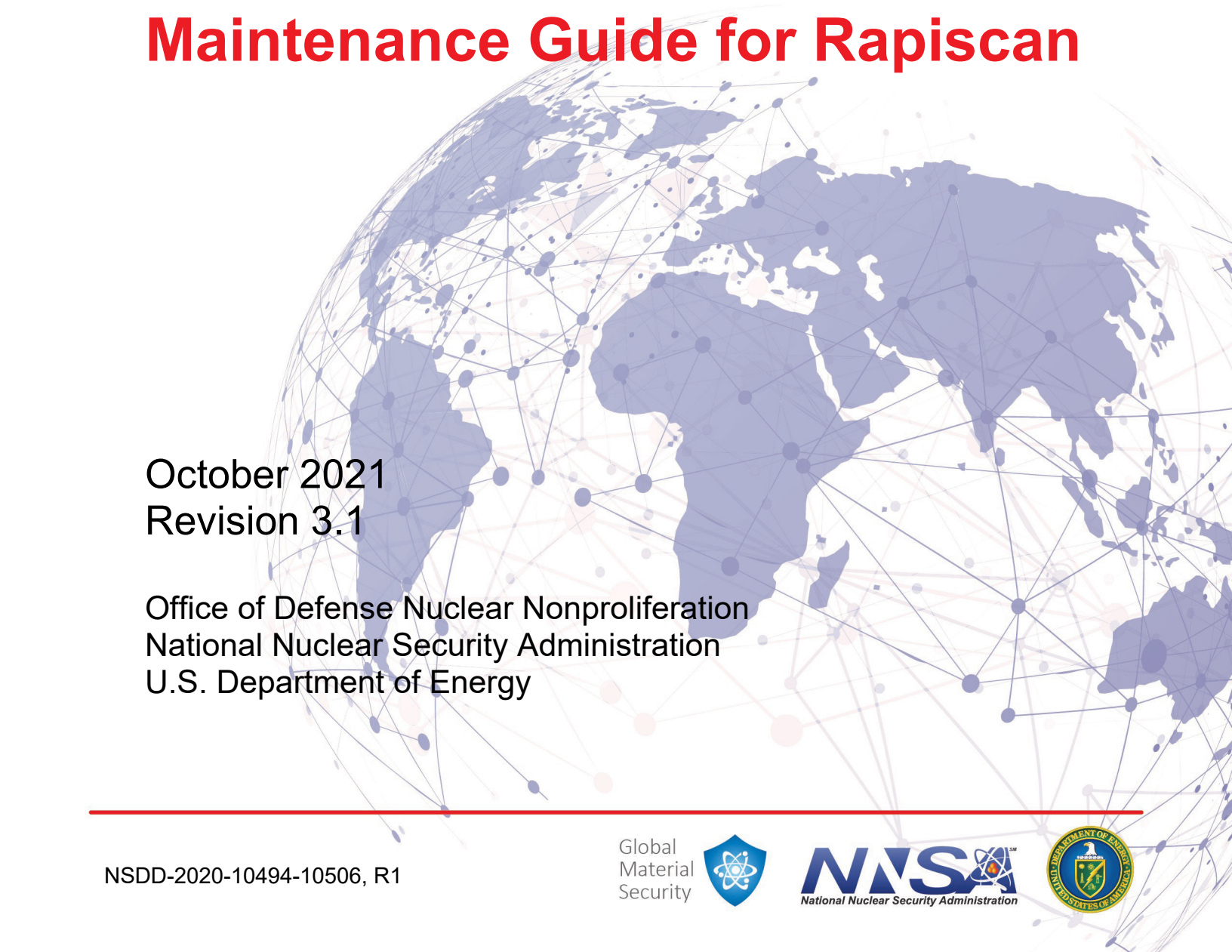
NSDD
NUCLEAR SMUGGLING DETECTION AND DETERRENCE

Radiation Portal Monitor
Maintenance Guide for Rapiscan



October 2021
Revision 3.1

Office of Defense Nuclear Nonproliferation
National Nuclear Security Administration
U.S. Department of Energy

NSDD-2020-10494-10506, R1

Global Material Security

National Nuclear Security Administration

Troubleshooting

The instructions and guidance in this troubleshooting section of the maintenance guide assumes the equipment and system were previously functioning properly but are currently not operating as expected. Following a methodical, systematic approach will help identify issues much faster than using a random approach (e.g., replacing components until the system works again).

In most cases, the following guidelines will lead the maintenance provider to a failure resolution in the fewest steps:

1. Identify and document the fault indications.
2. Determine which RPM subsystem is likely at fault and identify the applicable troubleshooting flowchart to follow.
3. Use applicable troubleshooting flowcharts and notes to attempt to identify the failed component.

The following text expands upon these three guidelines.

1. Identify and document the fault indication(s)

In most cases, the first indication the maintenance provider will have of a failure is communication from the equipment operators. Carry a notebook and document the symptom(s) and failures as well as the components and circuits that appear to be functioning normally. Document everything for future reference.

a. Identify fault indications

- What are the symptom(s) of the problem?
- When did the symptom(s) start?
- Is it still in a fault condition?
- Have there been any changes (storms, equipment modifications, recently replaced components, etc.)?
- What is the status of health on the CAS system? The CAS software can also be an invaluable diagnostic tool to aid in identifying failure symptom(s).

b. Assemble required tools and materials

Gather tools, spare parts, equipment, documentation, and radioactive check sources (as needed) to respond to the symptom(s). Some tools and materials to consider for identifying symptom(s):

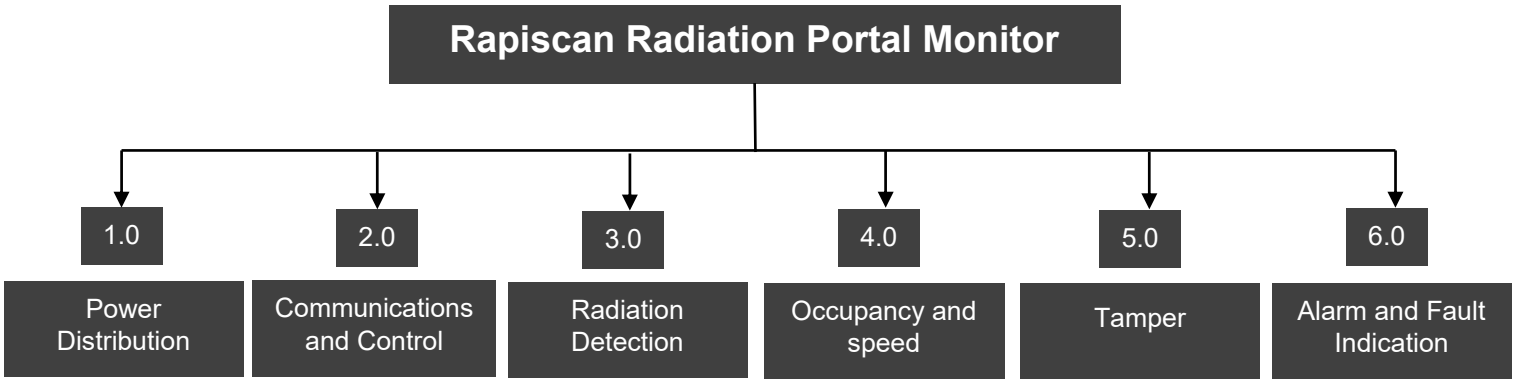
- NSDD-provided maintenance kit and a set of standard hand tools
- Radioactive check sources for troubleshooting and retest procedures
- *RPM Maintenance Guide*
- Documentation, including the most recent functional compliance test (FCT) spreadsheet, current approved parameter settings, drawings, and RPM maintenance history (if available)
- Laptop with NMT (or MCAAW or MCA software, and a FCT spreadsheet)
- A subset of the RPM spare parts inventory, including VD-580s, PMFX box, SC-770 and/or SC-771/Rabbit board assembly, SCA-775 and/or SCA-774 board, HHV-448/458, and spare cables

c. Make arrangements with operators to take RPM out of service for troubleshooting

Maintenance technicians are more successful when the repair actions are coordinated with the site equipment operators. The duration, lane location, and parts availability are considerations to use in promptly resolving the fault with minimal impact to RDS operations.

2. Determine which RPM subsystem is likely at fault and identify the applicable troubleshooting flowchart to follow

Most failures or conditions can be isolated to one of the six RPM subsystems. Depending on the symptom(s) identified in the previous step, there may be more than one subsystem to investigate.

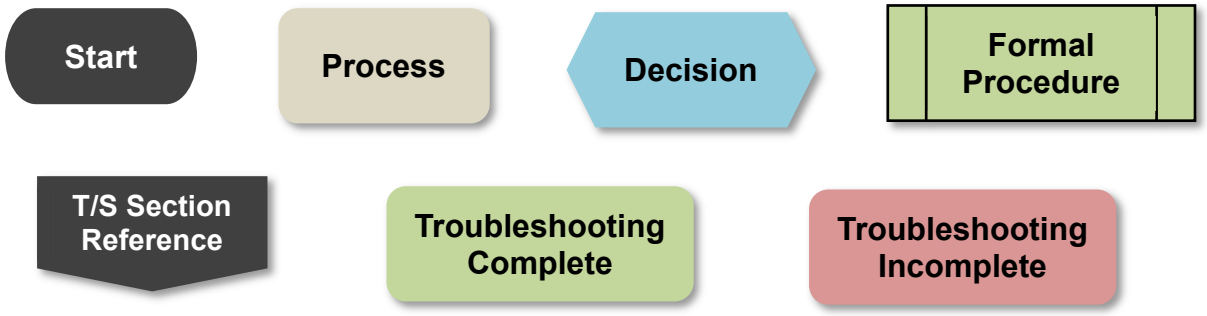


Each of the functional subsystems of the RPM contains a symptom table to help narrow down which troubleshooting section will most likely resolve the failure. Locate the previously identified symptom(s) in the symptom tables to determine which troubleshooting flowchart to follow:

Symptom	Flowchart
• Gamma HI background fault • Gamma LO background fault • Local alarm indication on every occupancy • Excessive alarm rates	**3.1 Gamma Detection**
• Neutron HI background fault • Local alarm indication on every occupancy • Excessive alarm rates	**3.2 Neutron Detection**

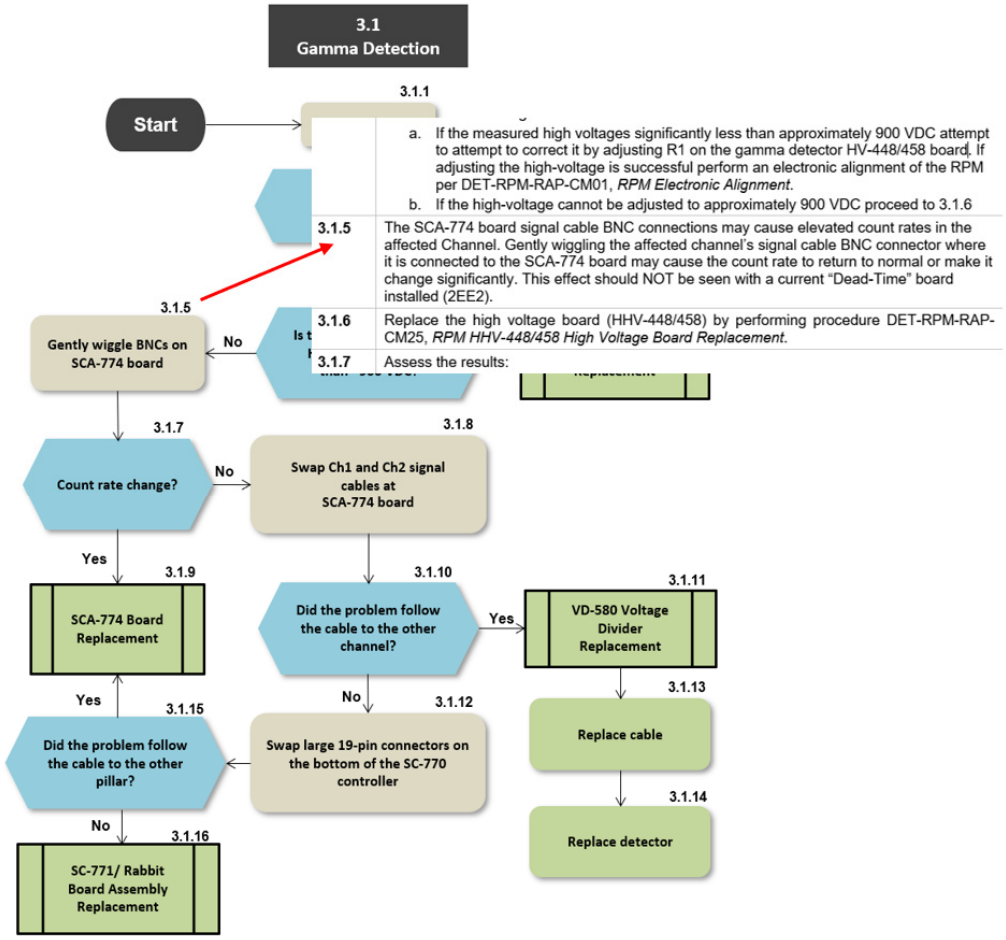
3. Use applicable troubleshooting flowcharts and notes to attempt to identify and correct the failed component

The troubleshooting flowcharts are a sequential series of simple questions and/or measurements that lead to the isolation and resolution of the fault/failure. There are seven types of shapes in the troubleshooting flowcharts, each with a specific role:

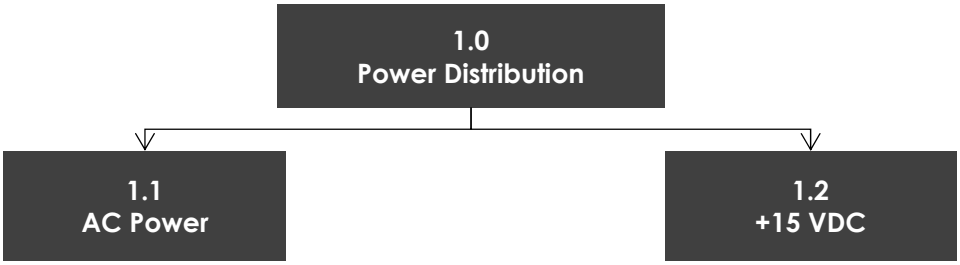


- Start – Indicates where to begin the troubleshooting flowchart
- Process – Represents a step or process to complete before moving to the next shape
- Decision – Indicates a decision to be made. Lines representing the options emerge from the shape, leading to alternate paths
- Formal Procedure – Conduct a maintenance procedure referenced in the maintenance guide
- T/S Section Reference – Refers to an alternate flowchart to continue troubleshooting fault/failure; may also show a connection to additional steps on the same flowchart
- Troubleshooting Complete – Solution is reached outside of completing a formal maintenance procedure
- Troubleshooting Incomplete – Additional steps are required outside of the troubleshooting flowcharts

Each numbered flowchart object has additional information contained in the accompanying notes as demonstrated below. The troubleshooting notes are crucial to successful navigation of the flowchart as they provide additional clarification or steps to complete in the troubleshooting process. These notes are referenced from numbered shapes in each flowchart.


3.1
Gamma Detection
Start
3.1.1
a. If the measured high voltages significantly less than approximately 900 VDC attempt to attempt to correct it by adjusting R1 on the gamma detector HV-448/458 board. If adjusting the high-voltage is successful perform an electronic alignment of the RPM per DET-RPM-RAP-CM01, RPM Electronic Alignment.
b. If the high-voltage cannot be adjusted to approximately 900 VDC proceed to 3.1.6
3.1.5
The SCA-774 board signal cable BNC connections may cause elevated count rates in the affected Channel. Gently wiggling the affected channel's signal cable BNC connector where it is connected to the SCA-774 board may cause the count rate to return to normal or make it change significantly. This effect should NOT be seen with a current "Dead-Time" board installed (2EE2).
3.1.6
Replace the high voltage board (HHV-448/458) by performing procedure DET-RPM-RAP-CM25, RPM HHV-448/458 High Voltage Board Replacement.
3.1.7
Assess the results:
3.1.5
Gently wiggle BNCs on SCA-774 board
No
3.1.7
Count rate change?
No
3.1.8
Swap Ch1 and Ch2 signal cables at SCA-774 board
Yes
3.1.9
SCA-774 Board Replacement
3.1.10
Did the problem follow the cable to the other channel?
Yes
3.1.11
VD-580 Voltage Divider Replacement
3.1.13
Replace cable
3.1.14
Replace detector
No
3.1.12
Swap large 19-pin connectors on the bottom of the SC-770 controller
Yes
3.1.15
Did the problem follow the cable to the other pillar?
No
3.1.16
SC-771/ Rabbit Board Assembly Replacement

