U. S. Army Corps of Engineers
Vapor Phase Carbon Adsorption Checklist

Installation Name	____________________
Site Name / I.D.	____________________
Evaluation Team	____________________
Site Visit Date	____________________

This checklist is designed to facilitate the performance evaluation of an activated carbon adsorption treatment unit used to remove organic vapors from a gas stream. It is divided into the following sections:

1) Evaluation team composition
2) Typical treatment objectives
3) References
4) Data collection requirements
5) Performance analysis calculations
6) Adequacy of operations and maintenance
7) Typical performance problems
8) Alternatives for possible cost savings
9) Supplemental notes and data.

The checklist provides suggestions for information gathering, and space has been provided to record data and notes from the site visit. Supplementary notes, if required, should be numbered to correspond to the appropriate checklist sections.

1) Evaluation Team Composition

The following disciplines should be included in the evaluation team for the vapor phase carbon adsorption treatment system.

- Process Engineer (site visit, treatment system evaluation)
- Cost Engineer (cost of alternatives)
- Regulatory Specialist (regulatory requirements for discharge)

2) Typical Treatment Objectives

Review the treatment objectives established when the carbon adsorption system was designed and installed to verify that the objectives are clear (in case the system objectives were poorly defined) and still valid.

Vapor phase carbon adsorption is typically used to remove organic contaminants from a gas stream. Examples include the removal of organic vapors discharged from an air stripper or from a soil vapor extraction (SVE) system.

3) References

Coordinate this checklist with the Vapor/Off-Gas Blower and Piping; Process Instrumentation and Control; and the applicable soil or groundwater treatment process checklists.

4) Data Collection Requirements

Record the following information needed for performance calculations and for checking the operation of the carbon adsorption system. Record the appropriate units with each value.

a) Record the nameplate information from the adsorption vessels, heat exchangers, filters, blowers, blower motor (direct or belt drive), and any other mechanical equipment for future reference.

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b) Sketch the process flow diagram (PFD), including valves and instrument locations, on the back of this sheet or a separate sheet.

c) Contaminants

Contaminant	Inlet Concentration	Outlet Concentration	Required Discharge Conc.

d) Adsorption Vessels (record appropriate units)

No. of vessels in series / treatment train			
No. of treatment trains operating in parallel			
Carbon bed cross-section dimensions	Length =	Width =	Diameter =
Carbon bed depth			
Carbon type			
Carbon particle size			
Total gas flow rate			
Pressure drop through adsorption bed			
Inlet gas temperature			

e) Is the spent carbon exchanged by a carbon vendor or regenerated on-site? If regenerated on site, what regeneration process is used? What is the carbon bed replacement/regeneration frequency?

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5) Performance Analysis Calculations

a) Are the inlet gas flow rates the same as those in the design specifications? Calculate the gas loading rate and verify that it is less than 80 cfm/ft^2 (preferably between 20 and 60 cfm/ft^2).

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6) Adequacy of Operations and Maintenance

6.1) General Operations

a) Check the pressure/vacuum rating of the vessel(s) and determine if an operator error or malfunction can cause these to be exceeded. Verify that pressure and vacuum relief valves are in place and operational.

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b) If the contaminant adsorbed on the carbon can ignite (e.g., ketones), is a temperature alarm provided and is an internal water spray present to extinguish the fire?

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c) Verify that all controls and alarms are working. Are there provisions to notify an operator of a malfunction when the unit is unattended? Are controls and alarms adequate?

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d) Verify that the effluent is being sampled and analyzed in accordance with the sampling and analysis plan designed to assess the unit performance. Determine if any additional monitoring is needed to properly evaluate the operating conditions. If samples are not needed for regulatory compliance, can simple field methods work?

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e) If the vapor stream entering the column might contain particulate matter, confirm that it is filtered. What type of filter is installed? Is the filter of adequate size? How and when is the filter cleaned?

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f) Inspect the vessels and piping for corrosion. Verify that the valves close tightly and do not leak. Check for obvious leaks in the system. How often does the operator inspect the equipment?

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g) Is the induced/forced draft blower and the auxiliary equipment maintained per the manufacturers recommendations? (See Vapor/Off-gas Blower and Piping checklists.)

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h) How are the carbon beds monitored for contaminant breakthrough to determine when regeneration is necessary.

• If monitoring requires sampling, are the analytical quality control procedures followed? How frequently are samples taken? Should the sample frequency be increased or decreased? Is there a simpler way to monitor for breakthrough? If samples are not needed for regulatory compliance, can simple field methods work?

• If the bed breakthrough is determined by the hours of operation or total cfm, calculate the expected breakthrough from the actual flow rate and the inlet contaminant concentration. Use the results to verify or modify the current practice. Has cycle time between breakthroughs stayed constant? Is monitoring by total cfm adequate or should there be automated or manual sampling for breakthrough?

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6.2) Carbon Replacement/Regeneration

a) When switching lead/lag vessels, are the specific valves to open and close, as well as the sequence of operation, clearly identified?

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b) If the carbon is regenerated on site, verify that tests are done to document that all the contaminants have been removed from the carbon. *(Heavy molecular weight contaminants, such as fuel oil, may not be desorbed during regeneration and will reduce the capacity of the carbon.)*

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c) If fresh replacement carbon is purchased, how is the carbon checked to assure it meets the specifications?

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6.3) Relative Humidity (RH) Control

a) How is the RH of the vapor entering the carbon units measured and managed to assure it is approximately 50 percent? Is there a more economical method of controlling the humidity?

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b) If there is a RH measuring and/or controlling instrument, how is it calibrated and maintained? If RH is controlled by maintaining a temperature rise above the air leaving the air stripper or SVE, are the temperature measuring devices maintained and calibrated?

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c) If the RH is maintained with a heat exchanger (heating or cooling), verify that the combination of thermodynamics and heating or cooling media, or the instrumentation, will maintain it at approximately 50 percent.

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d) If the RH is not measured or actively controlled, verify that the thermodynamics of the system will keep the RH at approximately 50 percent.

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e) If the carbon units are installed outside, verify that the vessel and piping insulation is adequate to prevent the relative humidity from rising much above 50 percent.

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7) Typical Performance Problems

a) If the carbon adsorption system is located outside, are there provisions to drain condensed water from the vessels and piping when the unit is shut down?

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b) Are there reports of carbon bed fouling? If so, how often does the bed foul?

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8) Alternatives for Possible Cost Savings.

Operating conditions may have changed to the extent that other alternatives are more cost effective. Consider the following:

a) Contaminant concentrations in the vapor entering the carbon unit may have decreased with time. Determine if the concentration, or mass emission rate, is low enough to allow the carbon unit(s) to be bypassed and the vapors emitted directly to the ambient air.

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b) Are more cost effective treatment alternatives available which will meet the present treatment requirements (e.g., internal combustion engine, flameless thermal oxidizer)?

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c) Consider whether the carbon units are sized correctly to provide adequate adsorption capacity. If regeneration/replacement is too frequent or too seldom, it may be cost effective to change the size or number of units.

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d) Can savings be realized by either implementing or eliminating on-site regeneration? If the carbon is currently regenerated on site, determine if the contaminant concentration has decreased to the point that it is now more economical to regenerate the carbon off site than to maintain the regeneration equipment on site.

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9) Supplemental Notes and Data

There are _______ pages of supplemental notes and data attached to this checklist.