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# MACT & Models for Pultrusion
## Information and Analysis to Assist with Case-by-case MACT Determinations

First Edition

DRAFT

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## Note to readers (disclaimer)

This document provides information about developing a Maximum Achievable Control Technology (MACT) emission standard on a case-by-case basis for the pultrusion subcategory within the Reinforced Plastics/Composites source category, for facilities that modify, construct, or reconstruct after their state operating program becomes effective. The information is based in part on regulations promulgated or proposed, and guidelines issued, by the U.S. Environmental Protection Agency. While the information provided in this document is offered in good faith and is believed to be reliable, it is made WITHOUT WARRANTY, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER MATTER. This document is not intended to provide advise (legal or otherwise) for a particular set of facts, but is of a general nature. It is the responsibility of each facility owner or operator to perform the necessary analysis to determine the appropriate MACT standard. SPI, its members, and contributors to this document do not assume any liability for the use, or results of use, of these recommendations or for compliance with applicable laws and regulations.

Much of the information in this document is based on EPA regulations and guidelines, several of which were available only in proposed form when this document was prepared. The Composites Institute will make every effort to update this document as new information is available from EPA, and users should check to see that they have the most recent edition. Users should also obtain and thoroughly familiarize themselves with the relevant EPA regulations. Copies of these regulations can be obtained by contacting the Office of Air Quality Planning and Standards, US EPA, MD-10, Research Triangle Park, NC 27711. The EPA Control Technology Hotline can be reached at 919-541-0800. Persons with access to a personal computer and modem can also obtain the most recent copies of relevant regulations by dialing the EPA Technology Transfer Network, 919-541-5742.

Users of this document should also check with their local permitting authority. Local regulations may have different requirements and procedures from those described in this document, or in the applicable EPA regulations or publications.

## Summary

Many composites manufacturing facilities will be faced with requirements for case-by-case MACT determinations, as they seek permits to install new production equipment or modify existing equipment. In addition, all facilities may need to implement case-by-case MACT if EPA misses the November 1997 deadline for the composites MACT standard. A case-by-case MACT determination is a process by which a permitting agency determines that the emission points in question will achieve a MACT emission limitation.

Case-by-case MACT requires facilities to identify any control technology currently in use in the industry. For composites, this review is likely to show that there is no data that could be used to set emission limitations based on the controls in use, or, for some industry subcategories, that there are no controls used. Facilities would be then required to identify all commercially available and demonstrated controls, and evaluate each for technical feasibility, costs, non-air health quality impacts, and energy usage.

**This document, *MACT & Models for Pultrusion*, has been prepared by the SPI Composites Institute to assist its members in complying with requirements for case-by-case MACT determinations. This document is intended for use in establishing case-by-case MACT for facilities producing thermoset polyester composite products by the pultrusion process.**

The procedures followed in this document are those specified by EPA for determining case-by-case MACT for new, reconstructed, or modified sources, as required under CAA Section 112(g). However, this document should also prove useful for determining case-by-case MACT for existing sources, as required under CAA Section 112(j).

Chapter 1 of this document reviews MACT requirements for the composites industry. Chapter 2 outlines the 3-tier EPA procedure for case-by-case MACT determinations. Chapter 3 provides a brief description of the pultrusion processes.

Chapter 4 contains a review and analysis of existing control technology and applicable state regulations. For facilities making a MACT application, Chapter 4 is intended to fulfill the EPA Tier I requirements for analysis of existing controls and regulations.

Chapters 5-8 contain a review and analysis of commercially available control technologies. These chapters include models that will allow facilities to determine the economic feasibility of each of the technically feasible control options. Chapters 5-8 are intended for use by facilities in conducting an EPA Tier II feasibility analysis of add-on controls.

A schematic description of the case-by-case MACT process is shown in Figure A.

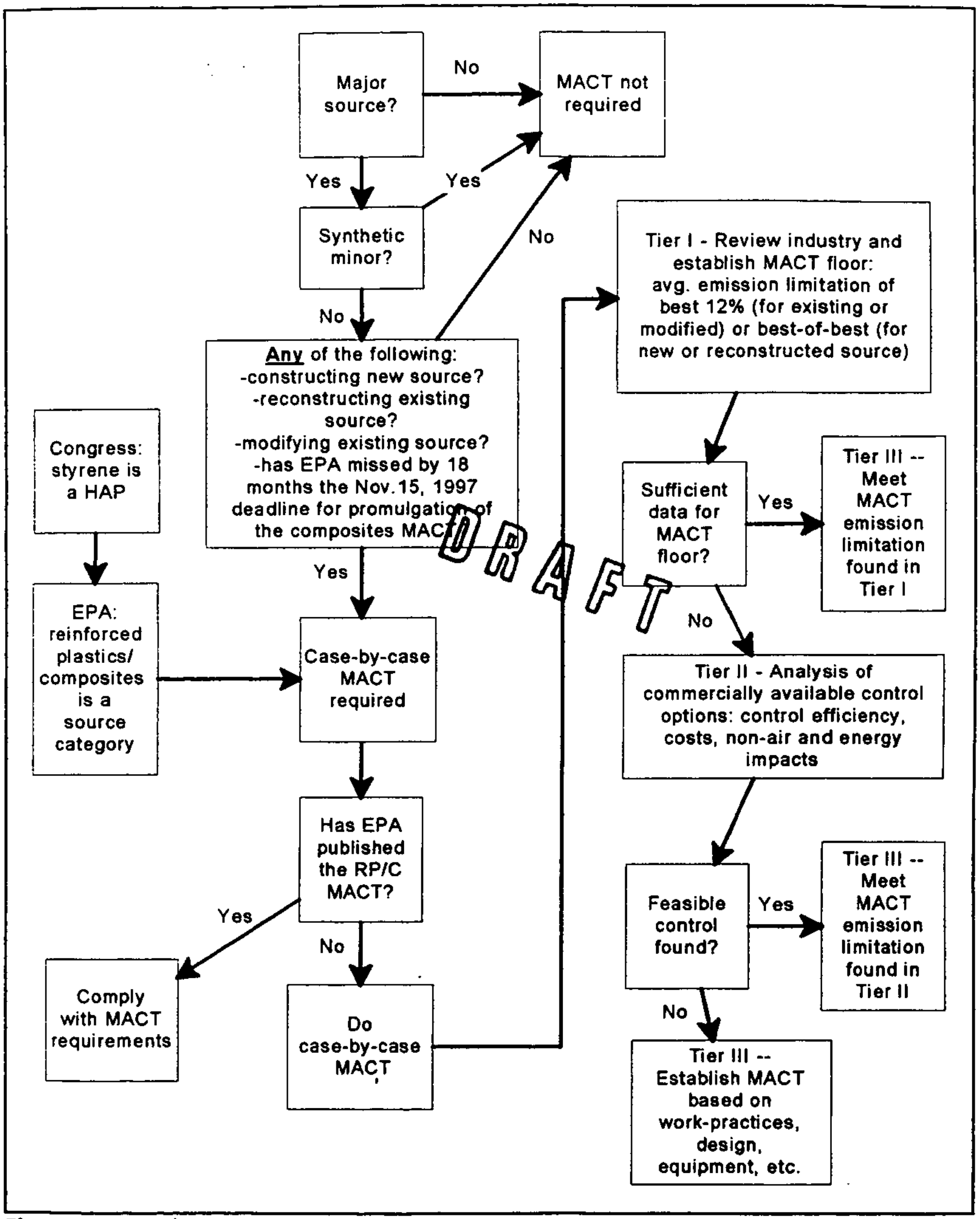


**Figure A** Case-by-case MACT process.

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## Chapter 1. MACT: What, Who, and When?

The Clean Air Act (CAA), as amended in 1990, established a number of new regulatory concepts, and elaborated on other concepts from the pre-1990 Act, including "Hazardous Air Pollutant," "MACT" and "major source," and set various deadlines for issuance of new regulations by EPA and compliance by industry. CAA Section 112 requires major sources of hazardous air pollutants to adopt MACT controls. The provisions of Section 112 are outlined in Table 1.1.

### Maximum Achievable Control Technology.

CAA Section 112 lists 189 Hazardous Air Pollutants (HAPs), and requires EPA to list categories of sources (i.e.: industries) that are emitters of these HAPs. EPA must then promulgate emission standards for each of the source categories. These standards will be issued in the form of National Emission Standard for Hazardous Air Pollutants (NESHAPs). All post-1990 NESHAPs will require major HAP sources to reduce emissions through the implementation of Maximum Achievable Control Technology (MACT).

The term MACT does not actually appear in the CAA, but is widely used to refer to the requirements of the Act. The Act reads:

> Emission standards . . . applicable to new or existing sources of hazardous air pollutants, shall require the *maximum* degree of reduction in emissions of the [HAPs] . . . that the Administrator . . . determines is *achievable* . . . (CAA Section 112(d)(2)).

The Act sets different MACT levels for new and existing sources. For *new sources*, "the maximum degree of reduction in emissions that is deemed achievable . . . shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source." For *existing sources*, MACT shall be not less stringent than "the average emission limitation achieved by the best performing 12 percent of the existing sources," or, for sources in categories with fewer than 30 sources, "the average emission limitation achieved by the best performing 5 sources." (CAA 112(d)(3)). These minimum requirements (average of best 12% for existing sources, and best-of-best for new sources) are referred to as the *MACT floors*; the MACT emission limitations set in the MACT standard or by case-by-case MACT determinations may be no less stringent than these levels.

In practice, EPA considers MACT to be the emission limitation achieved by the "control technology that achieves the maximum degree of HAP reductions with consideration to costs, non-air health quality and environmental impacts, and energy requirements."[1] The relative weight of the factors to be considered in setting MACT (costs, etc.) have not been determined by EPA; such decisions are to be based on the information available at the time of the MACT determination. Whatever the weights given to each of these factors in a given case, the MACT emission limitation may be no less stringent than the MACT floor.

Note that, in most cases, MACT is really an emission limitation. While MACT is based on the controls employed by the best-controlled source(s) in a source category, other sources are generally required to meet or exceed the emission limitation achieved by these sources, not necessarily employ the same controls. Maximum Achievable Emission Limitation would have been a more accurate term, but "MAEL" is not a particularly snappy acronym.

## Who must implement MACT?

Major sources[2] are required to achieve the MACT emission limitations. Under CAA Section 112, a major source is:

> . . . any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls . . . 10 tons per year or more of any [HAP] or 25 tons per year or more of any combination of [HAPs] (CAA 112(a)(1)).

EPA has interpreted this definition to mean that any facility with the potential to emit, *assuming continuous operations and without controls*, of 10 tons per year or more of any HAP or 25 tons per year or more of any combination of HAPs, is a major source. Use of controls, as well as limits on emissions resulting from operational restrictions, can be used to reduce potential emissions only if such controls or limits are federally enforceable. To be federally enforceable, controls or limitations must be specified in a permit that has been approved by EPA (or is issued as part of an EPA-approved permit program), subject to public review and comment, and enforceable as a practical matter.

Facilities that have potential emissions of 10 (or 25) tons per year or more, but that in reality will never exceed these levels, can take advantage of state *synthetic minor* or Federally

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[1]*Guidelines for MACT Determinations under Section 112(g)*, US EPA, March 1994 Proposal, p. 34.

[2]The NESHAP for a source category may also contain control requirements for non major sources. Although it has not done so in any of the NESHAPs promulgated to date, EPA may require all facilities in a source category to achieve MACT emission limitations.

