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DOE FUNDAMENTALS HANDBOOK

THERMODYNAMICS, HEAT TRANSFER, AND FLUID FLOW

Volume 3 of 3



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ABSTRACT

The *Thermodynamics, Heat Transfer, and Fluid Flow Fundamentals Handbook* was developed to assist nuclear facility operating contractors provide operators, maintenance personnel, and the technical staff with the necessary fundamentals training to ensure a basic understanding of the thermal sciences. The handbook includes information on thermodynamics and the properties of fluids; the three modes of heat transfer - conduction, convection, and radiation; and fluid flow, and the energy relationships in fluid systems. This information will provide personnel with a foundation for understanding the basic operation of various types of DOE nuclear facility fluid systems.

Key Words: Training Material, Thermodynamics, Heat Transfer, Fluid Flow, Bernoulli's Equation

FOREWORD

The *Department of Energy (DOE) Fundamentals Handbooks* consist of ten academic subjects, which include Mathematics; Classical Physics; Thermodynamics, Heat Transfer, and Fluid Flow; Instrumentation and Control; Electrical Science; Material Science; Mechanical Science; Chemistry; Engineering Symbology, Prints, and Drawings; and Nuclear Physics and Reactor Theory. The handbooks are provided as an aid to DOE nuclear facility contractors.

These handbooks were first published as Reactor Operator Fundamentals Manuals in 1985 for use by DOE Category A reactors. The subject areas, subject matter content, and level of detail of the Reactor Operator Fundamentals Manuals was determined from several sources. DOE Category A reactor training managers determined which materials should be included, and served as a primary reference in the initial development phase. Training guidelines from the commercial nuclear power industry, results of job and task analyses, and independent input from contractors and operations-oriented personnel were all considered and included to some degree in developing the text material and learning objectives.

The *DOE Fundamentals Handbooks* represent the needs of various DOE nuclear facilities' fundamentals training requirements. To increase their applicability to nonreactor nuclear facilities, the Reactor Operator Fundamentals Manual learning objectives were distributed to the Nuclear Facility Training Coordination Program Steering Committee for review and comment. To update their reactor-specific content, DOE Category A reactor training managers also reviewed and commented on the content. On the basis of feedback from these sources, information that applied to two or more DOE nuclear facilities was considered generic and was included. The final draft of each of these handbooks was then reviewed by these two groups. This approach has resulted in revised modular handbooks that contain sufficient detail such that each facility may adjust the content to fit their specific needs.

Each handbook contains an abstract, a foreword, an overview, learning objectives, and text material, and is divided into modules so that content and order may be modified by individual DOE contractors to suit their specific training needs. Each subject area is supported by a separate examination bank with an answer key.

The *DOE Fundamentals Handbooks* have been prepared for the Assistant Secretary for Nuclear Energy, Office of Nuclear Safety Policy and Standards, by the DOE Training Coordination Program. This program is managed by EG&G Idaho, Inc.

OVERVIEW

The *Department of Energy Fundamentals Handbook* entitled *Thermodynamics, Heat Transfer, and Fluid Flow* was prepared as an information resource for personnel who are responsible for the operation of the Department's nuclear facilities. A basic understanding of the thermal sciences is necessary for DOE nuclear facility operators, maintenance personnel, and the technical staff to safely operate and maintain the facility and facility support systems. The information in the handbook is presented to provide a foundation for applying engineering concepts to the job. This knowledge will help personnel more fully understand the impact that their actions may have on the safe and reliable operation of facility components and systems.

The *Thermodynamics, Heat Transfer, and Fluid Flow* handbook consists of three modules that are contained in three volumes. The following is a brief description of the information presented in each module of the handbook.

Volume 1 of 3

Module 1 - Thermodynamics

This module explains the properties of fluids and how those properties are affected by various processes. The module also explains how energy balances can be performed on facility systems or components and how efficiency can be calculated.

Volume 2 of 3

Module 2 - Heat Transfer

This module describes conduction, convection, and radiation heat transfer. The module also explains how specific parameters can affect the rate of heat transfer.

