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Cost and Feasibility of the Temporary Total Enclosure Method for Determining Capture Efficiency

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Final Report

November 1990

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COST AND FEASIBILITY OF THE TEMPORARY TOTAL ENCLOSURE
METHOD FOR DETERMINING CAPTURE EFFICIENCY

Final Report

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1.0 INTRODUCTION

This document presents a summary of the findings of Phase I of a project to investigate the temporary total enclosure (TE) procedure for measuring capture efficiency (CE) (Determination of Capture Efficiency Draft Procedure, April 1988). The procedure is presented in Appendix A. In Phase I, cost and feasibility studies were conducted at several coating and printing facilities. This report summarizes those studies and identifies issues that need to be addressed before actual testing is conducted. Conclusions are presented regarding whether the construction of TTE's and the subsequent testing according to the draft procedure are technically feasible for the facilities visited. Recommendations for candidate test facilities are included. More detailed information on each facility is presented in the site visit reports and cost and feasibility analyses appended to this report. The site visit reports are included in Appendix B, and the cost and feasibility analyses are in Appendix C.

BACKGROUND

Capture efficiency is defined in the draft CE procedure as the fraction of all volatile organic compounds (VOC's) generated by and released at an affected facility that is directed to a control device. The affected facility is the process or equipment to which an emission standard applies. Compliance determinations for VOC emission standards frequently require that the CE of the affected facility's capture system be determined.

A test procedure has been developed for determining CE using a total enclosure temporarily erected around the affected facility. The TTE contains the VOC emissions that normally are not captured and vented to the control device, allowing these "fugitive" emissions to be routed through a duct for measurement and quantification. Capture efficiency is then determined by comparing the quantity of captured VOC with the sum of fugitive and captured VOC.

In response to comments received at the National Air Pollution Control Techniques Advisory Committee (NAPCTAC) meeting of May 18, 1988, at which the CE/TTE procedure was presented, the cost and feasibility of constructing a TTE that meets the criteria contained in the draft procedure and conducting a CE test were examined in this study, which is the first phase of an overall study to evaluate the CE/TTE procedure. During Phase II, testing issues related to the CE/TTE procedure will be resolved, and a test program will be conducted. In Phase III, revisions will be made to the CE/TTE procedure as necessary based on the findings of Phases I and II.

1.2 OBJECTIVES OF PHASE I

The primary objective of Phase I was to evaluate the cost and feasibility of using the draft CE/TTE procedure. Site visits were conducted to gather data for site-specific analyses of the design, construction, testing, and dismantling issues and costs associated with measuring CE using the draft procedure. No attempt was made during this study to evaluate the procedure itself. The second objective of Phase I was to recommend candidates for Phase II testing from among the facilities visited during Phase I.

1.3 ORGANIZATION OF THIS REPORT

In Section 2.0, the findings of the cost and feasibility analysis for each facility are summarized. The issues and site-specific problems raised by the analyses are discussed further in Section 3.0. The conclusions of the study are presented in Section 4.0, and recommendations for the succeeding phases of the project are made in Section 5.0.

2.0 SUMMARY OF COST AND FEASIBILITY ANALYSES

Detailed cost and feasibility studies were completed on the following three facilities: American National Can Company (ANC) in Hammond, Indiana; Westvaco Corporation in Richmond, Virginia; and Kenyon Industries in Kenyon, Rhode Island. In addition, two simplified cost and feasibility studies were completed for Atlanta Film Converting Company and Printpack, Inc., both in Atlanta, Georgia. The latter two facilities were visited at the beginning of the project, before the cost and feasibility study guidelines were established. Therefore, some of the information necessary for a detailed cost and feasibility study was not obtained. Table 1 summarizes the facilities visited, their locations, and the type of coating or printing processes used.

The facilities chosen for the cost and feasibility study were referred by the industry commenters and also by EPA Regional Offices.

TABLE 1. FACILITIES SURVEYED FOR PHASE I STUDY

Facility/location	Type of facility
1. American National Can Company, Hammond, Ind.	Metal sheet coater, printer (litho) for 3-piece cans
2. Westvaco Corporation, Richmond, Va.	Rotogravure printing/box manufacturing
3. Kenyon Industries, Kenyon, R.I.	Fabric coater
4. Atlanta Film Converting Company, Inc., Atlanta, Ga.[a]	Flexible packaging, flexographic presses
5. Printpack, Inc., Atlanta, Ga.[a]	Flexible packaging, flexographic presses

[a]Less detailed cost and feasibility analyses were done on these facilities because they were visited before study plans had been formulated.

Some facilities had interest in the draft procedure because of the possibility that they might be required to demonstrate compliance using the procedure at some point in the future.

For process descriptions and details of the plants' layouts, the site visit reports for each of the facilities should be consulted. Details of the proposed TTE designs and testing plans are presented in the cost and feasibility analyses for the facilities. The site visit reports and cost and feasibility analyses are included as appendices to this document.

A TTE that meets the intent of the criteria outlined in the CE/TTE test procedure could be constructed at each of the facilities surveyed. A breakdown of estimated costs at each facility for TTE construction and testing according to the CE/TTE procedure is presented in Table 2. The estimated costs of constructing and dismantling the TTE's, including design, materials, equipment rental, and labor, range from about $5,000 to $10,000. The estimated costs of testing range from about $15,000 to $23,000. The total estimated costs of conducting a CE test using the TTE procedure range from about $20,000 to $30,000, excluding the costs associated with any lost production that results from the construction or dismantling of the enclosure.

Production losses could occur at plants that operate continuously if TTE construction or dismantling were to interfere with the operation of the process. No production losses would be expected at plants that operate less than 24 hours per day, 7 days per week; at such plants, activities that would disrupt production could be accomplished during scheduled downtime. At the facilities studied, estimates of lost production time range from 0 to 11 hours. No dollar values are assigned to lost production in this report because this information is claimed confidential by the facilities.

Table 3 summarizes the compliance status of the TTE's at each facility relative to the specific design criteria contained in the CE/TTE draft procedure. Construction of the TTE and testing at each facility studied are discussed in more detail in the following sections. The general issues and problems specific to individual facilities identified in Table 3 and in the site-specific discussions should be addressed before the testing phase of the CE/TTE study is initiated. These issues and problems are discussed more fully in Section 3.0.

TABLE 2. SUMMARY OF COSTS FOR CONSTRUCTION AND TESTING ACCORDING TO THE CE/TTE PROCEDURE[a]
(Dollars, Unless Otherwise Indicated)

Facility	Design[b]	Construction and dismantling[b c]	Lost production (Hours)[d]	Testing costs	Total costs[e f]
1. American National Can Company Hammond, Ind.	500	6,700	0 to 11[g]	17,100	24,300
2. Westvaco Corp., Richmond, Va.	500	6,700	8	22,600	29,800
3. Kenyon Industries, Kenyon R.I.	500	9,400	0	15,000	24,900
4. Atlanta Film Converting Company, Inc., Atlanta, Ga.	500	4,600	0	15,000	20,100
5. Printpack, Inc., Atlanta, Ga.	500	6,800	0 to 7[g]	15,000	22,200

[a]Costs have been rounded to the nearest $100.
[b]Includes labor rate of $40 per hour (including benefits and overhead).
[c]Includes materials, equipment rental, and labor.
[d]Lost production is presented in terms of hours rather than dollars to protect information considered by some facilities to be confidential.
[e]Excluding lost production costs.
[f]Totals may not match individual items due to independent rounding.
[g]Range results from variable plant operating schedule; production may be lost if the CE test is scheduled when the plant is operating 7 days per week.

TABLE 3. SUMMARY OF DESIGN PARAMETER COMPLIANCE WITH PROCEDURE CRITERIA

Facility	Average face velocity through NDO's ≥200 ft/min	Distance of VOC sources from NDO's >4 equivalent diameters	Distance of NDO's from exhausts >4 equivalent diameters	Total area of NDO's <5% of total TTE surface area	Comments/potential problems meeting protocol criteria
1. American National Can Company, Hammond, Ind.	Yes	Yes	Yes	Yes	Face velocity at drying oven exit slot may be less than 200 ft/min, average for all NDO's will meet face velocity criterion.
2. Westvaco Corp., Richmond, Va.	Yes	Yes	Yes	Yes	
3. Kenyon Industries, Kenyon, R.I.	Yes	Yes	Yes	Yes	May be some difficulty literally meeting the distance criteria using the revised definition of equivalent diameter. When orientation of NDO's is considered effective compliance is expected to be achieved. Redesign of TTE to literally meet all criteria is possible.
4. Atlanta Film Converting Company, Inc., Atlanta, Ga.	Yes	Yes	Yes	Yes	
5. Printpack Inc., Atlanta, Ga.	Yes	Yes	Yes	Yes	

2.1 AMERICAN NATIONAL CAN COMPANY

The ANC facility in Hammond, Indiana, coats and prints metal sheets for three-piece cans. The process evaluated for this study is a sheet-fed roll coating line. The drying oven is heated by direct recirculation of a portion of the exhaust gases from the line's incinerator. The TTE proposed for this facility would enclose the operator's normal working area from the sheet feeder to the front of the drying oven. The drying oven entrance would be within the TTE; the remainder of the oven would function as a component of the total enclosure around the process. Additional detail on the process and proposed TTE can be found in the appended site visit report and cost and feasibility analysis.

The cost and feasibility study performed for the ANC facility indicates that the construction of a TTE and the subsequent determination of CE according to the procedure are feasible, although some minor problems are present. These problems, which are not anticipated to be significant to the overall capture efficiency determination, include the effects of the incinerator exhaust recycle stream and the coater's nonaffected double-scraper cleaning system on the CE determination. In the case of the incinerator recycle stream, the recycled VOC can be measured and accounted for in the CE computation. In the case of the nonaffected coater cleaning system, emissions would be expected to be small relative to emissions from the coating process, although no data on these emissions are known. Also, it is not clear that this cleaning system would not be considered part of the affected facility for compliance purposes at this facility and others like it. The incinerator recycle stream and coater cleaning system are discussed further in Sections 3.2.1 and 3.2.2, respectively.

Because the portion of the drying oven that is not enclosed by the proposed TTE functions as a component of the total enclosure for the test, the CE/TTE procedure requires that the oven meet the criteria for a TTE. The cost and feasibility study for ANC indicates that the exit from the drying oven might not meet the minimum face velocity criterion of 200 feet per minute (ft/min) required for natural draft openings (NDO's). However, this statement resulted from a misinterpretation of the intent of the procedure. When the temporary enclosure structure and drying oven are evaluated against the criteria as a unit, as intended, the drying oven at ANC no longer presents a problem. This issue is discussed in more detail in Section 3.1.1.

The cost of determining CE is estimated to be about $24,000, not including the cost of production lost during construction and dismantling of the TTE. At this facility, production would be expected to be lost only if the test were scheduled during a period of heavy demand when the plant was operating 7 days per week. At such times, it is estimated that up to 11 hours of production could be lost.

Three test locations are necessary for the determination of CE at this facility. Four additional test points are included in the sampling plan for verification of airflow rates and ambient conditions.

The draft procedure includes an optional procedure that allows the CE to be determined by testing the captured emissions first with a TTE in place and then again without the TTE in place. This "with/without" option eliminates the need for testing a "fugitive stream" from the TTE. The option is intended for use only at facilities that generate emissions at a constant rate. The use of the with/without test option is not recommended at this facility because the normal production run durations are too short to conduct both sets of test runs during a single production run.

2.2 WESTVACO CORPORATION

Westvaco's Plant II in Richmond, Virginia, prints paperboard for use in consumer product boxes, such as cigarette cartons and fast food containers. Each process line consists of a web-fed, eight-color rotogravure press and an in-line cutter creaser that stamps out the appropriate forms to be folded subsequently into boxes. The ink for each line is mixed in an area beside the line. Each of the eight rotogravure print stations that make up a press has a dedicated dryer situated immediately on top of it. All but one of the process lines at this facility, including the line evaluated for this study, have direct-fired dryers. The TTE proposed for this facility would enclose the entire process line, including the dryers and the ink mixing area located beside the line. Additional detail on the process and proposed TTE can be found in the site visit report and cost and feasibility analysis appended to this report.

The construction of a TTE and the subsequent determination of CE according to the procedure are feasible at this facility. The proposed TTE configuration does not require any deviations from the procedure criteria. The use of direct-fired dryers interferes with CE determination, but this problem is not unique to the CE/TTE procedure. Under any procedure where the captured VOC stream is measured, the combustion of a portion of the captured VOC in a direct-fired dryer will cause the measured CE to understate the actual value. The problems associated with direct-fired dryers are discussed further in Section 3.1.3.

It is estimated that the CE test would cost about $30,000 on the process line selected for analysis. In addition, up to 8 hours of production could be lost because this facility operates continuously. Four test points would be used for the CE determination. An additional four test points are included in the sampling plan to monitor forced airstreams into the TTE and the ambient VOC concentrations inside and outside the TTE. The with/without test option may be applicable at this facility because the production runs appear to be long enough to allow the requisite test runs to be conducted during a single process run.

2.3 KENYON INDUSTRIES

The Kenyon Industries facility in Kenyon, Rhode Island, finishes, dyes, and coats fabric on a commission basis. The process line selected for evaluation in this study is a web-fed fabric coating line that consists of four floating-knife coaters and four drying ovens alternating in series. The proposed TTE would actually consist of four small TTE's, each enclosing a coating station. Except for the exit from the final drying oven, all the drying ovens' entrances and exits would be within one of the small TTE's. The remainder of each oven would function as a component of the total enclosure around the process. Additional detail on the process and proposed TTE can be found in the appended site visit report and cost and feasibility analysis for this facility.

The proposed TTE design at this facility deviates slightly from the procedure criteria, although no significant effects on the CE determination are expected to result. The proposed TTE design allows for considerable use of existing structures to support the TTE's while avoiding some of the obstructions a larger TTE would encounter. However, because of the small size of the TTE, the criteria governing the distance between NDO's and either VOC sources or exhaust ducts might not be met. Using a revised definition of equivalent diameter ($[4 \times \text{area}/\pi]^{0.5}$), the separation between some NDO's and some VOC sources or exhausts would be in the range of two equivalent diameters rather than the four equivalent diameters required by the draft procedure. Note that the proposed TTE's would meet the criteria if the original definition of equivalent diameter (4 x area/perimeter) were used. In any case, the orientation of NDO's to VOC sources and exhausts is such that the potential problems that the criteria are intended to prevent would not occur despite the fact that the distances would not fully meet the criteria. The relationship between the letter of the distance criteria and their intent is discussed further in Section 3.1.4.

As with ANC, in the cost and feasibility study for this facility, the TTE criteria were incorrectly applied to the drying ovens (which function as part of the proposed total enclosure), resulting in an apparent problem in meeting the criteria. However, when the TTE criteria are applied correctly, there is not a problem. The issue of drying ovens is discussed more fully in Section 3.1.1.

The cost of determining CE at the facility is estimated to be approximately $25,000. No lost production would be expected at this facility because the plant operates a maximum of 5½ days per week.

Two measurements would be used to determine CE. Eight additional points are included in the sampling plan to monitor the ambient VOC concentrations inside and outside each of the small TTE's. The with/without test option is not applicable to this facility because the production runs are typically too short to attain long periods with a constant emission rate.

A large TTE that would enclose the entire coating line could be built to meet the procedure criteria. It is not clear whether the expense would be greater than for the four small TTE's proposed. More plastic sheeting would be required, and more obstructions to the TTE walls would be encountered, possibly requiring additional construction labor hours. However, the complicated and expensive fugitive exhaust system included in the proposed TTE configuration to combine the fugitive streams from the four small TTE's could be simplified at a cost savings. The test program would be more complicated and expensive if the nonaffected direct-fired curing oven that follows the final drying oven could not be excluded from the large TTE.

2.4 ATLANTA FILM CONVERTING COMPANY AND PRINTPACK, INC.

Both these facilities are located in Atlanta, Georgia. These facilities were visited at the very outset of this project, before the cost and feasibility study plan had been formulated; thus, the data gathered at these two facilities are less detailed than were gathered during the later site visits to the facilities discussed previously. As a result, the cost and feasibility analyses for Atlanta Film Converting and Printpack are not as detailed as those for the other facilities.

Both these facilities print plastic film for flexible packaging using flexographic presses. The TTE's proposed for both facilities would enclose the entire process line selected for analysis. The site visit reports and cost and feasibility analyses appended to this report present additional detail on the processes and proposed TTE's.

Although the TTE designs and sampling plans are less detailed for these facilities, it is expected that the determination of CE according to the draft procedure is feasible. No deviations from the criteria established in the draft procedure are necessary in the TTE designs. Note that the direct-fired dryers used at Atlanta Film Converting and Printpack do present a problem, although it is not unique to this study or to the CE/TTE procedure. Direct-fired dryers are discussed in more detail in Section 3.1.3.

The CE determination using the draft procedure is estimated to cost about $20,000 at Atlanta Film Converting. No lost production would be expected because the plant operates 5 days per week. The sampling plan includes measurements at two points for the CE determination, at one point to quantify a forced airstream into the TTE, and at two points to monitor the ambient VOC concentrations inside and outside the TTE. The typical production runs are too short to allow use of the with/without test option.

The cost of determining CE at Printpack is estimated to be approximately $22,000. In addition, up to 7 hours of production could be lost during construction and dismantling of the TTE, depending on the facility's operating schedule at the time of the test. This plant operates 5, 6, or 7 days per week, depending on demand. Two measurements would be used to determine CE. Three additional points are included in the sampling plan to quantify a forced airstream into the TTE and to monitor the VOC concentrations inside and outside the TTE.

3.0 DISCUSSION

This section presents a discussion of the issues and site-specific problems regarding the determination of capture efficiency using the draft procedure. Following the discussion of the issues and problems, the criteria for selecting test sites are discussed.

3.1 ISSUES

Some general issues regarding the procedure have come up during the course of the cost and feasibility study. These issues are discussed below.

3.1.1 Drying Ovens Required to Meet the TTE Criteria

The CE/TTE procedure stipulates that any drying oven that is intended to function as a structural component of a total enclosure must meet the total enclosure criteria. The intent of this provision is not completely clear from the existing wording. As a result, the cost and feasibility studies for the two facilities that fall under this provision (ANC and Kenyon) were prepared under the mistaken assumption that the drying ovens were to be evaluated against the criteria independently. However, the intent of this provision is that the temporary enclosure structure and the drying oven are to be evaluated against the criteria together as a unit.

As discussed in the cost and feasibility studies for ANC and Kenyon, evaluating the drying ovens independently at these two facilities raised two concerns related to the oven exit as it functions as an NDO in the enclosure. First, in attempting to apply to the drying oven alone the criterion that specifies the minimum separation between NDO's and VOC sources, the area in the oven interior where VOC's are evaporated was considered a "VOC source," resulting in the perception that the oven exit NDO will virtually never attain the required separation. Second, face velocity measurements with a hand-held anemometer at the ANC drying oven indicated that the oven might not meet the minimum face velocity required by the procedure for a total enclosure.

Reconsideration in the light of the intended interpretation of the provision on drying ovens largely dispels these concerns. For purposes of the distance criterion, "VOC sources" are meant to include the emission points in the application and flashoff areas where fugitive emissions may be generated, not emissions within the drying oven that are already contained for delivery to the control device. The mistaken treatment of the drying oven interior as a VOC source resulted from trying to force the criteria to fit an oven in isolation instead of considering the entire total enclosure (made up of the drying oven and the temporary enclosure structure) as a unit.

The concern with oven exit face velocity arose similarly. The CE/TTE procedure stipulates that the average face velocity across the all the NDO's in the enclosure is to be calculated from the forced airflows into and out of the enclosure. This calculation procedure was developed with the understanding that the actual face velocities at the various NDO's would vary somewhat around this average value; therefore, direct measurement at an individual NDO is not appropriate. When the entire integrated total enclosure is considered, the average face velocity normally will meet the requirement even if the value at the oven exit is somewhat lower. The large fugitive exhaust volume (required to maintain the VOC concentration in the temporary portion of the enclosure at an appropriate level for the workers) typically will more than counterbalance a lower flow at the oven exit. Where necessary, the fugitive exhaust rate and/or the size of the other NDO's can be adjusted to assure that the face velocity criterion is met. In any case, concern regarding the face velocity at the oven exit is misplaced. Unlike the haphazard airflow patterns typical of application and flashoff areas (which are the basis of the face velocity requirement), drying oven airflow patterns typically are engineered so that the VOC released in the oven will be contained. Also, it should be noted that the face velocity measurements at ANC were taken when the coating line was not in production; it is not known whether the values observed are representative of conditions during normal production.

In consideration of the discussion above, the statements in the cost and feasibility studies for ANC and Kenyon that the drying ovens technically do not meet the TTE criteria are incorrect. However, the cost and feasibility studies for these two facilities have not been corrected because the level of effort required to do so is not justified. Should testing be conducted at either of these facilities, an evaluation of the integrated total enclosure will be made at that time. It is not anticipated that incorporation of the drying oven as a structural component of the total enclosure will result in any difficulty in meeting the TTE criteria when the provision governing such situations is applied as intended.

Nevertheless, some issues remain regarding whether the drying oven and the temporary enclosure structure should be evaluated as a unit. As mentioned above, different airflow conditions prevail inside the two types of enclosure components; it may be more reasonable to apply different criteria to these components than to try to apply a single set of criteria to the combined enclosure. Also, while the fugitive exhaust rate and NDO's in the temporary enclosure structure can be adjusted to compensate for a low face velocity at the drying oven exit, such adjustments may affect the operation of the TTE. Consideration of the integrated enclosure as a unit also might allow the NDO's in the temporary structure to greatly exceed 5 percent of that component's surface area, particularly when the drying oven is very large. This situation may not be desirable. Finally, because the entrance to the drying oven functions as a capture device during normal operations, the airflow patterns around this opening should not be disrupted during the CE test; the oven entrance should be treated as a "hood or exhaust" for purposes of the criterion governing the separation of these devices from NDO's. However, if the drying oven and the temporary enclosure structure are evaluated together, the oven entrance (which will be located inside the temporary structure) is only an opening between two sections of the total enclosure, and its function during normal operations may be overlooked. Based on the issues discussed above, further evaluation of the appropriate treatment for total enclosures that incorporate the drying oven as a structural component is warranted.

3.1.2 Choice of Emission Test Method

The choice of which test method to use to measure VOC concentration is an issue. The draft procedure lists EPA Methods 18, 25, 25A, and 25B as acceptable test methods. The two most likely candidates are Method 25, "Determination of Total Gaseous Nonmethane Organic Emissions as Carbon, and Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer." The method chosen should be selected on a case-by-case basis, and the selection will depend primarily on the concentration of VOC in the stream and whether the stream will undergo any process that changes the VOC composition (such as partial combustion). Method 25A may be more desirable because measurement results are obtained continuously during sampling, allowing personnel to make adjustments during the test period, if necessary. Also, Method 25A has a lower detection limit than Method 25. Low concentrations are expected in the fugitive exhaust ducts (less than 100 ppm). However, Method 25 is preferred for partially combusted streams (such as in incinerator efficiency determinations) or in other cases where gas streams with significantly different VOC compositions must be compared.

In the absence of partial combustion, the compositions of the fugitive and captured streams typically would not be expected to differ enough to significantly affect the CE determination. However, the possibility of varied VOC compositions should be considered during the planning phase. When multiple-solvent systems are involved, the fugitive stream from the application and flashoff areas could be enriched with the high-vapor-pressure components relative to the captured stream that originates in the drying oven. Also, in processes where cure volatiles are formed as the coating cures in the drying oven, the gas streams will differ to some degree.

3.1.3 Direct-Fired Drying Ovens

Two issues are associated with performing a CE test on a process employing direct-fired drying ovens. The first is that there is destruction in the drying ovens that will not be accounted for in the CE determination. When direct-fired burners are used to heat the drying ovens, some VOC's that are present in the ovens will be completely or partially combusted. The amount of combustion that occurs depends upon the oven configuration and the circulation currents within the oven. Any VOC that is oxidized to CO_2 or CO will not be measured as having been captured. This combustion of VOC poses a technical problem outside the scope intended for this study. For this reason, facilities without the complication of indeterminate internal incineration will be selected for the testing phase of this project.

It should be noted that this problem with direct-fired drying ovens is common to any compliance demonstration method that involves measurement of the captured or recovered VOC. Whether the captured gas stream or recovered liquid solvent is measured, the value obtained will not account for VOC combusted in the direct-fired drying ovens.

The second issue concerns the selection of an appropriate test method when determining CE for a unit with a direct-fired drying oven. Method 25 is appropriate for measuring partial combustion products created in the ovens. However, the low-concentration (<100 ppm) fugitive exhaust stream that also must be measured would suggest that Method 25A is the preferred method. A conflict exists because the determination of capture efficiency must involve the use of the same type of measurement (i.e., all measurements by Method 25 or all by Method 25A).

3.1.4 TTE Criteria Governing Distances From NDO's to VOC Sources and Exhausts

The TTE criterion specifying that NDO's must be a minimum of 4 NDO equivalent diameters from each VOC source is intended to minimize the effects of the enclosure on the normal air vectors around the VOC source. The criterion requiring NDO's to be at least 4 exhaust equivalent diameters from each exhaust hood or duct is intended to prevent air entering through the NDO from being channeled directly into the exhaust. The intended effects of these criteria are important to the success of the CE determination. However, as written, the criteria do not take into account the relative orientation of the NDO's and VOC sources or exhausts. This aspect of NDO placement is as important as distance in determining the interaction of these points in the TTE.

With the NDO's making up no more than 5 percent of the TTE surface area, the TTE will function as a plenum, essentially equalizing the static pressure differential across all points of the NDO's. As a result, the inward flow through the NDO's will occur in the direction perpendicular to the plane of the opening. Thus, for the undesirable effects that the distance criteria are intended to prevent to occur, the VOC source or exhaust (or the associated air currents) must be directly in front of the NDO.

As discussed in the summary of Kenyon Industries (Section 2.3), reliance on distance criteria alone can be a problem, particularly when small TTE's are desirable. In such cases, a process-imposed NDO or existing exhaust may dictate separations that cannot be attained. At the same time, the orientation of the NDO's and VOC sources or exhausts may assure that the success of the CE determination is not endangered despite the failure to meet the distance criteria.

A related issue concerns whether the distance criteria are protective enough when the NDO is directly aligned with the VOC source or exhaust. Additional information on the distance air drawn through an opening will carry is necessary to resolve this issue.

3.1.5 Sizing of Fugitive Exhausts

For the cost and feasibility analyses that have been performed, the fugitive exhaust was sized based on theoretical considerations. In a sizing procedure analogous to that included in the draft TTE/CE procedure, the estimated fugitive emission rate and the applicable threshold limit value (TLV) were used to estimate the fugitive exhaust rate necessary to prevent the TLV from being exceeded inside the TTE. These calculations resulted in fugitive exhaust rates of about 7,000 to 13,000 cubic feet per minute (ft^3/min). The costs of the required exhaust systems exceeded all other components of the TTE. There is some question that such high exhaust rates would actually be needed to maintain a healthful atmosphere within the enclosure. For example, a CE test was carried out at an Arrow Group coil coating facility using the with/without test option with no supplemental fugitive exhaust. During the portion of the test with the TTE in place, the VOC concentration increased but did not approach the TLV.

3.2 SPECIFIC PROBLEMS ASSOCIATED WITH THE FACILITIES VISITED

3.2.1 Recycle Streams with Solvent Destruction

Three facilities examined in the study have recycle streams associated with their drying systems. At ANC, a portion of the incinerator exhaust stream is recycled back to the drying oven. Because the incinerator is not 100 percent efficient in destroying VOC, some VOC is recycled back to the oven. The recycled VOC biases the amount captured high, which is to the facility's advantage in a compliance determination. This issue could be resolved by measuring the incinerator outlet (both VOC concentration and gas flow rate), assuming that the VOC concentration in the exhaust equals the concentration in the recycle, and subtracting the exhaust volume from the inlet flows to obtain, by difference, the amount of VOC's going to recycle. At Westvaco and Printpack, a portion of the drying oven gases are recirculated past the direct-fired burner. Suitable points for determining the destruction of VOC at these plants are not available.

3.2.2 Nonaffected VOC Sources

At ANC, a "double-scraper" solvent cleaning system for the coating equipment cannot be excluded from the TTE, although it is not considered a part of the affected facility according to a company representative. The coater cleaning system is an integral part of the coating equipment; emissions from this system would be expected to be captured by the coater hood and floor sweep in the same proportions as the coating emissions that occur at the coater. Thus, the cleaning system emissions would increase the VOC in both the captured and fugitive streams. The effect of these emissions on the CE determination would depend on the amount of fugitive and captured VOC's generated at each emission point in the process. If, as expected in this industry, the large majority of coating emissions occur within the drying oven and are captured there, the cleaning system emissions would add a smaller percentage to the VOC in the captured stream than to the fugitive stream. This effect would bias the capture efficiency determination low, which would be disadvantageous to the facility in a compliance test. At present, this problem has not been resolved, and it is not known whether the amount of VOC's released from the system could significantly affect the CE determination. Emissions from the coater cleaning system would be expected to be small relative to coating process emissions, but ANC has been unable to provide any data to confirm or disprove this expectation.

Nonaffected emissions that enter the affected gas streams also would affect other compliance determination procedures such as the liquid/gas method. However, in a procedure where the captured gas stream or recovered liquid solvent is measured, but fugitive emissions are not, a nonaffected source such as this one would be advantageous to the source. In such cases, only the VOC added to the captured stream would be detected.

In any case, it appears that, in principle, the coater cleaning system should be considered part of the affected facility. The system is intimately associated with the coating equipment and essential to proper operation. It is not known whether this emission source is considered nonaffected in other jurisdictions.

It should be noted that the presence of the nonaffected source in this case will not affect the potential usefulness of the facility for testing. The purpose of the test program is to demonstrate that the procedure can be carried out, not to determine the actual CE at the test facilities. Thus, the coater cleaning system could be considered part of the affected facility for purposes of the test program.

3.3 CRITERIA FOR SELECTING TEST SITES

In Phase II of this project, two CE determinations are to be conducted using the draft TTE procedure. In the sections that follow, the criteria for selecting test sites are discussed, and the potential sites are evaluated relative to the selection criteria. A summary matrix of the site selection criteria and facilities is presented in Table 4. Note that a second Westvaco facility that has not been visited is included in the matrix. Matrix entries for this facility are based on telephone contacts with a company representative.

3.3.1 Proposed TTE Meets Procedure Design Criteria

This selection criterion must be met for a successful demonstration of the CE/TTE procedure. However, one objective of this project is to revise the procedure as necessary (Phase III). Thus, revisions to the draft procedure that have been decided upon prior to actual testing should be used when considering this selection criterion.

TABLE 4. MATRIX FOR SELECTION OF TEST FACILITIES

Facility	Meets design criteria	Direct-fired drying ovens	Degree of difficulty expected	Test points[a]	Typical process run length, hours	Facility cooperative	Estimated cost, $	Estimated lost production, hours
American National Can	Yes	No	Difficult	7	4-5	Uncertain	24,300	0-11[b]
Westvaco Corp.								
Plant II	Yes	Yes	Difficult	8	24	Unlikely	29,800	8
Cofer Road Plant[c]	Yes	No	Moderate	4	24	Unlikely	22,200[d]	8
Kenyon Industries	Yes[e]	No	Difficult	7[f]	4	Likely	24,900	0
Atlanta Film Converting	Yes	Yes	Moderate	5	8	Likely	20,100	0
Printpack	Yes	Yes	Moderate	5	4-6	Uncertain	22,200	0-7[b]

[a] Includes ambient measurements inside and outside TTE.
[b] Production loss expected only during periods of continuous process operation.
[c] Facility has not been visited; matrix entries based on telephone contacts.
[d] Estimated assuming TTE costs identical to Plant II and minimum testing costs.
[e] May be some difficulty in literally meeting distance criteria with the proposed TTE configuration under the revised definition of equivalent diameter. When orientation of NDO's is considered, effective compliance is achieved (see Sections 2.3 and 3.1.4). Literal compliance could be achieved with an alternative TTE design.
[f] Includes four points for ambient measurements inside small TTE's.

As indicated in Table 4, all the facilities meet this selection criterion. Although the cost and feasibility studies for ANC and Kenyon indicate that the use of the drying ovens as components of the total enclosure would cause problems in this regard, that judgment was based on an incorrect interpretation of the provisions of the procedure (see Section 3.1.1). The TTE proposed for Kenyon may have difficulty literally meeting the distance criteria when the revised definition of equivalent diameter is used. However, when the orientation of the NDO's, exhausts, and VOC sources is considered, the intent of the TTE design criteria is achieved (see Section 3.1.4). In addition, the TTE configuration could be modified to meet the letter of the design criteria at Kenyon, although design specifications and estimated costs have not been prepared for a different TTE configuration.

3.3.2 <u>No Direct-Fired Drying Ovens</u>

Direct-fired drying ovens introduce complications to the CE determination that are not desirable for the testing phase of this project (see Section 3.1.3). Facilities using direct-fired drying ovens will not be selected for testing.

This selection criterion eliminates Printpack and Atlanta Film Converting from consideration for testing. In addition, the Westvaco facility that was visited (Plant II) is eliminated on this basis. However, Westvaco has a second facility in Richmond that does not use direct-fired dryers. According to a company representative, the process and air handling systems at the Cofer Road facility are essentially the same as those at Plant II. For this reason, the Westvaco Cofer Road facility is considered a candidate for testing pending a site visit. The ANC drying oven, which is heated with incinerator effluent, could be considered direct fired. However, unlike most direct-fired drying ovens, this system affords sampling locations that will allow the VOC destruction to be accounted for in the CE determination.

3.3.3 <u>Degree of Difficulty of CE Determination</u>

This selection criterion will be applied differently in selecting the two test sites. For the first test, a site where the CE determination is expected to be relatively easy is desired. A test at such a site will allow the project team to gain experience with the procedure under favorable conditions. In addition, the procedure itself can be evaluated without confounding variables.

For the second test, more difficult conditions are desired. This situation will allow a demonstration that the procedure can be successfully conducted under poor conditions as well as favorable ones.

Among facilities that have not been eliminated by the use of direct-fired drying ovens, the Westvaco Cofer Road facility is expected to offer the least difficult test conditions. The TTE at this facility could be quite large but should not be overly complex. The process lines are believed to be spaced with ample clearance to avoid interference between lines. These tentative conclusions about this facility must be verified by a site visit prior to the final selection of test sites.

The ANC facility is representative of more difficult conditions. The process line selected for analysis is between two others, and the aisles between lines are commonly used by the operators of both lines. Such cramped conditions have often been cited by industry as an impediment to the use of the TTE procedure. The multiple gas streams and incinerator recycle at this facility make testing complicated, as well.

The Kenyon facility also represents a more difficult site for a CE determination. While the clearance between process lines is ample, the process layout, with four separate coating stations, presents a challenge to enclose. The proposed configuration of four small TTE's requires a complex fugitive exhaust system; the system will have to be balanced in the field to maintain acceptable VOC concentrations in all the TTE's. Alternatively, the TTE could be redesigned as one large enclosure surrounding the entire process. With this configuration, complications would include multiple obstructions to be pieced around and the handling of the final curing oven.

Table 4 includes a rating of the degree of difficulty expected in setting up the TTE considering the constraints at the facility and the complexity of the TTE and fugitive exhaust system. The number of test points is included in the matrix as an indicator of testing complexity.

3.3.4 Length of Process Runs

If possible, one facility with long process runs should be included in the test program. This would allow the with/without test option to be conducted. In addition, long periods of constant emissions would allow some experimentation with test parameters to validate the test procedure. For example, the captured VOC stream could be measured before and after the TTE was constructed to assess the effect of the enclosure on the performance of the existing capture system. Only Westvaco typically has process runs of 24 hours or longer.

3.3.5 Facility Cooperation

Conducting the CE determinations would be much easier with the full cooperation of the facilities involved. A rating of the expected level of cooperation for each facility based on conversations with company representatives is included in Table 4.

3.3.6 Cost

The final selection criterion is cost. Resources for testing are limited; minimizing costs will allow the most extensive testing program. The estimated cost of a CE determination using the TTE procedure is listed in Table 4 for each facility. Note that the costs presented do not include the cost of any lost production experienced as a result of TTE construction and dismantling. A column has been included in Table 4 to indicate the likelihood that production would be lost during the test period. The prospect of lost production is likely to figure prominently in the degree of cooperation shown by the facilities.

The estimated cost of a CE determination ranges from a low of about $20,000 at Atlanta Film Converting to a high of about $30,000 at Westvaco Plant II. Estimates of lost production range from 0 hours at Atlanta Film Converting and Kenyon to a high of 11 hours at ANC. Loss of production at ANC and Printpack would occur only if the testing were scheduled at times of high demand when the facilities were operating continuously. The actual cost to EPA of the tests may be higher than indicated because data beyond that which is strictly necessary for a CE determination may be collected.

4.0 CONCLUSIONS

4.1 FEASIBILITY

The construction of a TTE and the subsequent testing according to the intent of the CE/TTE procedure are feasible at the facilities surveyed. Note that such factors as the contributions of recycle flows and the effect of direct-fired ovens can cause the determination of CE to be less than straightforward despite the feasibility of the procedure. Such complications generally will affect any CE determination method, however.

At the two facilities where the proposed TTE would not enclose the entire drying oven, the cost and feasibility studies indicate that the drying ovens do not meet all the TTE design criteria. However, this conclusion was based on a misinterpretation of the provisions of the procedure that apply to this situation (see Section 3.1.1). When the provisions are applied correctly, there is not a problem with meeting the criteria.

The proposed TTE at one facility could have difficulties in meeting the design criteria governing the separation of NDO's from VOC sources and exhausts when the revised definition of equivalent diameter is used. This situation could occur at other facilities where small TTE's are desired. As discussed in Section 3.1.4, these criteria specify distance alone; no consideration is given to orientation. It should be noted that a TTE that would meet every requirement of the draft procedure could be built at this facility. The costs for the larger TTE that would be required to do so have not been calculated during this study.

4.2 COST

All cost estimates calculated for this study are based on the site-specific conditions at the facilities that were visited. Costs at other facilities could be higher or lower than those presented in this report, but lower costs would be expected to predominate. Most facilities selected for study were referred by industry commenters at the NAPCTAC meeting at which the draft procedure was presented. These commenters expressed the belief that the procedure would be difficult and expensive to conduct; the facilities suggested by the commenters are likely to be among the least favorable for the procedure. In addition, the most difficult process line to enclose was chosen for analysis at each facility.

At the facilities studied, the estimated total cost of conducting a CE determination using the draft procedure ranges from about $20,000 to $30,000, excluding the costs associated with lost production. Estimates of the amount of production time that could be lost during construction and dismantling of the TTE range from none to 11 hours. The estimated dollar value of lost production is not included in this report because this information is considered confidential by the facilities. Estimated costs are summarized by facility in Table 2.

In all cases, the largest cost component of the CE determination is the testing itself. Testing costs are estimated to range between about $15,000 and $23,000.

Construction and dismantling costs (excluding lost production) for the proposed TTE's are estimated to range from about $5,000 to $10,000. The greatest expense associated with the construction of the TTE is the fugitive exhaust system. These systems account for over half the cost of constructing the TTE's.

4.3 FUGITIVE EXHAUST RATE

The procedure requires that the necessary fugitive exhaust rate be determined when designing the TTE. Engineering calculations based on expected VOC emission rates, estimated capture efficiencies, and allowable ambient concentrations are used to determine the flow rate. For the facilities analyzed, estimates of capture efficiency were derived from a number of sources. For ANC, the value accepted by the local air pollution control agency for compliance purposes was used. At Westvaco, capture efficiency was back-calculated from the typical recovery efficiency achieved by the plant's solvent recovery system. At Kenyon, the capture efficiency was estimated. The value used for Atlanta Film Converting had been estimated for the company by a consultant, and the Printpack value was based on a previous liquid/gas CE test.

The fugitive exhaust rate calculations yielded very high flow rates (about 7,000 to 13,000 ft^3/min) which, in turn, resulted in the expensive fugitive exhaust systems discussed above. There is some uncertainty that such high flow rates are actually necessary. At least one facility has conducted the CE/TTE procedure using the with/without option with no supplemental fugitive exhaust. The VOC concentration within the TTE did not reach unhealthful levels. The steps taken to determine the flow rate need to be documented and validated prior to or during the test program.

4.4 CHOICE OF TEST METHODS

Guidance will need to be established regarding which EPA test method, Method 25 or Method 25A, should be used in specific cases.

4.5 TEST SITES

The test site selection criteria are presented and discussed in Section 3.3. A summary matrix is presented in Table 4.

Based on those considerations, the best site for the first CE determination is the Westvaco Cofer Road facility. However, this conclusion is based on information received from a facility representative over the telephone; the facility has not been visited. Confirmation that the conditions at the facility are as described is needed. A potential problem with testing at this facility is that the company may not wish to host the test.

Either ANC or Kenyon would be acceptable for the second test. However, some problems are associated with testing at these facilities. It is uncertain whether ANC would willingly host a test. Representatives have made it clear that cooperation with the cost and feasibility study should not be taken as willingness to undergo testing. In addition, the direct recycle of incinerator effluent to the drying oven introduces complexity to the testing that is unrelated to the TTE procedure. While more difficult conditions are desired for the second test, such difficulties would better be related to construction and use of the TTE.

The management at Kenyon has given no indication that testing at their facility would be resisted. However, the proposed TTE at this facility could have difficulty meeting the NDO distance criteria under the revised definition of equivalent diameter. A different TTE configuration could be used at this facility, but such a configuration has not been analyzed.

5.0 RECOMMENDATIONS

5.1 FURTHER ACTION ON ISSUES

Several issues that have arisen during the course of the cost and feasibility study were discussed in Section 3.1. These issues and recommendations on how to proceed are presented below.

5.1.1 Drying Ovens Required to Meet the TTE Criteria

As discussed previously, this requirement was misinterpreted when the cost and feasibility studies were prepared. At a minimum, this provision should be revised to clarify that the drying oven and temporary enclosure structure are to be evaluated against the TTE design criteria as a unit. Further consideration should be given to more sweeping revisions that would subject drying ovens to different criteria more tailored to their unique characteristics. In any case, the procedure should include a provision to verify that the drying oven does, in fact, contain the VOC vaporized within it for delivery to the control device.

5.1.2 Choice of Emission Test Method

Additional consultation with the Emission Measurement Branch is needed on this issue. Method 25A should be the first choice for CE determinations, particularly at facilities that do not use direct-fired drying ovens. However, some method of verifying that the gas streams to be tested have the same relative VOC proportions might be desirable. One possibility would be to collect a small sample from each gas stream during the site survey for subsequent analysis by gas chromatograph. Such analyses should be adequate to determine whether there are significant variations in the VOC constituents among the gas streams.

5.1.3 Direct-Fired Drying Ovens

As discussed previously, facilities using direct-fired drying ovens should not be selected for testing. The resolution of the difficulties presented by these facilities is outside the scope of this project.

5.1.4 TTE Criteria Governing Distances from NDO's to VOC Sources and Exhausts

These criteria should be reevaluated to determine whether the relative orientation of the NDO and VOC source or exhaust should be incorporated. If a decision is reached before the test program begins, any revisions should be formulated for use during the testing.

5.1.5 Sizing of Fugitive Exhausts

The theoretical basis for the existing sizing methodology and any available data from CE determinations that have been conducted should be evaluated prior to testing. During testing, data should be gathered for a subsequent examination of the relationship between the expected VOC concentration in the TTE and the actual concentration experienced.

5.2 SELECTION OF PLANTS FOR TESTING

Recommended test sites are presented below. These recommendations are based on the site selection criteria discussed in Section 3.3 and on the conclusions presented in Section 4.5.

5.2.1 First Test--Westvaco Corporation Cofer Road Facility

The Westvaco Cofer Road facility appears to be the best candidate for the first CE determination based on information received by telephone. A site visit should be conducted to confirm this conclusion.

5.2.2 Second Test--ANC or Kenyon Industries

Either ANC or Kenyon is recommended as the second test site. Each site has potential drawbacks that should be weighed before a decision between the two is made.

At Kenyon, the proposed TTE may not meet the NDO distance criteria when the revised definition of equivalent diameter is used. If the criteria are not modified prior to the second test, the TTE at Kenyon will have to be redesigned. It is recommended that modifications to the NDO distance criteria be considered and finalized prior to the second test.

It is uncertain whether ANC will agree to serve as a test site. This issue will be pursued with ANC representatives. Another drawback to ANC as a test site is the complexity of the testing required to determine CE. This complexity is the result of the incinerator recycle stream and is unrelated to the construction or use of the TTE.

APPENDIX A.

DETERMINATION OF CAPTURE EFFICIENCY, DRAFT PROCEDURE

DETERMINATION OF CAPTURE EFFICIENCY

The Environmental Protection Agency is currently developing procedures for determining the efficiency with which a device or combination of devices contains volatile organic compounds for treatment by a control device. Attached is a draft preamble and regulation to be reviewed at the meeting of the National Air Pollution Control Techniques Advisory Committee on May 17-18, 1988.

Attachment

6560-50

ENVIRONMENTAL PROTECTION AGENCY

40 CFR 52

Determination of Capture Efficiency

[AD-FRL-   ]

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed revisions of existing rule.

SUMMARY: The EPA is proposing to revise 40 CFR part 52 to clarify [illegible] source [illegible] enforcement provisions [illegible] a new Appendix G setting forth a procedure for determining the efficiency with which a device (or combination of devices) contains volatile organic compounds (VOC) for treatment by a control device. This procedure will be available for enforcement of VOC regulations in State implementation plans [illegible] that are deficient with respect to such procedures, or for plans promulgated by the Administrator. Promulgation of this procedure will not, of itself, require a change to any SIP.

DATES: Comments must be submitted within 60 days after [insert date 60 days after publication in FEDERAL REGISTER].

Addresses: Send Comments to: Central Docket Section (LE-131), U.S. EPA, Attention: Docket No. A-87-13, 401 M Street, S.W., Washington, D.C. 20460.

Docket No. A-87-13 containing material relevant to this rulemaking, is located in EPA's Central Docket Section, South Conference Center, Room 4, 401 M Street, Washington, D.C. 20460. The docket may be inspected between 8:00 a.m. and 4:00 p.m. on weekdays. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Questions regarding the procedures for determining capture efficiency should be directed to James C. Berry, EPA, Research Triangle Park North Carolina 27711, telephone (commercial) 919-541-5605 or (FTS) 629-5605. For information regarding SIPs and enforcement of SIPs contact Steven J. Hitte, EPA, Washington, D.C. 20360, telephone (202) 382-2829.

SUPPLEMENTARY INFORMATION:

INTRODUCTION

The EPA is proposing a procedure for determining the efficiency with which a device (or combination of devices) captures or contains VOC, that how well the device (or devices) prevents VOC from escaping treatment by an abatement control device. Such a so called "capture device" may be an enclosed room, hood, "floor sweep" or other means of containing or collecting VOC in order to direct it to a control device such as a carbon adsorber or incinerator. "Volatile organic compound" (VOC) is defined in 40 CFR 60.3 as "any organic compound which participates in atmospheric photochemical reactions; or which is measured by a reference method, an equivalent method, an alternative method, or which is determined by procedures specified under any subpart."

Some SIP's, Subparts of 40 CFR Part 52, define VOC in terms of vapor pressure. Certain SIP's also give specific exemptions for compounds that have been determined by EPA's Administrator to be negligibly photochemically reactive. The efficiency of this procedure is not affectd by the definition of VOC that is used.

The EPA has previously provided guidance on determining "capture efficiency" in select subparts of 40 CFR Part 60; each of which contains regulations for new or significantly modified or reconstructed sources in a specific industry. This proposal, however, describes a general procedure for determining the efficiency of any capture device serving a discrete, new or existing line, operation or part thereof that produces VOC emissions, regardless of the industry. The procedure will aid in the enforcement of VOC regulations in SIP's that do not contain an appropriate method or procedure for determining capture efficiency.

This procedure will not of itself require a change to any SIP. It will merely provide a procedure for determining capture efficiency in the event that a SIP is determined by its respective State or EPA to be deficient with respect to such procedures, or for the Administrator's use if a Federal plan must be promulgated for a State. Comments and recommendations for improving this procedure or suggestions for another procedure are encouraged, but any comments or suggestions should be explained in detail.

Also proposed herein is a revision to 40 CFR part [illegible] which sets forth EPA's long-term position that evidence of violation is not to be solely limited to test results, but violations may be proven by any evidence admissible under Federal Rules of Evidence.

BACKGROUND:

The Clean Air Act (CAA) includes requirements that EPA establish national ambient air quality standards (NAAQS) for various pollutants which may reasonably be anticipated to endanger public health and welfare. Ozone, which is formed by complex atmospheric reactions between VOC and oxides of nitrogen in the presence of sunlight, is one such pollutant. The CAA requires that States implement a comprehensive plan (SIP) that will reduce the ambient ozone concentrations to below the NAAQS for those areas that exceed it and that will provide for maintenance of the NAAQS for those areas that have attained it.

Numerous VOC regulations have been included in SIP's. They vary in stringency and complexity depending on many factors including whether the source is new or existing and whether it is or will be located where the air complies with the NAAQS for ozone, i.e., an attainment area. Either of two approaches may be taken by a source to comply with regulations. One would alter the process or raw materials to lower emissions. An example would be to substitute low-solvent coatings such as waterborne, powder, or higher solids where coatings with high solvent content have traditionally been used. The other approach would be to reduce VOC emissions from the facility by treating the exhaust gas streams. Most State regulations allow a source to use either or some combination of the two approaches.

If a source's compliance strategy includes installation of a control system to treat the exhaust gas, a determination of the reduction achieved by that system must be part of the compliance test. Such a determination is relatively easy when the VOC is recovered and the reduction can be directly determined via a liquid material balance, i.e., measurement of VOC entering and recovered from the facility. Typically, however, such direct measurements are extremely difficult. For example, the design of the control system or plant operating procedures might not be conducive or it might not be possible to conduct a liquid material balance over the averaging period for which compliance is required by the applicable regulation. In situations where the liquid material balance is not available or is not adequate for determining compliance, the efficiency of the control system must be determined by measuring the efficiencies of the two major components of the system, the capture and control devices.

The capture device collects or contains the VOC, permitting it to be directed to the control device which, depending on its design, may recover or destroy the VOC. The efficiency of the capture device(s), "capture efficiency," is the fraction of all VOC emissions generated by an affected facility that is contained and directed to a control device.

The control device receives emissions from the capture device and either incinerates them or recovers them, as in the case of adsorbers and condensers. The efficiency of the control device is the ratio of the quantity of VOC destroyed or recovered to the quantity delivered to it.

The efficiency of the control system is equal to the product of the efficiencies of the capture and control devices and is the ratio of the emissions destroyed (or recovered) to the total of all VOC emissions generated at the affected facility. The efficiency of the control system is a measure only of the capabilities of the capture and control devices to collect or contain, and then destroy or recover the VOC emitted at the affected facility. It may not, however, reflect the efficiency by which the source reduces ... VOC emissions attributable to the affected facility, the so-called "overall control efficiency." For example, if a manufactured product has absorbed a substantial amount of VOC from the process, the efficiency of the control system (the capture and control devices' efficiencies) could be quite high yet the overall control efficiency would be lower since the absorbed VOC could later evaporate from the product.

<u>Conditions that Preclude the Need for Measuring Capture Efficiency</u>

If a source is located inside a "total enclosure" and all emissions are directed to a control device, the requirement to measure the efficiency of capture is waived, and presumed 100 percent. By definition then, a "total enclosure" precludes fugitive emissions. Such an enclosure can be described as a structure that completely surrounds or enshrouds and affected facility such that all VOC emissions are contained and directed through an exhaust stack or into an oven. An entire building can function as a total enclosure if the conditions above are satisfied.

For regulatory purposes, an enclosure will be presumed "total" if the following criteria are met:

1. Access doors and windows in the total enclosure must be closed during routine operation of the process.

2. The interior of the total enclosure must operate at a lower pressure than its surroundings so that air flows into the enclosure at all "natural draft openings" at all times. A natural draft opening (NDO) is defined as an opening that is not connected to a duct in which a fan or a blower is installed. Examples of NDO's are the entrances and exits to the enclosure which accommodate raw material and product flow. Air will flow inward through the NDO's only if forced make-up air, if any, is introduced to the total enclosure at a rate less than the rate at which air is exhausted.

3. The average velocity through all NDO's must be at least 3,600 m/hr (200 ft/min). This velocity would be calculated by dividing the difference between the rate of any forced make-up air and exhaust rate (cubic meters per hour) by the total cross-sectional area of all NDO's (square meters). If the calculated average velocity is between 3600 and 9000 m/hr (200-500 FPM), however, it will be necessary to verify that the flow through the NDO's is continuously into the enclosure. An average velocity greater than 9000 m/hr (500 FPM) will be considered adequate to ensure that the direction of air flow through the NDO's is continously inward unless there is obvious evidence to the contrary.

This set of criteria was selected for the following reasons. Two authoritative references recommend the value of 3, 600 m/hr (200 ft/min) through enclosure openings, Industrial Ventilation, A Manual of Recommended Practice, 18th Edition, 1984, published by the Americl Conference of Governmental Industrial Hygienists, and the Air Pollution Engineering Manual, Publication AP 40, 2nd Edition, 1973, published by the EPA. These references present 3600 m/hr (200 ft/min) as the higher end of the range of capture velocities for contaminants released at low velocity into moderately still air and the lower end of the range for capture of contaminates released into air in rapid motion. It is also near the high end of recommended velocities for air moving through spray booths and openings of occupied enclosures in which organic vapors are generated. A velocity of 3600 m/hr through the NDO's represents a static pressure drop of about 1.0 Pa (0.004 in. H_2O). This very small pressure differential has two paradoxical effects. On the one hand [illegible] low that it should have a negligible effect on the performance of any existing capture devices that serve the affected facility. On the other hand, it is so marginal that movement of machinery or even a person past an NDO could cause a temporary outward flow of air from the NDO.

An air velocity of 9000 m/hr (500 FPM), according to Industrial Ventilation and the Air Pollution engineering Manual, is adequate to capture VOC emissions projected from a source at high velocity, or even for overcoming dispersive turbulence in order to capture emissions. The static pressure drop associated with an air velocity of 9000 m/hr through an NDO is 6 Pa (.024 in. H_2O). The EPA, therefore, believes that this pressure drop is adequate under practically all circumstances to overcome any potential disruptive effect of human or machine passing by an NDO. The effectiveness of velocities through the NDO of between 3600 and 9000 m/hr in preventing air from being drawn out of an enclosure because of exterior influences is not as well documented; consequently, when this range of velocities is encountered, the continuity of the direction of air flow should be established. Techniques for making this determination include: observation of streamers attached to the perimeter of the NDO's, smoke released from smoke tubes just inside NDO's, or tracer gas analyses.

4. Any source of VOC emissions inside the enclosure must be at least four equivalent diameters (4 times the opening area divided by the perimeter) from each NDO. This requirement is to prevent air entering an enclosure through an NDO from immediately impinging on the source of emissions, causing turbulence that can force air and VOC from the inside to the outside of the enclosure back through the NDO.

5. The total area of all NDO's shall be less than 5 percent of the surface area of the total enclosure's four walls, floor, and ceiling. This requirement will ensure that the area of NDO will always be small compared to the size of the total enclosure.

If the conditions for presuming that the enclosure is "total" are satisfied and all emissions from the total enclosure are directed to a control device, capture efficiency may be presumed to be 100% and no performance test of capture efficiency will be required. If any of the five requirements listed above for a total enclosure is not satisfied, the source must measure the efficiency of the capture device(s) as explained below.

The Determination of Capture Efficiency in the Absence of a Total Enclosure

When the source relies on a hood, open-faced booth, floor sweeps, partial enclosure, or combinations thereof to capture emissions, the efficiency of the capture device(s) must be determined.

On several occasions the EPA has attempted to use traditional liquid-gas material balance techniques to measure the capture efficiency at surface coating facilities. The liquid VOC measurements were based on coating consumption and a VOC analysis using Method 24. Gas-phase measurements were made of the VOC concentration by Method 25 and gas flow rate of all emisions from an enclosure by Method 2. Attempts to balance the liquid VOC contained in the coating with the total gaseous VOC (that delivered to the control device plus the would-be fugitive losses from the affected facility) gave results that varied by as much as ± 50 percent.

In evaluating these tests and their results to understand why traditional material balance techniques do not appear valid, the EPA has identified several factors that may contribute to the poor correlation between such liquid and gas phase measurements:

(1) Method 24, the reference method for determining VOC from coatings gives an accurate measure of the mass of VOC released under plant conditions primarily for those coatings cured in low temperature ovens by evaporative drying and have no volatile organic byproducts. Those coatings that cure by a condensation reaction release additional VOC that may not have been detected by Method 24, and whose contribution to the total VOC may vary depending on the reaction conditions but will rarely exceed 10% of the total. Method 24 exposes a coating to a maximum of 110 degrees. Many industrial ovens operate at significantly higher temperatures which can cause evaporation of additional VOC for which Method 24 is not sensitive. The magnitude of this additional VOC is unknown and indeed would likely be zero for many coatings but could be significant for others.

(2) In many plants it is difficult to measure the net total coating delivered to the process for any of several reasons:

- ° difficulty of determining the net quantity of coating used by some processes
- ° difficulty of measuring and recording intermittent solvent additions to a process
- ° physical constraints of the process and associated operational capabilities
- ° physical properties of the coating

(3) Method 25, the most commonly used reference method for determining the VOC content of a vapor, does not measure VOC mass but rather the concentration of carbon atoms. Organic compounds that contain other atoms besides carbon and hydrogen yields an apparent mass that is lower than that detected by Method 24. Consequently, results of Method 25 tests must be subjected to a correction factor based on the concentration and the ratio of carbon to molecular weight of each compound in the stream being sampled. This is difficult because the VOC composition is known only in those processes where the coating cures through evaporation of the carrier solvents, the composition of the carrier solvent is known, and reaction byproducts are not generated.

(4) To conduct a complete gas liquid material balance often requires a multiplicity of measurements, both liquid and gaseous, to account for all VOC which enters and leaves the affected facility.

(5) Finally, since fugitive emissions are usually not measured in a typical plant-conducted material balance, but rather obtained by subtracting the gas phase measurement of captured emissions from the liquid phase determination of the VOC introduced to the process, the resulting material "balance" is never subject to any check to assure the balance indeed closes. As a consequence, the results of such a liquid-gas determination have no inherent verification that all VOC delivered to the process has been accurately accounted for by the liquid phase tests.

These complicating factors suggest that a liquid-gas material balance based on Methods 1, 2, 24 & 25 approach to measuring capture efficiency (e.g., a gravimetric measurement of the net VOC available for capture and a gas phase measurement of VOC delivered to the control device would have the greatest chance for success if:

(1) The affected facility uses a single known solvent or very simple known solvent blend.

(2) No VOC is generated as a reaction by-product during the process.

(3) The tester is able to accurately quantify the total amount of VOC which evaporates within the affected facility (the net of liquid feed and any that can be accounted for in the product, waste water, etc.)

To positively confirm the results of such a liquid-gas test, the Agency will require an analysis that identifies and quantifies all VOC species in every gas stream. This information is essential for the mass material balance.

The Agency has also investigated the potential of direct measurement techniques such as use of tracer gases, tracer solvents, smoke guns, and ambient air analysis. None of these hold promise as a quantitative means of measuring capture efficiency.

As a result of the experience with liquid-gas material balances using the Agencies' Reference Methods identified above and the costs associated with speciating the exhaust gases, EPA is herein proposing a gas phase method of determining capture efficiency founded on containing essentially all vapor emissions from a process, so that they can be withdrawn in a controlled manner and measured by identical Reference Methods thereby avoiding the need to measure feed rate of VOC or know the composition of the exhaust gases.

The EPA has promulgated (or proposed) a variation of this procedure in several subparts of 40 CFR Part 60.

1. Subpart RR -- Standards of Performance for Pressure Sensitive Tape and Label Surface Coating Operations: 60.444(c)(4)(i) and (ii)

2. Subpart TT -- Standards of Performance for Metal Coil Surface Coating: 60.463(c)(2)(i)(B).

3. Subpart FFF -- Standards of Performance for Flexible Vinyl and Urethane Coating and Printing 60.583(d)(4)(i) and (ii).

4. Subpart SSS -- Standards of Performance for Magnetic Tape Coating Facilities. Proposed at 51 FR 2996, January 22, 1986.

5. Subpart VVV -- Standards of Performance for Polymeric Coating of Supporting Substrates, Proposed at 52 FR 15906, April 30, 1987.

