Guidelines
for
Vapor Monitoring

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GUIDELINES FOR VAPOR MONITORING

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INTRODUCTION.

As an external method of release detection, vapor monitoring relies on the ability of the volatile constituents of stored substances to move through backfill or soil to a point of detection. The volatile constituents must move with sufficient velocity and quantity so as to be detected within a timely manner. However, for vapor monitoring to be an approved method of release detection, consideration must also be given to the detection capabilities of the monitoring devices and the proper evaluation of vapor levels to determine whether a release has occurred.

In order to assure that all the necessary factors have been considered to verify that the site is suitable for vapor monitoring, and that the vapor monitoring methodology is sound, a vapor monitoring plan (VMP) must be developed. The VMP must be able to demonstrate that the method of vapor monitoring will be able to detect a release within 30 days and must incorporate the following three basic elements:

1. An assessment of the site to determine its suitability for the use of vapor monitoring;

2. A description of the methodology used to determine a vapor level that, when reached or exceeded, cause an initiation of an investigation of whether a release has occurred; and

3. A description of the method to be used for monthly monitoring, as well as a plan for the data management.

However, vapor monitoring is not solely dependent upon one characteristic. It is instead dependent upon on how well components such as monitoring equipment, the product's physical properties and the excavation conditions complement as well as compensate for each other. Therefore, the inability of the vapor monitoring method to meet one of the conditions specified within this guideline does not necessarily preclude the use of vapor monitoring. The limiting condition can be compensated for by other excavation properties or monitoring equipment.

In addition, in situations where site suitability or monitoring data may not demonstrate the effectiveness of the vapor monitoring method, other options can be used. Some options are:

- Diffusion calculations that address the movement of product or its volatile constituents through soil, as influenced by soil porosity and moisture content.

- Tracer tests that use a known or marked volatile compound to mimic the movement of the volatile constituents of the product through the soil.

- Evidence that confirms release will be detected in accordance with Chapter 62-761, F.A.C.

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These guidelines are applicable to both underground storage tank systems (USTs) and aboveground storage tank systems (ASTs). The guidelines also apply to sites with or without existing contamination.

The use of the term “product” used throughout this document refers to the stored substance, not any particular type of petroleum as defined in Chapters 62-761 and 770, F.A.C. The use of the term “site” refers to the storage tank system excavation and the area within its immediate proximity, not the facility as a whole. For example, a facility may have three separate sites. All other terms, such as “existing contamination” and “release”, are in keeping with definitions of those Chapters.

Historical monitoring data may be used to support the claim that the site is suitable for vapor monitoring. However, the use of vapor monitoring cannot be solely justified by the use of the historical monitoring data documenting the times that a release has been detected. Sufficient documentation must be provided to establish that the vapor monitoring procedure minimizes the number of releases that may go undetected (i.e. false negatives).

Finally, fluctuations in vapor levels require careful evaluation in order to differentiate between the detection of contaminants due to superficial spills as opposed to problems in tank integrity. However, this is the extra burden that owners and operators using external release detection methods assume. Furthermore, while the presence of contamination detected by the external method may subsequently be determined to be from a source external to the storage tank system, this does not remove the obligation of the owner and operator to address the presence of contamination in accordance with federal, state and local rules.

1. SITE SUITABILITY

For vapor monitoring to be an effective method of release detection, the site conditions must be appropriate for performing external monitoring. Therefore, the site must be assessed to

determine the feasibility of vapor monitoring to detect a release from any portion of the storage tank system that vapor monitoring is being utilized as a release detection method. The site assessment must be performed in accordance with the Department's "Guidelines for Site Suitability Determinations".

The site suitability determination (SSD) must demonstrate that the site is suitable for external monitoring before the VMP can be developed. For those sites where conditions prevent the use of vapor monitoring for one or more months during the year, the VMP must include a description of the method of release detection to be used in place of vapor monitoring.

