INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE
INSTRUCTOR LESSON PLAN

Overview

Integral to industrial processes, instruments are electrical or pneumatic devices that provide information about and/or control of process variables. There are four major components in a typical closed instrument loop—process sensor, transmitter, controller, and final control element. A closed loop is designed to maintain a process variable at a desired value known as a setpoint. An open loop provides information, but manual control, of a process variable. A typical open loop consists of a primary element and a local or transmitted indicator.

Primary elements sense or respond to a change in a process variable. Measuring elements provide a local or transmitted indication of the process variable value. Controlling elements receive a signal from the measuring element, compare it to the setpoint, compute the difference, and then send a correcting signal to the final control element. Final control elements receive the correcting signal from the controlling element and adjust accordingly.

There are also auxiliary instruments associated with instrument loops and local or remote indicators: transducers, which convert a signal in one form to a proportional signal in another form; positioners, which ensure the final control element is in the proper position; and interlocks, which prevent something unwanted from happening.

Because the instruments are critical to the processes, production, quality, and expenses, the process technician must have a basic understanding of troubleshooting techniques to recognize and take appropriate actions accordingly. Appropriate actions include acknowledging, recognizing importance, and responding to alarms, which give an audible and/or visual indication that a process variable has exceeded desired values.

Competency	Performance Standards
Troubleshoot problems with instrument and instrument loop failures	Performance will be satisfactory when: ☐ Learner recognizes the problem and captures the problem in written form. ☐ Learner evaluates HSE risks involved with continued operation. ☐ Learner recognizes when the HSE hazard/s warrants shutting down equipment. ☐ Learner collects and analyzes data associated with the problem. ☐ Learner rewords problem based on initial observations and reasoning. ☐ Learner identifies possible causes of the problem. ☐ Learner selects most probable cause of the problem, one that explains every observation. ☐ Learner proposes corrective action that is rational and eliminates true cause (when possible). ☐ Learner accurately and completely documents problem and corrective action(s). ☐ Process equipment is stabilized (if simulator-based problem). ☐ System is returned to within ± 5% of design parameters (if simulator-based problem).
	Conditions: Given a paper-based (P&ID) and/or simulator-based problem, competence will be demonstrated by the completion of troubleshooting steps and subsequent documentation.

Learning Objectives

1. Recall the purpose, applications, and types of instruments.
2. Recall and discuss potential problems associated with instruments.
3. Describe immediate actions a process technician could take to solve instrument problems.
4. Explain the relationship between variables for a specific process under normal operating conditions.
5. Given normal and abnormal operating conditions for a specific process:
    - Recognize the problem.
    - Collect and analyze data associated with the problem.
    - Define the problem.
    - Identify possible causes and the most probable cause of the problem.
    - Evaluate the effect of investigative, compensating and corrective actions.
    - Select an appropriate corrective action.
    - Document the problem and corrective action.

Learning Activities

Time Frame	Learning Activity	Teaching Activity	Instructional Materials	Supplies and Equipment	Notes
	PREVIEW learning objectives and performance standards for this competency.		Learning Plan		
	READ information provided in the Introduction section.		Learning Plan		
	LISTEN to the lecture on the purpose, types of, and problems associated with instruments (if provided).	Deliver a brief presentation on instruments and associated problems.		Lecture Equipment	Address first two learning objectives.
	REVIEW the process flow, product specifications, equipment specifications, normal operating conditions, and normal design conditions sections for the specified process.	Choose a specific problem/s for learners to solve. Lead discussion of process to assure learners understand all aspects.	Process Description		
	COMPLETE the Self-Check Questions worksheet.	Introduce activity. Review worksheet with learners after completion.	Self-Check Questions worksheet		Reinforce learning objectives 1, 2, and 4.
	BRAINSTORM immediate actions a process technician could take to solve instrument problems with a small group of your peers.	Divide learners into groups of 3 to 4. Introduce activity.			
	COMPARE your list of immediate actions for solving instrument problems to another group's work.	Write all actions on board or flipchart.			
	LISTEN to instructor expand on actions a process technician could take to solve instrument problems.	Lecture on actions not captured and expand on those listed.		Lecture Equipment	Address the third learning objective.

	SOLVE at least one paper-based problem associated with instrumentation failure including the completion of a Troubleshooting Form.	Choose a specific problem/s for learners to solve. Guide learners as needed during the activity. Do a quick de-brief after activity.	Problem Packet		Information for four Scenarios has been provided for students. Any one can be paper or simulator-based. Address learning objective 5.
	OBSERVE a normal and/or abnormal condition on the simulator associated with a instrument (if simulator is available).	Set up simulation. Guide learners as needed during the activity.		Simulator	
	SOLVE at least one simulator-based problem associated with instrument failure including the completion of a Troubleshooting form (if simulator is available).	Create a problem/s for learners to solve. Program fault for simulator-based problem. Guide learners as needed during the activity. Do a quick de-brief after activity.	Troubleshooting Form	Simulator	Information to program the fault for four simulation problems is provided in this lesson plan. Address learning objective 5.

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE
PROCESS DESCRIPTION

Introduction

Integral to industrial processes, instruments are electrical or pneumatic devices that provide information about and/or control of process variables. There are four major components in a typical closed instrument loop — process sensor (primary elements), transmitter, controller, and final control element. A closed loop is designed to maintain a process variable at a desired value known as a setpoint. An open loop provides information, but manual control, of a process variable. A typical open loop consists of a primary element and a local or transmitted indicator.

Primary elements sense or respond to a change in a process variable. Measuring elements provide a local or transmitted indication of the process variable value. Controlling elements receive a signal from the measuring element, compare it to the setpoint, compute the difference, and then send a correcting signal to the final control element. Final control elements receive the correcting signal from the controlling element and adjust accordingly.

There are also auxiliary instruments associated with instrument loops and local or remote indicators, transducers, which convert a signal in one form to a proportional signal in another form, positioners, which ensure the final control element is in the proper position; and interlocks, which prevent something unwanted from happening.

Because the instruments are critical to the processes, production, quality, and expenses, the process technician must have a basic understanding of troubleshooting techniques to recognize and take appropriate actions accordingly. Appropriate actions include acknowledging, recognizing importance, and responding to alarms, which give an audible and/or visual indication that a process variable has exceeded desired values.

The following additional factors affect instruments' efficiency and accuracy:

- Ambient temperature changes
- Humidity of the air
- Steam leaks
- Harsh chemical environments
- Age of instrumentation
- Adjustments
- Excess process variable values outside of standard range
- Excessive fluctuations in process variables
- Changes to isolation devices
- Engineering design

In the short term, these factors can cause the following situations:

- Inaccurate, inconsistent, or failing instrumentation
- Unsafe conditions
- Reduced and/or loss of production
- Damage to equipment
- Unit or plant shutdown

Process Description

The levels in Tanks 1, 2, and 3 are controlled by flow of water out of the tanks by hydrostatic head pressure (the pressure exerted by a column of liquid) and/or applied pressure (the pressure exerted on the surface of the liquid).

FIC-102, FIC-102, and FIC-103 (Flow Indicating Controllers) control the flow of water out of the tanks. They are set to automatic control. They will adjust their outputs to the FCVs (Flow Control Valves) to maintain the water levels at setpoint (50%). LICs are cascaded to the FICs.

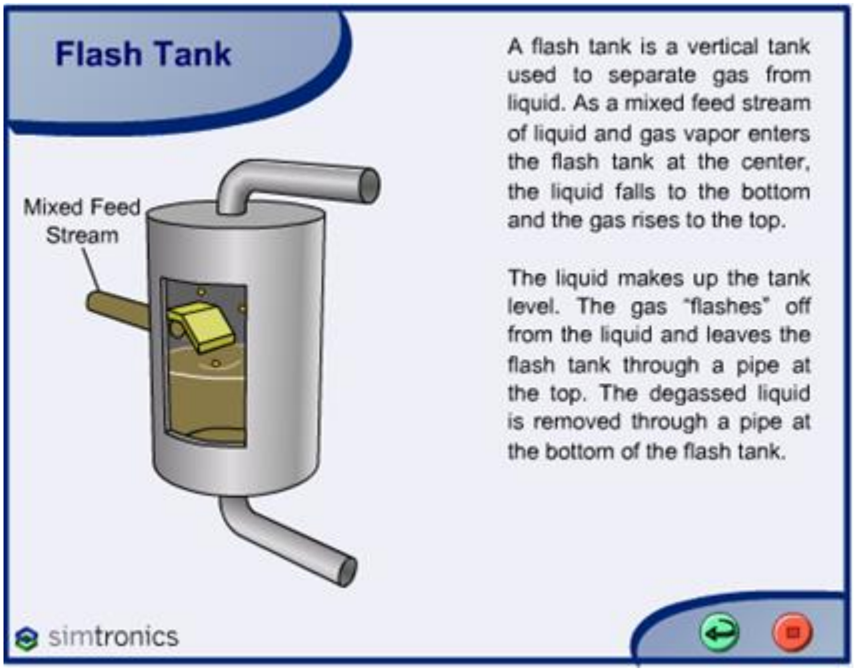

Figure 1. Flash Tank

Courtesy of Simtronics Corporation

Cascaded means the output from one controller becomes the setpoint of another controller.

Compensating and Corrective Actions

Compensating and corrective actions that the process technician might take if an instrument fails are listed below. If the problem is in an open loop, then the solution is taking actions to either repair or replace it. If the problem is in a closed loop, the compensating and corrective actions are more complicated.

Open Loop Failure

- Put a spare instrument on line (if available).
- Isolate the instrument taken out of service.
- Ensure that the process connection is not fouled or plugged.
- If the process connection is plugged or fouled, then clear it.
- Repair or replace the failed instrument.
- Document actions taken.

Closed Loop Failure

- Determine which component (primary, measuring, controlling, or final control) in the loop has failed.
- Place the loop in manual mode.
- Stabilize the loop if possible.
- Repair or replace the failed component (or have it repaired or replaced).
- Ensure the loop is repaired.
- Place the loop back in automatic mode.
- Monitor the loop to ensure it is functioning properly.
- Document actions taken.

Other Actions

- Determine the cause of the failure.
- Take (or have taken) actions to prevent reoccurrence of the failure.

Document actions taken and their results.

Instrument Failure/Control Loop Failure Troubleshooting Module Self-Check Questions

1. Explain the difference between a properly-functioning instrument and a failed instrument.

   A properly-functioning instrument gives an accurate indication of a process variable. A failed instrument gives a false (or no) indication or control.

2. List four observations that would indicate an instrument or instrument loop failure.

   a. False or no indication of a process variable
   b. A process out-of-control
   c. Alarms or shutdowns of equipment
   d. Improper analytical test results

3. List five possible short-term impacts of instrumentation failure.

   a. Reduced or loss of pressure, flow, level or temperature
   b. Production slowed
   c. Deteriorated product quality
   d. Equipment shutdown or damage
   e. Possible fire or explosion

4. List three possible long-term impacts of instrument failure.

   a. Improper analytical test results
   b. Shutdown of a process or unit
   c. Loss of customers

5. What are three possible solutions to the impact of instrumentation failures?

   a. Redundancy
   b. Improved instrumentation
   c. Better calibration and maintenance

6. List five longer-term maintenance and engineering design actions that could solve chronic instrumentation problems.

   a. Relocate instruments to a less-hostile environment
   b. Increase frequency of routine maintenance
   c. Install devices that separate instruments from hostile processes
   d. Replace instruments with more-rugged designs
   e. Protect instruments from physical abuse
   f. Consider the applications for new instrumentation installations

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE
SCENARIO #1 (PAPER OR SIMULATOR-BASED)

Scenario Statement

The control room technician reports to the field operator that he shows a higher level indication for T-3. The field technician investigates and confirms that the tank does have a higher level. The tank sightglass indicates 55%. The tank level is rising slowly.

Troubleshoot this situation and complete the Troubleshooting Form.

Simulator Programming

The following table includes information needed for you to program the fault for a process simulation exercise. The fault has been written for use with Simtronics Corporation's SPM-100 Tank System.

Table 1. Fault Programming Information for Scenario #1
Freeze at 2:40

Description	FV-104	**Signal**	1.0	**Rise**	10:00
Status	Idle	**Normal**	1.0	**Start**	2:00
Direction	Fail Low	**High**	2.0	**Stop**	00:00:00
Function	Ramp	**Low**	0.0	**Delay**	2:00

Normal and Abnormal Operating Conditions

Normal flow into Tank 1 is 50 GPM (gallons per minute). To maintain the levels in Tanks 1, 2, and 3 the flows out of them must be 50 GPM.

The following tables provide a list of the normal design conditions and abnormal operating conditions associated with this process.

