed in the stator shift winding.	1. Check the X-ray tube stator wiring. 2. Check the rotor board.
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.	1. Check to see if the maximum filament current limit can be increased. 2. Retry auto calibration.

5.2.3 Error Messages (Cont)

ERROR CODE	MESSAGE (membrane console)	MESSAGE (touch screen console)	PROBLEM	ACTION
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.	Call product support.
E105	CAL-MIN MA ERR.	Calibration error – minimum mA not calibrated	Minimum generator mA was exceeded at start of calibration.	Reduce filament standby current on primary and/or secondary filament.
E240	OUT OF LABELS		The printer is out of labels.	Load more labels.
E241	LABEL JAMMED		The labels are jammed.	Clear the paper jam.
E242	PRINTER ERROR		The printer self-diagnostics have reported a printer problem.	Refer to the printer manual.
E243	PRINTER COMM ERR		The printer has reported a communication error.	Try printing again.
E244	PLATEN OPEN		The paper platen is not positioned properly.	Check the platen position.
E245	PRINTER OFF-LINE		The printer is off-line.	Put the printer on-line.

***** 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 MISCELLANEOUS FAULTS

5.3.1 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 beside the main input fuse block. This is marked GROUND CONNECTION in the figure “*Generator mains connection*” in chapter 2.

CHAPTER 6

REGULAR MAINTENANCE

CONTENTS:

6.1.0 INTRODUCTION

This chapter provides a recommended schedule for periodic maintenance of the CMP 200 X-ray generator.

The initial installation date and location, and all service performed on the generator, should be recorded in table 6-1. 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.

If a major component (such as the HT oil tank or a major circuit board) is replaced, recalibration will be needed. A separate procedure will be included with the spare in those cases, detailing the required calibration procedure. The acceptance test procedure per Chapter 4 should then be performed prior to placing the generator back into service.

WARNING:	***MAINTENANCE IS TO BE PERFORMED ONLY BY COMPETENT, TRAINED PERSONNEL WHO ARE FAMILIAR WITH THE POTENTIAL HAZARDS ASSOCIATED WITH THIS EQUIPMENT.***

NOTE:	***MAINTENANCE SCHEDULE FREQUENCY MAY BE DICTATED BY CERTAIN REGULATORY REQUIREMENTS OF THE COUNTRY OR STATE IN WHICH THE INSTALLATION IS LOCATED. ALWAYS CHECK THE LOCAL CODES AND REGULATIONS WHEN SETTING THE MAINTENANCE SCHEDULE.***

WARNING:	***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.***

6.2.0 SERVICE RECORD

INSTALLED BY: _____ DATE: _____ LOCATION: _____		
Service Date	**Description of Service**	**Performed By**

Table 6-1: Installation and service record

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6.3.0 MAINTENANCE SCHEDULE

Maintenance Frequency	Description of Preventative Maintenance
Every 6 Months AND whenever a related certifiable X-ray component is replaced:	1. Clean and re-grease all HV connections using vapor proof compound. 2. Check that all HV connections are tight. 3. Clean the control console, and main cabinet as needed. **REFER TO 6.5.0 CLEANING BEFORE PROCEEDING.** 4. Perform the X-ray tube auto calibration routine; refer to Chapter 3C. 5. Verify the calibration of the generator; refer to Chapter 4. 6. Test the X-ray tube thermal switch circuits in the generator. Disconnect the tube thermal switch and verify the correct error message, and that X-ray exposures are inhibited. 7. Perform any additional tests required by laws governing this installation.
Every 12 months:	1. Examine the following for any visible damage and replace any damaged components: • The exterior of the control console, including the membrane switch assembly. • The cable between the control console and the generator main cabinet. • The hand switch (if used) and the cables connecting this to the console. • The HT cables. 2. Open the generator main cabinet and examine the unit for any visible damage: missing or loose ground connections, oil leaks, damaged cables etc.
Every 3 years:	Replace the cooling fan in the generator main cabinet.
Every 5 years:	Replace the lithium battery on the CPU board in the control console and in the generator. Refer to the spares list in chapter 8 for the required part number. Refer to 6.7.0 for the battery replacement procedure.

6.4.0 OIL FILL / LEVEL CHECK

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.

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 lid of the HT tank.**
   - 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.

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, tighten the screw 4 turns. This will secure the oil fill plug. Wipe up any spills. Dispose of soiled absorber in compliance with government requirements, and ensure conformity to local disposal regulations. THE OIL DOES NOT CONTAIN PCBs.

6.4.0 OIL FILL / LEVEL CHECK (Cont)

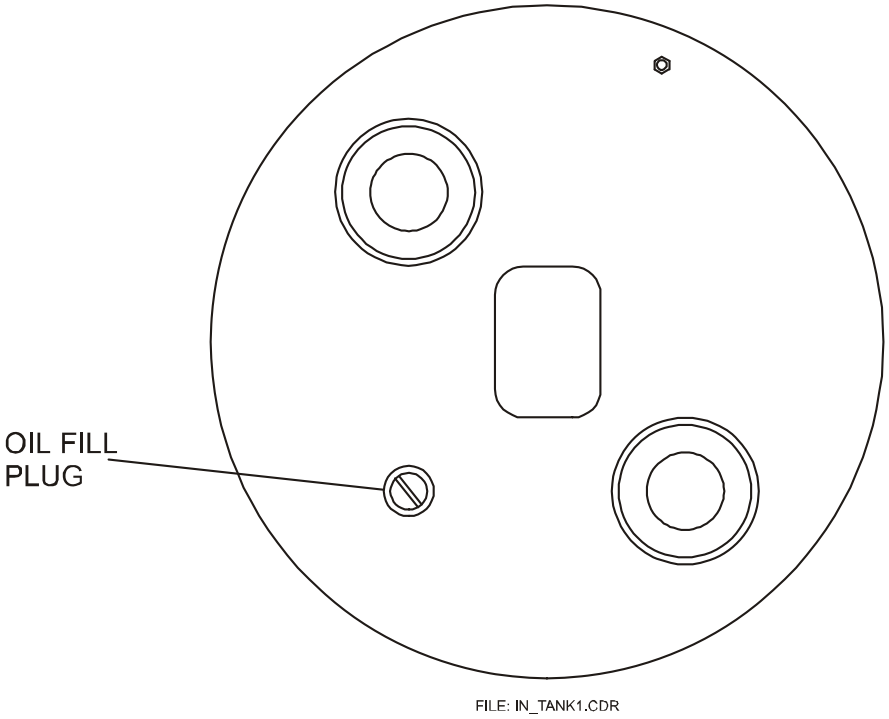

Figure 6-1: HT tank oil fill

6.5.0 CLEANING

- Never use anything other than mild soap and water to clean plastic surfaces. Other cleaners may damage the plastic.
- **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

WARNING: ***PLEASE TAKE APPROPRIATE ELECTROSTATIC PRECAUTIONS AT ALL TIMES WHEN HANDLING THE EPROM(S).***
REFER TO 6.6.3, SETTING FACTORY DEFAULTS, AFTER REPLACING THE EPROM(S).

THE FOLLOWING SOFTWARE SETS MUST ONLY BE USED ON GENERATORS WITH COOLING FANS. USE OF THIS FIRMWARE IN UNITS WITHOUT COOLING FANS MAY CAUSE SEVERE GENERATOR DAMAGE.

SOFTWARE SET	APPLICATION
73940300	30 kW medical
73940600	32 kW medical
73940900	40 kW medical
73941200	50 kW medical
73941500	30 kW chiropractic
73941600	32 kW chiropractic
73941700	40 kW chiropractic
739418	50 kW chiropractic

6.6.1 Console EPROM

1. Switch the generator OFF at the console, and disconnect the mains voltage.
2. Turn the console on its face. A soft, clean cloth should be placed on the work surface to protect the console from damage while it is face down.
3. Disconnect all connections, including the console ground connection, from the rear of the console.
4. Remove and temporarily set aside the jackscrews from the ‘D’ connectors on the rear of the console. Remove and temporarily set aside the hardware from the console ground stud.
5. Remove the 6 screws securing the base to the molded case.
6. Gently remove the console bottom (the metal bottom panel with the feet attached).
7. Locate and carefully remove the existing EPROM U6 on the console board. Refer to the appropriate figure in chapter 1, in the section *GENERATOR LAYOUT AND MAJOR COMPONENTS*.
8. Carefully insert the replacement EPROM into the socket *observing the orientation per the figure identified in the previous step*.
9. Re-assemble the console in the reverse order of the above. Use of a removable thread locker (loctite or equivalent) is recommended when reinstalling the jackscrews to prevent them from loosening if the mating connectors are removed.
10. Reconnect the console ground and all cables removed in step 3.

6.6.2 Generator EPROM

The AEC board will need to be temporarily removed to replace the generator EPROM, if the AEC option is fitted. Refer to 6.8.0 for the procedure to remove and replace the AEC board.

1. Switch the generator OFF at the console, and disconnect the mains voltage.
2. Remove the generator cover as described in chapter 2.
3. Locate and carefully remove the existing EPROM U6 on the generator control board. Refer to the appropriate figure in chapter 1, in the section *GENERATOR LAYOUT AND MAJOR COMPONENTS*.
4. Carefully insert the replacement EPROM into the socket *observing the orientation per the figure identified in the previous step*.

6.6.3 Setting Factory Defaults

Should the ***part number*** *(not revision)* of the replacement EPROM be different from the EPROM being replaced, then the factory default procedure(s) must be performed as detailed below. This will initialize the CPU's NVRAM as required by the new software and sets the data to its factory-configured state. Note that there are separate procedures for the console CPU and for the generator CPU.

CONSOLE CPU FACTORY DEFAULTS:

The procedure for loading console defaults is described in chapter 3C. Refer *to LOAD CONSOLE DEFAULTS*. This is described in the section *UTILITY MENU*, under *CONSOLE*.

GENERATOR CPU FACTORY DEFAULTS:

1. Switch the generator OFF at the console, and disconnect the mains voltage.
2. Remove the generator cover as described in chapter 2.
3. Locate JW2 on the generator control board. Refer to the appropriate figure in chapter 1, in the section *GENERATOR LAYOUT AND MAJOR COMPONENTS*.
4. Set JW2 to the LOAD DEFAULTS position.
5. Switch ON the generator. After a brief period, the console will pause at the message **FACTORY DEFAULTS**.
6. Switch OFF the generator. Set JW2 back to the NORMAL position.

This will initialize all generator data to the factory defaults [tube selection, generator limits (including anode boost time), receptor setup, I/O configuration, AEC setup, AEC calibration, tube calibration, time & date, error log and statistics].

NOTE: ***IF THE FACTORY DEFAULTS HAVE BEEN SET, CRITICAL PARAMETERS (I.E ANODE BOOST TIME, ETC) MUST BE MANUALLY REPROGRAMMED BEFORE OPERATING THE GENERATOR.***

6.7.0 BATTERY REPLACEMENT

The AEC board will need to be temporarily removed to replace the battery, if the AEC option is fitted. Refer to 6.8.0 for the procedure to remove and replace the AEC board.

1. Switch the generator OFF at the console, and disconnect the mains voltage.
2. Refer to 6.6.0 (EPROM replacement) for the procedure to access the console board or the generator control board as required to change the batteries. The figures described in 6.6.0 that show the EPROMs also show the battery locations.
3. 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.
4. Check the voltage of the new battery prior to inserting it. This should be nominally 3.2V, do not use if it is under 2.90 V.
5. Wipe the replacement battery with a clean cloth, and ensure that the holder is clean before inserting the new battery.
6. Gently lift the spring contact on the holder and insert the replacement battery, positive (+) side up.
7. A stamp error message may be observed at initial turn-on after replacing the battery. This is normal at this point and will be cleared by setting the date and time in the next step.
8. Reset the date and time, if required. Refer to chapter 3C for the procedure to do this.

6.8.0 AEC BOARD REMOVAL AND INSTALLATION

1. Switch the generator OFF at the console, and disconnect the mains voltage.
2. Disconnect the AEC chamber connections at the AEC board.
3. Disconnect the AEC control cable at J7 of the generator control board.
4. Locate the four nylon standoffs that secure the AEC board to the control board.
5. Turn the head of each plunger on the nylon standoffs approximately 90° counterclockwise.
6. Gently lift the AEC board off the nylon standoffs. Set the AEC board aside until the required components underneath are replaced. The AEC board should only be placed on a static-safe surface.
7. Reverse the above steps to replace the AEC board.

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 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

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.***

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.

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, follow steps 2, 4, and 6.

X-ray tube seasoning should be done on LARGE focus in order to minimize tube wear.

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.

6.10.0 END OF PRODUCT LIFE

The generator's useful life has been estimated at 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 Litre (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 CMP 200 X-ray generator. 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 System ON (MD-0832)

The generator control board on the CMP 200 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 control board. This turns on Q3, holding the collector of Q3 low. This latches Q2 in the “on” state by holding the base of Q2 low when the ON button is released.

The collector of Q3 is connected to K1 on the generator control board (MD-0831). K1 will energize when the generator is switched on, supplying +24 V to the console.

With Q3 turned on, the base of Q21 is held low, turning Q21 off. The collector of Q21 is connected to the ON / OFF control pins on the +5 V, +12 V, and +15 V regulators on the generator control board (MD-0831). With Q21 turned off, the regulator control pins will be pulled to a logic high state, enabling the +5 V, +/-12 V, and +15 V supplies.

When the +5 V rail is established, the CPU on the generator control board will start to function. The CPU will perform its start-up diagnostics, and then output a command via U2 and U40 on the generator control board to energize soft-start contactor K2 on the H.V auxiliary board. The CPU will then wait for up to 10 seconds for the output of opto-coupler U5 on the H.V auxiliary board to ramp high, indicating that the DC bus capacitors are charged. If U5 indicates proper DC bus capacitor charging, within the allotted time, the CPU will output a command to U2 and U40 on the generator control board to energize the main power contactor via the H.V auxiliary board. Soft-start contactor K2 will be de-energized after a maximum of 10 seconds, as the soft-start circuit is not needed once the bus capacitors are charged.

If the indication of normal bus capacitor charge is not received within the allowed time limit, an error message will be presented and the turn-on sequence will be aborted.

Pressing either of the OFF switches turns on Q1 on the generator control board. This turns off Q2, turning off Q3. This will de-energize K1 on the generator control board, removing the +24 V supply from the console, and will also turn on Q21. With Q21 on, the ON / OFF control pins on the +5 V, +12 V, and +15 V regulators on the generator control board will be pulled low, disabling the regulators, thus removing the +5 V, +/-12 V, and +15 V supplies.

7.2.2 DC bus & power distribution (MD-0831)

Sheet 1 applies to single-phase generators.

Assuming that the AC mains is connected and switched on, line voltage is applied to the primary of the auxiliary transformer via F8 and F9. This will establish the +/-35 V supplies via F1 and D1, and the +24 V supply via F2 and F3, and D3 / D4.

When the generator is switched on as described in 7.2.1, +24 V is supplied via K1 to the console where it is regulated to +5 V and -20 V on the console board. Also, the +5 V, +/-12 V, and +15 V supplies on the generator control board are established as per 7.2.1.

After the soft-start command is received from the CPU (refer to 7.2.1), K2 on the H.V. auxiliary board is energized. This will pre-charge the DC bus capacitors via F4 and F5, K2, D5 and current limiting resistors R11 / R16. DC bus charging current will also flow through R17, developing sufficient voltage drop to energize U5. The output of U5 will be low while the DC bus capacitors are charging. As the bus capacitors approach a fully charged state, the current in R17 will approach zero, U5 will stop conducting, and the output of U5 will go high. When the CPU detects that the bus is charged via U5, the main power contactor and the cooling fan will be energized. The line voltage will then be rectified by the chassis mounted mains rectifier assembly to produce approximately 320 VDC for 230 VAC input. This DC bus voltage is switched by the inverter board to produce the drive for the primary of the HT transformer as described in 7.2.5.

LED DS1 on the H.V. auxiliary board confirms the presence of the +24 VDC supply, and an LED (DS1) on the EMC capacitor board indicates that the DC bus is charged.

The console board contains a 300 VAC (approximately) power supply that drives the cold-cathode fluorescent lamp in the LCD display assembly. This power supply is driven from the +5 VDC supply.

The *BUCKY DRIVE* output may be configured for +24 VDC, 110 VAC, or 220 VAC. Connecting E11 to E5 and E10 to E8 supplies +24 VDC, wiring E9 to E5 and E7 to E8 supplies 110 VAC, and jumpering E12 to E5 and E7 to E8 outputs 220 VAC.

K6 on the H.V. auxiliary board will be energized when the +12 V supply on the generator control board is present, supplying +24 VDC, 120 VAC, or 240 VAC to the Bucky drive circuits (section 7.2.3).

The low speed starter boost voltage is jumper selectable to be 120 or 240 VAC. Connecting E16 to E15 selects 240 V boost, and jumpering E14 to E15 selects 120 V boost.

Sheet 2 applies to three phase 400 / 480 V generators.

Assuming that the AC mains is connected and switched on, line voltage is applied to the primary of the auxiliary transformer via F8 and F9. This will establish the +/-35 V supplies via F1 and D1, and the +24 V supply via F2 and F3, and D3 / D4.

When the generator is switched on as described in 7.2.1, +24 V is supplied via K1 to the console where it is regulated to +5 V and -20 V on the console board. Also, the +5 V, +/-12 V, and +15 V supplies on the generator control board are established as per 7.2.1.

After the soft-start command is received from the CPU (refer to 7.2.1), K2 on the H.V. auxiliary board is energized. This will pre-charge the DC bus capacitors via F4 and F5, K2, D5 and current limiting resistors R11 / R27. DC bus charging current will also flow through R17, developing sufficient voltage drop to energize U5. The output of U5 will be low while the DC bus capacitors are charging. As the bus capacitors approach a fully charged state, the current in R17 will approach zero, U5 will stop conducting, and the output of U5 will go high. When the CPU detects that the bus is charged via U5, the main power contactor and the cooling fan will be energized. The line voltage will then be rectified by the chassis mounted mains rectifier assembly to produce approximately 560 VDC for 400 VAC input, or approximately 670 VDC for 480 VAC input. This DC bus voltage is switched by the inverter board to produce the drive for the primary of the HT transformer as described in 7.2.5.

7.2.2 DC bus & power distribution (Cont)

LED DS1 on the H.V. auxiliary board confirms the presence of the +24 VDC supply, and an LED (DS1) located on the EMC capacitor board indicates that the DC bus is charged.

The console board contains a 300 VAC (approximately) power supply that drives the cold-cathode fluorescent lamp in the LCD display assembly. This power supply is driven from the +5 VDC supply.

The *BUCKY DRIVE* output may be configured for +24 VDC, 110 VAC, or 220 VAC. Connecting E11 to E5 and E10 to E8 supplies +24 VDC, wiring E9 to E5 and E7 to E8 supplies 110 VAC, and jumpering E12 to E5 and E7 to E8 outputs 220 VAC.

K6 on the H.V. auxiliary board will be energized when the +12 V supply on the generator control board is present, supplying +24 VDC, 120 VAC, or 240 VAC to the Bucky drive circuits (section 7.2.3).

The low speed starter boost voltage is jumper selectable to be 120 or 240 VAC. Connecting E16 to E15 selects 240 V boost, and jumpering E14 to E15 selects 120 V boost.

Sheet 3 applies to three phase 208 / 230 V generators.

Assuming that the AC mains is connected and switched on, line voltage is applied to the primary of the auxiliary transformer via F8 and F9. This will establish the +/-35 V supplies via F1 and D1, and the +24 V supply via F2 and F3, and D3 / D4.

