CRAY T3E AC Power, Control, and Troubleshooting

HMM-169-A
CRAY T3E Air-cooled System
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Revision A. Added information on the clock distribution power supply and made corrections to the first troubleshooting flowchart.

Introduction

This document describes the procedures for powering on and powering off CRAY T3E air-cooled (AC) cabinets. It also describes the warning and control system (WACS) display and the cabinet switches. In addition, it includes tips for troubleshooting electrical and mechanical problems.

NOTE: Read *Safety and ESD Guidelines*, Cray Research publication HGM-016-A, before you perform any power-related procedure.

NOTE: Non-CRI personnel should perform only procedures and tasks that are specified in their maintenance agreements.

Terms

You will need to know the following terms to fully understand the material discussed in this document:

Contactor (CT1) – The main contactor removes or applies power to the module power supplies and to the blower circuit. Its function is controlled by the warning and control system (WACS) scanners, which do not receive power through CT1.

Power-on – The sequence of events that renders a cabinet (or system) operational. When used without the term “remote,” it includes the events that apply input power to the cabinet.

Power-off – The sequence of events that renders a cabinet (or system) nonoperational. When used without the term “remote,” it includes the events that remove input power from the cabinet.

Remote power-on – A power-on sequence that personnel initiate from a remote location, such as from the SWS. The WACS must be operational before a remote power-on can occur. During the remote power-on, the WACS closes the contactor to apply power to the module power supplies and blower.

Remote power-off – A power-off sequence that personnel initiate from a remote location, such as from the SWS. In a remote power-off, the cabinet continues to receive input power; however, the WACS opens the contactor to remove power from the module power supplies and blower. The WACS remains operational after the remote power-down.

Power Overview

The CRAY T3E AC cabinet plugs directly into customer power. Table 1 shows the input power specifications.

Table 1. Input Power

Voltage	Frequency	Wiring	Phase Requirement
200–240 Vac (+6%, –10%)	50/60 Hz (±5%)	3 phases and ground	Phase-to-phase (delta)
400 Vac (±10%)	50 Hz (±5%)	3 phases, neutral, and ground	Phase-to-neutral (wye)

When 200- to 240-Vac power is used, the cabinet is configured for phase-to-phase operation and requires a 30-A power circuit. When 400-Vac power is used, the cabinet is configured for phase-to-neutral operation and requires a 20-A circuit. Swappable power cords are provided to conform to the available 3-phase power.

Power enters the cabinet through the main disconnect circuit breaker (CB1), which controls power to the entire cabinet. (The cabinet does not contain a designated start switch or stop switch.) CB1 is controlled in the following ways: manually by the service personnel; indirectly when personnel use the Cabinet Power switch (SW2); or automatically by two exhaust air thermostats (SW4 and SW5). The Cabinet Power switch and the thermostats connect to CB1's shunt trip.

After passing through CB1, power flows through a line filter (FL1), which removes electrical noise from the power wires. Power then follows two paths:

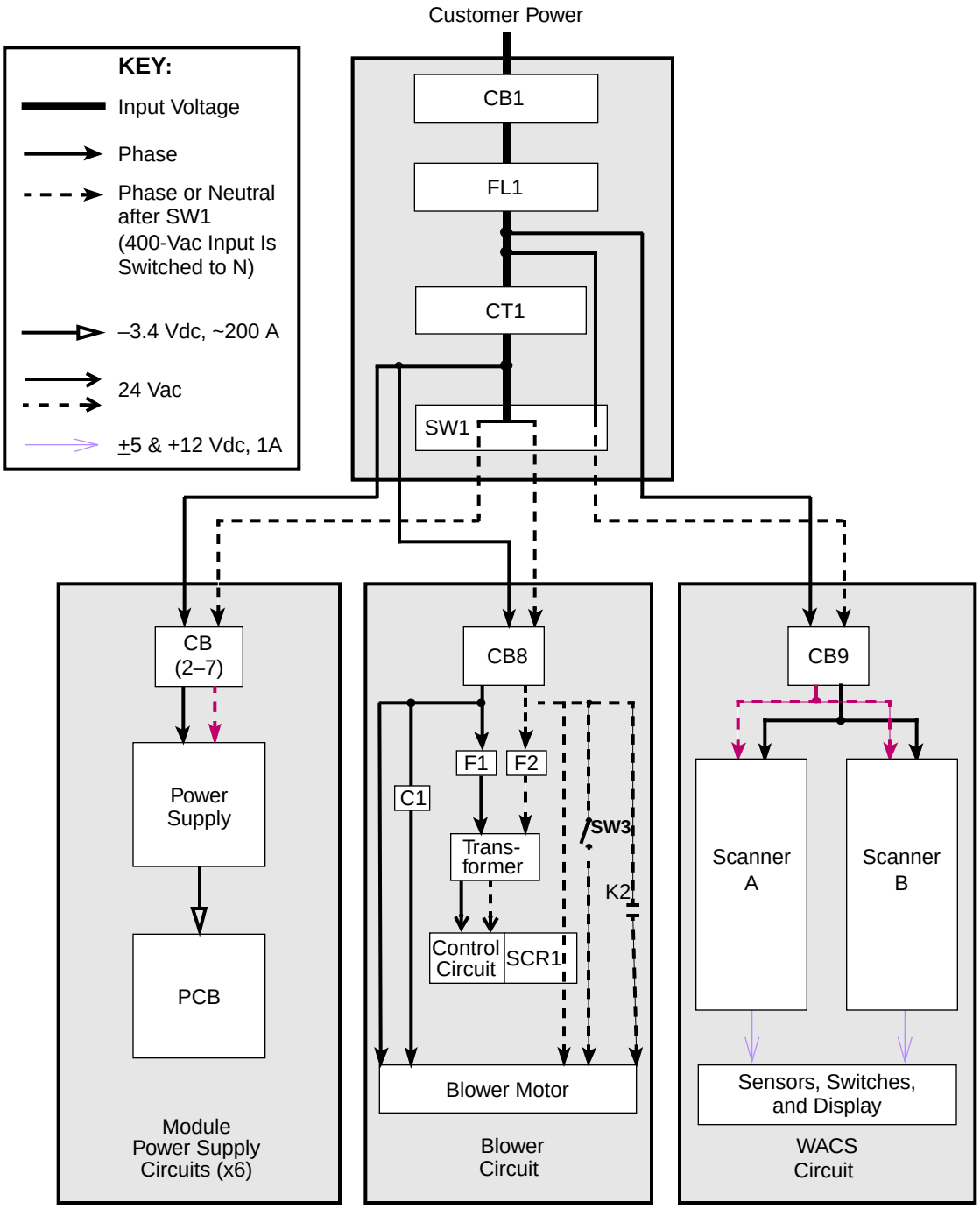
1. To the WACS (and to the auxiliary circuit breaker). This power wiring does not pass through the contactor (CT1).

2. Through the contactor (CT1), then to the module power supplies and to the blower circuitry.

In both cases, one phase (and the neutral wiring) passes through the Voltage Selector switch (SW1). SW1 selects either phase-to-phase power distribution or phase-to-neutral power distribution, depending on the input voltage.

Figure 1 shows the general power flow through an AC cabinet.

Figure 1. Power Distribution Block Diagram

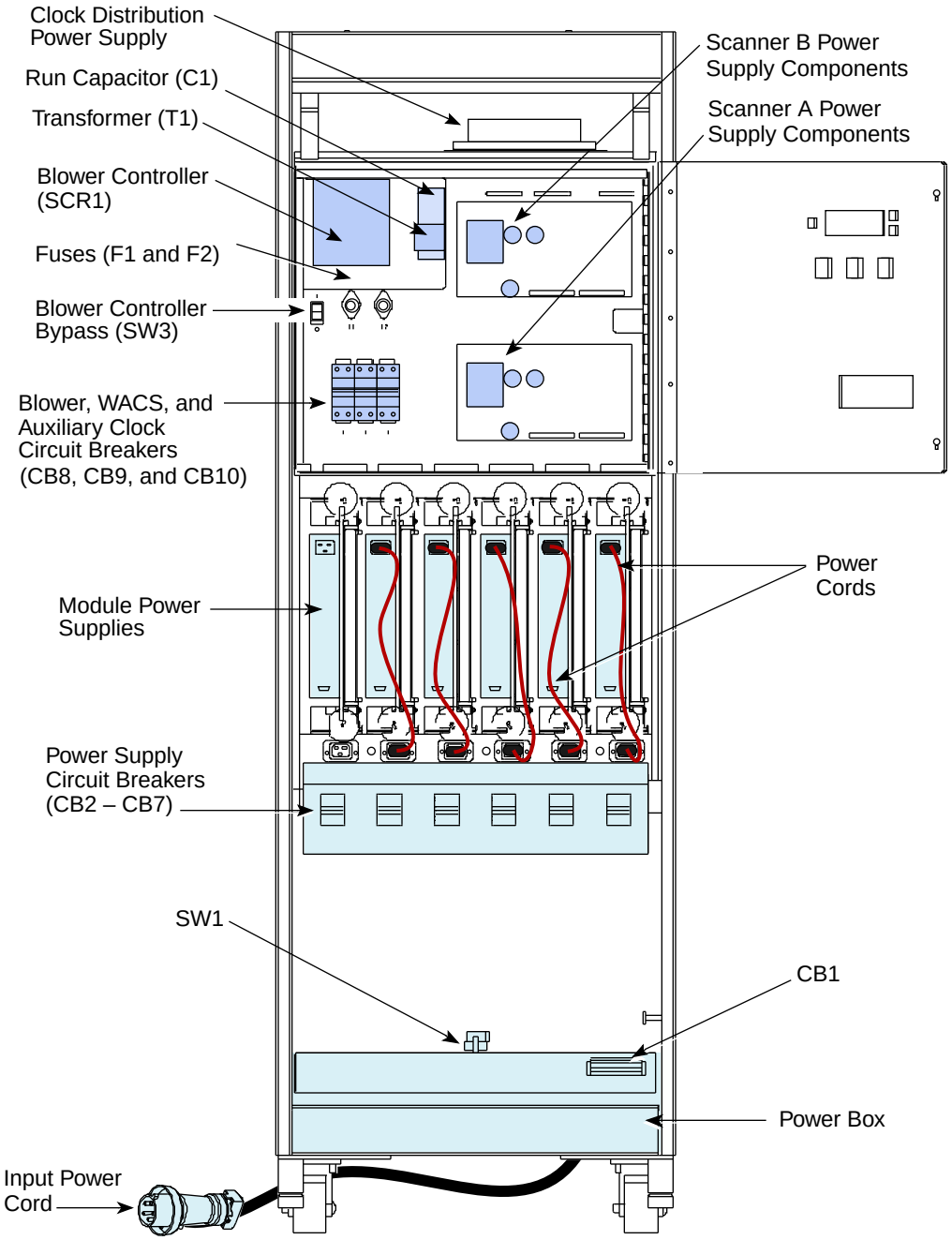


NOTE: Power also flows to the clock power supply circuit breaker (CB10) in cabinet 0. CB10 controls power to the clock distribution power supply.

Power Components

The following pages provide an overview of the power distribution components in the CRAY T3E AC cabinet. For more detailed information, refer to the *AC Power* training module, HTM-211-B, in the T3EHO-S training package. Figure 2 shows a front view of the main cabinet power components.

Figure 2. Power Components – Front View

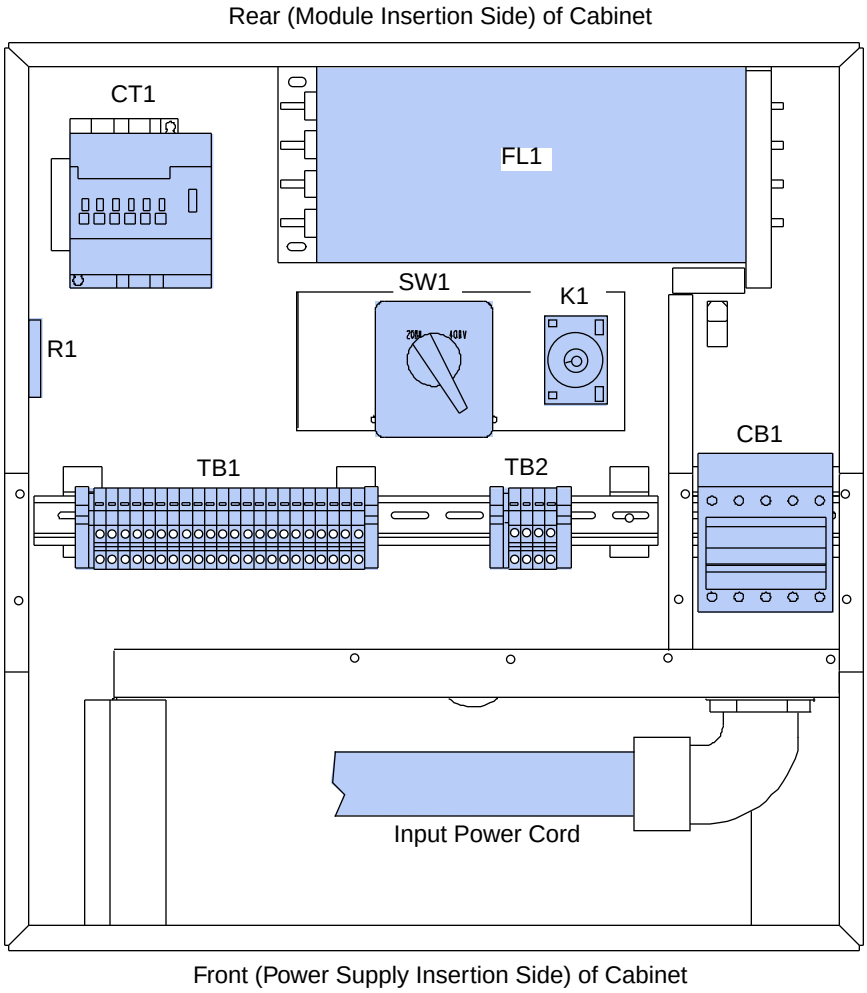


Power Box

The power box, shown in Figure 3, is located in the bottom of the cabinet, beneath the module power supplies. The power box contains the following components:

- Main disconnect (CB1)
- AC line filter (FL1)
- Contactor (CT1)
- Resistor (R1)
- Time-delay relay (K1)
- Voltage selector switch (SW1)
- Power-interconnect terminal blocks (TB1)
- Remote alarm contacts (TB2)

Figure 3. Power Box Components

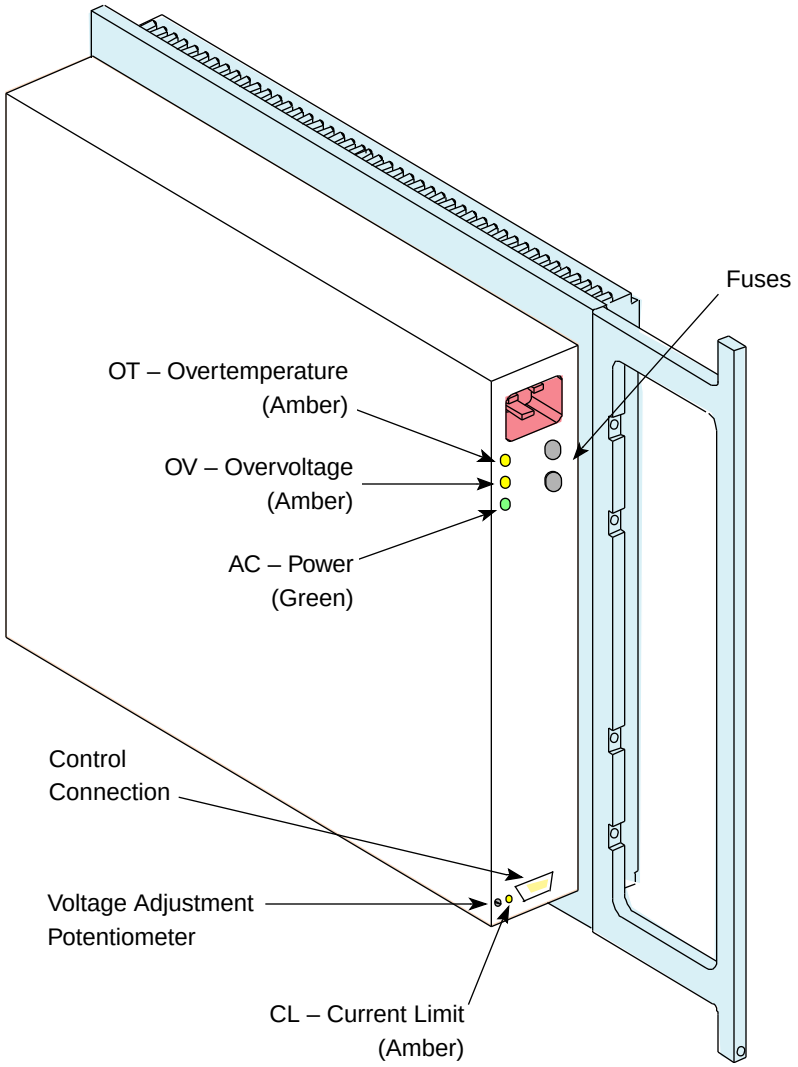


Module Power Supplies

Each PEM and clock module has its own power supply. (Refer to Figure 4.) Each power supply is controlled by its own circuit breaker.

The power supply requires a nominal voltage of 200 to 240 Vac. It outputs –3.4 Vdc through its main power connector. All modules require the –3.4 Vdc power. In addition, the power supply produces an auxiliary voltage of approximately –12 Vdc. The auxiliary voltage passes out of the supply via the control connection. The clock module receives this auxiliary voltage via its own control wiring; it then regulates the voltage down to –4.5 Vdc.

Figure 4. Module Power Supply



The power supply has four LED indicators, as shown in Figure 4.

- The AC LED illuminates when the power supply receives input power.
- The OT LED indicates that the power supply's internal temperature is or was too high and that the power supply powered off. You must cycle the power supply's circuit breaker to clear the indicator and restore power. (You should also isolate the fault and replace any faulty component.)
- The OV LED indicates that the power supply detected an overvoltage and powered off. You must cycle the power supply's circuit breaker to clear the indicator and restore power. (Of course, you should also isolate the fault and replace any faulty component.)
- The CL LED indicates that an overcurrent or short occurred. The power supply will return to operational status as soon as the current problem is gone; however, it may be necessary to press the Restart switch (SW6) to restore the power supply and module pair to function.

Clock Distribution Power Supply

In addition to the main power supply that drives the clock module, the clock module requires a clock distribution power supply. The clock distribution power supply is located above the WACS plenum in cabinet 0.

The clock distribution power supply provides power to help fan out GigaRing clock signals. The power supply outputs two voltages: –4 Vdc and +1 Vdc (these voltages may change with hardware revisions).

CB10, the Clock Power Supply circuit breaker, controls power to the clock distribution power supply. For proper operation, CB10 must be enabled before the clock's main power supply circuit breaker (CB7) is enabled.

Circuit Breakers and Power Switches

Each CRAY T3E AC cabinet contains the following circuit breakers:

- Main disconnect circuit breaker (CB1)
- Module power supply circuit breakers (CB2 through CB7)
- Blower circuit breaker (CB8)
- WACS circuit breaker (CB9)
- Clock power supply circuit breaker (CB10) -- cabinet 0 only

Each cabinet also contains a contactor (CT1) and the following manual power switches:

- Cabinet Power switch (SW2)
- Blower Controller Bypass switch (SW3)
- Restart switch (SW6)
- Remote Restart Enable switch (SW7)
- Power Supply Margin switch (SW8)

Refer to “Switches” in the “Control” section of this document for descriptions of these cabinet switches.

The cabinet does not contain a designated start switch or stop switch. Instead, service personnel use the main disconnect circuit breaker (CB1) to apply power to and remove power from the cabinet. Personnel can also use the Cabinet Power switch (SW2) to remove power from the cabinet; however, this should be avoided because it decreases the life cycle of CB1’s shunt trip. In addition, personnel can power the modules and blower on and off from remote locations.

Things to Remember

Before you attempt to apply power to a CRAY T3E AC cabinet, the Cabinet Power switch (SW2) must be in the On (1) position. If SW2 is in the Off (0) position, CB1 trips when you attempt to close it.

In addition, the WACS circuit breaker (CB9) must be in the On position before you can power on the cabinet. If the breaker is not in the On position, power is applied to a few power distribution components only. The WACS must be on so that it can close the contactor to supply power to the module power supplies and blower.

If the blower breaker (CB8) and power supply breakers (CB2 through CB7) for the installed modules are not engaged (On), the WACS still powers on.

You cannot perform a remote power-on if the WACS is not on.

The WACS remains on during a remote power-off.

You cannot perform a local power-on of the module power supplies and blower if the Remote Restart Enable switch is on. When the Remote Restart Enable switch is on, the WACS will not close the contactor until it receives a remote Power Up signal.

Module Interlocks

Each module rail contains two interlock switches. When you cam the module, one interlock completes the module enable circuit. In other words, it informs the WACS that the module is installed and cammed. The other interlock completes the power supply enable circuit. Therefore, if a module is not cammed properly, the WACS will not enable the associated power supply for operation.

The power supply enable circuit is in series with the module enable circuit.

Blower Power

When the WACS closes the contactor (CT1), the blower receives input power through CB9. Within 15 seconds, the blower achieves the required speed. The WACS controls the blower speed according to the average temperature of the installed modules. A control loop on scanner B calculates the required speed and signals the blower controller (SCR1) to adjust the blower speed accordingly.

A relay (K2) on scanner B and a manual Blower Controller Bypass switch (SW3) are wired in parallel with SCR1. If scanner B senses that the modules are not receiving proper cooling (for example, if SCR1 malfunctions), the scanner can close the relay to supply full power to the blower. The manual Blower Controller Bypass switch (SW3) enables service personnel to bypass SCR1 if they suspect that SCR1 or scanner B is malfunctioning.

SCR1 contains control circuitry as well as power adjustment circuitry. The control circuitry requires 24-Vac power. It receives this power from a transformer (T1). Two small fuses, F1 and F2 (approximately 0.5 A each), protect T1.

The blower circuit also contains a run capacitor (C1). C1 produces an off-phase voltage in the blower motor’s second winding. The motor spins as a result of the phase differences between the two windings.

WACS Power

Each WACS scanner includes the following onboard power supply components:

- Fuse
- Transzorbs
- Transformer
- Regulators
- Capacitors
- Diodes

If any of these components (other than the fuses) fail, you must replace the scanner.

The WACS power components convert the approximately 200- to 240-Vac power into three WACS voltages: +5 Vdc, – 5 Vdc, and + 12 Vdc. These voltages are required by the WACS sensors, display, etc.

WACS Control of Power

The WACS controls cabinet power in the following ways:

- It opens and closes the contactor (CT1), which controls power to the module power supplies and to the blower circuitry.

  Both scanners must send a power relay signal to the contactor to close it. However, a single scanner can open the contactor. Relay K18 (designated K1 in some documentation) on each scanner controls the power relay signal to CT1.

- It controls the Power Supply Enable signals to the individual module power supplies. This controls power to the individual modules.

  Both scanners are required to enable a power supply.

NOTE: The WACS cannot open the main disconnect circuit breaker (CB1) to remove power from the cabinet. As a result, the WACS scanners continue to receive power until personnel move the WACS circuit breaker (CB9) to the Off position or remove input power to the cabinet.

At power-on, the WACS will not close the contactor if any of the following conditions exist:

- The inlet air temperature is beyond the fault threshold.
- The exhaust air temperature is beyond the fault threshold.
- The cabinet does not contain a cammed module.

During operation, the WACS will open the contactor if any of the following conditions develop:

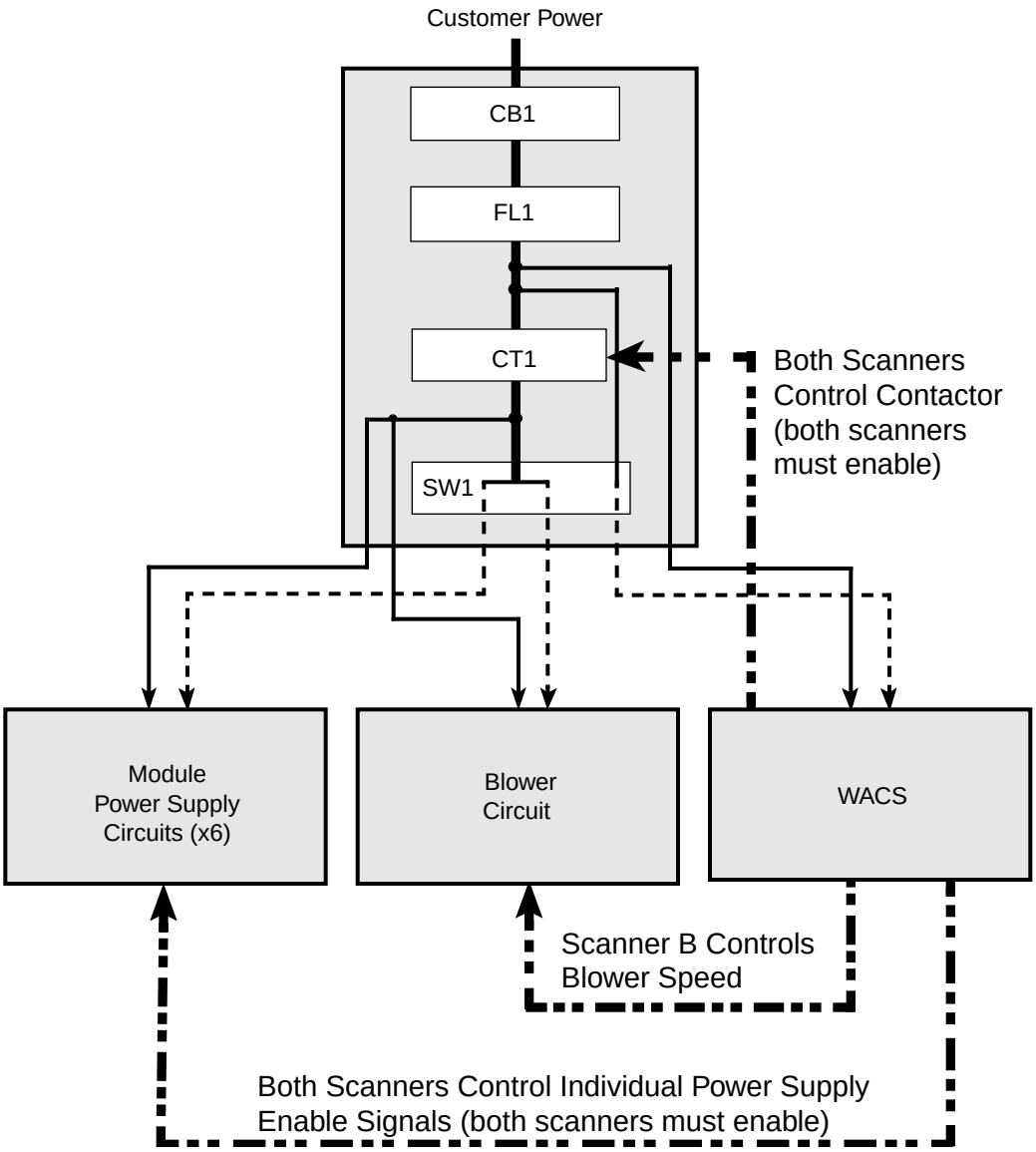
- The inlet air temperature reaches the fault threshold.
- The exhaust air temperature reaches the fault threshold.
- It detects more than 0.8 Vdc on a module that is supposed to be Off.
- All modules are uncammed.
- The WACS loses power.