Enforceable State Operating Permit (FESOP) programs to escape major source designation and MACT requirements. Note that while a given NESHAP may apply MACT only to major sources, the standard my contain other, less stringent control requirements for minor and synthetic minor sources.

### When is MACT required?

CAA Section 112 set deadlines for EPA to promulgate MACT standards for all of the approximately 150 listed source categories. EPA was required to publish standards for 40 source categories by November, 1992, standards for 25 percent of source categories in both 1994 and 1997, and all remaining standards by 2000. EPA can allow existing sources up to three years, following the deadline for promulgation, to comply with the requirements of the NESHAP. New sources, with limited exceptions, must comply upon startup.

If EPA has not yet promulgated the NESHAP by the date established in the schedule set under CAA Section 112(e), then 18 months after that date, a source must file a permit application. The permit must contain emission limitations based on a case-by-case MACT determination. This "MACT hammer," contained in CAA Section 112(j), is an attempt by Congress to force emission reductions by industry even if EPA is late in writing standards.

Under CAA Section 112(g), once a state has received approval for its Title V permit program, a *new, reconstructed, or modified source* is required to achieve MACT emission limitations, whether or not a MACT standard has been promulgated. Reconstruction is defined as replacing components of a source such that the cost of the new components exceed 50% of the cost to construct a comparable new source. A modification is defined as a change in operations, resulting in a greater-than-de minimis increase in potential emissions, unless offset by a decrease in other HAPs. Major sources may not commence construction of a new source, or reconstruction or modification of an existing source, until the permitting authority has revised the facility's Title V permit or issued a Notice of MACT Approval (NOMA). The Title V permit or NOMA will contain the MACT emission limitation and other requirements, such as reporting and record keeping, to ensure federal enforceability of the emission limitation. Modified sources must meet the MACT emission limitation for existing sources; new and reconstructed sources must meet the MACT emission limitation for new sources.

Requirements under 112(g) come into effect as soon as EPA approves a state's Title V permit program.[3] EPA started approving these Title V programs in late 1994, and all states will have

[3]In February, 1995, EPA issued an interpretive notice which states that Section 112(g) does not take effect until EPA issues final notice and comment guidance addressing implementation of the section.

at least interim approvals by late 1995. Like the "hammer" for existing sources, the MACT requirements for new, reconstructed, and modified sources apply even if EPA has not published the applicable NESHAP.

Unless EPA has published the applicable NESHAP, or has issued other guidance on MACT for the source category, facilities required to achieve MACT emission limitations under provisions of CAA Sections 112(g) or 112(j) are to negotiate *case-by-case MACT* with their states. Case-by-case MACT is essentially an informed guess of what MACT would be if EPA had already published it.

## MACT for composites manufacturing

Styrene was listed as a HAP in the 1990 Amendments to the CAA, and EPA subsequently listed Reinforced Plastics/Composites as one of the source categories for development of MACT standards. EPA placed the Reinforced Plastics/Composites category with those targeted for NESHAP promulgation in November, 1997.

Any composites facility with the potential to emit, assuming continuous operations and without controls, of 10 tons of styrene (or other HAP) per year, or 25 tons of any combination of HAPs, is a major source. Unless exempted under state FESOP or other programs establishing a federally enforceable limitation on potential emissions, these facilities are required to obtain Title V operating permits and comply with the applicable MACT emission limitation.

Since the composites MACT is scheduled for promulgation in November, 1997, all major sources in the composites industry should plan to start adopting MACT controls in early 1998, with installation of any required add-on controls competed by November, 2000. Under CAA Section 112(j), if EPA has not published the MACT standard by November 1997, then facilities should expect to negotiate a case-by-case MACT with their state no later than May, 1999.

For major sources in the composites industry wishing to construct a new source, reconstruct an existing source, or modify an existing source, MACT is required under CAA 112(g). The de minimis level for styrene is 1 ton per year.[4]

Relevant CAA requirements for the composites industry are outlined in Table 1.2.

[4]EPA proposed rule for implementing 112(g)

| | |
|---|---|
| 112(a) | Definitions |
| 112(b) | List of regulated Hazardous Air Pollutants (HAPs). |
| 112(c) | Requires EPA to publish a list of categories of major and area (non-major) sources of the substances listed in 112(b). |
| 112(d) | Requires EPA to promulgate emission standards (MACT standards) for the source categories listed under 112(c). |
| 112(e) | Sets a schedule for EPA to promulgate the 112(d) standards. |
| 112(f) | Requires EPA to issue a report to Congress on residual risk (after adoption of the 112(d) standards) and promulgate additional standards for any source category where the 112(d) standard does not provide an ample margin of safety to protect the public health. |
| 112(g) | Requires case-by-case MACT for facilities modifying, constructing, or reconstructing a major source, unless EPA has promulgated the applicable 112(d) standard for the source category, or unless the resulting increase in emissions is offset by a decrease in emissions of another HAP from the source. |
| 112(h) | Allows EPA to promulgate a design, equipment, work practice, or operational standard if it is not feasible to prescribe or enforce an emission standard based on control technology. |
| 112(i) | Sets compliance schedules for new, reconstructed, modified, and existing sources, and allows a 6-year exemption from 112(d) standards for facilities achieving a 90% reduction in HAPs (95% for particulates) before the applicable 112(d) standard is proposed by EPA. |
| 112(j) | *Requires case-by-case MACT for existing major sources within 18 months of EPA missing a* 112(e) deadline for promulgation of the applicable 112(d) standard. |
| 112(k) | Requires EPA to promulgate regulations to achieve a substantial reduction in emissions of HAPs from area sources, and achieve a reduction in public health risks associated with such sources, including a 75% reduction in the incidence of cancer attributable to such sources. |
| 112(l) | Requires EPA to consider petitions from states for approval of state air toxics programs in place of CAA programs. |
| 112(o) | Requests the National Academy of Sciences to study and issue a report on the methods used by EPA to determine the carcinogenic risk associated with exposure to HAPs. |
| 112(r) | Requires EPA to promulgate regulations to prevent the accidental release and to minimize the consequences of any such release of any of at least 100 substances which cause the greatest risk of death, injury, or serious adverse effects to human health and the environment. |

**Table 1.1** Summary of relevant parts of CAA Section 112.

| | |
|---|---|
| **112(b) Hazardous Air Pollutant list** | 189 substances, including styrene, methylene chloride, methyl methacrylate |
| **112(c) Source Category list** | 150+ categories, including Reinforced Plastics/Composites |
| **112(e) deadline for EPA to publish composites NESHAP (MACT)** | November 15, 1997 |
| **MACT required for existing sources** | If EPA promulgates the MACT standard on time, begin compliance in 1998.<br>Add-on controls (if required) installed by November 15, 2000.<br>If EPA has not yet published MACT, then complete negotiation of case-by-case MACT with state by May, 1999. |
| **MACT for new or reconstructed sources** (reconstruction = replacement of component with value greater than or equal to 50% of capital cost to construct a comparable new source) | Effective: date of EPA approval of state Title V program (by November 1995 in most states).<br>Permitting authority must issue Notice of MACT Approval, or issue or revise a Title V permit, prior to construction or reconstruction.<br>If EPA has not yet published MACT, then negotiate case-by-case MACT with state. |
| **MACT for modified sources** (modification = change in operations resulting in greater than 1 ton/year increase in potential emissions of styrene) | Effective: date of EPA approval of state Title V program (by November 1995 in most states).<br>Permitting authority must issue Notice of MACT Approval, or issue or revise a Title V permit, prior to operation of modified source.<br>If EPA has not yet published MACT, then negotiate case-by-case MACT with state. |

**Table 1.2.** Summary of requirements for composites manufacturers under CAA Section 112.

## Chapter 2. Case-by-case MACT

When a facility is required to achieve MACT emission limitations, but EPA has not yet published the applicable MACT standard, then a case-by-case MACT determination is required. For example, if a composites manufacturing facility which is a major HAP source wishes to install a new production line after EPA has approved its state's Title V program, then the facility must obtain a Notice of MACT Approval from its state, or obtain or revise its Title V permit, before installation of the new equipment. If EPA has not yet published a MACT standard for composites, then the facility must submit a case-by-case MACT determination for the proposed expansion.

In March, 1994, EPA published *Guidelines for MACT Determinations under 112(g)*.[5] The *Guidelines* describe the same general procedures that EPA will use in setting a MACT standard. Existing sources are surveyed to determine what controls are in use. If controls are used by at least some facilities in the industry, and if emission limitations resulting from use of these controls can be quantified, then these emission limitations can be used to establish the MACT floor. The *MACT floor* is the minimum emission limitation that must be met by the facility. Under the requirements of the CAA, the MACT floor for new or reconstructed major sources is the level of control achieved by the best controlled similar source. For modified or existing sources, the MACT floor is the average level of control achieved by the best controlled 12% of facilities in the source category (or average of best 5 facilities in categories with fewer than 30 sources).

If there are no controls in use, or if there is little or no data on emission limitations, then it may not be possible to establish the MACT floor. In this case, commercially available control options, that have been successfully demonstrated in practice for a similar source, are evaluated for technical and economic feasibility for the facility in question. If feasible controls are found, then the emission limitations that would result from use of these controls are employed to set the MACT emission limitation. If no feasible controls are found, then the permitting authority can allow the use of work-practice, equipment, design, or other standards.

The MACT analysis is divided into three tiers. A MACT floor finding is made in Tier I. Tier II identifies and evaluates commercially available and demonstrated control technologies that could be used if no floor was found in Tier I. Tier III sets a MACT emission limitation based on information developed in Tier I or Tier II. The MACT analysis process is shown schematically in Figure 2.1.

[5]The March, 1994 *Guidelines* were published as a proposal. Before conducting a case-by-case MACT determination, facilities should check the EPA BBS to obtain a final version of the *Guidelines*, if available.