Power Distribution



Components

AC input power breaker, terminal block, and line filter

+15 VDC power supply

LD-260

+12 VDC battery

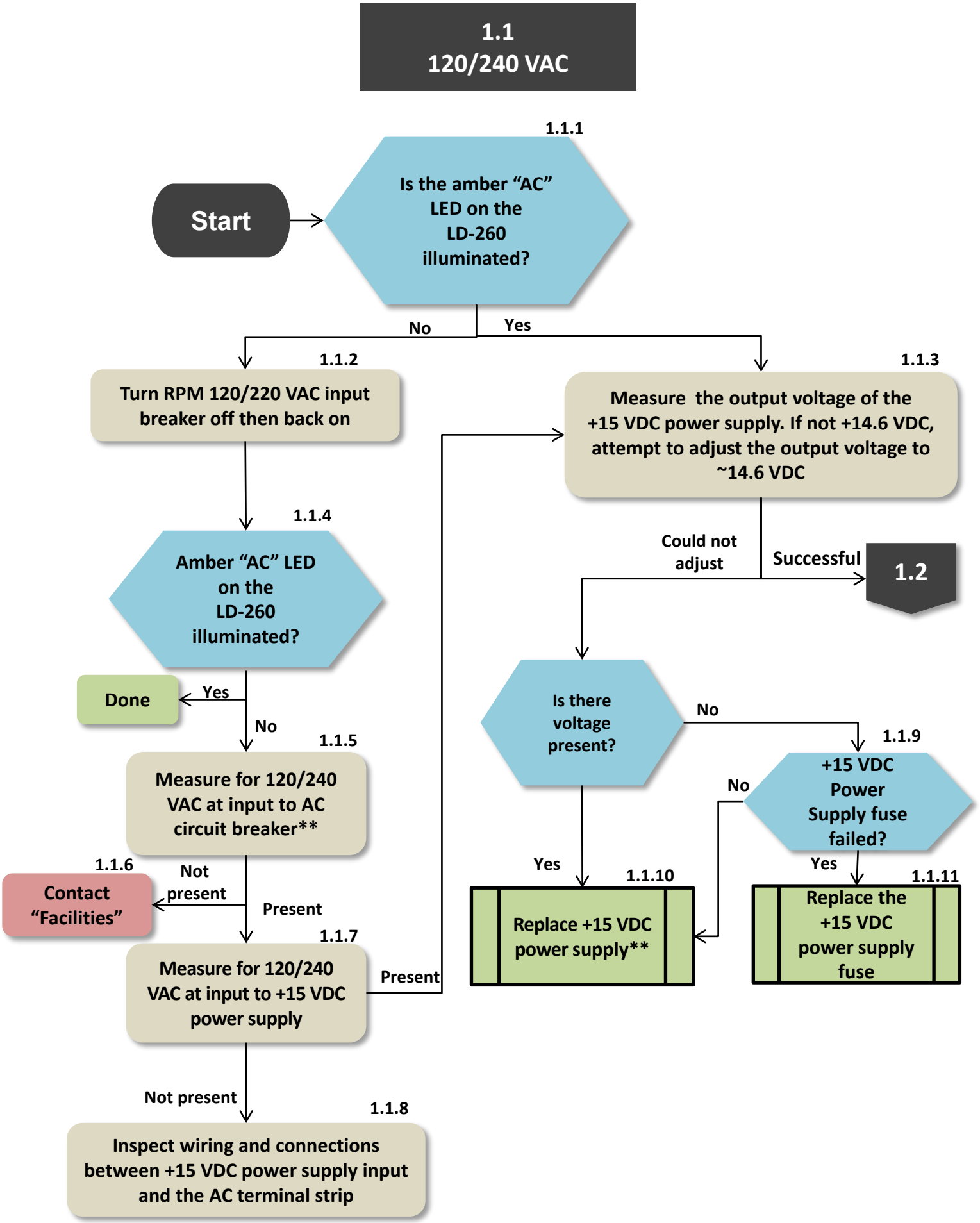
Terminal blocks and switches

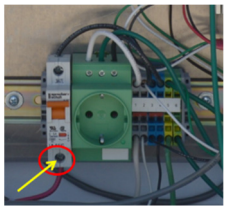
Cables, wires, and connectors

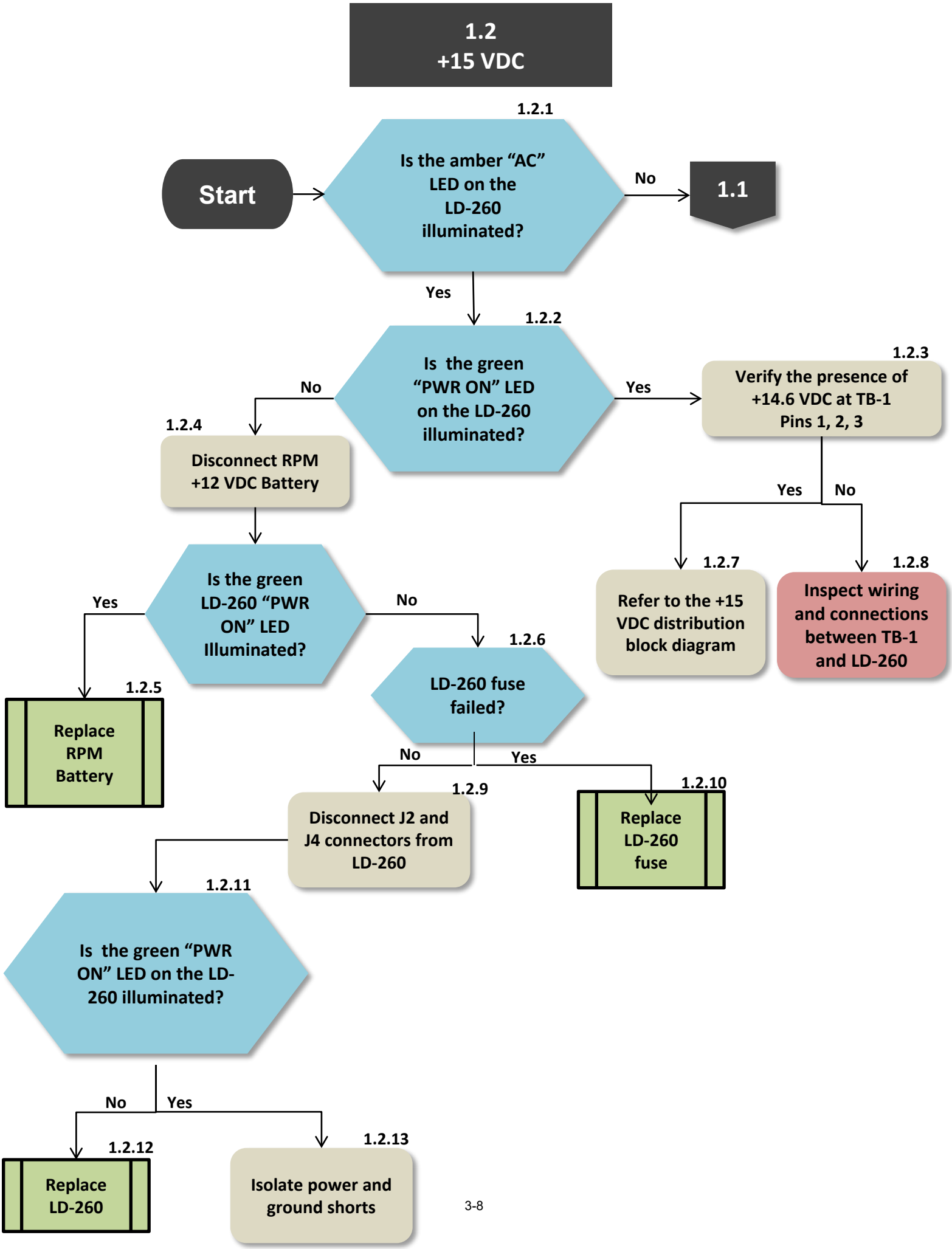
Operational or Environmental Considerations

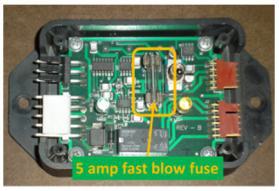
- Upon loss of AC power to the RPM, the RPM will operate for approximately 8 hours on a healthy battery. After that, the RPM will power off automatically if battery voltage drops below +10 VDC.
- Various types of AC line filters are installed in RPMs depending on date of installation.
- The system operates on a nominal +12 VDC system. The range will vary from about +10.6 to +14.6 VDC.
- RPM will indicate a tamper fault on loss of +12 VDC to the LD-260 as long as the RPM is being powered by the battery.

Symptom	Flowchart
• Screen on SC-770 controller blank • Amber “AC” LED on LD-260 not illuminated • Green “PWR ON” LED on LD-260 not illuminated • “TT” line in daily files • “Tamper” fault on Status of Health screen at CAS • “Loss of RPM Communications” fault screen in CAS	**1.1 AC Power**
• No DC voltage to one or more components • Battery <+10.6 VDC	**1.2 +15 VDC**


1.1
120/240 VAC
Start
1.1.1
Is the amber "AC" LED on the LD-260 illuminated?
No
Yes
1.1.2
Turn RPM 120/220 VAC input breaker off then back on
1.1.3
Measure the output voltage of the +15 VDC power supply. If not +14.6 VDC, attempt to adjust the output voltage to ~14.6 VDC
1.1.4
Amber "AC" LED on the LD-260 illuminated?
Could not adjust
Successful
1.2
Done
Yes
No
1.1.5
Measure for 120/240 VAC at input to AC circuit breaker**
Is there voltage present?
No
1.1.9
+15 VDC Power Supply fuse failed?
1.1.6
Contact "Facilities"
Not present
Present
Yes
1.1.10
Replace +15 VDC power supply**
No
Yes
1.1.11
Replace the +15 VDC power supply fuse
1.1.7
Measure for 120/240 VAC at input to +15 VDC power supply
Present
Not present
1.1.8
Inspect wiring and connections between +15 VDC power supply input and the AC terminal strip

120/240 VAC Power Distribution Troubleshooting Notes:		
1.1.1	Is the amber “AC” LED on the LD-260 illuminated? If the amber LED is not on, the problem could be lack of AC power, a failed +15 VDC power supply, +15 VDC power supply fuse, AC Line Filter, or cables and connectors.	
1.1.2	Occasionally the AC breaker might be off, tripped, or in an intermediate position. Try to reset the breaker in the bottom of the RPM control pillar before troubleshooting further. If the breaker trips again, there is likely a ground fault that should be located and corrected.	
1.1.3	Measure the output of the +15 VDC power supply using a digital multi-meter. The optimal output voltage is +14.6 VDC. Attempt to adjust the output voltage from the +15 VDC power supply using the potentiometer near the AC and DC terminal strip. If the DC output voltage was already +14.6 VDC, or the adjustment was successful, proceed to flowchart 1.2. Be cautious when taking this measurement as the 120/240vac terminal is very near the DC output terminals.	
1.1.4	The amber “AC” LED on the LD-260 indicates that there is at least +10.5 VDC being supplied to the LD-260 from the +15 VDC power supply.	
1.1.5	Using a digital multi-meter in the AC mode, measure the voltage potential between the bottom terminals of the AC input breaker and ground. **The technician performing this measurement should be appropriately trained and certified as dangerous electrical currents may be present.**	
1.1.6	If 120/240vac is not present at the supply side of the RPM input breaker, the problem is not in the RPM. The source of the RPM AC power varies by installation. If the AC power is supplied from an NSDD-installed lane side utility panel, begin troubleshooting there. If the AC power is supplied from site power, contact the organization responsible to assist you.	
1.1.7	If 120/240vac is present at the supply side of the RPM input breaker, and the breaker is closed, measure the AC voltage at the input to the +15 VDC power supply. A Plexiglas cover may have to be removed to perform this measurement. **See safety precaution in step 1.1.5**	
1.1.8	If 120/240vac is present at the output side of the RPM AC breaker and the breaker is closed but the 120/240vac is not present at the input to the +15 VDC power supply, carefully inspect the wiring and connection between them. Additionally, Check the input and output sides of the AC Line filter if installed.	
1.1.9	Inspect the power supply fuse in the +15 VDC power supply **See safety precaution in step 1.1.5**	
1.1.10	If you could not adjust the output voltage of the +15 VDC power supply but there was voltage present, replace the +15 VDC power supply by performing procedure DET-RPM-RAP-CM26, *+15 VDC Power Supply Replacement.*	
1.1.11	If you could not adjust the output voltage of the +15 VDC power supply and there was not voltage present and the power supply fuse is bad, replace the +15 VDC power supply fuse by performing procedure DET-RPM-RAP-CM35, *+15 VDC Power Supply Fuse Replacement*.	


1.2
+15 VDC
Start
1.2.1
Is the amber "AC" LED on the LD-260 illuminated?
No
1.1
Yes
1.2.2
Is the green "PWR ON" LED on the LD-260 illuminated?
No
Yes
1.2.3
Verify the presence of +14.6 VDC at TB-1 Pins 1, 2, 3
1.2.4
Disconnect RPM +12 VDC Battery
Yes
No
1.2.7
Refer to the +15 VDC distribution block diagram
1.2.8
Inspect wiring and connections between TB-1 and LD-260
Is the green LD-260 "PWR ON" LED Illuminated?
Yes
No
1.2.5
Replace RPM Battery
1.2.6
LD-260 fuse failed?
No
Yes
1.2.9
Disconnect J2 and J4 connectors from LD-260
1.2.10
Replace LD-260 fuse
1.2.11
Is the green "PWR ON" LED on the LD-260 illuminated?
No
Yes
1.2.12
Replace LD-260
1.2.13
Isolate power and ground shorts

+15 VDC Power Distribution Troubleshooting Notes:	
1.2.1	The amber “AC” led on the LD-260 indicates that there is at least +10.5 VDC (+14.6 VDC nominal) present at the LD-260 input from the +15 VDC power supply. The switch on the LD-260 must be in the ON position to provide dc power to the system. This will illuminate the green ““PWR ON”” LED on the LD-260.
1.2.2	The green ““PWR ON”” LED being illuminated indicates that there is at least +10.5 VDC (+14.6 VDC nominal) present at the LD-260 output. The LD-260 switch must be in the “ON” position!
1.2.3	Using a digital multi-meter Verify the presence of +15 VDC at the first dc power distribution point, TB-1 pins 1, 2 and 3, which are +15 VDC and jumpered together and Pins 4, 5, and 6 are ground and jumpered together.
1.2.4	Remove the RPM battery from the circuit by disconnecting the two-pin inline connector between the battery and the LD-260. This is typically located very near the battery. If the connector is not installed, it will be necessary to disconnect the red wire from the battery terminal. The RPM will continue to operate on AC power.
1.2.5	If the green “PWR ON” LED is illuminated after disconnecting the battery, the battery may be old or have failed (shorted cells) and must be replaced by performing procedure DET-RPM-RAP-CM28, *+12 VDC Battery Replacement*.
1.2.6	If the green “PWR ON” LED did not illuminate after disconnecting the battery, inspect the LD-260 fuse. To Check the LD-260 fuse, turn off power to the RPM at the AC input breaker, remove the four cover plate screws and the nut on the toggle switch. Examine the fuse visually or Check continuity with a multi-meter. 
1.2.7	If you have verified the presence of a +15 VDC at the first DC power distribution point (TB-1 Pins 1, 2, and 3 are all +15 VDC and jumpered together; Pins 4, 5, and 6 are ground and jumpered together) but there is no +15 VDC at the component in question, you will have to trace the DC power distribution between and terminal block and component in question.
1.2.8	If there is no +15 VDC at the first DC power distribution point (TB-1 Pins 1, 2, and 3 are +12 VDC jumpered together; Pins 4, 5, and 6 are ground and jumpered together) but the green “PWR ON” LED is illuminated, measure the output of the LD-260 across LD-260 J4 pin4 and 5. If the +15 VDC is present, inspect the connector and wiring. 
1.2.9	See 1.2.8 for connector identification. Do not pull on the wires or connectors. Rock the connectors out gently.
1.2.10	Replace the LD-260 fuse by performing procedure DET-RPM-RAP-CM05, *RPM LD-260 Load Disconnect Fuse Replacement*.
1.2.11	Disconnecting LD-260 J2 and J4 will remove potential ground faults from the circuit. If the green “PWR ON” LED illuminates, diagnose the ground fault. If it does not illuminate, replace the LD-260.
1.2.12	Replace the LD-260 by performing procedure DET-RPM-RAP-CM06, *RPM LD-260 Load Disconnect Replacement*.
1.2.13	Isolate power and ground shorts by systematically disconnecting wires to remove components from the circuit until the power to the rest of the system is restored.

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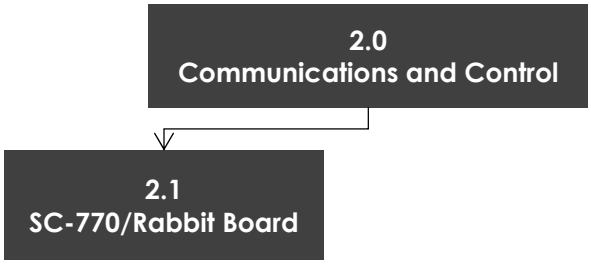
Communications and Control



Components

SC-770 controller module (SC-771 controller board/Rabbit board assembly)

Ethernet to fiber optic converter

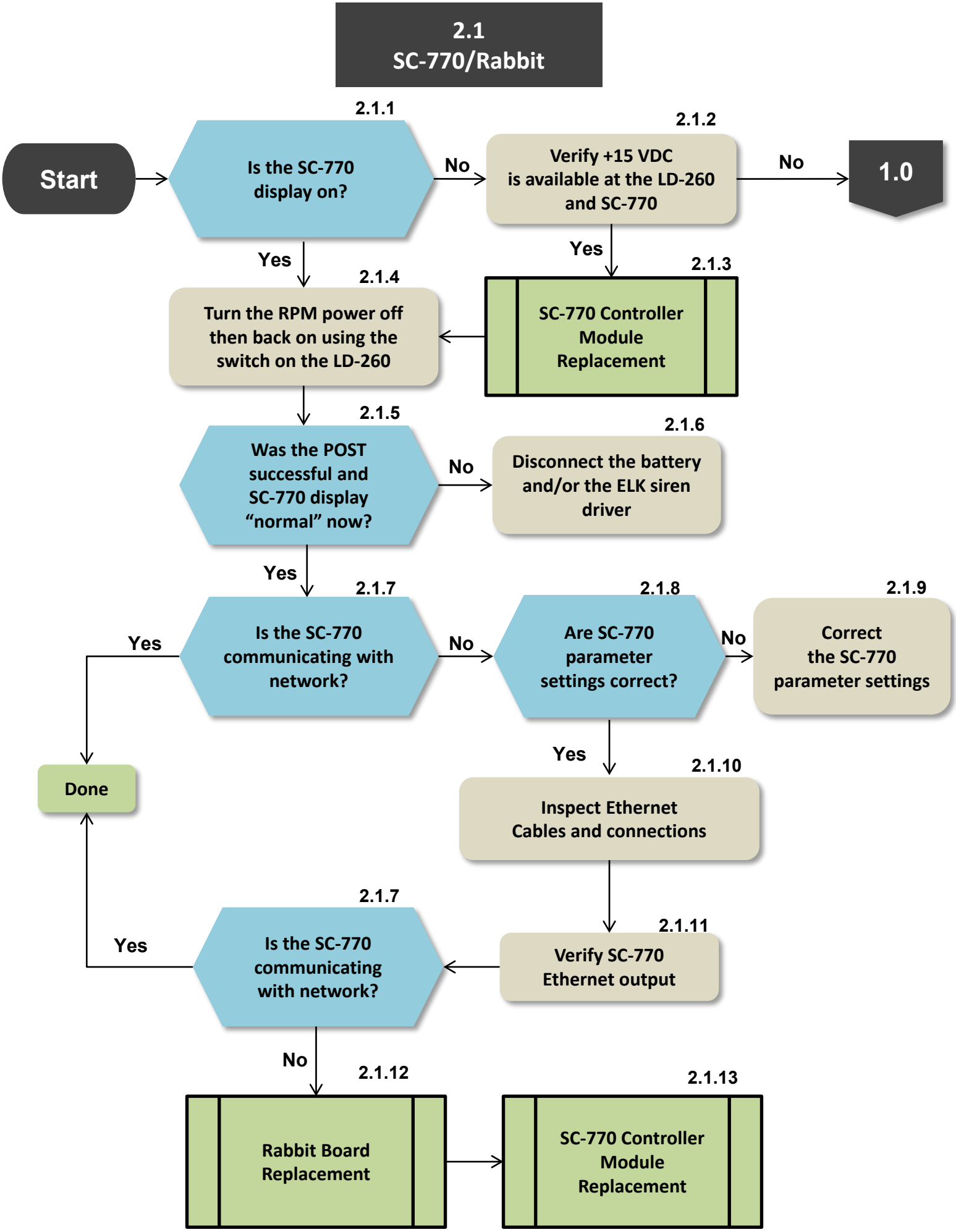
Data concentrator

Cables, wires, and connectors

Operational or Environmental Considerations

- When SC-770 is in program mode, communication output from SC-770 is disabled.
- Cycling RPM power off/on may resolve communication and control faults.

