APPENDIX C
MONITORING PROTOCOLS FOR THE PRINTING AND FLEXIBLE PACKAGING INDUSTRIES

1.0 INTRODUCTION

What Is the Purpose of This Document?

This document pertains to flexible packaging and printing industry emission sources that utilize air pollution control systems. The monitoring protocols in this document provide approaches that may be used to comply with the Compliance Assurance Monitoring (CAM) Rule. These protocols represent "presumptively acceptable" monitoring for both the capture systems and air pollution control devices (i.e., the capture and control systems) for identified emission sources. Monitoring protocols designated by the Administrator as presumptively acceptable satisfy the requirements of the CAM Rule's Monitoring Design Criteria. Such protocols also satisfy the title V monitoring requirements. These requirements include both general criteria and performance criteria. The general criteria set guidelines for:

1. Designing an appropriate monitoring system; and
2. Setting the appropriate parameter ranges(s).

The performance criteria require:

1. Data representativeness;
2. A method to confirm the operational status of the equipment (for new or modified equipment, only);
3. Quality assurance and quality control procedures; and
4. Specifications for the monitoring frequency and data collection procedure, including recordkeeping and reporting.

Table 1 lists the presumptively acceptable monitoring protocols presented in this document. Note that separate protocols are presented for capture systems and add-on control devices. Also note that the CAM rule protocols given here may not be applicable for emission units subject to regulations promulgated after November 1990 (such as subpart KK), since the monitoring required by those rules already provide a reasonable assurance of compliance.

How Do I Use Presumptively Acceptable Monitoring Protocols?

If a protocol is applicable to a type of source, capture system, and add-on control device used by an owner or operator in your jurisdiction, he or she may propose to use the presumptively acceptable monitoring protocol(s) without needing to provide us with additional permit content or justification. However, for new or modified monitoring systems, he or she also must submit information on the method to be used to confirm the operational status of the monitoring equipment when it is put into service.

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TABLE 1. LIST OF MONITORING PROTOCOLS INCLUDED IN DOCUMENT

Protocol	Type	Source	Key Parameters
A	Capture System	Unenclosed non-rotogravure presses	1. Integrity of bypass damper 2. Ductwork integrity and inspections 3. Interlocks on flow header
B	Capture System	Unenclosed coaters or laminators	1. Integrity of bypass damper 2. Ductwork integrity and inspections 3. Monitoring (recording) of indicator of exhaust flow rate
C	Capture System, Permanent Total Enclosure	Any	1. Integrity of bypass damper 2. Enclosure pressure differential
D	Capture System, Permanent Total Enclosure	Any	1. Integrity of bypass damper 2. Interlocks on system airflow, interlocks on doors, inspections
E	Capture System, Permanent Total Enclosure	Any; Controlled emissions less than MST	1. Integrity of bypass damper 2. Interlocks on system airflow, self-closing doors, inspections
1	Thermal Oxidizer	Presses, coaters, and laminators	1. Integrity of bypass damper 2. Combustion chamber temperature 3. Inspections 4. Performance Testing once every 5 years
2	Catalytic Oxidizer	Presses, coaters, and laminators	1. Integrity of bypass damper 2. Catalyst bed inlet temperature 3. Annual catalyst sampling and testing 4. Inspections 5. Performance Testing once every 5 years
3	Solvent Recovery	Presses, coaters, and laminators	1. Integrity of bypass damper 2. Inlet and Outlet solvent concentration 3. Inlet and outlet air flow rate 4. Inspections 5. Performance Testing once every 5 years
4	Solvent Recovery	Presses, coaters, and laminators	Liquid-liquid material balance

What Inks or Coatings That Do Not Require Add-On Controls Are Used?

The monitoring protocols only apply when operating with materials that require control. However, if equipment sometimes operates with materials that require control and sometimes with materials that do not require control, the position of the air pollution control device bypass valve must be monitored and documented to assure that the air pollution control device is not bypassed while operating with materials that require control.

What Are the Types of Sources to Which These Monitoring Protocols Apply?

The types of equipment or sources to which these protocols apply include those defined in the Printing and Publishing MACT, 40 CFR Part 63 Subpart KK, and the draft Paper and Other Web Coating MACT, 40 CFR Part 63 Subpart JJJJ. Emission sources specifically exempted under these two MACT Standards also may use these protocols to address their CAM and title V monitoring requirements (i.e., minor sources, narrow web presses, etc.).

How Do I Know If a Protocol Is Applicable to My Source Type, Capture System, and Add-On Control Device?

Table 2 presents a list of source types and shows the protocols that are applicable for each source type.

Must Owners or Operators in My Jurisdiction Always Use the Presumptively Acceptable Monitoring Protocols Presented in This Document?

No. The monitoring protocols presented in this document are not mandatory. A presumptively acceptable monitoring protocol is simply a monitoring protocol that has been reviewed by us and determined to meet all the CAM criteria. As such, owners or operators in your jurisdiction may choose to use the monitoring protocol without additional justification. However, they may desire to propose other monitoring approaches. Their proposed approach must meet all monitoring criteria for the applicable requirements; e.g., title V, CAM, and/or MACT.

May Owners or Operators Modify the Presumptively Acceptable Monitoring Protocol to Meet Their Own Particular Needs?

Owners or operators in your jurisdiction may choose to modify the monitoring protocol; however, a rationale for the modification will need to be submitted along with their permit application. In addition, the modification will need to be approved by you. For example, one component of the monitoring protocol for the catalytic oxidizer is an annual sample and analysis of the catalyst activity. The owner or operator may have data to show that, for his or her type of application, the expected catalyst life is 12 years. Based on these data your owner or operator might propose an initial catalyst check after 1 year followed by less frequent catalyst testing (e.g., every 2 or 3 years). You would determine whether this modification were acceptable.

TABLE 2. SUMMARY OF PRESUMPTIVELY ACCEPTABLE COMPLIANCE ASSURANCE MONITORING & TITLE V MONITORING FOR THE PRINTING INDUSTRY

	Controlled Permanent Total Enclosure			Monitoring protocol		
Source type	Less than major source threshold	Greater than major source threshold	Capture system type	Capture system	Control device	Comments
Central Impression (CI) Flexographic or In-line Press with tunnel dryers	X	X	Unenclosed Press and dryer	A	No. 1, 2, or 3	Capture efficiency inherent to design and operation of press
Coaters & laminators	X	X	Unenclosed Coater or Laminator	B	No. 1, 2, or 3	
CI Flexographic or In-line Press with tunnel dryers; Coaters & Laminators	X		Permanent Total Enclosure	C, D, or E	No. 1, 2, or 3	
CI Flexographic or In-line Press with tunnel dryers; Coaters & Laminators		X	Permanent Total Enclosure	C or D	No. 1, 2, or 3	
CI Flexographic or In-line Press with tunnel dryers; Coaters & Laminators	X		Partial Enclosure or Local Exhaust	D or E	No. 1, 2, or 3	
CI Flexographic or In-line Press with tunnel dryers; Coaters & Laminators		X	Partial Enclosure or Local Exhaust	D	No. 1, 2, or 3	

2.0 CAPTURE SYSTEMS

What Is Capture Efficiency?

Capture efficiency is defined as the weight per unit of time of an air contaminant entering a capture system and delivered to a control device divided by the weight per unit time of the air contaminant generated by the source, expressed as a percentage. Various systems may be used to capture emissions and direct them to a control device. For purposes of this document, capture systems are classified into three distinct categories. These are:

1. Permanent total enclosures;
2. Partial enclosures (i.e., hoods and enclosures not meeting permanent total enclosures criteria); and
3. Local exhaust systems inherent to the design of unenclosed process operations (e.g., CI flexographic presses).

What Is a Permanent Total Enclosure?

A permanent total enclosure is an enclosure that completely encompasses a source such that all volatile organic compound (VOC) emissions are contained and directed to a control device. We have established a set of criteria that must be met for an enclosure to qualify as a permanent total enclosure; these criteria are contained in Reference Method 204--Criteria For And Verification of a Permanent or Temporary Total Enclosure (40 CFR 51, Appendix M). If the criteria set forth in this method are met, the capture efficiency may be assumed to be 100 percent and need not be determined. Table 3 summarizes the permanent total enclosures criteria.

TABLE 3. PERMANENT TOTAL ENCLOSURE CRITERIA

1.	Any natural draft opening (NDO) shall be at least four equivalent opening diameters from each VOC emitting point;
2.	The total area of all NDOs shall not exceed 5 percent of the surface area of the enclosures four walls, floor, and ceiling;
3.	The average face velocity (FV) of air through all NDOs shall be at least 3,600 m/hr (200 ft/min). The direction of flow through all NDOs shall be “into” the enclosure;
4.	All access doors and windows whose areas are not included in the calculation in item No. 2 shall be closed during routine operation of the process; and
5.	All VOC emissions must be captured and contained for discharge through a control device.

What Is a Partial Enclosure?

In some cases, an enclosure that is not designed to meet permanent total enclosures criteria may be built to encompass a source, or encompass a portion of a source. For purposes of this document such an enclosure is referred to as a partial enclosure. For purposes of this document a local ventilation hood or system (including floor sweeps), not inherent to the design of the process, installed to improve the capture efficiency of the system is considered a partial enclosure. The capture efficiency of a partial enclosure cannot be assumed to be 100 percent and the efficiency is determined by measurement.

What Is a Local Exhaust System Inherent to the Design of Unenclosed Process Operations?

The third type of control measure used to capture emissions and vent them to a control device is the application of local exhaust ventilation systems inherent to the design of the process equipment. In this industry, the local exhaust system typically consists of the dryer(s) and associated ductwork that are an integral part of the printers and coaters. Equipment not contained in a permanent total enclosures or a partial enclosure that relies solely on the dryer exhaust systems inherent to the process equipment for capture of emissions, is referred to as an “unenclosed” process.

What Are the Key Factors to Consider When Monitoring an Unenclosed Process?

Multicolor in-line and central impression (CI) cylinder presses used in the rotogravure, flexographic and lithographic industries utilize between color dryers and/or tunnel dryers. The system of dryer(s), and associated ductwork (dryer system), as well as the airflow through the system, is an integral part of the process as designed by the manufacturer. The dryer systems are designed to operate under negative pressure and once installed do not change significantly. A poorly performing dryer system would not allow proper drying of inks, coatings, primers or adhesives, thereby resulting in performance problems for the applied materials. Furthermore, a properly balanced air system must be maintained in order to assure that the concentration of flammable materials in the exhaust gas is maintained below the lower explosive limit (LEL). In order to meet fire insurance requirements, all exhaust ducts typically are fitted with LEL sensors and alarms and with flow sensors that will trigger a shutdown if the flow falls below a minimum value.