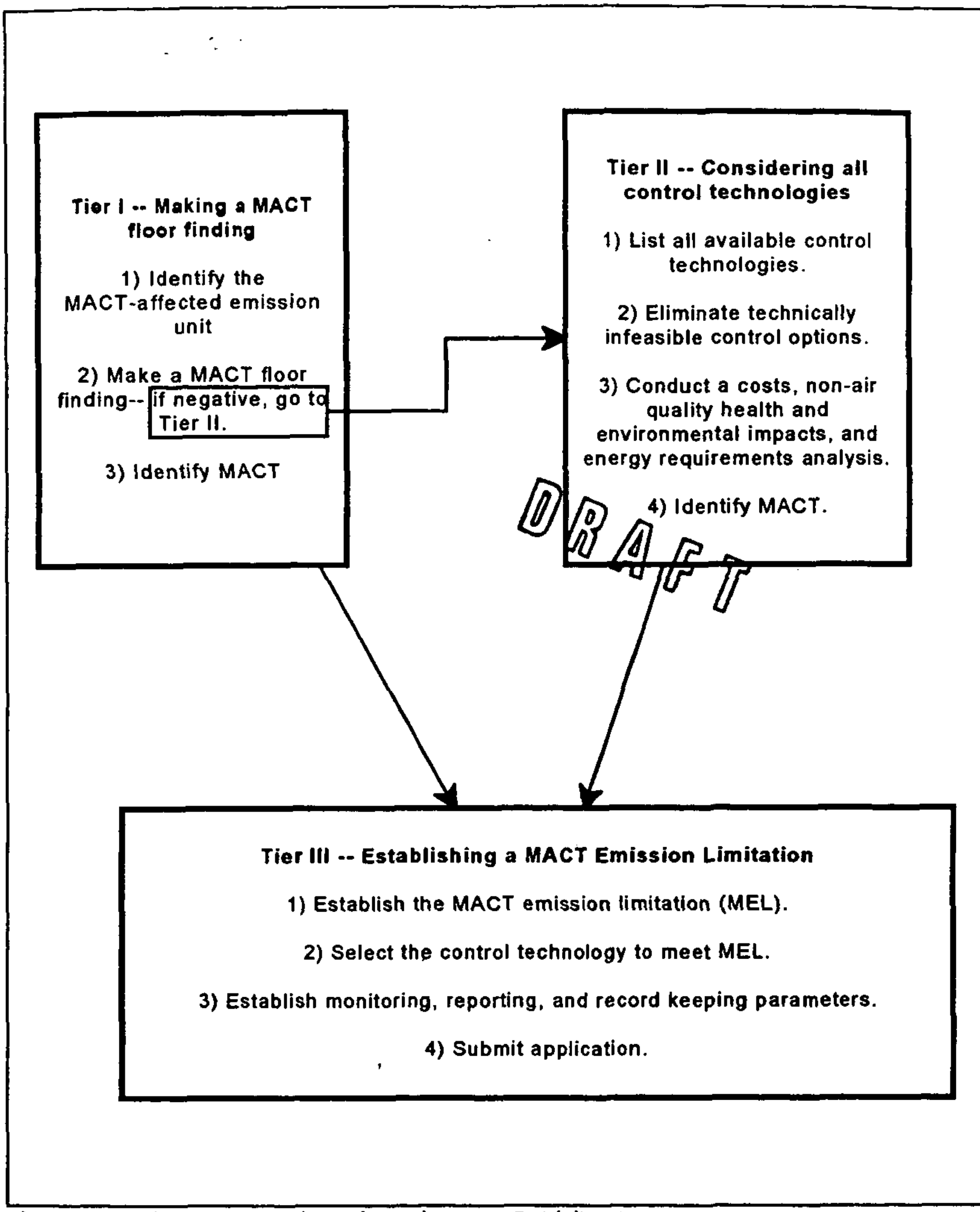


**Figure 2.1** The MACT analysis (from the EPA *Guidelines).*

## How does *MACT & Models* assist in case-by-case determinations?

This document, *MACT & Models for Pultrusion*, has been prepared to assist in complying with requirements for case-by-case MACT determinations.[6] This document is intended for use in establishing case-by-case MACT for facilities producing thermoset polyester composite products by the pultrusion process.

In particular, Chapter 4 of this document contains a review and analysis of existing control technology and applicable state regulations. For facilities making a MACT application, Chapter 4 is intended to fulfill the Tier I requirements for analysis of existing controls and regulations.

Chapters 5-8 contain a review and analysis of commercially available control technologies. This chapter includes models that will allow facilities to determine the economic feasibility of each of the technically feasible control options. Chapters 5-8 are intended for use by facilities in conducting a Tier II feasibility analysis of add-on controls.

Owners or operators of pultrusion facilities seeking Title V permits or Notice of MACT Approval for new, reconstructed, modified, or existing sources should be able to use Chapter 4 to demonstrate a negative MACT floor finding. Chapters 5-8 should be used to justify the selection of certain control technologies as technically feasible, and the models should be employed to evaluate the economic feasibility of these controls for the facility in question.

If none of the technically feasible controls described in Chapters 5-8 prove feasible, due to operational and economic characteristics of a given facility, then the owner/operator should negotiate with the appropriate permitting authority for a Title V permit or Notice of MACT Approval based on work practice, design, equipment, recycling and/or other practices. The consideration of existing pollution prevention technologies in Chapter 4 should assist in determining the applicability of these technologies to a given facility.

[6] The procedures followed in this document are those specified by EPA for determining case-by-case MACT for new, reconstructed, or modified sources, as required under CAA Section 112(g). However, this document should also prove useful for determining case-by-case MACT for existing sources, are required under CAA Section 112(j).

## Outline of case-by-case MACT procedure

This section outlines the procedures and requirements for case-by-case MACT determinations, as set forth in the EPA *Guidelines*.

I. Tier I -- MACT floor finding
   A. Identify source category.
      1. Composites industry facilities will generally fall in the Reinforced Plastics/Composites source category.
      2. Subcategorization within the source category may be considered when it can be clearly demonstrated that there are air pollution control engineering differences. Criteria to consider include type of process operation (batch vs. continuous), emission characteristics, control device applicability, costs, safety, and pollution prevention opportunities.
   B. Identify affected emission units.[7]
      1. If EPA has published the applicable MACT standard, this standard should be consulted in determining the MACT-affected emission unit.
      2. When a source category on the source category list is designated as a specific piece of equipment, the MACT-affected emission unit is that piece of equipment.[8]
      3. EPA's Office of Air Quality Planning and Standards should be consulted to see if a suggested method of grouping affected emission points is available.
      4. Emission points should be combined into a single MACT-affected emission unit when the combination of points leads to a more cost-effective method of control, and achieves a greater degree of emission reduction.
      5. The affected emission unit should not be defined in an unnecessarily unique manner so that it cannot be compared with other similar emission units.
   C. Collect *available information*.
      1. This includes information available from EPA, states, and databases. MACT determinations made for similar emission units, state regulations pertaining to the source category, and information collected by EPA in preparation for promulgation of the MACT standard should be

[7] Facilities should also obtain guidance from their local permitting authority on definition of emission units. Some states will consider the entire facility to be the emission unit; others will consider production lines or individual pieces of equipment to be emission units.

[8] This is not the case for composites manufacturing.

considered.

2. Information should be collected for *similar emission units* outside of the source category. Emission units are similar if they have similar emission types and can be controlled with the same type of control technology. Types of emission units include process vents and stacks, equipment leaks, evaporation and breathing losses, transfer losses, and operational losses. Concentration and type of constituents of a gas stream should be considered when deciding if two emission units are similar.
3. For emission units requiring existing source MACT, information sources outside the source category need not be considered.

D. Make a MACT floor finding

1. For emission units subject to new source MACT (construction of a new unit, or reconstruction of an existing unit), use the available information to determine the level of emission reduction achieved by the best-controlled similar source. This level of emission reduction is the MACT floor.
2. For emission units subject to existing source MACT (modified and existing units), use the available information to calculate the average emission reduction achieved by the best-performing 12% of sources in the source category (or average of best 5 source in categories with fewer than 30 sources). This level of emission reduction is the MACT floor.
3. Depending on what information is available, the calculapion can be based on emission reductions specified in state and local regulations, control efficiencies for add-on controls and emission reduction ratios for add-on controls, work practices, recycling, reuse or pollution prevention technology.
4. Owners/operators of emission units subject to existing source MACT can avoid calculating a MACT floor by agreeing to adopt the new source MACT emission limitation.
5. If the available information is not sufficient to calculate the MACT floor, or if the floor equals "no control," then a negative MACT floor finding is made, and the MACT analysis should proceed to Tier II.

E. Identify a MACT control technology that reduces HAP emissions from the affected emission unit to the maximum extent and to a level that is at least equal to the MACT floor (assuming positive MACT floor finding). Consideration is given to costs, non-air quality health and environmental impacts, and energy requirements. Proceed to Tier III.

II. Tier II -- Consideration of commercially available and demonstrated control technologies (when MACT floor finding is negative)

A. Using the available information, develop a list of commercially available control technologies that have been successfully demonstrated in practice for similar emission units.

B. Eliminate technically infeasible control technologies
   1. Technologies are infeasible if there are structural, design, physical, or operational constraints that prevent the application of the control technology to the emission unit.
   2. Cost to install or maintain the control technology is not considered a factor in determining technical feasibility.
   3. The owner/operator should be prepared to justify the elimination of any control technology for technical infeasibility.

C. Conduct an impacts analysis for each technically feasible control technology. Determine the control efficiency, costs, non-air quality health and environmental impact, and energy requirements for each control technology. The importance and relative weight of each of these factors should be made on a case-by-case basis by the owner/operator and the permitting authority.
   1. Cost impacts.
      a. For each alternative, list emission performance level, total capital cost, and total annual cost. Total annual costs are comprised of operation and maintenance costs, administrative charges, overhead, taxes, insurance, and capital recovery costs minus recovery credits (credit for product recovery or sale of by-products).
      b. Costs should be reported in equal end-of-year payments over the life of the equipment. Total annual costs should also be reported on an overall basis.
      c. Rank the alternatives by cost effectiveness (total annual cost divided by the amount of HAP removed). Refer to other MACT standards to determine what EPA considers to be a reasonable cost effectiveness.
      d. If the control costs place a significant burden on the facility, then the cost analysis should include the financial information necessary to assess the affordability of the control for the facility. For example, this information could address the impact of the control equipment on the unit cost of the product made in the facility, or the ratio of the capital cost of the control compared to the total capital structure of the company.
   2. Environmental impacts.
      a. Identify secondary environmental impacts that may affect the selection or rejection of each control technology.
      b. Secondary environmental impacts include solid or hazardous waste generation, discharges of polluted water, visibility impacts, or emission of other air pollutants that result from operation of the control alternative.
      c. Identify the public or environmental consequences of releasing

these materials.

d. The generation or reduction of toxic or hazardous emissions other than those for which the MACT determination is being made, including compounds not regulated under the Clean Air Act, should be included in the environmental impact analysis.

3. Energy impacts.
   a. Quantify the energy penalties (e.g., use of fuel to operate the control) and benefits (e.g., recovery of the heat value from combustion of a concentrated waste stream) associated with operation of each control alternative.
   b. If appropriate, the energy impact may be converted into dollar costs and factored into the cost analysis.
   c. The energy impact analysis may address concerns over locally-scarce fuels, where appropriate.

D. Select as MACT the technology allowing the highest degree of HAP emission reductions, with consideration to the other factors.

III. Tier III -- Establish a MACT emission limitation

A. Determine the degree of emission reduction that can be obtained from the affected emission unit, if MACT (as identified in Tier I or Tier II) is applied, and properly operated and maintained.
   1. If it is not feasible to establish a specific numerical or efficiency limitation, then specific design, process or control technology should be designated.
   2. When control efficiencies are used to establish the MACT floor, the MACT emission limitation (MEL) can be computed by multiplying the MACT efficiency by the uncontrolled emission level (UCEL):
      MEL = UCEL * MACT efficiency
   3. When emission reduction ratios (ERR) are used to calculate the MACT floor, the MACT emission limitation can be computed by multiplying the uncontrolled emission level by the sum of one minus the emission reduction ratio:
      $MEL = UCEL * (1\text{-}MACT_{ERR})$
   4. A five-year period may be employed to calculate uncontrolled emissions; this allows facilities to take credit for recently-implemented pollution prevention measures.

B. Select a control technology to meet the MACT emission limitation.
   1. The owner/operator should propose a control strategy that allows the emission unit to obtain the required MACT emission limitation.
   2. In many cases the MACT emission limitation will be achieved through use of the MACT technology. However, in other cases, pollution prevention or other controls have been already implemented at the facility, and a level of control less than that achieved though use of the

MACT technology will be sufficient to achieve the incremental reduction to the MACT emission limitation.

