DeviceNet™

ODVA

Plant Floor Troubleshooting Guide

PUB00147R0 MARCH 2006

The ODVA Automotive Special Interest Group (SIG) is pleased to offer this document as a tool for troubleshooting devices that have been implemented into a DeviceNet network as well as the DeviceNet network itself.

The following individuals have been invaluable in putting this document together:

Training Committee Members:

Matt Kuzel	Huron Networks
Borisa Begic	InterlinkBT
James O'Laughlin	SICK, Incorporated
Erick Rudaitis	SMC Corporation of America
Michael Giroux	WAGO Corporation

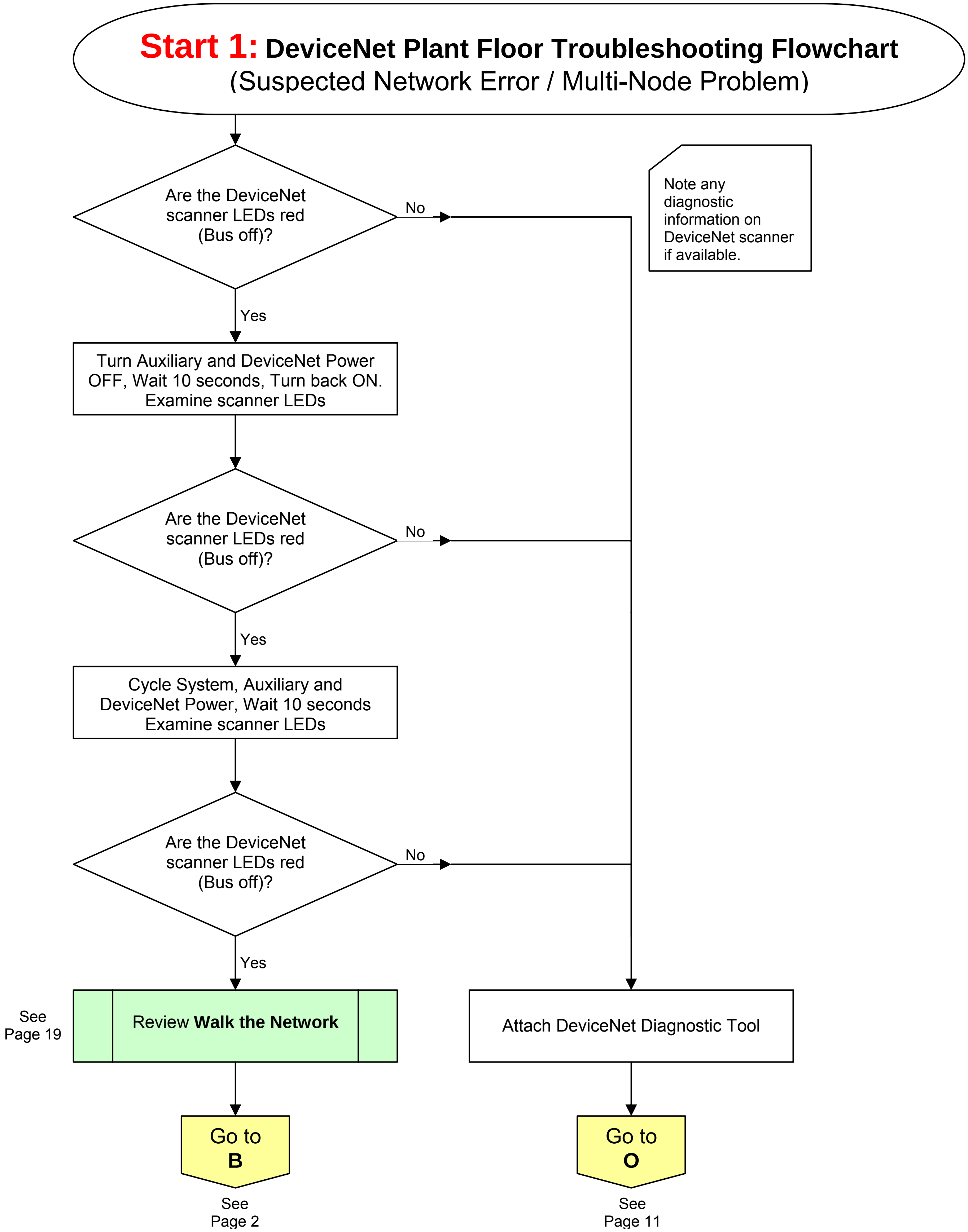
Automotive SIG Members:

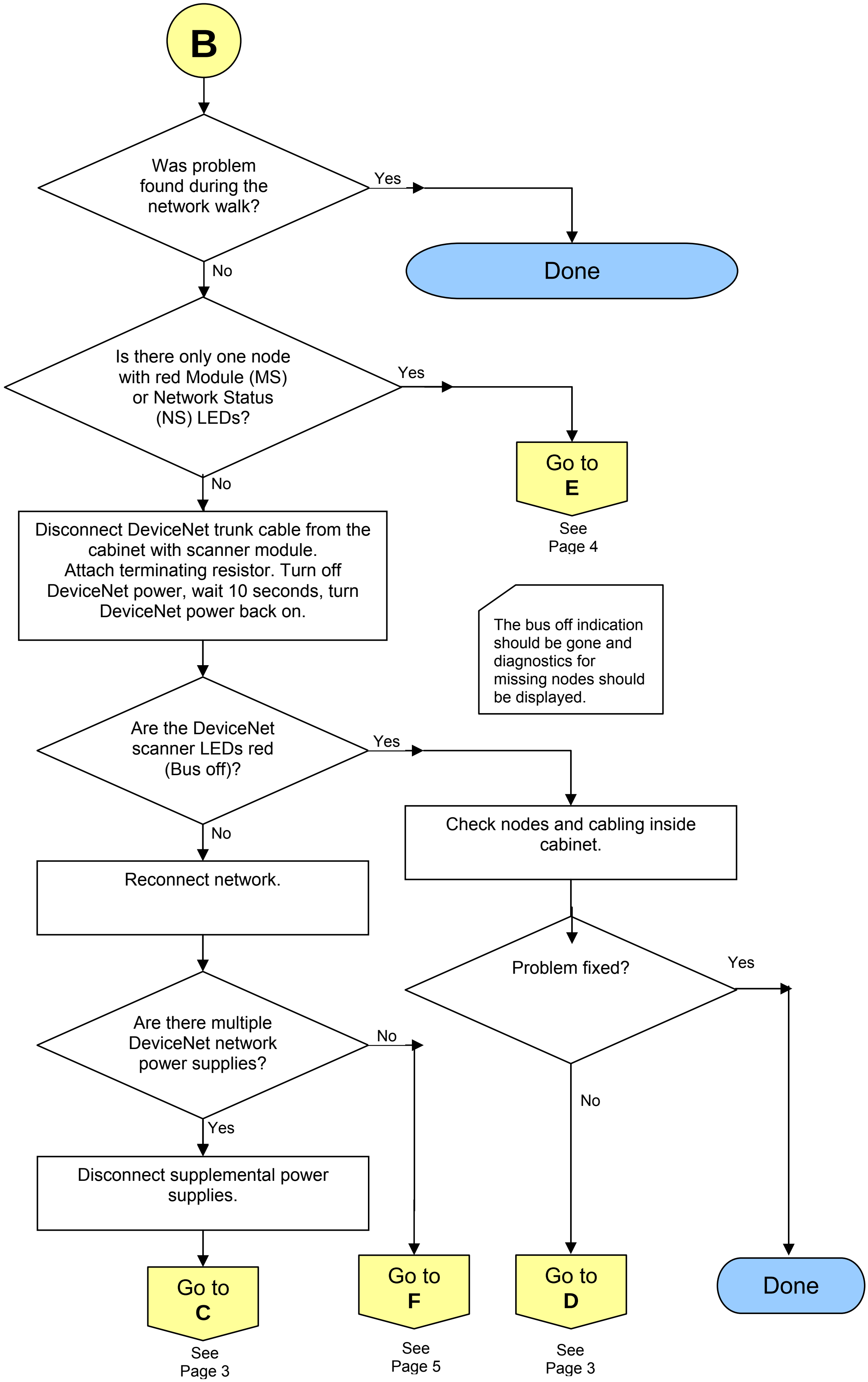
Erick Rudaitis, Chairperson	SMC Corporation of America
Marie Sandor, Administration	SMC Corporation of America
Thomas Dwyer	Bosch Rexroth
Greg Irwin	DaimlerChrysler
Gil Jones	EATON Corporation
Frank Latino	Festo
Matt Kuzel	Huron Networks
Borisa Begic	InterlinkBT LLC
Gary Workman	General Motors
Enrico DeCarolis	Numatics, Inc.
Anton Suarez	OMRON Corporation
Dave VanGompel	Rockwell Automation
James O'Laughlin	SICK, Incorporated
Ed Ingraham	Siemens
Mike Johnson	SOLA / Hevi Duty
Michael Giroux	WAGO Corporation
Chuck Sammut	Woodhead

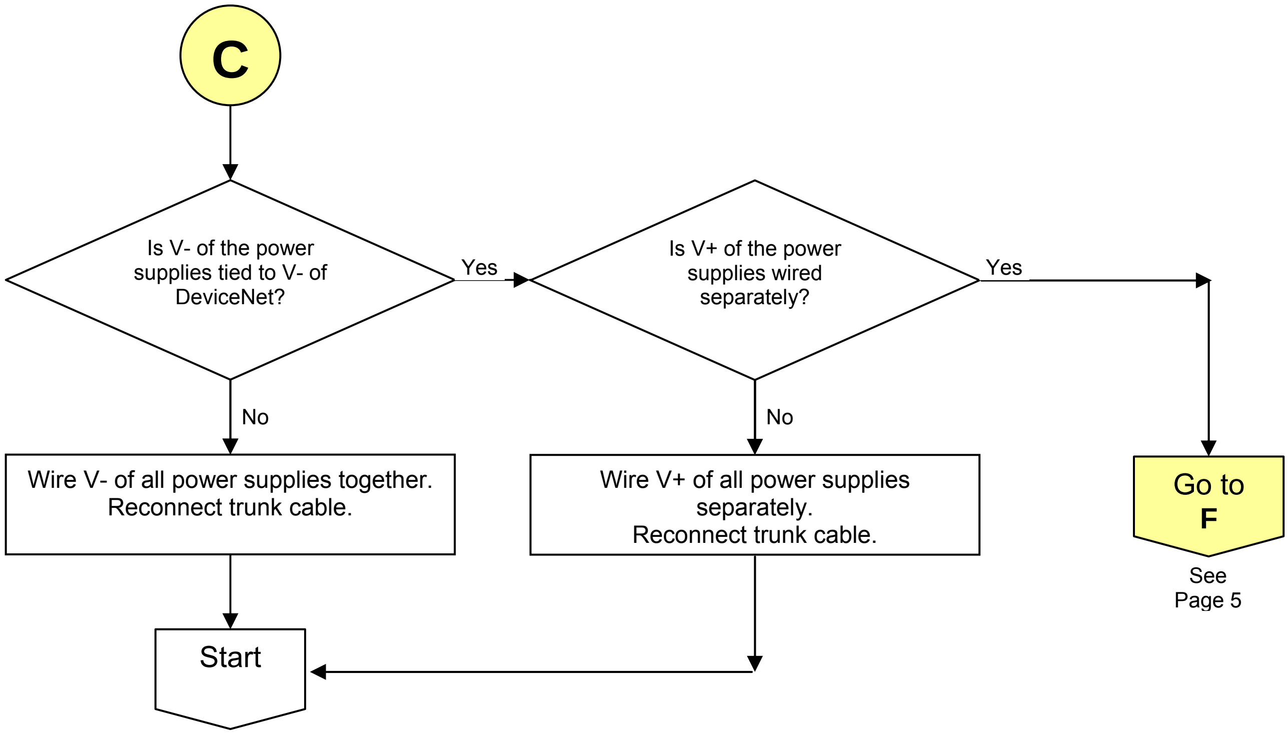
For more information regarding the ODVA, including the Automotive SIG, please refer to the ODVA website at:

