

# **Recommended Practices for Installation and Testing of Vapor- Recovery Systems at Vehicle-Fueling Sites**



# CONTENTS

**Foreword.....iii**

## SECTIONS

**1. Introduction..... 1**

1.1 Origin ..... 1

1.2 Background ..... 1

1.3 Purpose ..... 1

1.4 Scope ..... 1

1.5 Sources ..... 1

1.6 Use of Other PEI Recommended Practices ..... 1

1.7 Importance of Competent Personnel ..... 2

1.8 Written Plans and Specifications ..... 2

1.9 Regulations ..... 2

**2. Definitions ..... 2**

2.1 Air to Liquid (A/L) Volume Ratio Test ..... 2

2.2 Bond ..... 2

2.3 Breakaway..... 2

2.4 California Air Resources Board (CARB)..... 2

2.5 Coaxial Drop Tube..... 2

2.6 Coaxial Hose..... 3

2.7 Combustible-Gas Detector ..... 3

2.8 Cubic Feet Per Minute (CMF), Cubic Feet Per Hour (CFH)..... 3

2.9 Digital Manometer ..... 3

2.10 Dispenser..... 3

2.11 Dispenser Sump ..... 3

2.12 Drive-Off..... 3

2.13 Drop Tube ..... 3

2.14 Dynamic Backpressure Test..... 3

2.15 Enhanced Vapor-Recovery (EVR)..... 3

2.16 Extractor Fitting ..... 3

2.17 Face Seal ..... 3

2.18 Fuel Outlet Fitting..... 3

2.19 Fuel/Vapor Splitter ..... 3

2.20 Ground ..... 4

2.21 Hanging Hardware ..... 4

2.22 Hose ..... 4

2.23 Hose Retractor ..... 4

2.24 Inches Water Column (Inches WC)..... 4

2.25 Incline Manometer ..... 4

2.26 Liquid Collection Point..... 4

2.27 Listed..... 4

2.28 Manifold..... 4

2.29 Manometer ..... 4

2.30 National Pipe Thread (NPT)..... 4

2.31 Nozzle ..... 5

2.32 Nozzle, Bellowless..... 5

2.33 Nozzle Bellows ..... 5

2.34 Nozzle Boot ..... 5

2.35 Nozzle Spout..... 5

2.36 Personal Protective Equipment (PPE) ..... 5

2.37 Poppeted Coaxial Drop Tube..... 5

2.38	Pressure Decay Test .....	5
2.39	Pressure Regulator .....	5
2.40	Pressure/Vacuum (P/V) Vent Cap .....	5
2.41	Reference Gauge .....	5
2.42	Riser .....	5
2.43	Spill-Containment Manhole .....	5
2.44	Stage I Vapor Recovery .....	6
2.45	Stage II Vapor Recovery .....	6
2.46	Stage II Vapor-Recovery Nozzle .....	6
2.47	Swivel .....	6
2.48	Tank-Top Sump .....	6
2.49	Top Off .....	6
2.50	Transition Sump .....	6
2.51	Ullage .....	6
2.52	Vapor-Emission Guard .....	6
2.53	Vapor/Fuel Splitter .....	7
2.54	Vapor-Recovery Adapter .....	7
2.55	Vapor-Recovery System .....	7
2.56	Vapor Shear Valve .....	7
2.57	Vapor Valve .....	7
2.58	Vent Cap .....	7
2.59	Volatile Organic Compound (VOC) .....	7
2.60	Whip Hose .....	7
<b>3.</b>	<b>Stage I Vapor-Recovery Systems .....</b>	<b>7</b>
3.1	Stage I Vapor Recovery .....	7
3.2	Vapor-Recovery Adapters .....	7
3.3	Types of Stage I Vapor-Recovery Systems .....	7
3.3.1	Two-Point (Dual Point) Stage I Vapor-Recovery Systems .....	8
3.3.2	Coaxial Stage I Vapor-Recovery Systems .....	8
3.3.3	Manifolded Stage I Vapor-Recovery Systems .....	9
3.4	Aboveground Tanks .....	10
<b>4.</b>	<b>Stage II Vapor-Recovery Systems .....</b>	<b>10</b>
4.1	Stage II Vapor-Recovery .....	10
4.2	Balance Systems .....	10
4.3	Vacuum-Assist Systems .....	10
4.4	Aboveground Tanks .....	13
<b>5.</b>	<b>Stage II Vapor-Recovery System Components .....</b>	<b>13</b>
5.1	General .....	13
5.2	Nozzles .....	13
5.3	Hoses .....	13
5.4	Swivels .....	14
5.5	Breakaways .....	14
5.6	Hose Retractors .....	14
5.7	Vapor Valves .....	14
5.8	Dispensers .....	14
5.9	Vacuum-Assist Devices .....	15
5.10	Ball Valves .....	15
5.11	Vapor Shear Valves .....	15
5.12	Pressure/Vacuum Vent Valves .....	15
5.13	Vapor-Return Piping .....	16
5.14	Liquid-Collection Point .....	16