C. Establish appropriate monitoring, reporting and record keeping practices necessary to ensure compliance with the MACT emission limitation.

D. Prepare an application for Title V permit or Notice of MACT approval.

## Chapter 3. Pultrusion

In *pultrusion*, continuous lengths of glass strand (roving) and/or glass mat are pulled through a resin bath, then through a heated die, and then through pullers, and finally a cut-off device. The pultrusion process is employed to fabricate a wide variety of linear, constant-cross-section parts, such as ladder rails, window lineal, windmill blades, tent poles, demister blades, grating and hand rails, I-beams, lighting systems and exterior panels for busses, and fuse tubes.

### Process description

In a typical pultrusion operation, styrene-containing polyester resin is received in 55 gallon drums, 200 gallon totes, or bulk tanker truck. In the mixing operation, resin is blended with pigments, initiators, fillers, additional styrene (to adjust viscosity), and other materials. Mixing takes place in 55 gallon drums. When the mixing operation is complete, the drums are wheeled to the pultrusion machine. At the machine, a pump is used to transfer the resin mixture to the resin bath.

In the production area, spools of glass roving and mat are stored on large racks. The required number of rovings and mats (depending on the product being made) are threaded though various guides, then through the resin bath. After leaving the bath, the now-wet glass passes through forming guides, which begin to shape the glass into the shape of the product. The glass then passes into the forming die.

Some pultrusion operations inject the resin into the die, instead of employing a resin bath to saturate the glass with resin.

In the die, heat causes the styrene to polymerize and cross-link the polyester resin chains, forming the cured, rigid product. After exiting the die, the product reaches the pullers. Puller speed is adjusted so that the product spends the proper time in the die. Finally, the product is cut to lengths by a saw.

The pultrusion process is shown schematically in Figure 3.1.

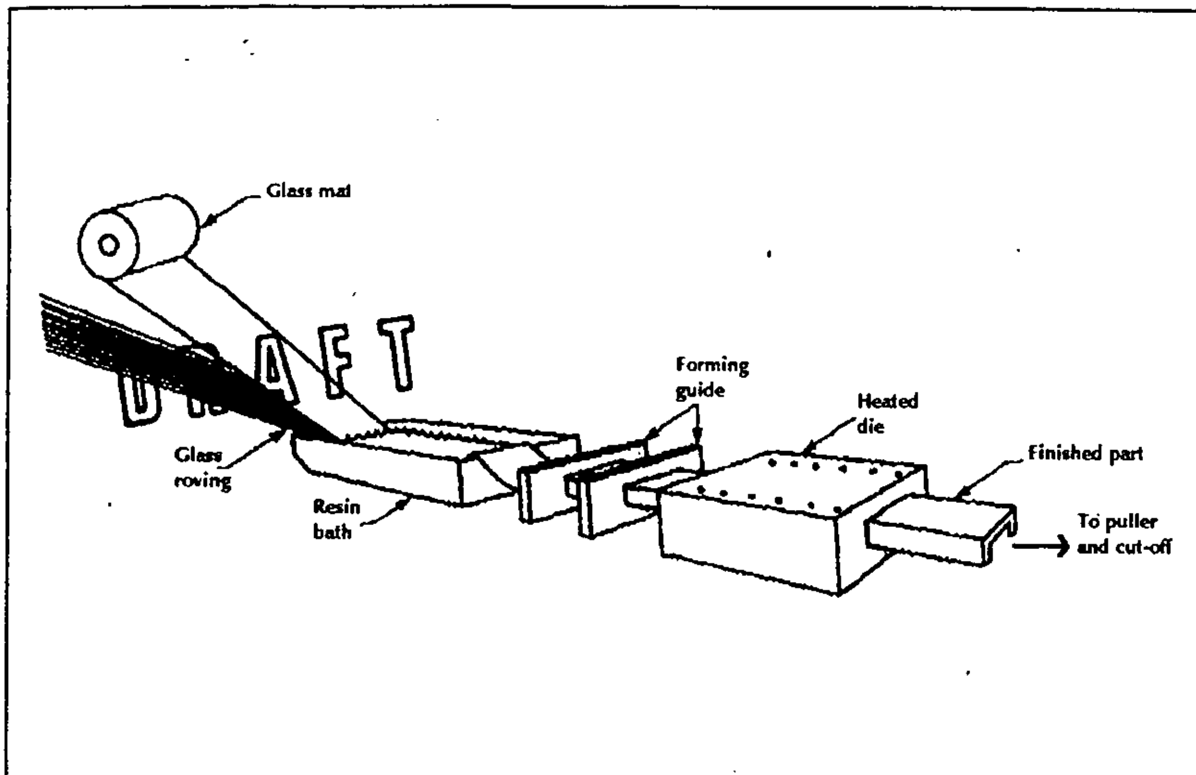


**Figure 3.1** The pultrusion process.

## Chapter 4. Tier I Analysis

In the EPA *Guidelines*, a MACT floor finding is made in Tier I. Tier I is comprised of the following steps:[9]

A. Identify the source category
B. Identify the affected emission unit
C. Collect available information
D. Make a MACT floor finding
E. Identify MACT technology

This chapter follows the procedures given in the EPA *Guidelines* to make a Tier I MACT floor finding for pultrusion.

### Identify the source category

The pultrusion of styrene cross-linked thermoset polyester resins is included in the *Reinforced Plastics/Composites source category*.

The EPA *Guidelines* allow subcategorization when it can be demonstrated that there are pollution control engineering differences within a source category. The pultrusion process is continuous, it makes use of continuous lengths of glass roving, mat, and veil, and the product is formed within a closed die. Especially when considering pollution prevention options, the pultrusions process is dissimilar from other composites manufacturing operations. Accordingly, this analysis will assume a *subcategory for pultrusion,* within the Reinforced Plastics/Composites source category.

### Identify the affected emissions unit

This document will consider the following possible emission units within the typical pultrusion operation:[10] Resin storage, Mixing, Pultrusion.

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[9]These steps are described in greater detail in Chapter 2, and in the EPA *Guidelines*.

[10]When making an application for a Notice of MACT Approval or Title V permit, the owner/operator will specify the affected emission unit (equipment, production line, or facility) that is to be covered.

**Collect available information**

According to the EPA *Guidelines*, available information may include databases such as EPA's BACT/LAER Clearinghouse, existing MACT determinations for facilities in the source category, state and local regulations, and information EPA has collected or prepared as part of the process of developing the NESHAP for the source category. In addition to these sources, this document will consider industry-sponsored research.

**BACT/LAER Clearinghouse** No pultrusion facilities were found in the BACT/LAER Clearinghouse.

**Existing MACT determinations for facilities in the source category** Members of the Composites Institute who employ pultrusion were polled, and none had prepared MACT determinations. Users of this document should contact the Composites Institute and EPA to confirm that a MACT determination has not been made by a facility subsequent to the issuance of this document.

While there have been no MACT determinations for pultrusion, one company did recently conduct a BACT analysis. This analysis found that add-on controls were not economically feasible as BACT for pultrusion operations, and suggested that facilities employ low-styrene resins, where the resulting change in product physical properties was acceptable.[11]

**State and local regulations** The *South Coast Air Quality Management District (California) Rule 1162*, adopted in 1987, and most recently amended in July, 1994, was one of the first state or local regulations specifically applicable to the composites industry. SCAQMD Rule 1162 has served as the model for subsequent state or local regulation of the composites industry.[12] Under Rule 1162, pultrusion manufacturers must comply with either a material requirement, a process requirement, or a control requirement. The material requirement specifies

[11] *Best Available Control Technology (BACT) Analysis for the Pultrusion Industry*, Center for Hazardous Materials Research, Pittsburgh, PA, 1994. This analysis assumed that reductions in emissions from use of low styrene resins are directly proportional to the reduction in styrene content (e.g., that switching from a 50% styrene resin to a 35% styrene resin -- a 30% decrease in styrene content -- will result in a 30% decrease in emissions). This assumption is technically questionable and remains unproven for pultrusion.

[12] For example, RACT regulations adopted for the Chicago area are based on Rule 1162 (Illinois Pollution Control Board R93-14, adopted January 6, 1994). In addition, California's San Joaquin Valley Unified Air Pollution Control District Rule 4686 and Bay Area Air Quality Management District Regulation 8, Rule 50 are similar to Rule 1162, but neither specifically address pultrusion.

maximum monomer content (by weight, as applied), for general purpose, corrosion-resistant, fire retardant, or high strength resins, of 35%, 48%, 42%, and 48%, respectively. The process requirement for pultrusion specifies covered resin baths and preform areas (from the exit of the bath to the die, all but 18 inches of the preform distance must the enclosed to minimize air flow), and a maximum weight loss of polyester materials of 3%.[13] The control requirement specifies control equipment, achieving a 90% capture and control efficiency.[14] In addition, Rule 1162 contains a number of general requirements for composites manufacturing, including the use of closed containers for all resin storage, use of low-VOC solvents, and record keeping.

**Information EPA has collected or prepared for the NESHAP** In August, 1993, EPA sent screening surveys to over 900 facilities in the composite industry. The Composites Institute has reviewed the surveys completed and returned to EPA (except for an unknown number of surveys that were returned marked "confidential"), as well as a number that were sent directly to CI. There are 33 surveys from facilities employing the pultrusion process. A summary of these surveys is shown in Table 4.1. The controls listed in the surveys, with the number and percentage of facilities employing each type of control, are shown in Table 4.2.



None of the surveys included information on emission or emission reductions. Two facilities reported the use of incinerators. In both cases, facility management reported that this control technology is used primarily to control emissions from operations not normally found at pultrusion facilities (painting line at Owens Corning, continuous laminating line at W.R. Grace), and that emissions from the pultrusion operation represented only a small fraction of

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[13]Pultrusion facilities regulated under Rule 1162 have reported to the Composites Institute that they employ emission factors when determining that their weight loss of polyester materials is less than 3%. Facilities typically have not conducted actual emission measurements. It is not known what fraction of pultrusion operations would actually meet the 3% maximum polyester weight loss requirement.

[14]To the knowledge of the Composites Institute, no pultrusion facilities in California achieve a 90% capture and control efficiency. In preparing Rule 1162, SCAQMD staff evaluated add-on controls which could be used for composites manufacturing, including incineration, absorption, adsorption, and condensation. SCAQMD found that add-on controls are "technically feasible but are not expected to be economically viable for the majority of polyester resin fabricators." The cost effectiveness for add-on controls was estimated to vary from $19,000 to $48,000 per ton of VOC emission reduction. (*Staff Report: Proposed Rule 1162 – Polyester Resin Operations*, South Coast Air Quality Management District Rule Development Division, January 23, 1987.)

emissions sent to the control device.[15]

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[15]Telephone discussions with Robert Deskin, W. R. Grace, and James Gauchel, Owens Corning.