When the generator is switched on as described in 7.2.1, +24 V is supplied via K1 to the console where it is regulated to +5 V and -20 V on the console board. Also, the +5 V, +/-12 V, and +15 V supplies on the generator control board are established as per 7.2.1.

After the soft-start command is received from the CPU (refer to 7.2.1), K2 on the H.V. auxiliary board is energized. This will pre-charge the DC bus capacitors via F4 and F5, K2, D5 and current limiting resistors R11 / R16. DC bus charging current will also flow through R17, developing sufficient voltage drop to energize U5. The output of U5 will be low while the DC bus capacitors are charging. As the bus capacitors approach a fully charged state, the current in R17 will approach zero, U5 will stop conducting, and the output of U5 will go high. When the CPU detects that the bus is charged via U5, the main power contactor and the cooling fan will be energized. The line voltage will then be rectified by the chassis mounted mains rectifier assembly to produce approximately 320 VDC FOR 230 VAC input. This DC bus voltage is switched by the inverter board to produce the drive for the primary of the HT transformer as described in 7.2.5.

LED DS1 on the H.V. auxiliary board confirms the presence of the +24 VDC supply, and an LED (DS1) located on the EMC capacitor board indicates that the DC bus is charged.

The console board contains a 300 VAC (approximately) power supply that drives the cold-cathode fluorescent lamp in the LCD display assembly. This power supply is driven from the +5 VDC supply.

The *BUCKY DRIVE* output may be configured for +24 VDC, 110 VAC, or 220 VAC. Connecting E11 to E5 and E10 to E8 supplies +24 VDC, wiring E9 to E5 and E7 to E8 supplies 110 VAC, and jumpering E12 to E5 and E7 to E8 outputs 220 VAC.

K6 on the H.V. auxiliary board will be energized when the +12 V supply on the generator control board is present, supplying +24 VDC, 120 VAC, or 240 VAC to the Bucky drive circuits (section 7.2.3).

The low speed starter boost voltage is jumper selectable to be 120 or 240 VAC. Connecting E16 to E15 selects 240 V boost, and jumpering E14 to E15 selects 120 V boost.

7.2.3 Room interface (MD-0833)

+24 VDC, 120 VAC, or 240 VAC for the *BUCKY DRIVE* is available when K6 on the H.V. auxiliary board is energized as described in 7.2.2. The 24 VAC and 24 VDC supplies are present at all times that the AC mains is energized. The 24 VAC supply is fused by F11 and brought out at J11-6 and J11-5 of the H.V. auxiliary board (maximum 150 watts for collimator use), and the 24 VDC supply is fused by F12 and made available at J11-2 and J11-1 for system locks use (maximum 45 watts).

Bucky relays K1 and K3 on the H.V. auxiliary board are driven by U2 and U40 on the generator control board. When K1 or K3 is energized, +24 VDC, 120 VAC, or 240 VAC is provided at J2-7 or J4-1 of the H.V. auxiliary board to start Bucky 1 or Bucky 2.

The Bucky 1 or Bucky 2 ready signal (a contact closure is needed) will energize opto coupler U2 or U6 respectively. The Bucky-ready status from U2 or U6 is conveyed to the CPU via buffer U44, where it is used to determine that the Buckys are ready to make an X-ray exposure.

During an X-ray exposure, the CPU will pull the base of Q23 on the generator control board high. This will turn on Q23, energizing K7 on the H.V. auxiliary board. K7 provides a dry contact closure when energized that may be used to control the room light.

The H.V. auxiliary board also contains 4 interlock inputs. These include interlocks 1 and 2, the door interlock, and the X-ray tube thermal switch interlock. Each of these interlock inputs requires a contact closure to indicate a normal condition, with a closed interlock energizing the associated opto coupler U1, U3, U4, or U9 respectively. The outputs of the opto-couplers are read by the CPU via U44 on the generator control board, where the information is used to determine the readiness of the associated input.

7.2.4 X-ray exposure (MD-0834)

The PREP and X-RAY switches on the console are connected in parallel with the Prep and X-ray switches in the hand switch as per drawing MD-0834. Pressing PREP energizes opto coupler U9 on the console board, and U41 on the generator control board. The output of these opto couplers is read directly by the console CPU and by the generator CPU, and interpreted as a valid prep command if the outputs of U9 and U41 are both low. DS5 on the generator control board will light to indicate that the console or hand switch PREP switch is pressed. Remove JW1 and JW2 on the console CPU board to disable the PREP and X-RAY buttons. This will prevent the PREP and X-RAY signals from being initiated via the control console. In this instance an external hand switch is required to create exposures.

Pressing X-ray will energize U10 on the console board, and U42 and U43 on the generator control board. The output of U10 is read by the console CPU, and the output of U42 is read by the generator CPU. If both of these commands are present, the software will recognize a valid X-ray request, and take the emitter of U43 low via U2 and driver U40 on the generator control board. With a valid hardware X-ray request (X-ray switch pressed) and a valid software X-ray request, the collector of U43 will be held low. The collector of U43 is OR'ed with several other signals on the generator control board, all of which must be at the correct logic level in order to be able to make an X-ray exposure. Refer to 7.2.5 for further details. DS6 on the generator control board will light to indicate that the console or hand switch X-ray switch is pressed.

7.2.5 kV control and feedback (MD-0835)

Refer to MD-0835, sheet 1:

Prior to the X-ray request being received, the CPU supplies base current to Q17 on the generator control board, turning Q17 on. Q17 then supplies base current to Q16, turning Q16 on, thus holding the junction of R178 / R179 high (+12 V). This ensures that the error amplifier cannot generate any kV demand.

When the X-ray request is received, Q17 is turned off, turning Q16 off, effectively isolating Q16 from the circuit. At the same time, the kV reference voltage is produced by D/A converter U46. The kV reference voltage is buffered by U50A, inverted by U35A, and then summed with the positive going kV feedback signal from U28B at the input of error amplifier U36A. Error amplifier U36A 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 T2, and rectified by D16 to D19 to produce a current limit signal (a negative voltage proportional to the primary current). This is applied to the input of U36B, where it will limit the kV demand if the primary current exceeds safe limits. This current limit signal is also fed to comparator U22, which generates a fault pulse if excessive primary current is sensed. This fault pulse is detected by U2, immediately causing the gate drive to be inhibited, preventing inverter damage due to the over-current condition.

The output of U36B swings increasingly negative for increased kV demand. This kV demand voltage is buffered and inverted by U37A, 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 T1 synchronizes the start of the pulses.

The output pulses from the VCO are applied to AND gates U17A and U17B. The control inputs of U17 (TP16) are held high if all logic conditions to allow an X-ray exposure are satisfied. The pulses are inverted and level shifted by U18A and U18B, and then applied to the gates of the MOSFET inverter consisting of Q9, Q10, Q12, and Q13 on the generator control board. These MOSFETS form a full bridge inverter circuit that outputs high frequency gate pulses to the power MOSFETS on the inverter board(s) via J5 and / or J13 on the generator control board.

In order for the control inputs of U17A and U17B to be pulled high, allowing the gate pulses to be passed, the following conditions must be satisfied:

- The base of Q14 must be held low by the CPU. This will only be true if all software logic conditions are satisfied to allow an X-ray exposure.
- The base of Q11 must be held low by U2. This will only be true if no faults have been detected.
- The X-RAY ENABLE command must be present as described in 7.2.4.
- The feedback cable (J9 generator control board to J3 of the HT tank) must be connected.

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 U28A and U30B, where the kV feedback scaling is precisely set by R218. The differential feedback signals are then summed by U28B. The output of U28B supplies a kV feedback signal to error amplifier U36A as described earlier in this section. The kV feedback signal is also supplied to the CPU via A/D converter U45, where it is used to monitor the output voltage during an exposure. Lastly, the kV feedback signal is fed to the kV over voltage comparator U29, which will send a fault pulse to the CPU via U2 if a kV over-voltage condition is detected.

The generator control board also contains circuits that guard against an inverter “shoot-through” fault. If a shoot through fault is detected, T3 and / or T4 on the generator control board will supply a current pulse that is detected by comparator circuits U39 and U57. The relevant comparator will then generate a fault pulse that is detected by U2, causing the gate drive to be inhibited immediately, thus preventing inverter damage due to this fault.

7.2.5 kV control and feedback (Cont)

Refer to MD-0835, sheet 2 and 3:

The inverter board(s) produce the high power drive for the HT transformers (30, 32, and 40 kW generators use one inverter board, 50 kW units use two inverter boards). The output of the inverter board(s) drive the primaries of the HT transformers via the resonant capacitor and the resonant / EMC / sharing inductors.

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 62.5 or 75 kV. The cathode section generates the cathode voltage, 0 to -62.5 or -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 generator control board as described earlier in this section.
The HT tank is not field-repairable. Defective HT tanks must be exchanged with equivalent units.

7.2.6 Filament drive and mA control (MD-0836)

Refer to MD-0836, sheet 1:

If a valid Prep command has been received by the CPU, D/A converter U48 on the generator control board will produce the filament reference voltage (1 volt = 1 amp of filament current). This is buffered by U52B, and then routed to the filament supply board via J14 of the generator control 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; it is shown set to limit at 5.5 amps on MD-0836.

The filament reference voltage is then summed with the filament feedback voltage at the input of error amplifier U4B. When the reference is greater than the feedback, the output of U4B rises, causing the pulse width at the output of U3 to increase.

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, large / small filament select relay K1, J5 on the filament supply board, and J4 on the tank lid board.

The secondaries of the filament transformers provide high voltage isolation, and drive the filaments via the HV cathode board and the cathode high voltage connector as shown.

The output of filament current sense transformer T1 on the filament supply board is rectified by D12, D13, D27, and D28, and fed to 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 described earlier in this section.

The output of U2B is brought to J2-2 on the filament supply board. This filament current feedback signal is then fed to A/D converter U45 on the generator control board, where it is monitored by the CPU.

7.2.6 Filament drive and mA control (Cont)

Refer to MD-0836, sheet 2:

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 generator 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 if the mA test jack is removed during high voltage arcs, and prevent the voltage at E17 and E18 from rising above approximately 15 volts if the ma test jack 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 U33B.

The output of U33B is taken to comparator U32, which detects high anode mA. U32 will send a fault pulse to U2 if an anode over-current condition is detected, causing the kV output to be inhibited immediately, thus preventing damage due to the over-current fault.

The output of U33B is also applied to the input of U33A, which provides a scaled mA feedback voltage. The mA is calibrated by R160 such that 1 volt = 100 mA at the output of U33A. The output of U33A is fed to the CPU via A/D converter U45, and also to voltage amplifier U38A, which provides a better quality (higher gain) feedback signal to the CPU at low anode currents. The mA feedback information is used by the CPU to regulate the X-ray tube mA and to perform mA monitoring functions during exposures.

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 U30A. The output of U30A is taken to comparator U31, which detects high cathode mA. U31 will send a fault pulse to U2 if a cathode over-current condition is detected, thus preventing damage due to the over-current fault.

7.2.7 Low speed starter (MD-0837)

Nominal 240 VAC is supplied to the low speed starter via F6 and F7 on the H.V. auxiliary board. For single-phase generators, this is derived directly from the AC mains. For three-phase units, 240 VAC for the low speed starter is supplied by a separate autotransformer that is fed from two of the three AC input phases. Refer to MD-0831 for further details.

The coil of K4 on the H.V auxiliary board is connected in parallel with the main power contactor, and is thus energized when the main power contactor is energized after completion of the generator power-on sequence. This is described in 7.2.1.

When a Prep request is made, K5 is energized for approximately 1.8 seconds by the CPU via U2 and U40 on the generator control board in order to boost the rotor. The rotor is allowed to coast briefly, and then boosted again for approximately 500 milliseconds every 5 seconds during Prep in order to maintain normal anode rotation. During the boost cycles (when K5 is energized), nominal 240 VAC is applied to the main winding, and to the shift winding of the stator via phase shift capacitor C12.

The main and shift currents will flow through R20 and R19 respectively, energizing opto couplers U7 and U8 if there is sufficient stator current. Normally, the opto couplers will only conduct during the peaks of the stator current. This is reflected in the output waveform of the opto couplers at TP8 and TP7 as shown on page 2 of MD-0837. If there is low (or no) stator current, U8 and / or U7 will not be energized. The output of the opto couplers at TP8 / TP7 will then be pulled high (+5 V). This condition is detected by the CPU via U44 on the generator control board, and recognized as a stator fault.

7.2.8 DAP (MD-0840)

The DAP circuits consist of micro-controller U11, RS-232 driver U13, and associated components on the generator control board. Micro-controller U11 operates under control of the CPU on the generator control board, and controls all DAP functions (switches the +15 V supply via Q4, Q6, and Q8 as required to control and test the DAP device, and counts the DAP pulses via U13).

7.2.9 Serial communications (MD-0839)

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, DS2 on the console board and DS3 on the generator control board will flash. DS2 on the generator control board and DS3 on the console board will flash to indicate that the generator control board is sending data to the console.

U11 is an RS-232 driver, and converts the +5 V TTL levels from the CPU to RS-232 levels for the serial port, J4. DS5 and DS4 on the console board will flash to indicate that data is being sent to, and received from the serial port.

DS1 on the console board and on the generator control board will flash at a consistent 1 Hz rate if the CPU is operational.

7.2.10 AEC (MD-0838)

Refer to MD-0838, sheet 1:

This shows the circuits on the generator control board that provide interfacing between the generator CPU and the AEC board. Eight lines supply the AEC chamber select signals, the start signal, and the field select signals to the AEC board via U2 and driver U26. The AEC ramp (*PT RAMP*), from the AEC board, is voltage-amplified by a factor of 20 by U23B and compared to the AEC reference voltage by U24. The output of U24 is normally high, switching low when the magnitude of the AEC ramp is approximately 5% of the AEC reference voltage. This step change at the output of U24 is detected by U2, and is used by the CPU to generate an error message if the trajectory of the AEC ramp is such that the AEC exposure will exceed the AEC backup time.

The AEC reference voltage is generated by D/A converter U47, buffered by U50B, and fed to comparator U24 and to the AEC board via J7-10. The magnitude of the AEC reference voltage is determined by the CPU, and will be a value between 0 and 10 volts.

The PT stop signal is generated by the AEC board when the magnitude of the AEC ramp is equal to the AEC reference voltage, and indicates that the desired AEC exposure should be terminated. The PT stop signal is squared by Schmidt trigger U56D, and then connected to an interrupt input on the CPU where it will terminate the AEC exposure immediately when the interrupt is received.

Refer to MD-0838, sheet 2:

This page shows the functional schematic of AEC assembly 733347, used with solid-state AEC chambers. The signal from the AEC chamber is applied between the common anode and the cathode inputs of J1/J11, J2/J12, J3/J13, and / or J4/J14. The AEC board will either be fitted with 5 pin in-line connectors, or circular style connectors, depending on the application. U11A, U11B, U1A, and U1B 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 fed to the AEC gain adjustment potentiometers, R1 to R4, used for AEC calibration. The AEC signal is then taken to the input of analog switch U6A to U6D.

The chamber-select signals originate on the generator control 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 U2A to U2D; and then connected to the control inputs of analog switches U6A to U6D. The analog switch corresponding to the selected AEC input channel will be closed when that channel is selected, thus connecting the preamplifier for the active channel to gain stage U9B.

The field select signals also originate on the generator control board, and are active-low. An active field select signal will pull the base of Q1, Q2, or Q3 low. This will turn on that transistor, supplying +12 V at the field select lines connected to D30, D18, or D19. More than one field may be active at one time.

The field select signals are connected to the control inputs of analog switches at the inputs of U11A, U11B, U1A, and U1B. This will switch the selected combination of AEC inputs (L, M, R) to the summing node of each preamplifier. The voltage output of the preamplifiers will be proportional to the number of fields selected, i.e. the preamplifier output with 3 fields selected will be 3 times that with a single field selected.

The field select signals are also connected to three analog switches in the feedback loop of U9B. One of these switches will be closed for each AEC field that is selected. With one field selected, the gain of this stage will be maximum; with three fields selected the gain of this stage will be divided by three. The variable gain of U9B, which depends on the number of fields selected, compensates for the variable voltage output of the preamplifiers as described in the previous paragraph, thus keeping the signal output from U9B constant relative to the number of fields that are selected. The output of U9B drives difference amplifier U10B, which subtracts the sample and hold voltage from the input voltage as described in the next paragraph.

7.2.10 AEC (Cont)

The start signal also originates on the generator control board. This signal, when active, will cause DS5 on the AEC board to light. The start signal is buffered and inverted by U2F and U2E, and will be logic low at the output of U2E when the start signal is active. This opens the analog switch that is part of the sample and hold circuit at the input of U10B, and also opens analog switch U12 during an AEC exposure. These analog switches are closed at all other times. The sample and hold circuit will sample any electrical noise at the output of U9B during standby operation, and subtract this noise from the AEC signal during an AEC exposure. This ensures that the output of U10B is proportional to the AEC chamber output current only, and is not influenced by noise.

The output of 10B drives integrating amplifier U10A. Analog switch U12 opens when an AEC exposure starts, allowing C37 to start integrating the AEC voltage. This will produce a ramp whose slope is proportional to the input voltage at U10A.

The AEC ramp is taken to the generator control board where it is processed as described earlier in this section, and also fed to comparator U13 on the AEC board where it is compared to the AEC reference voltage. The output of U13 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 control board.

Refer to MD-0838, sheet 3:

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 15 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 originate on the generator control 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.

The start signal also originates on the generator control 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.

7.2.10 AEC (Cont)

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 control 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 control 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 control 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, left, middle, or right 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 right field select signal to pin 6 and the left field select signal to pin 2. Jumpering pins 1-2 of the field selector jumpers connects the right field select signal to pin 2 and the left 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 a second pin on J1 to J4 (in addition to the + or - 300 V fixed output).

Refer to MD-0838, sheet 4:

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-0838.

7.2.10 AEC (Cont)

Refer to MD-0838, sheet 5:

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 U11B, and a sample and hold circuit is connected to the non-inverting input on U11B. This circuit samples any electrical noise at the input of U11B 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 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 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 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 control 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 control board.

The chamber-select signals exit on the generator control 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 5) for AEC channel selection and to the analog switches in series with R1 to R4 to select the required gain pot.

The field select signals from the generator control 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 control 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 6:

This is the functional schematic of AEC assembly 737998, used with A.I.D. 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 control 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.

7.2.10 AEC (Cont)

The start signal also exits from the generator control 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 control 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 control 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 right field select signal to pin 6 and the left field select signal to pin 2. Jumpering pins 1-2 of the field selector jumpers connects the right field select signal to pin 2 and the left field select signal to pin 6.

7.2.11 Touchscreen isolated 115 VAC supply (MD-0868)

The optional touchscreen isolated 115 VAC supply provides 115 VAC for the touchscreen console. The primary of the touchscreen transformer is supplied with nominally 230, 400, or 480 VAC from the AC mains. The CMP touchscreen fusing board provides connections and fusing for the primary and secondary of the touchscreen transformer, and the connections for the AC mains input and for the isolated 115 VAC output at J2.

7.2.12 Interconnect diagram (MD-0845)

This drawing shows the cabling between the major subassemblies in the CMP 200 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.

CHAPTER 8

SPARES

CONTENTS:

8.1.0 INTRODUCTION

This chapter contains the list of spare parts for the CMP 200 series of X-ray generators.