2. RELEASE DETECTION RESPONSE LEVEL

Every method of release detection must have some point at which a release is suspected. The release detection response level (RDRL) as defined in Chapter 62-761, F.A.C., is the level at which an investigative procedure must be initiated to determine if a problem in the storage tank system integrity exists. Most methods of release detection have very specific indicators of a release, such as the failure of a tank tightness test or the audible alarm of an interstitial monitor.

However, due to the complex nature of vapor movement through the soil, vapor monitoring is adversely affected by vapor levels that naturally fluctuate with changing environmental conditions. For example, changes in groundwater depth, subsurface humidity, and temperature can cause increases in vapor level readings, even in the absence of a release. Even if the preceding factors remain constant, naturally occurring differences in soil conditions can cause different vapor levels with different detection devices within the same excavation. Therefore, the RDRL for vapor monitoring must be a vapor level for every detection device that incorporates all variables while allowing for the determination of a release.

For vapor monitoring, the RDRL is statistically determined using the maximum and average vapor levels expected for the site's normal conditions. The VMP must include the RDRL for each well or probe, as well as a description of how the level was determined.

The RDRL is determined using the following factors:

a. The Department standard for vapor concentration readings (C_{all})
b. The maximum monthly vapor concentration (C_{max})
c. The time-weighted average (C_{ave})

d. The standard deviation of the background vapor concentration readings (S_{dev})
e. The time-related range in background vapor concentrations (T_r)

C_{all} for any monitoring well or probe shall be 50 ppm for diesel or its equivalent, or 500 ppm for gasoline or its equivalent. C_{all} for any hazardous substance must be determined from the nature of the substance stored.

The RDRL is then determined as follows:

1. When $C_{max} \leq C_{all}$, C_{all} becomes the RDRL.

2. When $C_{max} > C_{all,}$ but $C_{ave} \leq C_{all,}$ the RDRL = $C_{ave} + 2(S_{dev})$.

3. When C_{max} and $C_{ave} > C_{all}$, the RDRL = $C_{ave} + 2(S_{dev})$. However, in such cases, justification must be provided that the elevated readings will not mask the detection of a new release.

In simpler terms, if there is no existing contamination, the RDRL is 50 ppm for diesel (or its equivalent) or 500 ppm for gasoline (or its equivalent) storage tank systems. For sites with minimal existing contamination, the RDRL will be above the 50/500, but not by much. Those sites with high levels of existing contamination will have a higher RDRL, but will have the extra responsibility of demonstrating that the monitoring method will still detect a new release in spite of the higher vapor levels.

C_{ave} and S_{dev} should also be used to assess the time-related range in background vapor concentrations for each well or probe by the following formula:

$$T_r = [C_{ave} + 2(S_{dev})] / [C_{ave} - 2(S_{dev})]$$

Setting a maximum level of 5 for T_r accounts for normal variations in equipment and site conditions. However, when $T_r > 5$, variations may be considered to be beyond the normal variations expected for the equipment. Therefore, the environmental conditions associated with and potentially responsible for the fluctuation in readings must be determined. Those conditions must then be measured and recorded during the monthly sampling events.

3. VAPOR MONITORING INSTRUMENTS

The VMP must include a description of the instruments used for vapor monitoring. There are several instruments that can be used for vapor monitoring. Vapor detectors such as flame ionization detectors, photo ionization detectors and catalytic sensors are

commonly used. Other devices, such as colorimetric instruments or fiber optics, may also be used as long as they can demonstrate that they can detect a vapor level of 500 parts per million (ppm) for gasoline or its equivalent or 50 ppm for diesel or its equivalent. The requirements for vapor monitoring devices for hazardous substance storage tank systems are dependent upon the nature of the substance stored.