The WACS removes the Power Supply Enable signal from a module power supply if:

- The module temperature reaches the fault threshold.
- The module is uncammed. (Uncamming the module breaks the module enable circuit and power supply enable circuit.)

Figure 5 shows the WACS control of power in an AC cabinet. The WACS' role in blower control was mentioned in the "Blower Power" subsection.

Figure 5. WACS Control of Power



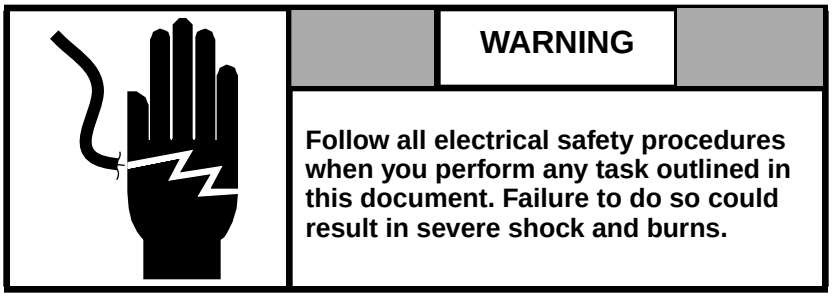
Power-on/off Procedures

A typical CRAY T3E AC system may include the following devices:

- One or more CRAY T3E AC cabinets
- A system workstation (SWS)
- One or more scalable IO cabinets (SIO)
- One or more SCSI drives

When you power on a CRAY T3E AC cabinet, you should ensure that the other devices in the computer system are also powered on. You cannot boot a CRAY T3E system if the support devices are not on.

This document contains power-on/off procedures that are specific to CRAY T3E AC cabinets. For the power-on/off procedures for the other devices in the computer system, refer to the power-on/off instructions that are specific to those devices.



Individual Cabinet Power-on Procedure

This subsection includes two power-on procedures: step-by-step and normal. Use the step-by-step procedure when you anticipate potential problems with the power-on. Use the normal procedure at other times.

Step-by-step Power-on

The following step-by-step power-on procedure helps isolate electrical and mechanical problems. Perform this procedure after you install a CRAY T3E AC cabinet, after you perform maintenance, or when you otherwise wish to ensure the proper operation of the power and control systems.

1. Ensure that you have removed all tools, etc., from the cabinet.
2. Ensure that all modules are properly installed and cammed.
3. Ensure that all cabinet circuit breakers are in the OFF (0) position.
4. Ensure that the Blower Controller Bypass switch (SW3) is in the NORMAL (0) position.
5. Ensure that the Cabinet Power switch (SW2) is in the ON (1) position.
6. Ensure that the customer circuit breaker that supplies power to the CRAY T3E AC cabinet is in the ON position and that the cabinet is plugged in.
7. Move the main disconnect circuit breaker (CB1) to the ON (1) position.
8. Move the WACS circuit breaker (CB9) to the ON (1) position. Then check the WACS display:

   - It should indicate that the cabinet is on.
   - The temperatures should be within the acceptable ranges.
   - No fault conditions should be present.
   - It should not indicate voltage on the modules.

   When CB1 and CB9 close, the WACS scanners receive input power (through CB9) and perform power-on/self-test routines. They then check the cabinet sensors for temperature faults.

   If the scanners do not detect an inlet air temperature fault or exhaust air temperature fault, they close the contactor (CT1). Closing the contactor provides power to the module power supplies and blower.

If the WACS scanners detect a temperature fault on an individual module, they remove the Power Supply Enable signal from that module's power supply and indicate a fault on the WACS display.

Eight voting circuits select the six Power Supply Enable signals, the power relay signal to the contactor (CT1), and the blower speed signal. Both microprocessors must select On before the Power Supply Enable signals and the power relay signal to the power contactor output are enabled. A feedback circuit for each Power Supply Enable signal informs the microprocessors that a power supply is connected and is accepting current on its enable.

After the WACS closes CT1, power is supplied to the module power supply circuit breakers (CB2 through CB7), the blower circuit breaker (CB8), and the clock power supply circuit breaker (CB10).

9. Move the blower circuit breaker (CB8) to the ON (1) position. Then check that the blower is spinning and producing airflow.

   The blower reaches the required speed approximately 15 seconds after power-on.

10. Move CB10 (the auxiliary clock power supply circuit breaker) to the ON (1) position.

11. Move CB7 (the main clock power supply circuit breaker) to the ON (1) position.

12. One at a time, move each power supply circuit breaker (for an installed power supply and module pair) to the ON position.

    The AC indicator on each power supply illuminates when the power supply receives input power. The power indicator on each module illuminates when the module receives DC power from its power supply.

    For each pair, check the following:

    - Check the power indicators on the power supply and module.
    - Check the WACS display to ensure that there are no faults and that the voltages are nominal.

If you notice any problems or if the WACS indicates any faults, take the appropriate corrective action. Otherwise, the cabinet is now ready for the boot sequence.

Normal Power-on

Perform the following procedure when you power on a CRAY T3E AC cabinet under normal conditions:

1. Ensure that you have removed all tools, etc., from the cabinet.
2. Ensure that all modules are properly installed and cammed.
3. Ensure that the main disconnect circuit breaker (CB1) is in the OFF (0) position and that the Blower Controller Bypass switch (SW3) is in the NORMAL (0) position.
4. Ensure that the following switch and circuit breakers are in the ON (1) position:
   - Cabinet Power switch (SW2)
   - Blower breaker (CB8)
   - WACS breaker (CB9)
   - Clock power supply breaker (CB10)
5. Ensure that the customer circuit breaker that supplies power to the CRAY T3E AC cabinet is in the ON position and that the cabinet is plugged in.
6. Move the main disconnect circuit breaker (CB1) to the ON (1) position.
7. Move the main clock power supply breaker (CB7) to the ON (1) position.
8. Move the appropriate power supply breakers (CB2 through CB6) to the ON (1) position.
9. Check the cabinet to ensure proper operation:
   - Check the WACS display (or SWS NWACS display).
     - Check for faults.
     - Check temperatures.
     - Ensure that the modules are On.
     - Check the module voltages.
   - Check the LED indicators on the power supplies and modules.

If you notice any problems or if the WACS indicates any faults, take the appropriate corrective action. Otherwise, the cabinet is now ready for the boot sequence.

Multiple-cabinet Power-on Procedure

Perform the “Individual Cabinet Power-on Procedure” for each CRAY T3E AC cabinet in the system. When you complete the power-on for each cabinet in the system, the system is ready for the boot sequence.

Module Power-on Procedure

Perform the following procedure when you restore power to one or more modules that were uncammed or powered down due to a fault:

1. Ensure that the rest of the cabinet is operational and that any faults were corrected.

2. Ensure that the modules are properly installed and cammed.

3. Check the WACS display to ensure that the temperatures are within the appropriate range.

4. Move the module power supply circuit breaker(s) to the ON (1) position. Then check the power indicators on the power supply and module.

5. Press the Restart switch on the WACS panel.

   The WACS should send the Power Supply Enable signals to the power supplies of the modules that were powered down.

6. Check the cabinet to ensure proper operation:

   - Check the WACS display (or SWS WACS display).
     - Check for faults.
     - Check temperatures.
     - Ensure that the modules are On.
     - Check the power supply output voltages.
   - Check the LED indicators on the power supplies and modules.

If you notice any problems or if the WACS indicates any faults, take the appropriate corrective action.

Remote Power-on Procedure

You may perform a remote power-on after a cabinet has been powered off remotely. A remote power-on does not provide input power to the cabinet. (The cabinet must have input power and the WACS must be operational before a remote power-on can take place.) Instead, a remote power-on causes the WACS to close the contactor (CT1), which restores power to the module power supplies and blower.

NOTE: You cannot power on a single module from a remote location.

To perform a remote power-on, the following cabinet circuit breakers and switches must be in the ON or enabled position:

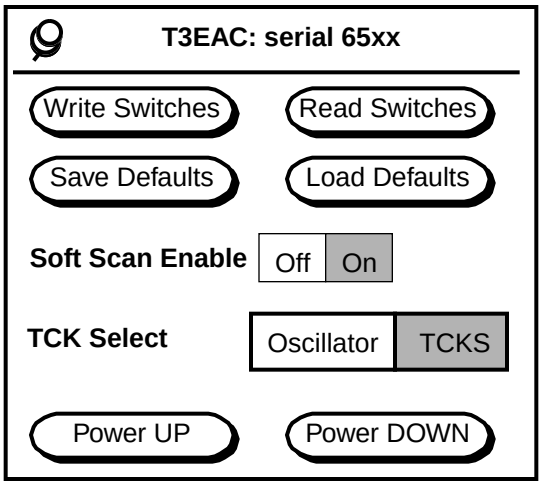
- Main disconnect (CB1)
- WACS breaker (CB9)
- Blower breaker (CB8)
- Any applicable power supply breakers (CB2 through CB7)
- Cabinet Power switch (SW2)
- Remote Restart Enable switch (SW7)

Perform the following procedure for each CRAY T3E AC cabinet that you wish to power on remotely.

1. Ensure that it is safe to power on the CRAY T3E AC cabinet(s). For example, ensure that no one is performing maintenance on the cabinet(s).

2. In NWACS, click on the Power UP button, and then click on the Write Switches button.

   The WACS scans the cabinet sensors for faults, then closes the contactor (CT1) to supply power to the module power supplies and blower.



3. To ensure proper cabinet operation, check the NWACS data screen:

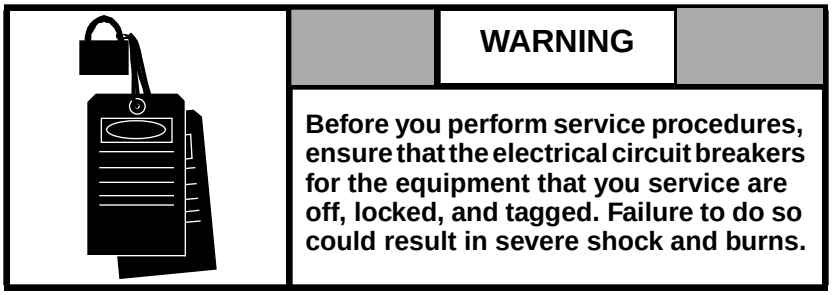
   - Ensure that it indicates that the cabinet is on.
   - Check for faults.
   - Check temperatures.
   - Ensure that the modules are On.
   - Check the power supply output voltages.
   - Ensure that the blower is on.
     (Check cabinet temperatures periodically. When the blower operates properly, the temperature difference between the modules and the exhaust air is less than 10 ˚F (~5.6 ˚C).

4. Continue to monitor the cabinet to ensure proper operation.

If you notice any problems, take the appropriate corrective action. If no problems exist, the cabinet is now ready for the boot sequence.

Individual Cabinet Power-off Procedure

1. Ensure that the operating system is not running before you proceed.
2. Open the front door, then check the WACS display to determine the condition of the cabinet.
3. Move the main disconnect circuit breaker (CB1) to the OFF (0) position.
   or
   Move the Cabinet Power Switch (SW2) to the OFF (0) position.
4. Ensure that power is removed.
5. If needed, open the customer circuit breaker that supplies power to the CRAY T3E AC cabinet, unplug the cabinet, and lock and tag the customer circuit breaker.



Multiple-cabinet Power-off Procedure

Use the “Individual Cabinet Power-off Procedure” for each CRAY T3E AC cabinet that you are powering off.

Module Power-off Procedure

To remove power from an individual module while the rest of the cabinet remains operational, move the module power supply circuit breaker (one of CB2 through CB7) to the OFF (0) position.

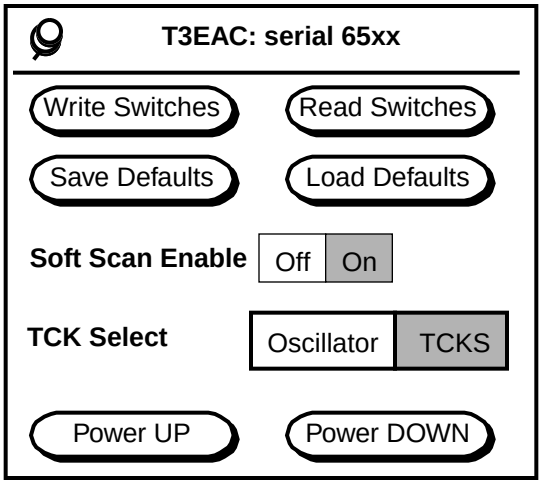
Remote Power-off Procedure

Use the following procedure to power off a CRAY T3E AC cabinet via the SWS. A remote power-off removes power from the module power supplies and from the blower. A remote power-off does not remove input power from the cabinet; it causes the WACS to open the contactor (CT1). The WACS remains operational during a remote power-off.

NOTE: You cannot power off a single module from a remote location.

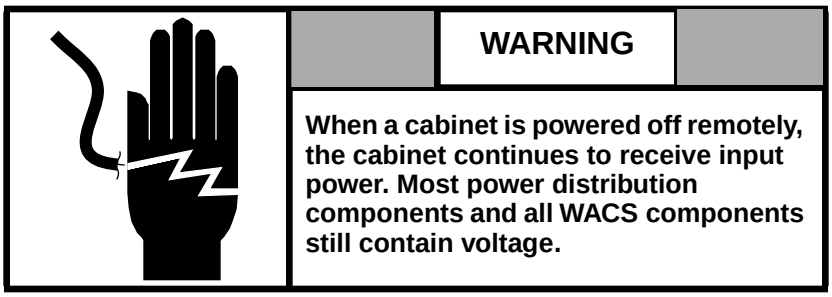
1. In NWACS, click on the Power DOWN button, and then click on the Write Switches button.

   The WACS opens the contactor (CT1), which removes power from the module power supplies and blower. The WACS continues to operate.



2. To ensure that cabinet components power off properly, check the NWACS data screen:

   - Ensure that it indicates that the contactor is open.
   - Check for faults.
   - Check temperatures.
   - Ensure that the modules are OFF.
   - Ensure that the power supplies are OFF.
   - Ensure that the module voltages are at or near 0 Vdc.



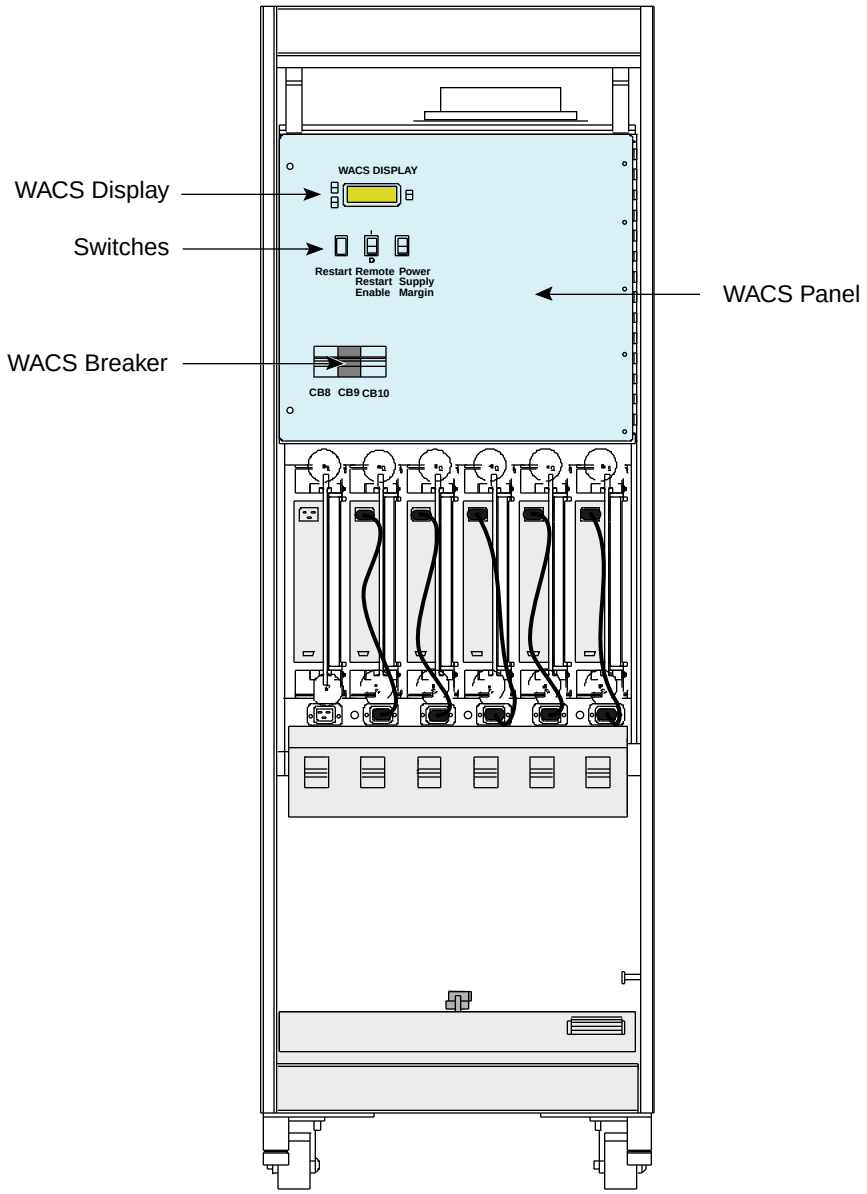
3. If needed, move the Remote Restart Enable switch (SW7) to the disable position. This prevents a subsequent remote power-up of the chassis until ready.

Control Overview

This section contains an overview of the control components of the CRAY T3E AC cabinet. It includes a brief overview of the WACS, descriptions of the cabinet switches, details on the WACS display, and fault and warning information.

For more information on the WACS components, refer to the *AC WACS* training module, HTM-213-B, in the CRAY T3E prerequisite training package.

Figure 6. WACS Panel



Warning and Control System (WACS)

The WACS contains two scanner boards, A and B. The scanners share most critical control functions and maintenance and monitoring functions. Figure 7 is a block diagram that shows the two scanners and the WACS signals that they process or control.

Figure 7. WACS Signal Block Diagram

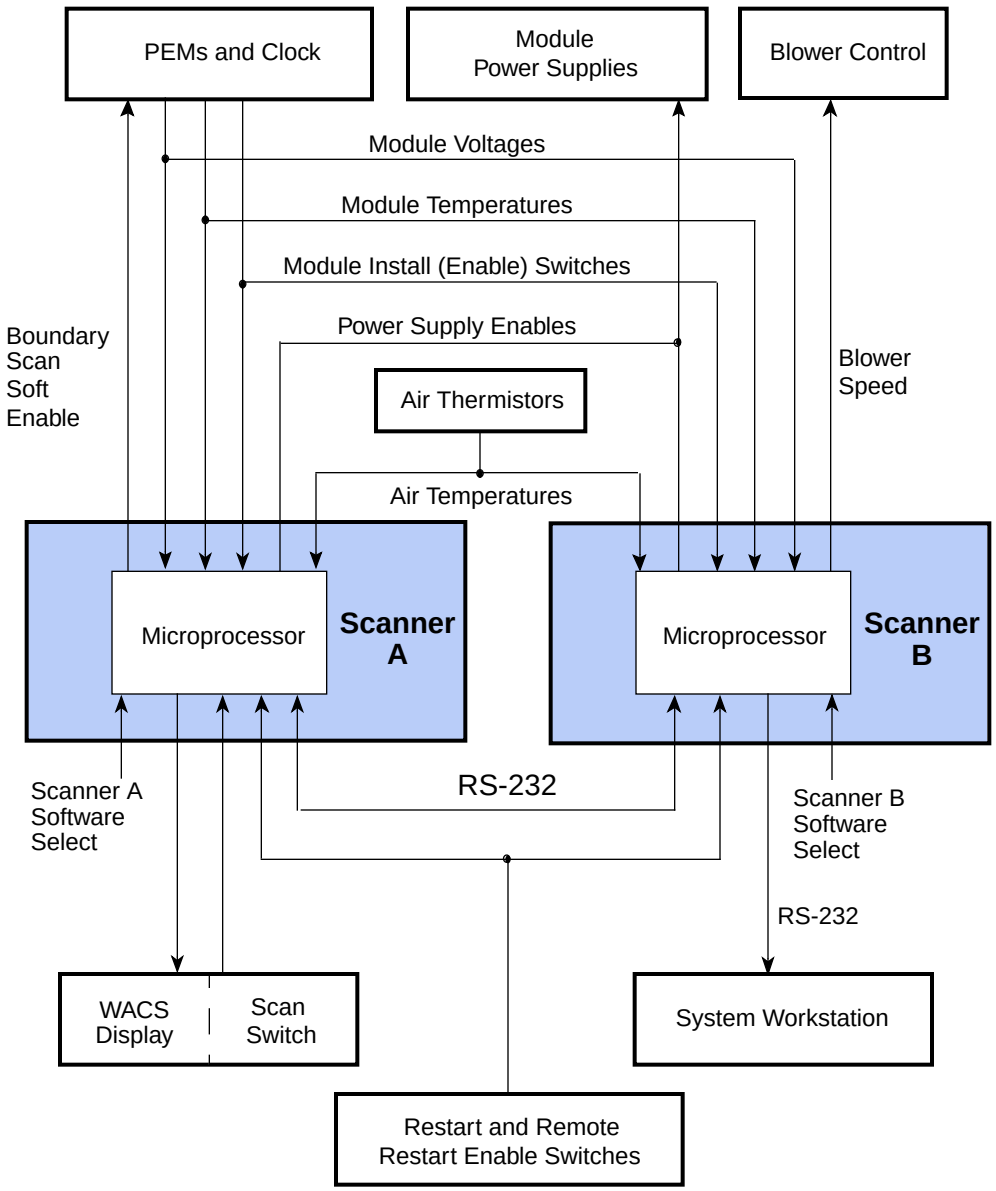
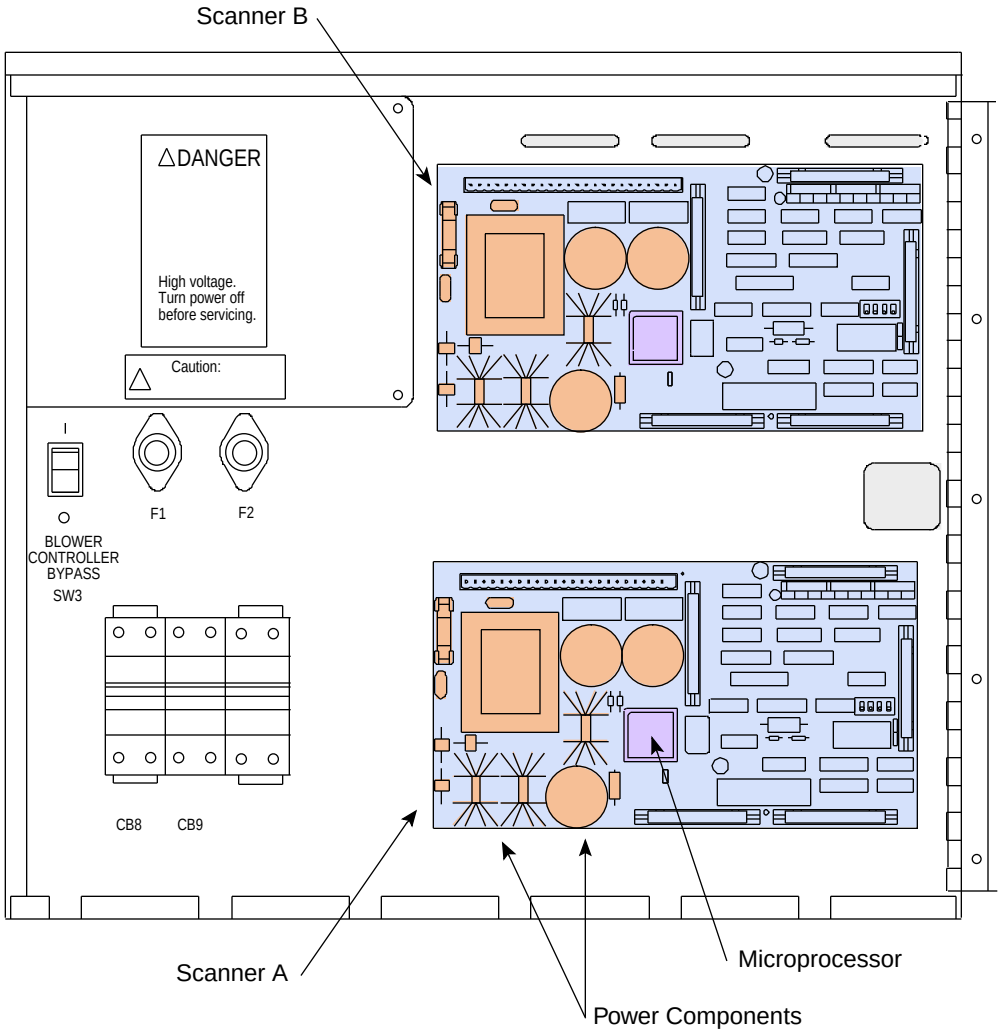


Figure 8 shows the locations of the scanners in the WACS box.