8.2.0 SPARE PARTS LIST

The matrix on the next page lists the recommended spare parts for the CMP 200 family of X-ray generators.

8.2.0 SPARE PARTS LIST (Cont)

TABLE 1					
DESCRIPTION	**1P 208/230V**	**3P 208/230V**	**3P 400/480V**	**SUGGESTED QTY**	**NOTE**
H.V. auxiliary board	See note 1	See note 1	See note 1	1	1
Generator control board	Consult factory	Consult factory	Consult factory	1	
Filament board	731407-00	731407-00	731407-00	1	
Inverter board	Consult factory	Consult factory	Consult factory	1	
Console board	736805-00	736805-00	736805-00	1	
LCD display assembly	737200-00	737200-00	737200-00	1	
AEC board	See note 2	See note 2	See note 2	1	
Contactor, main power	SC2715	SC2715	SC2715	1	
Capacitor, DC bus, 9000uF, 400V	736877-00			2	
Capacitor, DC bus, 2200uF, 400V		SC4108	SC4108	2	
Rectifier assembly, mains	6623071100	6623071100	6623071100	1	
Transformer, auxiliary	739446-00	739446-00	739446-00	1	
Transformer, touchscreen (optional)	739439-00	739439-00	739439-00	1	3
Fan assembly	739401-00	739401-00	739401-00	1	
HT tank assembly (complete)	Consult factory	Consult factory	Consult factory	1	

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8.2.0 SPARE PARTS LIST (Cont)

TABLE 2		
FUSE LOCATION	**FUSE TYPE & PART NO.**	**SUGGESTED QTY**
Main Line Fuses: (1 phase units): F1, F2 (50A 250V)	FRN-R-50, 5550031200	2
Main Line Fuses: (3 phase 32/40 kW units): F1, F2, F3 (40A 480V)	AG40, 6713837700	3
Main Line Fuses: (3 phase 50 kW units): F1, F2, F3 (60A 480V)	SC60, 6713837500	3
Generator control board: F1 (1A 250V Slo-Blo) Console board: F1 H.V. auxiliary board: F10 CMP touchscreen fusing board: F1	GDC-1, 5550032900	5
H.V. auxiliary board: F1, F6, F7 (8A 250V Slo-Blo)	S506-8A, 5550037500	5
H.V. auxiliary board: F2, F3 (3.15A 250V Slo-Blo)	GDC-3.15, 5550036600	5
H.V. auxiliary board: F11 (6.3A 250V Slo-Blo) H.V. auxiliary board, 208/230 V units: F4, F5	GDC-6.3, 5550033400	5
H.V. auxiliary board: F12 (2A 250V Slo-Blo) H.V. auxiliary board, 208/230 V units: F8, F9	GDC-2, 5550032600	5
H.V. auxiliary board, 400/480 V units: F4, F5 (1A 500V Slo-Blo)	FNQ-1, 6711905800	5
H.V. auxiliary board, 400/480 V units: F8, F9 (2A 500V Slo-Blo)	FNQ-2, 5550005300	5
Filament board: F1, F2 (4A 250V Slo-Blo)	MDL-4, 6713544000	5
CMP touchscreen fusing board, 208/230 V units: F2, F3 (1/2A 250V)	GDC-1/2-V, 5550041901	5
CMP touchscreen fusing board, 400/480 V units: F2, F3 (1/4A 500V)	FNQ-1/4, 6711907000	5

8.2.0 SPARE PARTS LIST (Cont)

NOTE:

1. Refer to table 8-1 for the part number for the H.V. auxiliary board. Four different part numbers are used, depending on the application:

TABLE 8-1		
STATOR TYPE	**208 / 230 V GENERATORS**	**400 / 480 V GENERATORS**
"R" type stator	739445-00	739442-00
GE 23/23 Ω stator	739445-01	739442-01

Before installing a replacement H.V. auxiliary board, jumpers must be properly installed on this board in order to select the Bucky voltage (24 VDC, 110 VAC, or 220 VAC). After determining the Bucky drive voltage requirement, connect the appropriate pair of jumpers in accordance with table 8-2 *****.

The jumpers that select the Bucky voltage must be set per the appropriate column in table 8-2. The column for units with isolated 110 / 220 VAC applies to units using auxiliary transformer 739446, which has 110 and 220 VAC secondary windings (shipments after approximately August 2005). The column for units without isolated 110 / 220 VAC applies to units using auxiliary transformers 737116 or 737804, which do not have isolated 110 / 220 VAC windings (shipments prior to approximately August 2005).

TABLE 8-2		
BUCKY OUTPUT	**H.V. AUXILIARY BOARD JUMPERS (units with isolated 110 / 220 VAC, using auxiliary transformer 739446)**	**H.V. AUXILIARY BOARD JUMPERS (units without isolated 110 / 220 VAC, using auxiliary transformer 737116 or 737804)**
24 VDC	E11-E5, E10-E8	E11-E5, E10-E8
110 VAC	E9-E5, E7-E8	E4-E5, E6-E8
220 VAC	E12-E5, E7-E8	E3-E5, E6-E8

After determining the required rotor boost voltage, connect a wire jumper between the desired tabs on the boards *****.

TABLE 8-3	
ROTOR BOOST VOLTAGE	**H.V. AUXILIARY BOARD JUMPERS**
120 VAC	E14-E15
240 VAC	E16-E15

***** A complete set of jumpers is shipped with each new generator. Three of the jumpers are installed on the H.V. auxiliary board, and the remaining jumpers are in a bag attached to the lip on the inside of the cable access slot above the HT tank.

If the Bucky or low-speed starter boost voltage needs to be changed on an existing H.V. auxiliary board, use the existing jumper(s) if they are of the correct length and have the proper connector to fit the tab(s) on the board. Otherwise, select the shortest wires from the spare jumper set that will connect between the desired tabs on the board and that have the proper connectors on the jumpers. For spares boards, the jumpers will need to be removed from the "old" board and reused.

8.2.0 SPARE PARTS LIST (Cont)

Additionally, JW1 must be set per table 8-3 before installing a replacement H.V. auxiliary board.

TABLE 8-4	
UNIT TYPE	**JW1 CONFIGURATION: H.V. AUXILIARY BOARD**
1 phase	OPEN (jumper pins 2-3)
3 phase	CLOSED (jumper pins 1-2)

2. The AEC board in your generator was selected to be compatible with specific AEC devices. 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 that was shipped in the generator for which this manual was prepared.

3. The touchscreen transformer supplies an isolated 115 VAC for the optional touchscreen console. This transformer is only fitted on generators intended for use with a touchscreen console.

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CHAPTER 9

SCHEMATICS

CONTENTS:

9.1.0 INTRODUCTION

This chapter contains the functional schematics for the CMP 200 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 CMP 200 X-ray generators.

9.2.0 FUNCTIONAL SCHEMATIC INDEX

The functional schematic index follows this page. The part number for the AEC board originally shipped in your generator is listed at the bottom of this form.

9.3.0 FUNCTIONAL DRAWINGS

The functional schematics immediately follow the functional schematic index.

REPLACE PAGE 9-3 WITH "FUNCTIONAL DRAWING INDEX" FORM MF-0863

THE ASSEMBLY PART NUMBER FOR THE AEC BOARD IS TO BE TAKEN FROM THE AS-BUILT RECORD:

USE

"PWBA, DEDICATED AEC"
OR
"UNIVERSAL AEC, FINAL ASSY"

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CMP 200 FUNCTIONAL DRAWINGS		
DESCRIPTION	**DRAWING NUMBER**	**REVISION**
DC Bus and Power Distribution	MD-0831	
System ON	MD-0832	
Room Interface	MD-0833	
X-Ray Exposure - Radiographic	MD-0834	
kV Control and Feedback	MD-0835	
Filament Drive and mA Control	MD-0836	
Low Speed Starter	MD-0837	
Automatic Exposure Control (AEC)	MD-0838	
Serial Communications	MD-0839	
DAP	MD-0840	
Interconnect Diagram	MD-0845	

THE PART NUMBER OF THE ORIGINAL AEC BOARD IN THE GENERATOR FOR WHICH THIS MANUAL WAS PREPARED IS LISTED BELOW:

AEC BOARD PART NUMBER (AS ORIGINALLY SHIPPED)
See Drawing List for the AEC Board Part Number for this particular unit.

REFER TO PAGE 4 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL:

AC MAINS INPUT

F1, F2

E1 + / E2 - → INVERTER BOARD

DS1

EMC CAPACITOR BOARD

J5-5, J5-7, J10-1, J10-3, J5-3, J5-1

D7

MAIN CONTACTOR DRIVE FROM MD-0832

FOR UNITS WITH TOUCHSCREEN TRANSFORMER, REFER TO MD-0868

E16 ** E15, E14, F7, F6

120/240 VAC TO LOW SPEED STARTER MD-0837

F5, K2, F4

+12V

SOFT-START CONTACTOR DRIVE FROM MD-0832

D8

D5, R16, C11, R11, R17, R14

2, 5, 1, 4, U5, R13

J6-12, J11-12

SOFT-START SENSE TO MD-0832

J6-6, J11-6

BUCKY DRIVE TO MD-0833

F8, F9, E10, E7, K6, E6, E8

J9-1, J9-3, J9-7, E3, E4, E5, F10, E11, E9, E12, +24 V, +12V, D10

D1, C2, C4

+12 V, J6-1, J11-1, J6-2, J11-2

+35 V, J1-4, J12-6, J1-5, J12-5

J1-8, J12-2, J1-9, J12-1, -35 V

0V, 220V, 110V, 0V, 120V, 26V, 0V, 208V, 240V, 18V, 400V, 0V, 480V, 18V

J8-5, J8-3, J8-1, J3-1, J3-4, J3-3, J3-5, J3-2

F11 → ***24 VAC*** TO MD-0833

F1, F2, F3

F12 → ***24 VDC*** TO MD-0833

+24 V, J1-1, J12-9, J1-2, J12-8

J1-6, J12-4, J1-7, J12-3

D3, D4, R27, DS1, C6, TP9

H.V. AUXILIARY BOARD

THIS SHEET DEPICTS 1 PH. UNITS. REFER TO PAGE 2 FOR 3 PH. 400/480 V UNITS, AND PAGE 3 FOR 3 PH. 208 V UNITS

* ***E3 TO E12 CONFIGURE THE BUCKY OUTPUTS FOR +24 VDC, 120 VAC, OR 240 VAC. REFER TO CHAPTER 8 FOR DETAILS.***

** ***E14, E15, E16 CONFIGURE THE LOW SPEED STARTER BOOST VOLTAGE FOR 120 OR 240 VAC. REFER TO CHAPTER 2 FOR DETAILS.***

ON / OFF COMMAND 2 FROM MD-0832

1, TP12, D4

+12V SWITCHING REGULATOR CIRCUIT (U12 AND ASSOCIATED COMPONENTS)

D6

+24V, TP13, +5V SWITCHING REGULATOR CIRCUIT (U10 AND ASSOCIATED COMPONENTS)

+5V, TP14, +12V

+15V SWITCHING REGULATOR CIRCUIT (U9 AND ASSOCIATED COMPONENTS)

D2

+24V, TP10, +15V

-12V SWITCHING REGULATOR CIRCUIT (U15 AND ASSOCIATED COMPONENTS)

TP11, -12 V

GENERATOR CONTROL BOARD

+35 V, J15-1, J15-3, J15-5, J15-6, J15-2, J15-4, -35 V, +12 V

J1-1, F2, J1-3, TP2, J1-5, J1-6, J1-2, F1, J1-4

FILAMENT SUPPLY BOARD

+12 V, J7-13, +24 V, J7-19, J7-17, J7-11, -12 V

REFER TO MD-0838 (***AEC***) FOR PINOUTS OF THE +/-12 VDC AND +24 VDC SUPPLIES

AEC BOARD

FLUORESCENT LAMP

LCD DISPLAY ASSEMBLY

+5V, TP9, 3, 300 VAC BACKLIGHT POWER SUPPLY (Q1, Q2, T1, ETC), C36

J5-1, J5-5

2, TP2, + 5 / -20VDC POWER SUPPLY & REGULATOR (U12, L1, D3-D7, ETC)

TP7, +5V, TP8, -20V

J3-8, J8-8, F1

TP9, TP3, J3-3, J8-3

CONSOLE BOARD

+24 V, F1, K1, D39

ON / OFF COMMAND 1 FROM MD-0832

DRAWN G. SANWALD	DATE 11 FEB 2003	**DC BUS & POWER DISTRIBUTION**
CHECKED Steve Blake	18 FEB 2003	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	**MD-0831 REV N**
		SHEET 1 OF 4

AC MAINS INPUT

F3 F2 F1

FOR UNITS WITH TOUCHSCREEN TRANSFORMER, REFER TO MD-0868

DS1

E1 + * INVERTER BOARD E2 -

* 50 KW UNITS USE TWO INVERTER BOARDS

EMC CAPACITOR BOARD

J5-5 J5-7 J10-1 J10-3 J5-3 J5-1

D7

MAIN CONTACTOR DRIVE FROM MD-0832

D5

F6 E16 ** E15 F7 — 120/240 VAC TO LOW SPEED STARTER MD-0837

E14

F5 K2 R11

F4

R27 R17 R14

+12V D8 SOFT-START CONTACTOR DRIVE FROM MD-0832

2 5 U5 1 4 R13

J6-12 J11-12 SOFT-START SENSE TO MD-0832

J6-6 J11-6

F8 F9

BUCKY DRIVE TO MD-0833

E10 E7 K6 E6 E8

J9-5 J9-1 J9-3 J9-7 E3 E4 E5 F10

+24 V E11 E12 E9

+12V D10

C2 R28 C4 R29

D1

+35 V TP2 J1-4 J12-6 J1-5 J12-5

-35 V TP3 J1-8 J12-2 J1-9 J12-1

24 VAC TO MD-0833 F11

24 VDC TO MD-0833 F12

+24 V TP1 J1-1 J12-9 J1-2 J12-8

TP12 J1-6 J12-4 J1-7 J12-3 TP9

R30 DS1 C6

D3 D4

0V 220V 110V 0V 120V 26V 208V 0V 240V 18V 400V 0V 480V 18V

J8-5 J8-3 J8-1 J3-1 F1 J3-4 F2 J3-3 J3-5 F3 J3-2

H.V. AUXILIARY BOARD

+12V TP11 J6-1 J11-1 J6-2 J11-2

+12 V +12 V

ON / OFF COMMAND 2 FROM MD-0832

1 TP12 D4

+24V +5V TP13

+5V SWITCHING REGULATOR CIRCUIT (U10 AND ASSOCIATED COMPONENTS)

+24V TP14

+12V SWITCHING REGULATOR CIRCUIT (U12 AND ASSOCIATED COMPONENTS)

D6

+24V TP10 +15V

+15V SWITCHING REGULATOR CIRCUIT (U9 AND ASSOCIATED COMPONENTS)

D2

+12V +35 V -12V SWITCHING REGULATOR CIRCUIT (U15 AND ASSOCIATED COMPONENTS) TP11 -12 V

GENERATOR CONTROL BOARD

+35 V J15-1 J1-1 F2 +35 V

J15-3 J1-3 -12 V

TP2 J15-5 J1-5 J15-6 J1-6

J15-2 J1-2 F1 -35 V -35 V

+12 V J15-4 J1-4

FILAMENT SUPPLY BOARD

+12 V J7-13

+24 V J7-19

J7-17

J7-11 -12 V

REFER TO MD-0838 (*AEC*) FOR PINOUTS OF THE +/-12 VDC AND +24 VDC SUPPLIES

AEC BOARD

FLUORESCENT LAMP

LCD DISPLAY ASSEMBLY

+5V TP9 3 J5-1 J5-5

300 VAC BACKLIGHT POWER SUPPLY (Q1, Q2, T1, ETC)

C36

+24 V F1 K1 D39

ON / OFF COMMAND 1 FROM MD-0832

2 TP2 + 5 / -20VDC POWER SUPPLY & REGULATOR (U12, L1, D3-D7, ETC) TP7 +5V TP8 -20V

J3-8 J8-8 F1

TP9 J3-3 J8-3 TP3

CONSOLE BOARD

THIS SHEET DEPICTS 3 PH. 400/480V UNITS. REFER TO PAGE 1 FOR 1 PH. UNITS, AND PAGE 3 FOR 3 PH. 208 V UNITS

* E3 TO E12 CONFIGURE THE BUCKY OUTPUTS FOR +24 VDC, 120 VAC, OR 240 VAC. REFER TO CHAPTER 8 FOR DETAILS.

** E14, E15, E16 CONFIGURE THE LOW SPEED STARTER BOOST VOLTAGE FOR 120 OR 240 VAC. REFER TO CHAPTER 2 FOR DETAILS.

DRAWN G. SANWALD	DATE 11 FEB 2003	DC BUS & POWER DISTRIBUTION
CHECKED Steve Blake	18 FEB 2003	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0831 REV N
		SHEET 2 OF 4

AC MAINS INPUT

F3
F2
F1

E1 +
INVERTER BOARD
E2 -

DS1

EMC CAPACITOR BOARD

FOR UNITS WITH TOUCHSCREEN TRANSFORMER, REFER TO MD-0868

J5-5 J5-7 J10-1 J10-3 J5-3 J5-1

D7

MAIN CONTACTOR DRIVE FROM MD-0832

D5

+12 V +12 V

J6-1 J11-1
J6-2 J11-2

E16 ** E15 F7
E14
F6

120/240 VAC TO LOW SPEED STARTER MD-0837

R16
C11
R11
R17
R14

F5 K2
F4

+12V

SOFT-START CONTACTOR DRIVE FROM MD-0832

D8

2 5
U5
1 4
R13

J6-12 J11-12
J6-6 J11-6

SOFT-START SENSE TO MD-0832

BUCKY DRIVE TO MD-0833

F8 F9
E10 E7 *
E6 E8 K6

+35 V

J9-1 J1-4 J12-6
J9-3 J1-5 J12-5
J9-7

E3 E4 E5 F10
E11 E9 E12
+24 V +12V

C2
C4
D1
D10

J1-8 J12-2
J1-9 J12-1
-35 V

24 VAC TO MD-0833
F11

24 VDC TO MD-0833
F12

+24 V

J1-1 J12-9
J1-2 J12-8

J1-6 J12-4
J1-7 J12-3

TP9

0V 220V J8-5
110V J8-3
0V J8-1
120V
26V J3-1 F1
208V 0V
240V 18V J3-4 F2
400V 0V J3-3
480V 18V J3-5 F3
J3-2

D3
R27
C6
DS1
D4

H.V. AUXILIARY BOARD

ON / OFF COMMAND 2 FROM MD-0832

1
TP12
D4

+12V
-12V SWITCHING REGULATOR CIRCUIT (U15 AND ASSOCIATED COMPONENTS)
TP11
-12 V

+35 V
J15-1 J1-1 F2
J15-3 J1-3
J15-5 J1-5
J15-6 J1-6
TP2
-12 V

+5V
TP13
+24V
+5V SWITCHING REGULATOR CIRCUIT (U10 AND ASSOCIATED COMPONENTS)

J15-2 J1-2 F1
-35 V -35 V
+12 V
J15-4 J1-4

FILAMENT SUPPLY BOARD

+12 V
J7-13
+24 V
J7-19
J7-17
J7-11
-12 V

REFER TO MD-0838 (**AEC**) FOR PINOUTS OF THE +/-12 VDC AND +24 VDC SUPPLIES

AEC BOARD

+12V
TP14
+24V
+12V SWITCHING REGULATOR CIRCUIT (U12 AND ASSOCIATED COMPONENTS)
D6

FLUORESCENT LAMP

LCD DISPLAY ASSEMBLY

+24 V
F1 K1
D39

ON / OFF COMMAND 1 FROM MD-0832

+5V
TP9 3
J5-1 J5-5
300 VAC BACKLIGHT POWER SUPPLY (Q1, Q2, T1, ETC)
C36

2 TP2
+ 5 / -20VDC POWER SUPPLY & REGULATOR (U12, L1, D3-D7, ETC)
TP7 +5V
TP8 -20V

J3-8 J8-8 F1

TP9 TP3
J3-3 J8-3

+15V
TP10
+24V
+15V SWITCHING REGULATOR CIRCUIT (U9 AND ASSOCIATED COMPONENTS)
D2

CONSOLE BOARD

GENERATOR CONTROL BOARD

THIS SHEET DEPICTS 3 PH. 208 V UNITS. REFER TO PAGE 1 FOR 1 PH. UNITS, AND PAGE 2 FOR 3 PH. 400/480 V UNITS

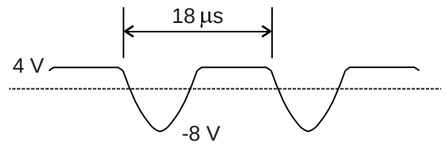
* E3 TO E12 CONFIGURE THE BUCKY OUTPUTS FOR +24 VDC, 120 VAC, OR 240 VAC. REFER TO CHAPTER 8 FOR DETAILS.