**Table 4.1** Pultrusion screening survey summary

| Name--------- | Address--- | -- | Contact------- | Phone---- | Proc | Controls----------- | ------------------- |
|---|---|---|---|---|---|---|---|
| Bedford RP | Bedford | pa | Dana LaGros | 8146238125 | pult | covered drums | |
| Carsonite Intl | Carson Cit | nv | Joe Briggs | 7028835104 | pult | conservation vents | |
| Coastal Eng.Pro | Varnville | sc | | 8039434538 | pult | baths eng.w/min.area | |
| Crain Enterpris | Mound City | il | Anthony Dover | 6187489227 | pult | conservation vents | |
| Creative Pultru | Alum Bank | pa | Kathy Barley | 8148394186 | pult | air conditioning | reduced pan size |
| | | | | | | covers on pans | injection |
| Creative Pultru | Roswell | nm | Dave Evans | 5053472226 | pult | temp.controlled stor | resin injection(1) |
| DFI Pult.Compos | Erlander | ky | Vern Kallenborn | 6062827300 | pult | lids on drums&mixers | partially encl.baths |
| Dasco Pro | Rockford | il | John Bacher | 8159623727 | pult | eliminated CH2Cl2 | |
| Enduro FG Sys. | Houston | tx | Charles Phaup | 7138694909 | pult | | |
| Fiberflex | Big Spring | tx | Bill Frey | 9152671661 | pult | refrig.stor&mix room | enclosed baths(2) |
| Francis Industr | Pataskola | oh | William Corban | 6149274019 | pult | covers on containers | |
| Glasforms | San Jose | ca | Terry McQuarrie | 408[illegible]300 | pult | conservation vents | closed containers |
| | | | | | | covered baths | scrap vap.to car.abs |
| Gould Shawmut | MrbleFalls | tx | Michael McDavid | 21[illegible]33522 | pult | closed drums | |
| Haysite RP | Erie | pa | Timothy Pfister | 8148[illegible]3691 | pult | | |
| IKG Industries | Nashville | tn | Lee Rake | [illegible]7824774 | pult | bottom-filling totes | |
| IMCO RP | Moorestown | nj | John Rhodes | 60[illegible]739517 | pult | | |
| Indus.Dielectri | Nobleville | in | Jon Coleman | 3177731766 | pult | | |
| Intl.Grating | Houston | tx | Leroy Heston | [illegible]6338614 | pult | covers on tanks | |
| Janco Products | Mishawaka | in | Leonard Northam | 2192553169 | pult | covered resin bath | baths partly closed(2) |
| Liberty Polygla | W.Mifflin | pa | Duane Ramseur | [illegible]124668611 | pult | | |
| MMFG | Bristol | va | Rob Camper | 7036458112 | pult | conservation vents | |
| Omega Pultrusio | Aurora | oh | Walt McSherry | 2165625201 | pult | ldar | cov. drum&containers |
| | | | | | | baths covered(1) | |
| Owens Corning | Hazleton | pa | Scott Flowers | 7173846210 | pult | incinerator(3) | conservation vents |
| | | | | | | rsn fill sta. enclos | |
| Plas/Steel Prod | Walkerton | in | Kevin Parks | 2192580778 | pult | partly closed bath | closed containers |
| Robroy Industri | Verona | pa | | 4128282100 | pult | conservation vents | refrig.resin storage |
| Shakespeare Elc | Newberry | sc | John Price | 8032765504 | pult | small resin baths | min. distance to die |
| St. Croix | Park Falls | wi | Paul Schluter | 7157623226 | pult | conservation vent | baths partly enclos(2) |
| Structron | San Marcos | ca | Tim Boddye | 6197446371 | pult | cov.tanks and drums | lead dect.& repair |
| W.R. Grace | Ft.Worth | tx | T. Walczyk | 8172321127 | pult | conservation vents | thermal oxidizer(4) |
| | | | | | | direct injection(5) | |
| WH Brady | Glendale | wi | Janeen Jackson | 4143328100 | pult | covered holding tank | |
| Wayne Manufactu | Cedar Rapi | ia | Neil Sherman | 3198484231 | pult | | |
| Werner | FranklinPk | il | Robert DeGraff | 7084559450 | pult | air conditioning | covers on containers |
| | | | | | | fume collection sys(6) | |
| confidential002 | | | | | pult | chilled resin tray | covered containers |

Notes: (1)where possible; (2)vented to atmosphere; (3)emissions from resin bath; (4)oxidizer achieves 95% reduction; (5)injection used for all products; (6)proprietary

| Type of control | No. of facilities reporting use | % of facilities reporting use |
|---|---|---|
| Vapor from storage of scrap sent to carbon canister | 1 | 3.0 |
| Minimize distance between bath and die | 1 | 3.0 |
| Bottom-filling of totes | 1 | 3.0 |
| Eliminate $CH_2Cl_2$ solvent | 1 | 3.0 |
| Incinerator | 2 | 6.1 |
| LDAR | 2 | 6.1 |
| Air conditioned plant | 2 | 6.1 |
| Resin injection | 3 | 9.1 |
| Low temperature resin storage or mixing | 4 | 12.1 |
| Minimize size of baths | 5 | 15.2 |
| Covered baths | 8 | 24.2 |
| Conservation vents | 8 | 24.2 |
| Covered drums and mix tanks | 12 | 36.4 |

**Table 4.2** Summary of controls reported in screening surveys

**Industry research** The Pultrusion Industry Council, an activity of the SPI Composites Institute, conducted a series of experiments to characterize the effect of key operating variables on styrene emissions.[16] A pultrusion machine was placed in a Total Temporary Enclosure, and styrene content in the stack exhaust was measured. The experimental conditions employed, and the results of the experiment, are summarized in Table 4.3.

Among the variables studied, blower speed had by far the largest impact on emissions. Air flow at the preformer area (between the bath and the die) was 5-10 ft/min at the "low" blower speed, and approximately 25 ft/min at the "high" blower speed. Resin mix temperature also proved to have significant effects on emissions.

The results of this study are only generally indicative of the effect of operating variables on emissions. The results shown in Table 4.3 are probably not useful in estimating emissions from a given pultrusion facility, or for estimating emission reductions that may result from changes in operating variables in a facility.

| Operating Variable | Conditions employed (high; low) | Average difference in emissions, high vs. low condition | Significant? |
|---|---|---|---|
| Bath and reservoir surface area (in$^2$) | 1050.2; 565.3 | 0.0005 | |
| Bath and reservoir covered | Yes; No | 0.0003 | |
| Resin mix temperature (°F) | 95; 77 | 0.0008 | Yes |
| Styrene content in resin (%) | 45; 35 | 0.0007 | |
| Line speed (in./min.) | 20; 10 | 0.0002 | |
| Part surface area (in$^2$ per foot length) | 147; 57 | 0.0006 | |
| Blower speed -- TTE exhaust (cfm) | 430; 170 | 0.0016 | Yes |

**Table 4.3** Summary of experimental conditions and results, Pultrusion Industry Council Emissions Study.

[16]PIC Emission Study Report, Society of the Plastics Industry, Inc., May 5, 1993.

## Make a MACT floor finding

To make a MACT floor finding, the available information is used to calculate the level of emission reduction achieved in the industry. The MACT floor is the minimum level of emission reduction that can be set as the MACT emission limitation in Tier III.

**Existing source MACT floor** For emission units subject to existing source MACT (existing and modified sources), the MACT floor is the average emission limitation achieved by the best-controlled 12% of sources in the source category. At least three industry facilities are located in California or Illinois, and potentially subject to the applicable rules in those states. Also, the screening survey shows that five technologies are employed by at least 12% of the facilities in the source category: covering drums and mix tanks, conservation vents, covered baths, baths of minimum size, and low temperature resin storage or mixing. Owners/operators of existing or modified facilities should consider employing these technologies. There is no data, however, that will allow calculation of emission reductions that result from compliance with the applicable state regulations or though use of the identified technologies (or to show that the technologies are actually effective in reducing emissions). Accordingly, a *negative MACT floor finding* is made for existing and modified source. Owners/operators applying for NOMA or Title V permit should proceed to Tier II to evaluate add-on controls.

**New source MACT floor** For emission units subject to new source MACT (new sources or reconstructed existing sources), the MACT floor is the emission limitation achieved by the best controlled similar source. The best controlled sources in this source category are probably the two facilities that employ incinerators. However, both of these facilities are highly atypical for pultrusion operations; in both cases, the incinerators are used primarily to control emissions from operations not generally found in pultrusion facilities (see discussion on page 20). Accordingly, these facilities should not be considered when setting a new source MACT floor. Of the remaining facilities, there is no data that would allow identification of the best-controlled similar source.

Owners/operators of new or reconstructed sources should consider employing the technologies appropriate for existing and modified sources. In addition, a number of the other technologies shown in Table 4.2 may be appropriate for new or reconstructed sources. In particular, a number of facilities employ resin injection or air conditioning. These technologies may be useful in minimizing exposure of resin to air, reducing air flow across wet resin, and/or reducing resin temperature. Industry research (see discussion on page 23) suggests that these technologies may be effective in reducing styrene emissions.

Since no data is available that will allow calculation of emission reduction achieved by the best controlled source, a *negative MACT floor finding* is made for new or reconstructed sources. Owners/operators applying for NOMA or Title V permit should proceed to Tier II to evaluate add-on controls.

**MACT floor summary** Table 4.4 summarizes the MACT floor findings.

| Emission Unit | Existing Source MACT | | New source MACT | |
|---|---|---|---|---|
| | Applicable Technology | Floor Finding | Applicable Technology | Floor Finding |
| Resin storage | Covered storage tanks, conservation vents, or low temperature storage | neg. | Covered storage tanks, conservation vents, or low temperature storage | neg. |
| Mixing | Covered mix tanks or low temperature mixing | neg. | Covered mix tanks or low temperature mixing | neg. |
| Pultrusion | Covered resin baths or baths of minimum size | neg. | Covered resin baths, baths of minimum size, resin injection, or air conditioning | neg. |

**Table 4.4** Summary of MACT floor findings

**Identify MACT technology**

Since the MACT floor findings for both existing/modified and new/reconstructed source were negative, no MACT technology can be identified in Tier I.

## Chapter 5. Tier II Analysis - Methods and Assumptions

### Identification of Available Control Technologies

Proposed MACT Tier II guidelines require a listing of all available controls for similar emission units. This is taken to require the listing of any commercially available, pre-designed system that has been successfully demonstrated in practice to control emissions similar in flow, concentration, and physical/chemical characteristics to the styrene emissions from composite production. Because unique custom designs developed specifically for individual facilities are not considered available for deployment elsewhere, they have been excluded from the list of technologies to evaluate. Unproven technologies, even if based on successful pilot-scale equipment, also have been excluded from the list of technologies to evaluate. As unproven technologies, they by definition cannot be considered successfully demonstrated in practice.

### Existing MACT Standards for Similar Emission Units

The proposed MACT guidelines also require that if any similar emission unit in another source category is subject to an existing or proposed MACT standard, the applicable control technology must be evaluated. Although the composite production process is unique, storage and bulk transfer of styrene-containing liquids is common in the Synthetic Organic Chemical Manufacturing Industry (SOCMI), a source category for which final MACT standards have been promulgated. These standards, based upon comprehensive economic analyses conducted over a three-year period, are known as the Hazardous Organic NESHAP (HON)[9].

For organic liquid storage tanks and bulk transfer facilities, the HKN defines two source classes: Group 1, for which controls are considered cost-efficient and mandatory, and Group 2, for which controls are considered cost-inefficient and not required. Based upon the vapor pressure of styrene (5 mm Hg or < 0.1 psia at room temperature), SOCMI storage tanks and transfer operations handling styrene are classified as Group 2 sources.

It is reasonable to conclude that control of storage tanks and bulk transfer operations handling styrene and styrene-containing resins in the Composites industry does not merit consideration, based upon the exhaustive cost analysis conducted to support promulgation of the HON.

