Chapter 2 Installation

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Introduction

This chapter contains instructions for unpacking and installing the CMP 200® and CMP 200® DR X-ray generators. This chapter also describes the basic wiring and setup of the generator (console, X-ray tube, AC mains, etc.), allowing for initial power-up of the generator. This is followed by tube seasoning and auto calibration.

Warning:

- Installation and servicing is to be performed only by competent, trained personnel who are familiar with the potential hazards associated with the equipment.
- Ensure the AC input power is locked out for servicing. Verify the absence of voltage. Wait minimum of 5 minutes for capacitors to discharge before beginning any servicing.
- Do not place any objects regardless of size or weight on the generator.
- Do not allow any obstruction of the cooling vents.

Unpacking

1. Inspect the shipping pack(s) for evidence of shipping damage.
   - The generator and the membrane control console (if applicable) are shipped in one pack.
   - The optional touchscreen console is shipped in a separate pack from the generator.
   If there is evidence of shipping damage, note this in the event that a damage claim is justified. Taking pictures of the damage is also recommended.

2. Remove the cardboard outer pack from the generator. See the cautionary note below before removing the pack.
   Caution: Open the cardboard pack(s) carefully. Sharp tools may damage the contents.

3. Set aside the cardboard pack.
   Warning: The generator mains cabinet (with HV Module) weighs approximately 135 pounds (61 kg). One person should not attempt to lift or move this assembly without proper equipment or assistance.

4. Remove and unpack the membrane control console, if included. This is strapped to the top of the generator. Then carefully lift the generator from the pallet.

5. Remove and unpack the optional hand switch, the optional mini-console or the optional mini-console with a pre-wired hand switch or an IPX8 certified foot switch, if included.

6. If applicable, unpack the optional touchscreen console along with the base and console cables.
7. Inspect all items for shipping damage, including loose hardware if applicable.
8. Unpack the manuals and any other paperwork that may be packed with the generator.
9. Keep the shipping packs. In case of shipping damage, place the unit(s) back in their shipping pack(s) and notify the carrier and the customer support department as described in chapter 1 of this manual.

Removing the Generator Cover

**Warning:**

- Before performing next steps, you must use good judgment and work practices to avoid injury and damage to equipment.

1. Remove and set aside the screws and washers securing the cover to the generator chassis.
2. Carefully lift the cover off the chassis.

Major Component Layout

Refer to the section [Generator Layout and Major Components](#) in Chapter 1, *Pre-installation* for major component identification and layout.

Equipment Placement

**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, *Pre-installation*.
- Air circulation: The main cabinet is fan cooled, therefore room-temperature air must be free to circulate around the cabinet. The cooling slots in the cabinet must be unobstructed at all times.
- A stable footing
- Close proximity to service-disconnect boxes. Cables should not be on the floor where they could be stepped on or tripped over.
- Do not locate the X-ray generator within the patient environment of the X-ray room.
Control Console

Note:

- Do not locate the control console where X-radiation may be present during setup / calibration or normal operation of the generator.
- You may choose to locate the console near the generator for initial programming and calibration temporarily. If so, complete the final console installation per this section when the generator installation is completed.

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

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

Membrane Console

Note:

- Some jurisdictions require that the console PREP and EXPOSE buttons be disabled if a hand switch is used. This is done by removing JW1 and JW2 from the console board as described below.

1. Turn the console upside down and place it on a clean, non-abrasive surface.
2. Remove and set aside the screws securing the console base to the molded case, and the hardware from the console ground stud.
3. Remove the console base (the metal bottom panel with the feet attached).
4. Locate and then remove JW1 and JW2 from the console board. Refer to the appropriate Figure in Chapter 1, Pre-installation, in the section Generator Layout and Major Components.
5. Do not discard the jumpers that were removed in the previous step. These will need to be reinstalled if the console PREP and EXPOSE buttons must be enabled in the future.
6. Reinstall the console base by reversing the previous steps.

Touchscreen Console

1. Carefully unpack the touchscreen console and the accessories and set the packaging aside. Verify that all components are undamaged.
2. Place the touchscreen console face down (see Figure 2-1) on a FLAT, CLEAN, NON-ABRASIVE surface.

![Connector Cover](image)

*Figure 2-1: Rear of the touchscreen*

**Anchoring the Generator to the Floor**

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

**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. Tightly secure the signal cables to the fan assembly cover lances with cable ties or equivalent cable fasteners.

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 (HV 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.

**Note:**
- *Excess lengths of cabling must never be bundled up and stored inside the generator.*

**Warning:**
- *To avoid the risk of electric shock, this equipment must only be connected to a mains supply with protective earth.*

### Control Console

**Membrane Console**

Figure 2-2 shows the designations of the connectors on the rear panel of the membrane and touchscreen consoles.

![Figure 2-2: Interface of control console](image)

1. **Note** the protective cover connected to the console cable. This is intended to protect the console cable connectors during shipping and while routing 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 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 damage. Please see Figure 2-3 for an example of such damage.