** E14, E15, E16 CONFIGURE THE LOW SPEED STARTER BOOST VOLTAGE FOR 120 OR 240 VAC. REFER TO CHAPTER 2 FOR DETAILS.

DRAWN G. SANWALD	DATE 11 FEB 2003	DC BUS & POWER DISTRIBUTION
CHECKED Steve Blake	18 FEB 2003	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0831 REV N
		SHEET 3 OF 4

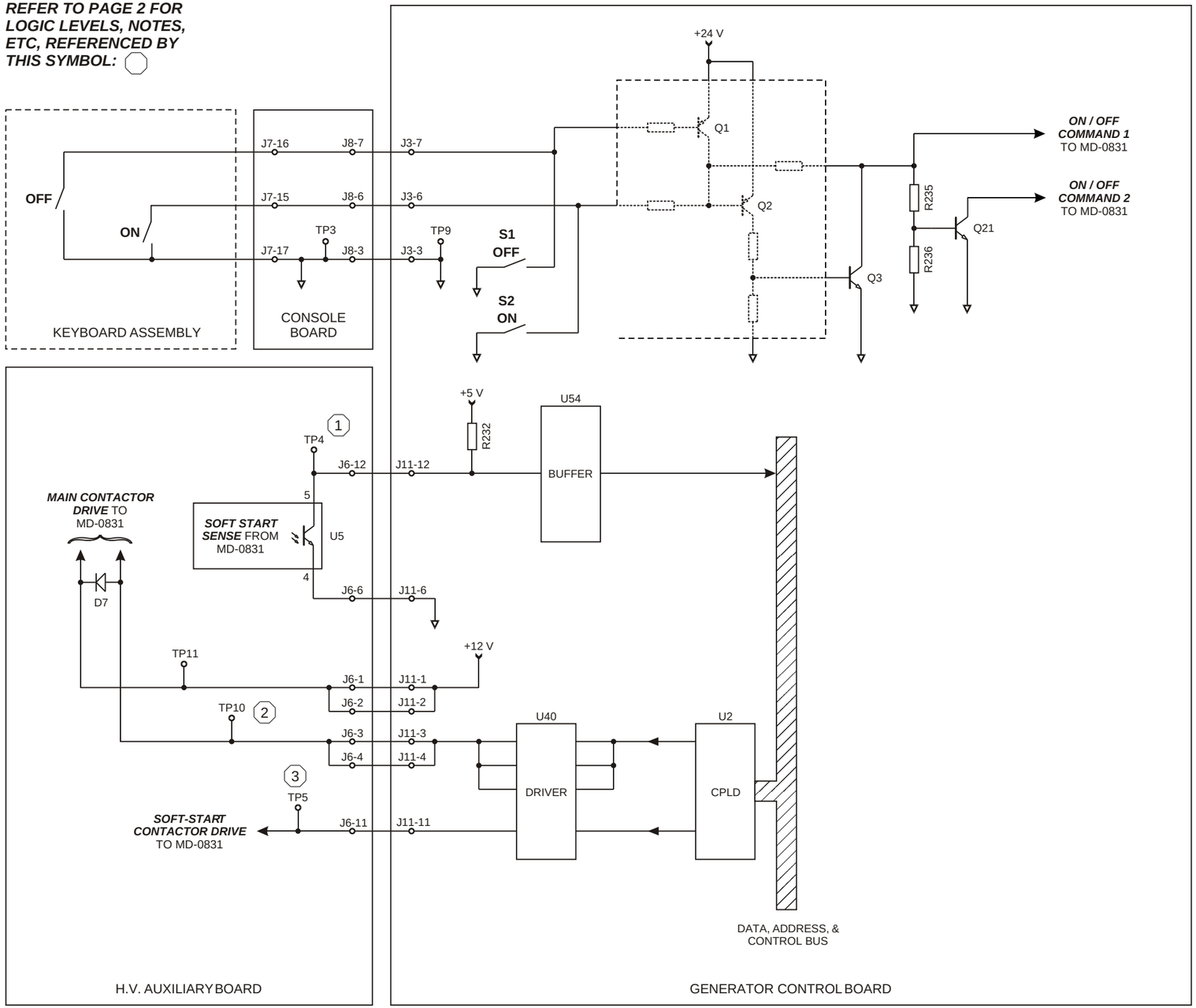
NOTE REFERENCE	REMARKS
1	“LOW” (APPROXIMATELY 0 VDC) DISABLES THE +5 V, +/-12 V, AND +15 V REGULATORS (GENERATOR SWITCHED OFF). “HIGH” (APPROXIMATELY 24 VDC) ENABLES THESE REGULATORS (GENERATOR SWITCHED ON VIA THE CONSOLE ON/OFF SWITCHES, OR VIA THE ON/OFF SWITCHES ON THE GENERATOR CONTROL BOARD) .
2	+24 VDC IS PRESENT AT THIS POINT WHEN THE GENERATOR IS SWITCHED ON, ENERGIZING K1 ON THE GENERATOR CONTROL BOARD.
3	THE VOLTAGE WAVEFORM AT THIS TEST POINT IS DEPICTED IN FIGURE 1 BELOW.

FIGURE 1



DRAWN G. SANWALD	DATE 11 FEB 2003	DC BUS & POWER DISTRIBUTION
CHECKED Steve Blake	18 FEB 2003	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0831 REV N
		SHEET 4 OF 4

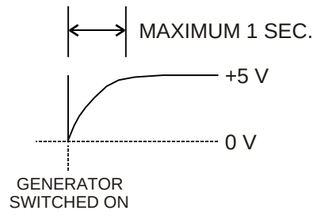
REFER TO PAGE 2 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL: ⬡



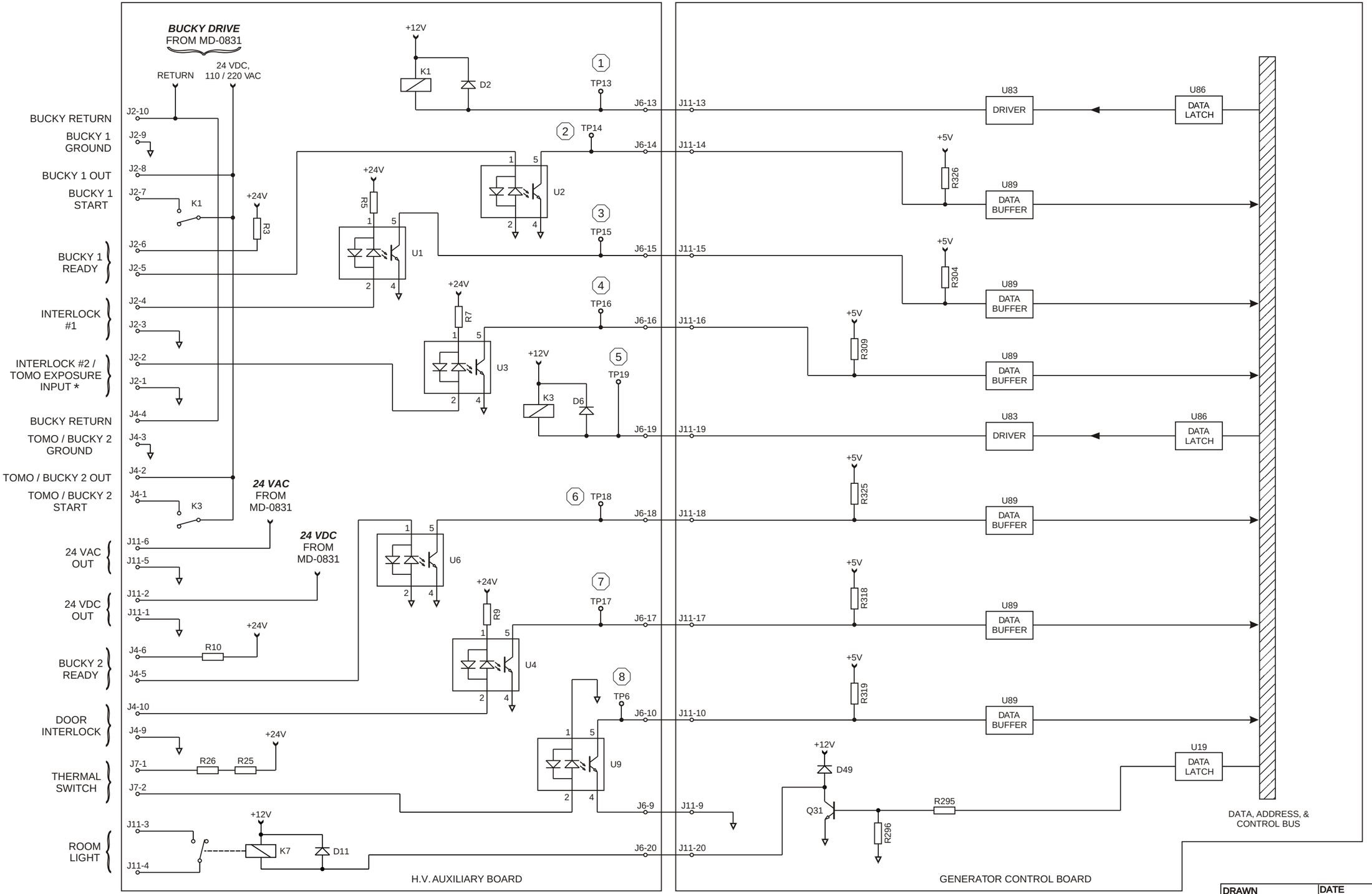
DRAWN G. SANWALD	DATE 11 FEB 2003	SYSTEM "ON"
CHECKED Steve Blake	18 FEB 2003	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0832 REV B
		SHEET 1 OF 2

NOTE REFERENCE	REMARKS
1	THE VOLTAGE WAVEFORM AT THIS TEST POINT IS DEPICTED IN FIGURE 1 BELOW.
2	“LOW” (APPROXIMATELY 0 VDC) ENERGIZES THE MAIN POWER CONTACTOR IN THE GENERATOR, (”HIGH”, + 12 VDC = NOT ENERGIZED). THIS CONTACTOR IS ENERGIZED AFTER THE MAIN BUS CAPACITORS ARE CHARGED, APPROXIMATELY 10 SECONDS AFTER POWER-ON.
3	“LOW” (APPROXIMATELY 0 VDC) ENERGIZES THE SOFT START CONTACTOR K2 ON THE H.V. AUXILIARY BOARD, (”HIGH”, + 12 VDC = NOT ENERGIZED). THIS CONTACTOR IS ENERGIZED FOR A MAXIMUM OF APPROXIMATELY 10 SECONDS AFTER POWER-ON IN ORDER TO CHARGE THE DC BUS CAPACITORS.

FIGURE 1



DRAWN G. SANWALD	DATE 11 FEB 2003	SYSTEM “ON”
CHECKED Steve Blake	18 FEB 2003	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0832 REV B
		SHEET 2 OF 2



REFER TO CHAPTER 3 OF THE SERVICE MANUAL FOR ADDITIONAL DETAILS REGARDING INTERFACING OF BUCKYS, INTERLOCKS, ETC.

* THIS IS THE TOMO EXPOSURE INPUT FOR ANY IMAGE RECEPTOR THAT IS PROGRAMMED FOR TOMO OPERATION. THIS INPUT IS AN INTERLOCK FOR ALL REMAINING RECEPTORS THAT DO NOT HAVE TOMO ENABLED. THIS INPUT MUST NORMALLY BE PROGRAMMED AS INACTIVE ON ALL NON-TOMO RECEPTORS IF THIS IS USED AS A TOMO INPUT ON THE TOMO RECEPTOR.

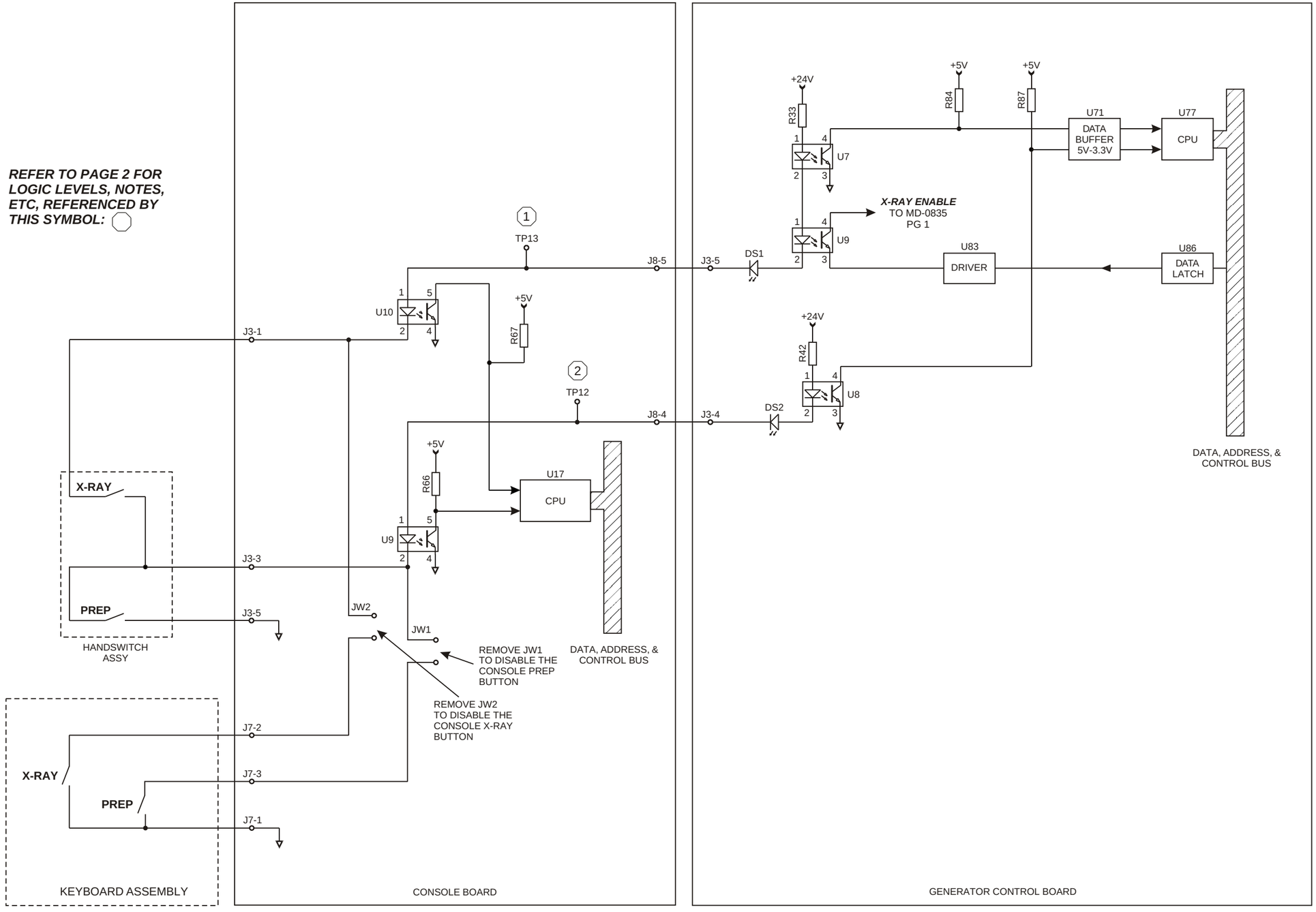
REFER TO PAGE 2 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL: ⯃

DRAWN G. SANWALD	DATE 11 FEB 2003	**ROOM INTERFACE**
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	**MD-0833 REV F**
		SHEET 1 OF 2

NOTE REFERENCE	REMARKS
1	“LOW” (APPROXIMATELY 0 VDC) = BUCKY 1 START. “HIGH” (APPROXIMATELY +12 VDC) = BUCKY 1 NOT REQUESTED TO START.
2	“LOW” (APPROXIMATELY 0 VDC) = BUCKY 1 READY. “HIGH” (APPROXIMATELY +5 VDC) = BUCKY 1 NOT READY.
3	“LOW” (APPROXIMATELY 0 VDC) = 40” S.I.D. INTERLOCK CLOSED. “HIGH” (APPROXIMATELY +5 VDC) = 40” S.I.D. INTERLOCK OPEN.
4	“LOW” (APPROXIMATELY 0 VDC) = 72” S.I.D. INTERLOCK CLOSED. “HIGH” (APPROXIMATELY +5 VDC) = 72” S.I.D. INTERLOCK OPEN.
5	“LOW” (APPROXIMATELY 0 VDC) = BUCKY 2 START. “HIGH” (APPROXIMATELY +12 VDC) = BUCKY 2 NOT REQUESTED TO START.
6	“LOW” (APPROXIMATELY 0 VDC) = BUCKY 2 READY. “HIGH” (APPROXIMATELY +5 VDC) = BUCKY 2 NOT READY.
7	“LOW” (APPROXIMATELY 0 VDC) = DOOR INTERLOCK CLOSED. “HIGH” (APPROXIMATELY +5 VDC) = DOOR INTERLOCK OPEN.
8	“LOW” (APPROXIMATELY 0 VDC) = THERMAL SWITCH CLOSED. “HIGH” (APPROXIMATELY +5 VDC) = THERMAL SWITCH OPEN.

DRAWN G. SANWALD	DATE 11 FEB 2003	ROOM INTERFACE
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0833 REV F
		SHEET 2 OF 2

REFER TO PAGE 2 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL: ⯃



DRAWN G. SANWALD	DATE 11 FEB 2003	X-RAY EXPOSURE (RADIOGRAPHIC)
CHECKED Steve Blake	13 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0834 REV C
		SHEET 1 OF 2

NOTE REFERENCE	REMARKS
1	“LOW” (APPROXIMATELY 0 VDC) = X-RAY REQUESTED. “HIGH” (APPROXIMATELY +24 VDC) = X-RAY NOT REQUESTED.
2	“LOW” (APPROXIMATELY 0 VDC) = PREP REQUESTED. “HIGH” (APPROXIMATELY +24 VDC) = PREP NOT REQUESTED.