The procedures for measuring capture efficiency prescribed in these subparts are fundamentally based on the whole being equal to the sum of its parts, the net VOC available for capture is equal to the sum of gaseous VOC delivered to the control device and the fugitive losses. If the affected facility and its capture device(s) are encased within a total enclosure, all the VOC that evaporates within the enclosure can be accounted for by measuring the VOC in all gaseous outlet streams. The proposed procedure, therefore, requires that the affected facility and its capture devices be totally enclosed in order to allow "captured" VOC, that which is directed to the control device, and the would-be fugitive or uncaptured VOC, which normally escapes to the atmosphere, to be measured. Specifically, this protocol would require that EPA Methods 1-4 be used to determine volumetric gas flow rates and any of EPA Methods 18, 25, 25A, or 25B, whichever is appropriate, be used to determine the the VOC fraction. The product of the VOC concentration and the volumetric flow rate of the gas will yield the mass flow rate of VOC.

This procedure is insensitive to downstream emissions such as VOC which subsequently evaporates from wastewater treatment facilities or from the product. Promulgation of this procedure is not intended to imply that such emissions are automatically exempt from regulation.

The source may enclose an affected facility in one of two ways--by either constructing a total enclosure around it, or by converting the room that houses the affected facility into a total enclosure. Both will be discussed below.

The source may choose to construct either a permanent enclosure or merely rig a temporary one for the duration of the test. A variety of coating operations presently employ permanent total enclosures that range from so-called gloveboxes (large enough only to insert hands and arms) to a room large enough to house not only the coater, but the entire line or process including complete access for maintenance. Some sources have incorporated residential garage and patio doors for quick, convenient access to provide for entry of heavy equipment. Others discharge all ventillation air from the plant through a control device, thereby making an entire building a total enclosure.

The advantages of a permanent total enclosure are:

1. If all exhaust is vented to a control device, the source will qualify as having 100 percent capture without being required to measure it.

2. Properly designed permanent total enclosures improve capture efficiency and tend to simplify testing should the source elect not to direct all exhaust to a control device.

A temporary total enclosure, on the other hand, is built solely for the purpose of measuring the fugitive emissions that ordinarily escape the capture device(s) that serve the affected facility. Because it is constructed only for the purposes of conducting a test and subject to subsequent removal, this type of enclosure invokes the following additional requirements:

1. The process must be operated under conditions that would generate the highest fugitive emission rate routinely expected. For example, if normal methyl ethyl ketone (MEK) were used in producing one product, but toluene in another, and the solids content and solids use rate were the same for both products, the rate of fugitive MEK emissions would be significantly greater than toluene emissions. The difference in this case would be due to differences in vapor pressure, but other factors, such as production rate or process temperature, might also be important.

2. The VOC concentration within the enclosure should stabilize before each test period commences. If a constant concentration is not achieved and the enclosure's atmosphere is at risk of exceeding the lower explosive limit, or the threshold limit value, one or more of the following corrective actions should be taken:

(i) The permanent capture devices within the enclosure should be more strategically located to ensure more of the VOC is captured, leaving less to aggravate the conditions within the enclosure.

(ii) The location of the temporary enclosure evacuation points should be reexamined to assure that they do not permit channeling of air directly from the NDO's, thereby thwarting the capture device which then fails to properly ventilate the enclosure.

(iii) The amount of air discharged to the control device or the amount discharged to the atmosphere, or both, should be increased.

It is recognized that construction of a temporary enclosure may well influence the effectiveness of the permanent capture devices. One of the following procedures must be followed to preclude measurements that under-estimate the true value and minimize the magnitude of overestimates.

1. If the evolution of VOC inside the temporary enclosure will occur at a relatively constant rate during the test period, the mass flow rate of captured emissions may be measured with and without the temporary enclosure in place.

If the temporary total enclosure is ventilated other than by the permanent capture devices, the new exhaust stream must be tested to determine the fugitive emissions. Capture efficiency may be calculated as the ratio of the mass flow rate of captured VOC emissions without the temporary enclosure and the sum of the mass flow rates of captured and fugitive VOC emissions with the temporary enclosure in place. A Capture efficiency greater than 100% is obviously incorrect and suggests the test was not valid. There are two potential causes for this result: (1) the process was not at steady state conditions; more emissions were generated when the enclosure was not in use than when it was, and/or (2) the imprecision of the gas phase test yielded the wrong average values of one or more of the captured or fugitive VOC mass flow rates.

The first problem can be addressed by evaluating the process conditions during the test and either retesting in the same manner or using the protocol described below for non-steady state. The second problem can be avoided by taking multiple measurements and using statistical techniques.

2. If the evolution of VOC is not constant, e.g., the source is a toll coater with varying formulations and production rates, the procedure is more involved since measurement before and after construction of the temporary enclosure may be meaningless because of changes in operating conditions. In these cases, it is important that care be taken to characterize the rate

at which fugitive emissions are generated in order to properly size the draft to be exhausted from the temporary enclosure.

Based on an estimate of the effectiveness of the permanent capture device(s), the maximum VOC evolution rate allowed by the operating permit, and acceptable VOC concentration to be tolerated in the enclosure, the ventilation rate required to remove fugitive emissions from the temporary enclosure can be determined and the enclosure may be designed and sized.

A quick graphical method was devised for estimating the required ventilation rate of a total enclosure. Figure 1 of the proposed procedure presents a family of capture efficiency curves generated from the general equation,

$$E_c = \frac{C_c\ Q_c}{C_c\ Q_c + C_f\ Q_f}$$

which can be rearranged to the form,

$$\frac{Q_f}{Q_c} = \frac{1-E_c}{E_c} \times \frac{C_c}{C_f}$$

where: E_c = Capture Efficiency

Q = the volumetric gas flow rate at standard conditions (m^3/hr),

C = the VOC concentration at stnadard conditions (ppmv),

the subscript "c" denotes parameters of the captured emissions stream, i.e., the one directed to the control device, and

the subscript "f" denotes parameters of the would-be fugitive emission exhaust stream.

The sum of the ventilation rates for the fugitive and captured emission streams and the requirement that the average air velocity through NDO's be at least 3600 m/hr (1 m/s), determines the allowable area of all NDO's. The minimum size of the temporary enclosure is then fixed by the requirement that the total area of the NDO's be less than five per cent of the total surface area of the enclosure.

The temporary enclosure can then be designed and constructed, thereby allowing the mass flow rates for captured and fugitive VOC to be measured. The capture efficiency is then calculated as the ratio of the mass VOC flow rate in the stream to the control device (captured emissions) and the sum of all of the gaseous emissions from the enclosure (the captured and fugitive emissions).

It may be possible to conduct a capture efficiency test without constructing a total enclosure if the operator can close the room or building that houses the affected facility and alter the ventilation air exhaust to permit measurement of all exiting gases. To properly conduct the test, there can be no sources of VOC within the room during the test other than those from the affected facility. The mass flow rates of VOC in the captured and fugitive emission streams must then be measured. Capture efficiency is calculated as the ratio of the mass flow rate of VOC delivered to the control device to the total mass flow rate of captured and fugitive VOC.

The utility of using the existing structure as a temporary enclosure is frequently limited because of practical limitations in measuring emissions from a large number of building or process vents simultaneously.

<u>Cost of Determining Capture Efficiency via Gas-phase Measurements</u>

The cost of conducting a capture efficiency test using direct, gas-phase measurement of all emission streams, fugitive as well as captured, depends largely on the approach that a source chooses to measure the fugitive emissions. If a source uses the room or building that houses the affected facility as a total enclosure, the cost will be a function of the number of exhaust stacks that convey VOC from the affected facility and/or building to the atmosphere, and the number of ducts that convey VOC from the affected facility to the control device. The cost is expected to be about $2,500 per test point in addition to travel and set-up expenses of the test contractor.

If the room or building has numerous exhaust stacks, the construction of a total enclosure around the affected facility will likely reduce the cost of the test because although the cost of a temporary total enclosure is estimated at $5,000 - $10,000; it would have only one exhaust stack to be tested. (The VOC flow in the duct to the control device must be measured in any event.) By effectually reducing to one the multiple exhaust stacks that otherwise would have to be tested, construction costs of a temporary enclosure would likely be completely offset.

Although the cost of a permanent total enclosure could be double that of a temporary one, even those costs would be almost completely offset in so much as the capture efficiency test would be waived; no additional test costs would be necessary if it meets conditions for 100 percent capture efficiency as specified in this proposal. Because facilities that use VOC are considered susceptible to fires, the source may also realize some savings in fire insurance premiums if the affected facility is properly isolated from other parts of the plant.

Regulatory Impact

Under Executive Order 12291, EPA must judge whether a regulation is "major" and therefore subject to the requirement of a regulatory impact analysis.

This action does not require revision of existing SIP's or changes to any SIP regulations. Its purpose is to establish the test procedure that EPA and the States use to determine capture efficiency when enforcing SIP regulations where test methods or procedures do not exist in the applicalbe SIP.

This proposed regulation is not a major rule because it will not result in an effect on the economy of $100 million or more, nor will it result in an increase in costs or prices to industry. There will be no adverse impact on the ability of U. S.- based enterprises to compete with foreign-based enterprises in domestic or export markets. Because this amendment is not a major regulation, no regulatory impact analysis is being conducted.

Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act, 5 U.S.C., Section 601 et seq., whenever an Agency is required to publish a general notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis which describes the impact of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions). The Administrator may certify, however, that the rule will not have a significant economic impact on a substantial number of small entities.

This amendment will have no adverse economic impact on small entities. Its only purpose is to ensure that EPA and the States have an appropriate procedure to enforce SIP VOC regulations. No new SIP regulations are being proposed, although the States whose SIP's do not contain a procedure or test method for determining capture efficiency will be required to use this method. Since this amendment does not significantly change the status quo for such entities, I hereby certify that this regulation will not have a significant economic impact on a substantial number of small entities. This regulation therefore does not require a regulatory flexibility analysis.

Paperwork Reduction Act

This rule does not contain any information collection requirements subject to the Office of Management and Budget review under the Paperwork Reduction Act of 1980, 44 U.S.C., 3501 et seq.

List of Subjects in 40 CFR Part 52

Air pollution control, Ozone, Sulfur oxides, Nitrogen dioxide, Lead, Particulate matter, Carbon monoxide, Hydrocarbons.

Date

Lee M. Thomas
Administrator

The EPA Proposes to Amend Title 40, Chapter I, Part 52 of the Code of Federal Regulations as Follows:

1. The authority citation for Part 52 continues to read as follows:

Authority: Section 110 of the Clean Air Act as amended, 42 U.S.C. 7410.

2. Section 52.12 is amended by revising paragraphs (c) introductory text and (c)(1) to read as follows:

§ 52.12 Source Surveillance.

* * * * *

(c) For purposes of Federal enforcement, the following test procedure shall be used:

(1) Sources subject to either State implementation plans that do not specify test procedures or plans promulgated by the Administrator, will be tested by means of the appropriate procedures and methods prescribed in Part 60 and Part 61. In deciding which methods to follow, the Administrator will use the method or methods which are most consistent with the applicable provisions of the plan.

* * * * *

3. Section 52.23 is amended by revising paragraph (b) to read as follows:

§ 52.23 Violation and enforcement.

(a) * * *

(b) The promulgation of test methods under Parts 52 and 60 is not intended as a limitation on the use of evidence that would be otherwise admissible under the Federal Rules of Evidence.

* * * * *

4. A new Appendix G is added to Part 52 as follows:

Appendix G - Procedures for Plan Enforcement by EPA

The procedures in this Appendix are referred to in § 52.12(c)(1) and (2) (Source Surveillance) of 40 CFR Part 52, Subpart A (General Provisions). These procedures shall be used in the determination of compliance with SIP regulations when the SIP fails to specify a test method or procedure or when EPA promulgates SIP regulations. This requirement may be waived if the source is either able to demonstrate compliance by an alternative procedure or is able to measure capture efficiency by an alternative method or procedure to the satisfaction of the Administrator

Procedure G-1 -- Determination of Capture Efficiency

Introduction

The procedure described below prescribes how EPA Reference Methods for gas phase measurements of volatile organic compounds (VOC) mass flow rates are to be used to determine the effectiveness of a device or combination of devices that contain and deliver VOC to a control device.

1.0 Principle and Applicability

1.1 Principle

This procedure is founded on the principle that in a material balance around a source of VOC emissions, the VOC that evaporates, and is either captured or allowed to escape, is equal to the net VOC in the liquid feed that is available for capture, ie., the whole is equal to the sum of its parts. By construction of a suitable total enclosure, all VOC emissions generated at an affected facility are directed through ducts suitable for measuring both gas flow rate and concentation of VOC. Capture efficiency is then determined by calculating the ratio of: (1) the emissions delivered to the control device to (2) the total emissions, i.e., the sum of emissions to the control device plus those exhausted to the atmosphere.

1.2 Applicability

This procedure is generally applicable to all sources of VOC that are served by a capture device and which can be segregated by a temporary or permanent total enclosure.

This procedure by itself may not be adequate for determining compliance if the applicable regulation holds the affected facility liable for emissions that occur downstream. Examples would be evaporative losses from process wastewater, scrapped process feed, and final product. In such case, information on those emissions would be required in addition to this procedure to certify compliance.

2.0 Definitions

2.1 Affected facility means any process, line or operation that is subject to a regulation or standard.

2.2 Capture device means a hood, enclosed room, floor sweep or other means of containing or collecting VOC and directing those VOC into a duct.

2.3 Capture efficiency means the fraction of all VOC generated by and released at an affected facility that is directed to a control device.

2.4 Control device means any equipment which reduces the quantity of VOC that is emitted to the air. The device may destroy the VOC or secure it for subsequent recovery by regeneration or disposal. Examples of control devices are incinerators, carbon adsorbers, and condensers.

2.5 Control device efficiency means the ratio of the VOC destroyed or recovered by a control device to the VOC delivered to the control device, usually expressed as a percentage.

2.6 Control system means any combination of capture and control devices.

2.7 Control system efficiency means the fraction of gaseous VOC that is generated at an affected facility that is prevented from entering the atmosphere as a result of the performance of its capture and control devices. Mathematically it is the product of the collective efficiencies of the capture and control devices.

2.8 Equivalent diameter means four times the area of an opening divided by the perimeter.

2.9 Exhaust rate means the volumetric flow rate (m^3/min) of gas that is withdrawn from a given space.

2.10 Forced make-up air means air blown into an enclosure or oven by one or more fans to replace air that has been exhausted.

2.11 Fugitive emissions (F) means all emissions that escape an affected facility's capture device(s) and subsequently escape to the atmosphere.

2.12 Natural draft opening means any permanent opening in a room, building, or total enclosure that remains open during operation of the facility and is not connected to a duct in which a fan is installed. The "natural draft," rate and direction, across the opening is a consequence of the difference in pressures on either side of the wall containing the opening.

2.13 Overall control efficiency means the fraction of all the VOC generated by an affected facility that is prevented from entering the atmosphere as a result of the performance of the control system that serves the affected facility. The overall control efficiency may be less than that of the control system because of additional VOC emissions downstream of the affected facility such as subsequent evaporation of VOC from spray booth wastewater or of solvent that leaves the process in the product.

2.14 Temporary total enclosure means a total enclosure that is constructed for the sole purpose of measuring fugitive emissions from an affected facility.

2.15 Total enclosure means a structure that completely surrounds a source of emissions so that all VOC emissions are contained for discharge. With a total enclosure there will be no fugitive emissions, only stack emissions. The only openings in a total enclosure are forced make-up air and exhaust ducts and any NDO's such as those that allow raw materials to enter and exit the enclosure for processing. All access doors or windows are closed during routine operation of the enclosed source.

2.16 Volatile organic compound (VOC) means any organic compound which participates in atmospheric photochemical reactions or which is measured by a reference method, or which is determined by procedures specified under any subpart. Some subparts of 40 CFR Part 52, the SIP's, define the term by vapor pressure. Certain SIP's also give specific exemptions for compounds that have been determined by EPA's Administrator to be negligibly photochemically reactive. The efficacy of this is not affected by the definition of VOC that is used.

3.0 Applicable Reference Methods

Method 1 Sample and Velocity Traverses for Stationary Sources, 40 CFR 60, Appendix A.

Method 1A Sample and Velocity Traverses for Stationary Sources with Small Stacks or Ducts, (proposed 48 FR 48955, October 21, 1983)

Method 2 Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S pitot Tube) 40 CFR 60, Appendix A.

Method 2A Direct Measurement of Gas Volume Through Pipes and Small Ducts, 40 CFR 60, Appendix A.

Method 2B Determination of Exhaust Gas Volume Flow Rate from Gasoline Vapor Incinerators, 40 CFR 60, Appendix A.

Method 2C Determination of Stack Gas Velocity and Volumetric Flow Rate from Small Stacks or Ducts (Standard Pitot Tube), (proposed 48 FR 48956, October 21, 1983).

Method 2D Measurement of Gas Volume Flow Rates in Small Pipes and Ducts, (proposed 48 FR 48957, October 21, 1983).

Method 3 Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight, 40 CFR 60, Appendix A.

Method 4 Determination of Moisture Content in Stack Gases, 40 CFR 60, Appendix A.

Method 18 Determination of Gaseous Organic Compounds by Gas Chromatography 40 CFR 60, Appendix A.

Method 25 Determination of Total Gaseous Nonmethane Organic Emissions as Carbon, 40 CFR 60, Appendix A.

Method 25A Determination of Total Gaseous Organic Concentrations Using A Flame Ionization Analyzer, 40 CFR 60, Appendix A.

Method 25B Determination of Total Gaseous Organic Concentration Using a Nondispersive Infrared Analyzer, 40 CFR 60, Appendix A.

4.0 Procedures

4.1 Initial Qualitative Assessment of the Existing Capture Device(s)

The affected facility's permanent capture device(s) should be evaluated to determine if it (they) may be presumed to be 100 percent effective. If the permanent capture device is a total enclosure and all emissions are delivered to a control device, a test of the capture efficiency is presumed 100% and a test is not necessary. The criteria for waiving the test are: (1) the average face velocity of air through all NDO's of the enclosure shall be at least 3,600 m/hr (200 FPM); its direction should be demonstrably continuous into the enclosure at all openings; (2) any source of VOC shall be a minimum of four equivalent diameters from each natural draft opening; (3) the cumulative area of all NDO's shall be no greater than five percent of the surface area of the total enclosure; (4) all gas streams from the total enclosure shall be directed to a control device; (5) all access doors and windows, except when used as NDO's, must be closed during routine operation of the process.

Any oven or dryer that is intended to function as a total enclosure or as a structural component of a total enclosure must also meet the same criteria.

4.1.1 Average Face Velocity at the Natural Draft Openings

The average face velocity through the NDO's, [illegible], is calculated as the quotient of the volumetric flow rate of natural draft air drawn into the enclosure and the combined areas of the NDO's. The volumetric flow rate of air drawn into the enclosure is equal to the net volumetric flow rate of forced exhaust air from the enclosure.

4.1.1.1 Net Forced Exhaust Air Rate

The flow rate in each duct or stack through which forced air is supplied to or exhausted from the enclosure (including the oven when a part of the enclosure) shall be measured using EPA Methods 1-4. Each flow rate must be normalized to standard conditions.

The net forced exhaust air rate (Q_{Forced}) is then calculated by:

$$Q_{Forced} = \sum_{i=1}^{m} Q_{f_i} + \sum_{j=1}^{n} Q_{c_j} - \sum_{k=1}^{q} Q_{a_k}$$

Where: Q_{f_i}, Q_{c_j} and Q_{a_k} = the volumetric gas flow rates (m^3/hr),

i = each stack that forceably exhausts fugitive emissions from the enclosure (or oven) to the atmosphere

j = each exhaust duct from the total enclosure (or oven) to the control device,

k = each forced make-up air duct to the enclosure (or oven); and

m, n, and q = the number of i, j, and k stacks or ducts, respectively.

4.1.1.2 Average Face Velocity at the Enclosure's Natural Draft Openings

$$_o = \frac{\sum_{i=1}^{m} Q_{f_i} + \sum_{j=1}^{n} Q_{c_j} - \sum_{k=1}^{q} Q_{a_k}}{\sum_{l=1}^{z} A_l}$$

Where: A = area (m^2)

l = each NDO, and

z = the number of NDO's

4.1.1.3 Direction of Air Flow

If $Q_{Forced} < 0$, the air flow through NDO's is from the inside of the total enclosure to the outside and the criteria for a total enclosure is not satisfied.

If $Q_{Forced} > 0$, the test for direction of air flow through NDO's is dictated by the average velocity that is calculated from the net forced exhaust air rate from the enclosure.

If $\nu_o > 9000$ m/hr (500 ft/min) the direction shall be presumed to be into the enclosure at all times (unless there is some obvious indication that backdrafts are occurring).

If $3600 \leq \nu_o \leq 9000$ m/hr ($200 \leq \nu_o \leq 500$ ft/min) the direction of airflow shall be monitored for a one hour period during which the forced exhaust air and make-up air rates are determined. During the one-hour test typical process conditions shall exist and normal plant activities shall take place.

4.2 Determination of Capture Efficiency

4.2.1 Basic Requirements

In order to determine the efficiency of a capture device at an affected facility, two basic requirements must be met:

a. All captured and fugitive VOC emissions from the affected facility shall be contained and exhausted through stacks suitable for gas phase measurements by the appropriate methods specified in Paragraph 4.2.4.

b. During a performance test, the owner or operator of an affected facility collocated with other sources of VOC shall isolate the affected facility from the other sources.

These two requirements shall be accomplished using either of the procedures listed in paragraphs 4.2.2 or 4.2.3.

4.2.2 (Recommended Option) Build an Enclosure Around the Affected Facility.

4.2.2.1 General Design and Ventilation Requirements for All Total Enclosures.

a. Air flow through any NDO must be into the enclosure at a minimum average velocity of 3,600 m/hr (200 ft/min). If the average velocity is less than 9000 m/hr (200-500 ft/min), the direction of flow will have to be verified according to paragraph 4.1.1.3.

b. Any source of VOC shall be a minimum of four equivalent opening diameters from each NDO.

c. Any NDO shall be a minimum of four equivalent duct or hood diameters from each respective duct or hood through which air from the enclosure is exhausted unless the enclosure is a permanent installation.

d. The total area of all NDO's shall be a maximum of five percent of the total surface area of the enclosure.

e. The VOC concentration inside a temporary enclosure must not continue to increase but shall reach a constant level before each test period commences. A continuing increase of VOC concentrations within the enclosure that place the enclosure's atmosphere at risk of exceeding the lower explosive limit (or the threshold limit value for employees if that is the design criteria), indicate one or more of the following corrective actions should be taken.

(i) The permanent capture devices should be more strategically located to assure more of the VOC is captured.

(ii) The location of the temporary enclosure evacuation points should be reexamined to assure that they do not permit channeling of air directly from the NDO's, thereby failing to properly ventilate the enclosure.

(iii) The amount of air discharged to the control device, or the amount discharged to the atmosphere, or both, should be increased.

4.2.2.2 *Determination of Capture efficiency When the Process is Generating Fugitive VOC Emissions at a Constant Rate*

a. Step 1: Determine Mass Flow Rate of Captured Emissions

The gas flow rate and VOC concentration shall be measured in all exhaust ducts that direct VOC emissions to a control device via the appropriate analytical methods listed in paragraph 4.2.4. The captured emissions mass flow rate ($\overline{C}$) shall be calculated as follows:

$$\overline{C} = \sum_{j=1}^{n} Q_{c_j} \times C_{c_j}$$

Where: Q_c = the volumetric gas flow rate at standard conditions (m^3/hr),

C_c = the VOC concentration at standard conditions (ppmv),

j = each exhaust from the total enclosure (and oven) to a control device, and

n = the number of exhaust ducts from the total enclosure (and oven) to a control device.

Note that the VOC concentration, C_c, here and in subsequent equations, is either an average based on the number and duration of bag samples that are taken or the integrated time average of continuously measured concentrations over the period of the test.

b. Step 2: Construct a Temporary Enclosure with or without Additional Ventilation as Decided by the Source.

Additional ventilation is any exhausted from the enclosure as a result of installation of additional fans or an increase in the capacity of an existing fan either of which is contemporaneous with construction of the enclosure.

c. Step 3: Determine Fugitive Emissions

(i) If additional ventilation is used, the air flow rates and VOC concentrations shall be measured in all ducts, stacks or vents that do not exhaust to a control device. The fugitive emissions mass flow rate shall be calculated as follows:

$$F = \sum_{i=1}^{m} Q_{f_i} \times C_{f_i}$$

Where: Q_f = the volumetric gas flow rate at standard conditions (m^3/hr),

C_f = the VOC concentration at standard conditins (ppmv),

i = each fugitive emission exhaust stack from the temporary total enclosure (and oven), and

m = the number of fugitive emission exhaust stacks from the temporary total enclosure (and oven).

(ii) If no additional ventilation is selected, then proceed directly to Step 4.

d. Step 4: Determine Mass Flow Rate of Captured Emissions with the enclosure in place.

The gas flow rate and VOC concentration shall be measured again in all exhaust ducts that direct VOC emissions to a control device via the appropriate analytical methods listed in paragraph 4.2.3. These measurements shall be made with the temporary enclosure in place and functioning. Simultaneously the mass flow rate of fugitive emission (if any) must also be measured.

e. Step 5. Calculate Capture Efficiency (E_c) as Follows:

$$E_c = \frac{\overline{C}}{F + \overline{C}_e}$$

Where the subscript "e" denotes the mass flow rate of captured emissions determined with the enclosure in place.

If no additional ventilation is used, F = 0, and the capture efficiency equation becomes:

$$E_c = \frac{\overline{C}}{\overline{C}_e}$$

f. If $E_c > 1.0$ either the process was not at the same steady state with and without the enclosure, or the imprecision of the individual gas-phase had not been overcome by a sufficient number of measurements. If this situation occurs, the operator should either revaluate the process conditions and repeat the test making more gas-phase measurements of both captured and fugitive emissions, or conduct the test according to paragraph 4.2.2.3.

4.2.2.3 Determination of Capture Efficiency when the Process is not Generating Fugitive Emissions at a Constant Rate

a. Step 1: Determine Mass Flow Rate of Captured Emissions

Without the enclosure in place, the gas flow rate and VOC concentration shall be measured in all exhaust ducts that direct VOC emissions to a control device via the appropriate analytical methods listed in paragraph 4.2.4. Measurements shall be made while the process is emitting VOC at or near its maximum rate. A minimum of three tests from 30 minutes to 3 hours in length should be conducted for each set of process conditions. The mass flow rate of captured emissions (C) shall be calculated for each set of process conditions as follows:

$$\bar{C} = \sum_{j}^{n} Q_{Cj} \times C_{Cj}$$

Where: Q_C = the average volumetric gas flow rate at standard condition (m^3/hr),

C_C = the average VOC concentration at standard condition (ppmv),

j = each exhaust from the total enclosure (and oven) to a control device, and

n = the number of exhaust ducts from the total enclosure (and oven) to a control device.

b. Step 2: Determine Ventilation Rate and Size of Temporary Enclosure

(i) Estimate the highest total solvent vapor evolution rate expected to occur inside the enclosure for each production or operating period during the test.

(ii) Identify the values of Q_C and C_C that were measured for the same process conditions in Step 1.

(iii) Estimate the cumulative capture efficiency of the existing capture devices including the oven.

(iv) Choose or estimate the maximum desired concentration of fugitive emissions in the enclosure's fugitive exhaust duct or stack.

(v) Determine the ventilation rate from Figure 1 or calculate it by the following equation.

$$Q_f = \frac{1-E_c^*}{E_c^*} \times \frac{\not{C}_c\ Q_c}{C_f}$$

where: E_c^* = the estimated capture efficiency

Q = the volumetric gas flow rate at standard conditions [illegible]

C = the VOC concentration at standard conditions (ppmv),

the subscript "c" denotes parameters of the captured emissions stream, i.e., the one directed to the control device, and the subscript "f" denotes parameters of the fugitive emissions exhaust stream.

(vi) Determine the maximum cumulative area of the tempo[illegible]y total enclosure's NDO's by the following equation:

$$A_{ndo} = \frac{Q_f\ (m^3/hr)}{3600\ m/hr} = \frac{Q_f (ft^3/min)}{200\ ft/min}$$

Where: A_{ndo} = Maximum cumulative area of the temporary enclosure's NDO's, m^2 (or ft^2),

Q_f = ventilation rate determined in (v), and

(vii) Determine the minimum surface area of the temporary total enclosure, A_e, by the following equation:

$$A_e = 20\ A_{ndo}$$

c. Step 3: Construct a Temporary Total Enclosure

The temporary enclosure must meet all design and ventilating requirements calculated in Step 2 or otherwise specified in paragraph 4.2.2.1.

d. Step 4: Determine Fugitive Emissions

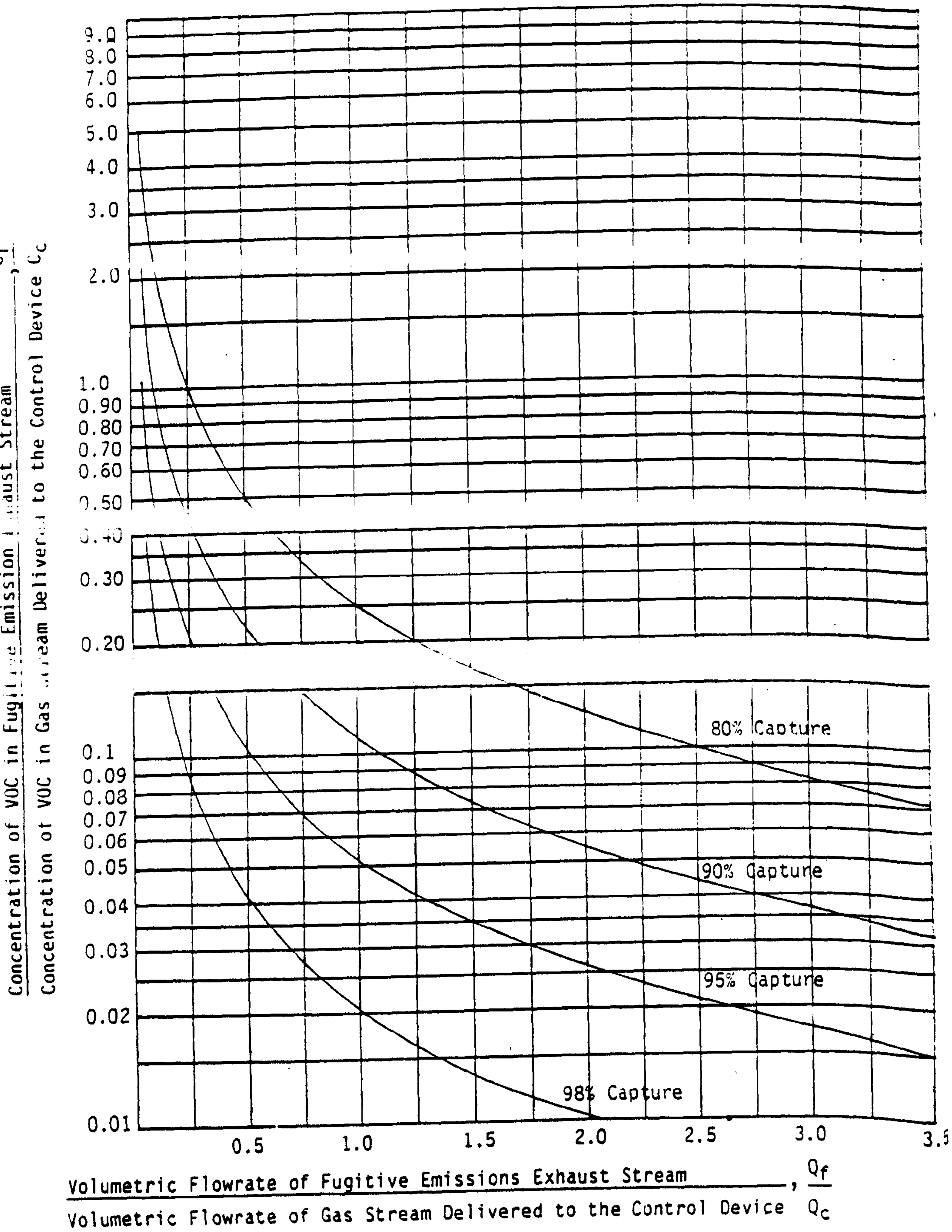

Figure .. The Crumpler Chart

The air flow rates and VOC concentrations shall be measured in all ducts, stacks or vents that do nto exhaust to a control device, via the appropriate analytical methods listed in paragraph 4.2.4. The fugitive emissions mass flow rate, F, shall be calculated as follows:

$$F = \sum_{i=1}^{m} Q_{f_i} \times C_{f_i}$$

Where: Q_f = the volumetric gas flow rate at standard conditions.(m^3/hr),

C_f = the VOC concentration at standard conditions (ppmv)

i = each fugitive emission exhaust stack from the temporary total enclosure (and oven),

m = the number of fugitive emission exhaust stacks from the temporary total enclosure (and oven), and

d. Step 5: Determine Mass Flow Rate of Captured Emissions with the enclosure in place and functioning as follows:

The gas flow rate and VOC concentration shall be measured again in all exhaust ducts that direct VOC emissions to a control device via the appropriate analytical methods listed in paragraph 4.2.3. These measurements shall be made simultaneously with the measurements for determining the fugitive emissions mass flow rate. The captured emissions mass flow rate, $\overline{E}$, shall be calculated by the following equation:

$$\overline{E} = \sum_{j=1}^{n} Q_{c_j} \times C_{c_j}$$

Where: Q_c = the average volumetric gas flow rate at standard conditions (m^3/hr),

C_c = the average VOC concentration at standard conditions (ppmv),

j = each exhaust from the total enclosure (and oven) to a control device, and

n = the number of exhaust ducts from the total enclosure (and oven) to a control device.

The subscript "e" again denotes the captured emissions mass flow rate determined with the enclosure in place.

e. Step 4. Calculate Capture Efficiency (E_c) as Follows:

$$E_c = \frac{C_e}{F + C_e}$$

4.2.3 (Alternate) Use the Room that Houses the Affected Facility as a Temporary Total Enclosure

a. Step 1: Determine Fugitive Emissions Mass Flow Rate.

Shut down other sources of VOC within the room. Using the appropriate methods specified in paragraph 4.2.4, measure the air flow rates and VOC concentrations in all outlets to the atmosphere such as the building ventilation system, windows, the discharge vents from process ovens, etc.

$$F = \sum_{i}^{m} Q_{f_i} \times C_{f_i}$$

Where: Q_f = the volumetric gas flow rate at standard conditions (m^3/hr),

C_f = the VOC concentration at standard conditions (ppmv),

i = each fugitive emission outlet or stack to the atmosphere, and

m = the number of fugitive emission outlets or stacks to the atmosphere.

b. Step 2: Determine the Mass Flow Rate of Captured Emissions.

The gas flow rate and VOC concentration shall be measured in all exhaust ducts that direct VOC emissions to a control device via the appropriate analytical methods listed in paragraph 4.2.4. Measurements shall be made simultaneously with the measurements of fugitive emissions in Step 1 above. The captured emissions mass flow rate ($\overline{C}$) shall be calculated as follows:

$$\overline{C} = \sum_{j=1}^{n} Q_{c_j} \times C_{c_j}$$

Where: Q_c = the volumetric gas flow rate at standard conditions (m^3/hr),

C_c = the VOC concentration at standard conditions (ppmv),

j = each exhaust from the room serving as the total enclosure and from the oven to a control device, and

n = the number of exhaust ducts from the room serving as the total enclosure and from the oven to a control device.

e. Step 4. Calculate Capture Efficiency (E_c) as follows:

$$E_c = \frac{\overline{C}}{F + \overline{C}}$$

4.2.4 Analytical Procedures

The mass flow rate of VOC shall be determined for each emission stream using the following EPA methods as detailed in Appendix A of 40 CFR Part 60.

(i) Method 1 (or 1A) for sample and velocity traverses.

(ii) Method 2 (or 2A, 2B, 2C, 2D as appropriate) for velocity and volumetric flow rates.

(iii) Method 3 for gas analysis.

(iv) Method 4 for stack gas moisture.

(v) Any of Methods 18, 25, 25A, or 25B as appropriate for VOC concentration

5.0 Development of Baseline for Monitoring and Recordkeeping

During the performance test (or inspection of an enclosure to determine if the capture efficiency test can be waived), the amperages on the fans that evacuate the capture devices (or the total enclosure) as well as operating parameters of the line such as speed, coating feed rate, etc., shall be recorded. Subsequently, an inspector may compare these baseline values to contemporaneous operating values to ensure: (1) that the capture device(s) (or total enclosure) continues to be operated at the conditions under which the performance test or evaluation was conducted, and (2) the affected facility is not operating at rates that would generate fugitive emissions in excess of the rate when the performance test or evaluation were conducted.

APPENDIX B. SITE VISIT REPORTS

American National Can Company
Westvaco Corporation
Kenyon Industries
Atlanta Film Converting Company
Printpack, Inc.

AMERICAN NATIONAL CAN COMPANY

MRI

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Date: May 16, 1989
(Finalized October 20, 1989)

Subject: Site Visit--American National Can Company, Hammond, Indiana
Investigation of the Temporary Total Enclosure Method for Measuring Capture Efficiency
EPA Contract No. 68-02-4379, Work Assignment 26
ESD Project No. 87/07; MRI Project No. 8951-26

From: Stephen W. Edgerton SE

To: Karen Catlett
EPA/CPB/CAS (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Purpose

This site visit was conducted to gather information for determining the cost and feasibility of conducting a capture efficiency test at this facility using the temporary total enclosure (TTE) protocol.

II. Place and Date

American National Can Company
Hammond Plant
2501 165th Street
Hammond, Indiana
February 8, 1989

III. Attendees

American National Can Company (ANC)

Robert Gere, Manager of Environmental Affairs
James E. Meadows, Litho Coordinator
Hugh Orr, Safety Coordinator

U. S. Environmental Protection Agency (EPA)

Karen Catlett, ESD/CPB
Candace Sorrell, TSD/EMB

Midwest Research Institute (MRI)

Stephen Edgerton
Roy Neulicht
Van R. Vogel

IV. *Discussion*

The visit began with a meeting among the attendees to discuss the purpose of the visit and to go over the questionnaire sent to ANC in advance of the visit. The meeting was followed by a tour of the production facilities and an extended period of data gathering. During this period, the operation of the process was observed, potential measurement points were identified, the physical dimensions of the process equipment and ductwork were measured, the plant layout and ductwork were sketched, and VOC concentrations at various points in the plant were measured using an OVA Model 128. A brief closing meeting was held to discuss the proposed TTE design for the facility and additional data needs.

The subsections that follow summarize the information gained from the meetings and from observations made in the plant. Subsection A below discusses process information. Subsection B presents information pertinent to the use of the TTE protocol.

Process Information

The ANC Hammond Plant primarily produces coated metal sheets that are processed elsewhere into three-piece food cans. A minor portion of the production is coated metal sheets used to make cans for automobile servicing fluids (e.g., brake and transmission fluids), but this portion of the business is decreasing as plastic containers replace metal cans. The plant has coating lines and printing lines. (The number and type of process lines and the plant operating hours are contained in item No. 1 of the Confidential Addendum to this report.) At the time of the site visit, the norm was 5 days per week, and only three of the printing lines and four or five of the coating lines typically were operated. However, demand is somewhat seasonal, picking up in the summer when vegetables are harvested.

The printing lines print the product logo on one side of the metal sheet that will later be processed into cans. These printing lines use paste inks that do not contain volatile organic compounds (VOC). However, a VOC-based varnish topcoat typically is applied over the ink; the varnish application station is a VOC source. The VOC emission control system for the printing lines is very similar to that of the coating lines. Because the printing lines are shorter and less crowded than the coating lines and do not present any additional impediments to conducting the TTE protocol, it was agreed with ANC that the cost and feasibility study for this plant would concentrate on the coating lines.

The coating lines at the plant are located side by side. The can stock enters the coating process as discrete sheets rather than being unwound from a continuous coil. The size of the sheets varies from run to run. The sheets typically are about 1 yard by 1 yard, but can vary up to nearly 1.5 yards. At the time of the site visit, the average run at the plant lasted about 4 to 5 hours. The shortest run would normally take about 1 hour. Setup time between runs varies from about 1 to 2 hours. (Additional information on the average run at the time of the site visit is contained in item No. 2 of the Confidential Addendum.)

A schematic of a coating line is presented in Figure 1. The sheets to be coated are introduced to the process in stacks or "loads" of 1,200 to 2,000 sheets. The load of sheets is pushed along rollers to an automatic feeder. The entire stack of sheets is placed in the feeder, which parcels the sheets out horizontally one at a time to the coater.

A schematic of a roll coater is presented in Figure 2. The roll coater applies a coating to the side of the sheet destined to be the interior of the can. The facility uses about 50 different coating formulations. The coatings are formulated to protect the can's contents based on the chemical properties of the product to be contained in the can. The coatings typically contain about four or five different solvents.

The coating is pumped from a 55-gallon drum to the point at which the steel metering roll and the steel transfer roll meet. The gap that is set between these rolls determines the thickness of the coating. A drip pan beneath these rolls catches the coating that is not applied; this coating is recirculated to the supply drum. From the transfer roll, the coating is passed to the rubber application roll. The metal sheets pass horizontally between the application roll above and the impression roll below, picking up the coating from the application roll.

Because the process is sheet fed, a cleaning system is necessary to remove the coating that is applied to the impression roll between the sheets. Cleaning solvent is pumped from a bucket to a felt wick on the underside of the impression roll. The solvent, now containing the coating that was applied to the roll, is scraped from the roll by a doctor blade before the roll contacts the underside of another sheet. The cleaning solvent drips into a pan underneath the impression roll and drains back into the supply bucket through a tube.

The coated sheets pass horizontally to the entrance of the drying oven. As each sheet enters the oven, it is lifted from the underside by a wicket and turned to rest on its leading edge in a nearly vertical orientation. The coated sheets travel the length of the oven in this vertical position separated by about 1.5 inches.

The drying ovens have five independently controlled heating zones with a total length of about 125 feet, followed by a 30-foot cooling section. In addition, one section of the wicket return area (located beneath the drying chamber of the oven) is heated to preheat the

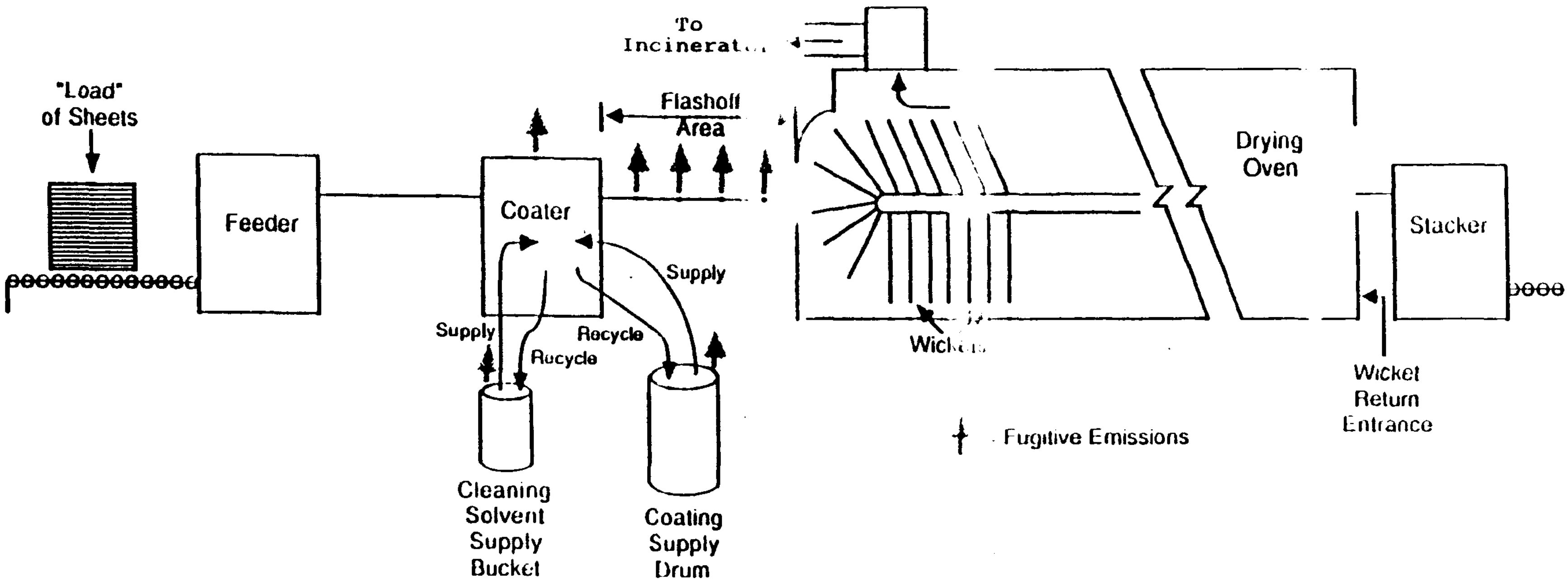

Figure 1. Schematic of a coating line.
(Modified to remove material claimed confidential by ANC. The original figure is contained in the Confidential Addendum -see item No. 3).

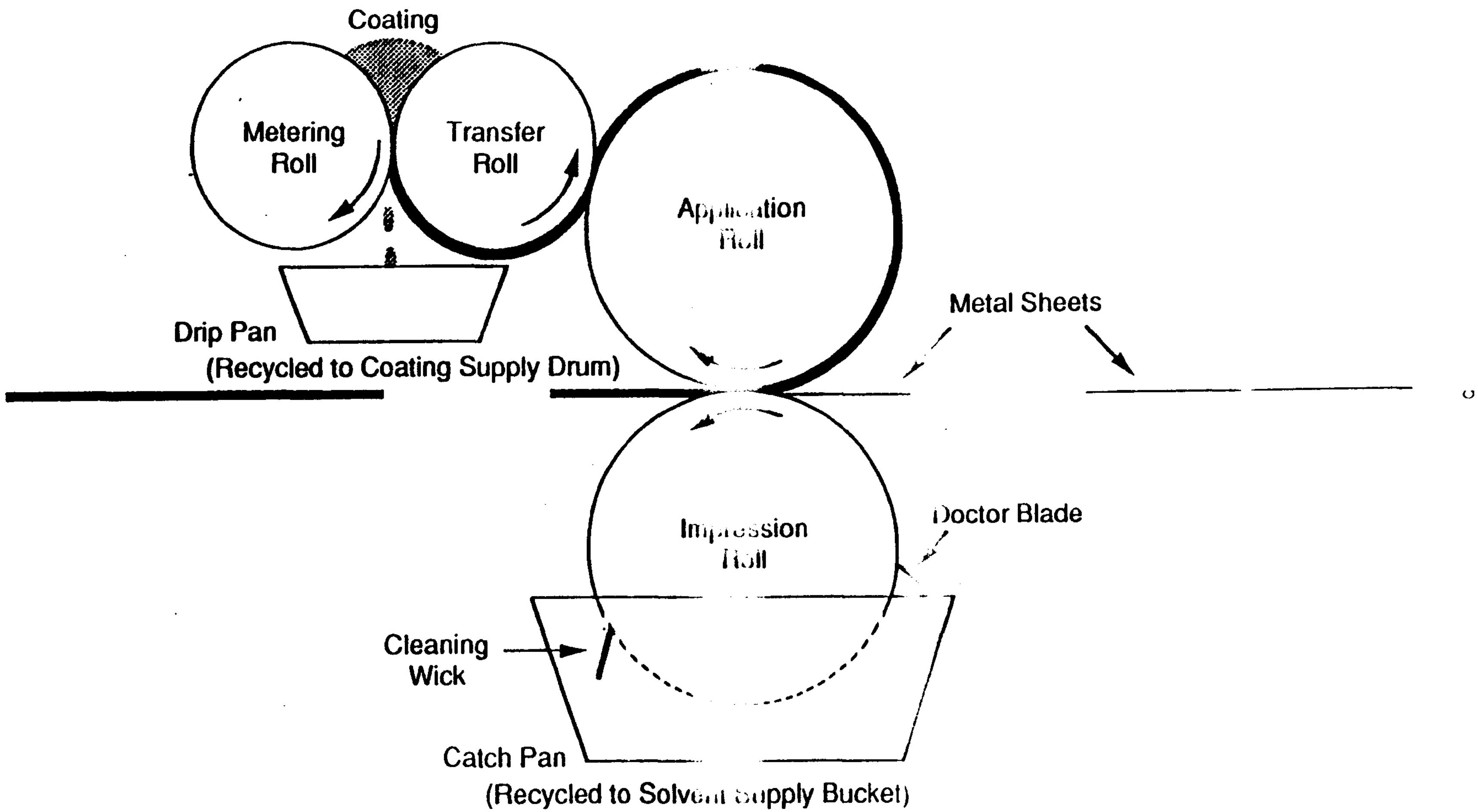

Figure 2. Schematic of a sheet-fed roll coater.

wickets. For each coating formulation, a particular "oven curve" is specified to ensure that the coating is properly dried and cured. The oven curve specifies the proper temperature of the metal sheet at each point as the sheet passes through the drying oven. Thus, the temperature settings for each zone of the oven must be adjusted for each coating.

The VOC emissions from each drying oven are controlled with a dedicated incinerator. (Additional information on the types and numbers of incinerators at the facility is contained in item No. 4 of the Confidential Addendum.) The exhaust gas from each oven's incinerator is recirculated to the oven to provide the heat for all but the final heating zone of the oven. The oven temperature is regulated by controlling the amount of recirculation. The final heating zone has an individual gas burner. The cooling section draws in ambient air from outside the plant and exhausts it to the atmosphere again. A schematic of a drying oven/incinerator air handling system with an explanation of the temperature control system is contained in the Confidential Addendum (see item No. 5). This material was supplied by ANC. It is general in nature rather than specific to the Hammond Plant.

After leaving the drying oven, the dried sheets are stacked horizontally on pallets. The coated sheets then may be printed on the reverse surface or shipped to a canning plant for use.

B. Observations Pertinent to the TTE Protocol

The affected facility to which air pollution regulations apply is each coating line. In the past, the plant was under a compliance bubble, but this is no longer the case. The VOC emission limitation is 2.8 pounds of VOC per gallon of coating less water or 4.52 pounds of VOC per gallon of coating solids. The plant complies through the use of complying coatings and the use of add-on controls. During the winter months when the formation of ozone is reduced, no control is required. There are three primary VOC emission points in each coating line: the coater, the flashoff area, and the drying oven.

The coater includes two independent systems that generate VOC emissions. The first of these is the coating supply and application system. As discussed previously, the coating is pumped to the roll coater from a 55-gallon drum, and the excess coating is continuously recycled to the supply drum. Emissions from this system can occur at the roll coater and at the supply drum, which is partially open. The supply drum is located next to the coater on the right side of the line. (Throughout this report, left and right will refer to the side of the line as viewed from feeder end.)

The second coater system that generates VOC emissions is the impression roll cleaning system. This system also has continuous recycle and generates emissions from the area in the coater where the cleaning is performed and from the supply bucket, which is completely open. The supply bucket is located to the right of the coater next to the coating supply drum. Whether the cleaning system is considered part of the affected facility is not entirely clear. For instance, it is unlikely that the required formulation for a complying coating takes emissions from the cleaning system into account.

The facility has a capture system for the VOC emissions from the coater. Air is drawn from the coater through two ducts from the hood on top of the coater and from a floor sweep below the coater. (Additional information on the coater capture system is contained in item No. 6 of the Confidential Addendum.)

The coating and cleaning solvent supply containers adjacent to the coater are sources of fugitive emissions. Some fugitive emissions also are generated in the flashoff area, the portion of the line between the coater and the entrance to the drying oven. This area is about 10 feet long; it takes about 1 second for a sheet to pass from the coater to the oven. Capture of emissions in this area is achieved only to the extent that they are drawn into the drying oven entrance.

The drying oven is the final source of emissions in the affected facility. The openings in the oven are the entrance, the exit, and a series of gasketed access doors down the left side. The access doors typically are kept closed during operation; the first access door may be opened occasionally to extract sheets for quality assurance (QA) activities. The oven entrance is about 51 inches wide by about 22 inches high; the exit from the last heating section is larger because the sheets are fully vertical as they exit. While this exit is not visible because of the cooling section, it must be about 4.5 feet by 4.5 feet. The access doors are roughly 4.5 feet high by 2 feet wide.

The oven is operated at negative pressure to the surrounding room. Face velocity measurements were conducted on one drying oven while the coating process was down but the oven was operting. The inward velocity through the oven entrance varied between 75 and 150 feet per minute at various points across the opening when measured with the first oven access door open. With the access door closed (as would typically be the case), the maximum inward velocity at the oven entrance was 180 feet per minute. No velocity measurements at the oven exit were possible. Mr. Gere and Mr. Meadows indicated that it is very obvious when air handling system upsets cause the oven to be at positive pressure because solvent odors are apparent. It appears that during normal operation no fugitive emissions escape from the drying oven.

The primary sources of nonaffected VOC emissions in proximity to each coating line are the other coating lines. The lines are separated by a minimum of about 8.5 feet. The most serious potential problem with inability to isolate affected emissions from nonaffected emissions comes from the coater cleaning system. Emissions from this system cannot be separated from affected emissions. Also, there are a number of other cleaning solvent containers along the right side of the line, but these containers are tightly closed and do not appear to present a problem regardless of their affected/nonaffected status.

A schematic of the process showing all emission sources and gas streams has previously been presented in Figure 1. Figures 3 and 4 present more precise renderings of the process layout from top and side views. These figures may not be completely accurate in every particular but are close enough for realistic design of a TTE in the process area. Not pictured are the coating supply drum, cleaning solvent supply bucket, and other cleaning solvent containers that are located along the right side of the line under the light fixture. Also not included are a large QA table normally located to the left of the line across from the oven entrance and a recordkeeping stand located to the left of the feeder. The table and stand should be enclosed in any TTE so that the operator can use them without leaving the enclosure.

The coating line operator must have access to all the process equipment from the feeder to the first access door in the drying oven. Most frequently, the operator works in the left aisle, but must also be able to access or change the coating supply drum on the right side of the line. During normal operation, the operator uses all of both aisles, but this clearance could be restricted to half of each aisle for the period of a capture efficiency test. The QA table, which normally abuts the next line on the left, could be rolled over into the half of the aisle next to the line being tested.

During changeover from one product to another between runs, the full width of both aisles on either side of the coater must be used. The rollers are changed out from the left side using the overhead chain hoist. The cleaning system components are changed out from the right side.

A TTE would not pose any significant problems with personnel traffic patterns in the process area. The only personnel normally between the lines are the operators. As indicated above, the operator for each line could make do with half of each aisle. There is a larger, more generally used aisle running perpendicular to the coating lines at the feed end, but the use of a TTE in the process area would not affect traffic in this aisle.

The flow of materials within the process was discussed earlier in the subsection on process information. There are limited flows to and from the process. Coating supply drums are brought to the line one at a time as needed. The new drum is brought to the feed end of the line by a fork lift. The drum is transported with a dolly down the right aisle to its appropriate location to the right of the coater. The spent drum is then transported back up the right aisle with the dolly. A drum of coating lasts an hour or more.

Loads of sheets are brought to the feed end of the line by a forklift and placed on the rollers leading to the feeder. Normally, two or three loads are lined up on the rollers waiting for use. The forklift comes to the line approximately every 15 to 20 minutes to bring a load to replace the load being used.

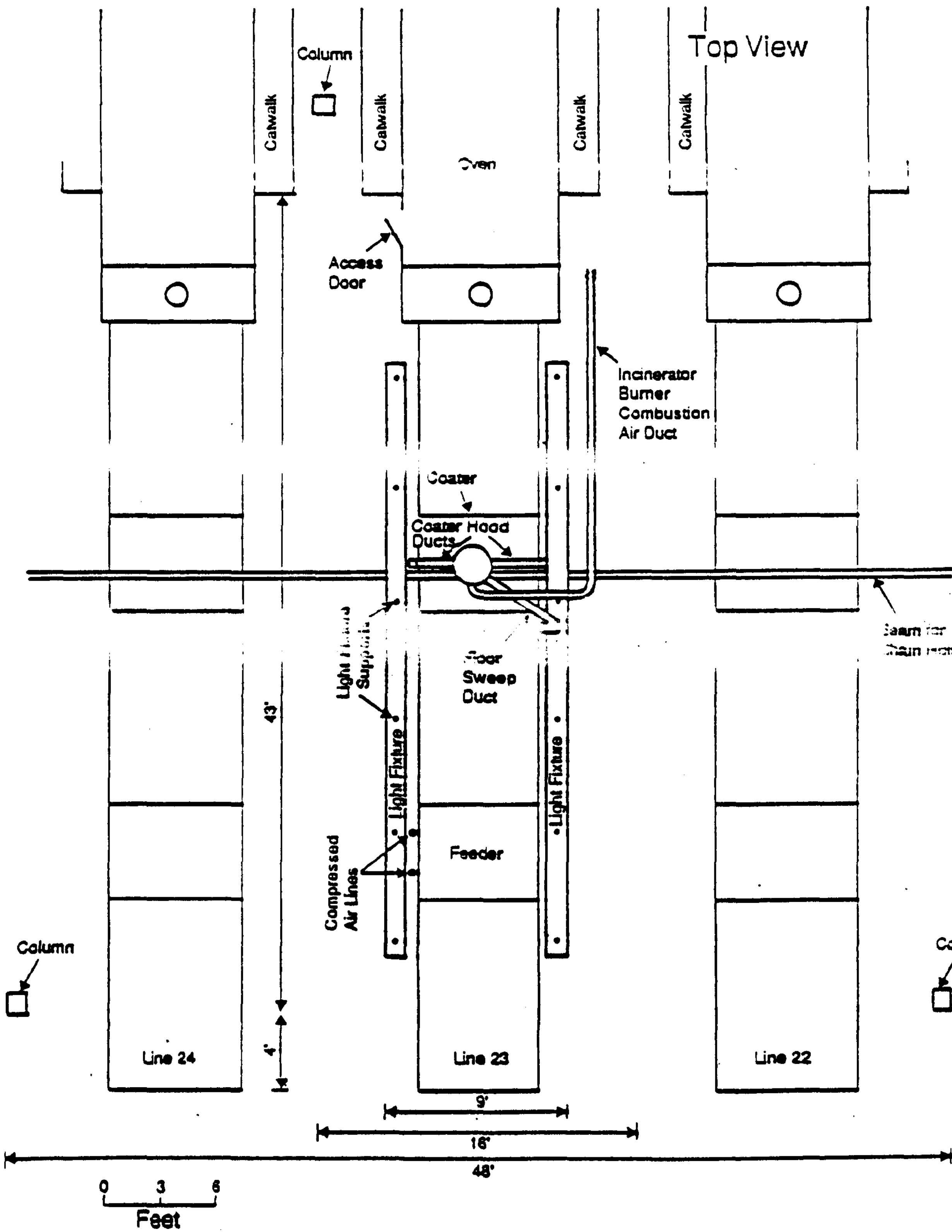

Figure 3. Top view of line No. 23.

