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An Operator's Guide To Eliminating Bias In CEM Systems

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
AIR AND RADIATION

It is a pleasure to transmit to you this *Operator's Guide to Eliminating Bias in CEM Systems*. Prepared for the U.S. Environmental Protection Agency by the internationally recognized continuous emission monitoring (CEM) systems expert Dr. James A. Jahnke, the *Guide* is an important tool for diagnosing and correcting the causes of measurement bias in CEM systems like those specified under the Acid Rain Regulations.

Experience gained through implementing the Acid Rain Program has shown that CEM operators can eliminate bias from monitoring systems by instituting and following appropriate installation, operation, and quality assurance and control procedures.

At the same time, Phase I certification test review has also revealed that many sources could use assistance in recognizing the physical and operational problems that produce systematic error and the remedies available to address those problems.

The *Operator's Guide* is designed to meet this need. Used as a reference document, the *Guide* makes it easier for CEM operators to improve monitor accuracy and meet regulatory requirements.

Sincerely,

Brian McLean, Director
Acid Rain Division

An Operator's Guide To Eliminating Bias in CEM Systems

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NOTICE

This is not an official policy and standards document. The opinions, findings, and conclusions are those of the author and not necessarily those of the U.S. Environmental Protection Agency. Every attempt has been made to represent the present state of the art as well as subject areas still under evaluation. Any mention of products or organizations does not constitute endorsement by the U.S. Environmental Protection Agency. This operator's guide is not an evaluation of the bias study the U.S. Environmental Protection Agency is to perform under 40 CFR 75.7.

PREFACE

The inclusion of the t-test for bias in the Acid Rain Regulations, 40 CFR Part 75, signaled a marked improvement in the capability to detect a significant source of measurement error that had previously remained hidden. The bias test provides an independent check of the full monitoring system, capable of determining whether systematic error is present in a monitoring system's measurements. It is a very forgiving test: it must be 97.5% confident that the error is not random in nature before it will describe the measurements as being biased. Field experience confirms that false positives are a rare occurrence when the bias test is properly performed.

At the same time, the capability to detect bias left environmental technicians and instrument operators with the often daunting job of, first, diagnosing the cause of the measurement bias, and, then, taking steps to correct it. This publication is intended to make that job easier.

It consists of two major components: A pull-out chart, entitled *Eliminating Bias in CEMS — A Checklist*, provides a comprehensive listing of the monitoring system problems that can cause systematic error. To make it easy for users to find problems associated with a particular type of monitor, the problems are grouped by monitoring system component type. A brief description and potential corrective actions are shown for each problem. Finally, the *Checklist* directs users to the appropriate pages in the accompanying *Operator's Guide*, where fuller descriptions of problems and remedies can be found.

The accompanying *Operator's Guide to Eliminating Bias in Monitoring Systems* is organized into eight chapters. Chapter 1 describes the history and the engineering and statistical basis for the bias test. Chapters 2–7 provide detailed descriptions of problems that can cause systematic measurement error and remedies that can be taken to address those problems. Each of the chapters is devoted to the problems associated with a different type of monitoring system component. The chapters begin with a table, excerpted from the *Checklist*, summarizing the problems to be discussed in that chapter. The problem areas covered are: Probe Location and Stratification (Chapter 2), Extractive Sampling Systems (Chapter 3), In-Situ Gas Monitoring Systems and Opacity Monitors (Chapter 4), Flow Monitors (Chapter 5), Gas Analyzers (Chapter 6), and Data Acquisition and Handling Systems (Chapter 7).

Chapter 8, the last chapter in the *Operator's Guide*, discusses elements that should be incorporated into ongoing Quality Assurance Programs to detect and prevent the problems that produce systematic error in monitor measurements. Each chapter ends with a list of references for further information on the subjects covered.

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