

# Refinery Sector Rule

## Case Study: MPV/PRD Synergistic Analysis & MPV/PRD EPA Proposed Technical Updates

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# Agenda

- Regulation Summary
- Case Studies: MPV and PRD Analysis
- Lesson Learned
- Proposed Amendment Updates

## Regulation Summary- MPV

- MPV Definition:
  - Gas stream > 20 ppmv of organic HAP;
  - Continuously or periodically discharged to the atmosphere or control device.
- MPV Category:
  - Group 1 MPV: VOC Emissions > 72 lb/day for existing vents and VOC Emissions > 15 lb/day for new vents
  - Group 2 MPV: Not a Group 1 MPV;
  - Maintenance MPV: Open only for startup, shutdown, maintenance, inspection purposes.
- Compliance Deadline:
  - August 1, 2017 – (Typical Extension granted was 1 year);
  - *Our Analysis took two (2) Months.*



## Case Study: MPV Analysis

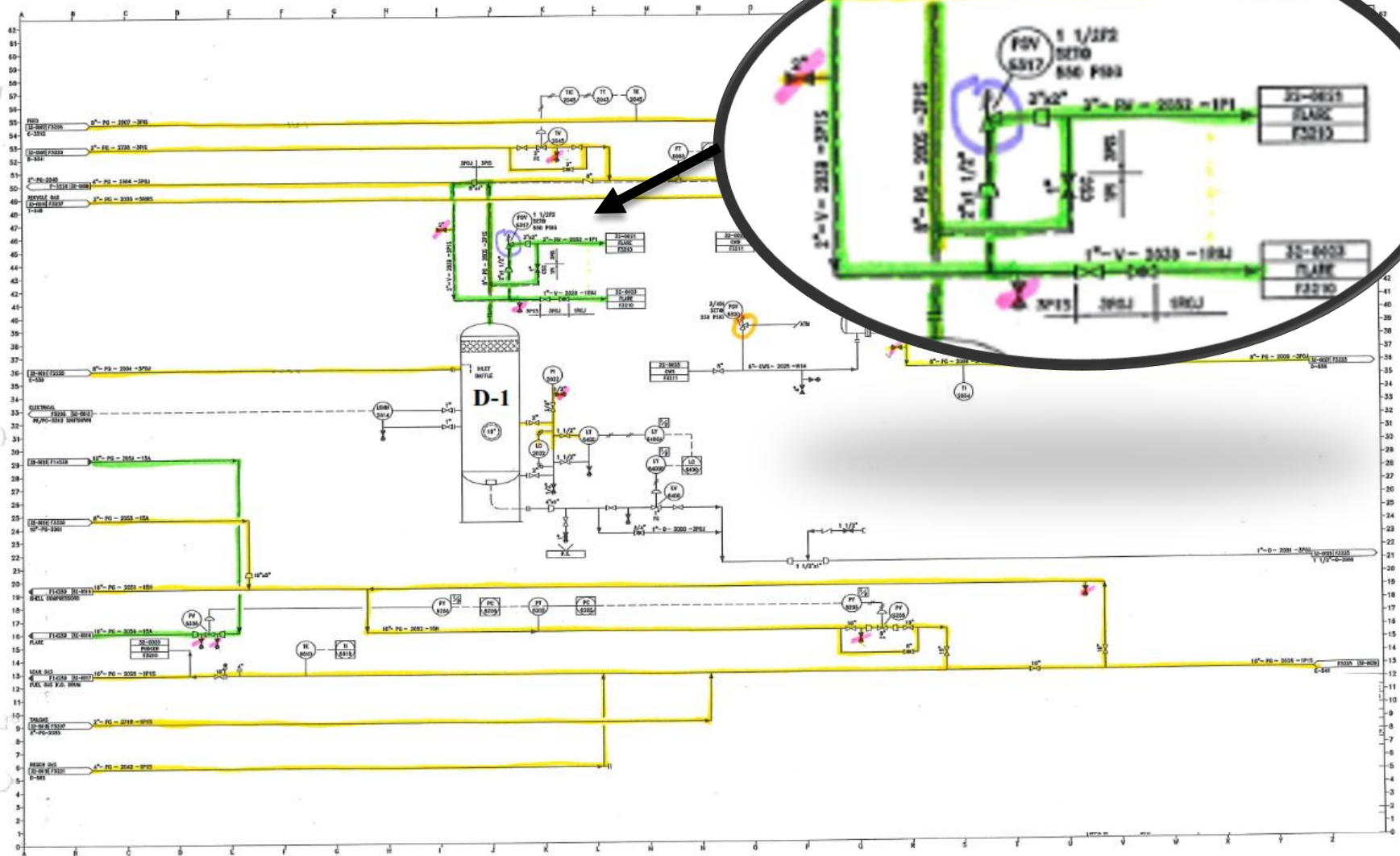
- Create a 'Property Stream Database'
- Highlight P&IDs to identify potential vent streams
- Create 'Applicability Tool':
  - Initial documentation based on the P&IDs for each MPV:
    - Source equipment dimensions (diameters, length);
    - Operating Temperatures; and
    - Stream composition;
  - Logic created for MPV Exemptions;
  - Calculate MPV VOC emissions lb/day.
- Operator / Process Engineer Interviews