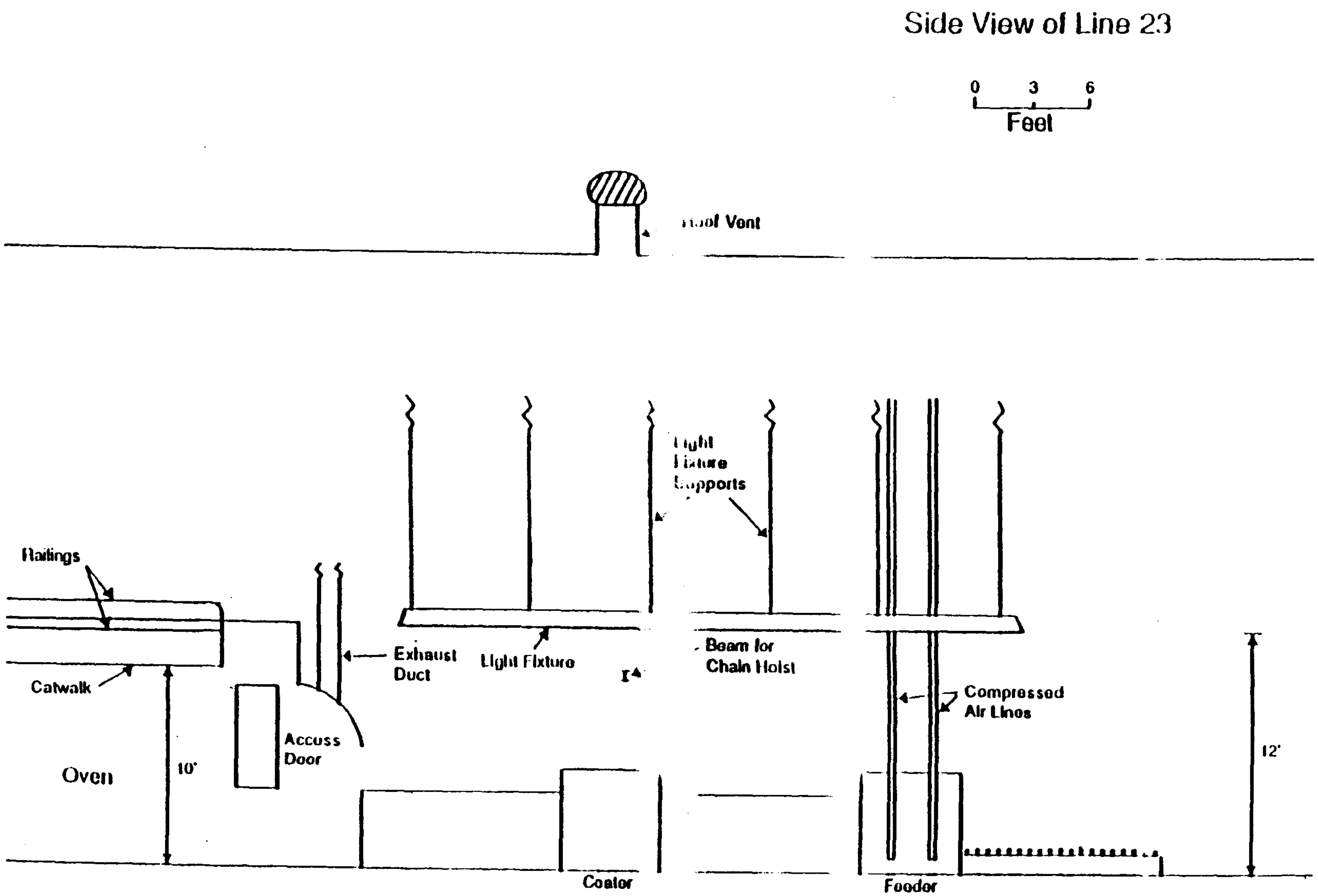

Figure 4. Side view of line No. 23.
(Modified to remove material claimed confidential by ANC. The original figure is contained in the Confidential Addendum -see item No. 7).

To change out rolls between runs or to replace a roll damaged during a run, the rolls are transported to and from the coater on a wheeled cart in the left aisle. Removal and replacement of the rolls is accomplished using the overhead chain hoist.

The lines adjacent to the one being tested would have identical personnel and material traffic patterns. These patterns generally would not affect the use of a TTE that enclosed half of the aisle on each side of one line. A possible exception would be encountered if the rolls on the line to the right or the cleaning system on the line to the left must be changed out during the test period. In either case, the entire aisle adjacent to the line being tested would be required, possibly requiring the TTE to be breached for the duration of the changeout.

The plant is required to meet OSHA standards regarding exposure of personnel to solvent vapors; these standards would have to be met within the TTE if workers were to remain inside during the testing. The identities and approximate quantities of the solvents released into the TTE (i.e., the fugitive emissions) can be used to determine the TTE exhaust rate necessary to ensure that the atmosphere within the enclosure meets the OSHA standards.

The plant is also subject to fire-prevention requirements. The requirements on maximum solvent vapor concentrations will not come into play for the TTE as long as the OSHA standards, which are much more stringent, are met. The plant also is required to use only explosion-proof equipment in the coating room. Any equipment associated with the TTE would have to meet this requirement. A sprinkler system is in place at the plant near ceiling level. If the sprinklers were outside the TTE, fire extinguishers would have to be placed inside.

Hearing protection is already required in the coating room. It is not expected that the TTE would appreciably affect the noise level in the area. The temperature in the vicinity of the ovens sometimes reaches 100°F in the summer. The potential for elevated temperatures in the TTE should be considered during the design of the TTE to allow for adequate heat removal.

For purposes of testing, emissions from the coater cleaning system cannot be isolated from other coating process emissions. If the cleaning system is not considered part of the affected facility, this mingling of solvent vapors could present a problem. However, the problem should not be severe. The quantity of emissions from the cleaning system is likely to be small, possibly small enough to be insignificant relative to the solvent content of the coating. Emissions from this small source are very unlikely to appreciably affect the capture efficiency measurement.

Nonaffected emissions also could enter the enclosure in the makeup air drawn in through the natural draft openings (NDO's). During the site visit, ambient readings around the process area were in the range of 10 to 20 ppm as propane. Higher ambient levels around an adjacent line would be likely when the line is cleaned between runs. To avoid drawing in significant quantities of VOC at these times, NDO's should not be located on the sides of the TTE near the coater, where the bulk of cleanup solvent is used.

In order to measure capture efficiency, a minimum of three gas streams would have to be tested simultaneously: the inlet to the incinerator, the incinerator burner combustion air duct, and the exhaust set up to vent the fugitives from the TTE. The "captured emissions" would be the sum of the VOC in the incinerator inlet (drawn from the drying oven) and the combustion air duct (drawn from the coater hood and floor sweep); the fugitives exhaust duct would contain the fugitive emissions. The incinerator inlet duct and combustion air duct are illustrated in Figures 5 and 6, respectively. (Figure 6 is contained in the Confidential Addendum--see item No. 8.) Potential test points for each also are illustrated. These ducts are suitable for VOC measurements and should be suitable for volumetric flow rate measurements, provided that cyclonic flow is not present.

Other gas streams also might be tested or periodically monitored. Because the incinerator provides the heat for most of the drying zones through direct recirculation of the incinerator combustion gases, the VOC content of the incinerator outlet is of interest. The VOC in this gas stream could be subtracted from the quantity measured in the incinerator inlet to derive the net quantity of "captured" VOC contained in the incinerator inlet stream. The ambient VOC level outside the NDO's might be monitored also. This VOC could be subtracted from the quantity measured in the fugitives stream to obtain the net VOC fugitives generated within the enclosure. The drying oven cooling section exhaust might be checked to determine whether VOC is escaping from the final heating section of the oven into the cooling section. All these gas streams likely would be tested only for the VOC concentration that is present; suitable test locations are sure to be available.

There is no indication that any compounds are present in the gas streams that would interfere with any EPA Methods for measuring VOC. Thus, any suitable Method could be used.

Mr. Gere has supplied available test data from this facility and data on the compositions of the most frequently used coatings. The quantity of fugitive VOC generated by the process can be approximated from the test results and an assumed capture efficiency of 90 percent. The allowable VOC concentration within the TTE can be determined based on the solvents that are used. From the approximate mass emission rates and identities of the solvents, the appropriate fugitive exhaust rate can be determined to ensure that the atmosphere within the TTE is safe for personnel.

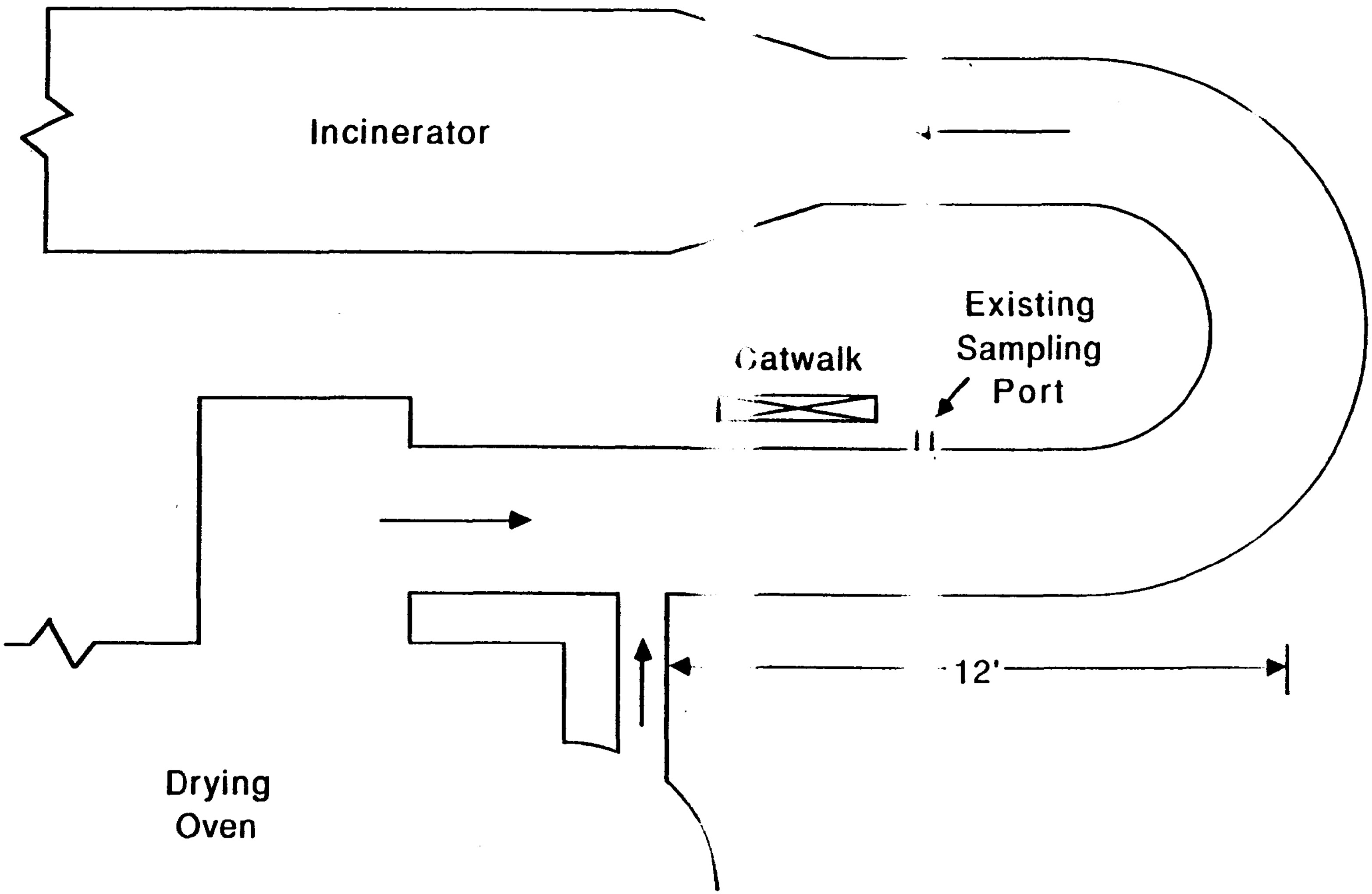

Figure 5. Incinerator inlet duct.

V. Conclusions

It appears that a TTE can be built at this facility. Midwest Research Institute has proceeded with preparation of a detailed cost and feasibility analysis for one coating line.

b1805-3/CBI

WESTVACO CORPORATION

MRI

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Date: May 12, 1989
(Finalized October 10, 1989)

Subject: Site Visit--Westvaco Corporation, Virginia Folding Box Division, Plant 2, Richmond, Virginia
Investigation of the Temporary Total Enclosure Method for Measuring Capture Efficiency
EPA Contract No. 68-02-4379, Work Assignment 18
ESD Project No. 87/07; MRI Project No. 8951-18

From: Stephen W. Edgerton SE

To: Karen Catlett
EPA/CPB/CAS (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Purpose

This site visit was conducted to gather information for determining the cost and feasibility of conducting a capture efficiency test at this facility using the temporary total enclosure (TTE) capture efficiency protocol.

II. Place and Date

Westvaco Corporation
Virginia Folding Box Division
Plant 2
Richmond, Virginia

February 16, 1989

III. Attendees

Westvaco Corporation (Westvaco)

John Murphy, Plant Engineer

Commonwealth of Virginia (Virginia)

Pamela Faggert, Dept. of Air Pollution Control
Katherine Miller, State Air Pollution Control Board

U. S. Environmental Protection Agency (EPA)

Karen Catlett, ESD/CPB
Gary McAlister, TSD/EMB
Roger Shigehara, TSD/EMB
Candace Sorrell, TSD/EMB

Midwest Research Institute (MRI)

Stephen Edgerton

IV. Discussion

At Westvaco's request, the visit began with a meeting among the attendees (except the representatives of EPA/TSD/EMB, who arrived later) to discuss compliance and testing issues. Ms. Catlett explained her earlier comments on Westvaco's proposed liquid/gas capture efficiency test protocol. Ms. Catlett and Mr. Edgerton emphasized that they have no authority in compliance matters and that their comments on these matters were general in nature and not authoritative. After this meeting, the representatives of Virginia departed, and the EPA representatives of TSD/EMB arrived a short time later.

At this time, a meeting was held among the remaining attendees to discuss the purpose of the visit and to go over the questionnaire sent to Westvaco in advance of the visit. This meeting was followed by a tour of the production facilities and an extended period of data gathering. During this period, the operation of the process was observed, potential measurement points were identified, the physical dimensions of the process equipment and ductwork were measured, and the plant layout and ductwork were sketched. A brief closing meeting was held to discuss the proposed TTE design for the facility.

The subsections that follow summarize the information gained from the meetings and from observations made in the plant. Some additional information and clarification have been obtained from telephone conversations with Mr. Murphy. Subsection A below discusses process information. Subsection B presents information pertinent to the use of the TTE protocol.

A. Process Information

The Westvaco plant prints and cuts paper to manufacture boxes for packaging. Products include flip-top boxes and cartons for cigarettes, boxes for cosmetic products, and boxes for fast foods. At the time of the site visit, the plant had six operational production lines (Nos. 10 through 15); a seventh line (No. 9) was being installed. The plant operates 24 hours per day, 7 days per week.

The production lines are located side by side in a large room. The basic process is very similar on all the lines. The paper is fed to the process as a continuous web from the unwind equipment, passes through an eight-color rotogravure press, and is cut in line to the desired shape for the finished boxes. The maximum web widths that can be accommodated by the lines are contained in Item No. 1 of the confidential addendum to this report. Line speeds vary by product and line. The range of line speeds is contained in Item No. 1 of the confidential addendum. The lines were installed between 1959 and the present, with some modifications to some equipment over the years. At the suggestion of Mr. Murphy, Line No. 13 was selected for in-depth study as the most difficult of the lines to enclose because it is crowded in between the lines on either side.

The facility is a "job shop" that produces boxes in the design and quantity specified by the customer. Product runs vary in duration from as little as 15 minutes to as long as a week. A typical job requires about 1 day.

Setup time between jobs can be as little as 2 hours when only ink colors or a couple of the rotogravure cylinders must be changed. An example of such a change would be switching from cigarette boxes to be sold in the U. S. to boxes destined for Hong Kong. A change from one product to a completely different product can require as much as 12 to 18 hours. This period would include changing all the rotogravure cylinders, preparing inks and ink delivery systems, preparing the die that stamps out the boxes from the continuous web, adjusting the "delivery equipment" that handles the cut boxes for the dimensions of the new product, and a startup period of adjusting the various process parameters until an acceptable product is produced.

The percentage of the time a line normally runs once it is up and running properly is contained in Item No. 2 of the confidential addendum. The line is stopped occasionally as necessary to correct any problems that develop. The most frequent cause of down time is a problem with the cutting die.

Attachment 1 is an equipment manufacturer's illustration of an eight-color packaging gravure line supplied by Westvaco. This illustration includes all available in-line features; all these features are not included on all lines at Westvaco. In the process description that follows, the primary focus will be on the details of Line No. 13.

The unwind equipment used at the plant is of the "turn-over" type pictured in Attachment 1. This configuration allows a replacement spool of paper to be mounted on the equipment while the active spool is in use. On Line No. 13, the maximum spool diameter is about 6 feet. From the unwind, the web passes through a "butt splicer" with which the end of one spool is spliced to the beginning of the next. On some lines at Westvaco, a "festoon" follows the butt splicer. This equipment accumulates a length of web to allow spool splicing to take place without stopping the line. Line No. 13 does not have a festoon. The final unit of the web feed equipment is a web guide/tension control. This apparatus prevents the web from slipping laterally during operation and imparts the proper tension to the web.

From the feeding equipment, the web passes into the printing equipment. All the lines at Westvaco have eight-color rotogravure presses that consist of eight discrete print stations, each of which can apply a single color ink or other coating. Some or all of the stations can be active on any given job, depending on the number of colors or other coatings that must be applied.

An equipment manufacturer's drawing of a typical print station supplied by Westvaco is presented as Attachment 2. The lower portion of the station is the printing deck. In rotogravure printing, the ink is carried by indentions or "cells" engraved into the gravure cylinder. There are typically 22,500 cells per square inch. The ink is actually applied as dots but flows together on the surface of the web. The area of coverage is determined by the pattern of the cells. Westvaco produces about half of their gravure cylinders and purchases the other half.

The facility performs two types of printing. In "line" work, solid colors are used, and the areas of coverage have sharp edges. In "process" or "tone" work, the cells vary in size and shape to fade the colors in and out for shading. Only the colors red, yellow, blue, and black are used in tone work; all colors in the finished product are combinations of these four.

Westvaco uses hundreds of different ink and coating formulations because the specifications are dictated by the customers. Certain products have unique colors used only for those products (e.g., "Marlboro red"). In addition to inks, other coatings may be specified by the customer. Examples are grease barriers applied to some fast food boxes and varnish overcoats frequently applied over the inks to protect the inks and impart the desired finish to the product.

Westvaco uses about eight primary solvents and about twelve others from time to time. Roughly in order of descending use, the solvents are toluene, isopropyl acetate, isopropyl alcohol, n-propyl acetate, methyl ethyl ketone, ethanol, hexane, acetone, and methyl cellosolve. The inks at this facility are mixed in ink tanks on the pressroom floor near the line on which they are to be used. As purchased, the inks are about 50 percent solids by weight. The solids content is reduced to about 25 percent through the addition of extenders and solvents prior to application.

In the printing deck, ink is pumped from the ink tank to a nozzle that extends across the width of the gravure cylinder. The ink cascades over the surface of the gravure cylinder as the cylinder rotates downward. The excess ink is caught below by an ink pan or sump. The lower portion of the gravure cylinder is submerged in this ink as the cylinder rotates through the ink pan. The ink in the ink pan is recirculated to the ink supply tank. As the ink is circulated, a device automatically tests the viscosity and adds solvent as necessary to adjust the ink to the proper viscosity.

After the gravure cylinder emerges from the ink pan, the cylinder passes under a doctor blade that scrapes the excess ink from the surface, leaving ink only in the engraved cells. The ink is transferred from the gravure cylinder to the web as the web passes between the gravure cylinder below and the impression cylinder above.

From the printing deck, the web passes into the print station's individual drying oven located on top of the printing deck. The configuration of the drying oven is illustrated in Attachment 2. At this facility, the drying ovens on six of the lines are direct fired with natural gas burners; the dryers on the seventh line are heated with electrical elements. The dryers contain a series of impingement tubes through which heated air is blown onto the printed surface of the web to dry it. Part of the air is recirculated past the heat source; part of the air is exhausted to a common carbon adsorption emission control system.

The volume of the exhaust stream is determined by an automatic damper controlled by a VOC concentration sensor. The damper controller is set to maintain the VOC concentration at 30 percent of the lower explosive limit (LEL). However, the concentration frequently varies from this value. When the print station is applying very light coverage (i.e., very little of the web surface receives the color being applied by that station), the VOC concentration will be well below the target value because a minimum exhaust rate must be maintained to keep the drying oven at negative pressure relative to the pressroom. At very high coverage, the VOC concentration in the exhaust stream will exceed the target value even with the damper in full open position. In accordance with insurance requirements, an alarm sounds if the concentration reaches 50 percent of the LEL, and the line automatically shuts down if the concentration reaches 60 percent.

From the drying oven of one print station, the web passes to the next print station where the next color ink is applied and dried. The web continues to pass from one print station to the next, alternately being printed upon and dried, until all the colors and any other coatings have been applied. Each color must be properly positioned relative to the other colors for the final image to have the proper appearance. The relative position of the colors is termed "registration."

After leaving the final print station, the web passes through a postpress web guide and then to the cutter creaser. The cutter creaser contains the cutting die that stamps out the separate pieces that later will be folded and glued to form a box. In addition to the blades that cut the web, the die has elements that crease the web to form the lines along which the box will be folded. To produce a satisfactory product, the cutter creaser must be in register with the print stations.

The cut boxes enter the "delivery equipment" from the cutter creaser. In this section of the line, the cut pieces are stacked while the scrap paper is drawn into the intakes of a pneumatic conveying system that leads to remote bailing equipment. At the end of the line, the stacked pieces are manually placed into shipping containers.

B. Observations Pertinent to the TTE Protocol

The affected facility to which air pollution regulations apply is each production line. According to Mr. Murphy, each affected facility includes the associated mixing area, which is located in the pressroom adjacent to the line. The newest line is required to achieve the "lowest achievable emission rate" (LAER). In Virginia for this type of operation, LAER is defined as an emission reduction of 73 percent. The remaining lines are required to meet "reasonably available control technology" (RACT) guidelines. The required RACT control level for this process is normally 65 percent control, but Westvaco has accepted a requirement of 68 percent control to offset the annual emission increase associated with the newest line.

The facility complies with these emission limits through the use of a carbon adsorption system to control emissions. Compliance is demonstrated through weekly and monthly liquid material balances across all the lines combined. An accounting system has been instituted to track all VOC introduced to the coating lines and all VOC recovered by the carbon adsorption system. All drums of coating and solvent are assigned a unique identification number. These drums and the quantity they contain are logged into and out of storage; records are kept on the VOC input to the process by line and job. The VOC content of the inks consumed is computed from formulation data. Solvent lines from bulk storage tanks to each line are metered. The recovered solvent is tracked through records of all additions to and withdrawals from the recovered solvent storage tanks. Recovered solvent is analyzed by gas chromatograph to determine the amount of each individual solvent that is recovered.

The cutoff for the weekly material balance is 7:00 a.m. each Wednesday. At that time, each line is inventoried to determine the quantity of ink and solvent present at the line, and the bulk solvent meter readings are recorded. The recovered solvent storage tank records are compiled. The records of VOC input and recovered for the week are compared to determine the recovery efficiency. This value is compared to a target recovery value for each week that is computed as a weighted average according to the solvent used on the LAER and RACT lines. Weekly data are compiled to compute the monthly material balances and target recovery values.

Included in the material balance is a solvent destruction credit of 8 percent for the lines with direct-fired ovens. This destruction credit was established through a liquid/gas material balance that compared the liquid solvent entering the process to the quantity of carbon dioxide and carbon monoxide in the exhaust. After accounting for the combustion of the natural gas input during the test period, the quantity of solvent combusted in the drying ovens was back-calculated from the amount of carbon dioxide and carbon monoxide in the exhaust.

Mr. Murphy indicated that the weekly and monthly material balances (including the solvent destruction credit) typically yield plant wide overall control efficiencies in excess of the 73 percent required to meet

LAER. However, the example weekly balance provided by Mr. Murphy indicated a plant wide level of about 69 percent.

The primary VOC emission points in each line are the eight print stations and the ink mixing area. Within each print station, emissions can occur from the printing deck, the flashoff area, and the drying oven.

Emissions from the printing deck are most likely to occur from the area where the ink is applied to the surface of the gravure cylinder. This area includes the point where a cascade of ink flows over the cylinder surface, the ink pan or sump, and the point where the doctor blade removes the excess ink. Some emissions are possible from the ink supply tank located on the floor by the print station, but these emissions should be minimal because these tanks were observed to be well covered during operation. After the ink is transferred to the web, there is a short flashoff area prior to the entrance of the drying oven immediately above the printing equipment.

There is no capture system per se for the emissions from the printing deck and flashoff area. However, as shown in Attachment 2, the entrance and exit slots of the drying oven are located just above these areas, and the airflow at these slots is inward into the oven. Capture through entrainment in this dryer makeup air is enhanced at this facility by fabric draped so as to cause the makeup air to be drawn primarily from the area where emissions occur.

The drying ovens are the primary emission points from the printing lines. Generally, the only openings in the drying ovens are the entrance and exit slots. The first two dryers on Line No. 13 are exceptions; the top sections of the dryer hoods on these dryers are open as well. The drying ovens are exhausted to the carbon adsorption system. The exhaust rate is varied depending on the VOC concentration, but a minimum exhaust rate is maintained to ensure that the direction of air flow at the dryer openings is inward. For this reason, it is unlikely that fugitive emissions escape the drying ovens. A possible exception would be the first two dryers on Line No. 13. However, these drying ovens are not equipped with automatic dampers; presumably the dampers have been set so that an adequate exhaust rate is maintained to avoid fugitive emissions from these dryers.

In addition to the emission points on the printing line itself, emissions occur in the ink mixing area adjacent to each line. At this facility, this equipment is considered part of the affected facility. Ink and solvent drums are held in this area for mixing the inks in use for the current job. Metered solvent lines also serve each printing line's mixing area. Drums are placed on copper grounding boards as a fire prevention precaution. Agitators for mixing the inks are inserted into the drums and attached to supports that extend upward from the grounding boards. The drums in which mixing occurred during the site visit were not covered during mixing. Emissions in the mixing area are not controlled except to the extent that they contribute to the ambient pressroom VOC concentration and are drawn into the drying ovens in the makeup air. A floor sweep that vents to the atmosphere is located in each mixing area.

The only sources of nonaffected emissions noted during the site visit were the other printing lines in the pressroom. Presumably, cleaning solvents are used to clean the presses between jobs. These emission sources also are not expected to be part of the affected facility.

A schematic provided by Westvaco of the air handling system is presented in Attachment 3. This schematic is not intended to present the plant layout accurately. The mixing equipment is not included in the schematic, although the floor sweep is pictured. Another airflow that is not included in the schematic is a fire prevention system. The lines each have electrical control boxes. In order to avoid a potentially hazardous concentration of VOC from contacting the electrical equipment, each line's control boxes are kept under positive pressure by an individual ventilation system that draws air from a low-concentration area of the pressroom. While these systems simply recirculate air within the room, this airflow could figure in TTE design.

A sketch of the layout of Line No. [illegible] is presented in Figure [illegible]. The purpose of the sketch is to present the features to be considered in designing a TTE for the facility. For purposes of clarity, the large quantity of ductwork, pipe, electrical conduit, light fixtures, and support structures located above the print stations and aisle to its left has not been pictured. (Throughout this report, left and right will refer to the side of the line as viewed from the unwind end.) However, it appeared that any attempt to span the print stations with a TTE [illegible] would be very difficult and would require a great deal of piecing to accommodate these obstructions. Some representation of the ducts, etc., has been included at the ends of the line to indicate the obstructions for the TTE end walls. At the unwind end of the line, the obstructions are fairly accurately presented in number and location, but at the cutter end, the obstructions shown are meant only to be indicative of the profusion of obstructions actually present. The line is equipped with an automatic carbon dioxide fire suppression system that has not been pictured. The outlet nozzles for this system are located on each print station and above the mixing equipment. A water sprinkler system extends throughout the pressroom near ceiling level. Also not pictured are large I-beam roof supports that run parallel to the printing line at the top of the I-beam columns shown in the sketch.

The press operating crew typically consists of an operator and two apprentices. These individuals handle the unwind and feed equipment, the print stations, the cutter creaser, and the mixing equipment. In addition, there are typically two or three "inspectors" that receive the cut boxes, check for flaws, and stack the cut boxes in larger cartons for shipping.

The operator and apprentices work in the aisle to the left of line, between the printing line and the mixing equipment. A wide aisle is maintained because the print stations are accessed from this side. The gravure cylinders are changed out in the aisle, so the aisle must be sufficiently broad to accommodate the breadth of the cylinders plus allow materials and equipment to be moved into and out of the area.

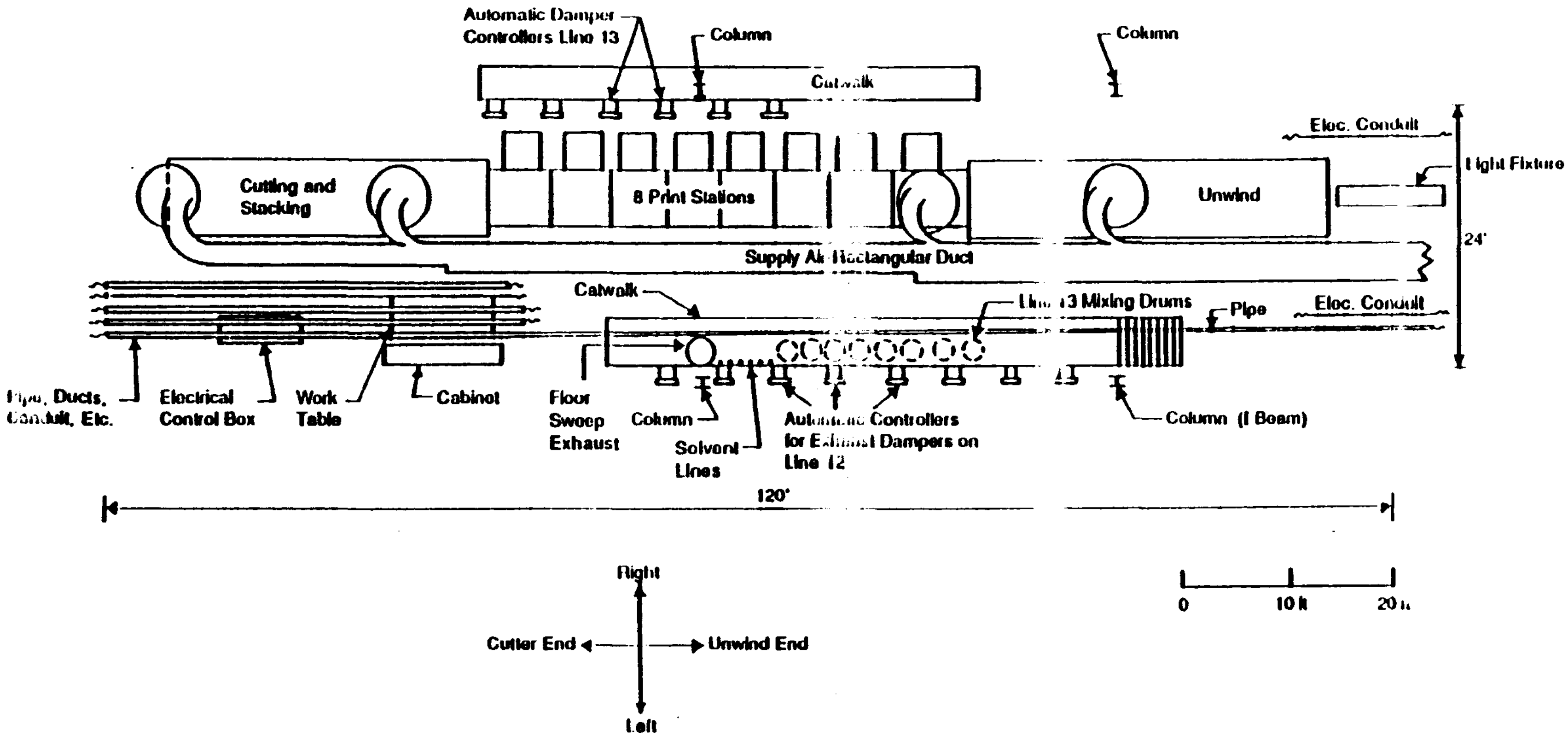


Figure 1. Top view of Line No. 13, Westvaco Corp., Richmond, Virginia.

During operation, the operator and apprentices need access to the unwind equipment to mount new paper spools, to the butt splicer to splice the new spool to the old (the line is stopped for this process on Line No. 13), and to the web guide/tension control to make any necessary adjustments. Access to the print stations during operation is necessary to replenish the ink supply tank and to make any adjustments required for proper color registration. In addition, some operators prefer to monitor and correct ink viscosity manually rather than relying on the automatic viscosity adjustment system. Access also is needed at the postpress web guide and at the cutter creaser when adjustments are required for proper registration of the cuts with the printed colors. Finally, the operator and apprentices need access to the mixing equipment to prepare the inks and to transfer ink to the printing equipment.

The inspectors need access to all areas of the delivery equipment during operation. Jams must be cleared from time to time, and minor adjustments are sometimes made. The operation crew and the inspectors need visual access to one another to signal when process adjustments are needed.

Except for workers who need to move ink drums, spools of paper, and finished goods to and from the presses as described below, there is little need for individuals other than those assigned to a particular line to have access to the line. Workers from adjacent lines do not need to enter the area in the course of their regular duties. The exception to this rule is that once each day the automatic damper control boxes of each line must be checked. These control boxes are accessed from a catwalk running parallel to the print stations immediately to their right. In the case of Line No. 13, the space between lines is so restricted that the mix equipment for Line No. 13 is located beneath the catwalk for Line No. 12. The only other personnel entering the immediate area of a line would be supervisors that occasionally check on the operation.

The personnel access and traffic patterns do not appear to present any major problems for construction of a TTE around Line No. 13. Because the mixing equipment is considered part of the affected facility at this plant, the TTE would be expected to include the press, the mixing equipment, and the aisle between. Thus, the operator and apprentices would generally remain within the TTE during testing, and access to the equipment would not be hindered. Also, the doors into the TTE would seldom be opened during a test run.

The flow of materials within the process was discussed earlier in the subsection on process information. There are limited flows to and from the process. Ink and solvent drums are brought to the line one at a time as needed. The drums are transported to the mixing area with a dolly. Spools of paper are brought with a fork lift through the large aisle that runs along the unwind end of the lines to the vicinity of the unwind equipment. From there, the spools are maneuvered into place by hand. A spool typically lasts about 1 hour. At the cutter end of the line, the cartons of cut boxes are loaded by hand onto a pallet; when the pallet is full, it is taken to storage with a dolly. A pallet is filled about every 45 minutes.

The flow of materials in the plant does not appear to present major problems with constructing a TTE. Depending on placement of the TTE, doors may have to be opened occasionally to accommodate flows to and from the line, but such occurrences should be brief and infrequent. Material flows on adjacent lines will not impact the use of a TTE.

The plant is required to meet OSHA standards regarding exposure of personnel to solvent vapors; these standards would have to be met within the TTE. The identities and approximate quantities of the solvents released into the TTE (i.e., the fugitive emissions) can be used to determine the TTE exhaust rate necessary to ensure that the atmosphere within the enclosure meets OSHA standards.

The plant is subject to the City of Richmond fire safety requirements. These requirements are drawn from NFPA guidelines. In addition, the facility's insurance carrier holds the plant to the Factory Mutual fire safety requirements. As discussed above, the facility has a plantwide sprinkler system, a localized carbon dioxide system, and a drying oven alert/shutdown system for fire safety. The TTE would have to be built so as to not interfere with the functioning of these systems.

Despite the care taken to ground the equipment, fires do occasionally occur at this facility. Mr. Murphy indicated that the frequency varies considerably but averages around once per month. These fires are typically extinguished rapidly by the carbon dioxide system. Mr. Murphy expressed concern for the workers in a TTE if the carbon dioxide system were triggered, primarily in regard to having adequate oxygen to breathe. However, it is unlikely that this would be a major problem at this facility because the volume enclosed by the very large TTE required to include the mixing equipment would not differ greatly from the situation in the absence of the TTE.

Hearing protection is not required in the plant; it is not expected that the presence of the TTE would appreciably affect noise levels. Heat buildup is not expected to be a major problem despite the fact that the drying ovens must be enclosed in the TTE; ambient heating in the vicinity of the dryers was not noted during the site visit. Again, the large enclosure needed at this facility would not be expected to trap heat much in excess of normal. A possible exception could occur during the hottest part of the summer when large room ventilation fans are sometimes used.

For purposes of testing, there are no nonaffected emission points in such close proximity to the process line that they must be included in the TTE. Nonaffected emissions from the adjacent lines could enter the enclosure in the makeup air drawn in through the natural draft openings (NDO's). According to Mr. Murphy, the ambient level in the plant is normally about 25 parts per million. To minimize the quantity of VOC entering through the NDO's, the NDO's should be located toward the ends of the line rather than along the sides where the printing and mixing equipment of the adjacent lines would be in closer proximity.

The number of gas streams that would have to be tested to determine capture efficiency would depend upon the extent of the TTE. In any case, the "captured emissions" would be measured in the common exhaust from the drying ovens of the line to the carbon adsorber. Also, the floor sweep exhaust from the mixing area would be expected to be within the TTE and would have to be tested. It is likely that the pneumatic scrap conveying system pickups also would be within the TTE. If so, this gas stream would need to be tested. If a supplemental fugitive emission exhaust is required to meet OSHA exposure standards, this stream also would have to be tested. The sum of the emissions in whichever of the latter three gas streams originate inside the TTE would comprise the fugitive emissions for the capture efficiency calculation. The captured and fugitive emission measurements would have to be made simultaneously.

The ducts involved appear to afford suitable measurement points for VOC concentrations and volumetric flow rates. The common duct from the Line No. 13 dryers to the main carbon adsorber duct is a round duct with a diameter of 24 or 28 inches; this duct has a straight run of about 16 feet on the plant roof. The floor sweep duct has a diameter of 13 inches; test ports are already present at a level about 12 feet above the floor accessible from the catwalk on Line No. 12. The fan for the floor sweep is located at the top of the duct above the plant roof. The supplemental fugitives exhaust, if needed, would be constructed to be testable. The suitability of the pneumatic scrap conveying duct is not so certain. This duct was not examined during the site visit because it was considered unlikely that the pickup would be within the TTE. However, consideration of the TTE criterion for separation of the NDO's from emission points now make inclusion of the pickup likely. A suitable test point is probably available; if not, modifications could be made to provide one.

Other gas streams also might be tested or periodically monitored. The VOC concentration within the TTE must be monitored to ensure that steady-state conditions are reached and that OSHA standards are not exceeded. The ambient VOC concentration outside the NDO's might also be monitored to determine the significance of VOC entering through these openings. Finally, the volume and VOC concentration of the air forced into the line's electrical control box might be measured or monitored to determine the significance of this gas stream on VOC measurements and the velocity of the air drawn inward through the NDO's. It is expected that suitable testing/monitoring points can be found for all these gas streams.

There are no indications that any compounds are present in the gas streams that would interfere with any EPA Methods for measuring VOC. Thus, any suitable EPA Method could be used.

The use of recirculating, direct-fired drying ovens at this facility presents a complicating factor in determining the true capture efficiency at this facility. Normal gas-phase measurements will not account for VOC destroyed as dryer air is recirculated near the burner flame. This may be significant at this facility where a past liquid/gas material balance indicated that 8 percent of the total solvent input into the process was destroyed in the drying ovens. However, it should be noted that destruction of VOC in direct-fired drying ovens is not normally accounted for by any capture efficiency determination method. In fact, the TTE protocol, in which only gas-phase VOC measurements are made, will minimize the error resulting from solvent destruction compared to methods that use liquid measures of the VOC available for capture by the capture system.

V. Conclusions

It appears that a TTE can be built at this facility. Midwest Research Institute has proceeded with preparation of a detailed cost and feasibility analysis for Line No. 13.

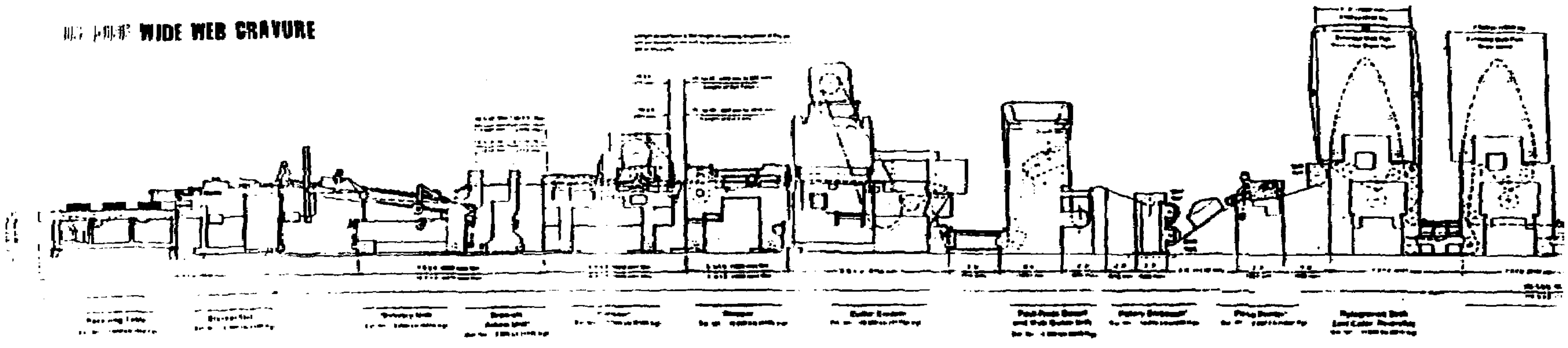
It should be noted that conducting a capture efficiency test using a TTE at this facility would be somewhat difficult because of the size of the area that must be enclosed, the number of obstructions about which the TTE walls would have to be pieced, and the number of gas streams that would have to be tested. For this reason, a liquid material balance might be preferable for determining compliance status if a method acceptable to all parties (Westvaco, the State of Virginia, and EPA Region III) could be developed. The shortcoming of this approach is that line-by-line control efficiencies cannot be obtained because the solvent recovery system serves all the process lines. Thus, unless some method of differentiating the recovered solvent by line of origin can be developed, the compliance status of the line subject to LAER cannot be determined individually as required by the enforcement policy for nonattainment areas:

3 Attachments

b2605-1/ESD

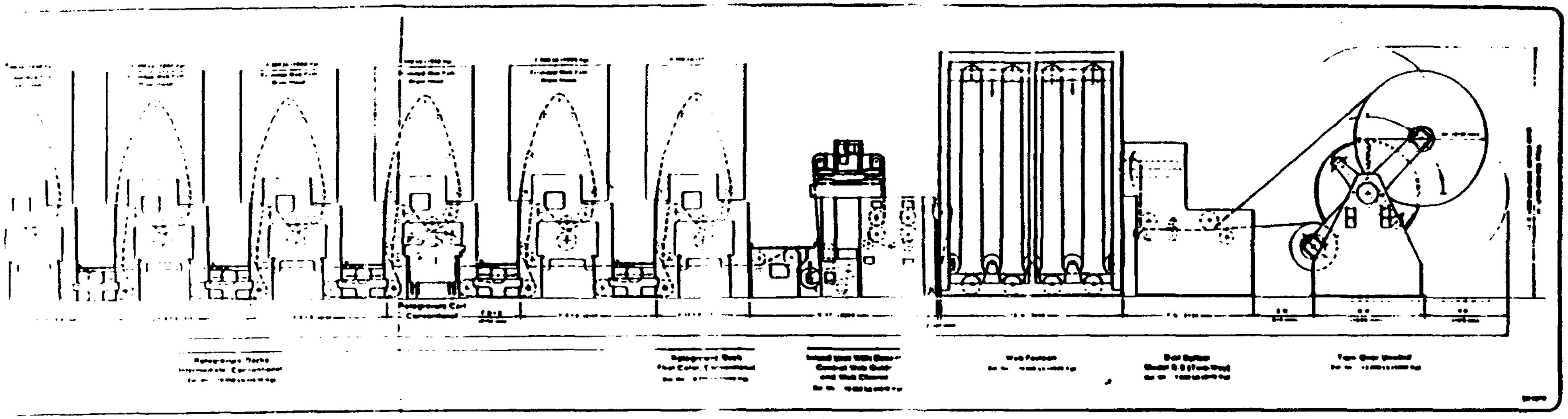
Attachment 1

WIDE WEB GRAVURE



ZERAND

IN-LINE FEATURES



PERFORMANCE

[illegible]

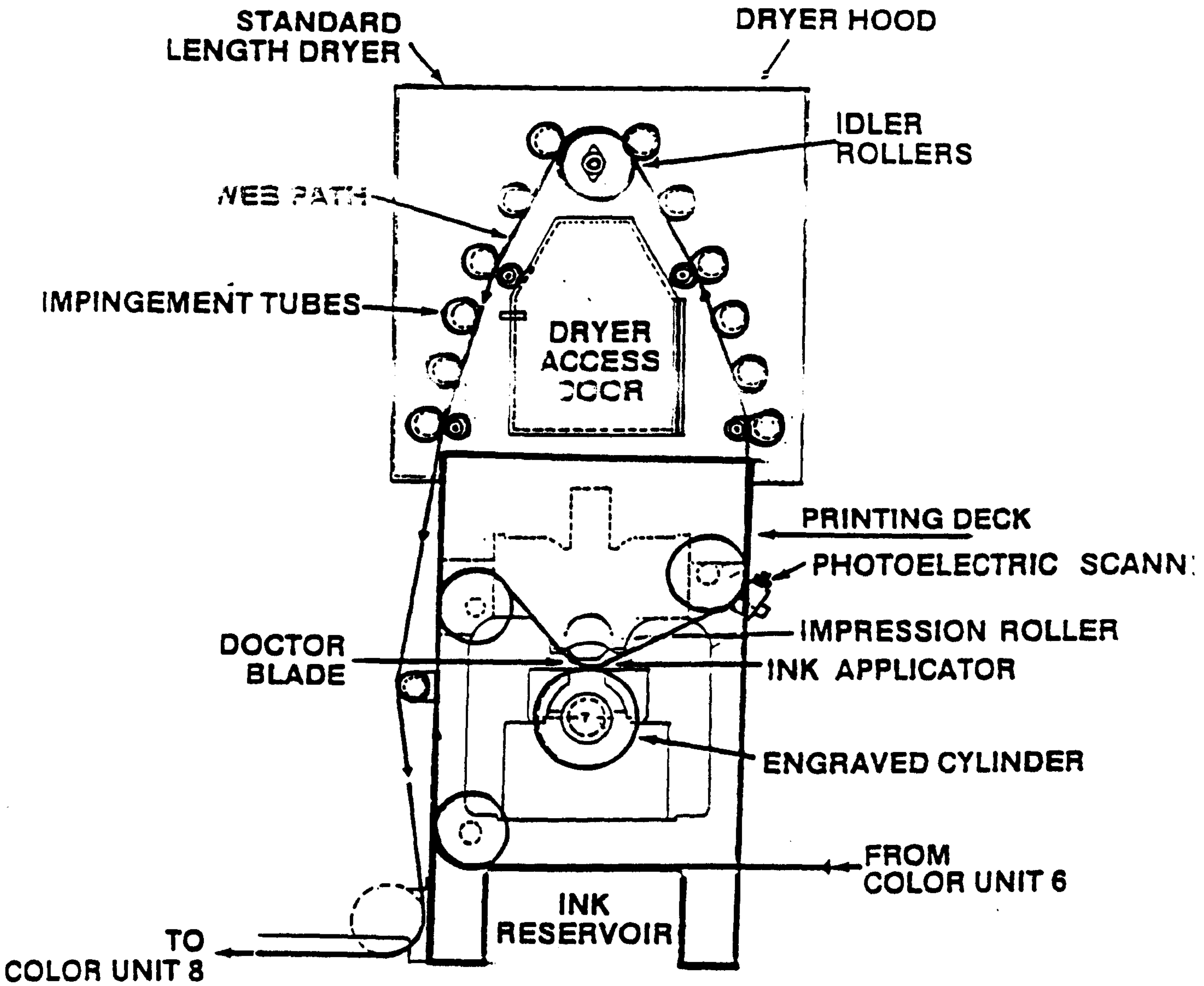
LINE SPECIFICATIONS

[illegible]

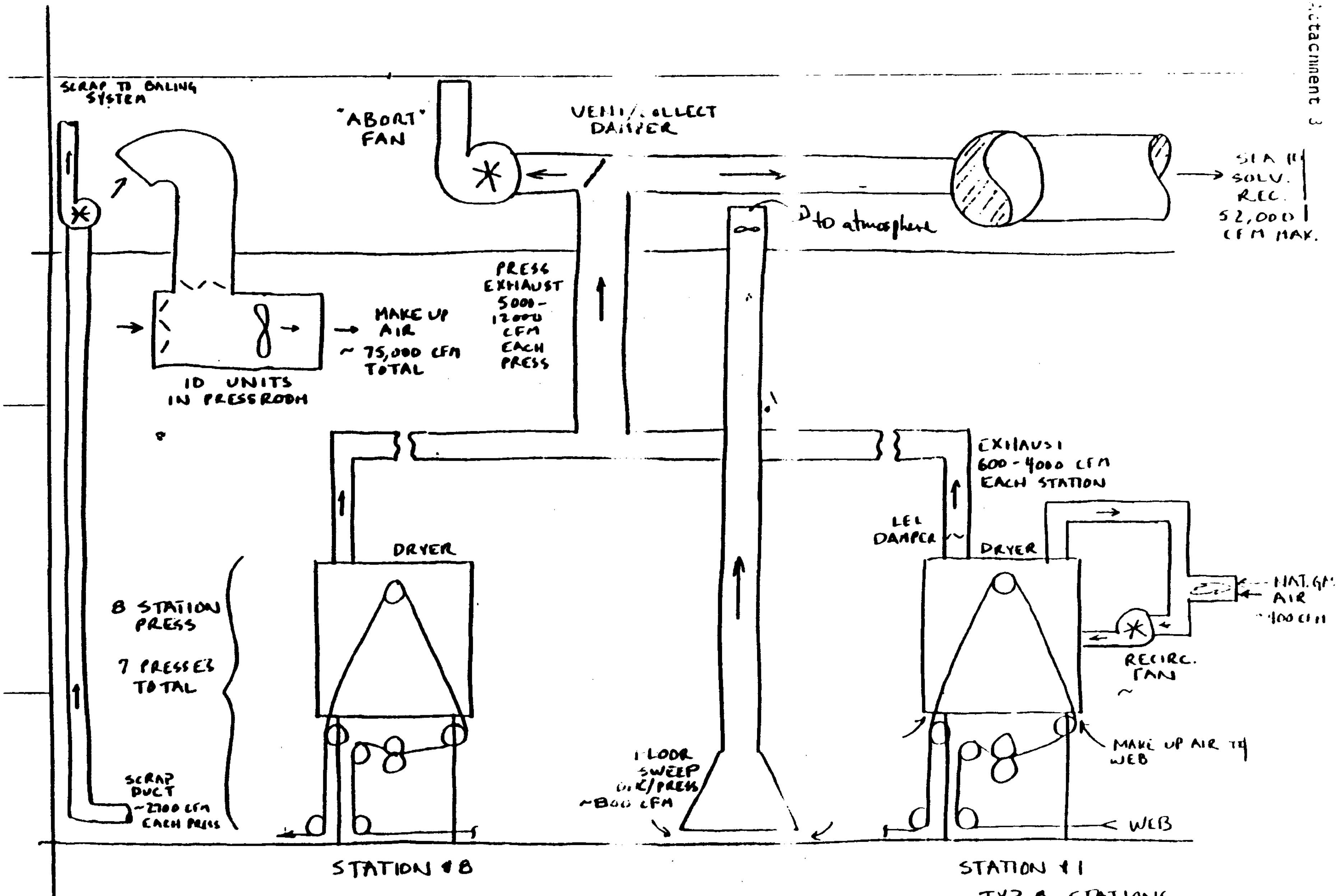
ZERAND

Attachment 2

Bobst Champlain Gravure Unit and Dryer System



Attachment 3



WESTVACO PLANT II AIR HANDLING

JLM 2/10/89

KENYON INDUSTRIES

MRI

MIDWEST RESEARCH INSTITU
Suite
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Telephone (919) 677-0
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Date: May 12, 1989
(Finalized April 27, 1990)

Subject: Site Visit--Kenyon Industries, Inc., Kenyon, Rhode Island
Investigation of the Temporary Total Enclosure Method for Measuring Capture Efficiency
EPA Contract No. 68-02-4379, Work Assignment 18
ESD Project No. 87/07; MRI Project No. 8951-18
(Finalized under Work Assignment 26; MRI Project No. 8952-26)

From: Stephen W. Edgerton SE

To: Karen Catlett
EPA/CPB/CAS (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Purpose

This site visit was conducted to gather information for determining the cost and feasibility of conducting a capture efficiency test at this facility using the temporary total enclosure (TTE) capture efficiency protocol.

II. Place and Date

Kenyon Industries, Inc.
Kenyon, Rhode Island 02836

February 28, 1989

III. Attendees

Kenyon Industries, Inc. (Kenyon)

Pete Nielsen, Vice President--Engineering

U. S. Environmental Protection Agency (EPA)

Karen Catlett, ESD/CPB
Candace Sorrell, TSD/EMB

Midwest Research Institute (MRI)

Stephen Edgerton

IV. Discussion

The visit began with a meeting among the attendees to discuss the purpose of the visit and go over the questionnaire sent to Kenyon in advance of the visit. The meeting was followed by a tour of the production facilities and an extended period of data gathering. During this period, the operation of the process was observed, potential measurement points were identified, the physical dimensions of the process equipment and ductwork were measured, the plant layout and ductwork were sketched, and photographs of the process area were taken. A brief closing meeting was held to discuss the proposed TTE design for the facility.

The subsections that follow summarize the information gained from the meetings and from observations made in the plant. Subsection A below discusses process information. Subsection B presents information pertinent to the use of the TTE protocol.

A. Process Information

The Kenyon plant performs fabric finishing, drying, printing, and coating. The coating lines generate emissions of volatile organic compounds (VOC) and were the objects of the site visit. The facility has six coating lines. The plant operates 24 hours per day and 5 to 5.5 days per week.

The three oldest and smallest coating lines (Nos. 1, 2, and 3) are located side by side in one room of the plant. The larger lines (Nos. 4, 5, and 6) are located side by side in the main coating room. All the coating lines consist of floating knife coaters followed by infrared drying ovens. Line 3 has only one coater and drying oven. Lines 1, 2, and 6 each consist of two coaters and two drying ovens. Lines 4 and 5 each have four coaters and four drying ovens. On the lines with multiple coaters and ovens, the fabric web is alternately coated and dried as it passes sequentially through a coater, a drying oven, then to the next coater and drying oven, and so on until it has passed along the entire line. Because lines 4 and 5 are the largest and most complicated of the coating lines, these two lines were most closely observed. The balance of this report will concentrate on these two lines.

Kenyon is a commission coater, coating its customers' fabric to order. As a result, coating runs vary in length and tend to be rather short. Much of the production is for use in outdoor products such as tents, backpacks, and parachutes. These are specialty items for which aesthetics (color, finish, etc.) and performance are very important. Runs vary between about 3,000 and (rarely) 100,000 yards, with shorter runs predominating. Normally, the maximum duration of a run for a single order would be about one shift. Sometimes orders can be grouped for longer runs.

The fabrics that are coated are mainly synthetics such as nylon and polyester. The coatings are solvent-based polyurethanes that contain about 50 percent solvent by weight. The solvent blend used in the coatings is predominantly toluene with a small amount of isopropyl alcohol. Very small amounts of other solvents (e.g., methyl ethyl ketone) are sometimes used to adjust the drying rate. The typical line speed is 10 to 11 yards per minute. The maximum web width is 70 inches.

A schematic representative of lines 4 and 5 is presented in Figure 1. The continuous web is unwound at one end of the line and passes through an accumulator. As one roll of fabric nears its end, this device accumulates a length of web so that the end of the roll can be spliced to the beginning of the next roll without stopping the line. From the accumulator, the web passes under a low catwalk about 1 foot off the floor. This catwalk affords the operator access to the coater from the front. After the catwalk, the web is routed vertically upward and then horizontally through the first coater. These coating lines use floating knife coaters in which the fabric is held against the coating knives by the tension created in the web as it is pulled through the coater. From the coater, the web passes into the first drying oven near the top. Inside the oven, the coated web makes two horizontal drying passes. First forward near the top of the oven, then back toward the coater at the midlevel of the oven. After the second drying pass, the web is turned again and passes forward to the second coating station. On line 5, the final forward pass to the next coating station occurs within the drying oven near the bottom as illustrated in Figure 1, but no heating elements are positioned for drying during this pass. On line 4, the drying ovens have been modified so that the oven floor is elevated above the plant floor. The web exits the front end of the oven after the second drying pass and is then routed under the oven to the next coating station. The coating and drying process is repeated in series down the line until, upon exiting the final drying oven, the coated web is directed to a direct-fired propane curing oven located at ceiling level and then to the rewind station.

Coating is delivered to the web directly in front of the coating knife, either by pump from a 450-gallon "tote" or 55-gallon drum or manually poured from a pail. The coating is manually poured when the run is too short to justify pump cleanup time or when the coating is too thick to pump. The supply totes and drums are located in the aisle to the left of the line. (Throughout this report, left and right will refer to the side of the line as viewed from the unwind end.) The coating in a pail is replenished from a 55-gallon drum in the left aisle.

The forward motion of the web holds the bank of coating against the knife; adjustable barriers or "dams" contain the coating on the sides. The coating is periodically replenished as it is used. When the coating is pumped, the pump is adjusted to maintain a fairly constant quantity of coating at the knife to ensure that the coating is applied evenly.

Lines 4 and 5 have very different emission control systems. These systems are discussed individually below.

The four drying ovens on line 4 operate under a nitrogen atmosphere and are each controlled with an individual recirculating condenser.

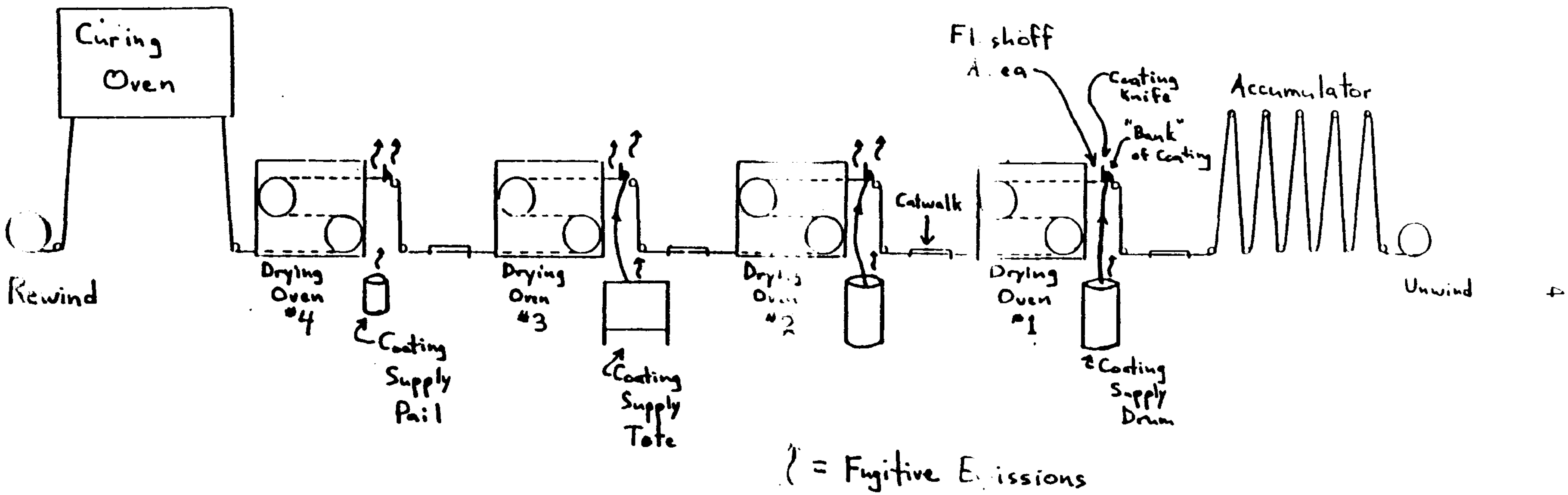


Figure 1. Schematic of coating lines 4 and 5.

schematic of one oven on line 4 supplied by Kenyon is presented in Attachment 1.

The ovens on this line have been extensively reworked to enhance the operation of the control system. The roll inside a drying oven that most frequently must be adjusted or replaced is typically located just inside the oven entrance slot. Gaining access to this roll in a typical inert atmosphere oven necessitates first purging the oven, resulting in a loss of solvent and nitrogen. On this coating line, each oven has been shortened on the front end so that this roll is outside the oven entrance. As mentioned earlier during the description of the coating process, the ovens on this line have been modified to elevate the oven floor above the floor of the room. These two changes to the ovens have reduced the size of these ovens and have lowered their nitrogen use and energy requirements.

The shortening of the ovens on the front end also has increased the length of the flashoff area (i.e., the area between the coater and the drying oven entrance) by an equivalent amount. To capture emissions from the flashoff area, a "vestibule" has been built between the coater and the oven. The vestibule is constructed of sheet metal and encloses approximately the same volume that was inside the drying oven before the oven was shortened. The coated web enters the vestibule about 1 foot after the coating knife through a slot about 5 inches high. The vestibule is under an air atmosphere and is vented to the outdoors at a rate of about 1,200 cubic feet per minute. The vestibule has side doors to allow access to the rolls. With this configuration, these rolls can be adjusted or changed without purging and entering the drying ovens. Like the vestibules, the curing oven at the end of the line is vented to the atmosphere.

The dedicated condensers on each drying oven have been modified by Kenyon to improve their performance. Also, these condensers each have a 2-gallon collection vessel into which the condensed liquid solvent runs. Each time the vessel is filled, the contents are decanted to the main recovered solvent storage tank, and a counter registers that this has occurred. Coupled with the accounting system used to track the liquid solvent content of the coatings used on each coating station, the recovered solvent counters allow the recovery efficiency of the condensation system to be calculated. Using this liquid/liquid material balance method, the solvent recovery system on line 4 has been shown to be about 85 percent efficient.