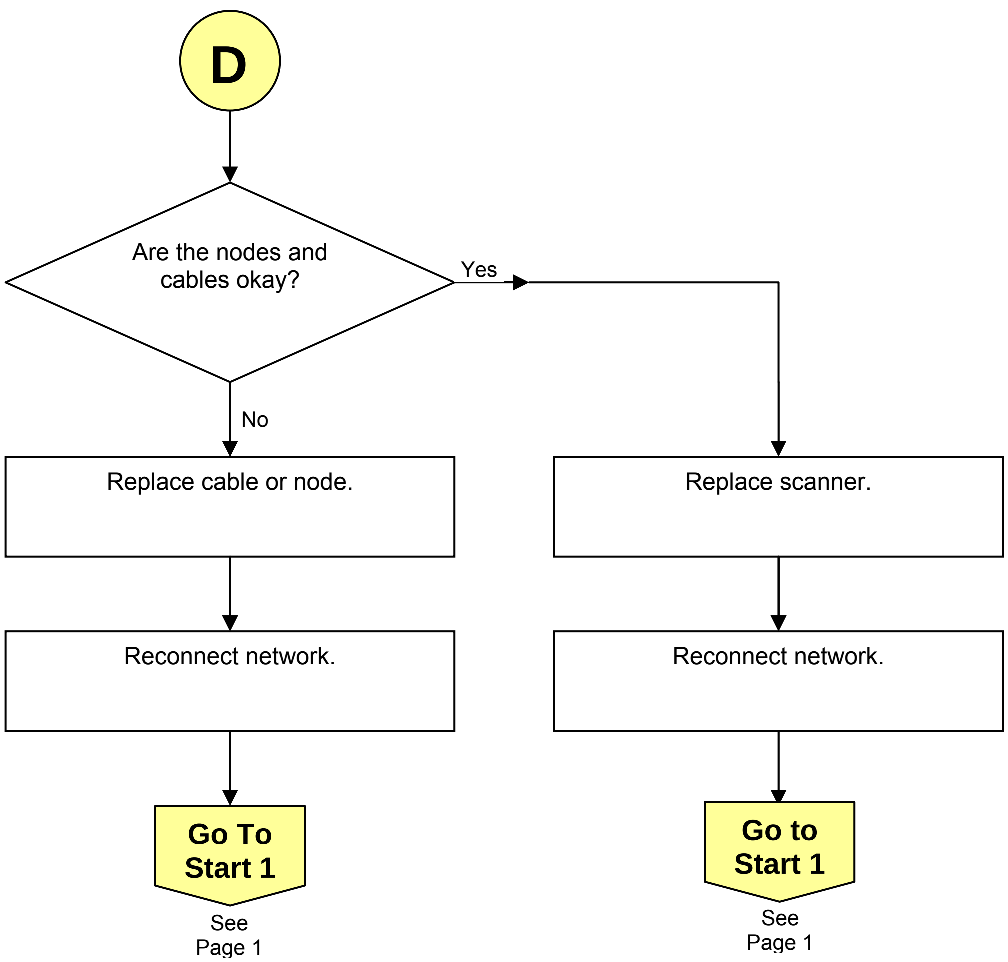
www.odva.org

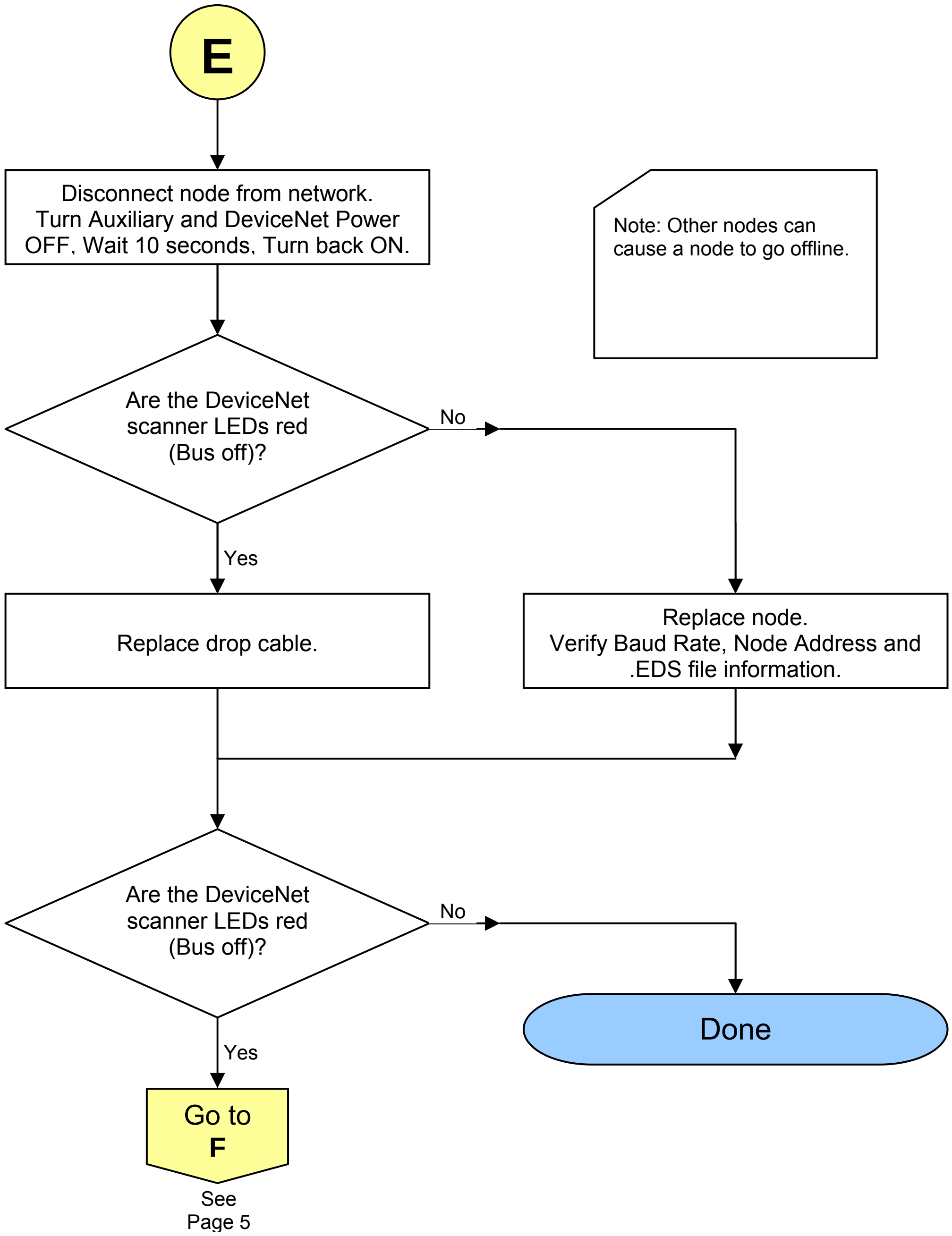
Plant Floor Troubleshooting Guide


Start 1: DeviceNet Plant Floor Troubleshooting Flowchart
(Suspected Network Error / Multi-Node Problem)
Are the DeviceNet scanner LEDs red (Bus off)?
No
Note any diagnostic information on DeviceNet scanner if available.
Yes
Turn Auxiliary and DeviceNet Power OFF, Wait 10 seconds, Turn back ON. Examine scanner LEDs
Are the DeviceNet scanner LEDs red (Bus off)?
No
Yes
Cycle System, Auxiliary and DeviceNet Power, Wait 10 seconds Examine scanner LEDs
Are the DeviceNet scanner LEDs red (Bus off)?
No
Yes
See Page 19
Review Walk the Network
Attach DeviceNet Diagnostic Tool
Go to B
See Page 2
Go to O
See Page 11