Volume 3 of 3

Module 3 - Fluid Flow

This module describes the relationship between the different types of energy in a fluid stream through the use of Bernoulli's equation. The module also discusses the causes of head loss in fluid systems and what factors affect head loss.

The information contained in this handbook is by no means all encompassing. An attempt to present the entire subject of thermodynamics, heat transfer, and fluid flow would be impractical. However, the *Thermodynamics, Heat Transfer, and Fluid Flow* handbook does present enough information to provide the reader with a fundamental knowledge level sufficient to understand the advanced theoretical concepts presented in other subject areas, and to better understand basic system and equipment operations.

Department of Energy
Fundamentals Handbook

THERMODYNAMICS, HEAT TRANSFER, AND FLUID FLOW, Module 3 Fluid Flow

TABLE OF CONTENTS

LIST OF FIGURES iv

LIST OF TABLES v

REFERENCES vi

OBJECTIVES vii

CONTINUITY EQUATION 1

- Introduction 1
- Properties of Fluids 2
- Buoyancy 2
- Compressibility 3
- Relationship Between Depth and Pressure 3
- Pascal's Law 7
- Control Volume 8
- Volumetric Flow Rate 9
- Mass Flow Rate 9
- Conservation of Mass 10
- Steady-State Flow 10
- Continuity Equation 11
- Summary 16

LAMINAR AND TURBULENT FLOW 17

- Flow Regimes 17
- Laminar Flow 17
- Turbulent Flow 17
- Flow Velocity Profiles 18
- Average (Bulk) Velocity 19
- Viscosity 19
- Ideal Fluid 19
- Reynolds Number 19
- Summary 20

TABLE OF CONTENTS (Cont.)

BERNOULLI'S EQUATION 21

General Energy Equation 21
Simplified Bernoulli Equation 22
Head 23
Energy Conversions in Fluid Systems 23
Restrictions on the Simplified Bernoulli Equation 25
Extended Bernoulli 25
Application of Bernoulli's Equation to a Venturi 27
Summary 30

HEAD LOSS 31

Head Loss 31
Friction Factor 31
Darcy's Equation 32
Minor Losses 34
Equivalent Piping Length 34
Summary 36

NATURAL CIRCULATION 37

Forced and Natural Circulation 37
Thermal Driving Head 37
Conditions Required for Natural Circulation 38
Example of Natural Circulation Cooling 39
Flow Rate and Temperature Difference 39
Summary 40

TWO-PHASE FLUID FLOW 41

Two-Phase Fluid Flow 41
Flow Instability 42
Pipe Whip 43
Water Hammer 43
Pressure spike 43
Steam Hammer 45
Operational Considerations 45
Summary 46

TABLE OF CONTENTS (Cont.)

CENTRIFUGAL PUMPS 47

Energy Conversion in a Centrifugal Pump 47
Operating Characteristics of a Centrifugal Pump 48
Cavitation 48
Net Positive Suction Head 49
Pump Laws 49
System Characteristic Curve 52
System Operating Point 52
System Use of Multiple Centrifugal Pumps 53
Centrifugal Pumps in Parallel 53
Centrifugal Pumps in Series 54
Summary 56

APPENDIX B Fluid Flow B-1

LIST OF FIGURES

Figure 1 Pressure Versus Depth 3

Figure 2 Pascal's Law 7

Figure 3 Continuity Equation 12

Figure 4 "Y" Configuration for Example Problem 14

Figure 5 Laminar and Turbulent Flow Velocity Profiles 18

Figure 6 Venturi Meter 27

Figure 7 Typical Centrifugal Pump Characteristic Curve 48

Figure 8 Changing Speeds for Centrifugal Pump 51

Figure 9 Typical System Head Loss Curve 52

Figure 10 Operating Point for a Centrifugal Pump 52

Figure 11 Pump Characteristic Curve for Two Identical Centrifugal Pumps Used in Parallel 53

Figure 12 Operating Point for Two Parallel Centrifugal Pumps 54

Figure 13 Pump Characteristic Curve for Two Identical Centrifugal Pumps Used in Series 54

Figure 14 Operating Point for Two Centrifugal Pumps in Series 55

Figure B-1 Moody Chart B-1