The VOC emissions from line 5 are controlled by a thermal incinerator. The four drying ovens operate under an air atmosphere and are the only equipment vented directly to the incinerator. A schematic of the system supplied by Kenyon is presented in Attachment 2. The curing oven is exhausted to the atmosphere. The total exhaust to the incinerator from the four drying ovens is about 6,000 cubic feet per minute. Makeup air for the ovens is drawn in from the coating room through the oven entrance and exit web slots and through air intake holes in the back wall of each oven facing the next coating station. A forced-air system supplies fresh makeup air to the room in the vicinity of this coating line.

On this line, each of the four flashoff areas is enclosed in a sheet metal box that is flush with the oven wall and extends beneath, to the sides, and above the flashoff area. The top of the flashoff area enclosure is hinged and counterweighted so that it can be lifted for visual and physical access to the back of the coating knife and the flash-off area. The front surface of this enclosure lid closes onto the top of the coating knife, leaving a slot about an inch high between the top of the knife and the lid. When the enclosure lid is closed, the makeup air drawn into the drying oven through the web entrance slot (which is within the enclosure) enters at a velocity of about 300 feet per minute as measured by Kenyon with a handheld velometer. This airflow is designed to capture any emissions from the bank of coating on the front of the coating knife; the emissions are carried into the drying oven with the makeup air. When the enclosure lid is open, the cross-sectional area of the opening into the enclosure is much larger, greatly reducing the inward airflow velocity; the inward airflow at such times is from the front, sides, and top. No test data are available on the capture efficiency of this system. The incinerator has been tested by the Rhode Island Department of Environmental Management at a destruction efficiency of 94.5 percent.

B. Observations Pertinent to the TTE Protocol

As mentioned in the previous subsection, line 4 is suitable for a liquid/liquid material balance system of tracking emission reduction efficiency. For this reason, this subsection will concentrate on line 5, where a capture efficiency determination might reasonably be expected to be conducted.

The affected facility to which air pollution regulations apply is each coating line. According to Mr. Nielsen, the curing oven is excluded from the affected facility because the solvent has been dried from the coated web before it enters the curing oven. The VOC emission limitation is 2.9 pounds of VOC per gallon of coating (less water). The plant complies on line 5 through the use of a thermal incinerator to destroy emissions. There are three primary types of emission points on the line: the coaters, the flashoff areas, and the drying ovens.

Line 5 has four coating stations. As discussed previously, at each station the coating is pumped or poured onto the web immediately in front of the coating knife. Emissions can occur at the coating knife and at the coating supply vessel, which may be partially open. Much of the VOC emitted at the coating knife is likely to be captured in the oven makeup air drawn into the flashoff area enclosure through the slot immediately above the coating knife. Emissions from coating supply vessels are fugitive emissions that are captured only to the extent that they are carried into the drying ovens with the ambient room air as oven makeup air.

The flashoff areas on line 5 are each contained in an enclosure as described in the previous subsection. Virtually all emissions in these areas would be expected to enter the drying ovens with the makeup air drawn in through the enclosures. An exception could occur during the brief periods that the operators open the enclosure lids.

The drying ovens are the primary emission points from the coating line. The openings in the ovens on line 5 are the entrance and exit web slots (each about 4 inches by 70 inches) and a row of seven 3-inch holes in the back wall of each oven. The side walls of the ovens also have a series of access doors, but these doors are typically kept closed during operation.

Emissions of VOC within the drying ovens are vented to the incinerator. As indicated in Attachment 2, the first three ovens are each exhausted at a rate of 1,200 cubic feet per minute, and the final oven is exhausted at a rate of 2,400 cubic feet per minute. These exhaust rates are sufficient to maintain an inward airflow velocity at the oven openings averaging in excess of 200 feet per minute. It is very unlikely that any fugitive emissions escape the drying ovens.

The primary sources of nonaffected emissions in the vicinity of line 5 are the other coating lines. The nearest coating line, line 4, is over 20 feet from line 5. Presumably, cleaning solvents are used to clean the coaters and pumps between runs, although this was not observed during the site visit. Also, the facility mix room is located at one end of the coating room; some fugitive emissions from the mix room are likely to enter the coating room through the open door between the rooms. Emissions from cleaning and mixing operations generally are not included in the affected emissions from a coating line.

The fugitive emission points of line 5 are illustrated in Figure 1, and the exhaust system is illustrated in Attachment 2. Not pictured in these illustrations is a forced makeup air system for the plant that brings in 60,000 cubic feet per minute from outdoors. This system provides makeup air for the entire plant in addition to the coating room. In fact, a strong airflow can be felt flowing out of the coating room toward the rest of the plant in the corridor connecting the coating room to the plant. One of the two supply ducts of this system extends down the left aisle of line 5 parallel to the line.

Sketches of the coating stations on line 5 from the side, front, and top are presented in Figures 2, 3, and 4, respectively. These figures may not be completely accurate in every detail but are close enough for realistic design of a TTE. Not pictured in the figures is a water sprinkler system that extends throughout the coating room just below the level of the ceiling trusses. A series of photographs taken at the plant is presented in Attachment 3.

The coating line has an operator for each coating station. These operators need routine access to the coaters and flashoff areas during coating. Coating occasionally must be added, frequently by manually

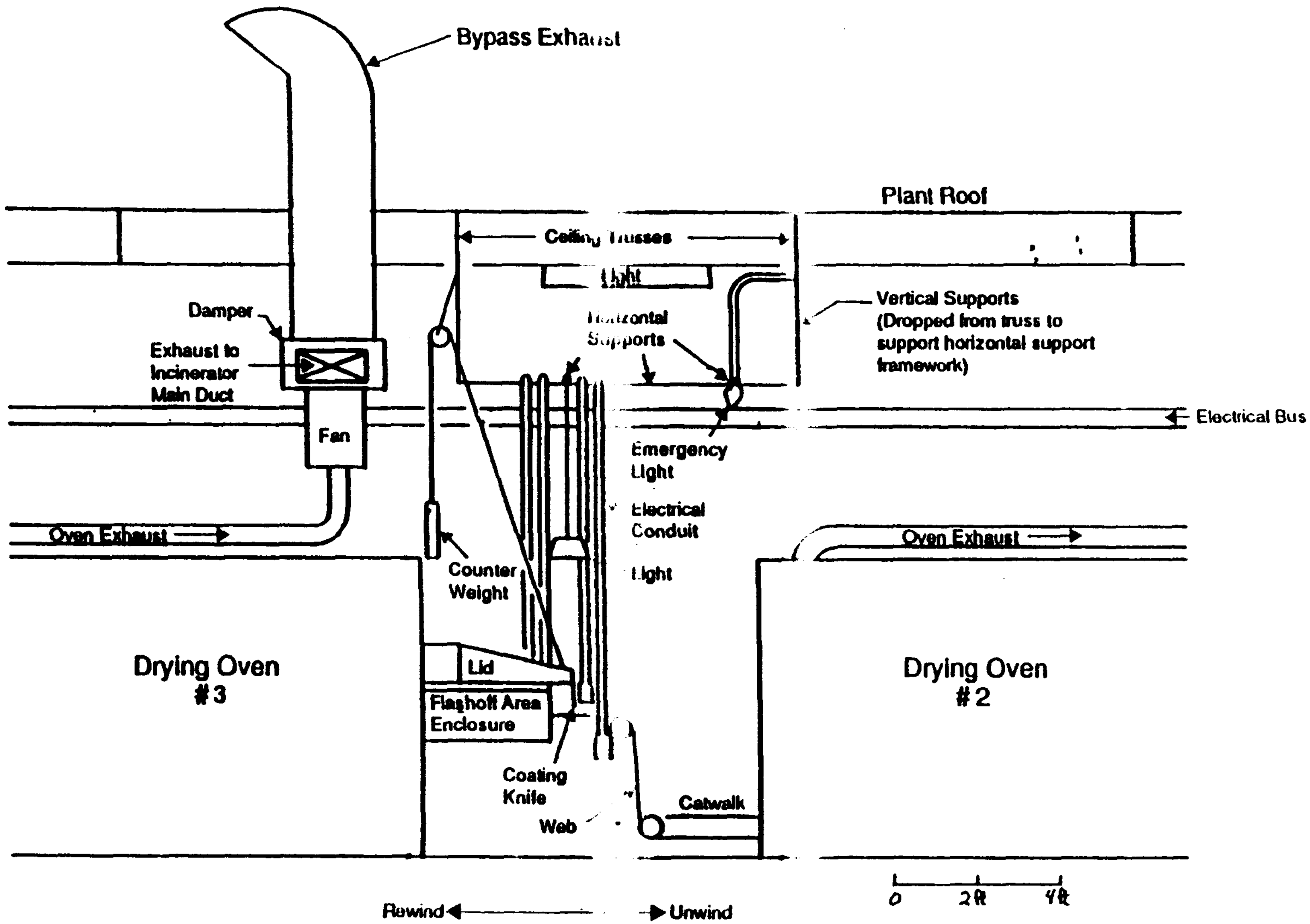


Figure 2. Side view of third coating station (typical of all coating stations).

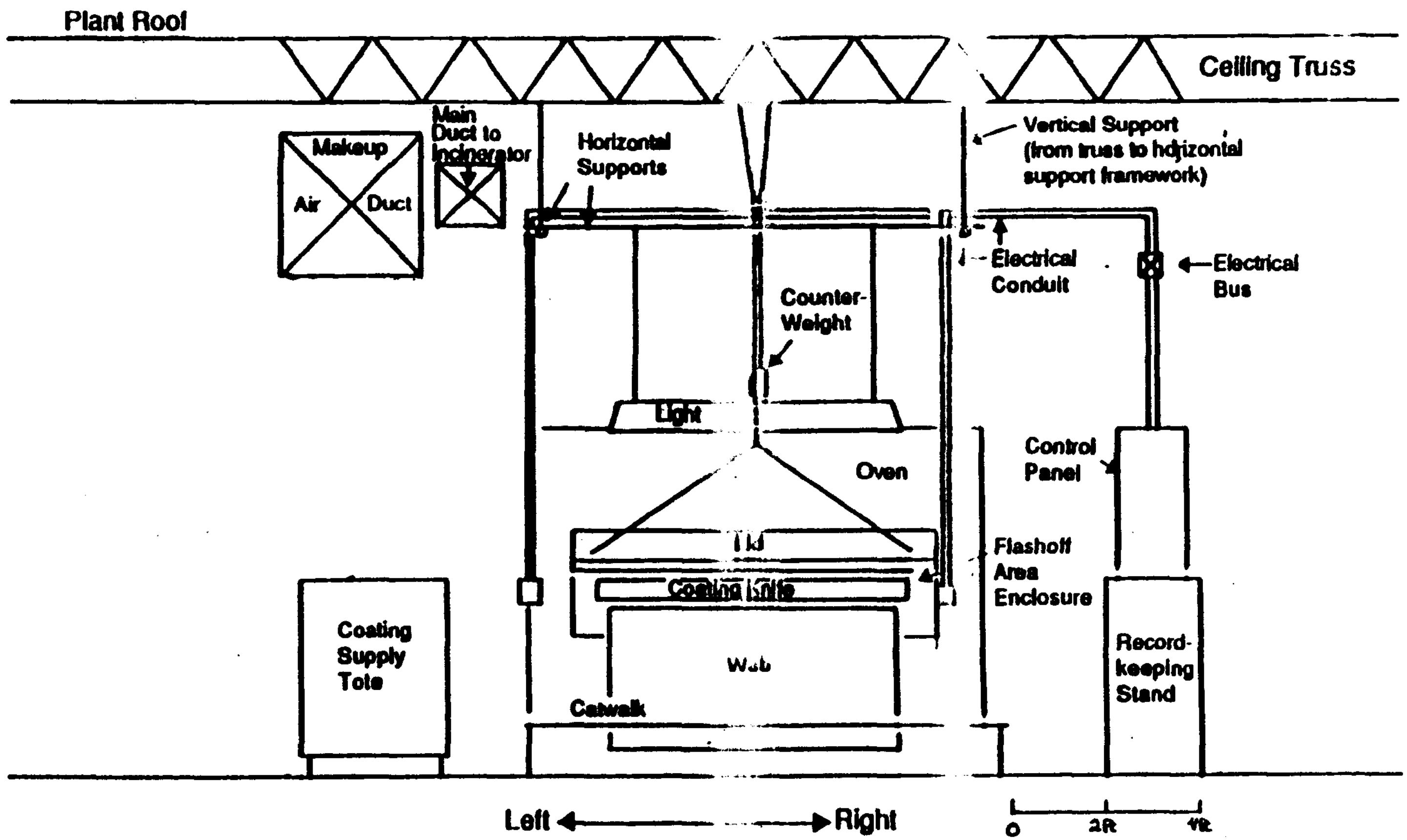


Figure 3. Front view of first coating station enclosure (generally typical of all stations).

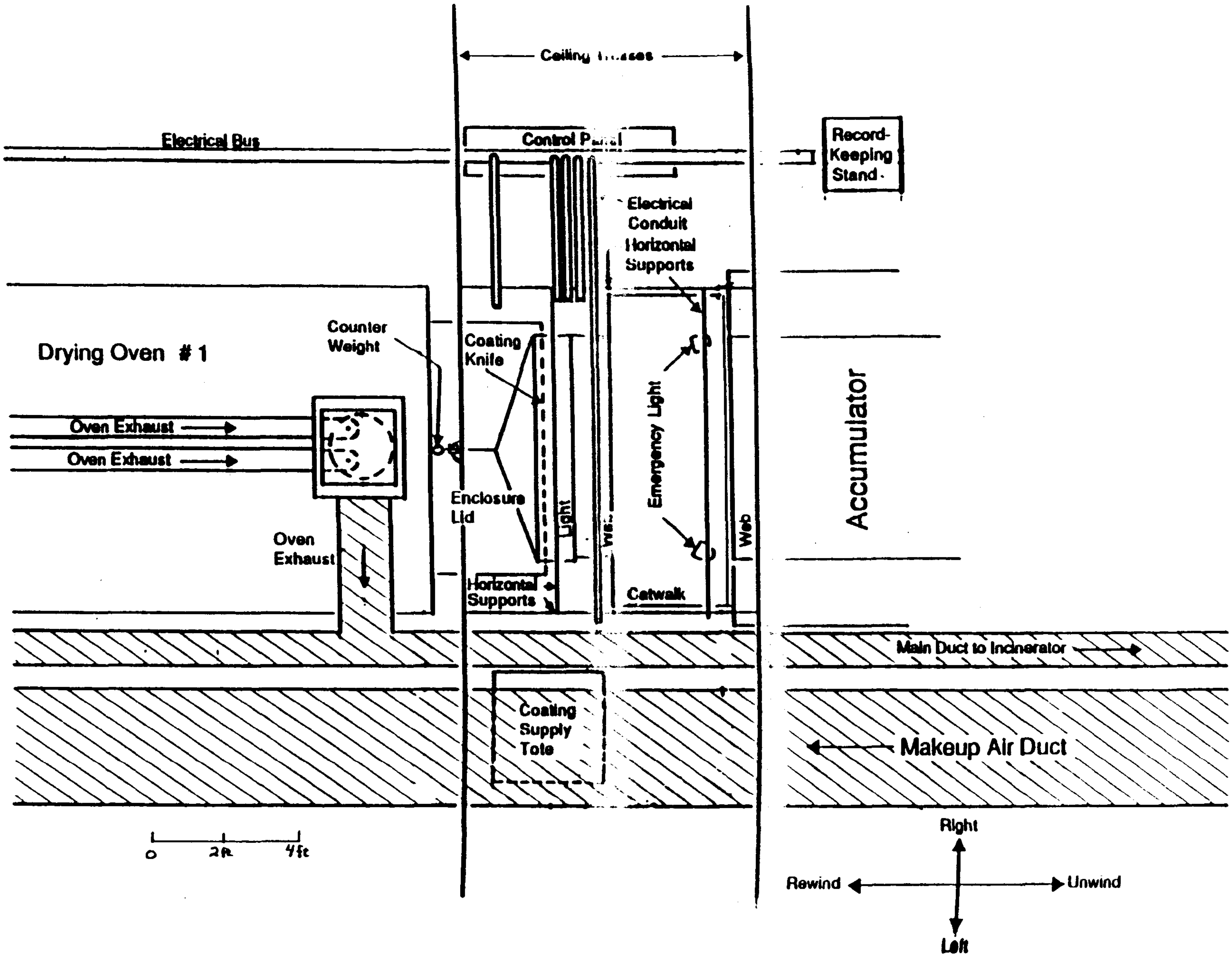


Figure 4. Top view of first coating statl (generally ypical of all stations).

pouring it from a pail, and the dams must sometimes be adjusted to adjust the coating width. The back side of the coating knife must be cleaned of dried coating occasionally to avoid streaks in the coating surface, and the flashoff area must be observed after the dams are adjusted to check the actual coating width downstream from the knife. From time to time during a coating run, a sample of the product is taken to test the coating solids application rate. Based on the results, the coating knives and tension rollers may have to be adjusted during the run.

"Bow rolls" are located at various points along the lines. The bow rolls are used to vary the tension on the web from the edges to the center, which compensates for variations in the web caused by the weaving machines. This compensation is necessary to assure uniform coating and to keep the web from "walking" from side to side on the rollers as it passes along the line. Some bow rolls are located in the ovens; consequently, the ovens must be opened to adjust or replace these rolls.

In the event of a web break during a run, access is needed throughout the coating operation for cleanup and rethreading the web. Between runs, access is needed to the coaters for cleanup. When starting a run, the final adjustments to the coater and rollers are typically made during the first 15 minutes that the line is running and the coating is being delivered to the coaters. For very thin fabrics to which relatively heavy coats are to be applied, this adjustment phase of the run may take up to an hour. Access to the coaters and rollers is required throughout this adjustment period.

Access also is needed from time to time at the unwind and rewind sections of the line. As the roll of fabric on the unwind equipment is nearing its end, the accumulator must be activated to "store" a length of fabric. When the roll is exhausted, the beginning of a new roll is spliced to the end of the old with a portable sewing machine while the process continues to operate. At the rewind end of the line, a full roll of coated fabric must be removed occasionally to be replaced by an empty roll.

The personnel access and traffic patterns do not appear to present any major problems for construction of a large TTE around line 5 or for construction of small TTE's around each coating station. The aisles on either side of the coating line have ample room to accommodate TTE walls while allowing normal traffic. Because access to the coaters is routinely required, the operators would generally remain within the TTE during testing, and access to the equipment would not be hindered. Doors would be provided to allow operators to pass out of the TTE as necessary to attend to unwind and rewind equipment. Even so, it is not expected that these doors would be opened frequently or for more than the time necessary to pass through.

The material flow within the process was discussed earlier in the subsection on process information. There are limited material flows to and from the process. Coating supply totes or drums are brought to the line one at a time as needed. Totes are transported with a fork lift;

drums are moved with a hand truck. The rolls of fabric to be coated are stored on a "stillage," or long, low rack, parallel to the line in the right aisle. As they are needed, the rolls are placed onto a rolling cart with a power hoist and rolled into place at the head of the line. The coated rolls of fabric are handled with a rolling cart or a fork lift when they are removed from the end of the line.

The flow of materials in the plant does not appear to present major problems for TTE construction and use. Depending on placement of the TTE (or TTE's), doors may have to be opened occasionally to accommodate flows to and from the line, but such occurrences should be brief and infrequent. Material flows on adjacent lines will not impact the use of a TTE.

The plant is required to meet OSHA standards regarding exposure of personnel to solvent vapors; these standards would have to be met within the TTE. The identities and approximate quantities of the solvents released into the TTE (i.e., the fugitive emissions) can be used to determine the TTE exhaust rate necessary to ensure that the atmosphere within the enclosure meets OSHA standards.

The plant is required to meet Factory Mutual fire safety requirements. As discussed above, the facility has a plantwide sprinkler system. If these sprinklers were outside the TTE, fire extinguishers would have to be placed inside. The plant currently has fire extinguishers deployed in the right aisle by each coating station. In addition, the drying ovens on line 5 are equipped with automatic carbon dioxide fire-suppression systems. Finally, all electrical equipment (e.g., lighting and control boxes) is required to be explosion proof, as are the fork lifts used to transport coating supply totes. Any equipment associated with the TTE also would have to meet this requirement.

Hearing protection is not required in the plant; it is not expected that the presence of the TTE would appreciably affect noise levels. Heat buildup is not expected to be a problem. The plant uses infrared heating elements, and very little heat escapes the drying ovens.

For purposes of testing, no nonaffected emission points are in such close proximity to the coating line that they must be included in the TTE. Nonaffected emissions from the other coating lines in the room and from the mix room could enter the enclosure in the makeup air drawn in through the natural draft openings (NDO's). To minimize the quantity of VOC entering through the NDO's, the NDO's should be located along the right side of line 5, away from the other coating lines.

Two gas streams would have to be tested to determine capture efficiency. The "captured emissions" would be measured in the common exhaust from the drying ovens to the incinerator. The "fugitive emissions" would be measured in a duct set up for that purpose. If the coating stations were individually enclosed, a common exhaust duct and fan would be provided to limit the measurement of fugitives to a single duct. The captured and fugitive emission measurements would have to be made simultaneously.

The ducts involved appear to afford suitable measurement points for VOC concentration and volumetric flow rate. The fugitives exhaust duct installed for the test would, of course, be constructed to be testable. The existing drying oven exhaust duct to the incinerator is a square duct approximately 2.5 feet by 2.5 feet that contains a straight run of about 20 feet. This section of duct was used for the destruction efficiency test performed on the incinerator, and measurement ports are present.

Other gas streams would also be tested or monitored. The VOC concentration within the TTE must be monitored to ensure that steady-state conditions are reached and that OSHA standards are not exceeded. The ambient VOC concentration outside the NDO's also might be monitored to determine the significance of VOC entering through these openings. Each dryer exhaust has a bypass to the atmosphere for use with water-based coatings, although Kenyon has not found any water-based coatings suitable for their purposes. Prior to testing, the absence of flow through the bypass stacks should be verified. Finally, the forced makeup air system must be accounted for in some way because some outlets are very likely to be within the TTE. Face velocity measurements across any included openings could be made during the test, but a more likely course would be to seal off these openings for the duration of the test period.

There is no indication that any compounds are present in the gas streams that would interfere with any EPA Methods for measuring VOC. Thus, any suitable EPA Method could be used. No other complicating conditions are known to exist.

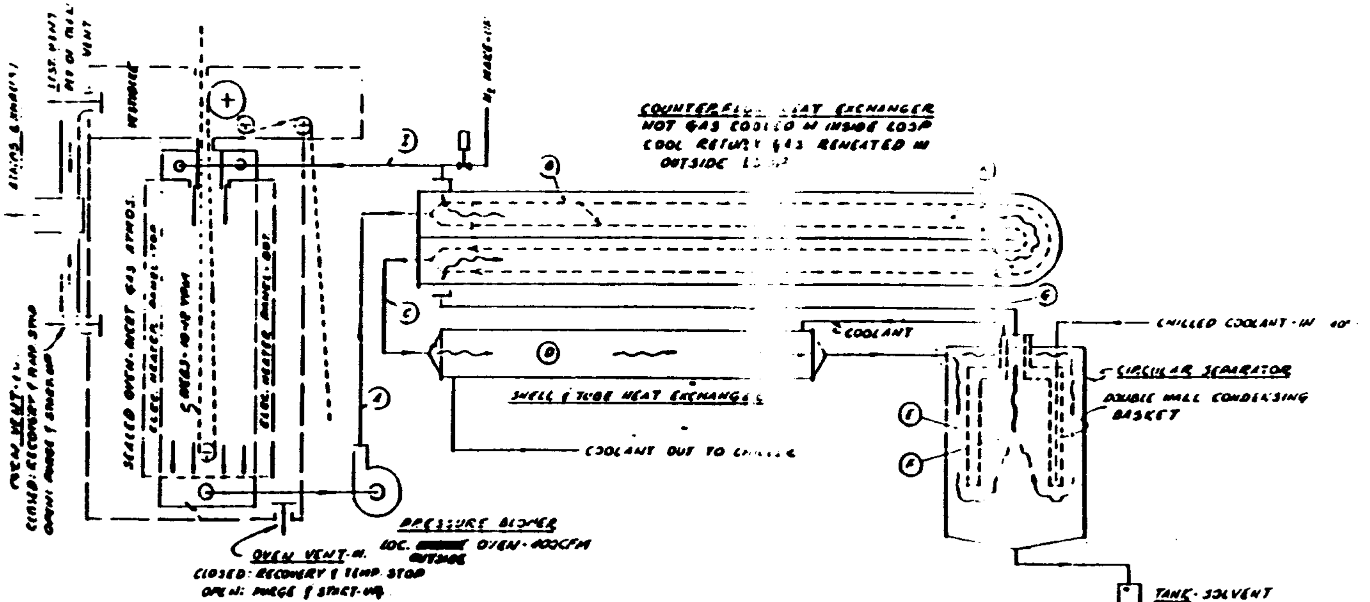
V. Conclusions

It appears that a TTE can be built at this facility. Midwest Research Institute has proceeded with preparation of a detailed cost and feasibility analysis for the individual coating station enclosures on line 5.

3 Attachments

b2605-2/ESD

Attachment 1



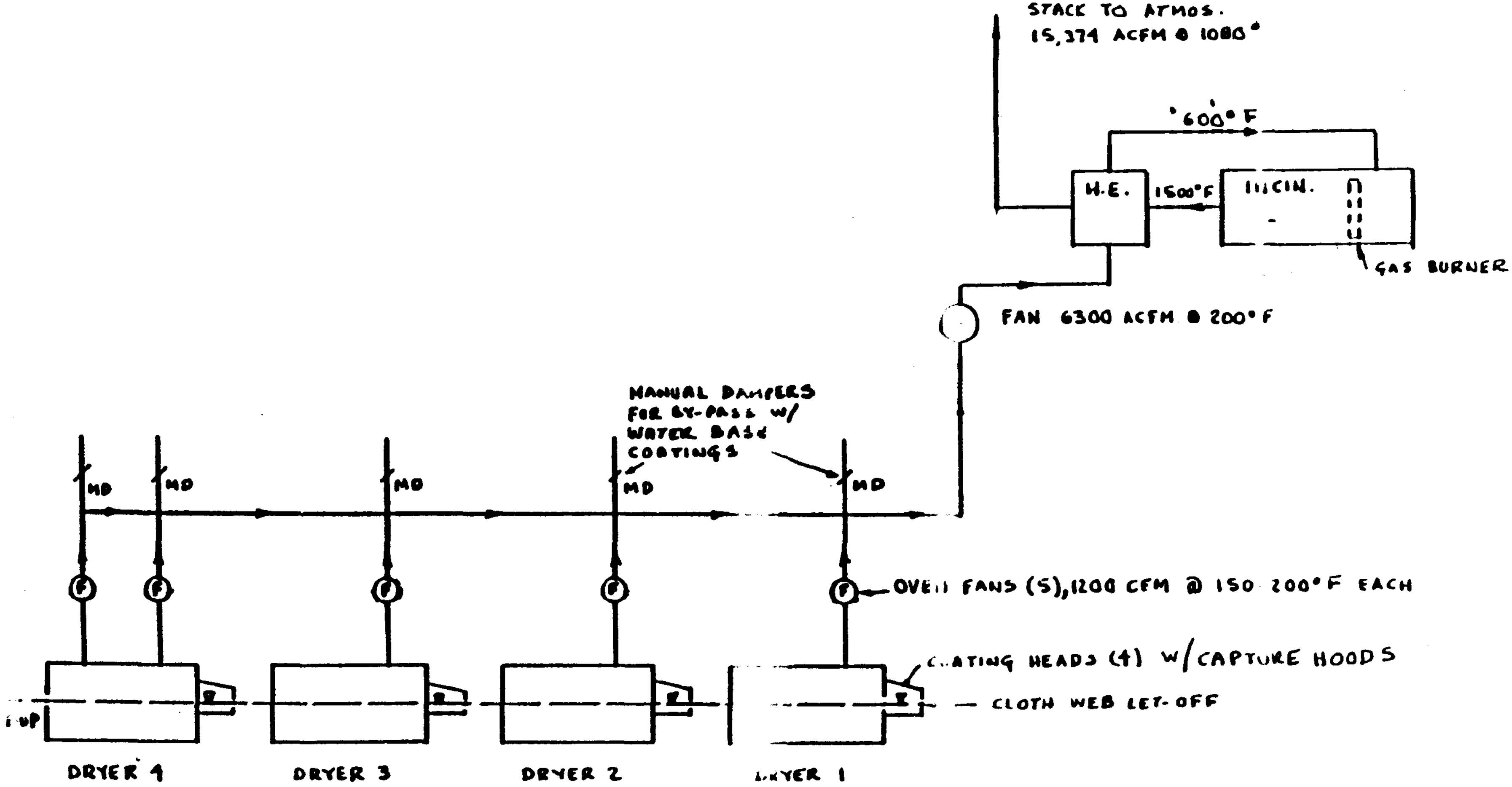
GAS VELOCITY & TEMPERATURE

SYM	SIZE	AREA-FT²	VEL.-FPM	°F-IN	°F-OUT
A	4" PIPE	.1026	3906	200	-
B	(2) 4" PIPES	.205	1953	200	140
C	4" PIPE	.1026	3906	140	-
D	510 - 1/4" DIA TUBES	.239	1646	140	65
E	32" DIA - 26 1/2" DIA.	3.26	123.5	65	50
F	24" DIA	3.14	127.5	50	-
G	4" PIPE	.1026	3906	50	-
H	10" x 10"	.105	19?8	50	100
I	4" PIPE	.1026	3906	100	-

Kenyon Piece Dyeworks Inc.

Schematic for Single Oven Installation on #4 Tk Range with 2 Ovens - Each Oven with Similar Recovery System

Attachment 2



NO. 5 K-KOTE RANGE

PROCESS SCHEMATIC

KENYON INDUSTRIES, INC.

KENYON, R.I. 028 36

Attachment 3

PHOTO LOG
KENYON INDUSTRIES, INC.

Note: "Left" and "right" refer to the side of the coating line as viewed from the unwind end looking in the direction of process flow to the rewind end.

A Aisle to the left of Line 5 (Line 4 for far left).

B Aisle immediately to the right of Line 5.

C View of electrical bus and conduit over the aisle immediately to the right of Line 4--representative of Line 5 also.

D Aisle farther to the right of Line 5.

E Line 5--Coating Station No. 1 from the left aisle. The final portion of the accumulator is to the right of the picture.

F Line 5--supports above Coating Station No. 1 from the left aisle.

G Line 5--Coating Station No. 3 from the left aisle.

H Line 5--Coating Station No. 3 from the right aisle.

I Line 5--supports above Coating Station No. 3 from the right aisle. The drying oven exhaust is in the background.

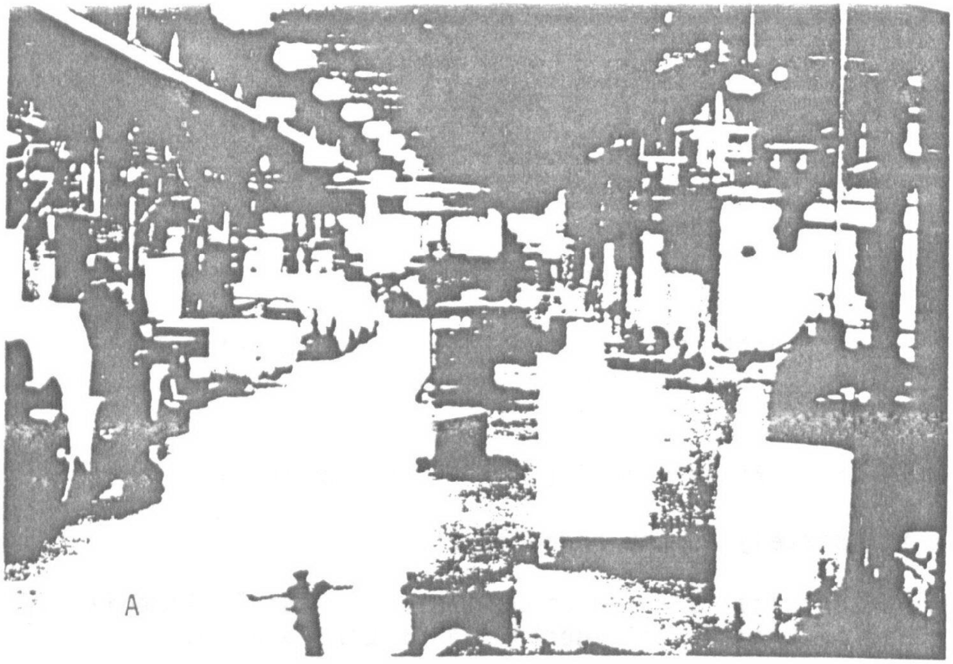
J Line 5--exit from the final drying oven. The bottom of the elevated curing oven is at the top of the picture.

K Line 5--view from the rewind end along the "left" aisle. (Line 5 is to the left of the picture).

L Duct from Line 5 to the incinerator.

M Bypass exhaust (24 in. x 25 in.) from one drying oven on Line 5.

N Rolling ladder available for access to elevated structures.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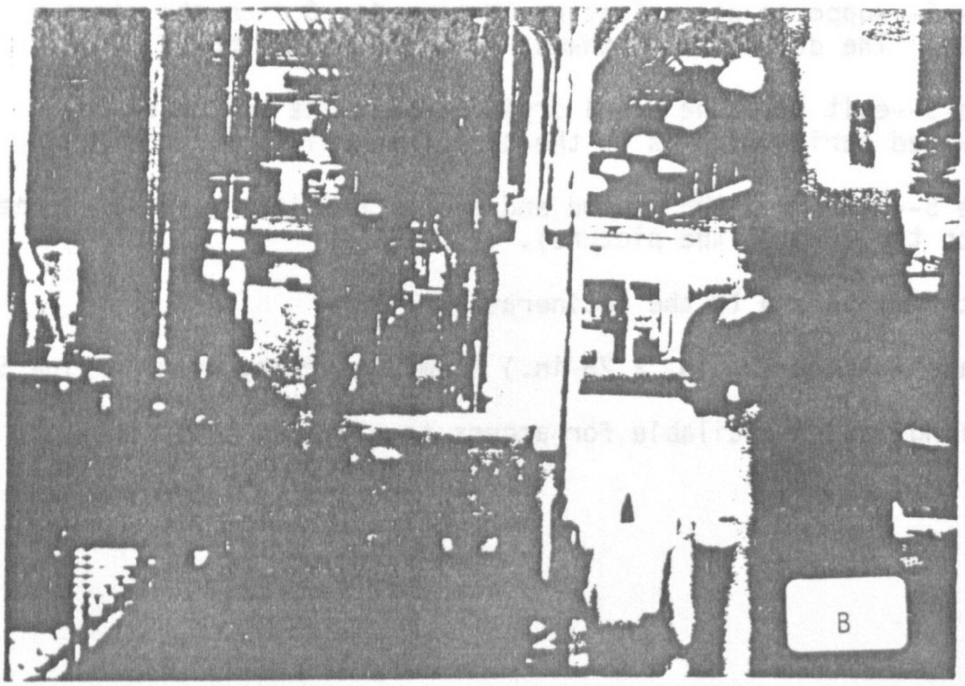
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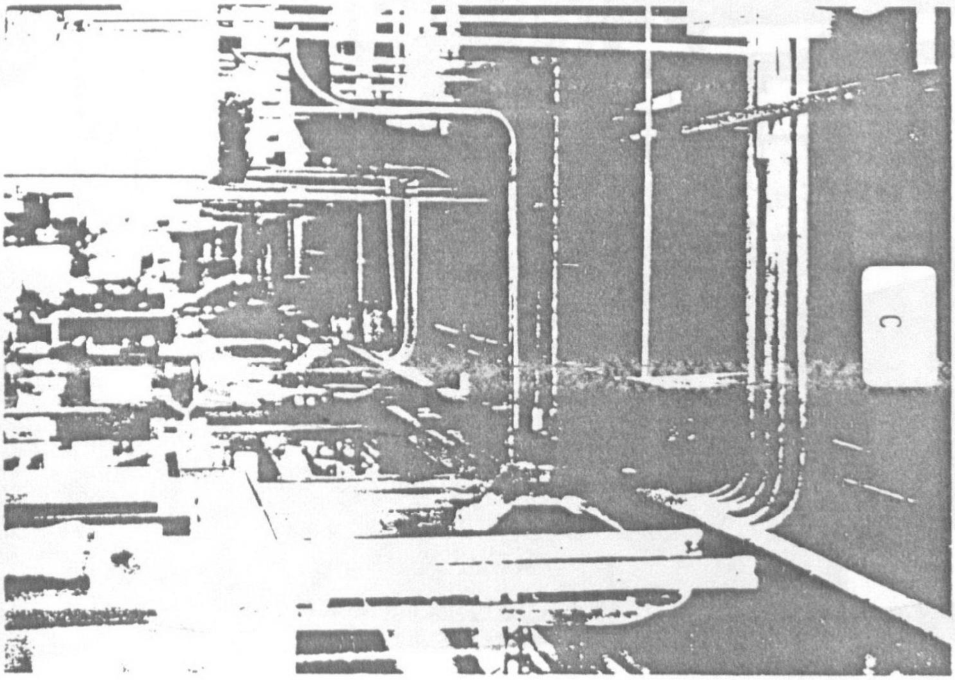
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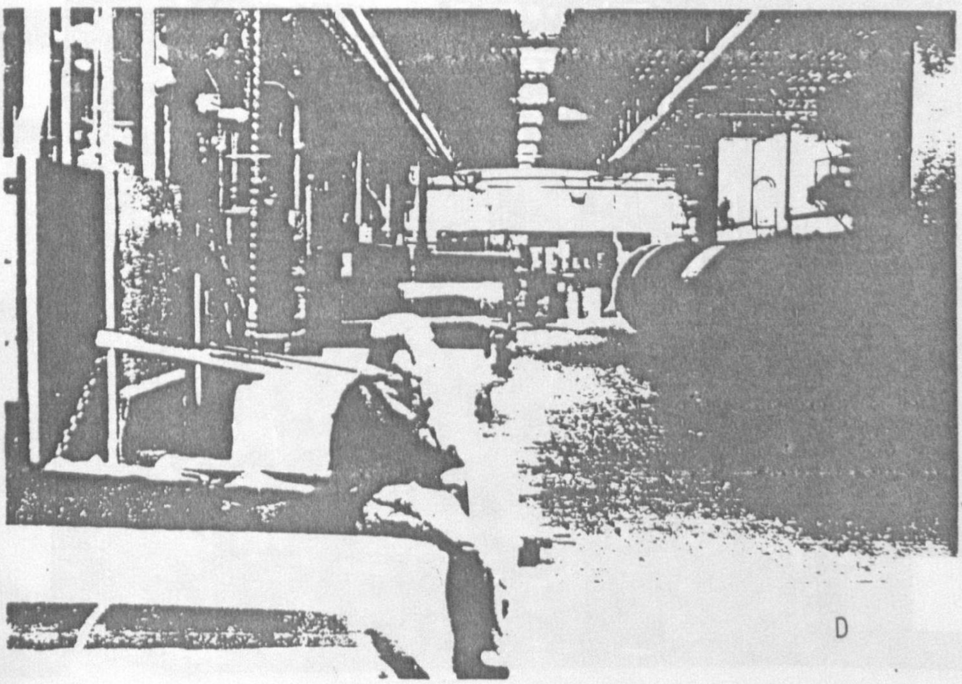
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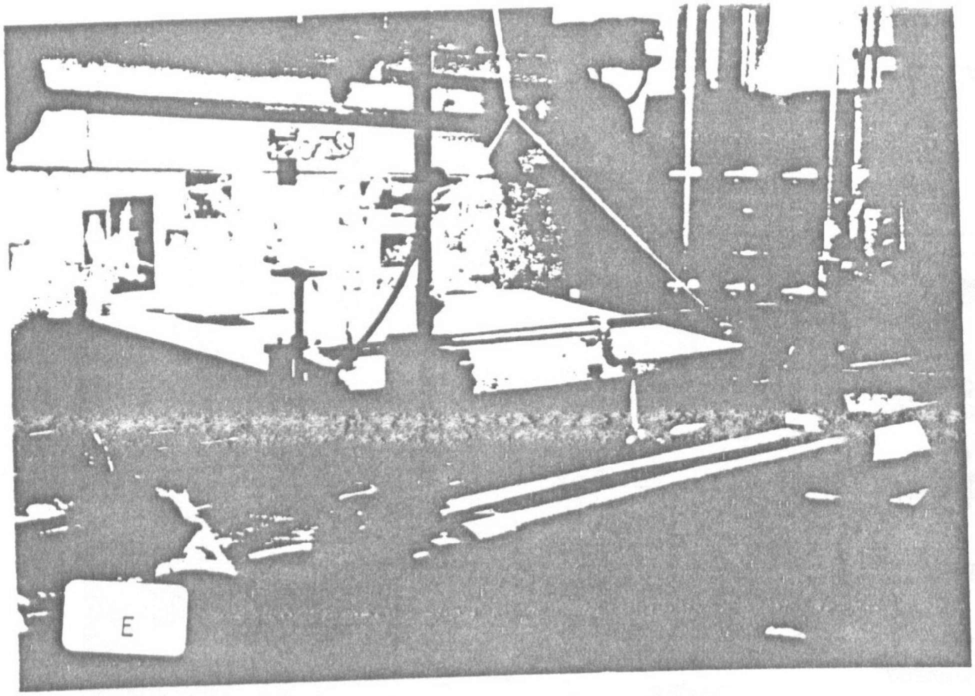
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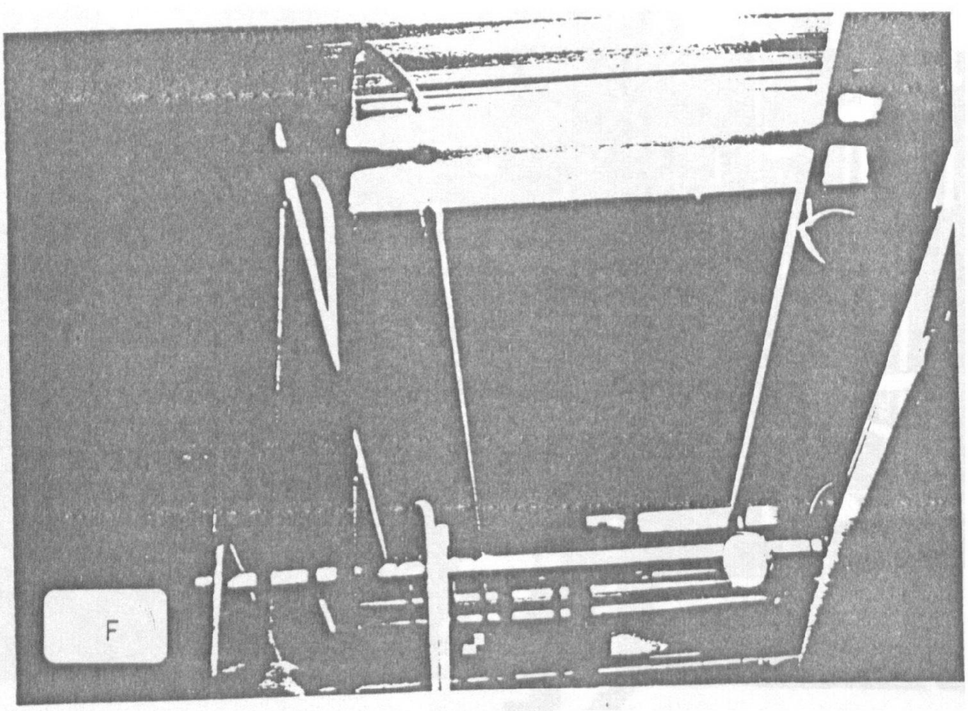
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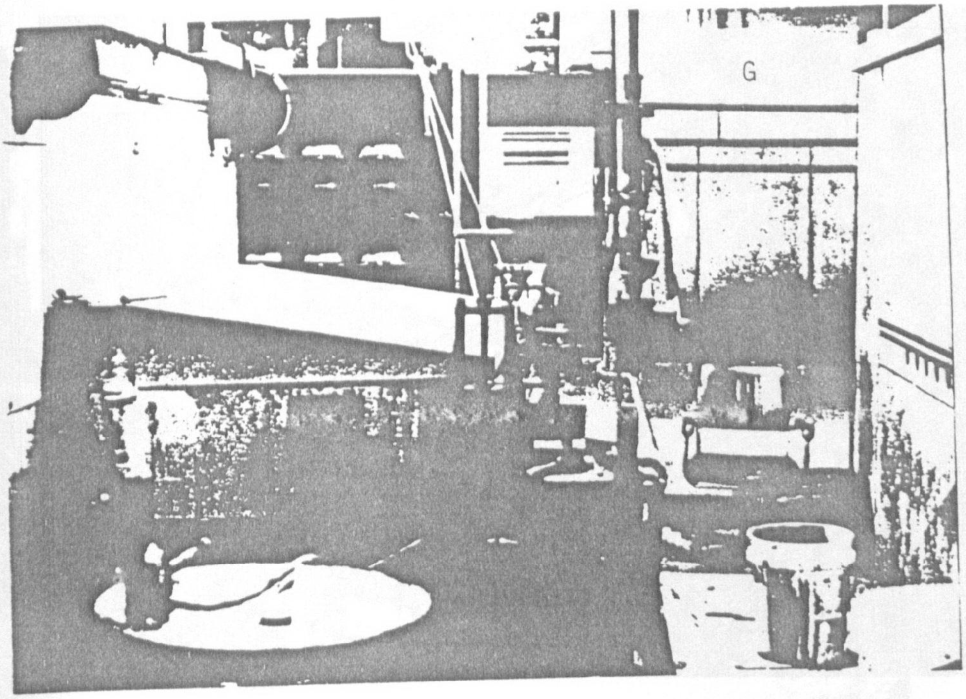
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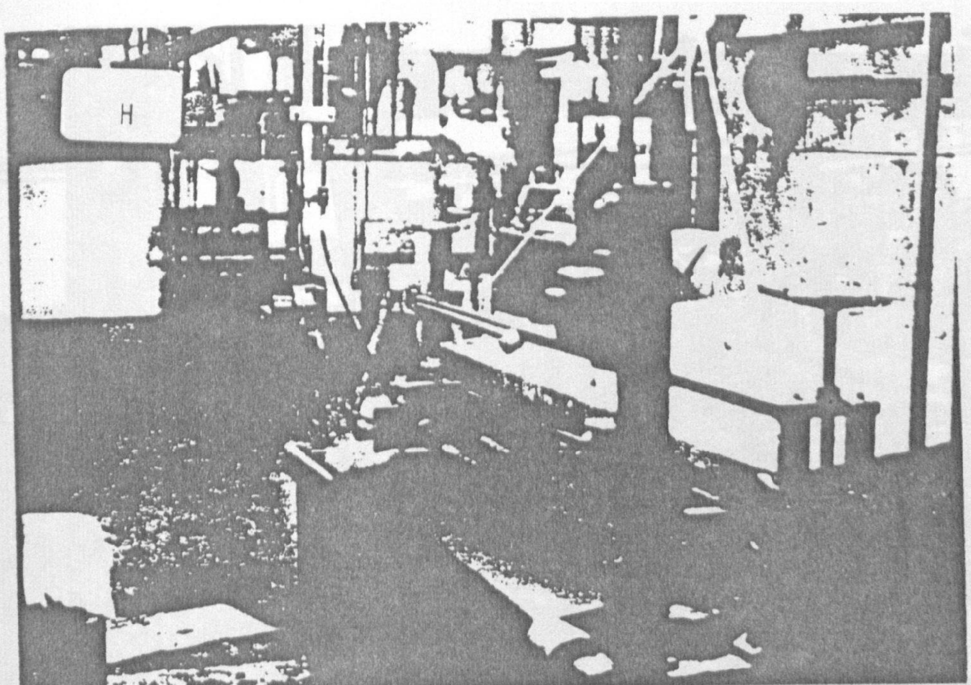
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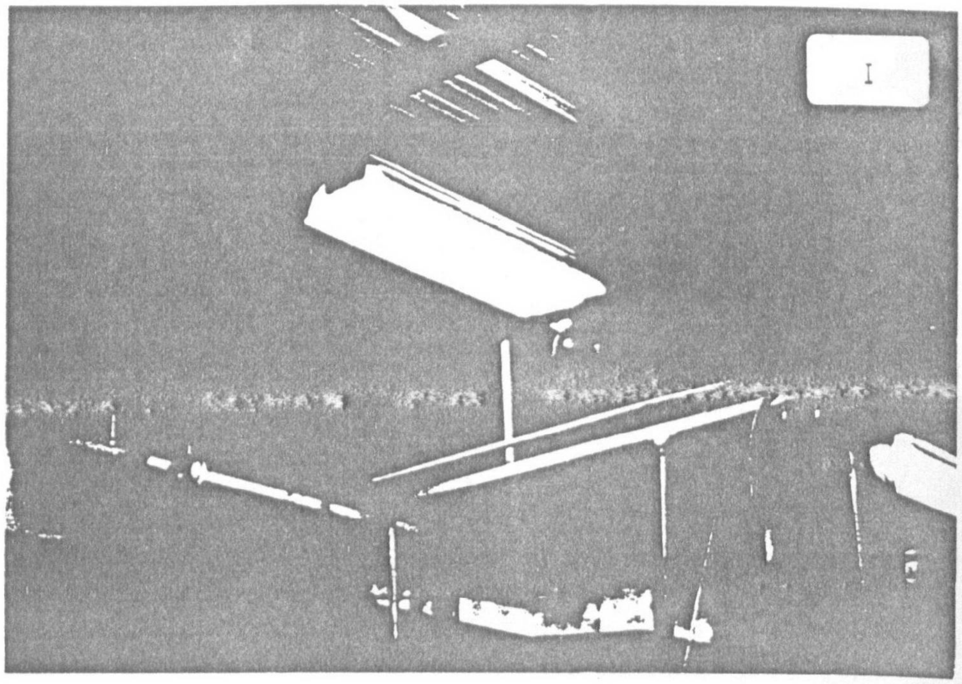
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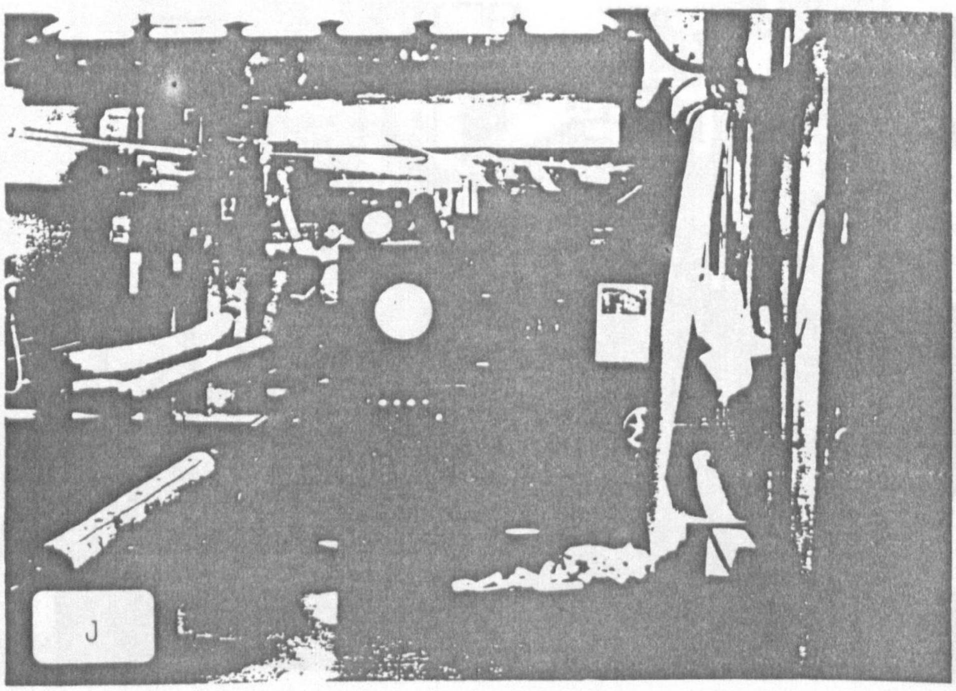
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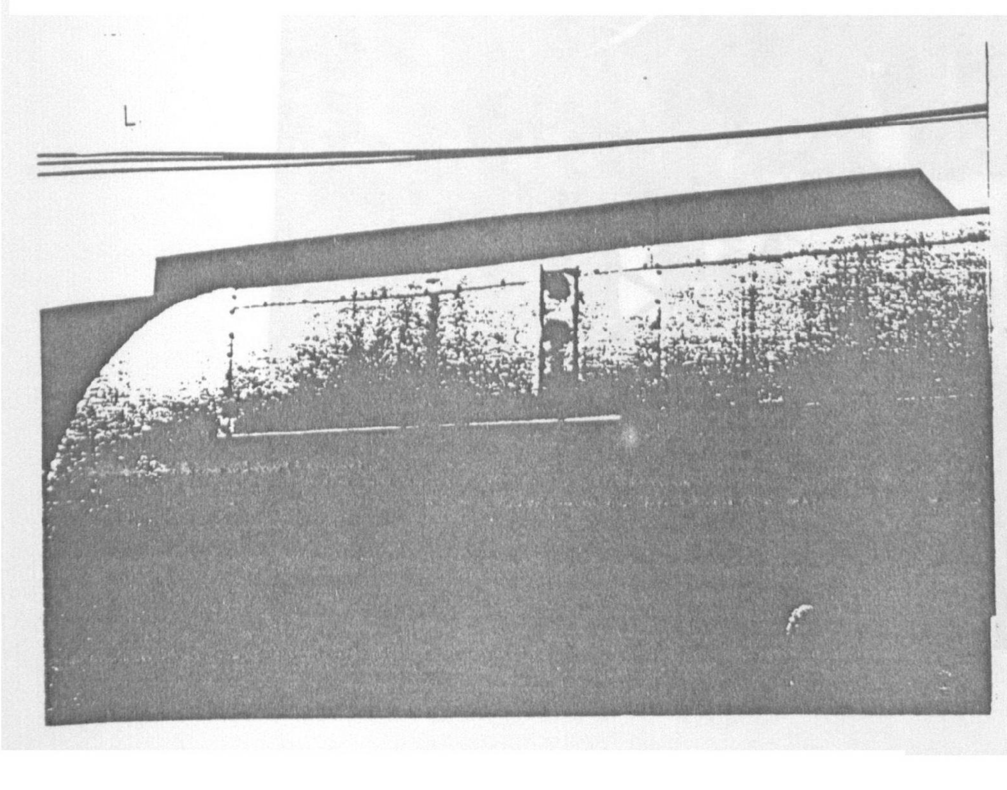
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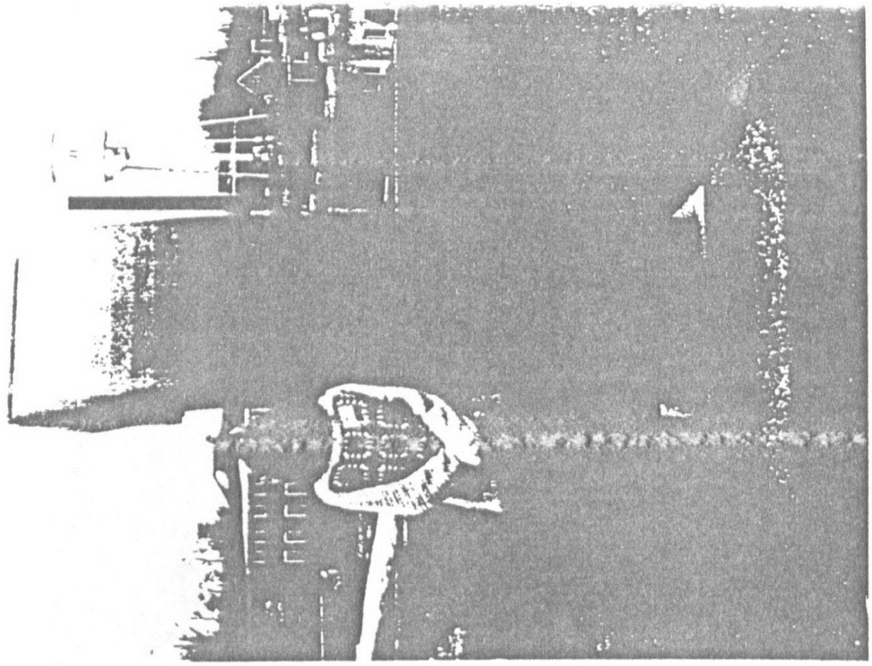

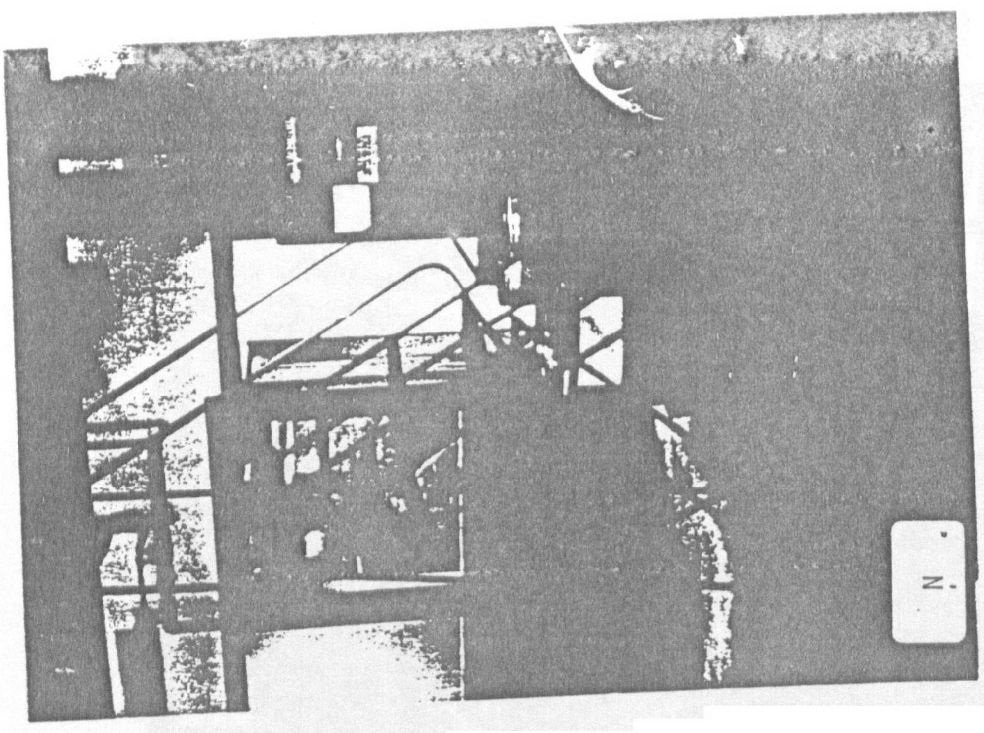

ATLANTA FILM CONVERTING COMPANY

MRI

MIDWEST RESEARCH INSTIT
Suit
401 Harrison Oaks Bou
Cary, North Carolina
Telephone (919) 677
FAX (919) 677

Date: February 17, 1989

Subject: Site Visit--Atlanta Film Converting Company, Inc., Atlanta, Georgia
Capture Efficiency
EPA Contract No. 68-02-4379, Work Assignment 16
ESD Project No. 87/07
MRI Project No. 8951-16

From: Stephen W. Edgerton SE

Karen Catlett
EPA/CPB/CAS (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

Purpose

The purpose of the visit was to investigate the feasibility of constructing a temporary total enclosure around a printing line suitable for conducting a capture efficiency test by the draft gas/gas procedure.

II. Place and Date

Atlanta Film Converting Company, Inc.

1132 Pryor Street, S.W.
Atlanta, Georgia 30315
September 13, 1988

III. Attendees

Atlanta Film Converting Company, Inc. (AFCO)

Jerry Mitchell, President
John Thompson, Executive Vice President

Flexible Packaging Association (FPA)

Marjina Kaplan, Director of Marketing and Communications
Edward Weary, Director of Technology

U. S. Environmental Protection Agency (EPA)

James Berry, EPA/CPB
Karen Catlett, EPA/CPB

Midwest Research Institute (MRI)

Stephen Edgerton

IV. Discussion

The visit began with a meeting among the attendees. The meeting was followed by a tour of the facility. A short meeting was held after the facility tour. The discussion that follows summarizes the information gained from the meetings and tour.

A. Facility Description

This facility manufactures flexible packaging. It is a service-oriented operation that competes with larger companies by providing quick turnaround on orders and a higher level of service than larger companies. The facility operates two six-color flexographic presses and one laminator. The flexographic presses were the focus of the visit and are described below. The volatile organic compound (VOC) emissions and controls are discussed in the section following the flexographic presses process description.