Every controlled press, coater or laminator employs an isolation damper that directs process line exhaust to the control device or to the atmosphere (bypass). These isolation or “bypass” dampers typically are monitored or have an interlock which allows the process to operate only when the exhaust gases are being sent to the control device. Typically, process line exhausts are only sent to the atmosphere when the web is disengaged or when the process is running materials that do not require emission control. The exhaust system also is isolated from the control device whenever the process line is not operating. Since a control device commonly processes emissions from multiple process lines, the isolation damper is necessary to eliminate bleed-in air from any non-operating lines.

Because the dryer system is an integral part of the process design and operation, the key parameters which can be monitored as indicators of performance include:

1. Individual bypass damper positions or interlocks;
2. Exhaust system air flow interlocks;
3. Indicators of exhaust system air flow (e.g., duct static pressure); and
4. Integrity of duct system from process to control device.

Monitoring some or all of these parameters will assure that capture integrity will continue to be maintained as initially verified at installation. Verification of the operational condition of the bypass interlock, verification of the operational condition of the exhaust system air flow interlocks, and inspection of the duct system are key factors to consider for monitoring.

An additional method that may be used to check the proper balance of airflow is the "smoke test." A smoke test utilizes a device that generates visible "smoke;" the smoke will be drawn into the exhaust and captured if the exhaust system is operating properly. For example, this method may be used to check the proper balance of the airflow after replacing dryers that have been removed for maintenance.

<u>What Are the Indicators of Performance Included in the Presumptively Acceptable Monitoring Protocols for Unenclosed Processes?</u>

Two monitoring protocols for capture systems inherent to the design of unenclosed processes are included in this document. Protocol A addresses monitoring of the capture system for unenclosed presses. The protocol relies on:

1. Inspections of the control device bypass damper and integrity of the ductwork between the process and control device;

2. Verification of the operational condition of the exhaust system air flow and bypass interlocks; and

3. Verification of negative flow by smoke test, as necessary, after maintenance operations.

Protocol B addresses monitoring of the capture system for unenclosed coaters and laminators The protocol relies on the same three parameters as Protocol A, and one additional parameter:

4. Continuously monitoring an indicator of exhaust gas flow (e.g., static pressure) of the process.

This additional parameter is included to provide an increased level of confidence that the proper airflow rate through the system is being maintained. For the printing presses, maintenance of the proper airflow in each print/dryer station is critical to maintaining print quality. Although maintaining the proper airflow for the dryers associated with the coating and laminating processes is important, such maintenance is not as critical to the quality of the product because multicolor applications are not being applied in rapid succession.

What Are the Key Factors to Consider When Monitoring a Permanent Total Enclosure?

Maintaining the integrity of the enclosure and the airflow (ventilation) through the system and to the control device are the critical factors with respect to maintaining capture system performance of a permanent total enclosures. The indicators of performance for permanent total enclosures relate to these two factors and, for purposes of this discussion, monitoring approaches can be divided into two subcategories:

1. Direct indicators of capture performance by the enclosure (e.g., enclosure differential pressure, natural draft opening (NDO) velocity); and

2. Indicators of system air flow (e.g., duct static pressure, fan RPM) measured downstream of the capture device combined with verifications of system integrity (e.g., door interlocks and periodic inspections).

The first approach is straightforward. Monitoring the differential pressure of the enclosure, which provides a direct indicator of performance, is the key parameter typically selected as the indicator of performance.

The second approach relies on monitoring the integrity of the enclosure (including whether doors to the enclosure are properly closed) and the airflow through the system. Techniques to monitor the integrity of the enclosure include periodic inspections, and use of interlocks and/or self-closing mechanisms on doors. Techniques to monitor the system airflow include the use of indicators such as interlocks, duct static pressure, fan amperage, or fan RPM.

The design and construction of the enclosure and its durability are factors to consider when selecting the inspection parameters and frequency. For example, an enclosure designed and built in conjunction with the installation of a new process line might essentially consist of a small building around the line with the necessary access doors. The doors may be fitted with interlocks that will shut down the process if the doors remain open for more than five minutes. The integrity and durability of this kind of enclosure is high and very frequent inspections (e.g., daily) should not be necessary. On the other hand, an enclosure built as a retrofit to an existing process line might require use of materials such as plastic stripping to fit around overhead piping and electrical wiring. Also, self-closing doors without interlocks or alarms might be used and one section of the wall might be constructed of hanging plastic stripping to allow ready access to the machine. This kind of enclosure is more susceptible to degradation (e.g., plastic strips breaking or getting knocked off; malfunction of self-closing door mechanisms going unnoticed or unrepaired), and may warrant more frequent inspection.

Every controlled press, coater or laminator employs an isolation damper that directs process line exhaust to the control device or to the atmosphere (bypass). These isolation or “bypass” dampers typically are monitored or have an interlock that allows the process to operate only when the exhaust gases are being vented to the control device. Typically, process line exhausts are only vented to the atmosphere when the web is disengaged or when the process is running materials that do not require emission control. The exhaust system also is isolated from the control device whenever the process line is not operating. Since a control device commonly processes emissions from multiple process lines, the isolation damper is necessary to eliminate bleed-in air from any non-operating lines. Verification of the operational condition of the bypass damper/interlock and inspection of the duct between the enclosure and the add-on control device is a key parameter to monitor for all permanent total enclosures.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocols for a Permanent Total Enclosures?

Three monitoring protocols for permanent total enclosures are included in this document. Protocols C and D are applicable to enclosures on any processes; protocol E is applicable only to enclosures of processes with emissions less than the major source threshold (MST) (e.g., 100 tons per year for VOC).

1. Protocol C relies on:

   (a) Monitoring the pressure differential of the enclosure; and

   (b) Inspecting of the operational condition of the bypass damper and interlock.

2. Protocol D relies on:

   (a) Verifying of operational status of interlocks on the system air flow (e.g., static pressure indicators);

   (b) Verifying of the operational status of interlocks on enclosure doors;

   (c) Inspecting of the enclosure integrity;

   (d) Inspecting of the operational condition of the bypass damper and interlock; and

   (e) Inspecting of the ductwork between the enclosure and add-on control device.

3. Protocol E is applicable only to processes with controlled emissions less than the major source threshold (MST) (e.g., 100 tons per year for VOC). The protocol relies on:

   (a) Verifying of operational status of interlocks on the system air flow (e.g., static pressure indicators);

   (b) Using of self closing door mechanisms;

   (c) Inspecting of the enclosure integrity;

   (d) Inspecting of the operational condition of the bypass damper and interlock; and

   (e) Inspecting of the ductwork between the enclosure and add-on control device.

What Are the Key Factors to Consider When Monitoring a Partial Enclosure ?

The key factors to consider for monitoring a partial enclosure are the same as those considered for monitoring a permanent total enclosures: the air flow through the system, the integrity of the enclosure, and the integrity of the ductwork between the enclosure and the control device. The primary difference is not in the monitoring, but in the fact that the enclosure has not been designed to capture all the emissions and a capture efficiency of 100 percent cannot be claimed. However, as discussed above for permanent total enclosures the design and construction of enclosures can vary significantly and, consequently, so can the susceptibility of the integrity of the enclosure. Because partial enclosures do not meet the minimum design criteria to qualify as permanent total enclosures, the design and construction of partial enclosures can vary even more widely than for permanent total enclosures. Consequently, more frequent inspections of the integrity of the enclosure are recommended.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocols for a Partial Enclosure?

The presumptively acceptable protocols for partial enclosures included in this document are protocols D and E for permanent total enclosures. However, more frequent inspection of the integrity of the enclosure is required for partial enclosures.

3.0 ADD-ON CONTROLS

What Is an Oxidizer?

Oxidizers are combustion systems that control VOC and volatile HAP by combusting them to carbon dioxide (CO_2) and water. The design of an oxidation system is dependent on the pollutant concentration in the waste gas stream, type of pollutant, presence of other gases, level of oxygen, and stability of processes vented to the system. Important design factors include residence time (sufficient time for the combustion reaction to occur), temperature (a temperature high enough to ignite the waste-auxiliary fuel mixture), and turbulence (turbulent mixing of the air and waste-fuel). Residence time, temperature, turbulence, and sufficient oxygen concentration govern the completeness of the combustion reaction. Of these, only temperature and oxygen can be significantly controlled after construction. Residence time and turbulence are fixed by oxidizer design.

The efficiency at which VOC and HAP compounds are oxidized is greatly affected by temperature. Because inlet exhaust gas concentrations are well below the lower explosive limit (LEL) to prevent pre-ignition explosions, the exhaust gas must be heated with auxiliary fuel and/or primary oxidizer heat recovery above the auto-ignition temperature. Thermal destruction of organic materials will vary depending on the chemical structure of the solvent. For organic solvents used in this industry, thermal destruction will be effected at combustion temperatures between 400 and 1800 degrees Fahrenheit (EF) depending on the oxidation technology used and the solvent types. Residence time is equal to the oxidizer chamber volume divided by the total flow of flue gases (waste gas flow, added air, and products of combustion). A residence time of 0.2 to 2.0 seconds is common. Turbulence is necessary to ensure that all waste and fuel come in contract with oxygen. Because 100 percent turbulence is not achieved, excess air/oxygen from the process exhaust and/or fresh air is added (above stoichiometric or theoretical amounts) to ensure complete combustion.

Normal operation of an oxidizer should include a controlled combustion chamber temperature. Monitoring and controlling the oxidizer combustion chamber temperature will provide a good method of ensuring VOC and HAP destruction efficiency.

<u>What Is the Difference Between a Thermal Oxidizer and a Catalytic Oxidizer?</u>

A catalytic oxidizer is a thermal oxidation system that uses a catalyst to lower the activation temperature of the VOCs in the exhaust stream. By use of a catalyst the oxidation process can be completed in the range of 400 to 700EF, while un-catalyzed thermal oxidizers operate in the range of 1,200 to 1,800EF.