DRAWN G. SANWALD	DATE 11 FEB 2003	X-RAY EXPOSURE (RADIOGRAPHIC)
CHECKED Steve Blake	13 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0834 REV C
		SHEET 2 OF 2

REFER TO PAGE 2 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL:

INVERTER "SHOOT THRU" DETECTOR CIRCUITS

INVERTER "SHOOT THRU" SENSE, FROM PAGE 2

INVERTER "SHOOT THRU" SENSE, FROM PAGE 2

1V = 20 kV OF H.V. FEEDBACK

KV FEEDBACK SIGNAL FROM PAGE 2

GATE DRIVE CIRCUIT FOR MOSFET INVERTER (INCLUDES Q9, 10, 12, 13)

INVERTER DRIVE SIGNAL CONTINUED ON PAGE 2

1V = 15 kV OF H.V. DEMAND

ERROR AMPLIFIERS INCLUDES U36A, U36B

VCO

INCLUDES U19, U20, U21, U34, U55, Q15

CURRENT SENSE

H.V. OIL TANK

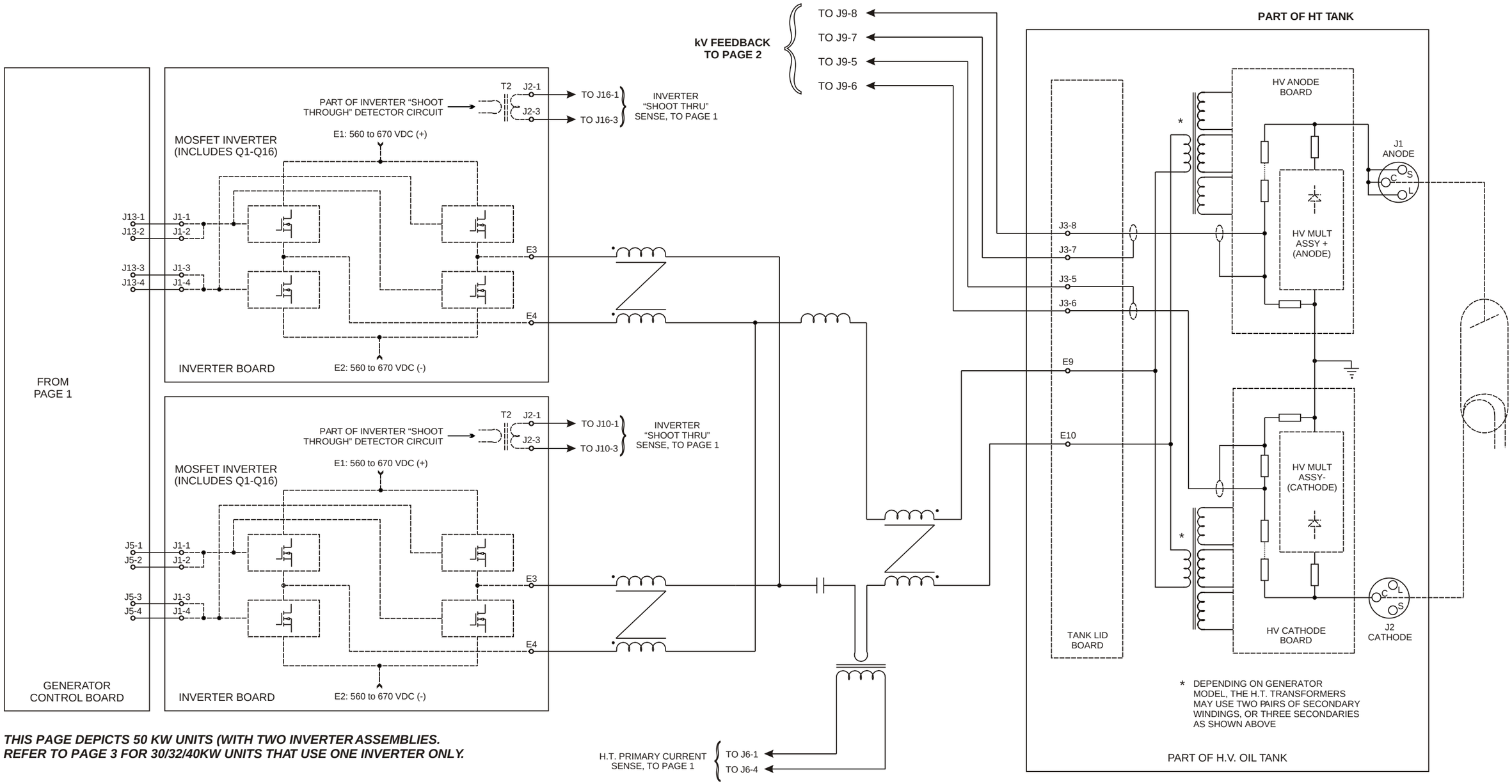
H.T. PRIMARY CURRENT SENSE FROM PAGE 2

X-RAY ENABLE FROM MD-0834

DATABUS D0..D7

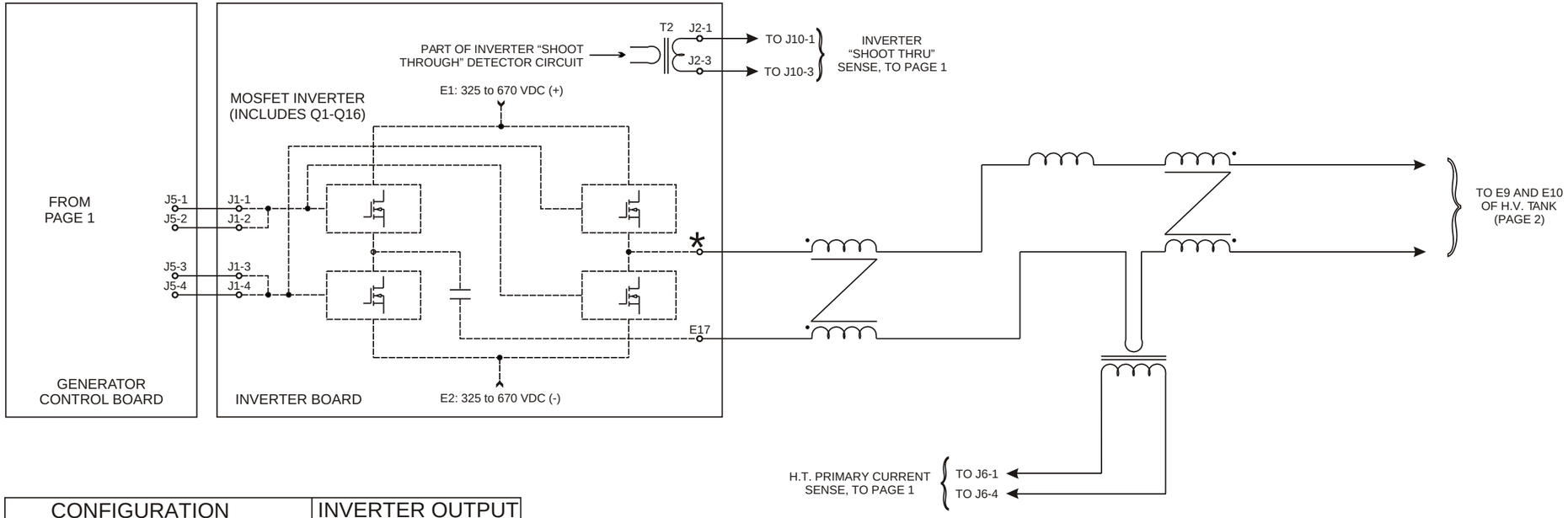
GENERATOR CONTROL BOARD

DRAWN G. SANWALD	DATE 11 FEB 2003	**KV CONTROL & FEEDBACK**
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	**MD-0835 REV D**
		SHEET 1 OF 3



THIS PAGE DEPICTS 50 KW UNITS (WITH TWO INVERTER ASSEMBLIES. REFER TO PAGE 3 FOR 30/32/40KW UNITS THAT USE ONE INVERTER ONLY.

DRAWN G. SANWALD	DATE 11 FEB 2003	KV CONTROL & FEEDBACK
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0835 REV D
		SHEET 2 OF 3



*

CONFIGURATION	INVERTER OUTPUT
32 kW / 40 kW - 208 / 230 VAC	E4
32 kW / 40 kW - 400 / 480 VAC	E3

NOTE REFERENCE	REMARKS
1	A NARROW PULSE WILL BE PRESENT AT THIS TEST POINT IF AN INVERTER "SHOOT THROUGH" HAS BEEN DETECTED. THE VOLTAGE WAVEFORM AT THIS TEST POINT IS DEPICTED IN FIGURE 1 BELOW. THIS PULSE MAY BE VERY DIFFICULT O DETECT, AS THE INVERTER DRIVE WILL BE SHUT DOWN WHEN A "SHOOT THROUGH" IS DETECTED, THUS REMOVING THE FAULT CONDITION.
2	AS PER # 1.
3	A NARROW PULSE WILL BE PRESENT AT THIS TEST POINT IF KV OVER VOLTAGE HAS BEEN DETECTED (130 KV FOR 125 KV UNITS, 163 KV FOR 150 KV UNITS). REFER TO FIGURE 1. THIS PULSE MAY BE VERY DIFFICULT TO DETECT, AS THE HIGH VOLTAGE WILL BE SHUT DOWN WHEN THE OVER VOLTAGE CONDITION IS DETECTED, THUS REMOVING THE FAULT CONDITION.
4	LOW (APPROXIMATELY 0 VDC) = X-RAY REQUESTED BY THE CPU, HIGH (APPROXIMATELY +5 VDC) = NO X-RAY REQUEST BY THE CPU.
5	A NARROW PULSE WILL BE PRESENT AT THIS TEST POINT IF INVERTER OVER CURRENT HAS BEEN DETECTED. THE VOLTAGE WAVEFORM AT THIS TEST POINT IS DEPICTED IN FIGURE 1 BELOW. THIS PULSE MAY BE VERY DIFFICULT O DETECT, AS THE INVERTER DRIVE WILL BE SHUT DOWN WHEN AN OVER CURRENT CONDITION S DETECTED, THUS REMOVING THE FAULT CONDITION.
6	LOW (APPROXIMATELY 0 VDC) = NO FAULT PRESENT, ALLOW AN X-RAY EXPOSURE. HIGH (APPROXIMATELY +5 VDC) = X-RAY EXPOSURE INHIBITED.
7	LOW (APPROXIMATELY 0 VDC) = X-RAY REQUESTED BY CONSOLE, HIGH (APPROXIMATELY +5 VDC) = X-RAY NOT REQUESTED.
8	LOW (APPROXIMATELY 0 VDC) = NAND GATES U17A, U17B DISABLED. HIGH (APPROXIMATELY +5 VDC) = NAND GATES ENABLED, THUS ALLOWING INVERTER GATE DRIVE.
9	LOW (0 VDC) = H.V. TANK CONNECTED, HIGH (APPROXIMATELY +5 VDC) = H.V. TANK NOT CONNECTED.
10	THE VOLTAGE AT TP2 AND TP3 SHOULD BE A 50% DUTY CYCLE SQUARE WAVE, RANGING IN FREQUENCY FROM APPROXIMATELY 80 kHz TO APPROXIMATELY 250 kHz, DEPENDING ON GENERATOR OUTPUT POWER. SEE FIGURE 2.

FIGURE 1

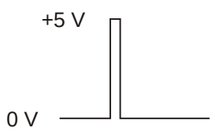
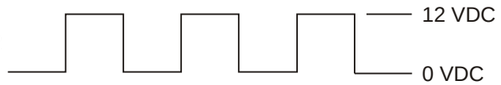


FIGURE 2



DRAWN G. SANWALD	DATE 11 FEB 2003	KV CONTROL & FEEDBACK
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0835 REV D
		SHEET 3 OF 3

REFER TO PAGE 3 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL: ⬡

GENERATOR CONTROL BOARD

FILAMENT SUPPLY BOARD

MAXIMUM FILAMENT CURRENT LIMIT CIRCUIT

SET MAX CURRENT

JW1

3 — 6.5 A

2 — 5.5 A

1

U1A

R76

-12V

ERROR AMPLIFIER, PWM REGULATOR, AND FILAMENT CURRENT DRIVERS

+35V

Q6

Q12

Q13

Q7

C22

-35V

U3

PWM REGULATOR

U4B

TP3

5

D6

R72

R95

R77

U1B

R71

R85

R84

TP4

4

TP21

+12V

K1

U48

D/A CONV

6

5

7

U52B

R206

R218

1

TP4

J14-6

J2-6

R65

J14-5

J2-5

R66

U2

CPLD

R227

R226

Q19

D38

+12V

2

TP29

J14-11

J2-11

U45

A/D CONV

R215

R213

3

TP28

J14-2

J2-2

R69

DATABUS D0..D7

FILAMENT CURRENT SENSE, RMS CONVERTER, AND FILAMENT FEEDBACK

U2B

U4A

U7

RMS CONVERTER

D12, 13
D 27, 28

T1

R21

K1

J5-2

J5-1

J5-4

J5-3

J4-2

J4-1

J4-4

J4-3

L

S

J2
CATHODE

C

L

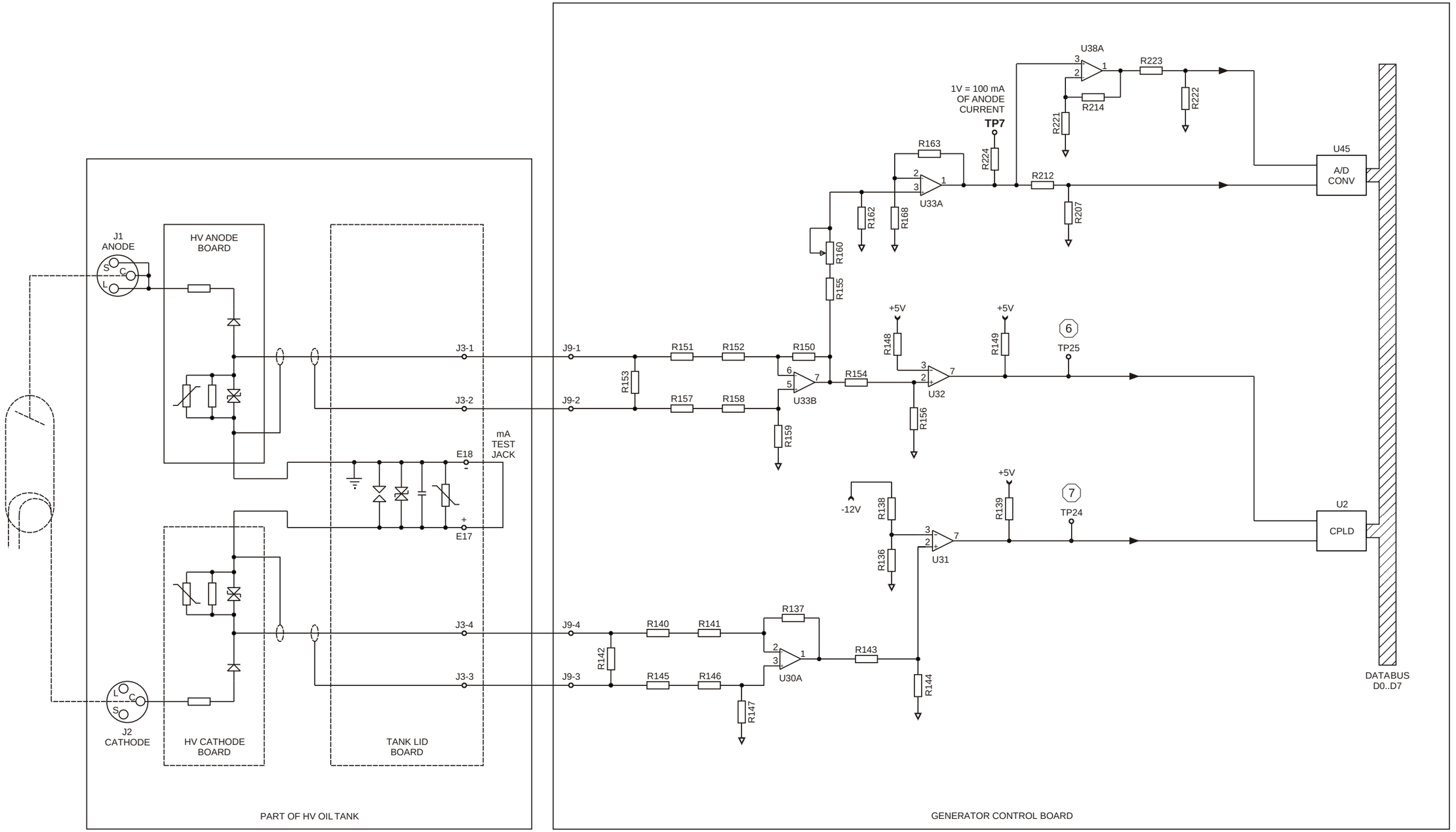
S

HV CATHODE BOARD

TANK LID BOARD

PART OF H.V. OIL TANK

DRAWN G. SANWALD	DATE 11 FEB 2003	**FILAMENT DRIVE & MA CONTROL**
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	**MD-0836 REV D**
		SHEET 1 OF 3



DRAWN G. SANWALD	DATE 11 FEB 2003	FILAMENT DRIVE & MA CONTROL
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0836 REV D
		SHEET 2 OF 3

NOTE REFERENCE	REMARKS
1	1 VOLT AT THIS TEST POINT = 1 AMP OF FILAMENT DEMAND.
2	“LOW” (APPROXIMATELY 0 VDC) ENERGIZES K1 ON THE FILAMENT SUPPLY BOARD (SMALL FILAMENT), “HIGH” (APPROXIMATELY +12 VDC) DE-ENERGIZES K1 (LARGE FILAMENT).
3	0.6 VOLT AT THIS TEST POINT = 1 AMP OF ACTUAL FILAMENT CURRENT.
4	1 VOLT AT THIS TEST POINT = 1 AMP OF ACTUAL FILAMENT CURRENT.
5	PWM OUTPUT. THE WAVEFORM WILL BE AS PER FIGURE 1 FOR LOW AND HIGH FILAMENT CURRENT DEMAND.
6, 7	A NARROW PULSE WILL BE PRESENT AT THESE TEST POINTS DURING SEVERE ANODE OR CATHODE OVER CURRENTS (I.E. TUBE OR TANK ARCS). REFER TO FIGURE 2. THESE PULSES MAY BE VERY DIFFICULT TO OBSERVE, AS THE HIGH VOLTAGE WILL SHUT DOWN WHEN A FAULT IS DETECTED, THUS REMOVING THE OVER CURRENT SITUATION.

