B.19 CAPTURE SYSTEMS[33]

B.19.1 Background

Capture efficiency is defined as the percentage of emissions captured and vented to a control device. Various capture systems may be used to capture emissions and direct them to a control device. These systems include enclosures and local exhaust ventilation measures.

There are basically two types of enclosures: (1) total enclosures, referred to as permanent total enclosures (PTEs), and (2) nontotal, or partial, enclosures. A PTE is an enclosure that completely surrounds a source such that all volatile organic compound (VOC) emissions are contained and directed to a control device. The EPA has established a set of criteria that must be met for an enclosure to qualify as a PTE; 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 measured. An enclosure that does not meet the minimum criteria for a PTE is not a total enclosure; it is a partial enclosure (PE) and capture efficiency is determined by measurement. Table B-19 summarizes the PTE criteria.

TABLE B-19. 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 enclosure's 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.
5. All VOC emissions must be captured and contained for discharge through a control device.

The second type of control measure used to capture emissions and vent them to a control device is the application of local exhaust ventilation. Local exhaust ventilation systems typically consist of a hood, or hoods, that capture the contaminant at the point of generation and a duct system and exhaust fan that moves the VOC-laden air to the control device.

For both types of capture systems discussed (enclosures and local exhaust ventilation systems), maintaining the integrity of the capture device (i.e., enclosure, hood) and the airflow (ventilation) through the system are the critical operating/maintenance parameters with respect to maintaining capture system performance. The indicators of performance for capture systems relate to these two parameters and, for purposes of this discussion, monitoring approaches can be divided into two subcategories:

1. Indicators of capture by the enclosure or hood (e.g., enclosure differential pressure, NDO velocity, hood face velocity); and

2. Indicators of system air flow (e.g., fan rpm, duct pressure differential) measured downstream of the capture device combined with a system integrity inspection.

The first monitoring approach is applicable to all types of capture systems. The second approach is applicable to simpler capture systems including either (a) a simply configured PTE or partial enclosure or (b) a simple exhaust ventilation system, such as a system consisting of a single hood (as opposed to multiple hoods), noncomplicated ductwork (e.g., without recirculation and multiple dampers), and a fan.

The first approach, measuring indicators of performance at the capture device, provides more reliable data related to capture efficiency than measuring air flow downstream of the capture device. For this reason, the second approach may provide a lower level of confidence than the first approach, which uses a more direct indicator of performance; the level of confidence will depend upon system design and frequency of inspection. While not essential to provide an acceptable level of confidence for the first monitoring approach, periodic inspection of the enclosure or hood and the exhaust system may be added to further increase the level of confidence. On the other hand, periodic inspections are necessary for the second monitoring approach to provide an acceptable level of confidence. The frequency and rigor of the inspection is a factor that affects the level of confidence; continuous data are not provided for this parameter. As with other CAM monitoring, the specific situation needs to be considered during selection of a monitoring approach and the factors discussed in Chapter 3 of the CAM technical guidance document should be considered (e.g., potential to emit, margin of safety, and cost).

In many cases, for both enclosures and other exhaust ventilation systems, single parameter monitoring may not be sufficient to ensure that capture efficiency is maintained. A combination of several parameters may be necessary to provide reasonable assurance of compliance with the capture efficiency requirements.

Common problems and malfunctions with capture systems include (1) an out-of-balance ventilation system due to the excessive opening and closing of doors and windows in an enclosure, (2) degradation in fan performance, (3) changes in PTE configuration due to process changes such as introducing a new VOC source within the enclosure (e.g., coating vessels or cleanup solvent drums that can be moved during the facility's day-to-day operations), and not maintaining the acceptable distance between VOC sources and NDOs; and (4) problems with the ductwork such as particulate matter accumulation in duct work, holes in the duct work, damaged hoods or enclosures, and disconnected pick up points.

B.19.2 Indicators of Capture System Performance

B.19.2.1 Enclosures. For enclosures, the primary indicators of performance include:

1. Face velocity (FV) through all NDOs or through selected representative NDOs (measurement of face velocity at each NDO);

2. Differential pressure across the enclosure; and

3. Average FV through all NDOs (measured using total volumetric air flow divided by NDO surface area) and daily inspection of NDOs.

For PTEs, FV through all NDOs and pressure differential across the enclosure are essentially equivalent measurements, and either can be used to demonstrate performance of the PTE. Note that Reference Method 204 [paragraph 8.3] indicates that a pressure differential of 0.013 mm Hg (0.0007 in. H_2O) corresponds to an average FV of 3,600 m/hr (200 ft/min). In some situations, the measurement of one parameter may be simpler than that of the other.

As stated earlier, periodic inspections of the enclosure can be used in conjunction with continuous or periodic measurement of the indicators identified above to further increase the level of confidence. The items incorporated into the inspection will vary depending on whether the enclosure is a PTE or a PE. For PTEs, the inspection should include all items required to demonstrate that the PTE criteria as established in EPA Reference Method 204 (summarized in Table 14-1) are maintained although the frequency of inspection for individual items might vary. For PEs, the inspection should require demonstration that the configuration of the enclosure remains identical to the configuration during the most recent test conducted to measure capture efficiency and is in good physical condition. Inspections for both types of enclosures also should demonstrate that the capture exhaust system is maintained in good working condition (ductwork is clear with no holes, damper operation is correct, fan is in good condition).