Table 2. Design Values and Output Percentages for Instrumentation at Design Operating Conditions for Scenario #1

Courtesy of Simtronics Corporation

Tag ID	Description	Design Value	Eng. Units	Output Percent
HV-101	WATER IN BLOCK VALVE	Open		Open
FIC-101	WATER TO TANK 1	50.0	GPM	50
LIC-101	TANK 1 LEVEL	50.0	%	50
FIC-102	WATER TO TANK 2	50.0	GPM	50
LIC-102	TANK 2 LEVEL	50.1	%	50
FIC-103	WATER TO TANK 3	50.0	GPM	50
LIC-103	TANK 3 LEVEL	50.0	%	50
FIC-104	WATER OUT OT TANK 3	50.0	GPM	50

Table 3. Process Indication Values and Output Percentages for Instrumentation During Abnormal Operating Conditions for Scenario #1 at 2:40

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-101	WATER IN BLOCK VALVE	Open		Open
FIC-101	WATER TO TANK 1	50.0	GPM	50
LIC-101	TANK 1 LEVEL	50.0	%	50
FIC-102	WATER TO TANK 2	50	GPM	50
LIC-102	TANK 2 LEVEL	50	%	50
FIC-103	WATER TO TANK 3	50.0	GPM	50
LIC-103	TANK 3 LEVEL	55.2	%	100
FIC-104	WATER OUT OT TANK 3	33	GPM	100

Initial Problem

Increased level indication for T-3 on DCS console and in the field.

Investigative Actions

Check T-3 sightglass to ensure it is correct.

Field technician confirms that valves are positioned correctly and connections are not plugged.

If LIC-103 and sightglass are accurate, then problem could be:

- *Level controller LIC-103*
- *Flow controller FIC-104*
- *FCV-104*
- *Obstruction in water line out of tank T-3*

Compensating Actions

Put LIC-103 in manual and increase the output percentage.

Check the tank level for increase or decrease.

Have outside technician monitor tank level closely.

Corrective Actions

Correct problems associated with LIC-103, FIC-104, FCV-104, or line blockage.

Screen shot during design conditions (Scenario #1)

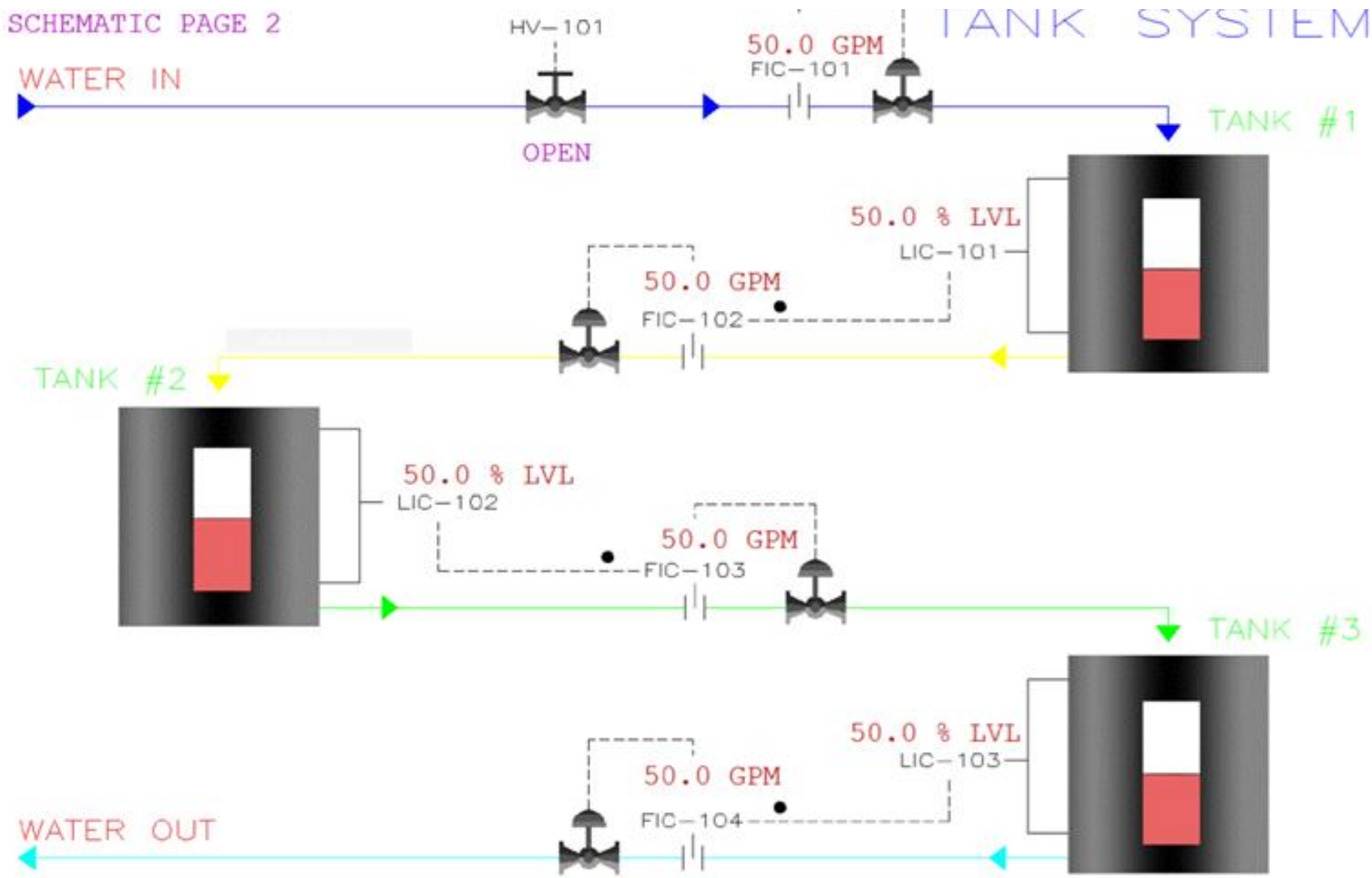

Figure 2. Simtronics SPM-100 Tank System
Initial Condition: Design; Fault: FV-104 Control Valve Partially Blocked
Freeze at 3:00

Courtesy of *Simtronics Corporation*

Screen shot during abnormal conditions (Scenario #1)

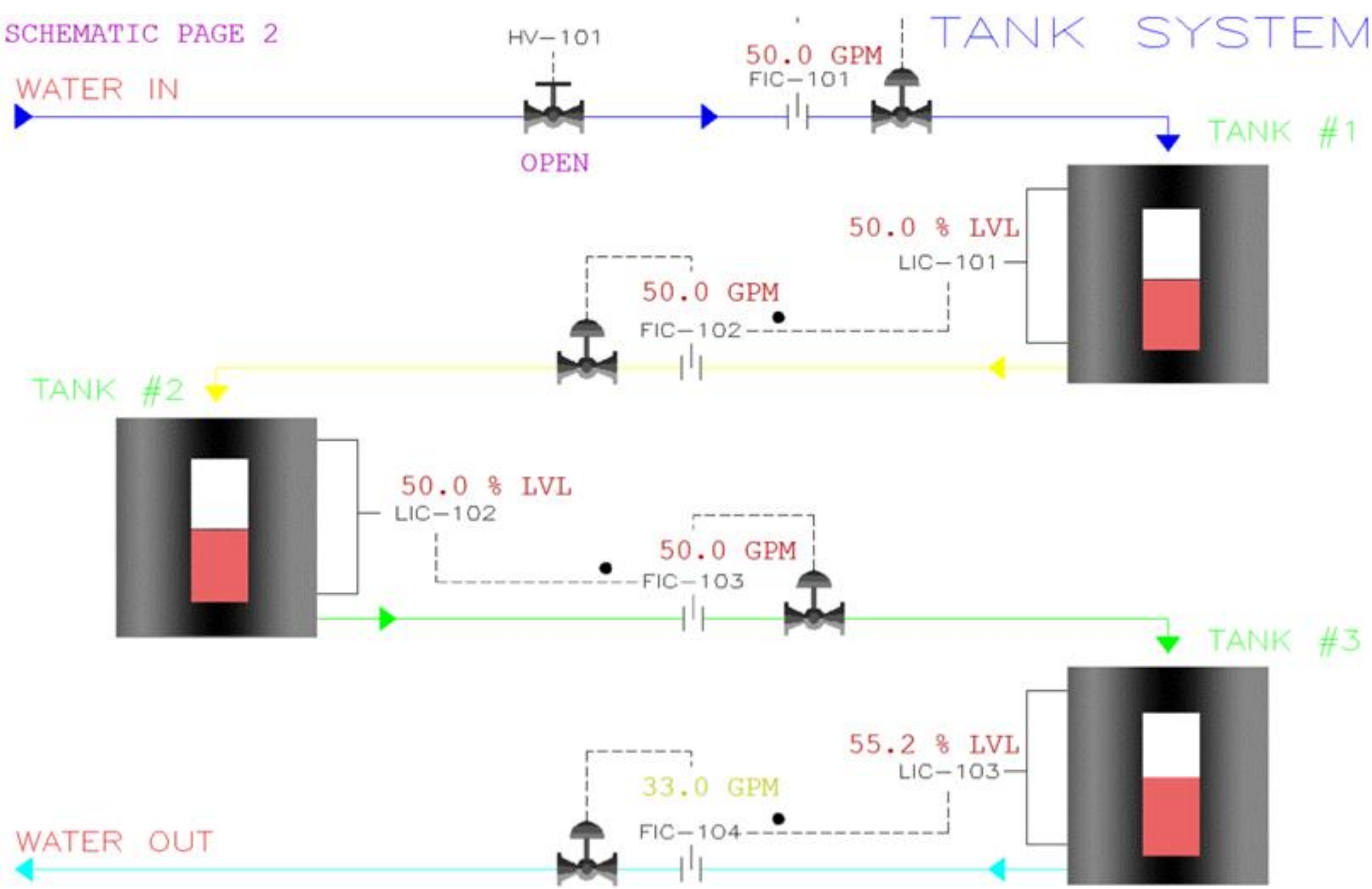

Figure 3. Simtronics SPM-100 Tank System
Initial Condition: Design; Fault: FV-104 Control Valve Partially Blocked
Frozen after three minutes with abnormal conditions

Courtesy of *Simtronics Corporation*

TROUBLESHOOTING FORM (WITH RESPONSES)

1. **Recognize (and write) the problem.**
*(What **is** happening that should not be or what **is not** happening that should be?)*
Tank 3 level is increasing. ______

2. **Stabilize the system.**
(Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)
Put LIC-103 in manual and increase the output percentage. ______
Check the tank level for increase or decrease. Have outside technician monitor tank level closely. ______

3. **Collect and analyze the data.**
(Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.
Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *Tank 3 level is increasing.* ______
why? because ______
why? because ______
why? because ______

Y N b. *FIC-104 is malfunctioning.* ______
why? because ______
why? because ______
why? because ______

Y N c. *All other variables are normal.* ______
why? because *nothing has changed.* ______
why? because ______
why? because ______

Y N d. ______
why? because ______
why? because ______
why? because ______

Y N e. ______
why? because ______
why? because ______
why? because ______

Y N f. ______
why? because ______
why? because ______
why? because ______

Y N g. ______
why? because ______
why? because ______
why? because ______

Y N h. ______
why? because ______
why? because ______
why? because ______

Y N i. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N j. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

Tank 3 level is increasing and flow out of tank is decreasing.

____

5. List **possible causes** of the problem.

Y N a. *Level controller LIC-103 is malfunctioning.*

Y N b. *Flow controller LIC-103 is malfunctioning.*

Y N c. *Flow control valve FCV-104 is failing.*

Y N d. *Flow control valve FCV-104 is partially fouled or plugged.*

Y N e. *Line out of Tank 3 or out of FCV-104 is partially fouled or plugged.*

*******Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

Flow control valve FCV-104 is partially fouled or plugged.

(The cause could be any of the possible causes.)

******* Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Put LIC-103 in manual and "exercise" the control valve (fully open and close several times).

b. What would be a **compensating** action you could take at this point? What would be the effect?

Bypass the control valve (if possible) or reduce rates upstream to prevent Tank 3 from overfilling.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Remove the fouling or pluggage.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

Reducing rates may cause problems.

It might be necessary to shut down the unit.

Reducing or stopping flow could affect whatever is downstream.

Notify those affected by reduced or stopped flow.

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

If fouling or pluggage was the problem control valve/lines may need to be fully cleaned.

Consider additives to the system to eliminate or reduce fouling.

10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE SCENARIO #2 (PAPER OR SIMULATOR-BASED)

Scenario Statement

The control room technician notices that several process variables are changing:

- FI-501 ↑
- PIC-501 ↑
- AI-503 ↓
- AI-504 ↑
- FI-502 ↓
- LIC-501 ↓
- TIC-406 ↓

After analyzing the data, the technician decides that TIC-406 is reading low. This would explain the changes to the other variables; the actual temperature higher than indicated causes increased boil-up and affects the other variables.