FIGURE 1

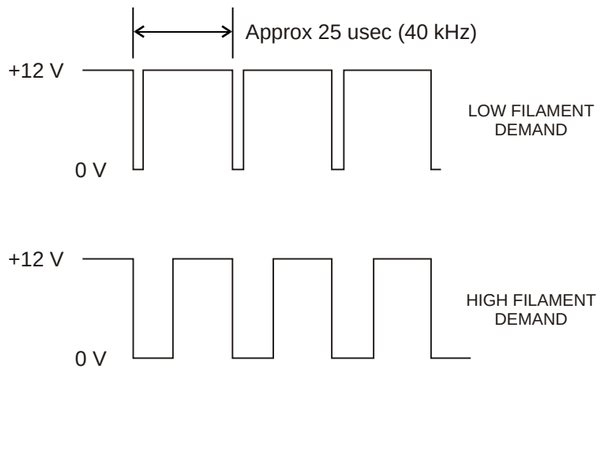
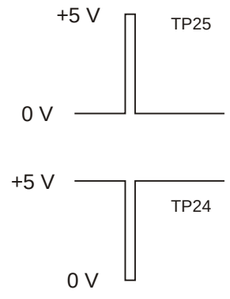
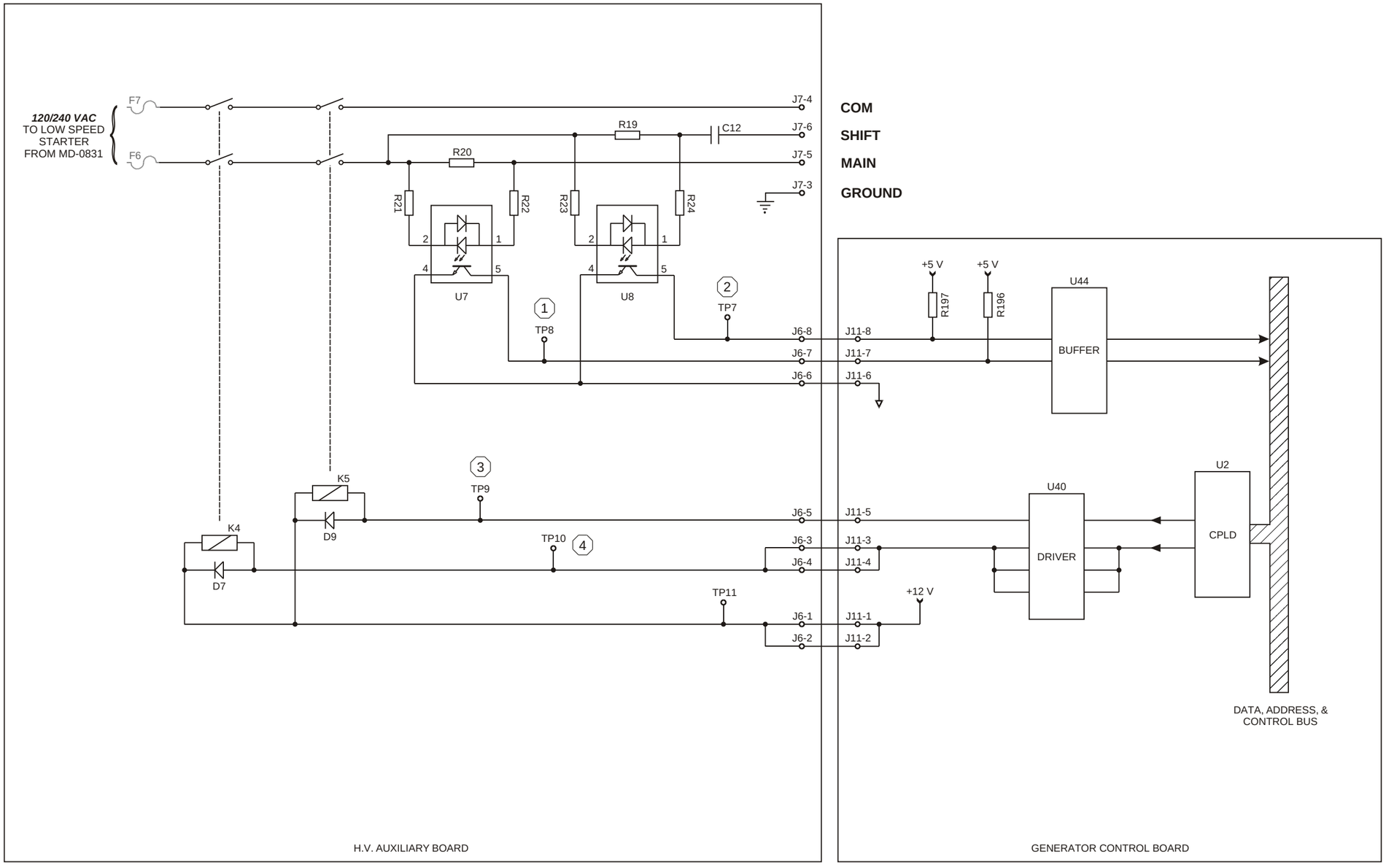


FIGURE 2



DRAWN G. SANWALD	DATE 11 FEB 2003	FILAMENT DRIVE & MA CONTROL
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0836 REV D
		SHEET 3 OF 3



COM

SHIFT

MAIN

GROUND

REFER TO PAGE 2 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL: ⬡

DRAWN G. SANWALD	DATE 11 FEB 2003	**LOW SPEED STARTER**
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	**MD-0837 REV C**
		SHEET 1 OF 2

NOTE REFERENCE	REMARKS
1	MAIN STATOR CURRENT SENSE. IF MAIN CURRENT IS LOW, THIS WILL BE APPROXIMATELY +5 VDC. PULSES AT 120 HZ WILL BE PRESENT AS SHOWN IN FIGURE 1 AT NORMAL STATOR CURRENT.
2	PHASE-SHIFT STATOR CURRENT SENSE. IF SHIFT CURRENT IS LOW, THIS WILL BE APPROXIMATELY +5 VDC. PULSES AT 120 HZ WILL BE PRESENT AS SHOWN IN FIGURE 1 AT NORMAL STATOR CURRENT.
3	“LOW” (APPROXIMATELY 0 VDC) FOR APPROXIMATELY 1.8 SEC DURING PREP, THEN PULSED LOW FOR 500 MSEC EVERY 5 SECONDS DURING PREP. REFER TO FIGURE 2.
4	“LOW” (APPROXIMATELY 0 VDC) ENERGIZES K4 ON THE H.V. AUXILIARY BOARD, (”HIGH”, + 12 VDC = NOT ENERGIZED). THIS RELAY IS ENERGIZED AFTER THE MAIN BUS CAPACITORS ARE CHARGED, APPROXIMATELY 10 SECONDS AFTER POWER-ON.

FIGURE 1

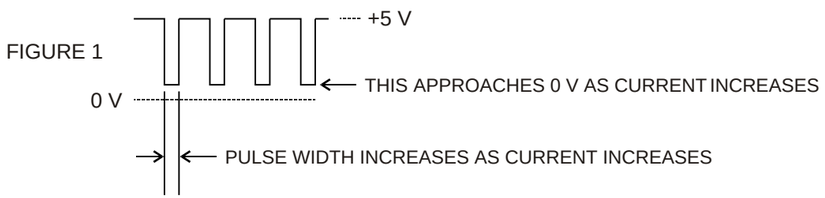
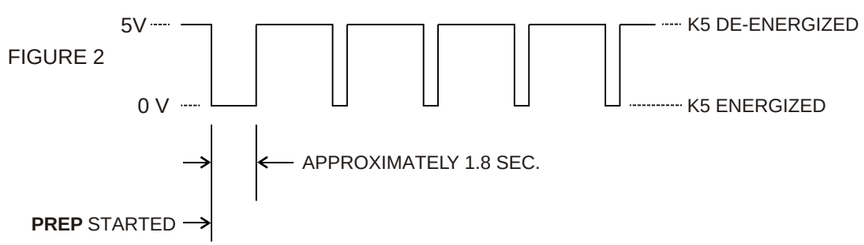
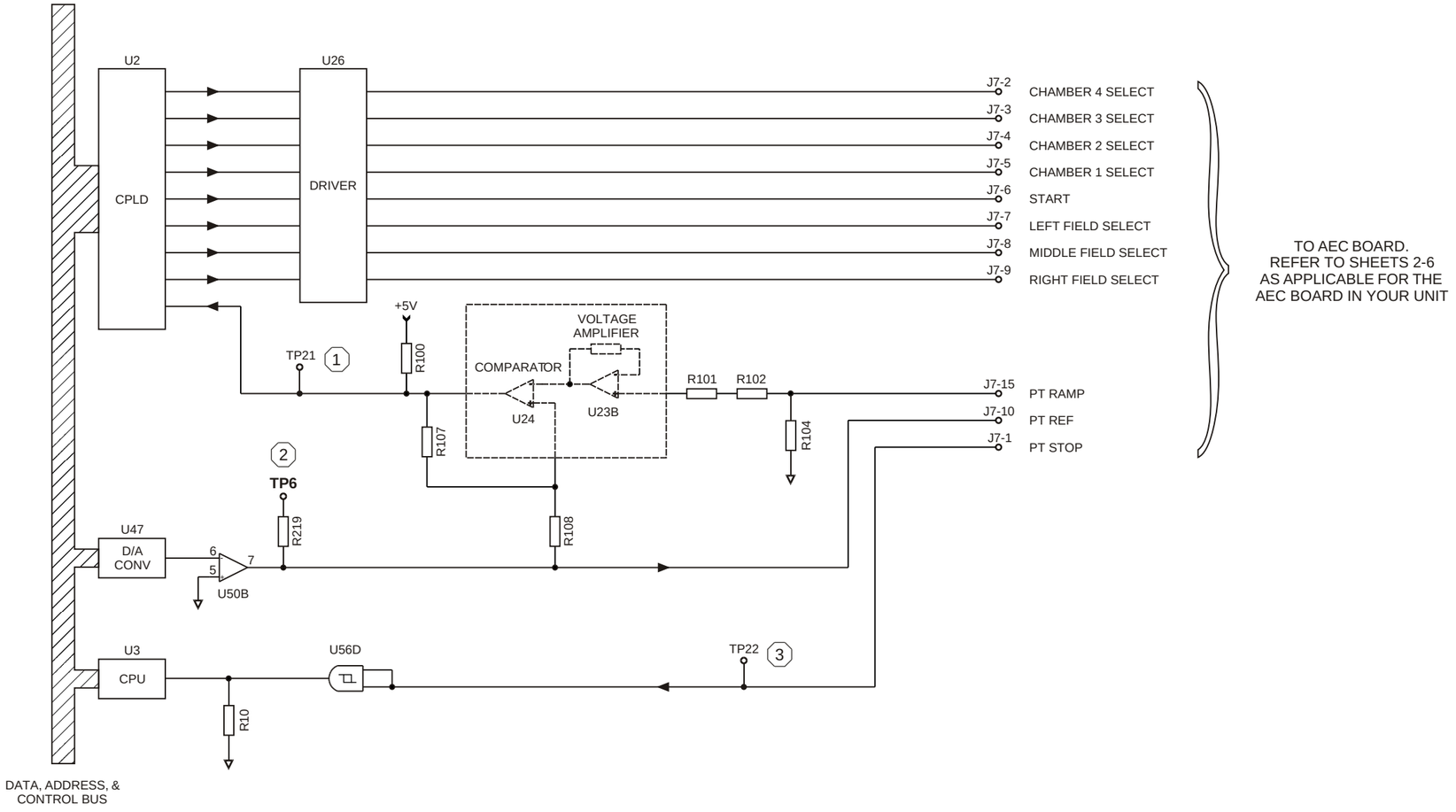


FIGURE 2



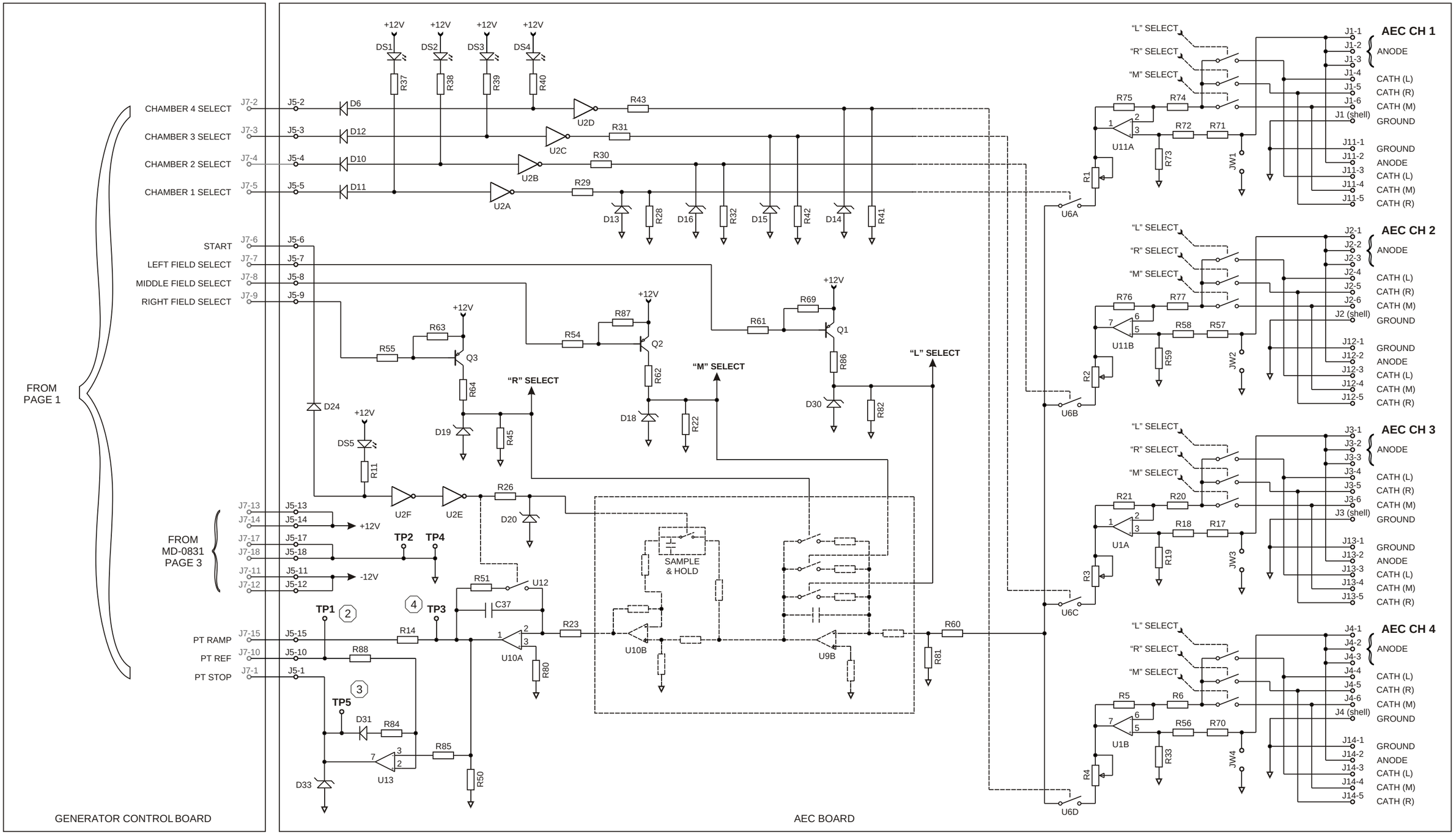
DRAWN G. SANWALD	DATE 11 FEB 2003	LOW SPEED STARTER
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0837 REV C
		SHEET 2 OF 2

REFER TO PAGE 7 FOR LOGIC LEVELS, NOTES, ETC, REFERENCED BY THIS SYMBOL: ⬡



GENERATOR CONTROL BOARD

DRAWN G. SANWALD	DATE 13 FEB 2003	AEC
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0838 REV D
		SHEET 1 OF 7



THIS SHEET APPLIES TO AEC BOARD ASSEMBLY 733347

REFER TO CHAPTER 3D FOR INSTALLATION AND CALIBRATION DETAILS.

DESIGNATES AN ANALOG SWITCH. THESE ARE I.C. "SWITCHES" THAT ARE SWITCHED ON / OFF BY APPLYING THE APPROPRIATE LOGIC LEVEL (0V = OFF, 12V = ON).

DRAWN G. SANWALD	DATE 13 FEB 2003	AEC
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0838 REV D
		SHEET 2 OF 7

FROM PAGE 1

CHAMBER 4 SELECT J7-2 J5-2 D6
CHAMBER 3 SELECT J7-3 J5-3 D5
CHAMBER 2 SELECT J7-4 J5-4 D12
CHAMBER 1 SELECT J7-5 J5-5 D4
START J7-6 J5-6 D11

+12V RN6B DS5
+12V RN6A DS1
+12V RN6C DS2
+12V RN6D DS3
+12V RN6E DS4

U3C RN4A CH 4
U3B RN3D CH 3
U3F RN3C CH 2
U3D RN3A CH 1
U3E U3A RN3B STRT

+12V +24V D16 Q1 * START

LEFT FIELD SELECT J7-7 J5-7
MIDDLE FIELD SELECT J7-8 J5-8
RIGHT FIELD SELECT J7-9 J5-9

+12V +24V D30 Q2 * LEFT
+12V +24V D40 Q3 * MIDDLE
+12V +24V D65 Q4 * RIGHT

6 TP22 +12V TP10 +500V * H.V.
TP24 +/-300V
TP9 R66 +45V
CONVERTER CIRCUIT 12 VDC TO 45 VDC AND 300 / 500 VDC
INCLUDES U7 AND T1
SET VALUE ** R79

FROM MD-0831 PAGE 3

TP18 J7-19 J5-19 +24V
TP23 J7-13 J5-13 +12V TP5 TP6 TP7
J7-17 J5-17
TP4 J7-11 J5-11 -12V

TP3 2
PT RAMP J7-15 J5-15 R54
PT REF J7-10 J5-10 RN4C
PT STOP J7-1 J5-1
D27 R56
RN4B
7 3 2 U6
D22

TP17 4
U4B U4A C11
S4 STRT R32 C4 *
CH 1 S3A R53 R11
CH 2 S3B R12
CH 3 S3C R13
CH 4 S3D R14
U2B
R1 S2A CH 1
R2 S2B CH 2
R3 S2C CH 3
R4 S2D CH 4

TP20 5
TP19 7
TP2 8
U2A U1A
STRT SAMPLE & HOLD

RIGHT JW8 LEFT
JW7
+/-300V H.V. +45V START MIDDLE L/R R/L
J1-2 +/-300 V
J11-1 J1-1 +/-300/+500 V
J1-3 +45 V
J11-4 J1-8 START
J11-3 J1-10 M FIELD SEL
J11-2 J1-9 L FIELD SEL
J11-6 J1-11 R FIELD SEL
J11-5 J1-12 SIGNAL
J11-9 J1-7 GROUND
TP11 9 R89
CH 1 S1D R90

AEC CH 1

RIGHT JW6 LEFT
JW5
+/-300V H.V. +45V START MIDDLE L/R R/L
J2-2 +/-300 V
J12-1 J2-1 +/-300/+500 V
J2-3 +45 V
J12-4 J2-8 START
J12-3 J2-10 M FIELD SEL
J12-2 J2-9 L FIELD SEL
J12-6 J2-11 R FIELD SEL
J12-5 J2-12 SIGNAL
J12-9 J2-7 GROUND
TP12 9 R67
CH 2 S1C R68

AEC CH 2

RIGHT JW4 LEFT
JW3
+/-300V H.V. +45V START MIDDLE L/R R/L
J3-2 +/-300 V
J13-1 J3-1 +/-300/+500 V
J3-3 +45 V
J13-4 J3-8 START
J13-3 J3-10 M FIELD SEL
J13-2 J3-9 L FIELD SEL
J13-6 J3-11 R FIELD SEL
J13-5 J3-12 SIGNAL
J13-9 J3-7 GROUND
TP13 9 R57
CH 3 S1B R58

AEC CH 3

RIGHT JW2 LEFT
JW1
+/-300V H.V. +45V START MIDDLE L/R R/L
J4-2 +/-300 V
J14-1 J4-1 +/-300/+500 V
J4-3 +45 V
J14-4 J4-8 START
J14-3 J4-10 M FIELD SEL
J14-2 J4-9 L FIELD SEL
J14-6 J4-11 R FIELD SEL
J14-5 J4-12 SIGNAL
J14-9 J4-7 GROUND
TP14 9 R35
CH 4 S1A R36

AEC CH 4

GENERATOR CONTROL BOARD

AEC BOARD

THIS SHEET APPLIES TO AEC BOARD ASSEMBLY 734614

REFER TO CHAPTER 3D FOR INSTALLATION AND CALIBRATION DETAILS.