# Example of 'Property Stream Database'

Product Code	System Description	VOC				MACT CC HAP		Stream VOC Vapor Pressure at Varying Temperatures (F)						
		Mass %	MW	Volume %	ppmv	Volume %	ppmv	60	68	95	100	120	150	200
50001	Atmospheric Tower Overhead Vapor	89.2	41.38	91.49	914,891	0.00	-	50.0	56.6	83.8	89.7	116	167	282
50002	Atmospheric Tower Bottoms	100.0	134.88	100.00	1,000,000	12.46	124,600	0.17	0.21	0.43	0.48	0.76	1.45	3.69
50003	Atmospheric Tower Overhead & Reflux (Liquid)	81.5	28.27	82.50	825,003	0.05	460	36.2	41.0	60.8	65.1	84.6	121	205
50009	Crude Feed to Atmospheric Tower	100.0	113.70	100.00	1,000,000	48.02	480,250	0.26	0.33	0.69	0.78	1.27	2.45	6.36
50025	Light Straight Run Naphtha	99.9	86.27	99.97	999,666	5.57	55,733	3.16	3.78	6.68	7.37	10.76	18.08	38.42

- Vapor pressure calculated using on Antoine's coefficients for each constituent in each stream.
- Property Stream Database was built from LDAR stream databased.
- Property Stream Database has multiple uses for Environmental Dept. programs such as upset/spill calculations, Emission Inventory, Maintenance, Startup and Shutdown (MSS) emission estimates.
- Creation of 'Property Stream Database' was completed in one (1) week.

# Example of Highlighted P&ID



## Example of 'Applicability Tool'

Equipment Number	Diameter ft	Length ft	Volume per unit Turnaround Calcs ft3	Vent Destination	Service Type	Temp F	Stream ID	VOC Content ppm	MACT CC HAP Content ppmw	Does it meet Miscellaneous Process Vent definition ?	Use for Maintenance Only?	VOC Maintenance Emissions lb/day (Pentane LEL)	MMPV	Group 1 MPV	Group 2 MPV
T-1	20.0	129.5	35,474.46	Atmosphere	Vapor	150	50003	814,762	460	Applicable	Yes	8.05	Yes	No	No
D14A	0.3	1	0.07	FGR	Vapor	100	62001	251,364	2,219	Applicable	No	1.75E-05	No	No	Yes