Catalytic oxidation control devices are widely used in the surface coating and printing industries to control both VOC and HAP. The following process variables must be considered when applying a catalytic oxidation system: exhaust flow rate of the process being controlled, type and concentration of the pollutants, temperature and oxygen levels of the exhaust stream, and the presence of other gases, poisons, or masking agents.

Catalytic oxidation systems can be designed to accommodate wide ranges of exhaust rates. The system size is dictated by the maximum exhaust rate of the source to be controlled. The concentration of VOC in the exhaust stream can impact the sizing of the catalytic oxidation system. As the concentration of VOC in the exhaust stream increases the heat released from the oxidation of these

VOC also increases. This heat release increases the temperature rise across the catalyst bed. At some point this heat release can cause the exhaust air temperature to exceed the safe operating limits of the catalyst material being used. If this occurs dilution air can be introduced into the stream to control temperature up to the airflow limit of the system. In most printing and coating applications the maximum airflow, not the maximum solvent load capacity is the factor that determines the unit sizing.

Residence time for catalytic oxidation systems is normally expressed in terms of gas hourly space velocity (GHSV). GHSV is calculated by dividing the cubic feet of exhaust gas / hour processed, by the cubic feet of catalyst in the system. GHSVs can range from 8,000 to > 50,000. Typically the lower the GHSV the greater the surface area of catalyst sites available to promote the oxidation of the VOC in the exhaust stream. As in thermal oxidation systems residence time, or in this case GHSV, in conjunction with operating temperature impacts the oxidation efficiency. In thermal oxidizers, lower residence times may require higher operating temperatures to achieve the desired oxidation of the VOC. The same can be true for catalytic oxidation systems; higher GHSVs require higher operating temperatures to achieve the desired oxidation levels.

Catalyst activation temperatures can range from 300EF to 1,300EF. Catalyst activation temperature is impacted by a wide variety of factors. These factors include the type of catalyst (i.e. base metal, precious metal, hybrid), surface area and density, type of supporting structure (i.e., bead, extruded material, metal or monolith structure), type or species of VOC to be controlled, and the accumulation level of poisons or masking agents. Oxygenated solvents such as alcohols and acetates typically used in the printing and surface coating industries are easily oxidized at relatively low temperatures. Other solvents may require higher temperatures. In some cases, the catalyst chamber operating temperature can be adjusted to compensate for decreases in activity.

Poisons and masking agents in the exhaust stream can contaminate the catalyst and reduce its effectiveness. Poisons and masking agents can be carried into the system with the exhaust gases being treated. Catalyst poisons are defined as contaminants that chemically affect the active catalyst materials rendering them inactive. Catalyst masking agents deactivate a catalyst by coating the active catalyst material preventing the VOC from contact with the active catalyst sites. Poisoning and masking of catalyst normally develops over extended periods of operation. Over the many years that catalytic systems have been used, the source of poisons and masking agents have been largely identified and either eliminated or compensated for in the catalytic oxidation system design. Catalyst testing can provide valuable information as to the activity level of the catalyst and help predict the useful life of the catalyst.

Thermal degradation of catalyst is exacerbated as temperatures in the catalyst beds are increased. Most manufacturers of catalytic oxidation systems address this issue by monitoring the catalyst bed outlet temperature. The physical break down or attrition of catalyst can occur as a result of loosely packed material abrading against itself or the catalyst containment system. In the case of structured monolith catalyst, vibration or the normal expansion and contraction of the catalyst containment system may cause physical damage.

What Is the Difference Between a Recuperative Oxidizer and a Regenerative Oxidizer?

Recuperative oxidation systems utilize heat recovery devices configured as either plate or shell and tube type metallic heat exchangers. In a recuperative oxidation system, the increase in heat content of the gases exiting the oxidation process are used to preheat the process exhaust gases prior to entering the oxidation chamber. This type of system can recover from 50 percent to 80 percent of the energy in the system. Using this design can allow the auxiliary heat source, typically a natural gas burner, to be modulated to a low fire rate or, in some cases, completely shut down, allowing the VOC in the exhaust gas to sustain the unit's operating temperature.

Regenerative oxidation systems are designed with a heat recovery device utilizing two or more towers of a ceramic media or other heat exchange media which store and release heat. A valve mechanism is used to alternate the exhaust stream between two or more towers. Energy is recovered by reversing the direction of gas flow through the towers allowing for up to 95 percent recovery of process energy. The ceramic media in these systems may be coated with a catalyst material.

What Are the Key Factors to Consider When Monitoring a Thermal Oxidizer?

The key factors to consider are:

1. Combustion chamber temperature;
2. System integrity; and
3. System bypass valve operation/status.

Normal operation of a thermal oxidizer should include a controlled combustion chamber temperature. Monitoring and controlling the oxidizer combustion chamber temperature will provide a good method of ensuring VOC and HAP destruction efficiency.

Also, it is important to monitor the operation of any bypass valve installed as a safety measure which, when activated, would vent emissions directly to the atmosphere.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocol for a Thermal Oxidizer?

Protocol 1 addresses monitoring of thermal oxidizers. The monitoring protocol relies on:

1. Continuously monitoring the oxidizer combustion chamber temperature (at least one measurement taken and recorded every 15 minutes);

2. Verification of the operational condition of the bypass valve and interlock;

3. Periodic inspection of the oxidizer, including the burner assembly; and

4. Performance testing once every 5 years.

<u>What Are the Key Factors to Consider When Monitoring a Catalytic Oxidizer?</u>

The key factors to consider are:

1. Combustion chamber temperature (inlet catalyst bed temperature);

2. Catalyst activity (life);

3. System integrity; and

4. System bypass valve operation/status.

The temperature at the inlet to the catalyst chamber (bed) is typically used to monitor and control the oxidizer operation. Most catalytic oxidation systems are set up to measure both the inlet and outlet temperatures of the catalyst chamber. While the differential temperature across the catalyst does provide an indication of catalyst activity, it does not provide a quantifiable indication of the efficiency of the system for operations subject to variable VOC loading, as in some elements of the printing/flexible packaging industry. The primary purpose of the outlet temperature measurement is for protection of the catalyst from overheating. Inlet operating temperatures are based on catalyst manufacturer's recommendations and are proven through compliance emission testing.

The life of catalyst materials are impacted by poisons, masking agents, thermal degradation and in some cases physical degradation. Poisons and masking agents can be carried into the system with the process exhaust gases. Over the long term, these poisons and masking agents can build up in the catalyst bed and slowly reduce the catalyst activity. Over the many years that catalytic systems have been used, the source of poisons and masking agents have been largely identified and either eliminated or compensated for in the catalytic oxidation system design. Thermal degradation of catalyst is exacerbated as temperatures in the catalyst beds are increased. Most manufacturers of catalytic oxidation systems address this issue by monitoring the catalyst bed outlet temperature. Physical break down or attrition of catalyst can occur as a result of loosely packed material abrading against itself or the catalyst containment system. In the case of structured monolith catalyst, vibration or the normal expansion and contraction of the catalyst containment system may also cause physical damage.

Periodic catalyst sampling and testing can be conducted to assure that the catalyst activity remains satisfactory. Some manufacturers provide catalyst "core samples" installed in the bed to facilitate removal of a sample for testing.

Also, it is important to monitor the operation of any bypass valve installed as a safety measure which, when activated, would vent emissions directly to the atmosphere.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocols for a Catalytic Oxidizer?

Protocol 2 addresses monitoring of catalytic oxidizers. The monitoring protocol relies on:

1. Continuously monitoring the catalyst bed inlet temperature (at least one measurement taken and recorded every 15 minutes);

2. Annual sampling and testing of the catalyst activity;

3. Verification of the operational condition of the bypass valve and interlock;

4. Periodic inspection of the oxidizer, including the burner assembly; and

5. Performance testing once every 5 years.

What Are Additional Key Factors to Consider When Monitoring a Regenerative Oxidizer?

An additional key operating factor to consider for regenerative oxidizers is the valve mechanism used to reverse the flow of gases through the towers. It is important to assure that the valves controlling the flow to and from the towers do not leak; leaking valves will allow untreated gases to bypass the oxidizing bed and will result in a reduced control efficiency. Also, the valve timing (the period of time between the combustion and regeneration cycle of a tower) can have a small impact on the overall control device efficiency. Each time the valves reverse flow through the tower, a small portion of untreated gases are back-purged (i.e., bypass treatment). As a result, one expects a small reduction in control efficiency as the valve timing (number of cycles per hour) is increased; or conversely, an increase in efficiency as the valve timing (number of cycles per hour) decreases. Valve timing is part of the process design. Modern oxidizers incorporate systems which automatically control (change) valve timing in order to assist with maintaining the proper regenerative bed/combustion chamber temperature. Consequently, it is not practical, nor is it necessary, to establish and monitor a strict set valve timing. Rather, the valve timing control system should be documented and understood upon installation of the system, and the integrity of the valve system should be verified periodically.

Periodic monitoring of the valve operating system should be conducted. Activities which could be used to assess valve operation include routine inspection of key parameters of the valve operating system (e.g., solenoid valve operation, air pressure, hydraulic pressure), visual inspection of the valves during internal inspections, and actual testing of the emission stream for leakage.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocols for Regenerative Oxidizers?

The monitoring protocols for thermal and catalytic oxidizers include the following additional monitoring parameters for regenerative units:

1. Assessment of proper closure of valves through periodic (at least annual) inspection or testing, and

2. Annual documentation of valve timing control system parameters (e.g., minimum and maximum set points) and documentation of any changes made.

What Are Additional Key Factors to Consider When Monitoring a Recuperative Oxidizer?

An additional key operating factor to consider for recuperative oxidizers is the potential for leakage in the heat exchanger. If the heat exchanger develops leaks, untreated emissions can pass through the heat exchanger to the oxidizer exhaust. The heat exchanger should be inspected or tested for leaks per the manufacturer’s recommendations.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocols for Recuperative Oxidizers?

The monitoring protocols for thermal and catalytic oxidizers include the following additional monitoring parameter for recuperative units:

1. Annual inspection or testing of the heat exchanger to assess leakage per manufacturer’s recommendations.

What Is a Solvent Recovery System?