Route the generator end of the console cable into the generator cabinet via the cable access slot nearest to the generator control board. The cable must be routed as per Figure 2-5. Connect the generator end of the console cable to J3 on the generator control board.
Tightly secure the console cable to the fan assembly cover lance with a cable tie or an equivalent fastener. Secure console cable as shown in Figure 2-6.

Figure 2-3: A damage example of Console cable connector

2. Connect the free end of the console cable to J8 at the rear of the console. Leave sufficient slack in the cabling to the console to allow for future service and maintenance.

3. Two ferrite cores were added to the cable for the CPI membrane console to meet the Radiated Emission requirements. For units installed with an alternate console, similar ferrite cores may also be required. Contact Customer Support (contact information listed on the cover or the back of cover page) for additional details.

Touchscreen Console

The 15.6-inch touchscreen console is available in two support configurations: universal base and wall mount (optional). A special installation is required for the optional wall mount. The installation instruction, Touchscreen Console Installation Instruction for Wall Mount # 2990041300 P/N INS90589700, is provided with the wall mount kit.

Figure 2-4 illustrates the connectors and the covers of the 15.6-inch touchscreen console.
Figure 2-4 The cover of connectors of the touchscreen

1. Remove the two screws securing the Connector Cover to the touchscreen console (see Figure 2-4).
2. Remove the Connector Cover and place it and all hardware aside.
3. Route all the cables through the slots of the Connector Cover (see Figure 2-4).
4. Connect the console cable to the connector labeled AS “COMM1”.
5. Connect the digital imaging system cable (if required) to the connector labeled as “COMM2”.
6. Dress all the cables properly to avoid trip hazards, which may cause personal injury or console damage.
7. Tighten the two screws removed earlier to install the Connector Cover.
8. Route the generator end of the console cable (CPI part number: 90178000) and the digital imaging system cable into the generator cabinet via the cable access slot nearest to the generator control board. The cables must be routed as per Figure 2-5. Connect the generator end of the console cable to J3 and the digital imaging system cable to J25 (if required) on the generator control board.

Warning: Connecting the touchscreen console cable to any connector other than J3 on the generator control board may cause damage to the generator. Verify that the console cable has been connected correctly prior to powering up the generator.
Note: Leave sufficient slack in the cabling to the touchscreen to allow for future service and maintenance.

9. Tighten the screw locks to secure the “D” connectors fully.

10. Connect the console power supply, part number 789-136-9300 to the DC Power Jack on the touchscreen console (see Figure 2-4).

11. Check the part number of the supplied power cord based on the following list before plugging in the cord into wall outlet.
   - 819-989-3500 (Europe)
   - 819-989-3100 (UK)
   - 819-989-3200 (North America)
   - 819-989-4100 (China)

   Note: The type of power cord supplied will depend on the region of generator shipment. If a power cord is required for a different region, contact CPI for inquiries.

12. Connect the power cord to the wall outlet.

   Note: Do not alter the power cord or power cord terminals in any way. Do not remove or disable the ground connections. Failure to follow these instructions may lead to personal injury and / or equipment damage.

**Mini-Console (optional)**

1. Install the fan assembly cover and confirm the connection of the fan assembly plug.

2. Connect the ferrite core end of the mini console cable to J19 on the generator control board. Gently move the mini console cable out of the way to tighten the screw locks fully. Avoid moving the ferrite core when tightening the two screw locks.

   Note: To maximize EMI performance, it is very important that the ferrite core is properly installed on the mini console cable.

3. Route the generator end of the mini console cable into the generator cabinet via the cable access slot nearest to the generator control board. The cable must be routed as per Figure 2-5.
4. Secure the mini console cable to one of the lances on the fan assembly cover as shown in Figure 2-6. Use a cable tie or an equivalent fastener to secure the cable to the lance fully.

   Secure cable to lance with appropriate cable fastener

5. Route the mini console cable through the cable access slot on the side of the generator chassis as shown in Figure 2-7. Keep the mini console cable and HV cables separated to maximize EMI performance.
6. For the mini-console with a pre-wired IPX8 certified foot switch, there are 2 holes provided for rigid mounting to floor or equipment.

Note: Connecting the mini console cable to any connector other than J19 on the generator control board may cause damage to the generator control board and mini console board. Verify that the console cable has been connected correctly prior to powering up the generator.

Warning: When routing the foot switch cable (5 meter), consider prevent of trip and fall hazards.

Note: If the fan cover needs to be removed, always remember to secure cables with an appropriate cable fastener to lances after reinstalling the fan assembly cover.

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Figure 2-7: Cable routing

---

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 touchscreen console:

- COMM1 on the bottom of the touchscreen is for the interconnect cable to the generator.
- COMM2 is the serial port for use by the digital imaging system.
- ETHERNET 1 and ETHERNET 2 are standard 10/100 Ethernet connections, that should not be used.
- The two USB ports are for connection of external devices such as a DAP printer or a USB key.

For the mini-console, the short piece of console cable with the attached
15-pin “D” connector is for connection of the console cable that is connected to J19 on the generator control board.

Properly bundle signal cables together and tightly secure to the lances on the fan assembly cover to maximize the EMI performance.

Verify that signal cables are tightly secured to the lances on the fan assembly cover and at the cable access slots on the back on the generator. Loosely secured signal cables may adversely impact the EMI performance of the generator.