<b>6. Aboveground Vapor-Recovery Piping Connected To Aboveground Tanks .....</b>	<b>18</b>
<b>7. Underground Piping and Fittings .....</b>	<b>18</b>
7.1 General Requirements for Underground Vapor-Recovery Piping.....	18
7.2 Underground Piping Materials.....	18
7.3 Underground Piping Practices .....	18
7.4 Underground Piping Layout and Trenches.....	18
7.5 Underground Piping Backfill and Compaction .....	19
7.6 Flexible Connectors .....	19
7.7 Underground Fiberglass Piping .....	19
7.8 Underground Flexible Piping.....	19
7.9 Containment Sumps.....	20
7.10 Riser Piping.....	20
7.11 Testing of Underground Primary-Vapor Piping.....	20
7.11.1 Initial Piping Test.....	20
7.11.2 Initial System Test .....	20
7.11.3 Dynamic Backpressure Test.....	21
7.11.4 Monitoring During Construction .....	21
7.11.5 Post-Construction Testing.....	21
7.12 Testing of Underground Secondary-Vapor Piping.....	21
7.12.1 Initial Test for Underground Secondary Piping.....	21
7.12.2 Monitoring During Construction .....	21
7.12.3 Final Integrity Test for Secondary Piping.....	21
7.12.4 Cleaning Up.....	21
<b>8. Pressure Decay Test .....</b>	<b>22</b>
8.1 General .....	22
8.2 Test Equipment .....	22
8.2.1 Nitrogen Cylinder and Regulator .....	22
8.2.2 Provision for Bonding and Grounding .....	22
8.2.3 Pressure-Relief Valve.....	22
8.2.4 Pressure-Measuring Equipment.....	22
8.2.4.1 Digital Manometer .....	22
8.2.4.2 Mechanical Pressure Gauge .....	23
8.2.4.3 Manometer.....	23
8.2.5 Vent Plug.....	23
8.2.6 Flow Meter.....	23
8.2.7 Stopwatch.....	23
8.2.8 Shut-Off Valve .....	23
8.2.9 Isolation Valve .....	23
8.2.10 Test Assembly .....	23
8.2.11 P/V Vent Valve Test Assembly .....	24
8.2.12 Leak-Locating Methods and Devices .....	24
8.3 Preparing for the Test.....	24
8.3.1 Safety .....	24
8.3.2 Delay After Deliveries .....	24
8.3.3 Delay After A/L Testing.....	24
8.3.4 Delay After Dispensing.....	24
8.3.5 Place Dispensing Equipment in Normal Operating Position .....	24
8.3.6 Remove Fill Adapter Caps and Vapor Adapter Dust Caps.....	24
8.3.7 Check Product Level.....	24
8.3.8 Check Drains in Spill-Containment Manholes.....	24
8.3.9 Check Ullage Volume .....	25
8.3.10 Drain Liquid-Collection Points.....	25
8.3.11 Connect Test Assembly.....	25