Each instrument or device has its own inherent limitations that must be overcome to avoid false readings. The VMP must include sufficient information to indicate how the sampling method will compensate for those limitations. The following is a brief description of the limitations of the more commonly used instruments:

- Flame Ionization Detectors (FID):
FIDs can exhibit flame-outs due to low oxygen levels within the well. Therefore, dilution of well vapors may be necessary to increase oxygen levels and avoid flame-outs. The instrument is also sensitive to methane, which may result from natural sources or the biodegradation of existing petroleum contamination. A carbon filter must be used to eliminate methane from the total hydrocarbon reading.

- Catalytic Sensors:
Catalytic sensors are quenched by low oxygen levels making dilution necessary. As with FIDs, the presence of methane can give false readings, making the use of a carbon filter necessary. However, catalytic sensors are also sensitive to high humidity in the well, and may indicate the presence of hydrocarbons without justification.

- Photo Ionization Detectors (PID):
PIDs have limitations similar to an FID, but with greater complexity. High soil gas humidity, high levels of methane and the alkane constituents may affect this instrument’s response. Therefore, sampling should always be performed with and without dilution. In addition, PIDs show a limited response to diesel fuel vapors and a limited linear response to gasoline vapors. Consequently, the practical use of this instrument may be restricted.

Each device must be calibrated according to the method and timetable given within the manufacturer’s recommendations. At a minimum, however, each device must be calibrated at least once per year. A copy of the calibration procedure and a log containing the calibration date, gas used, the final instrument reading, and the initials of the technician performing the calibration must be maintained. Portable detectors must be field

checked for calibration just prior to sampling the vapor monitoring wells at each site.

Automatic electronic sensing devices used for continuous vapor monitoring have additional requirements. The devices must be operated in a continuous mode and have alarms that are audible and visible to the person operating the facility should the RDRL be reached or exceeded. The devices should also have alarms to signal equipment malfunctions.

4. SAMPLING PROCEDURES

The VMP must include a description of the actual sampling methodology used to establish the RDRL, as well as the sampling method being used for monthly release detection. Organic vapor detectors, such as PIDs and FIDs must use the purging method, and at times the dilution method, as part of the methodology to achieve accurate readings.

Purging

Purging is performed to develop a representative vapor sample in the well. One method of purging is to use a tight-fitting well plug, drilled and equipped with a tube to connect a pump and sampling instrument to the vapor monitoring well. The well plug should be inserted immediately after the removal of the well cap. The well should then be purged with a very low volume pump until the vapor level or oxygen concentration equalize. Generally, at least one and one half well casing volumes should first be purged before sampling.

The well volume can be calculated be multiplying the depth of the well to groundwater by 3.14 times the radius of the well squared.

Example:
The vapor monitoring well is 10 feet deep (120 inches) and 2 inch diameter. The radius [r] is 1/2 the diameter, or 1 inch.

well volume = $3.14 \times r^2 \times$ depth

well volume = $3.14 \times 1 \times 120$

well volume = 376.8 cubic inches

565 cubic inches of air (1 and 1/2 volumes) must be purged prior to sampling. To convert cubic inches to cubic feet divide the volume in cubic

inches by 1728. In this example approximately 0.33 cubic feet of air would need to be purged.

After the vapor monitoring well has been sufficiently purged, the detector should be connected to the tubing and the sample drawn through it. The ambient air reading should be taken at ground level just prior to connecting the detector to the hose on the monitoring well plug.

Dilution

Dilution of the air flow from the well may be necessary to minimize false responses which could mask a release. The method of dilution must be described in the VMP. One method that can be used is an in-line “y” connector with the same diameter openings and equal length of tubing attached. The air flow would be diluted by a factor of two, resulting in a reading one half of the actual concentration. Higher levels of dilution can be obtained by using inexpensive flow meters (basically a plastic ball inside a calibrated tube) and plastic tubing clips. The dilution factor, as well as the undiluted and diluted readings must be recorded.