Two ferrite cores were added to the cable for the CPI membrane console to meet the Radiated Emission requirements. For units installed with an alternate console, similar ferrite cores may also be required. Consult Customer Support (contact information listed on the back of cover page) for additional details.

Incorrect connections or use of unapproved equipment may result in injury or equipment damage.

To Connect the DAP Printer:

**Note:**

- The compatible DAP printer model is SLP-440 only.

1. Refer to Figure 2-4.
2. Connect the DAP printer to the USB port (Figure 2-4) on the touchscreen console.
3. Perform the Installing the Connector Cover instruction described in this document before putting the console into service.
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 membrane 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.

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Connections (J3 membrane console)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X-ray</td>
</tr>
<tr>
<td>2</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>Prep</td>
</tr>
<tr>
<td>4</td>
<td>No Connection</td>
</tr>
<tr>
<td>5</td>
<td>Common (ground)</td>
</tr>
<tr>
<td>6</td>
<td>NOT USED</td>
</tr>
<tr>
<td>7</td>
<td>NOT USED</td>
</tr>
<tr>
<td>8</td>
<td>NOT USED</td>
</tr>
<tr>
<td>9</td>
<td>NOT USED</td>
</tr>
</tbody>
</table>

The optional Mini-console has a Hand Switch prewired to it.
X-ray Tube Stator Cable

The X-ray stator cable is the cable connecting between the X-ray generator and the X-ray tube. Although CPI does not supply this cable, **CPI requires the cable to meet the following requirements:**

1. The cable must be shielded.
2. The cable must meet 600 VAC-voltage rating.

The following two procedures will guide the connection of the X-ray stator cable for the low-speed starter and the dual-speed starter.

**Connecting the X-ray Tube Stator Cable for Low-speed Starter**

The J7 connector is designed for connecting the X-ray tube stator cable for the low-speed starter. It is located on the HV auxiliary board as shown in Figure 2-8.

![Figure 2-8: the connector of the X-ray tube stator cable for the low-speed starter](image)

Table 2-2 shows the pin information of the J7 connector.
Table 2-2: Pin Information of J7 Connector on H.V Auxiliary Board

<table>
<thead>
<tr>
<th>Function</th>
<th>Connect to</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHIFT</td>
<td>J7-6</td>
</tr>
<tr>
<td>MAIN</td>
<td>J7-5</td>
</tr>
<tr>
<td>COMMON</td>
<td>J7-4</td>
</tr>
<tr>
<td>GROUND</td>
<td>J7-3</td>
</tr>
<tr>
<td>THERMAL SWITCH (Term 1)</td>
<td>J7-2</td>
</tr>
<tr>
<td>THERMAL SWITCH (Term 2)</td>
<td>J7-1</td>
</tr>
</tbody>
</table>

To connect the X-ray tube stator cable for the low-speed starter:

1. Route the X-ray tube stator cable towards the J7 connector on the HV auxiliary board as shown in Figure 2-8.
   
   Note: The shield for the stator cable must be grounded properly at both tube end and the generator end of the cable.

2. Connect the shield ground of the stator cable to J7-3 on the HV auxiliary board.

3. Connect the X-ray tube stator cable to J7 on the HV auxiliary board as per Table 2-2.

4. Perform the procedure, checking the Connection of the X-ray Tube Stator Cable, described in the following section.

Connecting the X-ray Tube Stator Cable for Dual-speed Starter

The connector is designed for connecting the X-ray stator cable for the dual-speed starter is located on the back of the DSS board mounting plate as shown in Figure 2-9.
Figure 2-9: the connector of the X-ray stator cable for the dual-speed starter

1. Route the X-ray tube stator cable towards the X-ray stator cable connector on the back of the DSS board mounting plate. Refer to Figure 2-9.

   Note: The shield for the stator cable must be properly grounded at both tube end and the generator end of the cable.

2. Connect the shield ground of the stator cable to the ground connector on the mounting plate as shown in Figure 2-9.

3. Connect the X-ray tube stator cable to the X-ray stator cable connector as shown in Figure 2-9.

4. Secure the X-ray tube stator cable to the generator chassis using suitable tie-wraps or equivalent fasteners.

5. Perform the procedure, checking the Connection of the X-ray Tube Stator Cable, described in the following section.
Checking the Connection of the X-ray Tube Stator Cable

1. Check that the stator cable (SHIFT, MAIN, COMMON, GROUND, and THERMAL SWITCH) has been correctly connected and tightened as appropriate. Connection errors might cause X-ray generator or X-ray tube damage.

2. With an ohmmeter, measure the resistance between the Main, Common, and Shift connector pins for Tube. Record the results in Table 2-3.

<table>
<thead>
<tr>
<th>Table 2-3: Example Stator Resistance Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Pins 1 &amp; 2 (Common to Main)</td>
</tr>
<tr>
<td>Resistance, ohms</td>
</tr>
</tbody>
</table>

3. Confirm that the results agree with the resistances documented in the tube stator datasheet provided by the X-ray tube manufacturer.