Figure 8. WACS Scanners

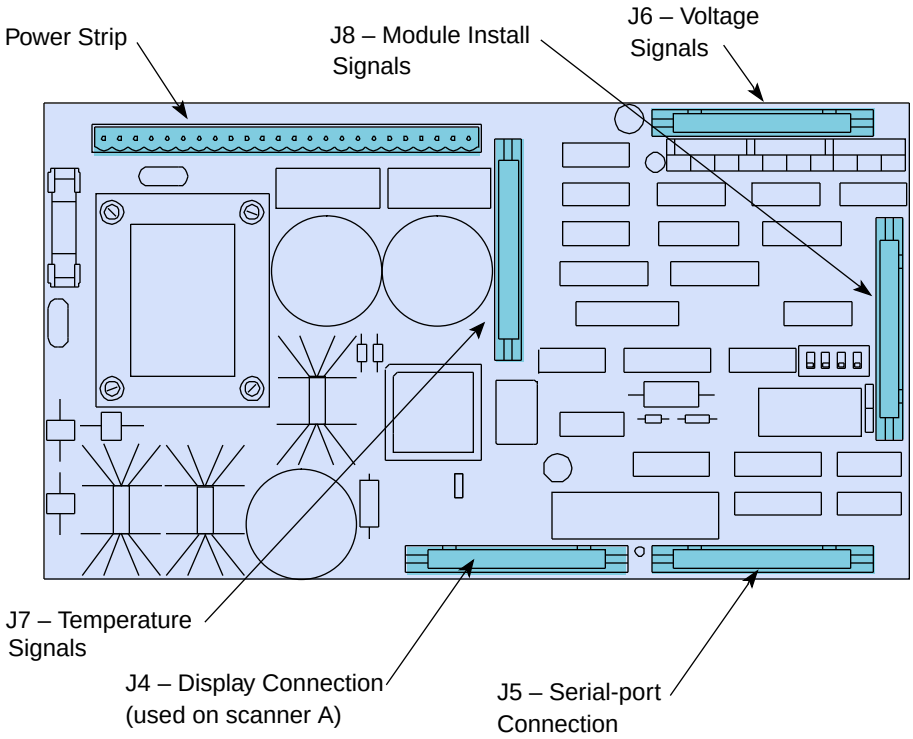


Each scanner contains a power connector strip (TB1) and five control connectors. The control connectors connect to the WACS wire harness. Each of the control connectors performs a primary function, as described in the following list:

- Connector J4 is the display connection (used on scanner A only)
- Connector J5 is the serial-port connection
- Connector J6 carries voltage signals
- Connector J7 carries temperature signals
- Connector J8 carries module install signals

Figure 9 shows the connector locations. Because the scanner boards are physically identical, the connectors on both scanners perform similar functions. However, because scanner B does not connect to the display, the associated connector (J4) is not used.

Figure 9. WACS Scanner Connectors



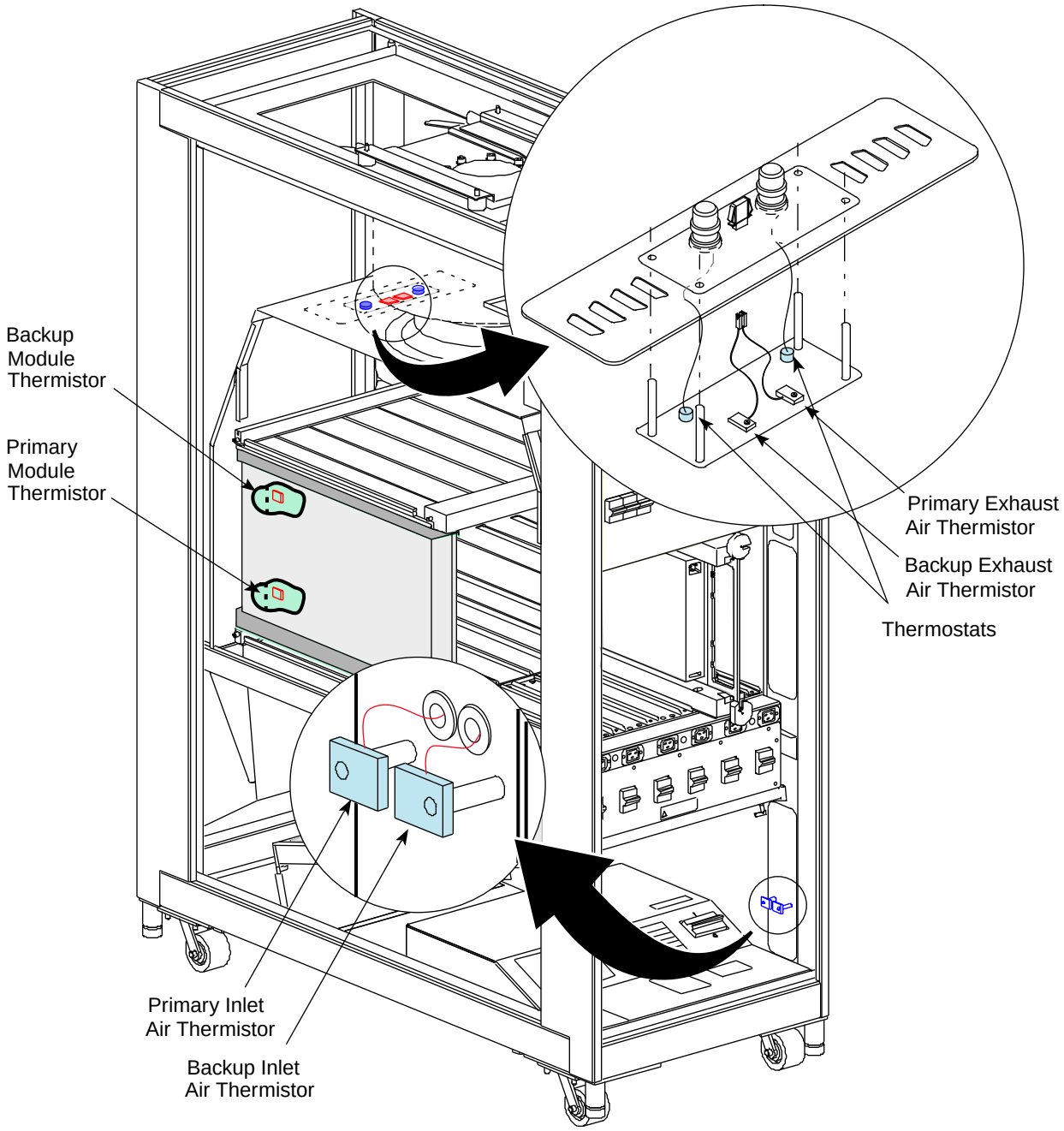
The following list gives the present locations of the primary and backup sensors:

- Module thermistors
  - Primary – bottom of module (toward floor).
  - Backup – top of module (toward ceiling). This thermistor is usually warmer (by approximately 4 °F) than the primary thermistor.
- Air inlet thermistors
  - Primary – toward module end of cabinet (away from front door).
  - Backup – toward power supply end of cabinet (toward front door).
- Air outlet (exhaust) thermistors
  - Primary – toward slot 6.
  - Backup – toward slot 1.

Figure 10 shows the locations of the temperature sensors.

NOTE: The locations of the primary and backup sensors may be reversed in some systems. To determine the sensor configuration on your cabinet, consult any applicable cabinet labels and/or test the sensors.

Figure 10. Sensor Locations



Switches

Each CRAY T3E AC cabinet contains the following manual switches:

On the front door:

- Cabinet Power switch

Inside the front door:

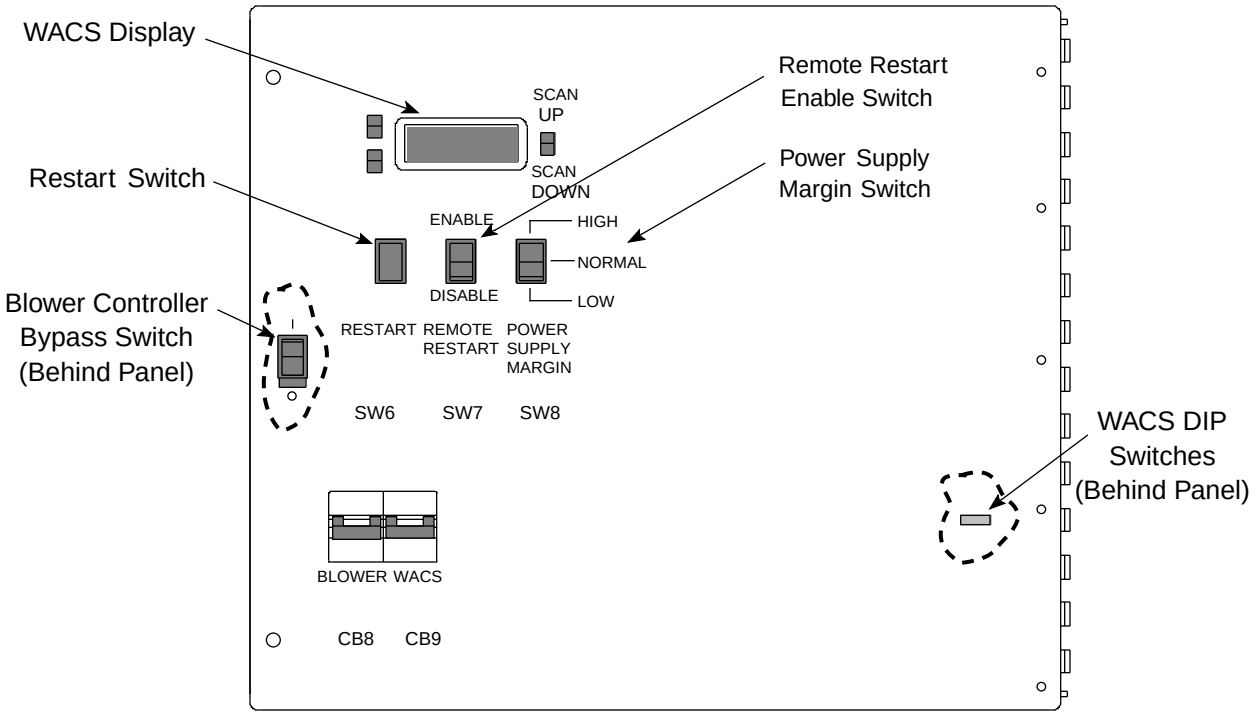
- Restart switch
- Remote Restart Enable switch
- Power Supply Margin switch
- WACS display switch
- WACS DIP switches
- Blower Controller Bypass switch

Inside the rear door:

- Scan Enable switch (boundary scan)
- Clock switches

Figure 11 shows the switches that are inside the front door.

Figure 11. WACS Panel Switches



Cabinet Power Switch

A Cabinet Power switch (SW2) is located on the front door of each AC cabinet. SW2 is not wired through the WACS; it is wired to the shunt trip on the main disconnect circuit breaker (CB1). SW2 enables operators to remove power from the cabinet quickly, without opening the cabinet door.

Because adjacent cabinets are wired independently, SW2 controls power to only one cabinet. Therefore, you may use SW2 to remove power from a single cabinet while the other cabinets remain powered on.

NOTE: Use CB1, rather than SW2, to remove power from the cabinet during normal power-off procedures. SW2 trips CB1's shunt trip, which may shorten the life cycle of the shunt trip.

SW2 is not a start switch. To restart a cabinet after using SW2, you must return SW2 to the On (1) position, then move CB1 to the On position.

SW2 is wired in parallel with a pair of thermostats: SW4 and SW5. SW2 and the thermostats are open during operation. Figure 12 shows the wiring for SW2 and the thermostats. Figure 13 shows the location of SW2.

Figure 12. Cabinet Power Switch (SW2) – Wiring Diagram

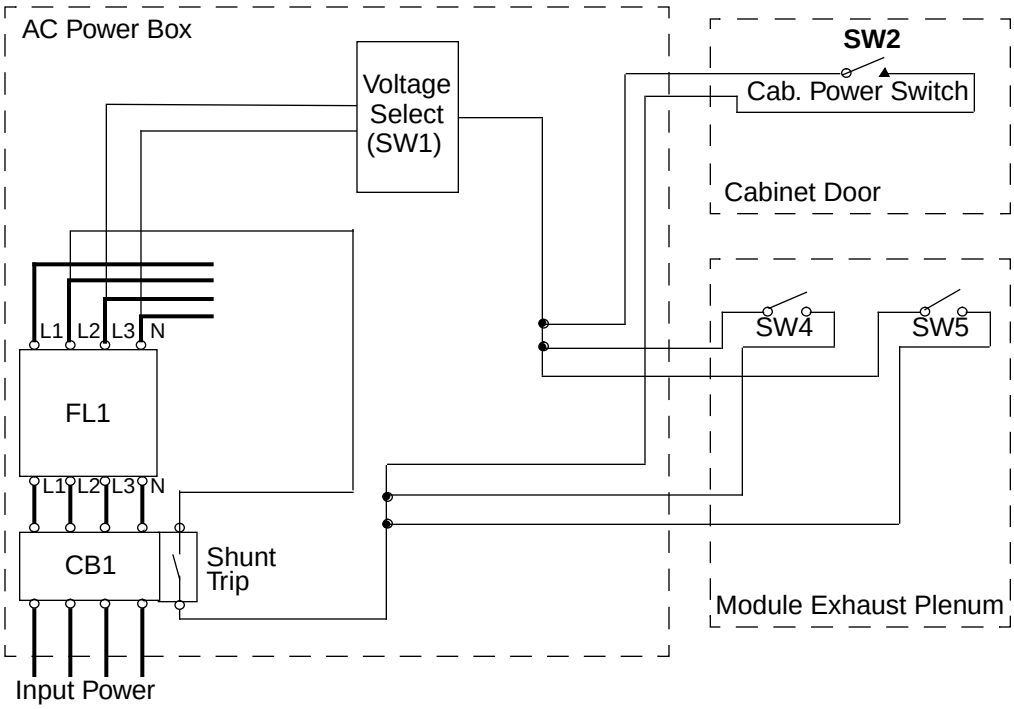
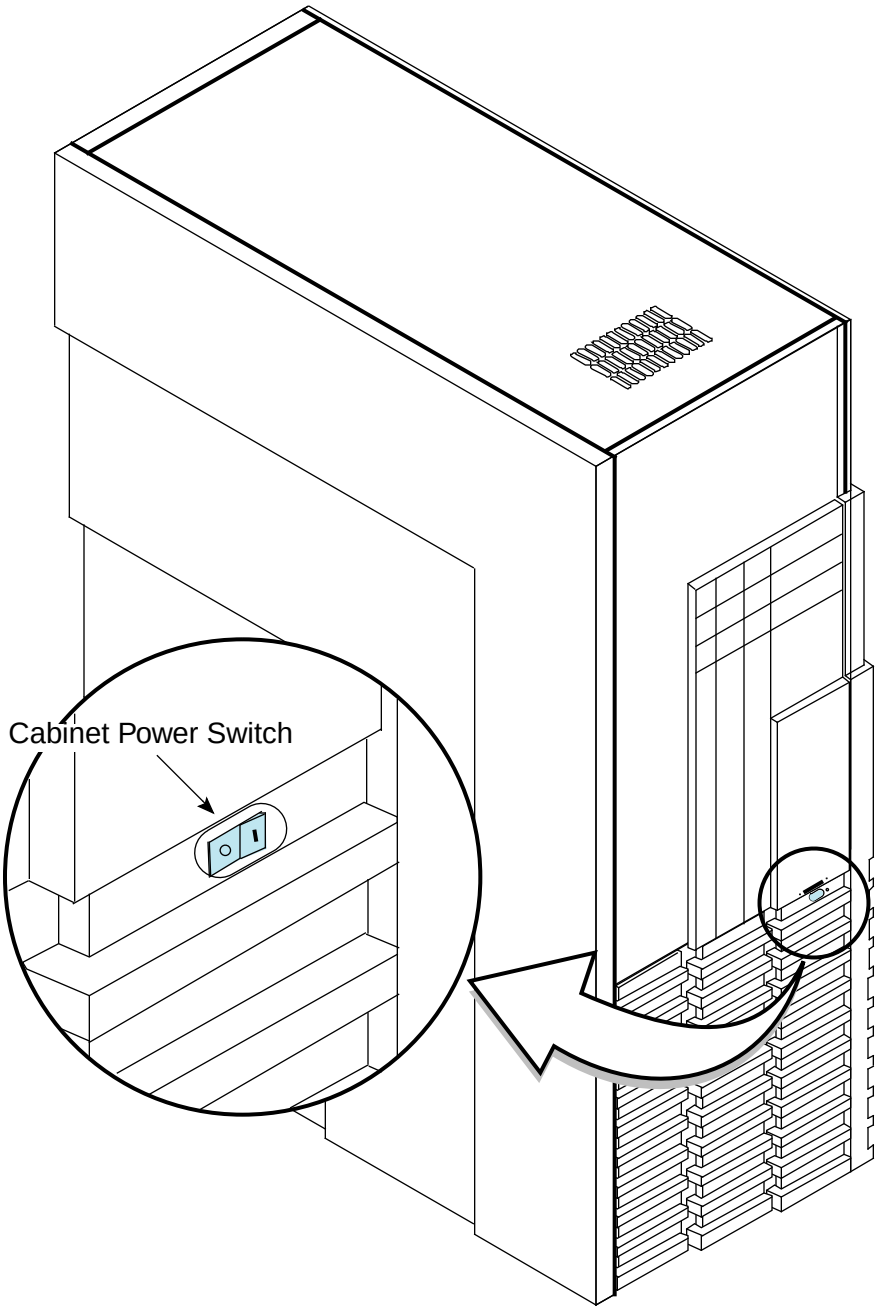


Figure 13. Cabinet Power Switch (SW2) – Location



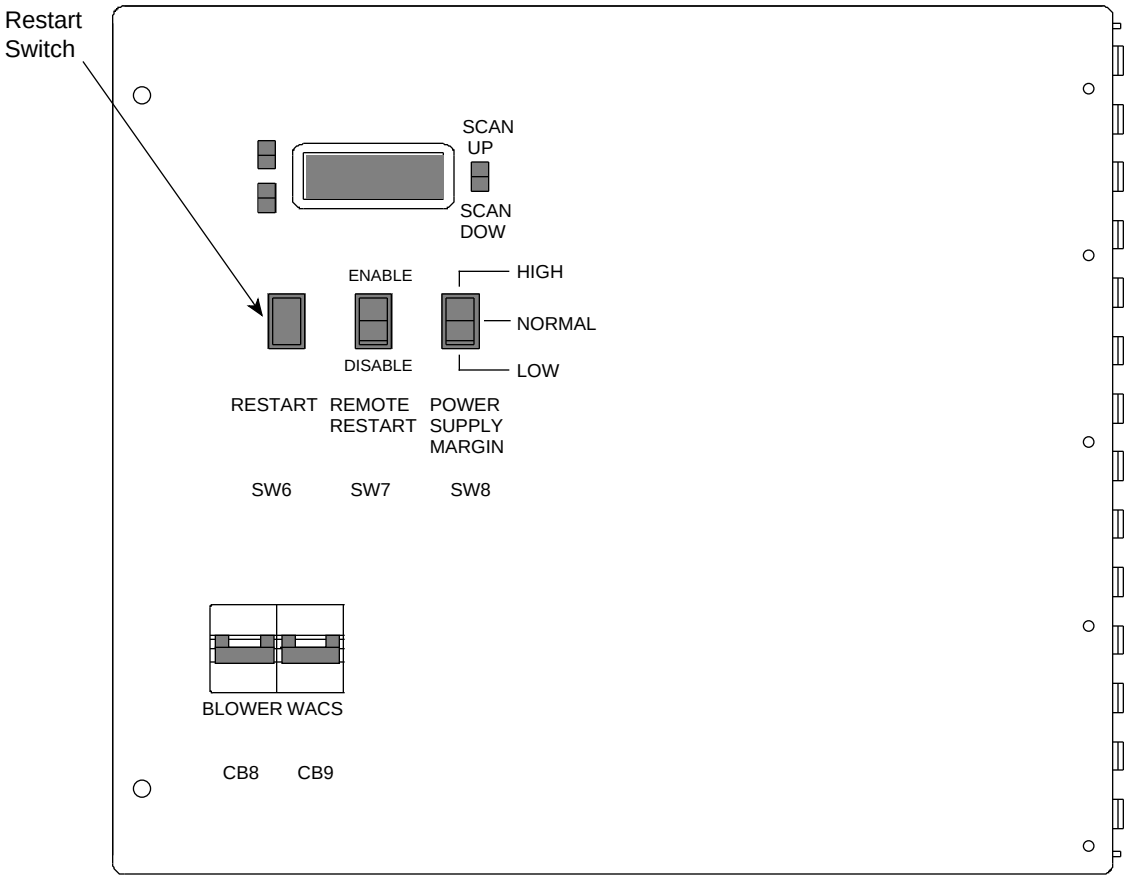
Restart Switch

The AC cabinet does not include a manual *start* switch; however, the WACS does include a manual *Restart* switch (SW6) that enables service providers to power on modules that were powered off for maintenance purposes or that powered off due to a fault.

When pressed, this momentary-contact switch restores the Power Supply Enable signals to the module power supplies. Of course, the power supply circuit breakers must be on and the module must be cammed and free from any fault condition.

In addition to restoring the Power Supply Enable signals, the Restart switch also clears any associated fault from the WACS display. (The fault/warning status is latched when a module powers off or when the cabinet powers off. The latch clears when you press the Restart switch and restart the module.)

Figure 14. Restart Switch

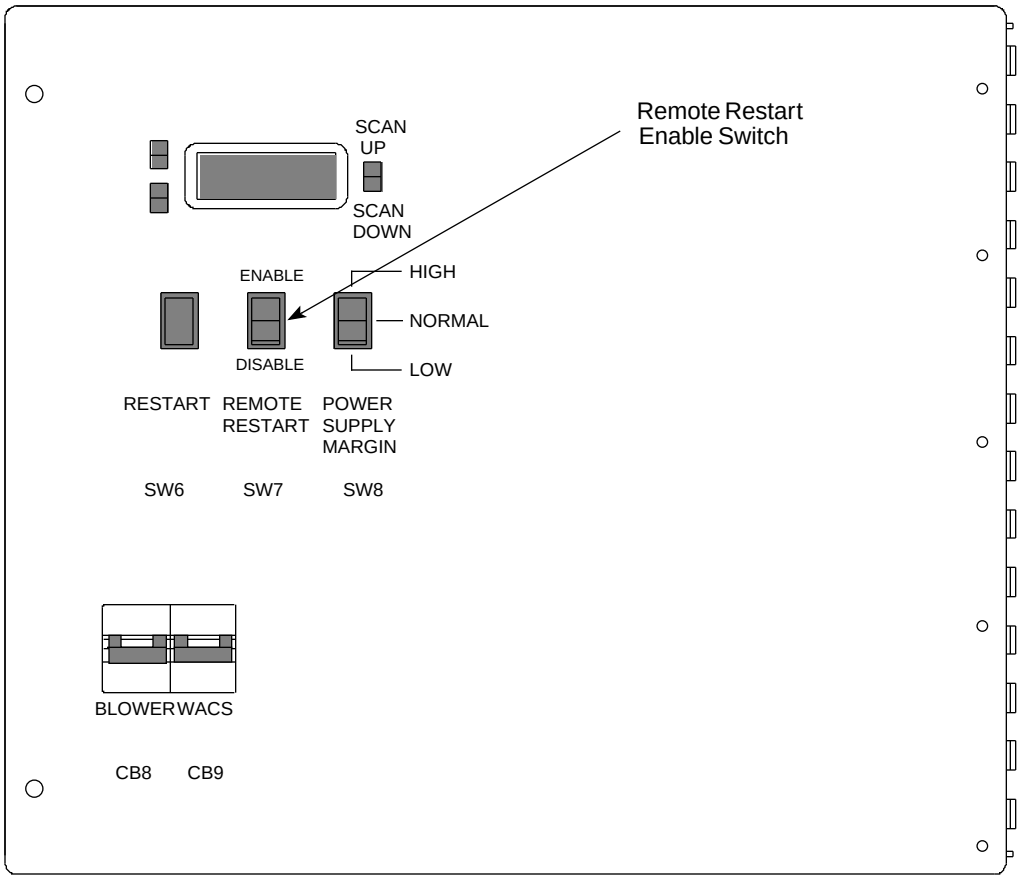


Remote Restart Enable Switch

The Remote Restart Enable switch (SW7) permits personnel to enable or disable the remote restart feature of the cabinet. When the switch is in the ENABLE (1) position: the remote restart capability is enabled; the switch indicator illuminates; the WACS display indicates that the cabinet is on *Standby*; and the WACS will not close the contactor until it receives a remote power-up command. In the DISABLE (0) position, the remote restart capability is disabled.

When you power off the cabinet to perform service functions, you should disable the remote restart feature to prevent others from remotely applying power to the cabinet. (Remember, when the cabinet is powered off remotely, the WACS and many power distribution components continue to receive input power.)