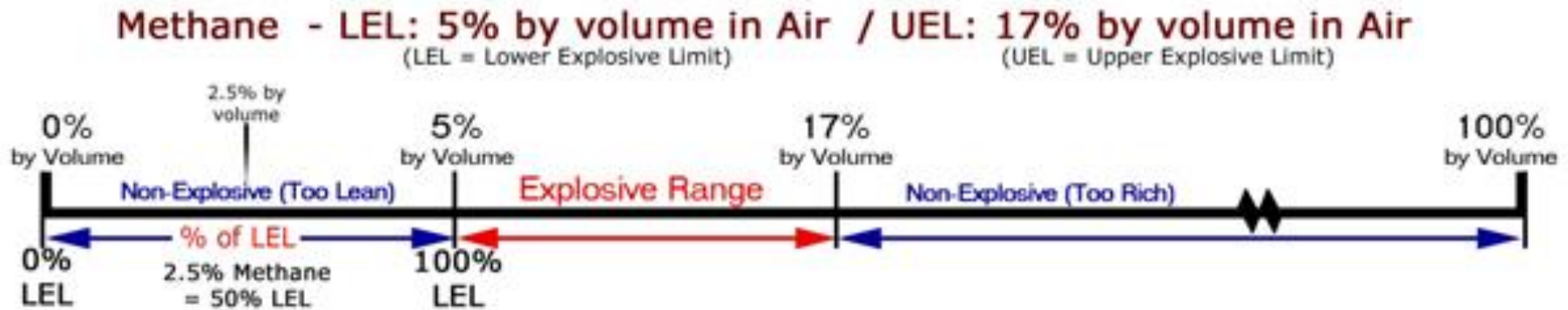
- P&ID highlighting and 'Applicability Tool' population took approx. 3 weeks.

Using %LEL to estimate VOC emissions greatly reduced our applicable Maintenance Vents!





# %LEL Calculation Background



Useful Tutorial: <https://www.shopcross.com/smart/lel-lower-explosive-limit>

# %LEL Calculation Example

Emissions based on Lower Explosive Level (LEL)			
Atmosphere Vapor Pressure	$P_{atm}$	14.7	psia
Ideal Gas constant	R	10.73	psia*ft <sub>3</sub> /R*lb-mol
Vessel Volume	V	35474	ft <sup>3</sup>
Operating Temperature	F	150	
LEL Reading upon opening vessel to atmosphere	LEL	10%	
Molecular Weight of measured Vapor	MW	16	lb/lb-mol based on Methane
Compound Concentration at 100% LEL	C	5.0%	Based on Methane
<b>VOC Emissions to Atmosphere</b>	<b>lb/event</b>	<b>6.37</b>	<b>=<math>P_{atm} * LEL\% * C\% * Volume * Mw / R</math></b>
Avg. Fraction of HAP in Materials		825,003	ppmw
<b>Mass of Vapor HAP Released to Atmosphere</b>	<b>lb/event</b>	<b>5.26</b>	<b>=VOC Emission*HAP Fraction</b>

# Liquid Heel –ICR Ex 11-2

Parameter Name & Variable			Value & Units		Basis/Calculation/Notes
1.	Values and Calculations		Values based on:		
	Fraction of Residual Liquid After De-inventory	%	2 %		
	Gas Constant	R	10.73	psia ft³/lb-mole °R	
	Density of Light Material	D	5.96	lb/gal	
	Atmospheric Pressure	P <sub>A</sub>	17.00	psig	
	Vessel Pressure at Opening to Atmosphere	P <sub>V</sub>	3.00	psig	
	Avg. Vapor Molecular Weight of Light Material	MW	86	lb/lb-mol	
	Operating Temperature	T	150	°F	= ( " °F " value) + 460
			610	°R	
	Avg. Fraction of HAP in Materials		825,003	ppmw	
2.	Hourly Max. Release to Atmosphere from Opening Cleared Vessel				
Parameter Name & Variable			Value & Units		Basis/Calculation/Notes
	Vessel Service Location		T-1		
	Volume of Total Vessel	V <sub>V</sub>	35,474	ft³	Based on Vessel Dimensions
	Mass of Liquid Volatilized Contained in Vessel	M <sub>L</sub>	31625	lb	= V <sub>V</sub> * 7.4805 gal/ft³ * % * D
	VOC Emissions to Atmosphere	M <sub>V</sub>	9,352	lb	= V <sub>V</sub> * M <sub>V</sub> * (P <sub>A</sub> + P <sub>V</sub> ) / ( R * T )
	Mass of Vapor HAP Released to Atmosphere	M <sub>HA</sub>	1,157	lb	= VV * MV * Pv * (CV/1000,000) / ( R * T )