   Note: The sum of the resistance (Common to Main) and Resistance (Common to Shift) approximately equals to the resistance (Shift to Main). The smallest resistance should be the resistance (Common to Main).

Power Line Mains

**Warning:**

Connection of the mains input cable must be done by a licensed electrician in accordance with the local electrical code.

**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.

**Warning:**

When Neutral is used in a single phase installation, ensure the Neutral wire is connected to the "N/L2" position of the fuse block. Failure to do so can result in increased risk of electrical shock.

Refer to [Generator Power Requirements](#) of Chapter 1, *Pre-installation*, for generator power and power line requirements.
Refer to AC Mains Termination Table for required length

Figure 2-10: Termination of AC mains cable

<table>
<thead>
<tr>
<th>Generator Configuration</th>
<th>Ground</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 kW and 80 kW, 400/480 VAC, 3P Configurations</td>
<td>7 (178)</td>
<td>3.25 (83)</td>
<td>3.25 (83)</td>
<td>4.25 (108)</td>
</tr>
<tr>
<td>50 kW 208/230 VAC, 3P Configurations</td>
<td>7 (178)</td>
<td>5 (127)</td>
<td>4.75 (121)</td>
<td>5 (127)</td>
</tr>
<tr>
<td>32 kW/40 kW/50kW 400/480 VAC, 3P Configurations</td>
<td>7 (178)</td>
<td>5.75 (146)</td>
<td>5.5 (140)</td>
<td>5.75 (146)</td>
</tr>
<tr>
<td>32 kW/40 kW, 208/230 VAC, 1P Configurations</td>
<td>11 (280)</td>
<td>5.5 (140)</td>
<td>5.5 (140)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Dimensions are in inches (mm)

1. Refer to Figure 2-11A and temporarily disconnect the fan by unplugging the fan power-connector and the EMC filter connector at the fan cover.
2. Refer to Figure 2-11A. Remove and set aside the hardware securing the assembly to the generator. Then remove the assembly and set it aside.

3. Temporarily remove the safety cover from the main fuses (if fitted). This must be reinstalled after the AC mains connections are made, before reinstalling the fan and EMC filter assembly.

4. Prepare the AC mains cable as per Figure 2-10 and the **AC Mains Termination Table**, and then strip the ends of the leads to the required length.

5. Pass the AC mains cable through the cable clamp (see Figure 2-11B) at the upper rear of the generator cabinet, adjacent to the main fuses. Tighten the clamps to secure the cable.
6. Connecting the mains cable to the fuse holder

- For 3-phase generators: Connect the ground wire of the mains power cable to the chassis ground connector (see Figure 2-11B), and connect the other wires to the terminals on the main fuse holder shown in Figure 2-11 C.
- For single-phase generator: Route the three wires of the mains power cable through the two ferrites inside the ESD bag located above the HVM. Connect the ground wire to the ground connector and the other wires to the terminals on the mains fuse holder.
1) Ferrules should be used on the ends of the AC mains wires. These must be supplied by the installer.

2) For China only, the power cable must be CCC approved.

7. Re-install the safety cover to the main fuses.

8. Refer to Figure 2-11D and gently reinstall the fan and EMC filter assembly to the generator. **Note:** There are cables and wires underneath the fuse block. When reinstalling the assembly, do not pinch cables or wires.
Figure 2-11D: Install the fan and EMC filter assembly

9. Secure the fan and EMC filter assembly to the chassis.

10. Reconnect the fan power cable to the fan power connector and the EMC filter cable to the EMC filter connector.

   **Warning:** The EMC filter installed inside the metal cover minimizes conducted and radiated emissions. This function will be disabled if the EMC filter cable is not reconnected to the EMC filter connector.

   **Warning:** The forced-air cooling fan is designed to operate in an ambient temperature of expected degrees (Celsius or Fahrenheit) in order to maximize performance and reliability of the generator. Failure to reconnect the fan will result in generator malfunction and error messages.

11. Do not switch on mains power until requested to do so in a later step.
High Voltage Cables

The X-ray tube should be mounted in its normal fixture i.e. tube stand or other device. To connect the High Voltage Cables:

Refer to Figure 2-12A and Figure 2-12B to install the HV cables:
1. Remove the dust caps that cover the HV (High Voltage) sockets on the HVM (high voltage module).
2. Check for debris inside the HV (ANODE and CATHODE) Sockets on the top of the HVM. If there is any debris found inside the sockets, it must be carefully removed.
3. Verify that the Plug Bodies are in good condition i.e., no cracks. The contact pins must be sufficiently opened to make good contact with the mating connectors inside the HV Socket.
4. Carefully clean the Plug Bodies of the HV cables by using dry lint-free paper towels.
5. Apply a thin coat of moisture-dissipating grease to each Plug Body.
6. Carefully clean the HV sockets by using dry lint-free paper towels.
7. Carefully observe the polarity (ANODE and CATHODE) for the HV Sockets and HV cables.
8. To connect the HV cables:
   1) In the ANODE (+) HV Socket, first identify the Slot in the socket and visually align it with the Key on the ANODE Plug Body as shown in Figure 12B. Then insert and push the Plug Body into the socket until it is firmly seated.
   2) In the CATHODE (-) HV Socket, first identify the Slot in the socket and visually align it with the Key on the CATHODE Plug Body as shown in Figure 12B. Then insert and push the Plug Body into the socket until it is firmly seated.