[9] 40 CFR 63 Subparts F, G, and H, published 4/22/94.

## Candidate Technologies

Based upon a review of regulatory databases, trade journals, technical publications of the Air and Waste Management Association, and literature provided by equipment vendors, the following technologies were evaluated to determine whether they were commercially demonstrated in practice on similar emission units (i.e., were candidates for feasibility analysis). The results of that determination are summarized below and detailed in Chapter 6.

- Removal Technologies evaluated include absorption, adsorption and condensation systems. Only adsorption and condensation systems were found to be commercially demonstrated in practice in similar emission units.

- Destruction Technologies evaluated include thermal oxidation systems (flame, flameless, catalytic, regenerative, and recuperative), combustion in existing boilers or process heaters, chemical oxidation, biological oxidation (biofiltration), and UV-enhanced ozonation. Only the thermal oxidation systems and boiler combustion were found to be commercially demonstrated in practice on similar emission units.

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## Evaluation Rationale and Criteria

The proposed MACT determination guidelines require an initial screening of listed technologies to eliminate technically infeasible controls, a cost-efficiency analysis of feasible controls, a qualitative discussion of other impacts associated with implementation of controls, and final selection of the MACT system. Key factors influencing this determination are as follows:

- Unique physical and chemical characteristics differentiate styrene from other volatile HAPs. The control of styrene in air streams is complicated by its low flashpoint (88ºF), low solubility in water (310 mg/l), tendency to spontaneously polymerize, and reactivity (with oxidizers, catalysts for vinyl polymers, peroxides, strong acids, and aluminum chloride), which may accelerate polymerization. Systems proven for control of non-styrene VOC streams cannot be assumed feasible for styrene control.

- Experience to date suggests that recovery of styrene for reuse as a feedstock, though attractive in theory, has yet to be demonstrated in practice. Impurities in unreacted styrene and introduced contaminants in exhaust streams concentrate to unacceptable levels in recovered styrene[10].

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[10] Telephone interview, H. Robert Goltz, PhD, Dow Chemical Company.

- Cost-efficiency is directly related to the volume and concentration of the control device inlet stream, which in turn is related to vapor collection system design. The latter defies generalization, so it was decided to evaluate the cost-efficiency of each technically feasible control technology with respect to three model inlet streams:

    - a dilute, high-volume stream (25 ppm at 15000 CFM), representing workspace ventilation exhausts such as those that might result from a permit-required "total enclosure."

    - a moderate concentration, moderate flow stream (100 ppm at 5000 CFM).

    - a concentrated, low volume stream (250 ppm at 150 CFM), representing exhausts from collection systems specifically engineered for close capture.

Cost-efficiency (cost per ton of emissions controlled) is evaluated based upon two parameters. Average Cost-Efficiency is defined as the sum of annualized capital and engineering costs plus annual operating and maintenance costs divided by the tons of emissions controlled per year. Incremental Cost-Efficiency is defined as the difference between the cost of the subject control system and the cost of the next most effective system divided by the difference between these two systems in tons of emissions controlled per year. In Chapter 7, cost-efficiency data are presented in spreadsheet form for examples of each technically feasible control option as applied to each model inlet stream.

Potential MACT for each model inlet stream is defined herein as the most effective control technology for which both the average and incremental cost-efficiencies are each less than $5,000/ton. The latter amount does not include the cost of the vapor collection system, which is impossible to generically estimate.

This definition is reasonable considering USEPA's cost analysis for the HON. The table below summarizes cost-efficiencies, including collection system costs, presented in the HON for MACT required on each class of emission point in the chemical manufacturing industry.

| Emission Point Category | Average Cost of MACT | Incremental Cost of MACT |
|---|---|---|
| Process Vents | $251/ton | $3,545/ton |
| Bulk Transfer Operations | $8700/ton | N/A - least efficient technology |
| Wastewater System Vents | $427/ton | $3,904/ton |
| Storage Tanks < 20(000 gallons<br>Storage Tanks 20-40,000 gallons<br>Storage Tanks > 40,000 gallons | N/A - not controlled<br>$6,000/ton<br>$2,545/ton | N/A - not controlled<br>N/A - least efficient technology<br>$3,545/ton |

**Table 5.1.** HON cost efficiencies.



A detailed discussion of the cost analysis methodology is given in Chapter 7.

## Absorption

Absorption systems remove vapors from an air stream by placing the stream in intimate contact with a liquid in which the vapors will dissolve. The removal efficiency depends upon the exposed contact surface area, contact time, and relative solubility. Many vendors supply this technology.

Commercially available packaged absorption systems typically use water as the solvent (wet scrubbers). Water is a very inefficient styrene absorbent, with over 800,000 gallons of water required to scrub one ton of styrene. For this reason, such units are not used in applications requiring styrene removal. Furthermore, no solvent-based absorber systems were identified in use for styrene removal. Accordingly, absorption systems cannot be listed as available control technologies demonstrated in similar emission units, and are not considered further.

## Adsorption

Adsorption systems rely on the adherence of vapor molecules to the surface of a solid medium (the adsorber), which is either discarded or regenerated once it reaches collection capacity. Regeneration typically involves controlled heating of the medium simultaneous with a low volume backwash gas sweep (typically nitrogen), resulting in a highly concentrated exhaust stream which is either condensed or oxidized. Available systems operate in either cyclical or continuous mode, the latter involving parallel sequential systems or fluidized bed designs. Commonly used adsorbers include activated carbon and various non-carbonaceous resins. Many vendors supply carbon adsorbers. Among resin-based systems are those using zeolites or other proprietary media, including systems developed by Purus (Padre™ system) and Weatherly (Polyad™ system).

Available field data suggest that styrene will polymerize on heated carbon adsorber beds due to the ash content of carbon. This "blinds" the adsorber, reducing uniform air flow, and can cause bed fires[11]. For this reason, carbon adsorption is considered technically infeasible in the typical environment of a composite manufacturer. However, resin-based adsorber systems are available and appear to be technically feasible for styrene removal. The resins are formulated to avoid styrene polymerization, and have demonstrated styrene removal efficiencies well in excess of 90%, assuming care is taken to filter out particulates from the inlet stream to the adsorption unit.

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[11] Technical Bulletin 3.03, Dow Chemical Company, February 1993. Also see "Assessment of VOC Emissions from Fiberglass Boat Manufacturing" - EPA 600/2-90-019.

### Membrane Separation

A system employing this technology is marketed by Membrane Technology, Inc. The system compresses and condenses a vapor-laden inlet stream. The compressed overhead stream is passed to a vessel divided by a membrane which is 10-100 times more permeable to organic compounds than to air. The enriched permeable stream is recycled to the compressor, while the stripped air stream is exhausted. Although available vendor data suggest that this system is technically feasible for styrene control, it has not been demonstrated in practice[12] and is eliminated from further consideration.

### Condensation

Removal of vapors from an air stream by chilling the air to condense the vapors is a common technique. The remaining air is saturated with vapor at a concentration dependent upon the condensation temperature. At the styrene concentration of the three hypothetical streams, extremely low temperature cryogenic systems would be required to condense styrene efficiently. Such systems employed singularly are considered technically infeasible because they are beyond the maintenance capabilities of even the most sophisticated composite production facilities.

However, condensers fronted by resin adsorption concentrators are the basis of equipment designed by vendors such as Purus and Weatherly, and are considered technically feasible for styrene removal.

### Thermal Oxidation

All of the following thermal oxidation methods are in general use and are considered technically feasible. Many vendors provide such systems. Site-specific analysis of each of these should address the impact of increased emissions of $NO_x$.

- Flame oxidation, with or without auxiliary fuel to support combustion.
- Catalytic oxidation, where a catalyst is used to promote oxidation at a lower temperature.
- Recuperative oxidation, essential a flame oxidizer fitted with a heat exchanger providing 65% heat recovery to preheat the incoming air stream.

[12] Telephone interview with David Dortmundt, Membrane Technology, indicating that there are no commercial installations controlling styrene sources.

- Regenerative oxidation, employing sequentially operated beds of ceramic media which are alternatively heated by the combustion gases and used to preheat the incoming air stream.

- Flameless oxidation, employing a shell and tube heat exchanger combined with an inert bed of ceramic media. Combustion occurs in the shell section and the resulting hot gases are passed through the ceramic bed in which the incoming gas tubes are embedded. This type relies on a self sustaining combustible emission stream.

### Combustion in Industrial Boilers

Although widely used at many large chemical plants and refineries, this technology is considered technically infeasible in the typical setting of a composite manufacturer. Boilers designed to support the relatively modest steam and heat requirements of typical composite manufacturers would be too small to reliably handle the hypothetical exhaust streams. Moreover, normal variability in inlet vapor concentrations would interfere with maintenance of boiler operation to reliably support manufacturing processes.

### Chemical Oxidation/Absorption

This process involves the wet scrubbing of vapors with aqueous solutions of sodium hydroxide, sodium hypochlorite, or other oxidizers. This technology was originally developed for odor control. A pilot scale test of this system, adapted for styrene control by QUAD Technologies, was conducted by USEPA's Control Technology Center in 1994[13]. The results suggest that removal efficiency will not exceed 55%.

Removal efficiency of styrene is enhanced over that for water scrubbing, because the chemicals react to oxidize the styrene. However, these systems introduce dangerous chemicals and generate considerable volumes of caustic wastewater to be managed. Although the wastewater appears to be relatively dilute, its discharge complicates environmental management at most composite facilities, which are generally not regulated as significant industrial wastewater sources.

This method has not be installed for styrene control in a manufacturing environment; moreover the low removal efficiency compared to other methods suggests that it will not be widely adapted for such applications. Accordingly, this method is not considered a commercially available control technology demonstrated in similar emission units, and will not be considered further.

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[13] "Evaluation of a Liquid Chemical Scrubber System for Styrene Removal" EPA-600/R-94-211, December, 1994.

## UV-Ozonation

This technology is typically employed to treat dilute aqueous streams. The ozone reacts (enhanced by UV light) to oxidize dissolved organics. Because styrene is relatively insoluble in water, relatively large volumes of water from absorber system would be required. No commercial installations for styrene control in manufacturing operations were identified. This method has not been demonstrated in similar emission units, and will not be considered further.

## Biological Decomposition (Biofiltration)

This technology involves passing the vapor-laden air stream through a "filter" medium in which microbes exist on superficial water films. The microbes extract the vapors dissolved in the water film and metabolize the organics, yielding biomass, carbon dioxide and water. Although widely available for control of many organics, this technology has not yet been successfully demonstrated in practice for styrene control. The low solubility of styrene in water would limit the efficiency of biofilters in such applications. Based upon available information, biofiltration is not demonstrated in practice on similar emission units and will not be considered further.

## Summary of Screening Analysis

Of the removal technologies considered, only the hybrid resin adsorption/condensation systems were considered to be commercially available, demonstrated in practice on similar emission units, and technically feasible for styrene removal in the composites industry.

All thermal oxidation technologies are considered commercially available, demonstrated in practice on similar sources, and technically feasible in the composites industry. No other destruction technologies merit further evaluation.

Resin adsorbers fronting a thermal oxidizer are also commercially available. These hybrid systems are considered technically feasible and worthy of further evaluation.

Cost-efficiency analyses for the model streams are evaluated in Chapter 7.