As discussed earlier, another indicator of performance for simply configured enclosures is measurement of the capture system air flow (or indicators of air flow, such as fan amperage, fan rpm, or static pressure) downstream of the enclosure. This monitoring approach must be combined with periodic inspections to provide an acceptable level of confidence for the approach. The type of inspection conducted will vary depending on whether the enclosure is a PTE or a PE. Also, inspections under this monitoring approach may need to be more frequent to provide a higher level of confidence.

B.19.2.3 Exhaust Ventilation Systems. For exhaust ventilation systems, the primary indicators of performance include:

1. Face velocity at the hood;

2. Exhaust flow rate in the duct near the hood; and

3. Hood static pressure.

Periodic inspections of the capture system (hood and exhaust system) could be used in conjunction with either continuous or periodic measurement of the indicators identified above to further increase the level of confidence.

Another indicator of performance for simple exhaust ventilation systems is measurement of the capture system air flow (or indicators of air flow such as fan amperage, fan rpm, or static pressure) downstream of the capture device (hood) combined with periodic capture system inspections. The frequency of inspections under this approach must be sufficient to provide an acceptable level of confidence.

B.19.3 Illustrations

The following illustrations present examples of compliance assurance monitoring for capture systems:

19a: PTE capture system for VOC: Pressure differential across the enclosure and periodic inspection of PTE capture system.
19b: PTE capture system for VOC: Average FV through all NDOs (net exhaust flow divided by NDO surface area) and periodic inspection of PTE capture system (including quarterly inspection of NDOs).
19c: PTE capture system for VOC: Average FV through selected NDOs (direct measure of FV) and periodic inspection of PTE capture system.
19d: PE capture system for VOC: Pressure differential across the enclosure and periodic inspection of capture system.
19e: Local exhaust ventilation system for capture of VOC: FV at the hood and periodic inspection of capture system.
19f: Local exhaust ventilation system for capture of VOC: Fan parameters and periodic inspection of capture system.

B.19.4 Bibliography

CAM ILLUSTRATION
No. 19a. PTE CAPTURE SYSTEM FOR VOC

1. APPLICABILITY

1.1 Capture Method: Permanent total enclosure (100 percent capture)
1.2 Pollutants: Volatile organic compounds (VOCs)
1.3 Process/Emissions Units: Coating operations, printing operations

2. MONITORING APPROACH DESCRIPTION

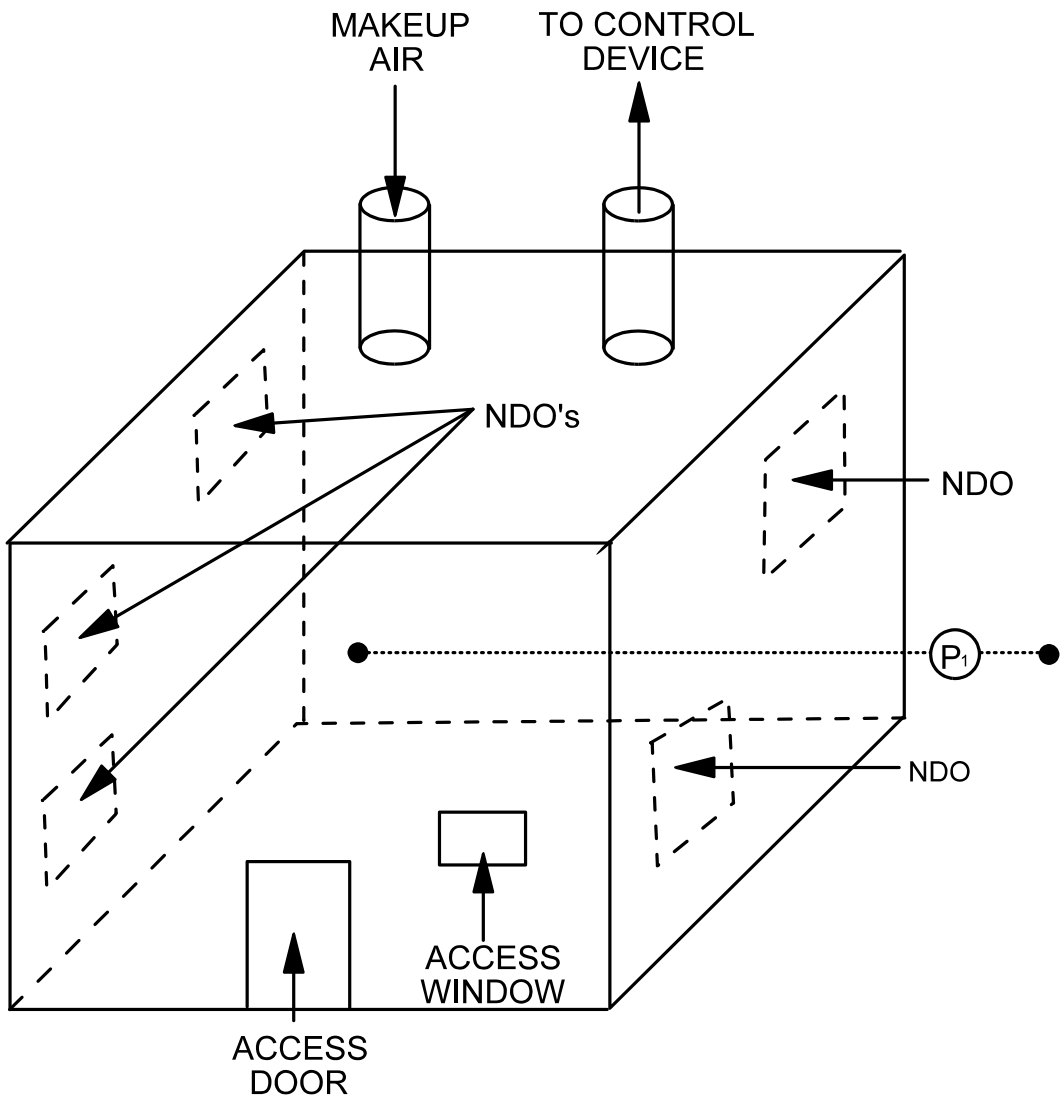
2.1 Indicators Monitored: Pressure differential across the enclosure and semi-annual inspection of PTE capture system.
2.2 Rationale for Monitoring Approach: Changes in pressure differential indicate changes in capture system performance. Semi-annual inspection and necessary maintenance will be used to ensure PTE criteria are maintained and exhaust system is in good working condition.
2.3 Monitoring Location (see Figure 1 for monitoring locations)
- Pressure differential: Pressure measured at points inside and outside the enclosure.
- Inspection: At all portions of PTE and exhaust system.