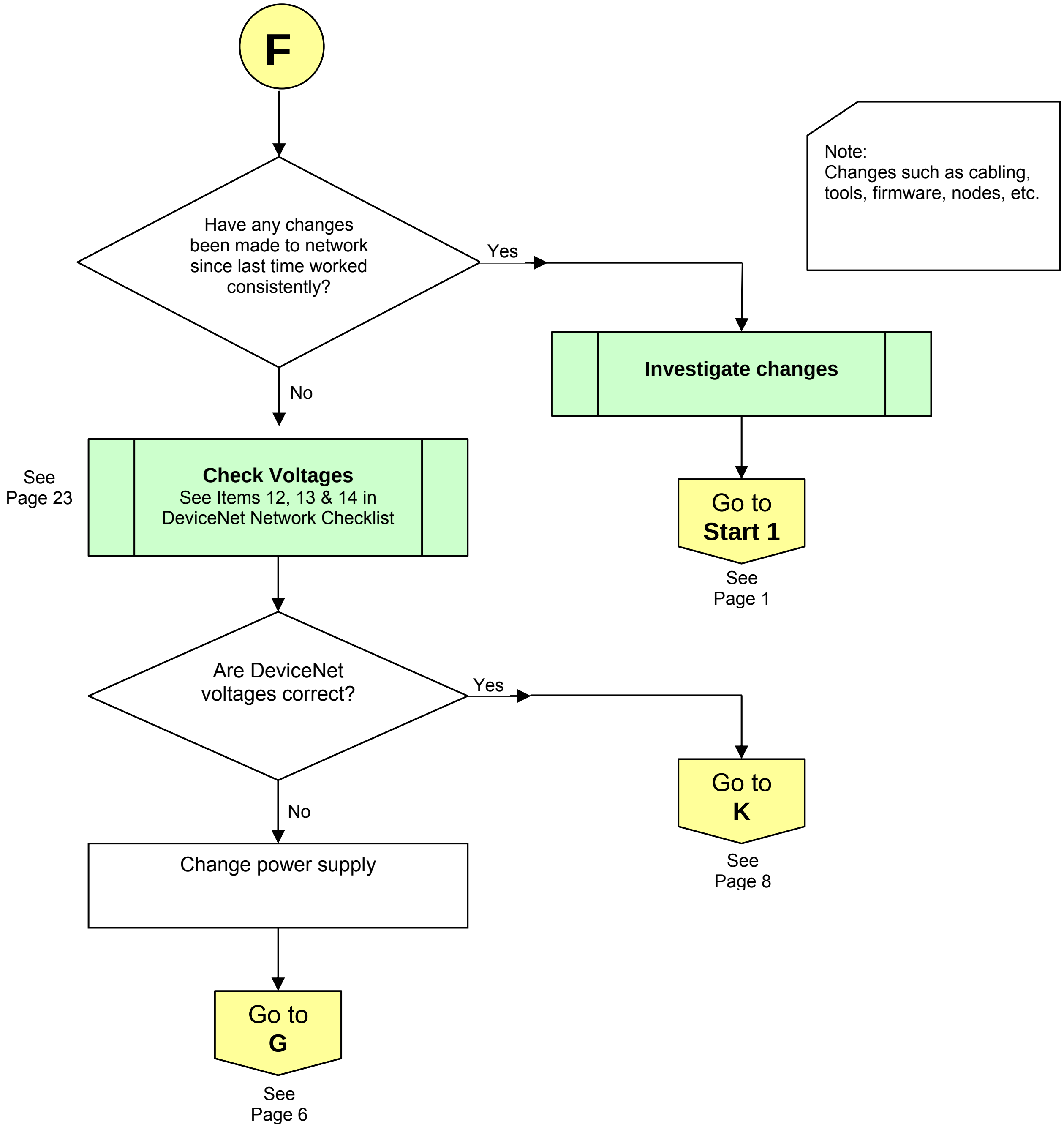

B
Was problem found during the network walk?
Yes
No
Done
Is there only one node with red Module (MS) or Network Status (NS) LEDs?
Yes
No
Go to E
See Page 4
Disconnect DeviceNet trunk cable from the cabinet with scanner module. Attach terminating resistor. Turn off DeviceNet power, wait 10 seconds, turn DeviceNet power back on.
The bus off indication should be gone and diagnostics for missing nodes should be displayed.
Are the DeviceNet scanner LEDs red (Bus off)?
Yes
No
Check nodes and cabling inside cabinet.
Reconnect network.
Problem fixed?
Yes
No
Are there multiple DeviceNet network power supplies?
No
Yes
Disconnect supplemental power supplies.
Go to C
See Page 3
Go to F
See Page 5
Go to D
See Page 3
Done

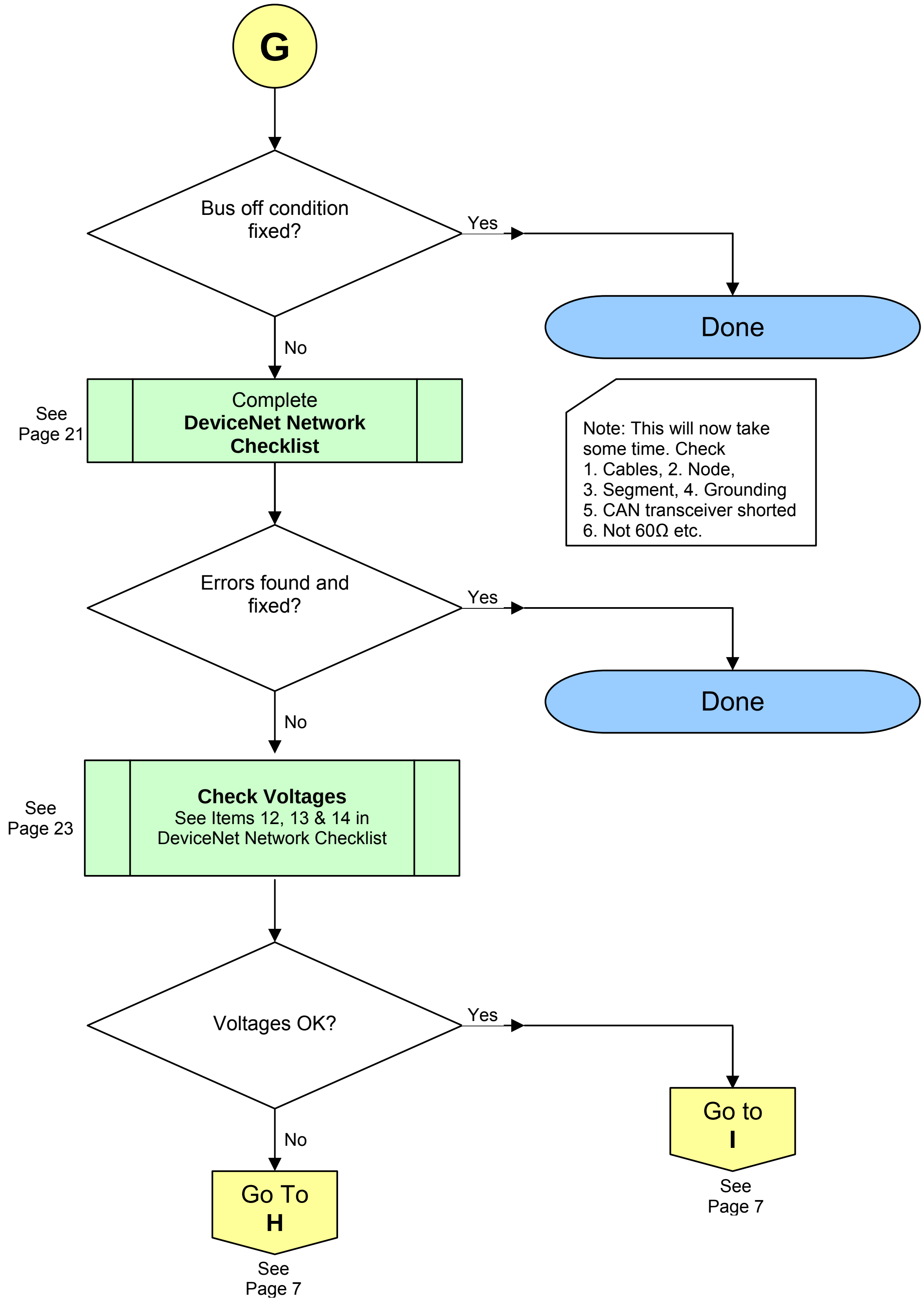

C
Is V- of the power supplies tied to V- of DeviceNet?
Yes
No
Is V+ of the power supplies wired separately?
Yes
No
Wire V- of all power supplies together. Reconnect trunk cable.
Wire V+ of all power supplies separately. Reconnect trunk cable.
Go to F
See Page 5
Start

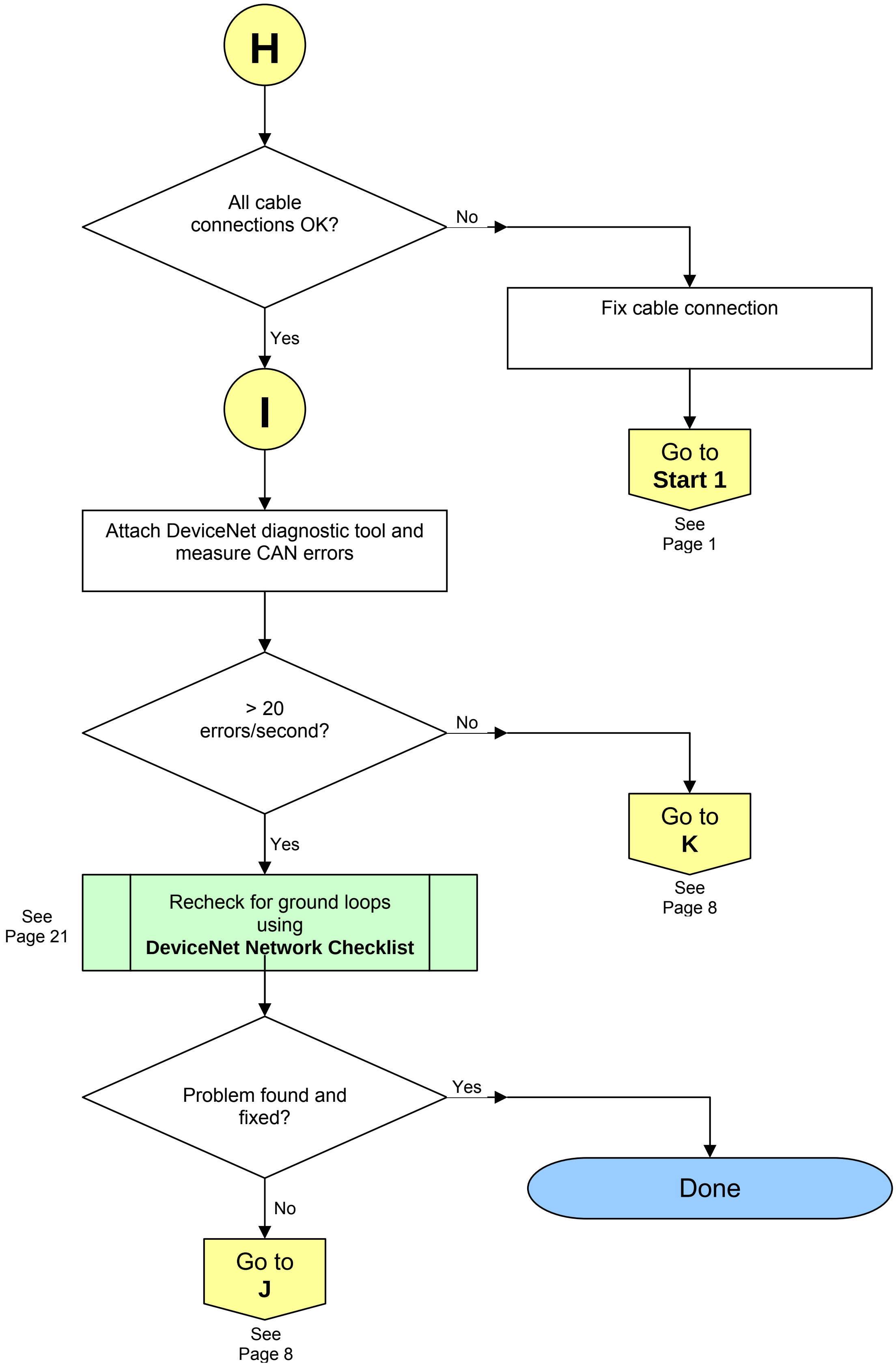

D
Are the nodes and cables okay?
Yes
No
Replace cable or node.
Replace scanner.
Reconnect network.
Reconnect network.
Go To Start 1
See Page 1
Go to Start 1
See Page 1