Figure 15. Remote Restart Enable Switch



Power Supply Margin Switch

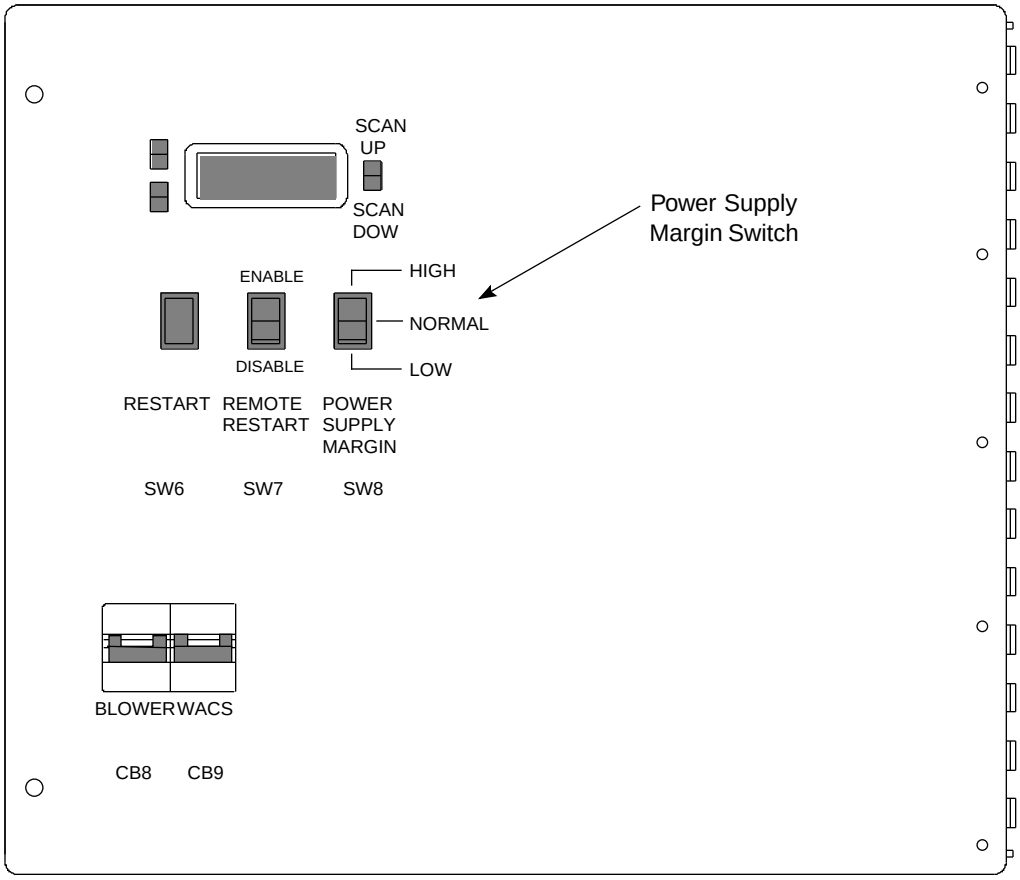
The Power Supply Margin switch (SW8) enables personnel to perform margin control on the module power supplies. The switch is located on the WACS panel as shown in Figure 16.

The switch has *High*, *Normal*, and *Low* positions. *Normal* sets the power supply voltages to the nominal setting. *High* sets the power supply voltages to 6% above the nominal setting. *Low* sets the power supply voltages to 6% below the nominal setting. For example, if the nominal voltage is –3.4 Vdc, then the *High* setting adjusts the power supply voltages to –3.4 Vdc, and the *Low* setting adjusts the voltages to –3.2 Vdc.

The switch does not adjust the margins of individual power supplies; instead, it adjusts the margins of all power supplies in the cabinet.

At present, it is not possible to adjust the power supply margins remotely.

Figure 16. Power Supply Margin Switch



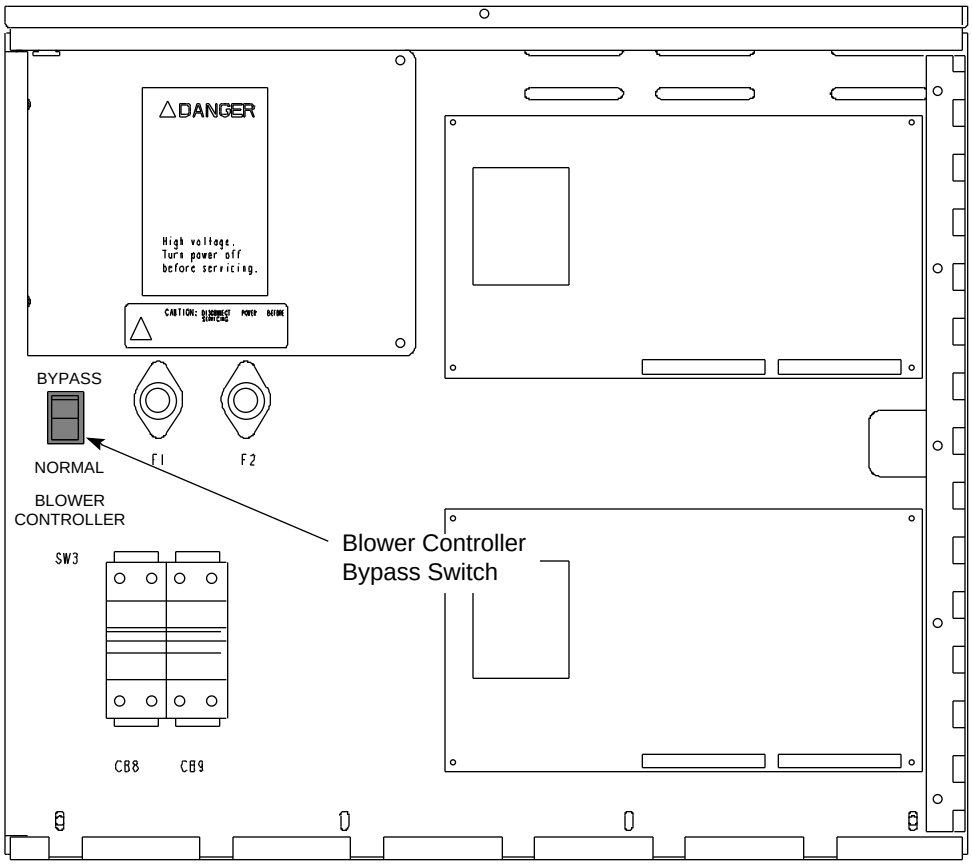
Blower Controller Bypass Switch

Each AC cabinet is equipped with a Blower Controller Bypass switch (SW3), which is located inside the WACS box, behind the WACS panel.

Service personnel can toggle this switch to bypass the blower controller (SCR1). Bypassing the blower controller provides full power to the blower motor, which forces it to full speed. In the BYPASS (1) position, the blower controller is bypassed. In the NORMAL (0) position, the blower controller is active.

In general, use this switch only if the blower controller (SCR1) or scanner B malfunctions.

Figure 17. Blower Controller Bypass Switch

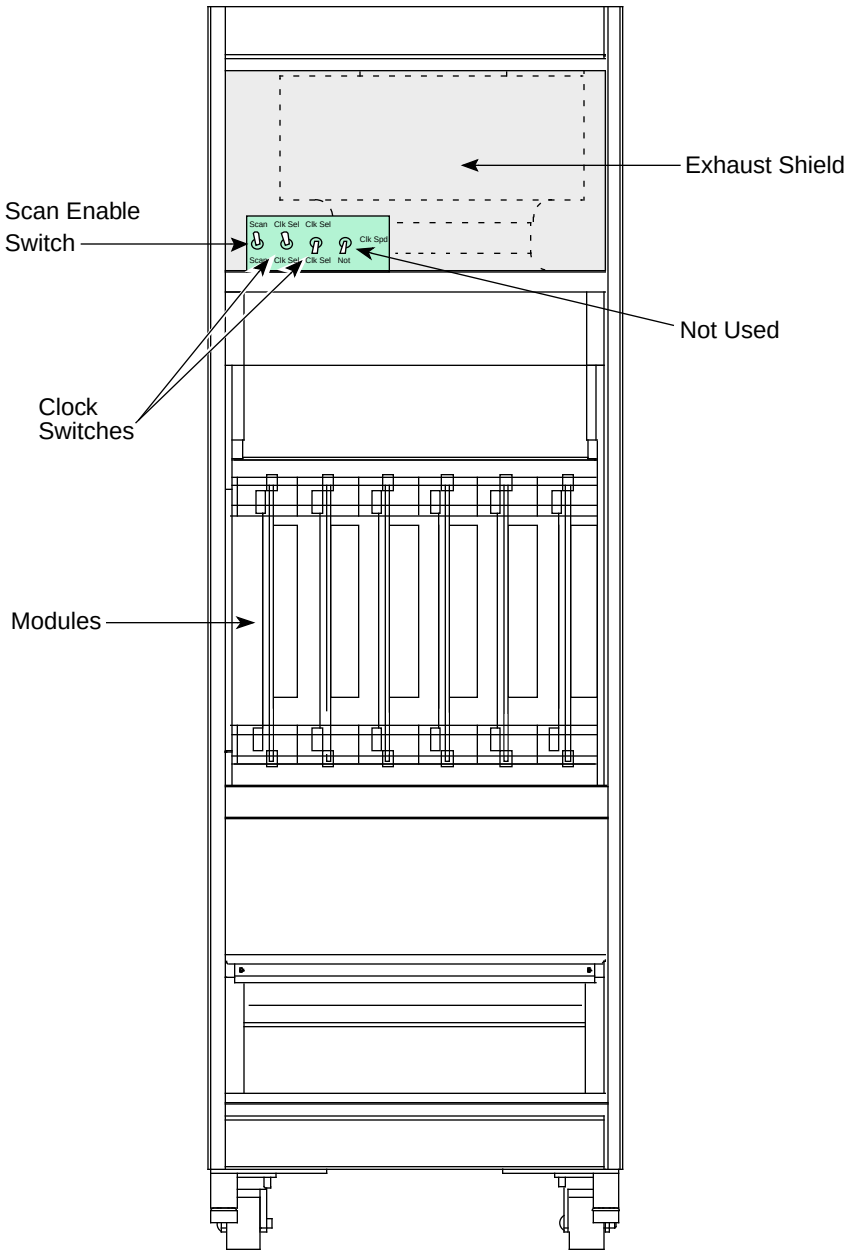


Scan Enable Switch (Boundary Scan)

The Scan Enable switch enables or disables the boundary scan feature. The switch does not initiate a boundary scan operation; instead, it enables personnel to initiate boundary scan from the SWS. The switch is located above the modules on the blower exhaust shield, as shown in Figure 18.

The system also has a *soft* enable switch, which personnel use from the SWS.

Figure 18. Scan Enable Switch



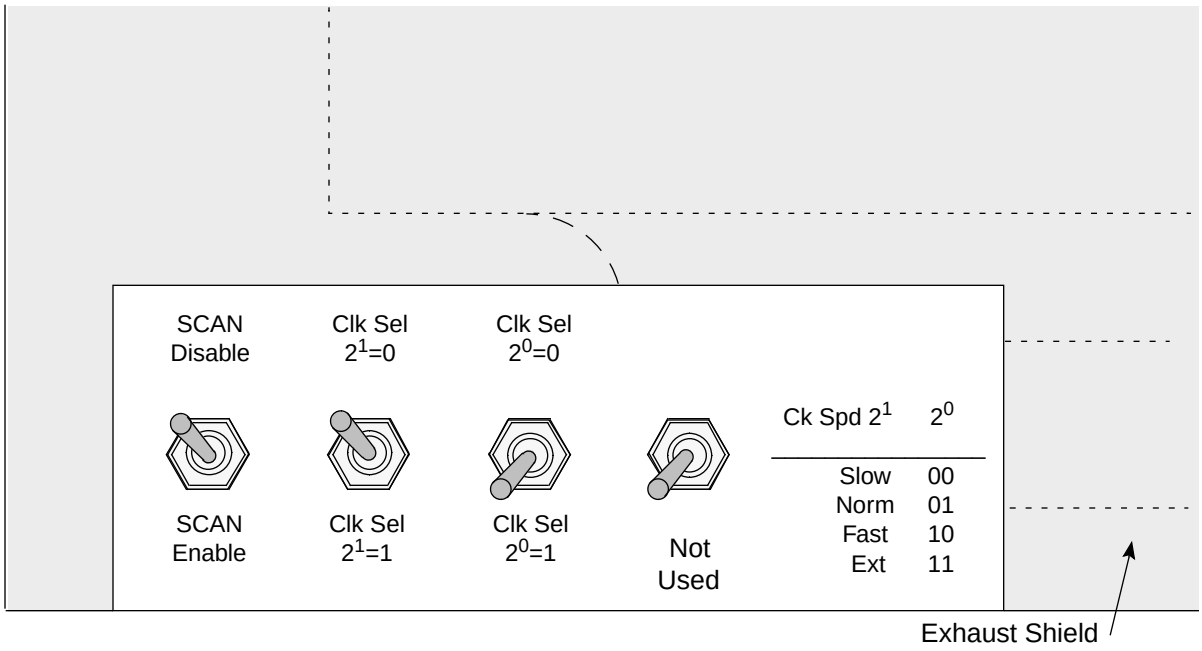
Clock Switches

The two clock switches (S0 and S1) enable personnel to select predetermined clock speeds. The following table lists the switch selections:

Margin	Switch 2^1	Switch 2^0
Slow	0	0
Normal	0	1
Fast	1	0
Coax (External clock)	1	1

The clock switches are located on the same switch board as the Boundary Scan Enable switch. Refer to Figure 19. (The switch board also contains a fourth switch, which is not used.)

Figure 19. Clock Switches



Display Switches

The WACS display module includes three switches, which are discussed in the “Viewing the WACS Display” section.

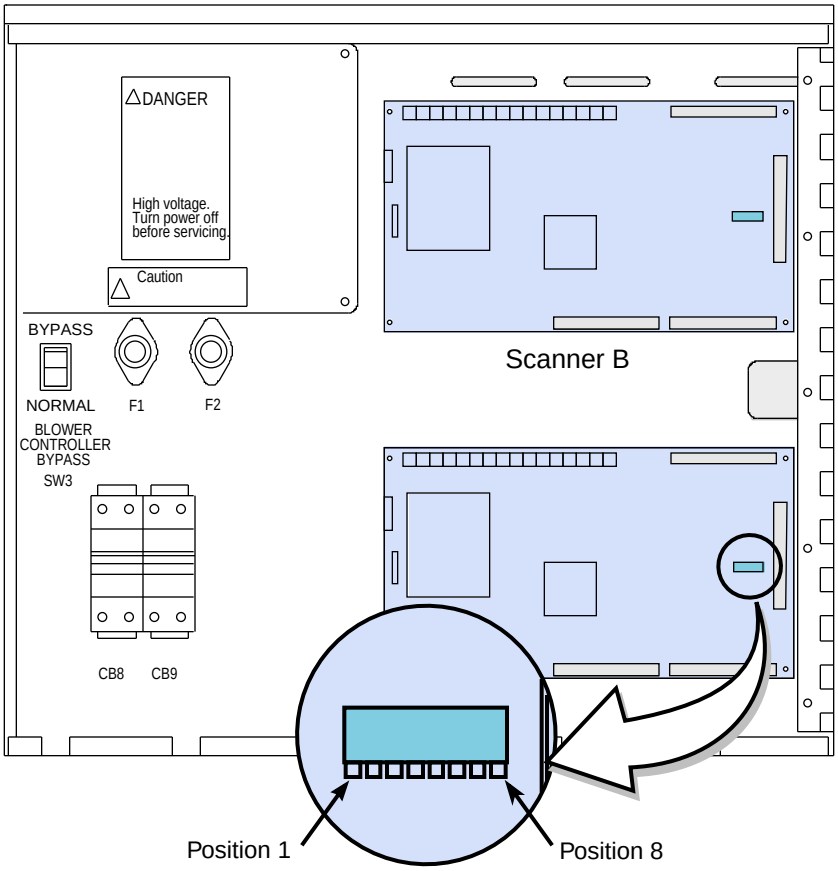
WACS DIP Switches

DIP switches on scanner A determine the remote alarm functions, the display temperature scale, and whether the WACS displays the auxiliary (clock) voltages. Table 2 lists the switch functions. Figure 20 shows the switch locations.

Table 2. Scanner A DIP Switch Functions

Positions	"On" Function
1	Display auxiliary (clock) voltages
2 through 4	Not used
5	Remote alarm energized (picked) if good – dropped if input power is lost (For example, this switch determines whether a 1 equals "Good" or "Bad." It is normally set to the "Off" position.)
6	Remote alarm enabled on warning and fault (off = alarm on fault only)
7	Remote alarm enabled if cabinet is powered off
8	WACS display temperature scale in Celsius (off = Fahrenheit)

Figure 20. WACS DIP Switches

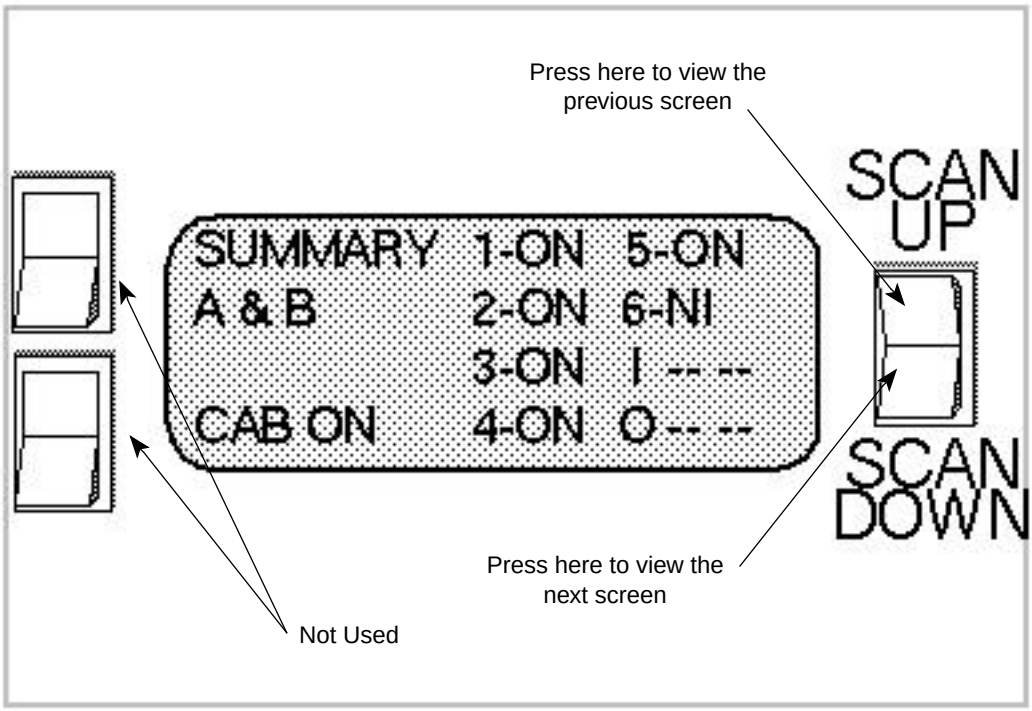


Viewing the WACS Display

Each CRAY T3E air-cooled cabinet contains a 4-line by 20-character liquid crystal display (LCD). Refer to Figure 21. The display contains 21 screens of information and connects to scanner A via an 8-bit data bus and 3 control lines.

This display module contains three display mode switches. The two switches on the left are not used. The other switch enables personnel to view (scan) the various WACS pages.

Figure 21. WACS Display



The following list describes the 21 screens of the WACS display, and the following pages explain the various types of screens.

- Three *summary* screens
- Six *module* screens
- One *in air* (inlet air) screen
- One *out air* (exhaust air) screen
- Six *power supply* screens
- Four *definition* screens

Main Summary Screen

Figure 22 shows the main Summary screen. This screen appears when you power up the WACS. Table 3 describes the screen output.

Figure 22. Main Summary Screen

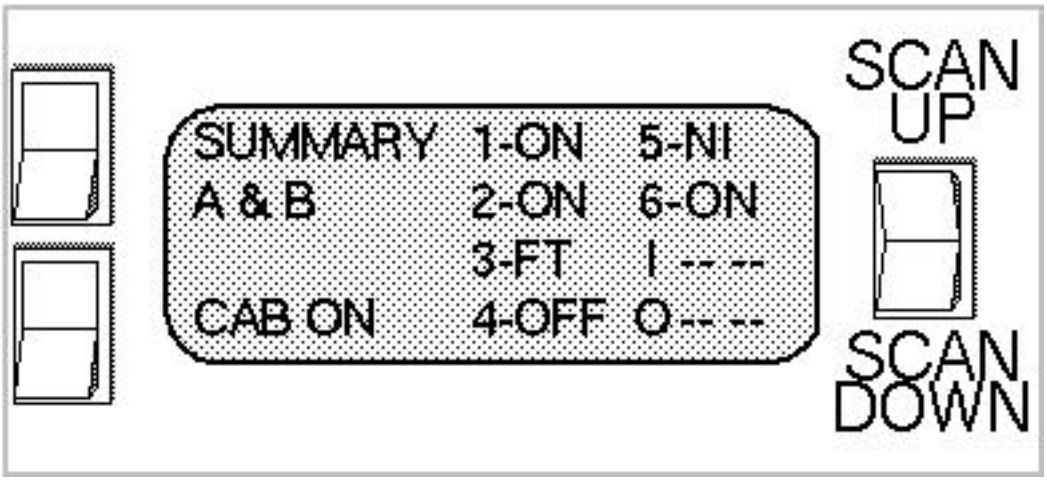


Table 3. Main Summary Screen Information

Screen Output	Description
A & B	Indicates that the system contains two operational WACS scanner boards: A and B. (If one scanner is not operational, this screen should display the message "SCANNER *X* NOT CONNECTED.")
CAB ON	This text area indicates the cabinet condition. CAB ON = Cabinet is on (contactor may be open or closed) STANDBY = Contactor is open and the Remote Restart Enable switch is in the enabled position (the cabinet is waiting for a remote power up signal) OFF-FLT = Contactor open due to a fault OFF-ERR = Contactor open due to an unknown error
n-ON	Indicates that module *n* is enabled and that the WACS is sending an enable signal to the module's power supply.
n-FT	Indicates that both scanners detect that module *n* has a fault.
n-OFF	Indicates that both scanners detect that module *n* is installed but the power supply is not enabled.
n-NI	Indicates that both scanners detect that module *n* is not installed or that the top rail is not cammed.
I -- --	Indicates that both scanners detect an inlet air temperature that is within the normal range. If a problem occurs, warning or fault designators appear in this area.
O -- --	Indicates that both scanners detect an outlet (exhaust) air temperature that is within the normal range. If a problem occurs, warning or fault designators appear here.

Scanner A Summary Screen

Figure 23 shows the scanner A Summary screen. Table 4 describes the screen output.

Figure 23. Scanner A Summary Screen

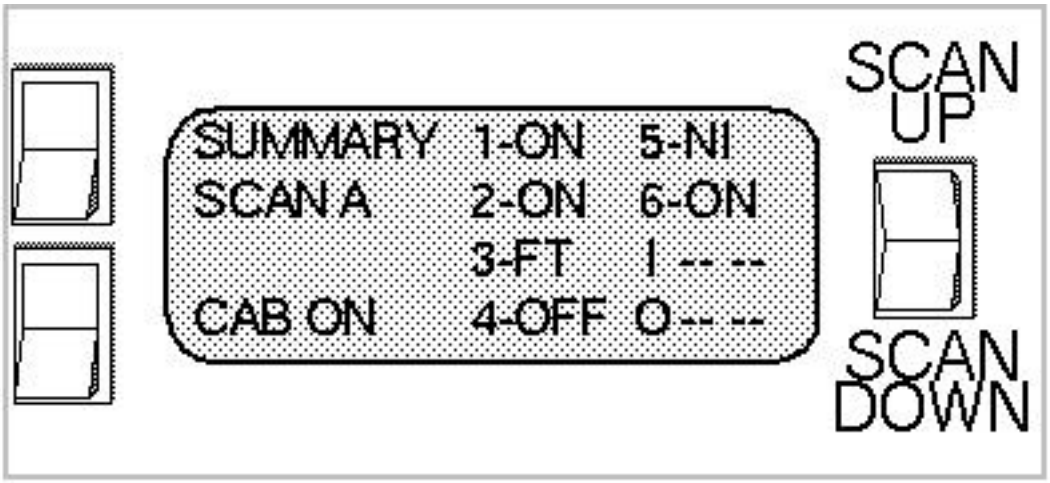


Table 4. Scanner A Summary Screen Information

Screen Output	Description
SCAN A	Indicates that this screen contains values detected by WACS scanner board A.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
n-ON	Indicates that scanner A detects that module *n* is powered on.
n-FT	Indicates that scanner A detects that module *n* has a fault.
n-OFF	Indicates that scanner A detects that module *n* is installed but the power supply is not enabled.
n-NI	Indicates that scanner A detects that module *n* is not installed or that the top rail is not cammed.
I -- --	Indicates that scanner A detects an inlet air temperature that is within the normal range. If a problem occurs, warning or fault designators (LW, LF, HW, HF) appear in this area.
O -- --	Indicates that scanner A detects an outlet (exhaust) air temperature that is within the normal range. If a problem occurs, warning or fault designators appear in this area.

Scanner B Summary Screen

Figure 24 shows the scanner B Summary screen. Table 5 describes the screen output.