2.4 Analytical Devices Required
- Pressure differential: Pressure transducers, differential pressure gauges, manometers, other methods and/or alternative instrumentation as appropriate.
- Inspection: None.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement:
  - Pressure differential: Recorded continuously at 1-minute intervals using data acquisition system.
  - Inspections: Conducted semi-annually.
- Reporting units:
  - Pressure differential: Inches of water column (in. w.c.).
  - Inspection: Checklist used to verify PTE configuration and maintenance status and exhaust system conditions.
- Recording process:
  - Pressure differential: Recorded automatically on data acquisition system.
  - Inspection: Results manually logged.

2.6 Supporting Data Requirements
- Pressure differential measurements taken during PTE verification test (not required if relying on minimum "equivalent" pressure differential of 0.013 mmHg [0.0007 in. w.c.]).
- Diagram of PTE and exhaust system at time of initial PTE verification.

3. COMMENTS



P1 = DIFFERENTIAL PRESSURE SENSOR (BETWEEN ENCLOSURE INTERIOR AND SURROUNDING AREA/ROOM)

Figure B-19A. PTE: Monitoring location for differential pressure across enclosure (Illustration 19a).

CAM ILLUSTRATION
No. 19b. PTE CAPTURE SYSTEM FOR VOC

1. APPLICABILITY

1.1 Capture Method: Permanent total enclosure (100 percent capture)
1.2 Pollutants: Volatile organic compounds (VOCs)
1.3 Process/Emissions Units: Coating operations, printing operations

2. MONITORING APPROACH DESCRIPTION

2.1 Indicators Monitored: Average FV through all NDOs determined by measuring exhaust gas flow rate to control device and flow rate of forced makeup air, if any. Quarterly inspection of NDOs, and semi-annual inspection of PTE.
2.2 Rationale for Monitoring Approach: Changes in FV indicate changes in capture system performance. Quarterly NDO inspections ensure NDOs are maintained as during initial PTE verification. Semi-annual inspection and necessary maintenance will be used to ensure PTE criteria are maintained and exhaust system is in good working condition.
2.3 Monitoring Location (see Figure 2 for monitoring locations)
- Average FV: Exhaust gas duct to control device; forced makeup air duct. Net exhaust flow (total exhaust minus forced makeup air, if any) is divided by the total NDO area to determine the average FV.
- Inspections: All portions of PTE and exhaust system.

2.4 Analytical Devices Required
- FV: Flow monitors.
- Inspections: None.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement:
  - FV: Recorded continuously at 1-minute intervals on data acquisition system.
  - Inspections: Conducted quarterly on NDOs and semi-annually on PTE capture system.
- Reporting units:
  - FV: Feet per minute (ft/min).
  - Inspections: Checklist used to verify NDO and PTE configuration and maintenance status, and exhaust system conditions.
- Recording process:
  - FV: Recorded automatically on data acquisition system.
  - Inspections: Results manually logged.