Automatic Electronic Sensing Equipment

Unlike monthly monitoring devices such as FIDs or PIDs, automatic electronic sensing equipment used for continuous vapor monitoring do not need to use purging or dilution methods. However, the well or probe used for the sensing equipment must be plugged in a manner that prevents surface air entry. In addition, the sensors must be located within screened sections of wells or probes. Electronic sensing equipment used in areas where the groundwater may reach or rise above the sensor require careful placement to ensure proper detection ability. Those sensors with the capability to detect liquid constituents as well as vapor concentrations of the stored product can exercise more latitude in placement. Electronic sensing equipment that detect only vapors, however, must be placed so that the presence of groundwater does not interfere with the detection of vapors. If the groundwater rises to a level that no sensor is exposed to vapors during the sampling period, another method of release detection must be used during that time, unless the sensor is approved by the Department in accordance with Rule 62-761.850, F.A.C., to detect or operate in water or vapor. The VMP must contain a description of placement of sensors in relation to the groundwater, as well as the method of release detection to be used in the event the sensing equipment is submerged for the month’s sampling period.

Presence of Groundwater

At least once a year, any groundwater within the well or probe must be sampled at the groundwater/air interface and examined for the presence of free product or sheen. Any odors characteristic of the stored product must also be noted.

5. DATA MANAGEMENT AND RECORDKEEPING

The VMP, as well as all records collected pursuant to the VMP, must be maintained in permanent form in accordance with the recordkeeping requirements of Rule 62-761.710, F.A.C.

The monitoring records should contain sufficient information to document the site conditions and sampling protocol for each monthly sampling event. The records must include, at a minimum, when applicable, the following information for each well:

a. Date of Sampling
b. Name of person performing the sampling
c. Weather conditions (e.g., relative humidity and ambient air temperature).
d. Instrument used to perform the sampling.
e. Readings of Ambient Air Vapor Levels.
f. Initial (undiluted/unfiltered) Reading.
g. Dilution Factor
h. Filtered Reading.
i. Diluted Reading.
j. Final Reading. (i.e. after dilution and filtering factors are considered.)
k. Any spills, overfills or other superficial sources of contamination since the last sampling event.

Records for sites where groundwater levels can reach above the bottom of the storage tank must also include:

a. Depth to groundwater.
b. Maximum product level in the tank since the last sampling event.

For those site where the time-related range in background concentrations (Tr) exceed 5, the monthly sampling record must also include descriptions or measurements of other environmental conditions such as subsurface temperature associated with and potentially responsible for the fluctuation in readings.

Whenever the final reading reaches or exceeds RDRL, notifications must be made in accordance with Rule 62-761.450, F.A.C. The owner/operator must investigate in accordance with Rule 62-761.820, F.A.C.

In addition, the data collected must be evaluated for variations from the VMP. Any modification needed as indicated by the collected data must be made as described in the Plan Modification Procedures section of this guideline.

It may also be possible to detect a suspected release prior to the exceedance of the RDRL by the use of statistical analyses, graphs and/or spreadsheets. While a spreadsheet format may ***be*** used, graphs are recommended for facilitating trend analysis. It may be helpful to show monthly vapor concentration levels as a function of the following:

a. Ambient air and ground temperature.
b. Groundwater depth.
c. Ambient air relative humidity.

6. PLAN COMPLETION PROCEDURES

A Site Suitability Determination must be performed before the VMP, but both may developed concurrently. The VMP must be kept on site as a record in accordance with Rule 62-761.710, F.A.C.

Any change in site conditions that adversely affects external release detection at a site will require modification of the Vapor Monitoring Plan. This modification shall be kept as a record. Any modifications to the VMP such as changes in the vapor monitoring equipment, sampling protocol or RDRL must also be documented as an amendment to the VMP.

Sites that have been using vapor monitoring as the method of release detection may continue to use vapor monitoring until the completion of the VMP, or by December 31, 1998, whichever is sooner. Sites that elect to use vapor monitoring as a new method of release detection after the adoption of this guideline must use another approved method of release detection until the completion of the SSD and the VMP.

If the results of a VMP indicate that vapor monitoring will not be acceptable as a means of release detection at a facility, another approved method of release detection must be utilized.

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