



AN INSTRUCTIONAL AID FOR OCCUPATIONAL SAFETY AND HEALTH IN MECHANICAL ENGINEERING DESIGN

Prepared by the

ASME Safety Division

Under the Sponsorship of the

National Institute for Occupational
Safety and Health

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
United Engineering Center 345 East 47th Street New York, N.Y. 10017

This booklet was prepared in fulfillment of P. O. No. 83-1006 under the sponsorship of the Division of Training and Manpower Development, National Institute for Occupational Safety and Health.

Library of Congress Catalog Card Number 84-72090

Statement from By-Laws: The Society shall not be responsible for statements or opinions advanced in papers . . . or printed in its publications (B7.1.3)

Any part of this volume may be reproduced without written permission as long as the source and publisher are acknowledged.

Copyright ©1984 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All Rights Reserved
Printed in U.S.A.
Reprinted in 2012

PREFACE

In 1982, the National Institute for Occupational Safety and Health issued a contract to the Safety Division, ASME to develop an occupational safety and health instructional module for undergraduate Mechanical Engineering students. This document represents the results of that effort which the authors expect will find a welcome audience among Mechanical Engineering design instructors and certainly students. Worker protection is an important product of the engineering design process which requires increased attention by the engineering profession.

The authors wish to express our gratitude to the following persons for their participation in the development and review of this document; John Talty, who served as the NIOSH project officer; John Etherton, Thomas Bloom, and Robert Hughes of NIOSH who served as technical reviewers.

FOREWORD – TO THE INSTRUCTOR

This booklet is intended to supplement the textbook selected for use in the basic Mechanical Engineering design course. The materials presented herein can be covered in depth over a period of three hours, or one week of a typical single semester course. This booklet has been written in simple terms so that it can be read and understood by third year Mechanical Engineering students who have had little or no exposure to the fundamental concepts of occupational safety and health. Wherever possible, the principles developed are illustrated with examples which should be familiar to such students. At the end of the unit, there are several practical examples which demonstrate how these principles can be applied in a realistic setting. The students' appreciation of these ideas can be reinforced by assigning a similar project for grading and critiquing by their classmates. Individual students, or squads of two or three, should choose an industrial production system, workstation, process, or product of intermediate complexity and thoroughly evaluate it by concentrating exclusively on safety and health. Such a structured exercise, where safety and health are the dominant design objectives, should provide an insight into this infrequently highlighted aspect of design. A modified work environment, production sequence, or a new system should then be suggested. Its advantages over the existing approach should be explained with special emphasis on improved safety and health techniques to protect either the production workers and/or the ultimate users. The negative features which such changes may introduce such as increased costs should be taken into account. Contrasting techniques which reduce potentially adverse effects should be compared and carefully evaluated.

Examples have been used wherever possible to illustrate design principles. However, the availability of appropriate quantitative examples is limited because they usually fall into one of two general categories. Either they are simple substitutions of measured data into empirically derived formulas, or they may require a great deal of supplementary information (usually specialized in nature) in order to be appreciated. Finally, there is little incentive for companies to publicize such data. In many instances, it can only serve to illustrate a certain lack of responsibility in the design and manufacture of products, equipment and facilities.

Throughout this unit the instructor needs to emphasize the following universal points which are often overlooked:

1. Well designed systems which are based upon the application of fundamental engineering principles must also take safety into account.
2. Product hazards are not only design related, but may also spring from other concerns such as defects in manufacturing, packaging or handling.
3. Designers cannot function in a vacuum, but need to interface with key personnel from other areas of the firm such as quality control, production, and customer relations.
4. There are a number of key differences in meaning between similar terms used both in engineering analysis and adversarial courtroom situations.

Obviously one will not become an expert in occupational safety and health after completing this elementary three hour unit. Its real purpose is simply to make future Mechanical Engineers aware of the importance of this aspect of design. Hopefully, they will be sensitized to what can, and should be done to minimize the risks faced by workers who manufacture, and those who use their products. This knowledge should help in making their engineering education more comprehensive and so improve their future work by teaching them how to minimize and control safety and health hazards.

CONTENTS

I.	Introduction — Occupational Safety and Health Responsibilities of the Design Engineer	1
II.	Principles of Hazard Recognition and Control	2
	A. Appreciating the capabilities and limitations of involved groups	
	B. Anticipating common errors and modes of failure	
	C. Evaluating a design for safety and health	
	D. Providing adequate instructions and warnings for product use and maintenance	
	E. Designing safe tooling and safe manufacturing workstations	
	F. Special considerations for maintenance personnel	
	G. Providing clear indications of malfunctions and dangerous conditions	
III.	Creating and Eliminating Workplace Hazards by Design	7
	A. Protection against excessive exposure to environmental stressors	
	B. Hazard reduction and control techniques available	
	C. Why upgrading an original design is superior to improvising retrofits	
	D. Anticipating product abuse and misuse	
IV.	Human Factors Engineering and Industrial Ergonomics	11
	A. The systems approach to safe and healthful workplace design	
	B. Optimizing the man machine interface	
	C. Adverse effects of workstress and workstrain	
V.	Integrating Safety and Health with Other Essential Design Goals	14
	A. Establishing cost/benefit justification	
	B. The influence of product liability litigation	
	C. Finding and using safety codes and standards	
	D. Designing to avoid occupational health problems	
VI.	The Safety Factor Approach and Its Limitations	17
VII.	References and Bibliography	18
VIII.	Appendices	19