Troubleshoot this situation and complete the Troubleshooting Form.

Simulator Programming

The following table includes information needed for you to program the fault for a process simulation exercise. The fault has been written for use with Simtronics Corporation's SPM-500 Flash Tank.

Table 4. Fault Programming Information for Scenario #2

Description	TC-106	**Signal**	.8	**Rise**	10:00
Status	Idle	**Normal**	1.0	**Start**	01:00
Direction	Fail Low	**High**	1.0	**Stop**	00:00:00
Function	Step Change	**Low**	.8	**Delay**	00:00:05

Normal and Abnormal Operating Conditions

The process indication values and output percentages for instrumentation during design operating conditions for Scenario #2 are shown in Table 5.

Table 5. Process Indication Values and Output Percentages for Instrumentation During Design Operating Conditions for Scenario #2

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-501	FLOW FROM FLASH TANK	OPEN		
HV-502	FLOW FROM FLASH TANK	CLOSED		
HV-503	FLOW FROM FLASH TANK	OPEN		
HV-504	FLOW FROM FLASH TANK	CLOSED		
FIC-401	FEED TO E-401	298.3	GPM	69
TIC-406	FEED TO FLASH TANK	390.3	DEG. F	24
AI-305	C6 WEIGHT PERCENT INTO TANK	46.0	WT %	
AI-306	C7 WEIGHT PERCENT INTO TANK	54.0	WT %	
LIC-501	FLASH TANK LEVEL	50.0	%	50
FI-502	FLOW FROM FLASH TANK	220.3	GPM	
PI-503	FLOW FROM FLASH TANK PRESSURE	81.8	PSIG	
AI-503	C6 WEIGHT PERCENT	41.6	WT %	
AI-504	C7 WEIGHT PERCENT	58.4	WT %	
TI-501	FLOW FROM FLASH TANK TEMP.	319.1	DEG. F	
FI-501	FLOW FROM FLASH TANK	419.9	ACFM	
PIC-501	FLOW FROM FLASH TANK PRESSURE	80.0	PSIG	6.1
AI-501	C6 WEIGHT PERCENT FROM TANK	58.4	WT %	
AI-502	C7 WEIGHT PERCENT FROM TANK	41.6	WT %	

The process indication values and output percentages for instrumentation and equipment during abnormal operating conditions for Scenario #2 are shown in Table 6.

Table 6. Process Indication Values and Output Percentages for Instrumentation During Abnormal Operating Conditions for Scenario #2

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-501	FLOW FROM FLASH TANK	OPEN		
HV-502	FLOW FROM FLASH TANK	CLOSED		
HV-503	FLOW FROM FLASH TANK	OPEN		
HV-504	FLOW FROM FLASH TANK	CLOSED		
FIC-401	FEED TO E-401	298.5	GPM	69.3
TIC-406	FEED TO FLASH TANK	380.3	DEG. F	61.4
AI-305	C6 WEIGHT PERCENT INTO TANK	46.0	WT %	
AI-306	C7 WEIGHT PERCENT INTO TANK	54.0	WT %	
LIC-501	FLASH TANK LEVEL	47.3	%	22.3
FI-502	FLOW FROM FLASH TANK	100.0	GPM	
PI-503	FLOW FROM FLASH TANK PRESSURE	84.1	PSIG	
AI-503	C6 WEIGHT PERCENT	38.9	WT %	
AI-504	C7 WEIGHT PERCENT	61.1	WT %	
TI-501	FLOW FROM FLASH TANK TEMP.	323.2	DEG. F	
FI-501	FLOW FROM FLASH TANK	881.7	ACFM	
PIC-501	FLOW FROM FLASH TANK PRESSURE	82.4	PSIG	15
AI-501	C6 WEIGHT PERCENT FROM TANK	55.5	WT %	
AI-502	C7 WEIGHT PERCENT FROM TANK	44.5	WT %	

Cause

TIC-406 is indicating low.

Investigative Actions

Check the temperature control loop.

Compensating Actions

Place TIC-406 in manual and adjust the output percentage.

Check local temperature readings and adjust TIC-406 output to bring temperature back to normal.

Other loops may need to be placed in manual until the temperature is returned to normal.

Run at reduce rates and/or shut the system down if temperature cannot be restored or controlled.

Corrective Actions

Repair or replace the temperature transmitter.

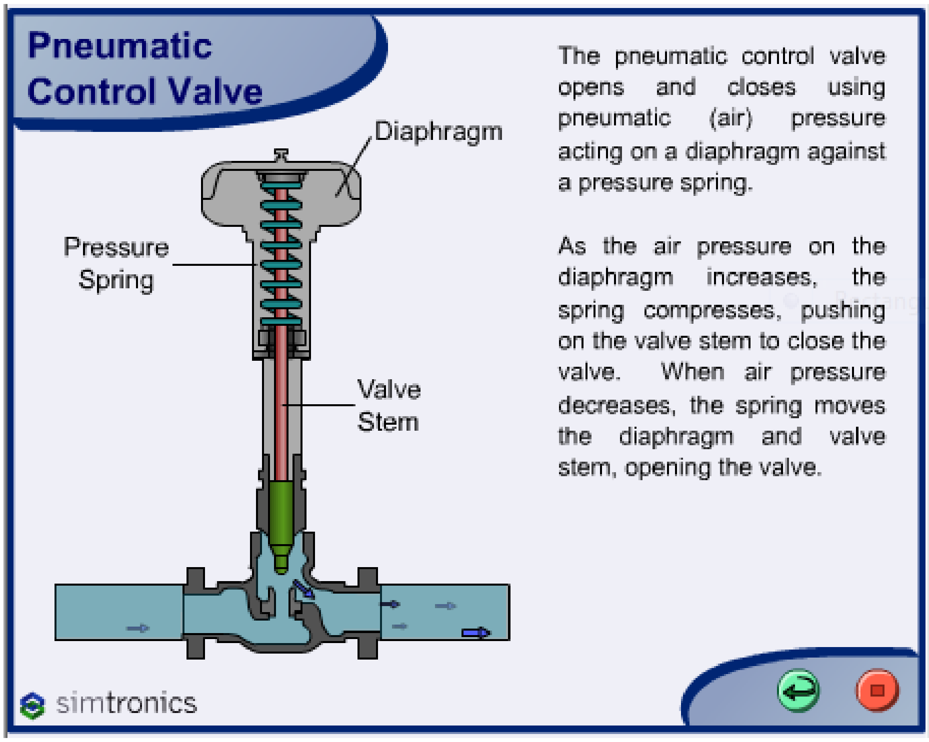

Figure 4. **Pneumatic Control Valve**

Courtesy of Simtronics Corporation

Screen shot during design conditions (Scenario #2)

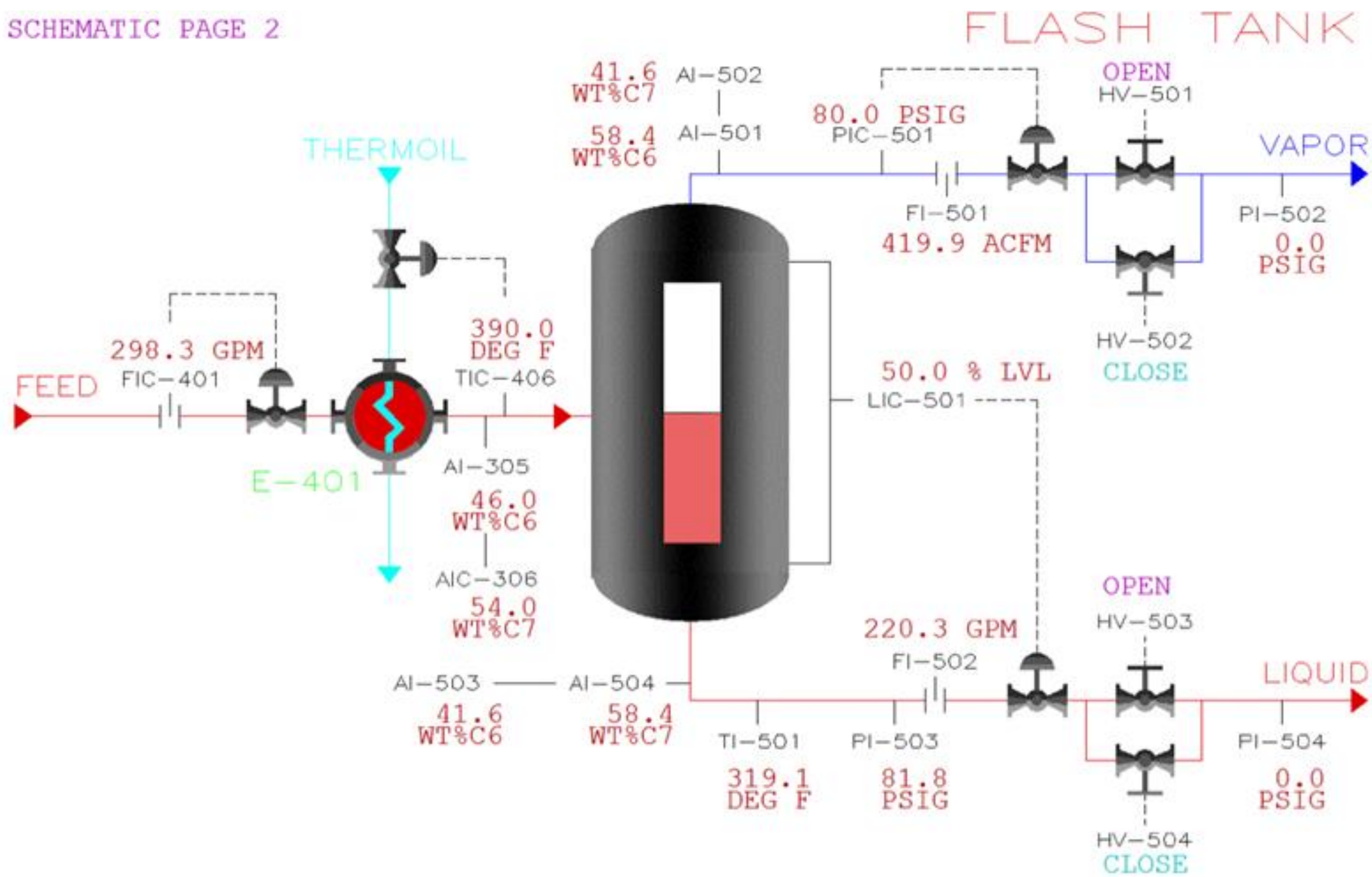

Figure 5. Simtronics SPM-500 Flash Tank
Initial Condition: Design; Fault: TC-406 Transmitter Reads Low
Freeze at 3:00

Courtesy of Simtronics Corporation

Screen shot during abnormal conditions (Scenario #2)

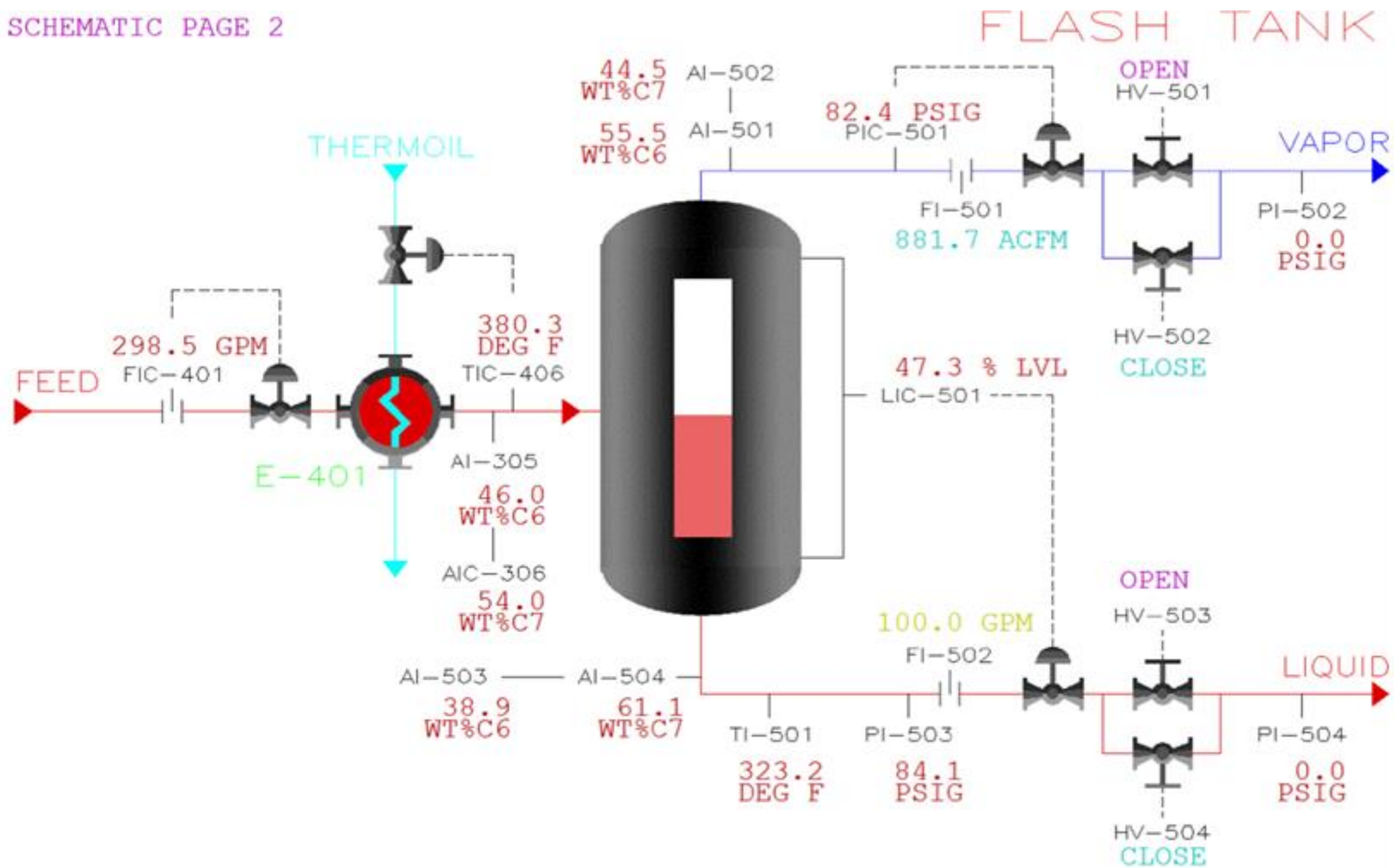

Figure 6. Simtronics SPM-500 Flash Tank
Initial Condition: Design; Fault: TC-406 Transmitter Reads Low
Frozen after three minutes with fault active