2.6 Supporting Data Requirements
- Diagram of PTE and exhaust system at time of initial PTE verification.

3. COMMENTS

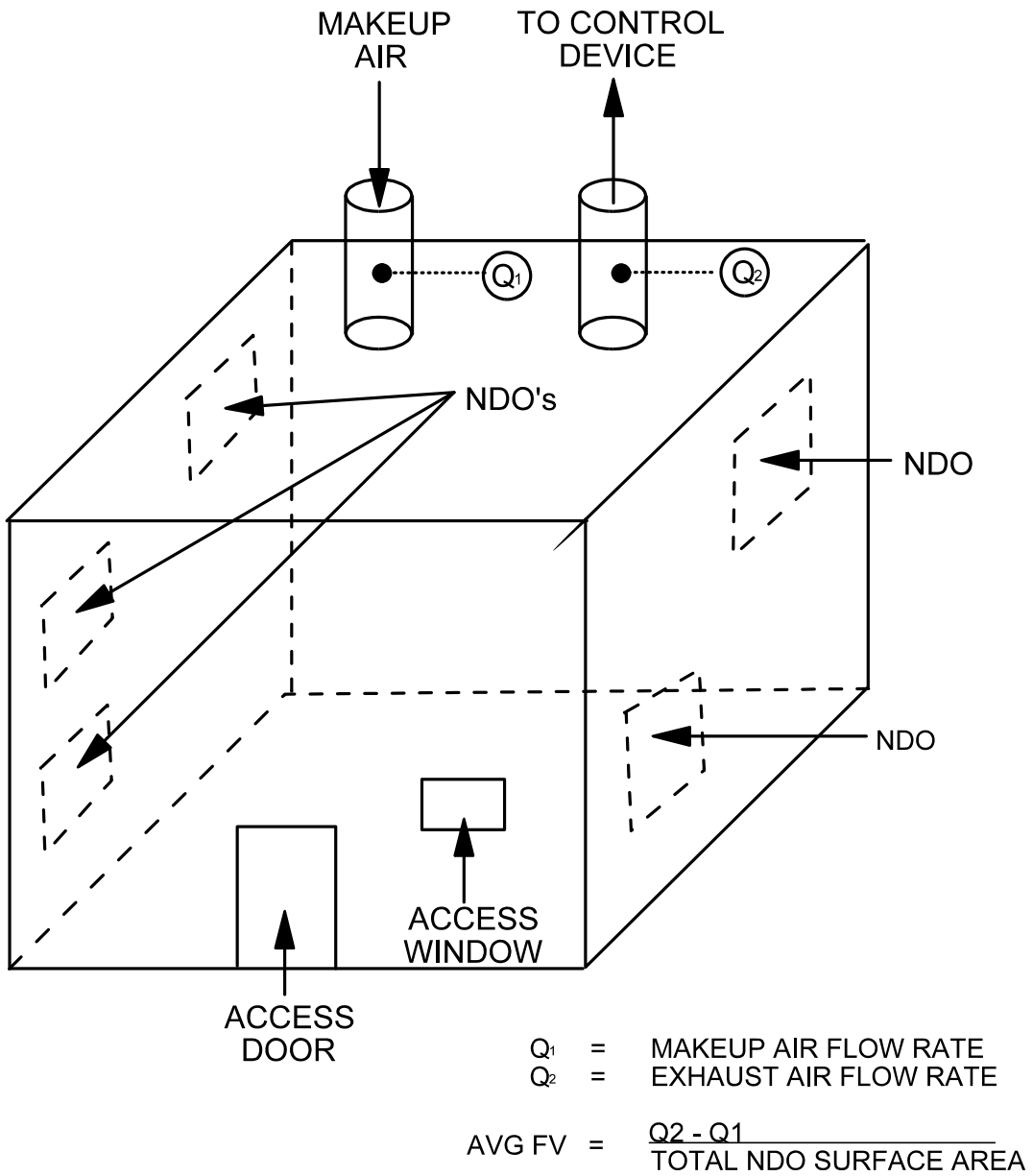


Figure B-19B. PTE: Monitoring location for average face velocity through all NDOs (Illustration 19b).

CAM ILLUSTRATION
No. 19c. PTE CAPTURE SYSTEM FOR VOC

1. APPLICABILITY

1.1 Capture Method: Permanent total enclosure (100 percent capture)
1.2 Pollutants: Volatile organic compounds (VOCs)
1.3 Process/Emissions Units: Coating operations, printing operations

2. MONITORING APPROACH DESCRIPTION

2.1 Indicators Monitored: FV at selected NDOs and semi-annual inspection of PTE capture system.
2.2 Rationale for Monitoring Approach: Changes in FV at NDOs indicate changes in capture system performance. Semi-annual inspection and necessary maintenance will be used to ensure PTE criteria are maintained and exhaust system is in good working condition.
2.3 Monitoring Location (see Figure 3 for monitoring locations)
- FV: Direct measurement at selected NDOs.
- Inspection: At all portions of PTE and exhaust system.

2.4 Analytical Devices Required
- FV: Flow velocity monitors.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement:
  - FV: Recorded continuously at 1-minute intervals on data acquisition system.
  - Inspections: Conducted semi-annually.
- Reporting units:
  - FV: Feet per minute (ft/min).
  - Inspection: Checklist used to verify PTE configuration and maintenance status and exhaust system conditions.
- Recording process:
  - FV: Recorded automatically on data acquisition system.
  - Inspections: Results manually logged.