Symptom	Flowchart
• RPM status icon in CAS is red • RPM alarms and faults not appearing in CAS • No RPM data in CAS	**2.1 SC-770/Rabbit Board**


2.1
SC-770/Rabbit
Start
2.1.1
Is the SC-770 display on?
No
2.1.2
Verify +15 VDC is available at the LD-260 and SC-770
No
1.0
Yes
Yes
2.1.3
SC-770 Controller Module Replacement
2.1.4
Turn the RPM power off then back on using the switch on the LD-260
2.1.5
Was the POST successful and SC-770 display "normal" now?
No
2.1.6
Disconnect the battery and/or the ELK siren driver
Yes
2.1.7
Is the SC-770 communicating with network?
Yes
No
2.1.8
Are SC-770 parameter settings correct?
No
2.1.9
Correct the SC-770 parameter settings
Done
Yes
2.1.10
Inspect Ethernet Cables and connections
2.1.11
Verify SC-770 Ethernet output
2.1.7
Is the SC-770 communicating with network?
Yes
No
2.1.12
Rabbit Board Replacement
2.1.13
SC-770 Controller Module Replacement

Communications and Control Circuitry Troubleshooting Notes:	
2.1.1	Does the LCD display on the SC-770 controller display anything?
2.1.2	The LD-260 amber “AC” LED indicates there is power to the LD-260, and the green “PWR ON” LED indicates that +15 VDC is available and the LD-260 is switched ON. Verify that +15 VDC is available to the SC-770 controller in VM/TM at TB2 pin 17, and in a PM at TB2 pin 20.
2.1.3	If power is available and the SC-770 display is still not lit, turn the RPM “OFF” then back “ON” again using the switch on the LD-260, if that fails to correct the problem, replace the SC-770 module per DET-RPM-RAP-CM10, *RPM SC-770 Controller Module Replacement*.
2.1.4	Cycle the power on the RPM “OFF” then back “ON” again using the switch on the LD-260, the RPM should perform a “Power On Self-Test (POST)” then gather an initial background.
2.1.5	During “normal” operation, the SC-770 controller will display date, time, gamma and neutron detector count rate sums, and any fault or alarm condition or “OK”. If the RPM fails to complete the “POST” go to step 2.0.6.
2.1.6	If the RPM fails to complete the POST and/or the SC-770 displays “V2.6 Alive!”, that typically indicates that there is not enough power to drive the ELK siren during the POST. A failing or shorted battery can cause this. Disconnecting the RPM battery or the +15 VDC to the ELK siren driver and restarting the RPM will indicate if this is the problem. If this corrects the problem, verify the +15 VDC power supply is set at +14.6 VDC and/or replace the battery per DET-RPM-RAP-CM28, *RPM +12 VDC Battery Replacement* as required.
2.1.7	Verify that the CAS is communicating with the RPM; the CAS status of health should indicate that there is a communications link (i.e. the CAS is able to “ping” the RPM controller). If not, the status of health will indicate “Loss of RPM Communication” or “RPM Offline”.
2.1.8	Verify the SC-770 parameters “PROFILING” and “IP ADDRESS”: 1. If the “PROFILING” parameter is disabled, the SC-770 will not output a raw data stream via the Ethernet output. Turn Profiling “ON”. Exit Program Mode. 2. Verify that the IP address is set correctly. The correct IP address should be listed on the most recent Functional Compliance Test Datasheet. Alternatively, contact your CAS System Admin or NSDD sustainability manager.
2.1.9	See 2.0.8.
2.1.10	Inspect Ethernet Cables and connections, especially the Ethernet cable/SC-770 box penetration connector inside the SC-770 controller which is prone to being unseated with repeated use.
2.1.11	To determine if the RPM data stream output is present at the Ethernet connection on the top of the SC-770 controller. Establish an Ethernet connection with a laptop directly at the SC-770 controller per the instructions in the back of this guide. If the data stream is present at the SC-770 output but not present at the CAS, the problem is not in the RPM unless the GarrettCom Ethernet to Fiber converter is being used. Check the GarrettCom converter, the switch in the utility panel, or the RDS communications network.
2.1.12	Re-flash the Rabbit board firmware per DET-RPM-RAP-CM02 or Replace the rabbit board per DET-RPM-RAP-CM23, *RPM Rapiscan Rabbit Board Replacement*, whichever is most convenient. If this does not correct the problem, go to 2.0.13.
2.1.13	Replace the SC-770 controller module per DET-RPM-RAP-CM10, *RPM SC-770 Controller Module Replacement*.

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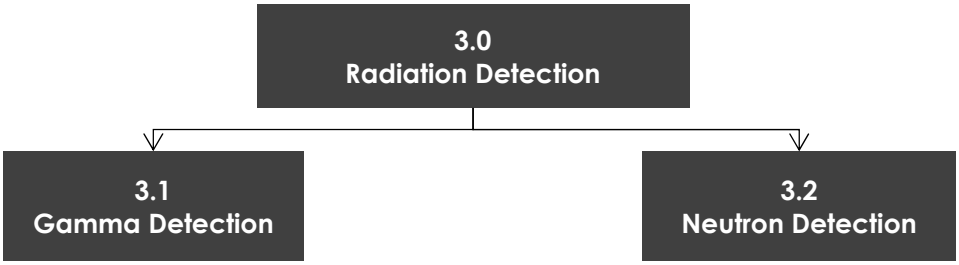
Radiation Detection



Common Components

SCA-775 single channel analyzer module (SCA-774 board)

SC-770 controller module (SC-771 controller board/Rabbit board assembly)

Cables, wires, and connectors

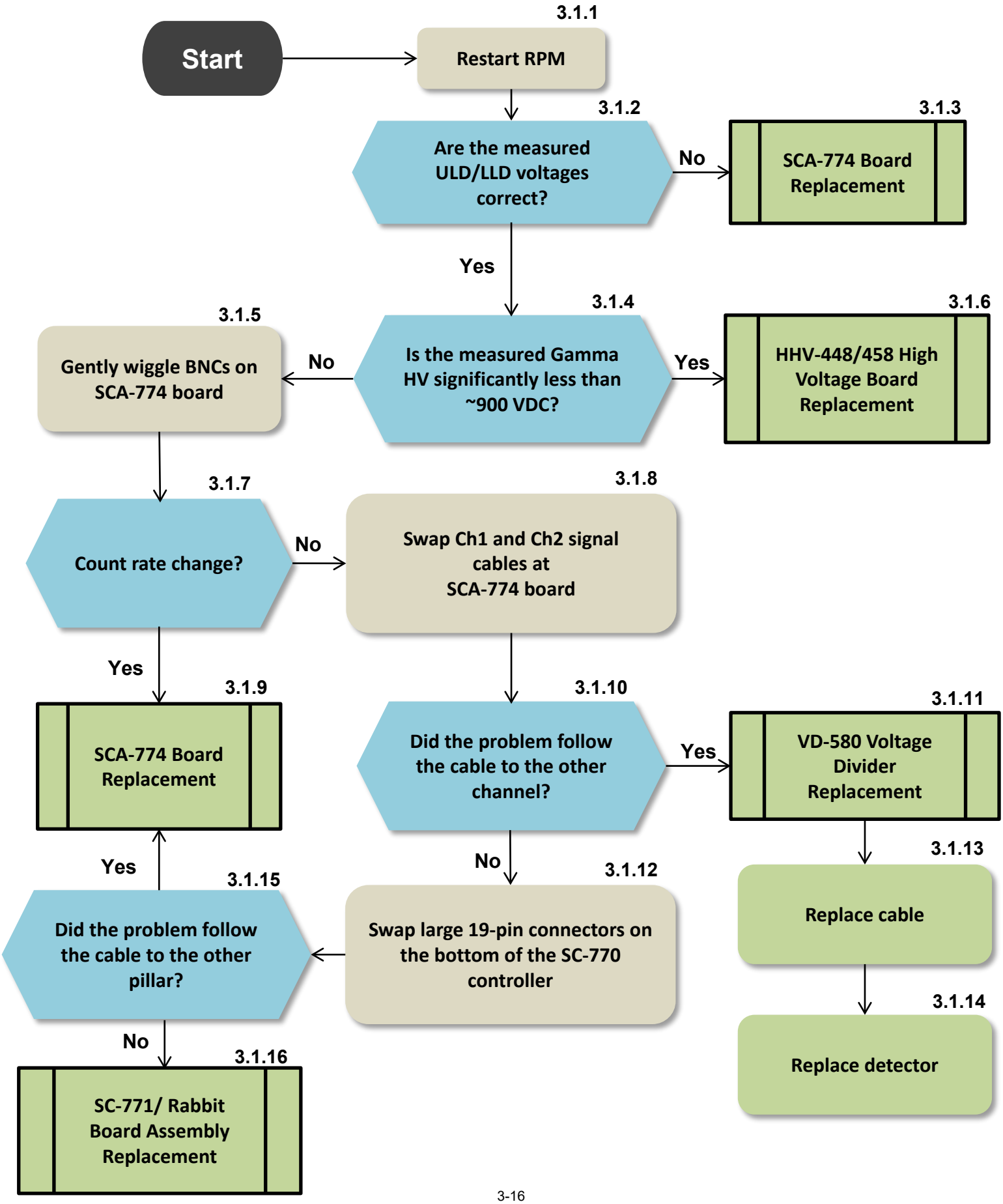
Gamma Only:	**Neutron Only:**
DA-630 Gamma detector assembly	Neutron (He-3) tube
DA-1248 Gamma detector assembly	PMFX box
VD-580 (high voltage divider)	Neutron HHV-448/458 (HV power supply)
Gamma HHV-448/458 (HV power supply)	

Operational or Environmental Considerations

- Gamma and neutron detectors rarely fail; replacement of detectors should be a last resort.
- A limited number of faults can affect both pillars. Failure of components common to both pillars should affect both channels similarly. If the reported problems in the pillars are different then troubleshoot the pillars separately, starting with the control pillar.
- X-ray machines in airports and non-intrusive imaging (NII) equipment at ports and border crossings may interfere with RPM detector performance.
- All SCA-774 boards with black connectors should be replaced with newer “dead-time” SCA-774 boards which can be identified by the “2EE2” sticker on the main board chip.

Symptom	Flowchart
• Gamma HI background fault • Gamma LO background fault • Local alarm indication on every occupancy • Excessive alarm rates	**3.1 Gamma Detection**
• Neutron HI background fault • Local alarm indication on every occupancy • Excessive alarm rates	**3.2 Neutron Detection**

3.1 Gamma Detection



Gamma Detection Troubleshooting Notes:	
3.1.1	Restarting the RPM may correct a fault condition in some cases. Restart the RPM by cycling the on/off switch on the LD 260, allow the RPM to complete the POST process and review status of RPM. If all gamma detector Channels are now functioning properly, troubleshooting is complete. There are a limited number of faults that can affect both pillars; troubleshoot each pillar independently starting with the control pillar. Failure of components that are common to both gamma detector Channels should affect both Channels similarly. If the problems in the Channels are different (GH in one and GL in the other), troubleshoot the gamma Channels separately.
3.1.2	Detector count rates are directly affected by ULD and LLD voltages. The ULD and LLD set points are sent to the SCA-774 digitally from the SC-770 controller via cables and are susceptible to voltage spikes. The ULD and LLD set points, as viewed in the SC-770 controller, cannot be relied upon in this case. Discriminator voltages must be directly measured on the SCA-774 boards at: ULD = 0.455 VDC at TP-18 and TP-19 LLD = 0.069 VDC at TP-10 and TP-11 Assess Results: a. If the ULD/LLD voltages are correct, proceed to step 3.1.4. b. If the ULD/LLD voltages are NOT correct, proceed to step 3.1.3. For simplicity, this document assumes that the RPM was installed correctly and was fully functional at some point before the fault was detected. If the fault conditions such as abnormal count rate (especially in the auxiliary pillar) change each time the RPM is powered on/off, this is an indication there may be an issue with the discriminator voltages. In cases where work may have been done on the RPM or the RPM was moved, verify that the correct crossover cable was used and connections are carefully verified.
3.1.3	Carefully reread 3.1.2. If the ULD/LLD parameter settings are correct in the SC-770 controller, but the voltages are incorrect when measured on the SCA-774 board, replace the single Channel analyzer board (SCA-774 board) by performing procedure DET-RPM-RAP-CM07, *RPM SCA-774 Single Channel Analyzer Board Replacement*.
3.1.4	There is only one high voltage power supply board that serves all gamma detectors in a single pillar. Measure the HV on the MHV cable at both detectors using a digital multi-meter and HV probe. The voltages should be the same and close to the voltage recorded during the last electronic alignment. a. If the measured high voltages significantly less than approximately 900 VDC attempt to attempt to correct it by adjusting R1 on the gamma detector HV-448/458 board. If adjusting the high-voltage is successful perform an electronic alignment of the RPM per DET-RPM-RAP-CM01, *RPM Electronic Alignment*. b. If the high-voltage cannot be adjusted to approximately 900 VDC proceed to 3.1.6
3.1.5	The SCA-774 board signal cable BNC connections may cause elevated count rates in the affected Channel. Gently wiggling the affected channel's signal cable BNC connector where it is connected to the SCA-774 board may cause the count rate to return to normal or make it change significantly. This effect should NOT be seen with a current "Dead-Time" board installed (2EE2).
3.1.6	Replace the high voltage board (HHV-448/458) by performing procedure DET-RPM-RAP-CM25, *RPM HHV-448/458 High Voltage Board Replacement*.
3.1.7	Assess the results:

Gamma Detection Troubleshooting Notes:	
	a. If the displayed count rate changes while wiggling the signal BNC connector, proceed to 3.1.9. b. If there was no change in count rate proceed to 3.1.8.
3.1.8	To determine if the problem is upstream or downstream of the SCA-774 BNC connectors, switch the BNC connectors for gamma CH1 and CH2 at the SCA-774 board. This means that the count rate information for gamma CH1 will be processed by gamma CH2 electronics, and the count rate information for gamma Channel 2 will be processed by gamma CH1 electronics.
3.1.9	The SCA-774 board should be replaced by performing the procedure DET-RPM-RAP-CM07 *RPM SCA-774 Single Channel Analyzer Board Replacement* if: a) the detector count rate changes while wiggling the SCA-774 board BNC connectors (from 3.1.5), or b) the problem stayed on the original Channel after switching the BNC signal cables (from 3.1.8, 3.1.10) AND the problem followed the cable after swapping the 19-pin connectors at the bottom of the SC-770 (from 3.1.12, 3.1.15).
3.1.10	Watch the gamma detector count rates in the SHOW COUNTS in the gamma settings on the SC-770 when switching the gamma detector signal cable connectors at the SCA-774 board. Assess the results: a. If the problem was originally on CH1 (or CH2), then moved to CH2 (or CH1) after switching connector positions, the problem is most likely the BNC cable or VD-580 that will need to be replaced, proceed to 3.1.11. b. If the fault indication stayed on the original Channel, proceed to 3.1.12.
3.1.11	Replace the affected VD-580 by performing procedure DET-RPM-RAP-CM03, *RPM VD-580 Replacement* (most likely fix). If this does not correct the fault, proceed to step 3.1.13.
3.1.12	Turn off the RPM at the LD-260; reverse the positions of the large 19-pin connectors on the bottom of the SC-770 controller. This puts the control pillar channels on the auxiliary pillar Channels and the auxiliary pillar Channels on the control pillar Channels. Turn the RPM back on. Proceed to step 3.1.15.
3.1.13	If replacing the VD-580 did not correct the fault, replace the affected signal cable.
3.1.14	If replacing the VD-580 and the signal cable did not correct the problem, replace the gamma detector per DET-RPM-RAP-CM22, *RPM DA-630 або DA-1248 Gamma Detector Assembly Replacement*. It is extremely unlikely that the gamma detector would need to be replaced. If the problem is a high gamma count rate carefully inspect the gamma detector for damage to the black plastic covering. This can also be facilitated by covering the detector with a thick fabric or towel and moving the towel up and down the detector while watching the count rate. Damage to the black plastic covering can be fixed using a high-quality black electrical tape.
3.1.15	After completing step 3.1.12, wait for the controller to complete the POST and obtain initial background, Assess results: a. If the fault indications from the original pillar moved to the opposite pillar (followed the cable), the problem is in the original pillar, or less likely the cross-over cable, proceed to step 3.1.9. b. If the fault indications remained on the Channels from the original pillar moved (did NOT followed the cable), the problem is likely in the SC-770 controller, proceed to 3.1.16. ***Be sure to return all cables and connectors to their correct positions at the end of troubleshooting and repair effort***
3.1.16	Replace the SC-770 controller module by performing procedure DET-RPM-RAP-CM10, *RPM SC-770 Controller Module Replacement*.