1. Flexographic presses. The two six-color flexographic presses were manufactured in the 1960's. One is a "stack" press; the other is a "central impression" (CI) press. The printing process is similar in both presses in that a continuous plastic film is fed through a sequence of six printing stations with dryers between. A schematic of a typical CI press is presented in Figure 1.

On both presses, the web is unwound, passes upward and then horizontally over the central bay, and enters the first printing station. The web then passes sequentially through the printing stations and intervening "between-color dryers," alternately being printed upon and then exposed to a between-color dryer. At each succeeding printing station, a new ink color is applied over the earlier coats until the final image is produced. For the final product to be acceptable, each color must be laid down in exactly the correct position relative to the preceding ones. This positioning process is termed "keeping register."

After the web leaves the final printing station, it passes horizontally through the "overhead dryer" located above the path traveled by the unprinted web over the bay. The dried web then travels downward to the rewind station.

Solvent-based inks are pumped to the printing stations from 5-gallon buckets. The ink is delivered to one end of a narrow trough or "fountain" that extends across the width of the web. At the other end of the

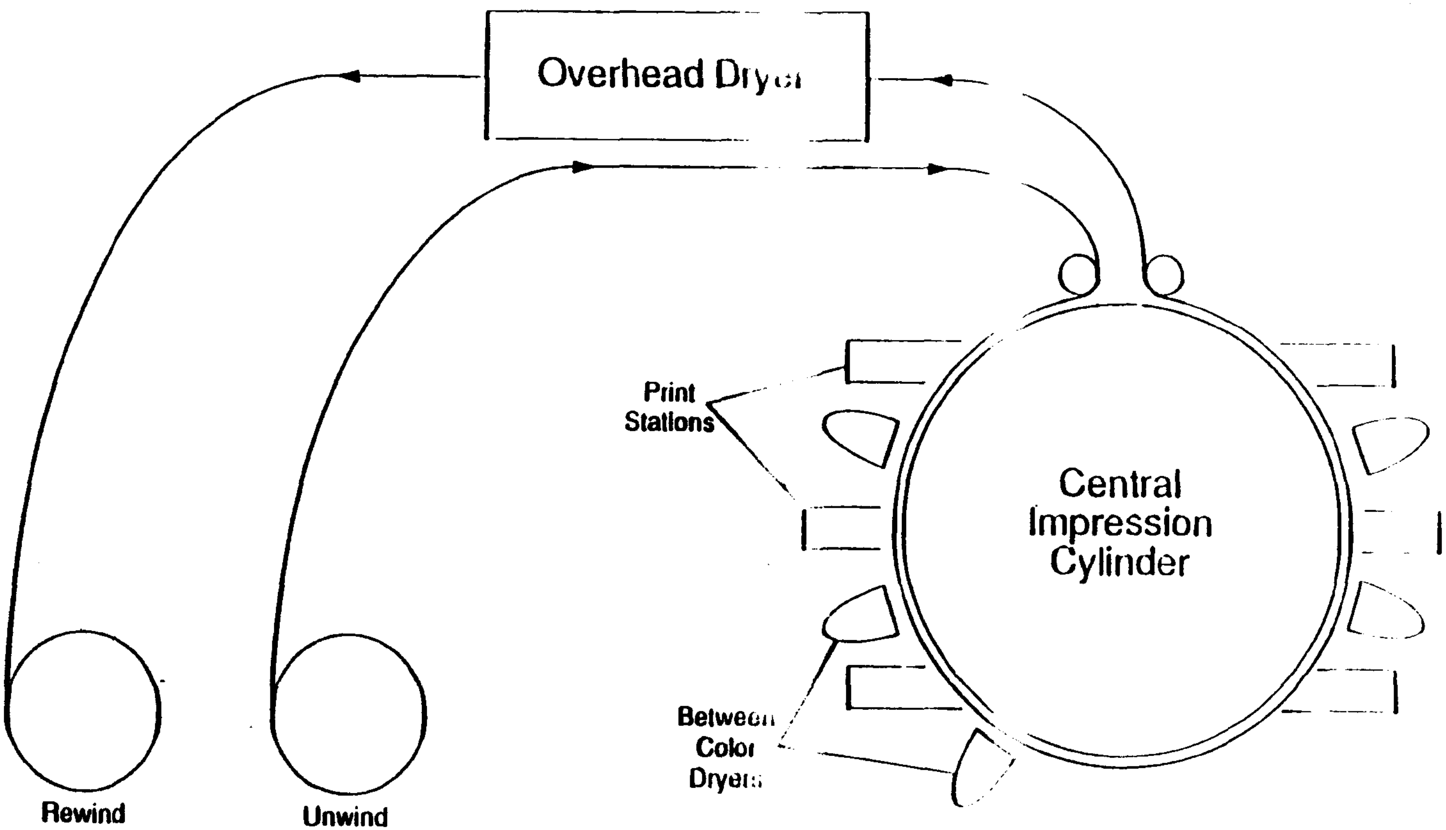

Figure 1. Schematic of a six-color, central impression flexographic press.

fountain, ink is drained back into the supply bucket. Thus, the ink is continually circulated through the fountain.

A "metering roller" is partially submerged in the fountain. This roller conveys the appropriate amount of ink to the "anilox roller," which then passes the ink to the "plate cylinder." This cylinder rolls the ink onto the web as it passes through the printing station. During the application of the ink, the web is supported from the back by the "impression cylinder."

The chief difference between the presses at this facility is in the impression cylinders. The stack press has a small impression cylinder for each printing station. In the CI press, these individual impression cylinders are replaced by a single large central impression cylinder around which the printing stations are arrayed.

In the stack press, the web enters the first printing station at a height of about 8 feet and passes vertically downward through the first three printing stations. After the direction is reversed on a roller near floor level, the web passes vertically upward through the final three printing stations and into the overhead dryer.

The stack press at this facility is of obsolete design. It was designed for use with a cellophane web, but today's plastic films are much thinner. These thinner webs vibrate as they pass through the printing stations, resulting in a lower-quality product. In addition, this press cannot keep register at line speeds in excess of about 225 feet per minute. To be truly competitive in the flexible packaging business, line speeds of about twice that are required. In spite of the drawbacks with the stack press, the facility is able to find a market for some products that can be produced on the press. The stack press is operated one shift per day.

In the CI press, the web is supported in back by the large central impression cylinder at all times. The web enters the first printing station near the top of the central cylinder at a height of about 8 feet and passes around the cylinder, first down the surface facing the central bay, then up the far surface and into the overhead dryer.

The bulk of the facility's production is produced on the CI press, which operates 24 hours per day. The line speed was about 250 feet per minute during the visit, but this press is capable of competitive line speeds of 350 to 400 feet per minute. This press typically processes about three runs per day, but it is not unusual to have as many as eight runs in a day.

Current plans call for a new CI press to be purchased to replace the stack press within the next 3 months. The new press will have much greater production capacity than the existing presses, and most of the production will be shifted to the new press.

2. <u>Volatile organic compound emissions and controls</u>. This facility presently operates no add-on control devices to reduce VOC emissions to the atmosphere; the exhausts from the dryers are vented to the atmosphere. Until recently, the facility was not required to reduce emissions because annual uncontrolled emissions were below the State's regulatory cutoff of 100 tons. However, persistent nonattainment of the national ambient air quality standard for ozone in the Atlanta area has led the Georgia enforcement agency to lower the cutoff to 25 tons per year, bringing AFCO under the regulations.

In order to comply, the company intends to vent the dryer effluent from the new CI press discussed above to an incinerator. The existing CI press will be either converted to water-based inks or also will be vented to the incinerator. The facility would not be able to comply using only the existing presses because these presses do not achieve adequate capture efficiency. The "captured" VOC's are those contained in the effluent from the overhead dryer and between-color dryers. A consultant has indicated to AFCO that the stack press captures 30 to 35 percent of the solvent load and that the existing CI press captures 40 to 45 percent. The new CI press is expected to achieve a capture efficiency of 60 to 65 percent.

All the dryers at this facility are direct-fired natural gas units. The makeup air for the overhead dryer on the CI press is drawn from outside the building. The makeup air for the overhead dryer on the stack press and for the between-color dryers on both presses is drawn from within the room housing the presses.

None of the exhaust from the existing dryers is recirculated. Much of AFCO's production is food packaging, so the customers specify very low levels of retained solvent. Recirculation of dryer exhaust makes it more difficult to achieve these low levels of retained solvent. Nevertheless, the new press is designated to meet customer specifications while recirculating 50 percent of the exhaust air.

Each overhead dryer is box-shaped with slots at either end through which the web passes into and out of the dryer. Heated air is supplied to the dryers with a forced-draft fan and drawn out of the dryers with an induced-draft fan. The dryers are operated at a negative pressure relative to the room to contain all the VOC evaporated by the dryers. Figures supplied by AFCO for the CI press indicate that the input volume for the overhead dryer is about 1,000 scfm and that the exhaust volume is about 1,100 scfm.

As implied by their name, the between-color dryers are located between the print stations and dry the web sufficiently that the next color can be applied. A drawing of a between-color dryer is presented in Figure 2. These dryers extend across the width of the web just above its surface. A burner located in a common manifold supplies heated air to all the between-color dryers on a single press. The heated air impinges on the printed web from two slots in each dryer running across the width of the web. Two intake slots situated to the outside of the impingement slots are operated under vacuum: an unknown quantity of the solvent-laden

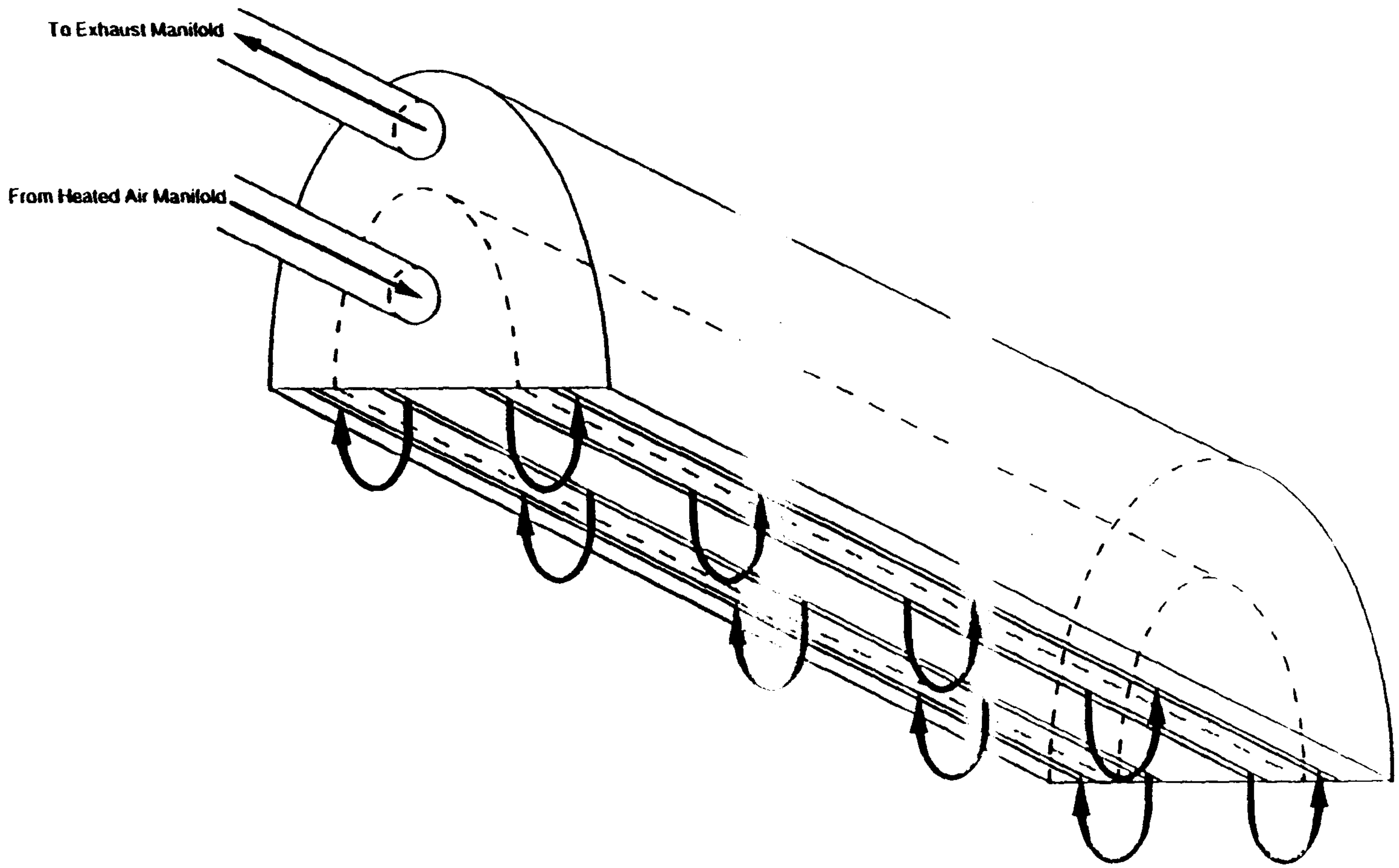

Figure 2. Between-color dryer.

impingement air is drawn onto the intake slots. The effluent from these dryers (i.e., the solvent-laden air [SLA] picked up by the intake slots) is combined in a single manifold and exhausted to the atmosphere.

As in the overhead ovens, more exhaust is pulled from the between-color dryers than is supplied. This is especially important for these dryers because, if the heated air were forced out of the dryers instead of being picked up by the intake slots, the heated air would impinge on the ink rollers and dry the ink on the plate. Figures supplied by AFCO for the between-color dryers on the CI press indicate that the total input volume is about 1,100 scfm and that the total exhaust volume is about 1,200 scfm.

Fugitive VOC emissions at the presses are possible from several points. The ink supply containers are not sealed. Most of the fountain and rollers in the printing station are covered during operation, but the plate cylinder is not. After the ink is applied, the web travels a few inches before it passes beneath the face of the between-color dryer. Solvent may be emitted from the plate and from the web in the area between the printing station and the dryer. Also, the effectiveness of the between-color dryer intake slots at capturing the solvent-laden impingement air is unknown; these dryers may generate fugitive emissions. After the final printing station, there is a run of about 6 feet before the web enters the overhead dryer. Mr. Mitchell believes that the greatest portion of the fugitive solvent flashes off between the final printing station and the overhead dryer and in the areas between the printing stations and between-color dryers.

B. <u>Observations Pertinent to the Draft Gas/Gas Capture Efficiency Test</u>

1. <u>Operator access</u>. Access to the presses is required constantly during operation. The operators periodically check the ink level in the supply containers and check and adjust ink viscosity. The print quality is constantly monitored, and register is manually adjusted at the press as needed. When necessary, the operator must stop the press to clean dried ink from the plates or to reapply a plate to its roller. Access is needed from all directions to change out unwind rolls, rewind rolls, and plate cylinders. A chain hoist that moves along an overhead beam is used to change out the unwind rolls and plate cylinders.

Consideration should be given to enclosing the entire press, including unwind and rewind stations, in the temporary total enclosure. Access to the unwind area is required periodically to replace the spent roll. If the enclosure did not include the unwind area, operators might have to pass in and out of the enclosure during a test run, possibly disrupting design airflow patterns or allowing fugitive emissions to escape the enclosure. In addition, it is possible that there are some emissions from the web after it exits the overhead dryer. However, this is unlikely considering the typical specifications for very low retained solvent discussed previously. Furthermore, the web is quickly rewound after leaving the overhead dryer, and the escape of any retained solven from the rewound web in the vicinity of the press is unlikely.

2. Press dimensions and layout. The existing presses vary in size. As estimated by pacing off distances, the CI press would require an enclosure 18 feet by 36 feet to contain the entire press. The new CI press to be installed will be longer than the existing one.

The two presses are housed together in a large room. The presses are parallel to one another and quite far apart. By pacing off the distances, it appears that the distance from the outside wall to an enclosure around the stack press would be about 18 feet. The enclosure itself would be about 10 feet wide and would be separated from an enclosure around the CI press by about 10 feet.

About half the room currently has no equipment in it and is being used for storage. The new CI press will be installed in this area.

3. Ceiling-level obstructions. The ceiling is supported by steel trusses 1 to 2 feet high with open interstices. There are few other obstructions at ceiling level.

4. Direct-fired dryers. The use of direct-fired dryers that draw combustion air and makeup air from the room may present problems in quantifying capture and overall destruction efficiencies because some VOC's will be destroyed in the burners before emissions enter the duct to the incinerator. Measurements to quantify VOC's destroyed by the burners could be complex if they are possible at all.

5. Heat buildup. Mr. Mitchell indicated that heat buildup in the temporary enclosure may be a problem because the overhead and between-color dryers will be within the enclosure. During the visit, the inlet temperatures for the between-color and overhead dryers were 250°F and 190°F, respectively. However, it was not noticeably warmer in the vicinity of the dryers than elsewhere. In any case, air flow patterns and volume could be engineered in a temporary total enclosure to achieve adequate heat removal.

C. Enclosure Design Options

Based on observations during the site visit, three preliminary design options for a temporary total enclosure were identified:

1. Dropping polyethylene enclosure walls from the plant ceiling, thereby using the plant ceiling as the temporary total enclosure ceiling;
2. Dropping polyethylene enclosure walls from the bottom of the ceiling support trusses. The plant ceiling would function as the temporary total enclosure ceiling. The open spaces between the top of the walls and plant ceiling would be considered natural draft openings as defined in the draft gas/gas test procedure; and
3. Constructing a wooden frame to which polyethylene would be fastened to form the temporary total enclosure walls and a ceiling spanning the press area.

Option 2 likely would be the least labor intensive and, therefore, the least expensive. Details on how the polyethylene would be fastened to the ceiling support trusses remain to be worked out. The applicability of this approach also hinges on meeting the temporary total enclosure criterion governing the allowable area of natural draft openings.

The use of Option 1 would avoid any problem with the natural draft opening criterion but would require contending with the trusses and obstructions near ceiling level. The exact methods of closing the areas near the plant ceiling and fastening the polyethylene to the ceiling remain to be worked out. Even with these difficulties, this approach would likely be less costly than Option 3, which would require considerable carpentry to ensure the stability of the enclosure frame.

Whichever the chosen option, every effort should be made to develop a design that will allow the polyethylene to be added quickly after the preliminary test runs without the enclosure have been conducted. For Options 1 and 2, the polyethylene should be fastened in place but remain rolled up at ceiling level. Once the preliminary test runs have been conducted, the polyethylene could be unrolled, and the temporary total enclosure test runs begun. For Option 3, the wooden frame should be constructed before any testing is conducted, with the polyethylene walls and ceiling added only when the temporary total enclosure test runs are to begin.

7. Conclusions

This facility appears typical of a small flexible packaging manufacturer. No conditions seem to exist that would make construction of a temporary enclosure more difficult at this facility than at other web coating and printing facilities. In fact, the amount of unused space in the press room and between the presses could make construction of an enclosure easier at this facility than at others where space constraints might be a factor.

It does not appear that noise would be a problem in an enclosure at this facility. Noise levels at the facility were not high, and no existing noise abatement measures were apparent.

The necessity of including the dryers in the enclosure could result in heat buildup. However, as discussed previously, it is believed that this potential problem can be avoided with proper enclosure design.

The use of direct-fired dryers at this and other facilities presents a possible problem with the draft gas/gas capture efficiency test procedure. (This problem was discussed in Section IV.B.4 above.) However, the same is true of other capture efficiency test methods.

PRINTPACK, INC.

MRI

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Telephone (919) 677-
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Date: February 17, 1989

Subject: Site Visit--Printpack inc., Atlanta, Georgia
Capture Efficiency
EPA Contract No. 68-02-4379, Work Assignment 18
ESD Project No. 87/07
MRI Project No. 8951-18

From: Stephen W. Edgerton SE

To: Karen Catlett
ESD/CPB/CAS (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. <u>Purpose</u>

The purpose of this site visit was to investigate the feasibility at this facility of constructing a temporary total enclosure around a printing line suitable for performing the draft gas/gas capture efficiency test.

II. <u>Place and Date</u>

Printpack inc.
4335 Wendell Drive SW
Atlanta, Georgia
September 12, 1988

III. <u>Attendees</u>

<u>Printpack inc. (Printpack)</u>

Doug Cook, Senior Specialist, Corporate Environmental Affairs

<u>Flexible Packaging Association (FPA)</u>

Marjina Kaplan, Director of Marketing and Communications
Edward Weary, Director of Technology

<u>U. S. Environmental Protection Agency (EPA)</u>

James Berry, ESD/CPB
Karen Catlett, ESD/CPB

Georgia Department of Natural Resources

Michael Fogle, Unit Coordinator

Midwest Research Institute (MRI)

Stephen Edgerton

IV. Discussion

The visit began with a meeting among the attendees. The meeting was followed by a facility tour concentrating on the printing lines and the emission control system. The discussion that follows summarizes the information gained from the meeting and tour.

A. Concerns With Draft Gas/Gas Capture Efficiency Test Procedure and Retrofitting Permanent Total Enclosures

Mr. Cook expressed two chief concerns about the draft capture efficiency test procedure: cost and accuracy. He made the following points related to the cost of conducting the test. A major cost would be the lost manufacturing time during construction and removal of the temporary enclosure required for the test. Another significant cost would be the labor required to build the enclosure. This facility has large presses that would require complicated enclosures taking several days to construct. The final major cost item for the test would be the increased time commitment from testing contractors to carry out the test. Test contractors have indicated to Mr. Cook that the cost of performing the test would be about three times the cost of the liquid/gas capture efficiency test now in use. The primary reason for this increase in test contractor charges is that the test crew will be onsite significantly longer for the draft gas/gas procedure than for the liquid/gas procedure. The test procedure requires that the exhaust to the control device be tested before the temporary enclosure is constructed. After this preliminary measurement is made, the test crew will be idle during construction of the enclosure, a significant period if construction takes as long as Mr. Cook projects. The costs of materials for constructing the enclosure would be small in comparison to the other costs associated with the test.

Mr. Cook expressed the following opinions on the accuracy of and support for the the draft test method. He has no confidence that the draft gas/gas capture efficiency test improves upon the accuracy of the liquid/gas test. The draft test procedure has not been performed enough times to establish its value, and the data from the tests that have been run have not been made available to industry for evaluation.[a] Mr. Cook believes that it is EPA's responsibility to develop and validate the test procedure. The costs to industry of regulatory development are too great to justify, particularly when there is a method (liquid/gas) that industry believes to be adequate. If the gas/gas method eventually proves to be a better method and if the costs can be contained, it should be adopted.

The chief concern Mr. Weary expressed about the draft gas/gas capture efficiency test procedure is that the results obtained with the temporary enclosure in place will not accurately reflect operation in the absence of the enclosure. He feels that the enclosure will alter such parameters as the quality of the product and the rate and pattern of the airflow in the vicinity of the line. To compensate for these effects, conditions (e.g., line speed) might have to be varied from those that prevail during normal operations.

Mr. Fogle expressed reservations concerning the fact that the minimum detection level for Method 25 is 50 ppm as carbon. Thus, this method may not be appropriate for measurement of the gas stream from the temporary enclosure that carries the VOC normally emitted as fugitive emissions. However, at facilities using incineration control, Method 25 is necessary to obtain accurate destruction efficiencies. These facts raise the possibility that capture efficiency and control device efficiency might have to be determined using different EPA Methods, which would increase testing costs. Mr. Fogle also indicated concern that the cost of the gas/gas test would be especially burdensome on small facilities that do not have the personnel or expertise to design and construct a suitable temporary enclosure.

Mr. Fogle stated that he has been satisfied with the results obtained using the liquid/gas capture efficiency test. He believes that problems with reconciling the liquid and gas measurements may stem from using Method 25A instead of Method 25 to make the gas measurements.

Mr. Cook believes that permanent total enclosures may be reasonable for new plants but are not practical for retrofit situations. Space constraints in existing plants are a prime impediment to permanent enclosures. Also of concern is the possibility of greatly increased airflow to the control device from the enclosed line in order to meet OSHA limits on exposure of personnel to VOC vapors. Such an increase could exceed the capacity of a control device designed to control only the effluent from the dryers. Mr. Cook agreed with Mr. Berry that, because of

[a]A similar comment was made by FPA at the meeting of the National Air Pollution Control Techniques Advisory Committee (NAPCTAC) at which the draft test procedure was discussed (May 18, 1988). The EPA believes that these comments are premature. The procedure was developed based on engineering rationale. The procedure was distributed widely and presented at the NAPCTAC meeting in order to solicit recommendations based on available expertise in the public and private sectors. The development of the method is continuing.

the increased control over the airflow patterns that is possible with a total enclosure, it is not clear that a permanent enclosure would require an increase in airflow volume. However, the ventilation volume currently used in the plant is high in order to meet the OSHA regulations. Printpack believes that the impact of enclosures on solvent concentrations and air volumes in relation to OSHA regulations must be precisely resolved prior to proposal of a total enclosure capture method.

B. <u>Facility Information</u>

1. <u>Printing operations</u>. The Printpack facility currently operates several central impression flexographic printing lines to produce flexible packaging products. The facility is permitted for an additional line, but that line has been moved to another facility. The primary webs used are polypropylene and polyethylene, with some metalized polyester. A very small portion of the printing is done on paper. The company uses essentially all solvent-based inks. Printpack "experimented with" water-based inks but was not able to achieve the quality products demanded by their customers.

The facility operates 24 hours per day and 5, 6, or 7 days per week, depending on demand. Typical printing runs average about 4 to 6 hours. About 60 percent of the presses are actually running at any given moment.

The facility has six-color presses and eight-color presses. The eight-color presses are the newest. These presses are larger, faster, and can accommodate a wider web (up to 44 inches) than some of the six-color presses.

On all presses, the printing stations are arrayed sequentially around a large central cylinder with intervening "between-color dryers." A schematic of a typical six-color printing line is presented in Figure 1. The web is unwound and passes over the central bay and enters the first printing station near the top of the central cylinder. The web then passes around the cylinder (down the near surface and up the far surface), alternately being printed upon and then exposed to a between-color dryer operated at 260° to 290°F. At each succeeding printing station, a new ink color is applied over the earlier coats until the final image is produced. For the final product to be acceptable, it is essential that each color be laid down in exactly the correct position relative to the preceding ones. This is termed "keeping register."

After the web leaves the final printing station, again near the top of the cylinder, it passes horizontally through the "overhead dryer" located above the path of the unprinted web over the bay. The overhead dryer ensures that the web is dry. Residence time is up to 30 times that of the between-color dryers. The overhead dryers are operated at 190° to 215°F The dried web then travels downward through a quality control observation area and to the rewind station.

The maximum mechanical speed of the presses varies from 600 to 1,200 feet per minute, with the newer presses being the fastest. However,

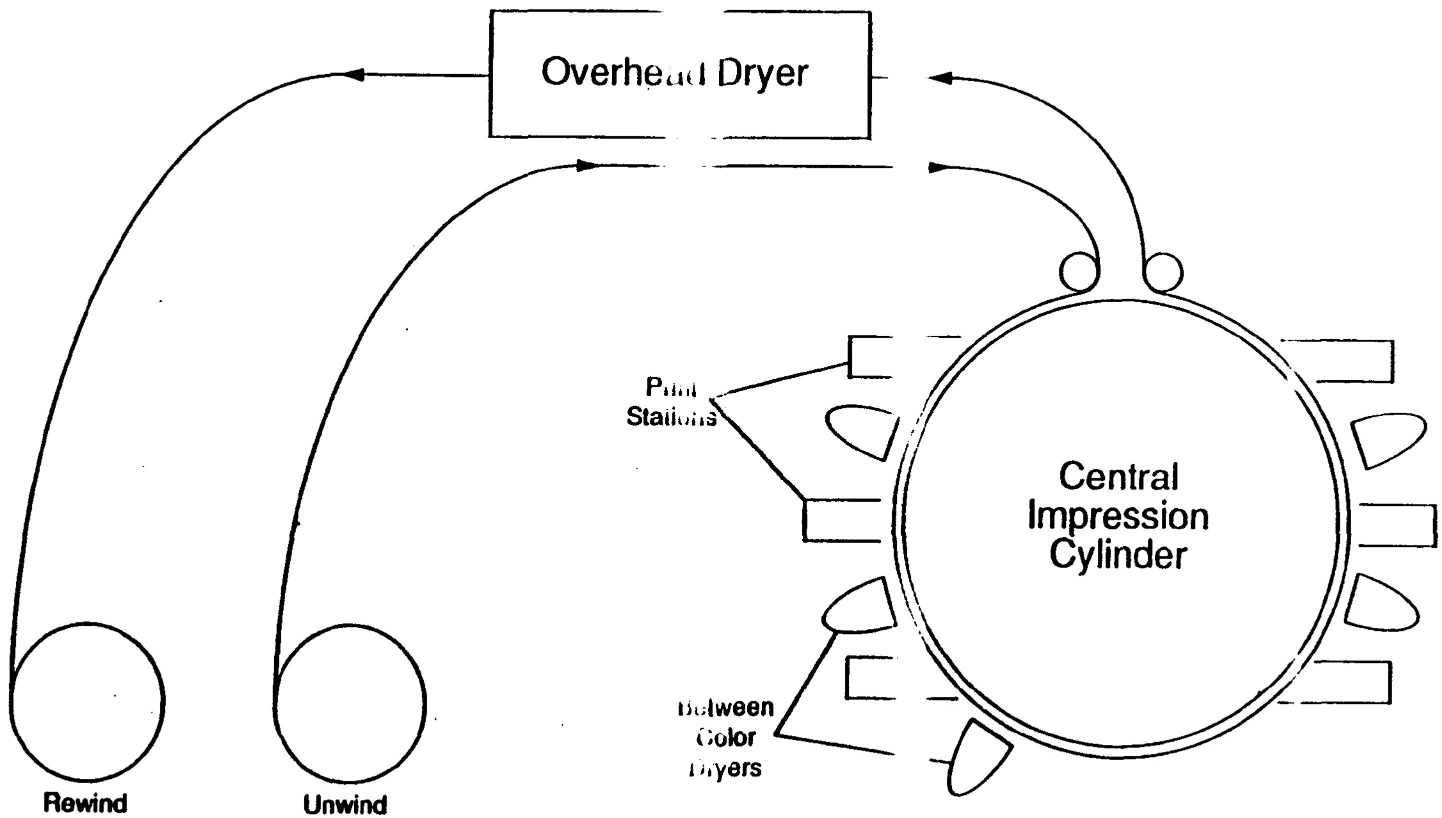

Figure 1. Schematic of a six-color, central impression flexographic press.

the presses cannot be operated at maximum mechanical speed during production. The actual printing speed is determined by drying capabilities and the ability to keep register. The printing speed of the presses varies between about 350 and 700 feet per minute, depending on the product and the press.

The facility performs two types of printing, "line" and "process." Line printing is the traditional flexographic printing method. In this method, the ink is picked up by a roll rotating in a tray of ink and passed to the anilox roll, which transfers the ink onto the raised printing surface of the plate cylinder. Each color is applied to the web to completely cover specific areas. The industry is now moving more to process printing. In this method, the ink is pumped to a doctor blade against the anilox roll. The ink is applied to the web as fine dots; the sum of the various color dots appears as the final image. This printing method produces the "graphics" type packaging that is becoming more prevalent. Process printing uses higher viscosity inks, and much less ink is applied to the web. Thus, less VOC is emitted from process printing than from line printing. All presses at Printpack can do line work. All eight-color presses and some six-color presses can do process work.

2. <u>VOC emissions and control system</u>. The Printpack facility operates a catalytic incinerator manufactured by Pillar for control of VOC emissions from the presses. The solvent-laden air (SLA) from the between-color dryers flows into the center of an annular catalyst bed; the VOC's are oxidized as they pass through the bed to the outside. The system is equipped for primary heat exchange: the inlet SLA is preheated by the incinerator exhaust gases. The incinerator has a capacity of 25,000 scfm. It is equipped with a variable-speed, induced-draft fan controlled by a static pressure sensor on the main SLA mixing plenum located on the roof. All the SLA vented to the incinerator is effluent from the between-color dryers.

The inks applied to the web are dried with direct-fired natural gas dryers. Mr. Cook has agreed to provide schematics of the various lines' air handling systems. All of the effluent from the overhead dryer is recirculated, with a portion diverted to the between-color dryers and replaced by fresh makeup air. Dampers in the ductwork on the roof and inside the plant allow the makeup air to be drawn from either source. The dampers within the plant were observed for two of the presses; these dampers were partially open. It is not known if additional makeup air was concurrently being drawn from outside. The overhead dryers on the eight-color presses consist of three distinct chambers supplied with heated air from a common burner tempered with room air; the effluent from the three chambers is also combined.

As implied by their name, the between-color dryers are located between the print stations and dry the web sufficiently that the next color can be applied. A sketch of a between-color dryer is presented in Figure 2. These dryers extend across the width of the web just above its surface. A common manifold and burner supply heated air to all the between-color dryers on a single press. In each dryer, the heated air

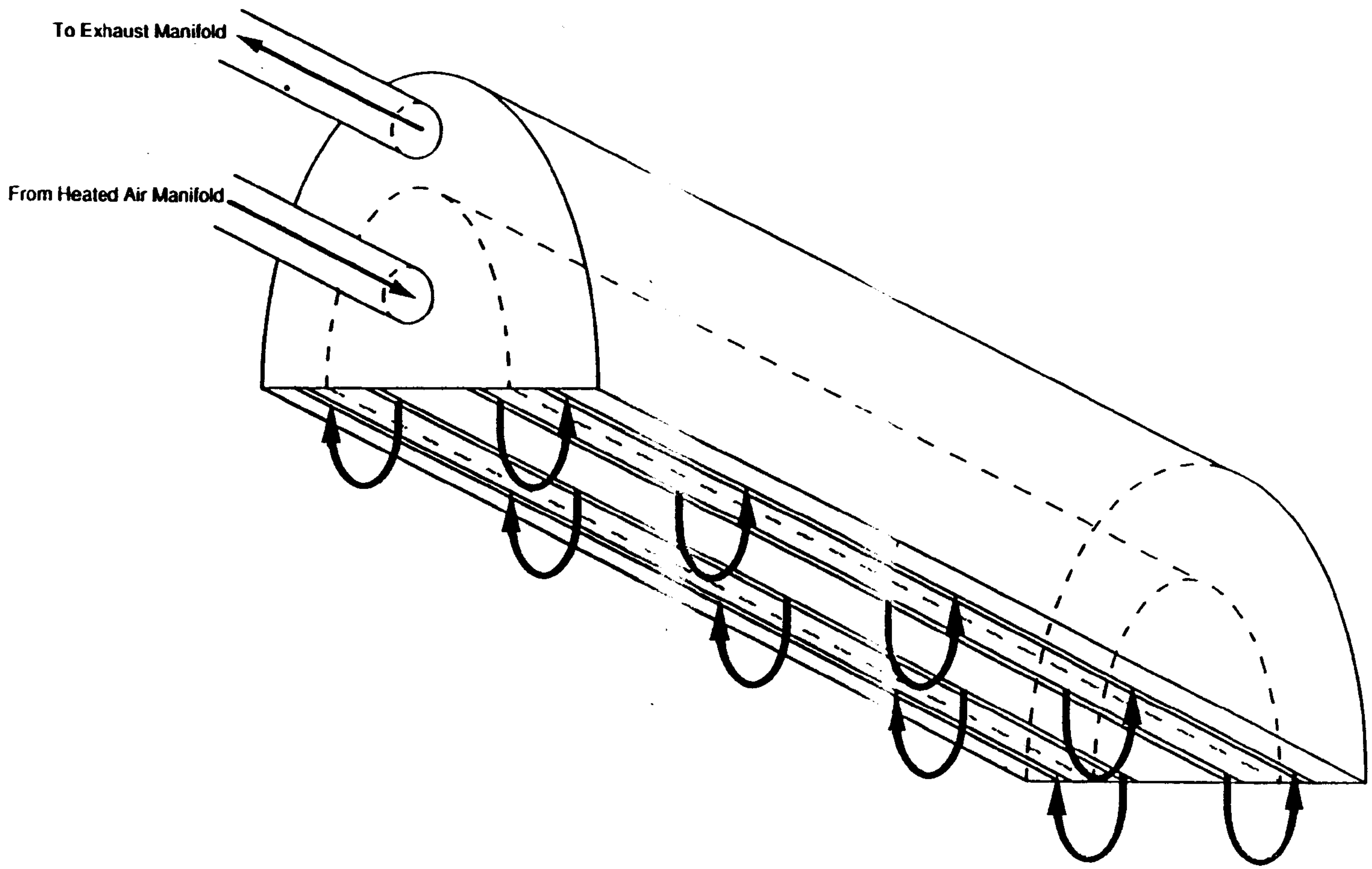

Figure 2. Between-color dryer.

impinges on the printed web from two slots running across the width of the web. Two intake slots situated outside of the impingement slots operate under vacuum; an unknown quantity of the evaporated solvent is drawn into the intake slots. The effluent from these dryers (i.e., the SLA picked up by the intake slots) is combined in a single manifold and ducted toward the incinerator. On some presses, ductwork and dampers are in place on the roof to allow some of the between-color dryer effluent to be recirculated to the overhead dryer or discharged to the atmosphere.

A total of about 6,000 scfm of SLA is generated by the dryers at each press, but with recirculation of the overhead dryer exhausts, only about 2,000 to 2,400 scfm from the between-color dryers is vented to the incinerator from each press. The airflow from these dryers is variable because press operators frequently adjust the flow to obtain proper drying characteristics. Mr. Cook indicated that he will supply the systems' duct flow rates when EPA requests them in writing.

Most of the recirculation and incinerator ductwork is on the facility's roof. Each final dryer exhaust is equipped with a bypass to the atmosphere installed for use when water-based inks are applied. Each bypass damper is controlled from a remote location with an actuator motor that is connected to the damper shaft by a control rod and an adjustable locking collar. The collar is locked onto the damper shaft in whatever position is required to achieve full closure given the location of the actuator motor and control rod. Because the collars are not operated according to convention (i.e., are not aligned with the dampers), it was not possible to ascertain from external observation whether the bypass dampers were fully closed. If a gas/gas capture efficiency test were to be conducted at this facility, full closure of the bypass dampers should be verified prior to testing.

Fugitive emissions are possible at a few points in the printing process. Ink is pumped to the printing stations from "kits," 5- or 15-gallon containers. These kits are not sealed, and fugitive emissions are likely from these sources. Most of the printing station is covered during operation, but the final roll that actually applies the ink to the substrate is not covered. After the ink is applied, the web travels a few inches before it passes under the face of the between-color dryer. Solvent may be emitted from the final roll and from the web in the area between the printing station and the dryer. Also, the effectiveness of the between-color dryer intake slots at capturing the solvent-laden impingement air is unknown; these dryers may generate fugitive emissions. After the final printing station, there is a run of about 6 feet before the web enters the overhead dryer. Fugitive emissions are likely in this area. On some of the older presses, a piece of metal has been installed over the web in this area to aid in directing solvent emitted in this area into the overhead dryer with the web.

The odor of solvent was strong in the room containing the presses. The odor extended into the visitor reception area, which is separated from the press room by at least three doors and 40 feet.

Mr. Cook stated that when all covers are in place and dryer airflows are properly balanced to achieve a good negative pressure, he believes that 99 percent of the fugitive emissions are from the "kits." Emissions at other points in the process will be drawn into the dryers and subsequently vented to the incinerator.

The capture efficiency has been determined at this facility using a liquid/gas material balance protocol. One capture efficiency test was performed for two presses at a cost of $12,000. Another test of capture efficiency for two presses and of the incinerator destruction efficiency was performed for a total cost of $18,000. The capture efficiencies determined by this test method have ranged between 66 and 71 percent for the older presses and have been in the mid-to-high 70's for the newer (eight-color) presses when newly installed.

C. Observations Pertinent to the Draft Gas/Gas Capture Efficiency Procedure

1. Operator access. Two operators are assigned to each press. additional two persons are assigned to the eight-color presses as a floating changeout team. Access to the presses is routinely required during operation. During operation, the operators check the ink level and viscosity in the kit supplying each printing station about every 30 minutes. The ink viscosity is tested using a Zahn cup, adjusted as necessary through solvent addition, and retested. This whole process takes about 5 minutes. The operators also must be free to adjust the printing stations as needed. Because frequent access to the printing equipment is required, a temporary total enclosure at this facility would need to be constructed so that operating personnel can safely remain within it during the test period.

Consideration should be given to enclosing the entire press, including unwind and rewind stations, in the temporary total enclosure. Access to the unwind area is required about every 45 minutes of operation to replace the spent web roll. The same operators that monitor the printing equipment perform the replacement using an overhead power crane. If the enclosure did not include the unwind area, operators might have to pass in and out of the enclosure during a test run, possibly disrupting design air flow patterns or allowing fugitive emissions to escape. In addition, it is possible that there are some emissions from the web after it exits the overhead dryer. However, this is unlikely because much of the production at this facility is food packaging with specifications for very low retained solvent. Furthermore, the web is quickly rewound after leaving the overhead dryer, and the escape of any retained solvent from the rewound web in the vicinity of the press is unlikely.

2. Press dimensions and layout. The presses vary somewhat in size. As estimated by pacing off the distances, one six-color press would require an enclosure 15 feet by 45 feet to contain the entire press. An enclosure for another six-color press was estimated at 27 feet by 54 feet. The ceiling in the room housing these presses is approximately

20 feet high. The eight-color presses are larger. An enclosure large enough to contain one of these presses would have to be approximately 33 feet by 66 feet. The ceiling in the room housing this press is about 30 feet high.

The presses are housed together in two large rooms of the plant. In most cases, there are aisles between the presses wide enough for a fork lift to pass through. One exception to this separation between presses was noted where one eight-color press is located next to a five-color press/laminator. At their nearest point, these presses are separated by only about 3 feet. Mr. Cook indicated that a plant floor diagram showing the locations and dimensions of the presses can be obtained with a written request from EPA.

3. Ceiling-level obstructions. In the 1 to 1.5 feet just beneath ceiling level in both rooms housing the presses are a number of obstructions. These include ventilation ducts, electrical conduit, piping, and support beams. In the room housing the eight-color presses, the ceiling is supported by steel trusses 1 to 2 feet high with open interstices.

4. Direct-fired drying ovens. The use of direct-fired, recirculating ovens may present problems in quantifying capture and destruction efficiencies because some VOC may be destroyed in the burners before emissions enter the duct to the incinerator. The configuration of the oven, burners, and ducting will be factors in whether a problem exists. If the percentage of VOC that is destroyed as the recirculated air passes through the burners can be determined and if the ducts leading to the burners are suitable for gas-phase VOC testing, the test problems may be overcome. It should be noted that combustion of VOC in direct-fired drying ovens is a potential problem for the liquid/gas capture efficiency test procedure as well as for the gas/gas test procedure.

D. Enclosure Construction Options

Based on observations during the site visit, three preliminary design options for a temporary total enclosure were identified:

1. Dropping polyethylene enclosure walls from the plant ceiling, thereby using the plant ceiling as the temporary total enclosure ceiling;
2. Dropping polyethylene enclosure walls from the bottom of the ceiling support beams or trusses. The plant ceiling would function as the temporary total enclosure ceiling. The open spaces between the top of the walls and plant ceiling would be considered natural draft openings as defined in the draft gas/gas test procedure; and
3. Constructing a wooden frame to which polyethylene would be fastened to form the temporary total enclosure walls and a ceiling spanning the press area.

Option 2 likely would be the least labor intensive and, therefore, the least expensive. Details on how the polyethylene would be fastened to the ceiling support beams remain to be worked out. The applicability of this approach also hinges on meeting the temporary total enclosure criterion governing the allowable area of natural draft openings.

The use of Option 1 would avoid any problem with the natural draft opening criterion but would require contending with the numerous obstructions near ceiling level. The exact methods of closing the areas near the plant ceiling and fastening the polyethylene to the ceiling remain to be worked out. Even with these difficulties, this approach would likely be less costly than Option 3, which would require considerable carpentry to ensure the stability of the enclosure frame.

Whichever option is chosen, every effort should be made to develop a design that will allow the polyethylene to be added quickly after the preliminary test runs without the enclosure have been conducted. For Options 1 and 2, the polyethylene should be fastened in place but remain rolled up at ceiling level. Once the preliminary test runs have been conducted, the polyethylene could be unrolled, and the temporary total enclosure test runs begun. For Option 3, the wooden frame should be constructed before any testing is conducted, with the polyethylene walls and ceiling added only when the temporary total enclosure test runs are to begin.

It might be possible to avoid the cost of lost production during enclosure construction and dismantling if the test could be scheduled at a time when the facility is not operating 7 days per week. However, production is scheduled on an irregular basis on weekends throughout the year, so lost production could be avoided only if the enforcement agency allowed considerable flexibility in scheduling the test. In any case, weekend construction and dismantling would require premium pay rates of 50 percent more on Saturday and 100 percent more on Sunday.

V. Conclusions

This facility appears typical of a large flexible packaging manufacturer. No conditions seem to exist that would make construction of a temporary total enclosure particularly more or less difficult at this facility than at other web coating and printing facilities. It does not appear that noise would be a problem in an enclosure at this facility. It is unlikely that heat buildup in the enclosure would be encountered; no ambient heating was noted in the vicinity of the dryers. At facilities that do not condition the plant air as Printpack does, an enclosure that reduces cross ventilation might be expected to produce a humid, stuffy, and intolerable work area during the summer months. However, the enclosure ventilation rate necessary to prevent solvent vapor buildup should be adequate to prevent heat buildup as well.

The imposition of State emission limits for flexographic printing facilities does not appear to have affected the process area of this facility at all. No added capture devices or equipment design improvements were evident. The only change appears to be the addition of an incinerator to destroy the solvent emissions previously vented to the atmosphere from the between-color dryers.

APPENDIX C. COST AND FEASIBILITY ANALYSES

American National Can Company
Westvaco Corporation
Kenyon Industries
Atlanta Film Converting Company
Printpack, Inc.

AMERICAN NATIONAL CAN COMPANY

MRI REPORT

FINAL COST AND FEASIBILITY STUDY: AMERICAN NATIONAL CAN COMPANY

EPA Contract No. 68-02-4379
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FINAL COST AND FEASIBILITY ANALYSIS
FOR
AMERICAN NATIONAL CAN COMPANY

I. Summary of Analysis and Findings

The American National Can Company (ANC) facility in Hammond, Indiana, prints and coats metal sheets for subsequent processing into three piece cans at other locations. The facility uses sheet-fed lithographic presses and roll coaters. A site visit report, dated May 16, 1989, contains detailed information on the process and the facility layout.

A. Temporary Total Enclosure (TTE) Configuration

In conjunction with Mr. Gere of ANC, Midwest Research Institute (MRI) determined that the coating lines present a greater challenge to enclose than do the lithographic printing lines. Coating line No. 22 was selected for in-depth analysis as the most difficult of the coating lines to enclose based on the relatively close proximity of adjacent coating lines on either side. Potential TTE configurations were identified and evaluated considering the layout of the process, the locations of affected and nonaffected VOC emission sources, the locations of permanent structures that could aid or obstruct TTE construction, operator access requirements, material flows, health and safety requirements, and the criteria included in the TTE protocol. One configuration was selected for further analysis. The proposed TTE would enclose the normal work area of the coater operator from the automatic feeder to the front end of the drying oven and from the midpoint of the left aisle to the midpoint of the right aisle. The TTE roof would pass just over the area light fixtures to allow adequate lighting and to utilize the fixtures for support. The exhaust duct for the fugitive emissions would run from the TTE roof up through an existing vent in the plant roof. The exhaust fan would be located on the roof. Additional detail on the proposed TTE configuration can be found in Section III.

B. Materials of Construction

After observing curtains in the plant suspended from cables strung between roof support columns, a similar system was selected for the TTE. Support cables for the TTE would be hung using a combination of the existing columns and 2x4's clamped to existing catwalk railings. The material selected for the walls and roof of the TTE is 6 mil polyethylene. More detail on construction is presented in Section III.

C. Testing

The gas streams, sampling locations, and EPA Method for measuring volatile organic compounds (VOC) for the capture efficiency determination were tentatively identified. (Final identifications will be made in the testing phase of this project should testing be carried out at this facility.) Measurements would be conducted on the incinerator inlet duct, the incinerator combustion air duct, and the fugitives exhaust duct using EPA Methods 1 through 4 (M1-M4) for the volumetric flow rate measurements and Method 25A (M25A) for the VOC concentration measurements. It appears that suitable test points exist for volumetric flow rate measurements without any duct modifications, provided cyclonic flow is not present.

Measurement of the flow rate and VOC concentration of the incinerator exhaust using M1-M4 and M25A would also be conducted to determine the amount and concentration of the gas recycled to the oven. An anemometer would be used to measure the gas velocity at the oven inlet to determine whether this parameter is affected by the presence of the enclosure. Finally, the ambient VOC concentration inside the enclosure would be measured with an OVA-1 meter to determine whether steady-state conditions have been reached within the enclosure. The ambient VOC concentration outside the enclosure would be measured with an OVA-1 meter to evaluate the potential for VOC drawn in through natural draft openings (NDO's) to affect the capture efficiency determination.

For each run, M25A measurements would be made continuously over a 1-hour period, while volumetric flow measurements would be taken with a traverse before and after each test and monitored with a 1-hour continuous single point measurement. A 1-hour continuous measurement of oven inlet velocity would be required for each test run to detect any variation in the inlet oven velocity. The OVA-1 measurement of VOC concentration within the enclosure would be made on a 1-hour continuous basis, while the ambient VOC concentration outside the enclosure would be measured before and after each test. Additional detail on testing considerations is presented in Section II, Part D.

D. <u>Specifications</u>

Specifications have been prepared for the TTE, including drawings of the TTE structure and a list of the materials and equipment necessary to construct the TTE. The specifications are presented in Section III.

E. <u>Cost Analysis</u>

The costs associated with performing a capture efficiency determination using the TTE protocol have been estimated based on the TTE specifications and sampling locations selected. Constructing and dismantling the TTE, including design, materials, equipment rental, and labor would total nearly $7,200. Additional costs of about $17,100 would be incurred for the testing. During most of the year, no production would be lost during TTE construction and dismantling; the total cost of the capture efficiency determination would be approximately $24,300. However, during peak demand in the summer months when the plant operates continuously, the total test cost could increase significantly due to lost production costs. The total cost of the capture efficiency determination in this situation is contained in the confidential addendum to this report.

II. Options Considered and Rationale for Selections

A. Production Line to be Evaluated

The facility contains both coating lines and lithographic printing lines. The lithographic presses use very thick paste inks that contain insignificant amounts of VOC; the VOC emissions from the printing lines are associated with a coater that applies a VOC-based varnish over the printing ink. The VOC emission points and control system associated with the varnish application operation are very similar to those of the coating lines. After discussion with Mr. Gere of ANC, it was determined that the coating lines would be more difficult and costly to enclose than would the printing line varnish coaters because the coating lines are closer together and are operated more frequently.

The coating lines are nearly identical, as are the VOC emission sources and control systems. The coating lines are located side by side in one area of the coating room: the widths of the aisles separating the lines vary somewhat as a result of the placement of structural columns. Line No. 23 was selected for in-depth evaluation because it has the minimum separation from the adjacent coating lines, thereby representing a worst-case situation.

B. TTE Configuration

The first decision to be made in considering the TTE configuration is whether the drying oven can be considered part of the total enclosure or must itself be enclosed. For the drying oven to be considered part of the enclosure, VOC emissions must not escape the drying oven as fugitive emissions. All VOC emissions must be vented through ducts or stacks. As a means of determining whether this condition is met, the draft TTE protocol requires that the drying oven meet specified criteria for a total enclosure.

At the ANC plant, it appears that the drying oven does not meet the criterion requiring an average inward face velocity of at least 200 feet per minute (ft/min) across the openings. Measurements with a hand-held anemometer at the oven entrance showed a maximum of 180 ft/min. A measurement at the opening of the wicket return chamber (located beneath the exit from the cooling section) indicated an inward velocity of 75 ft/min. However, these measurements were taken while the oven was operating but the coating process was not. Therefore, it is not certain whether the measurements are fully representative of periods of process operation. An automatic controller system adjusts oven airflows depending on heating requirements, so the face velocities could be different during process operation.

In any case, these openings are not the crucial ones. The oven entrance would have to be within any TTE in order to capture emissions from the flashoff area, so any losses through the oven entrance would be contained by the TTE. The wicket return chamber receives some VOC at a preheat section heated with recirculated incinerator exhaust, but this section is located at the front end of the oven about 100 ft from the entrance to the wicket return chamber. It is extremely unlikely that any VOC would escape from the wicket return entrance even with a face velocity of only 75 ft/min. Thus, only the drying oven exit realistically remains as a potential source of fugitive emissions from the drying oven.

The face velocity across the exit of the final oven heating section was not measured because the cooling section makes the exit inaccessible. The dried and cured sheets exit the drying oven in a vertical position, so the oven exit is relatively large. However, during operation, the effective area of the opening is actually very small because the great majority of the opening is blocked by the sheets as they exit (the sheets are spaced 1.5 inches apart). While the face velocity across this small opening is not known, the face velocity criterion could be met with a relatively low volumetric flow rate.

Regardless of the exact face velocity inward through the drying oven exit, it is unlikely that significant VOC escapes through the exit. The coatings applied in this process must be thoroughly dried of VOC to avoid contaminating the product eventually placed in the cans fabricated from the coated sheets. As a result, the drying process is largely complete before the sheets approach the oven exit, and very little VOC is emitted near the exit. In addition, the flow of gases within the drying oven is toward the entrance because the exhaust pickup is at the front of the oven.

For the reasons discussed above, it was determined that the quantity of fugitive VOC escaping the drying oven, if any, would be insignificant, and the drying oven need not be enclosed by the TTE. Thus, the emission points that would have to be within the TTE would be the coater (including the coating and cleaning solvent supply vessels) and the flashoff area.

The smallest enclosure that could contain these sources would fit immediately around the equipment from the entrance of the coater to the drying oven entrance. The operator would be outside such a small TTE. This configuration was rejected for several reasons. The TTE would hamper operator access to the coating equipment, which is required frequently during operation. With such a small TTE, it would be difficult to size and locate the NDO's to meet the criteria of the protocol, particularly if openings must be provided in specific locations for operator access. Also, location of the NDO's so close to the emission points could significantly alter the normal airflow patterns, changing the rate of evaporation and the performance of the capture system. Finally, the TTE would have to be largely freestanding; little use could be made of existing structures for support.

Instead of the minimum size TTE, a configuration enclosing the entire normal work area of the operator was selected. This configuration is illustrated in Section III where the TTE specifications are presented. The attachment presents a brief "check" of the TTE design criteria. The operator would remain inside the enclosure during the test. The side walls would be placed at the midpoint of the aisles on either side of the coating line, affording adequate room for the operators of all the lines. The walls would have to be fitted around the power hoist monorail that runs perpendicularly across all the lines above the coaters. Covered doors would be placed in the walls on either side of the coater. These doors would not be used during a test run but would be needed for equipment changeout between production runs should it occur during the period of the test program.

The end wall at the feeder end of the line would be placed to enclose the feeder. The end of the section of rollers leading to the feeder would protrude through this wall through an NDO large enough for a load of sheets to pass through. This placement would allow the loads to be delivered to the rollers with a forklift as is normally done. Covered doors would be located in this end wall on either side of the line to allow personnel access as necessary. The bottom portion of these doors likely would be left open as NDO's so that the aisle areas would be swept of VOC. It is not expected that the doors would be used frequently; the operator typically would get from one aisle to the other by cutting across the line at a point within the TTE. An operator was observed doing so during the site visit.

At the other end of the TTE, walls would extend from the side walls to the sides of the drying oven to enclose the front of the oven, including the oven entrance. The walls would be placed to include the first access door to the oven interior through which the operator sometimes extracts coated sheets for QA activities. Covered doors would be located in the end walls on either side of the oven to allow personnel to pass in and out as necessary. The bottom sections of these doors might also be left open to function as NDO's.

The roof of the TTE would pass just over the line's light fixtures. The lights would be inside the TTE to ensure adequate lighting and would function as supports for the roof. The roof would be fitted to the front of the drying oven above the entrance and would be joined to the side and end walls.

Four dampered pickups for the fugitive emissions exhaust are included in the specifications for the TTE for maximum flexibility in adjusting airflow patterns, although fewer might be sufficient. The locations of the pickups and the damper settings could be varied as necessary to control the VOC concentration within the enclosure and to minimize the effect of the TTE on capture efficiency. The dampered pickup ducts would extend downward from the TTE roof to a height of 1 to 2 ft above the floor. Above the TTE roof, the pickup ducts would be joined into a single exhaust duct which would extend upward through the existing vent in the plant roof. Primary support for the fugitives exhaust ducting would be provided by clamps at the level of the facility roof. Additional support for the pickup ducts may be provided by a conveniently located electrical bus that extends across the line above the TTE roof level. The exhaust fan and fugitives test point would be located on the roof.

As an alternative, the fugitives exhaust could be run from the TTE end wall down the aisle between the drying ovens and exhausted into the plant. However, in the latter case, the fan would be required to be "explosion-proof" for fire protection, increasing its cost.

C. Materials of Construction

Plastic sheeting (6 mils thick) was chosen for the walls and the top of the enclosure because it is lightweight, inexpensive (1 to 3 cents/ft^2 area), and offers some visibility from outside the enclosure. It is easy to work with in that it can be cut and resealed and can be easily moved if necessary. Also, the TTE could be vacated quickly in case of emergency.

Cables were selected instead of a wooden frame to support the plastic sheeting for a number of reasons. A wooden frame would be more costly in materials and labor to construct and dismantle. Cables are already used at the plant to hang curtains; therefore, facility personnel are familiar with the installation of such cables. It is likely that the TTE could be built by plant personnel rather than necessitating an outside contractor. The cables could be strung from existing roof support columns and catwalk railings so less fabrication would be required. Less space would be taken up between coating lines by the cable-draping method because a wooden frame would be wider and any additional bracing required by the frame would take up room in the narrow passageways.

D. Testing

Figure 1 is a schematic of the proposed sampling points for the capture efficiency test. Table 1 presents the suggested measurements, test methods, and frequencies for each sampling point. Capture efficiency would be calculated by dividing the sum of the VOC mass flow rates from test locations 1 (combustion air) and 2 (incinerator inlet) by the sum of the VOC mass flow rates from test locations 1, 2, and 3 (fugitives exhaust). The contribution of VOC from the incinerator recycle stream is not accounted for in this calculation. Calculations provided in the attachment based on data provided during a followup telephone conversation with Mr. Gere show that the VOC contribution from the recycle is a maximum of 7 percent of the total VOC concentration entering the incinerator. This value becomes relatively insignificant to the determination of capture efficiency because the incinerator inlet stream is included in both the numerator and denominator of the equation. However, measurement of the incinerator exhaust before and after each test run has been included in the test plan to allow determination of the amount of combustion gases recycled to the oven during the test period and, subsequently, the impact of the VOC contained in the recycled gases on the capture efficiency measurement.