2.6 Supporting Data Requirements
- Diagram of PTE and exhaust system at time of initial PTE verification.

3. COMMENTS

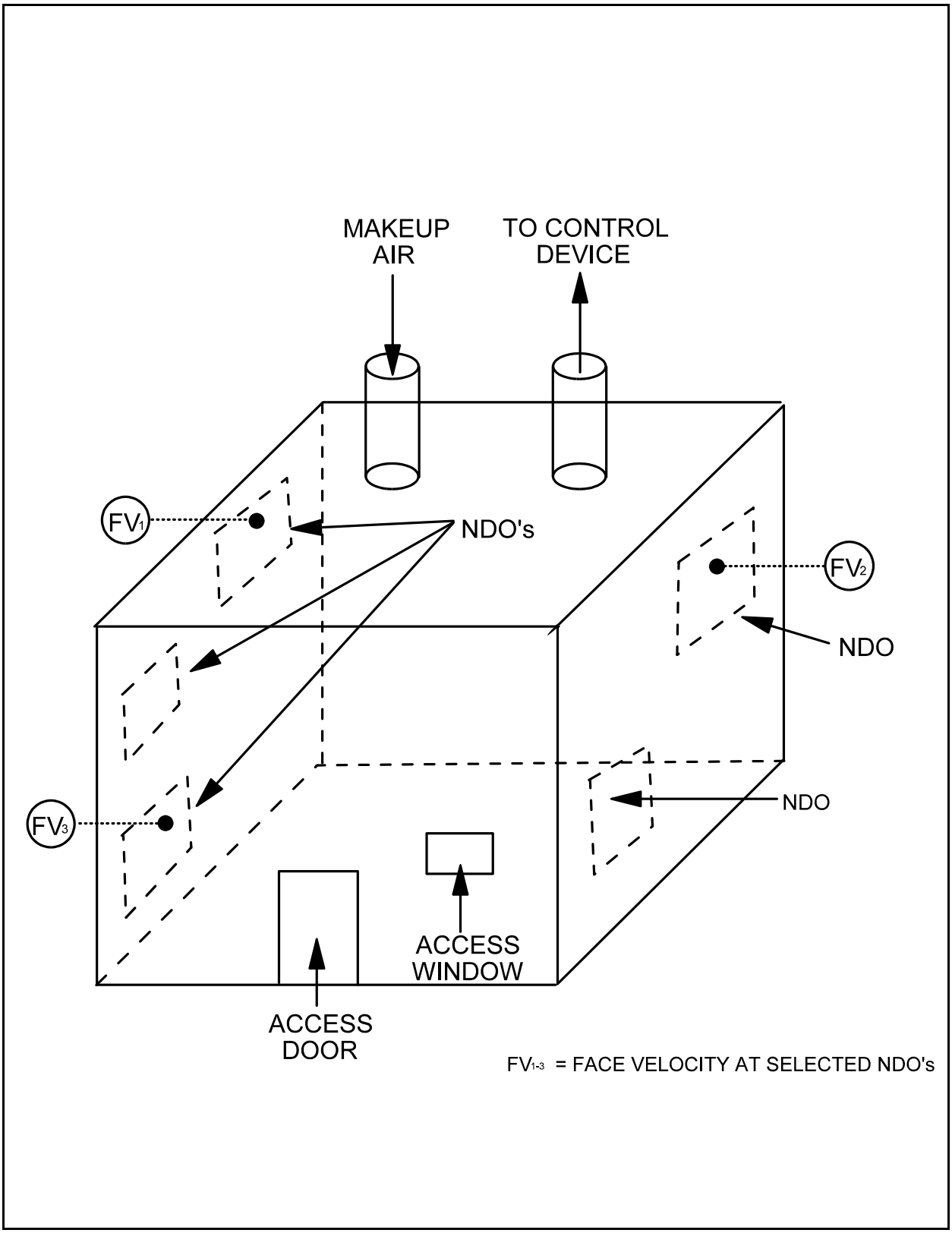


Figure B-19C. PTE: Monitoring location for face velocity at selected NDOs (Illustration 19c).

CAM ILLUSTRATION
No. 19d. PARTIAL ENCLOSURE CAPTURE SYSTEM FOR VOC

1. APPLICABILITY

1.1 Capture Method: Partial enclosure (less than 100 percent capture)
1.4 Pollutants: Volatile organic compounds (VOCs)
1.5 Process/Emissions Units: Coating operations, printing operations

2. MONITORING APPROACH DESCRIPTION

2.1 Indicators Monitored: Pressure differential across the enclosure and semi-annual inspection of capture system.
2.2 Rationale for Monitoring Approach: Changes in pressure differential indicate changes in capture system performance. Semi-annual inspections and necessary maintenance will be used to maintain capture system integrity.
2.3 Monitoring Location (see Figure 4 for monitoring locations)
- Pressure differential: Pressure measured at points inside and outside the enclosure (e.g., curing oven).
- Inspection: At all portions of capture system.

2.4 Analytical Devices Required
- Pressure differential: Pressure transducers, differential pressure gauges, manometers, other methods and/or alternative instrumentation as appropriate.
- Inspection: None.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement:
  - Pressure differential: Recorded continuously at 1-minute intervals on data acquisition system.
  - Inspection: Conducted semi-annually.
- Reporting units:
  - Pressure differential: Inches of water column (in. w.c.).
  - Inspection: Checklist used to verify condition of capture system.
- Recording process:
  - Pressure differential: Recorded automatically on data acquisition system.
  - Inspection: Results manually logged.