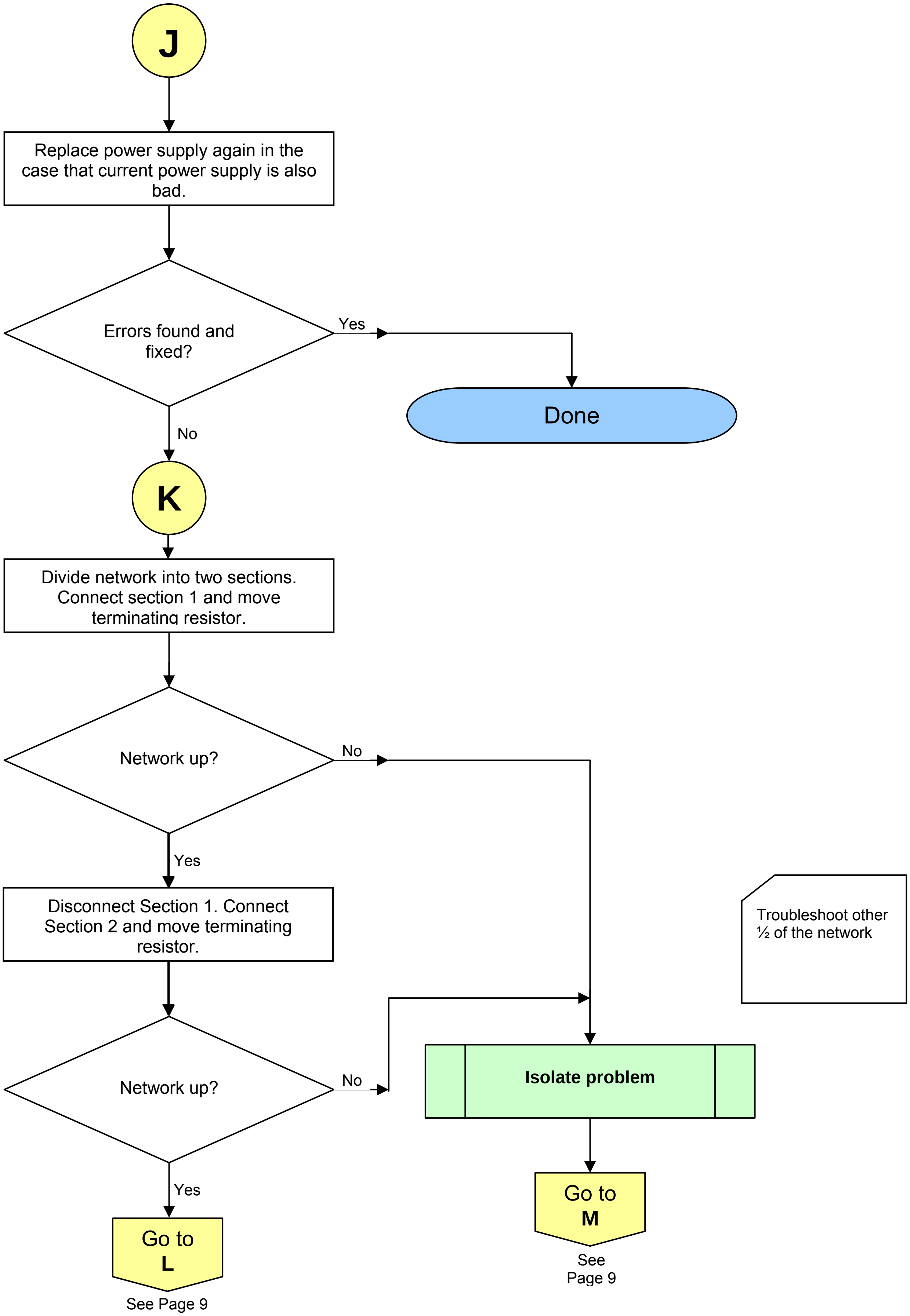


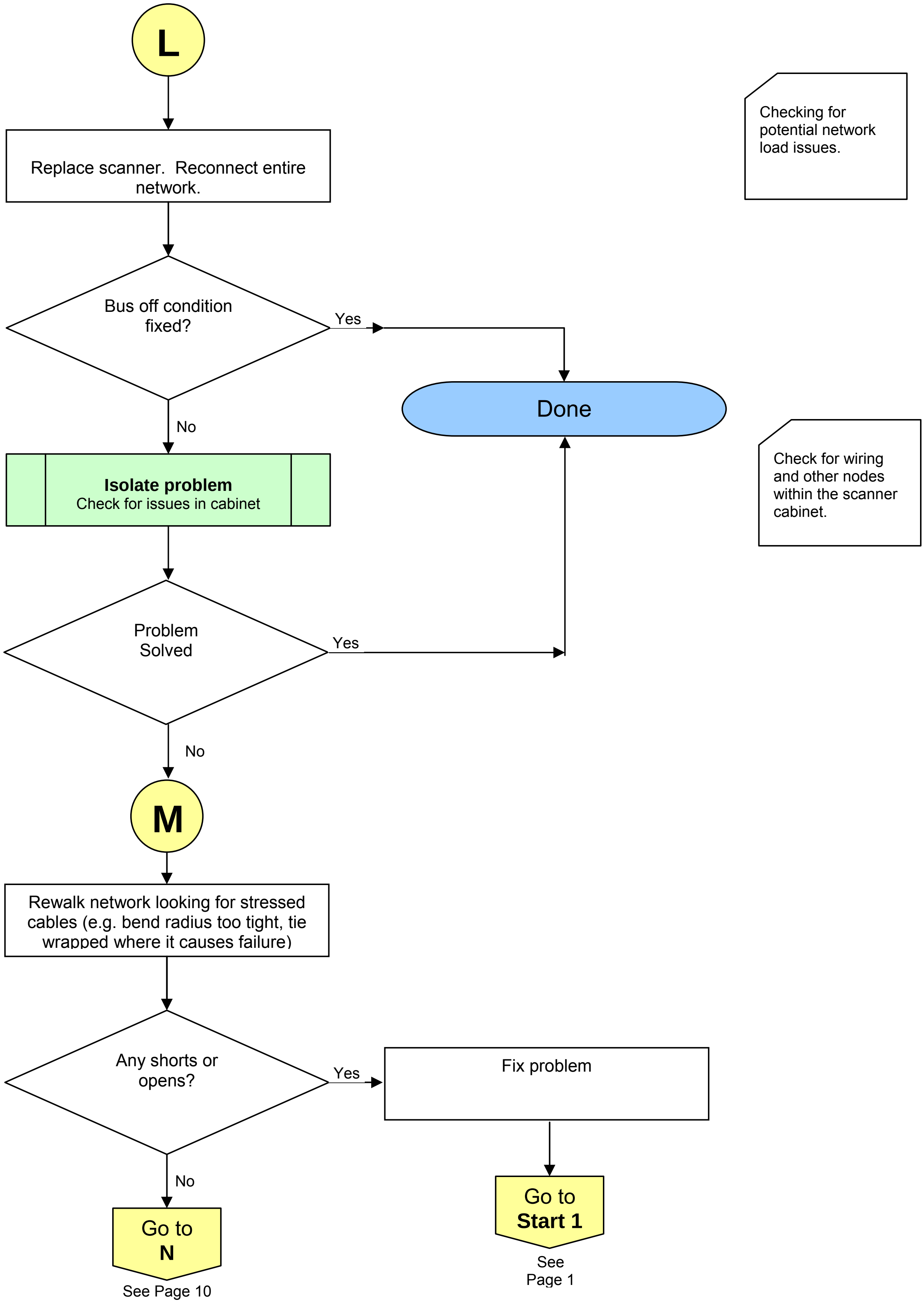
E
Disconnect node from network.
Turn Auxiliary and DeviceNet Power
OFF, Wait 10 seconds, Turn back ON.
Note: Other nodes can
cause a node to go offline.
Are the DeviceNet
scanner LEDs red
(Bus off)?
No
Yes
Replace drop cable.
Replace node.
Verify Baud Rate, Node Address and
.EDS file information.
Are the DeviceNet
scanner LEDs red
(Bus off)?
No
Yes
Done
Go to
F
See
Page 5

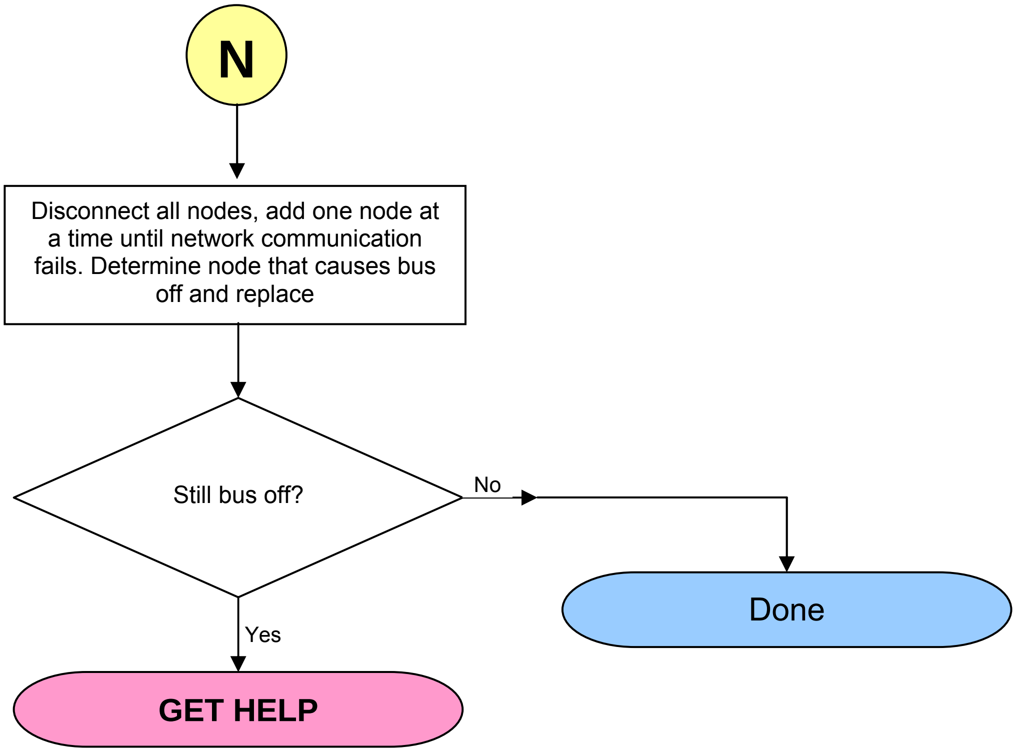

F
Have any changes been made to network since last time worked consistently?
Yes
No
Note:
Changes such as cabling, tools, firmware, nodes, etc.
Investigate changes
Go to
Start 1
See
Page 1
See
Page 23
Check Voltages
See Items 12, 13 & 14 in
DeviceNet Network Checklist
Are DeviceNet voltages correct?
Yes
No
Go to
K
See
Page 8
Change power supply
Go to
G
See
Page 6

