UEF Emission Factors
For Open Molding and Other Composite Processes

FIFTH EDITION

Published by American Composites Manufacturers Association
Notice and Disclaimer of Liability
Concerning the Use of this Standard

This document *UEF Emission Factors for Open Molding and Other Composite Processes* was developed through a consensus standards development process approved by the American National Standards Institute, as described on the following page. This process brings together volunteers representing a variety of companies, issues and interests to achieve consensus.

Please note that nothing herein should be viewed as a recommendation by the American Composites Manufacturers Association (ACMA) that any application, technique or process is appropriate in any particular circumstances. Similarly, the fact that a particular application, technique or process is listed in this document should not be viewed as an endorsement by ACMA of such application, technique or process.

ACMA makes no claims concerning the accuracy or applicability of the information contained in the this standard and ACMA is not responsible for the results obtained from the use of such information. Determination of the suitability of the information included is the sole responsibility of the user.

This Standard is sold without warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose. ACMA expressly disclaims all such warranties.

ACMA is not responsible for any damage or loss caused or alleged to be caused by the information contained herein. Accordingly, ACMA shall not be liable for any direct, indirect, incidental, special or consequential damages, resulting from the use of this standard. Additionally, ACMA has no power or ability to enforce, review or make any determination on the compliance with this Standard.
American National Standard

UEF Emission Factors
For Open Molding and Other Composite Processes

Larry B. Cox
Secretariat
American Composites Manufacturers Association

Approved: August 20, 2004
Revisions: May 21, 2010
January 26, 2011
October 5, 2011
April 15, 2019

American National Standards Institute, Inc.

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this Standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this Standard. Purchasers of American National Standards may receive current information on all Standards by calling or writing the American National Standards Institute.

American National Standards Institute, Inc., 25 West 43rd Street, New York, NY 10036
TABLE OF CONTENTS

Preface ........................................... xi

1.0 Scope and Purpose .................................. 1

2.0 Referenced Standards and Publications ...................... 1

3.0 Terms and Definitions .................................. 2

4.0 Instructions and Examples for the Emission Factor Table ........... 7

5.0 Estimation of VOC Emissions from Production of SMC ................. 9

6.0 Estimation of VOC Emissions from Compression Molding of SMC ........ 9

7.0 Estimation of VOC Emissions from Compression Molding of BMC .......... 10

8.0 Estimation of VOC Emissions from Compression Molding of LCM ........... 10

9.0 Emissions Factors for the Cast Polymer Open Molding Manufacturing Process .................................................... 11

LIST OF TABLES

EF Table 1 ............................................ 12
This forward is included as background information only. It is not part of the official American National Standard ACMA/UEF-5-19.

From 1996 through 1998, the American Composites Manufacturers Association (ACMA), formerly named the Composites Fabricators Association (CFA), conducted styrene emissions testing. The ACMA testing program consisted of three test phases, which investigated the effects of process parameters on the styrene emissions from the open molding of composites. The test protocol used in the ACMA testing is described in the November 18, 1998 ACMA report entitled *Styrene Emissions Test Protocol & Facility Certification Procedures, Revision 2.1*. The results of the ACMA Phase I testing are detailed in the September 1996 CFA report entitled *Phase I - Baseline Study; Hand Lay-up, Gel Coating, Spray Lay-up including Optimization Study*. The results of the ACMA Phase II and III testing are detailed in the report *Technical Discussion of the Unified Emission Factors for Open Molding of Composites*.

On February 28, 1998, Engineering Environmental Consulting Services (EECS) released a report entitled *CFA Emission Models for the Reinforced Plastics Industries* that details a set of equations developed from the ACMA test data. These equations predicted the styrene emission rates from typical lamination processes employed by the reinforced plastics industry. The report was subsequently posted on the EPA CHIEF website as a possible replacement for the obsolete AP-42 factors for reinforced plastics.

In 1997, the National Marine Manufacturers Association (NMMA) also conducted styrene emission testing using the CFA test protocol. The results of this testing are described in the August 1997 NMMA report entitled *Baseline Characterization of Emissions from Fiberglass Boat Manufacturing*. The NMMA report was also posted on the EPA CHIEF website as part of the AP-42 replacement process.

In November 1998, the CFA and NMMA agreed to merge the data from their respective test programs. The merged data sets were used to develop a new set of equations and factors that unify the methodology employed by boat builders and non-boat builders for estimating the VOC and HAP emissions from the open molding of composite parts. These new emission factors have been named the “Unified Emission Factors” (UEF). The Unified Emission Factor Table is the base data for this Standard.

From 2006 through 2008, emission tests were conducted on machines used to prepare sheet molding compound (SMC), which is used to form composite parts via closed molding in compression and injection presses. In 2008, studies were conducted by
Molded Fiber Glass Companies and Environmental Compliance and Risk Management (ECRM) Inc. to develop a predictive equation for emissions from SMC machines. The 2009 report *VOC Emissions from Production of Reinforced Composite Sheet Molding Compound* documents those study results and is the basis for the predictive equation in this Standard.

Styrene emission testing for SMC Compression Molding was conducted beginning August 11, 2008, ending September 4, 2008 by Engineering Environmental Consulting Services. The test report *SMC Compression Molding Test Results* was issued November 30, 2008.

Styrene emission testing for BMC and LCM Compression Molding was conducted beginning September 4, 2008, ending September 12, 2008 by Engineering Environmental Consulting Services. The test report *BMC/LCM Compression Molding Test Results* was issued October 12, 2009.

The test procedures and test methods for this testing were previously described in a test protocol report entitled *Test Protocol to Determine the Process Emissions from Compression Molding using a TTE Enclosure to Measure the VOC Emissions from Charge Preparation and Material Handling* that was submitted to Ohio EPA for comments on July 21, 2008.

This testing and the cited reports serve as the technical basis for the addition of styrene emission factors for compression molding of SMC, BMC, and LCM contained in this Standard.

VOC emissions factors for cast polymer manufacturing, including cultured marble and solid surface products, are published in the EPA AP-42 *Compilation of Air Pollutant Emission Factors*. The data for these factors was generated several decades ago and is unrelated to modern polymer casting equipment. Testing conducted in 2017 by ACMA under contract to the International Cast Polymer Association, and described in the report *Monomer Emissions from the Manufacture of Cultured Marble and Solid Surface Products*, is the basis for the polymer casting emission factors provided in Section 9 of this Standard.

ACMA is the registered trademark of the American Composites Manufacturers Association.
This Standard was developed under procedures accredited as meeting the criteria for American National Standards. The list of canvassers that reviewed this proposed standard was balanced to assure that individuals from competent and concerned interests had an opportunity to participate. The standard is available for public input from industry, academia, regulatory agencies and the public-at-large. ACMA does not “approve,” “rate,” or “endorse” any item or proprietary device described in this Standard. Participation by federal /state agency representative(s) or persons associated with industry is not to be interpreted as government or industry endorsement of this Standard.

Requests for interpretations or suggestions for revision should be sent to ANSI Secretariat, American Composites Manufacturers Association, 2000 N. 15th Street, Suite 250, Arlington, Virginia 22201.