## Make sure you use MPV Exemptions:

- **Streams routed to a fuel gas recovery system;**
- **Leaks from equipment regulated under §63.648;**
- FCCU catalyst regeneration vents;
- Catalytic reformer regeneration vents;
- Sulfur plant vents;
- Vents from control devices applied to FCC regeneration vents, reformer regeneration vents, and sulfur plant vents;
- **Wastewater stripping vents that comply with HON or BWON;**
- Delayed coking unit decoking operations;
- **Storage vessels;**
- Wastewater (sewer) vents; and
- Hydrogen production plant vents through which CO<sub>2</sub> is removed from process streams or through which steam condensate produced or treated within the hydrogen plant is degassed or deaerated.

# Operator / Process Engineer Interview

- Refinery Interviews were conducted in 10 hours divide across units/weeks
- Tools:
  - Highlighted P&IDs
  - MPV 'Applicability Tool' print out
  - 'Property Stream Database' stream names
  - Operations Interview Agenda
  - Use of data historian to obtain information
- Staff Required:
  - Knowledgeable operator
  - Process Engineer
  - Environmental Personnel

# Ops Interview Agenda

1	Discuss Purpose of Meeting/Define Miscellaneous Process Vents (MPV), Miscellaneous Maintenance Process Vents (MMPV) and Process Relief Valves (PRDs)
2	Review Highlighted Piping and Instrumentation Diagrams (P&IDs)
3	Discuss Maintenance Preparation Procedures/Wash Procedures
4	Classify MPVs vs. MMPVs. MMPVs- is a vent only used as a result of startup, shutdown, maintenance, or inspection of equipment where equipment is emptied, depressurized, degassed or placed into service.
5	Identify/Verify the Destination of Each MPV and PRD (e.g. flare, control device, atmosphere, etc.)
6	Identify Any "Other" MPVs or MMPVs not listed in the PIDs or in the PRD list.
7	Quantify daily vent gas flow rates from MPVs
8	Quantify Deinventory Volumes for MMPVs
9	Quantity flow rate from PRDs
10	Verify gas stream temperature
11	Verify accuracy of Stream Speciation (See attached Stream Component Composition)
12	Account for in-situ samplers (onstream analyzers)
13	Account commonly missed MPVs: Caustic wash accumulators, distillation tower condensers/accumulators, flash/knockout drums, reactor vessels, scrubber overheads, stripper overheads, vacuum pumps, steam ejectors, hot wells, high point bleeds, wash tower overheads, water wash accumulators, and blowdown condensers/accumulators.

Texas MSS Permit (applicability based on VOC VP of material at process temperatures or 100F)	Maintenance Misc. Process Vent Work Practice Standard
Depressure to control device	Depressure to control device, FGR, process
Drain process liquids to a closed vessel (can use open container if constrained by equipment configuration)	Drain process liquids from equipment
Degass to control device or controlled recovery system until: <ul style="list-style-type: none"> <li>• LEL &lt;10%</li> <li>• VOC &lt;10,000 ppm</li> </ul>	Depressure vapor from equipment to control device, FGR, process until: <ul style="list-style-type: none"> <li>• LEL &lt;10%</li> <li>• Equipment Pressure &lt; 5psig (if LEL cannot physically cannot be measured)</li> <li>• Equipment contains &lt; 72 lb VOC/day</li> </ul>
LEL detector calibrated monthly to pentane, daily function test on each detector.	Calibrate and maintain LEL meters according to manufacture specifications
The following can vent directly to ATM: <ul style="list-style-type: none"> <li>• Equipment contains &lt; 50 lb air contaminate/day</li> <li>• Not technically practicable to depressure/degas</li> <li>• No available connection to plant flare</li> <li>• Material with VOC VP &lt;0.5 psi at process temp/100 F (must drain liquid)</li> </ul>	