Warning: The method, described in the next step, of how to tighten the threaded rings to the HV sockets must be performed by hand only. Use of mechanical tools such as a wrench may result in over-tightening, which may rotate the HV socket. This rotation may seriously damage the high voltage module (HVM) or the X-ray generator.

9. Use the method described below to tighten the two Threaded Rings to the two HV Sockets.
   Note: A substantial amount of force is needed to secure the threaded ring of the HV connectors into the HVM interface. There is a risk of muscle strain. Avoid awkward posture and practice sound ergonomic procedures when performing this task.
   1) Tighten the Threaded Rings by hand only and ensure there is no gap between the Threaded Ring and the HV Socket, but do not over tighten.
   2) Using a hex key (1.5 mm), tighten the Set Screw, which will secure the Threaded Ring and ensure a good contact between the HV cable and the HVM.
10. After verifying normal X-ray generator operations, re-tighten the Threaded Rings connecting to the HV Sockets and the X-ray tube.

X-Ray Tube Housing Ground

In addition to the X-ray tube manufacturers recommended tube grounding procedure, a separate ground wire (10 AWG, 6 mm²) must be connected from the X-ray tube housing to one of the ground studs on the HV module. Refer to Figure 2-12A 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.

Room Equipment

Refer to Chapter 3, Interface and Programming, for connection of Buckys, interlocks, room lights, the DR imaging system (if applicable), DAP, collimator lamp and system locks power, and to Chapter 4, AEC Calibration, for installation and calibration of AEC. It is suggested that these items not be connected until 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.

Emergency Power Off / Power Distribution Relay

To connect an external emergency power-off switch, disconnect the jumper from J2-1 to J2-2 on the generator control board. Then connect the emergency-off switch to J2-1 and J2-2. Refer to MD-0928 (System ON) in Chapter 10, Functional Drawings.

For installations where installer-supplied auxiliary power distribution circuits are added to the generator, 24 VDC is available on the high voltage auxiliary board to drive the coil of the power distribution relay. Connect the coil to J2-3 (+) and J2-4 (ground). Refer to MD-0927 (DC Bus and Power Distribution) in Chapter 10, Functional Drawings. The maximum current available from this source is 100 mA.

Warning:

- The Emergency Power Off switch does not remove the AC mains input voltage. High voltages still exist inside the generator in the area of the auxiliary transformer and the HV auxiliary board. Ensure that the AC mains disconnect is locked out in the OFF position and all capacitors are discharged before servicing.
Safety Interlocks

The room door-interlock switch must be wired to the generator as described in Inputs of Section Wiring to Inputs and Outputs in Chapter C before the generator is powered up. This switch must provide an open contact when the door is open.

**Note:**
- The installer must provide a visual indication of the ON / OFF state of each external device that can prevent the generator from emitting radiation, or that can stop the generator from emitting radiation, or both.

Jumper Settings on the HV Auxiliary Board

The jumpers on the HV Auxiliary board are used to configure the settings for a boost voltage for the Low Speed Starter and a Bucky supply voltage.

The Low Speed Starter is integrated into the HV Auxiliary board. The boost voltage for this starter based on the X-ray tube stator can be set to:

120 VAC / 240 VAC (factory default)

The Bucky supply voltage can be set to:

110 VAC / 230 VAC / +24 VDC

**Warning:**
- High voltage is present on the HV auxiliary board at all times that the generator is switched on. Take appropriate precautions when servicing this board.

**Note:**
- The rotor boost time may be adjusted in the range of 0.9 second to 3.9 seconds. This should be set per the X-ray tube manufactures recommendation, or as required to ensure proper anode rotation at the end of the prep cycle.
- Refer to rotor boost, under generator limits in Chapter 3, Interface and Programming, for the procedure to set the rotor boost time.
- The low speed starter boost must not exceed 5 consecutive boosts, and must be allowed by a minimum 10-second wait period.
Figure 13: Bucky Select and Rotor Boost Jumpers

Settings the Bucky Voltage and the Boost Voltage on the HV Auxiliary Board

<table>
<thead>
<tr>
<th>Connect</th>
<th>To</th>
<th>To select</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead 1</td>
<td>E14 and E15</td>
<td>120 V Boost Voltage</td>
</tr>
</tbody>
</table>

*Changing 120 V to 240 V Boost Voltage or vice versa: Remove lead 1 or 4 from the board and then

Perform “Verify the Low Speed Stator” in the Acceptance Testing chapter of this manual.

Note: The leads shown at left can be found on the HV Auxiliary board and inside the static bag (see Figure 13).