In addition to measurements at test locations 1, 2, and 3 that will be used to calculate capture efficiency, measurements at test locations 4, 5, 6, and 7 have been included in the tentative test program. As discussed above, the measurement at test location 4 will provide an indication of the effect of the recycle stream. Measurements at test locations 5, 6, and 7 will indicate whether the TTE affects airflow into the oven, whether the

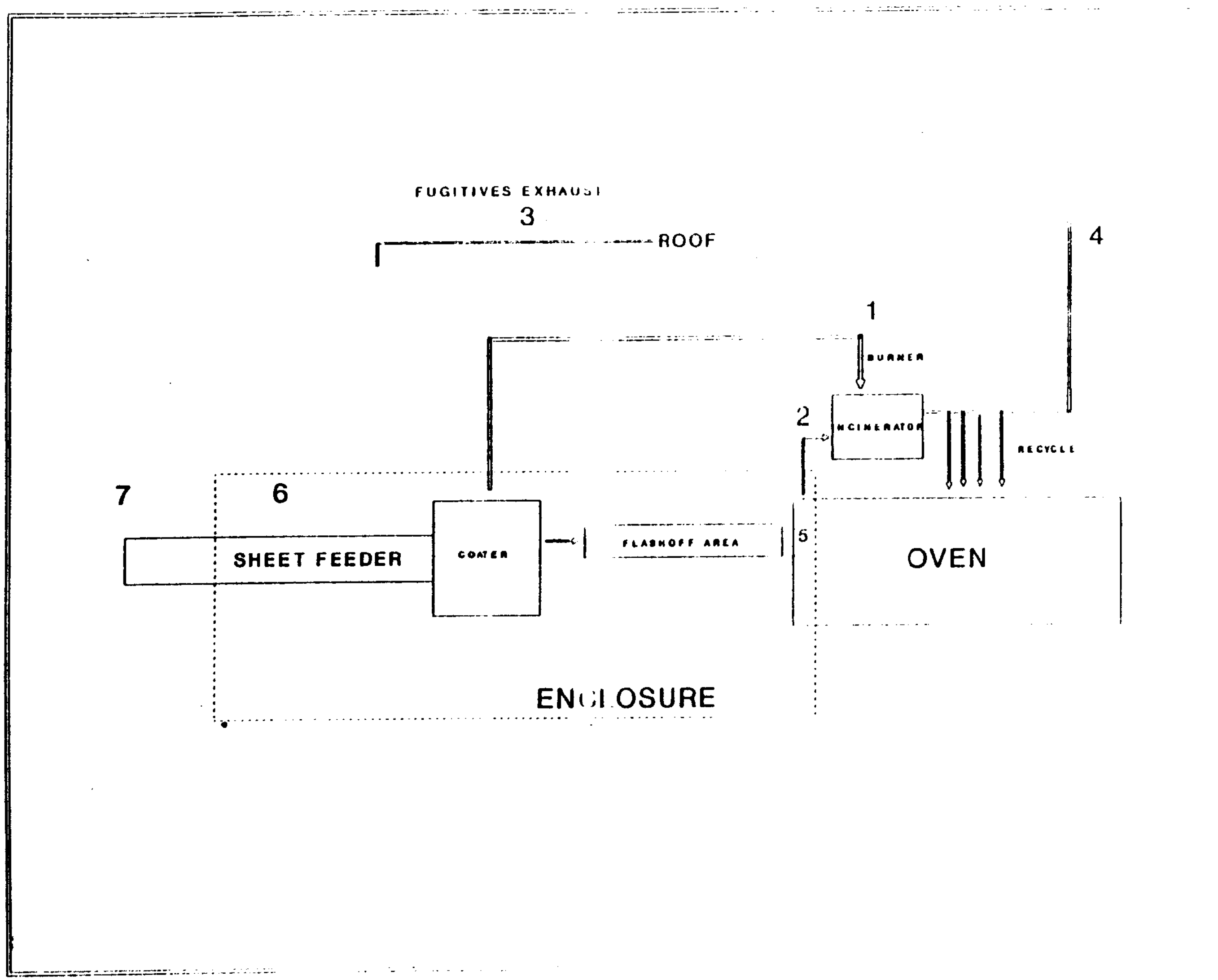

Figure 1. Sampling points at American National Can Company.

TABLE 1. SAMPLING PLAN FOR AMERICAN NATIONAL CAN COMPANY

Test location	Measurement	Method	Frequency
1. Combustion air[a]	Velocity	M1-M4	Traverse before/after each test; continuously monitor single point
	VOC	M25A	1 h continuous
2. Incinerator inlet[a]	Velocity	M1-M4	Traverse before/after each test; continuously monitor single point
	VOC	M25A	1-h continuous
3. Enclosure vent[a]	Velocity	M1-M4	Traverse before/after each test; continuously monitor single point
	VOC	M25A	1-h continuous
4. Incinerator exhaust	Velocity	M1-M4	Traverse before/after each test; continuously monitor single point
	VOC	M25A	Monitor before/after each test run
5. Oven inlet	Velocity	Anemometer	1-h continuous
6. Ambient within enclosure	VOC	M25A (OVA-1)	Continuous
7. Ambient outside enclosure	VOC	M25A (OVA-1)	Before/after each test

M25A = flame ionization analyzer (FIA).
M25 = Total gaseous nonmethane organics (TGNMO).
[a]Simultaneous sampling.

Option 1--add M25 at locations 1, 2, and 4
Option 2--replace M25A with M25 at 1, 2, 3, and 4

system is at steady state, and whether significant VOC is drawn into the TTE through the NDO's, respectively.

An alternative to using M25A (which uses a flame ionization analyzer [FIA]) is to use Method 25 (M25), although M25A appears to be more suitable because a continuous measurement may be made. A continuous readout at the site would be preferable to having to wait for lab analysis after testing because it would allow the site crew to modify parameters such as the fugitive exhaust flow rate before actual test runs began. If the control device efficiency were being measured, M25 at locations 1, 2, and 4 would be the more suitable method because M25 is not affected by the presence of a variable mixture of compounds (including products of incomplete combustion) and, therefore, would yield a more accurate measurement of control device efficiency. Note, however, that M25 is less sensitive to low concentrations, which could be encountered at the incinerator exhaust (test location 4) and the fugitive exhaust (test location 3).

An OVA-1 type meter is recommended to monitor the ambient VOC concentration inside and outside the enclosure because a lesser level of accuracy is acceptable for these two measurements. The purpose of the ambient inside measurement is to assure that steady state is maintained within the enclosure. The purpose of the outside ambient measurement is to evaluate the potential impact of ambient VOC drawn into the TTE. The OVA-1 measurements could be "calibrated" against the FIA measurements, if necessary, to provide a basis of comparison.

It is recommended that the test protocol procedure for processes that do not generate fugitive emissions at a constant rate be used at this facility. The facility uses many different coatings, and process runs typically are too short (average about 5 hours) to allow two complete sets of three test runs to be conducted during a single process run as required by the "before/after" procedure for processes that generate fugitives at a constant rate.

III. Specifications

Drawings of the top and side views of the proposed TTE are presented in Figures 2 and 3, respectively. A drawing of the proposed fugitive exhaust system is presented in Figure 4.

The materials used to construct the TTE and their costs are listed in Table 2. The most significant materials, from a cost standpoint, are the fan and associated ducting. The fan was sized for an exhaust rate of 10,300 ft^3/min, based on the amount of air needed to maintain the concentration of VOC in the enclosure at a maximum of 100 ppm. The calculations and assumptions that provide a basis for this fugitive exhaust rate are included in the attachment. In addition to the materials necessary for construction of the temporary total enclosure as specified in Table 2, Table 3 lists suggested tools and equipment necessary for installation. It was assumed for the cost analysis that the facility would have access to all tools except for the scaffolds and walkboard (these were assumed to be rented) at no additional cost.

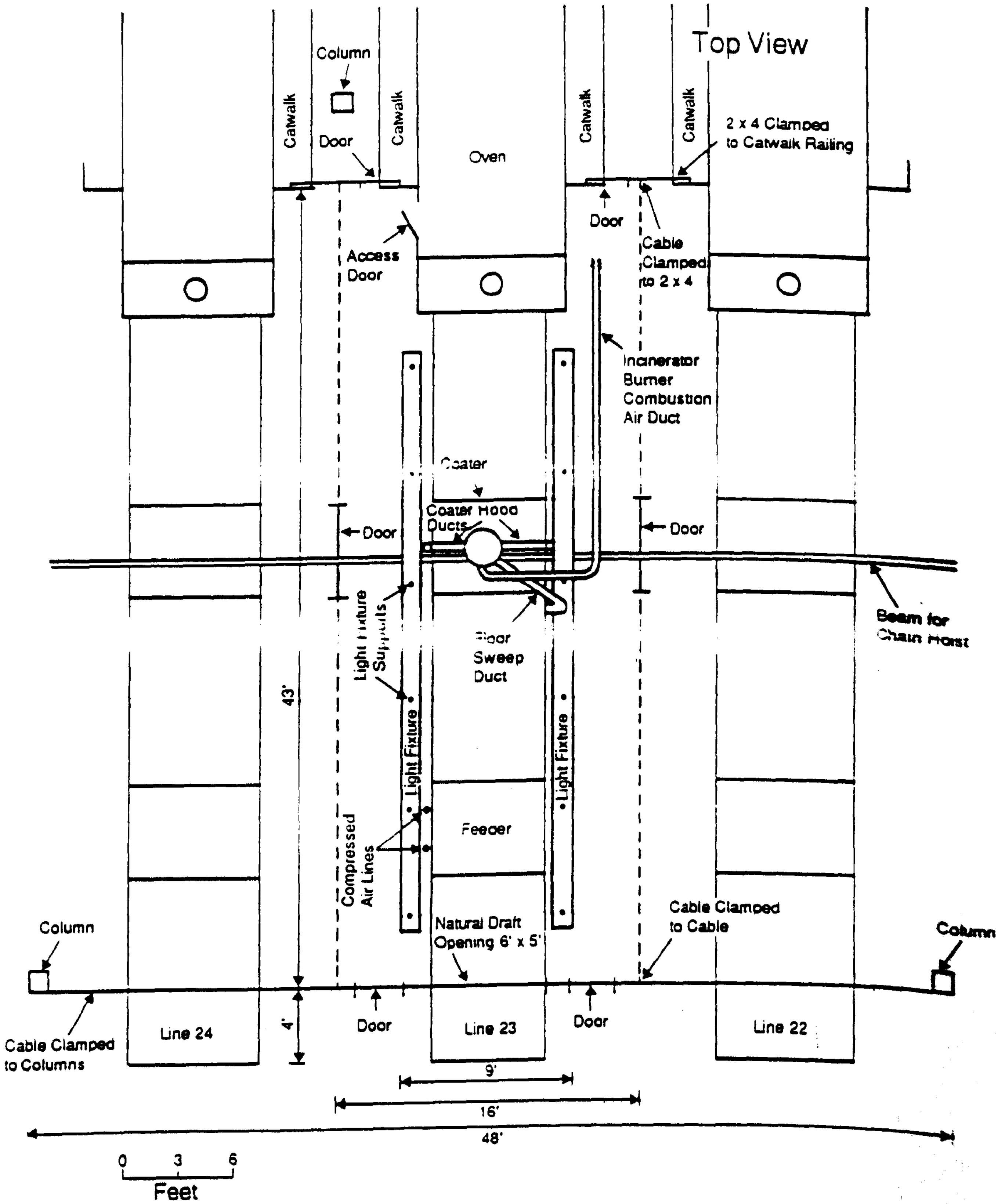

Figure 2. Top view of the TTE over coating line 23 at American National Can Company.

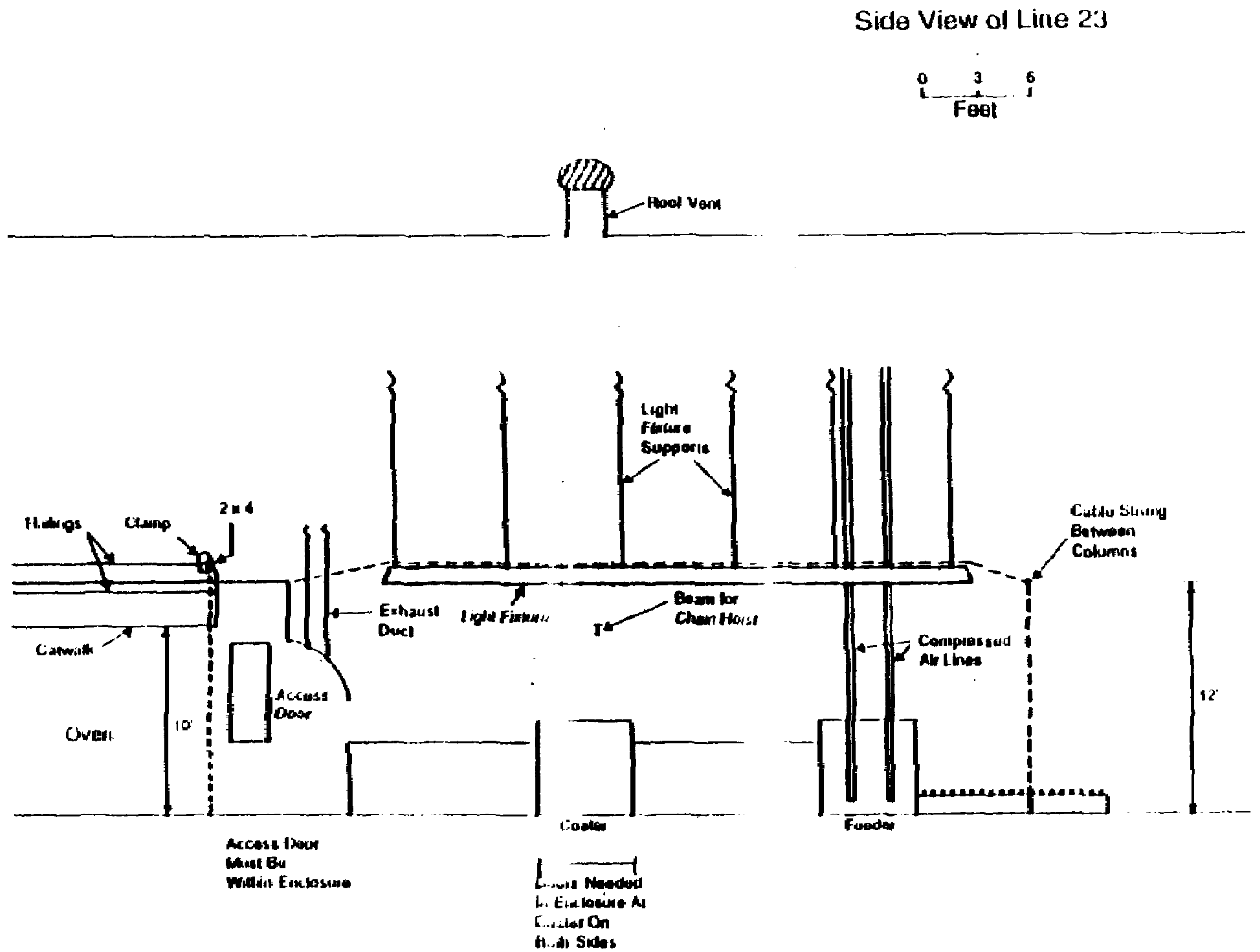

Figure 3. Side view of the TTE over coating line 23 at American National Can Company. (Modified to remove material considered confidential by ANC. The entire figure is included in the confidential addendum to this report.)

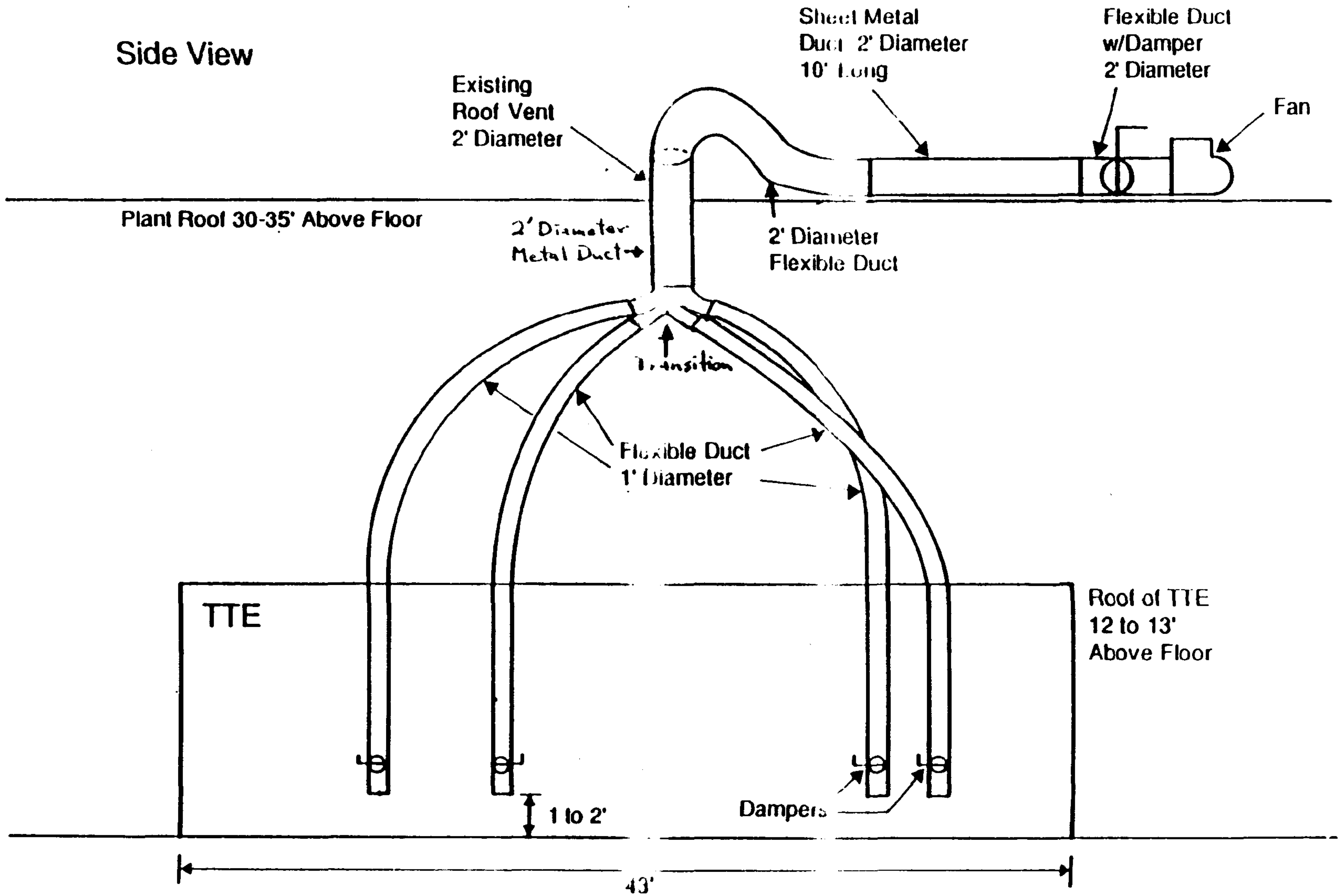

Figure 4. Proposed fugitive exhaust system at American National Can Company.

TABLE 2. MATERIALS, EQUIPMENT, AND LABOR FOR CONSTRUCTION OF A TEMPORARY TOTAL ENCLOSURE AT AMERICAN CAN COMPANY, CHICAGO, ILLINOIS

Materials	Quantity	Cost, $	Labor	Cost, $	Total cost, $[a]
Cable installation					
1. 3/16 in. fiber core cable	200 ft	60.00			
2. 3/4 in. beam clamps	8	40.00	2 FTE'sx4 hours = 8 MH	320	
3. 3/16 in. U-bolts	4	28.00	@ $40.00/MH		
4. 2 in.x4 in.x14 ft lumber brace	12.00	24.00			
SUBTOTAL		152.00		320	472.00
Hang plastic					
1. 6 milx20 ft plastic	50 ft	35.00	Hang plastic, clip to cable, seal	640	
2. 6 milx16 ft plastic	300 ft	55.00	all joints, i.e., wall to wall,		
3. Duct tape	3 rolls	10.50	wall to ceiling, wall to oven,		
4. Medium binder clips	1 gross	12.60	wall to wall		
5. Floor cleaning solvent	1 gal	25.00	2 FTEx8 hours = 16 MH		
6. Scaffold rental	2 @ 4 days	80.00	@ $40.00/MH		
[illegible] 15' walkboard rental	4 days	40.00			
SUBTOTAL		258.10		640	898.10
Exhaust system					
1. Peerless Model 300J belt drive utility blower. 3 HP, 460V 3-phase motor. 10,340 ft^3/min, 1 in. S.P., 377 rpm	1	2,010.00	Mount blower and instruments on roof platforms. Drop flex duct for fugitive exhaust system. 2 FTEx8 hours = 16 MH @ $40.00/MH	640	
2. 12 in. flex duct drops	4	1,040.00			
3. 12 in. full blast gate dampers	4	382.80			
4. 12 in. connecting duct clamps	16	52.20			
5. 24 in. flexible duct and damper	5 ft	182.00			
6. 24 in. sheet metal duct (include 12 in.x24 transition)	3 @ 5 ft	390.00			
7. Roof support clamps	4	62.00			
8. 24 in. duct clamps	4	36.00			
9. 4 ft x 8 ft x 1/2 in. plywood for roof platform	2	50.00			
SUBTOTAL		4,205.00		640	4,845.00
Dismantling			2 FTE x 6 hours = 12 MH @ $40.00/MH	480	480.00
TOTAL		4,615.10		2,080	6,695.10

[a]Materials and labor.
FTE = Full time employee.
MH = Manhour.

TABLE 3. SUGGESTED TOOL AND EQUIPMENT LIST FOR INSTALLATION

Tools	Equipment
Cutting knife (utility)	Two narrow rolling scaffolds[a]
Cable cutter	Ladders
Screw drivers	Cable ties
Handsaw	Rags
Hammer	Fire extinguishers (2)
Pliers	16 ft walk board[a]
Wrenches	Over-wall hoist
Metal snips	

<u>Suggested staging of construction</u>

1. Place blower and ductwork
2. Place top plastic
3. Place side wall plastic

[a]Assumed to be rented.

IV. Cost Analysis

The estimated cost of a capture efficiency determination at this facility using the TTE protocol is about $24,000, not including the cost of lost production. This cost includes costs associated with TTE design, materials, equipment rental, labor, and testing for the TTE design specified in Section III. If the test were conducted during a peak demand period, it is estimated that as much as 11 hours of production could be lost during construction and dismantling of the TTE. The estimated cost of this lost production and estimated total cost of the capture efficiency determination under these conditions are contained in the confidential addendum to this report.

The specifics of the cost of materials, equipment, and labor are presented in Tables 2 and 3. The details of the proposed test program were presented earlier in Section II, Part D. Specific costs associated with the testing are broken down in Table 4.

Except for the testing crew, a wage rate of $40 per hour, including fringes and overhead, has been used throughout this analysis. This value is likely to overstate the actual wage rate in many cases, but has been adopted to be conservative. It is also assumed that this high wage rate would allow for the cost of labor supervision, if necessary. The wage rate included for testing personnel has been adjusted upward to allow for moderate travel costs.

Table 5 summarizes the costs associated with performing the capture efficiency test at this facility. The first component cost in Table 5 is design of the TTE. This step is further subdivided into the onsite evaluation phase and the actual design phase.

During the onsite evaluation, one individual would examine the affected facility to be tested, noting the physical and process-related requirements for the TTE, taking the necessary measurements, and sketching the layout. This process would be similar to the site visit conducted for this analysis but would not be as extensive. Under normal conditions, the evaluation would be limited to the single line for which testing was being required and would not include the extensive background discussions with plant personnel on the TTE protocol and the process that were necessary for this study. In addition, the site survey for testing purposes would be a separate activity carried out by the testing contractor. The cost of this test survey is included in the testing costs. The onsite evaluation phase of TTE design is estimated to require 4 hours. At a labor rate of $40 per hour, this activity would cost $160.

During the actual design phase, the ventilation requirements for the TTE would be determined from process information. The proposed TTE configuration would then be evaluated relative to the criteria in the protocol to verify that the criteria can be met. Upon corroboration that the criteria can be met, drawings of the TTE and materials, equipment, and labor specifications would be prepared. These activities might or might not be carried out by a single individual, but the total labor required is estimated at 8 hours. At $40 per hour, the cost of this phase would total $320.

TABLE 4. SAMPLING COST ESTIMATE

<u>Base cost</u>	
Site survey - 1 person, 2 daysx8 hx$75	$1,200
2 THC operators - 2x3 daysx10 hx$70	4,200
3 velocity persons - 3x3daysx10hx$70	6,300
Preparation and posttest checks - 40 hx$50	2,000
Calibration gases and supplies	1,000
Data reduction and reporting - 40hx$60	2,400
Total	$17,100
<u>Option 1</u> - add M25 at locations 1, 2, and 4	
2 operators - 2x3 daysx10 hx$70	$4,200
Added prep - 40 hx$50	2,000
Analysis - 3x3x$150	1,350
Total	$7,700
<u>Option 2</u> - replace M25A with M25 at 1, 2, 3, and 4	
Same size crew	
Less calibration gases	-$1,000
Analysis - 4x3x$150	+ 1,800
Total	+$ 800

<u>Assumptions</u>:

1. 3 runs of 1-h each.
2. Method 25 options will use single sampling trains.
3. Base cost requires three heated THC analyzers and one OVA HC monitor.
4. Estimates include moderate travel costs.
5. One day of travel/setup, 1 day of testing, and 1 day of teardown/travel in field.
6. Note that the base cost requires $80K of analyzers. Equipment costs for Option 2 would save about $60K in equipment but M25A is capable of 0 to 10 ppm range with detectable values to <1 ppm with good AC noise. M25 is not useful except at 10 to 100 times higher concentrations.

TABLE 5. COST ANALYSIS FOR THE CAPTURE EFFICIENCY TEST

Task	Cost to complete, $
1. Design	
a. Examination of facility	160[a]
b. Design of enclosure	320[b]
2. Materials and equipment rental	4,615
3. Construction labor	1,600[c]
4. Lost production	d
5. Testing costs	17,100
6. Dismantling	480[e]
TOTAL	24,275[f]

[a]Four labor hours at $40/h, including benefits and overhead.
[b]Eight labor hours at $40/h, including benefits and overhead.
[c]Forty labor hours at $40/h, including benefits and overhead.
[d]The dollars per hour cost of lost production is considered by ANC to be confidential business information (CBI). This value is contained in the confidential addendum to the report. Lost production is estimated to be as much as 11 hours, assuming 8 hours for hanging plastic and suspending exhaust duct and 3 hours for dismantling plastic and exhaust duct.
[e]Twelve labor hours at $40/h.
[f]The total cost of the capture efficiency determination, including the cost of lost production, is contained in the confidential addendum to this report.

The next two components costs in Table 5 are drawn from Table 2. Materials and equipment rental costs for TTE construction are estimated at $4,615. The construction labor cost estimate totals $1,600 for 40 labor hours.

The fourth item in Table 5, the value of production lost during construction and dismantling of the TTE, is contained in the confidential addendum to this report. It is estimated that a maximum of 11 hours of production could be lost. Of the 11 hours, 8 hours would occur during the construction phase when placement of the fugitive exhaust ductwork and TTE roof immediately above the line would be expected to interfere with process operations. The remaining 3 hours would occur during dismantling when the TTE roof and exhaust system components immediately above the line were removed. The basis for the hourly dollar value is presented in the confidential addendum to this report.

It should be noted that during much of the year, the test could be conducted without loss of production. The primary product of the facility is coated metal sheets for food cans; demand is somewhat seasonal, peaking in the summer when many vegetables are harvested. During the highest demand period, the plant operates 24 hours per day, 7 days per week, and production likely would be lost during TTE construction and dismantling. At other times, the plant operates only 5 or 6 days per week. During these periods, TTE construction and dismantling could be accomplished during normal downtime with no loss of production. Production loss costs have been included in this analysis to represent the worst-case situation, although it is expected that an actual test at this facility could be scheduled to avoid these losses.

The testing costs appear next in Table 5. At over $17,000, this component represents the largest contribution to the total cost of using the TTE protocol. This cost estimate is based on the use of M25A for VOC measurements. If M25 were used instead, testing would cost about $800 more.

The final component cost listed in Table 5 is the cost of dismantling the TTE. It is estimated that this activity would take about 12 labor hours to accomplish for a total cost of $480. Much of the dismantling could be accomplished without shutting down the process, but, as discussed previously, removal of the TTE roof and fugitive exhaust ducts could require up to 3 hours of lost production during those periods when the plant operates 7 days per week. This cost is included under lost production in Table 5.

Taken together, the component costs discussed above total over $24,000 for the TTE design specified in Section III, not including lost production. If the capture efficiency test were scheduled so that production losses would be incurred (i.e., at a time when the plant was operating 7 days per week), the total cost of the test could be increased by a significant amount.

The cost analysis presented above is specific to line No. 23. However, because the roll coating lines at this facility appear to be nearly identical, the cost of testing any of the lines would be expected to be similar. A capture efficiency determination for a lithographic printing line also would be expected to involve similar costs because the process layout, VOC sources, and emission capture system are similar to the roll coating lines.

V. Potential Problems

Several potential problems with the measurement of capture efficiency using the TTE protocol specific to this plant and the chosen coating line are listed below.

A. Drying Oven

The drying oven apparently does not meet the criteria for a TTE. It is unlikely, however, that a significant amount of VOC will escape the oven as fugitive emissions, as discussed in Section II, Part [illegible].

B. Oven Recycle

Because combustion gases are recirculated into the drying oven to supply heat, any VOC contained on these gases will be measured at the incinerator inlet along with solvent vapors dried from the coated sheets. From rough calculations presented in the attachment, the maximum contribution to VOC concentration at the incinerator inlet from the recirculated combustion gases is 7 percent, based on a 92 percent incinerator destruction efficiency and flow rates for the streams supplied by ANC. Testing at the incinerator exhaust has been recommended to allow the effect of the recycle to be evaluated.

C. Cleaning Solvent Emissions

According to Mr. Gere, the "double-scraper" or continuous cleaning system that services the coater is not considered part of the affected facility. It would not be possible to exclude this VOC source from the TTE. The effect of emissions from the cleaning system on the measured capture efficiency is uncertain. Some VOC from this system would be measured with the "captured" emissions in the incinerator combustion air stream, while some would be drawn out through the fugitives exhaust vent. The direction of the effect upon the measured captive efficiency value will depend on whether the emissions from the cleaning system are captured at a higher or lower proportion than are emissions from the coating. In any case, emissions from this source should be small relative to the affected emissions and should not have a large effect on the measured capture efficiency.

VI. Conclusions

A TTE could be constructed around coating line 23. The capture efficiency test using the TTE protocol would be feasible with the above qualifiers.

Attachment

b1806-3/ESD

Attachment

I. Calculation of Necessary Exhaust

Based on information received from Mr. Gere of ANC transmitted by cover letter dated March 6, 1989, and in followup telephone conversations.

Assumptions:

1. Coating type is specified in the confidential addendum to this report;
2. Plant achieves 90 percent capture; fugitive emission rate is 10 percent; and
3. 20 ppm solvent background ambient concentration in plant.

Total solvent application rate:

The dry solids application rate for the coating is 11 mg/4 in.^{2}. A large sheet size would have 1,345 in.^{2} of coating. The coating line operates at about 100 sheets/min. According to the formulation data forwarded by ANC, the coating is 35 percent solids and 65 percent solvent by weight.

$$\left(\frac{11\ \text{mg solids}}{4\ \text{in.}^2}\right)\left(\frac{1{,}343\ \text{in.}^2}{\text{sheet}}\right)\left(\frac{65\ \text{mg solvent}}{35\ \text{mg solids}}\right) \approx 6{,}859\ \text{mg solvent/sheet}$$

$$\left(\frac{6{,}859\ \text{mg solvent}}{\text{sheet}}\right)\left(\frac{100\ \text{sheet}}{\text{min}}\right)\left(\frac{60\ \text{min}}{\text{h}}\right)\left(\frac{1\ \text{kg}}{10^6\ \text{mg}}\right)\left(\frac{2.2\ \text{lb}}{\text{kg}}\right) = 90.5\ \text{lb/h}$$

Application rate by solvent species:

(From formulation data for the coating)

$$\left(\frac{\text{Solvent species wt. percent}}{\text{Total solvent wt. percent}}\right)(\text{Total solvent application rate})$$

= Solvent species application rate

Xylene--36.7 lb/h

MIBK--38.0 lb/h

n-Butanol--14.9 lb/h

Diacetone alcohol--0.9 lb/h

Volume of fugitive emissions by solvent species:

At 32°F and 1 atm.

$$(\text{Solvent species application rate})\left(\frac{1}{MW}\right)\left(\frac{359\ ft^3}{lbmol}\right)(0.10)\left(\frac{1\ h}{60\ min}\right)$$

= Solvent species volumetric emission rate

Xylene (MW = 106)--0.21 ft^3/min

MIBK (MW = 100)--0.23 ft^3/min

n-Butanol (MW = 74)--0.12 ft^3/min

Diacetone alcohol (MW = 116)--0.005 ft^3/min

Volume of ventilation air required to meet OSHA standards:

The OSHA standaros are:

100 ppm - Xylene

50 ppm - MIBK, n-Butanol, diacetone alcohol

The calculation of necessary ventilation air is accomplished using the following formulas:

$$E_m = \left(C_1/L_1 + C_2/L_2 + C_3/L_3 + \ldots + C_N/L_N\right) \quad (1)$$

where,

E_m = equivalent exposure for the mixture (must be less than or equal to unity)

C_N = the concentration of a particular contaminant N

L_N = the exposure limit for contaminant N

and

$$C_N = \frac{\text{Volume of fugitive emissions}}{\text{Volume of ventilation air}} \quad (2)$$

The calculation of the speciated background concentration is accomplished through ratio of their relative vapor pressures as follows:

Compound	VP @ 0 °C, mmHg	Background concentration
Xylene	2	9.0
MIBK	1.26	5.6
n-Butanol	1.22	5.4
Diacetone alcohol	~0	0
		20 ppm

Therefore, the volume of ventilation air required to meet OSHA standards is found as follows:

$$\frac{\dfrac{0.21\ ft^3/min}{x\ ft^3/min}}{\dfrac{(100-9)\ parts}{10^6\ parts}} + \frac{\dfrac{0.23\ ft^3/min}{x\ ft^3/min}}{\dfrac{(50-6)\ parts}{10^6\ parts}} + \frac{\dfrac{0.12\ ft^3/min}{x\ ft^3/min}}{\dfrac{(50-5)\ parts}{10^6\ parts}}$$

$$+ \frac{\dfrac{0.005\ ft^3/min}{x\ ft^3/min}}{\dfrac{(50-0)\ parts}{10^6\ parts}} = 1$$

$$\frac{(0.21)(10^6)}{91\ x} + \frac{(0.23)(10^6)}{44\ x} + \frac{(0.12)(10^6)}{45\ x} + \frac{(0.005)(10^6)}{50\ x} = 1$$

$$\frac{1}{x}(10{,}301) = 1$$

$$x = 10{,}301\ ft^3/min$$

II. Estimation of Recycle Contribution

See Figure 1 for a schematic of the corresponding stream numbers

V = volumetric flow

$V_1 + V_2 = V_4 + V_R$

$V_R = V_1 + V_2 - V_4 = 681 + 7{,}121 - 1{,}569 = 6{,}233$ scfm

$V_R + V_{makeup} = V_2$

(V_{makeup} = volume air entering oven from other sources)

$V_m = V_2 - V_R = 7,121 - 6,233 = 888$ scfm

C = concentration

Assume incinerator is 92 percent efficient and that the VOC content in the combustion air is completely destroyed (between the action of the burner flame and the incinerator)

$C_4 = C_R = 0.08\ C_2$

What contribution to C_2 does C_R have after it is diluted by makeup air?

C_R' = concentration at point 2 resulting from recycle

$$C_R' = C_R\left(\frac{V_R}{V_R+V_m}\right) = C_R\left(\frac{V_R}{V_2}\right) = (0.08\ C_2)\left(\frac{6,233}{7,121}\right) \approx 0.07\ C_2$$

∴ up to 7 percent of the incinerator inlet concentration could be from the recycle stream rather than from VOC evaporated from the substrate in the oven.

III. <u>Evaluation of TTE vs. Criteria</u>

1. Average face velocity through NDO's ≥200 ft/min.

Air will be drawn from the TTE in three places, the oven sheet entrance, the incinerator combustion air pickup, and the fugitive exhaust. An equal volume of ventilation air will be drawn into the TTE through the NDO's.

- Volume drawn into oven through sheet entrance:

  Average inward velocity ~140 ft/min

  $(140\ ft/min)(4.25\ ft \times 1.83\ ft) = 1,090\ ft^3/min$

- Volume of incinerator combustion air:

  $680\ ft^3/min$ (from ANC submittal)

- Volume of fugitive exhaust:

  10,300 ft^3/min (as calculated above in Section I)

Total volume drawn in through NDO's:

1,090	ft^3/min
680	
10,300	
12,070	ft^3/min

There is one required NDO where the line penetrates the end wall. This NDO was sized to be 6 ft wide x 5 ft high. Since there are about 12,000 ft^3/min drawn into the TTE, the face velocity across it will be:

$$\frac{12{,}000\ ft^3/min}{30\ ft^2} = 400\ ft/min$$

2. Distance between VOC sources and NDO's $\geq$4 x NDO equivalent diameter.

NDO area is 30 ft^2. The equivalent diameter for this area is:

$$\frac{\pi D^2}{4} = 30\ ft^2$$

$$D = 6.2$$

4x (6.2 ft) = 24.8 ft minimum distance. From the proposed TTE design shown in Figure 2, the distance between the NDO at the end wall and the coater just meets the minimum distance criterion.

3. Distance between exhaust hoods or ducts and NDO's $\geq$4 x exhaust equivalent diameter.

The four exhaust ducts each have 1-foot diameters. Therefore, the minimum distance between the ducts and the NDO at the end wall must be 4 feet, which is easily met.

4. Total area of NDO's $\leq$5 percent of the enclosure surface area.

The total surface area of the walls, ceiling, and floor of the total enclosure is:

$$(2 \times 43\ ft \times 13\ ft) + (2 \times 16\ ft \times 13\ ft) + (2 \times 43\ ft \times 16\ ft)$$

$$= 2{,}910\ ft^2$$

The only design NDO in the TTE is 5 ft x 6 ft, or 30 ft^2.

$$\frac{30\ ft^2}{2{,}910\ ft^2} \approx 0.01 \text{ or } 1 \text{ percent}$$

IV. Value of Lost Production

See discussion in the confidential addendum to this report.

b1806-3A/ESD

WESTVACO CORPORATION

MRI REPORT

FINAL COST AND FEASIBILITY STUDY: WESTVACO CORPORATION

EPA Contract No. 68-02-4379
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MRI Project No. 8952-26

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FINAL COST AND FEASIBILITY STUDY: WESTVACO CORPORATION

I. Summary of Analysis and Findings

The Westvaco Corporation facility in Richmond, Virginia, prints and cuts paper to manufacture boxes for packaging. The facility uses eight-color rotogravure presses. A site visit report, dated May 12, 1989, contains detailed information on the process and facility layout.

A. Temporary Total Enclosure (TTE) Configuration

The Westvaco facility production lines are located side-by-side in a large room called the press room. The basic process is very similar on all the lines. At the suggestion of Mr. John Murphy, Plant Engineer at the facility, Line No. 13 was selected for in-depth study as the most difficult of the lines to enclose because it is crowded between lines on either side. Potential TTE configurations were identified and evaluated considering the layout of the process, the locations of affected and nonaffected sources of emissions of volatile organic compounds (VOC), the locations of permanent structures that could aid or obstruct TTE construction, operator access requirements, material flows, health and safety requirements, and the criteria included in the TTE protocol.

It was determined that the TTE should enclose all of what is normally considered to be Line No. 13, from the unwind section to the cutting and stacking area. Because mixing equipment is considered part of the affected facility at this plant, the TTE would include the press, the mixing equipment, and the aisle between. Operators would generally remain within the TTE during testing, and access to the equipment would not be hindered. It appears that any attempt to span the print stations with a TTE roof would be difficult because of obstructions; therefore, the TTE is designed so that its walls reach to the plant roof.

The exhaust duct for the fugitive emissions should run from the unwind end of the TTE out to a location on the plant floor inside the press room. The exhaust fan would be located on the plant floor. A natural draft opening (NDO) would be provided in the form of an open door 4 feet (ft) wide by 8 ft high at the cutting and stacking end of the TTE. Additional detail on the TTE configuration can be found in Section III.

B. TTE Materials of Construction

The TTE side walls should be constructed out of 6-mil polyethylene sheets hung from I-beam roof supports that run parallel to the production line. The plastic sheeting would be fastened using C-clamps and lath strips. The end walls should be constructed out of 6-mil polyethylene sheets hung from the bottom of the ceiling trussels that run perpendicular between the beams. These plastic sheets would be fastened using binder clips and wire ties. The open lattice of the trusses would be closed off using paperboard from the plant. Duct tape would be used to seal any gaps in the plastic sheeting and to connect the walls of the enclosure to the floor.

Specifications have been prepared for the TTE, including drawings of the TTE structure and a list of materials and equipment necessary to construct the TTE. The specifications are presented in Section III.

C. Testing

The gas streams, sampling locations, and EPA Methods for measuring VOC for the capture efficiency determination have been tentatively identified. (Final identifications will be made in the testing phase of this project should testing be carried out at this facility.) Volumetric flow rate and VOC concentration measurements would be conducted on the duct to the control device, the floor sweep duct, the scrap vent, and the enclosure vent (fugitive exhaust) using EPA Methods 1 through 4 (velocity) and Method 25 (VOC concentration). Additional volumetric flow measurements would be made on the forced makeup air and forced-air fire safety system ducts using Methods 1 through 4. The ambient VOC concentration inside and outside of the enclosure, along with the VOC concentration in the forced makeup air and forced-air fire safety system ducts would also be measured using Method 25A (using an OVA-1 type meter).

For each test run, velocity traverse measurements would be taken before and after each test run and continuously monitored during the run at a single point. Method 25 measurements would be taken over a 1-hour period for each run, with the resulting concentration determined as a 1-hour average value. The OVA-1 measurement of VOC concentration within the enclosure would be made continuously during each 1-hour run, while the ambient VOC concentration outside the enclosure and in the forced makeup air and forced-air fire safety system ducts would be measured before and after each test. Additional detail on testing considerations is presented in Section II, Part D.

D. Cost Analysis

The costs associated with performing the TTE protocol have been estimated based on the TTE specifications and sampling locations selected. Constructing and dismantling the TTE would total approximately $7,200, including design, labor, and materials, but not including lost production time. Additional costs of about $22,600 would be incurred for the testing. The cost of lost production time is contained in the confidential addendum to this report.

II. Options Considered and Rationale for Selections

A. Production Line to be Evaluated

Line No. 13 was chosen to be studied in detail because it is crowded between two other lines. Line No. 13 is also a good candidate for this worst-case study because of the obstructions at either end of the line.

B. <u>TTE Configuration</u>

There are few options in the TTE design for Line No. 13. Because the mixing area which is located on the press room floor across from the press line is considered part of the affected facility, it has to be included in the TTE. Because each of the line's eight dryers sits immediately on top of its respective print station, the dryers also are included in the TTE. The only options in the TTE design are how far to extend the sides of the TTE along the cutting and stacking area (one end) and the unwind station, and how high to build the TTE roof. There also is some freedom in the placement of the fugitive exhaust system and NDO's. A discussion of how the recommended options were chosen is presented below.

1. <u>Length of TTE sides</u>. The TTE was designed to extend for 120 feet to enclose all of the unwind area, the print stations, the mixing line, and the cutting and stacking area. A shorter TTE could have been designed to exclude the cutting and stacking area and the unwind area, but it was determined that placing the enclosure around the process equipment and other obstructions present in these areas would be more difficult than enclosing the entire line. Many obstructions such as pipes, ducts, electrical conduit, and light fixtures would protrude through the end walls with the shorter design; fewer obstructions would be encountered with the longer TTE. Also, the separation between the nearest print stations and the NDO's necessary to allow the process line to pass through the ends of a shorter TTE would not meet the equivalent diameter distance criterion set forth in the TTE protocol.

2. <u>TTE roof</u>. A large quantity of ductwork, pipe, electrical conduit, light fixtures, and support structures are located above the print stations. These obstructions, in conjunction with a water sprinkler system located near the ceiling level, make any attempt to span the line with a TTE roof very difficult. As a solution, the side and end walls of the TTE are proposed to be draped from ceiling supports thereby making use of the press room roof for the TTE roof. Note that draping the plastic from the ceiling eliminates the need for a TTE frame, which is cumbersome in the crowded areas between the press lines.

3. <u>Exhaust pickup</u>. Two dampered pickups for the fugitive emissions exhaust are included in the specifications for the TTE for maximum flexibility in adjusting air flow patterns. The dampered pickup ducts are proposed to be located at the unwind end of the TTE extending approximately 15 to 20 ft into the TTE. The pickup ducts would be joined into a single exhaust duct which would discharge at floor level inside the plant. The NDO, an open door 4 ft by 8 ft, would be located at the other end of the TTE near the cutting and stacking area.

Locating the fugitive exhaust duct and NDO in this manner would create a general flow of air along the aisle between the line and the mixing area from the cutting and stacking area toward the unwind area. This airflow would tend to sweep the VOC out of the areas where personnel are working. Secondly, the inspectors that work at the cutting and stacking and will need to pass in and out of the TTE occasionally;

locating the fugitive exhaust system at this end might hinder their work space or create unsuitable working conditions. Of course, the fugitive exhaust ducts could also be located above the print line at any distances meeting the criterion of four equivalent duct diameters from the NDO's. However, these locations would present the problem of hanging the ducts or attaching them to existing structures. Also, there is more room available for the fugitive exhaust system on the plant floor at the unwind end of the line.

It should be noted that, because the recommended TTE encloses all the makeup air sources and exhausts that normally operate in the vicinity of the process line, the addition of a fugitive exhaust system may not be necessary for adequate ventilation of the area. However, theoretical calculations provided in the attachment show that additional ventilation is needed to keep the level of toluene inside the TTE below 100 parts per million (ppm). Therefore, an exhaust duct is part of the TTE design.

C. <u>Materials of Construction</u>

Plastic sheeting (6 mils thick) was chosen for the walls of the enclosure for a number of reasons. These reasons include its low cost, manageability, relative transparency, availability, and flexibility.

D. <u>Testing</u>

Figure 1 presents a schematic of the Westvaco Plant air handling system. Table 1 presents the suggested measurements, test methods, and frequencies for each sampling point. Capture efficiency would be calculated by dividing the VOC mass flow rate from test location 1 by the sum of the VOC mass flow rates from test locations 1, 2, 3, and 4. Measurements of the ambient VOC concentration inside of the enclosure (location 5) will indicate whether the system is at steady state and whether the OSHA standards for personnel exposure are being met. Ambient VOC measurents outside the NDO's (location 6) will indicate to what extent nonaffected emissions are drawn into the enclosure during the test runs.

The additional measurements of VOC and volumetric flow at points 7 (forced makeup air) and 8 (forced-air fire safety system) would provide an indication of the amount of forced makeup air flowing into the enclosure and would indicate whether the background VOC levels outside the TTE where the respective air intakes are located are low enough not to interfere with the capture efficiency test.

The choice of which EPA method to use when measuring VOC concentration at points 1, 2, 3, and 4 presents a problem because the dryers operate with direct-fired recirculation. Because direct-fired dryers frequently have partially combusted VOC, Method 25 is preferred to Method 25A. However, the fugitive exhaust duct will contain a low concentration of VOC in it, dictating Method 25A. A comparision of the measured VOC concentrations using two different methods will probably

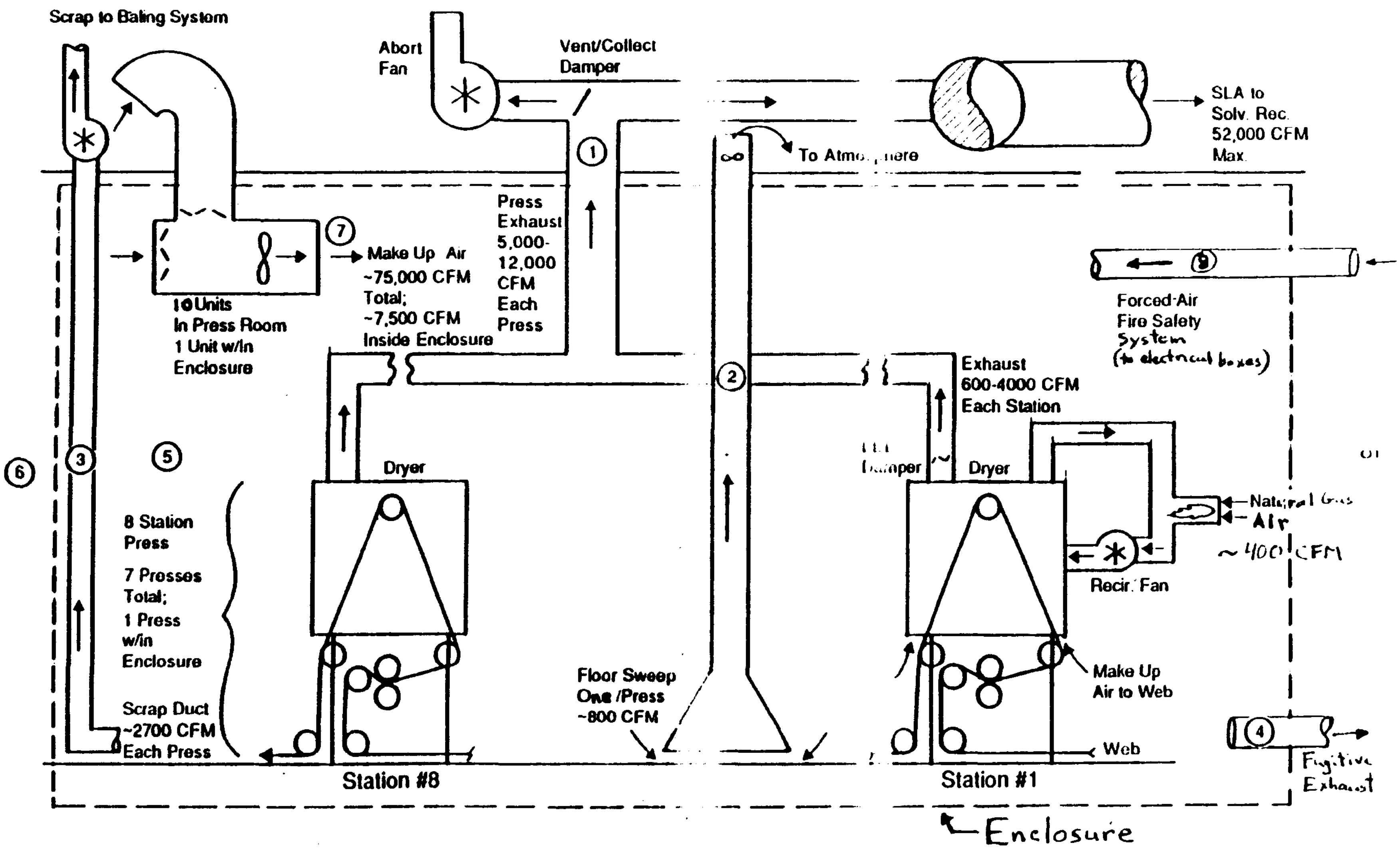

Figure 1. Schematic of the Westv... Plant air han...ling system.

TABLE 1. SAMPLING PLAN FOR WESTVACO CORPORATION

Test location	Measurement	Method	Frequency
1. Duct to control	Volumetric flow	Methods 1-4	Traverse before/after; continuous single point
	VOC	Method 25	1-h integrated
2. Floor sweep duct	Volumetric flow	Methods 1-4	Traverse before/after; continuous single point
	VOC	Method 25	1-h integrated
3. Scrap vent	Volumetric flow	Methods 1-4	Traverse before/after; continuous single point
	VOC	Method 25	1-h integrated
4. Enclosure vent	Volumetric flow	Methods 1-4	Traverse before/after; continuous single point
	VOC	Method 25	1-h integrated
5. Ambient w/in enclosure	VOC	Method 25A (OVA-1)	Continuous
6. Ambient outside enclosure	VOC	Method 25A (OVA-1)	Before/after each test
7. Forced make-up	Volumetric flow	Methods 1-4	Traverse before/after; continuous single point
	VOC	Method 25A (OVA-1)	Before/after
8. Forced air fire safety	Volumetric flow	Methods 1-4	Travere before/after; continuous single point
	VOC	Method 25A (OVA-1)	Before/after

ASSUMPTIONS

For integrated measurements, 1-h durations (3 runs)

ALTERNATIVE:

Replace M25 with M25A at all sample locations yield a faulty capture efficiency value. Therefore, this approach is not advised.

Our initial recommendation is to use Method 25 for the VOC measurements of streams 1, 2, 3, and 4 to account for the effect of the direct-fired ovens. It should be noted, however, that concentratons below 100 ppm may not be accurately measured using Method 25. An alternative to using Method 25 at 1, 2, 3, and 4 would be to use Method 25A. This method has the added advantage of a continuous display of results, allowing adjustments to be made to the fugitive exhaust system, NDO's, etc., if necessary during the test. Note that the effect of the direct-fired oven on the gas stream composition cannot be measured directly because there are no defined ducts (contrary to Figure 1) where measurements might be made.

In the event that this facility is selected for testing, further information can be gathered to facilitate a final choice between Methods 25 and 25A. This facility analyzes the recovered solvent by gas chromatograph (GC) to determine the quantity of each solvent recovered. Small quantities of impurities, such as partial combustion products, are ignored. Examination of representative GC charts should allow a determination to be made with regard to how the direct-fired ovens affect the gas stream composition. That is, the compostion of the captured stream can be compared to the expected composition of the fugitive stream, and a determination can be made regarding whether an FID will provide comparable results at the two locations.

An OVA-1 type meter is recommended to monitor the ambient VOC concentration at points 5, 6, 7, and 8 because a lesser level of accuracy is acceptable for these measurements. The OVA-1 measurements could be calibrated against FID measurements, if necessary, to provide a basis of comparision.

III. Specifications

A drawing of the top view of the proposed TTE is presented in Figure 2. A drawing of the proposed fugitive exhaust system is presented in Figure 3. The materials used to construct the TTE and their costs are listed in Table 2. The most significant materials, from a cost standpoint, are the fan and associated ducting. The fan was sized for an exhaust rate of 10,200 cubic feet per minute (ft^3/min), based on the amount of air needed to maintain the concentration of VOC in the enclosure at a maximum of 100 ppm. The calculations and assumptions that provide a basis for this fugitive exhaust rate are included in the attachment. The rate was calculated based on coating usage and formulation data provided by the facility. In addition to the materials necessary for construction of the temporary total enclosure as specified in Table 2, Table 3 lists suggested tools and equipment necessary for installation.

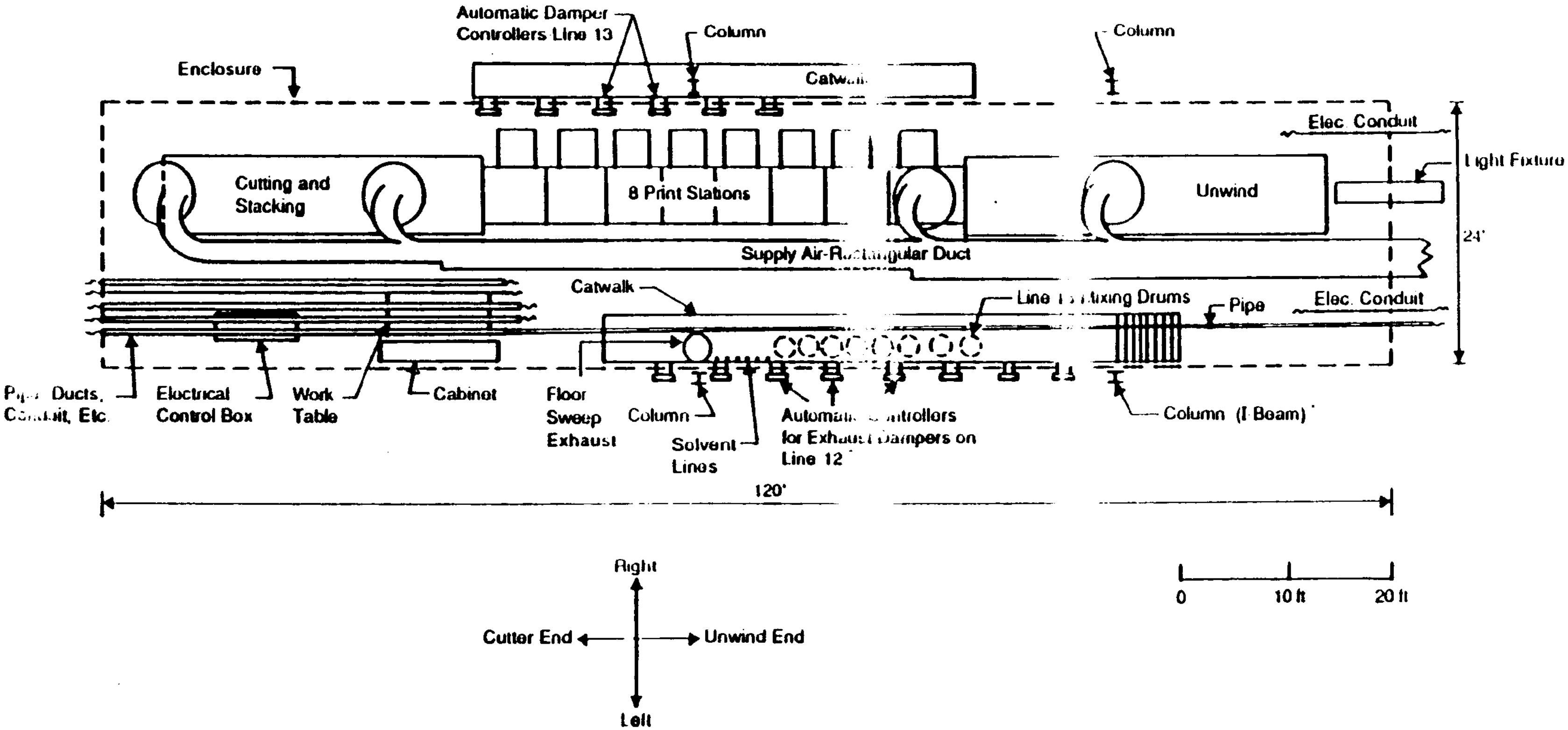

Figure 2. Top view of proposed TTE at Westvaco Corp., Richmond, Virginia.

Top View

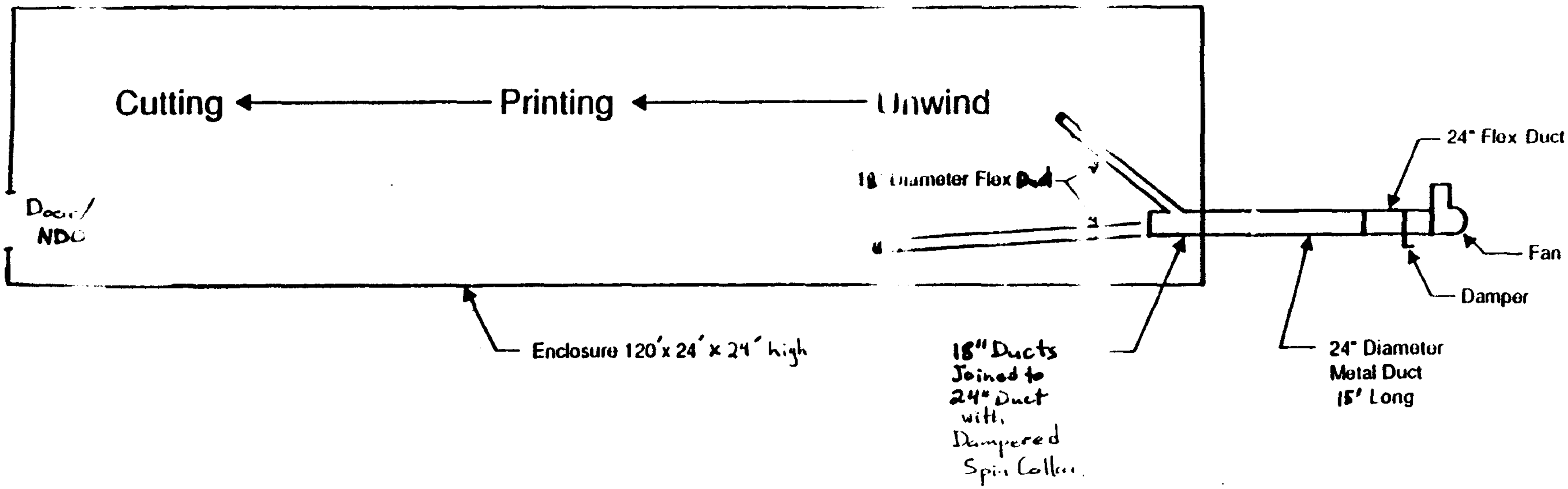

Figure 3. Proposed fugitive exhaust system

TABLE 2. MATERIALS AND LABOR FOR CONSTRUCTION OF A TEMPORARY TOTAL ENCLOSURE AT WESTVACO CORPORATION, RICHMOND, VIRGINIA

Materials	Cost, $	Labor	Cost, $	Total cost, $
1. Sidewalls--24x120'x2				
Construction of side walls. Hang from I-beam with lath strips and C-clamps; duct tape to floor		2 FTEx16 h = 32 MH @$40.00/MH	1,280.00	
Plastic	145.00			
Lath bundles	59.00			
C-clamps	322.00			
Duct tape	14.00			
Floor solvent	25.00			
SUBTOTAL	565.00		1,280.00	1,845.00
2. End walls--24'x24'x2				
Hang from roof bar joist with binder clips and wire ties, duct tape to duct, through-pipe, and floor				
Plastic	35.20	2 FTEx8 h = 16 MH @ $40/MH	640.00	
Binder clips	12.60			
Wire ties	35.00			
Duct tape	10.50			
Scaffold rental (also used in sidewall construction) [4 days x $10/day]	40.00			
SUBTOTAL	133.30		640.00	773.30
3. Exhaust system[a]				
a. Peerless Model 300J belt drive utility blower, 3HP, 460V, 3-phase explosion-proof motor and conduit box 10,340 ft^3/min, 1 in. SP, 877 rpm	2,200.00	1 FTE x 5 h = 5 MH @ $40/MH	200.00	
b. 24 in. Hypolon™ notchlock expansion collar, to blower	62.00			
c. 24 in. x 5 ft flexible duct and damper	182.00			
d. 24 in. x 15 ft duct, blank one end	190.00			
e. Two 18 in. dampered spin collars	160.00			
f. 18 in. flexible ductx60 ft	772.00			
g. Connecting duct clamps	34.00			
SUBTOTAL	3,600.00		200.00	3,800.00
4. Dismantling		2 FTE x 4 h = 8 MH @ $40/MH	320.00	320.00
TOTAL COST	4,298.30		2,440.00	6,738.30

FTE = Full time employee.