Courtesy of Simtronics Corporation

TROUBLESHOOTING FORM (WITH RESPONSES)

1. **Recognize (and write) the problem.**

*(What **is** happening that should not be or what **is not** happening that should be?)*

FIC-201 and FIC-202 have increased.

2. **Stabilize the system.**

(Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)

Place TIC-406 in manual and adjust the output percentage.

Check local temperature readings and adjust TIC-406 output to bring temperature back to normal.

3. **Collect and analyze the data.**

(Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.

Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *TIC-406 decreased.*

why? because

why? because

why? because

Y N b. *FI-501 has increased*

why? because *boil-up rate increased.*

why? because *temperature in Flash Tank apparently increased.*

why? because

Y N c. *PIC-501 increased.*

why? because *vapor flow from the Flash Tank increased.*

why? because *temperature in Flash Tank apparently increased.*

why? because

Y N d. *LIC-501 decreased.*

why? because *temperature in Flash Tank apparently increased.*

why? because *increased temperature in Flash Tank affected the boiling point of the liquid mixture.*

why? because *C6 has a higher boiling point than C7.*

Y N e. *AI-504 increased.*

why? because *temperature in Flash Tank apparently increased.*

why? because *increased temperature in Flash Tank affected the boiling point of the liquid mixture.*

why? because *C7 has a lower boiling point than C6.*

Y N f. *FI-502 decreased.*

why? because *LIC-501 decreased output to hold level at 50%.*

why? because *LIC-501 is in automatic mode with a setpoint of 50%.*

why? because

Y N g.

why? because

why? because

why? because

Y N h.

why? because

why? because

why? because

Y N i. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N j. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

Flash Tank temperature increased, causing the other process variables to change.

____

5. List **possible causes** of the problem.

Y N a. *TIC-406 failure or FT-406 out-of-calibration.*

Y N b. *TCV-406 needs to be "stroked" (adjusted).*

Y N c. *Temperature of Thermoil to E-401 increased.*

Y N d. *TY-406 transducer failed or out-of-calibration.*

Y N e. *PIC-501 failed.*

NOTE: TY-406 is a transducer that converts the electronic output from TIC-406 to pneumatic signal to TCV-406.

*****Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

TIC-406 failure or FT-406 out-of-calibration.

***** Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Check local temperature readings and adjust TIC-406 output in manual to bring temperature back to normal.

b. What would be a **compensating** action you could take at this point? What would be the effect?

Place TIC-406 in manual and lower the output percentage.

Closely monitor temperature and other variables.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Repair, replace or calibrate faulty instrument(s). Restore system to normal operation

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

Possible disruption to processes upstream and/or downstream.

Production of off-spec materials.

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

____

____

10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE SCENARIO #3 (PAPER OR SIMULATOR-BASED)

Scenario Statement

After analyzing the data, the technician decides that FIC-201 is reading high.

Troubleshoot this situation, listing investigative, compensative, and corrective actions on the Troubleshooting Form.

Simulator Programming

The following table includes information needed for you to program the fault for a process simulation exercise. The fault has been written for use with Simtronics Corporation's SPM-600 Unit Operations of Chemical Processing.

Table 7. Fault Programming Information for Scenario #3

Description	FC-201 Transmitter	**Signal**	100.00	**Rise**	10.0
Status	Idle	**Normal**	100.00	**Start**	00:01:00
Direction	Fail High	**High**	200.00	**Stop**	00:00:00
Function	Sine Wave	**Low**	00.00	**Delay**	00:01:00

Normal and Abnormal Operating Conditions

The process indication values and output percentages for instrumentation during design operating conditions for Scenario #3 are shown in Table 8.

Table 8. Process Indication Values and Output Percentages for Instrumentation During Normal Operating Conditions for Scenario #3

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-201	C6 SUPPLY	OPEN		
HV-203	C7 SUPPLY	OPEN		
PI-202	P-201 DISCHARGE	251.1	PSIG	
PI-205	P-203 DISCHARGE	242.7	PSIG	
FIC-201	FLOW FROM P-201	201.6	GPM	19.0
AIC-306	C7 WEIGHT PERCENT	42.8	%	31.7
FIC-202	P-203 DISCHARGE FLOW	325.5	GPM	58.8

Table 9. Process Indication Values and Output Percentages for Instrumentation During Abnormal Operating Conditions for Scenario #3

Courtesy of Simtronics Corporation

	Description	Value	Eng. Units	Output Percent
HV-201	C6 SUPPLY	OPEN		
HV-203	C7 SUPPLY	OPEN		
PI-202	P-201 DISCHARGE	254.5	PSIG	
PI-205	P-203 DISCHARGE	242.1	PSIG	
FIC-201	FLOW FROM P-201	240	GPM	25.4
AIC-306	C7 WEIGHT PERCENT	43.8	%	71.6
FIC-202	P-203 DISCHARGE FLOW	231.3	GPM	78.2

NOTE: The white dot indicates that AIC-306 is cascaded to FIC-202. In Cascade Mode the output from one controller (AIC-306) is the setpoint to another controller (FIC-202).

Cause

FIC 201 is indicating higher-than-actual flow.

FIC-201 or FT-201 fault.

Investigative Actions

Check the flow control loop.

Compensating Actions

Place FIC-201 in manual and adjust the output percentage to get PI-202 back to normal. Check local flow readings and adjust FIC-201 output to bring flow back to normal. Other loops may need to be placed in manual until the flow is returned to normal. Run at reduce rates and/or shut the system down if temperature cannot be restored.

Corrective Actions

Instrument technician should calibrate, repair, or replace the flow transmitter and/or controller.

If this doesn’t solve the problem, then FCV-201 may need to be “stroked” (adjusted).

Screen shot during design conditions (Scenario #3)

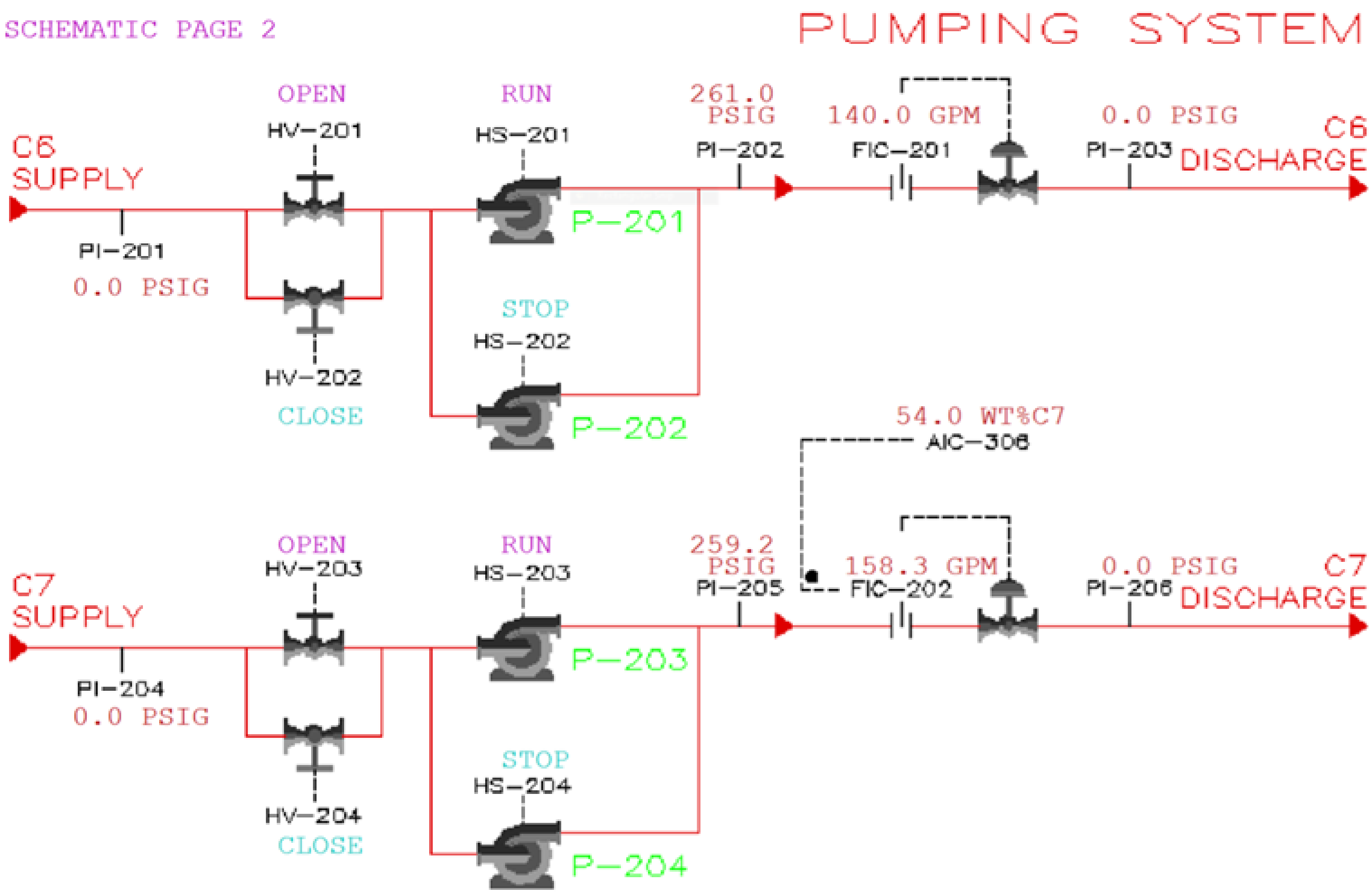

Figure 7. **Simtronics SPM-600 Unit Operations of Chemical Processing**
Initial Condition: Design; Fault: FIC-201 Faulty Transmitter
Freeze at 3:00

Courtesy of Simtronics Corporation

Screen shot during abnormal conditions (Scenario #3)