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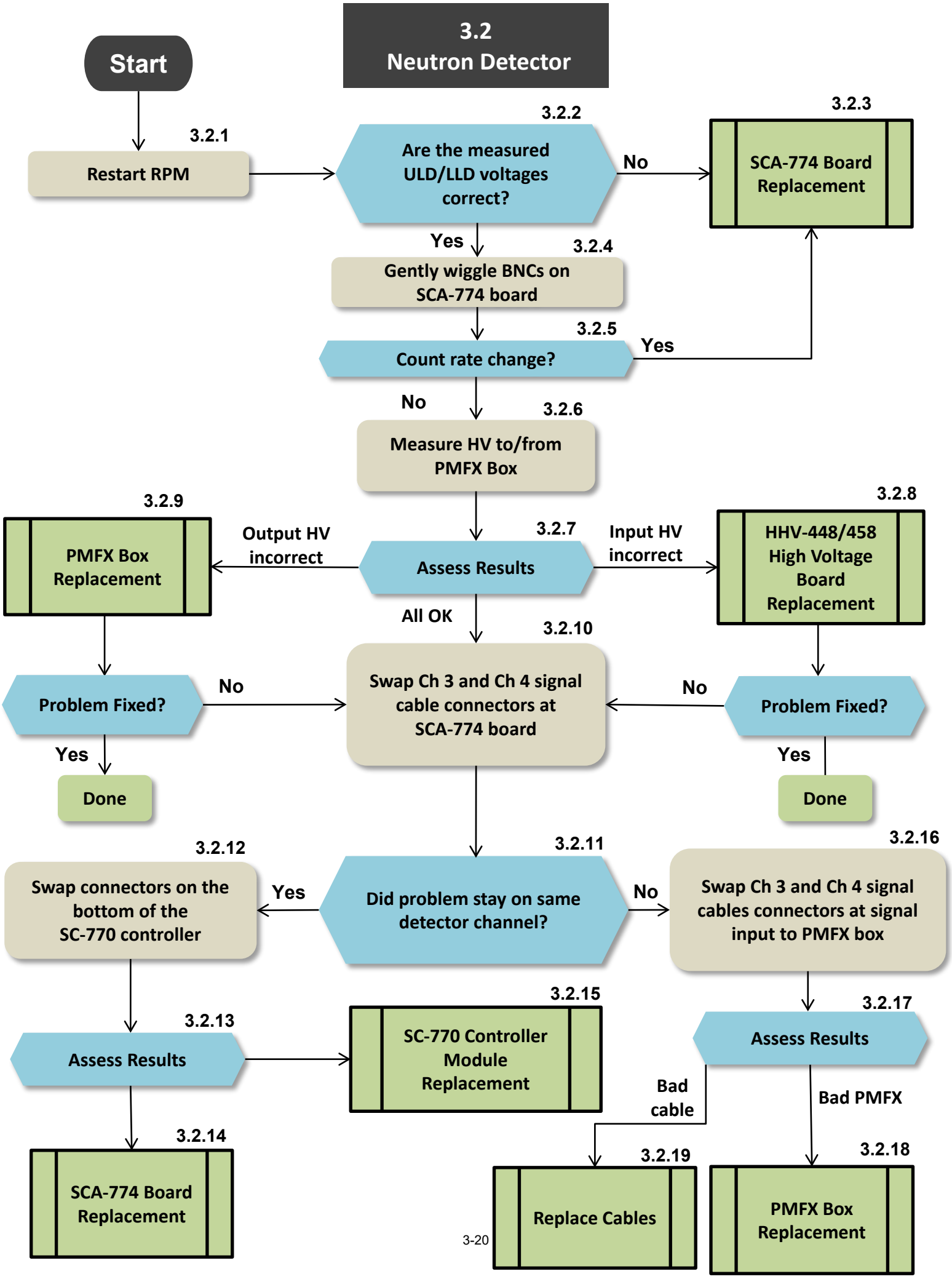
3.2
Neutron Detector
Start
3.2.1
Restart RPM
3.2.2
Are the measured ULD/LLD voltages correct?
No
3.2.3
SCA-774 Board Replacement
Yes
3.2.4
Gently wiggle BNCs on SCA-774 board
3.2.5
Count rate change?
Yes
No
3.2.6
Measure HV to/from PMFX Box
3.2.9
PMFX Box Replacement
Output HV incorrect
3.2.7
Assess Results
Input HV incorrect
3.2.8
HHV-448/458 High Voltage Board Replacement
All OK
3.2.10
Swap Ch 3 and Ch 4 signal cable connectors at SCA-774 board
Problem Fixed?
No
Yes
Done
No
Problem Fixed?
Yes
Done
3.2.12
Swap connectors on the bottom of the SC-770 controller
Yes
3.2.11
Did problem stay on same detector channel?
No
3.2.16
Swap Ch 3 and Ch 4 signal cables connectors at signal input to PMFX box
3.2.13
Assess Results
3.2.15
SC-770 Controller Module Replacement
3.2.17
Assess Results
Bad cable
Bad PMFX
3.2.14
SCA-774 Board Replacement
3.2.19
Replace Cables
3.2.18
PMFX Box Replacement

Neutron Detection Troubleshooting Notes:	
3.2.1	Restarting the RPM may correct a fault in some cases. Restart the RPM by cycling the "ON/OFF" switch on the LD-260, allow the RPM to complete the POST process and review status of RPM. If all neutron detector Channels are now functioning properly, troubleshooting is complete. There are a limited number of faults that can affect both pillars; troubleshoot each pillar independently starting with the control pillar. Failure of components that are common to both neutron detector Channels should affect both Channels similarly. If the problems in the Channels are different (for example NH in one and zero counts in the other), troubleshoot the neutron Channels separately.
3.2.2	Detector count rates are directly affected by ULD and LLD voltages. The ULD and LLD set points are sent to the SCA-774 digitally from the SC-770 controller via cables and are susceptible to voltage spikes. The ULD and LLD set points as viewed on the SC-770 controller cannot always be relied upon in this case. Voltages must be directly measured on the SCA-774 boards at: ULD = 5.04 VDC at TP-20 and TP-21 LLD = 0.504 VDC at TP-12 and TP-13 Assess Results: a. If the ULD/LLD voltages are correct, proceed to step 3.2.4. b. If the ULD/LLD voltages are NOT correct, proceed to step 3.2.3. For simplicity, this document assumes that the RPM was installed correctly and was fully functional at some point before the fault was detected. If the fault conditions such as abnormal count rate (especially in the auxiliary pillar) change each time the RPM is powered on/off, this is an indication there may be an issue with the discriminator voltages. In cases where work may have been done on the RPM or the RPM was moved, verify that the correct crossover cable was used and connections are carefully verified.
3.2.3	Carefully reread 3.2.2. If the ULD/LLD parameter settings are correct in the SC-770 controller, but the voltages are incorrect when measured on the SCA-774 board, replace the SCA-774 single Channel analyzer board by performing procedure DET-RPM-RAP-CM07, *RPM SCA-774 Single Channel Analyzer Board Replacement*.
3.2.4	The SCA-774 board signal cable BNC connections may cause elevated count rates in the affected Channel. Wiggling the affected Channel's signal BNC connector where it is connected to the SCA-774 board may cause the count rate to return to normal or make it Change significantly. This effect should NOT be seen with a current "Dead-Time" board installed (2EE2).
3.2.5	Assess the results: a. If there was a noticeable count rate Change in step 3.2.4, proceed to 3.2.3. b. If there was NO noticeable count rate Change in step 3.2.4, proceed to 3.2.6.
3.2.6	Measure the HV going into and out of the PMFX box using a digital multi-meter and HV probe: a. Measure the neutron detector high voltage at the input to the PMFX box. There is only one high voltage power supply board that services all neutron detector banks in a single pillar. Measure the HV on the MHV cable at the center top of the PMFX box using a multi-meter and HV probe. The voltage should be approximately +1375 VDC. b. Measure the HV supplied to each tube from the PMFX box; these voltages should be approximately +1250 VDC.
3.2.7	Assess results: a. If the HV supplied to the PMFX box in step 3.2.6.a is incorrect, proceed to step 3.2.8.

Neutron Detection Troubleshooting Notes:	
	b. If the HV supplied to the neutron tubes (from the PMFX box) are incorrect, proceed to step 3.2.9. c. If the voltage in and out of the PMFX box are correct, proceed to step 3.2.10.
3.2.8	If the HV supplied to the PMFX box from the SCA-775 module (HHV-448/458) is not +1375 VDC, attempt to correct it by adjusting R1 on the neutron detector HV-448/458 board. a. If the adjustment is successful, perform the neutron detector efficiency portion of the functional compliance test on the affected RPM pillar per DET-RPM-RAP-RM05, *RPM Functional Compliance Test*. b. If the adjustment is NOT is not successful, replace the HHV-448/458 by performing procedure DET-RPM-RAP-CM25. It would be prudent to replace the HV cable between the HHV-448/458 board in the SCA-775 module and the PMFX box first to see if that corrects the fault. c. If none of these actions correct the fault, proceed to 3.2.10.
3.2.9	If the HV supplied to the PMFX box from the SCA-775 module is +1375 VDC but the HV supplied to all of the neutron tubes from the PMFX box is not +1250 VDC, replace the PMFX box by performing procedure DET-RPM-RAP-CM04, *RPM Neutron Signal Pick-Off Box (PMFX) Replacement*. If this action does not correct the fault, proceed to 3.2.10.
3.2.10	On top of the SCA-774 board, move the CH3 signal cable to CH4, and the CH4 signal cable to CH3. This will move the detector signal count rates from CH3 to the CH4 electronics, and the detector signal count rates from CH4 to the CH3 electronics.
3.2.11	After completing step 3.2.10, assess the results: a. If the fault indication stayed on the same channel, the problem is upstream (SCA-774 board or SC-770 controller). Proceed to step 3.2.12. b. If the fault indication follows the cable to the other channel, the problem is downstream (cables, PMFX box, or detector tubes). Proceed to step 3.2.16
3.2.12	Turn off the RPM (at the LD-260), reverse the positions of the large 19-pin connectors on the bottom of the SC-770 controller. This puts the control pillar Channels on the auxiliary pillar channels and the auxiliary pillar channels on the control pillar channels. Turn the RPM back on.
3.2.13	After completing step 3.2.12, wait for the controller to complete the POST and obtain initial background, assess results: a. If the fault indications from the original pillar moved to the opposite pillar (followed the cable), the problem is in the original pillar, or less likely the cross-over cable, proceed to 3.2.14. b. If the fault indications remained on the channels from the original pillar moved (did NOT follow the cable), the problem is likely in the SC-770 controller, proceed to 3.2.15. ***Be sure to return all cables and connectors to their correct positions at the end of troubleshooting and repair effort***
3.2.14	Replace the SCA-774 board by performing procedure DET-RPM-RAP-CM07, *RPM SCA-774 Single Channel Analyzer Board Replacement.*
3.2.15	Replace the SC-770 controller module by performing procedure DET-RPM-RAP-CM10, *RPM SC-770 Controller Module Replacement.*

Neutron Detection Troubleshooting Notes:		
3.2.16	Faults in a PMFX box can affect the count rate from 1, 2, 3, or all 4 He3 tubes (if installed). Move the HV/signal cables from the upper detector bank (the two on the left) to the two connectors on the right, and the HV/signal cables from the lower detector bank (the two on the right) to the connectors on the left.	
3.2.17	After completing step 3.2.16, assess results: a. If the fault indication stayed on the original channel (CH3 or CH4), the fault is likely in the PMFX box. Proceed to step 3.2.18. b. If the fault indication followed the cables to the other channel, the fault is likely one of the signal/HV cables between the tubes and PMFX box. Proceed to 3.2.19.	
3.2.18	Replace the PMFX box by performing procedure DET-RPM-RAP-CM04, *RPM Neutron Signal Pick-Off Box (PMFX) Replacement*.	
3.2.19	Replace the suspected neutron detector high voltage cable with one of the appropriate length from your spare parts inventory. Wire ties will need to be cut to complete this task. It is good engineering practice to replace them neatly when done. Replace the He3 tubes as a last resort effort. He3 tube failures are extremely rare. If the faulty is “no neutron counts”, be sure to use the neutron source when troubleshooting as the natural neutron background count rate can be zero.	

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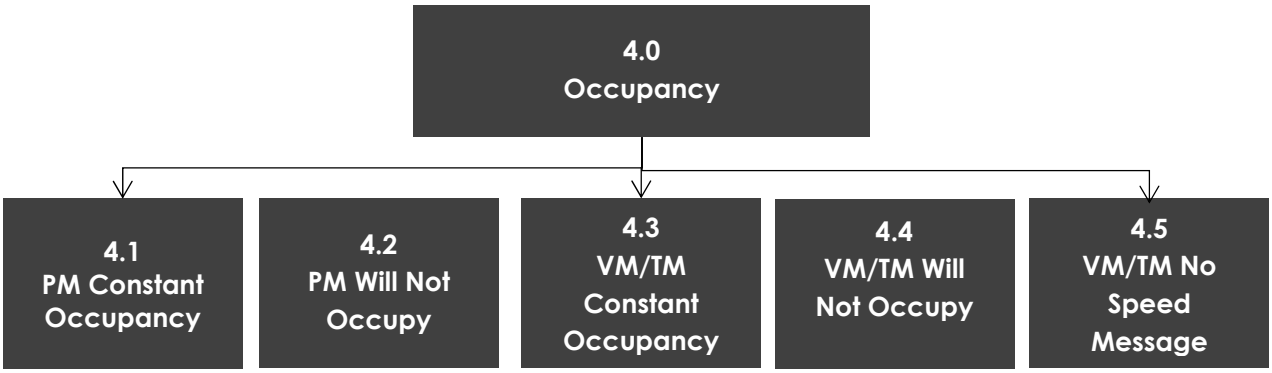
Occupancy



Components

Nanocontroller and RS-232 to RS-485 Converter (VM and TM only)

SCA-774 (single channel analyzer board)

SC-770 controller module (SC-771 controller board/Rabbit board assembly)

Cables, wires, and connectors

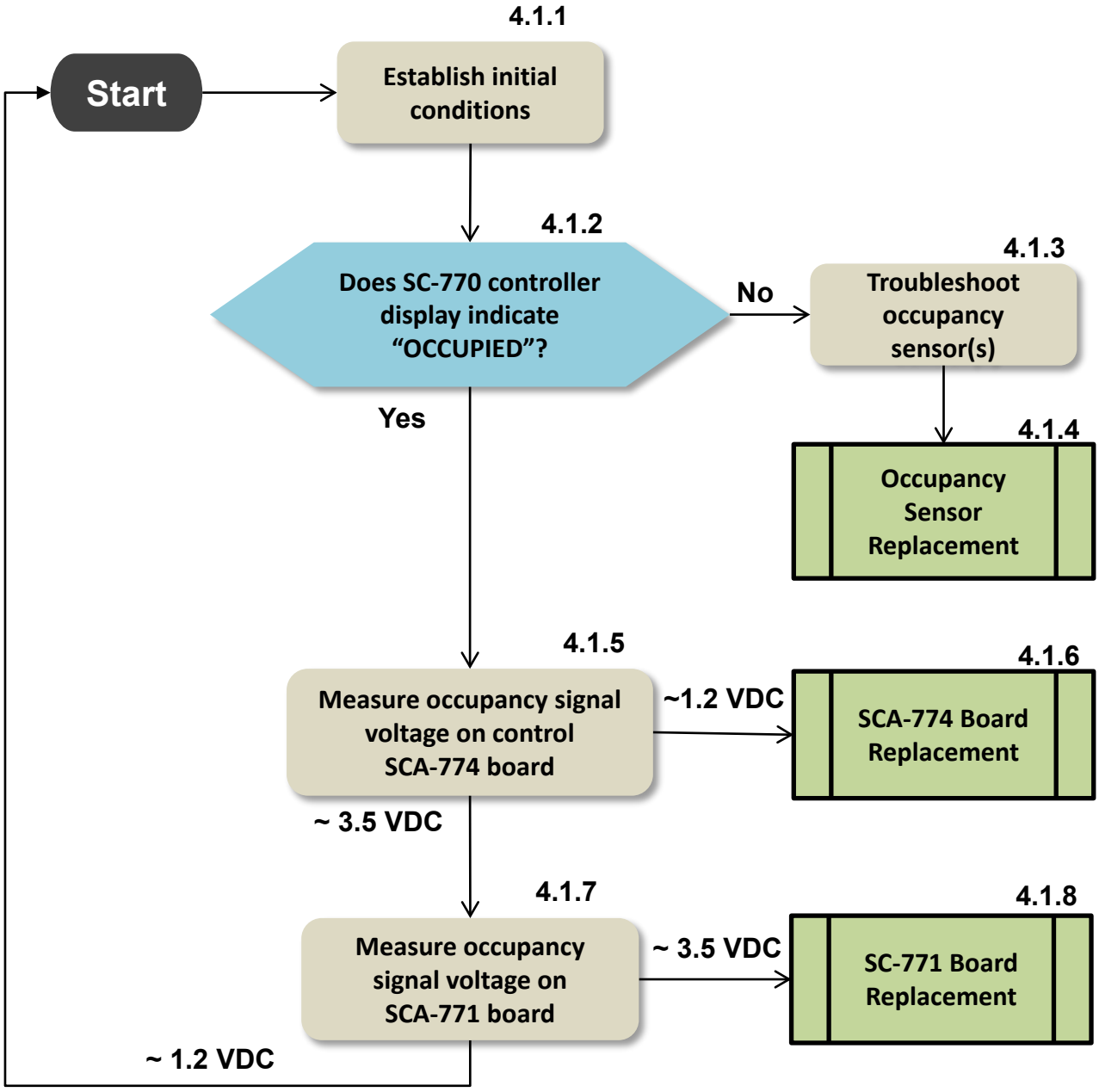
Vehicle and Rail Only:	**Pedestrian Only:**
Banner IR break-beams	BEA Wizard Dual Technology
Senix ultrasonic	Spy-2 IR
Banner radar	

Operational or Environmental Considerations

- Occupancy sensor location (height with respect to vehicles) is critical for proper operation.
- Both IR break-beam sensors are required to provide speed indication, but either one alone will initiate an occupancy.
- Senix ultrasonic and Banner radar sensors must be properly configured when replaced.