THE +/- 12V OUTPUTS ON J1 TO J4 AND J11 TO J14 ARE NOT SHOWN ON THIS DIAGRAM. THESE ARE DETAILED ON THE CONNECTOR PIN OUT TABLES IN CHAPTER 3D.

** R79 ADJUSTS THE +45V, +300V, AND +500V OUTPUTS FROM THE DC TO DC CONVERTER CIRCUIT. REFER TO CHAPTER 3D FOR DETAILS.

DESIGNATES AN ANALOG SWITCH. THESE ARE I.C. “SWITCHES” THAT ARE SWITCHED ON / OFF BY APPLYING THE APPROPRIATE LOGIC LEVEL.

DESIGNATES A FACTORY CONFIGURED LOGIC OR SIGNAL LEVEL. AEC BOARDS ARE CONFIGURED AT THE TIME OF ORDER TO BE COMPATIBLE WITH THE SPECIFIED AEC CHAMBER(S). FOR EXAMPLE, THE **START** SIGNAL TO THE CHAMBER MAY BE FACTORY CONFIGURED TO BE ACTIVE LOW (0 V), ACTIVE HIGH (+12 V), OR ACTIVE HIGH (+24 V).

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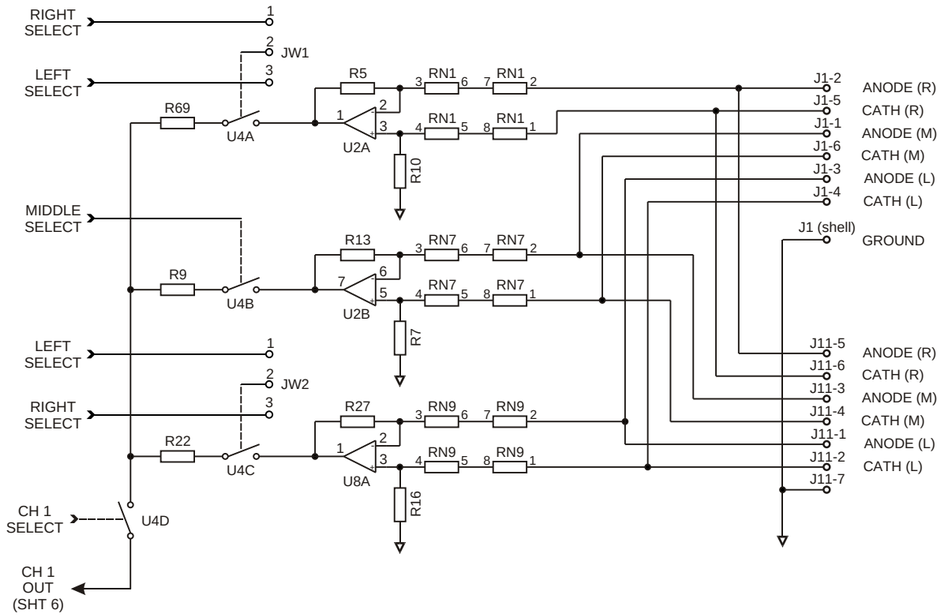
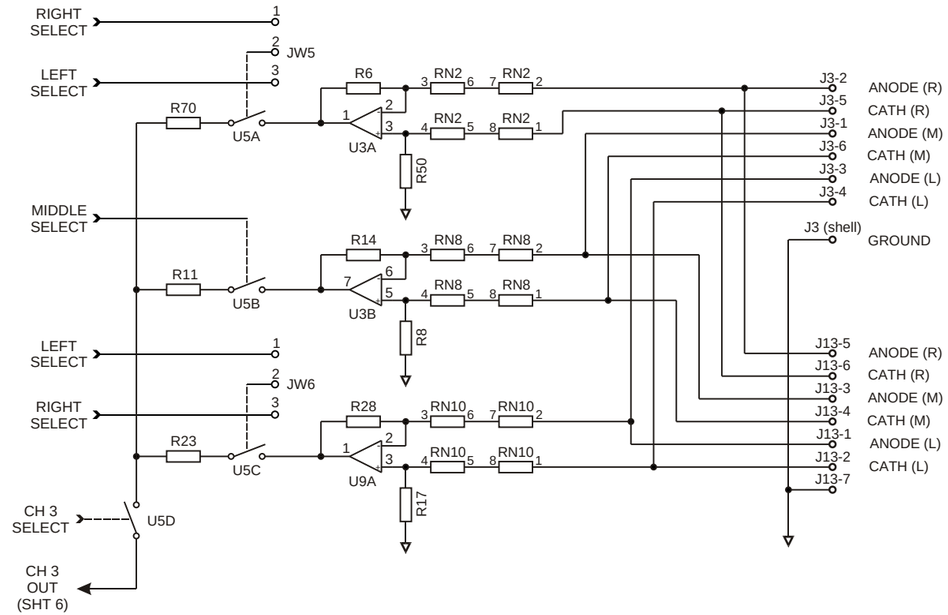
		SHEET 3 OF 7

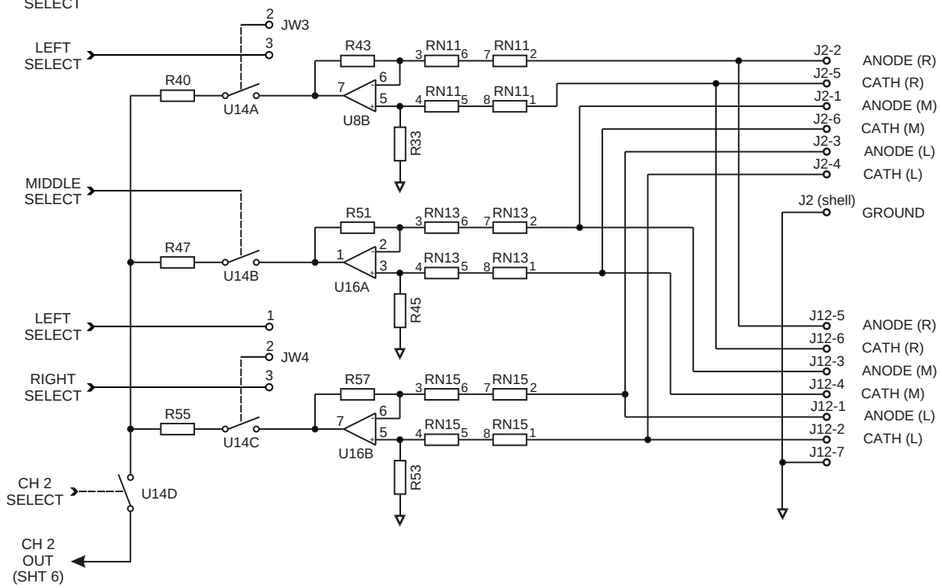
AEC CH 1



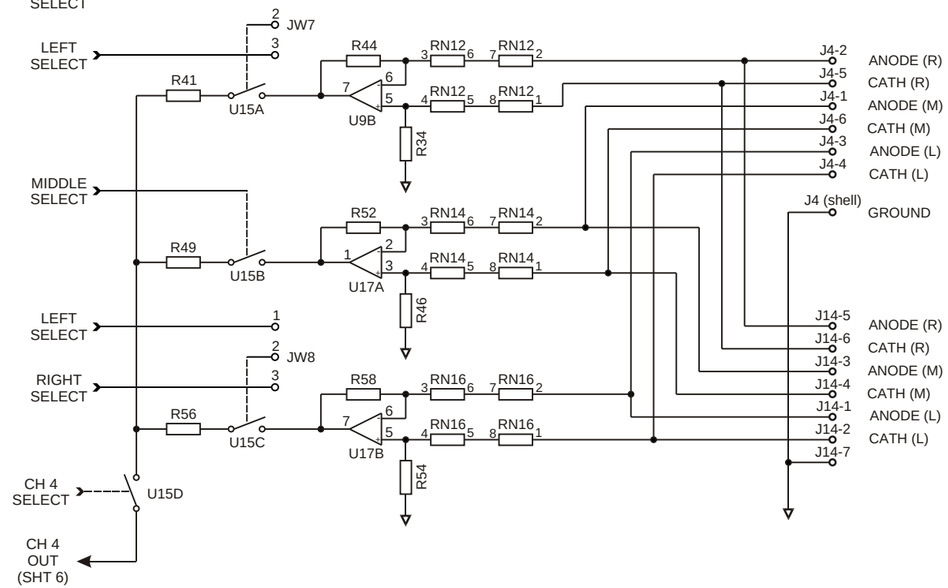
AEC CH 3



AEC CH 2



AEC CH 4



THIS SHEET APPLIES TO AEC BOARD ASSEMBLY 737992. THIS PAGE SHOWS THE INPUT CIRCUITS; THE SIGNAL PROCESSING CIRCUITS ARE CONTINUED ON THE NEXT PAGE.

REFER TO CHAPTER 3D FOR INSTALLATION AND CALIBRATION DETAILS.

DESIGNATES AN ANALOG SWITCH. THESE ARE I.C. “SWITCHES” THAT ARE SWITCHED ON / OFF BY APPLYING THE APPROPRIATE LOGIC LEVEL (0V = OFF, 5V = ON).

DRAWN G. SANWALD	DATE 13 FEB 2003	AEC
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		SHEET 4 OF 7

FROM PAGE 1

CHAMBER 4 SELECT
CHAMBER 3 SELECT
CHAMBER 2 SELECT
CHAMBER 1 SELECT
START
LEFT FIELD SELECT
MIDDLE FIELD SELECT
RIGHT FIELD SELECT

J7-2 J7-3 J7-4 J7-5 J7-6 J7-7 J7-8 J7-9
J5-2 J5-3 J5-4 J5-5 J5-6 J5-7 J5-8 J5-9

R67 R66 R65 R64 R63 R62 R61

+5V ×4 RN3 (8 7 6 5 / 1 2 3 4)
DS4 DS3 DS2 DS1
D28

U6 INVERTING BUFFER
2 3 4 5 6 7 8 9 → 18 17 16 15 14 13 12 11

CH 4 SELECT
CH 3 SELECT
CH 2 SELECT
CH 1 SELECT
LEFT SELECT
MIDDLE SELECT
RIGHT SELECT

CH 1 OUT (FROM SHT 5)
CH 2 OUT (FROM SHT 5)
CH 3 OUT (FROM SHT 5)
CH 4 OUT (FROM SHT 5)

FROM MD-0831 PAGE 3

J7-13 J7-17 J7-11
J5-13 J5-17 J5-11

+12V → U1 +5 V REGULATOR → +5V
-12V

TP6 TP7

PT RAMP
PT REF
PT STOP

J7-15 J7-10 J7-1
J5-15 J5-10 J5-1

TP4 (2) TP3 (4) TP5 (3)

R26 R19 R20 R12 R24 R30 R36 R39 R35 R38 R42 R59 R60

D37 D38

C31

U10 U11A

TP1 (10) TP2 (11)

Q2

CH 1 SELECT
CH 2 SELECT
CH 3 SELECT
CH 4 SELECT

R1 R2 R3 R4

R15 R18 R21

R25 R29 R68 R32 R37 R31

U12A U11B U12B

SAMPLE & HOLD

GENERATOR CONTROL BOARD

AEC BOARD

THIS SHEET APPLIES TO AEC BOARD ASSEMBLY 737992. THIS PAGE SHOWS THE SIGNAL PROCESSING CIRCUITS; THE INPUT CIRCUITS ARE SHOWN ON THE PREVIOUS PAGE.

REFER TO CHAPTER 3D FOR INSTALLATION AND CALIBRATION DETAILS.

DESIGNATES AN ANALOG SWITCH. THESE ARE I.C. “SWITCHES” THAT ARE SWITCHED ON / OFF BY APPLYING THE APPROPRIATE LOGIC LEVEL (0V = OFF, 5V = ON).

DRAWN G. SANWALD	DATE 13 FEB 2003	AEC
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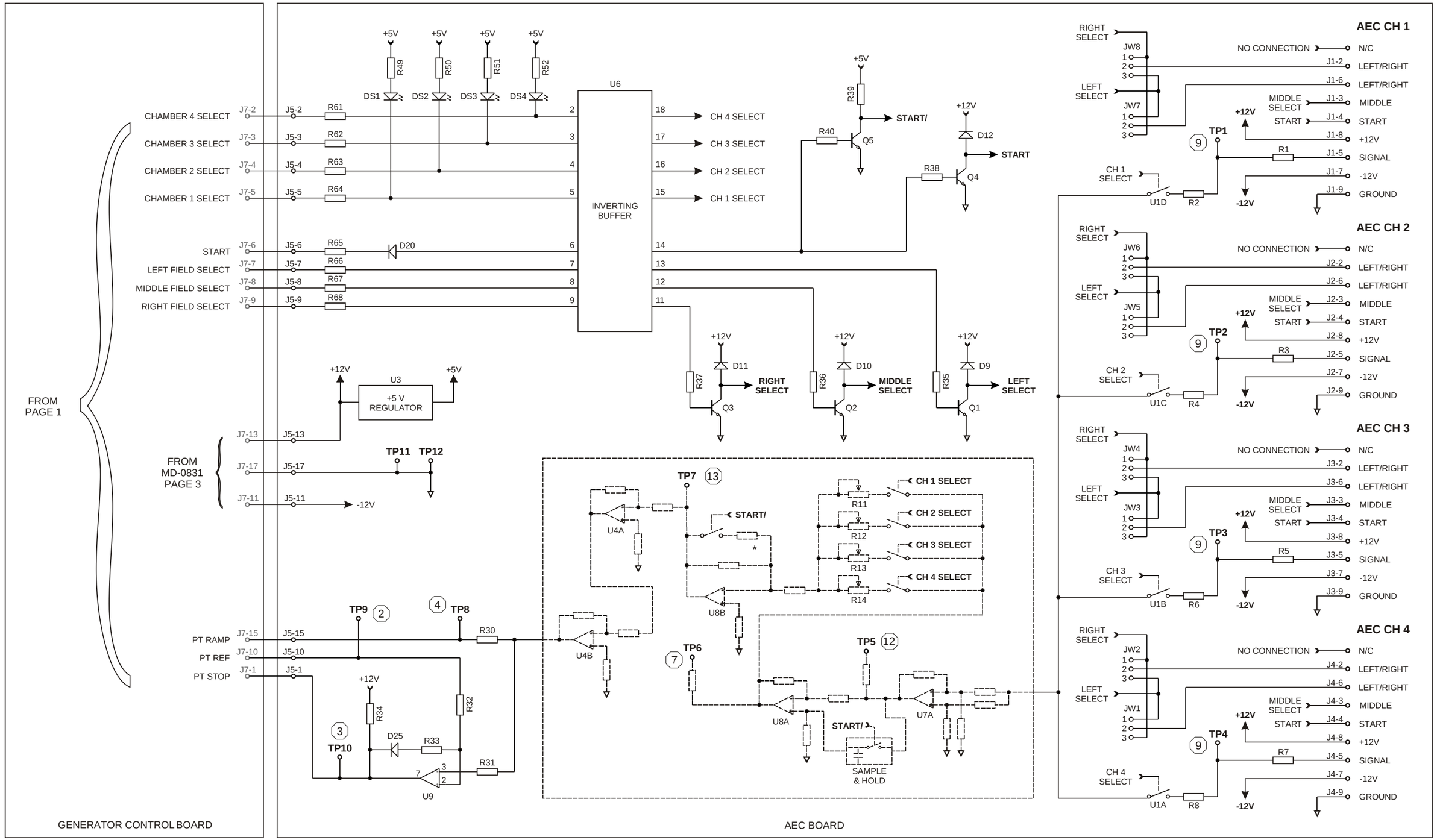
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0838 REV D
		SHEET 5 OF 7



THIS SHEET APPLIES TO AEC BOARD ASSEMBLY 737998

REFER TO CHAPTER 3D FOR INSTALLATION AND CALIBRATION DETAILS.

DESIGNATES AN ANALOG SWITCH. THESE ARE I.C. “SWITCHES” THAT ARE SWITCHED ON / OFF BY APPLYING THE APPROPRIATE LOGIC LEVEL.

DRAWN G. SANWALD	DATE 13 FEB 2003	AEC
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0838 REV D
		SHEET 6 OF 7

NOTE REFERENCE	REMARKS
1	GENERATES A PULSE PER FIGURE 1 WHEN THE AEC RAMP IS APPROXIMATELY 5 % OF THE AEC REFERENCE IF THE AEC RAMP IS ON THE CORRECT TRAJECTORY.
2	AEC REFERENCE VOLTAGE, 0 TO +10 VDC, DEPENDING ON AEC TECHNIQUE. THE LENGTH OF THE AEC EXPOSURE IS PROPORTIONAL TO THE AEC REFERENCE VOLTAGE.
3	AEC STOP (PT STOP) SIGNAL. THIS IS NORMALLY HIGH (APPROXIMATELY +5 VDC), SWITCHING LOW WHEN THE AEC RAMP = THE AEC REFERENCE VOLTAGE. REFER TO FIGURE 1.
4	AEC RAMP. THIS IS A SIGNAL RAMPING FROM 0 TOWARD +10 VDC, THE ACTUAL MAGNITUDE WILL DEPEND ON THE AEC TECHNIQUE. REFER TO FIGURE 2.
5	AS PER # 4.
6	PWM OUTPUT. THIS WILL BE VARIABLE WIDTH PULSES (PULSE WIDTH INCREASING AT INCREASING LOAD), UP TO A MAXIMUM OF 50% DUTY CYCLE. REFER TO FIGURE 4.
7	AEC RAMP OR DC VOLTAGE. THIS IS A RAMP OR DC VOLTAGE, DEPENDING ON AEC CHAMBER TYPE (INTEGRATING OR NON-INTEGRATING). REFER TO FIGURE 3.
8	AS PER # 7, EXCEPT THAT THE RAMP OR DC VOLTAGE WILL BE POSITIVE GOING AND NOT OF THE SAME MAGNITUDE.
9	THE VOLTAGE AT THIS TEST POINT IS THE OUTPUT OF THE AEC CHAMBER. REFER TO THE AEC CHAMBER MANUFACTURERS DOCUMENTATION FOR DETAILS.
10	THIS IS THE START SIGNAL. “HIGH” (5 VDC) = $\overline{\text{START}}$ = ANALOG SWITCHES CLOSED, “LOW” (0 VDC) = START = ANALOG SWITCHES OPEN.
11	THIS WILL BE A NEGATIVE DC VOLTAGE. THE MAGNITUDE OF THE DC VOLTAGE IS DEPENDENT ON THE AEC TECHNIQUE IN USE.
12	AS PER # 7, EXCEPT THAT THE POLARITY WILL BE POSITIVE.
13	THE POLARITY AND MAGNITUDE OF THE RAMP AT THIS POINT SHOULD BE APPROXIMATELY THE SAME AS THE **PT RAMP** OUTPUT. NOTE REFERENCE 4.