## Regulation Summary- PRD

- **PRD Definition:**
  - Gas stream > 20 ppmv of organic HAP;
  - Continuously or periodically discharged to the atmosphere or control device.
- **PRD Category:**
  - Group 1 MPV: VOC Emissions > 72 lb/day
  - Group 2 MPV: Not a Group 1 MPV
- **Compliance Deadline:**
  - January 30, 2019



## Case Study: PRD Analysis

- Use 'Property Stream Database'
- Used Inspection Department PRD Database as a starting point and verified against the highlight P&IDs
- Create 'Applicability Tool'
  - Initial documentation based on the PIDs for each MPV:
    - Source equipment dimensions (diameters, length);
    - Operating temperature; and
    - Stream composition;
  - Logic created for PRD Exemptions;
  - Calculate PRD VOC emissions lb/day;

# Applicability Tool

Process Unit Name	PSV #	Set Pressure	Pipe diameter (in)	Pipe Length (ft)	Temp (F)	Vents to	Stream ID	VOC MW	VOC Emissions (lb/day)	MACT CC "In Service Organic HAP"	RSR Applicable
FCC	1	50	6	500	300	Flare	55012	134.41	81	Yes	N- Vents to Control
FCC	2	14.7	4.4	500	236	ATM	1000	0.00	0	No	Exempt < 72 lb/day
FCC	3	200	4.4	500	236	Process	55014	136.89	194	Yes	N-Vents to Process

- VOC emission calculations use ideal gas law at process temperature and set pressure.

# PRD Ideal Gas Equation Volume Worst Case Calculations

		Pipe Diameter (in.)									
		4	6	8	10	12	18	24			
Pipe Length (ft.)	10	0.4	0.8	1.4	2.2	3.2	7.2	12.7	<b>Inputs (yellow)</b>		
	50	1.8	4.0	7.1	11.0	15.9	35.8	63.6	130	Vapor MW	lb/lb-mol
	100	3.5	7.9	14.1	22.1	31.8	71.5	127.1	5	Pipe P	psig
	150	5.3	11.9	21.2	33.1	47.7	107.3	190.7	70	Pipe T	°F
	200	7.1	15.9	28.2	44.1	63.6	143.0	254.2	n	Any liquid?	y/n
	250	8.8	19.9	35.3	55.2	79.4	178.8	317.8	17.7	Absolute Pressure	
	300	10.6	23.8	42.4	66.2	95.3	214.5	381.3	530.0	Temperature	
	350	12.4	27.8	49.4	77.2	111.2	250.3	444.9	10.73	R	psia ft <sup>3</sup> /lb-mole °R
	400	14.1	31.8	56.5	88.3	127.1	286.0	508.5	Assumption: vapor only, 100% VOC		
	450	15.9	35.8	63.6	99.3	143.0	321.8	572.0			
	500	17.7	39.7	70.6	110.3	158.9	357.5	635.6			
	550	19.4	43.7	77.7	121.4	174.8	393.3	699.1			

# Use PRD Exemptions

- **PRD in heavy liquid service;**
- PRD that only release material that is liquid at standard conditions and that are hard-piped to a controlled drain system or piped back to the process or pipeline;
- **Thermal expansion relief valves;**
- PRD designed with a set relief pressure of <2.5 psig;
- PRD with PTE <72 lbs/day VOC; and
- PRD on mobile equipment.

*Cooling towers (and other potential places at your site) may not meet the definition of "In Organic HAP Service" for more than 300 hours per year (per LDAR rules).*

## MPV/PRD Analysis Assumptions:

- Assume all vessels were mixed phase during P&ID review;
- Vents on top of vessels are in vapor service and vents on bottom of vessel are in liquid service;
- Deinventory volume worst case assumptions:
  - Pumps: 50 gal/event;
  - Exchangers: 150 gal/event;
  - Compressors: 100 gal/event;
  - Heaters: a worst case volume based on 500 ft length hose and used diameter given in P&IDs.