Symptom	Flowchart
• PM constant occupancy state	**4.1 PM Constant Occupancy**
• PM will not occupy	**4.2 PM Will Not Occupy**
• VM or TM constant occupancy state	**4.3 VM/TM Constant Occupancy**
• VM or TM will not occupy	**4.4 VM/TM Will Not Occupy**
• No “SP” line in RPM data stream • No speed value in “SP” line of RPM data stream • Lack of speed value at CAS alarm event page	**4.5 VM/TM No Speed Message**

4.1 PM Constant Occupancy



Pedestrian Monitor Constant Occupancy Troubleshooting Notes:		
4.1.1	Establish Initial conditions for troubleshooting: 1. Disable the door tamper switch with a magnet (or piece of tape for spring loaded tamper switch). 2. Disable Spy-2 or Wizard Dual Technology sensor by disconnecting green occupancy signal wire (going to SCA-775 module) on TB2 pin 6 (in control pillar). 3. In rare cases, there may be a second occupancy sensor in the auxiliary pillar of a pedestrian monitor, in that case, also disconnect the occupancy signal wire (going to SCA-775 Module) in the auxiliary pillar at TB4 pin 8 (in auxiliary pillar).	
4.1.2	Determine if the SC-770 display still shows OCCUPIED. 1. If it still displays “OCCUPIED” go to step 4.1.5. 2. If it DOES NOT display “OCCUPIED”, go to step 4.1.3.	
4.1.3	If disconnecting the occupancy signal wire in step 4.1.1 cleared the occupancy, the problem is likely in the occupancy sensor. Reconnect the occupancy signal wire and carefully verify that the area in front of the sensor is clear of all people and obstacles. If the SC-770 controller again displays “OCCUPIED”: 1. If the installed occupancy sensor is a Spy-2, go to step 4.1.4. 2. If the sensor is a Wizard Dual Technology sensor, attempt to adjust the sensors field of view per DET-RPM-RAP-CM16, *RPM Wizard Dual Tech Occupancy Sensor Replacement*. If that adjustment is not successful, go to step 4.1.4.	
4.1.4	Replace the occupancy sensor per: 1. If the installed occupancy sensor is a Spy-2, replace the sensor with a spare Spy-2, or if one is not available, replace it with a Wizard Dual Technology sensor, per DET-RPM-RAP-CM15, *RPM Wizard Dual Tech Occupancy Sensor Replacement*. 2. If the sensor is a Wizard Dual Technology sensor, perform DET-RPM-RAP-CM16, *RPM Wizard Dual Tech Occupancy Sensor Replacement.*	
4.1.5	In the affected pillar(s), measure the occupancy signal **output** from the SCA-774 board at connector J10 Pin 1 (green wire) 1. If the voltage measured is ~1.2 VDC (occupied), proceed to step 4.1.6. 2. If the voltage measured is ~3.5 VDC (not occupied), proceed to step 4.1.7.	
4.1.6	Before replacing the SCA-774 board, verify that the occupancy signal **input** to the SCA-774 board indicates “not occupied”. This is measured at SCA-774 board connector J11 Pin 4 (green wire). Occupied = ~0 VDC Not occupied = ~3.5 VDC If the input to the SCA-774 indicates “not occupied”, but the output indicates “occupied”, replace the SCA-774 board per DET-RPM-	

Pedestrian Monitor Constant Occupancy Troubleshooting Notes:		
	RAP-CM07, SCA-774 *RPM Single Channel Analyzer Board Replacement.*	
4.1.7	Measure the occupancy signal **input** voltage on the SC-771 board at two connectors. 1. If the voltage at P3 Pin 1, and P6 pin 1 are both ~3.5 VDC (not occupied), proceed to step 4.1.8. 2. If either voltage is ~1.2 VDC (occupied), go back to step 4.1.1.	
4.1.8	Perform DET-RPM-RAP-CM09, *RPM SC-771 Controller Board Replacement.*	

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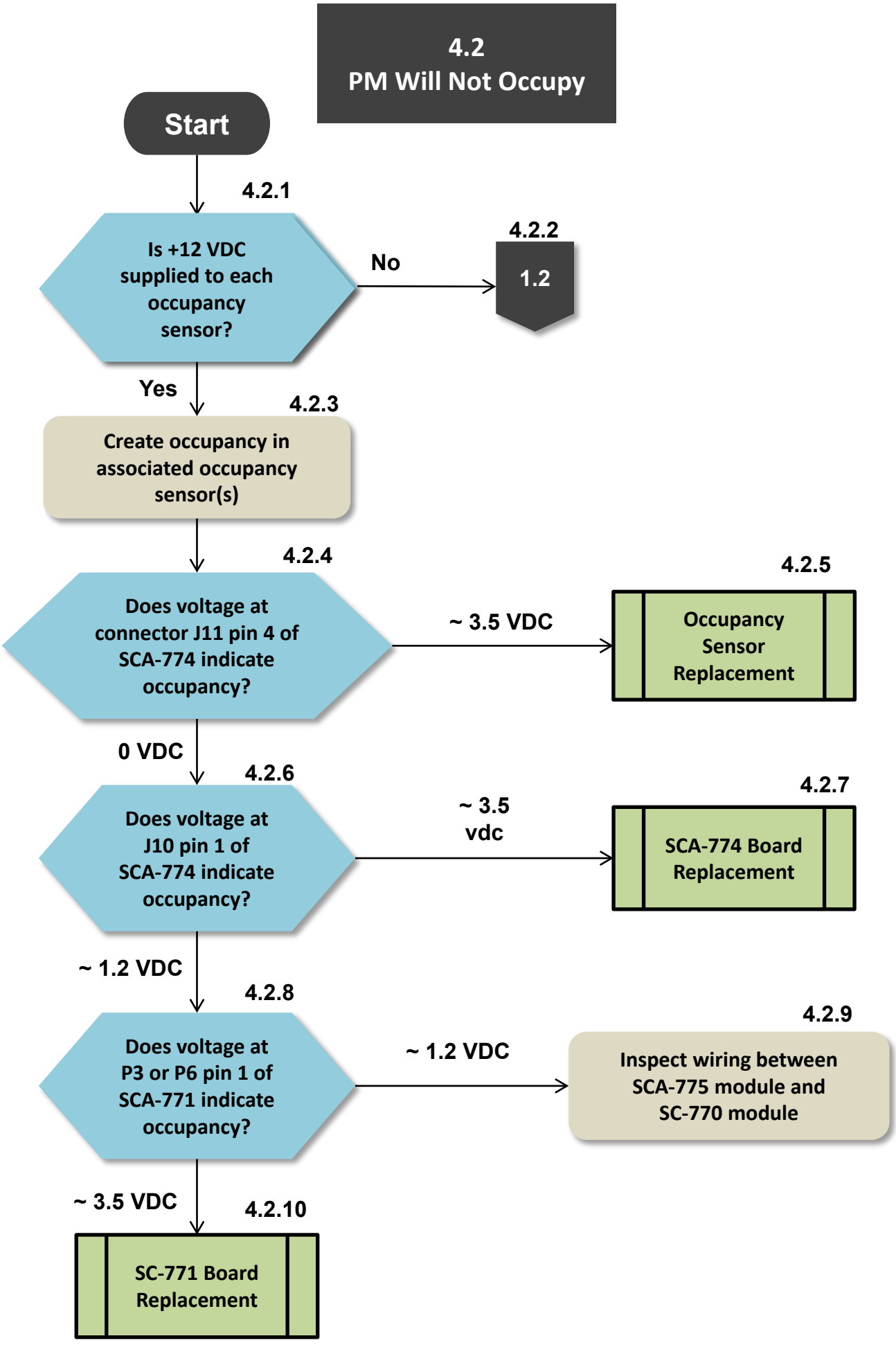
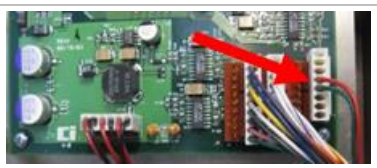
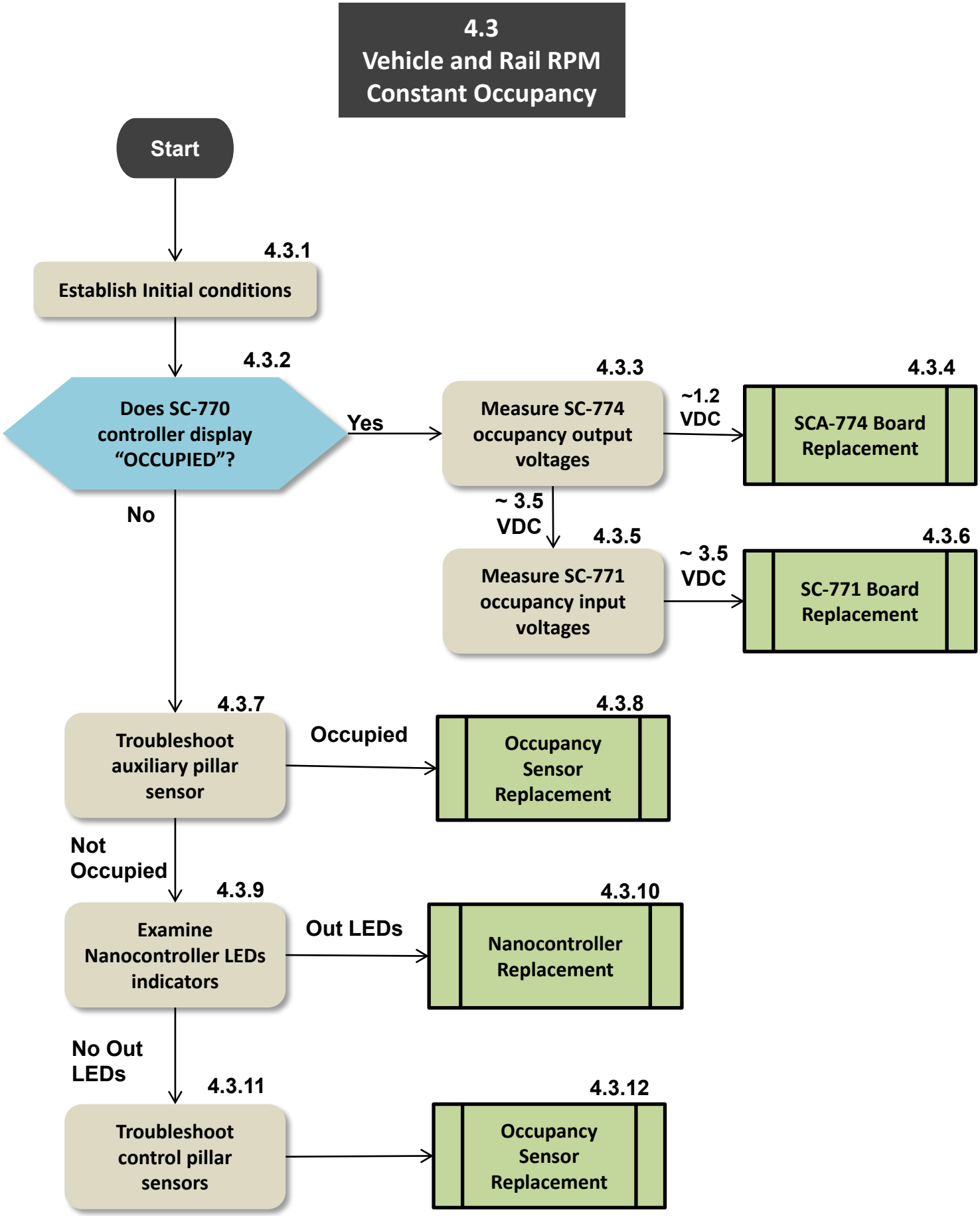

4.2
PM Will Not Occupy
Start
4.2.1
Is +12 VDC supplied to each occupancy sensor?
No
4.2.2
1.2
Yes
4.2.3
Create occupancy in associated occupancy sensor(s)
4.2.4
Does voltage at connector J11 pin 4 of SCA-774 indicate occupancy?
~ 3.5 VDC
4.2.5
Occupancy Sensor Replacement
0 VDC
4.2.6
Does voltage at J10 pin 1 of SCA-774 indicate occupancy?
~ 3.5 vdc
4.2.7
SCA-774 Board Replacement
~ 1.2 VDC
4.2.8
Does voltage at P3 or P6 pin 1 of SCA-771 indicate occupancy?
~ 1.2 VDC
4.2.9
Inspect wiring between SCA-775 module and SC-770 module
~ 3.5 VDC
4.2.10
SC-771 Board Replacement

Pedestrian Monitor will Not Occupy Troubleshooting Notes:		
4.2.1	Occupancy sensors require +15 VDC to function. +15 VDC is typically a red wire and ground is typically a black wire and +15 VDC sections are typically jumpered together with amber colored jumpers. The exact pin location of the +15 VDC and ground does not matter as long as it is actually +15 VDC or ground. If there is an occupancy sensor in each pillar, +15 VDC must be measured in each pillar. • Control pillar: Verify +15 VDC at TB-2 Pin 19. • Auxiliary pillar: Verify +15 VDC at TB-4 Pin 1.	
4.2.2	If the +15 VDC is not present but the rest of the RPM appears to be functioning normal, start tracing the +15 VDC back to the source looking for loose or disconnected wires by following Flowchart 1.2. Sometimes a ground fault will pull down the +15 VDC in certain sections of the RPM, disconnecting components is sometimes the only way to trace this.	
4.2.3	Create an occupancy condition by placing a hand or other object in front of the sensor.	
4.2.4	In the applicable pillar, measure the occupancy signal input to the SCA-774 board at connector J11 Pin 4 (green wire). • If the voltage measures ~3.5 VDC (not occupied), proceed to step 4.2.5. • If the voltage measures ~0 VDC (occupied), proceed to step 4.2.6.	
4.2.5	Perform DET-RPM-RAP-CM16, *PM Wizard Dual Tech Occupancy Sensor Replacement* 1. If the installed occupancy sensor is a Spy-2, replace the sensor with a spare Spy-2, or if one is not available, replace it with a Wizard Dual Technology sensor, per DET-RPM-RAP-CM15, *RPM SPY to Wizard Occupancy Sensor Installation*. 2. If the sensor is a Wizard Dual Technology sensor, perform DET-RPM-RAP-CM16, R*PM Wizard Dual Tech Occupancy Sensor Replacement.*	
4.2.6	Measure the occupancy signal voltage output of the SCA-774 board at connector J10 Pin 1: • If the voltage measures ~3.5 VDC (not occupied), proceed to step 4.2.7. • If the voltage measures ~1.2 VDC (occupied), proceed to step 4.2.8.	
4.2.7	Perform DET-RPM-RAP-CM07, SCA-774 *Single Channel Analyzer Board Replacement*. ** Remember that an Electronic Alignment, procedure DET-RPM-RAP-CM01, RPM Electronic Alignment, MUST be performed AFTER replacement of the SCA-774 board for any reason.	
4.2.8	Measure the voltage of the occupancy circuit input to the SC-771 board at connector P3 Pin 1 for occupancy sensors in the control pillar and/or connector P6 Pin 1 for occupancy sensors in the auxiliary pillar • If the voltage measures ~1.2 VDC (occupied), proceed to step 4.2.9. • If the voltage measures ~3.5 VDC (not occupied), proceed to step 4.2.10.	
4.2.9	Inspect the wiring and connectors between the SCA-775 and SC-770 module.	
4.2.10	Perform DET-RPM-RAP-CM09, *RPM SC-771 Controller Board Replacement*.	