## Chapter 7. Tier II Cost Analysis

### Cost Analysis Methodology

Cost analyses are consistent with the methods set forth in the latest version of the USEPA Office of Air Quality Planning and Standards (OAQPS) Control Cost Manual.[14] This manual provides guidance and cost factors to be used to develop comparative control cost estimates, purported by OAQPS to be accurate to within +/- 30%. OAQPS cost factors have been used in this report, except where vendor information or engineering judgment suggest that more accurate cost data are available. Cost factors are described below.

- OAQPS calculates Total Direct Costs based upon purchase costs plus factors multiplied by the purchase costs to cover instrumentation (3%), taxes (3%), freight (5%), and installation costs (30%), to which are added site preparation costs. Because all considered control systems were provided as turnkey installations, purchase costs typically include or specify costs for instrumentation, installation, and freight. Sales taxes are estimated at a more reasonable rate of 7%, while site preparation costs (outside foundations and auxiliary ductwork connecting the control systems to the building ventilation header) are estimated at 20% for the thermal oxidizer and fluidized bed adsorber systems, and 10% for the smaller adsorber systems.

- OAQPS bases indirect costs on the following factors to be multiplied by the equipment purchase cost: engineering (10%), construction and field expenses (5%), contractor fees (10%), startup (2%), performance test (1%), and contingencies (3%). OAQPS factors for engineering, construction and field expenses have been used in this report. However, due to the turnkey nature of the considered control systems, contractor fees and startup costs are already included within the purchase price. Based upon engineering experience, OAQPS cost factors for performance (stack testing) and contingencies do not reflect current conditions. For this report, a cost of $15,000 has been used for stack testing and analysis of hazardous air pollutants (predominantly styrene), and a contingency of 10% of direct and indirect cost has been used.

- Capital cost recovery factors, which are used to annualize the capital investment for control systems, have been updated from the OAQPS timeframe of 1989, reflecting a current interest rate of 9% over a 10-year economic life.

- Operating labor, material, and utility costs have been updated to reflect typical current prices. OAQPS indirect annual cost factors for overhead (60% of operating labor), administration (2% of total capital investment) and property tax + insurance (2% of total

[14] OAQPS Control Cost Manual, Fourth Edition, EPA 450/3-90-006, published January 1990.

capital investment) have been used without modification.

## Overview of Model Analyses

Each of the three model inlet streams was used as a basis to evaluate the average and incremental cost-efficiency of each technically feasible control option. For each model stream, control options considered were thermal oxidation, adsorption + condensation, and adsorption + thermal oxidation. A representative vendor's system was then selected for each technology, and the vendor was contacted to develop the cost analysis. If no vendors were able to provide a system properly sized to process the model stream in question, that technology was dropped from the model analysis.

Vendor cost data and resulting cost-efficiency analyses are summarized in spreadsheet tables 7.1 to 7.4. (Table 7.1 is shown below; Tables 7.2 - 7.4 can be found following chapter 9.) Results are discussed below for each model stream.



| CONTROL SYSTEM PERFORMANCE | INLET STREAM CONCENTRATIONS AND FLOWRATE | | | | | |
|---|---|---|---|---|---|---|
| | 25 PPM 15000 CFM | | 100PPM 5000 CFM | | | 250 PPM 150 CFM |
| VENDOR TECHNOLOGY | DURR | WEATHERLY | DURR | WEATHERLY | PURUS | PURUS |
| | REGENERATIVE THERMAL OXIDIZER | ADSORBER W/ THERMAL OXIDIZER | REGENERATIVE THERMAL OXIDIZER | ADSORBER W/ THERMAL OXIDIZER | ADSORBER W/ CONDENSER | ADSORBER W/ CONDENSER |
| CONTROL EFFICIENCY | 99.99% | 98% | 99.99% | 98% | 95% | 95% |
| | | | | | | |
| TONS REMOVED | 26.59 | 26.06 | 35.48 | 34.77 | 33.71 | 2.54 |
| | | | | | | |
| COST PER TONS REMOVED | $10,197 | $8,338 | $4,450 | $4,898 | $8,941 | $32,098 |
| | | | | | | |
| INCREMENTAL COSTS PER TON REMOVED | $3,513 | N/A | ($635) | ($3,798) | N/A | N/A |

**Table 7.1** Summary of Cost Efficiency Analysis on Model Streams

For each model stream, the following method was used to identify potential MACT:

- Control options were ranked in order of efficiency (amount of styrene removed from the model stream).

- Average cost-efficiency for each option was calculated as annualized control costs divided by tons of styrene removed. Note that although the cost of in-plant vapor collection systems was not included, the costs of outside foundations and duct-work leading to the plant from the outside-control device were included.

- Incremental cost-efficiency relative to the most efficient option was calculated for all other options as the difference in annualized costs divided by the difference in tons of styrene removed. The lower the incremental cost efficiency, the better. Note that if the annualized cost of the most efficient option was lower than that of a less efficient option, the incremental cost efficiency would be negative.

- Potential MACT is identified as the most efficient option for which the average and incremental cost-efficiencies are each better than (lower than) $5,000/ton of styrene removed.

The following control system vendors provided cost data used in the Model Stream analyses:

- Purus
  48751 Thornbury
  Novi, Michigan 48374-2747
  (810) 380-9410

- Durr Industries, Inc.
  900 Hillside
  Elmhurst, Illinois 60126
  (708) 530-8361

- Weatherly, Inc.
  1100 Spring Street N.W., Suite 800
  Atlanta, Georgia 30309
  (404) 873-5030

### Model Stream 1

This stream is characterized by an inlet styrene concentration of 25 ppm at a flow rate of 15000 SCFM. Of the three potentially feasible control options, only two were deemed actually feasible based upon equipment availability. The control systems evaluated were:

- Durr Regenerative Oxidizer
- Weatherly Polyad™ Resin Adsorber + Oxidizer

Average cost-efficiencies are $10,107/ton and $8,338/ton respectively. These are substantially higher than the $5,000/ton selection criterion, so potential MACT may be considered to be no controls. This stream is too dilute to control efficiently. At 15,000 SCFM, the inlet concentration at which controls become cost-effective can be estimated at 25 ppm x $8,338/$5,000, or 42 ppm.

### Model Stream 2

This stream is characterized by an inlet styrene concentration of 100 ppm at a flow rate of 5000 SCFM. The control systems selected for evaluation were:

- Durr Regenerative Oxidizer
- Weatherly Polyad™ Resin Adsorber + Oxidizer
- Purus Padre™ Resin Adsorber + Concentrator

With average cost efficiencies and incremental cost efficiencies of $4,450/ton and $-635/ton, respectively, thermal oxidation is the most efficient system, providing 99.99% reduction in styrene emissions. It is also the most cost-efficient system; it is less costly than the next most efficient system, which is reflected in the negative value for incremental cost efficiency. Because thermal oxidation exhibits both average and incremental cost efficiencies less than $5,000, this system would qualify as potential MACT.

### Model Stream 3

This stream is characterized by an inlet styrene concentration of 250 ppm at a flow rate of 150 SCFM. Based upon sizing considerations, the only control system applicable for this model stream is:

- Purus Padre™ Resin Adsorber + Condenser

The average cost efficiency is $32,098/ton, far in excess of the $ 5,000/ton selection criterion. Accordingly, potential MACT in this application is considered to be no controls. At 150 SCFM, the inlet concentration at which controls become cost-effective is calculated (as before) to be 1600 ppm.

## Extending the Models to Site-Specific Streams

The sizing and installation cost of control systems are primarily a function of the volumetric airflow, because individual control systems models operate over discrete airflow ranges. For this reason, it is impossible to interpolate costs between systems designed to handle airstreams widely differing in airflow. Vendors must be consulted to develop site - specific costs.

However, it is possible to derive a site-specific analysis where required airflows match any of the considered model streams. The higher the inlet stream styrene concentration at any given flow rate, the more styrene will be removed per year, and the lower the cost per ton of styrene removed.

For instance, consider a stream with a flow rate of 5,000 SCFM (as in Model 2), but with styrene concentration of 200 ppm rather than 100 ppm. The annual costs would be essentially the same a those developed for Model 2 (actually about 1% less due to increased heat recovery of the additional styrene). However, the amount of styrene controlled, a direct function of styrene concentration, would double. The cost per ton removed would be halved to approximately $2,225 for the thermal oxidizer, $2,449 for the adsorber + oxidizer, and $4,470 for the adsorber + condenser.

## Chapter 8. Site Specific Impact Analysis

### Internalizing Indirect Costs

The proposed MACT guidelines require an evaluation of indirect effects such as energy impacts associated with each control option. However, from the perspective of the composite industry it is much more persuasive to quantify the impact of such effects, by including them in the cost-efficiency analysis, than it is to qualitatively describe them. Site-specific costs should be developed for all of the following that apply:

- Acquisition or modification of air permits.
- Disposal of waste (filter media, treatment sludges, etc) or discharge of wastewater.
- Acquisition of water discharge permits, if required, and the cost of manufacturing compliance therewith.
- Energy and material usage.
- The value of space consumed by the control device, which would otherwise be available for manufacturing equipment.

### $NO_x$ Emissions from Thermal Oxidizers

Based upon the latest available information from vendors and the project and fuel usage, $NO_x$ emissions should be calculated. The impact of such emissions is as follows:

- Control device $NO_x$ emissions must be added to the facility-wide $NO_x$ emission inventory. At most composites plants, the only other $NO_x$ sources will be boilers and space heaters. Regulatory triggers may be exceeded by total $NO_x$ emission levels, requiring additional permitting. In extreme or severe ozone nonattainment areas, $NO_x$ emissions from control devices might required control!
- Even if no controls or permits are required, $NO_x$ emissions are undesirable, both as $NO_x$ itself and as a precursor to ozone. Both $NO_x$ and ozone are contaminants for which National Ambient Air Quality Standards have been promulgated to protect human health and the environment.

### Condensate from Adsorber/Condenser Systems

This material, essentially impure styrene, would be considered an ignitable hazardous waste if disposed or recovered offsite. In addition to the cost of managing such material, its disposal creates a paper trail for discovery, should the waste disposal site become subject to cleanup liability in the future.

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## Chapter 9. An Action Plan for Owners

The proposed Case-by-Case MACT standards have been heavily criticized as hopelessly complex and needlessly burdensome. Although final standards are expected to address these issues at least in part, owners in the composite industry should not assume these regulations will "go away." Prudent owners will recognize the following and plan to act accordingly:

1. The most cost-effective way to deal with these regulations (and with the related Title V permit regulations) is to <u>avoid</u> them by demonstrating that styrene emissions (potential-to-emit) will not exceed 10 tons/year. Owners should evaluate their current facility emissions, and determine whether voluntary controls or pollution prevention measures could be implemented to avoid these burdensome regulations.

2. If faced with an unavoidable requirement to conduct a Case-by-Case MACT determination, owners should first research whether final regulations have changed the methods described herein.



3. Before proceeding with a Tier II technology analysis, owners should confirm that an updated Tier I analysis would not yield a positive MACT finding. Owners could receive assistance in locating and evaluating information from SPI and from industry consultants.

4. Vendors must be identified who offer systems proven to work in practice on styrene-laden air streams. Because new systems are continually being developed, owners should not assume that only the vendors identified in this report need to be contacted. On the other hand, owners should recognize that under this regulation they are <u>not required to consider</u> new systems, no matter how promising, that are not proven in practice.