## Things to Consider...

- Use Existing Tools:
  - LDAR Database;
  - BWON Turnaround assumptions;
  - Flare Tie-in Checklists;
  - PRD Inspections Database.
- Construct tools with other applications in mind (i.e, Emissions Inventory, upsets, spills).
- Docks are not considered process units under the definition of MACT CC.

# Implementation Considerations

- Update FMP:
  - Consider how to minimize PRD releases;
  - Revise current RCA/CA process to include new PRD triggers;
  - Roll out PRD List to operations:
    - DCS flag to inform Operations when an applicable PRD has lifted to trigger RCA process;
    - Email notifications of applicable PRD lifting.
- Create PRD Routed to Flare Database to Store/Update:
  - PRD Diameter (Traveler Sheet vs. Spec Sheet);
  - Set Pressure;
  - Prevention Measures.
- Schedule Annual PRD/MPV review/update.

A large, bold, black text overlay reading "Regulatory Update" is centered over a background image of a bookshelf. The bookshelf contains numerous old, leather-bound volumes with gold-leaf lettering on their spines. Some visible text on the spines includes "TESTAMENTARY AND ADMINISTRATIVE", "RECORD LETTERS TESTAMENTARY AND ADMINISTRATIVE", "LETTERS", "ADMINISTRATIVE", and "SURROGATE OF".

# Regulatory Update

## RSR Proposed Amendment Updates – March 19, 2018:

- Miscellaneous Process Vents Provisions
- Pressure Relief Device Provisions



## Proposed MPV Amendment Updates- March 19, 2018:



1. Maintenance vents do not need be identified in the NOCS report.
2. [40 CFR 63.643\(c\)\(1\)\(iv\)](#): “If the maintenance vent is associated with equipment containing pyrophoric catalyst **and** a pure hydrogen supply **is not available at the equipment at the time of the startup, shutdown, maintenance, or inspection activity**, the LEL of the vapor in the equipment must be less than 20%, except for one event per year not to exceed 35 %.”

*A refinery can have a pure hydrogen supply and still get the increased LEL vs. before the was only granted the increased LEL limit if they didn't have a pure hydrogen supply.*

## Proposed MPV Amendment Updates- March 19, 2018:

3. 40 CFR 63.643(c)(1) : Deinventorying equipment is to be depressurized to a control device **meeting control requirements in paragraphs 63.643(a)(1) or (2)**, or to a fuel gas system or back into the process.

*The site must use a control device that meets the MACT CC flare requirements or reduce HAPs by 98 wt%/20 ppm*

4. Blind Flange installation for maintenance requires depressuring the equipment to 2 psig or less prior to equipment opening and maintaining the pressure of purge gas entering the equipment at or below 2 psig during installation.

5. Open-ended valves or lines that are capped and plugged sufficiently to meet the standards in NSPS subpart VV are exempt from the bypass monitoring.