4.3
Vehicle and Rail RPM
Constant Occupancy
Start
4.3.1
Establish Initial conditions
4.3.2
Does SC-770 controller display "OCCUPIED"?
Yes
No
4.3.3
Measure SC-774 occupancy output voltages
~1.2 VDC
4.3.4
SCA-774 Board Replacement
~ 3.5 VDC
4.3.5
Measure SC-771 occupancy input voltages
~ 3.5 VDC
4.3.6
SC-771 Board Replacement
4.3.7
Troubleshoot auxiliary pillar sensor
Occupied
4.3.8
Occupancy Sensor Replacement
Not Occupied
4.3.9
Examine Nanocontroller LEDs indicators
Out LEDs
4.3.10
Nanocontroller Replacement
No Out LEDs
4.3.11
Troubleshoot control pillar sensors
4.3.12
Occupancy Sensor Replacement

Vehicle and Rail RPM Constant Occupancy Troubleshooting Notes:		
4.3.1	Establish Initial conditions for troubleshooting: 1. Disable any open door tamper switch with a magnet (or piece of tape for spring loaded tamper switch). 2. Disable occupancy sensors by disconnecting green occupancy signal wires (going to SCA-775 module) on TB2 pin 6 (in control pillar) and at TB6 pin 8 (in auxiliary pillar). 3. Disconnect the cables to the two Banner IR barrel receivers in the control pillar.	
4.3.2	Determine if the SC-770 display stills shows “OCCUPIED”. 1. If it still displays “OCCUPIED” go to step 4.3.3, 2. If it DOES NOT display “OCCUPIED”, go to step 4.3.7.	
4.3.3	In each pillar, measure the occupancy signal **output** of the SCA-774 board at connector J10 Pin 1 (green wire) 1. If the voltage measured is ~1.2 VDC proceed to step 4.3.4, 2. If the voltage measured is ~3.5 VDC proceed to step 4.3.5. Occupied = ~1.2 VDC Not occupied = ~3.5 VDC	
4.3.4	Before replacing the SCA-774 board, verify that the occupancy signal **input** to the SCA-774 board indicates “not occupied”. This is measured at SCA-774 board connector J11 Pin 4 (green wire). Occupied = 0 VDC Not occupied = ~3.5 VDC If the input to the SCA-774 indicates “not occupied”, but the output indicates “occupied”, replace the SCA-774 board per DET-RPM-RAP-CM07, SCA-774 *RPM Single Channel Analyzer Board Replacement*	
4.3.5	Measure the voltages on the SC-771 board at P3 Pin 1 and P6 Pin 1 connectors. 1. If P3 Pin 1 and P6 Pin 1 are both ~3.5 VDC, there is no occupancy originating in the pillars. Proceed to step 4.3.6. 2. If either connector indicates ~1.2 VDC, proceed to 4.3.1.	
4.3.6	Perform DET-RPM-RAP-CM09, *RPM SC-771 Controller Board Replacement.*	
4.3.7	Troubleshoot auxiliary pillar occupancy sensor: 1. In the auxiliary pillar, reconnect the green occupancy signal wire at TB6 pin 8. 2. Open the cabinet door with the occupancy sensor installed on it and defeat that tamper switch with a magnet. Carefully verify that the area in front of the sensor is clear of all people and obstacles. Determine if the SC-770 display stills shows “OCCUPIED”. 3. If it displays “OCCUPIED” go to step 4.3.8,	

Vehicle and Rail RPM Constant Occupancy Troubleshooting Notes:	
	4. If it DOES NOT display “OCCUPIED”, go to step 4.3.9.
4.3.8	Replace auxiliary pillar occupancy sensor: *1.* If Senix Ultrasonic sensor installed - Perform DET-RPM-RAP-CMXX, RPM Senix Ultrasonic Sensor Replacement. 2. If Banner radar sensor installed – Perform DET-RPM-RAP-CMXX, *RPM Banner Radar Occupancy Sensor Replacement*. The Senix sensor is discontinued so it may have to be replaced with a Banner radar sensor.
4.3.9	Verify that the cables to the Banner IR barrel receivers (in control pillar) are still disconnected, then examine the Nanocontroller LED indicators: 1. The”PWR”, “OK”, and “RUN” LEDs should be illuminated anytime the RPM is powered on. 2. “IN” and “OUT” LEDs should NOT be illuminated with barrel sensors disconnected. 3. If any “OUT” LEDs are illuminated proceed to step 4.3.10, 4. If no “OUT” LEDs are illuminated, proceed to step 4.3.11.
4.3.10	The Nano-controller contains mechanical relay contacts that may become sticky. Tapping on the Nanocontroller will sometimes free them temporarily, but the unit should be replaced as soon as possible. Perform DET-RPM-RAP-CM11, *RPM Nanocontroller Replacement.*
4.3.11	Troubleshoot control pillar occupancy sensors: 1. Verify that the Banner IR “receivers” are installed in the control pillar, and Banner IR “transmitters” are installed in the auxiliary pillar.** (see label on the sensor) 2. Reconnect the cable to one of the two IR sensors and verify that on the Nano-controller the “IN” and “OUT” LEDs on one of the Channels illuminates and the SC-770 controller indicates “OCCUPIED” (with the center control pillar cabinet door open). 3. Close the cabinet door and stand clear of the occupancy sensors to clear the occupancy. 4. Quickly reopen the cabinet door and look at the SC-770 controller display. You should see the controller display change from “OK” to “OCCUPIED” when you open the door. 5. Disconnect the cable to that barrel sensor then repeat steps 2 through 4 for the other Channel. 6. If the occupancy does not clear with the cabinet door shut with either barrel sensor connected. Proceed to step 4.3.12. **In rare cases, the IR receivers are installed in the auxiliary pillar and emitters in the control pillar, and spare wires on the crossover cable are used to send the occupancy signal to the Nanocontroller.
4.3.12	Perform DET-RPM-RAP-CM14, *RPM Banner IR Occupancy Sensor Replacement.* Take care that you replace the barrel sensor with the appropriate spare. Black with black, yellow with yellow, and verify the label indicates that it is a receiver or emitter as appropriate.

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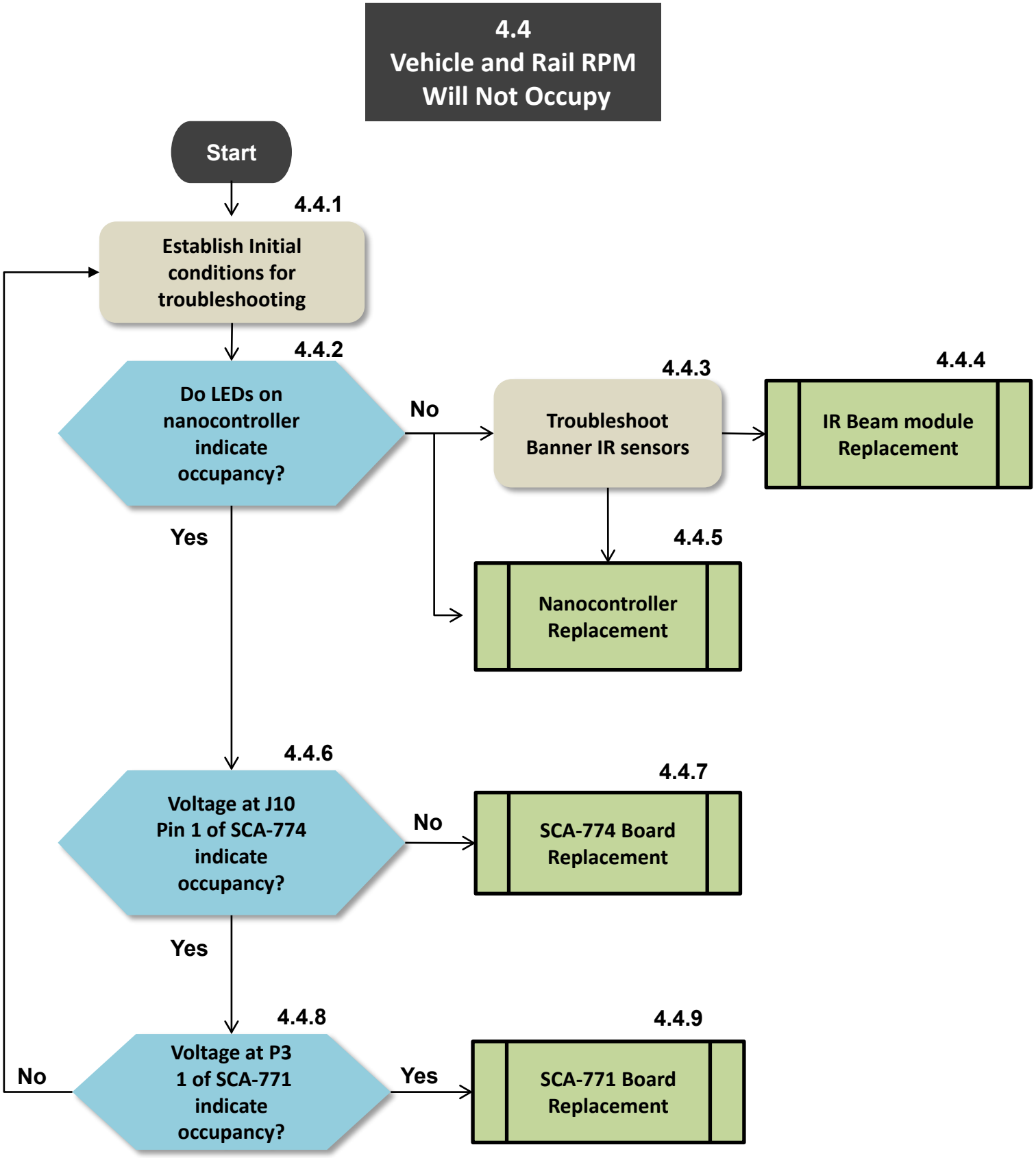
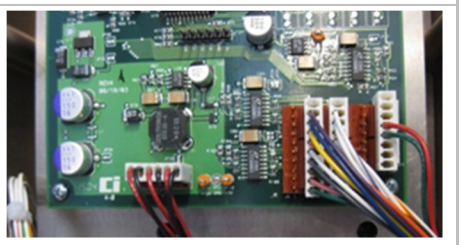

4.4
Vehicle and Rail RPM
Will Not Occupy
Start
4.4.1
Establish Initial conditions for troubleshooting
4.4.2
Do LEDs on nanocontroller indicate occupancy?
No
4.4.3
Troubleshoot Banner IR sensors
4.4.4
IR Beam module Replacement
4.4.5
Nanocontroller Replacement
Yes
4.4.6
Voltage at J10 Pin 1 of SCA-774 indicate occupancy?
No
4.4.7
SCA-774 Board Replacement
Yes
4.4.8
Voltage at P3 1 of SCA-771 indicate occupancy?
No
Yes
4.4.9
SCA-771 Board Replacement

Vehicle and Rail RPM Will Not Occupy Troubleshooting Notes:	
4.4.1	Establish Initial conditions for troubleshooting: 1. Verify RPM is ON, 2. Initiate an “OCCUPIED” condition by opening the middle cabinet door on the control pillar of a vehicle RPM or, covering the Banner IR barrel sensors of a Rail RPM with heavy tape or cardboard. (The IR beam can pass through some thin tape and/or paper).
4.4.2	Examine the Nanocontroller LED indicators: 1. The ”PWR”, “OK”, and “RUN” LEDs should be illuminated anytime the RPM is powered on. 2. Two “IN” and “OUT” LEDs should be illuminated with IR beams between pillars disrupted,** 3. If none of the “IN” LEDs are illuminated proceed to step 4.4.3, 4. If “IN” LEDs are illuminated, but no “OUT” LEDs are illuminated, proceed to step 4.4.5 ** Depending on the Nanocontroller firmware version, either 2 or all four “OUT” LEDs will be lit with the both IR sensors blocked.
4.4.3	1. Verify that the Banner IR “receivers” are installed in the control pillar, and Banner IR “emitters” are installed in the auxiliary pillar. ** (see label on the sensor) 2. Verify +15 VDC applied to sensors: • +15 VDC is supplied to Banner IR sensors in a vehicle monitor at control pillar TB-1, pins 1,2, or 3 (receivers) and auxiliary pillar TB-6, pin 1,2, or 3 (emitters). • +15 VDC is supplied to Banner IR sensors in a Rail monitor at control pillarTB-2, pin 17 (receivers) and auxiliary pillar TB-6, pin 2 & 3. 3. Measure the voltages at I1 and I2 (Nanocontroller inputs) • If voltages are 0 VDC (not occupied), proceed to step 4.4.4. • If voltages are +12 VDC (occupied), proceed to step 4.4.5. **In rare cases, the IR receivers are installed in the auxiliary pillar and transmitters in the control pillar. Spare wire in the crossover cable is used to send the occupancy signal to the Nanocontroller.
4.4.4	Perform DET-RPM-RAP-CM14, *RPM Banner IR Occupancy Sensor Replacement*** Take care that you replace the barrel sensor with the appropriate spare. Black with black, yellow with yellow, and verify the label indicates that it is a receiver or transmitter as appropriate. **It would be extremely unlikely for both IR Occupancy sensor pairs to be faulty at the same time. Recheck the sensor functionality and wiring carefully before deciding to replace IR occupancy sensors.
4.4.5	The Nano-controller contains mechanical relay contacts that may become sticky. Tapping on the Nano-controller will sometimes free them temporarily, but the unit should be replaced as soon as possible. Perform DET-RPM-RAP-CM11, *RPM Nanocontroller Replacement.*
4.4.6	With the occupancy sensors of the control pillar occupied, measure the voltage at the occupancy circuit output of SCA-774 board J10 pin 1 (green wire): a. If the voltage measures ~3.84 VDC (not occupied), proceed to step 4.4.7. b. If the voltage measures ~0.0 VDC (Occupied), proceed to step 4.4.8.
	

Vehicle and Rail RPM Will Not Occupy Troubleshooting Notes:		
4.4.7	If the occupancy circuit input to the SCA-774 board indicates occupied, but the output of SCA-774 board does not, perform DET-RPM-RAP-CM07, SCA-774 *Single Channel Analyzer Board Replacement.*	
4.4.8	Measure the voltage at the occupancy circuit input to SC-771 board P3 pin 1 (green wire): a. If the occupancy circuit input to the SC-771 board is ~1.5 VDC (Occupied), but the SC-770 display does not indicate OCCUPIED, proceed to step 4.4.9, b. If the occupancy circuit input to the SC-771 board is 3.5 VDC (Not occupied), proceed to step 4.4.1 and recheck all indications and measurements.	
4.4.9	Perform DET-RPM-RAP-CM09, *RPM SC-771 Controller Board Replacement.*	

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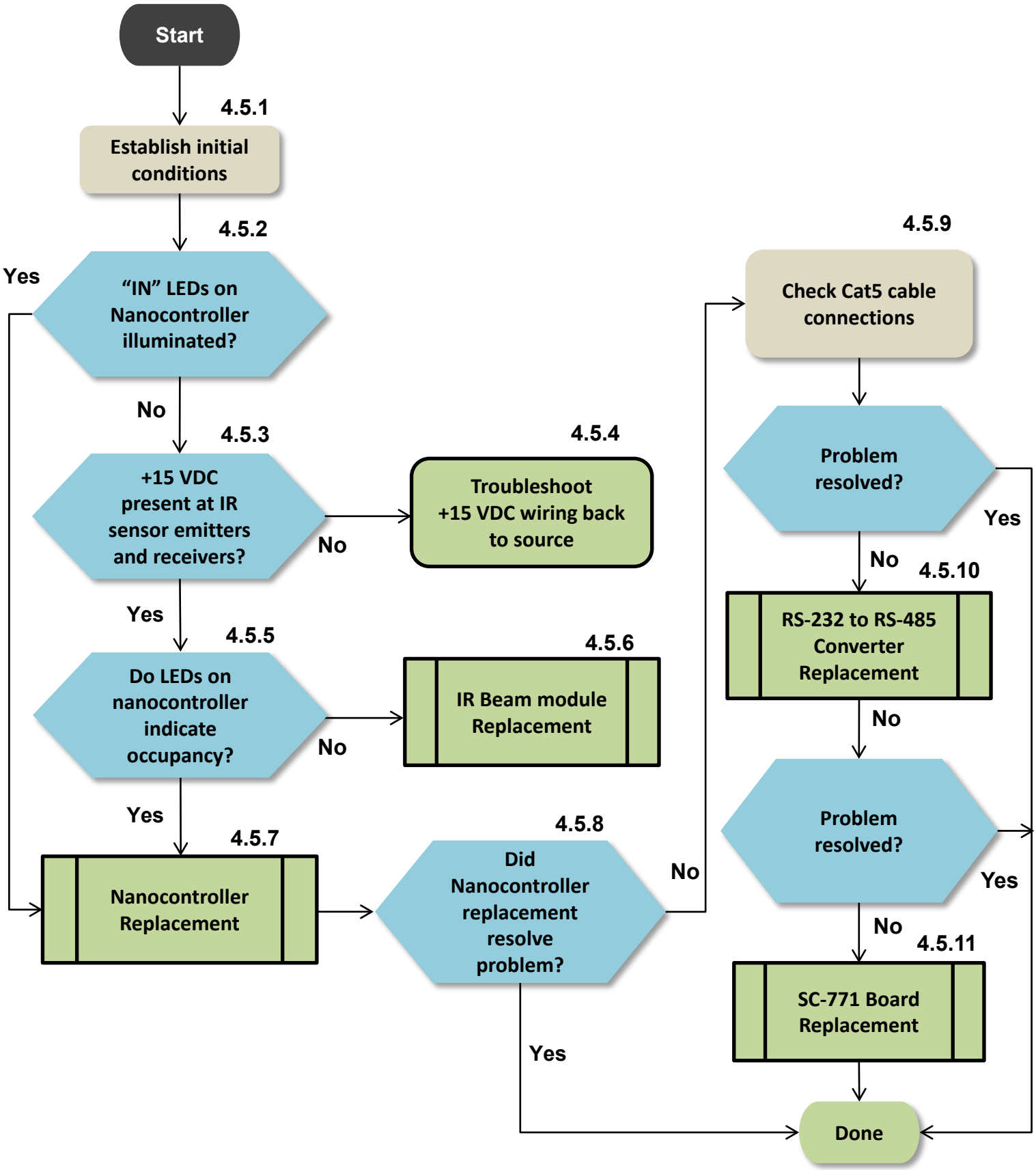
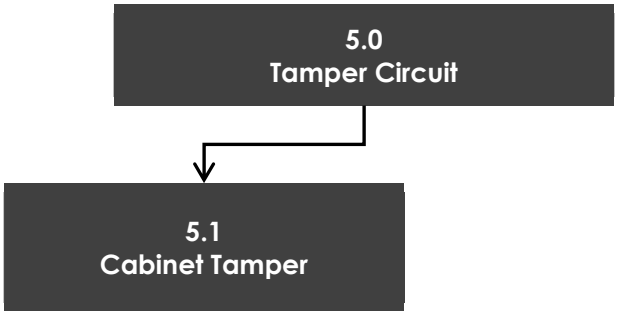
4.5 Vehicle and Rail RPM No Speed Message