*Note: Before continuing, refer to Table 1A, in the X-ray Tube Stator Compatibility Tables supplement. Note the phase-shift capacitor value is compatible with your X-ray tube stator and determine the boost voltage for the desired X-ray tube. If the value of the phase-shift capacitor (See Figure 1-4) is not compatible with the desired X-ray tube stator type or the desire tube type cannot be found in Table 1A, contact CPI product support for assistance.
Changing 110 V / 230 V to +24 VDC Bucky Voltage: Remove leads 5 and 6 from the board and then

<table>
<thead>
<tr>
<th>Connect</th>
<th>To</th>
<th>To select</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead 2</td>
<td>E8 and E10</td>
<td>Secondary Return</td>
</tr>
<tr>
<td>Lead 3</td>
<td>E5 and E11</td>
<td>+24 VDC Bucky Voltage</td>
</tr>
</tbody>
</table>

Changing +24 VDC to 110 V / 230 V Bucky Voltage: Remove leads 2 and 3 from the board and then

<table>
<thead>
<tr>
<th>Connect</th>
<th>To</th>
<th>To select</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead 5</td>
<td>E7 and E8</td>
<td>Earth Ground</td>
</tr>
<tr>
<td>Lead 6</td>
<td>E5 and E9</td>
<td>110 V Bucky Voltage</td>
</tr>
<tr>
<td></td>
<td>E5 and E12</td>
<td>230 V Bucky Voltage</td>
</tr>
</tbody>
</table>

Changing 110 V to 230 V Bucky Voltage or vice versa:

<table>
<thead>
<tr>
<th>Connect</th>
<th>To</th>
<th>To select</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead 5</td>
<td>E7 and E8</td>
<td>Earth Ground</td>
</tr>
<tr>
<td>Lead 6</td>
<td>E5 and E9</td>
<td>110 V Bucky Voltage</td>
</tr>
<tr>
<td></td>
<td>E5 and E12</td>
<td>230 V Bucky Voltage</td>
</tr>
</tbody>
</table>

**Programming the Dual-Speed Starter**

This section provides the following instructions for Dual-Speed Starter:

- Setting Tube Types
- Setting Line Input Voltages
- Verifying Phase-Shift Capacitor Configuration
- Inspecting DIP-Switch SW8 Setting

These instructions are only applicable to the generators with a Dual-Speed Starter 2 (DSS2) board, part number 90313202. The settings are done via SW1 and SW3 DIP-Switches on this board (see Figure 2-14A).
Caution:

• Improper DIP-Switch settings will result in improper anode speed rotation which can cause overheating and/or damage to the X-ray tube.

Warning:

• Ensure programming the Dual-Speed Starter is fully understood and properly done before putting the generator in service.
• DIP-switches SW1 and SW3 on the Dual-Speed Starter must be set correctly to match the X-ray tube in use. Failure to set this correctly may result in improper anode RPM and/or excessive stator heat and therefore may damage the X-ray tube.
• The voltage doubler board supplies the DC bus voltage for the Dual-Speed Starter (DSS) installed in a generator configured for 208/230 VAC input mains power. This DSS is not compatible with tubes using “Q” stators or other low impedance stators. It is recommended to use this DSS with tubes rated for 400 kHU or lower anode heat content figures. For tubes exceeding 400 kHU, contact CPI for more information.
Setting Tube Type

The Dual-Speed Starter must be programmed for the X-ray tube type connected to the generator. This is done via DIP-switch SW1 and SW3-7 on the Dual-speed Starter board as shown in Figure 2-14B.

**Figure 2-14B: Tube Type and Boost Time Increase Settings**

Warning: For X-ray tube types with required switch settings greater than 31, the DSS2 software must be revision E or higher.

The switch settings determine the voltage, frequency, and timing to the stator. Boost time may also be increased in 100 ms steps in the range of 100 to 700 ms.

1. Record the desired tube type number (housing and insert) and the binary code as per the third column in Table 2 of the *X-ray Tube Stator Compatibility Tables* supplement. Note that the tube compatibility applies only to the housing and inserts listed, i.e. for the specific manufacturer(s) shown.

   **Note:** If the desired tube type is not listed, please contact CPI product support for assistance.
2. Refer to Figure 2-14C to check the revision of the DSS2 software 90667800. If the revision is D or older and the tube type is greater than 31, stop this setting and contact CPI product support for assistance.

3. Refer to Figure 2-14B to set DIP-switch SW1 and SW3-7 with the recorded binary code for the selected tube.

**Explanation:** The binary code shown in the referenced Table 2 in the X-ray Tube Stator Compatibility Tables supplement programs the tube type (housing and insert), for example housing type Varian Sapphire with standard “R” stator and inserts per Table 2 requires SW1-1 to be set ON, SW1-2 OFF, SW1-3 ON, SW1-4 OFF, SW1-5 OFF and SW3-7 OFF. This programs the voltages, brake times, and boost times required.

4. If required, SW1-6 to SW1-8 can be set to give incremental increases in boost time (0.1 to 0.7 second) over the preselected values (i.e. to run an older tube with worn bearings). For example, binary 000 gives zero increase, binary 001 gives 100 ms increase, binary 100 gives 400 ms increase, and binary 111 gives a 700 ms increase in boost time. SW1-6 represents bit 1, SW1-7 bit 2, and SW1-8 represents bit 3.