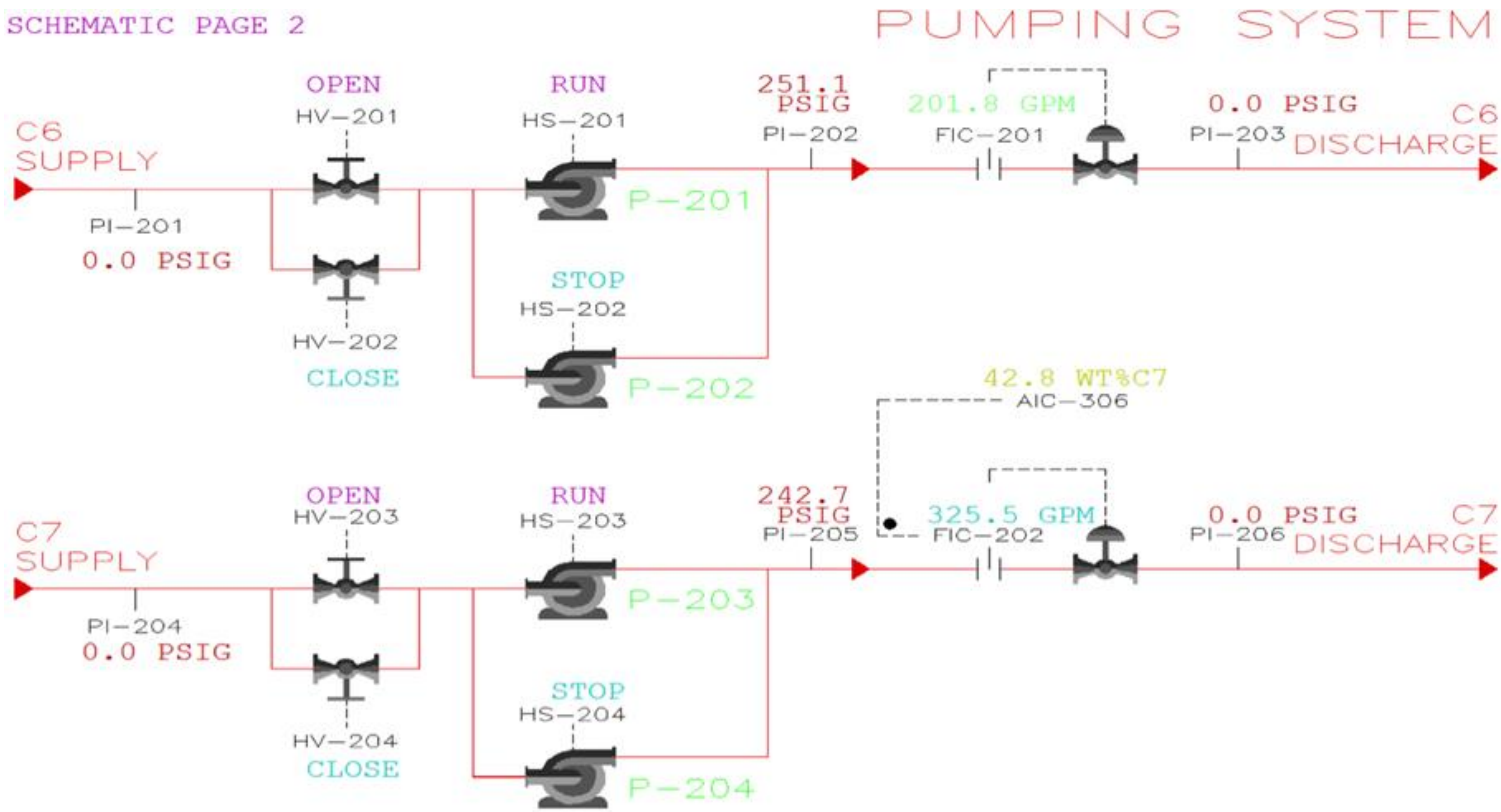

Figure 8. Simtronics SPM-600 Unit Operations of Chemical Processing
Initial Condition: Design; Fault: FIC-201 Faulty Transmitter

Courtesy of Simtronics Corporation

TROUBLESHOOTING FORM (WITH RESPONSES)

1. **Recognize (and write) the problem.**
*(What **is** happening that should not be or what **is not** happening that should be?)*
FIC-201 and FIC-202 have increased.

2. **Stabilize the system.**
(Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)
Place FIC-201 in manual and adjust the output percentage.
Check local flow readings and adjust FIC-201 output to bring flow back to normal.

3. **Collect and analyze the data.**
(Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.
Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *FIC-201 increased.*
why? because ______
why? because ______
why? because ______

Y N b. *PI-202 decreased.*
why? because *flow increased.*
why? because *FCV-201 is open more.*
why? because *less restriction to flow.*

Y N c. *PI-205 decreased.*
why? because *FCV-202 is open more.*
why? because *AIC-306 output increased.*
why? because *needed to maintain C7 discharge purity.*

Y N d. *AIC-306 decreased.*
why? because *needed to maintain C7 discharge purity.*
why? because *C6 flow out increased.*
why? because ______

Y N e. *FIC-302 increased.*
why? because *its input setpoint is cascaded from AIC-306.*
why? because *of control loop design.*
why? because ______

Y N f. ______
why? because ______
why? because ______
why? because ______

Y N g. ______
why? because ______
why? because ______
why? because ______

Y N h. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N i. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N j. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

C7 discharge flow increased, causing the other process variables to change.

____

5. List **possible causes** of the problem.

Y N a. *FIC-201 failure*

Y N b. *FT-201 out-of-calibration*

Y N c. *FCV-201 needs to be "stroked" (adjusted).*

Y N d. ______________________________

Y N e. ______________________________

***Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

FIC-201 failure

*** Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Check local flow readings and adjust FIC-201 output in manual to bring flow back to normal.

b. What would be a **compensating** action you could take at this point? What would be the effect?

Adjust FIC-201 output in manual to bring flow back to normal. Closely monitor other variables.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Repair, replace or calibrate faulty instrument. Restore system to normal operation.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

Possible disruption to processes upstream and/or downstream

Production of off-spec materials

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

____

____

10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE SCENARIO #4 (PAPER OR SIMULATOR-BASED)

Scenario Statement

The control room technician notices that process variables are changing, and multiple alarms are activating:

- FIC-103 ↓ ↑ Alarms High and Low
- LIC-102 ↓ ↑
- LIC-103 ↓ ↑
- FIC-104 ↑ ↓ Alarms High and Low

After analyzing the data, the technician decides that the level and flow for Tank 2 and Tank 3 are fluctuating. This would explain the alarms that are activating.

Troubleshoot this situation listing investigative, compensating, and corrective actions on the Troubleshooting Form.

Simulator Programming

The following table includes information needed for you to program the fault for a process simulation exercise. The fault has been written for use with Simtronics Corporation's SPM-100 Tank System.

Table 10. Fault programming Information for Scenario #4

Description	LIC-201 Level Transmitter Cycles	**Signal**	1.0	**Rise**	10.0
Status	Idle	**Normal**	1.0	**Start**	01:00
Direction	Fail High	**High**	1.25	**Stop**	00:00:00
Function	Sine Wave	**Low**	0.75	**Delay**	02:00

Normal and Abnormal Operating Conditions

Table 11. Process Indication Values and Output Percentages for Instrumentation During Normal Operating Conditions for Scenario #4

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-101	WATER IN	OPEN		
FIC-101	FLOW CONTROL TO TANK #1	50	GPM	
LIC-101	TANK #1 LEVEL CONTROL	50	%	
FIC-102	FLOW CONTROL TO TANK #2	50	GPM	50.0
LIC-102	TANK #2 LEVEL CONTROL	50	%	50.0
FIC-103	FLOW CONTROL TO TANK #3	50	GPM	50.0
LIC-103	TANK #3 LEVEL CONTROL	50	%	50.0
FIC-104	FLOW CONTROL FROM TANK #3	50	GPM	50.0

Table 12. Process Indication Values and Output Percentages for Instrumentation During Abnormal Operating Conditions for Scenario #4

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-101	WATER IN	OPEN		
FIC-101	FLOW CONTROL TO TANK #1	50	GPM	
LIC-101	TANK #1 LEVEL CONTROL	50	%	
FIC-102	FLOW CONTROL TO TANK #2	50	GPM	50.0
LIC-102	TANK #2 LEVEL CONTROL	44.1	%	20.9
FIC-103	FLOW CONTROL TO TANK #3	29.7	GPM	32.8
LIC-103	TANK #3 LEVEL CONTROL	47.1	%	36.7
FIC-104	FLOW CONTROL FROM TANK #3	41.2	GPM	43.1

NOTE: Cascade Mode is a control mode in which the output of one controller (primary) becomes the setpoint of another controller (secondary).

LIC-102 is in Cascade Mode. Its output becomes the setpoint of FIC-103.

LIC-103 is in Cascade Mode. Its output becomes the setpoint of FIC-104.

Cause

Level and flow for Tank 2 and Tank 3 are fluctuating.

Investigative Actions

Check the flow and level loops for Tank 2 and Tank 3.

Compensating Actions

Place LIC-102 in manual.

Check local flow and level readings and adjust LIC-102 output to bring level back to normal.

Other loops may need to be placed in manual until the level is returned to normal.

Run at reduce rates and/or shut the system down if flows and levels cannot be controlled.

Corrective Actions

Repair, calibrate, or tune Tank 2 level controller.

Screen shot during design conditions (Scenario #4)

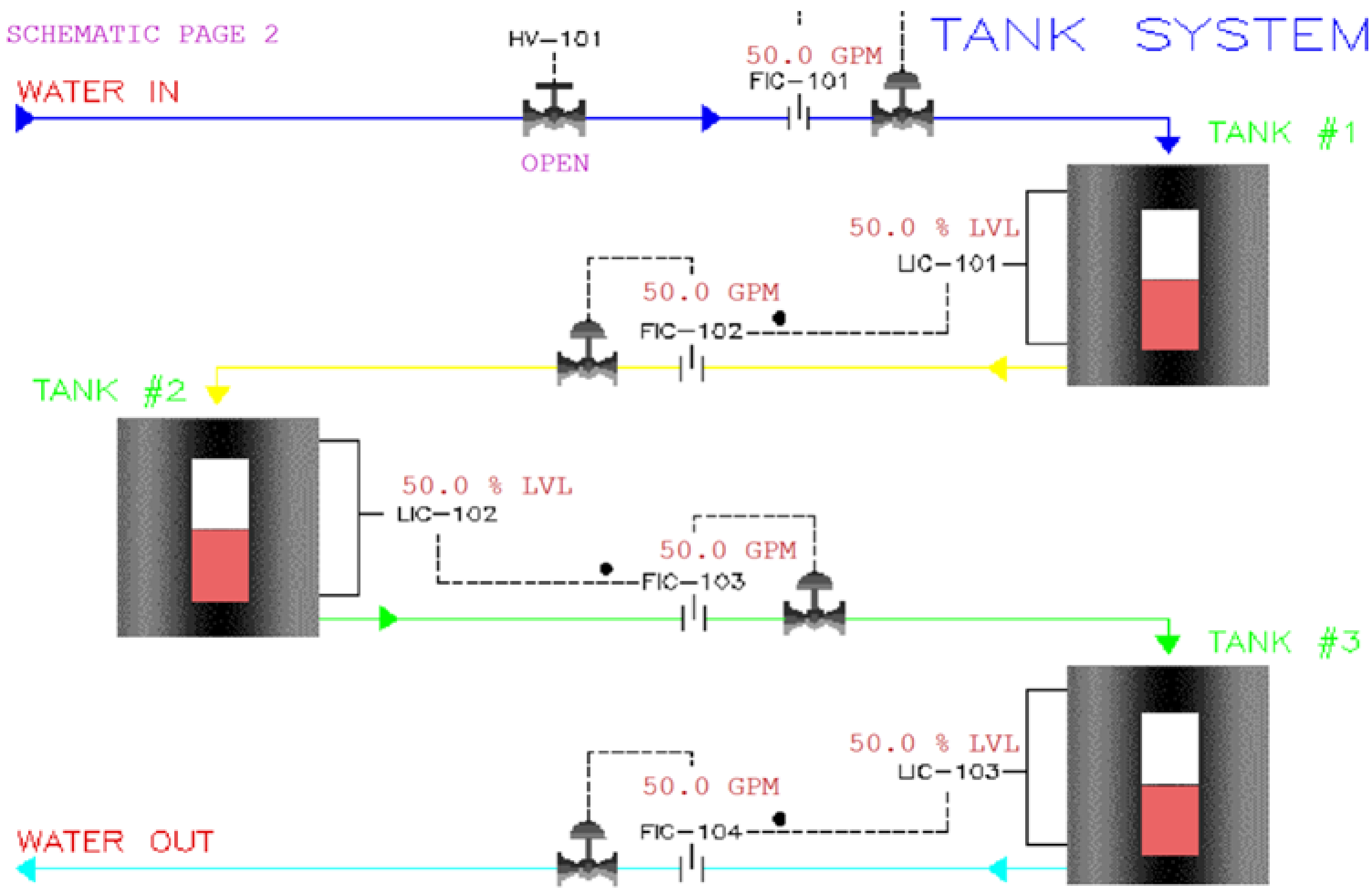

Figure 9. Simtronics SPM-100 Tank System
Initial Condition: Design; Fault: LC-102 Level Transmitter Cycles
Freeze at 3:00

Courtesy of Simtronics Corporation

Screen shot during abnormal conditions (Scenario #4)

