Preface

Refrigeration & Air Conditioning Technology is designed and written for students in vocational-technical schools and colleges, community colleges, and apprenticeship programs. The content is in a format appropriate for students who are attending classes full-time while preparing for their first job, for students attending classes part-time while preparing for a career change, or for those working in the field who want to increase their knowledge and skills. Emphasis throughout the text is placed on the practical applications of the knowledge and skills technicians need to be productive in the refrigeration and air-conditioning industry. The contents of this book can be used as a study guide to prepare for the Environmental Protection Agency (EPA) mandatory technician certification examinations. It can be used in the HVAC/R field or closely related fields by students, technicians, installers, contractor employees, service personnel, and owners of businesses.

This text is also an excellent study guide for the Industry Competency Exam (ICE), the North American Technician Excellence (NATE), the HVAC Excellence, the Refrigeration Service Engineers Society (RSES), the United Association (UA) STAR certification, and the Heating, Air Conditioning, and Refrigeration Distributors International (HARDI) voluntary HVAC/R technician certification and home-study examinations.

The book is also written to correspond to the National Skill Standards for HVAC/R technicians. Previous editions of this text are often carried to the job site by technicians and used as a reference for service procedures. "Do-it-yourselfers" will find this text valuable for understanding and maintaining heating and cooling systems.

As general technology has evolved, so has the refrigeration and air-conditioning industry. A greater emphasis is placed on digital electronic controls and system efficiency. At the time of this writing, Every central split cooling system manufactured in the United States today must have a Seasonal Energy Efficiency Ratio (SEER) rating of at least 13. This energy requirement was mandated by federal law as of January 23, 2006. SEER is calculated on the basis of the total amount of cooling (in Btus) the system will provide over the entire season, divided by the total number watt-hours it will consume. Higher SEER ratings reflect a more efficient cooling system. Air-conditioning and refrigeration technicians are responsible for following procedures to protect our environment, particularly with regard to the handling of refrigerants. Technician certification has become increasingly important in the industry.

Global warming has become a major environmental issue. When HVAC/R systems are working correctly and efficiently, they will greatly reduce energy consumption and greenhouse gases. Organizations like the Green Mechanical Council (GreenMech) are advocates for the HVAC/R industry and assist the industry in meeting with government, educational, industry, and labor interests to find solutions to the world's global-warming problem. GreenMech has created a scoring system designed to help engineers, contractors, and consumers know the "green value" of each mechanical installation. The "green value" encompasses the system's energy efficiency, pollution output, and sustainability. Realtors, building inspectors, builders, and planning and zoning officials will now have some knowledge about and guidance on how buildings and mechanical systems are performing. Green buildings and green mechanical systems are becoming increasingly popular in today's world as a way to curb global warming.

Energy audits have become an integral part of evaluating and assessing an existing building's energy performance. Higher efficiency standards for the energy performance of new buildings have been established. Higher levels of training and certification have been developed for HVAC/R technicians to meet the needs of more sophisticated, energy-efficient buildings and HVAC/R equipment.

TEXT DEVELOPMENT

This text was developed to provide the technical information necessary for a technic be able to perform satisfactorily on the job. It is written at a level that most studen easily understand. Practical application of the technology is emphasized. Terms comm used by technicians and mechanics have been used throughout to make the text easy t and to present the material in a practical way. Many of these key terms are also defi the glossary. This text is updated regularly in response to market needs and emerging t Refrigeration and air-conditioning instructors have reviewed each unit. A technical r takes place before a revision is started and also during the revision process.

Illustrations and photos are used extensively throughout the text. Full-color treatm most photos and illustrations helps amplify the concepts presented.

No prerequisites are required for this text. It is designed to be used by beginning stu as well as by those with training and experience.

ORGANIZATION

Considerable thought and study have been devoted to the organization of this text. Dif decisions had to be made to provide text in a format that would meet the needs of v institutions. Instructors from different areas of the country and from various institu were asked for their ideas regarding the organization of the instructional content.

The text is organized so that after completing the first four sections, students may co trate on courses in refrigeration or air conditioning (heating and/or cooling). If the obj is to complete a whole program, the instruction may proceed until the sequence schedul the school's curriculum is completed.

NEW IN THIS EDITION

SERVICE TECHNICIAN CALLS

This edition of the book will involve a universal change for units incorporating SERV TECHNICIAN CALLS. The SERVICE TECHNICIAN CALLS will now incorporate tomer relations and technician soft skills.

INTRODUCTION

The introduction is now part of Section 1. New and/or expanded topics include:

- New updated timeline
- New topic on Green Awareness
- Expanded coverage on Leadership in Energy and Environmental Design (LEED)
- New topic on Programmatic Accreditation
- Expanded coverage on Customer Relations and Technician Soft Skills

UNIT 1 Heat, Temperature, and Pressure

- Some new images
- Removal of metric terms (joule, gram, etc.)
- Improved specific heat chart
- Additional content on latent heat of vaporization, latent heat of condensation, and la heat of fusion

UNIT 3 Refrigeration and Refrigerants

- Larger, color-coded, and easier to read pressure/temperature charts of refrigerants
- Expanded coverage of new refrigerants and refrigerant blends

UNIT 4 General Safety Practices

- New photo and coverage of a new carrying strap for refrigerant cylinders for ladder safety
- New toxicity and flammability matrix for ASHRAE Standard 34-2010 (Designation and Safety Classifications of Refrigerants). Includes new A2L and B2L categories for lower flammability refrigerants.

UNIT 5 Tools and Equipment

- Over 50 new photos on tools and equipment
- Ten new photos on residential energy auditing tools and equipment

UNIT 6 Fasteners

- Addition of many hollow wall fasteners
- Expanded content on connecting stranded wire under screw terminals
- Expanded content on power-actuated fastener systems
- Expanded content on threaded rod and steel channel
- Over 25 new photos

UNIT 7 Tubing and Piping

- Over 20 new images and photos
- Regulatory information on line sets
- Expanded content on fluxing
- Information regarding the scrubbing effect that esther-based lubricants have on interior piping surfaces and the importance of using nitrogen during the brazing process

UNIT 8 Leak Detection, System Evacuation, and System Cleanup

Entirely new section on advanced leak detection. Revised sections on evacuation and system clean-up procedures. The following topics are discussed:

- Over 30 new photos on leak detection and equipment, evacuation, and system clean-up
- Defining leaks
- Types of leaks
- Exposing the leak site
- Standing leaks
- Pressure-dependent leaks
- Temperature-dependent leaks
- Vibration-dependent leaks
- Combination-dependent leaks
- Cumulative micro-leaks
- Testing for evaporator section leaks
- Testing for condenser section leaks
- Spotting oil residue from leaks
- Testing for suction and liquid line leaks
- Advanced leak detection
- Modern evacuation techniques and equipment
- Modern system clean-up procedures

UNIT 9 Refrigerant and Oil Chemistry and Management—Recovery, Recycling, Reclaiming, and Retrofitting

- New toxicity and flammability matrix for ASHRAE Standard 34-2010 (Designation and Safety Classifications of Refrigerants)
- Many new popular refrigerants and refrigerant blends with their compatible oils are discussed