

QUALITY SYSTEMS in the NUCLEAR INDUSTRY



B. W. Marguglio



STP 616
AMERICAN SOCIETY FOR TESTING AND MATERIALS

QUALITY SYSTEMS IN THE NUCLEAR INDUSTRY

(AND IN OTHER HIGH TECHNOLOGY INDUSTRIES)

Sponsored by ASTM
Committee on Publications
AMERICAN SOCIETY FOR
TESTING AND MATERIALS

ASTM SPECIAL TECHNICAL PUBLICATION 616
B. W. MARGUGLIO

List price \$37.75
04-616000-34



AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race Street, Philadelphia, Pa. 19103

© by American Society for Testing and Materials 1977
Library of Congress Catalog Card Number: 76-40795

NOTE

**The Society is not responsible, as a body,
for the statements and opinions
advanced in this publication.**

Printed in Baltimore, Md.
May 1977

Preface

I would like to relate the circumstances which prompted me to write this book. In November 1966, I arranged a meeting among Industrial Relations and Quality executives of major Dallas-Fort Worth companies and educators from the University of Dallas. The purpose of the meeting was to propose, in general, the establishment of a full fledged quality curriculum. From this initial meeting emerged The Joint Industry-University of Dallas Committee For A Graduate Quality Systems Curriculum. The Committee's purpose was to arrive at a specific proposal including course content, texts, teachers, and degree requirements for the quality curriculum. Members of the Committee were Messrs. B. Cunningham, Varo; H. B. Epstein, then with LTV Aerospace and currently with Aerospatial; J. F. Hamje, Texas Instruments; J. K. Lyons, Collins Radio; R. G. Lynch, University of Dallas; L. C. Moon, General Dynamics; G. M. Powell, Jr., Bell Helicopter; S. W. Ray, Collins Radio; E. H. Rowell, LTV Aerospace; A. O. Watson, General Dynamics; and Dr. N. H. Simpson, General Dynamics. I had the honor of chairing the Committee. Thanks to the support of Mr. R. G. Lynch (then Dean of the University of Dallas' Braniff Graduate School of Management), to the farsightedness of Rev. Damian Fandal (then Academic Dean) and to the general responsiveness of the University of Dallas to community needs, the Master of Science in Quality Systems (MSQS) Program was started in September 1967. It was the first of its kind in the country.

Working as part of the Committee and teaching thereafter for a number of years reinforced my belief that there are very few books, if any, which adequately cover quality systems in the newest sense of the term "systems." Many books on quality are steeped in statistics or cover just statistical quality systems which, in most companies, comprise only a small portion of the total quality systems in effect. Few books, if any, adequately cover design quality systems. Some excellent books are incomplete with regard to quality systems applicable to the procurement and fabrication phases. Now, after having taught hundreds of quality practitioners and having assimilated their practical experiences with my own, this book attempts to fill the voids.

The book is written in the spirit of the total quality concept. It is organized by project phase, that is, quality systems applicable predominately to either the design, procurement, or fabrication, assembly, installation, and construction phases.

Very generally, in applying the systems approach to the management of quality, the quality objectives or missions are defined for each project phase and subphase. The characteristics of the inputs to and the outputs from each quality system (or subsystem) are described. Timing and other systems' constraints are considered by means of requirements analyses to determine what systems' capabilities must exist to satisfy given quality missions. The systems are optimized and "noise" is reduced. The advantages of the systems approach are mainly as follows.

- The systems are objectives oriented which, in itself, tends to weed out extraneous, nonprofit efforts.
- A somewhat scientific approach is employed to assure, to begin with, the adequacy of systems inputs and constraints rather than trying to design systems under inadequate ground rules.
- The systems are optimized for maximum control value within cost constraints or for adequate control value at minimum cost.
- The systems tend both to "unburden" the human elements for maximum control consistency and to "quicken" feedback on the effects of human responses thereby providing partial built-in test mechanisms.
- The systems approach tends to assure complete and adequate coordination and interface of the various quality efforts.