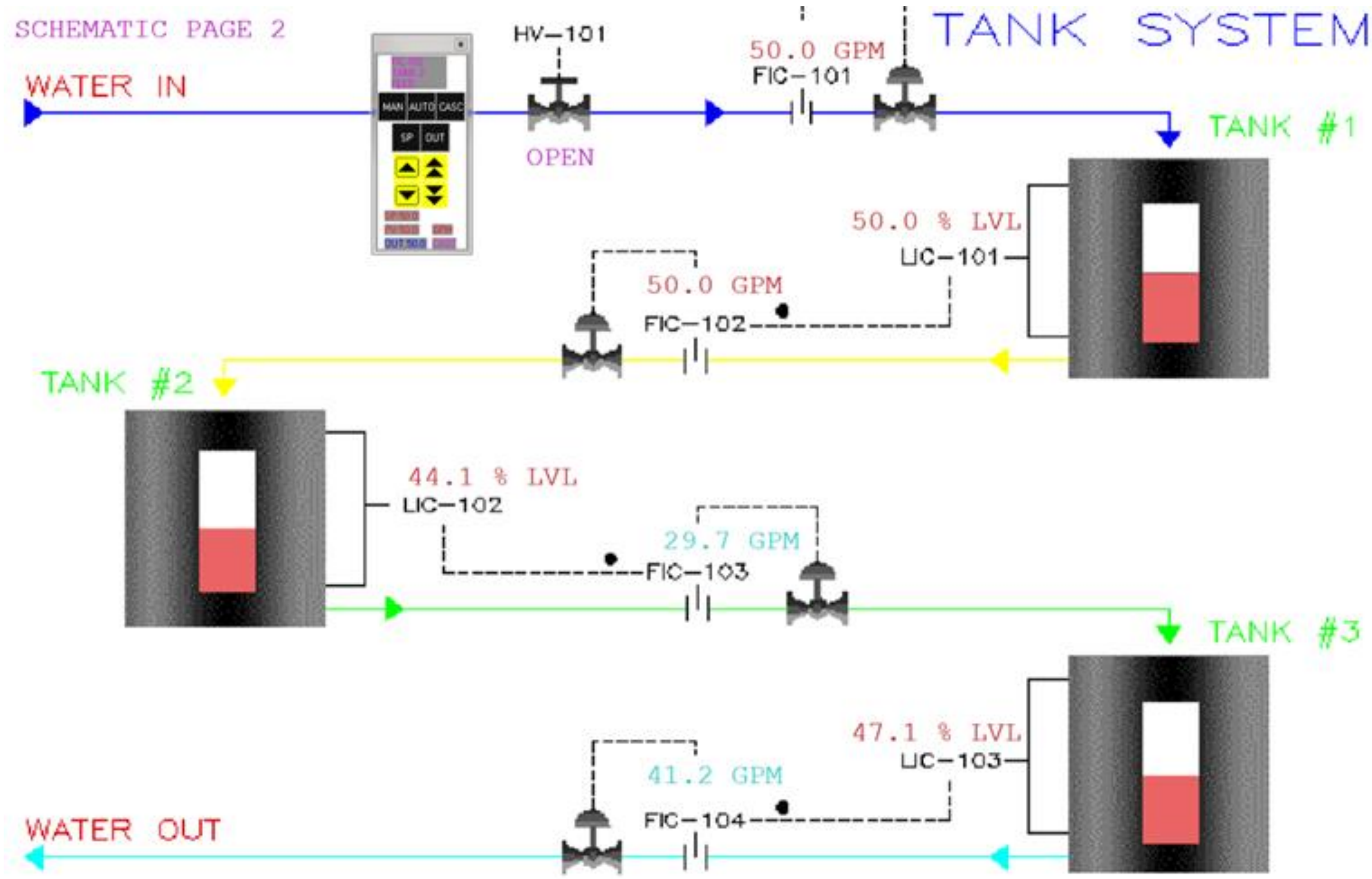

Figure 10. Simtronics SPM-100 Tank System
Initial Condition: Design; Fault: LC-102 Level Transmitter Cycles
Freeze at 3:00

Courtesy of Simtronics Corporation

TROUBLESHOOTING FORM (WITH RESPONSES)

1. **Recognize (and write) the problem.**
   *(What **is** happening that should not be or what **is not** happening that should be?)*
   Tank 2 and Tank 3 levels and flows are cycling.

2. **Stabilize the system.**
   (Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)
   Place LIC-102 in manual and lower the output percentage.
   Check local level and flow readings and adjust LIC-102 output to bring level back to normal.

3. **Collect and analyze the data.**
   (Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.
   Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *FIC-101, LIC-101, and FIC-102 are normal.*
why? because________
why? because________
why? because________

Y N b. *LIC-102 is cycling.*
why? because________
why? because________
why? because________

Y N c. *FIC-103 is cycling.*
why? because________
why? because________
why? because________

Y N d. *LIC-103 is cycling.*
why? because________
why? because________
why? because________

Y N e. *FIC-104 is cycling.*
why? because________
why? because________
why? because________

Y N f. ________
why? because________
why? because________
why? because________

Y N g. ________
why? because________
why? because________
why? because________

Y N h. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N i. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N j. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

LIC-102 is cycling causing other loops to cycle.

____

5. List **possible causes** of the problem.

Y N a. *LIC-102 failure*

Y N b. *LIC-102 tuning issue*

Y N c. *LT-102 faulty*

Y N d. ______________________________

Y N e. ______________________________

*****Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

LIC-102 tuning issue

***** Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Have instrument technician check LIC-102 and its tuning settings.

Instrument technician may need to put LIC-102 in manual.

b. What would be a **compensating** action you could take at this point? What would be the effect?

Adjust LIC-102 output in manual to bring level back to normal. Closely monitor other variables.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Repair, replace or calibrate faulty instrument. Restore system to normal operation.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

Possible disruption to processes upstream and/or downstream

Production of off-spec materials

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the "real" cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