8.3.12	Bond and Ground the Test Equipment .....	25
8.3.13	Calculate Pressurization Time .....	25
8.3.14	Turn Off Vapor Processors.....	25
8.4	Test Procedure.....	25
8.4.1	Initiate Safety Procedures .....	25
8.4.2	Warm Up the Digital Manometer .....	25
8.4.3	Pre-Test the Stage I Vapor-Recovery Adapter.....	25
8.4.4	Close the Valve Between the Vacuum Pump and the Storage Tank .....	26
8.4.5	Stop Dispensing and Monitor Pressure .....	26
8.4.6	Pressurize the Ullage Space of the Storage System.....	26
8.4.7	Monitor the Time Required to Pressurize the Storage System .....	26
8.4.8	Pressurize the Ullage to 2.2 Inches WC.....	26
8.4.9	Conduct the Test .....	27
8.4.10	If the Storage System Fails the Test.....	27
8.4.11	If the Vapor Return Lines Are Not Manifolder.....	27
8.4.12	If the Vapor Piping Was Isolated from the Tank(s).....	27
8.4.13	Test the P/V Vent Valve .....	27
8.4.14	Reporting Results.....	27
8.4.15	Cleaning Up.....	28
8.5	Testing Aboveground Tanks .....	28
<b>9.</b>	<b>Dynamic Backpressure Test .....</b>	<b>28</b>
9.1	General .....	28
9.2	Dynamic Backpressure Test Methods .....	28
9.3	Dynamic Backpressure Test Equipment.....	29
9.3.1	Nitrogen Cylinder and Regulator .....	29
9.3.2	Provision for Bonding and Grounding .....	29
9.3.3	Pressure-Relief Valve.....	29
9.3.4	Pressure-Measuring Equipment.....	29
	9.3.4.1 Digital Manometer .....	29
	9.3.4.2 Mechanical Pressure Gauge .....	29
9.3.5	Flow Meter.....	30
9.3.6	Shut-Off Valve .....	30
9.3.7	Simulated Fill Pipe .....	30
9.3.8	Gasket .....	30
9.3.9	“T” Assembly.....	30
9.3.10	Pump .....	30
9.3.11	Portable Gasoline Tank.....	30
9.3.12	Stopwatch.....	30
9.3.13	Vapor-Adapter Opener.....	30
9.4	Preparing for the Test.....	30
9.4.1	Initiate Safety Procedures.....	30
9.4.2	Verify the Integrity of the Storage System .....	30
9.4.3	Flow Liquid Through the Vapor Piping.....	31
9.4.4	Drain Liquid-Collection Point.....	31
9.4.5	Bond and Ground the Test Equipment .....	31
9.4.6	Check Test Equipment for Leaks.....	31
9.4.7	Check Method 1 Test Equipment for Backpressure .....	31
9.4.8	Check Method 4 Test Equipment for Backpressure .....	31
9.4.9	Connect “T” Assembly .....	31
9.5	Test Procedure .....	31
9.5.1	Initiate Safety Procedures.....	31
9.5.2	Vent the Storage System.....	31
9.5.3	Insert Nozzle in Simulated Fill Pipe.....	32
9.5.4	Close the Nitrogen Flow-Control Valve .....	32
9.5.5	Close the Inlet Valve of the Low-Pressure Mechanical Gauge.....	32