Figure 24. Scanner B Summary Screen

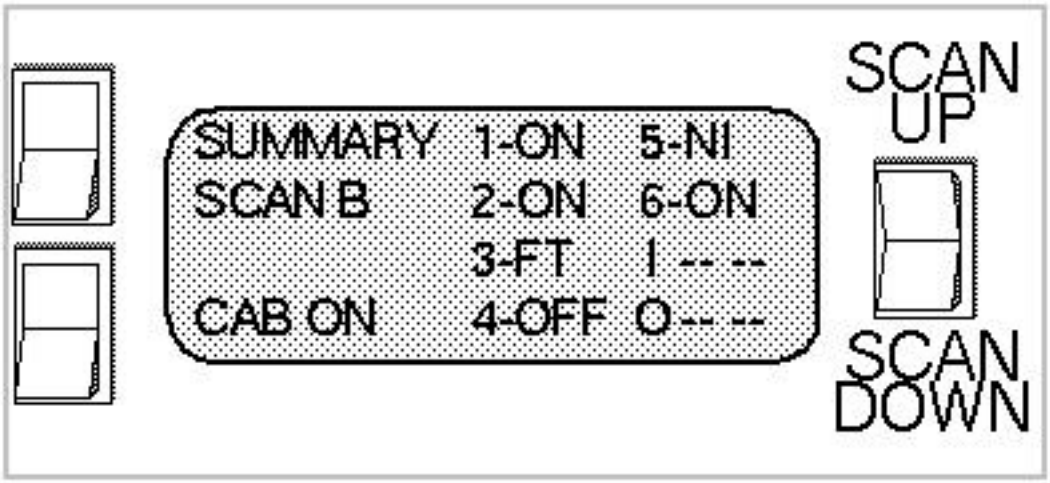


Table 5. Scanner B Summary Screen Information

Screen Output	Description
SCAN B	Indicates that this screen contains values detected by WACS scanner board B.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
n-ON	Indicates that scanner B detects that module *n* is powered on.
n-FT	Indicates that scanner B detects that module *n* has a fault.
n-OFF	Indicates that scanner B detects that module *n* is installed but the power supply is not enabled.
n-NI	Indicates that scanner B detects that module *n* is not installed or that the top rail is not cammed.
I -- --	Indicates that scanner B detects an inlet air temperature that is within the normal range. If a problem occurs, warning or fault designators (LW, LF, HW, HF) appear in this area.
O -- --	Indicates that scanner B detects an outlet (exhaust) air temperature that is within the normal range. If a problem occurs, warning or fault designators appear in this area.

Module Screen – Module Installed

Figure 25 shows the screen that provides information on module 1. In this case, module 1and PS1 are installed and operating. Table 6 describes the screen output.

Figure 25. Module Screen – Module Installed

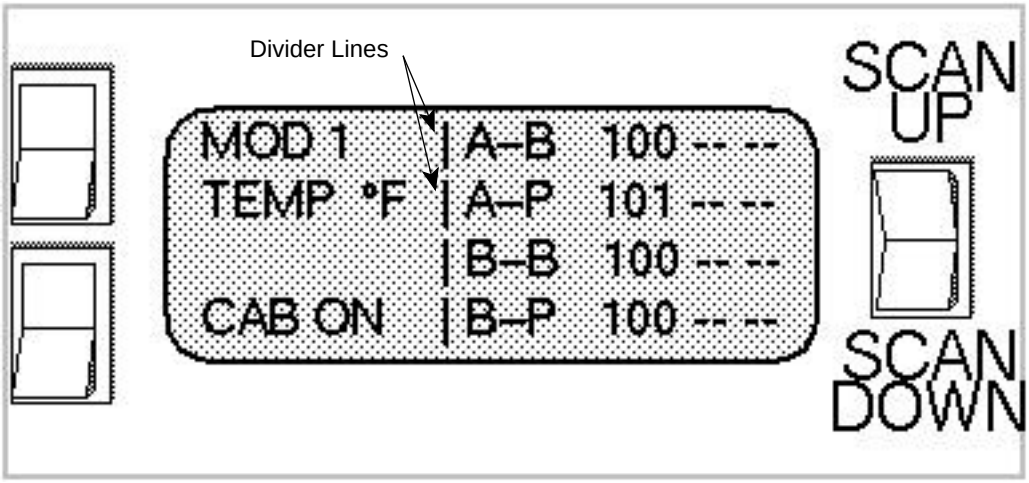


Table 6. Module Screen Information – Module Installed

Screen Output	Description
MOD 1 TEMP °F	Indicates the module (slot 1) to which the screen information applies. The temperature scale is Fahrenheit.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
A–B 100	Scanner A detects a backup thermistor temperature of 100 °F.
A–P 101	Scanner A detects a primary thermistor temperature of 101 °F.
B–B 100	Scanner B detects a backup thermistor temperature of 100 °F.
B–P 100	Scanner B detects a primary thermistor temperature of 100 °F.
-- --	Warning or fault designators (LW, LF, HW, HF) appear in this area.

Module Screen – Module Not Installed

Figure 26 shows the screen that provides information on module 5. In this case, module 5 is not installed. Table 7 describes the screen output.

Figure 26. Module Screen – Module Not Installed

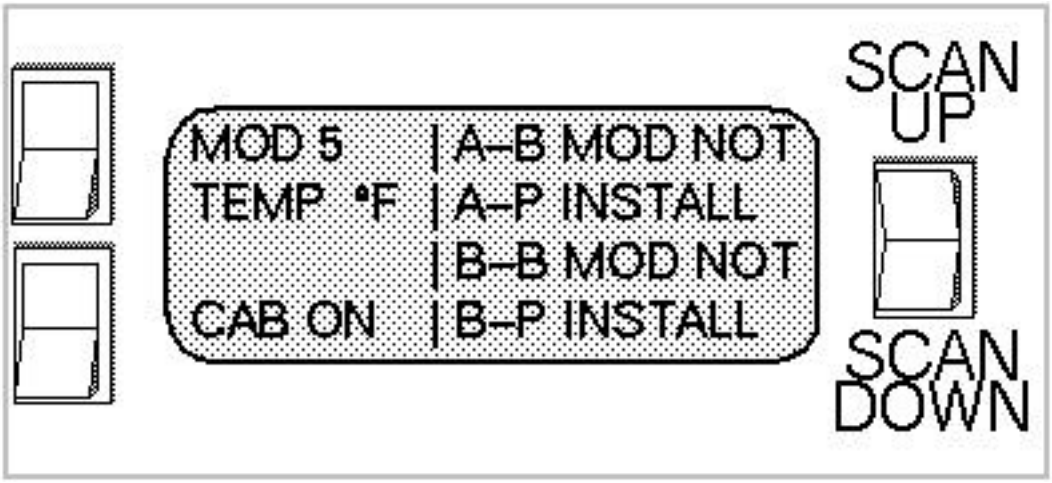


Table 7. Module Screen Information – Module Not Installed

Screen Output	Description
MOD 5 TEMP °F	Indicates the module (slot 5) to which the screen information applies.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
A–B MOD NOT A– P INSTALL	Indicates that scanner A does not detect a logic module in slot 5.
B–B MOD NOT B–P INSTALL	Indicates that scanner B does not detect a logic module in slot 5.

In (Inlet) Air Screen

Figure 27 shows the screen that provides information on the inlet air temperature. Table 8 describes the screen output.

Figure 27. Inlet Air Screen

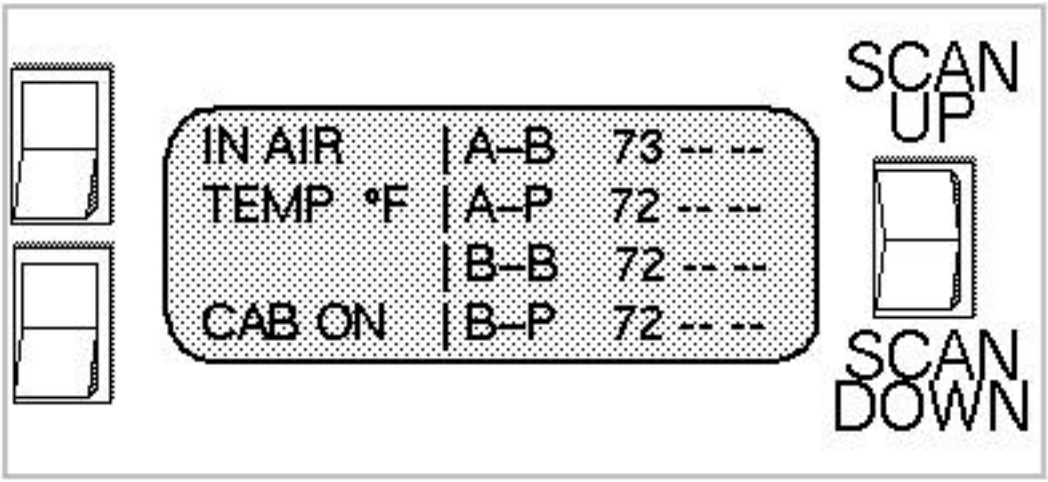


Table 8. Inlet Air Screen Information

Screen Output	Description
IN AIR TEMP °F	Indicates that this screen contains information about the inlet air temperature.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
A–B 73	Scanner A detects a backup air thermistor temperature of 73 °F.
A–P 72	Scanner A detects a primary air thermistor temperature of 72 °F.
B–B 72	Scanner B detects a backup air thermistor temperature of 72 °F.
B–P 72	Scanner B detects a primary air thermistor temperature of 72 °F.
-- --	Warning or fault designators (LW, LF, HW, HF) appear in this area.

Out (Exhaust) Air Screen

Figure 28 shows the screen that provides information on the exhaust air temperature. Table 9 describes the screen output.

Figure 28. Exhaust Air Screen

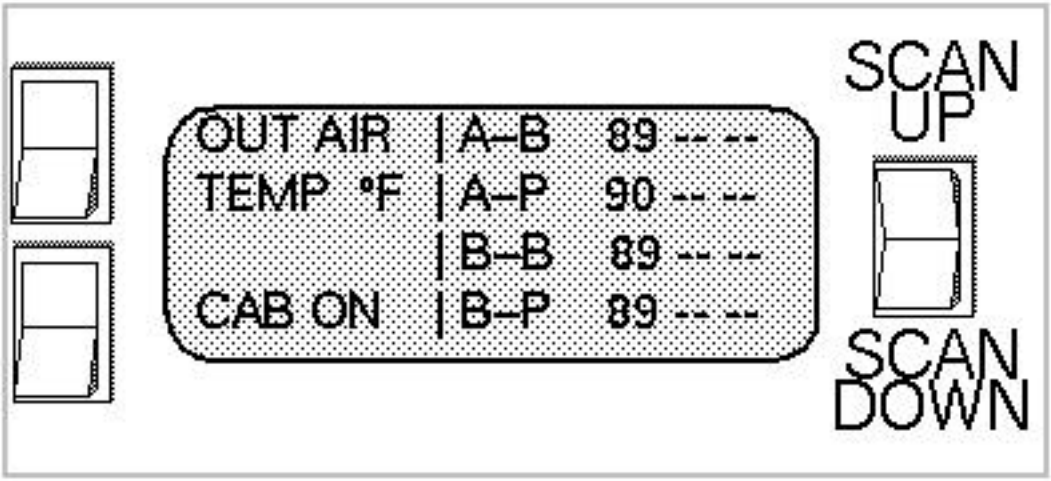


Table 9. Exhaust Air Screen Information

Screen Output	Description
OUT AIR TEMP °F	Indicates that this screen contains information about the exhaust air temperature.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
A–B 89	Scanner A detects a backup air thermistor temperature of 89 °F.
A–P 90	Scanner A detects a primary air thermistor temperature of 90 °F.
B–B 89	Scanner B detects a backup air thermistor temperature of 89 °F.
B–P 89	Scanner B detects a primary air thermistor temperature of 89 °F.
-- --	Warning or fault designators (LW, LF, HW, HF) appear in this area.

Module Power Supply Screen – Module Installed and On

Figure 29 shows the screen that provides information on the voltage of the module in slot 1. In this case, module 1and its power supply (PS1) are installed and operating. Table 10 describes the screen output.

Figure 29. Power Supply Screen – Module Installed and On

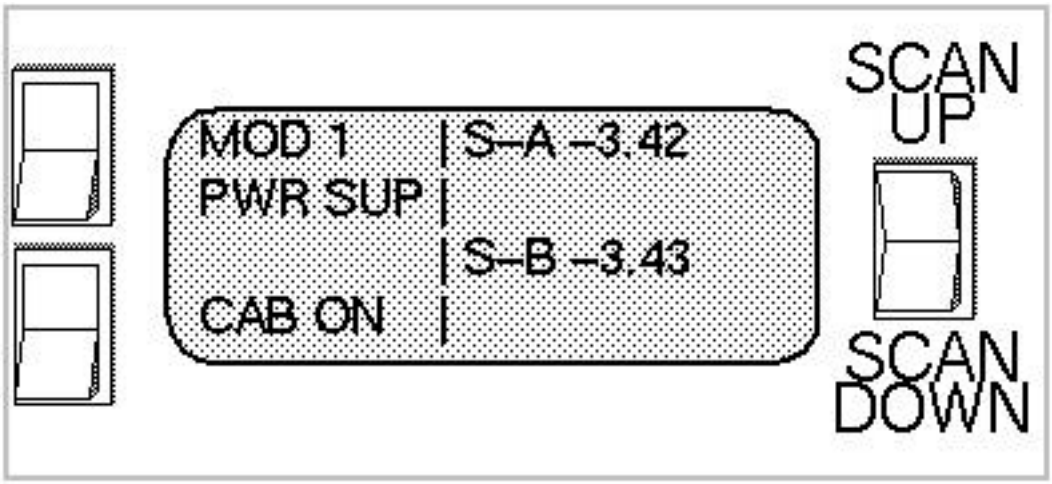


Table 10. Power Supply Screen Information – Module Installed and On

Screen Output	Description
MOD 1 PWR SUP	Indicates the module and module power supply (slot 1) to which the screen information applies.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
S–A –3.42	This area indicates the voltage that scanner A detects on the module: When the power supply is enabled, this area indicates the operational voltage (in this case, –3.42 Vac). When the enable signal is removed, the scanner should detect a voltage near 0 (approximately –0.07 to +0.07 Vdc).
S–B –3.43	This area indicates the voltage that scanner B detects on the module.

Module Power Supply Screen – Module Installed and Off

Figure 30 shows the screen that provides information on the voltage of the module in slot 4. In this case, module 4 and its power supply (PS4) are installed and operating. Table 11 describes the screen output.

Figure 30. Power Supply Screen – Module Installed and Off

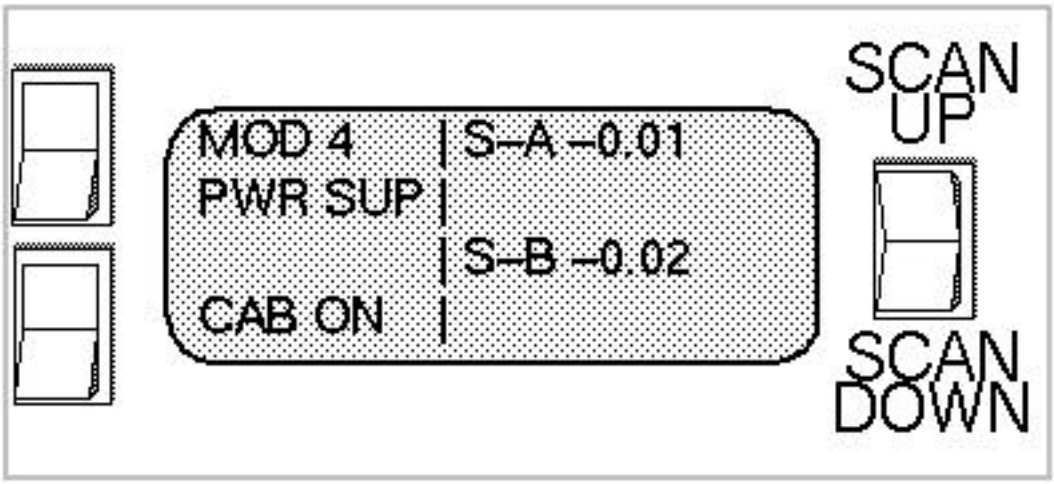


Table 11. Power Supply Screen Information – Module Installed and Off

Screen Output	Description
MOD 4 PWR SUP	Indicates the module and module power supply (slot 4) to which the screen information applies.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
S–A –0.01	This area indicates the voltage that scanner A detects on the module: When the power supply is enabled, this area indicates the operational voltage. When the enable signal is removed, the scanner should detect a voltage near 0 (in this case –0.01 Vdc).
S–B –3.43	This area indicates the voltage that scanner B detects on the module.

Module Power Supply Screen – Module Not Installed

Figure 31 shows the screen that provides information on the power supply (PS5) that supports module 5. In this case, module 5 is not installed. Table 12 describes the screen output.

Figure 31. Power Supply Screen – Module Not Installed

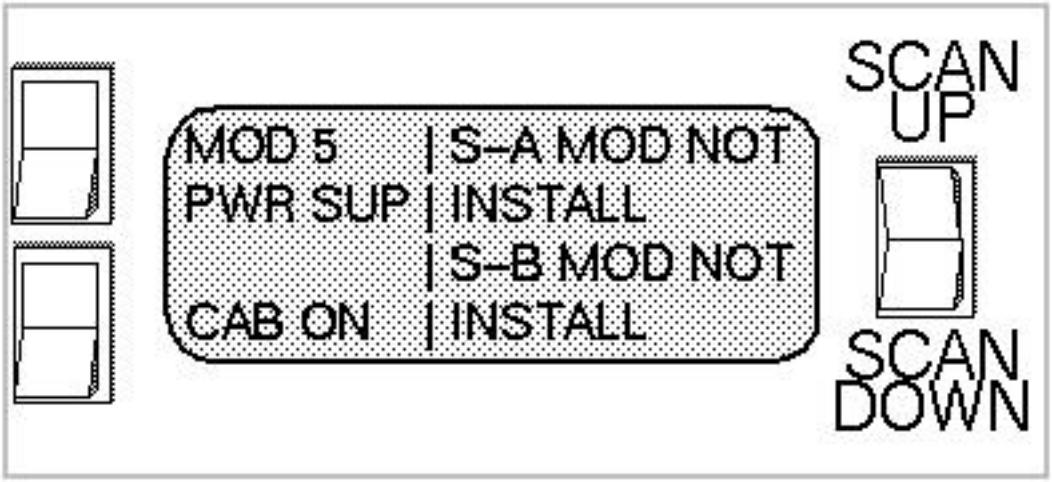


Table 12. Power Supply Screen Information – Module Not Installed

Screen Output	Description
MOD 5 PWR SUP	Indicates the module power supply (slot 5) to which the screen information applies.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
S–A MOD NOT INSTALL	Indicates that scanner A does not detect a logic module in slot 5.
S–B MOD NOT INSTALL	Indicates that scanner B does not detect a logic module in slot 5.

Module Power Supply Screen – Power Error

Figure 32 shows the screen for a slot where the WACS detects more than 0.08 Vdc on a module that should be off. Table 13 describes the screen output.

Figure 32. Power Supply Screen – Power Error

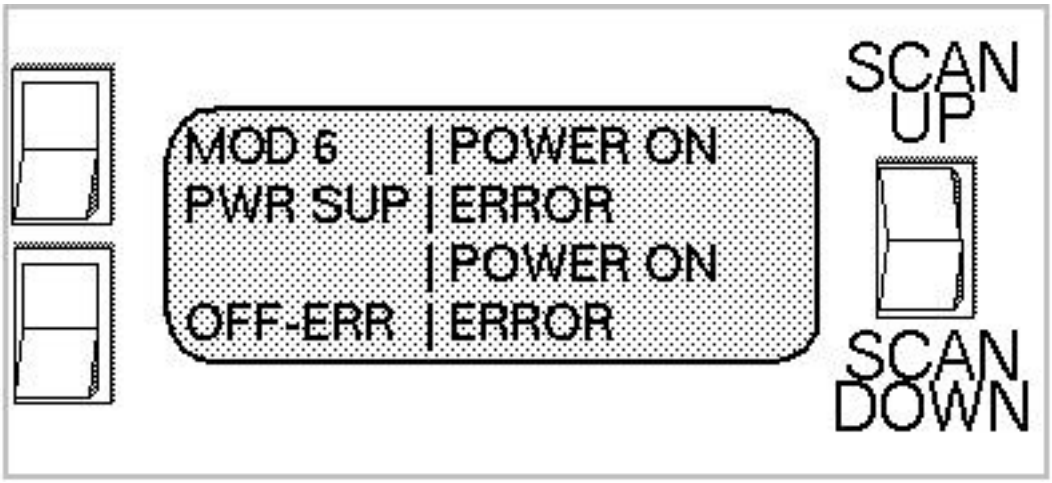


Table 13. Power Supply Screen Information – Power Error

Screen Output	Description
MOD 6 PWR SUP	Indicates the module power supply (slot 6) to which the screen information applies.
OFF-ERR	Indicates that the WACS opened the contactor due to an unknown fault. At other times, it contains cabinet information as described in Table 3.
POWER ON ERROR (top)	Indicates that scanner A detected more than 0.08 Vdc on the module in slot 6, which should have been off. The scanner then opened the contactor (CT1).
POWER ON ERROR (bottom)	Indicates that scanner B detected a power error for slot 6 (as described above).

Module Power Supply Screen – Clock Module Installed

Figure 33 shows the screen that provides information on the power supply (PS6) that supports a clock module. In this case, the clock and PS6 are installed and operating. Table 14 describes the screen output.

Figure 33. Power Supply Screen – Clock Module Installed

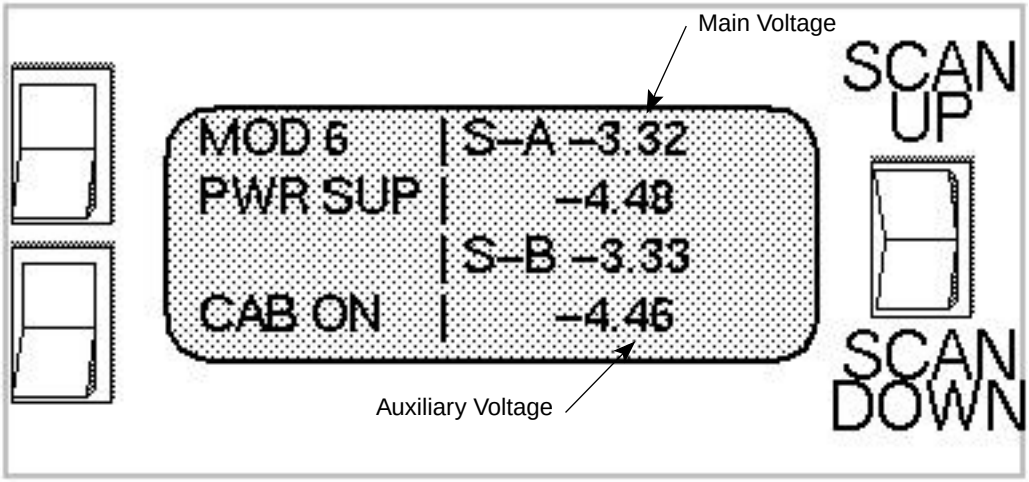


Table 14. Power Supply Screen Information – Clock Module Installed

Screen Output	Description
MOD 6 PWR SUP	Indicates the module power supply (slot 6) to which the screen information applies.
CAB ON	Indicates that the cabinet is currently powered on. At other times, it contains cabinet information as described in Table 3.
S–A –3.42	Indicates that scanner A detects a main voltage of –3.42 Vac on the clock module. When the enable signal is removed, the scanner normally shows a voltage of approximately –0.07 to +0.07 Vdc.
–4.48	Indicates that scanner A detects an auxiliary voltage of –4.48 Vac on the clock module.
S–B –3.43	Indicates that scanner B detects an output voltage of –3.43 Vac on the clock module. When the enable signal is removed, the scanner normally shows a voltage of approximately –0.07 to +0.07 Vdc.
–4.46	Indicates that scanner B detects an auxiliary voltage of –4.46 Vac on the clock module.

First Definition Screen

Figure 34 shows the first of four definition screens. In general, these definitions apply to the modules. Table 15 describes the screen output.

Figure 34. First Definition Screen

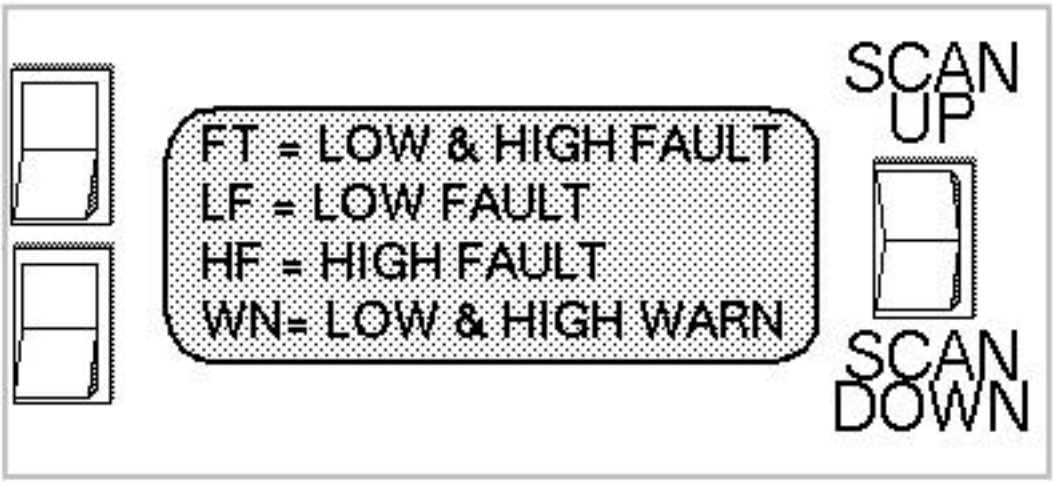


Table 15. First Definition Screen Information

Screen Output	Description
FT = LOW & HIGH FAULT	The letters “FT” indicate a combination low and high fault. For example, one module thermistor may have shorted (high fault) and one thermistor may be open (low fault).
LF = LOW FAULT	The letters “LF” indicate a low fault.
HF = HIGH FAULT	The letters “HF” indicate a high fault.
WN = LOW & HIGH WARN	The letters “WN” indicate a combination high and low warning.

Second Definition Screen

Figure 35 shows the second of four definition screens. Table 16 describes the screen output.