## Proposed MPV Amendment Updates- March 19, 2018:

6. Documentation of each release from maintenance vents containing less than 72 lbs of VOC is not necessary



**As long as** there is record demonstrating less than 72 lbs of VOC at the time of the maintenance vent opening.

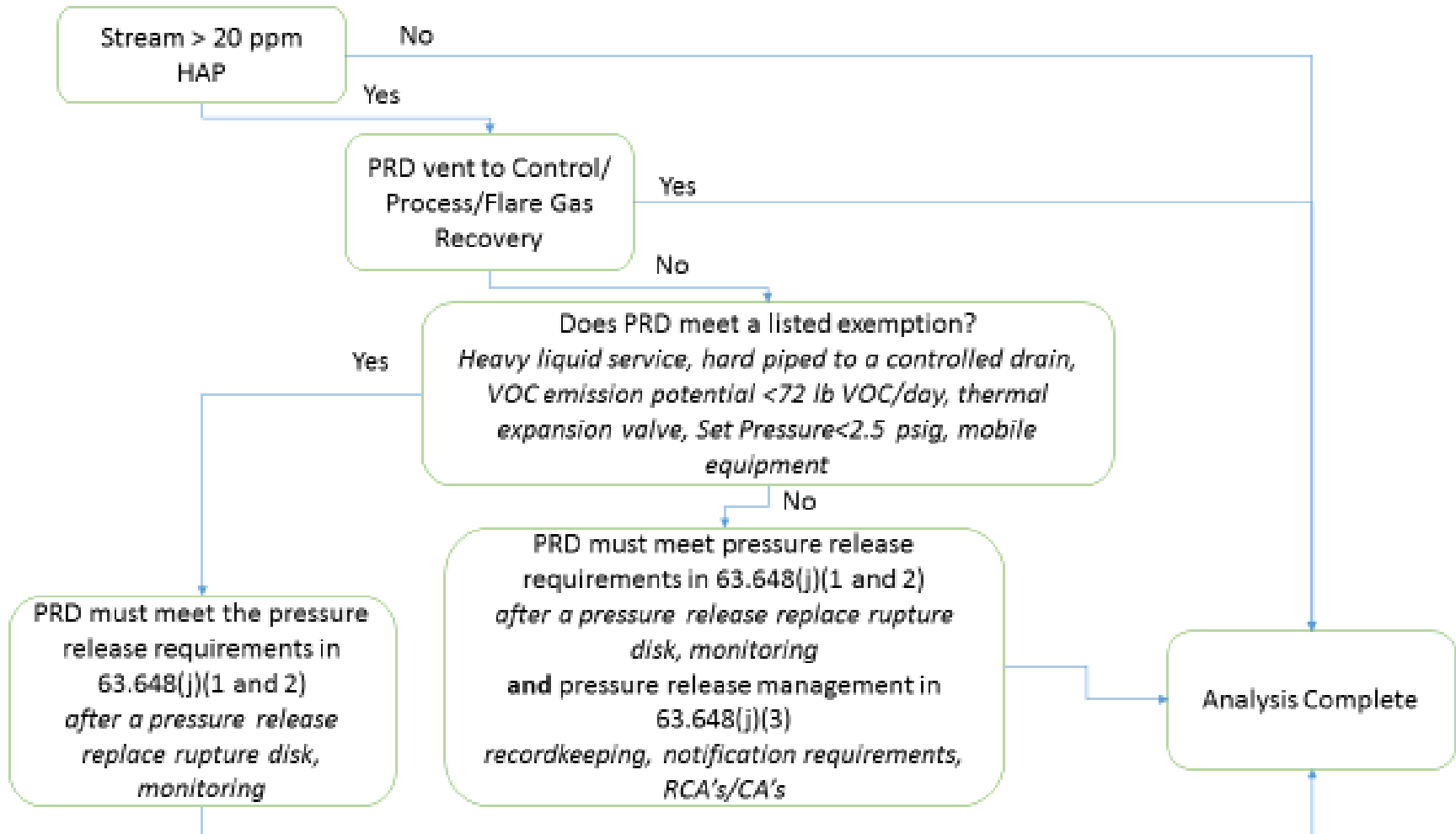
7. Maintenance Vent “Event-Specific Records” are required if:

- Deinventory procedure is not followed [40 CFR §63.643(c)(1)]
- Equipment emits > 72 lbs of VOC when opened

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## Proposed PRD Amendment Updates- March 19, 2018:

- Adding a definition of *Pressure Relief Device* and revising the definition of *Relief Valve* and consistently using the term "pressure relief device" throughout the rule.
- Clarification that the requirements in 63.648(j)(3)(v) also apply to releases from PRDs in organic HAP service.
- Independent, non-duplicative systems count as separate redundant prevention measures.
- Report and keep records of each release to the atmosphere through the pilot vent that exceeds 72 lbs/day of VOC, including the duration of the pressure release through the pilot vent and the estimate of the mass quantity of each organic HAP release.



# Questions

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