Solvent recovery systems, as used in the printing and flexible packaging industry, consist of two or more adsorber vessels that contain activated carbon. Solvent laden air (SLA) from the manufacturing process is passed through one or more adsorbers. The solvent from the air stream is retained or adsorbed by the carbon as it passes through the bed(s). Cleansed air is released to atmosphere. Once the carbon in an adsorber becomes saturated with solvents, the solvent laden air is routed to an alternate adsorber and the saturated adsorber is regenerated (i.e, the adsorbed solvent is stripped from the carbon). Different mechanisms may be used to regenerate the carbon. In one method, the carbon is heated with steam, which causes the carbon to release the solvent vapors. The steam and solvent vapors from the regenerating adsorber are condensed. Many carbon adsorbers have mechanisms to treat the condensate to separate the solvent from the water. After a period of time regeneration is stopped and the adsorber goes idle while waiting to go back on line. Two or more adsorbers are used to enable continuous operation with one or more vessels adsorbing while another is being regenerated. There are other methods to regenerate the carbon beds; these include the use of nitrogen as the regeneration gas or vacuum regeneration (placing the adsorber under vacuum to desorb the solvent).

What Are the Key Factors to Consider When Monitoring a Solvent Recovery System?

The key factors to consider when monitoring a solvent recovery system are either:

1. The quantity of solvent recovered, or

2. System operating parameters, including

   A. System integrity,

   B. Proper operation of the bypass damper interlock,

   C. Inlet and outlet solvent concentration, and

   D. Inlet and outlet air flow rate.

Because the solvent is recovered (and not destroyed such as in a thermal incinerator), it is possible to conduct a material balance to determine if emission limits are being met (simply stated: emissions equal solvent used in the process less solvent recovered). One monitoring approach is to conduct a periodic material balance; typically monthly.

Another approach relies on monitoring the inlet and outlet concentrations and air flows of the adsorber to provide the information necessary to calculate the control efficiency of the device.

A third monitoring approach is to monitor key operating parameters of the adsorber. For example, a rise in outlet solvent concentration indicates that the adsorption capacity of a bed has been reached. Continuously monitoring the solvent concentration of the treated air exhaust stream can be used to detect the increase in concentration and initiate the switch from the adsorbing to the regenerating phase. An instrument used in this approach is typically referred to as a "breakthrough detector." Another approach is to establish regeneration criteria based on design and performance results and monitor these regeneration criteria. For example, establishing a maximum time between regeneration cycles, as well as the minimum quantity and temperature of the steam used for regeneration during each cycle are parameters that could be monitored. Because this parameter monitoring approach does not rely on a direct measure of the solvent concentration in the treated air exhaust stream, it does not provide as high a level of confidence as the use of a breakthrough detector.

What Are the Indicators of Performance Included in the Presumptively Acceptable Protocols for a Solvent Recovery System?

Two protocols for solvent recovery systems are included in this document. Protocol 3 addresses monitoring of solvent recovery system concentrations to determine control device efficiency. Protocol 4 relies on measurement of the solvent recovered and material balance calculation.

Protocol 3 includes:

1. Adsorption system inspection for component integrity,

2. Continuously monitoring the control system bypass position using a process interlock,

3. Continuously monitoring solvent concentration in the inlet and outlet of the carbon adsorption system, and

4. Continuously monitoring air flow rates in the inlet and outlet of the carbon adsorption system.

Protocol 4 references the liquid-liquid material balance procedures of 40 CFR 63, subpart KK, section 63.824(b)(1)(I). If this liquid-liquid material balance procedure is used, no additional monitoring of the control device is required, other than monitoring system bypass.

Parameter monitoring of regeneration cycle criteria has not been included in this document as a presumptively acceptable protocol. It was not included because it does not meet subpart KK requirements and, therefore, would not be acceptable for sources subject to subpart KK. Nonetheless, the approach may be applicable to some facilities not subject to subpart KK. Appendix A of the Compliance Assurance Monitoring Technical Guidance Document (CAM TGD) includes several examples of parameter monitoring for carbon adsorbers; one example relies on the use of a breakthrough detector, and another relies on monitoring the vacuum regeneration operating parameters. You should refer to the CAM document if you are interested in reviewing parameter monitoring options.

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PROTOCOL A
Capture System for VOC Control: Unenclosed Presses

I. Applicability

A. Emissions Unit

This monitoring protocol is applicable to the following types of emissions units:

1. Unenclosed Central Impression (CI) and In-line flexographic printing presses and dryers.

B. Minimum Design Criteria for Emissions Unit and Capture System

This monitoring protocol is presumptively acceptable if the emissions unit and capture system meet the minimum design criteria identified in this section.

1. Emissions Unit

(a) Has enclosed doctor blades;
(b) Is between color dryer;
(c) Has air flow into dryers;
(d) Is maintained and operated as designed by the manufacturer; and
(e) Has flow sensor(s) (e.g., static pressure) in dryer air flow system with interlock to press.

2. Capture System

(a) Has local exhaust system inherent to design of press, and
(b) Is maintained and operated as designed by the manufacturer.

3. Bypass Dampers

Each bypass damper located in the exhaust system between the process and the control device is interlocked with the process so that the process cannot operate unless the damper is directing the process emissions to the control device. The sole exception is that the press may be operated with the bypass vented to atmosphere when using compliant inks/coatings.

II. Monitoring Approach

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria are presented in Table A.

III. Rationale for Selection of Performance Indicators

Multicolor in-line and CI presses used in the rotogravure, and flexographic industries utilize dryers. These dryers are designed to operate under negative pressure and comprise the capture system. The dryer system and the airflow through the system is an integral part of the process designed by the manufacturer. Once installed and tested it does not change. A properly balanced air system must be maintained in order to assure that the exhaust gas is maintained below the lower explosive limit (LEL) of the inks or coatings. In order to meet fire insurance requirements, all exhaust ducts typically are fitted with LEL sensors and alarms and with flow sensors that will trigger a shutdown if the flow falls below a minimum value, typically a fraction of the LEL. Assuring the flow sensor interlocks are properly set and operating will assure the airflow through the system is properly maintained, the press is operating as designed, and the design capture efficiency is achieved.

Monitoring the operation of the bypass damper interlock and integrity of the exhaust system between the process line and control device will assure that the process is exhausting all emissions to the control device. Bypass dampers on the system are electrically interlocked to assure the process exhaust stream is directed to the oxidation system during operation. Inspections of the ductwork and damper interlocks will ensure their integrity.

When necessary after equipment maintenance, or adjustment, a smoke test will verify capture (negative flow from the atmosphere into the exhaust system) at the test location.

IV. Rationale for Selection of Indicator Ranges

A performance test is conducted on the dryer and exhaust system (unenclosed process) when first installed to demonstrate compliance with the capture efficiency required in the air pollution permit or as guaranteed by the manufacturer.

The level at which the low-flow sensor interlock activates is established by the manufacturer at the time of installation. It is set at a level to assure proper operation of the press and to maintain operation below the LEL. Maintaining airflow above this level assures the press is properly operating and provides a reasonable assurance that the capture efficiency is being maintained.

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TABLE A. MONITORING APPROACH FOR EMISSIONS CAPTURE FOR UNENCLOSED PRESSES

		Indicator #1	Indicator #2	Indicator #3[a]
I.	Indicator	Work Practice	Work Practice	Work Practice
	Measurement Approach	Inspect the operational condition of the control device bypass damper and the integrity of the exhaust system from the process to the control device.	Inspect operational condition of all interlocks, including: • between color dryer flow; • tunnel oven flow; and • bypass damper.	Use a smoke stick or equivalent approach to assure that the dryer is negative to the surrounding atmosphere.
II.	Indicator Range	An excursion is defined as any finding that the integrity of the bypass damper, or the exhaust system has been compromised.	Establish the interlock set-point at the time of installation. An excursion is defined as any finding that any interlocks are inoperative.	Case-by-case determination of appropriate compliance demonstration technique.
	Corrective Action	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Press shall not be operated until proper placement of dryer cans is demonstrated. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.
III.	Performance Criteria			
	A. Data Representativeness	Properly positioned dampers and leak free ductwork will assure that all of the normally captured exhaust will reach the control device. Inspections will identify problems.	Properly operating interlocks will assure that dampers are correctly positioned. Inspections will identify problems.	Monitoring approach will assure the dryer is set to properly contain supply air.
	B. Verification of Operational Status	Inspection records.	Inspection records.	Not applicable.
	C. QA/QC Practices and Criteria		Validate set-point of between color dryer and tunnel oven exhaust flow sensors by measuring static pressure (or flow), as appropriate; annually.	

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TABLE A. (CONTINUED)

		Indicator #1	Indicator #2	Indicator #3[a]
D.	Monitoring Frequency	Semiannually.	Annually.	Whenever the location of the dryer is disrupted. [This may not be necessary for two piece dryers.]
	Data Collection Procedure	Record results of inspections and observations.	Record results of inspections and observations	Not applicable
	Averaging Period	Not applicable.	Not applicable.	Not applicable.
E.	Recordkeeping	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.
F.	Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.
	Frequency	Semiannually.	Semiannually.	Semiannually.

[a] Indicator #3 is only necessary for unenclosed presses with variable placement settings for the between color dryer cans.

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PROTOCOL B
Capture System for VOC Control:
Unenclosed Coaters and Laminators

I. Applicability

A. Emissions Unit

This monitoring protocol is applicable to the following types of emissions units:

1. Unenclosed coaters and laminators.

B. Minimum Design Criteria for Emissions Unit and Capture System

This monitoring protocol is presumptively acceptable if the emissions unit and capture system meet the minimum design criteria identified in this section.

1. Emissions Unit

(a) Has enclosed doctor blades;
(b) Has air flow into dryers;
(c) Is maintained and operated as designed by the manufacturer; and
(d) Has flow sensor(s) (e.g., static pressure) in dryer air flow system with interlock to press.

2. Capture System

(a) Has local exhaust system inherent to design of press, and
(b) Is maintained and operated as designed by the manufacturer.

3. Bypass Dampers

Each bypass damper located in the exhaust system between the process and the control device is interlocked with the process so that the process cannot operate unless the damper is directing the process emissions to the control device. The sole exception is that the press may be operated with the bypass vented to atmosphere when using compliant coatings.

II. Monitoring Approach

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria are presented in Table B.