FIGURE 1

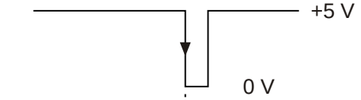


FIGURE 2

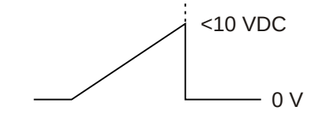
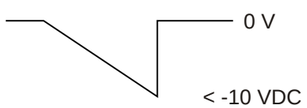
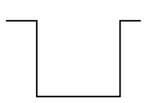


FIGURE 3



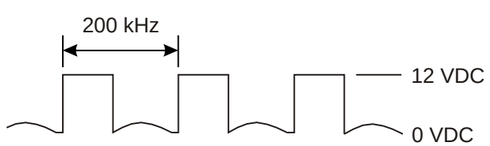
INTEGRATING AEC CHAMBERS

OR

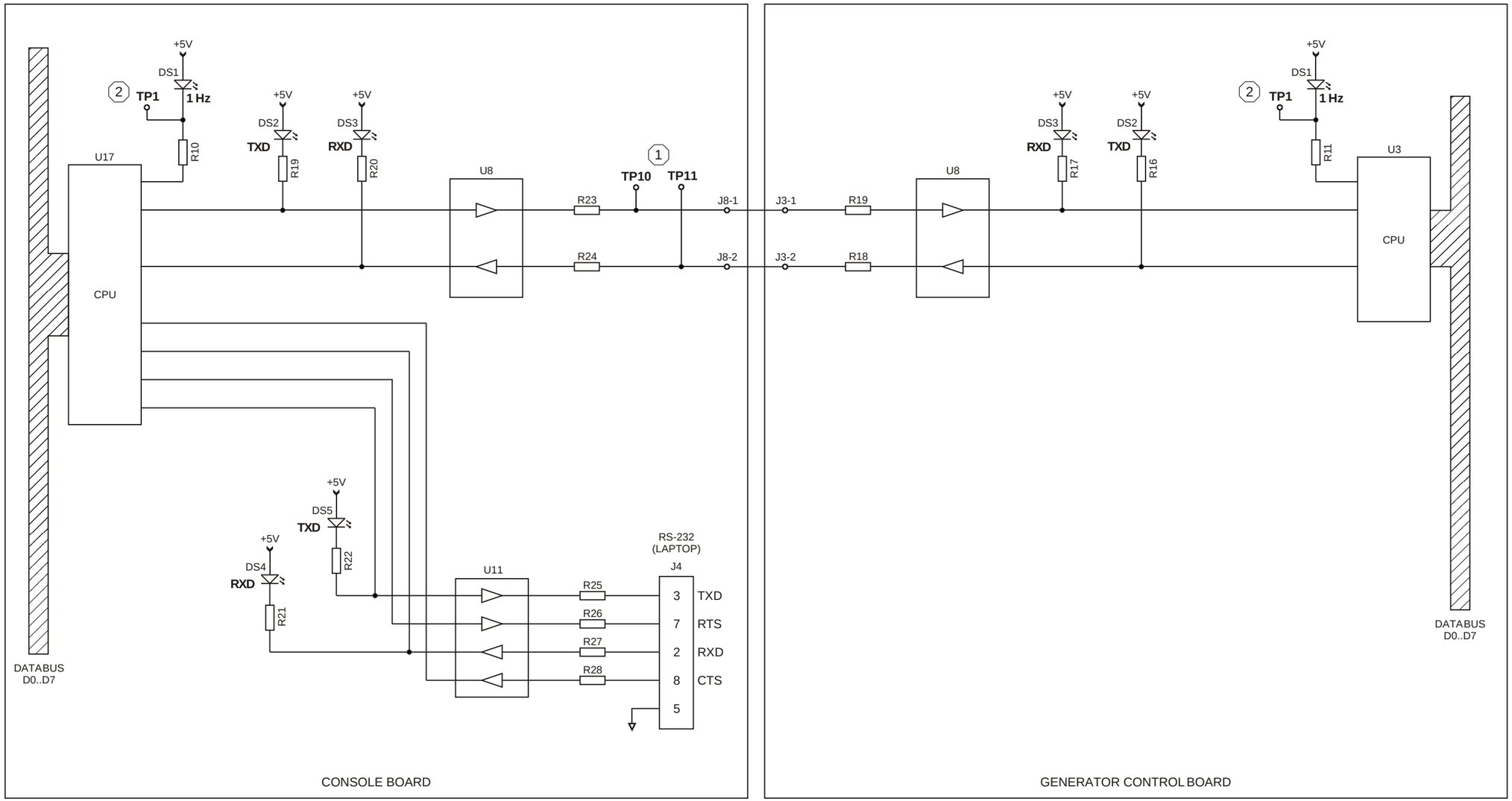


NON-INTEGRATING AEC CHAMBERS

FIGURE 4



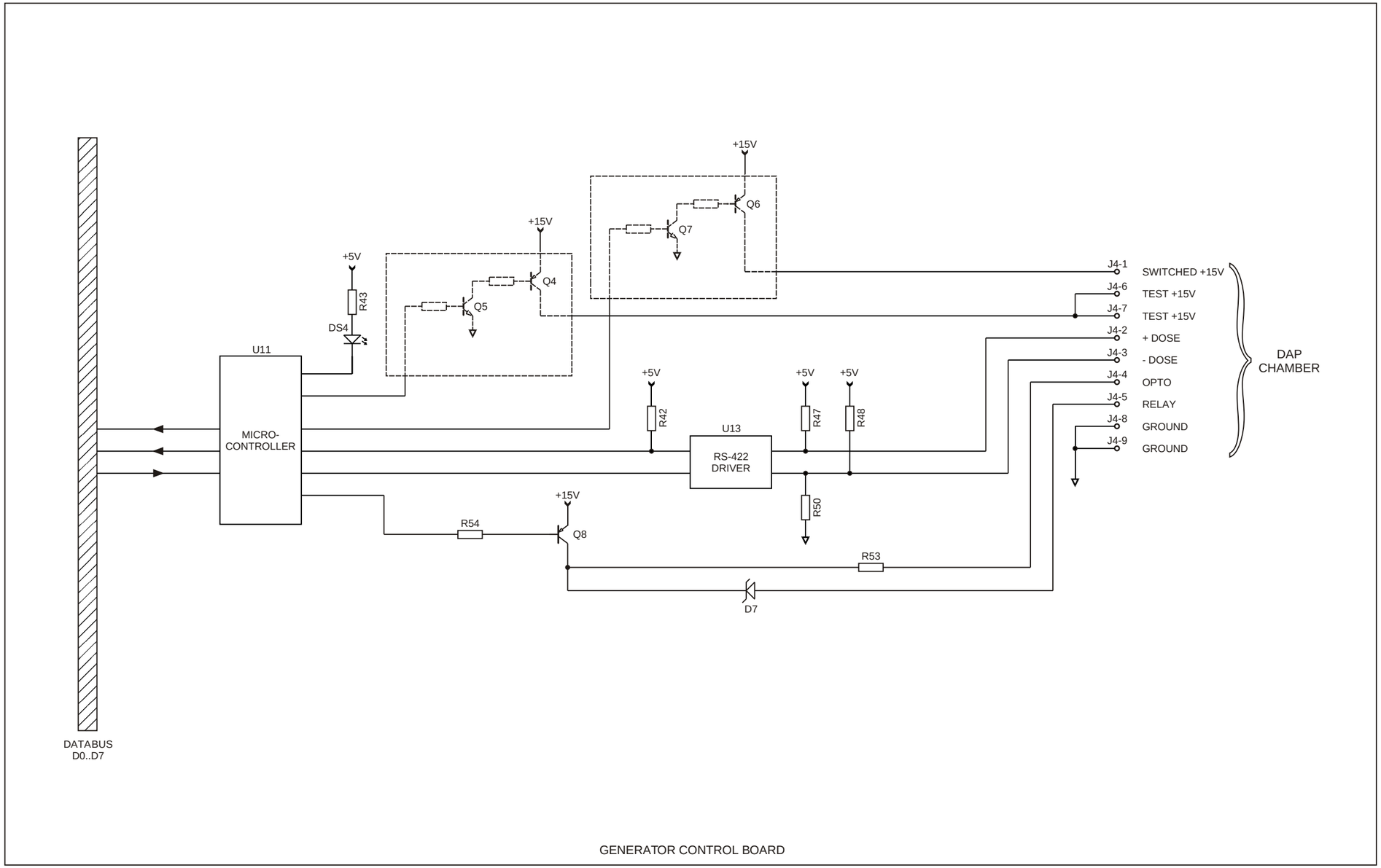
DRAWN G. SANWALD	DATE 13 FEB 2003	AEC
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0838 REV D
		SHEET 7 OF 7



1. A PULSE TRAIN WILL BE OBSERVED AT TP10, TP11 DURING CONSOLE - GENERATOR COMMUNICATION. THE TXD AND RXD LEDs ON THE CONSOLE BOARD AND GENERATOR CONTROL BOARD WILL FLASH TO INDICATE THE PRESENCE OF THESE PULSES.

2. THIS LED SHOULD FLASH AT A CONSTANT 1 HZ RATE, INDICATING THAT THE CPU IS FUNCTIONAL.

DRAWN G. SANWALD	DATE 11 FEB 2003	**SERIAL COMMUNICATIONS**
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	**MD-0839 REV B**
		SHEET 1 OF 1



DRAWN G. SANWALD	DATE 11 FEB 2003	DAP
CHECKED Steve Blake	18 FEB/03	
DES.\MFG.\AUTH. ED WOOD	FEB 13/03	MD-0840 REV B
		SHEET 1 OF 1

SEE MD-0837

THERMAL SWITCH INPUT
SEE MD-0833

SEE MD-0831,
SHEET 1, 2, 3

BUCKY 2 IN/OUT,
DOOR INTERLOCK
SEE MD-0833

BUCKY 1 IN/OUT,
INTERLOCK I & 2
INPUTS
SEE MD-0833

AC MAINS FROM
LINE FUSES

"SOFT START" BUS
VOLTAGE TO DC
BUS CAPACITORS

J4 J2 J7

PRIMARY OF
AUXILIARY TRANSFORMER
SEE MD-0831 SHEET 1, 2, 3

J9

H.V. AUXILIARY BOARD

J8

208 / 230 VAC
ASSEMBLY 736173 SCH 736171

24 VAC & 24
VDC OUT, ROOM
LIGHT OUT
SEE MD-0833

J11

J5

400 / 480 VAC
ASSEMBLY 737182 SCH 737180

J10

12 VDC DRIVE FOR MAIN
POWER CONTACTOR
SEE MD-0831 SHEET 1, 2, 3

SECONDARY OF
AUXILIARY TRANSFORMER
SEE MD-0831 SHEET 1, 2, 3

J3

J6

J1

SEE
SHEET
2

FROM DAP
CHAMBER
SEE MD-0840

J4

J3

J12

J15

J2 J1

J4

INTERNAL SYSTEM
GROUNDS

J3

X-RAY TUBE
HOUSING GROUND

HT TANK

J5

CONTROL BOARD
ASSEMBLY 736763
SCHEMATIC 736761

FILAMENT SUPPLY
BOARD
ASSEMBLY 731407
SCHEMATIC 731405

FOR FUTURE
USE

J8

J14

J1 J7 J2 J9 J11

J5
J13
J6
J10
J16

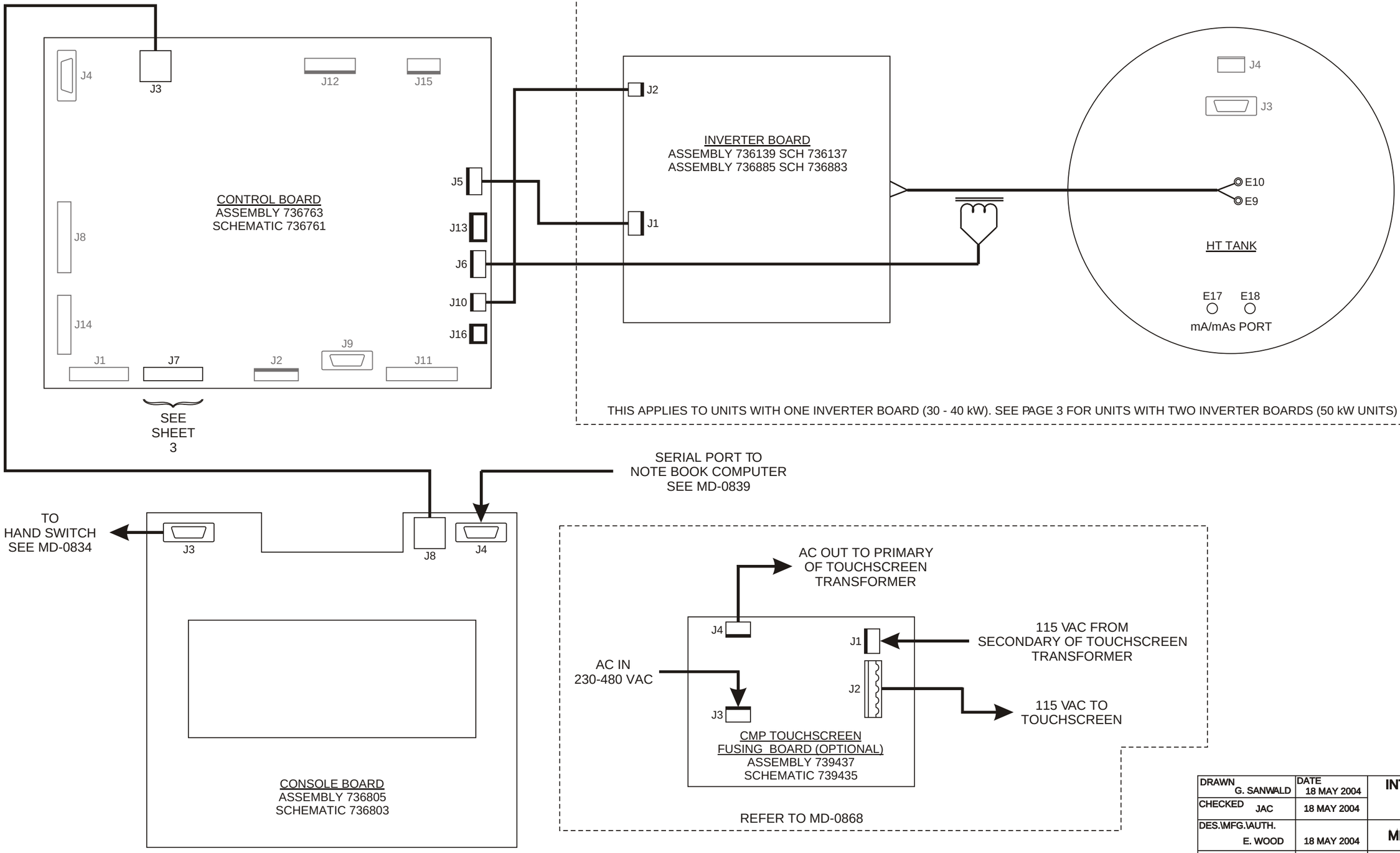
SEE
SHEET 2

FOR CPI
USE ONLY

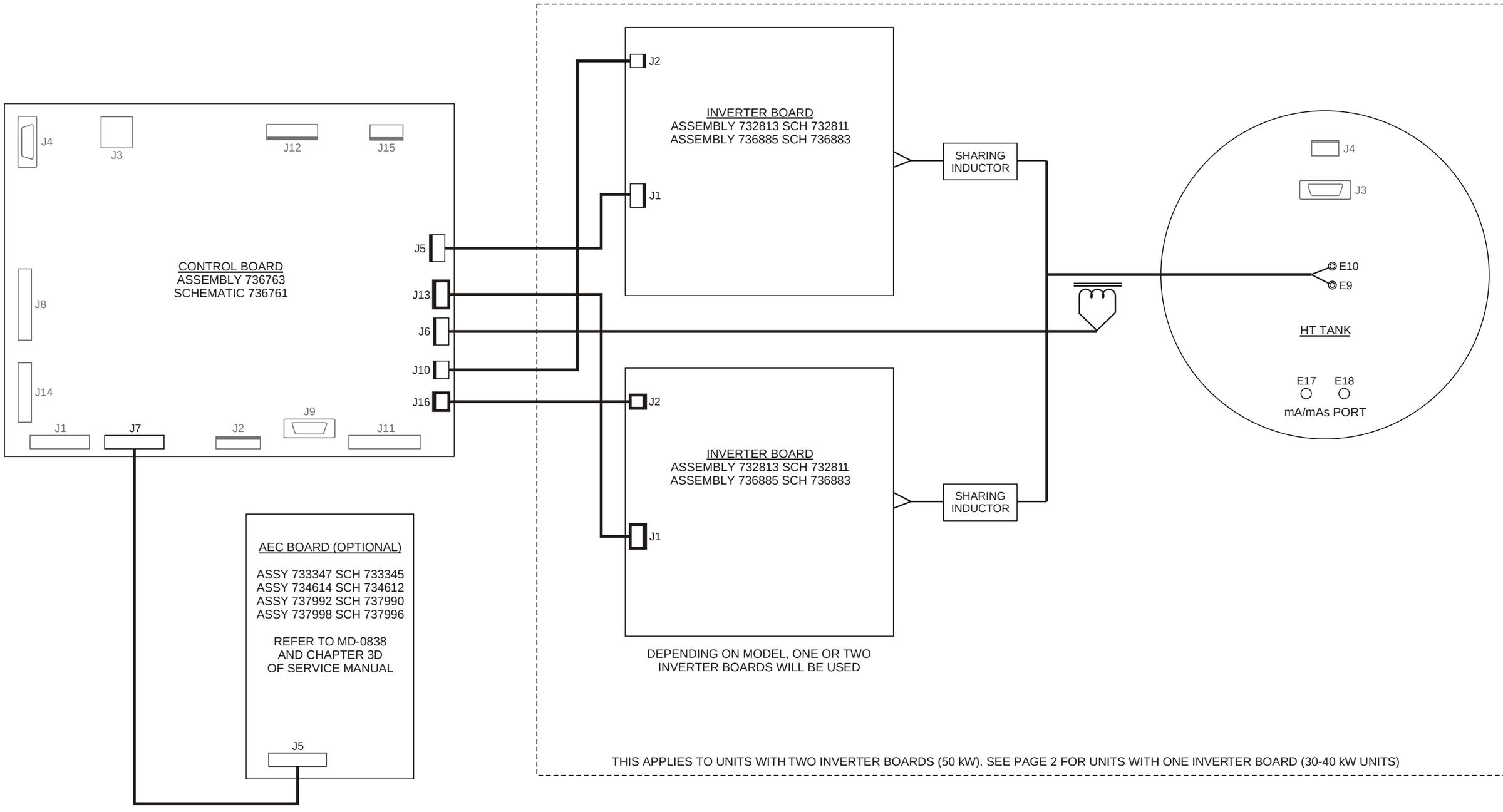
SEE
SHEET
3

FOR CPI
USE ONLY

DRAWN G. SANWALD	DATE 18 MAY 2004	INTERCONNECT DIAGRAM (CMP 200)
CHECKED JAC	18 MAY 2004	
DES.\MFG.\AUTH. E. WOOD	18 MAY 2004	MD-0845 REV D
		SHEET 1 OF 3



DRAWN G. SANWALD	DATE 18 MAY 2004	INTERCONNECT DIAGRAM (CMP 200)
CHECKED JAC	18 MAY 2004	
DES.\MFG.\AUTH. E. WOOD	18 MAY 2004	MD-0845 REV D
		SHEET 2 OF 3



DRAWN G. SANWALD	DATE 18 MAY 2004	INTERCONNECT DIAGRAM (CMP 200)
CHECKED JAC	18 MAY 2004	
DES.\MFG.\AUTH. E. WOOD	18 MAY 2004	MD-0845 REV D
		SHEET 3 OF 3