9.5.6	Set the Nitrogen Delivery Pressure .....	32
9.5.7	Adjust the Nitrogen Flow Rate.....	32
9.5.8	Record Backpressure .....	32
9.5.9	Compare Measured Backpressure to Acceptable Backpressure Level .....	32
9.5.10	If the Backpressure Exceeds the Acceptable Level.....	32
9.5.11	Record Results .....	32
9.5.12	Increase Nitrogen Flow Rates.....	33
9.5.13	Repeat Test for All Other Nozzles/Dispensers .....	33
9.5.14	Clean Up .....	33
9.6	Aboveground Tanks .....	33
<b>10.</b>	<b>Air-to-Liquid (A/L) Volume Ratio Test.....</b>	<b>33</b>
10.1	General .....	33
10.2	Test Equipment .....	33
10.2.1	Air-Volume Meter.....	33
10.2.2	Nozzle Vapor Adapter.....	34
10.2.3	Portable Gasoline Tank.....	34
10.2.4	Air-Volume Meter Air Intake.....	35
10.2.5	Liquid-Volume Meter.....	35
10.2.6	Stopwatch.....	35
10.2.7	Lubricant.....	35
10.3	Preparing for the Test.....	35
10.3.1	Initiate Safety Procedures.....	35
10.3.2	Determine Whether the Test Is to be Conducted with the Pressure/Vacuum Vent Valve Installed .....	36
10.3.3	Determine If the Test Is to be Conducted with the Vapor Processor On or Off .....	36
10.3.4	Determine the Volume to be Dispensed During the A/L Test .....	36
10.3.5	Determine the Fuel-Dispensing Rate Required by the Equipment Certification.....	36
10.3.6	Check to See If the Air-Meter Calibration Is Current .....	36
10.3.7	Verify that the Spouts of the Nozzles to be Tested are in Good Condition .....	36
10.3.8	Check that the Nozzle Vapor Adapter is Compatible with the Nozzle Spout.....	36
10.3.9	Check the Condition of the Nozzle-Vapor-Adapter Seals.....	36
10.4	Test Procedures .....	36
10.4.1	Initiate Safety Procedures .....	36
10.4.2	Ground the Portable Test Tank .....	36
10.4.3	Ensure that There Is No Gasoline in the Test-Equipment Tubing.....	36
10.4.4	Install the Nozzle Vapor Adapter.....	36
10.4.5	Record the Initial Air-Volume Meter Reading.....	37
10.4.6	Reset the Dispenser Meter Display.....	37
10.4.7	Reset the Stopwatch.....	37
10.4.8	Insert Nozzle in Test Tank and Start the Test .....	37
10.4.9	Dispense Fuel and Time the Test.....	37
10.4.10	Calculate the Fuel Dispensing Rate and Verify that it is Acceptable .....	37
10.4.11	Calculate A/L Ratio.....	37
10.4.12	If a Nozzle Fails by a Narrow Margin.....	38
10.4.13	Record Data.....	38
10.4.14	Testing Unihose Dispensers .....	38
10.5	Troubleshooting .....	38
10.5.1	Test the Nozzle Vapor Adapter Seal .....	38
10.5.1.1	Nozzle-Vapor-Adapter Test Equipment .....	38
10.5.1.2	Nozzle-Vapor-Adapter Test Procedure.....	39
10.6	Post-Test Procedures .....	39
10.6.1	Replace P/V Vent Valve.....	39
10.6.2	Empty Portable Tank .....	39
10.6.3	Carefully Seal the Inlet and the Outlet of the Air-Volume Meter .....	39
10.7	Aboveground Storage Tanks.....	39

<b>11. Electrical Installation</b> .....	<b>39</b>
11.1 General Requirements.....	39
11.2 Classifications.....	39
11.3 Electrical Equipment.....	40
<b>12. Testing and Inspection</b> .....	<b>42</b>
12.1 General.....	42
12.2 Test Results.....	42
12.3 Other Testing.....	42
<b>13. Documentation and Training</b> .....	<b>42</b>
13.1 As-Built Drawings.....	42
13.2 Component Documentation.....	43
13.3 Scheduled Maintenance.....	43
13.4 Training.....	
<b>14. Decommissioning Stage II Vapor-Recovery Piping</b> .....	<b>43</b>
14.1 Introduction.....	43
14.2 Nature of the Procedure.....	43
14.3 Qualifications.....	44
14.4 Paperwork.....	44
14.5 Applicability.....	44
14.6 Decommissioning Procedure.....	44
14.6.1 Initiate Safety Procedures.....	44
14.6.2 Relieve Pressure in the Tank Ullage.....	44
14.6.3 Drain Liquid-Collection Points.....	44
14.6.4 Vacuum-Assist Systems with Vapor Pumps for Each Fueling Position.....	45
14.6.5 Vacuum Assist Systems with a Centrally Located Vapor Pump.....	45
14.6.6 Isolate the Below-Grade Vapor Piping at the Base of the Dispenser.....	45
14.6.7 Disconnect the Vapor Piping at the Tank Top.....	45
14.6.8 Seal the Dispenser Cabinet Vapor Piping.....	46
14.6.9 Replace Hanging Hardware.....	46
14.6.10 Replace the Pressure/Vacuum Vent Valve(s).....	46
14.6.11 Remove Stage II Operating Instructions from Dispensers.....	46
14.6.12 Conduct Pressure Decay Test and Tie-Tank Test.....	46
14.6.13 Conduct a Final Visual Check.....	46
14.6.14 Complete the Checklist in Appendix C of this document.....	46

**APPENDICES**

<b>Appendix A: Pressure Decay Test Tables</b> .....	<b>47</b>
<b>Appendix B: Sample Forms for Test Data Recording</b> .....	<b>49</b>
<b>Appendix C: Stage II Decommissioning Checklist</b> .....	<b>52</b>
<b>Appendix D: Publication Reference</b> .....	<b>53</b>