III. Rationale for Selection of Performance Indicators

Unenclosed coaters and laminators are designed with a capture system for the application area and dryers which operate under negative pressure; these components comprise the capture system for an unenclosed laminator or coater. The capture, dryer and exhaust system and the airflow through the system is a part of the process designed by the manufacturer. Once installed and tested it does not change. A properly balanced air system must be maintained in order to assure that the exhaust gas is maintained below the lower explosive limit (LEL) of the inks or coatings. In order to meet fire insurance requirements, all exhaust ducts typically are fitted with LEL sensors and alarms and with flow sensors that will trigger a shutdown if the flow falls below a minimum value, typically a fraction of the LEL. Continuously monitoring an indicator of flow (e.g., static pressure) and maintaining the flow at the proper level provides a reasonable assurance that the capture efficiency is being maintained.

Monitoring the operation of the bypass damper interlock and integrity of the exhaust system between the process line and control device will assure that the process is exhausting all emissions to the control device. Bypass dampers on the system are electrically interlocked to assure the process exhaust stream is directed to the oxidation system during operation. Inspections of the ductwork and damper interlocks will ensure their integrity.

When necessary after equipment maintenance, or adjustment, a smoke test will verify capture (negative flow from the atmosphere into the exhaust system) at the test location.

IV. Rationale for Selection of Indicator Ranges

A performance test is conducted on the unenclosed laminator or coater when first installed to demonstrate compliance with the capture efficiency required in the air pollution permit or as guaranteed by the manufacturer.

The selected indicator range is between 75 and 100 percent of the value measured during the performance test.

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TABLE B. MONITORING APPROACH FOR EMISSIONS CAPTURE FOR UNENCLOSED COATERS AND LAMINATORS

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
I. Indicator	Work Practice	Work Practice	Exhaust flow	Work Practice
Measurement Approach	Inspect the operational condition of the control device bypass damper and the integrity of the exhaust system from the process to the control device.	Inspect operational condition of all interlocks, including: • tunnel oven flow; and • bypass damper.	Continuously monitor an indicator of flow of: • the applicator area • the tunnel dryer Monitor either the static pressure, or a direct measure of flow.	Use a smoke stick or equivalent approach to assure that the dryer is negative to the surrounding atmosphere.
II. Indicator Range	An excursion is defined as any finding that the integrity of the bypass damper, or the exhaust system has been compromised.	An excursion is defined as any finding that any interlocks are inoperative.	Establish indicator range at a value between the average value measured during the most recent performance test and 75% of this value. Establish the indicator range based upon the test data, historical data, and engineering judgment.	Case-by-case determination of appropriate compliance demonstration technique.
Corrective Action	Each excursion triggers an inspection, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an inspection, corrective action and a reporting requirement.	Process shall not be operated until negative flow into the dryer system or application area capture system is demonstrated. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.

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TABLE B. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
III. Performance Criteria				
A. Data Representativeness	Properly positioned dampers and leak free ductwork will assure that all of the normally captured exhaust will reach the control device. Inspections will identify problems.	Properly operating interlocks will assure that dampers are correctly positioned. Inspections will identify problems.	Continuously monitoring an indicator of flow will assure that adequate flow to achieve the designed capture rate is maintained.	Monitoring approach will assure the dryer is set to properly contain supply air, and that the airflow is into the application area capture system.
B. Verification of Operational Status	Inspection records.	Inspection records.	Upon installation, compare to measured flow using standard flow measurement techniques; (e.g., EPA Method 2); per manufacturer's instructions.	Not applicable.
C. QA/QC Practices and Criteria		Validate set point of application area capture system and tunnel oven exhaust flow sensors by measuring static pressure (or flow), as appropriate; annually.	Confirm proper operation and calibration of sensor annually. • Static pressure: compare to calibrated meter or manometer; • Flow sensor: compare to measured value using standard method (e.g., EPA Method 2).	
D. Monitoring Frequency	Semiannually.	Semiannually.	At least 4 times per hour.	Whenever the application area capture system or dryer system is disrupted.
Data Collection Procedure	Record results of inspections and observations.	Record results of inspections and observations.	Data acquisition system or strip chart or circular recorder.	Not applicable.
Averaging Period	Not applicable.	Not applicable.	1-hr.	Not applicable.

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TABLE B. (CONTINUED)

		Indicator #1	Indicator #2	Indicator #3	Indicator #4
E.	Recordkeeping	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.
F.	Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.
	Frequency	Semiannually.	Semiannually.	Semiannually.	Semiannually.

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PROTOCOL C
Capture System for VOC Control: Permanent Total Enclosures

I. Applicability

A. Emissions Unit

This protocol is applicable to the following types of emissions units:

1. Central Impression (CI) and In-line flexographic printing presses and dryers;

2. CI and In-line rotogravure printing presses and dryers; and

3. Coating and laminating operations.

B. Minimum Design Criteria for Emissions Unit and Capture System

This monitoring protocol is presumptively acceptable if the emissions unit and capture system meet the minimum design criteria identified in this section.

1. Emissions Unit

Emissions units are contained within the permanent total enclosure.

2. Capture System

The enclosure shall be designed and operated in accordance with the criteria in USEPA Method 204.

3. Bypass Dampers

Each bypass damper located in the exhaust system between the permanent total enclosure and the control device shall be interlocked with the process so that the process can not operate unless the damper is directing the process emissions to the control device.

II. Monitoring Approach

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria are presented in Table C.

III. Rationale for Selection of Performance Indicators

Maintaining the enclosure under sufficient negative pressure at all times assures that the capture efficiency is maintained; therefore, monitoring the differential pressure across the enclosure provides an indicator of performance.

The operation of the bypass damper and integrity of the ductwork between the process and add-on control device are indicative that the process is exhausting all emissions to the control device. Bypass dampers on the system are electrically interlocked to assure the process exhaust stream is directed to the oxidation system during operation.

IV. Rationale for Selection of Indicator Ranges

The selected indicator range is a differential pressure of less than - 0.007 in.w.c. This indicator range is based upon Method 204 criteria. A differential pressure of -0.007 is considered equivalent to a face velocity of 200 ft/minute for natural draft openings. Alternatively, the differential pressure can be established at a value demonstrated during the performance test as sufficient to meet the required capture efficiency.

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TABLE C. MONITORING APPROACH FOR PERMANENT TOTAL ENCLOSURES UTILIZING PRESSURE DIFFERENTIAL

	Indicator #1	Indicator #2	Indicator # 3
I. Indicator	Work Practice	Work Practice	Pressure differential
Measurement Approach	Inspect the operational condition of the control device bypass damper, the integrity of the exhaust system from the process to the control device, and the integrity of the enclosure.	Inspect operational condition of all bypass interlocks.	Monitor pressure differential across the enclosure wall and the surrounding atmosphere.
II. Indicator Range	An excursion is identified as any finding that the integrity of the bypass damper, the exhaust system ductwork, or the enclosure have been compromised.	An excursion is identified as any finding that the bypass interlock is inoperative.	An excursion is defined as a pressure differential of less than negative (-)0.007” w.c. for 5 consecutive minutes; alternatively, a smaller differential [i.e., less than (-)0.007 w.c.] can be used as the indicator if such a differential is demonstrated as adequate to qualify the permanent total enclosure during the performance test.
Corrective Action	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.
III. Performance Criteria			
A. Data Representativeness	Properly positioned dampers, leak-free ductwork and a leak-free enclosure of the process will assure that all of the exhaust will reach the control device. Inspections will identify problems.	Properly operating interlocks will assure that the processes will be shut down if the bypass damper is open to atmosphere.	The monitor measures the pressure differential at the interface between the wall of the enclosure and surrounding atmospheres.

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TABLE C. (CONTINUED)

	Indicator #1	Indicator #2	Indicator # 3
B. Verification of Operational Status	Inspection records.	Inspection records.	Not applicable.
C. QA/QC Practices and Criteria	Not applicable.	Not applicable.	Validation of instrument calibration conducted annually. Compare to calibrated meter or manometer, or calibrate using pressure standard.
D. Monitoring Frequency	**Semiannually**	**Semiannually**	Monitor continuously.
Data Collection Procedure	Record results of inspections and observations.	Record results of inspections and observations.	Record continuously on a chart or electronic media.
Averaging Period	Not applicable.	Not applicable.	None taken.
E. Recordkeeping	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of data and of corrective actions taken in response to excursions.
F. Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.
Frequency	Semiannually.	Semiannually.	Semiannually.

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PROTOCOL D
Capture System for VOC Control: Permanent Total Enclosures

I. Applicability

A. Emissions Unit

This protocol is applicable to the following types of emissions units:

1. Central Impression (CI) and In-line flexographic printing presses and dryers;

2. CI and In-line rotogravure printing presses and dryers; and

3. Coating and laminating operations.

B. Minimum Design Criteria for Emissions Unit and Capture System

This monitoring protocol is presumptively acceptable if the emissions unit and capture system meet the minimum design criteria identified in this section.

1. Emissions Unit

Emissions Units are contained within the permanent total enclosure.

2. Capture System

(a) The enclosure shall be designed and operated in accordance with the criteria in USEPA Method 204;
(b) All doors on the enclosure shall be equipped with sensors that are interlocked to the process operation; and
(c) The capture system shall include an indicator of flow exhausted from the permanent total enclosure (e.g., static pressure, fan RPM).

Note: Additional monitoring criteria apply if the capture system does not meet permanent total enclosure criteria (i.e., if the capture system is a local exhaust system or partial enclosure).

3. Bypass Dampers

   Each bypass damper located in the exhaust system between the permanent total enclosure and the control device shall be interlocked with the process so that the process can not operate unless the damper is directing the process emissions to the control device.

II. Monitoring Approach

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria are presented in Table D.

III. Rationale for Selection of Performance Indicators

If the integrity of the enclosure and exhaust flow are maintained, the enclosure will achieve the design capture efficiency (100 percent). The selected parameters assure the integrity of the enclosure is maintained and that the exhaust flow is maintained.

Inspections of the enclosure will provide the necessary information to assure the integrity of the enclosure is maintained. Interlocks on all doors will assure that doors remain in a closed position during process operation

An indicator of flow in the permanent total enclosure exhaust system will assure the airflow through the system is properly maintained at a minimum value necessary to meet permanent total enclosure criteria, and that the enclosure is maintained under negative pressure.

Monitoring the operation of the bypass damper interlock and the integrity of the exhaust system ductwork between the permanent total enclosure and control device will assure that the process is exhausting all emissions to the control device. Bypass dampers on the system are electrically interlocked to assure the process exhaust stream is directed to the air pollution control device during operation.