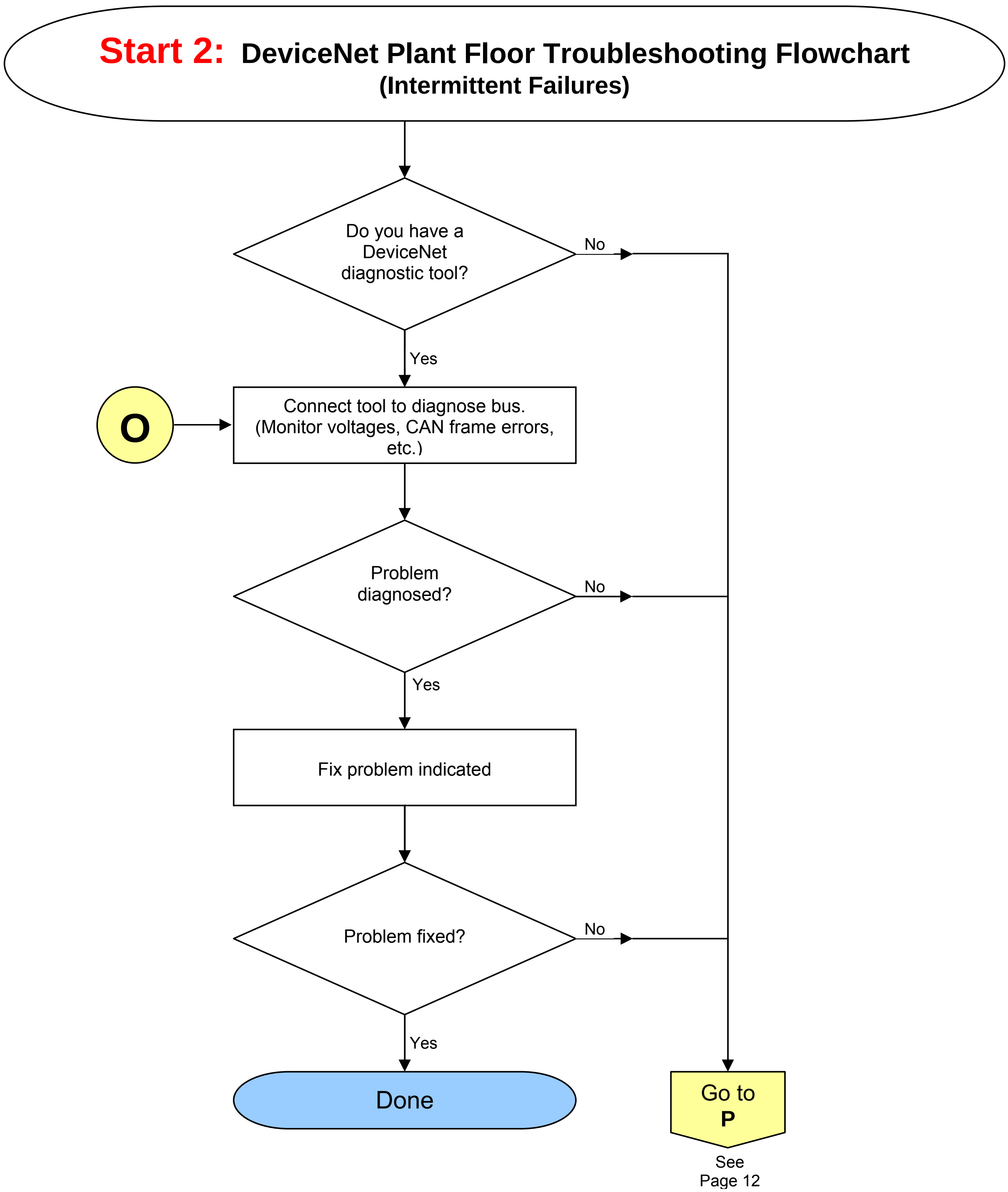

G
Bus off condition fixed?
Yes
Done
No
See Page 21
Complete
DeviceNet Network Checklist
Note: This will now take some time. Check
1. Cables, 2. Node,
3. Segment, 4. Grounding
5. CAN transceiver shorted
6. Not 60Ω etc.
Errors found and fixed?
Yes
Done
No
See Page 23
Check Voltages
See Items 12, 13 & 14 in DeviceNet Network Checklist
Voltages OK?
Yes
Go to I
See Page 7
No
Go To H
See Page 7

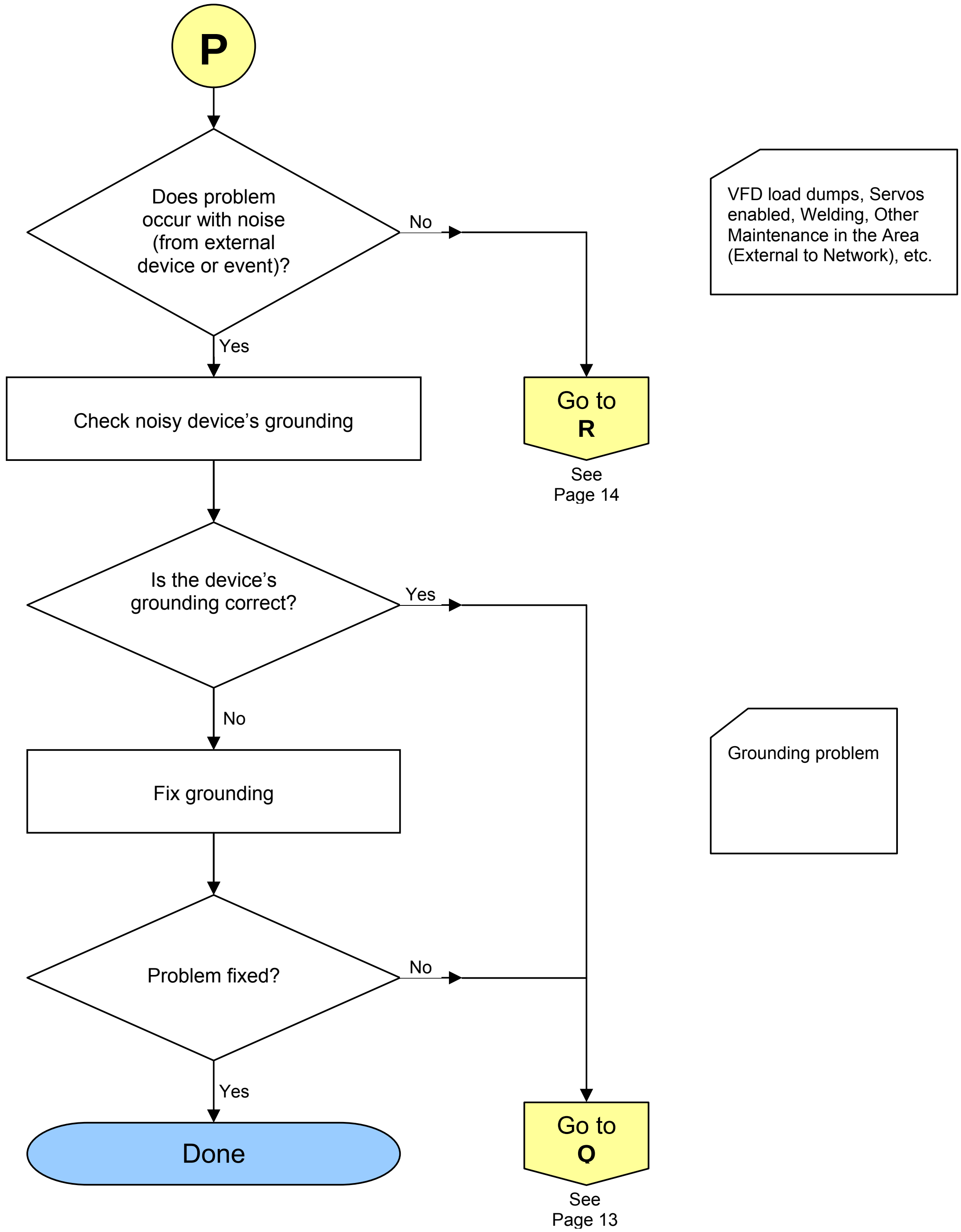

H
All cable connections OK?
No
Fix cable connection
Go to
Start 1
See Page 1
Yes
I
Attach DeviceNet diagnostic tool and measure CAN errors
> 20 errors/second?
No
Go to
K
See Page 8
Yes
See Page 21
Recheck for ground loops using
DeviceNet Network Checklist
Problem found and fixed?
Yes
Done
No
Go to
J
See Page 8

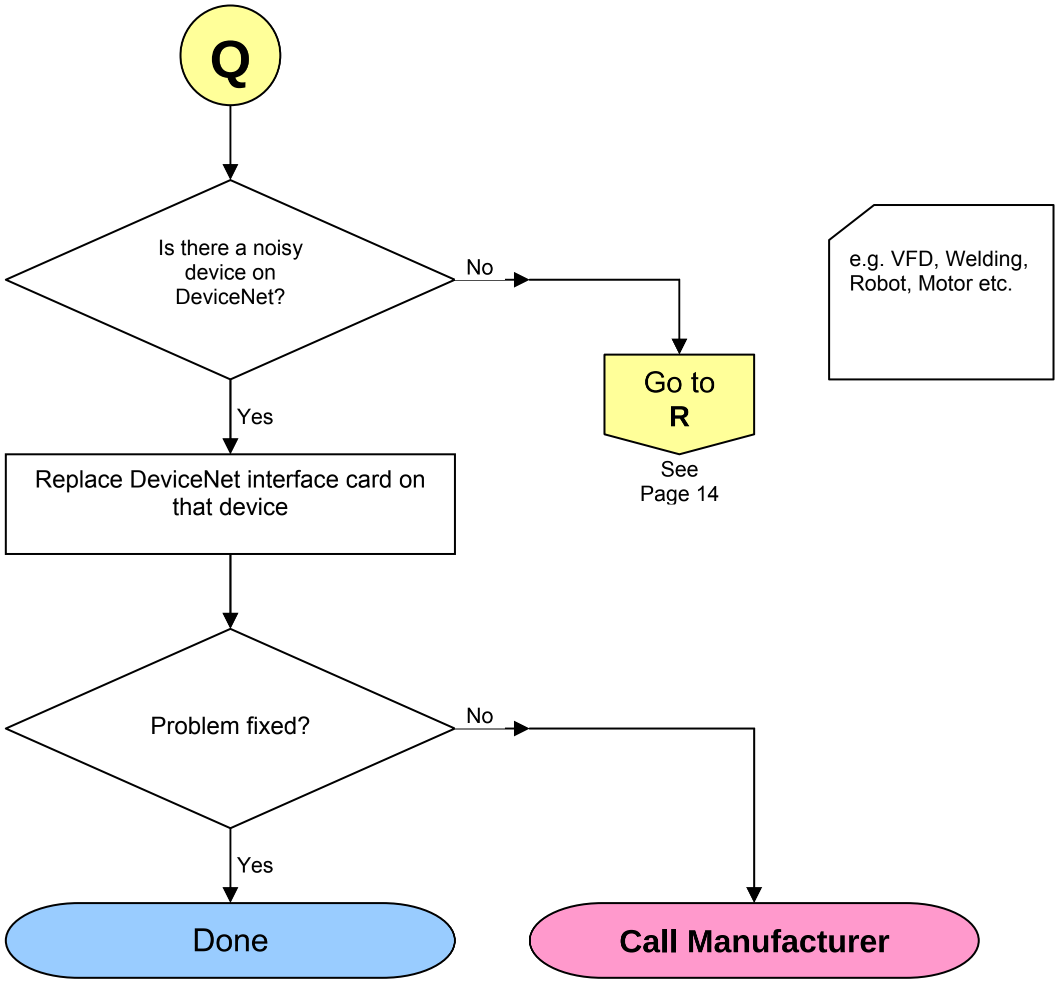

J
Replace power supply again in the case that current power supply is also bad.
Errors found and fixed?
Yes
Done
No
K
Divide network into two sections. Connect section 1 and move terminating resistor.
Network up?
No
Yes
Disconnect Section 1. Connect Section 2 and move terminating resistor.
Troubleshoot other ½ of the network
Network up?
No
Isolate problem
Yes
Go to M
See Page 9
Go to L
See Page 9