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bit 3</td>
<td>Bit 2</td>
<td>Bit 1</td>
</tr>
<tr>
<td>SW1-8</td>
<td>SW1-7</td>
<td>SW1-6</td>
</tr>
</tbody>
</table>
**Note**: The DIP-switch setting shown in Figure 2-14B is for the example in step 2 with an incremental increase in boost time of 200 ms.

5. Follow the tube manufacturer’s recommendation for verifying the anode speed. If the tube manufacturer does not supply recommendations or instructions to measure the anode speed, use a suitable tachometer that is capable of measuring the anode rotation speed.

**Note**: It is critical that the tube anode speed meets the tube manufacturer’s requirements. If the tube anode does not reach the required rotation speed, the tube may experience premature failure.

Additionally, the following options may be available to some service personnel to verify the anode rotation speed:

1) An accelerometer and a spectrum analyzer
2) An accelerometer and an oscilloscope with Fast Fourier Transform (FFT) feature

**Note**: For tubes where “Low speed operation only” is indicated, the Dual-speed Starter must be programmed for low speed only, and where “high speed operation only” is indicated, the Dual-speed Starter must be programmed for high speed operation only. Refer to the *Tube Selection / Tube Setup* section in Chapter 3, *Interface and Programming*, for the procedure to do this.

The DIP-switch shown in Figure 2-14B is representative of one style of switch only. Depending on manufacturer, your DIP-switch style may vary. Note the ON / OFF positions carefully for your unit.
Setting Line Input Voltage

The Dual-speed Starter must be programmed to match the line input voltage to the generator and the phase-shift capacitors connected to the board.

Caution: Ensure that SW3-8 setting matches the line input voltage.

Refer to Figure 2-14D and set the SW3-8 described as follows:

- For generators with a mains input of **208 VAC** - Set SW3 - 8 - OFF
- For generators with a mains input of **230 VAC** - Set SW3 - 8 - ON
- For generators with a mains input of **400 VAC** - Set SW3 - 8 - OFF
- For generators with a mains input of **480 VAC** - Set SW3 - 8 – ON

Verifying Phase-Shift Capacitor Configuration:

The DIP-Switch SW3, switches 1 to 6 are set to correlate to the DSS phase-shift capacitors attached to the plate assembly (see Figure 2-14E). They are set at the factory. Adjustment of these switches is not required. The incorrect settings may result in damage to the X-ray tube or generator. It is recommended to verify that the settings are set properly before proceeding further.
To verify the phase-shift capacitor configuration:

1. Record the Dual-speed Starter assembly part number labeled on the back of the mounting plate, opposite the DSS2 board (see Figure 2-14E). The number should be one of the following part numbers: 906672-21, 22, 23, 24 (400 VAC/480 VAC) or 950785-21, 23, 24 (208 VAC / 230 VAC).

2. Refer to Figure 2-14D and Table 2-6. Verify the settings of SW3, switches 1 to 6.

<table>
<thead>
<tr>
<th>Tab Number</th>
<th>SW3 Setting</th>
<th>Tab Number</th>
<th>SW3 Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>ON 1 2 3 4 5 6</td>
<td>22</td>
<td>ON 1 2 3 4 5 6</td>
</tr>
<tr>
<td>23</td>
<td>ON 1 2 3 4 5 6</td>
<td>24</td>
<td>ON 1 2 3 4 5 6</td>
</tr>
</tbody>
</table>

Inspecting DIP-Switch SW8 Setting

DIP-Switch SW8 on the Dual-speed Starter must be set correctly. Failure to do this may result in damage to the X-ray tube or generator.

SW8 is set at the factory. Adjustment of this switch is not required. However, it is recommended to inspect the switch to verify that it is set properly before proceeding further. The settings are as follows:

- **SW8** - switches 1,2,3,4,6,7 – **OFF**
- **SW8** - switches 5,8 – **ON**

**Note:** Only check the switch settings of DIP-Switch SW8. Making adjustments different from this setting will result in improper anode RPM, which can cause overheating and / or damage to the X-ray tube.
Verifying the X-ray Anode Speed

1. Follow the tube manufacturer’s recommendation for verifying the anode speed. If the tube manufacturer does not supply recommendations or instructions to measure the anode speed, use a suitable tachometer that is capable of measuring the anode rotation speed.  
   **Note:** It is critical that the tube anode speed meets the tube manufacturer’s requirements. If the tube anode does not reach the required rotation speed, the tube may experience premature failure.

2. The following options may be available to some service personnel to verify the anode rotation speed:
   1) An accelerometer and a spectrum analyzer
   2) An accelerometer and an oscilloscope with Fast Fourier Transform (FFT) feature

   **Note:** For tubes where “Low speed operation only” is indicated, the Dual-speed Starter must be programmed for low speed only, and where “high speed operation only” is indicated, the Dual-speed Starter must be programmed for high speed operation only. Refer to the Tube Selection / Tube Setup section in Chapter 3, Interface and Programming, for the procedure to do this. The DIP-switch shown in Figure 2-14B is representative of one style of switch only. Depending on manufacturer, your DIP-switch style may vary. Note the ON / OFF positions carefully for your unit.
Generator Control Board DIP-Switch Settings

Before continuing, verify the DIP-switch settings on the generator control board. These switches have been factory set but may have been readjusted, particularly if this generator is a re-install.