2.6 Supporting Data Requirements
- Pressure differential measurements taken during test to measure capture efficiency, or design information if capture efficiency test not required by applicable regulation.
- Diagram of enclosure and exhaust system at time of test to measure capture efficiency.

3. COMMENTS

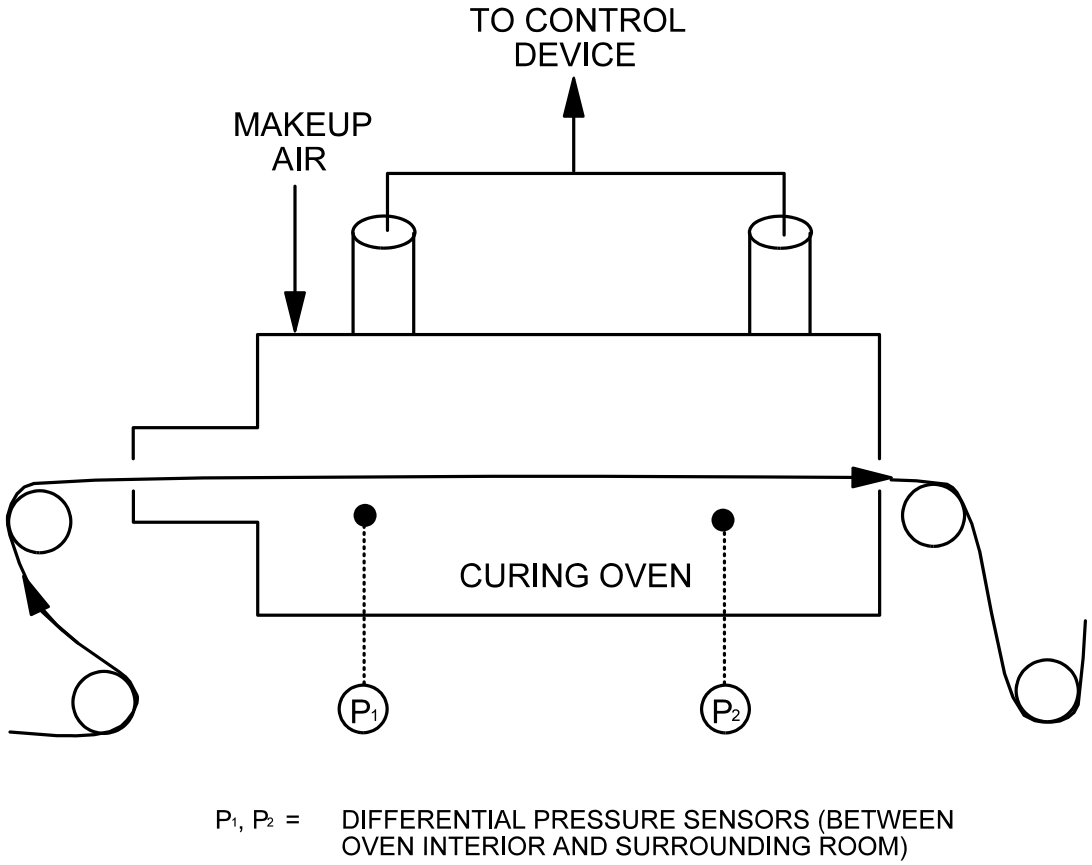


Figure B-19D. Partial enclosure: Example monitoring locations for pressure differential across enclosure (Illustration 19d).

CAM ILLUSTRATION
No. 19e. LOCAL EXHAUST VENTILATION SYSTEM FOR CAPTURE OF VOC

1. APPLICABILITY

1.3 Capture Method: Local exhaust ventilation system
1.4 Pollutants: Volatile organic compounds (VOCs)
1.5 Process/Emissions Units: Coating operations

2. MONITORING APPROACH DESCRIPTION

2.1 Indicators Monitored: Velocity at the hood and semi-annual inspection of capture system.
2.2 Rationale for Monitoring Approach: A change in velocity at the hood indicates changes in capture system performance. Semi-annual inspections and necessary maintenance will be used to maintain the capture system in good working condition.
2.3 Monitoring Location (see Figure 5 for monitoring locations)
- Velocity: At hood or in duct near hood.
- Inspection: At all portions of capture system.

2.4 Analytical Devices Required
- Velocity: Velocity meter.
- Inspection: None.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement:
  - Velocity: Recorded continuously at 1-minute intervals on data acquisition system.
  - Inspection: Conducted semi-annually.
- Reporting units:
  - Velocity: Feet per minute (ft/min).
  - Inspection: Checklist used to verify condition of capture system.
- Recording process:
  - Velocity: Recorded automatically on data acquisition system.
  - Inspection: Results manually logged.

2.6 Supporting Data Requirements
- Velocity measurements taken during test to measure capture efficiency or design velocity information if capture efficiency test not required by applicable regulation.