MH = Man hour.

[a] An exhaust system was costed out. However, plant representatives stated in a follow-up telephone conversation that there would be enough air flow through the proposed enclosure due to the numerous forced air and exhaust systems to maintain OSHA standards for solvent vapor. However, calculations (included in the attachment) show that an additional exhaust may be necessary.

TABLE 3. SUGGESTED TOOL AND EQUIPMENT LIST FOR INSTALLATION

Tools cost	Equipment
Utility knives	Ladders (2)
Metal snips	Rolling scaffold[a]
Pliers	100 ft 3/8 in. rope
Screwdrivers	Gloves
	Rags

[a]Assumed to be rented.

IV. Cost Analysis

A breakdown of the testing costs is provided in Table 4. Materials, equipment, and labor are listed specifically in Tables 2 and 3. Table 5 summarizes the costs associated with performing the capture efficiency test at the facility.

The major cost of the test program is the actual testing cost ($22,600), not the design and construction of the TTE. This testing cost represents about 76 percent of the total cost, not including the cost of any lost production.

Production losses are estimated at a maximum of 8 hours for this facility. The cost associated with lost production is included in the confidential addendum to this report. The lost production would occur during the construction of the TTE end walls, since the unwind and cutting and stacking areas require unencumbered access during production and the amount of piecing around of obstructions in the end walls is expected to create some spatial hindrances.

Costs are presented for conducting the test on one line. The cost of tests on the other lines is expected to be comparable. It is not clear whether test results from one line could be reasonably generalized to the other lines. The process equipment is not identical, but the air handling systems appear to be very similar. The plant currently demonstrates compliance using a plantwide liquid/liquid material balance. However, one line is subject to LAER requirements, and Region III is pressing for a compliance test on this line alone.

V. Potential Problems

As stated in Section II, the direct-fired ovens present a problem that is not unique to the TTE protocol for determining capture efficiency. The problem is that there likely is destruction of solvents in the ovens that won't be accounted for in the CE determination. Any VOC that is completely destroyed will not be measured. Also, products of incomplete combustion may affect the accuracy of Method 25A for comparison of the captured and fugitive streams.

VI. Conclusions

A TTE can be constructed around line No. 13. The capture efficiency test using the TTE protocol is feasible with the above qualifiers.

Attachment

b1802-6/ESD

TABLE 4. ESTIMATED TESTING COSTS AT WESTVACO CORPORATION, RICHMOND, VIRGINIA

Base cost	
Site survey--1 person, 2 days x 8h x $75/h	$1,200
4 M25 operators--4x3 days x 10h x $70/h	8,400
1 OVA operator--1x3 days x 10 h x $70/h	2,100
2 lab persons--2x3 days x 10h x $70/h	4,200
Preparation and posttest checks--40h x $50/h	2,000
Supplies	500
Data reduction and reporting 40h x $60/h	2,400
Analysis--4 locations x 3 runs x $150/sample	1,800
TOTAL	$22,600
Option: Replace M25 with M25A	
Remove 2 lab persons	-$4,200
Remove analysis	-1,800
Add calibration gases	+1,000
Remove one operator	-2,100
TOTAL	-$7,100

Assumptions

1. Three runs of 1 h each
2. Method 25 uses single sampling trains
3. Estimates include moderate travel costs
4. One day of travel/set-up; 1 day of testing, and 1 day of teardown/travel in field
5. The option requires four THC analyzers, gaining sensitivity of 10 to 100 times M25 but requires more THC's than most test contractors would have available. Combination might be useful.
6. Industrial-style project costing, no test, QA plans, etc.

TABLE 5. COST ANALYSIS FOR THE CAPTURE EFFICIENCY TEST AT WESTVACO CORPORATION, RICHMOND, VIRGINIA

Task	Cost to complete, $
1. Design	
a. Examination of facility	160[a]
b. Design of enclosure	320[b]
2. Materials and equipment rental for construction of TTE	4,300
3. Labor costs for construction of TTE	2,120
4. Lost production	c
5. Testing costs	22,600
6. Dismantling	320[b]
TOTAL	29,820[d]

[a]Four labor hours at $40/h, including benefits and overhead.
[b]Eight labor hours at $40/h, including benefits and overhead.
[c]Eight hours estimated lost production time. The Westvaco Corporation estimate of cost of lost production, in $/h, is contained in the confidential addendum to this report.
[d]Not including lost production costs. The total cost of performing a capture efficiency test, including lost production cost, is included in the confidential addendum to this report.

Attachment

I. Calculation of Necessary Exhaust

Assumptions:

1. 75 lb VOC/h on Line 13.
2. 79 percent capture.
3. Assume all solvent is toluene.
4. 25 ppm background concentration.

(75 lb VOC/h) (1-0.79) = 15.75 lb/h

(15.75 lb/h/92 lb/lbmol) (359 ft^3/lbmol) = 61.5 ft^3/h = 1 ft^3/min

$$100 \text{ ppm (fugitive)} - 25 \text{ ppm (background)} = \frac{\text{VOC } (ft^3/\text{min})}{ft^3/\text{min necessary airflow}}$$

$$\frac{(61.5\ ft^3/h)(h/60\ \text{min})}{} = \frac{(100-25)}{1\times10^6}$$

x = 13,700 ft^3/min

Other exhaust sources:

1.	Floor sweep:	800 ft^3/min
2.	Scrap duct:	2,700 ft^3/min
		3,500 ft^3/min

13,700 ft^3/min-3,500 ft^3/min = 10,200 ft^3/min

The exhaust fan should be sized for 10,200 ft^3/min because there are two other sources that exhaust 3,500 ft^3/min from the enclosure.

II. Criterion Checklist

See Checklist Table for summary.

A. Minimum Face Velocity of 200 ft/min Through NDO's

Under the most likely test conditions, the press exhaust will be operating at or near the maximum rate of 12,000 ft^3/min. The total exhaust rate from the TTE in this case, therefore, will be about 25,700 ft^3/min. However, a forced makeup air system supplies about 7,500 ft^3/min to the enclosure. Thus, the net quantity of makeup air that will flow in through the NDO's is about 18,200 ft^3/min.

The design calls for a doorway measuring approximately 8 ft x 4 ft, or 32 ft^2. Therefore, the face velocity through this NDO is:

$$\frac{18,200\ ft^3/\text{min}}{32\ ft^2} = 570\ \text{ft/min}$$

Therefore, the criterion of greater than 200 ft/min through the NDO's is met.

B. <u>Distance of VOC Emission Sources to NDO's Must Be At Least Four NDO Equivalent Diameters</u>

$\pi r^2 = 32\ ft^2$ (area of doorway)

$r_{eq} = 3.2\ ft$

$D_{eq} = 6.4\ ft$

VOC sources must be $\geq$26 feet from this NDO. From the diagrams, this criterion is met as the end of the TTE at the cutting and stacking end (which is where the doorway would be located) is at least 30 feet away from the closest VOC source, which is the last print station.

C. <u>Distance of NDO's to Hoods or Exhaust Ducts Must Be At Least Four Equivalent Duct Diameters</u>

Since the NDO is at the other end of the TTE from the exhaust duct distance of greater than 100 ft), the criterion of four equivalent duct diameters from the NDO is met.

D. <u>Area of NDO's Must Be Less Than 5 Percent of the Total Surface Area of the TTE</u>

Surface area of NDO: 32 ft^2

Surface area of TTE:

$(120\ ft \times 24\ ft \times 4) + (24\ ft \times 24\ ft \times 2) = 12{,}672\ ft^2$

32/12,672 = 0.003 or 0.3 percent of surface area. Therefore, this criterion is met.

b1802-6A/CBI

CHECKLIST TABLE

	Criterion	Plant-specific design: Applicable value	Plant-specific design: Criterion met
1. Airflow through NDO's	≥200 ft/min inward	570 ft/min	Yes
2. Distance of VOC emission sources to NDO's	≥4 NDO equivalent diameters (26.5 ft)	>30 ft	Yes
3. Distance of NDO's to hoods or exhaust ducts	≥4 hood or duct equivalent diameters (6 ft each)	>100 ft	Yes
4. Area of NDO's	≤5 percent of total surface area of the TTE	0.3 percent	Yes

KENYON INDUSTRIES

MRI REPORT

FINAL COST AND FEASIBILITY STUDY: KENYON INDUSTRIES, INC.

EPA Contract No. 68-02-4379
Work Assignment 26
ESD Project No. 87/07
MRI Project No. 8952-26

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May 16, 1989
(Finalized May 3, 1990)

FINAL COST AND FEASIBILITY ANALYSIS
FOR
KENYON INDUSTRIES, INC.

I. Summary of Analysis and Findings

The Kenyon Industries, Inc. (Kenyon), facility in Kenyon, Rhode Island, performs fabric finishing, drying, printing, and coating on a commission basis. The fabric coating lines generate emissions of volatile organic compounds (VOC) and are the objects of this analysis. A site visit report, dated May 12, 1989 (finalized April 27, 1990), contains detailed information on the process and the facility layout.

A. Temporary Total Enclosure Configuration

Coating line 5 was selected for in-depth analysis based on its large size, relatively complex temporary total enclosure (TTE) requirements, and type of add-on control device (thermal incinerator). This coating line consists of four coating stations and drying ovens alternating in series. Potential TTE configurations were identified and evaluated considering the layout of the process, the locations of affected and nonaffected VOC emission sources, the locations of permanent structures that would aid or obstruct TTE construction, operator access requirements, material flows, health and safety requirements, and the criteria included in the TTE protocol. The proposed enclosure would consist of four TTE's, each enclosing one of the coating stations and the normal work area of the station's operator. Each of the individual TTE's would have a fugitive emission exhaust duct. These four ducts would join, and the common duct would pass through an unused stack to a fan located on the plant roof. Additional detail on the TTE configuration can be found in Section II, Part B, and in Section III.

B. Materials of Construction

The proposed TTE's would be constructed of 6-mil plastic sheeting. The support structure would consist of existing structures augmented with wire and 2x4's as necessary. More detail on construction is presented in Section III.

C. Testing

The gas streams, sampling locations, and U. S. Environmental Protection Agency (EPA) Methods for the capture efficiency determination were tentatively identified. (Final identifications will be made in the testing phase of this project should testing be carried out at this facility.) Volumetric flow rate and VOC concentration measurements would be conducted on the incinerator inlet duct and the common fugitive emission exhaust duct using EPA Methods 1 through 4 (M1-M4) for the volumetric flow rate measurements and EPA Method 25A (M25A) for the VOC concentration measurements. It appears that a suitable test point for the volumetric flow rate measurement is present in the incinerator inlet without any duct modifications, provided cyclonic flow is not present.

For each run, simultaneous M25A measurements at the two test locations would be made continuously over a 1-hour (h) period. Volumetric flow rate measurement traverses would be conducted at each point before and after each test run. A single point on the traverse would be monitored continuously during the 1-h test runs.

The ambient VOC concentration inside the TTE's would be monitored with an OVA meter during the test runs to ensure that steady-state conditions exist and that the personnel exposure standards are not violated. The ambient VOC concentration outside the enclosures would be monitored with an OVA meter to evaluate the potential for VOC drawn in through the natural draft openings (NDO's) to affect the capture efficiency determination significantly.

Additional detail on testing considerations is presented in Section II, Part D. Testing costs are presented in Part IV.

D. Specifications

Specifications have been prepared for the TTE, including drawings of the TTE structure and a list of the materials and equipment necessary to construct the TTE. The specifications are presented in Section III.

E. Cost Analysis

The costs associated with performing a capture efficiency determination using the TTE protocol have been estimated based on the TTE specifications and sampling locations selected. All aspects of constructing and dismantling the TTE would total approximately $9,900. Additional costs of about $15,000 would be incurred for the testing, for a total of approximately $24,900. Details on costs are presented in Sections III and IV.

II. Options Considered and Rationale for Selections

A. Production Line to be Evaluated

The facility has six fabric coating lines. All the coating lines consist of floating knife coaters followed by infrared drying ovens. Line 3 has only one coater and drying oven. Lines 1, 2, and 6 each consist of two coaters and two drying ovens. Lines 4 and 5 each consist of four coaters and four drying ovens. On the lines with multiple coaters and ovens, the fabric web is alternately coated and dried as it passes sequentially through a coater, a drying oven, then to the next coater and drying oven, and so on until it has passed along the entire line.

Line 5 was chosen for detailed analysis because of its large size, the relatively complicated TTE configuration required, and the add-on control device (thermal incinerator) used to reduce emissions. Lines 1, 2, and 3 are older, smaller lines located together in a small room that could be augmented with plastic film relatively easily to construct a common TTE or individual TTE's. Line 4 is similar in size and complexity to line 5, but its emissions are controlled and recovered with a system of dedicated condensers. For this reason, compliance determinations for line 4 would be very likely to be conducted using a liquid/liquid material balance. Line 6 is smaller than line 5 and also is controlled using dedicated condensers to recover VOC emissions.

B. TTE Configuration

The first decision to be made in considering the TTE configuration is whether the drying oven can be considered part of the total enclosure or must itself be enclosed. For the drying oven to be considered part of the enclosure, VOC emissions must not escape the drying oven as fugitive emissions. All VOC emissions must be vented through ducts or stacks. As a means of determining whether this condition is met, the draft TTE protocol requires that the drying oven meet the general criteria specified for a total enclosure.

As illustrated in Attachment 1, the drying ovens on line 5 meet all the criteria of the protocol except that governing the minimum allowable distance between the NDO's and the sources of VOC. However, this criterion will never be met at a drying oven entrance slot, and conformity at the exit slot and any other NDO's is doubtful for any drying oven. Of course, the drying oven entrance slot at this or any facility will not be a problem because the entrance slot must be within the TTE for the enclosure to capture emissions from the entire flashoff area. The same is not necessarily true of the drying oven exit slot. Nevertheless, drying ovens are constructed to contain the VOC emissions generated within them. Airflow patterns within the oven generally are engineered rather than haphazard. The comfort of the employees and OSHA exposure standards dictate that drying ovens be operated at negative pressure so that VOC does not escape into the process area. For these reasons, the requirement that a drying oven meet the criteria for a TTE in order to avoid being enclosed by the TTE should be reevaluated when revisions to the protocol are considered.

In the case of the drying ovens on line 5, it is unlikely that significant VOC escapes through the exit slot or the row of makeup air intake holes in the back wall of the oven. As shown in Attachment 1, the average velocity inward through these openings is in excess of 200 feet per minute (ft/min). The orientation of the intake holes relative to the wet web within the oven is unknown, but it is clear that the exit slot (which has a much greater area than the intake holes) is oriented such that the air entering the slot will flow parallel to the web after it has already been dried. Thus, the air entering the exit slot will not impinge directly on the wet web, and little turbulence will be created.

For the reasons discussed above, it would be unnecessary for the drying ovens at this facility to be within the TTE. The emission points that would have to be within the TTE are the coater, the coating supply vessel, and the flashoff area.

The smallest enclosure that could contain these sources would actually consist of four small enclosures, each fitting closely around the coating equipment (including the coating supply vessel) adjacent to the drying oven entrance. The operator would remain outside these small TTE's. This configuration was rejected for several reasons. The TTE's would hamper operator access to the coating equipment, which is frequently required during operation. With such small TTE's, it would be difficult to size and locate the NDO's to meet the criteria of the protocol, particularly if openings must be provided in specific locations for operator access. Also, location of the NDO's so close to the emission points could significantly alter the normal airflow patterns, changing the rate of evaporation and the performance of the capture system. Finally, the TTE would have to be largely freestanding; little use could be made of existing structures for support.

Instead of these small TTE's enclosing the coaters, larger individual TTE's enclosing the normal work area of each coating station's operator were selected for this facility. Each of the four TTE's would encompass the entire area between successive drying ovens and extend outward on either side of the line to include the coating supply container in the left aisle and the drying oven control panel in the right aisle. The operators typically would remain inside the enclosures during the test runs; covered doors would be supplied to allow passage in and out of the enclosures as necessary. This configuration is illustrated and discussed in greater detail in Section III where the TTE specifications are presented.

An evaluation of the TTE's in relation to the protocol's design criteria is presented in Attachment 2. As discussed in the attachment, the TTE's might have difficulty meeting the criteria that establish the minimum allowable distances between NDO's and VOC sources or exhausts. These difficulties would result from the relatively small size of the TTE's. However, as presented in Attachment 2, the TTE's would violate only the letter of the criteria; the conditions that the criteria were intended to prevent would not occur in the TTE's. For this reason, this configuration was not rejected. This situation indicates that the design criteria in the protocol should be reevaluated when revisions to the protocol are considered.

A single large TTE consisting of walls running from the plant ceiling to the floor to enclose the entire line was considered for this analysis and rejected. Such an enclosure could meet all the design criteria of the protocol but would be much larger than the selected combination of four TTE's. A single large enclosure would have to contend with numerous obstructions avoided by the selected configuration. The large enclosure would have to include the line's nonaffected curing oven, which would require an additional sampling point, or the builders would have to contend with placement of the TTE end wall between the final drying oven and the curing oven. Finally, a large enclosure would not take advantage of the existing support structures conveniently located above each coating station.

The fugitive emissions from each of the four TTE's of the selected configuration would be exhausted through a dampered duct connected to a fan and ductwork suitable for emission testing located on the plant roof. As an alternative, the fugitive exhaust system could be placed entirely within the plant and exhausted inside. However, this might create obstructions to the normal flow of materials and personnel. Also, an "explosion-proof" fan would be required for fire safety, increasing the fan cost.

C. Materials of Construction

Plastic sheeting (6 mils thick) was chosen for the walls and roof of the enclosures because it is lightweight, inexpensive, and offers some visibility from outside the enclosure. Plastic sheeting is also easy to work with because it can be cut and resealed and can be moved easily if necessary. Also, the TTE could be vacated quickly in case of emergency.

Support for the four TTE's would come largely from existing structures. Above each coating station there is a framework suspended from the ceiling trusses to support the light fixtures and electrical conduit that serve the station. This framework would provide much of the necessary support for each station's individual TTE. Additional support would be provided by existing ductwork to the left of the line and an electrical bus to the right of the line. These existing structures would be augmented as necessary with wire and 2x4's to complete the support structure for the TTE's.

The support system outlined above was selected instead of a self-supporting wooden frame. A wooden frame would be more costly in materials and labor to construct and dismantle. Also, the selected supports would take up less space than a wooden frame in the aisles on either side of the line.

D. Testing

Figure 1 is a schematic of the proposed sampling points for the capture efficiency test. This figure has been adapted from a schematic supplied by Kenyon. Table 1 presents the suggested measurements, test methods, and frequencies for each sampling point. At this facility, short product runs are the rule. Consequently, use of the TTE protocol option that allows testing with and without the TTE to determine capture efficiency is not recommended. Capture efficiency would be calculated by dividing the VOC mass flow rate from test location 1 (exhaust duct to the incinerator) by the sum of the VOC mass flow rates from test locations 1 and 2 (fugitives exhaust).

In addition to the measurements at test locations 1 and 2, measurements at locations 3a through 3d and 4a through 4d have been included in the tentative test program. The ambient measurements inside the TTE's (locations 3a through 3d) would indicate whether the system is at steady state and whether personnel exposure regulations are in danger of being violated. The ambient measurements outside the TTE's would

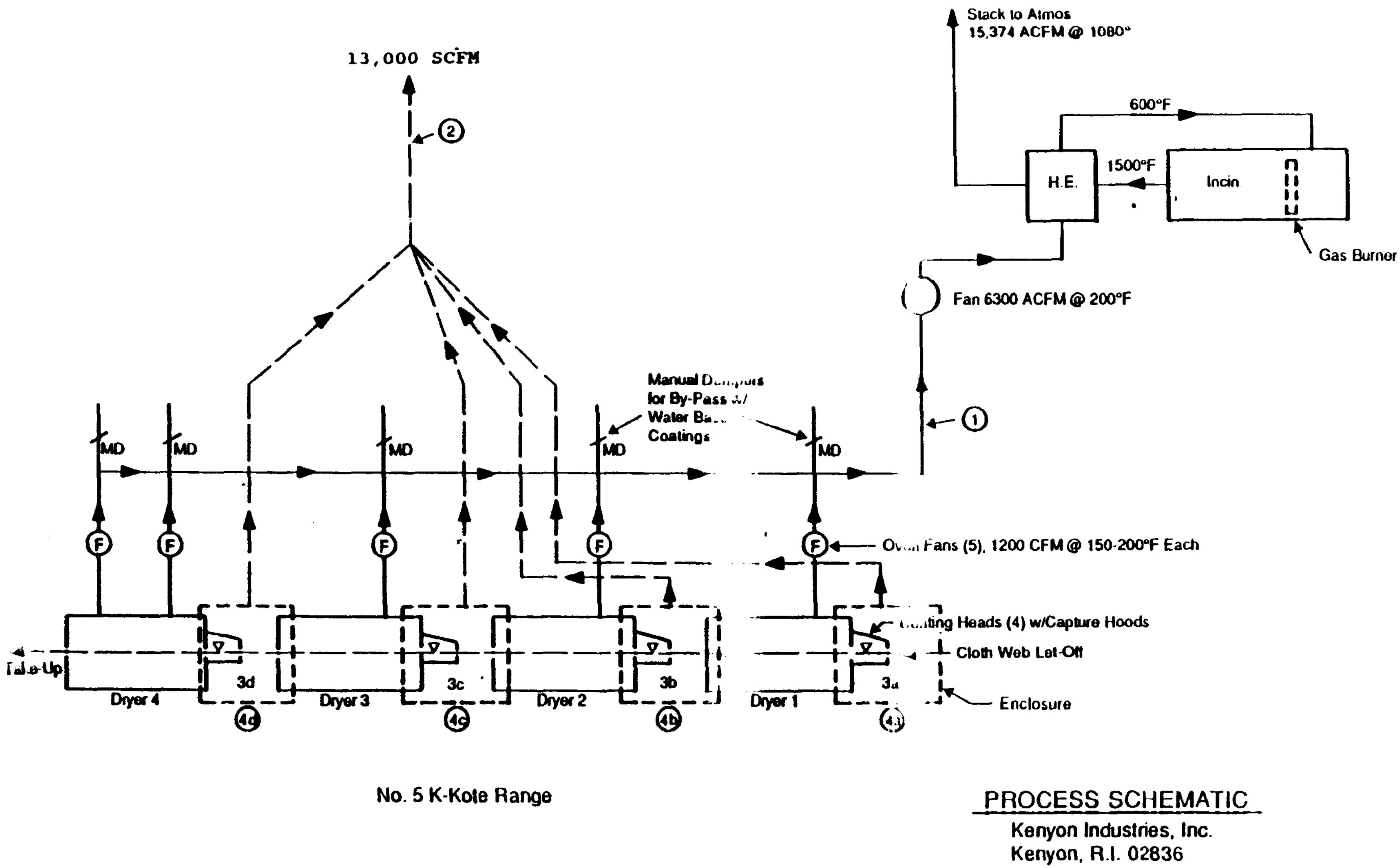

Figure 1. Sampling points at Kenyon Industries, Inc. (Adapted from schematic supplied by the facility.)

TABLE 1. SAMPLING PLAN FOR KENYON INDUSTRIES, KENYON, RHODE ISLAND

Test location	Measurement	Method	Frequency
1. Captured	Volumetric flow	M1-M4	Traverse before/after run; continuously monitor single point
	VOC	M25A	1 h continuous runs
2. Fugitive	Volumetric flow	M1-M4	Traverse before/after run; continuously monitor single point
	VOC	M25A	1 h continuous runs
3a, b, c, d Inside ambient	VOC	M25A (OVA)	Monitor, alternating among locations during test runs
4a, b, c, d Outside ambient	VOC	M25A (OVA)	Monitor, alternating among locations before and after test runs

Alternative--Replace M25A with M25

provide an indication of whether a significant quantity of VOC enters the TTE's through the NDO's.

Method 25A is recommended for measuring VOC concentrations at test locations 1 and 2. Method 25A uses a total hydrocarbon analyzer with a flame ionization detector (FID) and provides a continuous measurement. A continuous measurement would allow the test crew to monitor emission levels and adjust parameters such as the fugitive exhaust flow rate before actual test runs begin. In addition, M25A has a low detection limit, and relatively low VOC concentrations are expected in the fugitive exhaust.

As an alternative to M25A, EPA Method 25 (M25) could be used at test locations 1 and 2. Although M25 involves collecting gas samples for subsequent analysis in the laboratory and has a higher detection limit than M25A, M25 might be preferable over M25A if there were a significant difference in the VOC compositions of the gas streams at test locations 1 and 2. However, this condition is not expected at this facility. Because M25 is used for tests of incinerator destruction efficiency, M25 might be desirable for the capture efficiency test in cases where the capture efficiency and control device efficiency tests are conducted concurrently, as would be likely for a compliance test. Using M25 for both tests would allow a single measurement of the incinerator inlet stream (test location 1) to be used in both calculations. If M25A were used for capture efficiency measurements and incinerator destruction efficiency measurements also were desired, the incinerator inlet stream would have to be measured using both M25A and M25.

An OVA portable FID instrument is recommended for semicontinuous monitoring of the ambient VOC concentrations inside and outside the TTE's (test locations 3a through d and 4a through d) because a lesser level of accuracy is acceptable for these measurements. When M25A is used at test locations 1 and 2, the OVA could be "calibrated" against the test FID to provide a basis of comparison.

III. Specifications

Drawings of three views of the proposed TTE's are presented in Figures 2, 3, and 4. A drawing of the proposed fugitive exhaust system is presented in Figure 5.

The materials used to construct the TTE's and their costs are listed in Table 2. The greatest expense is associated with the exhaust system fan and ducting. The fan was sized based on the quantity of ventilation air needed to maintain the concentration of VOC in the enclosures at a maximum of 100 ppm. The required fan size was calculated to be 13,000 cubic feet per minute (ft^3/min). The assumptions and calculations that provide the basis for this fugitive exhaust rate are presented in Attachment 3. In addition to the materials necessary for construction of the TTE's, Table 2 lists the estimated labor hours required to construct and dismantle the TTE's.

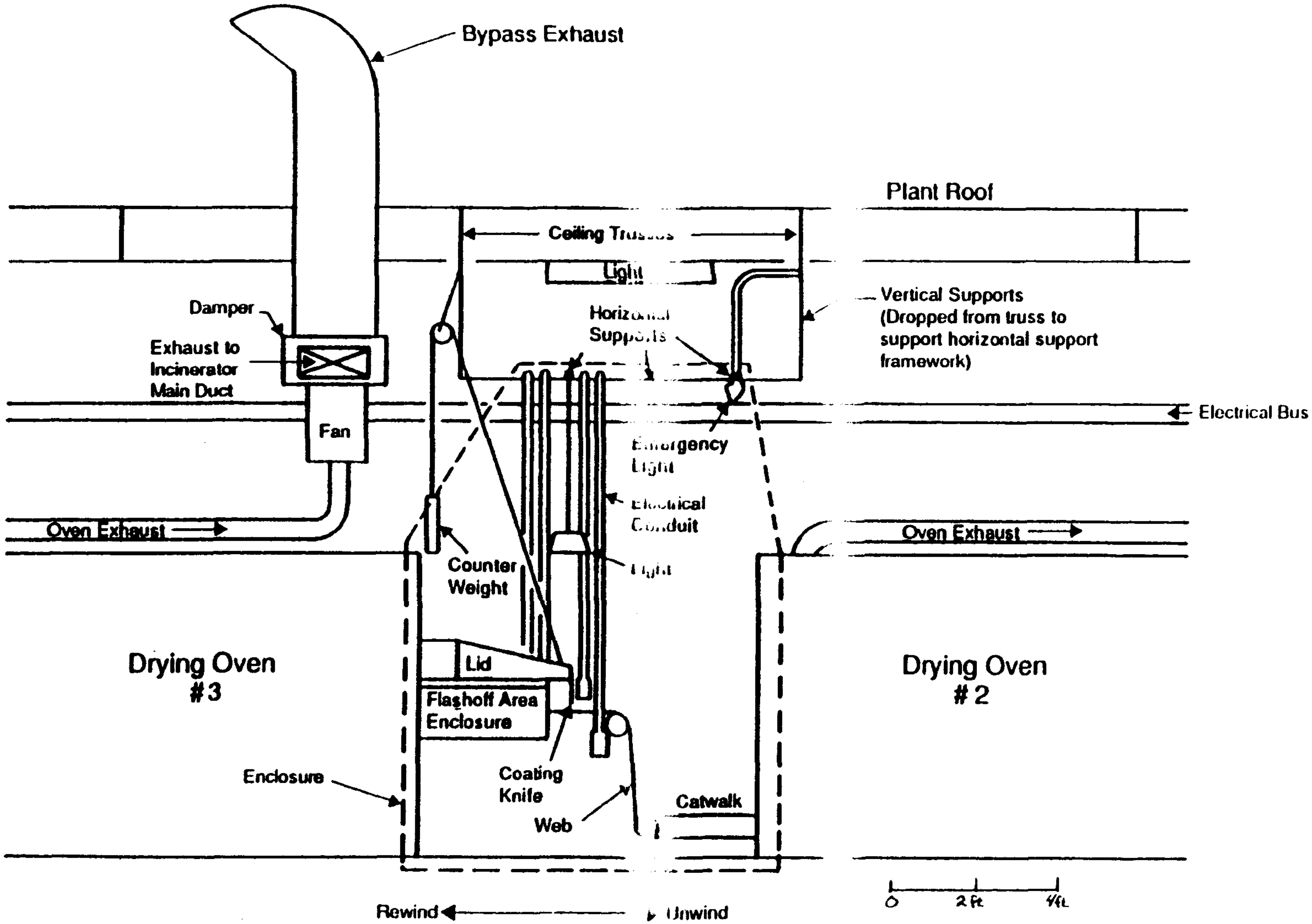

Figure 2. Side view of third coating station (typical of all coating stations).

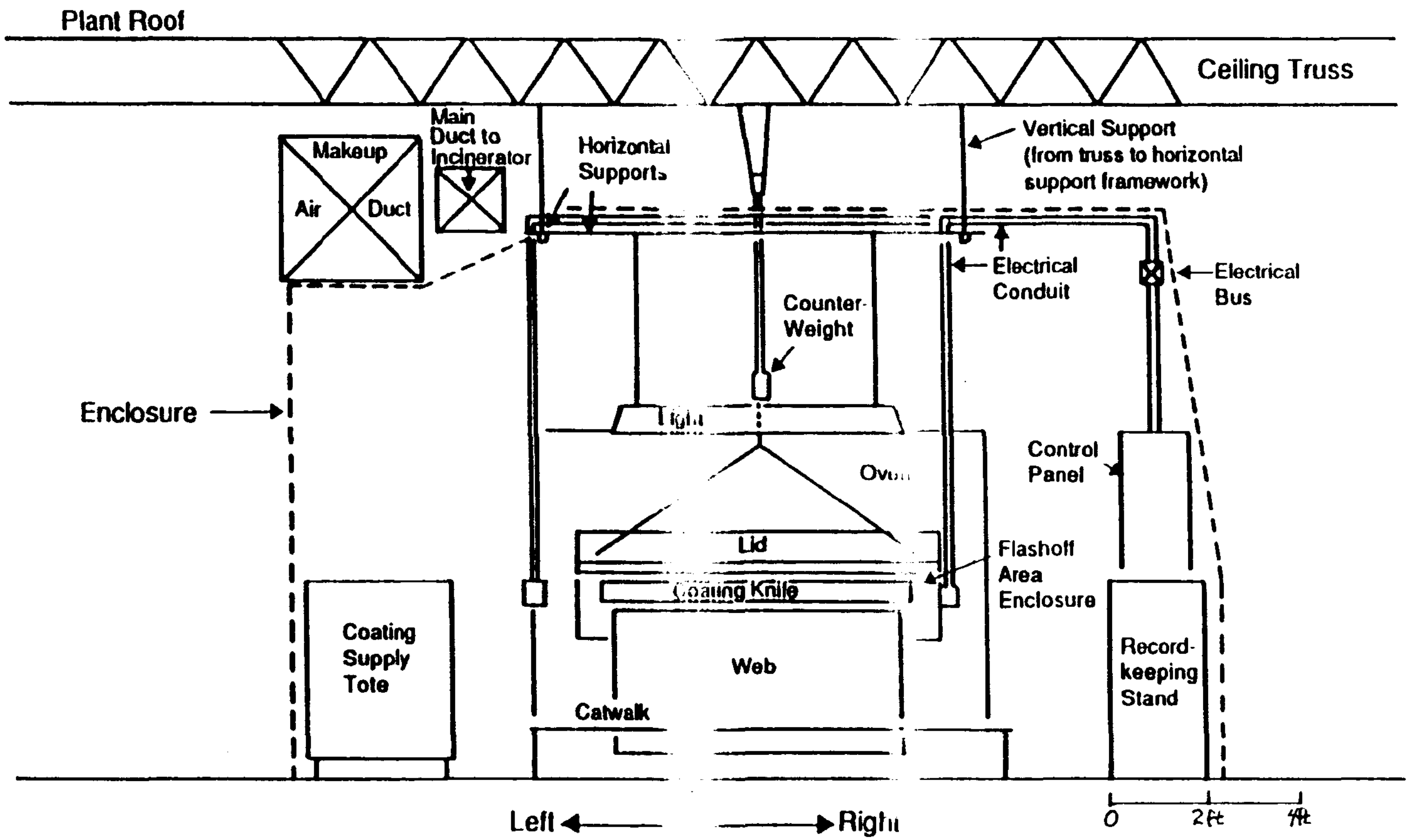

Figure 3. Front view of first coating stati... enclosure (g...erally typical of all stations).

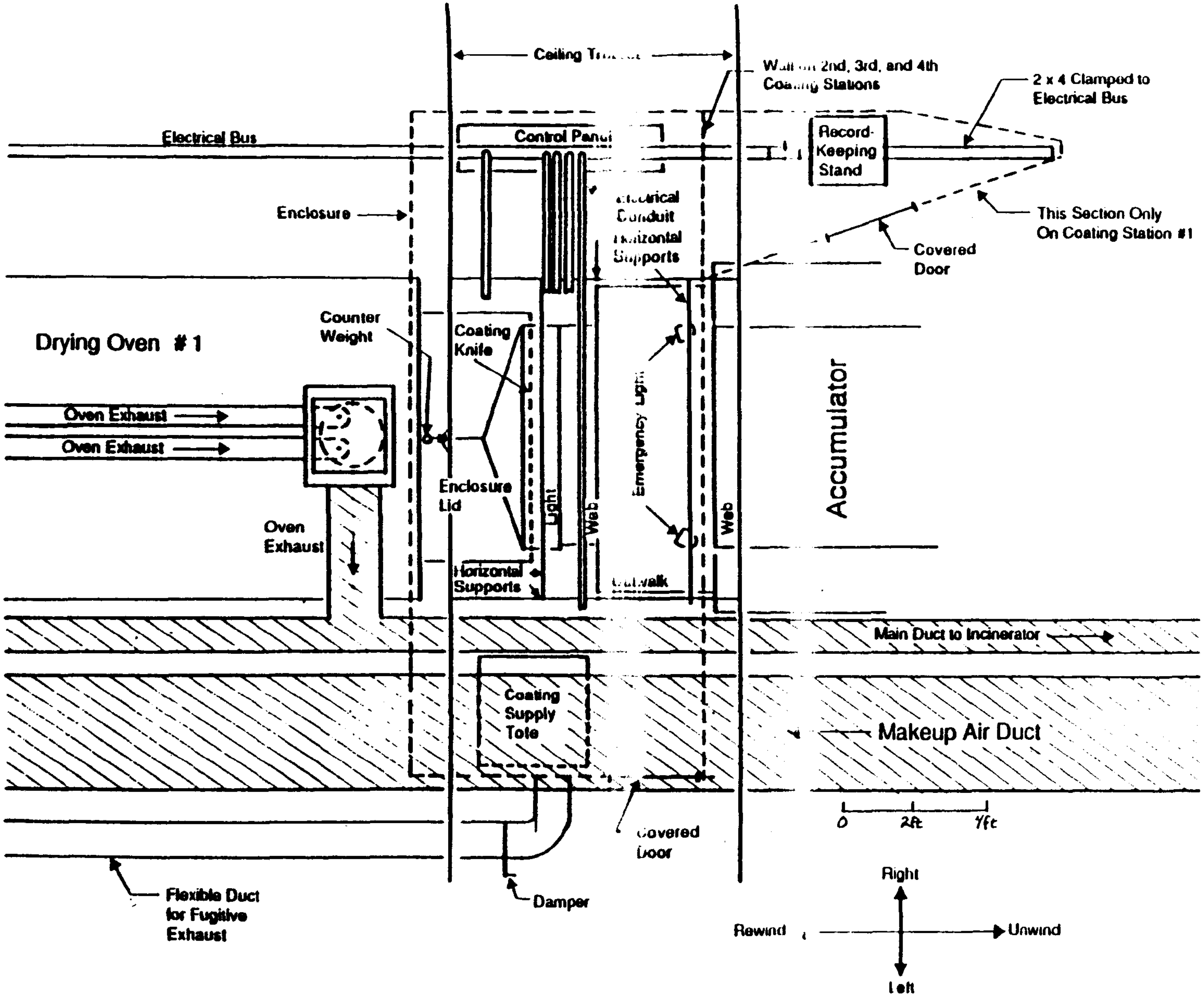

Figure 4. Top view of first coating station enclosure (generally typical of all stations).

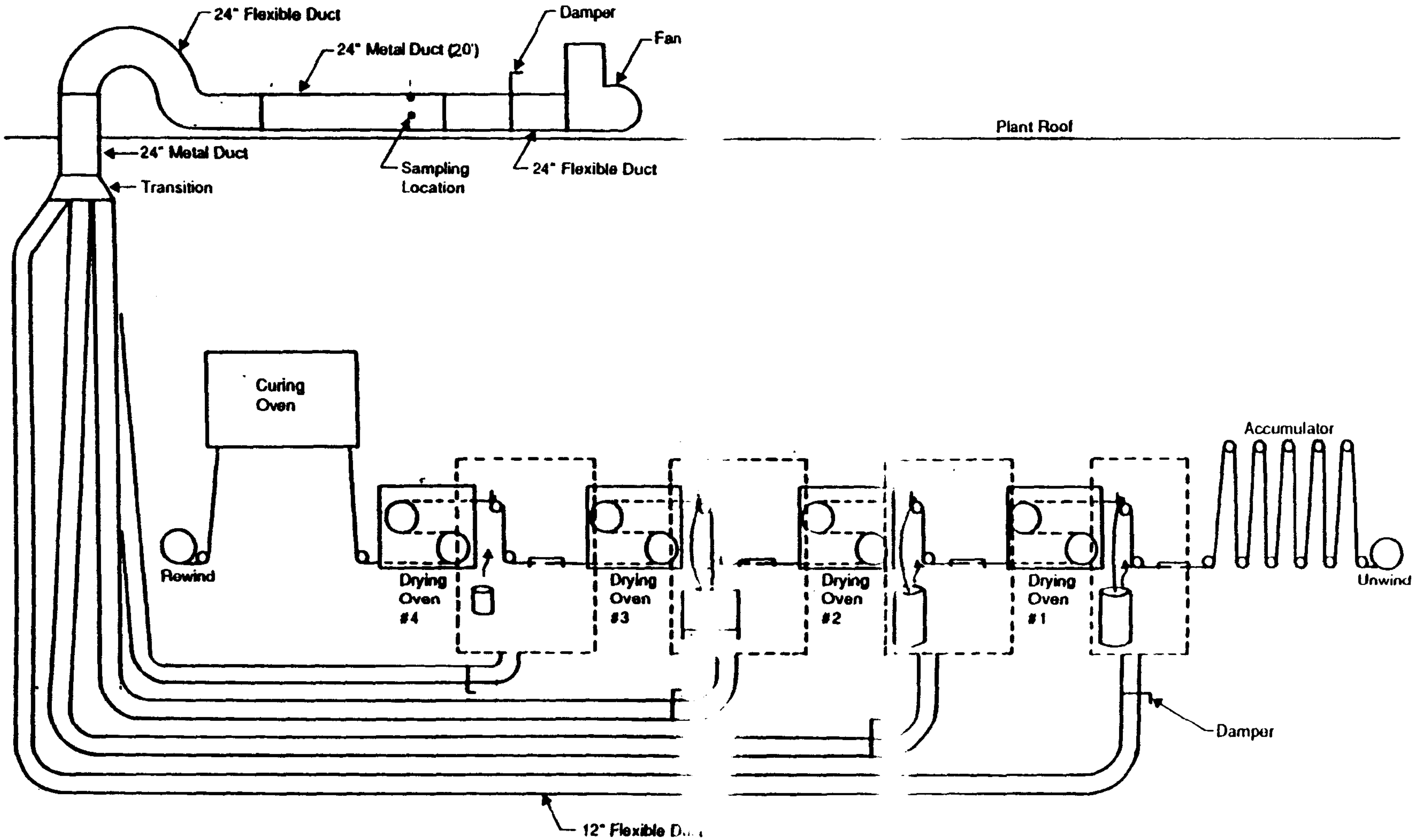

Figure 5. Proposed fugitive exhaust system.

TABLE 2. MATERIALS AND LABOR FOR CONSTRUCTION OF TEMPORARY TOTAL ENCLOSURES AT KENYON INDUSTRIES, KENYON, RHODE ISLAND

Materials	Quantity	Cost, $	Labor	Cost, $	Total cost, $[a]
FRAMING (1st station)					
1. 2 in.x4 in.x16 ft lumber	2	6.00	Fabricate support framing	160.00	
2. Tie wire	4 lb roll	3.10	2 FTEx2 h = 4 MH @ $40/MH		
3. 5 in. C-clamps	10	59.20			
PLASTIC SHROUDING (1st station)					
1. 6-mil plastic (20 ft wide)	75 ft	56.00	Hang plastic, clip wall to ceiling plastic,		
2. 6-mil plastic (12 ft wide)	36 ft	21.00	seal all joints, i.e., wall to wall, wall		
3. Duct tape	3 rolls	10.50	to ceiling, wall to oven and accumulator,		
4. Medium binder clips	1 gross	12.60	wall to floor		
5. Floor cleaning solvent	1 gal	25.00	2 FTEx4 h = 8 MH @ $40/MH	320.00	
6. Rolling scaffold rental	2 @ 4 days	80.00			
7. 16-ft walkboard rental	4 days	40.00			
1st STATION SUBTOTAL		313.40		480.00	793.40
2nd, 3rd, and 4th stations					
FRAMING					
1. 2 in.x4 in.x16 ft lumber	3	9.00	Fabricate support framing	480.00	
2. Tie wire	4 lb roll	3.10	2 FTEx6 h = 12 MH @ $40/MH		
3. 5 in. C-clamps	15	88.80			
PLASTIC SHROUDING					
1. 6-mil plastic (16 ft wide)	200 ft	112.00	Hang plastic, clip walls to ceiling	960.00	
2. 6-mil plastic (12 ft wide)	100 ft	42.00	plastic, seal all joints as above		
3. Duct tape	6 rolls	21.00	2 FTEx12 h = 24 MH @ $40/MH		
4. Binder clips	3 gross	37.80			
5. Floor cleaning solvent	2 gal	50.00			
6. Rolling scaffold rental	Included above	--			
7. 16-ft walkboard rental	Included above	--			
2nd, 3rd, AND 4th STATION SUBTOTAL		363.70		1,440.00	1,803.70

(continued)

TABLE 2. (continued)

Materials	Quantity	Cost, $	Labor	Cost, $	Total cost, $[a]
EXHAUST SYSTEM					
1. Utility blower 13,000 ft^3/min	1	2,300.00	Mount blower and instruments on roof platforms. Drop flex duct and electrical extension cord for roof power requirements 2 FTEx8 h = 16 MH @ $40/h	640.00	
2. 12 in. flex duct drops	4	2,080.00			
3. 12 in. full blast gate dampers	4	382.80			
4. 12 in. connecting duct clamps	16	52.20			
5. 24 in. flexible duct with damper	5 ft	182.00			
6. 24 in. sheet metal duct (include 12 in.x24 in. transition)	5 @ 5 ft	520.00			
7. Roof support clamps	4	62.00			
8. 24-in. duct clamps	4	36.00			
9. 4 ftx8 ftx1/2 in. plywood for roof platforms	2	50.00			
EXHAUST SYSTEM SUBTOTAL		5,665.00		640.00	6,305.00
DISMANTLING			2 FTEx6 h = 12 MH @ $40/h	480.00	480.00
TOTAL		6,342.10		3,040.00	9,382.10

[a] Materials and labor.
FTE = full time employee.
MH = man hour.

Table 3 lists the tools and equipment necessary for construction of the TTE's. It was assumed for the cost analysis that the facility would have access to all these items at no cost except for the rolling scaffolds and walkboard. The scaffolds and walkboard rental charges were included in Table 2.

For each coating station's TTE, the left side wall would be hung from the bottom of the duct that supplies makeup air to the coating room. The wall would be located to contain the coating supply vessel (a 450-gallon "tote" or a 55-gallon drum). Openings in the room makeup air supply duct within the TTE would be sealed off because the volume of these forced airstreams would be difficult to determine accurately. The right side wall of each TTE would be suspended from the electrical bus and would fall outside the drying oven control panel to include the panel in the TTE. On the first coating station, the bus would be extended using a 2x4 so that the recordkeeping stand could be included (see Figure 4).

The end wall of the TTE's toward the rewind end of the line would be supported with a wire running from the makeup air supply duct to the overhead horizontal support frame, then by the frame itself over the coating station, and finally by the electrical conduit that runs across the right aisle from the support frame to the electrical bus. These walls would hang to the floor in the aisles and would be fastened to the sides and top of the drying oven at that end of the coating station.

The end walls at the unwind end of the second, third, and fourth coating stations would be similarly hung. Because there is no conveniently placed electrical conduit spanning the right aisle at this end of the coating stations, a 2x4 would be placed between the support frame and the electrical bus to support the wall in this area. (The placement of electrical conduit varies among the stations; 2x4's will be used where necessary to span the right aisle for either end wall.) Again, the walls will extend to the floor in the aisles and will be attached to the sides and top of the drying oven at that end of the station. Thus, the exit slots and makeup air intake holes of all but the final drying oven will be inside one of the TTE's.

The first coating station wall at the unwind end would be somewhat different from that described above for the other stations. Here the wall would be suspended from a wire strung between the 2x4 extension of the side wall and the overhead support frame. This configuration would complete the inclusion of the recordkeeping stand. Where the wall crosses the coating line, it would extend down to the back of the operator's catwalk because there is no drying oven preceding this station. From there, the wall would be identical to the other stations.

The roof of the TTE would pass just over the support frame over the coating station. This frame and the wall supports would support the roof. The roof would be joined to the side and end walls. The light fixture immediately above the coating knife would be included in the TTE, providing adequate light for the operator.

TABLE 3. SUGGESTED TOOL AND EQUIPMENT LIST FOR INSTALLATION

Tools	Equipment
Utility knives	Two narrow rolling scaffolds
Side cutter pliers	16-ft walk board
Hand saw	Two 8-ft ladders
Pliers	Rags
Wrenches	Fire extinguishers (4)
Hammers	Over wall hoist
Gloves	
16-ft tape measure	

Suggested staging of construction

1. Place blower and ductwork
2. Place framing
3. Place top plastic
4. Place side plastic

A series of small NDO's would be cut in both end walls that cross the right aisle. Additional small NDO's would be cut in the roof above the right aisle and/or in the right wall above the control panel. Together, the area of the NDO's for each TTE would total more than 8 square feet (ft^2) but less than 23 ft^2. The size and placement of the NDO's was chosen to allow the TTE's to achieve the intent of the protocol's design criteria and, at the same time, operate at a static pressure relative to the coating room (maximum differential of less than 0.05 inches of water) that would maintain the integrity of the TTE. This NDO placement also would tend to establish a general airflow from the NDO's at the right of the line toward the fugitive exhaust pickup at the left, which would tend to sweep the VOC from the enclosure. At the same time, the makeup air entering the NDO's would not impinge directly on the coating equipment, and significant effects on the normal evaporation rate and capture efficiency would be avoided.

Each TTE would be exhausted by a dampered duct. The four individual ducts would be joined to a single duct passing through an unused roof exhaust at the end of line 4. (In order to use this exhaust, the existing stack would have to be removed.) A horizontal run of duct on the plant roof would afford a suitable test point. The system fan would be located on the roof either before and after the horizontal test duct according to the preference of the testing contractor. This system is illustrated in Figure 5.

IV. Cost Analysis

The total cost of conducting a capture efficiency determination at this facility using the TTE protocol is estimated to be about $24,900. This total cost includes costs associated with TTE design, materials, equipment rental, labor, lost production, and testing for the TTE design specified in Section III.

The specifics of the cost of materials, equipment, and labor are presented in Tables 2 and 3. The details of the proposed test program were presented earlier in Section II, Part D. Specific costs associated with the testing are broken down in Table 4.

Except for the testing crew, a wage rate of $40 per hour, including fringes and overhead, has been used throughout this analysis. This value is likely to overstate the actual wage rate in many cases, but has been adopted to be conservative. The wage rate included for testing personnel has been adjusted upward to allow for moderate travel costs.

Table 5 summarizes the costs associated with performing the capture efficiency test at this facility. The first component cost in Table 5 is design of the TTE's. This step is further subdivided into the onsite evaluation phase and the actual design phase.

During the onsite evaluation, one individual would examine the affected facility to be tested, noting the physical and process-related requirements for the TTE's, taking the necessary measurements, and

TABLE 4. ESTIMATED COSTS FOR SAMPLING AT KENYON INDUSTRIES
KENYON, RHODE ISLAND

Base cost	Dollars
Site survey--1 person, 2 days x 8 h x $75/h	1,200
1 THC operator--1 x 3 days x 10 h x $70/h	2,100
2 velocity persons--2 x 3 days x 10 h x $70/h	4,200
1 OVA operator--1 x 3 days x 10 h x $70/h	2,100
Preparation and posttest checks--40 h x $50/h	2,000
Calibration gases and supplies	1,000
Data reduction and reporting 40 h x $60/h	2,400
TOTAL	15,000
<u>Alternative</u>--Replace M25A with M25 at test locations 1 and 2	
Same size crew	
Add analysis--2 locations x 3 runs x $150/sample	900
Add 1 lab person--1 x 3 days x 10 h x $70/h	2,100
Less calibration gases	-1,000
ADDED COST	2,000

<u>Assumptions</u>

1. Three runs of 1 h each
2. Method 25 options will use single sampling trains
3. Estimates include moderate travel costs
4. 1 day of travel/setup; 1 day of testing; and 1 day of teardown/travel in field

TABLE 5. COST ANALYSIS FOR THE CAPTURE EFFICIENCY TEST AT KENYON INDUSTRIES, KENYON, RHODE ISLAND

Task	Cost to complete, $
1. Design	
a. Examination of facility	160[a]
b. Design of enclosure	320[b]
2. Materials and equipment rental	6,342
3. Construction labor	2,560[c]
4. Lost production	0
5. Testing costs	15,000
6. Dismantling labor	480[d]
TOTAL	24,862

[a]Four labor hours at $40/h, including fringes and overhead.
[b]Eight labor hours at $40/h, including fringes and overhead.
[c]Sixty-four labor hours at $40/h, including fringes and overhead.
[d]Twelve labor hours at $40/h, including fringes and overhead.

sketching the layout. This process would be similar to the site visit conducted for this analysis but would not be as extensive. Under normal conditions, the evaluation would be limited to the single line for which testing was being required and would not include the extensive background discussions with plant personnel on the TTE protocol and the process that were necessary for this study. In addition, the site survey for testing purposes would be a separate activity carried out by the testing contractor. The cost of this test survey is included in the testing costs. The onsite evaluation phase of TTE design is estimated to require 4 hours. At a labor rate of $40 per hour, this activity would cost $160.

During the actual design phase, the ventilation requirements for the TTE's would be determined from process information. The proposed TTE configuration would then be evaluated relative to the criteria in the protocol to verify that the criteria can be met. Upon corroboration that the criteria can be met, drawings of the TTE's and materials, equipment, and labor specifications would be prepared. These activities might or might not be carried out by a single individual, but the total labor required is estimated at 8 hours. At $40 per hour, the cost of this phase would total $320.

The next two component costs in Table 5 are drawn from Table 2. Materials and equipment rental costs for TTE construction are estimated at $6,342. The construction labor cost estimate totals $2,560 for 64 labor hours.

The fourth item in Table 5 is the value of production lost during construction and dismantling of the TTE's. At this facility, no lost production is expected. Placement of the exhaust system and the TTE support framing could be accomplished during the week prior to testing because these activities could be conducted while the process operates. Placement of the plastic ceiling and walls, which might require the line to be shut down, could be accomplished without lost production on the weekend prior to testing because the facility does not operate for more than half a day on weekends.

The testing costs appear next in Table 5. At $15,000, this component is the major cost of using the TTE protocol. This cost estimate is based on the use of EPA Method 25A for VOC measurements; if Method 25 were used, testing would cost about $2,000 more.

The final component cost listed on Table 5 is the cost of dismantling the TTE. It is estimated that this activity would take about 12 labor hours for a total cost of $480. Most of the dismantling could be accomplished without shutting down the process; the balance (e.g., roof) could wait until the line was down for the weekend. Thus, no production is expected to be lost as a result of dismantling the TTE.

Taken together, the component costs discussed above total almost $24,900 for the TTE design specified in Section III. However, the costs could be greatly reduced if the facility were allowed to test only one coating station and to generalize the results to the other stations. In this case, the cost of TTE construction would be cut by about 75 percent, although actual testing costs would not be reduced. A technical problem with this approach is the lack of a suitable test point in the drying oven exhaust duct prior to its junction with the main duct to the incinerator. In any case, it would seem unlikely that such an approach would be approved because of the variable coating application rates and the variations in configuration at the various stations of the line.

The cost analysis presented above is specific to line 5. Compliance tests for lines 4 and 6, which are each served by inert atmosphere condensation systems, would not be expected to involve capture efficiency determinations. Rather, these lines' emissions reductions likely would be determined using liquid/liquid material balances. Lines 1, 2, and 3 might be tested using the TTE protocol. These lines are controlled by a thermal incinerator.

The cost of testing lines 1, 2, and 3 would be expected to be considerably less than the cost for line 5. These lines are much smaller and are located in a small room. The capture efficiency determination cost would be minimized if the applicable regulation allowed the three lines to be tested together. In that case, the room containing the lines could be adapted fairly easily to function as an enclosure for testing. Even if individual tests were required, the existing room could be augmented with plastic sheeting to form individual TTE's without great difficulty. However, the ductwork to the incinerator that serves these lines was not examined. While it is likely that a suitable point could be found for a combined capture efficiency determination, it is not known if suitable test points are present for determinations of the capture efficiencies of the individual lines.

V. Potential Problems

Other than the difficulties in meeting the letter of the protocol's design criteria (discussed in Attachment 2), no potential problems with determining capture efficiency using the TTE protocol that are specific to this facility have been identified for the selected coating line.

VI. Conclusions

1. Four individual TTE's that meet the intent of the criteria in the protocol could be constructed around the coating stations of line 5 at this facility. The total cost of the TTE's and fugitive exhaust system is estimated at about $9,900.

2. Suitable test points for the gas-phase measurements necessary to determine capture efficiency appear to exist at this facility, provided that the fugitive exhaust system is constructed to provide a suitable location. The estimated cost of the gas-phase testing is about $15,000.

3 Attachments

b1806-5/ESD

Attachment 1

EVALUATION OF DRYING OVENS VS. TTE CRITERIA

1. Average face velocity through natural draft openings $\geq$200 ft/min.

   Minimum oven exhaust rate is 1,200 ft^3/min at 150° to 200°F (see Figure 1). At standard conditions (32°F, 1 atmosphere), this exhaust rate is a minimum of:

   $$1{,}200\ ft^3/min \left(\frac{460 + 32}{460 + 200}\right) \approx 895\ scfm$$

   Natural draft openings:

   Entrance slot--4 in. x 70 in.
   Exit slot--4 in. x 70 in.
   Intake holes--7 at 3 in. diameter

   Total NDO area

   $$\frac{(2 \times 4\ in. \times 70\ in.) + (7 \times \pi \times (1.5\ in.)^2)}{144\ in.^2/ft^2}$$

   $$\approx 4.2\ ft^2$$

   Minimum average face velocity (FV):

   $$FV = 895\ scfm/4.2\ ft^2 \approx 213\ ft/min$$

   (Note: Drying oven No. 4, with twice the exhaust rate used above, would have a face velocity exceeding 400 ft/min)

2. Distance between VOC sources and NDO's $\geq$4 x NDO equivalent diameter.

   This criterion is not met for these drying ovens or any other drying ovens. See the discussion on this subject in Section II, Part B.

3. Distance between exhaust ducts or hoods and NDO's $\geq$4 X exhaust equivalent diameter unless the enclosure is a permanent installation.

   This criterion is not applicable because the drying ovens are permanent installations.

4. Total area of NDO's $\leq$5 percent of the enclosure surface area.

   The minimum oven dimensions (No. 4 is larger than the others) are approximately 9.5 ft wide by 14 ft long by 7 ft high.

   $$Area = (2 \times 9.5 \times 14) + (2 \times 9.5 \times 7) + (2 \times 14 \times 7) = 595\ ft^2$$

   Maximum allowable NDO area:

   $$595\ ft^2 \times 0.05 \approx 30\ ft^2$$

As calculated above for Criterion No. 1, the NDO area is only 4.2 ft^2, so this criterion is met.

5. The VOC concentration inside the enclosure must not continue to increase but shall reach a constant level.

   This criterion is more applicable to TTE's erected to contain process fugitive emissions. However, these drying ovens will surely meet this criterion because they are designed and operated to meet Factory Mutual requirements for fire safety.

Attachment 2

EVALUATION OF TTE's vs. CRITERIA

1. Average face velocity through natural draft openings ≥200 ft/min.

Each coating station's TTE needs ventilation air (i.e., fugitive exhaust) totaling 3,250 scfm (32°F, 1 atmosphere) to maintain VOC concentration at 100 ppm at the maximum coating application rate (see Attachment 3). In addition, the makeup air for the drying ovens will be drawn through the TTE's because the oven openings will be within the TTE's. As indicated in figure 1, the first three drying ovens have exhaust rates of 1,200 acfm at 150° to 200°F (about 930 scfm), and the fourth oven has double this exhaust rate (2,400 acfm, or about 1,860 scfm). Assuming that half the makeup air for each oven enters through the web entrance slot (located in the oven's front wall) and half enters through the web exit slot and intake holes (located in the back wall), the minimum volume of air that must be drawn through each enclosure's NDO's at the maximum coating application rate is as follows:

Dampered enclosure serving Coater 1:
(Enclosure contains inlet to Drying Oven No. 1)

3,250 scfm + 465 scfm = 3,715 scfm

Dampered enclosure serving Coater 2:
(Enclosure contains outlet from Drying Oven No. 1 and inlet to No. 2)

3,250 scfm + 465 scfm + 465 scfm = 4,180 scfm

Dampered enclosure serving Coater 3:
(Enclosure contains outlet from Drying Oven No. 2 and inlet to No. 3)

3,250 scfm + 465 scfm + 465 scfm = 4,180 scfm

Dampered enclosure serving Coater 4:
(Enclosure contains outlet from Drying Oven No. 3 and inlet to No. 4)

3,250 scfm + 465 scfm + 930 scfm = 4,645 scfm

Thus, to maintain average face velocities of at least 200 ft/min under these conditions, the maximum allowable NDO area varies from about 18 ft^2 for the first TTE to about 23 ft^2 for the fourth.

Only the first coating station has a process-imposed NDO, the area under the operator's catwalk where the web enters the TTE. The functional area of this opening is not certain because it is partially blocked by a roller. Based on the outside dimensions of the opening (about 9 ft x 1 ft), the maximum area is 9 ft^2. Thus, this mandatory NDO meets this criterion, and any additional NDO's added in the first coating station can be sized so that the total area continues to meet the criterion.