Figure 35. Second Definition Screen

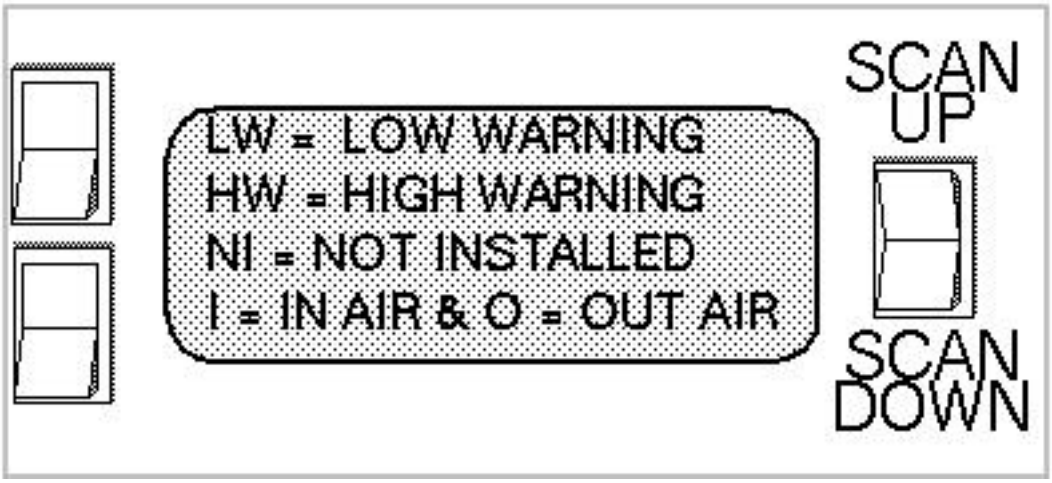


Table 16. Second Definition Screen Information

Screen Output	Description
LW = LOW WARNING	The letters “LW” indicate a low warning.
HW = HIGH WARNING	The letters “HW” indicate a high warning.
NI = NOT INSTALLED	The letters “NI” indicate that a module is either not installed or not cammed.
I = IN AIR	The letter “I” indicates the inlet air thermistors/temperature.
O = OUT AIR	The letter “O” indicates the outlet (exhaust) air thermistors/temperature.

Third Definition Screen

Figure 36 shows the Third of four definition screens. Table 17 describes the screen output.

Figure 36. Third Definition Screen

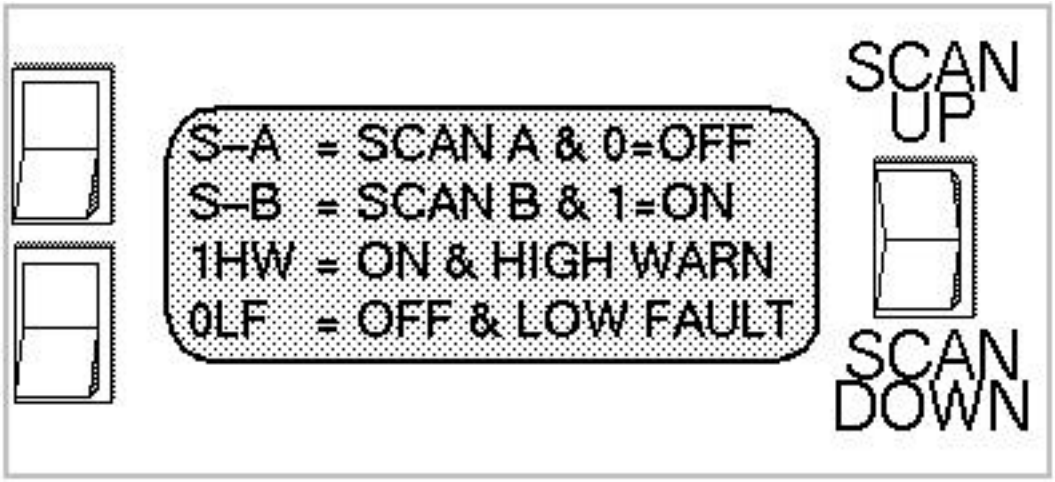


Table 17. Third Definition Screen Information

Screen Output	Description
S–A = SCAN A	“S–A” is an abbreviation for scanner A.
S–B = SCAN B	“S–B” is an abbreviation for scanner B.
0 = OFF	“0” indicates that a module (and power supply) is powered off.
1 = ON	“1” indicates that a module (and power supply) is powered on.
1HW=ON & HIGH WARN	“1HW” indicates that the WACS monitored a high warning condition (HW) on a module but did not remove power (1). This indication appears on the Summary screens.
0LF=OFF & LOW FAULT	“1LF” indicates that the WACS monitored a low fault condition on a module and removed power from the module. This indication appears on the Summary screens.

Fourth Definition Screen

Figure 37 shows the last of four definition screens. These screens define the abbreviations used in later screens. Table 18 describes the screen output.

Figure 37. Fourth Definition Screen

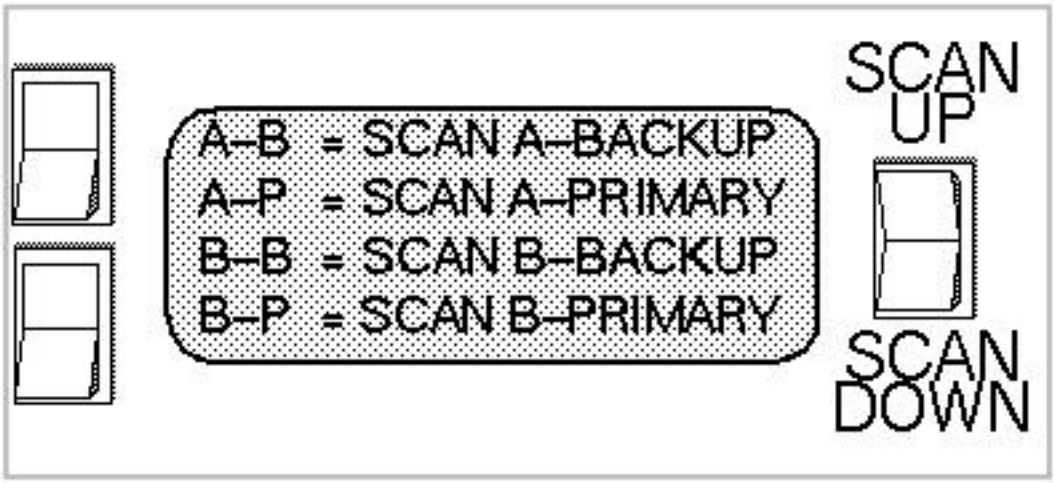


Table 18. Fourth Definition Screen Information

Screen Output	Description
A–B=SCAN A–BACKUP	“A–B” is an abbreviation for a backup sensor that connects to scanner A.
A–P=SCAN A–PRIMARY	“A–P” is an abbreviation for the primary sensor that connects to scanner A.
B–B=SCAN B–BACKUP	“B–B” is an abbreviation for a backup sensor that connects to scanner B.
B–P=SCAN B–PRIMARY	“B–P” is an abbreviation for the primary sensor that connects to scanner B.

Viewing WACS Information from the SWS (NWACS)

Use NWACS (and NWACSUSER) to view the WACS parameters from the SWS. Refer to *xelog, xcfg, and nwacs User Information*, publication HDM-012-D, for a description of the NWACS software application and for an explanation of how to use NWACS.

Figure 38 shows the main NWACS screen.

Figure 38. NWACS – Main Screen

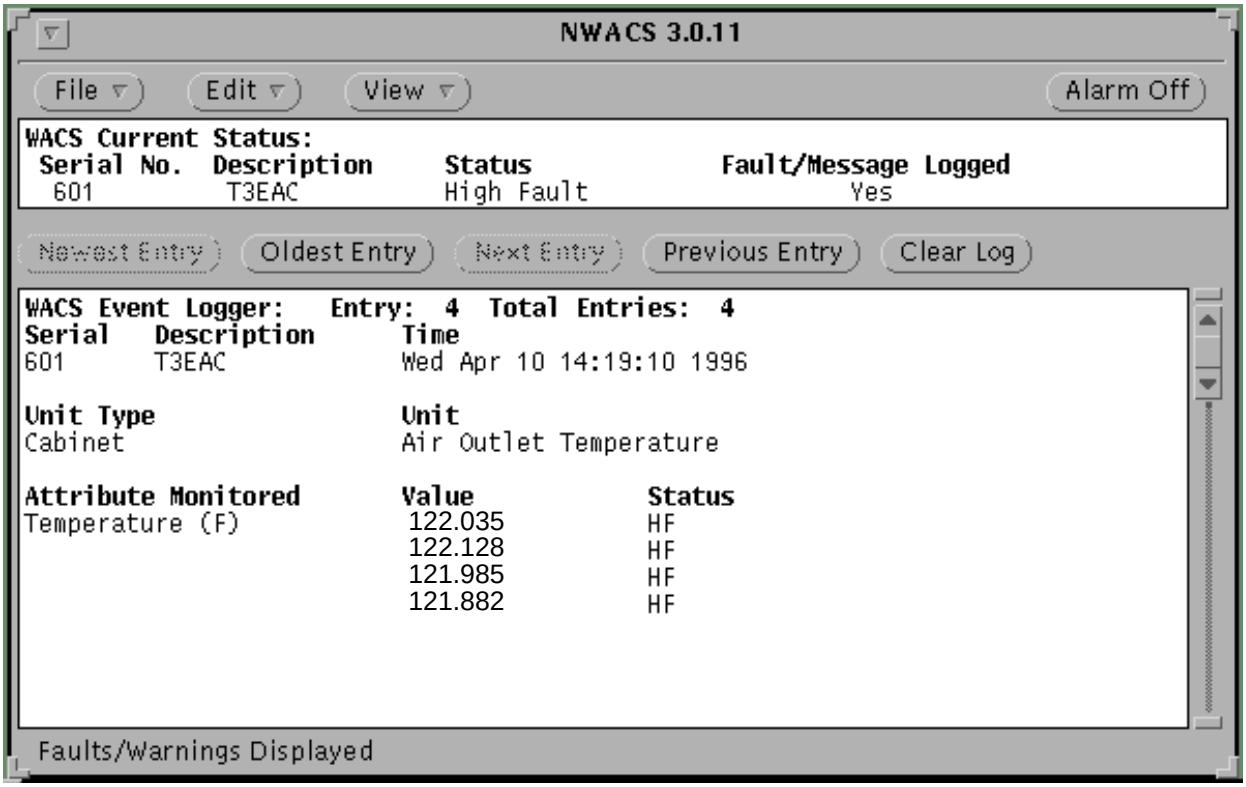


Figure 39 shows the main NWACS data screen. If NWACS records a fault, the associated text is shown in **bold** type.

Figure 39. NWACS Data (for Cabinet with Two PEMs and a Clock Module)

This column contains the readings that scanner A detects on the primary sensors.

This column contains the readings that scanner B detects on the backup sensors.

T3EAC: serial 6504

Unit	Measurement	A Primary	A Backup	B Primary	B Backup
Module					
Module 1	Temperature (F)	N 75.391	N 78.913	N 75.087	N 78.609
Module 2		N 75.043	N 79.435	N 74.696	N 79.174
Module 3		D 0.000	D 0.000	D 0.000	D 0.000
Module 4		D 0.000	D 0.000	D 0.000	D 0.000
Module 5		D 0.000	D 0.000	D 0.000	D 0.000
Module 6		N 75.826	N 77.174	N 75.478	N 76.913
Module 1 -3.3/-4.5 Volts	DC Volts	N -2.948	D 0.000	N -2.968	D 0.000
Module 2 -3.3/-4.5 Volts		N -2.948	D 0.000	N -2.973	D 0.000
Module 3 -3.3/-4.5 Volts		N 0.000	D 0.000	N 0.000	D 0.000
Module 4 -3.3/-4.5 Volts		N 0.000	D 0.000	N 0.000	D 0.000
Module 5 -3.3/-4.5 Volts		N 0.000	D 0.000	N 0.000	D 0.000
Module 6 -3.3/-4.5 Volts		N -3.194	N -4.399	N -3.219	N -4.414
Cabinet					
Air Inlet Temperature	Temperature (F)	N 69.957	N 70.391	N 69.652	N 70.087
Air Outlet Temperature		N 78.696	N 78.739	N 78.522	N 78.478
Main Power On K1	State	N On	N On		
Remote Warning		N Off	N Off		
Power Supply 1		N Enabled	N Enabled		
Power Supply 2		N Enabled	N Enabled		
Power Supply 3		N Disabled	N Disabled		
Power Supply 4		N Disabled	N Disabled		
Power Supply 5		N Disabled	N Disabled		
Power Supply 6		N Enabled	N Enabled		

State of Contactor

Auxiliary voltage (on clock)

Soft Switches

The NWACS software includes the following soft switches:

- Power UP
- Power DOWN
- Test Mode (boundary scan enable/disable)

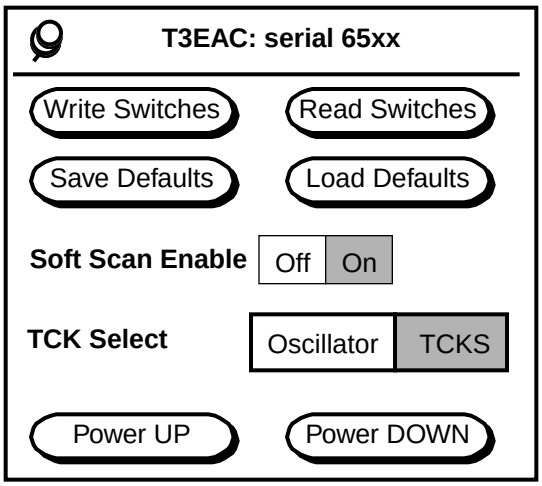
The Power UP switch causes the cabinet WACS to close the contactor, which provides power to the module power supplies and blower.

The Power DOWN switch causes the cabinet WACS to open the contactor, which removes power from the module power supplies and blower.

The Test Mode switch enables (On) and disables (Off) the boundary scan feature.

Figure 40 shows the NWACS switches menu. As in other versions of NWACS, you must click on the Write Switches button to apply your switch selections.

Figure 40. NWACS Switches



Faults and Warnings

The WACS compares the air temperatures and module temperatures to predetermined operating ranges. If a temperature exceeds the normal operating range slightly, the WACS issues a *warning*. If a temperature is far beyond the operating range and may cause cabinet damage, the WACS issues a *fault.*

A warning usually indicates a pending failure or cause for concern. If at least one scanner detects a warning-level reading from any sensor (primary or backup), the WACS sends a warning signal to the display and to the SWS. The WACS may also send this warning to the customer's private alarm, if one exists.

A fault indicates component failure or an otherwise dangerous condition. If at least one scanner detects fault-level readings from one sensor (primary or backup), the WACS sends a fault signal to the display and to the SWS. If a scanner detects fault-level readings from both sensors, it also removes power from the appropriate cabinet components. In addition, the WACS sends a signal to the customer's alarm, if one exists.

Fault and Warning Limits

Table 19 lists the fault and warning limits for cabinet temperatures.

Table 19. Temperature Fault and Warning Limits

Monitored Condition	Low Warning	Low Fault	High Warning	High Fault
Inlet air temperature	10 °F (–12 °C)	0 °F (–18 °C)	85 °F (29 °C)	90 °F (32 °C)
Exhaust air temperature	10 °F (–12 °C)	0 °F (–18 °C)	110 °F (43 °C)	120 °F (49 °C)
Module temperature	10 °F (–12 °C)	0 °F (–18 °C)	110 °F (43 °C)	120 °F (49 °C)

Fault and Warning Indicators and Actions

When the WACS detects a warning or fault condition, the display indicates the type of condition by using 2- and 3-character abbreviations. Table 20 lists the indicators and WACS actions for the various conditions. The display also indicates the component where the condition was detected.

The WACS may take either of the following actions when it detects a fault condition:

- If it detects a cabinet fault, such as an inlet air temperature fault, the WACS opens the contactor to remove power from the module power supplies. This also removes power from the blower.
- If the fault is isolated to a module and power supply pair, the WACS disables the power supply by removing the Power Supply Enable signal.

When the WACS is on, but the blower and module power supplies are powered down, the WACS continues to monitor temperatures and voltages. It also takes the following protective action:

- If the WACS detects a cabinet fault, it keeps the contactor open, which prevents personnel from powering up the cabinet while the condition is present.
- If it detects a fault that is isolated to a module and power supply pair, it removes the Power Supply Enable signal, which prevents personnel from powering up the pair until the condition is corrected.

The WACS latches the fault/warning status for any fault that causes the WACS to remove a Power Supply Enable signal or to open the contactor. This status is ORed with the present fault/warning for the display on the screen. As a result, the screen can show a normal temperature and a high fault.

To clear latches, press the Restart switch, or cycle the input power to the cabinet.

In some cases, a fault may occur – and be corrected – before the WACS opens the contactor or removes a Power Supply Enable signal. In such cases, the fault does not latch.

Table 20. Fault and Warning Indicators and Actions

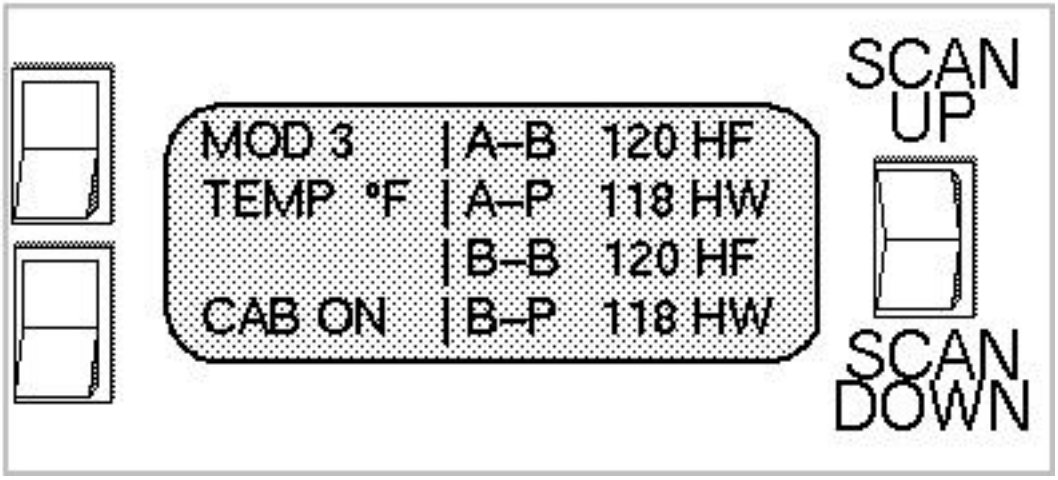
Condition	Display Indicator	WACS Action
High-temperature warning – module, exhaust air, or inlet air	HW	Display only
Low-temperature warning – module, exhaust air, or inlet air	LW	Display only
High-temperature fault – module	HF	Removes the enable signal from the associated power supply
High-temperature fault – exhaust air or inlet air	HF	Opens the contactor to remove power from the module power supplies (and blower)
Low-temperature fault – module	LF	Removes the enable signal from the associated power supply
Low-temperature fault – exhaust air or inlet air	LF	Opens the contactor to remove power from the module power supplies (and blower)
Low and high fault on a module thermistor pair	FT	Removes the enable signal from the associated power supply
Loss of power supply	OFF	Display only
High fault above the calibration limit (above the reference voltage)	HGH	Opens the contactor to remove power from the module power supplies (and blower)
Low fault below the calibration limit (below the reference voltage)	LOW	Opens the contactor to remove power from the module power supplies (and blower)

Table 20 does not contain conditions that are specific to problems within the module power supplies. This is because the WACS does not monitor the module power supplies for internal voltage, current, and temperature. Instead, each module power supply monitors its own internal parameters. If a module power supply detects a significant deviation from the normal range of internal voltage, current, or temperature, it powers itself off. You must view the power supply LED indicators to determine the nature of the fault.

The WACS detects the power-off of a module power supply as a loss of operating voltage on the affected module (refer to Figure 30). Although the WACS monitors voltage on the modules, the WACS only takes protective action if it detects more than 0.8 Vdc on a module that is supposed to be off. In such a case, the WACS opens the contactor and displays the message “POWER ON ERROR” on the appropriate module power supply screens of the WACS display.

Figure 41 shows the display indicators for a high-module-temperature fault (and high-temperature warning). In this example, both scanners reflect that the backup thermistor detects 120 °F, which is the high-fault threshold. Both scanners also reflect that the primary thermistor detects 118 °F, which is in the high-warning range. In such a case, the WACS removes the Power Supply Enable signal to the module power supply.

Figure 41. Fault Indicator – Module Temperature Fault on One Sensor



Electrical and Mechanical Troubleshooting

This section contains flowcharts for troubleshooting various electrical and mechanical problems that you may encounter with a CRAY T3E air-cooled (AC) system. The flowcharts contain tips only; vary your actions from the troubleshooting tips as appropriate. In addition, the flowcharts contain few troubleshooting details; instead, they provide a general troubleshooting path that includes many *obvious* suggestions (for possible oversights) and a few reminders of electromechanical aspects that are peculiar to the CRAY T3E AC cabinet.

Read *Safety and ESD Guidelines*, HGM-016-A, before you perform any power-related procedure.

The flowcharts are arranged according to cabinet conditions, as shown in the following list:

- Condition 1: Major electrical problem occurs during power-on
- Condition 2: Cabinet, including WACS, does not power on
- Condition 3: WACS is on, but modules and blower do not have power
- Condition 4: WACS and blower are on, but all module power supplies and modules are off or disabled
- Condition 5: Power supply and module pair are off or disabled
- Condition 6: Power supply is enabled, but the module is not on
- Condition 7: WACS and modules are on, but the blower does not run
- Condition 8: Blower runs at full speed
- Condition 9: WACS display does not operate
    - Condition 9a: Blank WACS display
    - Condition 9b: Static WACS data
- Condition 10: WACS fails during operation
- Condition 11: The WACS indicates a fault

Condition 1: Major electrical problem occurs during power-on

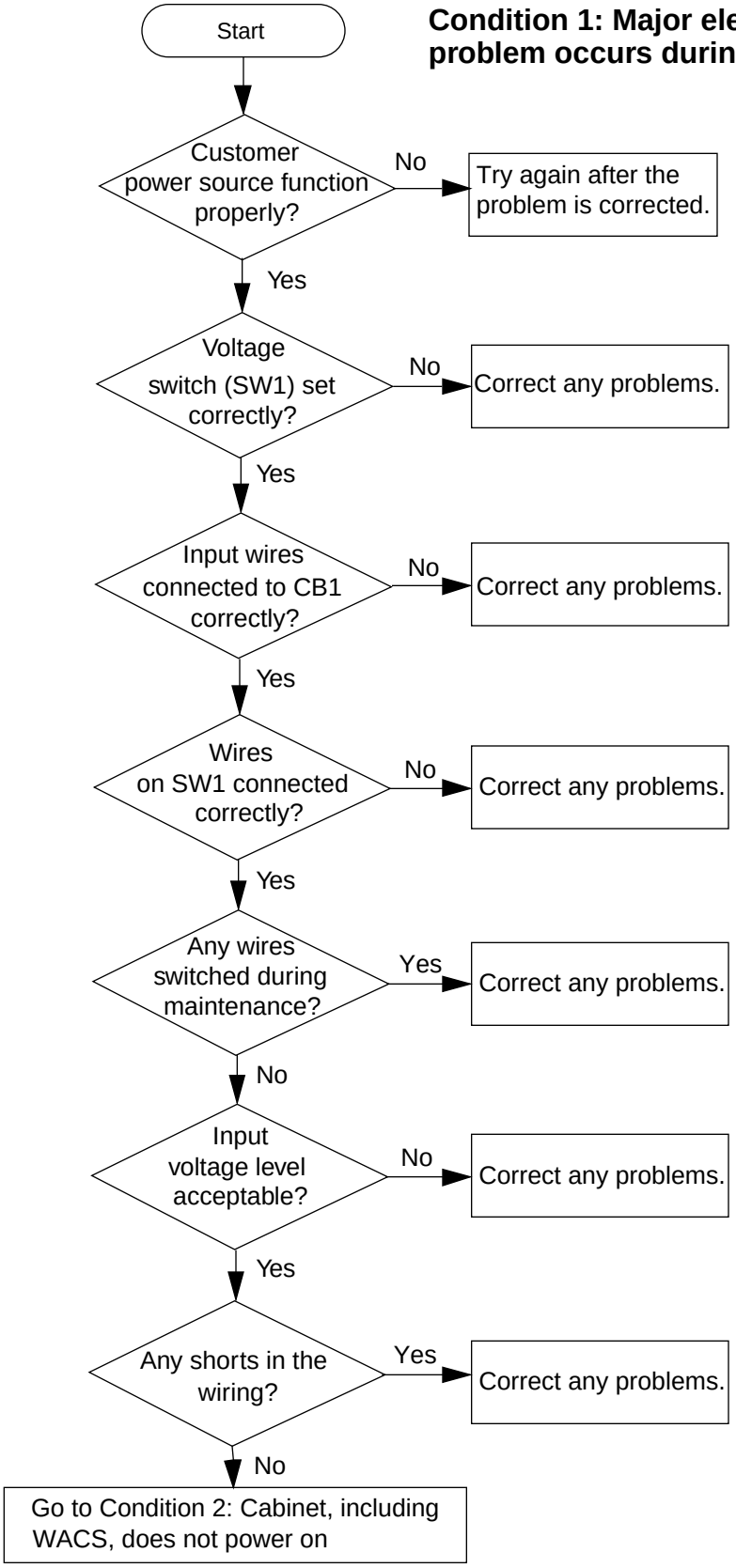
A major electrical problem may occur during initial power-on if any of the following conditions exist:

- The Voltage Selector switch (SW1) is set to the wrong voltage.
- The input power wires are connected to the wrong locations on CB1.
- Power wires are connected to the wrong locations on SW1 or on any other components.
- The input power is not within the specified range.
- There is an electrical short.

During subsequent power-on procedures, a major electrical problem should not occur in the areas listed in the first three bullets above unless the site or cabinet has been rewired.

Use the flow chart on the opposite page to help troubleshoot an electrical problem that occurs during power-on.