3. COMMENTS

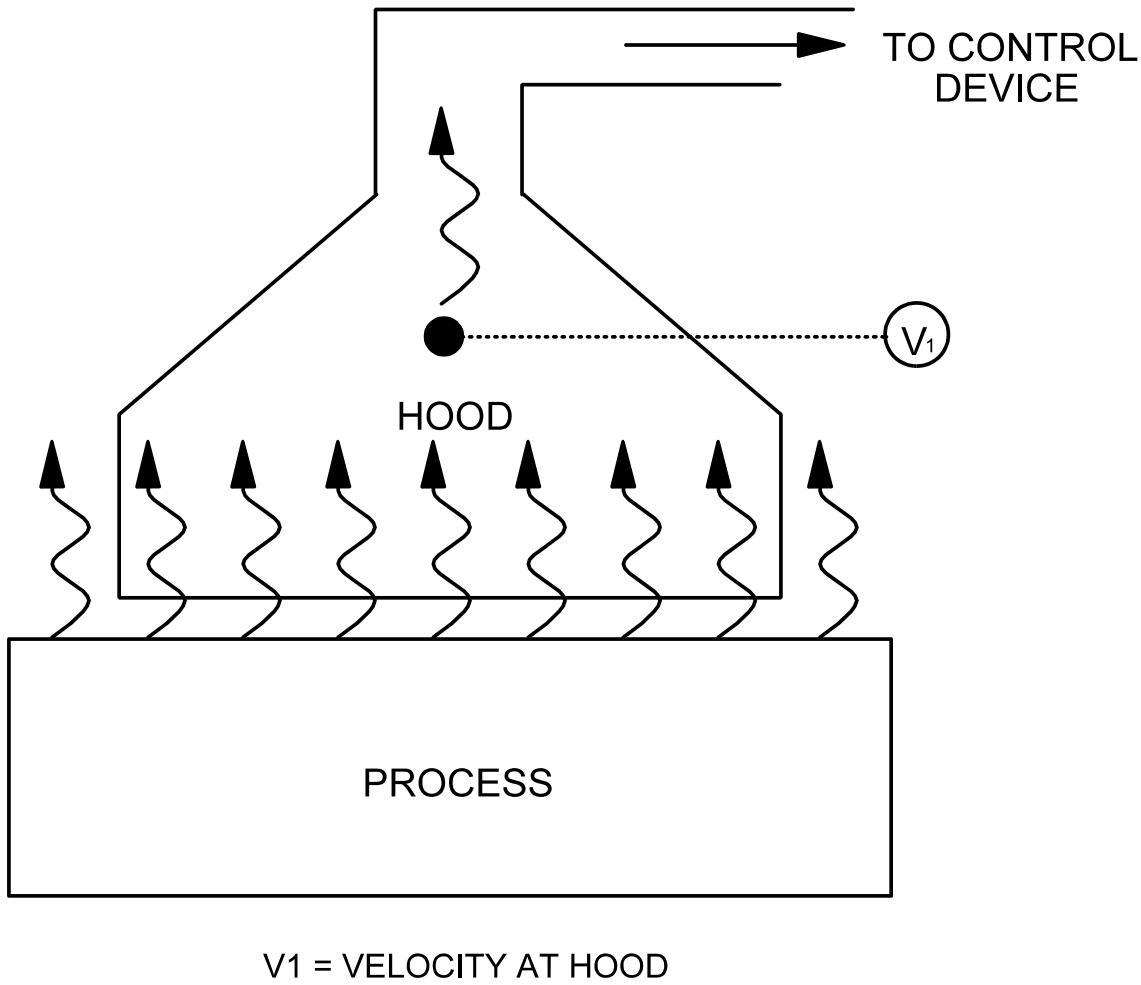


Figure B-19E. Local exhaust ventilation system: Monitoring location for velocity at the hood (Illustration 19e).

CAM ILLUSTRATION
No. 19f. LOCAL EXHAUST VENTILATION SYSTEM FOR CAPTURE OF VOC OR FUGITIVE PM

1. APPLICABILITY

1.1 Capture Method: Local exhaust ventilation system
1.2 Pollutants: Volatile organic compounds (VOCs), fugitive particulate matter (PM)
1.3 Process/Emissions Units: Coating operations, material handling

2. MONITORING APPROACH DESCRIPTION

2.1 Indicators Monitored
- Ventilation system fan parameters such as speed, current, static pressure, damper position, or a combination these parameters depending upon fan type and system design; and
- Inspection of capture hood and duct integrity.

2.2 Rationale for Monitoring Approach: A change in ventilation flow through the system will impact capture system efficiency; a decrease in flow will decrease the capture efficiency. Also, for any given ventilation rate through the system, the integrity of the capture hood and ducting must be maintained in order to maintain the capture efficiency. Fan performance is monitored as an indicator that a minimum ventilation rate is maintained. Periodic inspection is used to monitor the capture system condition and indicate the need for corrective action (maintenance).

2.3 Monitoring Location (see Figure 6 for monitoring locations)
- Fan operation: Fan housing and ductwork.
- Inspection: All portions of capture system.

2.4 Analytical Devices Required
- Fan parameters: (Will depend on parameters monitored)
  - Fan speed: revolutions per minute (rpm) meter.
  - Fan current: Ammeter.
  - Fan static pressure: Differential pressure gauge.
  - Damper position: Position indicator.
- Inspection: None.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement:
  - Fan parameters: Once per day or once per shift, or continuously at 15-minute intervals on data acquisition system; less frequent measurements (e.g., once per shift or day) may be considered for smaller systems.
  - Inspection: Daily.
- Reporting units:
  - Fan parameters: Speed (rpm), current (amperage), pressure (inches of water).
  - Inspection: Checklist used to verify condition of capture system.