IV. Rationale for Selection of Indicator Ranges

The indicator range established for the permanent total enclosure flow is selected based upon design criteria (minimum flow necessary to maintain required average face velocity at natural draft openings) and historical data during normal operation. The indicator range established for the level at which the low-flow sensor interlock activates is established by the manufacturer at the time of installation. It is set at a level to assure proper operation of the press and to maintain operation below the lower explosive level (LEL). Maintaining airflow above this level assures the press is properly operating and provides a reasonable assurance that the capture efficiency is being maintained.

The selected indicator for the door interlocks is 5 minutes. 5 minutes is sufficient time to allow necessary activities to occur; a door remaining open for longer than 5 minutes during normal operation is indicative of a problem requiring corrective action.

The design and construction of enclosures can vary significantly and, consequently, so can the susceptibility of the integrity of the enclosure. Because partial enclosures do not meet the minimum design criteria to qualify as permanent total enclosures, the design and construction of partial enclosures can vary even more widely than for permanent total enclosures. Hence, for capture systems that do not meet permanent total enclosure criteria, more frequent monitoring of the capture system integrity is required.

TABLE D. MONITORING APPROACH FOR PERMANENT TOTAL ENCLOSURES UTILIZING DOOR INTERLOCKS, ROUTINE INSPECTIONS, AND AN INDICATOR OF FLOW

		Indicator #1	Indicator #2	Indicator #3	Indicator #4
I.	Indicator	Work Practice	Work Practice	Door Position Interlocks	Permanent Total Enclosure Exhaust Flow
	Measurement Approach	Inspect the operational condition of the control device bypass damper, the integrity of the exhaust system from the process to the control device, and the integrity of the enclosure.[a]	Inspect operational condition of all bypass interlocks.	Doors shall be fitted with a door position monitor with a timer and interlock to the process.	A flow sensor (e.g., flow meter, static pressure measurement, fan RPM) is used to monitor the total exhaust flow rate from the permanent total enclosure.
II.	Indicator Range	An excursion is identified as any finding that the integrity of the bypass damper, the exhaust system ductwork, or the enclosure have been compromised.	An excursion is identified as any finding that the bypass interlock is inoperative.	An excursion is identified as any finding that an interlock is inoperative. The process shall shutdown after five minutes of the enclosure door being open.	The indicator range is established at, or above, the level representative of the minimum flow necessary to meet permanent total enclosure criteria (minimum average NDO flow rate).
	Corrective Action	Each excursion triggers an inspection, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement	Any excursion shall require that the process be immediately shut down until the problem can be corrected.	Any excursion triggers corrective action and a reporting requirement.

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TABLE D. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
III. Performance Criteria				
A. Data Representativeness	Properly positioned dampers, leak free ductwork and enclosure on process will assure that all of the exhaust will reach the control device. Inspections will identify problems.	Properly operating interlocks will assure that the processes will shut down if the bypass damper is open to atmosphere.	Properly operating door interlocks will assure that the doors are closed during process operation.	Continuously monitoring an indicator of flow assures the minimum required flow rate from the permanent total enclosure is maintained and the permanent total enclosure is maintained under negative pressure.
B. Verification of Operational Status	Inspection records.	Inspection records.	Not applicable.	The instrument is installed and calibrated according to the manufacturer's instructions. EPA Method 2 is used to verify the flow rate and establish the minimum indicator range.
C. QA/QC Practices and Criteria	Not applicable.	Check operation of bypass interlock semiannually.	Check operation of interlocks semiannually.	Annually use Method 2 to verify flow rate and relationship of flow indicator to flow rate.
D. Monitoring Frequency	Semiannually.[a]	Semiannually	Measured continuously.	Measured continuously.
Data Collection Procedure	Record results of inspections and observations	Record results of inspections and observations	Record results of any excursion	Record on strip chart or electronic data system
Averaging Period	Not applicable	Not applicable	Not applicable	Not applicable
E. Recordkeeping	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.

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TABLE D. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
F. Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.
Frequency	Semiannually.	Semiannually.	Semiannually.	Semiannually.

[a] For enclosures and local exhaust systems that do not meet permanent total enclosure criteria, more frequent inspections of the integrity of the capture system are required. The minimum frequency is monthly.

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PROTOCOL E
Capture System for VOC Control: Permanent Total Enclosures

I. Applicability

A. Emissions Unit

This protocol is applicable to the following types of emissions units:

1. Central Impression (CI) and In-line flexographic printing presses and dryers with a controlled potential to emit less than the major source threshold of the pollutant (VOC or HAP).

2. CI and In-line rotogravure printing presses and dryers with a controlled potential to emit less than the major source threshold of the pollutant (VOC or HAP).

3. Coating and laminating operations with a controlled potential to emit less than the major source threshold of the pollutant (VOC or HAP).

B. Minimum Design Criteria for Emissions Unit and Capture System

This protocol is presumptively acceptable if the emissions unit and capture system meet the minimum design criteria identified in this section.

1. Emissions Unit

Emissions Units are contained within the permanent total enclosure.

2. Capture System

(a) The enclosure shall be designed and operated in accordance with the criteria in USEPA Method 204;
(b) All doors on the enclosure shall be equipped with self closing doors or sensors that are interlocked to the process operation; and
(c) The capture system shall include an indicator of flow (e.g., flow sensor, static pressure, fan RPM) exhausted from the permanent total enclosure. The process operation shall be interlocked to the permanent total enclosure flow.

3. Bypass Dampers

   Each bypass damper located in the exhaust system duct between the permanent total enclosure and the control device shall be interlocked with the process so that the process can not operate unless the damper is directing the process emissions to the control device.

II. Monitoring Approach

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria are presented in Table E.

III. Rationale for Selection of Performance Indicators

If the integrity of the enclosure and exhaust flow are maintained, the enclosure will achieve the design capture efficiency (100 percent). The selected parameters provide a reasonable assurance that the integrity of the enclosure is maintained and that the exhaust flow is maintained.

Inspections of the enclosure will provide the necessary information to assure the integrity of the enclosure is maintained. Self-closing mechanisms on all doors will provide a reasonable assurance that doors will remain in a closed position during process operation. Self-closing doors provide a lower level of confidence than door interlocks (see Protocol D). However, because this protocol is applicable only to sources with post control emissions of less than the major source threshold, the level of confidence is considered acceptable.

Flow sensor interlocks will assure the airflow through the system is properly maintained at a minimum value necessary to operate the press as designed, and that the enclosure is maintained under negative pressure.

Monitoring the operation of the bypass damper interlock and the integrity of the exhaust system ductwork between the permanent total enclosure and control device will assure that the process is exhausting all emissions to the control device. Bypass dampers on the system are electrically interlocked to assure the process exhaust stream is directed to the air pollution control device during operation.

IV. Rationale for Selection of Indicator Ranges

The indicator range established for the level at which the interlock for low flow activates is established based upon permanent total enclosure design criteria (minimum flow necessary to maintain the required face velocity at natural draft openings) and historical data during normal operation.

The design and construction of enclosures can vary significantly and, consequently, so can the susceptibility of the integrity of the enclosure. Because partial enclosures do not meet the minimum design criteria to qualify as permanent total enclosures, the design and construction of partial enclosures can vary even more widely than for permanent total enclosures. Hence, for capture systems that do not meet permanent total enclosure criteria, more frequent monitoring of the capture system integrity is required.

TABLE E. MONITORING APPROACH FOR PERMANENT TOTAL ENCLOSURE RELYING ON SELF-CLOSING DOORS, ROUTINE INSPECTIONS, AND A FLOW RATE INTERLOCK

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
I. Indicator	Work Practice	Work Practice	Door Position	Permanent Total Enclosure Exhaust Flow
Measurement Approach	Inspect the operational condition of the control device bypass damper, the integrity of the exhaust system from the process to the control device, and the integrity of the enclosure.[a]	Inspect operational condition of all bypass interlocks.	Doors shall be of self-closing type or monitor door position with a timer and interlock to the process. If doors are of the self-closing type, daily inspections of the door and verification of proper operation shall be conducted.	A flow sensor (e.g., flow meter, static pressure measurement, fan RPM) is used to monitor the total exhaust flow rate from the permanent total enclosure. A "low flow" value is established and a process interlock is established at this value.
II. Indicator Range	An excursion is identified as any finding that the integrity of the bypass damper, the ductwork, or the enclosure have been compromised.	An excursion is defined as any finding that the bypass interlock is inoperative.	An excursion is identified as any finding where the interlocks are inoperative or self-closing doors have been bypassed.	The indicator range is established at, or above, the level representative of the minimum flow necessary to meet permanent total enclosure criteria (minimum average natural draft openings flow rate).
Corrective Action	Each excursion triggers an inspection, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down until the problem can be corrected.	Any excursion triggers corrective action and a reporting requirement.

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TABLE E. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
III. Performance Criteria				
A. Data Representativeness	Properly positioned dampers, leak free ductwork and enclosure on process will assure that all of the exhaust will reach the control device. Inspections will identify problems.	Properly operating interlocks will assure that the processes will shut down if the bypass damper is open to atmosphere.	Properly operating self-closing doors or door interlocks will ensure that the doors are closed during process operation.	Continuously monitoring an indicator of flow assures the minimum required flow rate from the permanent total enclosure is maintained and the permanent total enclosure is maintained under negative pressure.
B. Verification of Operational Status	Inspection records.	Inspection records.	Not applicable.	The instrument is installed and calibrated according to the manufacturer's instructions. EPA Method 2 is used to verify the flow rate and establish the minimum indicator range.
C. QA/QC Practices and Criteria	Not applicable.	Check operation of bypass damper semiannually.	Not applicable.	Annually use Method 2 to verify flow rate and relationship of flow indicator to flow rate.
D. Monitoring Frequency	Semiannually.[a]	Semiannually.	Interlocks: Measured continuously. Self-closing: daily inspection .	Measured continuously.
Data Collection Procedure	Record results of inspections and observations.	Record results of inspections and observations.	Record results of any excursion.	Record results of any excursion (i.e., low flow interlock is activated).
Averaging Period	Not applicable.	Not applicable.	Not applicable.	Not applicable.