____

____

10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

ADDITIONAL INFORMATION

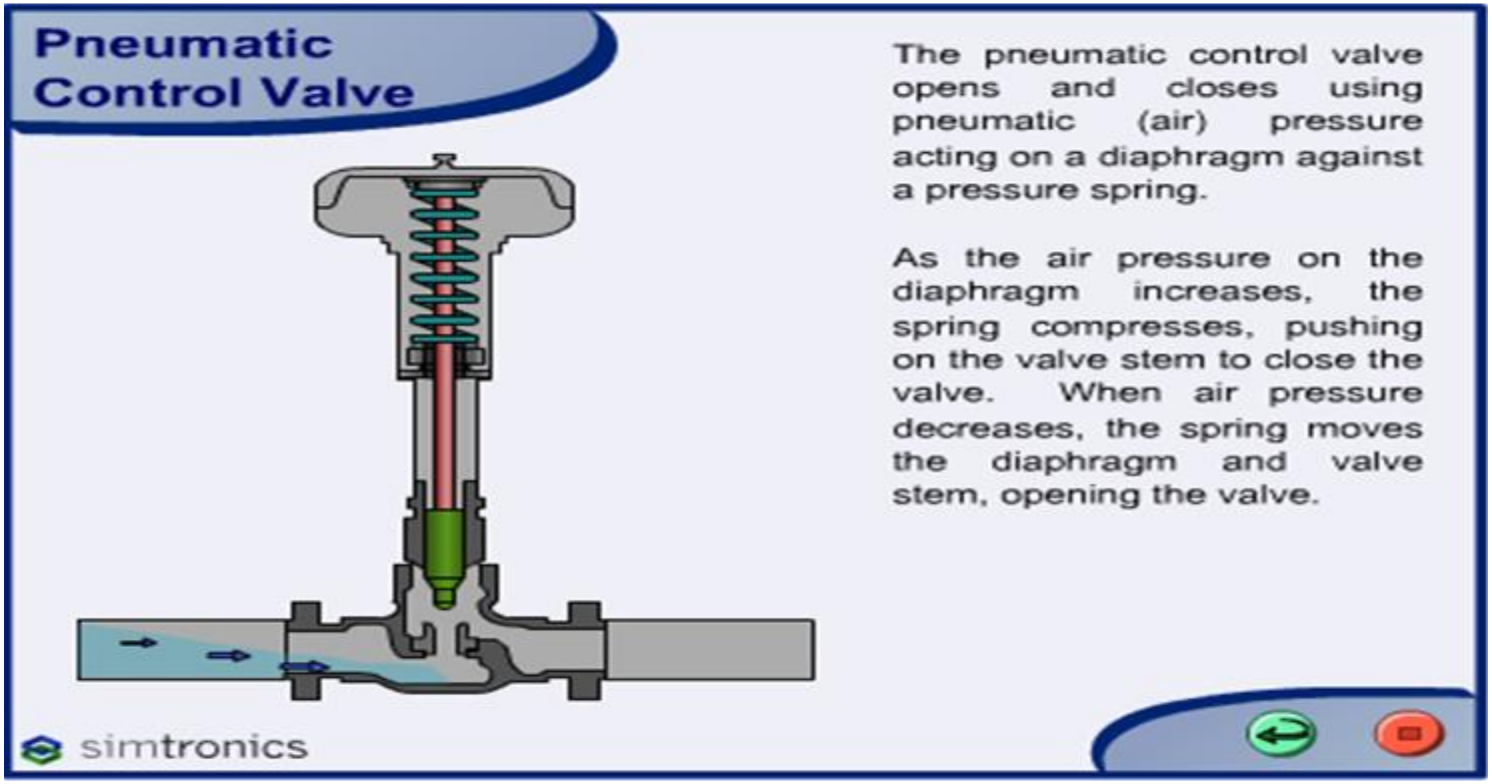

Figure 11. Pneumatic Control Valve

Courtesy of Simtronics Corporation

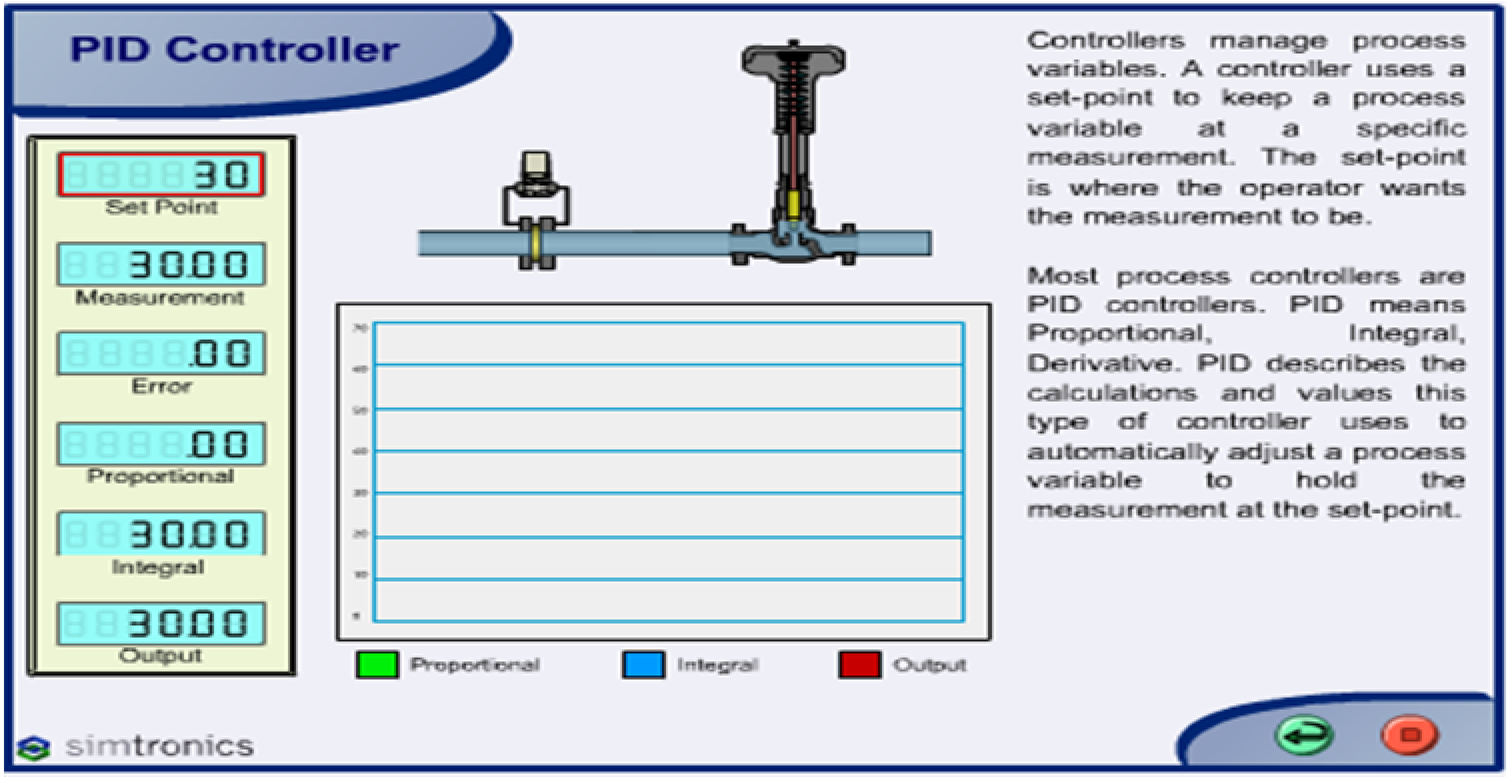

Figure 12. PID Controller

Courtesy of Simtronics Corporation

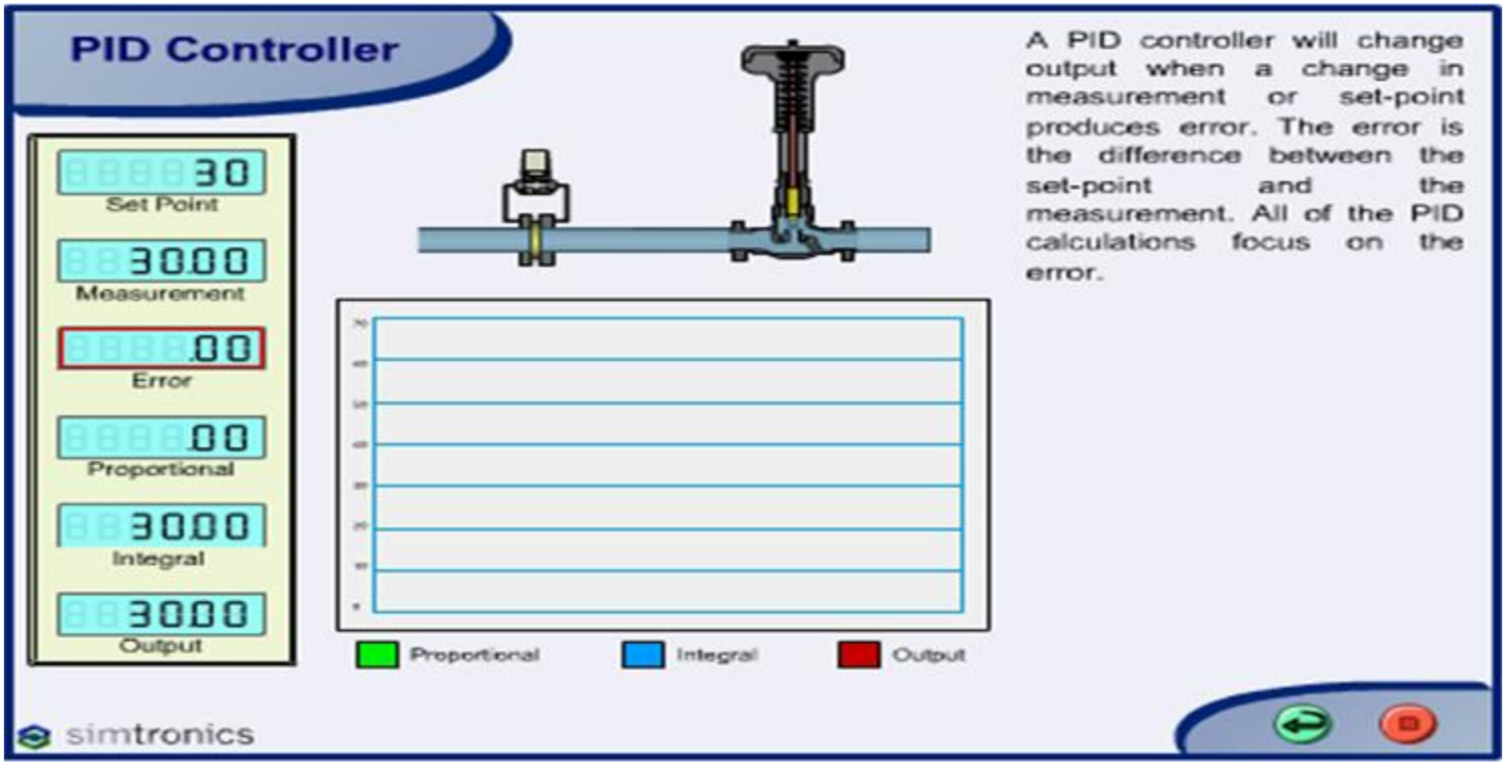

Figure 13. PID Controller

Courtesy of Simtronics Corporation

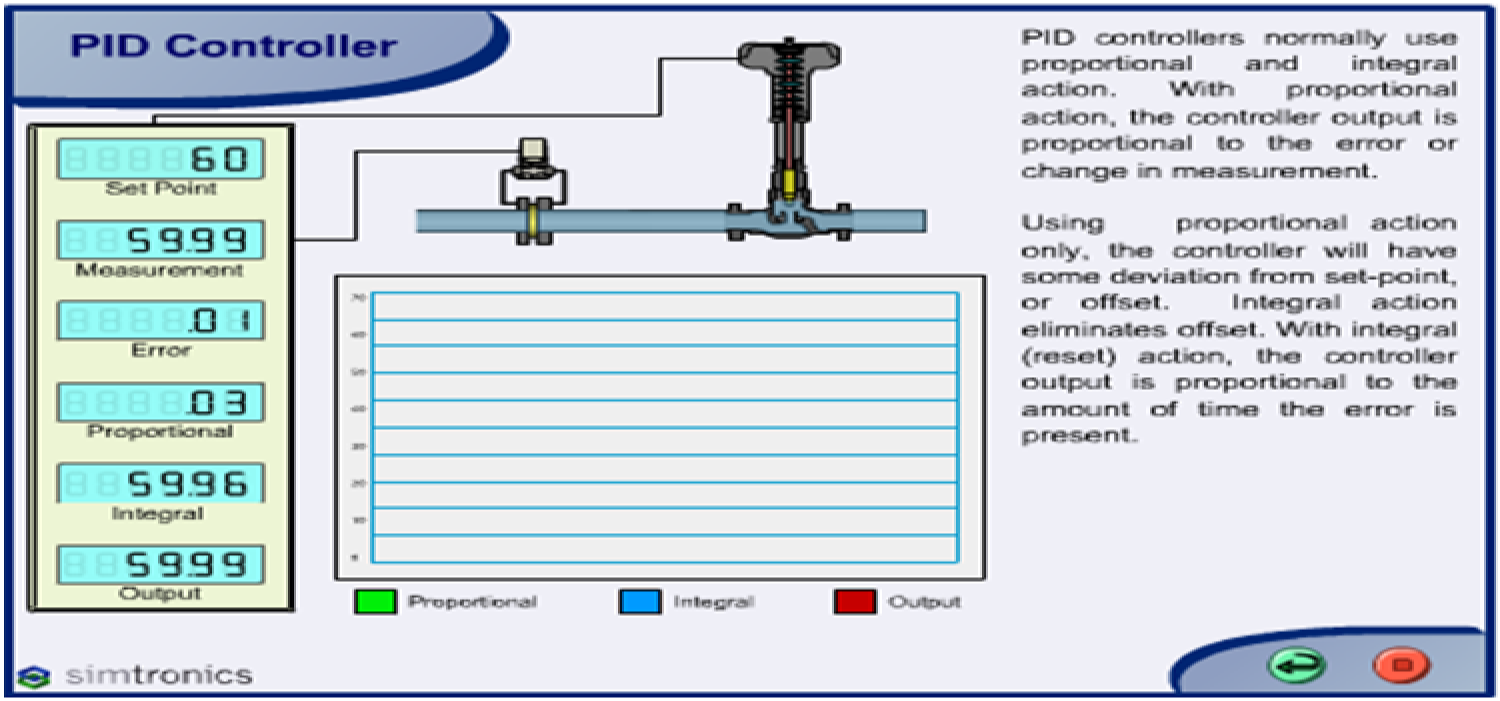

Figure 14. PID Controller

Courtesy of Simtronics Corporation

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING MODULE PERFORMANCE ASSESSMENT ACTIVITY (PAPER OR SIMULATOR-BASED)

Learner Directions: In this assessment, you will analyze and solve a paper or scenario-based instrumentation problem. Your instructor will provide you with the problem scenario and supporting materials.

Complete and submit all documentation requested including an Abnormal Operating Conditions table and Troubleshooting Form to your instructor.

Competency: Troubleshoot problems with a process variable.

Performance Criteria: Performance will be satisfactory when:

- Learner recognizes the problem and captures the problem in written form.
- Learner evaluates HSE risks involved with continued operation.
- Learner recognizes when the HSE hazard/s warrants shutting down equipment.
- Learner collects and analyzes data associated with the problem.
- Learner rewords problem based on initial observations and reasoning.
- Learner identifies possible causes of the problem.
- Learner selects most probable cause of the problem, one that explains every observation.
- Learner proposes corrective action that is rational and eliminates true cause (when possible).
- Learner accurately and completely documents problem and corrective action/s.
- Process equipment is stabilized (if simulator-based).
- System is returned to within $\pm$ 5% of design parameters (if simulator-based).
-

Conditions: Given a simulator-based problem (which may include a process description, equipment specifications, normal and abnormal operating conditions and appropriate tools), competence will be demonstrated by the completion of troubleshooting steps and subsequent documentation.

Assessment Strategy: Skill-based Performance Test

Standard: To be determined by the instructor. Example: Satisfactory performance requires learner must meet all criteria on the checklist.

NOTE: If the instructor uses simulator software that includes a performance scoring utility tool, then the instructor may wish to base the standard on the scoring tool. The instructor must describe the performance standards (generally by categories) for learners. Then, the instructor would have multiple options for the performance standard statement. For example, "Satisfactory performance requires learner to score a minimum of 80 for each of the performance category."

Scenario Statement

The control room technician notices that process variables are changing:

- PIC-501 ↓
- FI-501 ↓
- LIC-501 ↓
- FI-502 ↑
- PI-503 ↑

After analyzing the data, the technician decides that the pressure of the vapors out of the Flash Tank has dropped and the flow of vapors out to the Flash Tank has increased. The level in the Flash Tank has dropped and the pressure and flow out of the Flash Tank have increased.

Troubleshoot this situation.

Simulator Programming

The following table includes information needed for you to program the fault for a process simulation exercise. The fault has been written for use with Simtronics Corporation's SPM-500 Flash Tank.

Table 13. Fault Programming for Performance Assessment Activity

Description	PC-501 Transmitter	**Signal**	1.0	**Rise**	0.1
Status	Idle	**Normal**	1.0	**Start**	01:00
Direction	Fail Low	**High**	1.25	**Stop**	00:00:00
Function	Staircase	**Low**	0.0	**Delay**	00:01:00

Normal and Abnormal Operating Conditions

Table 14. Process Indication Values and Output Percentages for Instrumentation During Design Operating Conditions for Performance Assessment Activity

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-501	VAPORS FROM FLASH TANK	OPEN		
PIC-501	VAPORS PRESSURE FROM FLASH TANK	80.0	PSIG	61
LIC-501	FLASH TANK LEVEL	50.0	%	50.0
FI-501	VAPORS FLOW FROM FLASH TANK	420.0	ACFM	
FI-502	LIQUID FLOW FROM FLASH TANK	220.4	GPM	
PI-502	VAPOR PRESSURE FROM FLASH TANK	0.0	PSIG	
PI-503	LIQUID PRESSURE FROM FLASH TANK	81.8	PSIG	

Table 15. Process Indication Values and Output Percentages for Instrumentation During Abnormal Operating Conditions for Performance Assessment Activity

Courtesy of Simtronics Corporation

Tag ID	Description	Value	Eng. Units	Output Percent
HV-501	VAPORS FROM FLASH TANK	OPEN		
PIC-501	VAPORS PRESSURE FROM FLASH TANK	69.6	PSIG	2.2
LIC-501	FLASH TANK LEVEL	49.9	%	49.0
FI-501	VAPORS FLOW FROM FLASH TANK	267.3	ACFM	
FI-502	LIQUID FLOW FROM FLASH TANK	239.9	GPM	
PI-502	VAPOR PRESSURE FROM FLASH TANK	0.0	PSIG	
PI-503	LIQUID PRESSURE FROM FLASH TANK	101.1	PSIG	

Problem

Pressure at PIC-501 is falling. The vapor flow at FI-501 is decreasing. The liquid flow and pressure at the Flash Tank bottom has increased.

Investigative Actions

Check the pressure loop for Flash Tank vapor out.

Cause

PC-501 transmitter is failing low.

Compensating Actions

Place PIC-501 in manual.

Check local flow and level readings and adjust PIC-501 output to bring level back to normal.

Other loops may need to be placed in manual until the pressure is returned to normal.

Run at reduce rates and/or shut the system down if pressures, flows, and levels cannot be controlled.

Corrective Actions

Repair, calibrate or tune PIC-501 pressure controller.