Vehicle and Rail RPM No Speed Message Troubleshooting Notes:	
4.5.1	Establish Initial conditions for troubleshooting: 1. Verify RPM is ON. 2. Initiate an “OCCUPIED” condition by opening the middle cabinet door on the control pillar of a vehicle RPM or, covering the Banner IR barrel sensors of a Rail RPM with heavy tape or cardboard. (The IR beam can pass through some thin tape and/or paper).
4.5.2	Examine the Nanocontroller LED indicators: 1. The “PWR”, “OK”, and “RUN” LEDs should be illuminated anytime the RPM is powered on. • If the “PWR” LED is not illuminated, refer to the TSA Systems Schematic Diagram VM-250AGN or TM-850 and trace the wiring back to the source, measuring for +15 VDC at each point along the way until the problem is identified. • If +15 VDC is supplied to the Nanocontroller and the “PWR”, “OK”, and “RUN” LEDs are not illuminated, proceed to step 4.5.7. 2. Two “IN” and “OUT” LEDs should be illuminated with IR beams between pillars disrupted. ** 3. If none of the “IN” LEDs are illuminated proceed to step 4.5.3, 4. If “IN” LEDs are illuminated, but no “OUT” LEDs are illuminated, proceed to step 4.5.7. **Depending on the Nanocontroller firmware version, either 2 or all four “OUT” LEDs will be lit with the both IR sensors blocked. 
4.5.3	1. Verify that the Banner IR “receivers” are installed in the control pillar, and Banner IR “transmitters” are installed in the auxiliary pillar. ** (see label on the sensor) 2. Verify +15 VDC applied to sensors: • +15 VDC is supplied to Banner IR sensors in a vehicle monitor at control pillar TB-1, pins 1,2, or 3 (receivers) and auxiliary pillar TB-6, pin 1,2, or 3 (emitters). If No, proceed to step 4.5.4. If Yes, proceed to step 4.5.6. • +15 VDC is supplied to Banner IR sensors in a Rail monitor at control pillarTB-2, pin 17 (receivers) and auxiliary pillar TB-6 pin 2 & 3. If No, proceed to step 4.5.4. If Yes, proceed to step 4.5.6. **In rare cases, the IR receivers are installed in the auxiliary pillar and transmitters in the control pillar. Spare wires in the crossover cable are used to send the occupancy signal to the Nanocontroller.
4.5.4	If +15 VDC is not supplied to the emitters or receivers, refer to the TSA Systems Schematic Diagram VM-250AGN or TM-850 and trace the wiring back to the source, measuring for +15 VDC at each point along the way until the problem is identified.
4.5.5	Measure the voltages at the Nanocontroller inputs I1 and I2: • If voltages are 0 VDC (Not Occupied), proceed to step 4.5.4. • If voltages are +15 VDC, (Occupied), proceed to step 4.5.5.
4.5.6	Perform DET-RPM-RAP-CM14, *RPM Banner IR Occupancy Sensor Replacement***

Vehicle and Rail RPM No Speed Message Troubleshooting Notes:	
	Take care that you replace the barrel sensor with the appropriate spare. Black with black, yellow with yellow, and verify the label indicates that it is a receiver or transmitter as appropriate. **It would be extremely unlikely for both IR Occupancy sensor pairs to be faulty at the same time. Recheck the sensor functionality and wiring carefully before deciding to replace IR occupancy sensors.
4.5.7	Perform DET-RPM-RAP-CM11, *RPM Nanocontroller Replacement.*
4.5.8	Determine if valid speed messages are being generated by looking at occupancy events in the CAS or by watching the SC-770 data output using a terminal emulator.
4.5.9	Check the Cat5 cable connections at the Nanocontroller and the RS232 to RS485 converter.
4.5.10	Perform DET-RPM-RAP-CM17, *RPM RS232-485 Converter Replacement.*
4.5.11	Perform DET-RPM-RAP-CM09, *RPM SC-771 Controller Board Replacement.*

Tamper



Components

Tamper switches

LD-260

SCA-775 single channel analyzer module (SCA-774 board)

SC-770 controller module (SC-771 controller board/Rabbit board assembly)

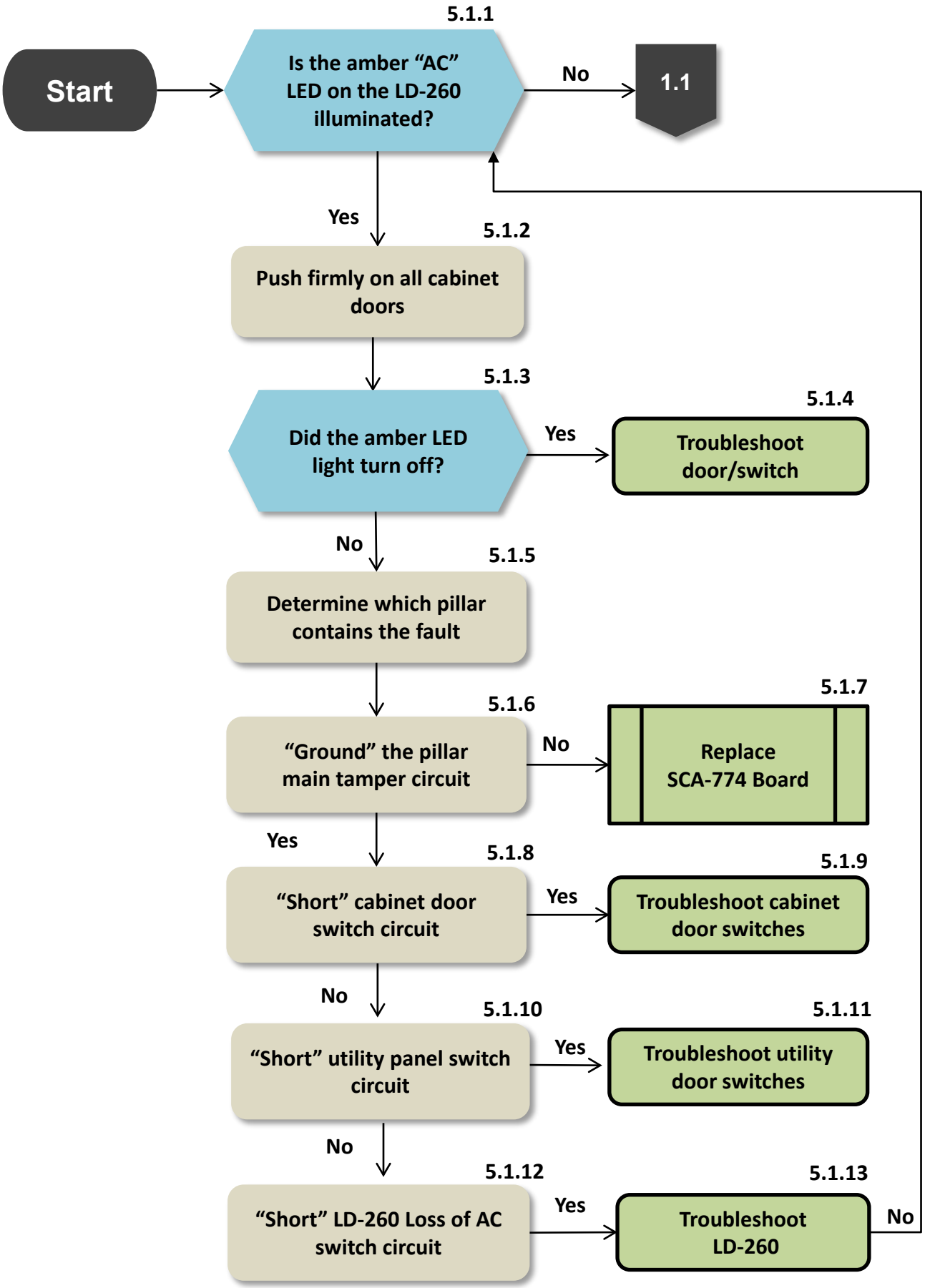
Cables, wires, and connectors

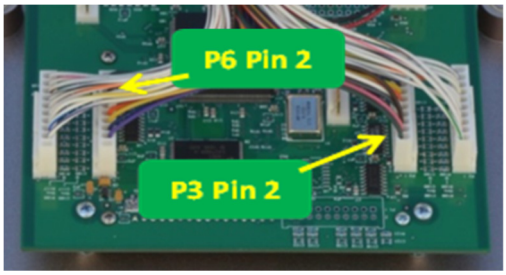
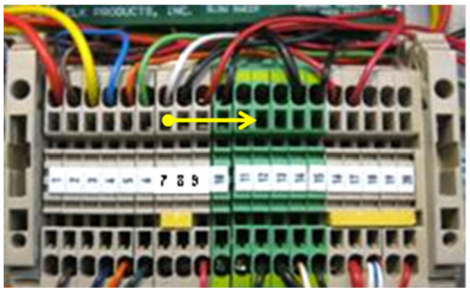
Operational or Environmental Considerations

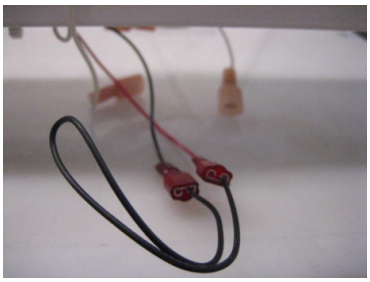
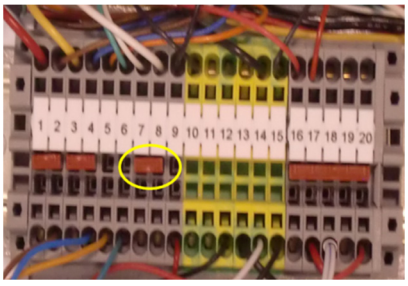
- If the amber “AC” LED on LD-260 is illuminated, the tamper fault is likely due to a cabinet tamper switch or less likely a LD-260, or digital driver/receiver failure.
- Multiple tampers (into the hundreds) on a single RPM may be indicative of a loose door chattering in the wind.
- Simultaneous tampers on multiple RPMs may indicate a site power problem.
- RPM door latches can be carefully tightened – they have plastic components and breakage results in need to replace door.

Symptom	Flowchart
• Amber “fault” LED illuminated on control pillar • RPM “fault” screen on CAS workstation • “Tamper” fault on Status of Health screen at CAS	**5.1 Cabinet Tamper**
• Amber “AC” LED on LD-260 is not illuminated	**1.1 AC Power**

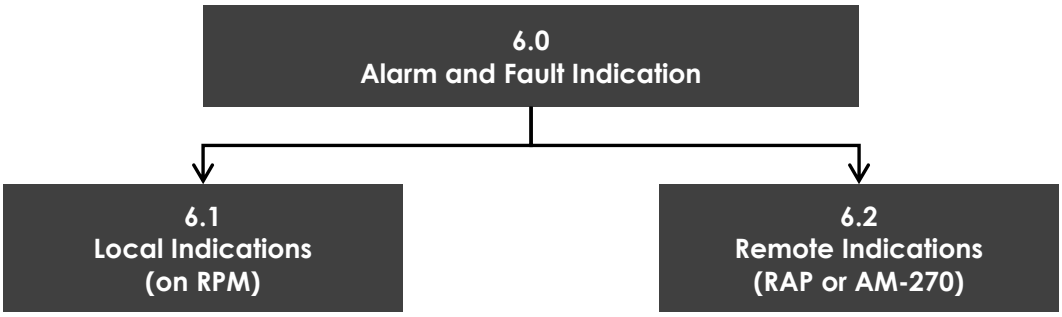
5.1 Cabinet Tamper



Tamper Circuitry Troubleshooting Notes:		
5.1.1	A “tamper fault” indication in this case requires that there is a “TAMPER” indicated on the SC-770 controller or on the CAS user interface. • If the amber “Fault” LED on the control pillar is illuminated but the fault is not indicated on the SC-770 controller or CAS user interface, proceed to section 6.1 “Local Alarm Indication.” • If a tamper fault is indicated on the CAS interface but the amber LED on the control pillar is not illuminated, check the “RELAY OUTPUT” parameter on the SC-770 controller and ensure that the local alarm/fault indicators are “ON” (enabled). A tamper fault can be caused by either a loss of AC power or an open cabinet tamper switch. a. If the amber “AC” LED on the LD-260 is not illuminated troubleshoot the Loss of AC Power in Section 1.1. b. If the amber “AC” LED on the LD-260 is illuminated, proceed to 5.1.3.	
5.1.2	A cabinet tamper fault condition is often caused by a loose cabinet door latch. Close all RPM cabinet doors. While watching the amber fault light on the control pillar, push firmly on the RPM cabinet doors.	
5.1.3	Assess the results of step 5.1.2: • If the amber LED went out while pressing on a door, troubleshooting the door and/or tamper switch in question per step 5.1.4. • If the amber LED remained on during this process, proceed to step 5.1.5.	
5.1.4	If the amber LED went out while pressing on a cabinet door, that door likely has a loose locking mechanism. For the affected door, check tightness of locking mechanism, and/or troubleshoot tamper switch alignment and wiring connections. Door latch mechanisms can be **<u>*carefully*</u>** tightened – they have plastic components and breakage will result in need to replace door.	
5.1.5	Determine which pillar is generating the tamper fault: Measure the voltage on the tamper circuit inputs to the SC-771 board (inside the SC-770 controller). The control pillar tamper signal can be measured at P3, pin 2 (pink wire), and the auxiliary input at P6, pin 2 (pink wire). • Tamper = ~3.9 VDC • OK = ~1.1 VDC Troubleshoot the pillar that contains the fault starting with step 5.1.6.	
5.1.6	Ground the main (white colored) tamper signal wire to the SCA-774 board from TB-2 pin 7 (control) or TB-6 pin 7 (auxiliary) directly to ground (any green terminal). a. If grounding the white wire clears the tamper condition, go to step 5.1.8. b. If grounding the white wire does not clear the tamper condition, go to step 5.1.7.	
5.1.7	Replace the SCA-774 board in that pillar per DET-RPM-RAP-CM07, *RPM SCA-774 Single Channel Analyzer Board Replacement*. If this does not clear the fault, there is a chance that the fault is on the SC-771 board.	

Tamper Circuitry Troubleshooting Notes:		
5.1.8	In a vehicle monitor, place a jumper across control pillar TB-2 pin 8 & 9 or auxiliary pillar TB-6 pin 6 & 7, this removes the door tamper switches from the circuit. a. If the tamper clears, troubleshoot the door switch starting with step 5.1.9, b. If the tamper does not clear go to step 5.1.10.	
5.1.9	Troubleshoot the door tamper switches one at a time by disconnecting the connectors and placing a jumper across the circuit. Placing a jumper across the circuit effectively bypasses the tamper switch. If bypassing a switch clears the fault, verify magnet/switch position and orientation. Repeat this for each door switch in the circuit. A jumper across the Molex connector in a vehicle monitor can rule out the lower two detectors.	
5.1.10	If placing a jumper across each cabinet door switch does not clear the fault, short the utility panel door switch (if installed). If a utility panel tamper switch is wired through the control pillar, it will be connected across TB-2 pins 7 and 8. a. If bypassing the switch clears the fault, proceed to step 5.1.11. b. If bypassing the switch does not clear the fault, proceed to step 5.1.12.	
5.1.11	Troubleshoot the utility panel door tamper switch by disconnecting the connectors and placing a jumper across the circuit. If bypassing the switch clears the fault, verify magnet/switch position and orientation.	
5.1.12	"Short" LD-260 Loss of AC switch circuit by placing a jumper between TB-2 pin 9 and ground (control pillar only). a. If bypassing the LD-260 "loss of AC switch clears the fault, proceed to step 5.1.13. b. If bypassing the LD-260 "loss of AC" switch does not clears the fault, proceed back to step 5.1.1 and re-evaluate the troubleshooting process.	
5.1.13	If "Shorting" the LD-260 "Loss of AC switch" clears the fault, troubleshoot the LD-260 switch by disconnecting connector J2 (6 pin Molex), place a jumper between pin 4 and 6 on the Molex connector. a. If this corrects the fault, replace the LD-260 per DET-RPM-RAP-CM06, *RPM LD-260 Load Disconnect Replacement*, b. If this does not correct the fault, proceed back to step 5.1.1 and re-evaluate the troubleshooting process.	