Recognizing the space restrictions in this Preface, Chapter 2 of the book is devoted to a detailed discussion of the systems approach as applied to the quality mission.

Throughout the book, in-depth detail of each quality systems' universal features of design and logic are stressed. The intent is to give the reader an understanding of why things are as they are and of the factors which must be considered in the establishment of each system to arrive at "good" quality decisions. Although the systems are universal, they are exemplified with cases from the nuclear, aeronautics, electronics, and space industries in which my more than twenty years of experience has been gained. (The reader should not assume that the examples come from my present employer.) An attempt is made to give all of the facts necessary for you to make the systems application transition to your own industry.

An important point, implied if not stressed, is that the book deals with quality systems functioning within the whole enterprise, not merely with those systems functioning within the Quality organization. Generally, no attempt is made to emphasize the elements of any system as being the responsibility of any particular organization within the enterprise. The book recommends the quality systems which a company might employ, regardless of which organizations within the company are charged with the specific responsibility. There are, however, some exceptions to this generality.

The book is not intended for the statistician; the book does not include any detailed material on either mathematical or applied statistics. However, the book does describe statistical systems (especially in the areas of

acceptance sampling and process control) to the degree of detail necessary for the quality manager to make prudent decisions about their use.

I have striven to write a thorough, functionally practical, and original book. On these scores the book speaks for itself. I have no claim with regard to the originality of the technical content of the statistical acceptance sampling and statistical process control sections of this book; in these areas my only claim to originality is in the method of presentation which is intended to facilitate management understanding.

In the process of transforming the notes for the book (some of which I had prepared years ago) into the final text, it became apparent to me that my views have changed significantly in some cases. I have written this book with the nagging fear that in the future years my views may change still further but, for a large number of reasons which I will not discuss here, nevertheless, I have decided that the endeavor is worthwhile to the people in the industries which the book is intended to serve.

Acknowledgments

This book was written while I served as Quality Division Director of Aerojet Nuclear Company which, at that time, operated the Idaho National Engineering Laboratory (INEL) under contract to the Energy Research and Development Administration.

I am especially grateful to Dr. C. K. Leeper, President and General Manager of Aerojet Nuclear Company, my former boss, under whose guidance my thoughts on the subject have been expanded and clarified and under whose wisdom many of the systems described in this book or very similar systems have been implemented at Aerojet Nuclear Company.

I would be remiss if I did not express my gratitude to the persons who have educated and trained me along the way and through whose supervision I have gained the insight necessary for the writing of this book. In addition to Dr. Leeper, I especially remember some of my other outstanding supervisors of the past, such as H. B. Epstein, E. F. Taylor, and M. W. Sullivan.

Of course, I also want to take this opportunity to pay homage to the greats of our profession from whom we have all learned and from whose books and technical publications we have gleaned so much information for so long a time that it is hard to differentiate now among the thoughts which are theirs and those which are our own. This is the heritage expected from one generation to the next.

To the Branch Managers who served within the Quality Division at Aerojet Nuclear Company and who provided me with numerous revisions in the preparation of this book, I also wish to express my thanks. Namely, they are W. R. Bird, E. R. Goffaux, G. E. Grow, B. H. Hilton, D. F. Redford, M. J. Sexey and William Yurkowsky.

My thanks also go to Renee Demick and V. A. Coston who typed the manuscript and who also contributed improvements to the manner in which the manuscript is presented here.