Screen shot during design conditions (Performance Assessment Activity)

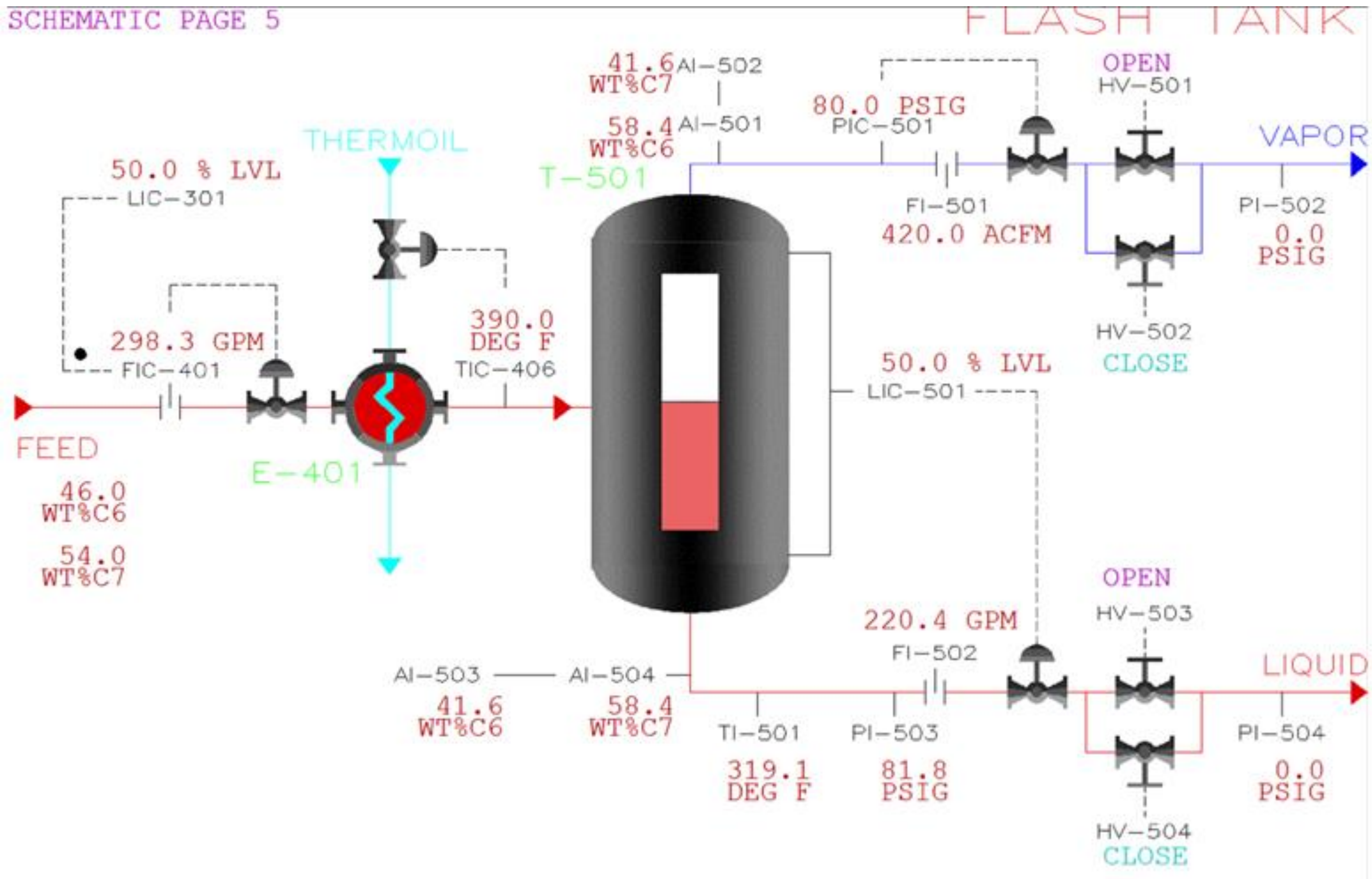

Figure 15. **Simtronics SPM-600 Unit Operations of Chemical Processing (Flash Tank)**
Initial Condition: Design; Fault: PC-501 Fails Low
Freeze at 3:00

Courtesy of Simtronics Corporation

Screen shot during abnormal conditions (Performance Assessment Activity)

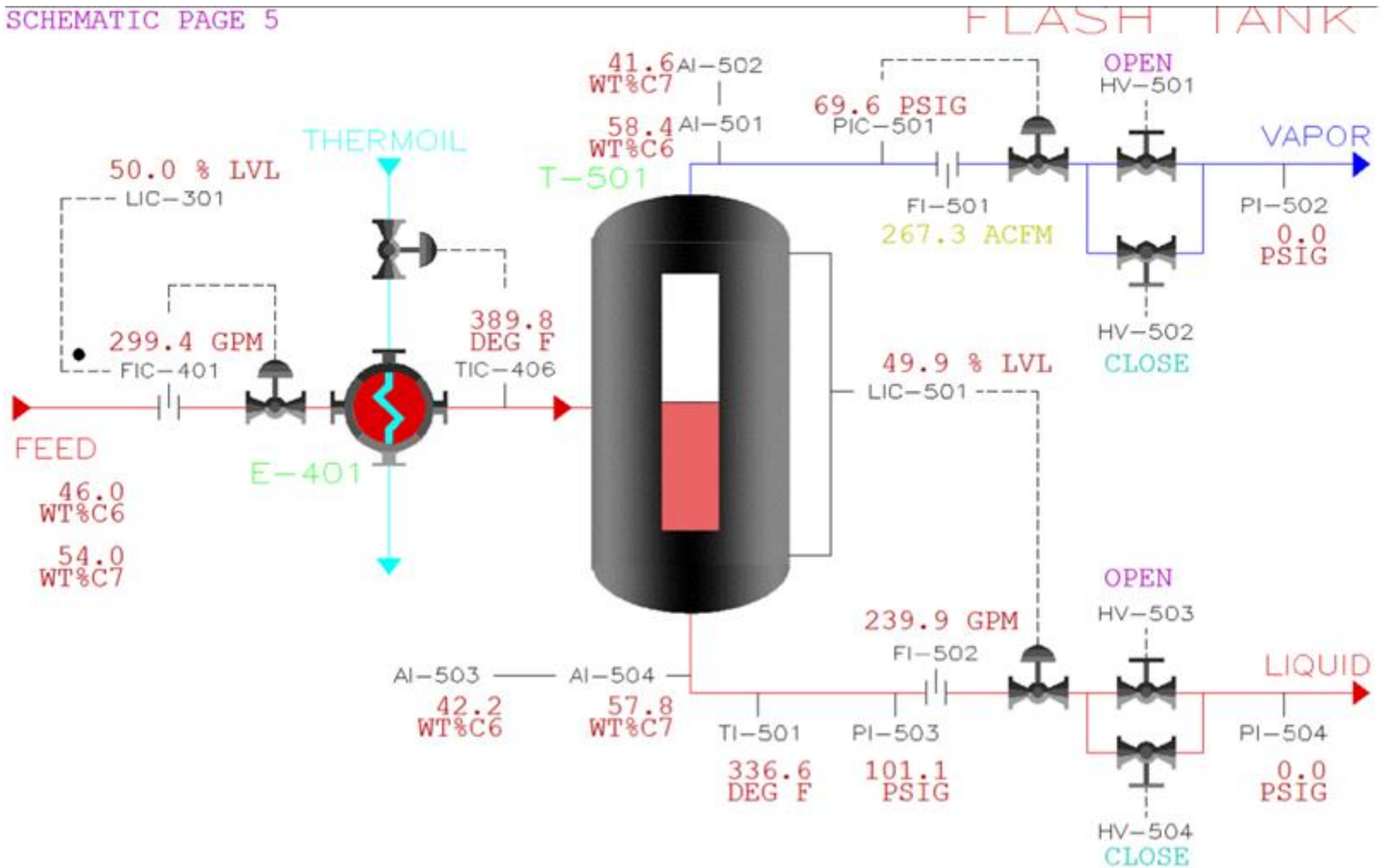

Figure 16. **Simtronics SPM-600 Unit Operations of Chemical Processing (Flash Tank)**
Initial Condition: Design; Fault: PC-501 Fails Low
Freeze at 3:00

Courtesy of Simtronics Corporation

TROUBLESHOOTING FORM (WITH RESPONSES)

1. **Recognize (and write) the problem.**

*(What **is** happening that should not be or what **is not** happening that should be?)*

Vapor pressure out of Flash Tank has decreased and flow out has decreased.

2. **Stabilize the system.**

(Does it need fixing? Stabilize the unit. Can we keep the unit running? Do we need to shut it down?)

Place PIC-501 in manual and adjust the output percentage.

Check local level and flow readings and adjust other loops to return to proper values.

3. **Collect and analyze the data.**

(Look for changes, differences, readings that have not changed, etc. Write down all observations. After every observation, write down the reason why. Then answer why for each reason.

Ex. Observation why? because Reasoning why? because Reasoning why? because Reasoning...)

Y N a. *HV-501 is open.*

why? because *it hasn't been changed.*

why? because *it should not have been changed.*

why? because *of system design.*

Y N b. *PIC-102 is indicating lower pressure.*

why? because

why? because

why? because

Y N c. *LIC-501 has decreased.*

why? because *pressure change has affected the boiling points of C6 and C7.*

why? because *of process dynamics.*

why? because *PIC-501 is trying to bring pressure back to setpoint.*

Y N d. *FI-501 has decreased.*

why? because *LIC-501 is trying to maintain level in Flash Tank.*

why? because *of control loop design.*

why? because

Y N e. *FI-502 has increased.*

why? because *LIC-501 is trying to maintain level in Flash Tank.*

why? because *of control loop design.*

why? because

Y N f. *PI-503 has increased.*

why? because *flow out of Flash Tank has increased..*

why? because *LIC-501 is trying to maintain level in Flash Tank.*

why? because

Y N g.

why? because

why? because

why? because

Y N h. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N i. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

Y N j. ______________________________

why? because______________________________

why? because______________________________

why? because______________________________

4. After initial observations and reasoning, **reword the problem** as specifically as possible.

PIC-501 is indicating lower pressure but vapor flow out of Flash Tank has decreased.

5. List **possible causes** of the problem.

Y N a. *PIC-501 is failing.*

Y N b. *PIC-501 tuning issue*

Y N c. *PT-501 is failing or out-of-calibration.*

Y N d. ______________________________

Y N e. ______________________________

*******Would each possible cause explain the problem? Circle **Y** or **N** beside each possible cause.

6. List the **most probable cause** of the problem. *(Use your knowledge, experience and best judgment.)*

PIC-501 is failing.

******* Does this cause explain every observation? Circle **Y** or N beside every observation.

7. Determine alternative solutions and select solution.

a. What would be an **investigative** action you could take at this point? What would be the effect?

Have instrument technician check PIC-501.

Instrument technician may need to place PIC-501 in manual.

b. What would be a **compensating** action you could take at this point? What would be the effect?

Adjust PIC-501 output in manual to bring pressure back to normal.

Will require close monitoring of pressure and other variables.

c. What would be a **corrective** action you could take at this point? What would be the effect?

Repair, replace or calibrate faulty instrument. Restore system to normal operation.

d. What will be the **effect** of the above actions? *(Would any of the actions cause other problems?)*

Possible disruption to processes upstream and/or downstream

Production of off-spec materials

8. Take the **corrective action** *(if empowered or within your responsibility).*

9. **Follow-up.** *(Was the problem eliminated? Was the “real” cause eliminated? What caused the real cause? You may need to start the problem-solving process again.)*

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10. **Document and share** with others.
(Document problem and actions taken in logbook or report; communicate with others.)

INSTRUMENT FAILURE/CONTROL LOOP FAILURE TROUBLESHOOTING RUBRIC
PAPER OR SIMULATOR-BASED PROBLEM

Competency: Troubleshoot problems with instrument failure.

CRITERIA		SCALE			
Product					
1.	Process equipment is stabilized (if simulator-based).	4	3	2	1
2.	System is returned to within $\pm$ 5% of design parameters (if simulator-based).	4	3	2	1
3.	Documentation is accurate.	4	3	2	1
4.	Documentation is complete.	4	3	2	1
5.	Documentation reflects correct use of terminology.	4	3	2	1
Process					
1.	Learner recognizes the problem and captures the problem in written form.	4	3	2	1
2.	Learner evaluates and documents HSE risks involved with continued operation.	4	3	2	1
3.	Learner recognizes and documents when the HSE hazard/s warrants shutting down equipment.	4	3	2	1
4.	Learner collects and analyzes data associated with the problem.	4	3	2	1
5.	Learner rewords problem based on initial observations and reasoning.	4	3	2	1
6.	Learner identifies possible causes of the problem.	4	3	2	1
7.	Learner selects most probable cause of the problem, one that explains every observation.	4	3	2	1
8.	Learner proposes corrective action that is rational and eliminates true cause (when possible).	4	3	2	1

Key

4 =	Met and/or surpassed criteria
3 =	Met criteria
2 =	Showed progress toward meeting criteria
1 =	Did not meet criteria

Bibliography

All figures and tables are courtesy of *Simtronics Corporation*.