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TABLE E. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
E. Recordkeeping	Maintain for a period of 5 years records of inspections and corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.
F. Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.
Frequency	Semiannually.	Semiannually.	Semiannually.	Semiannually.

[a] For enclosures and local exhaust systems that do not meet permanent total enclosure criteria more frequent inspections of the integrity of the capture system are required. The minimum frequency is monthly.

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PROTOCOL 1
Thermal Oxidizers

I. Applicability

This monitoring protocol is applicable to thermal oxidizers controlling VOC and organic HAP emissions from flexographic presses, rotogravure presses, coating operations, and laminating operations in the printing and publishing and flexible packaging industries.

This monitoring protocol addresses monitoring of the control device operation, only, and does not address monitoring required of capture systems associated with the individual process units. [See associated protocols for capture systems.]

A. Minimum Design Criteria for Control Device

This monitoring protocol is presumptively acceptable if the control device meets the minimum design criteria identified in this section.

1. Bypass Indicator/Interlock

Any control device bypass damper shall be interlocked with the processes vented to the control device so that the processes cannot operate when the control device bypass is vented to atmosphere.

II. Monitoring Approach

A. The monitoring approach is comprised of:

1. Continuous monitoring and recording of combustion zone temperature with a thermocouple system;

2. Periodic internal and external inspection of the structural integrity of the control devices, bypass damper, and of the process and/or permanent total enclosure exhaust system to the control device;

3. Use of an interlock to monitor control device bypass operation; and

4. Periodic emissions performance tests.

B. For regenerative thermal oxidizers, the monitoring approach includes the following additional items:

1. Periodic inspection of valves for leakage.

2. Documentation of the valve timing system design at the time of performance testing and documentation of any changes made to the design or operation of the system.

C. For recuperative thermal oxidizers, the monitoring approach includes the following additional item:

1. Periodic inspection of the heat exchanger for leakage.

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria, are presented in Table 1.

III. Rationale for Selection of Performance Indicators

The oxidizer chamber control temperature was selected because it is indicative of the thermal oxidizer's operation. By maintaining the operating temperature at or above a minimum value, a desired level of control efficiency can be expected to be maintained. If the chamber temperature decreases significantly, complete combustion may not occur.

It is important to assure the control device is not bypassed during process operation except that processes operating with compliant inks/coatings may be vented directly to atmosphere. One method of monitoring bypass position is the use of interlocks. If these interlocks are maintained properly, the process will not be allowed to operate if the exhaust gases from the process are not vented to the control device. The process will not be allowed to exhaust into the oxidizer until the oxidizer has reached a sufficient temperature to ensure VOC destruction. These interlocks can also be used to prevent the process from operating in the event of an oxidizer malfunction.

To further ensure consistent VOC oxidation, the structural integrity of the oxidizer must be checked periodically. This will indicate any problems with oxidizer integrity that could result in decreased oxidizer performance or efficiency. Further, the auxiliary burner will be checked and/or tuned periodically to assure efficient operation and to minimize incomplete combustion products (i.e., carbon monoxide).

For regenerative units, the chamber sequencing valves will be checked periodically to be sure that they are properly positioned during each heat recovery heating and cooling cycle. This will avoid the leakage of VOC to the oxidizer stack if the valves are not functioning properly. The design and operation of the chamber sequencing valves timing system will be documented during the performance test and at annual inspections. This will identify changes in operation that might impact control efficiency.

An emissions performance test on the oxidizer is conducted once every 5 years to demonstrate compliance with permit conditions (i.e., percent destruction efficiency).

IV. Rationale for Selection of Indicator Ranges

The selected indicator range for the oxidizer chamber control temperature is established based upon demonstrated performance during a performance test.

The minimum required operating temperature of the oxidizer is established at the operating temperature maintained during a performance test. The thermal oxidation system includes a temperature controller that maintains the desired combustion chamber temperature by using an auxiliary burner. The temperature controller is set to maintain a temperature at or above the established indicator range.

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TABLE 1. MONITORING APPROACH FOR THERMAL OXIDIZER

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
I. Indicator	Oxidizer chamber temp. control.	Bypass interlock.	Work practice/inspection.	Performance test
Measurement Approach	Continuously record the operating temperature of the oxidizer combustion zone.	Verify operational condition of control device bypass interlocks.	Inspect internal and external structural integrity of oxidizer to ensure proper operation.[b,c] Inspect burner operation and tune, as necessary.	Conduct emissions test to demonstrate compliance with permitted destruction efficiency.
II. Indicator Range	An excursion is identified as a measurement of 50EF less than the average temperature demonstrated during the most recent compliance demonstration.	An excursion is identified as any finding that any bypass damper interlocks are inoperative.	An excursion is identified as any finding that the structural integrity of the oxidizer has been jeopardized and it no longer operates as designed.	An excursion is identified as any finding that the oxidizer does not meet the permitted destruction efficiency.
Corrective Action	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.

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TABLE 1. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
III. Performance Criteria				
A. Data Representativeness	Any temperature-monitoring device employed to measure the oxidizer combustion zone temperature shall be accurate to within 0.5% of temperature measured or ±5EF, whichever is greater.	Properly operating interlocks will ensure that dampers are correctly positioned. Periodic inspection and verification will adequately identify problems.	Inspections of the oxidizer system will identify problems.	A test protocol shall be prepared and approved by the regulatory Agency prior to conducting the performance test.
B. Verification of Operational Status	Temperatures recorded on chart paper or electronic media.	Inspection records.	Inspection records.	Not applicable.
C. QA/QC Practices and Criteria	Validation of temperature system conducted annually. Acceptance criteria ± 20F.[a]	Not applicable.	Not applicable.	EPA test methods approved in protocol.
D. Monitoring Frequency	Measured continuously	Annually.	• External inspection – monthly. • Internal inspection – annually.[b,c,d] • Burner inspection –annually.	Once every 5 years.
Data Collection Procedure	Recorded at least every 15-minutes on a chart or electronic media.	Record results of interlock operation verification, inspections and observations.	Record results of inspections and observations.	Per approved test method.
Averaging Period	Not applicable.	Not applicable.	Not applicable.	Not applicable.
E. Record Keeping	Maintain for a period of 5 years records of chart recorder paper or electronic media and corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and corrective actions taken in response to excursions.	Maintain a copy of the test report for 5 years or until another test is conducted. Maintain records of corrective actions taken in response to excursions.

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TABLE 1. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4
F. Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Submit test protocol and notification of testing to Agency 30 days prior to test date. Submit test report 60 days after conducting a performance test.
Frequency	Semiannually.	Semiannually.	Semiannually.	For each performance test conducted.

[a] Facility to maintain Standard Operating Procedure on-site for verifying accuracy of system.

[b] Internal inspection of regenerative units must include annual assessment (inspection or testing) of valves for leakage.

[c] Internal inspection of recuperative units must include annual assessment (inspection or testing) of heat exchange for leakage.

[d] Annual check of VOC content of exhaust gas, before and after thermal oxidizer, using an FID for three 20-minute runs, will serve in lieu of an annual internal inspection.

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PROTOCOL 2
Catalytic Oxidizers

I. Applicability

This monitoring protocol is applicable to catalytic oxidizers controlling VOC and organic HAP emissions from flexographic presses, rotogravure presses, coating operations, and laminating operations in the printing and publishing and flexible packaging industries.

This monitoring protocol addresses monitoring of the control device operation, only, and does not address monitoring required of capture systems associated with the individual process units. [See associated protocols for capture systems.]

A. Minimum Design Criteria for Control Device

This monitoring protocol is presumptively acceptable if the control device meets the minimum design criteria identified in this section.

1. Bypass Indicator/Interlock

Any control device bypass damper shall be interlocked with the processes vented to the control device so that the processes cannot operate when the control device bypass is vented to atmosphere.

II. Monitoring Approach

A. The monitoring approach is comprised of:

1. Continuous monitoring and recording of catalyst bed inlet temperature with a thermocouple system;

2. Periodic internal and external inspection of the structural integrity of the control devices, bypass damper, and of the process and/or permanent total enclosure exhaust system to the control device;

3. Use of an interlock to monitor control device bypass operation; and

4. Periodic emissions performance tests.

B. For regenerative thermal oxidizers, the monitoring approach includes the following additional items:

1. Periodic inspection of valves for leakage.

2. Documentation of the valve timing system design at the time of performance testing and documentation of any changes made to the design or operation of the system.

C. For recuperative thermal oxidizers, the monitoring approach includes the following additional item:

   1. Periodic inspection of the heat exchanger for leakage.

The elements of the monitoring approach, including indicators to be monitored, indicator ranges, and performance criteria, are presented in Table 2.

III. Rationale for Selection of Performance Indicators

The catalytic oxidation system catalyst bed inlet temperature was selected because it is indicative of the effective operation of the catalytic oxidation system. It has been demonstrated that the control efficiency achieved by a catalytic oxidation system is a function of the catalyst temperature and associated catalyst activity. By maintaining the temperature at or above a minimum level, a predetermined control efficiency can be expected.

Periodically sampling and testing the catalyst activity will assure that the catalyst will function properly when the minimum bed temperature is maintained. The catalyst conversion efficiency and surface area are evaluated and compared to typical values for fresh catalyst.

It is important to assure the control device is not bypassed during process operation except that processes operating with compliant inks/coatings may be vented directly to atmosphere. One method of monitoring bypass position is the use of interlocks. If these interlocks are maintained properly, the process will not be allowed to operate if the exhaust gases from the process are not vented to the control device. The process will not be allowed to exhaust into the oxidizer until the oxidizer has reached a sufficient temperature to ensure VOC destruction. These interlocks can also be used to prevent the process from operating in the event of an oxidizer malfunction.

To further ensure consistent VOC oxidation, the structural integrity of the oxidizer must be checked periodically. This will indicate any problems with oxidizer integrity that could result in decreased oxidizer performance or efficiency. Further, the auxiliary burner will be checked and/or tuned periodically to assure efficient operation and to minimize incomplete combustion products (i.e., carbon monoxide).

For regenerative units, the chamber sequencing valves will be checked periodically to be sure that they are properly positioned during each heat recovery heating and cooling cycle. This will avoid the leakage of VOC to the oxidizer stack if the valves are not functioning properly. The design and operation of the chamber sequencing valves timing system will be documented during the performance test and at annual inspections. This will identify changes in operation that might impact control efficiency.