On the other coating stations, no process-imposed NDO's are required. The NDO's can be placed and sized to meet the criterion. The total area of the NDO's for these stations will be between 8 and 23 ft^2.

Final verification that the TTE's meet this criterion will have to be made at the time of the test because the actual ventilation volume will not be known until then. The NDO areas can be adjusted as necessary at that time.

2. Distance between VOC sources and NDO's $\geq$4 X NDO equivalent diameter.

The only potential problem with meeting this criterion is the opening under the operator's catwalk where the web enters the first coating station's TTE. The outside dimensions of the opening are about 9 ft x 1 ft. As discussed above, the functional area of this NDO is uncertain because a roller blocks much of the area. With a straight-line distance to the nearest VOC source (the coating knife) of about 5 ft, the maximum equivalent diameter this opening could have to meet the letter of this criterion is only 1.2 ft, corresponding to an opening of 9 ft x 1.6 in. If the opening is considered to function as two separate NDO's, one above the roller and one below, it is possible that each of the openings would conform to these dimensions. Detailed measurements of the opening that could confirm or rule out this interpretation were not made during the site visit. In any case, other considerations indicate that the opening under the catwalk would not cause the problems that this criterion is intended to prevent. According to the preamble to the protocol, this criterion is intended to keep air entering an NDO from impinging directly on a VOC source, creating turbulence that could carry VOC back out through the NDO. This situation would not occur in this case because the air entering this opening would be channeled under the catwalk and could not impinge directly on any VOC source. Therefore, while the letter of this criterion may not be met, the purpose of the criterion is not violated. This situation indicates that this criterion should be reevaluated when revisions to the protocol are considered.

No problems with this criterion would be encountered for any other NDO's in any of the individual TTE's. These NDO's can be sized and placed to meet the criterion. However, because the TTE's are relatively small, several small NDO's would have to be supplied for each instead of a few larger NDO's. The most likely placement would be in the portion of the TTE to the right of the line. A likely arrangement would have five 1-ft square NDO's in each of the walls crossing the right aisle and in the roof above the aisle. With this configuration, the letter of the criterion could just be met (NDO's each at least 4.5 ft from the nearest VOC source), and the air entering the NDO's would not be directed straight at any VOC sources. Also, the entering airstreams would intersect from different directions, breaking up the directionality of the individual streams and further preventing direct impingement on the sources of VOC inside the enclosure.

3. Distance between exhaust hoods or ducts and NDO's ≥4 X exhaust equivalent diameter.

Each individual TTE would have a fugitive exhaust duct with a 1-ft diameter and a slot above the coating knife (1 in. x 70 in.) that would serve as an enclosure exhaust. (Makeup air enters the drying oven that follows the coater through the slot.) In addition, all but the first coating station would have the back wall of the preceding oven within the TTE. This oven wall has seven 3-in. intake holes and the exit slot (4 in. x 70 in.), which would all act as enclosure exhausts as makeup air for the ovens was drawn in through them.

Only the oven exit slots present any problem with the letter of this criterion. The fugitive exhaust duct, located in the left wall of the TTE, would be more than the required 4 ft from the NDO's. The slot above the coating knife would be separated from the NDO's by more than the required 3 ft, and the small intake holes in the back wall of the oven would be more than the required 1 ft away from the NDO's. However, the NDO's placed in the wall that crosses the right aisle from the end of the preceding oven to the right wall would be only about half the required 6.3 ft from the nearest end of the oven exit slot. The other NDO's would be far enough away from the slot. As discussed above in relation to the second criterion, the failure to meet the letter of this criterion should not be significant in this case. There is no discussion of the purpose of this criterion in the protocol preamble, but presumably the criterion is intended to avoid the channeling of air from an NDO into an exhaust. Were channeling to occur, the normal capture achieved by a permanent exhaust could be altered, and the exhausts might not adequately remove VOC from the TTE, allowing the concentration to increase to potentially dangerous levels. (This latter effect is addressed more directly by the following criterion.) However, such channeling is unlikely in this case because the critical exhaust opening (the preceding oven's exit slot) and the nearest NDO's would be in approximately the same plane. Thus, the airstream entering the NDO's would not be directed toward the exit slot and would not be channeled into the slot. Also, because of the orientation of the NDO's, the airstreams would be expected to intersect and lose their directionality before channeling could occur. This criterion should be reevaluated when revisions to the protocol are considered.

4. Total area of NDO's ≤5 percent of the enclosure surface area.

This criterion would be easily met. The surface area of each TEE (with approximate dimensions of 16 ft x 8 ft x 11 ft high) is:

$$(2 \times 16 \times 8) + (2 \times 16 \times 11) + (2 \times 8 \times 11) = 784 \text{ ft}^2$$

Five percent of this area is about 39 ft^2. Because the NDO's would be sized to meet Criterion No. 1, which imposes a maximum total NDO area of about 23 ft^2, this criterion would certainly be met also.

5. The VOC concentration inside the enclosure must not continue to increase but shall reach a constant level.

The fugitive exhaust system at this facility has been designed to meet this criterion. The exhaust fan has been sized to provide adequate ventilation volume for the maximum coating application rate on each of the coaters. Each TTE's exhaust duct would have a damper to allow the flows from each to be adjusted and balanced. Finally, the exhaust duct would be located across the TTE from the NDO's, so the general airflow should sweep the enclosure of VOC.

There is potential for fugitive VOC emissions to increase above the level at maximum production when equipment is cleaned with solvents between process runs. Because testing will be suspended at such times, the TTE doors can be opened and the makeup air supply vents can be uncovered to ensure that the atmosphere within the TTE's remains safe and healthful.

Attachment 3

CALCULATION OF NECESSARY EXHAUST, KENYON INDUSTRIES

Assumptions

1. 10 gal/h maximum coating use per station
2. Coating is 50 percent solvent by weight
3. Coating density is 8 lb/gal
4. Fugitives comprise 10 percent of sovlent by weight
5. Solvent is toluene

Volume of ventilation air (at background concentration of 20 ppm) needed to dilute fugitives to 100 ppm:

$$\left(\frac{10\text{ gal}}{\text{h}}\right)\left(\frac{8\text{ lb}}{\text{gal}}\right)(0.50)(0.10) = 4\text{ lb toluene/h}$$

$$(4\text{ lb tol/h}) \div (92\text{ lb/lbmol toluene}) = 4.3\text{x}10^{-2}\text{ lbmol tol/h}$$

At standard conditions (32°F, 1 atm)

$$\left(\frac{359\text{ ft}^3}{\text{lbmol}}\right)(4.3\text{x}10^{-2}\text{ lbmol/h}) = 15.6\text{ ft}^3\text{/h}$$

$$\frac{15.6\text{ ft}^3\text{/h}}{x} = \frac{(100-20)}{1\text{x}10^6}$$

$$x = 195{,}000\text{ ft}^3\text{/h} = 3{,}250\text{ scfm/coater}$$

Total for all four coaters = 13,000 scfm

ATLANTA FILM CONVERTING COMPANY

MRI REPORT

FINAL COST AND FEASIBILITY STUDY: ATLANTA FILM CONVERTING

EPA Contract No. 68-02-4379
Work Assignment 26
ESD Project No. 87/07
MRI Project No. 8952-26

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I. INTRODUCTION

The Atlanta Film Converting facility in Atlanta, Georgia, prints flexible packaging such as plastic film that is used mostly for food wrapping. At the time of the site visit in September 1988, the facility operated two six-color flexographic presses (one "stack" press and one "central impression" [CI] press) and one laminator. A site visit report, dated February 17, 1989, contains detailed information on the process and the facility layout at the time of the site visit. Since that time, the stack press has been replaced by a new CI press, and the bulk of the facility's production has been shifted to the new press. However, this facility has been analyzed based on conditions as they existed at the time of the site visit because no details of the subsequent modifications are known. This report presents the findings of the cost and feasibility analysis of constructing a temporary total enclosure (TTE) and conducting a capture efficiency (CE) test according to the draft procedure at this facility prior to the recent modifications.

There is one exception to the above statement that the analysis was based on conditions as they existed during the site visit. At that time, the facility did not control emissions of volatile organic compounds (VOC). Each press's overhead dryer and between-color dryers were exhausted directly to the atmosphere through separate stacks. However, a determination of CE is useless and would not be conducted in the absence of an add-on control device. Therefore, this analysis was carried out as if the dryer exhausts from the selected press were joined on the plant roof into a common duct leading to a control device.

II. OPTIONS CONSIDERED AND RATIONALE FOR SELECTION

A. Production Line to be Evaluated

The CI press was chosen for analysis because, at the time of the site visit, the bulk of the facility's output was produced on that press. At that time, the CI press operated up to 24 hours a day, thus making operator access requirements more stringent than those of the stack press, which was operated a maximum of one shift per day. The stack press also was of obsolete design (according to facility representatives) and likely would not be typical of other small, independent flexographic press operations. Finally, the CI press is larger than the stack press and would require more time and materials to enclose.

B. Temporary Total Enclosure Configuration and Materials of Construction

It was determined that the TTE should enclose the entire press, including the unwind and rewind stations. This configuration would allow the press operators to remain inside the TTE much of the time rather than frequently passing in and out to monitor the parts of the press inside and outside the enclosure. In addition, enclosing the entire press would avoid the difficult task of piecing an enclosure wall around the overhead dryer and the ductwork on top of the dryer. For the CI press, the TTE dimensions would be 18 feet (ft) wide by 36 ft long. The TTE roof would have to be at least 16 ft high to clear the press and ductwork. A fugitive exhaust would be located in the end wall of the enclosure nearest the CI cylinder. Additionally, the following three stacks would pierce the roof of the enclosure: (1) the between-color dryer exhaust stack, (2) the overhead dryer exhaust stack, and (3) the makeup air intake duct for the overhead dryer. There would be one door measuring approximately 4 ft x 8 ft located in the side wall of the TTE on the side of the press where print cylinders and rolls of film are changed out. Natural draft openings (NDO's) would be located in the end wall of the TTE nearest the unwind/rewind end of the press, the opposite end from the fugitive exhaust. As indicated in Attachment 1, this TTE configuration would meet the criteria in the draft test procedure.

A self-supporting wooden frame covered by 6-mil polyethylene was chosen over the following two options: (1) dropping polyethylene enclosure walls from the plant ceiling, thereby using the plant ceiling as the TTE ceiling; and (2) dropping polyethylene enclosure walls from the bottom of the ceiling support trusses, leaving open spaces (which would function as NDO's) between the top of the walls and the plant ceiling, which also would be the TTE ceiling. The latter two options actually might prove to be less costly in both materials and labor; however, because this site visit was made before the cost and feasibility study plan was formulated, not enough information about the CI press area (including potential overhead obstructions to the TTE construction) was gathered during the site visit for a proper evaluation of these options. Therefore, the construction of a self-supporting frame was used in evaluating the cost and feasibility of performing a capture test at this facility using the CE/TTE protocol. The selection of this construction option has the added benefit for the overall project of generating cost figures that could be applicable at other facilities where the other options would not be feasible.

C. <u>Testing</u>

The gas streams, sampling locations, and EPA methods for measuring VOC for the CE determination were tentatively identified. Figure 1 presents a schematic of the proposed sampling locations, while Table 1 is a summary of the sampling plan for the facility. (Final identifications will be made in the testing phase of the project should testing be carried out at this facility.) Measurements would be conducted on the fugitive exhaust stream and the capture stream to the control device using EPA Methods 1 through 4 (M1-M4) for volumetric flow rate and EPA Method 25A (M25A) for VOC concentration. In addition, a volumetric flow measurement of the overhead dryer intake air duct would be performed using M1-M4 so that the average face velocity across the NDO's could be calculated. The VOC concentration inside the TTE would be continuously measured during each run using an OVA meter, while the ambient VOC concentration outside the enclosure would be measured before and after each run using the same OVA meter.

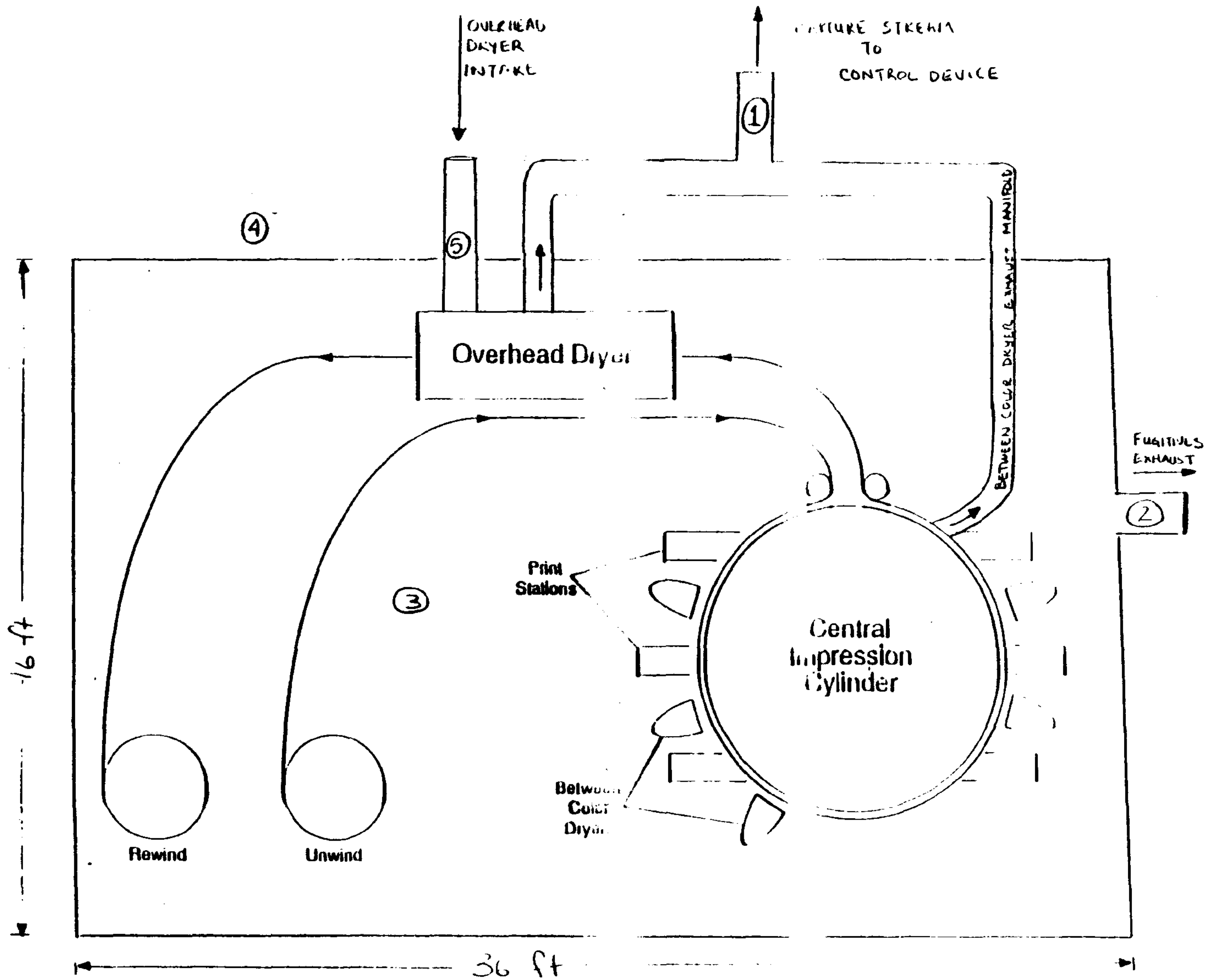

Figure 1. Proposed testing locations fo Atlanta Film Converting, Atlanta, Georgia.

TABLE 1. SAMPLING PLAN FOR ATLANTA FILM CONVERTING, ATLANTA, GEORGIA

Test location	Measurement	Method	Frequency
1. Captured[a]	VOC VEL	M25A M1-M4	1-h continuous each run Traverse before/after run; continuous single point measurement
2. Fugitive[a]	VOC VEL	M25A M1-M4	1-h continuous each run Traverse before/after run; continuous single point measurement
3. Inside ambient	VOC	M25A (OVA)	1-h continuous each run
4. Outside ambient	VOC	M25A (OVA)	Before/after run
5. Dryer intake	VEL	M1-M4	Traverse before/after run; continuous single point measurement

M25A = flame ionization analyzer (FIA).
M25 = total gaseous nonmethane organics (TGNMO).
[a]Simultaneous sampling.

Option: Replace M25A with M25 at locations 1 and 2.

The M25A measurements using the OVA meter would verify that steady-state conditions prevail inside the enclosure and would be used to evaluate the potential for VOC drawn in through the NDO's to affect the CE determination significantly. A great degree of accuracy in the measurements is not necessary; therefore, the use of an OVA meter is appropriate. For the capture and fugitive stream VOC concentration measurements, however, flame ionization analyzers with a higher degree of accuracy would be used. The VOC concentration measurements would be made continuously during each run, while the volumetric flow determinations would be made before and after each run with a continuous single point measurement during each run.

III. Specifications

Tables 2 and 3 present the materials and labor costs for construction of a TTE and the suggested tools and equipment necessary for construction. The TTE would consist of a 16-ft-high, self-supporting wooden frame to which polyethylene would be fastened to form the TTE walls and ceiling. The plastic sheeting would be fastened to the frame with staples initially; the stapled areas subsequently would be reinforced with wood laths. Duct tape would be used to seal any gaps in the plastic and to piece around the three exhaust vents. Figure 2 presents a diagram of the enclosure.

The fugitive exhaust system would consist of two 15-ft flexible duct pickups with 18-inch (in.) diameters joined with dampered join collars into a single 15-ft, 24-in.-diameter metal duct to provide a sampling location. The exhaust fan was sized for about 6,600 cubic feet per minute as indicated by the calculations presented in Attachment 2.

IV. Cost Analysis

The costs associated with performing the test according to the draft protocol have been estimated based on the TTE specifications and sampling locations selected. The specific material and labor costs of constructing and dismantling the TTE are presented in Table 2. The details of the proposed test program were presented in Section II, Part C. A breakdown of the testing costs is provided in Table 4.

Table 5 summarizes the costs associated with performing the CE test at the facility. Of the total estimated cost of about $20,000, the major cost of the test program is the actual testing cost ($15,000).

V. Potential Problems

The destruction of VOC emissions in the direct-fired dryers used at this facility presents a problem because the destroyed VOC will not be measured as having been captured. (This would be a problem no matter which CE determination method was used.) Also, because some partial combustion products may be present, the use of M25 over M25A might be preferred for this stream, even though the measurement of the low VOC concentration in the fugitive exhaust stream dictates the use of M25A.

TABLE 2. MATERIALS AND LABOR FOR CONSTRUCTION OF A TEMPORARY TOTAL ENCLOSURE AT ATLANTA FILM CONVERTING COMPANY, ATLANTA, GEORGIA

Materials	Quantity	Cost, $	Labor	Cost, $	Total cost
Enclosure					
1. 2 in.x4 in.x16 ft boards	107	321.00	Build self-supporting frame, attach plastic with staples and laths	360	
2. Wood laths	2 bundles	22.00	2 FTEx12 h = 24 MH at $40/MH		
3. 6 milx16 ft plastic	150 ft	55.00			
4. Nails, 16 d	25 lb	17.75			
5. Nails, 4 d	10 lb	9.80			
6. Duct tape and staples		18.60			
7. Rolling scaffold rental	2 @ 3 days	60.00			
SUBTOTAL		504.15		360	1,464.15
Exhaust system					
1. 6,600 ft^3/min explosion-proof fan with motor		1,550.00	Install exhaust system	320	
2. Flexible 18 in. duct and clamps	2 @ 15 ft	386.00	2 FTEx4 h = 8 MH at $40/MH		
3. 18 in. dampered spin collars	2	160.00			
4. 24 in. flexible duct and damper	5 ft	182.00			
5. 24 in. metal duct	15 ft	190.00			
6. 24 in. clamps	[illegible]	[illegible]			
SUBTOTAL		2,486.00		320	2,806.00
Dismantling					
			Dismantle enclosure 2 FTEx4 h= 8 MH at $40/MH	320	
SUBTOTAL		0		320	320.00
TOTAL		[illegible]90.15		[illegible]	[illegible]

FTE = full time employee.

MH = manhour.

TABLE 3. SUGGESTED TOOL AND EQUIPMENT LIST

Tools	Equipment
Skilsaw	Two narrow rolling scaffolds
Utility knife	10 ft step ladder
Hammer	
Tri square	
Staple-gun	
Ramset and concrete nails (if wish to anchor TTE to floor)	

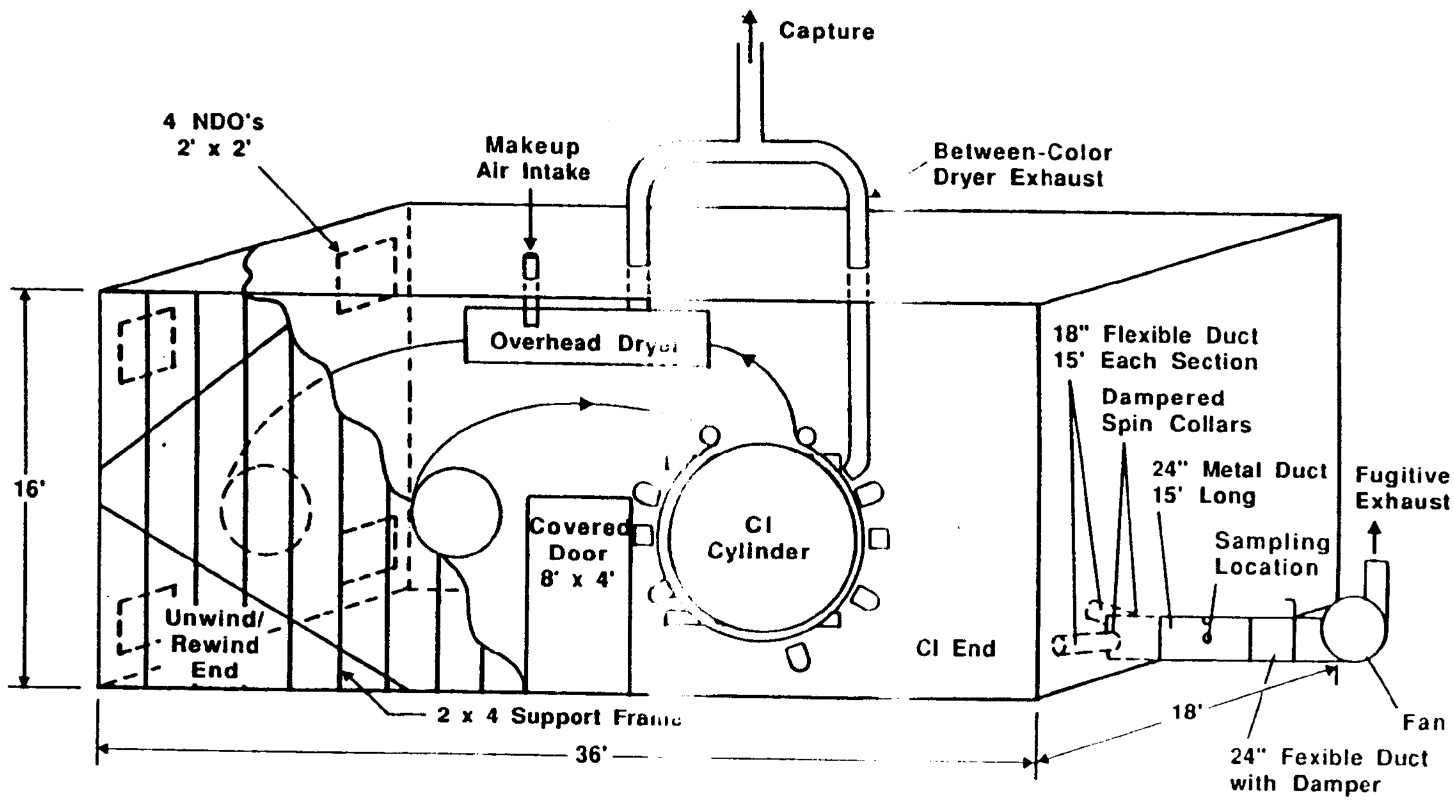

Figure 2. Proposed TTE for Atlanta Film Converting, Atlanta, Georgia.

TABLE 4. SAMPLING COST ESTIMATE FOR ATLANTA FILM CONVERTING, ATLANTA, GEORGIA

<u>Base cost</u>	
Site survey--1 person, 2 days x 8 h x $75/h	$ 1,200
1 THC operator--1 x 3 days x 10 h x $70/h	2,100
2 velocity persons--2 x 3 days x 10 h x $70/h	4,200
1 OVA operator--1 x 3 days x 10 h x $70/h	2,100
Preparation and posttest checks--40 h x $50/h	2,000
Calibration gases and supplies	1,000
Data reduction and reporting 40 h x $60/h	2,400
TOTAL	$15,000
<u>Option</u>: Replace M25A with M25 at 1, 2	
Same site crew	
Add analysis--2 points x 3 runs x $150/sample	$ 900
Add one lab person--1 x 3 days x 10 h x $70/h	[illegible]
Less calibration gases	-1,000
ADDED COST	$ 2,000

<u>Assumptions</u>

1. Three runs of 1 h each
2. Method 25 options will use single sampling trains
3. Estimates include moderate travel costs
4. One day of travel/set-up, 1 day of testing, and 1 day of teardown/travel in field

TABLE 5. COST ANALYSIS FOR THE CAPTURE EFFICIENCY TEST AT ATLANTA FILM CONVERTING, ATLANTA, GEORGIA

Task	Cost to complete, $
1. Design	
a. Examination of facility	160[a]
b. Design of enclosure	320[b]
2. Materials and equipment rental	2,990
3. Construction labor	1,280[c]
4. Lost production	
5. Testing costs	15,000
6. Dismantling	320[b]
TOTAL	20,070

[a]Four labor hours at $40/h, including benefits and overhead.
[b]Eight labor hours at $40/h, including benefits and overhead.
[c]Thirty-two labor hours at $40/h, including benefits and overhead.
[d]No production loss expected because TTE can be constructed and dismantled during weekends when the plant normally does not operate.

VI. Conclusions

A TTE can be constructed around the CI line. The CE test using the CE/TTE protocol is feasible.

2 Attachments

Attachment 1

EVALUATION OF TTE VS. CRITERIA

1. Average face velocity through NDO's ≥200 ft/min.

   Because the entire press would be enclosed, there would be no process-imposed NDO's. Therefore, the NDO's can readily be sized to meet this criterion. The net exhaust rate from the enclosure associated with the dryers would be about 1,300 ft^3/min. At the maximum VOC usage rate, about 6,600 ft^3/min of supplemental ventilation air would be needed to assure a healthful atmosphere within the TTE (see Attachment 2, Situation No. 2). Thus, the total net exhaust rate from the enclosure would be about 7,900 ft^3/min. The maximum NDO area under these conditions would be:

$$\frac{7{,}900 \text{ ft}^3\text{/min}}{200 \text{ ft/min}} = 39.5 \text{ ft}^2$$

   At lesser VOC usage rates, the ventilation rate could be decreased, and the allowable NDO area would decrease accordingly. In any case, the area of the NDO's can be adjusted to meet this criterion.

2. Distance between VOC sources and NDO's ≥4 x NDO equivalent diameter.

   The sources of VOC within the enclosure include the ink supply buckets, the printing decks, and the printed film (prior to drying). These sources would all be located in the vicinity of the central impression (CI) cylinder. The NDO's in the enclosure would be located at the unwind/rewind end of the TTE, away from the CI cylinder and VOC sources. Because there are no process-related constraints on the NDO's, they can readily be sized and located to meet this criterion.

   A likely configuration would consist of four 2 ft x 2 ft NDO's in the wall at the opposite end of the TTE from the CI cylinder, each located near a corner of the end wall. Up to five additional 2 ft x 2 ft NDO's (depending on the actual net exhaust rate from the TTE) would be placed near the same end of the enclosure. All the NDO's could easily be located to exceed the 9-ft separation from VOC sources necessary to meet this criterion.

3. Distance between exhaust hoods or ducts and NDO's ≥4 x exhaust equivalent diameter.

   The exhausts from the enclosure would include the intake slots of the between-color dryers, the web slots of the overhead dryer, and the fugitive exhaust system pickups. The precise dimensions of the between-color and overhead dryer slots are not known, but none is likely to exceed 4 in. x 60 in. As discussed above, there is considerable freedom in NDO placement in this case; no difficulty is anticipated in locating the NDO's at least 6 ft away from the dryer slots in order to meet this criterion. (Based on slots 4 in. x 60 in., a separation of just over 5.8 ft would be required.)

Likewise, the fugitive exhaust system pickups could meet this criterion easily. Two dampered 18-in. flexible ducts have been included in this analysis as pickups to provide flexibility in the exhaust system. The duct openings would have to be a minimum of 6 ft from any NDO. The proposed TTE configuration would have the fugitive exhaust system located at the end of the enclosure nearest the CI cylinder; the flexible duct pickups would be placed near this end of the TTE. With the NDO's located at the far end of the enclosure, this criterion would be met.

4. Total area of NDO's ≤5 percent of the enclosure surface area.

   The proposed TTE dimensions are 18 ft x 36 ft x 16 ft tall. The total surface area of the walls, ceiling, and floor of the enclosure is 3,024 ft^2. Five percent of this surface area is about 151 ft^2. This criterion is much less restrictive than the criterion governing minimum face velocity (No. 1 above), which dictates a maximum area of 39.5 ft^2. This criterion would be met easily.

5. The VOC concentration inside the enclosure must not continue to increase but shall reach a constant level.

   The fugitive exhaust system at this facility has been designed to meet this criterion. The exhaust fan has been sized to provide adequate ventilation volume for the maximum VOC application rate. Dampers have been included in the exhaust system to allow the flow to be adjusted as necessary. Finally, the exhaust system pickups would be located at the opposite end of the TTE from the NDO's, so the general airflow should sweep the enclosure of VOC.

Attachment 2

Calculation of Necessary Supplemental Exhaust for Atlanta Film Converting

A. Situation No. 1

Assumptions

1. Max VOC usage rate is 90 lb VOC/h
2. Capture efficiency is 70 percent (based on RACT)
3. Solvent is ethanol (TLV = 1,000 ppm)
4. 20 ppm already in ventilation air

$$(90 \text{ lb VOC/h})(0.30) = 27 \text{ lb VOC/h}$$

$$MW_{ethanol} = 46 \text{ lb/lbmole}$$

$$\frac{27 \text{ lb/h}}{46 \text{ lb/lbmol}} = 0.59 \text{ lbmol/h}$$

$$(0.59 \text{ lbmol/h})(359 \text{ ft}^3\text{/lbmol}) = 211 \text{ ft}^3\text{/h}$$

$$1{,}000 \text{ ppm (fugitive)} - 20 \text{ ppm (background)} = \frac{\text{VOC (ft}^3\text{/min)}}{\text{necessary airflow (ft}^3\text{/min)}}$$

$$\frac{211 \text{ ft}^3\text{/h}}{x} = \frac{(1{,}000-20)}{1 \times 10^{6}}$$

$$x = 21{,}113 \text{ ft}^3\text{/h}$$

$$x = 352 \text{ ft}^3\text{/min}$$

B. Situation No. 2

Assumptions

1. Max VOC usage rate is 90 lb/h
2. Capture efficiency is 45 percent (as indicated by facility personnel)
3. Solvent is ethanol (TLV = 1,000 ppm)
4. 20 ppm already in ventilation air

$$(90 \text{ lb VOC/h})(0.55) = 49.5 \text{ lb VOC/h}$$

$$MW_{ethanol} = 46 \text{ lb/lbmol}$$

$$\frac{49.5 \text{ lb}}{46 \text{ lb/lbmol}} = 1.1 \text{ lbmol/h}$$

$$(1.1 \text{ lbmol/h})(359 \text{ ft}^3\text{/lbmol}) = 386 \text{ ft}^3\text{/h}$$

$$1{,}000 \text{ ppm (fugitive)} - 20 \text{ ppm (background)} = \frac{\text{VOC } (ft^3/min)}{\text{necessary airflow } (ft^3/min)}$$

$$\frac{386 \; ft^3/h}{x} = \frac{(1{,}000-20)}{1 \times 10^6}$$

$$x = 6{,}570 \; ft^3/min$$

PRINTPACK, INC.

MRI REPORT

FINAL COST AND FEASIBILITY STUDY: PRINTPACK INC.

EPA Contract No. 68-02-4379
Work Assignment 26
ESD Project No. 87/07
MRI Project No. 8952-26

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I. Introduction

The Printpack facility in Atlanta, Georgia, currently operates several central impression flexographic printing lines to produce flexible packaging products. The facility has both six-color and eight-color web-fed presses. A site visit report dated February 17, 1989, contains detailed information on the process and the facility layout. This report presents the findings of the cost and feasibility analysis of constructing a temporary total enclosure (TTE) at this facility and conducting a capture efficiency determination according to the draft procedure.

II. Options Considered and Rationale for Selections

A. Production Line to be Evaluated

One of the eight-color presses (No. 12) was chosen for evaluation because this press represents the newer, larger presses at the facility. The newer presses are much longer and wider than the older presses, so a larger TTE would be required. Access requirements are more stringent for the eight-color presses because more individuals typically need access to these presses than to the six-color presses. In addition to two operators assigned to each press, an additional two persons are assigned to the eight-color presses as a floating changeout team. For all presses, access is routinely required during operation in order to check the ink level and viscosity in the "kit" supplying each printing station. About every 45 minutes, access to the unwind area is required to replace the spent web roll. The floating changeout team replaces the spent web rolls on the eight-color presses.

B. Temporary Total Enclosure Configuration and Materials of Construction

It was determined that the TTE should enclose the entire press, including the unwind and rewind stations. This configuration would allow the press operators to remain inside the TTE much of the time rather than frequently passing in and out to monitor the parts of the press inside and outside the enclosure. In addition, enclosing the entire press would avoid the difficult task of piecing an enclosure wall around the overhead dryer and the ductwork on top of the dryer.

During the site visit, it was estimated that an enclosure approximately 33 feet (ft) wide by 66 ft long by 30 ft high would be needed to contain this press. After followup contacts with facility representatives, it was determined that the actual enclosure dimensions necessary to contain the press are 33 ft wide by 72 ft long. The height of the building over this area, measured from floor to ceiling, is 25 ft. The TTE's fugitive exhaust would be located in the end wall of the enclosure nearest the printing stations. There would be one covered door measuring approximately 4 ft by 8 ft located in the side wall of the TTE on the side of the press where print cylinders and rolls of film are changed out. Natural draft openings (NDO's) would be located in the end wall of the TTE at the rewind end of the press, the opposite end from the fugitive exhaust. As indicated in Attachment 1, this TTE configuration would meet the criteria in the draft test procedure.

The NDO's and fugitive exhaust pickups would be located so as to minimize effects on the normal fugitive emission rate and capture efficiency that prevail in the absence of the TTE. Measures to minimize disruption of normal conditions would include adhering to the TTE criteria that govern distances and orienting the NDO's and fugitive exhaust pickups so that air currents will not impinge directly on sources of volatile organic compounds (VOC) or on permanent exhausts from the enclosure. Additional measures, such as the use of baffles, could be used if deemed necessary.

The following three construction options for the TTE were tentatively identified in the site visit report:

1. Dropping polyethylene enclosure walls from the plant ceiling, thereby using the plant ceiling as the TTE ceiling;

2. Dropping polyethylene enclosure walls from the bottom of the ceiling support beams or trusses. The plant ceiling would function as the TTE ceiling. The open spaces between the top of the walls and the plant ceiling would be considered NDO's; and

3. Constructing a wooden frame to which polyethylene would be fastened to form the TTE walls and a ceiling spanning the press area.

Initially, the third option was selected for this analysis as the most generally applicable configuration across facilities of all types. This approach was adopted at first because the site visit was made before the cost and feasibility study plan was formulated, so little specific information about the press area (including ceiling-level obstructions that might interfere with the other TTE configurations) was gathered during the site visit. However, because the minimum height necessary to clear the press is about 20 ft and the TTE would be too wide to span with 2x4's, a wooden structure would need braces extending out from the walls in order to be self supporting. There is insufficient clearance around the presses at this facility to accommodate such braces. As a result, the construction option finally selected for this cost and feasibility analysis is the first option described above.

Under this construction option, 6-mil plastic sheeting would be suspended from the bottom of the ceiling bar joists to the floor, and the area between the bottom of the joists and the ceiling would be filled in with separate pieces of 6-mil plastic. Considering the need to piece around the ceiling joists, this method of extending the walls to the ceiling is expected to be easier than attempting to fit a single piece of plastic from floor to ceiling.

C. Testing

The gas streams, sampling locations, and EPA methods for measuring VOC for the capture efficiency determination were tentatively identified. (Final identifications will be made in the testing phase of the project should testing be carried out at this facility.) Figure 1 presents a schematic of the proposed sampling locations, while Table 1 is a summary of the sampling plan for the facility. Measurements would be conducted on the fugitive exhaust stream and the captured stream to the control device using EPA Methods 1 through 4 (M1-M4) for volumetric flow rate and EPA Method 25A (M25A) for VOC concentration. In addition, a volumetric flow measurement of the makeup air intake duct would be performed using M1-M4 so that the average face velocity across the NDO's could be calculated. The VOC concentration inside the TTE would be continuously measured during each run using an OVA meter, while the ambient VOC concentration outside the enclosure would be measured before and after each run using the same OVA meter.

The M25A measurements using the OVA meter would verify that steady-state conditions prevail inside the enclosure and would be used to evaluate the potential for VOC drawn in through the NDO's to affect the capture efficiency determination significantly. A great degree of accuracy in the measurements is not necessary; therefore, the use of an OVA meter is appropriate. For the captured and fugitive stream VOC concentration measurements, however, flame ionization analyzers with a higher degree of accuracy would be used. The VOC concentration measurements would be made continuously during each run, while the volumetric flow determinations would be made before and after each run with a continuous single point measurement during each run.

III. Specifications

Tables 2 and 3 present the materials and labor and the suggested tools and equipment for construction of the proposed TTE. The TTE would consist of 6-mil plastic sheeting extending from the plant ceiling to the floor to enclose an area 33 ft wide by 72 ft long. The plastic sheeting would be suspended from the existing ceiling bar joists. A diagram of the enclosure is presented in Figure 2.

The joists run perpendicular to the press. The plastic for each end wall of the TTE (33 ft long) would be fastened directly to the bottom of a single joist. For the side walls (72 ft long), the plastic would be fastened to 1x4's laid across the spaces between the joists. Duct tape would be used to seal the walls to each other, to the floor, to the ceiling, and around any obstructions that must be accommodated.

The fugitive exhaust system would consist of two 15-ft flexible duct pickups with 18-inch (in.) diameters joined with dampered spin collars into a single 15-ft, 24-in.-diameter metal duct to provide a sampling location. The exhaust fan was sized for up to 11,400 cubic feet per minute (ft^3/min). The basis for this flow rate is presented in Attachment 2.

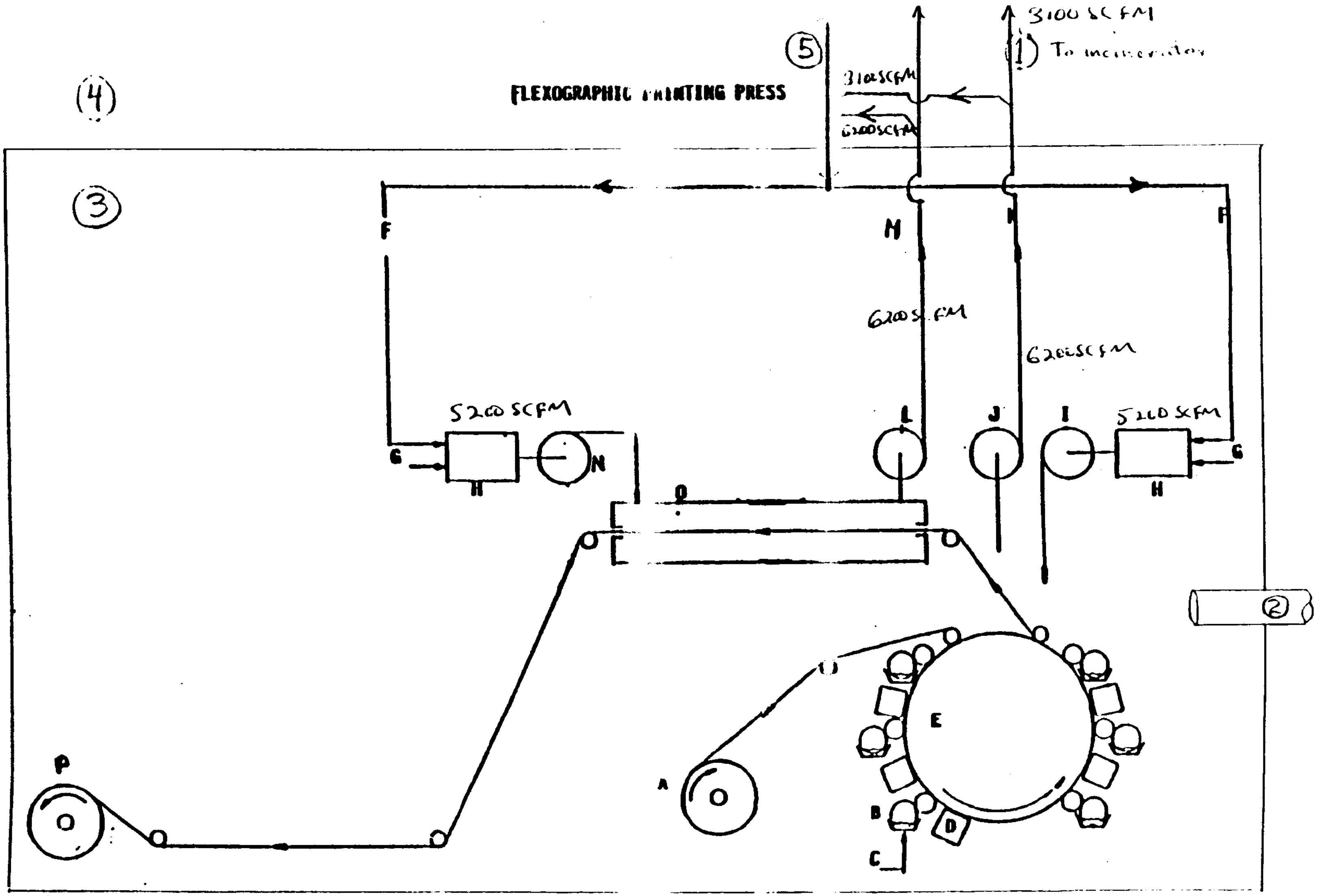

Figure 1. Sampling points at Printpack Inc., Atlanta, Georgia.

TABLE 1. SAMPLING PLAN FOR PRINTPACK INC., ATLANTA, GEORGIA

Test location	Measure-ment	Method	Frequency
1. Captured[a]	VOC VEL	M25A M1-M4	1-h continuous each run Traverse before/after run; continuous single point measurement
2. Fugitive[a]	VOC VEL	M25A M1-M4	1-h continuous each run Traverse before/after run; continuous single point measurement
3. Inside ambient	VOC	M25A (OVA)	1-h continuous each run
4. Outside ambient	VOC	M25A (OVA)	Before/after each run
5. Makeup air intake	VEL	M1-M4	Traverse before/after run; continuous single point measurement

M25A = flame ionization analyzer (FIA).
M25 = total gaseous nonmethane organics (TGNMO).

Option: Replace M25A with M25 at locations 1 and 2.

[a]Simultaneous sampling.

TABLE 2. MATERIALS AND LABOR FOR CONSTRUCTION OF TEMPORARY TOTAL ENCLOSURE AT PRINTPACK INC., ATLANTA, GEORGIA

Materials	Quantity	Cost, $	Labor	Cost, $	Total cost, $[a]
HANG PLASTIC					
1. 6-mil plastic (30 ft wide)	300 ft	300.00	Hang plastic to bar joist and 1 in.x4 in. supports 2 FTE×8 h = 16 MH @ $40/MH	640.00	
2. Duct tape	3 rolls	10.50			
3. Floor cleaning solvent	1 gal	25.00			
4. Medium binder clips	1 gross	12.60			
5. 2-in. C-clamps	12	16.92			
6. 1 in.x4 in.x12 ft lumber	16	48.00			
7. 4-ft laths	2 bundles	44.00			
8. Boom truck rental[b]	4 days	1,200.00			
SUBTOTAL		1,657.02		640.00	2,297.02
SEAL BAR JOISTS					
1. Plastic to roofline	Included above	--	Seal from bar joist to roof and add lath to reinforce 2 FTE×8 h = 16 MH @ $40/MH	640.00	
2. Cleaning solvent for roof	Included above	--			
3. Duct tape	Included above	--			
4. 3/8 in. staples	4 boxes	8.00			
5. 1¼ in. coated nails	5 pounds	8.00			
6. Boom truck rental	Included above	--			
SUBTOTAL		16.00		640.00	656.00
EXHAUST SYSTEM					
1. Utility blower with explosion-proof motor and conduit box 11,400 ft^3/min	1	2,330.00	Install exhaust system on plant floor 1 FTE×5 h = 5 MH @ $40/MH	200.00	
2. 18 in. flex duct with duct clamps	2 @ 15 ft	380.00			
3. 18 in. dampered spin collars	2	160.00			
4. 24 in. metal duct	15 ft	190.00			
5. 24 in. flex duct with damper	5 ft	182.00			
6. 24 in. duct clamps	2	18.00			
SUBTOTAL		3,266.00		200.00	3,466.00

continued

TABLE 2. (continued)

Materials	Quantity	Cost, $	Labor	Cost, $	Total cost, $[a]
DISMANTLING					
1. Dismantle TTE and dispose of TTE construction materials	150 ft^{3}[c]	26.00[d]	Remove plastic sheeting and scrap lumber and place in dumpster 2 FTE × 4 h = 8 MH @ $40/MH	320.00	
SUBTOTAL		26.00		320.00	346.00
TOTAL		4,965.02		1,800.00	6,765.02

FTE = full time employee.
MH = man hour.
[a]Materials and labor.
[b]Based on Printpack's comments on the draft cost and feasibility study, a rolling scaffold may not be adequate to hang the plastic walls on all sides of all presses due to spacial constraints. In this situation, a boom truck could be rented at a cost of approximately $1,200 for 4 days. This cost is included in this analysis to be conservative, although in most cases a rolling scaffold (at a rental cost of $40 for 4 days) would be adequate.
[c]Volume of wastes estimated by computing nominal volume of plastic sheeting and lumber and increasing by a factor of 10.
[d]Cost of disposal based on a charge of $190 per 40 cubic yard dumpster as indicated by Printpack.

TABLE 3. SUGGESTED TOOL AND EQUIPMENT LIST FOR INSTALLATION

Tools	Equipment
Utility knives	Boom truck or narrow rolling scaffold[a]
Staple gun	Two ladders
Hammer	Rags
Tape measure	100-ft rope
	2½-gallon bucket
	Gloves

Suggested staging of construction

1. Place wall parallel to press along side away from overhead crane.
2. Place end walls.
3. Place blower and ductwork.
4. Place wall along side with overhead crane.

[a]Assumed to be rented.

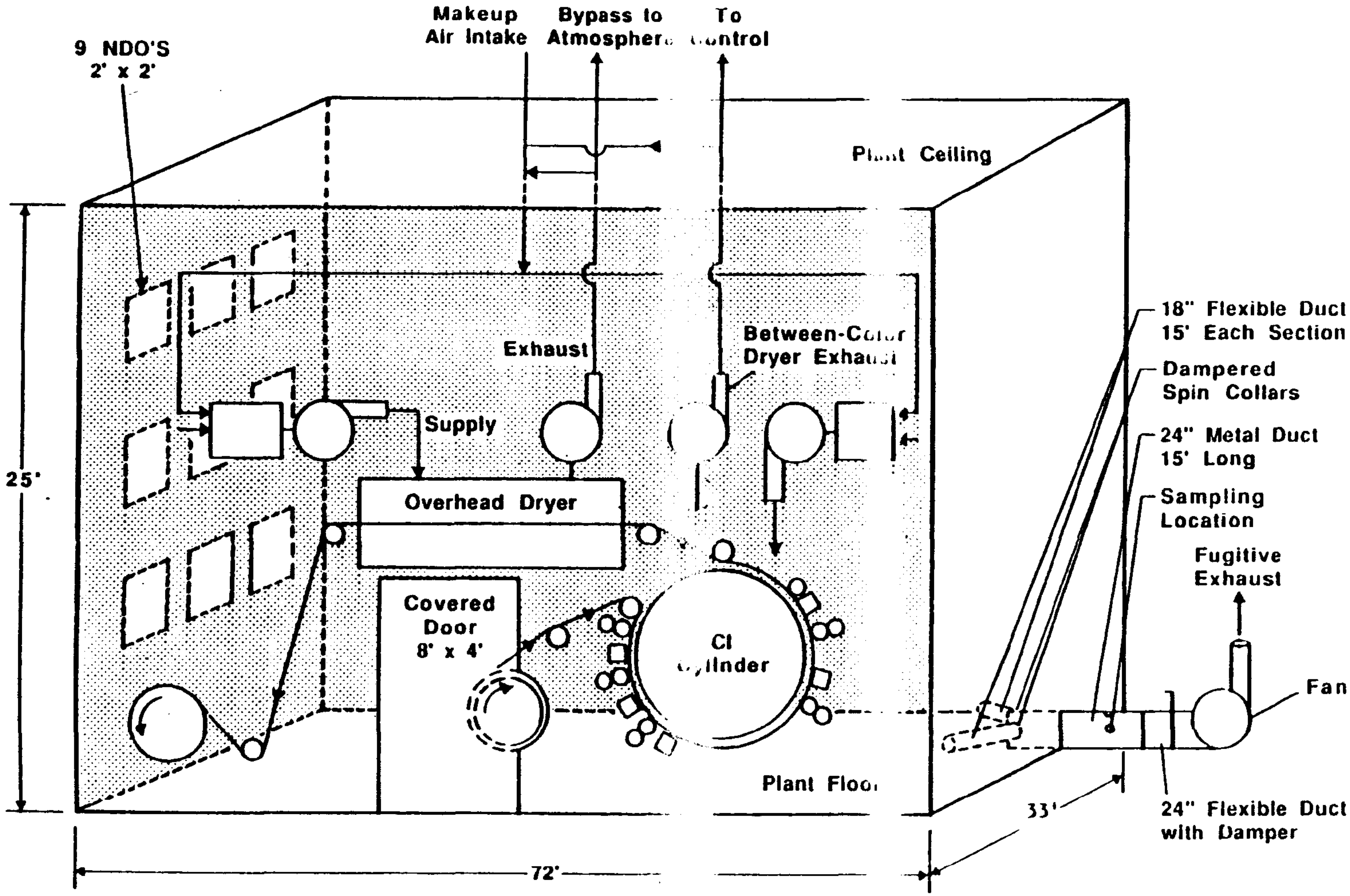

Figure 2. Proposed TTE for Printpack inc., Atlanta, Georgia.

IV. Cost Analysis

The costs associated with performing the test according to the draft protocol have been estimated based on the TTE specifications and sampling locations selected. The specific material and labor costs of constructing and dismantling the TTE are presented in Table 2. The details of the proposed test program were presented in Section II, Part C. A breakdown of the testing costs is provided in Table 4. A summary of all costs associated with the capture efficiency determination is presented in Table 5.

A wage rate of $40 per hour, including fringes and overhead, has been used for all labor except testing personnel. This rate is likely to overstate the labor costs in many cases, but has been used to be conservative. The wage rate for testing personnel has been adjusted upward to allow for moderate travel costs.

The total cost is estimated to be approximately $22,000, not including lost production costs. Of this total, the major component is the actual testing cost, at approximately $15,000. Testing represents about 67 percent of the total cost.

The cost of lost production is not included in this report because of confidentiality considerations. The confidential addenum to this report contains information received from Printpack on the cost of lost production.

It is estimated that 7 hours of lost production would be associated with the construction and dismantling of the TTE side wall on the side of the line from which the print cylinders and rolls of film are changed out. It is not expected that production would be lost during construction or dismantling of the other walls.

It should be noted that the capture efficiency determination may not require any production to be lost. The facility operates 5, 6, or 7 days per week, depending on demand. Production would be lost only if the test were scheduled at a time when the plant was operating 7 days per week. Otherwise, construction and dismantling of the TTE could take place when the line was not operating. However, increased labor costs would be incurred to construct the TTE over the weekend. At Printpack, the weekend labor rate is 150 percent of the weekday rate; the Sunday rate is 200 percent of the weekday rate.

V. Potential Problems

The use of direct-fired dryers at this facility presents a problem because some VOC will be destroyed and, therefore, will not be measured as having been captured. (This would be a problem with any of the capture efficiency determination methods.) Also, because some partial combustion products may be present, EPA Method 25 might be preferred over M25A even though the low VOC concentration in the fugitive exhaust stream tends to indicate the use of M25A.

TABLE 4. ESTIMATED COSTS FOR SAMPLING AT PRINTPACK INC., ATLANTA, GEORGIA

Base cost	
Site survey--1 person, 2 days x 8 h x $75/h	$ 1,200
1 THC operator--1 x 3 days x 10 h x $70/h	2,100
2 velocity persons--2 x 3 days x 10 h x $70/h	4,200
1 OVA operator--1 x 3 days x 10 h x $70/h	2,100
Preparation and posttest checks--40 h x $50/h	2,000
Calibration gases and supplies	1,000
Data reduction and reporting 40 h x $60/h	2,400
TOTAL	$15,000
Alternative--Replace M25A with M25 at test locations 1 and 2	
Same size crew	
Add analysis--2 locations x 3 runs x $150/sample	$ 900
Add 1 lab person--1 x 3 days x 10 h x $70/h	2,100
Less calibration gases	-1,000
ADDED COST	$ 2,000

Assumptions

1. Three runs of 1 h each
2. Method 25 options will use single sampling trains
3. Estimates include moderate travel costs
4. 1 day of travel/set-up; 1 day of testing; and 1 day of teardown/travel in field

TABLE 5. COST ANALYSIS FOR THE CAPTURE EFFICIENCY TEST AT PRINTPACK INC., ATLANTA, GEORGIA

Task	Cost to complete, $
1. Design	
a. Examination of facility	160[a]
b. Design of enclosure	320[b]
2. Materials and equipment rental	4,965
3. Construction labor	1,480[c]
4. Lost production	[d]
5. Testing costs	15,000
6. Dismantling labor	320[c]
TOTAL	22,245[e]

[a]Four labor hours at $40/h, including fringes and overhead.
[b]Eight labor hours at $40/h, including fringes and overhead.
[c]Thirty-seven labor hours at $40/h, including fringes and overhead.
[d]Estimated to total 7 hours, 6 hours during construction and 1 hour during dismantling. The hourly cost of lost production is subject to a claim of confidentiality and is not presented here. The confidential addendum to this report contains this information.
[e]This total does not include the cost of lost production. The total estimated cost including lost production is included in the confidential addendum to this report.

VI. Conclusions

1. It is feasible to construct a TTE around a press at this facility. Construction and dismantling are estimated to cost approximately $7,200, not including the cost of lost production.

2. A capture efficiency determination can be conducted at this facility. The testing is estimated to cost approximately $15,000.

2 Attachments

b2606-1/CBI

Attachment 1

EVALUATION OF TTE VS. CRITERIA

1. Average face velocity through NDO's $\geq$200 ft/min.

   Because the entire press would be enclosed, there would be no process-imposed NDO's. Therefore, the NDO's can readily be sized to meet this criterion. With dryer exhaust recirculation, the net exhaust from the enclosure associated with the dryers would be 2,000 ft^3/min (see Figure 1). At the maximum VOC usage rate, about 11,400 ft^3/min of ventilation air would be needed to assure a healthful atmosphere within the TTE (see Attachment 2). Thus, the total net exhaust rate from the enclosure would be 13,400 ft^3/min. The maximum NDO area under these conditions would be:

$$\frac{13{,}400\ ft^3/min}{200\ ft/min} = 67\ ft^2$$

   At lesser VOC usage rates, the ventilation rate could be decreased, and the allowable NDO area would decrease accordingly. In any case, the area of the NDO's can be adjusted to meet this criterion.

2. Distance between VOC sources and NDO's $\geq$4 x NDO equivalent diameter.

   The sources of VOC within the enclosure include the ink supply buckets, the printing decks, and the printed film (prior to drying). These sources would all be located in the vicinity of the central impression (CI) cylinder. The NDO's in the enclosure would be located at the unwind/rewind end of the TTE, away from the CI cylinder and VOC sources. Because there are no process-related constraints on the NDO's, they can readily be sized and located to meet this criterion.

   A likely configuration would consist of nine 2 ft x 2 ft NDO's (equally spaced in three rows of three) in the wall at the opposite end of the TTE from the CI cylinder. Up to seven additional 2 ft x 2 ft NDO's (depending on the actual net exhaust rate from the TTE) would be placed near the same end of the enclosure. All the NDO's could easily be located to exceed the 9-ft separation from VOC sources necessary to meet this criterion.

3. Distance between exhaust hoods or ducts and NDO's $\geq$4 x exhaust equivalent diameter.

   The exhausts from the enclosure would include the intake slots of the between-color dryers, the web slots of the overhead dryer, and the fugitive exhaust system pickups. The precise dimensions of the between-color and overhead dryer slots are not known, but none is likely to exceed 4 in. x 60 in. As discussed above, there is considerable freedom in NDO placement in this case; no difficulty is anticipated in locating the NDO's at least 6 ft away from the dryer slots in order to meet this criterion. (Based on slots 4 in. x 60 in., a separation of just over 5.8 ft would be required.)

Likewise, the fugitive exhaust system pickups could meet this criterion easily. Two dampered 18-in. flexible ducts have been included in this analysis as pickups to provide flexibility in the exhaust system. The duct openings would have to be a minimum of 6 ft from any NDO. The proposed TTE configuration would have the fugitive exhaust system located at the end of the enclosure nearest the CI cylinder; the flexible duct pickups would be placed near this end of the TTE. With the NDO's located at the far end of the enclosure, this criterion would be met.

4. Total area of NDO's $\leq$5 percent of the enclosure surface area.

   The proposed TTE dimensions are 33 ft x 72 ft x 25 ft tall. The total surface area of the walls, ceiling, and floor of the enclosure is 10,002 ft^2. Five percent of this surface area is about 500 ft^2. This criterion is much less restrictive than the criterion governing minimum face velocity (No. 1 above), which dictates a maximum area of 67 ft^2. This criterion would be met easily.

5. The VOC concentration inside the enclosure must not continue to increase but shall reach a constant level.

   The fugitive exhaust system at this facility has been designed to meet this criterion. The exhaust fan has been sized to provide adequate ventilation volume for the maximum VOC application rate. Dampers have been included in the exhaust system to allow the flow to be adjusted as necessary. Finally, the exhaust system pickups would be located at the opposite end of the TTE from the NDO's, so the general airflow should sweep the enclosure of VOC.

Attachment 2

CALCULATION OF NECESSARY SUPPLEMENTAL EXHAUST FOR PRINTPACK INC.

Based on a 4/4/89 telephone conversation between Mr. Doug Cook, Printpack inc., and Mr. Stephen Edgerton, MRI, the fugitive emission rate from a past liquid/gas test was:

9.09 lb carbon/h (Average of three runs)

These test runs were during a process run with coverage of about 150 percent, which is a typical coverage rate. Heavy coverage would be about 200 percent, so for a heavy coverage job, the fugitive rate would be about:

(9.09 lb C/h)(200/150) = 12.12 lb carbon/h

Assume the solvent is 100 percent n-propanol (TLV = 200 ppm). N-propanol is a major constituent of the inks used during the test runs, and its combination of a relatively low molecular weight and relatively restrictive TLV makes this a conservative assumption.

Mol. wt. = 60; 3 carbon atoms per molecule

(12.12 lb C/h)(1 lb mol C/12 lb C)(0.33 lb mol n-propanol/lb mol C)

= 0.33 lb mol n-propanol/h

(0.33 lb mol/h)(359 ft^3/lb mol) = 120 ft^3/h

Calculating the amount of ventilation air needed to dilute the n-propanol to 200 ppm, assuming a background concentration of 25 ppm:

$$\frac{(120\ ft^3/h)(h/60\ min)}{x} = \frac{(200-25)}{1 \times 10^6}$$

x = 11,396 ft^3/min

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT

This document presents the findings of a study of the cost and feasibility of determining VOC capture efficiency using the gas/gas temporary total enclosure method. For the study, five coating and printing facilities were visited, and site-specific cost and feasibility analyses were conducted. The five site visit reports and individual cost and feasibility analyses are appended.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Volatile Organic Compounds Performance Testing Capture Efficiency Temporary Total Enclosure	Determination of VOC Capture Efficiency	

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