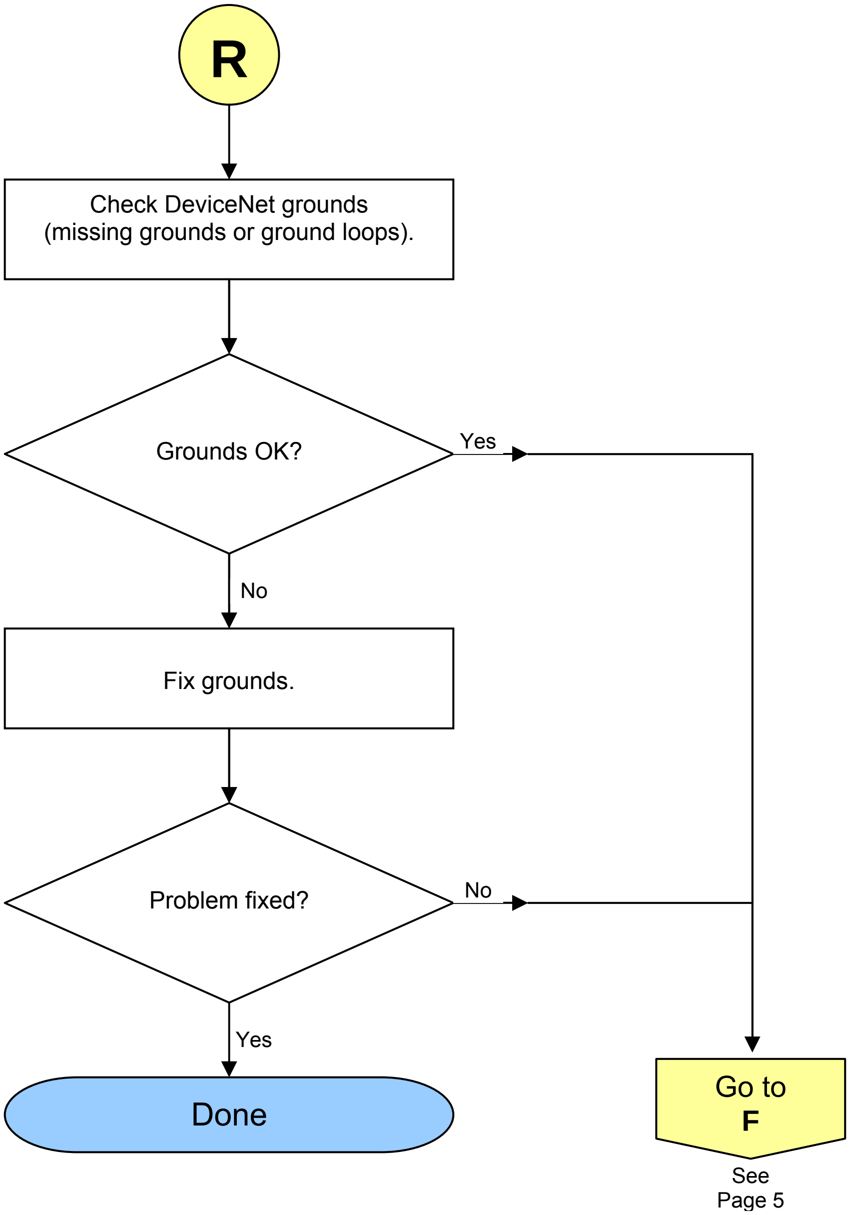

L
Replace scanner. Reconnect entire network.
Bus off condition fixed?
Yes
No
Done
Isolate problem
Check for issues in cabinet
Problem Solved
Yes
No
M
Rewalk network looking for stressed cables (e.g. bend radius too tight, tie wrapped where it causes failure)
Any shorts or opens?
Yes
Fix problem
No
Go to N
See Page 10
Go to Start 1
See Page 1
Checking for potential network load issues.
Check for wiring and other nodes within the scanner cabinet.

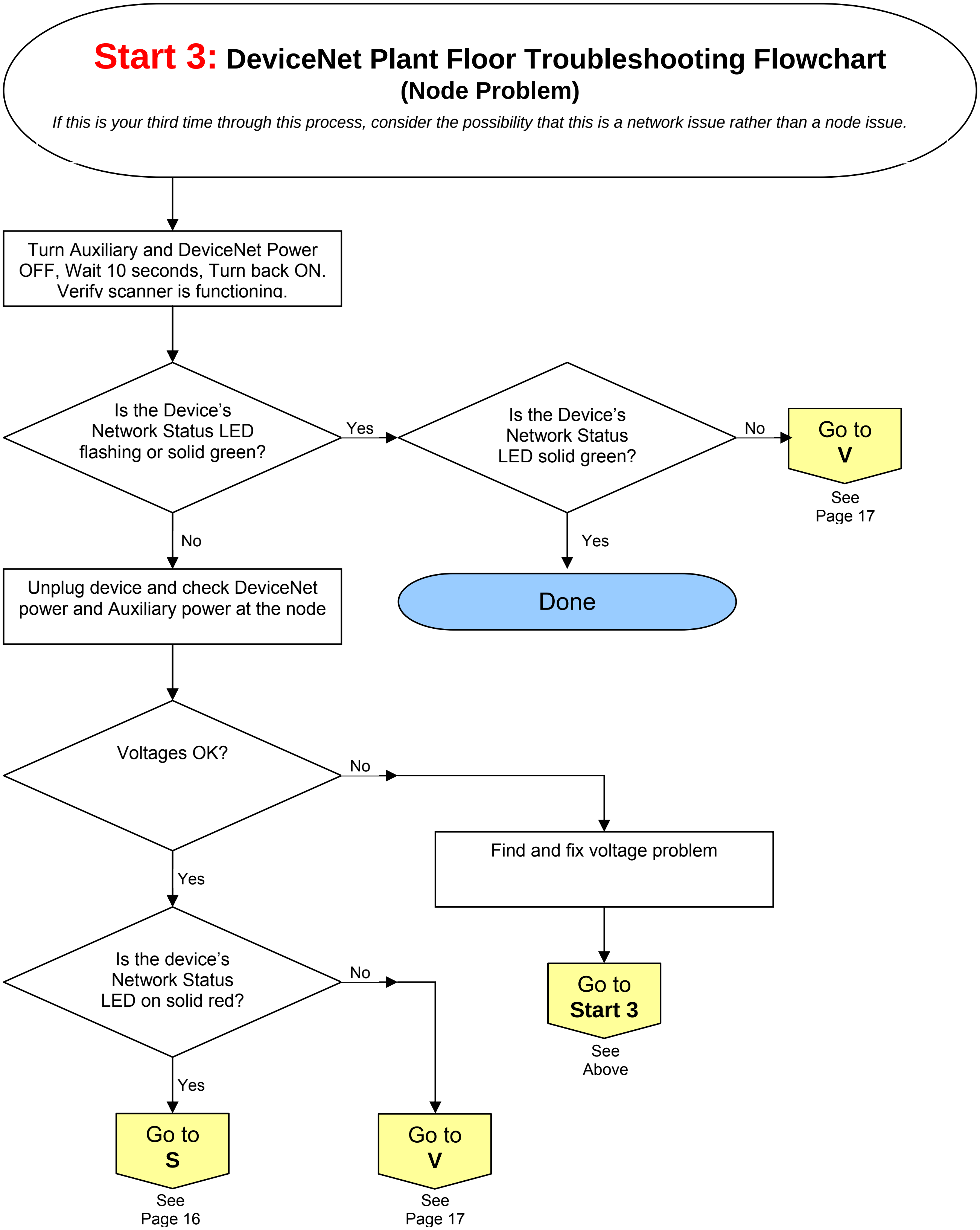

N
Disconnect all nodes, add one node at a time until network communication fails. Determine node that causes bus off and replace
Still bus off?
No
Done
Yes
GET HELP