For their willingness to share their expertise, I am thankful to the following people who have contributed sections within certain chapters of this book: G. E. Bingham, Manager of the Nuclear Waste Calcining Facility Project, Allied Chemical Corporation, Idaho National Engineering Laboratory (INEL), contributed a number of sections dealing with the Consumer Product Safety Act in Chapter 20; M. E. Eld, Contract Specialist, Aerojet Nuclear Company, INEL, Chapter 12, contributed the section on "Current Trends Regarding the Warranty, Inspection, and Source Inspection Clauses;" Dr. J. B. Fussell, previously with Aerojet Nuclear Company, INEL, and currently Assistant Professor, University of Tennessee, co-authored Chapter 7 on Cause and Effects Analysis; N. D. Gray, Assistant Director for Quality Assurance and Performance Improvement, Reactor Research and Development Division, U.S. Energy Research and Development Administration, contributed the sections dealing with Quality Awareness in Chapter 23; and Dr. R. J. Nertney, Senior Engineering Specialist, Aerojet Nuclear Company, INEL, wrote the section on "Analysis of Ability versus Value" in Chapter 23.

Dr. A. L. Bement, Professor of Nuclear Materials at Massachusetts Institute of Technology, provided the review of this book. I am thankful for his participation and depth of understanding which rendered his comments so useful.

There are at least four things which are basic to any profession: a high social purpose, an ethic, uniform standards of performance and evaluation, and a continuous body of knowledge. The University and The Press are the best agencies for the establishment of standards and for the depository of knowledge, and on that score, I am especially grateful to the American Society for Testing and Materials for providing the vehicle by which I can make this contribution to the Quality profession.

To the representatives of the American Society for Testing and Materials, J. B. Wheeler, Managing Editor, and A. L. Batik, Director of Publications, I am also grateful, first for their faith in me in accepting my manuscript for publication and second for their patience with me when I missed deadlines. Throughout this effort, Ms. Wheeler always has provided me with thoughtful encouragement. E. J. McGlinchey edited the manuscript, and I am indeed thankful for her technical excellence and contributions in helping to make this book more readable.

CONTENTS

Preface

PART I—INTRODUCTION

Chapter 1—Meanings, Goals, and Scope of Quality	1
Chapter 2—The Systems Approach	32
Chapter 3—The Product Evolution Cycle	50
Chapter 4—Requirements Type Documents	57

PART II—DESIGN

Chapter 5—Design Requirements	71
Chapter 6—Tolerancing	95
Chapter 7—Cause and Effects Analysis	120
Chapter 8—Consequence Analysis	140
Chapter 9—Component/Part Application Analysis	154
Chapter 10—Maintenance and Spares Analyses	166
Chapter 11—Design Review	175

PART III—PROCUREMENT

Chapter 12—Quality Requirements for Supplies	195
Chapter 13—Source Selection	301

PART IV—FABRICATION, ASSEMBLY, INSTALLATION, AND CONSTRUCTION

Chapter 14—Measurement Control	317
Chapter 15—Component Qualification	350
Chapter 16—Design Change Control	382
Chapter 17—Acceptance Sampling	404
Chapter 18—Inspection/Test Planning and Process Control	479
Chapter 19—Control of Nonconforming Items	546
Chapter 20—Product Liability and Consumer Product Safety	564
Chapter 21—Quality Information Feedback and Corrective Action	581

PART V—GENERAL

Chapter 22—Auditing Quality Systems and Inspection Effectiveness	605
Chapter 23—Industrial Psychology in Quality Control	617
Chapter 24—Economics of Quality	637
Index	667



B. W. (Ben) Marguglio is Consumers Power Company Director of Quality responsible for the design and construction of electric and gas production and transmission facilities. Prior to this, he was Quality Division Director for Aerojet Nuclear Company at the Idaho National Engineering Laboratory. Earlier he served as Product Assurance Manager for Philco Houston at the National Aeronautics and Space Administration's Mission Control Center.

Marguglio is a Fellow of the American Society for Quality Control. He has taught courses in quality at the Universities of Idaho, Dallas, and Baltimore. He has served on the Management Committees of the National Reliability and Maintainability Symposia. In addition to this book, he has authored approximately a dozen papers published in various technical journals. He has spoken at many national and regional quality meetings.

Marguglio received his B.B.A. from the City University of New York and, after being awarded a teaching fellowship, completed his M.B.A. at the same school.