Generator Control Board:

**Using Table 2-7 and verifying the settings on S3.**

<table>
<thead>
<tr>
<th>Generator Power</th>
<th>Maximum mA</th>
<th>S3-8</th>
<th>S3-7</th>
<th>S3-6</th>
<th>S3-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 kW</td>
<td>400 mA</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>40 kW</td>
<td>500 mA</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>50 kW</td>
<td>630 mA</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>65 kW</td>
<td>800 mA</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>80 kW</td>
<td>1000 mA</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

Note: SW3-1 when ON = Factory Defaults; OFF = Defaults Disabled; DIP-Switch S3-2, S3-3, S3-4 are not used. Refer to *Resetting Factory Defaults* in Chapter 6, *Regular Maintenance*, for details regarding the Factory Defaults setting.
Initial Run-up

This section describes the procedure for the tap selection of the auxiliary transformer line voltage, and for initial power-on of the generator after it has first been installed.

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 AC input to the transformer must be ground-referenced.

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, Pre-installation.
2. Locate the auxiliary transformer inside the generator cabinet. Refer to Figure 1-4 of Chapter 1, Pre-installation.
3. Note the line-voltage tap position on this transformer as determined by the location of the wire on the 208 V or the 240 V tap on the transformer primary. This is normally set to the 240 V tap. Refer to Figure 2-15.
   Caution: Ensure that DIP-switch SW3-8 setting on the Dual-speed Starter board (903132-02) is set according to the Programming DIP-switch SW3 for DSS Board #903132-02 procedure of Chapter 2, Installation, which should match the line voltage and the setting of the auxiliary transformer tap selected here.
4. Based on the nominal line voltage, set the transformer primary voltage tap as follows:
   1) Loosen the clamping screws for the current line-voltage tap, and for the required line-voltage tap.
2) Connect to the 208 V tap if the line voltage is 215 VAC or less.
3) Connect to the 240 V tap if the line voltage is 216 VAC or higher.
4) Retighten both of the clamping screws.

![Diagram of auxiliary transformer with clamping screws and voltage levels: 0V, 120V, 208V, 240V, 400V, 480V.]

*Figure 2-15: Auxiliary transformer, terminal view*

**For 400 / 480 VAC generators:**

The 400 / 480 VAC tap setting only needs to be changed if a 400 VAC generator is to be operated from 480 VAC mains, or if a 480 VAC 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, *Pre-installation*.
2. Locate the auxiliary transformer inside the generator cabinet. Refer to *Figure 1-4* of Chapter 1, *Pre-installation*.
3. Note the line-voltage tap position on this transformer as determined by the location of the wire on the 400 VAC or the 480 VAC tap on the transformer primary. This is set to the 400 or 480 VAC tap to match the line voltage specified at the time of the order. Refer to Figure 2-15.

  Caution: Ensure that DIP-switch SW3-8 setting on the Dual-speed Starter board (903132-02) is set according to the *Programming DIP-switch SW3 for DSS Board #903132-02* procedure of Chapter 2, *Installation*, which should match the line voltage and the setting of the auxiliary transformer tap selected here.

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

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 L3 phase: ______ VAC.
   L2 phase to L3 phase: ______ VAC.
   L1 phase to ground: ______ VAC.
   L2 phase to ground: ______ 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 voltage taps are set to the appropriate position as per the measured line voltage.
   ___ Check
Tube mA Auto Calibration

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

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

It is recommended that the tube be conditioned (seasoned) before beginning tube auto calibration, particularly if the tube has not been used for some time. Refer to Tube Conditioning / Seasoning in Chapter 6, Regular Maintenance.

Before beginning tube auto calibration, the tube used in this installation must be properly selected (Tube Selection / Tube Setup), and the generator limits should be programmed. Refer to Chapter 3, Interface and Programming.

Powering-up Touchscreen

The following messages may appear during the Power-up/initializing process:

- The message “Generator Offline, please turn on Generator.” displays if the console is switched ON, without switching the generator ON from the mini-console. If this is the case the message will disappear and the screen will refresh after the generator initializes.

- The message below displays when ‘SYSTEM SHUT DOWN“ has been selected in the Main Menu. This acts as a reminder to the user to also switch off the generator from the mini-console and avoid unnecessary idling. Tapping the YES button will properly shut down the Windows based software of the console.

There are two blue LED indicators on the 15.6-inch touchscreen console. They are located on the left side of the console. The top LED indicates the console is powered ON. The other indicates the hard drive status of the console.
Final Checks

The room interface connections may now be completed. These items are described in the *Room Equipment* section of this chapter.

1. When finished all wiring, check that all connections are tight and secure.
2. Check that all cables are dressed neatly inside the main cabinet, and secured as necessary.
3. Reconnect any grounds that have been removed from covers. Then reinstall all covers before placing the generator into service.
4. For units with the touchscreen console, perform *Touchscreen Calibration* in Chapter 3, *Interface and Programming*.
5. Re-install the generator cover. You must use good judgment and work practices to avoid injury and damage to equipment.

**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.