- Recording process:
  - Fan parameters: Operators log data manually (for smaller systems), or recorded automatically on strip chart or data acquisition system.
  - Inspection: Operators log results manually.

2.6 Supporting Data Requirements

- Fan parameters measured during initial demonstration test of capture system (e.g., initial capture system efficiency test, face velocity measurements) or parameters established by design (e.g, flow needed to achieve minimum hood face velocity); and
- Fan curve from manufacturer or vendor.

3. COMMENTS

This approach relies on the basic concept that a minimum capture system performance level will be achieved when the system ventilation rate is maintained at a minimum level and the capture system integrity is maintained. Consequently, this approach is most applicable to systems which are rather simple in design, e.g., a system consisting of a single hood or enclosure connected to a fan with a limited amount of ductwork and dampers. As the complexity of the capture system increases (e.g, a single fan ventilating multiple hoods or enclosures with a complicated dampering system and recycle air), the level of confidence of this approach decreases. For more complex capture systems, an approach that incorporates a performance indicator involving a more direct measure at the point of capture is recommended.

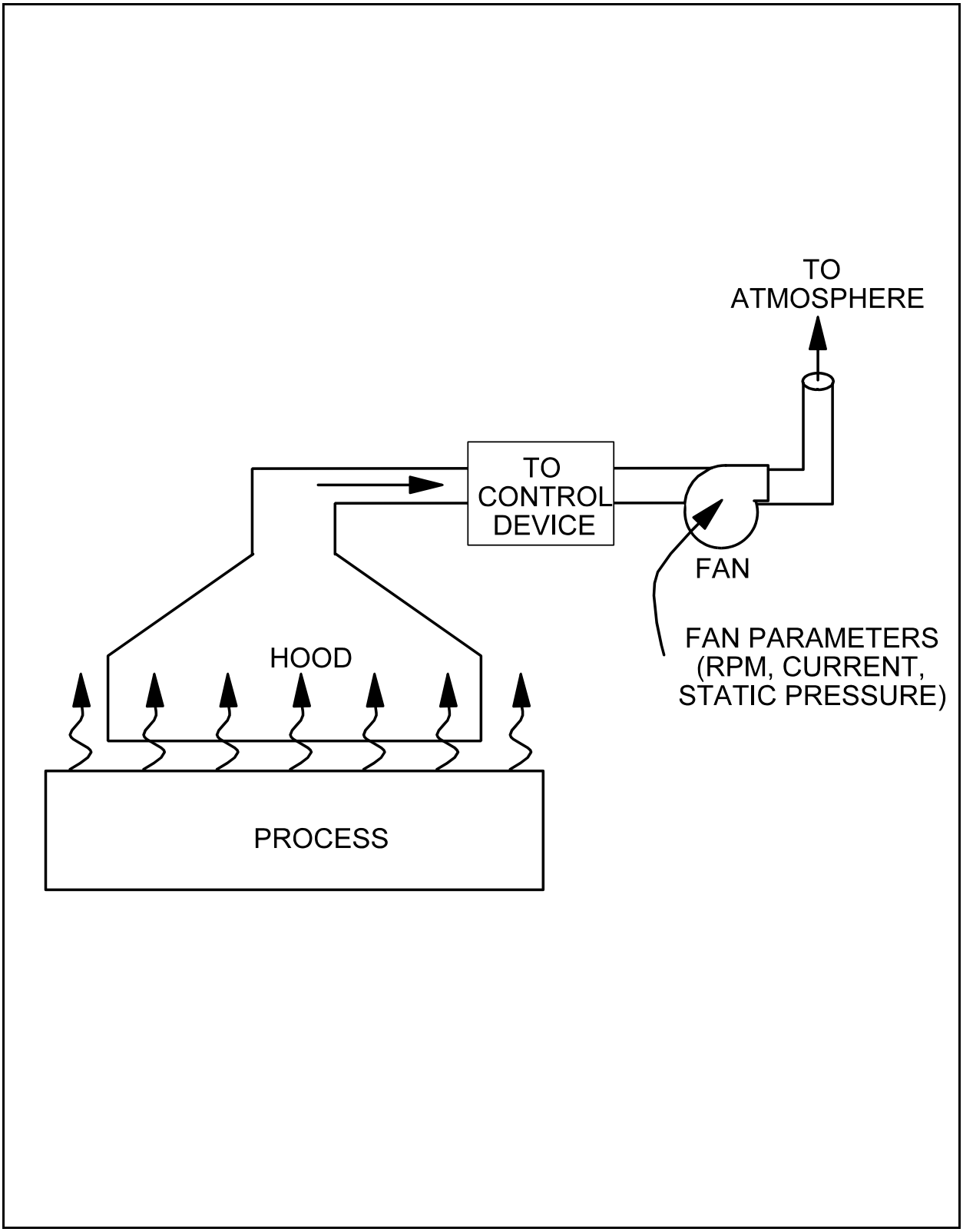


Figure B-19F. Local exhaust ventilation system: Monitoring locations for fan parameter (Illustration 19f).