Alarm and Fault Indication



Components

SC-770 controller module (SC-771 controller board/Rabbit board assembly)

GPRB

ELK Siren

ELK Driver

Sonalert Siren

LEDs and Strobes in blue, red, and amber colors

Remote Alarm Panel (RAP or AM-270)

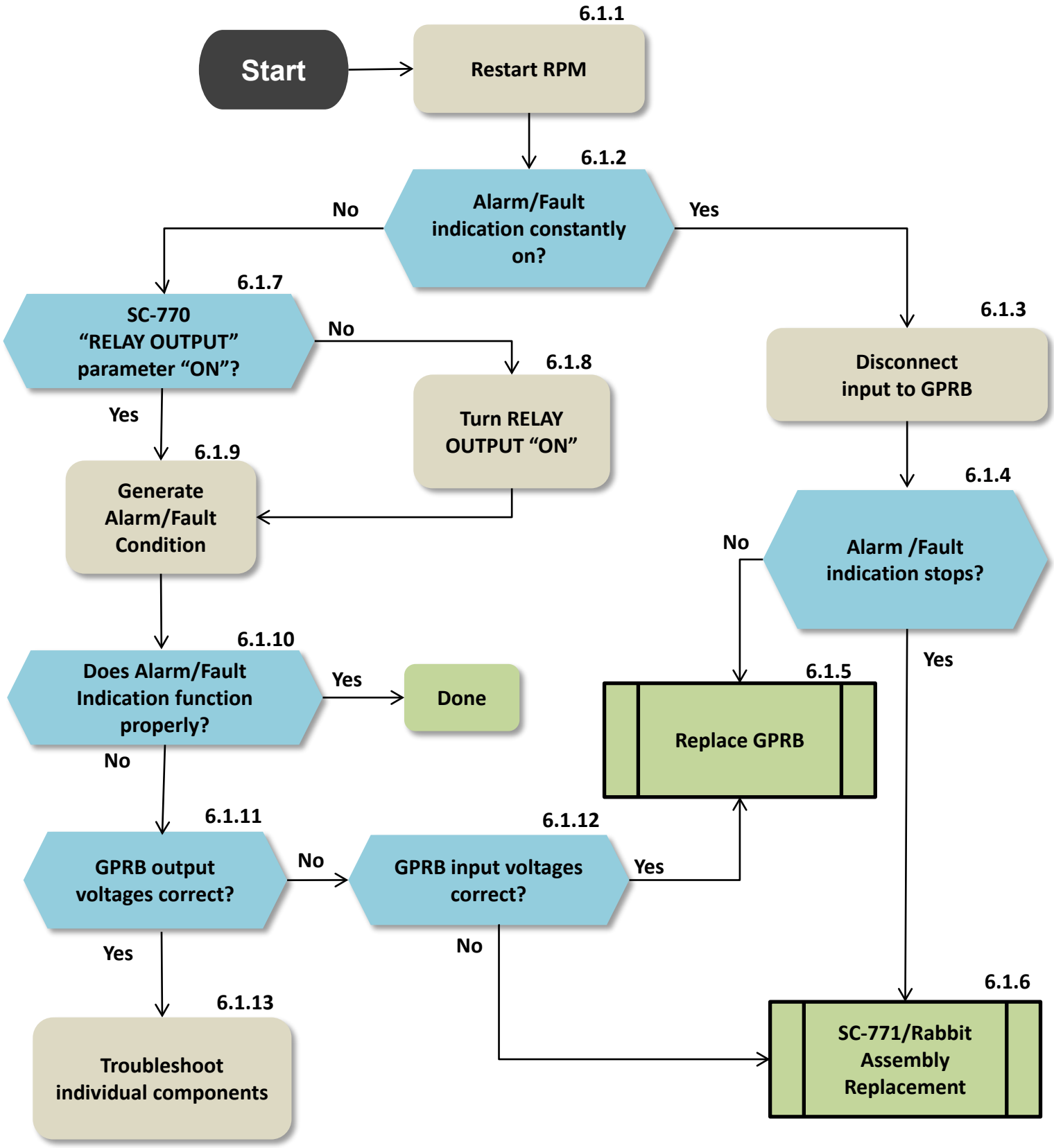
Cables, wires, and connectors

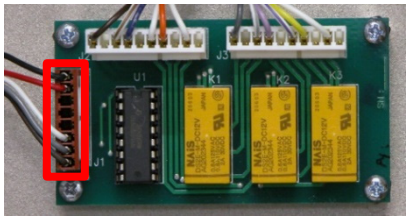
Operational or Environmental Considerations

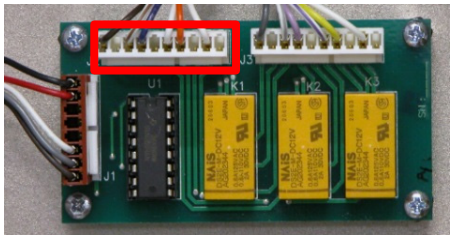
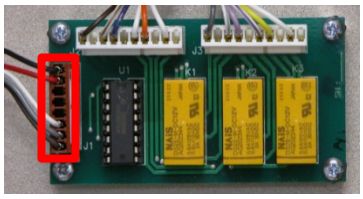
- Local LEDs, strobes, and siren should all function during RPM POST at RPM startup regardless of RPM parameter RELAY OUTPUT set to “ON” or “OFF”.
- RELAY OUTPUT parameter setting is typically determined by host country at RPM installation.

Symptom	Flowchart
• Failure of RPM Operational Testing Procedure. • LEDs and or strobes do not function during RPM POST or a known fault condition. • Audible siren does not function during RPM POST or a known fault condition. • LEDs and or strobes on constantly when no alarm or fault is indicated in the CAS or on the SC-770.	**6.1 Local Indications (on RPM)**
• AM-270 lights/audible do not function during RPM POST or a known alarm or fault condition.	**6.2 Remote Indications (AM-270)**

6.1 Local Alarm/Fault Indication



Local Alarm/Fault Indication Troubleshooting Notes:	
6.1.1	Restart RPM by turning the LD-260 “ON/OFF” switch “OFF” then back “ON”. Watch the local alarm indications during startup, the RPM will perform a “Power On Self-Test” (POST) and all lights and sirens on the control pillar (and Remote Alarm Panel if installed) should function for a brief period of time. Once the POST is complete, the RPM will collect an initial background. Once this is complete, verify there are no alarms or faults indicated on the SC-770 controller.
6.1.2	Observe the local alarm indications on the exterior of the control pillar: a. If the local alarm/fault indication in question is constantly on, proceed to step 6.1.3. b. If the local alarm/fault indication in question is not constantly on, proceed to step 6.1.7.
6.1.3	Disconnect the J1 connector on the General Purpose Relay Board (GPRB). The J1 connector contains the input wires for activating the GPRB relays. Proceed to step 6.1.4. 
6.1.4	Assess results of step 6.1.3: a. If the alarm/fault indication continues to function when no signal to generate a fault indication is present, proceed to step 6.1.5. b. If the alarm/fault indication stops, proceed to step 6.1.6.
6.1.5	Replace the GPRB by performing DET-RPM-RAP-CM24, *RPM GPRB-756 General Purpose Relay Board Replacement.*
6.1.6	Replace the SC-771/Rabbit board assembly per DET-RPM-RAP-CM09, RPM SC-771 Controller Board Replacement.
6.1.7	Verify the RELAY OUTPUT parameter setting in the SC-770 controller is ON (2). a. If the RELAY OUTPUT parameter setting in the SC-770 controller is not set to ON (2), proceed to step 6.1.8. b. If the RELAY OUTPUT parameter setting in the SC-770 controller is set to ON (2), proceed to step 6.1.9.
6.1.8	Set the RELAY OUTPUT parameter setting in the SC-770 controller to ON (2). Exit the SC-770 programming mode. Restart RPM. Proceed to step 6.1.9.
6.1.9	You should be at this point because an external alarm or fault indication is not functioning on the RPM control pillar when a known alarm or fault condition exists (GA, NA, GH, GL, NH, TAMPER). Next: a. Generate the alarm/fault condition in question per the RPM Operational Testing Procedure DET-RPM-RAP-RM03, *RPM Operational Testing* Procedure. b. Verify that the alarm/fault condition is indicated on the SC-770 controller display.
6.1.10	Assess the results of step 6.1.9: a. If the alarm/fault indication in question is now functioning properly troubleshooting is complete. b. If the alarm/fault indication in question is still not functioning properly, proceed to step 6.1.11.

Local Alarm/Fault Indication Troubleshooting Notes:		
6.1.11	Measure the voltages at the GPRB relay output connector J2 during POST. • Gamma alarm (red strobe and speaker): J2 Pin 1 (brown wire). • Neutron alarm (blue strobe and speaker): J2 Pin 4 (blue wire). • Fault (amber LED): J2 pin 7 (orange wire). During POST, these pins should have a voltage of ~0.0 VDC. After POST and with no alarms or faults, the pins should have a voltage of ~12 VDC. 1. If the relay output voltages are correct, proceed to step 6.1.12. 2. If the relay output voltages are NOT correct, proceed to step 6.1.13.	
6.1.12	Measure the voltages on the GPRB input that activates the alarm/fault relays (connector J1). • Gamma alarm (red strobe and speaker): J1 Pin 1 (brown wire). • Neutron alarm (blue strobe and speaker): J1 Pin 2 (blue wire). • Fault (amber LED): J1 Pin 3 (white wire) During a POST or alarm/fault condition, GPRB J1 Pins 1, 2, and 3 should read ~3.5 VDC. If no alarm or fault is indicated on the SC-770 controller display, GPRB J1 Pins 1, 2, and 3 should read ~0.0 VDC. 1. If the relay input voltages are correct, proceed to step 6.1.5. 2. If the relay input voltages are NOT correct, proceed to step 6.1.6.	
6.1.13	If the GPRB output voltages are correct for operating the alarm/fault indication in question, troubleshoot the wiring and individual components associated with that indication. Simplified block diagrams and full schematics are available in the Drawings section of this Guide.	

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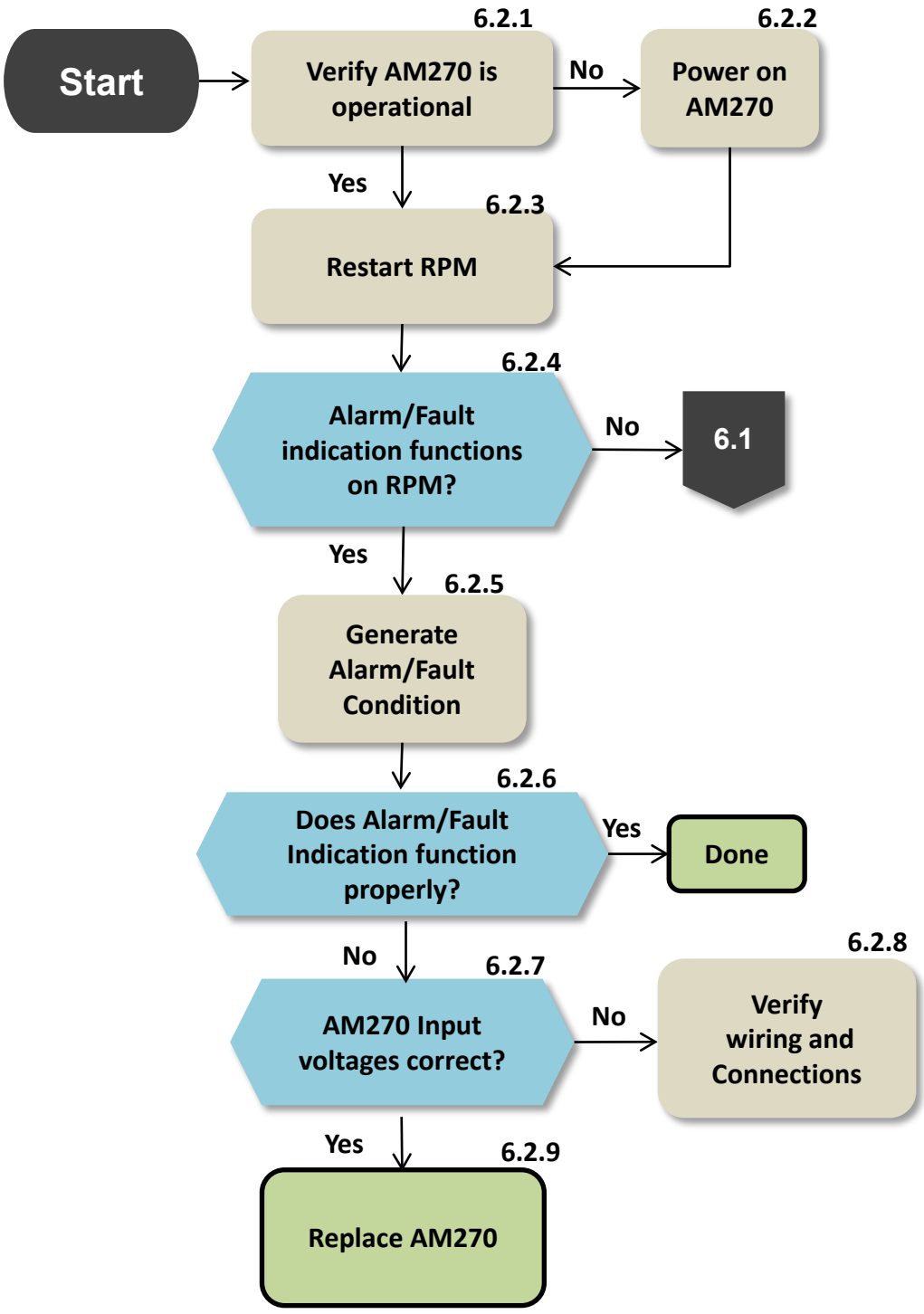
6.2
Remote Indications



Remote Alarm Panel Alarm/Fault Indication Troubleshooting Notes	
6.2.1	Verify AM270 is operational; • The green “power” LED on the front panel will be illuminated to indicate that the battery is charged and connected, and the power switch is in the on position. • The “ready” LED shows that the system is clear of alarms/faults and working properly. • Press the AM-270 “TEST” button; this will cause all the alarm/fault LEDs to flash. If the key switch is in the “normal” position, it will also cause the audible alarm to sound.

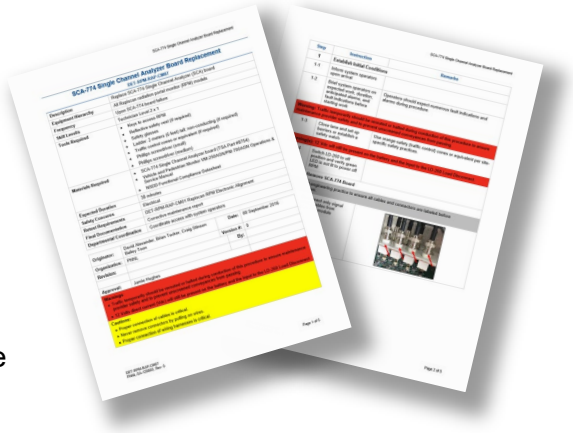
6.2.2	If the green “power” LED on the front panel is NOT illuminated:
	• Open AM-270 and verify toggle switch on the internal circuit board is in “ON” position. This switch must be turned on (away from the connector edge of the board),
	• Verify that there is 120/240 VAC supplied to unit,
	• Verify battery is charged and connected,
	  ○ Open the front panel and disconnect the positive lead to the battery. Measure the voltage, across the battery with a meter; it should be at least 12.4 volts. If the voltage is low or not present then the battery must be charged or replaced.
	  ○ To check the charger, disconnect the positive terminal from the battery and J1 from the AM-255A circuit board. Measure the voltage from between the black and red battery wires; it should be at least 13.5 volts. If it is not then the charger must be replaced.

6.2.3	Restart RPM by turning the LD-260 “ON/OFF” switch “OFF” then back “ON”. Watch the local and remote alarm/fault indications during startup, the RPM will perform a “Power On Self-Test” (POST) and all lights and sirens on the control pillar and Remote Alarm Panel should function for a brief period of time. Once the POST is complete, the RPM will collect an initial background. Once this is complete, verify there are no alarms or faults indicated on the SC-770 controller. Proceed to step 6.2.4.
6.2.4	Observe the local alarm indications on the exterior of the control pillar: a. If the local alarm/fault indication in question functions on the RPM, proceed to step 6.2.5. b. If the local alarm/fault indication in question did not function on the RPM, proceed to step 6.1 in the Local Alarm/Fault Indication sub-section.
6.2.5	You should be at this point because an alarm or fault indication is functioning on the RPM control pillar (external) but not functioning on the remote alarm panel when a known alarm or fault condition exists (GA, NA, GH, GL, NH, TAMPER). Next: a. Generate the alarm/fault condition in question per the RPM Operational Testing Procedure DET-RPM-RAP-RM03, *RPM Operational Testing Procedure*. b. Verify that the alarm/fault condition is indicated on the SC-770 controller display. c. Proceed to step 6.2.6.
6.2.6	After generating the alarm or fault condition in question in step 6.2.5, does the alarm or fault indication in question function on the AM270? a. If yes, troubleshooting is complete. a. If no, proceed to step 6.2.7.
6.2.7	Measure the signal input voltages to the AM270, on the main circuit board, J3 (or J4) during POST or in the presence of a known alarm or fault (as seen on the SC-770): **NOTE:** Each AM-270 will accept inputs from 2 separate RPMs. Verify which input is correct for the lane you are experiencing trouble with. The inputs connect to terminals labeled J3 and J4. • Gamma alarm (red strobe and speaker): J3 (J4) Pin 1 (brown wire). • Neutron alarm (blue strobe and speaker): J3 (J4) Pin 2 (red wire). • Fault (amber LED): J3 (J4) Pin 3 (orange wire).

Remote Alarm Panel Alarm/Fault Indication Troubleshooting Notes	
	1. If the voltages are correct, proceed to step 6.2.9. 2. If the voltages are NOT correct, proceed to step 6.2.8.
6.2.8	If the signal input voltages to the RAP/AM270 connector J3 (or J4) during POST or in the presence of a known alarm or fault (as seen on the SC-770) are NOT correct, verify the wiring between the RPM TB2 and TB3 (VM250), and the AM-270 J3 (J4) are correct.
6.2.9	If the signal input voltages to the AM-270 connector J3 (or J4) during POST or in the presence of a known alarm or fault (as seen on the SC-770) are correct, and assuming the AM-270 is functioning per step 6.2.1, Replace the AM-270 per DET-RPM-RAP-CM30, *RPM AM 270 Remote Alarm Panel Replacement*.

Corrective Maintenance Overview

Once a fault has been isolated through the troubleshooting process, corrections should be performed, and any defective components should be replaced by following the applicable corrective maintenance procedure.



The corrective maintenance procedures in this guide provide step-by-step instructions on how to repair or replace components. They also include safety precautions and specify any retest procedures that may be required to ensure the repaired/replaced component does not affect the proper operation of the equipment.

Retest and Documentation Requirements

Remember, the goal of an RPM is to detect the presence of radioactive materials on/in persons, vehicles, or cargo. Improper repair or maintenance of these systems will result in reduced performance and efficiency. Careful attention must be paid to post-maintenance retesting and reporting requirements.

Retest requirements for any corrective maintenance action are specified in the Retest Requirements section of the applicable corrective maintenance procedure.