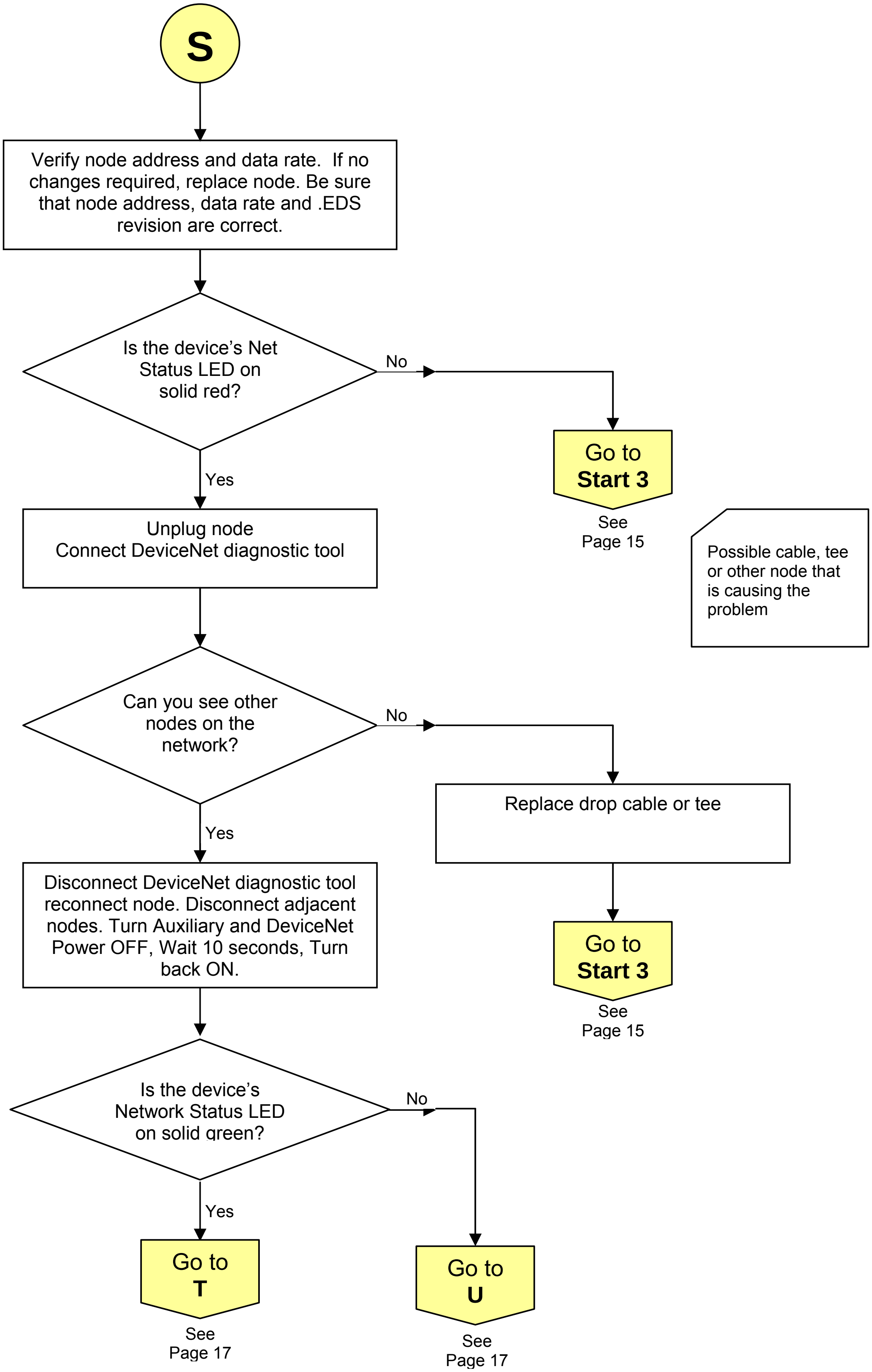

Start 2: DeviceNet Plant Floor Troubleshooting Flowchart
(Intermittent Failures)
Do you have a DeviceNet diagnostic tool?
No
Yes
O
Connect tool to diagnose bus. (Monitor voltages, CAN frame errors, etc.)
Problem diagnosed?
No
Yes
Fix problem indicated
Problem fixed?
No
Yes
Done
Go to P
See Page 12

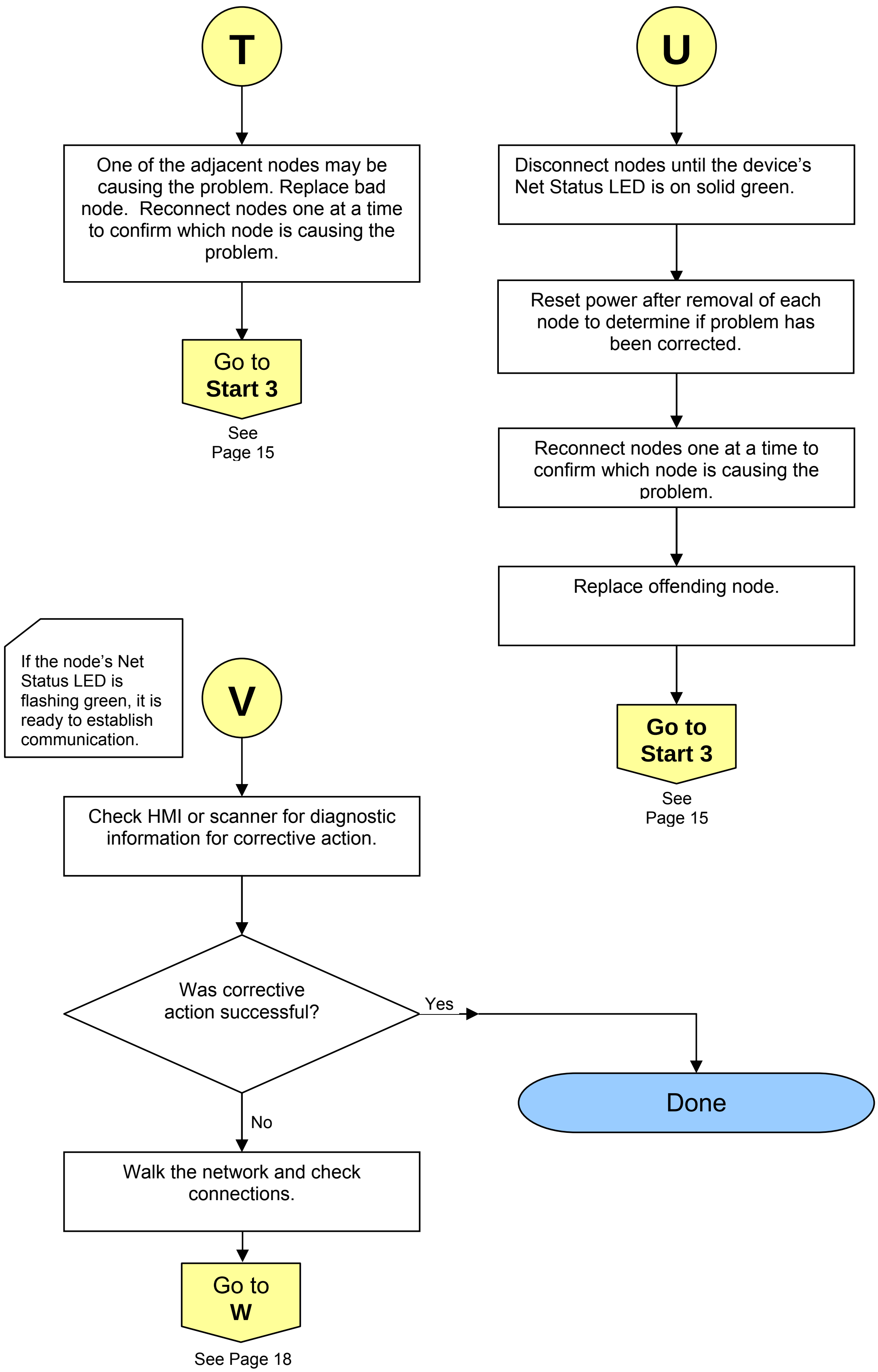

P
Does problem occur with noise (from external device or event)?
No
Yes
Check noisy device's grounding
Go to R
See Page 14
VFD load dumps, Servos enabled, Welding, Other Maintenance in the Area (External to Network), etc.
Is the device's grounding correct?
Yes
No
Fix grounding
Grounding problem
Problem fixed?
No
Yes
Done
Go to Q
See Page 13

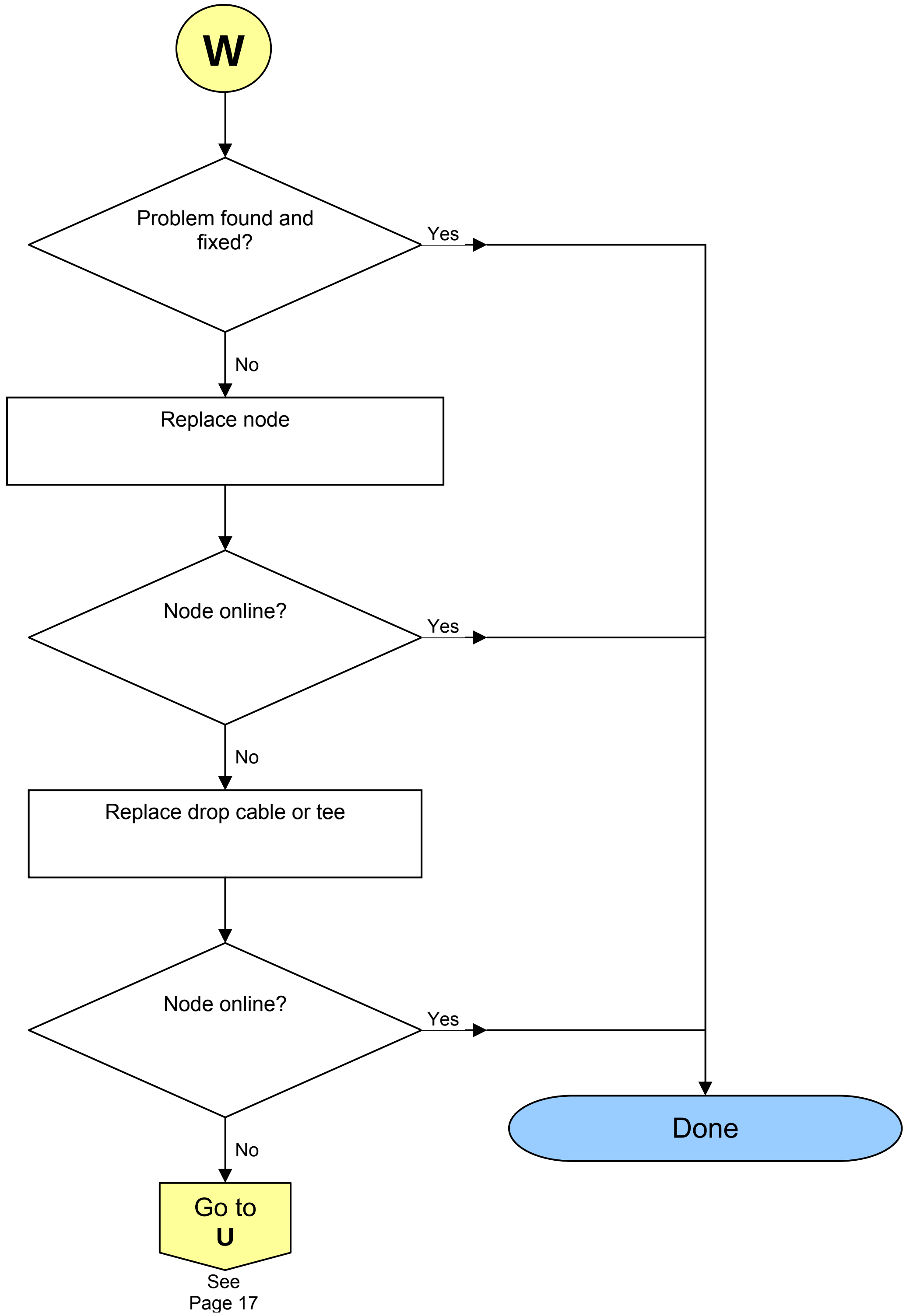

Q
Is there a noisy device on DeviceNet?
No
Go to R
See Page 14
e.g. VFD, Welding, Robot, Motor etc.
Yes
Replace DeviceNet interface card on that device
Problem fixed?
No
Yes
Done
Call Manufacturer