5. Companies that employ pollution prevention measures (covering vessels, using nylon carrier film, etc.) should ensure that they take credit for the resulting emission reductions. SPI is currently developing documentation of these reductions for a variety of pollution prevention techniques. Remember that the less styrene at the control device inlet, the less cost-efficient the control system will prove to be, and the less likely controls will be required.

# TABLE 7.2

**COST BASIS FOR STYRENE CONTROL TECHNOLOGIES**
**WEATHERLY FLUIDIZED BED WITH CATALYTIC OXIDATION**
Based on 98% anticipated efficiency

Basis of Design
Operating : @ 8760 hrs
Inlet Air Temp. @90 deg F

| | Units | 100 PPM @ 5000 CFM<br>8.10#/hr<br>35.48 tons per year | Units | 25 PPM @ 15000CFM<br>6.07#/hr<br>26.59 tons per year |
|---|---|---|---|---|
| Flow to Oxidizer @175 deg F | | | | |
| ***Capital Costs*** | | | | |
| Direct Costs | | | | |
| Control Equipment (CE) | | $388,500 | | $475,600 |
| Instrumentation & Controls- Electrical | | incl. | | incl. |
| Taxes (7% of CE) | | $27,195 | | $33,292 |
| Auxil. Sys Ductwork and Foundation Work (20% of CE) | | $77,700 | | $95,120 |
| Installation | | incl. | | incl. |
| Total Direct Costs (TDC) | | $493,395 | | $604,012 |
| Indirect Costs | | | | |
| Engineering and Supervision Owner (10% of TDC) | | $49,340 | | $60,401 |
| Construction/Field Exp. (5% of TDC) | | $24,670 | | $30,201 |
| Startup | | incl. | | incl. |
| Performance Tests - Two day tests | | $15,000 | | $15,000 |
| Total Indirect Costs (TIC) | | $64,340 | | $75,401 |
| Contingencies (10% of TDC and TIC) | | $55,773 | | $67,941 |
| Contractor Fee | | incl. | | incl. |
| ***Total Capital Investment (TCI)*** | | ***$613,508*** | | ***$747,355*** |
| Monthly Loan Payment 9% over 10 years | | $7,755 | | $9,447 |
| ***Annualized Costs*** | | | | |
| Direct Costs | | | | |
| Operating Labor/Materials (OL/M - 4 hrs. @ 52 wks.) @$50.00/hr | | $10,400 | | $10,400 |
| Supervision (15% of OL/M) | | $1,560 | | $1,560 |
| Maintenance Service Contract | | $10,000 | | $10,000 |
| Utilities | Units | Yearly Cost | Units | Yearly Cost |
| Electricity @ $0.055/kWh | 192720 | $10,600 | 516840 | $28,426 |
| Fuel @ $4.50 /MCF GAS - 24 HR START UP | 1.728 | $8 | 1.728 | $8 |
| Cooling Water @ $0.20/1000 gal | | $0 | | $0 |
| Steam @ $5/1000 lb | | $0 | | $0 |
| Adsorbent @ $30/# and #/yr. | 232 | $6,949 | 347 | $10,424 |
| Catalyst | | $4,810 | | $4,810 |
| Heat Recovery @13,000BTU/# Styrene 50% EFF | 452 | 2034 | 794 | 3573 |
| Note: Heat Recovery based on applicable use for waste heat | | | | |
| Units represent Equivalent MCF of natural gas saved. | | | | |
| Indirect Costs | | | | |
| Overhead and Administration (60% of OL/M and 2% of TCI) | | $25,446 | | $28,123 |
| Property Tax and Insurance (2% of TCI) | | $12,270 | | $14,947 |
| Capital Recovery- Debt Replacement (Monthly Loan Payments * 12) | | $93,057 | | $113,359 |
| ***Total Annualized Costs*** | | ***$170,290*** | | ***$217,246*** |
| Annualized Costs | | $170,290 | | $217,246 |
| TONNAGE REMOVED | | 34.77 | | 26.05 |
| COST/TON | | **$4,898** | | **$8,338** |

Cost Analysis based on OAQPS

# TABLE 7.3

**COST BASIS FOR STYRENE CONTROL TECHNOLOGIES**
**PURUS ADSORPTION WITH CONDENSATION**
Based on 95% anticipated efficiency

Basis of Design
Operating 8760 hrs pr year
Inlet air Temp. @90 deg F



| | | **250 PPM @ 150 CFM**<br>**0.61#/hr**<br>**2.67 tons per year** | | **100 PPM @ 5000 CFM**<br>**8.10#/hr**<br>**35.48 tons per year** |
|---|---|---|---|---|
| ***Capital Costs*** | | | | |
| Direct Costs | | | | |
| Control Equipment (CE) | | $160,000 | | $475,000 |
| Instrumentation & Controls- Electrical | | incl. | | incl. |
| Taxes (7% of CE) | | $11,200 | | $33,250 |
| Auxil. Sys Ductwork and Foundation Work (10% of CE) | | $16,000 | | $47,500 |
| Installation (20% of CE) | | $32,000 | | $95,000 |
| Total Direct Costs (TDC) | | $219,200 | | $650,750 |
| Indirect Costs | | | | |
| Engineering and Supervision Owner (10% of TDC) | | $21,920 | | $32,538 |
| Construction/Field Exp. (5% of TDC) | | $10,960 | | above |
| Startup | | incl. | | incl. |
| Performance Tests -Two day test | | $15,000 | | $15,000 |
| Total Indirect Costs (TIC) | | $36,920 | | $47,538 |
| Contingencies (10% of TDC and TIC) | | $21,920 | | $65,075 |
| Contractor Fee | | incl. | | incl. |
| ***Total Capital Investment (TCI)*** | | $278,040 | | $763,363 |
| Monthly Loan Payment 9% over 10 years | | $3,514 | | $9,649 |
| ***Annualized Costs*** | | | | |
| Direct Costs | | | | |
| Operating Labor/Materials (OL/M - 4 hrs. @ 52 wks.) @$50.00/hr | | $10,400 | | $10,400 |
| Supervision (15% of OL/M) | | $1,560 | | $1,560 |
| Maintenance Labor and Materials @ 80 hrs./yr. @ $55.00/hr | | $4,400 | | $4,400 |
| Utilities | Units | Yearly Cost | Units | Yearly Cost |
| Electricity @ $0.055/kWh | given | $2,000 | given | $28,000 |
| Fuel @ $4.50 /1,000 CF GAS | 0 | $0 | 0 | $0 |
| Nitrogen | | above | | above |
| Indirect Costs | | | | |
| Overhead and Administration (60% of OL/M and 2% of TCI) | | $15,377 | | $25,083 |
| Property Tax and Insurance (2% of TCI) | | $5,561 | | $15,267 |
| Capital Recovery- Debt Replacement (Monthly Loan Payment *12) | | $42,173 | | $115,787 |
| ***Total Annualized Costs*** | | ***$81,471*** | | ***$200,497*** |
| Annualized Costs | | $81,471 | | $200,497 |
| TONNAGE REMOVED | | 2.54 | | 33.70 |
| COST/TON | | $32,098 | | $5,949 |

Cost Analysis based on OAQPS

# TABLE 7.4

**DURR INDUSTRIES THERMAL OXIDATION**

Based on 99.99% anticipated efficiency

Basis of Design
Operating 8760 hrs pr year
Inlet air Temp. @90 deg F

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| | | 100 PPM @ 5000 CFM<br>8.10#/hr<br>35.48 tons per year | | 25 PPM @ 15000C<br>6.07#/hr<br>26.59 tons per ye |
|---|---|---|---|---|
| ***Capital Costs*** | | | | |
| Direct Costs | | | | |
| Control Equipment (CE) | | $315,000 | | $430,000 |
| Instrumentation & Controls- Electrical | | incl. | | incl. |
| Taxes (7% of CE) | | $22,050 | | $43,000 |
| Direct installation Costs | | | | |
| Auxil. Sys Ductwork and Foundation Work (20% of CE) | | $63,000 | | $86,000 |
| Installation | | $45,000 | | $95,000 |
| Total Direct Costs (TDC) | | $445,050 | | $654,000 |
| Indirect Costs | | | | |
| Engineering and Supervision Owner (10% of TDC) | | $44,505 | | $65,400 |
| Construction/Field Exp (5% of TDC) | | $22,253 | | $32,700 |
| Startup | | incl. | | incl. |
| Performance Tests - 2-day testing | | $15,000 | | $15,000 |
| Total Indirect Costs (TIC) | | $59,505 | | $80,400 |
| Contingencies (10% of TDC and TIC) | | $44,505 | | $65,400 |
| Contractor Fee | | incl. | | incl. |
| ***Total Capital Investment (TCI)*** | | **$549,060** | | **$799,800** |
| Monthly Loan Payment 9% over 10 years | | $6,940 | | $10,109 |
| ***Annualized Costs*** | | | | |
| Direct Costs | | | | |
| Operating Labor/Materials (OL/M - 4 hrs. @ 52 wks.) | $50.00/hr | $10,400 | | $10,400 |
| Supervision (15% of OL/M) | | $1,560 | | $1,560 |
| Maintenance Service Contract | | $4,840 | | $4,840 |
| Utilities | Units | Yearly Cost | Units | Yearly Cost |
| Electricity @ $0.055/kWh | 183960 | $10,118 | 543120 | $29,872 |
| Fuel @ $4.50 /1,000 CF GAS | 3469 | $15,610 | 13560 | $61,022 |
| Indirect Costs | | | | |
| Overhead and Administration (60% of OL/M and 2% of TCI) | | $21,061 | | $26,076 |
| Property Tax and Insurance (2% of TCI) | | $10,981 | | $15,996 |
| Capital Recovery- Debt Replacement (Monthly Loan Payment *12) | | $83,281 | | $121,314 |
| ***Total Annualized Costs*** | | ***$157,852*** | | ***$271,079*** |
| Annualized Costs | | $157,852 | | $271,079 |
| TONNAGE REMOVED | | 35.47 | | 26.58 |
| COST/TON | | **$4,450** | | **$10,197** |

Cost Analysis based on OAQPS

6/6/95

Table 7_4.WK3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

JUL 3 1995

JUL 3 1995

REINFORCED PLASTIC COMPOSITES NESHAP PRE-MACT TEAM MEMBERS

Dear Team and/or Work Group Member:

Enclosed is a document prepared by the SPI Composites Institute on *MACT & Models for Pultrusion*. The document contains Tier I and Tier II case-by-case MACT analyses for pultrusion operations, and was submitted to EPA for its review and comment. Your comments would be welcome, and would be very useful to have before the team discussion on pre-MACT for the pultrusion industry.

A meeting with representatives of the pultrusion industry has been scheduled with EPA for late July. This meeting will not address their MACT study; it will regard an emission testing program that the pultrusion industry will undertake to study the performance of partially enclosing the wet areas of a pultrusion machine. The results of that meeting will be distributed to the team.

A team teleconference on pollution prevention measures, with particular attention on the recent test efforts sponsored by ORD, will be held at the end of July or early August. Presentations will be given by several participants in the program. A notice providing further information will be sent out shortly.

Please contact me at (919) 541-2383, or Greg LaFlam or Jeffrey Best of PES at (919) 941-0333 if you have any questions or comments.

Sincerely,

Kim R Teal for

Madeleine Strum
Project Leader
Coatings and Consumer Products Group

Enclosure