Condition 1: Major electrical problem occurs during power-on



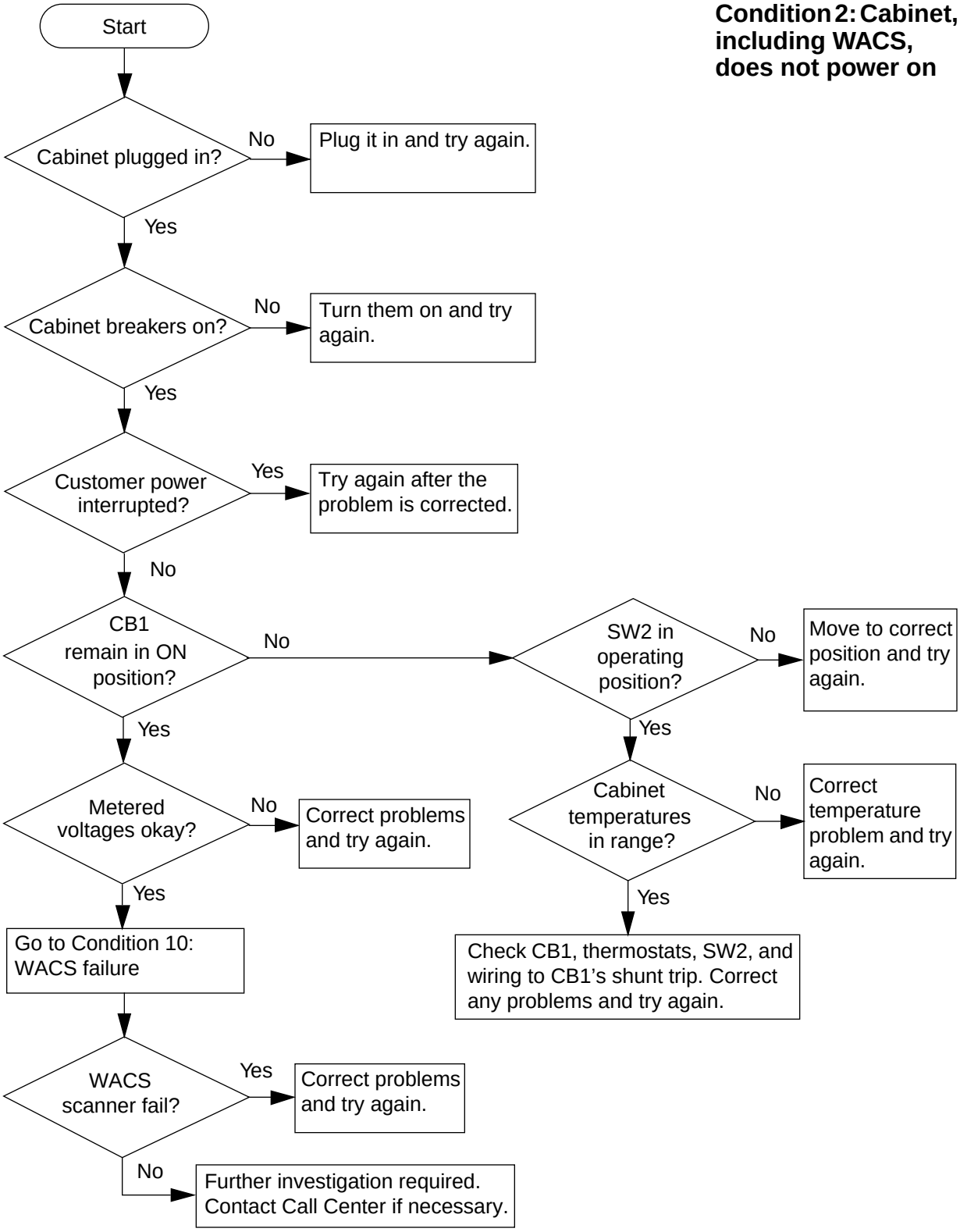
Condition 2: Cabinet, including WACS, does not power on

A CRAY T3E AC cabinet will not power on if any of the following conditions exist:

- The Cabinet Power switch (SW2) is in the OFF (0) position or is defective.
- The air temperature is in the fault range.
- One of the thermostats closes.
- CB1 is in the OFF position or is defective.
- The WACS circuit breaker (CB9) is in the OFF position or is defective.
- The WACS scanners do not have power due to a power-wiring or power-connection problem. Check for loose wires and connections. Check voltages.
- The customer power is not within the suitable range.
- The cabinet is not plugged in.
- The customer breaker(s) are in the OFF position or are defective.
- The customer power has been interrupted.
- There is a short in the SW2 wiring or thermostat wiring.

Use the flow chart on the opposite page to help troubleshoot a cabinet power-on problem.

Condition 2: Cabinet, including WACS, does not power on



Condition 3: WACS is on, but modules *and* blower do not have power

The WACS powers on or remains on – but the modules and blower do not – if any of the following conditions exist:

- The module power supply breakers (CB2 through CB7) and blower breaker (CB8) are in the OFF position.
- The contactor (CT1) does not close.
  - The WACS will open CT1 if it detects more than 0.8 Vdc on a module that should be off (the power supply is not enabled).
  - The WACS will open CT1 if it detects an inlet air or exhaust air temperature fault.
  - The WACS will not close CT1 if none of the modules are cammed.
  - The WACS will open CT1 if none of the modules are powered on.
  - CT1 may not close if electrical/mechanical problems exist in the power box.

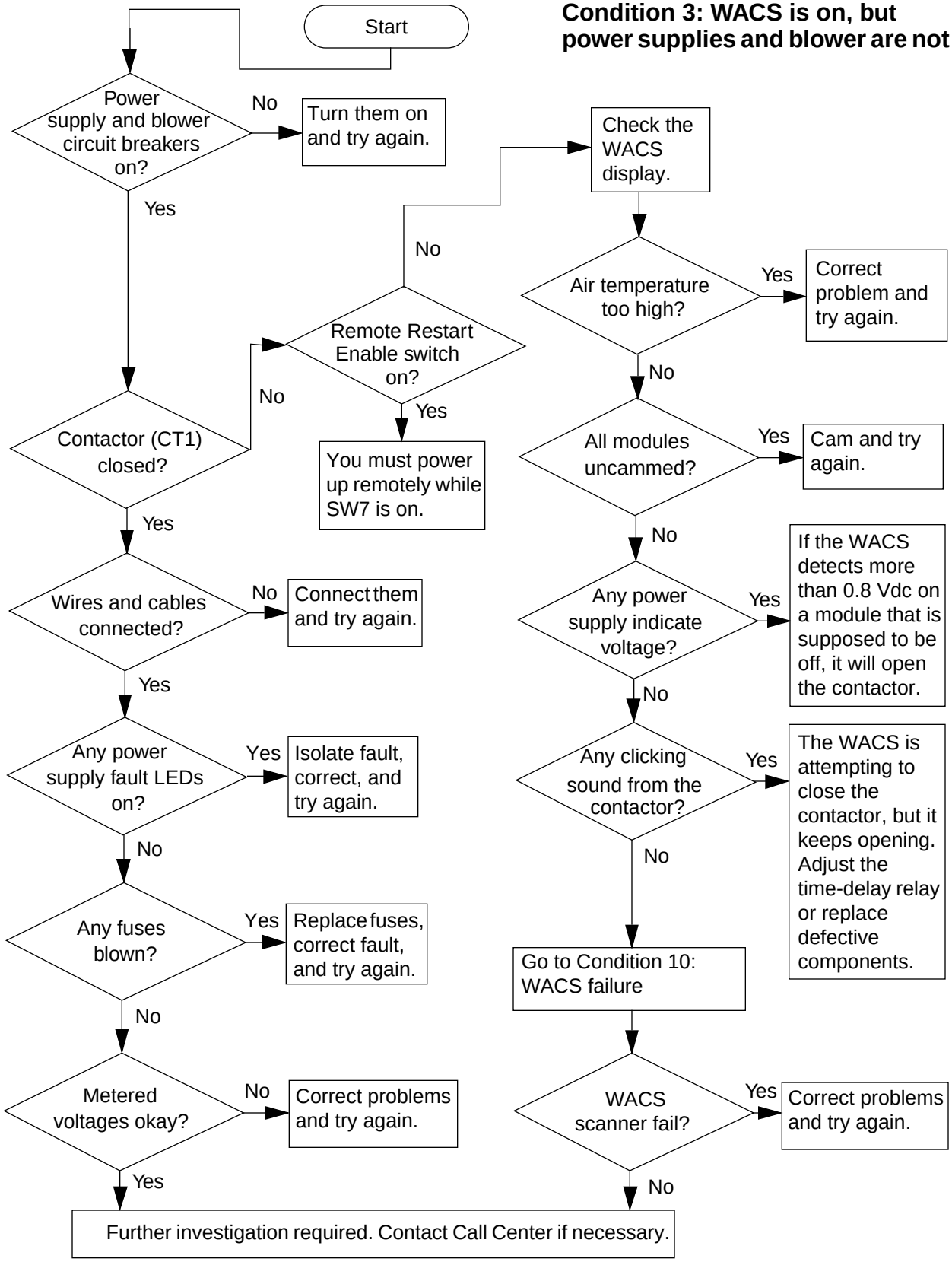
    If you hear a clicking sound coming from the power box, the WACS is attempting to close the contactor; however, the contactor keeps opening. The resistor (R1) is dissipating the power inrush to the contactor's coil; therefore, the contactor cannot close. There may be a problem with the contactor. There may be a problem with the time-delay relay; perhaps the relay needs to be set to a longer delay period; perhaps it is faulty.
  - CT1 cannot close if a WACS scanner fails.

    Compare the WACS data on the WACS display with the WACS data on the SWS. If no WACS data appears on either the display or the SWS, or if the WACS data is static on either, then a scanner is probably faulty. If there appears to be a problem with the WACS display, then scanner A may be faulty. If there is a problem with the WACS data on the SWS, then scanner B may be faulty.

    The problem may also be in the wiring or fuses.
  - CT1 will not close while the Remote Restart Enable switch (SW7) is on until the WACS receives the remote command.
- A power fluctuation blew the power supply fuses and blower fuses.
- Wires and cables are not connected.

Use the flow chart on the opposite page to help troubleshoot the power problem.

Condition 3: WACS is on, but power supplies and blower are not



Condition 4: WACS and blower are on, but all module power supplies and modules are off or disabled

The WACS and blower will power on or remain on – but the modules and module power supplies will not – if any of the following conditions exist:

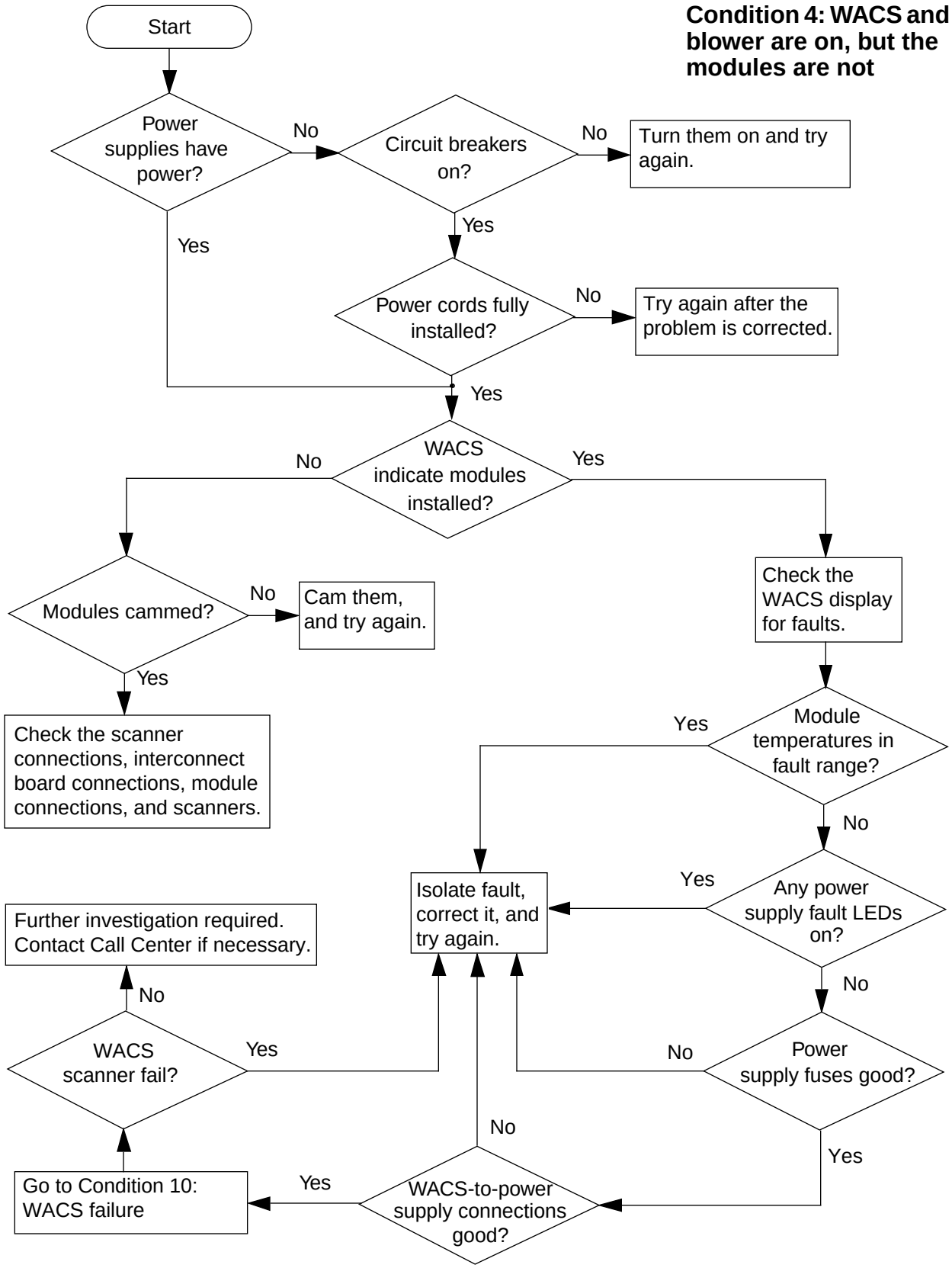
- The module power supply circuit breakers are in the OFF position.
- The power supply power cords are not fully installed.
- The WACS does not detect that the modules are cammed.
  - The module enable circuit is not complete.
  - The power supply enable circuit is not complete.
- The WACS detects all module temperatures in the fault range.
- The module power supplies do not receive the Power Supply Enable signals.

  This may be due to a bad interlock connection between the module and module rail. This may also be due to a bad control connection to the power supply or due to other bad connections, such as WACS to harness.
- A power fault caused damage to the module power supplies or otherwise caused them to power themselves off.

Use the flow chart on the opposite page to help troubleshoot a module power problem.

NOTE: If module temperatures rise to the fault level, the WACS will disable the Power Supply Enable signals to the module power supplies. If the cabinet air temperature rises to the fault level, the WACS will trip the contactor (CT1).

Condition 4: WACS and blower are on, but the modules are not



Condition 5: Power supply and module pair are off or disabled

A single module and module power supply pair will not power up (or will lose power) if any of the following conditions exist:

- The module power supply circuit breaker is in the OFF position.
- The power supply's power cord is not fully installed.
- The WACS does not detect that the module is cammed.
  - The module enable circuit is not complete.
  - The power supply enable circuit is not complete.
- The WACS detects that the module temperature is in the fault range.

  When a temperature fault is isolated to a module or module power supply, check the damper operation to ensure that the damper opens properly and provides sufficient airflow. The WACS will not enable power until the fault condition improves or is corrected.
- The module power supply does not receive the Power Supply Enable signal.

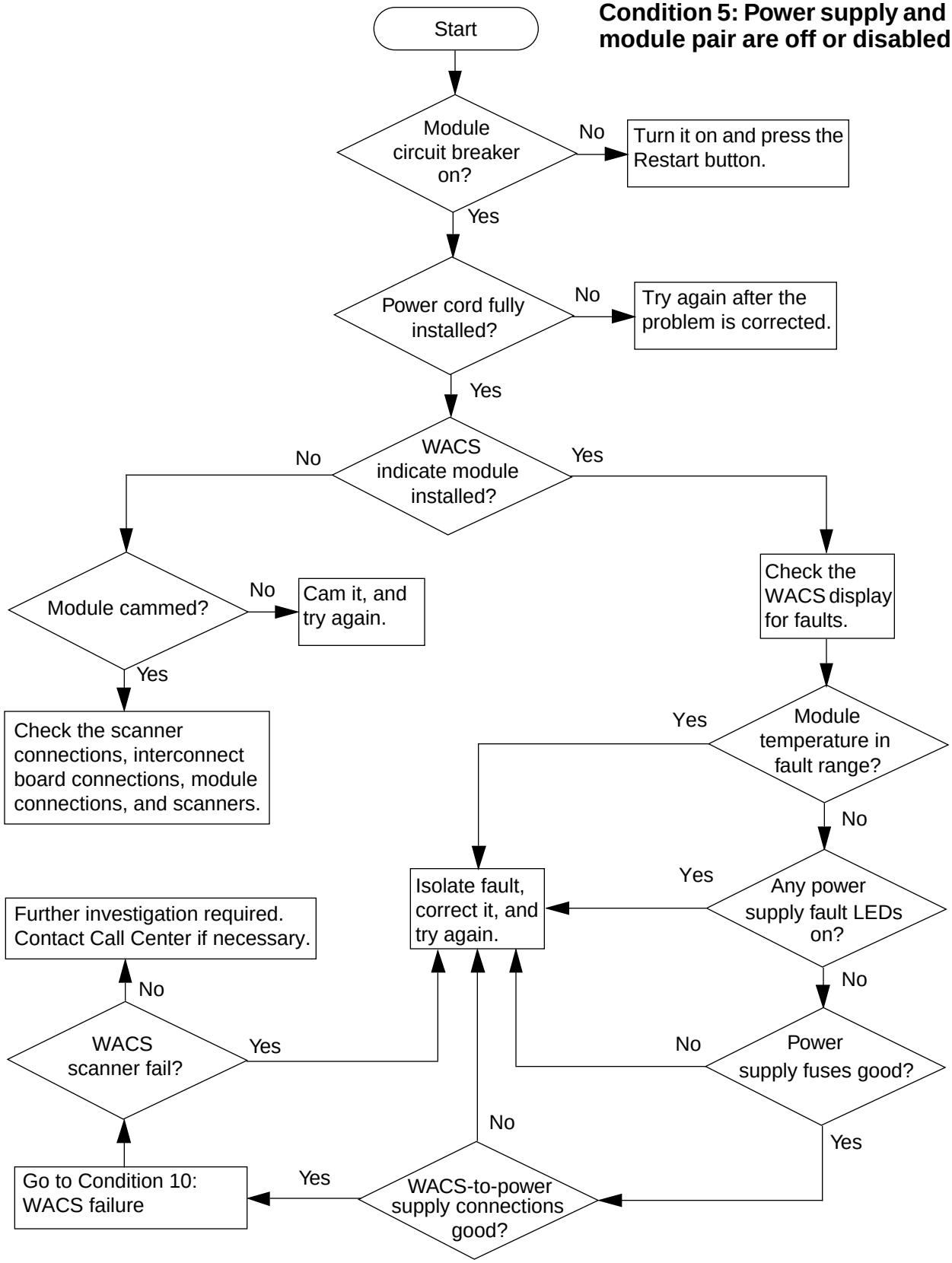
  This may be due to a bad interlock connection between the module and module rail. This may also be due to a bad control connection to the power supply or due to other bad connections, such as a WACS-to-harness connection.

  It is possible for the module enable circuit to be complete (the WACS indicates that the module is installed) while there is a problem with the power supply enable circuit.
- The module power supply malfunctioned or otherwise powered off.

  Check the WACS and LED indicators. You must power off the supply to clear the indicators.

Use the flow chart on the opposite page to help troubleshoot a module power problem.

Condition 5: Power supply and module pair are off or disabled



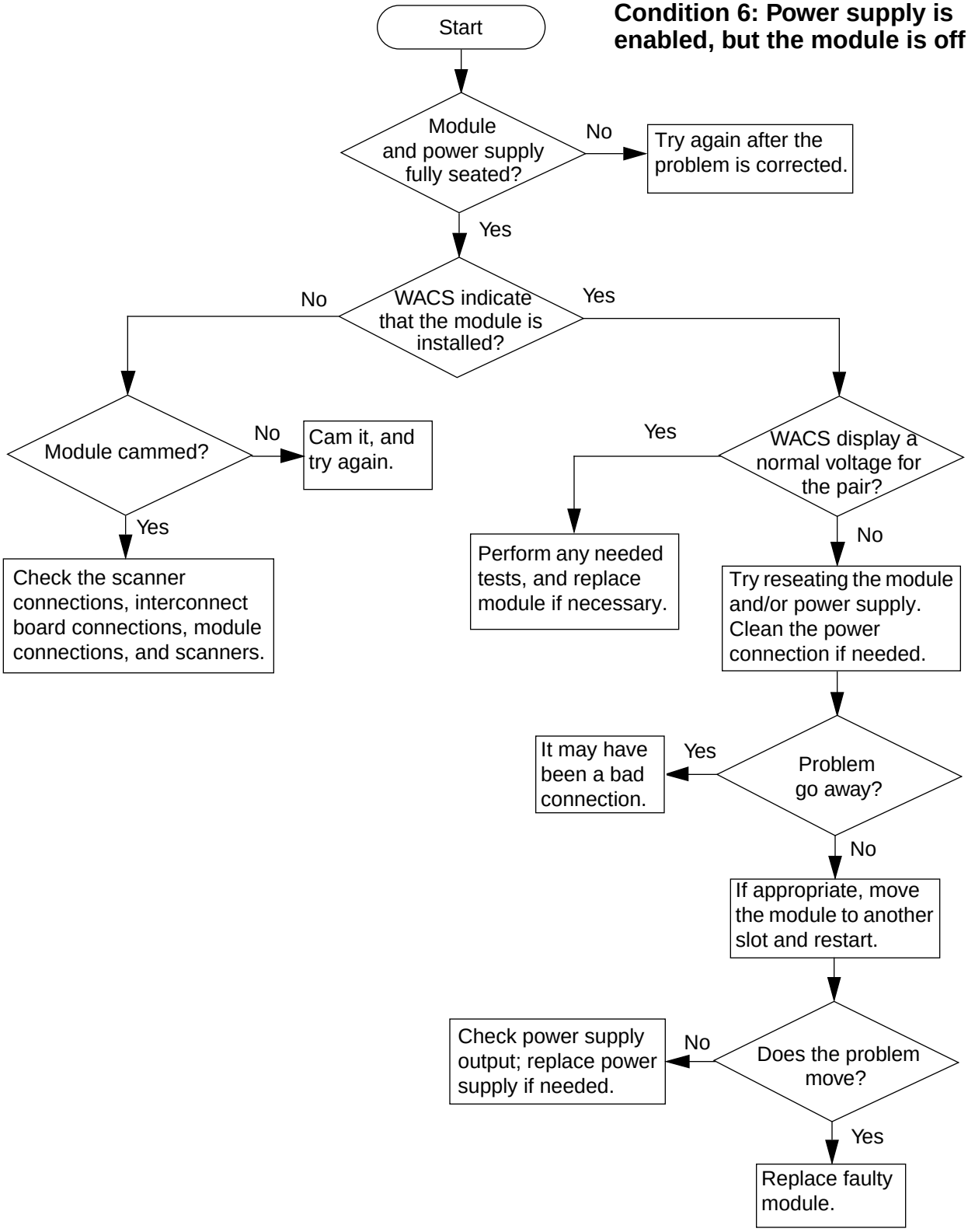
Condition 6: Power supply is enabled, but the module is not on

A module power supply powers up but the module does not power up (or will lose power) if any of the following conditions exist:

- The module is faulty.
- The power supply output is faulty.
- The module's power connection is not good.

Use the flow chart on the opposite page to help troubleshoot a module power problem.

Condition 6: Power supply is enabled, but the module is off



Condition 7: WACS and modules are on, but the blower does not run

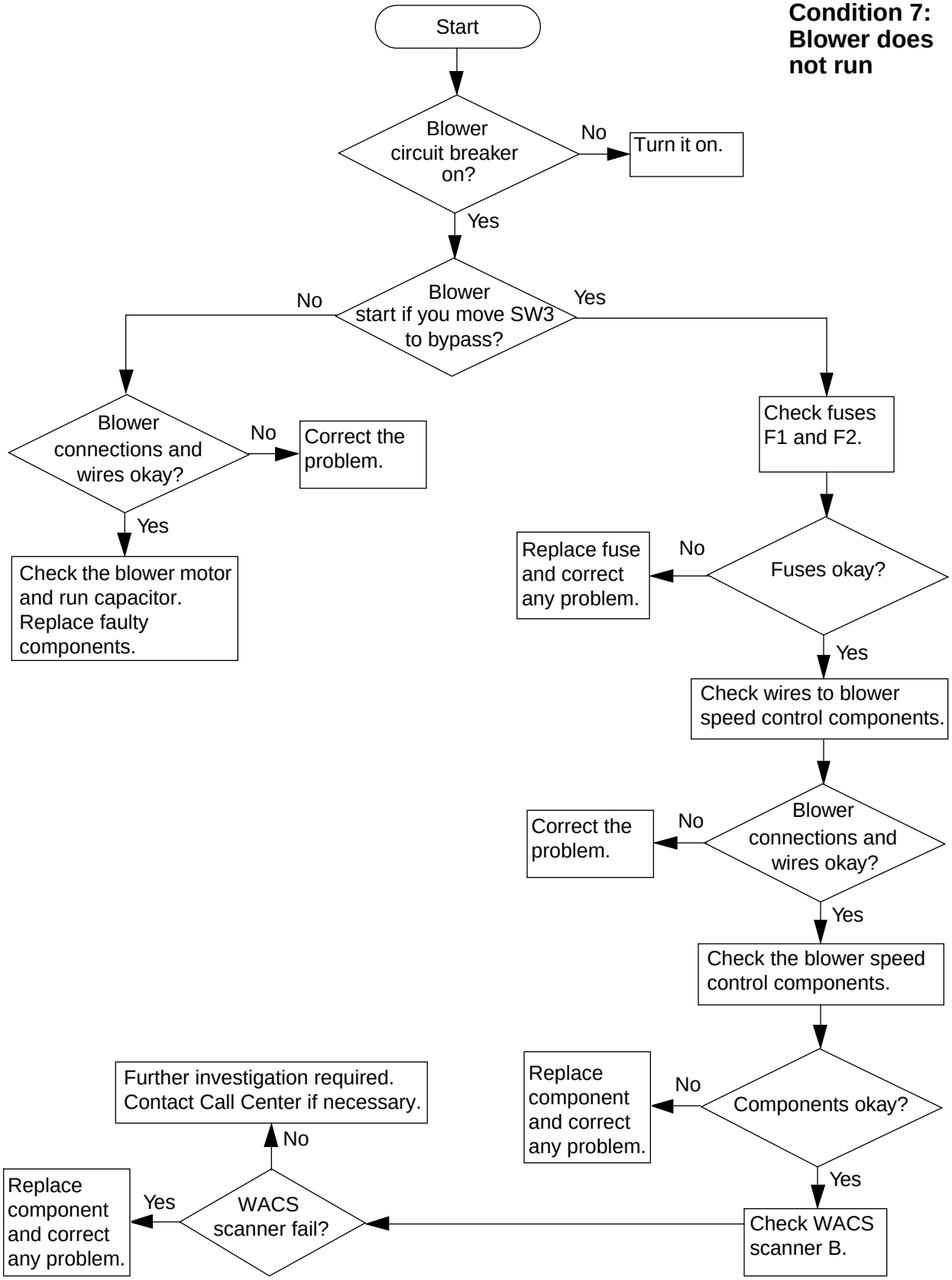
NOTE: The blower should run at all times that the modules are on, even when the modules are cool.