R
Check DeviceNet grounds
(missing grounds or ground loops).
Grounds OK?
Yes
No
Fix grounds.
Problem fixed?
No
Yes
Done
Go to
F
See
Page 5


Start 3: DeviceNet Plant Floor Troubleshooting Flowchart
(Node Problem)
If this is your third time through this process, consider the possibility that this is a network issue rather than a node issue.
Turn Auxiliary and DeviceNet Power OFF, Wait 10 seconds, Turn back ON. Verify scanner is functioning.
Is the Device's Network Status LED flashing or solid green?
Yes
Is the Device's Network Status LED solid green?
No
Go to V
See Page 17
Yes
Done
No
Unplug device and check DeviceNet power and Auxiliary power at the node
Voltages OK?
No
Find and fix voltage problem
Go to Start 3
See Above
Yes
Is the device's Network Status LED on solid red?
No
Yes
Go to S
See Page 16
Go to V
See Page 17


S
Verify node address and data rate. If no changes required, replace node. Be sure that node address, data rate and .EDS revision are correct.
Is the device's Net Status LED on solid red?
No
Go to Start 3
See Page 15
Yes
Unplug node
Connect DeviceNet diagnostic tool
Possible cable, tee or other node that is causing the problem
Can you see other nodes on the network?
No
Replace drop cable or tee
Go to Start 3
See Page 15
Yes
Disconnect DeviceNet diagnostic tool reconnect node. Disconnect adjacent nodes. Turn Auxiliary and DeviceNet Power OFF, Wait 10 seconds, Turn back ON.
Is the device's Network Status LED on solid green?
No
Yes
Go to T
See Page 17
Go to U
See Page 17


T
One of the adjacent nodes may be causing the problem. Replace bad node. Reconnect nodes one at a time to confirm which node is causing the problem.
Go to Start 3
See Page 15
U
Disconnect nodes until the device's Net Status LED is on solid green.
Reset power after removal of each node to determine if problem has been corrected.
Reconnect nodes one at a time to confirm which node is causing the problem.
Replace offending node.
Go to Start 3
See Page 15
If the node's Net Status LED is flashing green, it is ready to establish communication.
V
Check HMI or scanner for diagnostic information for corrective action.
Was corrective action successful?
Yes
Done
No
Walk the network and check connections.
Go to W
See Page 18


W
Problem found and fixed?
Yes
No
Replace node
Node online?
Yes
No
Replace drop cable or tee
Node online?
Yes
No
Done
Go to U
See Page 17

“Walking” the Network

Here are the things to keep in mind and look for when walking a network.

First try to look at a drawing or layout of the network so you know where the cables go and if the lengths are correct. Sometimes this is not possible but look around in the controller cabinet for this information. Also remember that Auxiliary Power topology and implementation is just as important as DeviceNet topology and implementation. Check both when walking the network (I.e. for additional information, see Auxiliary Power – Section 14 in the DeviceNet Network Checklist).

- Loose connections are the number one cause of failures.
  - Make sure all connections are undamaged.
  - Connections may look good but not be tight. Check them.
- Cable stress is the second thing to look for.
  - Cable radii might be too tight or stressed with tie wraps. There is a lot of vibration in a plant and if the cables are stressed it will create a failure point.
  - Some cable trays are mounted on long fence post and the cables brought down from them. At the point where they leave the cable tray and bend down could be a potential spot for failure.
- Grounds are very important!
  - Visually inspect grounding to assure that grounding location is clean and connection is tight. Make sure that all components are properly grounded.
- Separate high voltage cables from DeviceNet cables!
  - Power, welding or servo cables are sometimes put on top of the DeviceNet cables or put in the same cable trays. DeviceNet cables must have the proper distance between these cables.
  - To clean up the wiring power, servo, or welding cables are tie wrapped together. DeviceNet cables must have the proper distance between these cables.

Segmenting a network to troubleshoot a problem.

Finding a network cable problem is sometimes not the easiest thing to detect. The following step-by-step process will assist in locating cabling issues:

- Divide the network into two halves to determine which half is causing the trouble by physically disconnecting the trunk cable and placing the terminating resistor at the break point

- Once you determine the half causing the trouble you can approach the problem two ways.

  – Continue to divide the defective portion of the network in half to further isolate the trouble; or

  – Re-walk the network making sure that all connections are still “OK” .If everything looks “OK” then start at the controller and go to the first drop. Break the trunk cable and insert a terminator. Walk the terminator down the trunk until the network fails.

Once the problem location has been determined, consider the following cable connection / details as possible causes of the problem:

  – Tee Connection
  – Drop Connection
  – Node Connection
  – Loading problem with a node or insufficient bus power. (A volt-amp-meter should be used to determine if the problem is related to bus loading).

If the network has been running and then fails, it is often due to a bad cable or “Tee” connection.

Remember: There could be one or more causes for a specific problem. Take your time and check thoroughly to minimize the possibility of missing something.

Cell Number :_______________________ Percent Complete: _____________
Tool Number :_______________________ Station Number : _____________

DeviceNet Network Checklist

The following items should be completed during the implementation of DeviceNet networks commissioning. This will act as a record of the values attained after installation of a working network and can be used for comparison for any future network / device troubleshooting.

ID	Item Description	Checked	Date	Comments

Physical Inspection

ID	Item Description	Checked	Date	Comments
1	Are all DeviceNet devices approved for use on the project? Make sure that DeviceNet taps are of the proper type.		___/___/___	
2	Are 24VDC Power Supply calculations supplied? If the network uses more than one supply, is the network connected as designed?		___/___/___	
3	Are all the trunk and drop cables separated from high voltage and potential noise sources in accordance with the ODVA DeviceNet Planning and Installation Guide?		___/___/___	
4	Are all DeviceNet Drop & Trunk line cables routed without strain on the connection points due to bending or tension? Are all connections tight?		___/___/___	
5a	Are the drop cables less than or equal to 20 feet (6 meters)?		___/___/___	
5b	Is the sum of all drop lines less than the maximum allowed for the network data rate DeviceNet specification?		___/___/___	
6a	Is the trunk line less than the maximum length allowed for the network data rate in the DeviceNet specification?		___/___/___	
6b	Are both terminating resistors in place at the ends of the trunk line?		___/___/___	
7	Are all selectable DIP switch / rotary switch settings (node address & baud rate) correct?		___/___/___	
8	Is the DeviceNet 24VDC power supply (V-) bonded directly to the ground buss bar (#12 wire) at one location only?		___/___/___	
9	Are there any frayed or exposed wires on open style connectors creating a possible shorted condition?		___/___/___	
10	If the DeviceNet network uses more than one power supply, are the V- connections of all power supplies tied together and V- only bonded to the ground buss at one location?		___/___/___	

Note regarding all Electrical Tests that follow:
Always keep the same reference point when making measurements. This allows you to trace wiring problems and find grounding problems. If you put the black lead on the Earth ground point, make sure you always use the same point and the same lead. When performing any resistance check, you cannot have less than “0” Ohms. A negative resistance value indicates you may have voltage on the ground, or on the wire you are checking. Remove the source of any voltage to get an accurate measurement.

Design Source ________________________________ Controls Engineer ____________________________
Design Engineer ______________________________ Date ____________________________

ID	Item Description	Checked	Date	Comments
11	**Network Termination Test** 1. Follow shutdown procedures (if any) 2. Stop all network communication. 3. Turn all network and auxiliary power supplies off. 4. Measure and record the DC resistance between CANH and CANL at the middle and ends of the network. If the measured value is <50 ohms - Check for short circuit between CANH and CANL wiring - Check for more than two terminating resistors - Check nodes for faulty transceivers If the measured value is 50-70 ohms - Normal (Do nothing) If the measured value is 71-125 ohms - Check for open circuits in CANH or CANL wiring - Check for one missing terminating resistor If the measured value is > 125 ohms - Add terminating resistor - Check for open circuits in CANH and CANL wiring		___/___/___	

ID	Item Description	Checked	Date	Comments
12	**Network Power Supply Ground Test** 1. Turn all network power supplies off. Disconnect the V- and Shield wires from ground and from each other. 2. Using a Digital Voltmeter, measure DC voltage from shield to ground at all power supplies. Is there less than 1VDC?[1] 3. Remove all sources of voltage before continuing. 4. Measure and record the DC resistance between V- and earth ground. Measured value should show infinite resistance. If other value is measured, look for swapped V- and shield wires at termination points. 5. Measure and record the DC resistance between Shield and earth ground. Measured values greater than 20kΩ are considered Normal. For measured values that are greater than 1 kΩ and less than 20 kΩ: - Disconnect both DeviceNet connectors on the top of the main control panel and repeat the above procedure. If the problem remains, check connections in the main control panel. Look for swapped V- and shield wires at termination points. - If the problem went away, segment the network and isolate the location of the problem, and check for grounded V- or Shield wires. Sometimes the V- and Shield connections are transposed, which would cause ground loops. 6. Reconnect the V- and Shield wires to ground. 7. Go to each end of the network and remove terminator. Check resistance between V- and Shield to verify that there is not a broken shield wire. DC Resistance should be < 20Ω.[1] For measured values greater than 20Ω, check for broken shield		___/___/___	

[1] Does not apply to applications in which flat cable is utilized for DeviceNet Communication.

ID	Item Description	Checked	Date	Comments
13	**Network Power Supply Common Mode Voltage Test** 1. Turn all network power supplies on. 2. Configure all nodes for their maximum current draw from network power. Turn on outputs that use network power. 3. Measure and record the DC voltage between V+ and V- where each power supply connects to the trunk. 4. Measure and record the DC voltage between V+ and V- at the ends of the network. Measured values between 11.0 VDC and 25.0 VDC are consistent with the DeviceNet Specification for proper DeviceNet communication. However, input devices that may rely V+ and V- for power may not operate properly at voltages less than 20 VDC. Check input device (e.g. proximity sensors, photoelectric sensors, etc.) to verify device is within voltage specifications. 5. Measure between V- and Shield. Measured values less than 4.6 VDC are considered normal. If measured value from: Item 4. Is < 11.0 VDC; or Item 5. Is > 4.6 VDC, The network may not operate properly. Possible solutions are : - Shorten the overall length of the network cable. - Move the power supply in the direction of the overloaded section. - Move nodes from the overload section to less loaded section. - Move high current loads close to the power supply. - Break the network into two separate networks. - Add power supply.		___/___/___	

ID	Item Description	Checked	Date	Comments
14	**Auxiliary Power Measurements** 1. Monitor the voltage present at both ends of the auxiliary power trunk cable under normal operating conditions and record the high and low values observed. The use of an oscilloscope may be necessary. 2. Check all manufacturers' specifications to verify that the auxiliary power observed falls within the manufacturers' specifications. If problems are observed, consider the following - Add an additional power supply - Shorten auxiliary power trunk line cabling - Check for influence of noise - Assure that the grounding requirements outlined in the manufacturers' specifications have been met.		___/___/___	