An emissions performance test on the oxidizer is conducted once every 5 years to demonstrate compliance with permit conditions (i.e., percent destruction efficiency).

IV. Rationale for Selection of Indicator Ranges

The selected indicator range for the catalyst inlet bed control temperature is established based upon demonstrated performance during a performance test.

The minimum required operating temperature of the catalyst bed is established at the operating temperature maintained during a performance test. The thermal oxidation system includes a temperature controller that maintains the desired catalyst bed temperature by using an auxiliary burner. The temperature controller is set to maintain a temperature at or above the established indicator range.

TABLE 2. MONITORING APPROACH FOR CATALYTIC OXIDIZER

	Indicator #1	Indicator #2	Indicator #3	Indicator #4	Indicator #5
I. Indicator	Catalyst bed (Inlet) temperature.	Bypass interlock.	Work practice/inspection.	Performance test	Catalyst activity analysis.
Measurement Approach	Continuously record the operating temperature of the oxidizer catalyst bed.	Verify operational condition of control device bypass interlocks.	Inspect internal and external structural integrity of oxidizer to ensure proper operation.[b,c] Inspect burner operation and tune, as necessary.	Conduct emissions test to demonstrate compliance with permitted destruction efficiency.	Determine the catalyst activity level by evaluating the conversion efficiency and surface area.
II. Indicator Range	An excursion is identified as a measurement of 50EF less than the average temperature demonstrated during the most recent compliance demonstration.	An excursion is identified as any finding that any bypass damper interlocks are inoperative.	An excursion is identified as any finding that the structural integrity of the oxidizer has been jeopardized and it no longer operates as designed.	An excursion is identified as any finding that the oxidizer does not meet the permitted destruction efficiency.	The conversion efficiency and surface area are compared to the typical values for fresh catalyst. An excursion is identified as a finding that the catalyst is poisoned or masked beyond the operational range of the catalyst as defined by the manufacturer.
Corrective Action	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an inspection, correction action and a reporting requirement.

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TABLE 2. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4	Indicator #5
III. Performance Criteria					
A. Data Representativeness	Any temperature-monitoring device employed to measure the oxidizer chamber temperature shall be accurate to within 0.5% of temperature measured or ±5EF, whichever is greater.	Properly operating interlocks will ensure that dampers are correctly positioned. Periodic inspection and verification will adequately identify problems.	Inspections of the oxidizer system will identify problems.	A test protocol shall be prepared and approved by the regulatory Agency prior to conducting the performance test.	Analysis will determine the masking or poisoning of the catalyst.
B. Verification of Operational Status	Temperatures recorded on chart paper or electronic media.	Inspection records.	Inspection records.	Not applicable.	Not applicable.
C. QA/QC Practices and Criteria	Validation of temperature system conducted annually. Acceptance criteria ± 20F.[a]	Not applicable.	Not applicable.	EPA test methods approved in protocol.	Not applicable.
D. Monitoring Frequency	Measured continuously	Annually.	• External inspection – monthly. • Internal inspection – annually.[b,c,d] • Burner inspection –annually.	Once every 5 years.	Annually.
Data Collection Procedure	Recorded at least every 15-minutes on a chart or electronic media.	Record results of interlock operation verification, inspections and observations.	Record results of inspections and observations.	Per approved test method.	Record results of catalyst sample analyses.
Averaging Period	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.

TABLE 2. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3	Indicator #4	Indicator #5
E. Record Keeping	Maintain for a period of 5 years records of chart recorder paper or electronic media and corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and corrective actions taken in response to excursions.	Maintain a copy of the test report for 5 years or until another test is conducted. Maintain records of corrective actions taken in response to excursions.	Maintain for a period of 5 years records of catalyst analyses and corrective actions taken in response to excursions.
F. Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Submit test protocol and notification of testing to Agency 30 days prior to test date. Submit test report 60 days after conducting a performance test.	Number, duration, cause of any excursion and the corrective action taken.
Frequency	Semiannually.	Semiannually.	Semiannually.	For each performance test conducted.	Semiannually.

NOTE:

[a] Facility to maintain Standard Operating Procedure on-site for verifying accuracy of system.

[b] Internal inspection of regenerative units must include annual assessment (inspection or testing) of valves for leakage.

[c] Internal inspection of recuperative units must include annual assessment (inspection or testing) of heat exchange for leakage.

[d] Annual check of VOC content of exhaust gas, before and after catalytic oxidizer, using an FID for three 20-minute runs, will serve in lieu of an annual internal inspection.

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PROTOCOL 3
Solvent Recovery Systems
Inlet and Outlet Concentration

I. Applicability

This monitoring protocol is applicable to solvent recovery systems controlling VOC and organic HAP emissions from flexographic presses, rotogravure presses, coating operations and laminating operations in the flexible packaging industry.

This monitoring protocol addresses monitoring of the control device operation, only, and does not address required of emissions capture systems associated with the individual process units. [See associated protocols for capture systems.]

A. Minimum Design Criteria for Control Device

This protocol is presumptively acceptable if the control device meets the minimum design criteria identified in this section.

1. Bypass Indicator /Interlock

Any control device bypass shall be interlocked with the processes vented to the control device so that the processes can not operate when the control device bypass is vented to atmosphere.

II. Monitoring Approach

A continuous emissions monitoring system measures the concentration of VOC and air flow rate at the inlet and outlet of the adsorber to determine the removal efficiency of the adsorber on a real time basis.

III. Rationale for Selection of Performance Indicators

Solvent concentration in the adsorber inlet and exhaust air stream is the true indication of the systems adsorption activity and, therefore, removal efficiency. As a batch process, the adsorber loading increases over time to saturation at which point the solvent concentration in the exhaust stream approaches that of the inlet air. Therefore, removal efficiency is never constant and must be averaged over time. In conditions of low inlet concentrations, the adsorber outlet concentration will be a larger proportion of the inlet concentration (i.e., lower percent removal efficiency). Under such conditions, determining an average removal efficiency using the average inlet and outlet concentration will be biased (a lower removal efficiency will be calculated). Such conditions require the use of "mass" concentrations, considering inlet airflow and temperature, when calculating solvent removal efficiency.

IV. Rationale for Selection of Indicator Ranges

For this protocol the monitoring data are used to calculate an actual control device efficiency. The calculated control device efficiency is used to determine compliance. An indicator range is not selected. However, outlet solvent concentration as compared to the inlet concentration provides an indication of the adsorber efficiency. As saturation of the adsorber is reached, a breakthrough condition will occur, signaling the need to switch to a regenerated adsorber. Outlet concentration will range from very low, to concentrations approaching the inlet concentration at the point of breakthrough. As a practical matter, to properly operate the control device, the facility is likely to select an outlet concentration that will initiate bed switching and regeneration. However, this value need not be considered an indicator range for purposes of reporting excursions.

TABLE 3. MONITORING APPROACH FOR SOLVENT RECOVERY SYSTEMS

	Indicator #1	Indicator #2	Indicator #3 (Bypass Interlocks)
I. Indicator	Percent removal efficiency	Work practice	Work practice
Measurement Approach	A Continuous Emissions Monitoring Systems is used to measure the VOC concentration and air flow rate at the inlet and outlet of the adsorber system.	Inspect structural, mechanical and electrical integrity of the system.	Inspect operational condition of the bypass l interlock(s).
II. Indicator Range	An excursion is defined as a measured average (mass) recovery efficiency for the month less than regulatory requirements.	An excursion is identified as any finding that the integrity of the system has been jeopardized and it no longer operates as designed.	An excursion is identified as any finding that the bypass interlock(s) are inoperative.
Corrective Action	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.	Any excursion shall require that the process be immediately shut down and remain down until the problem can be corrected. Each excursion triggers an assessment of the problem, corrective action and a reporting requirement.
III. Performance Criteria			
A. Data Representativeness	Any monitoring device employed to measure the solvent concentration in air stream at accuracy of, +/- 3% of full scale.	Inspections will adequately identify problems.	Properly operating bypass interlock(s) will assure that dampers are correctly positioned. Inspection will identify problems.
B. Verification of Operational Status	Concentrations and air flow rates recorded on paper or electronic media.	Inspection records.	Inspection records.
C. QA/QC Practices and Criteria	Validation of instrument accuracy conducted quarterly. Daily calibration drift checks.	Not applicable.	Not applicable.
D. Monitoring Frequency	Measurement of inlet and outlet concentration and air flow rate once every 15 minutes.	• Internal adsorber inspection – annually. • External system inspection – monthly.	Annually.
Data Collection Procedure	Record on paper or electronic media.	Record results of inspections and observations.	Record results of inspections and observations.

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TABLE 3. (CONTINUED)

	Indicator #1	Indicator #2	Indicator #3 (Bypass Interlocks)
Averaging Period	1 month.	Not applicable.	Not applicable.
E. Record Keeping	Maintain for a period of 5 years paper or electronic media and corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and corrective actions taken in response to excursions.	Maintain for a period of 5 years records of inspections and of corrective actions taken in response to excursions.
F. Reporting	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.	Number, duration, cause of any excursion and the corrective action taken.
Frequency	Semiannually.	Semiannually.	Semiannually.

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PROTOCOL 4
Solvent Recovery Systems
Liquid-Liquid Material Balance

I. Applicability

This monitoring protocol is applicable to solvent recovery systems controlling VOC and organic HAP emissions from flexographic presses, rotogravure presses, coating operations and laminating operations in the flexible packaging industry.

This monitoring protocol addresses monitoring of the control device operation, only, and does not address required of emissions capture systems associated with the individual process units. [See associated protocols for capture systems.]

A. Minimum Design Criteria for Control Device

This protocol is presumptively acceptable if the control device meets the minimum design criteria identified in this section.

1. Bypass Indicator /Interlock

Any control device bypass shall be interlocked with the processes vented to the control device so that the processes can not operate when the control device bypass is vented to atmosphere.

II. Monitoring Approach

The solvent recovered is quantified and a liquid-liquid material balance is conducted.

III. Rationale for Selection of Performance Indicators

Use of the liquid-liquid material balance is a compliance determination method identified in 40 CFR 63, subpart KK.

IV. Rationale for Selection of Indicator Ranges

Not applicable

V. Procedures

Follow the liquid-liquid material balance procedures of 40 CFR 63, subpart KK, section 63.824(b)(1)(I). No additional monitoring of the control device is required, other than monitoring system bypass.