The blower will not run (but the WACS and modules will have power) if any of the following conditions exist:

- The blower circuit breaker (CB8) is in the OFF position.
- A transformer fuse (F1 and F2) is blown.
- There is a connection or wiring problem.
- There is a component problem: blower controller (SCR1), transformer (T1), run capacitor (C1), or blower motor (M1).
- WACS scanner B is faulty.

Use the flow chart on the opposite page to help troubleshoot a blower power problem.

Condition 7: Blower does not run



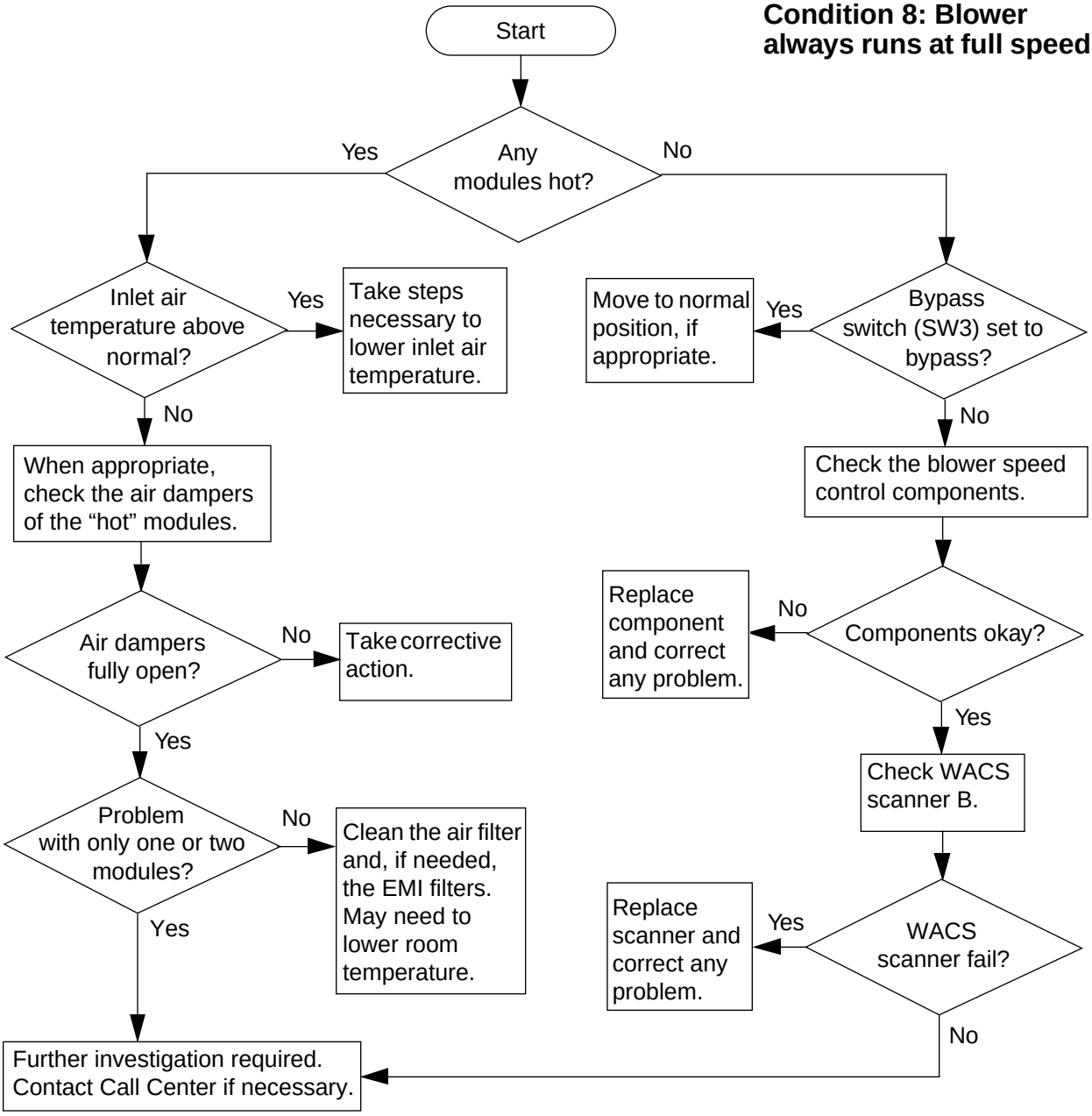
Condition 8: Blower always runs at full speed

The blower will run at full speed if any of the following conditions exist:

- The average temperature of the installed modules is near the high-warning limit.
- The Blower Controller Bypass switch (SW3) is in the bypass position.
- There is a connection or wiring problem.
- There is a component problem: blower controller (SCR1), transformer (T1), run capacitor (C1), or blower motor (M1).
- WACS scanner B is faulty.

Use the flow chart on the opposite page to help troubleshoot a blower speed problem.

Condition 8: Blower always runs at full speed



Condition 9: WACS display does not operate

The WACS display will not operate if any of the following conditions exist:

- The cabinet is not receiving input power.
- The main disconnect (CB1) or WACS breaker (CB9) is in the OFF position.
- The display module is faulty.
- There is a connection or wiring problem.
- WACS scanner A is faulty and cannot communicate with the display module.

Use the flow charts on the following pages to help troubleshoot a WACS display problem.

Things to Remember

Determine whether the power supplies and blower are on.

If they are, then the contactor is closed; therefore, both scanners are probably operational (at least partially). It is likely that scanner A is having problems communicating with the WACS display.

Possible causes: Bad connection; bad display module; problem with scanner A that does not affect other functions.

If the power supplies and blower are not on, then the contactor is open. Scanner B may be faulty. (If the blower is on and the modules are off, then the contactor is closed but the power supplies are probably not receiving enable signals from both scanners.)

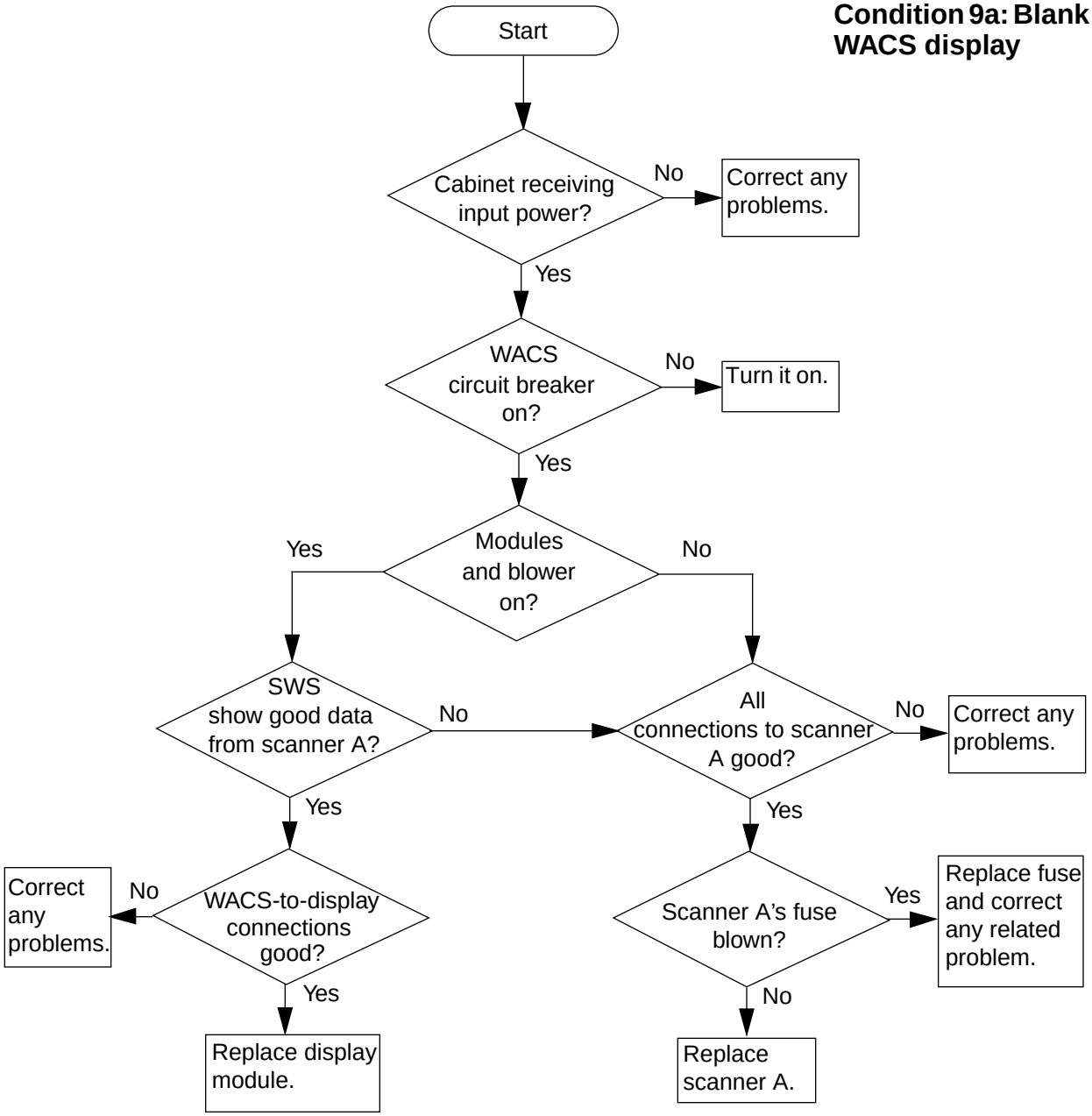
Check the SWS: Can you view the WACS data from scanner A? Does it update? (If scanner A fails, you will probably see static data from scanner A.)

If the WACS data is viewable and updates, then it is likely that the WACS has either a bad display module or a bad connection to the display module.

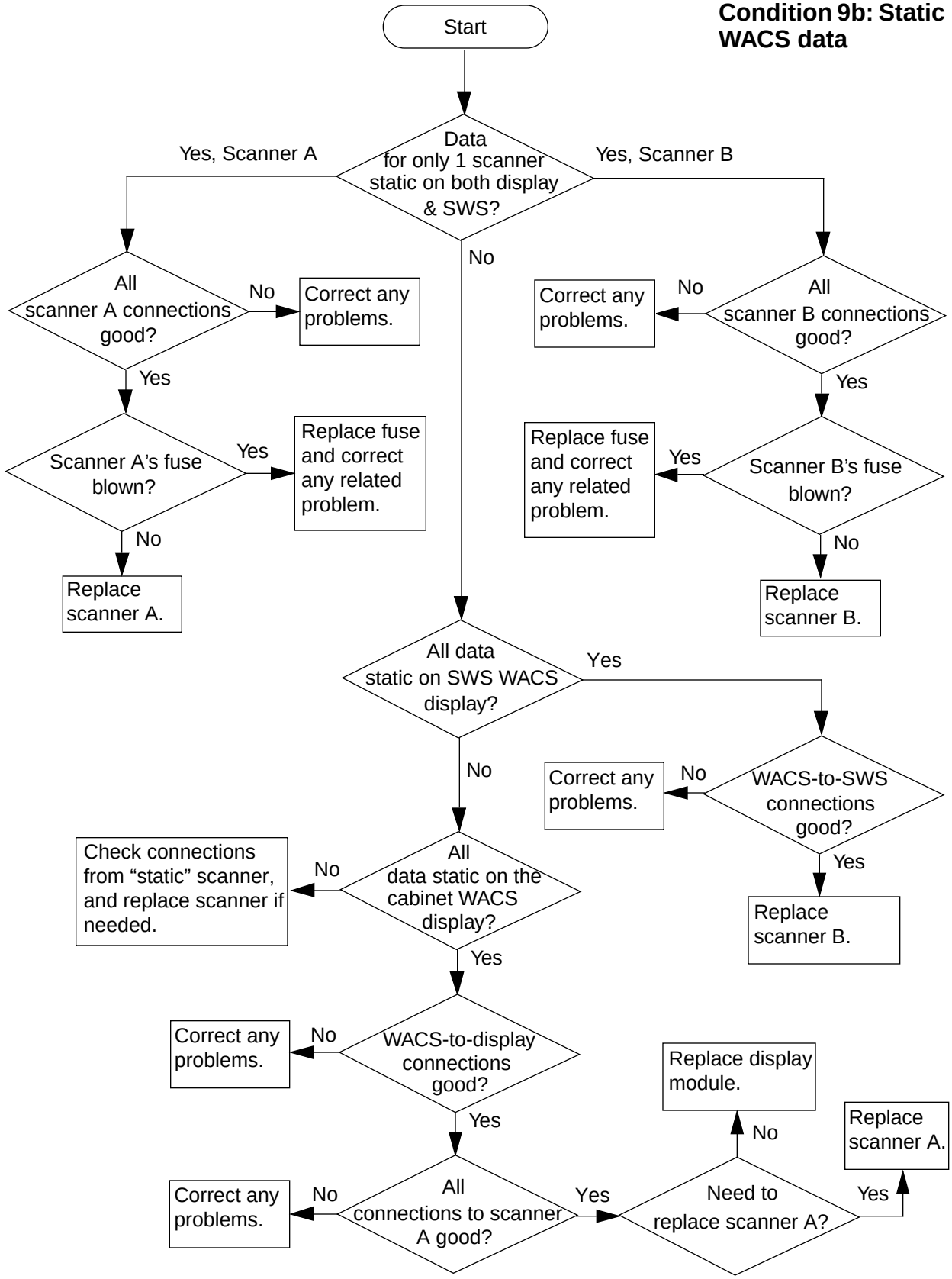
If the WACS data is not viewable or does not update, then it is likely that scanner B is faulty or that it contains faulty connections.

A WACS software hang may cause problems that appear to be mechanical.

Condition 9a: Blank WACS display



Condition 9b: Static WACS data



Condition 10: WACS fails during operation

The WACS may fail if any of the following conditions exist:

- A WACS microprocessor fails.

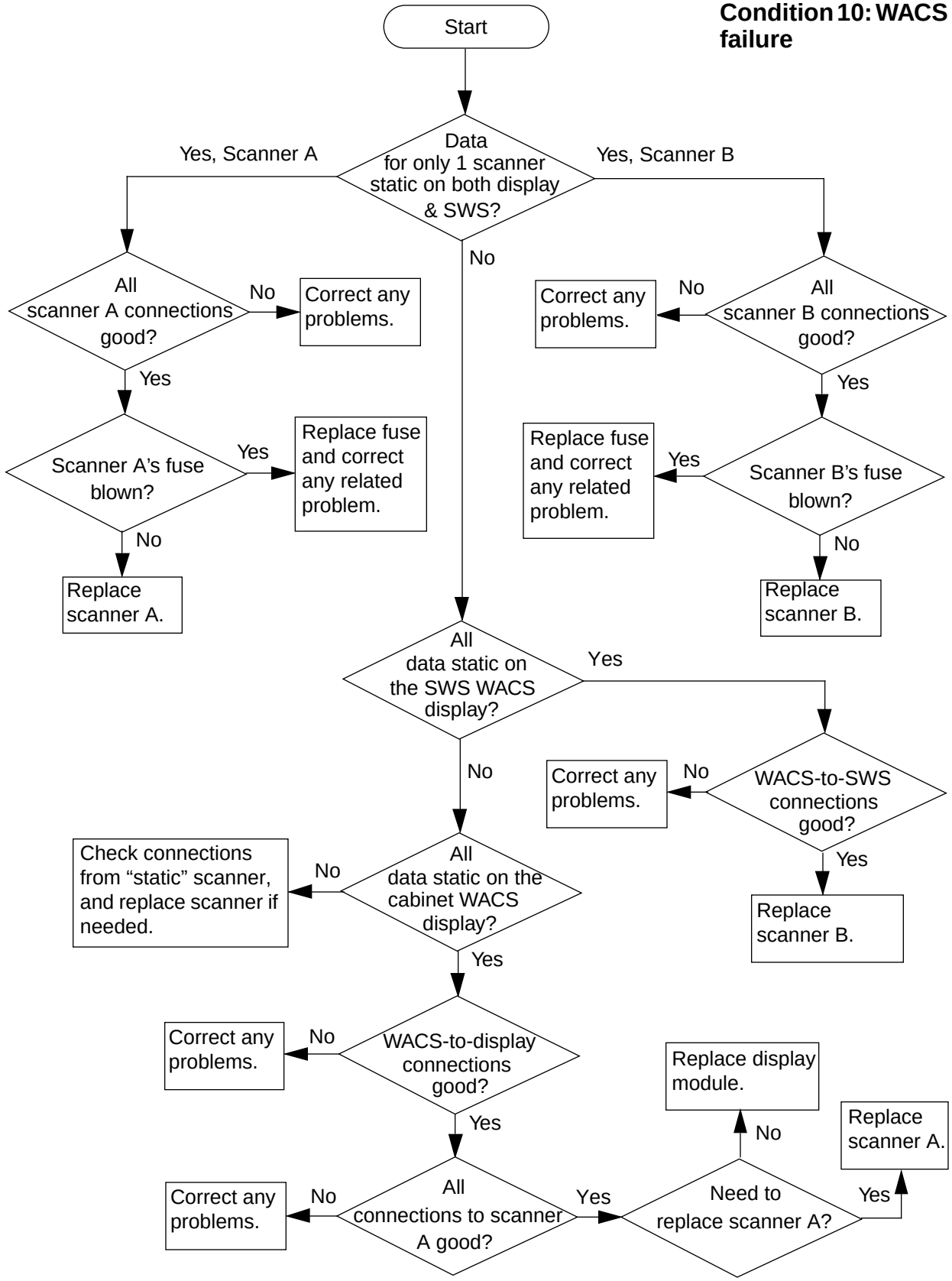
  There is a 50% chance (approximately) that the WACS will not open the contactor if a WACS microprocessor fails. However, the WACS data from the failing microprocessor (scanner) will be static.

- A WACS power problem occurs: blown WACS fuse, transzorb, etc.

- A connection problem or wiring problem occurs.

Use the flow chart on the next page to help troubleshoot a WACS scanner failure.

Condition 10: WACS failure



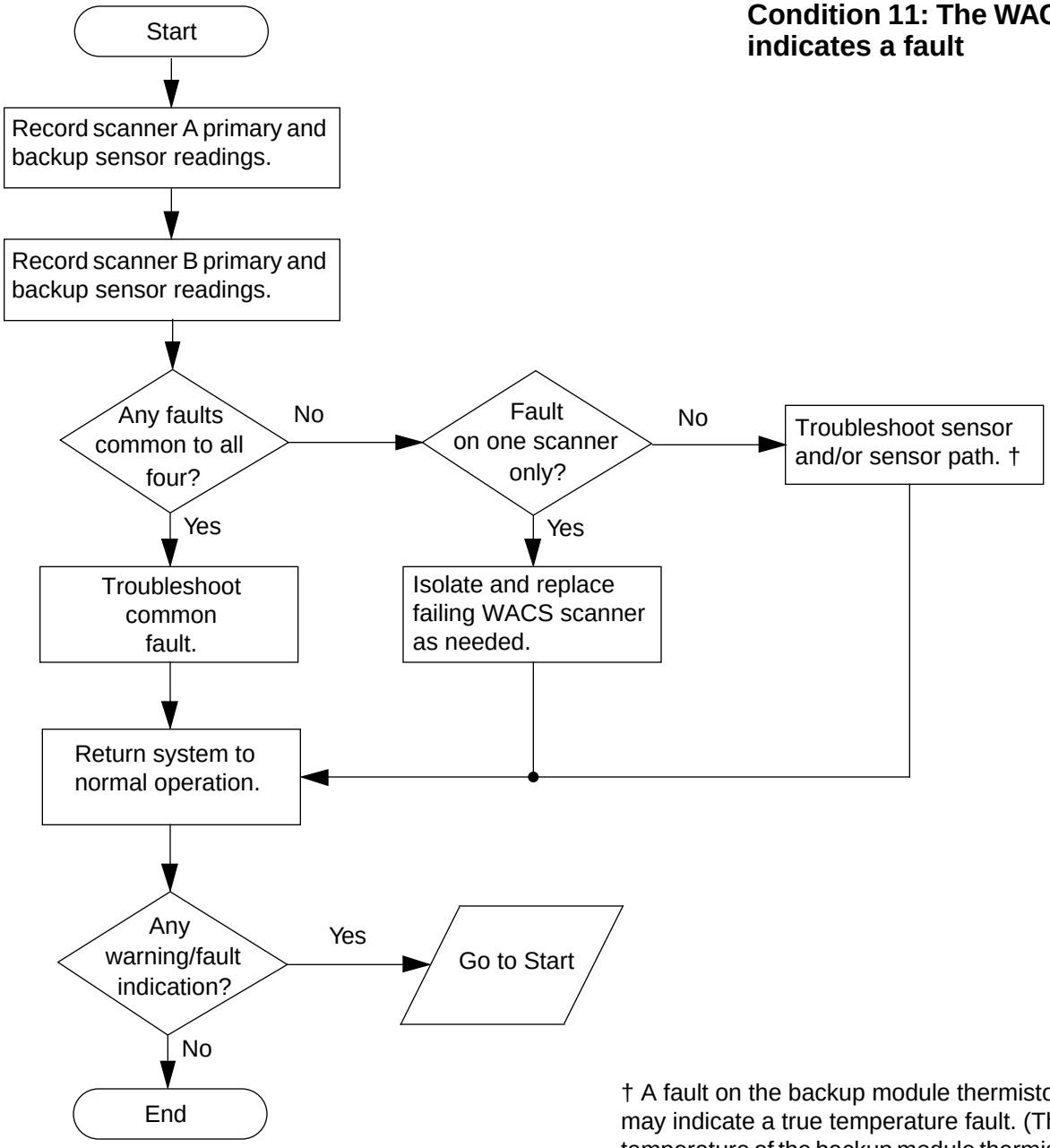
Condition 11: The WACS indicates a fault

The WACS may indicate a fault if any of the following conditions exist:

- A fault occurs.
- A sensor or sensor path problem occurs.
- A WACS scanner fails.

Use the flow chart on the next page to help troubleshoot a fault.

Condition 11: The WACS indicates a fault



† A fault on the backup module thermistor may indicate a true temperature fault. (The temperature of the backup module thermistor is usually higher than the temperature of the primary module thermistor.)

Service Contacts and Processes – Overview

Table 21 contains information related to three important service activities:

- Reporting and tracking hardware problems
- Ordering and returning parts
- Contacting technical support

NOTE: Customer-assist personnel and CRI personnel may use different processes for these and other service activities.

Table 21. Service Contacts and Processes

What	Source
Reporting and Tracking	
• Reporting site activities, problems, and solutions	• Use CRUISE; refer to the *CRUISE User Guide*, CRI publication HOM-248-A and the *Customer Service Reporting and Tracking Guidelines*, document HOM-203-A (these documents are also on the WWW at http://servinfo.cray.com/cruise/index.htm, and in ODIE and Logistics); existing CRUISE tickets and solutions are in the CRUISE Solutions and CRUISE Tickets files in Pages.
• Reporting hardware problems	• Instructions for hardware problem reports (HPRs) are in publication SD-0235; use CRUISE to enter HPRs (refer to the *CRUISE User Guide*, HOM-203-A). HPRs are in the Hardware Problem Reports file in Pages.
Ordering Spare Parts, Returning Spare and Repairable Parts	Customer-assist personnel use the Call Center. Cray Research personnel may use Logistics' LIONS system; for LIONS instructions, contact Cheryl Fehr at 715-726-6801 or cfehr@yak
Call Centers	
• Americas and Asia/Pacific	• 1 800 950 CRAY or +1 770 631 2244; or support@cray.com
• Europe Central (Germany)	• In German telephone network: 0130 865173 Outside network: +49 89 14903 146
• Europe North (UK)	• +44 1344 722133
• Europe South (France)	• +33 1 69 29 33 00
• Japan	• 24-hour support (CRAY EL series systems): +120 277 901 900-1700 support (CRAY EL series systems): +120 377 901 1000-1600 (Q & A) support: +120 458 901

Table 21. Service Contacts and Processes

What	Source
Field Technical Support (FTS)	
• West FTS	• Call 1 800 759 7243 and enter PIN no. 2025694. At the prompt, for a hardware problem enter 7777 + your area code and number
• East FTS	• Call 1 800 759 7243 and enter PIN no. 2020215. At the prompt, for a hardware problem enter your area code and number followed by code number 001
Problem Escalation Process	Hardware and software escalation flowcharts are at http://wwwcf.cray.com/PRIVATE/CShome/Escal/escal.html; the escalation process is described in the *Customer Service Reporting and Tracking Guidelines* (in ODIE or order document HOM-203-A from Logistics)