Quality Assurance of Chemical Measurements

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LEWIS PUBLISHERS, INC.

Library of Congress Cataloging-in-Publication Data

Taylor, John K. (John Keenan), 1912–
Quality assurance of chemical measurements.

Bibliography: p.
Includes index.
1. Chemical laboratories—Quality control.
I. Title.
QD51.T38 1987 542'.3 86-27335
ISBN 0-87371-097-5

3rd Printing 1988
2nd Printing 1987

LEWIS PUBLISHERS, INC.
121 South Main Street, P.O. Drawer 519, Chelsea, Michigan 48118

PRINTED IN THE UNITED STATES OF AMERICA

Preface

Chemical measurement data are often the basis for critical decisions on vital matters, ranging from the health of individuals, to the protection of the environment, to the production of safe, reliable, and useful products and services. Obviously, the data used for such purposes must be reliable, and there must be unequivocal evidence to prove it. The philosophy and procedures by which this is achieved and demonstrated are called quality assurance.

This book discusses the basic concepts of quality assurance as presented in a short course given by the author many times since 1979. It is based on the premise that a good understanding of the basic principles of chemical measurement is a necessary prerequisite to achieving accurate data and to designing and implementing a credible quality assurance program.

Credible data must be supported by probabilistic statements of the confidence that can be placed in it. This requires a systematic approach to measurement and to the attainment of statistical control of the measurement process by quality control procedures. The precision and accuracy of the data so produced can be evaluated by quality assessment techniques.

Not only the philosophy, but also practical approaches to quality assurance are discussed, and the statistical techniques vital to its various aspects are reviewed.

The book is written to provide guidance for the development of a credible quality assurance program and also for its implementation. The chapters are presented in a logical progression starting with the concept of quality assurance, the principles of good measurement, the principles of quality assurance, and the evaluation of measurement quality. Guidance is provided for the development of quality assurance programs and for the improvement of existing ones. Each chapter has a degree of independence so that it may be consulted, in isolation from the others, when its subject matter is of interest in a particular situation. An extensive appendix containing definitions of quality assurance terminology, a collection of useful statistical tables, outlines useful for guidance in the preparation of quality assurance program documents, study aids for those using the book for self instruction or as a text, and an extensive collection of abstracts of important quality assurance publications are also included. The abstracts also serve as the list for references cited in the text.

If the book achieves the above-mentioned objectives, it will have provided a valuable service to the producers and users of chemical measurement data.

However, it can serve another purpose as well—namely, in training analytical chemists. Most of modern analytical education is devoted to the theory and principles of measurement techniques, and such knowledge is a necessary foundation for reliable measurements. The present book supplements such information and provides guidance in the practice of the profession of analytical chemistry.

While the text focusses principally on chemical measurement, the author is confident that the material presented is widely applicable to the physical and biological sciences as well. The basic principles of measurement are the same, no matter what the subject area of application. In fact, he has developed quality assurance programs for high accuracy physical measurement and calibration programs that do not differ in kind, but only in detail, from the chemical programs described in this book. The biological scientist should also find the quality assurance principles enunciated useful in measurement programs.

Acknowledgments

The author is grateful to all of the excellent analytical chemists with whom he has been privileged to associate in various ways over many years, who have contributed to his education and have helped to mould his philosophy of good measurement. Unfortunately, most of them must go unnamed because of space limitations. The subject matter presented in the book is the result of the author's gleanings from many sources, including his long association with like-minded colleagues at the National Bureau of Standards (NBS), who have had measurement accuracy as their personal as well as institutional goals. He grew up under the tutelage of the late Dr. G.E.F. Lundell, one of the early deans of accurate chemical measurements. His concepts of the critical importance of sampling and the analytical sample were sharpened and increased by a year's sabbatical association with Professor Byron G. Kratochvil of the University of Alberta. His long personal involvement as a bench chemist, and later as a supervisor responsible for reference material analysis and certification, have provided practical insight to constructive planning and to the avoidance of measurement pitfalls.

The author was very fortunate to have worked under the late Leroy W. Tilton, who was a master metrologist and a pioneer in the application of statistics to experimental measurements. More recently, he has benefited from association with and guidance from the NBS Statistical Engineering Division, and especially from Mrs. Mary G. Natrella. His recent position as Coordinator for Quality Assurance of the NBS Center for Analytical Chemistry has provided the opportunity to put all of this past experience together in a systematic fashion as a quality assurance concept, which provides the substance for this book.

John K. Taylor is an analytical chemist of many years of varied experience. All of his professional life has been spent at the National Bureau of Standards, from which he recently retired after 57 years of service.

Dr. Taylor received his BS degree from George Washington University and MS and PhD degrees from the University of Maryland. At the National Bureau of Standards, he served first as a research chemist, and then managed research and development programs in general analytical chemistry, electrochemical analysis, microchemical analysis, and air, water, and particulate analysis. The development of reliable sampling plans was another area of interest. The development and certification of reference materials was a major activity throughout his career at NBS. For the past seven years, he coordinated the NBS Center for Analytical Chemistry's program in quality assurance, and conducted research activities to develop advanced concepts to improve and assure measurement reliability. He provided advisory services to other government agencies as part of his official duties.

As a part of his recent activities, he has developed a comprehensive short course—Quality Assurance of Chemical Measurements—that has been presented some 75 times to a cumulative audience of over 3200 persons.

Dr. Taylor has edited three books, and has written over 200 research papers in analytical chemistry, some 20 of which have dealt with various aspects of the quality assurance of measurements.

Dr. Taylor is the recipient of several awards for his accomplishments in analytical chemistry, including the Department of Commerce Silver and Gold Medal Awards. He is a past chairman of the Washington Academy of Sciences and the ACS Analytical Chemistry Division, and is currently chairman of ASTM Committee D 22 on Sampling and Analysis of Atmospheres.

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